SLEPc for Python

Release 3.26.1

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Abstract

This document describes slepc4py, a Python wrapper to the SLEPc libraries.

SLEPc is a software package for the parallel solution of large-scale eigenvalue problems. It can be used for computing eigenvalues and eigenvectors of large, sparse matrices, or matrix pairs, and also for computing singular values and vectors of a rectangular matrix. It also provides more advanced functionality such as solvers for nonlinear eigenvalue problems (either polynomial or general) and matrix functions.

SLEPc relies on PETSc for basic functionality such as the representation of matrices and vectors, and the solution of linear systems of equations. Thus, slepc4py must be used together with its companion petsc4py.

1 Discussion and Support

- You can write to the PETSc Users Mailing List
- See also the contact information for SLEPc

- Issue Tracker: https://gitlab.com/slepc/slepc/-/issues
- Git Repository: https://gitlab.com/slepc/slepc.git (the source code is in `src/binding/slepc4py`)
- Current release in PyPI: https://pypi.org/project/slepc4py/

2 Acknowledgments

L. Dalcin was partially supported by the Extreme Computing Research Center (ECRC), Division of Computer, Electrical, and Mathematical Sciences & Engineering (CEMSE), King Abdullah University of Science and Technology (KAUST).

See additional acknowledgements related to the SLEPc project.

3 Contents

3.1 Overview

SLEPc for Python (slepc4py) is a Python package that provides convenient access to the functionality of SLEPc.

SLEPc[1],[2] implements algorithms and tools for the numerical solution of large, sparse eigenvalue problems on parallel computers. It can be used for linear eigenvalue problems in either standard or generalized form, with real or complex arithmetic. It can also be used for computing a partial SVD of a large, sparse, rectangular matrix, and to solve nonlinear eigenvalue problems (polynomial or general). Additionally, SLEPc provides solvers for the computation of the action of a matrix function on a vector.

SLEPc is intended for computing a subset of the spectrum of a matrix (or matrix pair). One can for instance approximate the largest magnitude eigenvalues, or the smallest ones, or even those eigenvalues located near a given region of the complex plane. Interior eigenvalues are harder to compute, so SLEPc provides different methodologies. One such method is to use a spectral transformation. Cheaper alternatives are also available.

Features

Currently, the following types of eigenproblems can be addressed:

- Standard eigenvalue problem, $Ax = \lambda x$, either for Hermitian or non-Hermitian matrices.
- Generalized eigenvalue problem, $Ax = \lambda Bx$, either Hermitian positive-definite or not.
- Partial singular value decomposition of a rectangular matrix, $Au = \sigma v$.
- Generalized singular values of a matrix pair, $Ax = cu$, $Bx = sv$.
- Polynomial eigenvalue problem, $P(\lambda) = 0$.
- Nonlinear eigenvalue problem, $T(\lambda) = 0$.
- Computing the action of a matrix function on a vector, $w = f(\alpha A)v$.

For the linear eigenvalue problem, the following methods are available:

- Krylov eigensolvers, particularly Krylov-Schur, Arnoldi, and Lanczos.
- Davidson-type eigensolvers, including Generalized Davidson and Jacobi-Davidson.
- Subspace iteration and single vector iterations (inverse iteration, RQI).
- Conjugate gradient methods such as LOBPCG.

[1] J. E. Roman, C. Campos, L. Dalcin, E. Romero, A. Tomas. SLEPc Users Manual. DSIC-II/24/02 - Revision 3.26. D. Sistemas Informaticos y Computacion, Universitat Politecnica de Valencia. 2026.

[2] Vicente Hernandez, Jose E. Roman and Vicente Vidal. SLEPc: A Scalable and Flexible Toolkit for the Solution of Eigenvalue Problems, ACM Trans. Math. Softw. 31(3), pp. 351-362, 2005. https://doi.org/10.1145/1089014.1089019

- A contour integral solver using high-order moments.

For singular value computations, the following alternatives can be used:

- Use an eigensolver via the cross-product matrix A^*A or the cyclic matrix $\left[\begin{smallmatrix} 0 & A \\ A^* & 0 \end{smallmatrix}\right]$.
- Explicitly restarted Lanczos bidiagonalization.
- Implicitly restarted Lanczos bidiagonalization (thick-restart Lanczos).
- A basic randomized solver.

For polynomial eigenvalue problems, the following methods are available:

- Use an eigensolver to solve the generalized eigenvalue problem obtained after linearization.
- TOAR and Q-Arnoldi, memory efficient variants of Arnoldi for polynomial eigenproblems.
- Jacobi-Davidson for polynomial eigenproblems.
- A contour integral solver using high-order moments.

For general nonlinear eigenvalue problems, the following methods can be used:

- Solve a polynomial eigenproblem obtained via polynomial interpolation.
- Rational interpolation and linearization (NLEIGS).
- Newton-type methods such as SLP or RII.
- A subspace projection method (nonlinear Arnoldi).
- A contour integral solver using high-order moments.

Computation of interior eigenvalues is supported by means of the following methodologies:

- Spectral transformations, such as shift-and-invert. This technique implicitly uses the inverse of the shifted matrix $A - \sigma I$ in order to compute eigenvalues closest to a given target value, σ.
- Harmonic extraction, a cheap alternative to shift-and-invert that also tries to approximate eigenvalues closest to a target, σ, but without requiring a matrix inversion.

Other remarkable features include:

- High computational efficiency, by using NumPy and SLEPc under the hood.
- Data-structure neutral implementation, by using efficient sparse matrix storage provided by PETSc. Implicit matrix representation is also available by providing basic operations such as matrix-vector products as user-defined Python functions.
- Run-time flexibility, by specifying numerous setting at the command line.
- Ability to do the computation in parallel and/or using GPUs.

Components

SLEPc provides the following components, which are mirrored by slepc4py for its use from Python. The first six components are solvers for different classes of problems, while the rest can be considered auxiliary object.

EPS

The Eigenvalue Problem Solver is the component that provides all the functionality necessary to define and solve an eigenproblem. It provides mechanisms for completely specifying the problem: the problem type (e.g. standard symmetric), number of eigenvalues to compute, part of the spectrum of interest. Once the problem has been defined, a collection of solvers can be used to compute the required solutions. The behavior of the solvers can be tuned by means of a few parameters, such as the maximum dimension of the subspace to be used during the computation.

SVD
: This component is the analog of `EPS` for the case of Singular Value Decompositions. The user provides a rectangular matrix and specifies how many singular values and vectors are to be computed, whether the largest or smallest ones, as well as some other parameters for fine tuning the computation. Different solvers are available, as in the case of `EPS`.

PEP
: This component is the analog of `EPS` for the case of Polynomial Eigenvalue Problems. The user provides the coefficient matrices of the polynomial. Several parameters can be specified, as in the case of `EPS`. It is also possible to indicate whether the problem belongs to a special type, e.g., symmetric or gyroscopic.

NEP
: This component covers the case of general nonlinear eigenproblems, $T(\lambda) = 0$. The user provides the parameter-dependent matrix T via the split form or by means of callback functions.

MFN
: This component provides the functionality for computing the action of a matrix function on a vector. Given a matrix A and a vector b, the call `MFNSolve(mfn,b,x)` computes $x = f(A)b$, where f is a function such as the exponential.

LME
: This component provides the functionality for solving linear matrix equations such as Lyapunov or Sylvester where the solution has low rank.

ST
: The Spectral Transformation is a component that provides convenient implementations of common spectral transformations. These are simple transformations that map eigenvalues to different positions, in such a way that convergence to wanted eigenvalues is enhanced. The most common spectral transformation is shift-and-invert, that allows for the computation of eigenvalues closest to a given target value.

BV
: This component encapsulates the concept of a set of Basis Vectors spanning a vector space. This component provides convenient access to common operations such as orthogonalization of vectors. The `BV` component is usually not required by end-users.

DS
: The Dense System (or Direct Solver) component, used internally to solve dense eigenproblems of small size that appear in the course of iterative eigensolvers.

FN
: A component used to define mathematical functions. This is required by the end-user for instance to define function $T(\cdot)$ when solving nonlinear eigenproblems with `NEP` in split form.

RG
: A component used to define a region of the complex plane such as an ellipse or a rectangle. This is required by end-users in some cases such as contour-integral eigensolvers.

In addition to the above components, some extra functionality is provided in the `Sys` and `Util` sections.

3.2 Tutorial

Below we provide links to tutorial examples intended for learning the basics of slepc4py. For additional information, the reader is referred to:

- slepc4py *Reference* (manual pages for all slepc4py classes and methods).
- SLEPc documentation.
- petsc4py documentation.

Commented source of demo examples

- To get started, we recommend having a look at the source code of example `demo/ex1.py`, that has comments inserted inline. It is also available online here. This example solves a standard symmetric eigenvalue problem.
- Demo examples for other problems, including linear and nonlinear eigenvalue problems and singular value problems, are available in the section *slepc4py demos*.

3.3 Installation

Install from PyPI using pip

You can use **`pip`** to install slepc4py and its dependencies.

If you have a working MPI implementation and the `mpicc` compiler wrapper is on your search path, it is highly recommended to install mpi4py first:

```
$ python -m pip install mpi4py
```

Ensure you have NumPy and petsc4py installed:

```
$ python -m pip install numpy petsc petsc4py
```

Finally, install slepc4py:

```
$ python -m pip install slepc slepc4py
```

If you already have working PETSc and SLEPc installs, set environment variables `SLEPC_DIR` and `PETSC_DIR` (and perhaps `PETSC_ARCH` for non-prefix installs) to appropriate values and next use **`pip`**:

```
$ export SLEPC_DIR=/path/to/slepc
$ export PETSC_DIR=/path/to/petsc
$ export PETSC_ARCH=arch-linux2-c-opt
$ python -m pip install petsc4py slepc4py
```

Install from the SLEPc source tree

If you also want to install petsc4py from the PETSc source tree, follow the instructions in the petsc4py installation page.

Set the `PETSC_DIR` and `PETSC_ARCH` environment variables, as well as `SLEPC_DIR`. Follow the instructions to build SLEPc. Then `cd` to the top of the SLEPc source tree and run:

```
$ python -m pip install src/binding/slepc4py
```

The installation of slepc4py supports multiple `PETSC_ARCH` in the form of a colon separated list:

```
$ PETSC_ARCH='arch-0:...:arch-N' python -m pip install src/binding/slepc4py
```

If you are cross-compiling, and the `numpy` module cannot be loaded on your build host, then before invoking **`pip`**, set the `NUMPY_INCLUDE` environment variable to the path that would be returned by `import numpy; numpy.get_include()`:

```
$ export NUMPY_INCLUDE=/usr/lib/pythonX/site-packages/numpy/core/include
```

3.4 Citations

If SLEPc for Python has been significant to a project that leads to an academic publication, please acknowledge that fact by citing the project.

- L. Dalcin, P. Kler, R. Paz, and A. Cosimo, *Parallel Distributed Computing using Python*, Advances in Water Resources, 34(9):1124-1139, 2011. https://doi.org/10.1016/j.advwatres.2011.04.013
- V. Hernandez, J.E. Roman, and V. Vidal, *SLEPc: A scalable and flexible toolkit for the solution of eigenvalue problems*, ACM Transactions on Mathematical Software, 31(3):351-362, 2005. https://doi.org/10.1145/1089014.1089019

There is also a list of SLEPc-related references.

3.5 CHANGES

Release 3.26

- Update to SLEPc 3.26.

Release 3.25

- Update to SLEPc 3.25.

Release 3.24

- Update to SLEPc 3.24.
- Support (opt-in via setting the environment variable `SLEPC4PY_BUILD_PYSABI=1`) for building with `Py_LIMITED_API` (Python Stable ABI) under Python 3.10+ (requires Cython 3.1+).
- Add support for standard Python operators for `BV` and `FN` classes.
- Add new `LME` class.

Release 3.23

- Update to SLEPc 3.23.

Release 3.22

- Update to SLEPc 3.22.
- In slepc4py now `EPS.getEigenpair()` and `EPS.getEigenvalue()` will return a real value instead of a complex, if the problem is of Hermitian or generalized Hermitian type.

Release 3.21

- Update to SLEPc 3.21.

Release 3.20

- Update to SLEPc 3.20.

Release 3.19

- Update to SLEPc 3.19.

Release 3.18

- Update to SLEPc 3.18.

Release 3.17

- Update to SLEPc 3.17.

Release 3.16

- Update to SLEPc 3.16.

Release 3.15

- Update to SLEPc 3.15.
- Updates in installation scripts.

Release 3.14

- Update to SLEPc 3.14.

Release 3.13

- Update to SLEPc 3.13.

Release 3.12

- Update to SLEPc 3.12.

Release 3.11

- Update to SLEPc 3.11.

Release 3.10

- Update to SLEPc 3.10.

Release 3.9

- Update to SLEPc 3.9.

Release 3.8

- Update to SLEPc 3.8.

Release 3.7

- Update to SLEPc 3.7.

Release 3.6

- Update to SLEPc 3.6.

Release 3.5

- Update to SLEPc 3.5.
- Add `RG` class introduced in SLEPc 3.5 release.
- Add `PySlepcXXX_New/Get` C API functions.
- Fix compilation problem with complex scalars on OS X.
- Fix outdated SWIG interface file.

Release 3.4

- Update to SLEPc 3.4.

Release 3.3

- Update to SLEPc 3.3.
- Regenerate the wrappers using Cython 0.18 and fix binary compatibility issues with petsc4py 3.3.1.

Release 1.2

- Update to SLEPc 3.2.

Release 1.1

- Support for new QEP quadratic eigenproblem solver in SLEPc.
- Support for `pip install slepc4py` to download and install SLEPc.
- Support for PETSc/SLEPc static library builds (Linux-only).
- Preliminary support for Python 3.

Release 1.0.0

- This is the fist release of the all-new, Cython-based, implementation of *SLEPc for Python*.

3.6 Reference

slepc4py	The SLEPc for Python package.
slepc4py.typing	Typing support.
slepc4py.SLEPc	Scalable Library for Eigenvalue Problem Computations

slepc4py

The SLEPc for Python package.

This package is an interface to SLEPc libraries.

SLEPc (the Scalable Library for Eigenvalue Problem Computations) is a software library for the solution of large scale sparse eigenvalue problems on parallel computers. It is an extension of PETSc and can be used for either standard or generalized eigenproblems, with real or complex arithmetic. It can also be used for computing a partial SVD of a large, sparse, rectangular matrix, and to solve nonlinear eigenvalue problems (polynomial or general). Additionally, SLEPc provides solvers for the computation of the action of a matrix function on a vector.

Functions

get_config()	Return a dictionary with information about SLEPc.
get_include()	Return the directory in the package that contains header files.
init([args, arch, comm])	Initialize SLEPc.

slepc4py.get_config

slepc4py.**get_config**()

Return a dictionary with information about SLEPc.

Return type
dict[str, str]

slepc4py.get_include

slepc4py.**get_include**()

Return the directory in the package that contains header files.

Extension modules that need to compile against slepc4py should use this function to locate the appropriate include directory.

Examples

Using Python distutils or NumPy distutils:

```
import petscc4py, slepc4py
Extension('extension_name', ...
          include_dirs=[...,
                        petsc4py.get_include(),
                        slepc4py.get_include(),])
```

Return type
str

slepc4py.init

slepc4py.**init**(*args=None*, *arch=None*, *comm=None*)

Initialize SLEPc.

Parameters

- **args** (*str | list[str] | None*) – Command-line arguments, usually the `sys.argv` list.
- **arch** (*str | None*) – Specific configuration to use.
- **comm** (*Intracomm | None*) – MPI commmunicator.

Return type
None

Notes

This function should be called only once, typically at the very beginning of the bootstrap script of an application.

slepc4py.typing

Typing support.

Attributes

Scalar	Scalar type.
ArrayBool	Array of `bool`.
ArrayInt	Array of `int`.
ArrayReal	Array of `float`.
ArrayComplex	Array of `complex`.
ArrayScalar	Array of *Scalar* numbers.
LayoutSizeSpec	`int` or 2-`tuple` of `int` describing the layout sizes.
EPSStoppingFunction	*EPS* stopping test callback.
EPSArbitraryFunction	*EPS* arbitrary selection callback.
EPSEigenvalueComparison	*EPS* eigenvalue comparison callback.
EPSMonitorFunction	*EPS* monitor callback.
PEPStoppingFunction	*PEP* stopping test callback.
PEPEigenvalueComparison	*PEP* eigenvalue comparison callback.
PEPMonitorFunction	*PEP* monitor callback.
NEPStoppingFunction	*NEP* stopping test callback.
NEPEigenvalueComparison	*NEP* eigenvalue comparison callback.
NEPMonitorFunction	*NEP* monitor callback.
NEPFunction	*NEP* Function callback.
NEPJacobian	*NEP* Jacobian callback.
SVDStoppingFunction	*SVD* stopping test callback.
SVDMonitorFunction	*SVD* monitor callback.
MFNMonitorFunction	*MFN* monitor callback.
LMEMonitorFunction	*LME* monitor callback.

slepc4py.typing.Scalar

slepc4py.typing.**Scalar = float | complex**

Scalar type.

Scalars can be either `float` or `complex` (but not both) depending on how PETSc was configured (`./configure --with-scalar-type=real|complex`).

slepc4py.typing.ArrayBool

slepc4py.typing.**ArrayBool**

Array of `bool`.

alias of `ndarray`[`tuple`[`Any`, ...], `dtype`[`bool`]]

slepc4py.typing.ArrayInt

slepc4py.typing.**ArrayInt**

Array of int.

alias of ndarray[tuple[Any, ...], dtype[integer]]

slepc4py.typing.ArrayReal

slepc4py.typing.**ArrayReal**

Array of float.

alias of ndarray[tuple[Any, ...], dtype[floating]]

slepc4py.typing.ArrayComplex

slepc4py.typing.**ArrayComplex**

Array of complex.

alias of ndarray[tuple[Any, ...], dtype[complexfloating]]

slepc4py.typing.ArrayScalar

slepc4py.typing.**ArrayScalar**

Array of *Scalar* numbers.

alias of ndarray[tuple[Any, ...], dtype[floating | complexfloating]]

slepc4py.typing.LayoutSizeSpec

slepc4py.typing.**LayoutSizeSpec = int | tuple[int, int]**

int or 2-tuple of int describing the layout sizes.

A single int indicates global size. A tuple of int indicates (local_size, global_size).

slepc4py.typing.EPSStoppingFunction

slepc4py.typing.**EPSStoppingFunction**

EPS stopping test callback.

alias of Callable[[*EPS*, int, int, int, int], *ConvergedReason*]

slepc4py.typing.EPSArbitraryFunction

slepc4py.typing.**EPSArbitraryFunction**

EPS arbitrary selection callback.

alias of Callable[[float | complex, float | complex, Vec, Vec, float | complex, float | complex], [float | complex, float | complex]]

slepc4py.typing.EPSEigenvalueComparison

slepc4py.typing.**EPSEigenvalueComparison**

EPS eigenvalue comparison callback.

alias of Callable[[float | complex, float | complex, float | complex, float | complex], int]

slepc4py.typing.EPSMonitorFunction

slepc4py.typing.**EPSMonitorFunction**

EPS monitor callback.

alias of Callable[[*EPS*, int, int, ndarray[tuple[Any, ...], dtype[floating | complexfloating]], ndarray[tuple[Any, ...], dtype[floating | complexfloating]], ndarray[tuple[Any, ...], dtype[floating]], int], None]

slepc4py.typing.PEPStoppingFunction

slepc4py.typing.**PEPStoppingFunction**

PEP stopping test callback.

alias of Callable[[*PEP*, int, int, int, int], *ConvergedReason*]

slepc4py.typing.PEPEigenvalueComparison

slepc4py.typing.**PEPEigenvalueComparison**

PEP eigenvalue comparison callback.

alias of Callable[[float | complex, float | complex, float | complex, float | complex], int]

slepc4py.typing.PEPMonitorFunction

slepc4py.typing.**PEPMonitorFunction**

PEP monitor callback.

alias of Callable[[*PEP*, int, int, ndarray[tuple[Any, ...], dtype[floating | complexfloating]], ndarray[tuple[Any, ...], dtype[floating | complexfloating]], ndarray[tuple[Any, ...], dtype[floating]], int], None]

slepc4py.typing.NEPStoppingFunction

slepc4py.typing.**NEPStoppingFunction**

NEP stopping test callback.

alias of Callable[[*NEP*, int, int, int, int], *ConvergedReason*]

slepc4py.typing.NEPEigenvalueComparison

slepc4py.typing.**NEPEigenvalueComparison**

NEP eigenvalue comparison callback.

alias of Callable[[float | complex, float | complex, float | complex, float | complex], int]

slepc4py.typing.NEPMonitorFunction

slepc4py.typing.**NEPMonitorFunction**

NEP monitor callback.

alias of Callable[[*NEP*, int, int, ndarray[tuple[Any, ...], dtype[floating | complexfloating]], ndarray[tuple[Any, ...], dtype[floating | complexfloating]], ndarray[tuple[Any, ...], dtype[floating]], int], None]

slepc4py.typing.NEPFunction

slepc4py.typing.**NEPFunction**

NEP Function callback.

alias of Callable[[*NEP*, float | complex, Mat, Mat], None]

slepc4py.typing.NEPJacobian

slepc4py.typing.**NEPJacobian**

NEP Jacobian callback.

alias of Callable[[*NEP*, float | complex, Mat], None]

slepc4py.typing.SVDStoppingFunction

slepc4py.typing.**SVDStoppingFunction**

SVD stopping test callback.

alias of Callable[[*SVD*, int, int, int, int], *ConvergedReason*]

slepc4py.typing.SVDMonitorFunction

slepc4py.typing.**SVDMonitorFunction**

SVD monitor callback.

alias of Callable[[*SVD*, int, int, ndarray[tuple[Any, ...], dtype[floating]], ndarray[tuple[Any, ...], dtype[floating]], int], None]

slepc4py.typing.MFNMonitorFunction

slepc4py.typing.**MFNMonitorFunction**

MFN monitor callback.

alias of Callable[[*MFN*, int, float], None]

slepc4py.typing.LMEMonitorFunction

slepc4py.typing.**LMEMonitorFunction**

LME monitor callback.

alias of Callable[[*LME*, int, float], None]

slepc4py.SLEPc

Scalable Library for Eigenvalue Problem Computations

Classes

BV	Basis Vectors.
DS	Direct Solver (or Dense System).
EPS	Eigenvalue Problem Solver.
FN	Mathematical Function.
LME	Linear Matrix Equation.

continues on next page

Table 4 – continued from previous page

MFN	Matrix Function.
NEP	Nonlinear Eigenvalue Problem Solver.
PEP	Polynomial Eigenvalue Problem Solver.
RG	Region.
ST	Spectral Transformation.
SVD	Singular Value Decomposition Solver.
Sys	System utilities.
Util	Other utilities such as the creation of structured matrices.

slepc4py.SLEPc.BV

class slepc4py.SLEPc.**BV**

Bases: Object

Basis Vectors.

The *BV* package provides the concept of a block of vectors that represent the basis of a subspace. It is a convenient way of handling a collection of vectors that often operate together, rather than working with an array of petsc4py.PETSc.Vec.

Enumerations

MatMultType	BV mat-mult types.
OrthogBlockType	BV block-orthogonalization types.
OrthogRefineType	BV orthogonalization refinement types.
OrthogType	BV orthogonalization types.
SVDMethod	BV methods for computing the SVD.
Type	BV type.

slepc4py.SLEPc.BV.MatMultType

class slepc4py.SLEPc.BV.**MatMultType**

Bases: object

BV mat-mult types.

- *VECS*: Perform a matrix-vector multiply per each column.
- *MAT*: Carry out a Mat-Mat product with a dense matrix.

See also

BVMatMultType

Attributes Summary

MAT	Constant MAT of type int
VECS	Constant VECS of type int

Attributes Documentation

MAT: int = MAT

Constant MAT of type int

VECS: int = VECS

Constant VECS of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.BV.OrthogBlockType

class slepc4py.SLEPc.BV.**OrthogBlockType**

Bases: object

BV block-orthogonalization types.

- *GS*: Gram-Schmidt, column by column.
- *CHOL*: Cholesky QR method.
- *TSQR*: Tall-skinny QR method.
- *TSQRCHOL*: Tall-skinny QR, but computing the triangular factor only.
- *SVQB*: SVQB method.

See also

BVOrthogBlockType

Attributes Summary

CHOL	Constant CHOL of type int
GS	Constant GS of type int
SVQB	Constant SVQB of type int
TSQR	Constant TSQR of type int
TSQRCHOL	Constant TSQRCHOL of type int

Attributes Documentation

CHOL: int = CHOL

Constant CHOL of type int

GS: int = GS

Constant GS of type int

SVQB: int = SVQB

Constant SVQB of type int

TSQR: int = TSQR

Constant TSQR of type int

TSQRCHOL: int = TSQRCHOL

Constant TSQRCHOL of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.BV.OrthogRefineType

class slepc4py.SLEPc.BV.**OrthogRefineType**

Bases: object

BV orthogonalization refinement types.

- *IFNEEDED*: Reorthogonalize if a criterion is satisfied.
- *NEVER*: Never reorthogonalize.
- *ALWAYS*: Always reorthogonalize.

See also

BVOrthogRefineType

Attributes Summary

ALWAYS	Constant ALWAYS of type int
IFNEEDED	Constant IFNEEDED of type int
NEVER	Constant NEVER of type int

Attributes Documentation

ALWAYS: int = ALWAYS

Constant ALWAYS of type int

IFNEEDED: int = IFNEEDED

Constant IFNEEDED of type int

NEVER: int = NEVER

Constant NEVER of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.BV.OrthogType

class slepc4py.SLEPc.BV.**OrthogType**

Bases: object

BV orthogonalization types.

- *CGS*: Classical Gram-Schmidt.
- *MGS*: Modified Gram-Schmidt.

See also

BVOrthogType

Attributes Summary

CGS	Constant CGS of type int
MGS	Constant MGS of type int

Attributes Documentation

CGS: int = CGS

Constant CGS of type int

MGS: int = MGS

Constant MGS of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.BV.SVDMethod

class slepc4py.SLEPc.BV.**SVDMethod**

Bases: object

BV methods for computing the SVD.

- *REFINE*: Based on the SVD of the cross product matrix S^*S, with refinement.
- *QR*: Based on the SVD of the triangular factor of qr(S).
- *QR_CAA*: Variant of QR intended for use in communication-avoiding. Arnoldi.

See also

BVSVDMethod

Attributes Summary

QR	Constant QR of type int
QR_CAA	Constant QR_CAA of type int
REFINE	Constant REFINE of type int

Attributes Documentation

QR: int = QR

Constant QR of type int

QR_CAA: int = QR_CAA

Constant QR_CAA of type int

REFINE: int = REFINE

Constant REFINE of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.BV.Type

class slepc4py.SLEPc.BV.**Type**

Bases: object

BV type.

- *MAT*: A *BV* stored as a dense Mat.
- *SVEC*: A *BV* stored as a single Vec.
- *VECS*: A *BV* stored as an array of independent Vec.
- *CONTIGUOUS*: A *BV* stored as an array of Vec sharing a contiguous array of scalars.
- *TENSOR*: A special *BV* represented in compact form as $V = (I \otimes U)S$.

See also

BVType

Attributes Summary

CONTIGUOUS	Object CONTIGUOUS of type str
MAT	Object MAT of type str
SVEC	Object SVEC of type str
TENSOR	Object TENSOR of type str
VECS	Object VECS of type str

Attributes Documentation

CONTIGUOUS: str = CONTIGUOUS

Object CONTIGUOUS of type str

MAT: str = MAT

Object MAT of type str

SVEC: str = SVEC

Object SVEC of type str

TENSOR: str = TENSOR

Object TENSOR of type str

VECS: str = VECS

Object VECS of type str

__init__()

classmethod __new__(**args*, ***kwargs*)

Methods Summary

appendOptionsPrefix([prefix])	Append to the prefix used for searching for all BV options in the database.
applyMatrix(x, y)	Multiply a vector with the matrix associated to the bilinear form.
copy([result])	Copy a basis vector object into another one.
copyColumn(j, i)	Copy the values from one of the columns to another one.
copyVec(j, v)	Copy one of the columns of a basis vectors object into a vector.
create([comm])	Create the BV object.
createFromMat(A)	Create a basis vectors object from a dense matrix.
createMat()	Create a new dense matrix and copy the contents of the BV.
createVec()	Create a vector with the type and dimensions of the columns of the BV.
destroy()	Destroy the BV object.
dot(Y)	Compute the 'block-dot' product of two basis vectors objects.
dotColumn(j)	Dot products of a column against all the column vectors of a BV.
dotVec(v)	Dot products of a vector against all the column vectors of the BV.
duplicate()	Duplicate the BV object with the same type and dimensions.
duplicateResize(m)	Create a BV object of the same type and dimensions as an existing one.
getActiveColumns()	Get the current active dimensions.
getArray([readonly])	Return the array where the data is stored.
getColumn(j)	Get a vector with the entries of the column of the BV object.
getDefiniteTolerance()	Get the tolerance to be used when checking a definite inner product.
getLeadingDimension()	Get the leading dimension.
getMat()	Get a matrix of dense type that shares the memory of the BV object.
getMatMultMethod()	Get the method used for the *matMult()* operation.
getMatrix()	Get the matrix representation of the inner product.
getNumConstraints()	Get the number of constraints.
getOptionsPrefix()	Get the prefix used for searching for all BV options in the database.
getOrthogonalization()	Get the orthogonalization settings from the BV object.
getRandomContext()	Get the petsc4py.PETSc.Random object associated with the BV.
getSizes()	Get the local and global sizes, and the number of columns.
getType()	Get the BV type of this object.
getVecType()	Get the vector type used when creating vectors via *createVec()*.
insertConstraints(C)	Insert a set of vectors as constraints.

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Table 12 – continued from previous page

insertVec(j, w)	Insert a vector into the specified column.
insertVecs(s, W[, orth])	Insert a set of vectors into the specified columns.
matMult(A[, Y])	Compute the matrix-vector product for each column, $Y = AV$.
matMultColumn(A, j)	Mat-vec product for a column, storing the result in the next column.
matMultHermitianTranspose(A[, Y])	Pre-multiplication with the conjugate transpose of a matrix.
matMultHermitianTransposeColumn(A, j)	Conjugate-transpose matrix-vector product for a specified column.
matMultTranspose(A[, Y])	Pre-multiplication with the transpose of a matrix.
matMultTransposeColumn(A, j)	Transpose matrix-vector product for a specified column.
matProject(A, Y)	Compute the projection of a matrix onto a subspace.
mult(delta, gamma, X, Q)	Compute $Y = \gamma Y + \delta XQ$.
multColumn(delta, gamma, j, q)	Compute $y = \gamma y + \delta Xq$.
multInPlace(Q, s, e)	Update a set of vectors as $V(:, s : e-1) = VQ(:, s : e-1)$.
multVec(delta, gamma, y, q)	Compute $y = \gamma y + \delta Xq$.
norm([norm_type])	Compute the matrix norm of the BV.
normColumn(j[, norm_type])	Compute the vector norm of a selected column.
orthogonalize([R])	Orthogonalize all columns (except leading ones) (QR decomposition).
orthogonalizeColumn(j)	Orthogonalize a column vector with respect to the previous ones.
orthogonalizeVec(v)	Orthogonalize a vector with respect to all active columns.
orthonormalizeColumn(j[, replace])	Orthonormalize a column vector with respect to the previous ones.
resize(m[, copy])	Change the number of columns.
restoreColumn(j, v)	Restore a column obtained with *getColumn()*.
restoreMat(A)	Restore the matrix obtained with *getMat()*.
scale(alpha)	Multiply the entries by a scalar value.
scaleColumn(j, alpha)	Scale a column of a BV.
setActiveColumns(l, k)	Set the columns that will be involved in operations.
setDefiniteTolerance(deftol)	Set the tolerance to be used when checking a definite inner product.
setFromOptions()	Set BV options from the options database.
setLeadingDimension(ld)	Set the leading dimension.
setMatMultMethod(method)	Set the method used for the *matMult()* operation.
setMatrix(B[, indef])	Set the bilinear form to be used for inner products.
setNumConstraints(nc)	Set the number of constraints.
setOptionsPrefix([prefix])	Set the prefix used for searching for all BV options in the database.
setOrthogonalization([otype, refine, eta, block])	Set the method used for the (block-)orthogonalization of vectors.
setRandom()	Set the active columns of the BV to random numbers.
setRandomColumn(j)	Set one column of the BV to random numbers.
setRandomCond(condn)	Set the columns of a BV to random numbers.
setRandomContext(rnd)	Set the petsc4py.PETSc.Random object associated with the BV.

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Table 12 – continued from previous page

setRandomNormal()	Set the active columns of the BV to normal random numbers.
setRandomSign()	Set the entries of a BV to values 1 or -1 with equal probability.
setSizes(sizes, m)	Set the local and global sizes, and the number of columns.
setSizesFromVec(w, m)	Set the local and global sizes, and the number of columns.
setType(bv_type)	Set the type for the BV object.
setVecType(vec_type)	Set the vector type to be used when creating vectors via *createVec()*.
view([viewer])	Print the BV data structure.

Attributes Summary

column_size	Basis vectors column size.
local_size	Basis vectors local size.
size	Basis vectors global size.
sizes	Basis vectors local and global sizes, and the number of columns.

Methods Documentation

appendOptionsPrefix(*prefix=None*)

Append to the prefix used for searching for all BV options in the database.

Logically collective.

Parameters
prefix (*str | None*) – The prefix string to prepend to all BV option requests.

Return type
None

See also

setOptionsPrefix, *getOptionsPrefix*, BVAppendOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/BV.pyx:624 <slepc4py/SLEPc/BV.pyx#L624>`

applyMatrix(*x*, *y*)

Multiply a vector with the matrix associated to the bilinear form.

Neighbor-wise collective.

Parameters

- **x** (*Vec*) – The input vector.
- **y** (*Vec*) – The result vector.

Return type
None

Notes

If the bilinear form has no associated matrix this function copies the vector.

See also

setMatrix, BVApplyMatrix

:sources:`Source code at slepc4py/SLEPc/BV.pyx:869 <slepc4py/SLEPc/BV.pyx#L869>`

copy(*result=None*)

Copy a basis vector object into another one.

Logically collective.

Returns
The copy.

Return type
BV

Parameters
result (BV | *None*) – The copy.

Notes

Both objects must be distributed in the same manner; local copies are done. Only active columns (excluding the leading ones) are copied. In the destination BV, columns are overwritten starting from the leading ones. Constraints are not copied.

See also

BVCopy

:sources:`Source code at slepc4py/SLEPc/BV.pyx:360 <slepc4py/SLEPc/BV.pyx#L360>`

copyColumn(*j*, *i*)

Copy the values from one of the columns to another one.

Logically collective.

Parameters

- **j** (*int*) – The index of the source column.
- **i** (*int*) – The index of the destination column.

Return type
None

See also

copy, *copyVec*, BVCopyColumn

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1241 <slepc4py/SLEPc/BV.pyx#L1241>`

copyVec(*j*, *v*)

Copy one of the columns of a basis vectors object into a vector.

Logically collective.

Parameters

- **j** (*int*) – The column index to be copied.
- **v** (*Vec*) – A vector.

Return type
None

Notes

The BV and v must be distributed in the same manner; local copies are done.

See also

copy, *copyColumn*, BVCopyVec

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1216 <slepc4py/SLEPc/BV.pyx#L1216>`

create(*comm=None*)

Create the BV object.

Collective.

Parameters
comm (*Comm* | *None*) – MPI communicator; if not provided, it defaults to all processes.

Return type
Self

See also

createFromMat, BVCreate

:sources:`Source code at slepc4py/SLEPc/BV.pyx:231 <slepc4py/SLEPc/BV.pyx#L231>`

createFromMat(*A*)

Create a basis vectors object from a dense matrix.

Collective.

Parameters
A (*Mat*) – A dense tall-skinny matrix.

Return type
Self

Notes

The matrix values are copied to the *BV* data storage, memory is not shared.

The communicator of the *BV* object will be the same as *A*, and so will be the dimensions.

See also

create, *createMat*, BVCreateFromMat

:sources:`Source code at slepc4py/SLEPc/BV.pyx:253 <slepc4py/SLEPc/BV.pyx#L253>`

createMat()

Create a new dense matrix and copy the contents of the BV.

Collective.

Returns
The new matrix.

Return type
petsc4py.PETSc.Mat

Notes

The matrix contains all columns of the *BV*, not just the active columns.

See also

createFromMat, *createVec*, *getMat*, BVCreateMat

:sources:`Source code at slepc4py/SLEPc/BV.pyx:281 <slepc4py/SLEPc/BV.pyx#L281>`

createVec()

Create a vector with the type and dimensions of the columns of the BV.

Collective.

Returns
New vector.

Return type
petsc4py.PETSc.Vec

See also

createMat, *setVecType*, BVCreateVec

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1153 <slepc4py/SLEPc/BV.pyx#L1153>`

destroy()

Destroy the BV object.

Collective.

See also

BVDestroy

:sources:`Source code at slepc4py/SLEPc/BV.pyx:217 <slepc4py/SLEPc/BV.pyx#L217>`

Return type
Self

dot(*Y*)

Compute the 'block-dot' product of two basis vectors objects.

Collective.

$M = Y^*X$ ($m_{ij} = y_i^* x_j$) or $M = Y^*BX$

Parameters
Y (BV) – Left basis vectors, can be the same as self, giving $M = X^*X$.

Returns
The resulting matrix.

Return type
petsc4py.PETSc.Mat

Notes

This is the generalization of `Vec.dot()` for a collection of vectors, $M = Y^*X$. The result is a matrix M whose entry m_{ij} is equal to $y_i^* x_j$ (where y_i^* denotes the conjugate transpose of y_i).

X and Y can be the same object.

If a non-standard inner product has been specified with *setMatrix()*, then the result is $M = Y^*BX$. In this case, both X and Y must have the same associated matrix.

Only rows (resp. columns) of M starting from l_y (resp. l_x) are computed, where l_y (resp. l_x) is the number of leading columns of Y (resp. X).

See also

dotVec, *dotColumn*, *setActiveColumns*, *setMatrix*, BVDot

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1506 <slepc4py/SLEPc/BV.pyx#L1506>`

dotColumn(*j*)

Dot products of a column against all the column vectors of a BV.

Collective.

Parameters
j (*int*) – The index of the column.

Returns
The computed values.

Return type
ArrayScalar

Notes

This operation is equivalent to *dotVec()* but it uses column `j` of the BV rather than taking a vector as an argument. The number of active columns of the BV is set to `j` before the computation, and restored afterwards. If the BV has leading columns specified, then these columns do not participate in the computation. Therefore, the length of the returned array will be `j` minus the number of leading columns.

See also

dot, *dotVec*, BVDotColumn

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1350 <slepc4py/SLEPc/BV.pyx#L1350>`

dotVec(*v*)

Dot products of a vector against all the column vectors of the BV.

Collective.

Parameters
v (*Vec*) – A vector.

Returns
The computed values.

Return type
ArrayScalar

Notes

This is analogue to `Vec.mDot()`, but using *BV* to represent a collection of vectors `X`. The result is $m = X^* v$, so m_i is equal to $x_j^* v$. Note that here X is transposed as opposed to *dot()*.

If a non-standard inner product has been specified with *setMatrix()*, then the result is $m = X^* B v$.

See also

dot, *dotColumn*, *setMatrix*, BVDotVec

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1310 <slepc4py/SLEPc/BV.pyx#L1310>`

duplicate()

Duplicate the BV object with the same type and dimensions.

Collective.

Returns
The new object.

Return type
BV

Notes

This function does not copy the entries, it just allocates the storage for the new *BV*. Use *copy()* to copy the content.

See also

duplicateResize, BVDuplicate

:sources:`Source code at slepc4py/SLEPc/BV.pyx:305 <slepc4py/SLEPc/BV.pyx#L305>`

duplicateResize(*m*)

Create a BV object of the same type and dimensions as an existing one.

Collective.

Parameters
m (*int*) – The number of columns.

Returns
The new object.

Return type
BV

Notes

This is equivalent to a call to *duplicate()* followed by *resize()* with possibly different number of columns. The contents of this *BV* are not copied to the new one.

See also

duplicate, *resize*, BVDuplicateResize

:sources:`Source code at slepc4py/SLEPc/BV.pyx:329 <slepc4py/SLEPc/BV.pyx#L329>`

getActiveColumns()

Get the current active dimensions.

Not collective.

Returns

- **l** (int) – The leading number of columns.
- **k** (int) – The active number of columns.

Return type
tuple[int, int]

See also

setActiveColumns, BVGetActiveColumns

:sources:`Source code at slepc4py/SLEPc/BV.pyx:930 <slepc4py/SLEPc/BV.pyx#L930>`

getArray(*readonly=False*)

Return the array where the data is stored.

Not collective.

Parameters
readonly (*bool*) – Enable to obtain a read only array.

Returns
The array.

Return type
ArrayScalar

See also

BVGetArray, BVGetArrayRead

:sources:`Source code at slepc4py/SLEPc/BV.pyx:552 <slepc4py/SLEPc/BV.pyx#L552>`

getColumn(*j*)

Get a vector with the entries of the column of the BV object.

Logically collective.

Parameters
j (*int*) – The index of the requested column.

Returns
The vector containing the j-th column.

Return type
petsc4py.PETSc.Vec

Notes

Modifying the returned vector will change the BV entries as well.

The returned vector must not be destroyed, *restoreColumn()* must be called when it is no longer needed. At most, two columns can be fetched, that is, this function can only be called twice before the corresponding *restoreColumn()* is invoked.

A negative index j selects the i-th constraint, where i=-j. Constraints should not be modified.

See also

restoreColumn, *insertConstraints*, BVGetColumn

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1390 <slepc4py/SLEPc/BV.pyx#L1390>`

getDefiniteTolerance()

Get the tolerance to be used when checking a definite inner product.

Not collective.

Returns
The tolerance.

Return type
float

See also

setDefiniteTolerance, BVGetDefiniteTolerance

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1291 <slepc4py/SLEPc/BV.pyx#L1291>`

getLeadingDimension()

Get the leading dimension.

Not collective.

Returns
The leading dimension.

Return type
int

Notes

The returned value may be different in different processes.

The leading dimension must be used when accessing the internal array via *getArray()*.

See also

setLeadingDimension, BVGetLeadingDimension

:sources:`Source code at slepc4py/SLEPc/BV.pyx:526 <slepc4py/SLEPc/BV.pyx#L526>`

getMat()

Get a matrix of dense type that shares the memory of the BV object.

Collective.

Returns
The matrix.

Return type
petsc4py.PETSc.Mat

Notes

The returned matrix contains only the active columns. If the content of the matrix is modified, these changes are also done in the BV object. The user must call *restoreMat()* when no longer needed.

This operation implies a call to *getArray()*, which may result in data copies.

See also

restoreMat, *createMat*, *getArray*, BVGetMat

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1453 <slepc4py/SLEPc/BV.pyx#L1453>`

getMatMultMethod()

Get the method used for the *matMult()* operation.

Not collective.

Returns
The method for the *matMult()* operation.

Return type
MatMultType

See also

matMult, *setMatMultMethod*, BVGetMatMultMethod

:sources:`Source code at slepc4py/SLEPc/BV.pyx:766 <slepc4py/SLEPc/BV.pyx#L766>`

getMatrix()

Get the matrix representation of the inner product.

Not collective.

Returns

- **B** (petsc4py.PETSc.Mat) – The matrix of the inner product.
- **indef** (bool) – Whether the matrix is indefinite.

Return type

tuple[*Mat*, bool] | tuple[None, bool]

See also

setMatrix, BVGetMatrix

:sources:`Source code at slepc4py/SLEPc/BV.pyx:805 <slepc4py/SLEPc/BV.pyx#L805>`

getNumConstraints()

Get the number of constraints.

Not collective.

Returns

The number of constraints.

Return type

int

See also

insertConstraints, *setNumConstraints*, BVGetNumConstraints

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1134 <slepc4py/SLEPc/BV.pyx#L1134>`

getOptionsPrefix()

Get the prefix used for searching for all BV options in the database.

Not collective.

Returns

The prefix string set for this BV object.

Return type

str

See also

setOptionsPrefix, *appendOptionsPrefix*, BVGetOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/BV.pyx:643 <slepc4py/SLEPc/BV.pyx#L643>`

getOrthogonalization()

Get the orthogonalization settings from the BV object.

Not collective.

Returns

- **type** (*OrthogType*) – The type of orthogonalization technique.
- **refine** (*OrthogRefineType*) – The type of refinement.
- **eta** (float) – Parameter for selective refinement (used when the refinement type is *IFNEEDED*).
- **block** (*OrthogBlockType*) – The type of block orthogonalization.

Return type

tuple[*OrthogType*, *OrthogRefineType*, float, *OrthogBlockType*]

See also

setOrthogonalization, BVGetOrthogonalization

:sources:`Source code at slepc4py/SLEPc/BV.pyx:681 <slepc4py/SLEPc/BV.pyx#L681>`

getRandomContext()

Get the petsc4py.PETSc.Random object associated with the BV.

Collective.

Returns

The random number generator context.

Return type

petsc4py.PETSc.Random

See also

setRandomContext, BVGetRandomContext

:sources:`Source code at slepc4py/SLEPc/BV.pyx:2142 <slepc4py/SLEPc/BV.pyx#L2142>`

getSizes()

Get the local and global sizes, and the number of columns.

Not collective.

Returns

- **(n, N)** (tuple of int) – The local and global sizes.
- **m** (int) – The number of columns.

Return type
tuple[LayoutSizeSpec, int]

See also

setSizes, *setSizesFromVec*, BVGetSizes

:sources:`Source code at slepc4py/SLEPc/BV.pyx:483 <slepc4py/SLEPc/BV.pyx#L483>`

getType()

Get the BV type of this object.

Not collective.

Returns
The basis vectors type currently being used.

Return type
str

See also

setType, BVGetType

:sources:`Source code at slepc4py/SLEPc/BV.pyx:413 <slepc4py/SLEPc/BV.pyx#L413>`

getVecType()

Get the vector type used when creating vectors via *createVec()*.

Not collective.

Returns
The vector type.

Return type
str

See also

createVec, *setVecType*, BVGetVecType

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1197 <slepc4py/SLEPc/BV.pyx#L1197>`

insertConstraints(*C*)

Insert a set of vectors as constraints.

Collective.

Parameters
C (*Vec | list[Vec]*) – Set of vectors to be inserted as constraints.

Returns
Number of linearly independent constraints.

Return type
int

Notes

The constraints are relevant only during orthogonalization. Constraint vectors span a subspace that is deflated in every orthogonalization operation, so they are intended for removing those directions from the orthogonal basis computed in regular BV columns.

Constraints are not stored in regular columns, but in a special part of the storage. They can be accessed with negative indices in *getColumn()*.

This operation is DESTRUCTIVE, meaning that all data contained in the columns of the BV is lost. This is typically invoked just after creating the BV. Once a set of constraints has been set, it is not allowed to call this function again.

The vectors are copied one by one and then orthogonalized against the previous ones. If any of them is linearly dependent then it is discarded and not counted in the return value. The behavior is similar to *insertVecs()*.

See also

insertVecs, *setNumConstraints*, BVInsertConstraints

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1057 <slepc4py/SLEPc/BV.pyx#L1057>`

insertVec(*j*, *w*)

Insert a vector into the specified column.

Logically collective.

Parameters

- **j** (*int*) – The column to be overwritten.
- **w** (*Vec*) – The vector to be copied.

Return type
None

See also

insertVecs, BVInsertVec

:sources:`Source code at slepc4py/SLEPc/BV.pyx:994 <slepc4py/SLEPc/BV.pyx#L994>`

insertVecs(*s*, *W*, *orth=False*)

Insert a set of vectors into the specified columns.

Collective.

Parameters

- **s** (*int*) – The first column to be overwritten.
- **W** (*Vec | list[Vec]*) – Set of vectors to be copied.
- **orth** (*bool*) – Flag indicating if the vectors must be orthogonalized.

Returns
Number of linearly independent vectors.

Return type
int

Notes

Copies the contents of vectors `W` into the BV columns `s:s+n`, where `n` is the length of `W`. If `orth` is set, then the vectors are copied one by one and then orthogonalized against the previous one. If any of them is linearly dependent then it is discarded and the not counted in the return value.

See also

insertVec, *orthogonalizeColumn*, BVInsertVecs

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1014 <slepc4py/SLEPc/BV.pyx#L1014>`

matMult(*A*, *Y=None*)

Compute the matrix-vector product for each column, $Y = AV$.

Neighbor-wise collective.

Parameters

- **A** (*Mat*) – The matrix.
- **Y** (BV | *None*)

Returns
The result.

Return type
BV

Notes

Only active columns (excluding the leading ones) are processed. If `Y` is `None` a new BV is created.

It is possible to choose whether the computation is done column by column or as a dense matrix-matrix product with *setMatMultMethod()*.

See also

copy, *matMultColumn*, *matMultTranspose*, *setMatMultMethod*, BVMatMult

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1604 <slepc4py/SLEPc/BV.pyx#L1604>`

matMultColumn(*A*, *j*)

Mat-vec product for a column, storing the result in the next column.

Neighbor-wise collective.

$v_{j+1} = Av_j$.

Parameters

- **A** (*Mat*) – The matrix.
- **j** (*int*) – Index of column.

Return type
None

See also

matMult, BVMatMultColumn

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1749 <slepc4py/SLEPc/BV.pyx#L1749>`

matMultHermitianTranspose(*A*, *Y=None*)

Pre-multiplication with the conjugate transpose of a matrix.

Neighbor-wise collective.

$Y = A^*V$.

Parameters

- **A** (*Mat*) – The matrix.
- **Y** (BV | *None*)

Returns

The result.

Return type

BV

Notes

Only active columns (excluding the leading ones) are processed. If `Y` is `None` a new BV is created.

See also

matMult, *matMultHermitianTransposeColumn*, BVMatMultHermitianTranspose

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1701 <slepc4py/SLEPc/BV.pyx#L1701>`

matMultHermitianTransposeColumn(*A*, *j*)

Conjugate-transpose matrix-vector product for a specified column.

Neighbor-wise collective.

Store the result in the next column: $v_{j+1} = A^*v_j$.

Parameters

- **A** (*Mat*) – The matrix.
- **j** (*int*) – Index of column.

Return type

None

See also

matMultColumn, BVMatMultHermitianTransposeColumn

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1793 <slepc4py/SLEPc/BV.pyx#L1793>`

matMultTranspose(*A*, *Y=None*)

Pre-multiplication with the transpose of a matrix.

Neighbor-wise collective.

$Y = A^T V$.

Parameters

- **A** (*Mat*) – The matrix.
- **Y** (*BV | None*)

Returns

The result.

Return type

BV

Notes

Only active columns (excluding the leading ones) are processed. If `Y` is `None` a new BV is created.

See also

matMult, *matMultTransposeColumn*, BVMatMultTranspose

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1653 <slepc4py/SLEPc/BV.pyx#L1653>`

matMultTransposeColumn(*A*, *j*)

Transpose matrix-vector product for a specified column.

Neighbor-wise collective.

Store the result in the next column: $v_{j+1} = A^T v_j$.

Parameters

- **A** (*Mat*) – The matrix.
- **j** (*int*) – Index of column.

Return type

None

See also

matMultColumn, BVMatMultTransposeColumn

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1771 <slepc4py/SLEPc/BV.pyx#L1771>`

matProject(*A*, *Y*)

Compute the projection of a matrix onto a subspace.

Collective.

$M = Y^* A X$

Parameters

- **A** (*Mat | None*) – Matrix to be projected.

- **Y** (BV) – Left basis vectors, can be the same as self, giving $M = X^*AX$.

Returns
Projection of the matrix A onto the subspace.

Return type
petsc4py.PETSc.Mat

Notes

If A is None, then it is assumed that the BV already contains AX.

This operation is similar to *dot()*, with important differences. The goal is to compute the matrix resulting from the orthogonal projection of A onto the subspace spanned by the columns of the BV, $M = X^*AX$, or the oblique projection onto the BV along the second one Y, $M = Y^*AX$.

A difference with respect to *dot()* is that the standard inner product is always used, regardless of a non-standard inner product being specified with *setMatrix()*.

See also

dot, *setActiveColumns*, *setMatrix*, BVMatProject

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1555 <slepc4py/SLEPc/BV.pyx#L1555>`

mult(*delta*, *gamma*, *X*, *Q*)

Compute $Y = \gamma Y + \delta XQ$.

Logically collective.

Parameters

- **delta** (Scalar) – Coefficient that multiplies X.
- **gamma** (Scalar) – Coefficient that multiplies self (Y).
- **X** (BV) – Input basis vectors.
- **Q** (*Mat | None*) – Input matrix, if not given the identity matrix is assumed.

Return type
None

Notes

X must be different from self (Y). The case X=Y can be addressed with *multInPlace()*.

See also

multVec, *multColumn*, *multInPlace*, BVMult

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1815 <slepc4py/SLEPc/BV.pyx#L1815>`

multColumn(*delta*, *gamma*, *j*, *q*)

Compute $y = \gamma y + \delta Xq$.

Logically collective.

Compute $y = \gamma y + \delta Xq$, where y is the j-th column.

Parameters

- **delta** (Scalar) – Coefficient that multiplies self (X).
- **gamma** (Scalar) – Coefficient that multiplies y.
- **j** (*int*) – The column index.
- **q** (*Sequence[Scalar]*) – Input coefficients.

Return type
None

See also

mult, *multVec*, *multInPlace*, BVMultColumn

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1869 <slepc4py/SLEPc/BV.pyx#L1869>`

multInPlace(*Q*, *s*, *e*)

Update a set of vectors as $V(:,s:e-1) = VQ(:,s:e-1)$.

Logically collective.

Parameters

- **Q** (*Mat*) – A sequential dense matrix.
- **s** (*int*) – First column to be overwritten.
- **e** (*int*) – Last column to be overwritten.

Return type
None

See also

mult, *multVec*, BVMultInPlace

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1846 <slepc4py/SLEPc/BV.pyx#L1846>`

multVec(*delta*, *gamma*, *y*, *q*)

Compute $y = \gamma y + \delta X q$.

Logically collective.

Parameters

- **delta** (Scalar) – Coefficient that multiplies self (X).
- **gamma** (Scalar) – Coefficient that multiplies y.
- **y** (*Vec*) – Input/output vector.
- **q** (*Sequence[Scalar]*) – Input coefficients.

Return type
None

See also

mult, *multColumn*, *multInPlace*, BVMultVec

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1905 <slepc4py/SLEPc/BV.pyx#L1905>`

norm(*norm_type=None*)

Compute the matrix norm of the BV.

Collective.

Parameters
norm_type (*NormType* | *None*) – The norm type.

Returns
The norm.

Return type
float

Notes

All active columns (except the leading ones) are considered as a matrix. The allowed norms are NORM_1, NORM_FROBENIUS, and NORM_INFINITY.

This operation fails if a non-standard inner product has been specified with *setMatrix()*.

See also

normColumn, *setMatrix*, BVNorm

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1976 <slepc4py/SLEPc/BV.pyx#L1976>`

normColumn(*j*, *norm_type=None*)

Compute the vector norm of a selected column.

Collective.

Parameters

- **j** (*int*) – Index of column.
- **norm_type** (*NormType* | *None*) – The norm type.

Returns
The norm.

Return type
float

Notes

The norm of v_j is computed (NORM_1, NORM_2, or NORM_INFINITY).

If a non-standard inner product has been specified with *setMatrix()*, then the returned value is $\sqrt{v_j^* B v_j}$, where B is the inner product matrix (argument 'norm_type' is ignored).

See also

norm, *setMatrix*, BVNormColumn

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1937 <slepc4py/SLEPc/BV.pyx#L1937>`

orthogonalize(*R=None*, ***kargs*)

Orthogonalize all columns (except leading ones) (QR decomposition).

Collective.

Parameters

- **R** (*Mat* | *None*) – A sequential dense matrix.
- **kargs** (*Any*)

Return type
None

Notes

The output satisfies $V_0 = VR$ (where V_0 represent the input V) and $V^*V = I$ (or $V^*BV = I$ if an inner product matrix B has been specified with *setMatrix()*).

See also

orthogonalizeColumn, *setMatrix*, *setOrthogonalization*, BVOrthogonalize

:sources:`Source code at slepc4py/SLEPc/BV.pyx:2272 <slepc4py/SLEPc/BV.pyx#L2272>`

orthogonalizeColumn(*j*)

Orthogonalize a column vector with respect to the previous ones.

Collective.

Parameters
j (*int*) – Index of the column to be orthogonalized.

Returns

- **norm** (float) – The norm of the resulting vector.
- **lindep** (bool) – Flag indicating that refinement did not improve the quality of orthogonalization.

Return type
tuple[float, bool]

Notes

This function applies an orthogonal projector to project vector v_j onto the orthogonal complement of the span of the columns $V[0..j-1]$, where $V[.]$ are the vectors of the BV. The columns $V[0..j-1]$ are assumed to be mutually orthonormal.

This routine does not normalize the resulting vector.

See also

orthogonalizeVec, *setOrthogonalization*

:sources:`Source code at slepc4py/SLEPc/BV.pyx:2198 <slepc4py/SLEPc/BV.pyx#L2198>`

orthogonalizeVec(*v*)

Orthogonalize a vector with respect to all active columns.

Collective.

Parameters

v (*Vec*) – Vector to be orthogonalized, modified on return.

Returns

- **norm** (*float*) – The norm of the resulting vector.
- **lindep** (*bool*) – Flag indicating that refinement did not improve the quality of orthogonalization.

Return type

tuple[float, bool]

Notes

This function applies an orthogonal projector to project vector v onto the orthogonal complement of the span of the columns of the BV.

This routine does not normalize the resulting vector.

See also

orthogonalizeColumn, *setOrthogonalization*

:sources:`Source code at slepc4py/SLEPc/BV.pyx:2162 <slepc4py/SLEPc/BV.pyx#L2162>`

orthonormalizeColumn(*j*, *replace=False*)

Orthonormalize a column vector with respect to the previous ones.

Collective.

This is equivalent to a call to *orthogonalizeColumn()* followed by a call to *scaleColumn()* with the reciprocal of the norm.

Parameters

- **j** (*int*) – Index of the column to be orthonormalized.
- **replace** (*bool*) – Whether it is allowed to set the vector randomly.

Returns

- **norm** (*float*) – The norm of the resulting vector.
- **lindep** (*bool*) – Flag indicating that refinement did not improve the quality of orthogonalization.

Return type

tuple[float, bool]

See also

orthogonalizeColumn, *setOrthogonalization*

:sources:`Source code at slepc4py/SLEPc/BV.pyx:2236 <slepc4py/SLEPc/BV.pyx#L2236>`

resize(*m*, *copy=True*)

Change the number of columns.

Collective.

Parameters

- **m** (*int*) – The new number of columns.
- **copy** (*bool*) – A flag indicating whether current values should be kept.

Return type

None

Notes

Internal storage is reallocated. If `copy` is `True`, then the contents are copied to the leading part of the new space.

See also

setSizes, *setSizesFromVec*, BVResize

:sources:`Source code at slepc4py/SLEPc/BV.pyx:2011 <slepc4py/SLEPc/BV.pyx#L2011>`

restoreColumn(*j*, *v*)

Restore a column obtained with *getColumn()*.

Logically collective.

Parameters

- **j** (*int*) – The index of the requested column.
- **v** (*Vec*) – The vector obtained with *getColumn()*.

Return type

None

Notes

The arguments must match the corresponding call to *getColumn()*.

See also

getColumn, BVRestoreColumn

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1428 <slepc4py/SLEPc/BV.pyx#L1428>`

restoreMat(*A*)

Restore the matrix obtained with *getMat()*.

Logically collective.

Parameters
A (*Mat*) – The matrix obtained with *getMat()*.

Return type
None

Notes

A call to this function must match a previous call of *getMat()*. The effect is that the contents of the matrix are copied back to the BV internal data structures.

See also

getMat, BVRestoreMat

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1482 <slepc4py/SLEPc/BV.pyx#L1482>`

scale(*alpha*)

Multiply the entries by a scalar value.

Logically collective.

Parameters
alpha (Scalar) – scaling factor.

Return type
None

Notes

All active columns (except the leading ones) are scaled.

See also

scaleColumn, *setActiveColumns*, BVScale

:sources:`Source code at slepc4py/SLEPc/BV.pyx:972 <slepc4py/SLEPc/BV.pyx#L972>`

scaleColumn(*j*, *alpha*)

Scale a column of a BV.

Logically collective.

Parameters

- **j** (*int*) – column index to be scaled.
- **alpha** (Scalar) – scaling factor.

Return type
None

See also

scale, BVScaleColumn

:sources:`Source code at slepc4py/SLEPc/BV.pyx:951 <slepc4py/SLEPc/BV.pyx#L951>`

setActiveColumns(*l*, *k*)

Set the columns that will be involved in operations.

Logically collective.

Parameters

- **l** (*int*) – The leading number of columns.
- **k** (*int*) – The active number of columns.

Return type
None

Notes

In operations such as *mult()* or *dot()*, only the first **k** columns are considered. This is useful when the BV is filled from left to right, so the last **m**-**k** columns do not have relevant information.

Also in operations such as *mult()* or *dot()*, the first **l** columns are normally not included in the computation.

In orthogonalization operations, the first **l** columns are treated differently, they participate in the orthogonalization but the computed coefficients are not stored.

Use *CURRENT* to leave any of the values unchanged. Use *DETERMINE* to set **l** to the minimum value (**0**) and **k** to the maximum (**m**).

See also

getActiveColumns, *setSizes*, BVSetActiveColumns

:sources:`Source code at slepc4py/SLEPc/BV.pyx:893 <slepc4py/SLEPc/BV.pyx#L893>`

setDefiniteTolerance(*deftol*)

Set the tolerance to be used when checking a definite inner product.

Logically collective.

Parameters
deftol (*float*) – The tolerance.

Return type
None

Notes

When using a non-standard inner product, see *setMatrix()*, the solver needs to compute $\sqrt{z^*Bz}$ for various vectors z. If the inner product has not been declared indefinite, the value z^*Bz must be positive, but due to rounding error a tiny value may become negative. A tolerance is used to detect this situation. Likewise, in complex arithmetic z^*Bz should be real, and we use the same tolerance to check whether a nonzero imaginary part can be considered negligible.

See also

setMatrix, *getDefiniteTolerance*, BVSetDefiniteTolerance

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1262 <slepc4py/SLEPc/BV.pyx#L1262>`

setFromOptions()

Set BV options from the options database.

Collective.

Notes

To see all options, run your program with the `-help` option.

See also

setOptionsPrefix, BVSetFromOptions

:sources:`Source code at slepc4py/SLEPc/BV.pyx:662 <slepc4py/SLEPc/BV.pyx#L662>`

Return type
None

setLeadingDimension(*ld*)

Set the leading dimension.

Not collective.

Parameters
ld (*int*) – The leading dimension.

Return type
None

Notes

This parameter is relevant for a BV of *BV.Type.MAT*.

See also

getLeadingDimension, BVSetLeadingDimension

:sources:`Source code at slepc4py/SLEPc/BV.pyx:504 <slepc4py/SLEPc/BV.pyx#L504>`

setMatMultMethod(*method*)

Set the method used for the *matMult()* operation.

Logically collective.

Parameters
method (MatMultType) – The method for the *matMult()* operation.

Return type
None

See also

matMult, *getMatMultMethod*, BVSetMatMultMethod

:sources:`Source code at slepc4py/SLEPc/BV.pyx:785 <slepc4py/SLEPc/BV.pyx#L785>`

setMatrix(*B*, *indef=False*)

Set the bilinear form to be used for inner products.

Collective.

Parameters

- **B** (*Mat* | *None*) – The matrix of the inner product.
- **indef** (*bool*) – Whether the matrix is indefinite.

Return type
None

Notes

This is used to specify a non-standard inner product, whose matrix representation is given by B. Then, all inner products required during orthogonalization are computed as $(x,y)_B = y^*Bx$ rather than the standard form $(x,y) = y^*x$.

Matrix B must be real symmetric (or complex Hermitian). A genuine inner product requires that B is also positive (semi-)definite. However, we also allow for an indefinite B (setting indef=True), in which case the orthogonalization uses an indefinite inner product.

This affects operations *dot()*, *norm()*, *orthogonalize()*, and variants.

Omitting B has the same effect as if the identity matrix was passed.

See also

getMatrix, BVSetMatrix

:sources:`Source code at slepc4py/SLEPc/BV.pyx:831 <slepc4py/SLEPc/BV.pyx#L831>`

setNumConstraints(*nc*)

Set the number of constraints.

Logically collective.

Parameters
nc (*int*) – The number of constraints.

Return type
None

Notes

This function sets the number of constraints to nc and marks all remaining columns as regular. Normal usage would be to call *insertConstraints()* instead.

If nc is smaller than the previously set value, then some of the constraints are discarded. In particular, using nc=0 removes all constraints preserving the content of regular columns.

See also

insertConstraints, *getNumConstraints*, BVSetNumConstraints

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1107 <slepc4py/SLEPc/BV.pyx#L1107>`

setOptionsPrefix(*prefix=None*)

Set the prefix used for searching for all BV options in the database.

Logically collective.

Parameters

prefix (*str* | *None*) – The prefix string to prepend to all BV option requests.

Return type

None

Notes

A hyphen (-) must NOT be given at the beginning of the prefix name. The first character of all runtime options is AUTOMATICALLY the hyphen.

See also

appendOptionsPrefix, *getOptionsPrefix*, BVGetOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/BV.pyx:599 <slepc4py/SLEPc/BV.pyx#L599>`

setOrthogonalization(*otype=None*, *refine=None*, *eta=None*, *block=None*)

Set the method used for the (block-)orthogonalization of vectors.

Logically collective.

Ortogonalization of vectors (classical or modified Gram-Schmidt with or without refinement), and for the block-orthogonalization (simultaneous orthogonalization of a set of vectors).

Parameters

- **otype** (OrthogType | *None*) – The type of orthogonalization technique.
- **refine** (OrthogRefineType | *None*) – The type of refinement.
- **eta** (*float* | *None*) – Parameter for selective refinement.
- **block** (OrthogBlockType | *None*) – The type of block orthogonalization.

Return type

None

Notes

The default settings work well for most problems.

The parameter `eta` should be a real value between `0` and `1` (or *DETERMINE*). The value of `eta` is used only when the refinement type is *IFNEEDED*.

When using several processes, *MGS* is likely to result in bad scalability.

If the method set for block orthogonalization is *GS*, then the computation is done column by column with the vector orthogonalization.

See also

getOrthogonalization, BVSetOrthogonalization

:sources:`Source code at slepc4py/SLEPc/BV.pyx:710 <slepc4py/SLEPc/BV.pyx#L710>`

setRandom()

Set the active columns of the BV to random numbers.

Logically collective.

Notes

All active columns (except the leading ones) are modified.

See also

setRandomContext, *setRandomColumn*, *setRandomNormal*, BVSetRandom

:sources:`Source code at slepc4py/SLEPc/BV.pyx:2037 <slepc4py/SLEPc/BV.pyx#L2037>`

Return type
None

setRandomColumn(*j*)

Set one column of the BV to random numbers.

Logically collective.

Parameters
j (*int*) – Column index to be set.

Return type
None

See also

setRandomContext, *setRandom*, *setRandomNormal*, BVSetRandomColumn

:sources:`Source code at slepc4py/SLEPc/BV.pyx:2085 <slepc4py/SLEPc/BV.pyx#L2085>`

setRandomCond(*condn*)

Set the columns of a BV to random numbers.

Logically collective.

The generated matrix has a prescribed condition number.

Parameters
condn (*float*) – Condition number.

Return type
None

See also

setRandomContext, *setRandomSign*, *setRandomNormal*, BVSetRandomCond

:sources:`Source code at slepc4py/SLEPc/BV.pyx:2103 <slepc4py/SLEPc/BV.pyx#L2103>`

setRandomContext(*rnd*)

Set the petsc4py.PETSc.Random object associated with the BV.

Collective.

To be used in operations that need random numbers.

Parameters

rnd (*Random*) – The random number generator context.

Return type

None

See also

getRandomContext, *setRandom*, *setRandomColumn*, BVSetRandomContext

:sources:`Source code at slepc4py/SLEPc/BV.pyx:2123 <slepc4py/SLEPc/BV.pyx#L2123>`

setRandomNormal()

Set the active columns of the BV to normal random numbers.

Logically collective.

Notes

All active columns (except the leading ones) are modified.

See also

setRandomContext, *setRandom*, *setRandomSign*, BVSetRandomNormal

:sources:`Source code at slepc4py/SLEPc/BV.pyx:2053 <slepc4py/SLEPc/BV.pyx#L2053>`

Return type

None

setRandomSign()

Set the entries of a BV to values 1 or -1 with equal probability.

Logically collective.

Notes

All active columns (except the leading ones) are modified.

See also

setRandomContext, *setRandom*, *setRandomNormal*, BVSetRandomSign

:sources:`Source code at slepc4py/SLEPc/BV.pyx:2069 <slepc4py/SLEPc/BV.pyx#L2069>`

Return type
None

setSizes(*sizes*, *m*)

Set the local and global sizes, and the number of columns.

Collective.

Parameters

- **sizes** (LayoutSizeSpec) – The global size `N` or a two-tuple `(n, N)` with the local and global sizes.
- **m** (*int*) – The number of columns.

Return type
None

Notes

Either `n` or `N` (but not both) can be *DETERMINE* or `None` to have it automatically set.

See also

setSizesFromVec, *getSizes*, BVSetSizes

:sources:`Source code at slepc4py/SLEPc/BV.pyx:432 <slepc4py/SLEPc/BV.pyx#L432>`

setSizesFromVec(*w*, *m*)

Set the local and global sizes, and the number of columns.

Collective.

Local and global sizes are specified indirectly by passing a template vector.

Parameters

- **w** (*Vec*) – The template vector.
- **m** (*int*) – The number of columns.

Return type
None

See also

setSizes, *getSizes*, BVSetSizesFromVec

:sources:`Source code at slepc4py/SLEPc/BV.pyx:460 <slepc4py/SLEPc/BV.pyx#L460>`

setType(*bv_type*)

Set the type for the BV object.

Logically collective.

Parameters
bv_type (Type | str) – The basis vectors type to be used.

Return type
None

See also

getType, BVSetType

:sources:`Source code at slepc4py/SLEPc/BV.pyx:394 <slepc4py/SLEPc/BV.pyx#L394>`

setVecType(*vec_type*)

Set the vector type to be used when creating vectors via *createVec()*.

Collective.

Parameters
vec_type (*petsc4py.PETSc.Vec.Type* | str) – Vector type used when creating vectors with *createVec*.

Return type
None

Notes

This is not needed if the BV object is set up with *setSizesFromVec()*, but may be required in the case of *setSizes()* if one wants to work with non-standard vectors.

See also

createVec, *getVecType*, *setSizes*, *setSizesFromVec*, BVSetVecType

:sources:`Source code at slepc4py/SLEPc/BV.pyx:1172 <slepc4py/SLEPc/BV.pyx#L1172>`

view(*viewer=None*)

Print the BV data structure.

Collective.

Parameters
viewer (*Viewer* | *None*) – Visualization context; if not provided, the standard output is used.

Return type
None

See also

BVView

:sources:`Source code at slepc4py/SLEPc/BV.pyx:198 <slepc4py/SLEPc/BV.pyx#L198>`

Attributes Documentation

column_size

Basis vectors column size.

:sources:`Source code at slepc4py/SLEPc/BV.pyx:2314 <slepc4py/SLEPc/BV.pyx#L2314>`

local_size

Basis vectors local size.

:sources:`Source code at slepc4py/SLEPc/BV.pyx:2309 <slepc4py/SLEPc/BV.pyx#L2309>`

size

Basis vectors global size.

:sources:`Source code at slepc4py/SLEPc/BV.pyx:2304 <slepc4py/SLEPc/BV.pyx#L2304>`

sizes

Basis vectors local and global sizes, and the number of columns.

:sources:`Source code at slepc4py/SLEPc/BV.pyx:2299 <slepc4py/SLEPc/BV.pyx#L2299>`

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.DS

class slepc4py.SLEPc.**DS**

Bases: Object

Direct Solver (or Dense System).

The *DS* package provides auxiliary routines that are internally used by the different slepc4py solvers. It is used to represent low-dimensional eigenproblems that must be solved within iterative solvers with direct methods. It can be seen as a structured wrapper to LAPACK functionality.

Enumerations

MatType	To refer to one of the matrices stored internally in DS.
ParallelType	Indicates the parallel mode that the direct solver will use.
StateType	DS state types.
Type	DS type.

slepc4py.SLEPc.DS.MatType

class slepc4py.SLEPc.DS.**MatType**

Bases: object

To refer to one of the matrices stored internally in DS.

- *A*: first matrix of eigenproblem/singular value problem.
- *B*: second matrix of a generalized eigenproblem.
- *C*: third matrix of a quadratic eigenproblem.
- *T*: tridiagonal matrix.

- `D`: diagonal matrix.
- `Q`: orthogonal matrix of (right) Schur vectors.
- `Z`: orthogonal matrix of left Schur vectors.
- `X`: right eigenvectors.
- `Y`: left eigenvectors.
- `U`: left singular vectors.
- `V`: right singular vectors.
- `W`: workspace matrix.

See also

`DSMatType`

Attributes Summary

`A`	Constant `A` of type `int`
`B`	Constant `B` of type `int`
`C`	Constant `C` of type `int`
`D`	Constant `D` of type `int`
`Q`	Constant `Q` of type `int`
`T`	Constant `T` of type `int`
`U`	Constant `U` of type `int`
`V`	Constant `V` of type `int`
`W`	Constant `W` of type `int`
`X`	Constant `X` of type `int`
`Y`	Constant `Y` of type `int`
`Z`	Constant `Z` of type `int`

Attributes Documentation

`A: int = A`

Constant `A` of type `int`

`B: int = B`

Constant `B` of type `int`

`C: int = C`

Constant `C` of type `int`

`D: int = D`

Constant `D` of type `int`

`Q: int = Q`

Constant `Q` of type `int`

`T: int = T`

Constant `T` of type `int`

`U: int = U`

Constant `U` of type `int`

V: int = V

Constant V of type int

W: int = W

Constant W of type int

X: int = X

Constant X of type int

Y: int = Y

Constant Y of type int

Z: int = Z

Constant Z of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.DS.ParallelType

class slepc4py.SLEPc.DS.**ParallelType**

Bases: object

Indicates the parallel mode that the direct solver will use.

- *REDUNDANT*: Every process performs the computation redundantly.
- *SYNCHRONIZED*: The first process sends the result to the rest.
- *DISTRIBUTED*: Used in some cases to distribute the computation among processes.

See also

DSParallelType

Attributes Summary

DISTRIBUTED	Constant DISTRIBUTED of type int
REDUNDANT	Constant REDUNDANT of type int
SYNCHRONIZED	Constant SYNCHRONIZED of type int

Attributes Documentation

DISTRIBUTED: int = DISTRIBUTED

Constant DISTRIBUTED of type int

REDUNDANT: int = REDUNDANT

Constant REDUNDANT of type int

SYNCHRONIZED: int = SYNCHRONIZED

Constant SYNCHRONIZED of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.DS.StateType

class slepc4py.SLEPc.DS.**StateType**

Bases: object

DS state types.

- *RAW*: Not processed yet.
- *INTERMEDIATE*: Reduced to Hessenberg or tridiagonal form (or equivalent).
- *CONDENSED*: Reduced to Schur or diagonal form (or equivalent).
- *TRUNCATED*: Condensed form truncated to a smaller size.

See also

DSStateType

Attributes Summary

CONDENSED	Constant CONDENSED of type int
INTERMEDIATE	Constant INTERMEDIATE of type int
RAW	Constant RAW of type int
TRUNCATED	Constant TRUNCATED of type int

Attributes Documentation

CONDENSED: int = CONDENSED

Constant CONDENSED of type int

INTERMEDIATE: int = INTERMEDIATE

Constant INTERMEDIATE of type int

RAW: int = RAW

Constant RAW of type int

TRUNCATED: int = TRUNCATED

Constant TRUNCATED of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.DS.Type

class slepc4py.SLEPc.DS.**Type**

Bases: object

DS type.

- *HEP*: Dense Hermitian Eigenvalue Problem.
- *NHEP*: Dense Non-Hermitian Eigenvalue Problem.
- *GHEP*: Dense Generalized Hermitian Eigenvalue Problem.
- *GHIEP*: Dense Generalized Hermitian Indefinite Eigenvalue Problem.

- *GNHEP*: Dense Generalized Non-Hermitian Eigenvalue Problem.
- *NHEPTS*: Dense Non-Hermitian Eigenvalue Problem (special variant intended for two-sided Krylov solvers).
- *SVD*: Dense Singular Value Decomposition.
- *HSVD*: Dense Hyperbolic Singular Value Decomposition.
- *GSVD*: Dense Generalized Singular Value Decomposition.
- *PEP*: Dense Polynomial Eigenvalue Problem.
- *NEP*: Dense Nonlinear Eigenvalue Problem.

See also

DSType

Attributes Summary

GHEP	Object GHEP of type str
GHIEP	Object GHIEP of type str
GNHEP	Object GNHEP of type str
GSVD	Object GSVD of type str
HEP	Object HEP of type str
HSVD	Object HSVD of type str
NEP	Object NEP of type str
NHEP	Object NHEP of type str
NHEPTS	Object NHEPTS of type str
PEP	Object PEP of type str
SVD	Object SVD of type str

Attributes Documentation

GHEP: str = GHEP

Object GHEP of type str

GHIEP: str = GHIEP

Object GHIEP of type str

GNHEP: str = GNHEP

Object GNHEP of type str

GSVD: str = GSVD

Object GSVD of type str

HEP: str = HEP

Object HEP of type str

HSVD: str = HSVD

Object HSVD of type str

NEP: str = NEP

Object NEP of type str

NHEP: str = NHEP

Object NHEP of type str

NHEPTS: str = NHEPTS

Object NHEPTS of type str

PEP: str = PEP

Object PEP of type str

SVD: str = SVD

Object SVD of type str

__init__()

classmethod __new__(**args*, ***kwargs*)

Methods Summary

allocate(ld)	Allocate memory for internal storage or matrices in DS.
appendOptionsPrefix([prefix])	Append to the prefix used for searching for all DS options in the database.
cond()	Compute the inf-norm condition number of the first matrix.
create([comm])	Create the DS object.
destroy()	Destroy the DS object.
duplicate()	Duplicate the DS object with the same type and dimensions.
getArray(matname)	Return the array where the data is stored.
getBlockSize()	Get the block size.
getCompact()	Get the compact storage flag.
getDimensions()	Get the current dimensions.
getExtraRow()	Get the extra row flag.
getGSVDDimensions()	Get the number of columns and rows of a *DS* of type *GSVD*.
getHSVDDimensions()	Get the number of columns of a *DS* of type *HSVD*.
getLeadingDimension()	Get the leading dimension of the allocated matrices.
getMat(matname)	Get the requested matrix as a sequential dense Mat object.
getMethod()	Get the method currently used in the DS.
getOptionsPrefix()	Get the prefix used for searching for all DS options in the database.
getPEPCoefficients()	Get the polynomial basis coefficients of a *DS* of type *PEP*.
getPEPDegree()	Get the polynomial degree of a *DS* of type *PEP*.
getParallel()	Get the mode of operation in parallel runs.
getRefined()	Get the refined vectors flag.
getSVDDimensions()	Get the number of columns of a *DS* of type *SVD*.
getState()	Get the current state.
getType()	Get the DS type of this object.
reset()	Reset the DS object.
restoreMat(matname, mat)	Restore the previously seized matrix.
setBlockSize(bs)	Set the block size.
setCompact([comp])	Set the compact flag for storage of matrices.

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setDimensions([n, l, k])	Set the matrix sizes in the DS object.
setExtraRow([ext])	Set a flag to indicate that the matrix has one extra row.
setFromOptions()	Set DS options from the options database.
setGSVDDimensions(m, p)	Set the number of columns and rows of a *DS* of type *GSVD*.
setHSVDDimensions(m)	Set the number of columns of a *DS* of type *HSVD*.
setIdentity(matname)	Set the identity on the active part of a matrix.
setMethod(meth)	Set the method to be used to solve the problem.
setOptionsPrefix([prefix])	Set the prefix used for searching for all DS options in the database.
setPEPCoefficients(pbc)	Set the polynomial basis coefficients of a *DS* of type *PEP*.
setPEPDegree(deg)	Set the polynomial degree of a *DS* of type *PEP*.
setParallel(pmode)	Set the mode of operation in parallel runs.
setRefined([ref])	Set a flag to indicate that refined vectors must be computed.
setSVDDimensions(m)	Set the number of columns of a *DS* of type *SVD*.
setState(state)	Set the state of the DS object.
setType(ds_type)	Set the type for the DS object.
solve()	Solve the problem.
truncate(n[, trim])	Truncate the system represented in the DS object.
updateExtraRow()	Ensure that the extra row gets up-to-date after a call to *DS.solve()*.
vectors([matname])	Compute vectors associated to the dense system such as eigenvectors.
view([viewer])	Print the DS data structure.

Attributes Summary

block_size	The block size.
compact	Compact storage of matrices.
extra_row	If the matrix has one extra row.
method	The method to be used to solve the problem.
parallel	The mode of operation in parallel runs.
refined	If refined vectors must be computed.
state	The state of the DS object.

Methods Documentation

allocate(*ld*)

Allocate memory for internal storage or matrices in DS.

Logically collective.

Parameters

ld (*int*) – Leading dimension (maximum allowed dimension for the matrices, including the extra row if present).

Return type

None

Notes

If the leading dimension is different from a previously set value, then all matrices are destroyed with *reset()*.

See also

getLeadingDimension, *setDimensions*, *setExtraRow*, *reset*, DSAllocate

:sources:`Source code at slepc4py/SLEPc/DS.pyx:342 <slepc4py/SLEPc/DS.pyx#L342>`

appendOptionsPrefix(*prefix=None*)

Append to the prefix used for searching for all DS options in the database.

Logically collective.

Parameters
prefix (*str* | *None*) – The prefix string to prepend to all DS option requests.

Return type
None

See also

setOptionsPrefix, *getOptionsPrefix*, DSSetOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/DS.pyx:260 <slepc4py/SLEPc/DS.pyx#L260>`

cond()

Compute the inf-norm condition number of the first matrix.

Logically collective.

Returns
Condition number.

Return type
float

See also

DSCond

:sources:`Source code at slepc4py/SLEPc/DS.pyx:909 <slepc4py/SLEPc/DS.pyx#L909>`

create(*comm=None*)

Create the DS object.

Collective.

Parameters
comm (*Comm* | *None*) – MPI communicator; if not provided, it defaults to all processes.

Return type
Self

See also

duplicate, DSCreate

:sources:`Source code at slepc4py/SLEPc/DS.pyx:176 <slepc4py/SLEPc/DS.pyx#L176>`

destroy()

Destroy the DS object.

Collective.

See also

DSDestroy

:sources:`Source code at slepc4py/SLEPc/DS.pyx:150 <slepc4py/SLEPc/DS.pyx#L150>`

Return type
Self

duplicate()

Duplicate the DS object with the same type and dimensions.

Collective.

Returns
The new object.

Return type
DS

Notes

This method does not copy the matrices, and the new object does not even have internal arrays allocated. Use *allocate()* to use the new *DS*.

See also

create, *allocate*, DSDuplicate

:sources:`Source code at slepc4py/SLEPc/DS.pyx:315 <slepc4py/SLEPc/DS.pyx#L315>`

getArray(*matname*)

Return the array where the data is stored.

Not collective.

Parameters
matname (MatType) – The selected matrix.

Returns
The array.

Return type
ArrayScalar

See also

DSGetArray

:sources:`Source code at slepc4py/SLEPc/DS.pyx:849 <slepc4py/SLEPc/DS.pyx#L849>`

`getBlockSize()`

Get the block size.

Not collective.

Returns
The block size.

Return type
int

See also

setBlockSize, DSGetBlockSize

:sources:`Source code at slepc4py/SLEPc/DS.pyx:559 <slepc4py/SLEPc/DS.pyx#L559>`

`getCompact()`

Get the compact storage flag.

Not collective.

Returns
The flag.

Return type
bool

See also

setCompact, DSGetCompact

:sources:`Source code at slepc4py/SLEPc/DS.pyx:643 <slepc4py/SLEPc/DS.pyx#L643>`

`getDimensions()`

Get the current dimensions.

Not collective.

Returns

- **n** (int) – The new size.
- **l** (int) – Number of locked (inactive) leading columns.
- **k** (int) – Intermediate dimension (e.g., position of arrow).
- **t** (int) – Truncated length.

Return type
tuple[int, int, int, int]

Notes

The `t` value makes sense only if *truncate()* has been called. Otherwise it is equal to `n`.

See also

setDimensions, *truncate*, *getLeadingDimension*, DSGetDimensions

:sources:`Source code at slepc4py/SLEPc/DS.pyx:508 <slepc4py/SLEPc/DS.pyx#L508>`

getExtraRow()

Get the extra row flag.

Not collective.

Returns
The flag.

Return type
bool

See also

setExtraRow, DSGetExtraRow

:sources:`Source code at slepc4py/SLEPc/DS.pyx:690 <slepc4py/SLEPc/DS.pyx#L690>`

getGSVDDimensions()

Get the number of columns and rows of a *DS* of type *GSVD*.

Not collective.

Returns

- **m** (int) – The number of columns.
- **p** (int) – The number of rows for the second matrix.

Return type
tuple[int, int]

See also

setGSVDDimensions, DSGSVDGetDimensions

:sources:`Source code at slepc4py/SLEPc/DS.pyx:1086 <slepc4py/SLEPc/DS.pyx#L1086>`

getHSVDDimensions()

Get the number of columns of a *DS* of type *HSVD*.

Not collective.

Returns
The number of columns.

Return type
int

See also

setHSVDDimensions, DSHSVDGetDimensions

:sources:`Source code at slepc4py/SLEPc/DS.pyx:1041 <slepc4py/SLEPc/DS.pyx#L1041>`

getLeadingDimension()

Get the leading dimension of the allocated matrices.

Not collective.

Returns
Leading dimension (maximum allowed dimension for the matrices).

Return type
int

See also

allocate, *setDimensions*, DSGetLeadingDimension

:sources:`Source code at slepc4py/SLEPc/DS.pyx:366 <slepc4py/SLEPc/DS.pyx#L366>`

getMat(*matname*)

Get the requested matrix as a sequential dense Mat object.

Not collective.

Parameters
matname (MatType) – The requested matrix.

Returns
The matrix.

Return type
petsc4py.PETSc.Mat

Notes

The returned matrix has sizes equal to the current *DS* dimensions (see *setDimensions()*), and contains the values that would be obtained with *getArray()*. If the *DS* was truncated, then the number of rows is equal to the dimension prior to truncation, see *truncate()*.

When no longer needed the user must call *restoreMat()*.

See also

restoreMat, *setDimensions*, *getArray*, *truncate*, DSGetMat

:sources:`Source code at slepc4py/SLEPc/DS.pyx:793 <slepc4py/SLEPc/DS.pyx#L793>`

getMethod()

Get the method currently used in the DS.

Not collective.

Returns
Identifier of the method.

Return type
int

See also

setMethod, DSGetMethod

:sources:`Source code at slepc4py/SLEPc/DS.pyx:596 <slepc4py/SLEPc/DS.pyx#L596>`

getOptionsPrefix()

Get the prefix used for searching for all DS options in the database.

Not collective.

Returns
The prefix string set for this DS object.

Return type
str

See also

appendOptionsPrefix, *setOptionsPrefix*, DSSetOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/DS.pyx:279 <slepc4py/SLEPc/DS.pyx#L279>`

getPEPCoefficients()

Get the polynomial basis coefficients of a *DS* of type *PEP*.

Not collective.

Returns
Coefficients.

Return type
ArrayReal

See also

setPEPCoefficients, DSPEPGetCoefficients

:sources:`Source code at slepc4py/SLEPc/DS.pyx:1180 <slepc4py/SLEPc/DS.pyx#L1180>`

getPEPDegree()

Get the polynomial degree of a *DS* of type *PEP*.

Not collective.

Returns
The polynomial degree.

Return type
int

See also

setPEPDegree, DSPEPGetDegree

:sources:`Source code at slepc4py/SLEPc/DS.pyx:1126 <slepc4py/SLEPc/DS.pyx#L1126>`

getParallel()

Get the mode of operation in parallel runs.

Not collective.

Returns
The parallel mode.

Return type
ParallelType

See also

setParallel, DSGetParallel

:sources:`Source code at slepc4py/SLEPc/DS.pyx:454 <slepc4py/SLEPc/DS.pyx#L454>`

getRefined()

Get the refined vectors flag.

Not collective.

Returns
The flag.

Return type
bool

See also

setRefined, DSGetRefined

:sources:`Source code at slepc4py/SLEPc/DS.pyx:738 <slepc4py/SLEPc/DS.pyx#L738>`

getSVDDimensions()

Get the number of columns of a *DS* of type *SVD*.

Not collective.

Returns
The number of columns.

Return type
int

See also

setSVDDimensions, DSSVDGetDimensions

:sources:`Source code at slepc4py/SLEPc/DS.pyx:999 <slepc4py/SLEPc/DS.pyx#L999>`

getState()

Get the current state.

Not collective.

Returns
The current state.

Return type
StateType

See also

setState, DSGetState

:sources:`Source code at slepc4py/SLEPc/DS.pyx:417 <slepc4py/SLEPc/DS.pyx#L417>`

getType()

Get the DS type of this object.

Not collective.

Returns
The direct solver type currently being used.

Return type
str

See also

setType, DSGetType

:sources:`Source code at slepc4py/SLEPc/DS.pyx:216 <slepc4py/SLEPc/DS.pyx#L216>`

reset()

Reset the DS object.

Collective.

See also

allocate, DSReset

:sources:`Source code at slepc4py/SLEPc/DS.pyx:164 <slepc4py/SLEPc/DS.pyx#L164>`

Return type
None

restoreMat(*matname*, *mat*)

Restore the previously seized matrix.

Not collective.

Parameters

- **matname** (MatType) – The selected matrix.
- **mat** (*petsc4py.PETSc.Mat*) – The matrix previously obtained with *getMat()*.

Return type
None

See also

getMat, DSRestoreMat

:sources:`Source code at slepc4py/SLEPc/DS.pyx:828 <slepc4py/SLEPc/DS.pyx#L828>`

setBlockSize(*bs*)

Set the block size.

Logically collective.

Parameters
bs (*int*) – The block size.

Return type
None

See also

getBlockSize, DSSetBlockSize

:sources:`Source code at slepc4py/SLEPc/DS.pyx:541 <slepc4py/SLEPc/DS.pyx#L541>`

setCompact(*comp=True*)

Set the compact flag for storage of matrices.

Logically collective.

Parameters
comp (*bool*) – `True` means compact storage.

Return type
None

Notes

Compact storage is used in some *DS* types such as *DS.Type.HEP* when the matrix is tridiagonal. This flag can be used to indicate whether the user provides the matrix entries via the compact form (the tridiagonal *DS.MatType.T*) or the non-compact one (*DS.MatType.A*).

The default is `False`.

See also

getCompact, DSSetCompact

:sources:`Source code at slepc4py/SLEPc/DS.pyx:615 <slepc4py/SLEPc/DS.pyx#L615>`

setDimensions(*n=None*, *l=None*, *k=None*)

Set the matrix sizes in the DS object.

Logically collective.

Parameters

- **n** (*int* | *None*) – The new size.
- **l** (*int* | *None*) – Number of locked (inactive) leading columns.
- **k** (*int* | *None*) – Intermediate dimension (e.g., position of arrow).

Return type
None

Notes

The internal arrays are not reallocated.

Some *DS* types have additional dimensions, e.g., the number of columns in *DS.Type.SVD*. For these, you should call a specific interface function.

See also

getDimensions, *allocate*, DSSetDimensions

:sources:`Source code at slepc4py/SLEPc/DS.pyx:473 <slepc4py/SLEPc/DS.pyx#L473>`

setExtraRow(*ext=True*)

Set a flag to indicate that the matrix has one extra row.

Logically collective.

Parameters
ext (*bool*) – `True` if the matrix has extra row.

Return type
None

Notes

In Krylov methods it is useful that the matrix representing the direct solver has one extra row, i.e., has $(n+1)$ rows and $(n+1)$ columns. If this flag is activated, all transformations applied to the right of the matrix also affect this additional row. In that case, $(n+1)$ must be less or equal than the leading dimension.

The default is `False`.

See also

getExtraRow, *solve*, *allocate*, DSSetExtraRow

:sources:`Source code at slepc4py/SLEPc/DS.pyx:662 <slepc4py/SLEPc/DS.pyx#L662>`

setFromOptions()

Set DS options from the options database.

Collective.

Notes

To see all options, run your program with the `-help` option.

See also

setOptionsPrefix, DSSetFromOptions

:sources:`Source code at slepc4py/SLEPc/DS.pyx:298 <slepc4py/SLEPc/DS.pyx#L298>`

Return type
None

setGSVDDimensions(*m*, *p*)

Set the number of columns and rows of a *DS* of type *GSVD*.

Logically collective.

Parameters

- **m** (*int*) – The number of columns.
- **p** (*int*) – The number of rows for the second matrix.

Return type
None

Notes

This call is complementary to *setDimensions()*, to provide dimensions that are specific to this *DS.Type*.

See also

setDimensions, *getGSVDDimensions*, DSGSVDSetDimensions

:sources:`Source code at slepc4py/SLEPc/DS.pyx:1060 <slepc4py/SLEPc/DS.pyx#L1060>`

setHSVDDimensions(*m*)

Set the number of columns of a *DS* of type *HSVD*.

Logically collective.

Parameters
m (*int*) – The number of columns.

Return type
None

Notes

This call is complementary to *setDimensions()*, to provide a dimension that is specific to this *DS.Type*.

See also

setDimensions, *getHSVDDimensions*, DSHSVDSetDimensions

:sources:`Source code at slepc4py/SLEPc/DS.pyx:1018 <slepc4py/SLEPc/DS.pyx#L1018>`

setIdentity(*matname*)

Set the identity on the active part of a matrix.

Logically collective.

Parameters
matname (MatType) – The matrix to be changed.

Return type
None

See also

DSSetIdentity

:sources:`Source code at slepc4py/SLEPc/DS.pyx:889 <slepc4py/SLEPc/DS.pyx#L889>`

setMethod(*meth*)

Set the method to be used to solve the problem.

Logically collective.

Parameters
meth (*int*) – An index identifying the method.

Return type
None

See also

getMethod, DSSetMethod

:sources:`Source code at slepc4py/SLEPc/DS.pyx:578 <slepc4py/SLEPc/DS.pyx#L578>`

setOptionsPrefix(*prefix=None*)

Set the prefix used for searching for all DS options in the database.

Logically collective.

Parameters
prefix (*str | None*) – The prefix string to prepend to all DS option requests.

Return type
None

Notes

A hyphen (-) must NOT be given at the beginning of the prefix name. The first character of all runtime options is AUTOMATICALLY the hyphen.

See also

appendOptionsPrefix, *getOptionsPrefix*, DSSetOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/DS.pyx:235 <slepc4py/SLEPc/DS.pyx#L235>`

setPEPCoefficients(*pbc*)

Set the polynomial basis coefficients of a *DS* of type *PEP*.

Logically collective.

Parameters
pbc (*Sequence[float]*) – Coefficients.

Return type
None

Notes

This function is required only in the case of a polynomial specified in a non-monomial basis, to provide the coefficients that will be used during the linearization, multiplying the identity blocks on the three main diagonal blocks. Depending on the polynomial basis (Chebyshev, Legendre, ...) the coefficients must be different.

There must be a total of $3(d+1)$ coefficients, where d is the degree of the polynomial. The coefficients are arranged in three groups, a_i, b_i, c_i, according to the definition of the three-term recurrence. In the case of the monomial basis, $a_i = 1$ and $b_i = c_i = 0$, in which case it is not necessary to invoke this function.

See also

getPEPCoefficients, DSPEPSetCoefficients

:sources:`Source code at slepc4py/SLEPc/DS.pyx:1145 <slepc4py/SLEPc/DS.pyx#L1145>`

setPEPDegree(*deg*)

Set the polynomial degree of a *DS* of type *PEP*.

Logically collective.

Parameters
deg (*int*) – The polynomial degree.

Return type
None

See also

getPEPDegree, DSPEPSetDegree

:sources:`Source code at slepc4py/SLEPc/DS.pyx:1108 <slepc4py/SLEPc/DS.pyx#L1108>`

setParallel(*pmode*)

Set the mode of operation in parallel runs.

Logically collective.

Parameters
pmode (ParallelType) – The parallel mode.

Return type
None

See also

getParallel, DSSetParallel

:sources:`Source code at slepc4py/SLEPc/DS.pyx:436 <slepc4py/SLEPc/DS.pyx#L436>`

setRefined(*ref=True*)

Set a flag to indicate that refined vectors must be computed.

Logically collective.

Parameters
ref (*bool*) – True if refined vectors must be used.

Return type
None

Notes

Normally the vectors returned in *DS.MatType.X* are eigenvectors of the projected matrix. With this flag activated, *vectors()* will return the right singular vector of the smallest singular value of matrix $\hat{A} - \eta I$, where $\hat{A}$ is the extended matrix (with extra row) and η is the Ritz value. This is used in the refined Ritz approximation.

The default is False.

See also

getRefined, *vectors*, *setExtraRow*, DSSetRefined

:sources:`Source code at slepc4py/SLEPc/DS.pyx:709 <slepc4py/SLEPc/DS.pyx#L709>`

setSVDDimensions(*m*)

Set the number of columns of a *DS* of type *SVD*.

Logically collective.

Parameters
m (*int*) – The number of columns.

Return type
None

Notes

This call is complementary to *setDimensions()*, to provide a dimension that is specific to this *DS.Type*.

See also

setDimensions, *getSVDDimensions*, DSSVDSetDimensions

:sources:`Source code at slepc4py/SLEPc/DS.pyx:976 <slepc4py/SLEPc/DS.pyx#L976>`

setState(*state*)

Set the state of the DS object.

Logically collective.

Parameters
state (StateType) – The new state.

Return type
None

Notes

The state indicates that the dense system is in an initial state (raw), in an intermediate state (such as tridiagonal, Hessenberg or Hessenberg-triangular), in a condensed state (such as diagonal, Schur or generalized Schur), or in a truncated state.

The state is automatically changed in functions such as *solve()* or *truncate()*. This function is normally used to return to the raw state when the condensed structure is destroyed, or to indicate that *solve()* must start with a problem that already has an intermediate form.

See also

getState, *solve*, *truncate*, DSSetState

:sources:`Source code at slepc4py/SLEPc/DS.pyx:385 <slepc4py/SLEPc/DS.pyx#L385>`

setType(*ds_type*)

Set the type for the DS object.

Logically collective.

Parameters

ds_type (Type | *str*) – The direct solver type to be used.

Return type

None

See also

getType, DSSetType

:sources:`Source code at slepc4py/SLEPc/DS.pyx:197 <slepc4py/SLEPc/DS.pyx#L197>`

solve()

Solve the problem.

Logically collective.

Returns

Eigenvalues or singular values.

Return type

ArrayScalar

See also

DSSolve

:sources:`Source code at slepc4py/SLEPc/DS.pyx:928 <slepc4py/SLEPc/DS.pyx#L928>`

truncate(*n*, *trim=False*)

Truncate the system represented in the DS object.

Logically collective.

Parameters

- **n** (*int*) – The new size.

- **trim** (*bool*) – A flag to indicate if the factorization must be trimmed.

Return type
None

See also

setDimensions, *setExtraRow*, DSTruncate

:sources:`Source code at slepc4py/SLEPc/DS.pyx:757 <slepc4py/SLEPc/DS.pyx#L757>`

updateExtraRow()

Ensure that the extra row gets up-to-date after a call to *DS.solve()*.

Logically collective.

Perform all necessary operations so that the extra row gets up-to-date after a call to *DS.solve()*.

See also

DSUpdateExtraRow

:sources:`Source code at slepc4py/SLEPc/DS.pyx:778 <slepc4py/SLEPc/DS.pyx#L778>`

Return type
None

vectors(*matname=X*)

Compute vectors associated to the dense system such as eigenvectors.

Logically collective.

Parameters
matname – The matrix, used to indicate which vectors are required.

Return type
None

See also

DSVectors

:sources:`Source code at slepc4py/SLEPc/DS.pyx:956 <slepc4py/SLEPc/DS.pyx#L956>`

view(*viewer=None*)

Print the DS data structure.

Collective.

Parameters
viewer (*Viewer | None*) – Visualization context; if not provided, the standard output is used.

Return type
None

See also

DSView

:sources:`Source code at slepc4py/SLEPc/DS.pyx:131 <slepc4py/SLEPc/DS.pyx#L131>`

Attributes Documentation

block_size

The block size.

:sources:`Source code at slepc4py/SLEPc/DS.pyx:1224 <slepc4py/SLEPc/DS.pyx#L1224>`

compact

Compact storage of matrices.

:sources:`Source code at slepc4py/SLEPc/DS.pyx:1240 <slepc4py/SLEPc/DS.pyx#L1240>`

extra_row

If the matrix has one extra row.

:sources:`Source code at slepc4py/SLEPc/DS.pyx:1248 <slepc4py/SLEPc/DS.pyx#L1248>`

method

The method to be used to solve the problem.

:sources:`Source code at slepc4py/SLEPc/DS.pyx:1232 <slepc4py/SLEPc/DS.pyx#L1232>`

parallel

The mode of operation in parallel runs.

:sources:`Source code at slepc4py/SLEPc/DS.pyx:1216 <slepc4py/SLEPc/DS.pyx#L1216>`

refined

If refined vectors must be computed.

:sources:`Source code at slepc4py/SLEPc/DS.pyx:1256 <slepc4py/SLEPc/DS.pyx#L1256>`

state

The state of the DS object.

:sources:`Source code at slepc4py/SLEPc/DS.pyx:1208 <slepc4py/SLEPc/DS.pyx#L1208>`

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.EPS

class slepc4py.SLEPc.**EPS**

Bases: Object

Eigenvalue Problem Solver.

The Eigenvalue Problem Solver (*EPS*) is the object provided by slepc4py for specifying a linear eigenvalue problem, either in standard or generalized form. It provides uniform and efficient access to all of the linear eigensolvers included in the package.

Enumerations

Balance	EPS type of balancing used for non-Hermitian problems.
CISSExtraction	EPS CISS extraction technique.
CISSQuadRule	EPS CISS quadrature rule.
CISSStrategy	EPS CISS strategy to solve the linear systems.
Conv	EPS convergence test.
ConvergedReason	EPS convergence reasons.
ErrorType	EPS error type to assess accuracy of computed solutions.
Extraction	EPS extraction technique.
KrylovSchurBSEType	EPS Krylov-Schur method for BSE problems.
KrylovSchurLREPType	EPS Krylov-Schur method for LREP problems.
LanczosReorthogType	EPS Lanczos reorthogonalization type.
PowerShiftType	EPS Power shift type.
ProblemType	EPS problem type.
Stop	EPS stopping test.
Type	EPS type.
Which	EPS desired part of spectrum.

slepc4py.SLEPc.EPS.Balance

class slepc4py.SLEPc.EPS.**Balance**

Bases: object

EPS type of balancing used for non-Hermitian problems.

- *NONE*: None.
- *ONESIDE*: One-sided balancing.
- *TWOSIDE*: Two-sided balancing.
- *USER*: User-provided balancing matrices.

See also

EPSBalance

Attributes Summary

NONE	Constant NONE of type int
ONESIDE	Constant ONESIDE of type int
TWOSIDE	Constant TWOSIDE of type int
USER	Constant USER of type int

Attributes Documentation

NONE: int = NONE

Constant NONE of type int

ONESIDE: int = ONESIDE

Constant ONESIDE of type int

TWOSIDE: int = TWOSIDE

Constant TWOSIDE of type int

USER: int = USER

Constant USER of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.EPS.CISSExtraction

class slepc4py.SLEPc.EPS.**CISSExtraction**

Bases: object

EPS CISS extraction technique.

- *RITZ*: Ritz extraction.
- *HANKEL*: Extraction via Hankel eigenproblem.

See also

EPSCISSExtraction

Attributes Summary

HANKEL	Constant HANKEL of type int
RITZ	Constant RITZ of type int

Attributes Documentation

HANKEL: int = HANKEL

Constant HANKEL of type int

RITZ: int = RITZ

Constant RITZ of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.EPS.CISSQuadRule

class slepc4py.SLEPc.EPS.**CISSQuadRule**

Bases: object

EPS CISS quadrature rule.

- *TRAPEZOIDAL*: Trapezoidal rule.
- *CHEBYSHEV*: Chebyshev points.

See also

EPSCISSQuadRule

Attributes Summary

CHEBYSHEV	Constant CHEBYSHEV of type int
TRAPEZOIDAL	Constant TRAPEZOIDAL of type int

Attributes Documentation

CHEBYSHEV: int = CHEBYSHEV

Constant CHEBYSHEV of type int

TRAPEZOIDAL: int = TRAPEZOIDAL

Constant TRAPEZOIDAL of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.EPS.CISSStrategy

class slepc4py.SLEPc.EPS.**CISSStrategy**

Bases: object

EPS CISS strategy to solve the linear systems.

- *USEST*: Use the *ST* object for the linear solves.
- *SPLIT*: Use a collection of independent petsc4py.PETSc.KSP objects.
- *MULTISHIFT*: Use a petsc4py.PETSc.KSP for multiple shifted systems.

See also

EPSCISSStrategy

Attributes Summary

MULTISHIFT	Constant MULTISHIFT of type int
SPLIT	Constant SPLIT of type int
USEST	Constant USEST of type int

Attributes Documentation

MULTISHIFT: int = MULTISHIFT

Constant MULTISHIFT of type int

SPLIT: int = SPLIT

Constant SPLIT of type int

USEST: int = USEST

Constant USEST of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.EPS.Conv

class slepc4py.SLEPc.EPS.**Conv**

Bases: object

EPS convergence test.

- *ABS*: Absolute convergence test.
- *REL*: Convergence test relative to the eigenvalue.
- *NORM*: Convergence test relative to the matrix norms.
- *USER*: User-defined convergence test.

See also

EPSConv

Attributes Summary

ABS	Constant ABS of type int
NORM	Constant NORM of type int
REL	Constant REL of type int
USER	Constant USER of type int

Attributes Documentation

ABS: int = ABS

Constant ABS of type int

NORM: int = NORM

Constant NORM of type int

REL: int = REL

Constant REL of type int

USER: int = USER

Constant USER of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.EPS.ConvergedReason

class slepc4py.SLEPc.EPS.**ConvergedReason**

Bases: object

EPS convergence reasons.

- *CONVERGED_TOL*: All eigenpairs converged to requested tolerance.
- *CONVERGED_USER*: User-defined convergence criterion satisfied.
- *DIVERGED_ITS*: Maximum number of iterations exceeded.
- *DIVERGED_BREAKDOWN*: Solver failed due to breakdown.
- *DIVERGED_SYMMETRY_LOST*: Lanczos-type method could not preserve symmetry.
- *CONVERGED_ITERATING*: Iteration not finished yet.

See also

EPSConvergedReason

Attributes Summary

CONVERGED_ITERATING	Constant CONVERGED_ITERATING of type int
CONVERGED_TOL	Constant CONVERGED_TOL of type int
CONVERGED_USER	Constant CONVERGED_USER of type int
DIVERGED_BREAKDOWN	Constant DIVERGED_BREAKDOWN of type int
DIVERGED_ITS	Constant DIVERGED_ITS of type int
DIVERGED_SYMMETRY_LOST	Constant DIVERGED_SYMMETRY_LOST of type int
ITERATING	Constant ITERATING of type int

Attributes Documentation

CONVERGED_ITERATING: int = CONVERGED_ITERATING

Constant CONVERGED_ITERATING of type int

CONVERGED_TOL: int = CONVERGED_TOL

Constant CONVERGED_TOL of type int

CONVERGED_USER: int = CONVERGED_USER

Constant CONVERGED_USER of type int

DIVERGED_BREAKDOWN: int = DIVERGED_BREAKDOWN

Constant DIVERGED_BREAKDOWN of type int

DIVERGED_ITS: int = DIVERGED_ITS

Constant DIVERGED_ITS of type int

DIVERGED_SYMMETRY_LOST: int = DIVERGED_SYMMETRY_LOST

Constant DIVERGED_SYMMETRY_LOST of type int

ITERATING: int = ITERATING

Constant ITERATING of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.EPS.ErrorType

class slepc4py.SLEPc.EPS.**ErrorType**

Bases: object

EPS error type to assess accuracy of computed solutions.

- *ABSOLUTE*: Absolute error.
- *RELATIVE*: Relative error.
- *BACKWARD*: Backward error.

See also

EPSErrorType

Attributes Summary

ABSOLUTE	Constant ABSOLUTE of type int
BACKWARD	Constant BACKWARD of type int
RELATIVE	Constant RELATIVE of type int

Attributes Documentation

ABSOLUTE: int = ABSOLUTE

Constant ABSOLUTE of type int

BACKWARD: int = BACKWARD

Constant BACKWARD of type int

RELATIVE: int = RELATIVE

Constant RELATIVE of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.EPS.Extraction

class slepc4py.SLEPc.EPS.**Extraction**

Bases: object

EPS extraction technique.

- *RITZ*: Standard Rayleigh-Ritz extraction.
- *HARMONIC*: Harmonic extraction.
- *HARMONIC_RELATIVE*: Harmonic extraction relative to the eigenvalue.
- *HARMONIC_RIGHT*: Harmonic extraction for rightmost eigenvalues.
- *HARMONIC_LARGEST*: Harmonic extraction for largest magnitude (without target).
- *REFINED*: Refined extraction.
- *REFINED_HARMONIC*: Refined harmonic extraction.

See also

EPSExtraction

Attributes Summary

HARMONIC	Constant HARMONIC of type int
HARMONIC_LARGEST	Constant HARMONIC_LARGEST of type int
HARMONIC_RELATIVE	Constant HARMONIC_RELATIVE of type int
HARMONIC_RIGHT	Constant HARMONIC_RIGHT of type int
REFINED	Constant REFINED of type int
REFINED_HARMONIC	Constant REFINED_HARMONIC of type int
RITZ	Constant RITZ of type int

Attributes Documentation

HARMONIC: int = HARMONIC

Constant HARMONIC of type int

HARMONIC_LARGEST: int = HARMONIC_LARGEST

Constant HARMONIC_LARGEST of type int

HARMONIC_RELATIVE: int = HARMONIC_RELATIVE

Constant HARMONIC_RELATIVE of type int

HARMONIC_RIGHT: int = HARMONIC_RIGHT

Constant HARMONIC_RIGHT of type int

REFINED: int = REFINED

Constant REFINED of type int

REFINED_HARMONIC: int = REFINED_HARMONIC

Constant REFINED_HARMONIC of type int

RITZ: int = RITZ

Constant RITZ of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.EPS.KrylovSchurBSEType

class slepc4py.SLEPc.EPS.**KrylovSchurBSEType**

Bases: object

EPS Krylov-Schur method for BSE problems.

- *SHAO*: Lanczos recurrence for H square.
- *GRUNING*: Lanczos recurrence for H.
- *PROJECTEDBSE*: Lanczos where the projected problem has BSE structure.

See also

EPSKrylovSchurBSEType

Attributes Summary

GRUNING	Constant GRUNING of type int
PROJECTEDBSE	Constant PROJECTEDBSE of type int
SHAO	Constant SHAO of type int

Attributes Documentation

GRUNING: int = GRUNING

Constant GRUNING of type int

PROJECTEDBSE: int = PROJECTEDBSE

Constant PROJECTEDBSE of type int

SHAO: int = SHAO

Constant SHAO of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.EPS.KrylovSchurLREPType

class slepc4py.SLEPc.EPS.**KrylovSchurLREPType**

Bases: object

EPS Krylov-Schur method for LREP problems.

- *TENG*: Lanczos method proposed by Teng and Li.
- *ZHONG*: Lanczos method proposed by Zhong and Xu.

See also

EPSKrylovSchurLREPType

Attributes Summary

TENG	Constant TENG of type int
ZHONG	Constant ZHONG of type int

Attributes Documentation

TENG: int = TENG

Constant TENG of type int

ZHONG: int = ZHONG

Constant ZHONG of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.EPS.LanczosReorthogType

class slepc4py.SLEPc.EPS.**LanczosReorthogType**

Bases: object

EPS Lanczos reorthogonalization type.

- *LOCAL*: Local reorthogonalization only.
- *FULL*: Full reorthogonalization.
- *SELECTIVE*: Selective reorthogonalization.
- *PERIODIC*: Periodic reorthogonalization.
- *PARTIAL*: Partial reorthogonalization.
- *DELAYED*: Delayed reorthogonalization.

See also

EPSLanczosReorthogType

Attributes Summary

DELAYED	Constant DELAYED of type int
FULL	Constant FULL of type int
LOCAL	Constant LOCAL of type int
PARTIAL	Constant PARTIAL of type int
PERIODIC	Constant PERIODIC of type int
SELECTIVE	Constant SELECTIVE of type int

Attributes Documentation

DELAYED: int = DELAYED

Constant DELAYED of type int

FULL: int = FULL

Constant FULL of type int

LOCAL: int = LOCAL

Constant LOCAL of type int

PARTIAL: int = PARTIAL

Constant PARTIAL of type int

PERIODIC: int = PERIODIC

Constant PERIODIC of type int

SELECTIVE: int = SELECTIVE

Constant SELECTIVE of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.EPS.PowerShiftType

class slepc4py.SLEPc.EPS.**PowerShiftType**

Bases: object

EPS Power shift type.

- *CONSTANT*: Constant shift.
- *RAYLEIGH*: Rayleigh quotient.
- *WILKINSON*: Wilkinson shift.

See also

EPSPowerShiftType

Attributes Summary

CONSTANT	Constant CONSTANT of type int
RAYLEIGH	Constant RAYLEIGH of type int
WILKINSON	Constant WILKINSON of type int

Attributes Documentation

CONSTANT: int = CONSTANT

Constant CONSTANT of type int

RAYLEIGH: int = RAYLEIGH

Constant RAYLEIGH of type int

WILKINSON: int = WILKINSON

Constant WILKINSON of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.EPS.ProblemType

class slepc4py.SLEPc.EPS.**ProblemType**

Bases: object

EPS problem type.

- *HEP*: Hermitian eigenproblem.
- *NHEP*: Non-Hermitian eigenproblem.
- *GHEP*: Generalized Hermitian eigenproblem.
- *GNHEP*: Generalized Non-Hermitian eigenproblem.

- *PGNHEP*: Generalized Non-Hermitian eigenproblem with positive definite B.
- *GHIEP*: Generalized Hermitian-indefinite eigenproblem.
- *BSE*: Structured Bethe-Salpeter eigenproblem.
- *HAMILT*: Hamiltonian eigenproblem.
- *LREP*: Structured Linear Response eigenvalue problem.

See also

EPSProblemType

Attributes Summary

BSE	Constant BSE of type int
GHEP	Constant GHEP of type int
GHIEP	Constant GHIEP of type int
GNHEP	Constant GNHEP of type int
HAMILT	Constant HAMILT of type int
HEP	Constant HEP of type int
LREP	Constant LREP of type int
NHEP	Constant NHEP of type int
PGNHEP	Constant PGNHEP of type int

Attributes Documentation

BSE: int = BSE

Constant BSE of type int

GHEP: int = GHEP

Constant GHEP of type int

GHIEP: int = GHIEP

Constant GHIEP of type int

GNHEP: int = GNHEP

Constant GNHEP of type int

HAMILT: int = HAMILT

Constant HAMILT of type int

HEP: int = HEP

Constant HEP of type int

LREP: int = LREP

Constant LREP of type int

NHEP: int = NHEP

Constant NHEP of type int

PGNHEP: int = PGNHEP

Constant PGNHEP of type int

__init__()

classmethod **__new__**(**args*, ***kwargs*)

slepc4py.SLEPc.EPS.Stop

class slepc4py.SLEPc.EPS.**Stop**

Bases: object

EPS stopping test.

- *BASIC*: Default stopping test.
- *USER*: User-defined stopping test.
- *THRESHOLD*: Threshold stopping test.

See also

EPSStop

Attributes Summary

BASIC	Constant BASIC of type int
THRESHOLD	Constant THRESHOLD of type int
USER	Constant USER of type int

Attributes Documentation

BASIC: int = BASIC

Constant BASIC of type int

THRESHOLD: int = THRESHOLD

Constant THRESHOLD of type int

USER: int = USER

Constant USER of type int

__init__()

classmethod **__new__**(**args*, ***kwargs*)

slepc4py.SLEPc.EPS.Type

class slepc4py.SLEPc.EPS.**Type**

Bases: object

EPS type.

Native eigenvalue solvers.

- *POWER*: Power Iteration, Inverse Iteration, RQI.
- *SUBSPACE*: Subspace Iteration.
- *ARNOLDI*: Arnoldi.
- *LANCZOS*: Lanczos.
- *KRYLOVSCHUR*: Krylov-Schur (default).

- *GD*: Generalized Davidson.
- *JD*: Jacobi-Davidson.
- *RQCG*: Rayleigh Quotient Conjugate Gradient.
- *LOBPCG*: Locally Optimal Block Preconditioned Conjugate Gradient.
- *CISS*: Contour Integral Spectrum Slicing.
- *LYAPII*: Lyapunov inverse iteration.

Wrappers to external eigensolvers (should be enabled during installation of SLEPc).

- *LAPACK*: Sequential dense eigensolver.
- *ARPACK*: Iterative Krylov-based eigensolver.
- *BLOPEX*: Implementation of LOBPCG.
- *PRIMME*: Iterative eigensolvers of Davidson type.
- *FEAST*: Contour integral eigensolver.
- *SCALAPACK*: Parallel dense eigensolver for symmetric problems.
- *ELPA*: Parallel dense eigensolver for symmetric problems.
- *ELEMENTAL*: Parallel dense eigensolver for symmetric problems.
- *EVSL*: Iterative eigensolver based on polynomial filters.
- *CHASE*: Subspace iteration accelerated with polynomials.

See also

`EPSType`

Attributes Summary

ARNOLDI	Object `ARNOLDI` of type `str`
ARPACK	Object `ARPACK` of type `str`
BLOPEX	Object `BLOPEX` of type `str`
CHASE	Object `CHASE` of type `str`
CISS	Object `CISS` of type `str`
ELEMENTAL	Object `ELEMENTAL` of type `str`
ELPA	Object `ELPA` of type `str`
EVSL	Object `EVSL` of type `str`
FEAST	Object `FEAST` of type `str`
GD	Object `GD` of type `str`
JD	Object `JD` of type `str`
KRYLOVSCHUR	Object `KRYLOVSCHUR` of type `str`
LANCZOS	Object `LANCZOS` of type `str`
LAPACK	Object `LAPACK` of type `str`
LOBPCG	Object `LOBPCG` of type `str`
LYAPII	Object `LYAPII` of type `str`
POWER	Object `POWER` of type `str`
PRIMME	Object `PRIMME` of type `str`
RQCG	Object `RQCG` of type `str`

continues on next page

Table 36 – continued from previous page

SCALAPACK	Object SCALAPACK of type str
SUBSPACE	Object SUBSPACE of type str

Attributes Documentation

ARNOLDI: str = ARNOLDI

Object ARNOLDI of type str

ARPACK: str = ARPACK

Object ARPACK of type str

BLOPEX: str = BLOPEX

Object BLOPEX of type str

CHASE: str = CHASE

Object CHASE of type str

CISS: str = CISS

Object CISS of type str

ELEMENTAL: str = ELEMENTAL

Object ELEMENTAL of type str

ELPA: str = ELPA

Object ELPA of type str

EVSL: str = EVSL

Object EVSL of type str

FEAST: str = FEAST

Object FEAST of type str

GD: str = GD

Object GD of type str

JD: str = JD

Object JD of type str

KRYLOVSCHUR: str = KRYLOVSCHUR

Object KRYLOVSCHUR of type str

LANCZOS: str = LANCZOS

Object LANCZOS of type str

LAPACK: str = LAPACK

Object LAPACK of type str

LOBPCG: str = LOBPCG

Object LOBPCG of type str

LYAPII: str = LYAPII

Object LYAPII of type str

POWER: str = POWER

Object POWER of type str

PRIMME: str = PRIMME

Object PRIMME of type str

RQCG: str = RQCG

Object RQCG of type str

SCALAPACK: str = SCALAPACK

Object SCALAPACK of type str

SUBSPACE: str = SUBSPACE

Object SUBSPACE of type str

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.EPS.Which

class slepc4py.SLEPc.EPS.**Which**

Bases: object

EPS desired part of spectrum.

- *LARGEST_MAGNITUDE*: Largest magnitude (default).
- *SMALLEST_MAGNITUDE*: Smallest magnitude.
- *LARGEST_REAL*: Largest real parts.
- *SMALLEST_REAL*: Smallest real parts.
- *LARGEST_IMAGINARY*: Largest imaginary parts in magnitude.
- *SMALLEST_IMAGINARY*: Smallest imaginary parts in magnitude.
- *TARGET_MAGNITUDE*: Closest to target (in magnitude).
- *TARGET_REAL*: Real part closest to target.
- *TARGET_IMAGINARY*: Imaginary part closest to target.
- *ALL*: All eigenvalues in an interval.
- *USER*: User defined selection.

See also

EPSWhich

Attributes Summary

ALL	Constant ALL of type int
LARGEST_IMAGINARY	Constant LARGEST_IMAGINARY of type int
LARGEST_MAGNITUDE	Constant LARGEST_MAGNITUDE of type int
LARGEST_REAL	Constant LARGEST_REAL of type int
SMALLEST_IMAGINARY	Constant SMALLEST_IMAGINARY of type int
SMALLEST_MAGNITUDE	Constant SMALLEST_MAGNITUDE of type int
SMALLEST_REAL	Constant SMALLEST_REAL of type int

continues on next page

Table 37 – continued from previous page

TARGET_IMAGINARY	Constant TARGET_IMAGINARY of type int
TARGET_MAGNITUDE	Constant TARGET_MAGNITUDE of type int
TARGET_REAL	Constant TARGET_REAL of type int
USER	Constant USER of type int

Attributes Documentation

ALL: int = ALL

Constant ALL of type int

LARGEST_IMAGINARY: int = LARGEST_IMAGINARY

Constant LARGEST_IMAGINARY of type int

LARGEST_MAGNITUDE: int = LARGEST_MAGNITUDE

Constant LARGEST_MAGNITUDE of type int

LARGEST_REAL: int = LARGEST_REAL

Constant LARGEST_REAL of type int

SMALLEST_IMAGINARY: int = SMALLEST_IMAGINARY

Constant SMALLEST_IMAGINARY of type int

SMALLEST_MAGNITUDE: int = SMALLEST_MAGNITUDE

Constant SMALLEST_MAGNITUDE of type int

SMALLEST_REAL: int = SMALLEST_REAL

Constant SMALLEST_REAL of type int

TARGET_IMAGINARY: int = TARGET_IMAGINARY

Constant TARGET_IMAGINARY of type int

TARGET_MAGNITUDE: int = TARGET_MAGNITUDE

Constant TARGET_MAGNITUDE of type int

TARGET_REAL: int = TARGET_REAL

Constant TARGET_REAL of type int

USER: int = USER

Constant USER of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

Methods Summary

appendOptionsPrefix([prefix])	Append to the prefix used for searching for all EPS options in the database.
cancelMonitor()	Clear all monitors for an *EPS* object.
computeError(i[, etype])	Compute the error associated with the i-th computed eigenpair.
create([comm])	Create the EPS object.
destroy()	Destroy the EPS object.

continues on next page

Table 38 – continued from previous page

errorView([etype, viewer])	Display the errors associated with the computed solution.
getArbitrarySelection()	Get the arbitrary selection function.
getArnoldiDelayed()	Get the type of reorthogonalization used during the Arnoldi iteration.
getBV()	Get the basis vectors object associated to the eigensolver.
getBalance()	Get the balancing type used by the EPS, and the associated parameters.
getCISSExtraction()	Get the extraction technique used in the CISS solver.
getCISSKSPs()	Get the array of linear solver objects associated with the CISS solver.
getCISSQuadRule()	Get the quadrature rule used in the CISS solver.
getCISSRefinement()	Get the values of various refinement parameters in the CISS solver.
getCISSSizes()	Get the values of various size parameters in the CISS solver.
getCISSStrategy()	Get the strategy for linear solves used in the CISS solver.
getCISSThreshold()	Get the values of various threshold parameters in the CISS solver.
getCISSUseST()	Deprecated, use getCISSStrategy()
getConverged()	Get the number of converged eigenpairs.
getConvergedReason()	Get the reason why the *solve()* iteration was stopped.
getConvergenceTest()	Get how to compute the error estimate used in the convergence test.
getDS()	Get the direct solver associated to the eigensolver.
getDimensions()	Get number of eigenvalues to compute and the dimension of the subspace.
getEigenpair(i[, Vr, Vi])	Get the i-th solution of the eigenproblem as computed by *solve()*.
getEigenvalue(i)	Get the i-th eigenvalue as computed by *solve()*.
getEigenvalueComparison()	Get the eigenvalue comparison function.
getEigenvector(i[, Vr, Vi])	Get the i-th right eigenvector as computed by *solve()*.
getErrorEstimate(i)	Get the error estimate associated to the i-th computed eigenpair.
getExtraction()	Get the extraction type used by the EPS object.
getGDBOrth()	Get the orthogonalization used in the search subspace.
getGDBlockSize()	Get the number of vectors to be added to the searching space.
getGDDoubleExpansion()	Get a flag indicating whether the double expansion variant is active.
getGDInitialSize()	Get the initial size of the searching space.
getGDKrylovStart()	Get a flag indicating if the search subspace is started with a Krylov basis.
getGDRestart()	Get the number of vectors of the search space after restart.
getInterval()	Get the computational interval for spectrum slicing.

continues on next page

Table 38 – continued from previous page

getInvariantSubspace()	Get an orthonormal basis of the computed invariant subspace.
getIterationNumber()	Get the current iteration number.
getJDBOrth()	Get the orthogonalization used in the search subspace.
getJDBlockSize()	Get the number of vectors to be added to the searching space.
getJDConstCorrectionTol()	Get the flag indicating if the dynamic stopping is being used.
getJDFix()	Get the threshold for changing the target in the correction equation.
getJDInitialSize()	Get the initial size of the searching space.
getJDKrylovStart()	Get a flag indicating if the search subspace is started with a Krylov basis.
getJDRestart()	Get the number of vectors of the search space after restart.
getKrylovSchurBSEType()	Get the method used for BSE structured eigenproblems (Krylov-Schur).
getKrylovSchurDetectZeros()	Get the flag that enforces zero detection in spectrum slicing.
getKrylovSchurDimensions()	Get the dimensions used for each subsolve step (spectrum slicing).
getKrylovSchurInertias()	Get the values of the shifts and their corresponding inertias.
getKrylovSchurKSP()	Get the linear solver object associated with the internal *EPS* object.
getKrylovSchurLREPType()	Get the method used for LREP structured eigenproblems (Krylov-Schur).
getKrylovSchurLocking()	Get the locking flag used in the Krylov-Schur method.
getKrylovSchurPartitions()	Get the number of partitions of the communicator (spectrum slicing).
getKrylovSchurRestart()	Get the restart parameter used in the Krylov-Schur method.
getKrylovSchurSubcommInfo()	Get information related to the case of doing spectrum slicing.
getKrylovSchurSubcommMats()	Get the eigenproblem matrices stored in the subcommunicator.
getKrylovSchurSubcommPairs(i[, v])	Get the i-th eigenpair stored in the multicommunicator of the process.
getKrylovSchurSubintervals()	Get the points that delimit the subintervals.
getLOBPCGBlockSize()	Get the block size used in the LOBPCG method.
getLOBPCGLocking()	Get the locking flag used in the LOBPCG method.
getLOBPCGRestart()	Get the restart parameter used in the LOBPCG method.
getLanczosReorthogType()	Get the type of reorthogonalization used during the Lanczos iteration.
getLeftEigenvector(i[, Wr, Wi])	Get the i-th left eigenvector as computed by *solve()*.
getLyapIIRanks()	Get the rank values used for the Lyapunov step.
getMonitor()	Get the list of monitor functions.
getOperators()	Get the matrices associated with the eigenvalue problem.

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getOptionsPrefix()	Get the prefix used for searching for all EPS options in the database.
getPowerShiftType()	Get the type of shifts used during the power iteration.
getProblemType()	Get the problem type from the EPS object.
getPurify()	Get the flag indicating whether purification is activated or not.
getRG()	Get the region object associated to the eigensolver.
getRQCGReset()	Get the reset parameter used in the RQCG method.
getST()	Get the spectral transformation object associated to the eigensolver.
getStoppingTest()	Get the stopping test function.
getTarget()	Get the value of the target.
getThreshold()	Get the threshold used in the threshold stopping test.
getTolerances()	Get the tolerance and max.
getTrackAll()	Get the flag indicating if all residual norms must be computed or not.
getTrueResidual()	Get the flag indicating if true residual must be computed explicitly.
getTwoSided()	Get the flag indicating if a two-sided variant of the algorithm is being used.
getType()	Get the EPS type of this object.
getWhichEigenpairs()	Get which portion of the spectrum is to be sought.
isGeneralized()	Tell if the EPS object corresponds to a generalized eigenproblem.
isHermitian()	Tell if the EPS object corresponds to a Hermitian eigenproblem.
isPositive()	Eigenproblem requiring a positive (semi-) definite matrix B.
isStructured()	Tell if the EPS object corresponds to a structured eigenvalue problem.
reset()	Reset the EPS object.
setArbitrarySelection(arbitrary[, args, kargs])	Set an arbitrary selection criterion function.
setArnoldiDelayed([delayed])	Set (toggle) delayed reorthogonalization in the Arnoldi iteration.
setBV(bv)	Set a basis vectors object associated to the eigensolver.
setBalance([balance, iterations, cutoff])	Set the balancing technique to be used by the eigensolver.
setCISSExtraction(extraction)	Set the extraction technique used in the CISS solver.
setCISSQuadRule(quad)	Set the quadrature rule used in the CISS solver.
setCISSRefinement([inner, blsize])	Set the values of various refinement parameters in the CISS solver.
setCISSSizes([ip, bs, ms, npart, bsmax, ...])	Set the values of various size parameters in the CISS solver.
setCISSStrategy(strategy)	Set the strategy for linear solves in the CISS solver.
setCISSThreshold([delta, spur])	Set the values of various threshold parameters in the CISS solver.
setCISSUseST([usest])	Deprecated, use setCISSStrategy()
setConvergenceTest(conv)	Set how to compute the error estimate used in the convergence test.
setDS(ds)	Set a direct solver object associated to the eigensolver.
setDeflationSpace(space)	Set vectors to form a basis of the deflation space.

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Table 38 – continued from previous page

setDimensions([nev, ncv, mpd])	Set number of eigenvalues to compute and the dimension of the subspace.
setEigenvalueComparison(comparison[, args, ...])	Set an eigenvalue comparison function.
setExtraction(extraction)	Set the extraction type used by the eigensolver.
setFromOptions()	Set EPS options from the options database.
setGDBOrth([borth])	Set the orthogonalization that will be used in the search subspace.
setGDBlockSize(bs)	Set the number of vectors to be added to the searching space.
setGDDoubleExpansion([doubleexp])	Set that the search subspace is expanded with double expansion.
setGDInitialSize(initialsize)	Set the initial size of the searching space.
setGDKrylovStart([krylovstart])	Set (toggle) starting the search subspace with a Krylov basis.
setGDRestart([minv, plusk])	Set the number of vectors of the search space after restart.
setInitialSpace(space)	Set the initial space from which the eigensolver starts to iterate.
setInterval(inta, intb)	Set the computational interval for spectrum slicing.
setJDBOrth([borth])	Set the orthogonalization that will be used in the search subspace.
setJDBlockSize(bs)	Set the number of vectors to be added to the searching space.
setJDConstCorrectionTol([constant])	Deactivate the dynamic stopping criterion.
setJDFix(fix)	Set the threshold for changing the target in the correction equation.
setJDInitialSize(initialsize)	Set the initial size of the searching space.
setJDKrylovStart([krylovstart])	Set (toggle) starting the search subspace with a Krylov basis.
setJDRestart([minv, plusk])	Set the number of vectors of the search space after restart.
setKrylovSchurBSEType(bse)	Set the Krylov-Schur variant used for BSE structured eigenproblems.
setKrylovSchurDetectZeros([detect])	Set the flag that enforces zero detection in spectrum slicing.
setKrylovSchurDimensions([nev, ncv, mpd])	Set the dimensions used for each subsolve step (spectrum slicing).
setKrylovSchurLREPType(lrep)	Set the Krylov-Schur variant used for LREP structured eigenproblems.
setKrylovSchurLocking([lock])	Set (toggle) locking/non-locking variants of the Krylov-Schur method.
setKrylovSchurPartitions(npart)	Set the number of partitions of the communicator (spectrum slicing).
setKrylovSchurRestart(keep)	Set the restart parameter for the Krylov-Schur method.
setKrylovSchurSubintervals(subint)	Set the subinterval boundaries.
setLOBPCGBlockSize(bs)	Set the block size of the LOBPCG method.
setLOBPCGLocking([lock])	Toggle between locking and non-locking (LOBPCG method).
setLOBPCGRestart(restart)	Set the restart parameter for the LOBPCG method.

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setLanczosReorthogType(reorthog)	Set the type of reorthogonalization used during the Lanczos iteration.
setLeftInitialSpace(space)	Set a left initial space from which the eigensolver starts to iterate.
setLyapIIRanks([rkc, rkl])	Set the ranks used in the solution of the Lyapunov equation.
setMonitor(monitor[, args, kargs])	Append a monitor function to the list of monitors.
setOperators(A[, B])	Set the matrices associated with the eigenvalue problem.
setOptionsPrefix([prefix])	Set the prefix used for searching for all EPS options in the database.
setPowerShiftType(shift)	Set the type of shifts used during the power iteration.
setProblemType(problem_type)	Set the type of the eigenvalue problem.
setPurify([purify])	Set (toggle) eigenvector purification.
setRG(rg)	Set a region object associated to the eigensolver.
setRQCGReset(nrest)	Set the reset parameter of the RQCG iteration.
setST(st)	Set a spectral transformation object associated to the eigensolver.
setStoppingTest(stopping[, args, kargs])	Set a function to decide when to stop the outer iteration of the eigensolver.
setTarget(target)	Set the value of the target.
setThreshold(thres[, rel])	Set the threshold used in the threshold stopping test.
setTolerances([tol, max_it])	Set the tolerance and max.
setTrackAll([trackall])	Set if the solver must compute the residual of all approximate eigenpairs.
setTrueResidual([trueres])	Set if the solver must compute the true residual explicitly or not.
setTwoSided([twosided])	Set to use a two-sided variant that also computes left eigenvectors.
setType(eps_type)	Set the particular solver to be used in the EPS object.
setUp()	Set up all the internal data structures.
setWhichEigenpairs(which)	Set which portion of the spectrum is to be sought.
solve()	Solve the eigensystem.
updateKrylovSchurSubcommMats([s, a, Au, t, ...])	Update the eigenproblem matrices stored internally in the communicator.
valuesView([viewer])	Display the computed eigenvalues in a viewer.
vectorsView([viewer])	Output computed eigenvectors to a viewer.
view([viewer])	Print the EPS data structure.

Attributes Summary

bv	The basis vectors (BV) object associated.
ds	The direct solver (DS) object associated.
extraction	The type of extraction technique to be employed.
max_it	The maximum iteration count.
problem_type	The type of the eigenvalue problem.
purify	Eigenvector purification.
rg	The region (RG) object associated.
st	The spectral transformation (ST) object associated.
target	The value of the target.
tol	The tolerance.

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track_all	Compute the residual norm of all approximate eigenpairs.
true_residual	Compute the true residual explicitly.
two_sided	Two-sided that also computes left eigenvectors.
which	The portion of the spectrum to be sought.

Methods Documentation

appendOptionsPrefix(*prefix=None*)

Append to the prefix used for searching for all EPS options in the database.

Logically collective.

Parameters
prefix (*str* | *None*) – The prefix string to prepend to all EPS option requests.

Return type
None

See also

setOptionsPrefix, *getOptionsPrefix*, EPSAppendOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:563 <slepc4py/SLEPc/EPS.pyx#L563>`

cancelMonitor()

Clear all monitors for an *EPS* object.

Logically collective.

See also

EPSMonitorCancel

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1910 <slepc4py/SLEPc/EPS.pyx#L1910>`

Return type
None

computeError(*i*, *etype=None*)

Compute the error associated with the i-th computed eigenpair.

Collective.

Compute the error (based on the residual norm) associated with the i-th computed eigenpair.

Parameters

- **i** (*int*) – Index of the solution to be considered.
- **etype** (ErrorType | *None*) – The error type to compute.

Returns
The error bound, computed in various ways from the residual norm $\|Ax - \lambda Bx\|_2$ where λ is the eigenvalue and x is the eigenvector.

Return type
float

Notes

The index `i` should be a value between `0` and `nconv-1` (see *getConverged()*).

If the computation of left eigenvectors was enabled with *setTwoSided()*, then the error will be computed using the maximum of the value above and the left residual norm $\|y^*A - \lambda y^*B\|_2$, where y is the approximate left eigenvector.

See also

getErrorEstimate, *setTwoSided*, EPSComputeError

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2269 <slepc4py/SLEPc/EPS.pyx#L2269>`

create(*comm=None*)

Create the EPS object.

Collective.

Parameters
comm (*Comm* | *None*) – MPI communicator; if not provided, it defaults to all processes.

Return type
Self

See also

EPSCreate

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:446 <slepc4py/SLEPc/EPS.pyx#L446>`

destroy()

Destroy the EPS object.

Collective.

See also

EPSDestroy

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:420 <slepc4py/SLEPc/EPS.pyx#L420>`

Return type
Self

errorView(*etype=None*, *viewer=None*)

Display the errors associated with the computed solution.

Collective.

Display the errors and the eigenvalues.

Parameters

- **etype** (*ErrorType* | *None*) – The error type to compute.
- **viewer** (*petsc4py.PETSc.Viewer* | *None*) – Visualization context; if not provided, the standard output is used.

Return type
None

Notes

By default, this function checks the error of all eigenpairs and prints the eigenvalues if all of them are below the requested tolerance. If the viewer has format `ASCII_INFO_DETAIL` then a table with eigenvalues and corresponding errors is printed.

See also

solve, *valuesView*, *vectorsView*, EPSErrorView

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2313 <slepc4py/SLEPc/EPS.pyx#L2313>`

getArbitrarySelection()

Get the arbitrary selection function.

Not collective.

Returns
The arbitrary selection function.

Return type
EPSArbitraryFunction

See also

setArbitrarySelection

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1804 <slepc4py/SLEPc/EPS.pyx#L1804>`

getArnoldiDelayed()

Get the type of reorthogonalization used during the Arnoldi iteration.

Not collective.

Returns
`True` if delayed reorthogonalization is to be used.

Return type
bool

See also

setArnoldiDelayed, EPSArnoldiGetDelayed

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2468 <slepc4py/SLEPc/EPS.pyx#L2468>`

getBV()

Get the basis vectors object associated to the eigensolver.

Not collective.

Returns
The basis vectors context.

Return type
BV

See also

setBV, EPSGetBV

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1457 <slepc4py/SLEPc/EPS.pyx#L1457>`

getBalance()

Get the balancing type used by the EPS, and the associated parameters.

Not collective.

Returns

- **balance** (*Balance*) – The balancing method.
- **iterations** (int) – Number of iterations of the balancing algorithm.
- **cutoff** (float) – Cutoff value.

Return type
tuple[*Balance*, int, float]

See also

setBalance, EPSGetBalance

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:743 <slepc4py/SLEPc/EPS.pyx#L743>`

getCISSExtraction()

Get the extraction technique used in the CISS solver.

Not collective.

Returns
The extraction technique.

Return type
CISSExtraction

See also

setCISSExtraction, EPSCISSGetExtraction

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4059 <slepc4py/SLEPc/EPS.pyx#L4059>`

`getCISSKSPs()`

Get the array of linear solver objects associated with the CISS solver.

Not collective.

Returns
The linear solver objects.

Return type
`list` of `petsc4py.PETSc.KSP`

Notes

The number of `petsc4py.PETSc.KSP` solvers is equal to the number of integration points divided by the number of partitions. This value is halved in the case of real matrices with a region centered at the real axis.

See also

setCISSSizes, EPSCISSGetKSPs

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4362 <slepc4py/SLEPc/EPS.pyx#L4362>`

`getCISSQuadRule()`

Get the quadrature rule used in the CISS solver.

Not collective.

Returns
The quadrature rule.

Return type
CISSQuadRule

See also

setCISSQuadRule, EPSCISSGetQuadRule

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4096 <slepc4py/SLEPc/EPS.pyx#L4096>`

`getCISSRefinement()`

Get the values of various refinement parameters in the CISS solver.

Not collective.

Returns

- **inner** (`int`) – Number of iterative refinement iterations (inner loop).
- **blsize** (`int`) – Number of iterative refinement iterations (blocksize loop).

Return type
tuple[int, int]

See also

setCISSRefinement, EPSCISSGetRefinement

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4318 <slepc4py/SLEPc/EPS.pyx#L4318>`

`getCISSSizes()`

Get the values of various size parameters in the CISS solver.

Not collective.

Returns

- **ip** (int) – Number of integration points.
- **bs** (int) – Block size.
- **ms** (int) – Moment size.
- **npart** (int) – Number of partitions when splitting the communicator.
- **bsmax** (int) – Maximum block size.
- **realmats** (bool) – True if A and B are real.

Return type

tuple[int, int, int, int, int, bool]

See also

setCISSSizes, EPSCISSGetSizes

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4216 <slepc4py/SLEPc/EPS.pyx#L4216>`

`getCISSStrategy()`

Get the strategy for linear solves used in the CISS solver.

Not collective.

Returns

The strategy for solving the linear systems.

Return type

CISSStrategy

See also

setCISSStrategy, EPSCISSGetStrategy

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4143 <slepc4py/SLEPc/EPS.pyx#L4143>`

`getCISSThreshold()`

Get the values of various threshold parameters in the CISS solver.

Not collective.

Returns

- **delta** (float) – Threshold for numerical rank.

- **spur** (float) – Spurious threshold (to discard spurious eigenpairs.

Return type
tuple[float, float]

See also

setCISSThreshold, EPSCISSGetThreshold

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4273 <slepc4py/SLEPc/EPS.pyx#L4273>`

getCISSUseST()

Deprecated, use getCISSStrategy()

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4351 <slepc4py/SLEPc/EPS.pyx#L4351>`

Return type
bool

getConverged()

Get the number of converged eigenpairs.

Not collective.

Returns
nconv – Number of converged eigenpairs.

Return type
int

Notes

This function should be called after *solve()* has finished.

The value nconv may be different from the number of requested solutions nev, but not larger than ncv, see *setDimensions()*.

See also

setDimensions, *solve*, *getEigenpair*, EPSGetConverged

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2010 <slepc4py/SLEPc/EPS.pyx#L2010>`

getConvergedReason()

Get the reason why the *solve()* iteration was stopped.

Not collective.

Returns
Negative value indicates diverged, positive value converged.

Return type
ConvergedReason

See also

setTolerances, *solve*, EPSGetConvergedReason

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1991 <slepc4py/SLEPc/EPS.pyx#L1991>`

getConvergenceTest()

Get how to compute the error estimate used in the convergence test.

Not collective.

Returns

The method used to compute the error estimate used in the convergence test.

Return type

Conv

See also

setConvergenceTest, EPSGetConvergenceTest

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1227 <slepc4py/SLEPc/EPS.pyx#L1227>`

getDS()

Get the direct solver associated to the eigensolver.

Not collective.

Returns

The direct solver context.

Return type

DS

See also

setDS, EPSGetDS

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1494 <slepc4py/SLEPc/EPS.pyx#L1494>`

getDimensions()

Get number of eigenvalues to compute and the dimension of the subspace.

Not collective.

Returns

- **nev** (int) – Number of eigenvalues to compute.
- **ncv** (int) – Maximum dimension of the subspace to be used by the solver.
- **mpd** (int) – Maximum dimension allowed for the projected problem.

Return type

tuple[int, int, int]

See also

setDimensions, EPSGetDimensions

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1340 <slepc4py/SLEPc/EPS.pyx#L1340>`

getEigenpair(*i*, *Vr=None*, *Vi=None*)

Get the i-th solution of the eigenproblem as computed by *solve()*.

Collective.

The solution consists of both the eigenvalue and the eigenvector.

Parameters

- **i** (*int*) – Index of the solution to be obtained.
- **Vr** (*Vec* | *None*) – Placeholder for the returned eigenvector (real part).
- **Vi** (*Vec* | *None*) – Placeholder for the returned eigenvector (imaginary part).

Returns

e – The computed eigenvalue. It will be a real variable in case of a Hermitian or generalized Hermitian eigenproblem. Otherwise it will be a complex variable (possibly with zero imaginary part).

Return type

Scalar

Notes

The index `i` should be a value between `0` and `nconv-1` (see *getConverged()*). Eigenpairs are indexed according to the ordering criterion established with *setWhichEigenpairs()*.

The 2-norm of the eigenvector is one unless the problem is generalized Hermitian. In this case the eigenvector is normalized with respect to the norm defined by the B matrix.

See also

solve, *getConverged*, *setWhichEigenpairs*, EPSGetEigenpair

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2144 <slepc4py/SLEPc/EPS.pyx#L2144>`

getEigenvalue(*i*)

Get the i-th eigenvalue as computed by *solve()*.

Not collective.

Parameters

i (*int*) – Index of the solution to be obtained.

Returns

The computed eigenvalue. It will be a real variable in case of a Hermitian or generalized Hermitian eigenproblem, and in some structured eigenvalue problems. Otherwise it will be a complex variable (possibly with zero imaginary part).

Return type

Scalar

Notes

The index `i` should be a value between `0` and `nconv-1` (see *getConverged()*). Eigenpairs are indexed according to the ordering criterion established with *setWhichEigenpairs()*.

See also

getConverged, *setWhichEigenpairs*, *getEigenpair*, EPSGetEigenvalue

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2036 <slepc4py/SLEPc/EPS.pyx#L2036>`

getEigenvalueComparison()

Get the eigenvalue comparison function.

Not collective.

Returns
The eigenvalue comparison function.

Return type
EPSEigenvalueComparison

See also

setEigenvalueComparison

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1851 <slepc4py/SLEPc/EPS.pyx#L1851>`

getEigenvector(*i*, *Vr=None*, *Vi=None*)

Get the i-th right eigenvector as computed by *solve()*.

Collective.

Parameters

- **i** (*int*) – Index of the solution to be obtained.
- **Vr** (*Vec | None*) – Placeholder for the returned eigenvector (real part).
- **Vi** (*Vec | None*) – Placeholder for the returned eigenvector (imaginary part).

Return type
None

Notes

The index `i` should be a value between `0` and `nconv-1` (see *getConverged()*). Eigenpairs are indexed according to the ordering criterion established with *setWhichEigenpairs()*.

The 2-norm of the eigenvector is one unless the problem is generalized Hermitian. In this case the eigenvector is normalized with respect to the norm defined by the B matrix.

See also

getConverged, *setWhichEigenpairs*, *getEigenpair*, EPSGetEigenvector

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2076 <slepc4py/SLEPc/EPS.pyx#L2076>`

getErrorEstimate(*i*)

Get the error estimate associated to the i-th computed eigenpair.

Not collective.

Parameters
i (*int*) – Index of the solution to be considered.

Returns
Error estimate.

Return type
float

Notes

This is the error estimate used internally by the eigensolver. The actual error bound can be computed with *computeError()*.

See also

computeError, EPSGetErrorEstimate

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2239 <slepc4py/SLEPc/EPS.pyx#L2239>`

getExtraction()

Get the extraction type used by the EPS object.

Not collective.

Returns
The method of extraction.

Return type
Extraction

See also

setExtraction, EPSGetExtraction

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:818 <slepc4py/SLEPc/EPS.pyx#L818>`

getGDBOrth()

Get the orthogonalization used in the search subspace.

Not collective.

Get the orthogonalization used in the search subspace in case of generalized Hermitian problems.

Returns
Whether to B-orthogonalize the search subspace.

Return type
bool

See also

setGDBOrth, EPSGDGetBOrth

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3436 <slepc4py/SLEPc/EPS.pyx#L3436>`

getGDBlockSize()

Get the number of vectors to be added to the searching space.

Not collective.

Get the number of vectors to be added to the searching space in every iteration.

Returns
The number of vectors added to the search space in every iteration.

Return type
int

See also

setGDBlockSize, EPSGDGetBlockSize

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3295 <slepc4py/SLEPc/EPS.pyx#L3295>`

getGDDoubleExpansion()

Get a flag indicating whether the double expansion variant is active.

Not collective.

Get a flag indicating whether the double expansion variant has been activated or not.

Returns
True if using double expansion.

Return type
bool

See also

setGDDoubleExpansion, EPSGDGetDoubleExpansion

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3484 <slepc4py/SLEPc/EPS.pyx#L3484>`

getGDInitialSize()

Get the initial size of the searching space.

Not collective.

Returns
The number of vectors of the initial searching subspace.

Return type
int

See also

setGDInitialSize, EPSGDGetInitialSize

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3396 <slepc4py/SLEPc/EPS.pyx#L3396>`

getGDKrylovStart()

Get a flag indicating if the search subspace is started with a Krylov basis.

Not collective.

Returns

`True` if starting the search subspace with a Krylov basis.

Return type

bool

See also

setGDKrylovStart, EPSGDGetKrylovStart

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3255 <slepc4py/SLEPc/EPS.pyx#L3255>`

getGDRestart()

Get the number of vectors of the search space after restart.

Not collective.

Get the number of vectors of the search space after restart and the number of vectors saved from the previous iteration.

Returns

- **minv** (int) – The number of vectors of the search subspace after restart.
- **plusk** (int) – The number of vectors saved from the previous iteration.

Return type

tuple[int, int]

See also

setGDRestart, EPSGDGetRestart

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3343 <slepc4py/SLEPc/EPS.pyx#L3343>`

getInterval()

Get the computational interval for spectrum slicing.

Not collective.

Returns

- **inta** (float) – The left end of the interval.
- **intb** (float) – The right end of the interval.

Return type

tuple[float, float]

Notes

If the interval was not set by the user, then zeros are returned.

See also

setInterval, EPSGetInterval

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1022 <slepc4py/SLEPc/EPS.pyx#L1022>`

getInvariantSubspace()

Get an orthonormal basis of the computed invariant subspace.

Collective.

Returns
Basis of the invariant subspace.

Return type
list of petsc4py.PETSc.Vec

Notes

This function should be called after *solve()* has finished.

The returned vectors span an invariant subspace associated with the computed eigenvalues. An invariant subspace X of A satisfies $Ax \in X$, for all $x \in X$ (a similar definition applies for generalized eigenproblems).

See also

getEigenpair, *getConverged*, *solve*, EPSGetInvariantSubspace

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2195 <slepc4py/SLEPc/EPS.pyx#L2195>`

getIterationNumber()

Get the current iteration number.

Not collective.

If the call to *solve()* is complete, then it returns the number of iterations carried out by the solution method.

Returns
Iteration number.

Return type
int

See also

getConvergedReason, *setTolerances*, EPSGetIterationNumber

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1969 <slepc4py/SLEPc/EPS.pyx#L1969>`

`getJDBOrth()`

Get the orthogonalization used in the search subspace.

Not collective.

Get the orthogonalization used in the search subspace in case of generalized Hermitian problems.

Returns
Whether to B-orthogonalize the search subspace.

Return type
bool

See also

setJDBOrth, EPSJDGetBOrth

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3795 <slepc4py/SLEPc/EPS.pyx#L3795>`

`getJDBlockSize()`

Get the number of vectors to be added to the searching space.

Not collective.

Get the number of vectors to be added to the searching space in every iteration.

Returns
The number of vectors added to the search space in every iteration.

Return type
int

See also

setJDBlockSize, EPSJDGetBlockSize

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3566 <slepc4py/SLEPc/EPS.pyx#L3566>`

`getJDConstCorrectionTol()`

Get the flag indicating if the dynamic stopping is being used.

Not collective.

Returns
`True` if the dynamic stopping criterion is not being used.

Return type
bool

See also

setJDConstCorrectionTol, EPSJDGetConstCorrectionTol

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3755 <slepc4py/SLEPc/EPS.pyx#L3755>`

getJDFix()

Get the threshold for changing the target in the correction equation.

Not collective.

Returns
The threshold for changing the target.

Return type
float

See also

setJDFix, EPSJDGetFix

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3710 <slepc4py/SLEPc/EPS.pyx#L3710>`

getJDInitialSize()

Get the initial size of the searching space.

Not collective.

Returns
The number of vectors of the initial searching subspace.

Return type
int

See also

setJDInitialSize, EPSJDGetInitialSize

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3667 <slepc4py/SLEPc/EPS.pyx#L3667>`

getJDKrylovStart()

Get a flag indicating if the search subspace is started with a Krylov basis.

Not collective.

Returns
True if starting the search subspace with a Krylov basis.

Return type
bool

See also

setJDKrylovStart, EPSJDGetKrylovStart

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3526 <slepc4py/SLEPc/EPS.pyx#L3526>`

getJDRestart()

Get the number of vectors of the search space after restart.

Not collective.

Get the number of vectors of the search space after restart and the number of vectors saved from the previous iteration.

Returns

- **minv** (int) – The number of vectors of the search subspace after restart.
- **plusk** (int) – The number of vectors saved from the previous iteration.

Return type
tuple[int, int]

See also

setJDRestart, EPSJDGetRestart

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3614 <slepc4py/SLEPc/EPS.pyx#L3614>`

getKrylovSchurBSEType()

Get the method used for BSE structured eigenproblems (Krylov-Schur).

Not collective.

Returns
The BSE method.

Return type
KrylovSchurBSEType

See also

setKrylovSchurBSEType, EPSKrylovSchurGetBSEType

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2556 <slepc4py/SLEPc/EPS.pyx#L2556>`

getKrylovSchurDetectZeros()

Get the flag that enforces zero detection in spectrum slicing.

Not collective.

Returns
The zero detection flag.

Return type
bool

See also

setKrylovSchurDetectZeros, EPSKrylovSchurGetDetectZeros

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2793 <slepc4py/SLEPc/EPS.pyx#L2793>`

getKrylovSchurDimensions()

Get the dimensions used for each subsolve step (spectrum slicing).

Not collective.

Returns

- **nev** (int) – Number of eigenvalues to compute.
- **ncv** (int) – Maximum dimension of the subspace to be used by the solver.
- **mpd** (int) – Maximum dimension allowed for the projected problem.

Return type
tuple[int, int, int]

See also

setKrylovSchurDimensions, EPSKrylovSchurGetDimensions

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2852 <slepc4py/SLEPc/EPS.pyx#L2852>`

getKrylovSchurInertias()

Get the values of the shifts and their corresponding inertias.

Not collective.

Get the values of the shifts and their corresponding inertias in case of doing spectrum slicing for a computational interval.

Returns

- **shifts** (*ArrayReal*) – The values of the shifts used internally in the solver.
- **inertias** (*ArrayInt*) – The values of the inertia in each shift.

Return type
tuple[ArrayReal, ArrayInt]

Notes

This call makes sense only for spectrum slicing runs, that is, when an interval has been given with *setInterval()* and *SINVERT* is set.

If called after *solve()*, all shifts used internally by the solver are returned (including both endpoints and any intermediate ones). If called before *solve()* and after *setUp()* then only the information of the endpoints of subintervals is available.

See also

setInterval, *setKrylovSchurSubintervals*, EPSKrylovSchurGetInertias

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3152 <slepc4py/SLEPc/EPS.pyx#L3152>`

getKrylovSchurKSP()

Get the linear solver object associated with the internal *EPS* object.

Collective.

Get the linear solver object associated with the internal *EPS* object in case of doing spectrum slicing for a computational interval.

Returns
The linear solver object.

Return type
petsc4py.PETSc.KSP

Notes

This call makes sense only for spectrum slicing runs, that is, when an interval has been given with *setInterval()* and *SINVERT* is set.

When invoked to compute all eigenvalues in an interval with spectrum slicing, *KRYLOVSCHUR* creates another *EPS* object internally that is used to compute eigenvalues by chunks near selected shifts. This function allows access to the KSP object associated to this internal *EPS* object.

In case of having more than one partition, the returned KSP will be different in MPI processes belonging to different partitions. Hence, if required, *setKrylovSchurPartitions()* must be called BEFORE this function.

See also

setInterval, *setKrylovSchurPartitions*, EPSKrylovSchurGetKSP

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3196 <slepc4py/SLEPc/EPS.pyx#L3196>`

getKrylovSchurLREPType()

Get the method used for LREP structured eigenproblems (Krylov-Schur).

Not collective.

Returns
The LREP method.

Return type
KrylovSchurLREPType

See also

setKrylovSchurLREPType, EPSKrylovSchurGetLREPType

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2599 <slepc4py/SLEPc/EPS.pyx#L2599>`

getKrylovSchurLocking()

Get the locking flag used in the Krylov-Schur method.

Not collective.

Returns
The locking flag.

Return type
bool

See also

setKrylovSchurLocking, EPSKrylovSchurGetLocking

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2686 <slepc4py/SLEPc/EPS.pyx#L2686>`

getKrylovSchurPartitions()

Get the number of partitions of the communicator (spectrum slicing).

Not collective.

Returns
The number of partitions.

Return type
int

See also

setKrylovSchurPartitions, EPSKrylovSchurGetPartitions

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2740 <slepc4py/SLEPc/EPS.pyx#L2740>`

getKrylovSchurRestart()

Get the restart parameter used in the Krylov-Schur method.

Not collective.

Returns
The number of vectors to be kept at restart.

Return type
float

See also

setKrylovSchurRestart, EPSKrylovSchurGetRestart

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2642 <slepc4py/SLEPc/EPS.pyx#L2642>`

getKrylovSchurSubcommInfo()

Get information related to the case of doing spectrum slicing.

Collective on the subcommunicator.

Get information related to the case of doing spectrum slicing for a computational interval with multiple communicators.

Returns

- **k** (int) – Index of the subinterval for the calling process.
- **n** (int) – Number of eigenvalues found in the **k**-th subinterval.
- **v** (petsc4py.PETSc.Vec) – A vector owned by processes in the subcommunicator with dimensions compatible for locally computed eigenvectors.

Return type
tuple[int, int, *Vec*]

Notes

This call makes sense only for spectrum slicing runs, that is, when an interval has been given with *setInterval()* and *SINVERT* is set.

See also

getKrylovSchurSubcommPairs, EPSKrylovSchurGetSubcommInfo

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2877 <slepc4py/SLEPc/EPS.pyx#L2877>`

getKrylovSchurSubcommMats()

Get the eigenproblem matrices stored in the subcommunicator.

Collective on the subcommunicator.

Get the eigenproblem matrices stored internally in the subcommunicator to which the calling process belongs.

Returns

- **A** (petsc4py.PETSc.Mat) – The matrix associated with the eigensystem.
- **B** (petsc4py.PETSc.Mat) – The second matrix in the case of generalized eigenproblems.

Return type

tuple[*Mat*, *Mat*] | tuple[*Mat*, None]

Notes

This call makes sense only for spectrum slicing runs, that is, when an interval has been given with *setInterval()* and *SINVERT* is set. And is relevant only when the number of partitions (*setKrylovSchurPartitions()*) is larger than one.

This is the analog of *getOperators()*, but returns the matrices distributed differently (in the subcommunicator rather than in the parent communicator).

These matrices should not be modified by the user.

See also

setInterval, *setKrylovSchurPartitions*, EPSKrylovSchurGetSubcommMats

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2956 <slepc4py/SLEPc/EPS.pyx#L2956>`

getKrylovSchurSubcommPairs(*i*, *v=None*)

Get the i-th eigenpair stored in the multi-communicator of the process.

Collective on the subcommunicator (if v is given).

Get the i-th eigenpair stored internally in the multi-communicator to which the calling process belongs.

Parameters

- **i** (*int*) – Index of the solution to be obtained.
- **v** (*Vec* | *None*) – Placeholder for the returned eigenvector.

Returns

The computed eigenvalue.

Return type

Scalar

Notes

This call makes sense only for spectrum slicing runs, that is, when an interval has been given with *setInterval()* and *SINVERT* is set. And is relevant only when the number of partitions (*setKrylovSchurPartitions()*) is larger than one.

Argument `v` must be a valid `Vec` object, created by calling *getKrylovSchurSubcommInfo()*.

The index `i` should be a value between `0` and `n-1`, where `n` is the number of vectors in the local subinterval, see *getKrylovSchurSubcommInfo()*.

See also

getKrylovSchurSubcommMats, EPSKrylovSchurGetSubcommPairs

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2911 <slepc4py/SLEPc/EPS.pyx#L2911>`

getKrylovSchurSubintervals()

Get the points that delimit the subintervals.

Not collective.

Get the points that delimit the subintervals used in spectrum slicing with several partitions.

Returns
Real values specifying subintervals.

Return type
ArrayReal

Notes

This call makes sense only for spectrum slicing runs, that is, when an interval has been given with *setInterval()* and *SINVERT* is set.

If the user passed values with *setKrylovSchurSubintervals()*, then the same values are returned here. Otherwise, the values computed internally are obtained.

See also

setKrylovSchurSubintervals, EPSKrylovSchurGetSubintervals

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3114 <slepc4py/SLEPc/EPS.pyx#L3114>`

getLOBPCGBlockSize()

Get the block size used in the LOBPCG method.

Not collective.

Returns
The block size.

Return type
int

See also

setLOBPCGBlockSize, EPSLOBPCGGetBlockSize

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3879 <slepc4py/SLEPc/EPS.pyx#L3879>`

getLOBPCGLocking()

Get the locking flag used in the LOBPCG method.

Not collective.

Returns
The locking flag.

Return type
bool

See also

setLOBPCGLocking, EPSLOBPCGGetLocking

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3966 <slepc4py/SLEPc/EPS.pyx#L3966>`

getLOBPCGRestart()

Get the restart parameter used in the LOBPCG method.

Not collective.

Returns
The restart parameter.

Return type
float

See also

setLOBPCGRestart, EPSLOBPCGGetRestart

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3923 <slepc4py/SLEPc/EPS.pyx#L3923>`

getLanczosReorthogType()

Get the type of reorthogonalization used during the Lanczos iteration.

Not collective.

Returns
The type of reorthogonalization.

Return type
LanczosReorthogType

See also

setLanczosReorthogType, EPSLanczosGetReorthog

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2510 <slepc4py/SLEPc/EPS.pyx#L2510>`

getLeftEigenvector(*i*, *Wr=None*, *Wi=None*)

Get the i-th left eigenvector as computed by *solve()*.

Collective.

Parameters

- **i** (*int*) – Index of the solution to be obtained.
- **Wr** (*Vec | None*) – Placeholder for the returned left eigenvector (real part).
- **Wi** (*Vec | None*) – Placeholder for the returned left eigenvector (imaginary part).

Return type
None

Notes

The index `i` should be a value between `0` and `nconv-1` (see *getConverged()*). Eigensolutions are indexed according to the ordering criterion established with *setWhichEigenpairs()*.

Left eigenvectors are available only if the twosided flag was set with *setTwoSided()*.

See also

getConverged, *setWhichEigenpairs*, *getEigenpair*, EPSGetLeftEigenvector

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2111 <slepc4py/SLEPc/EPS.pyx#L2111>`

getLyapIIRanks()

Get the rank values used for the Lyapunov step.

Not collective.

Returns

- **rkc** (int) – The compressed rank.
- **rkl** (int) – The Lyapunov rank.

Return type
tuple[int, int]

See also

setLyapIIRanks, EPSLyapIIGetRanks

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4017 <slepc4py/SLEPc/EPS.pyx#L4017>`

getMonitor()

Get the list of monitor functions.

Not collective.

Returns
The list of monitor functions.

Return type
EPSMonitorFunction

See also

setMonitor

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1893 <slepc4py/SLEPc/EPS.pyx#L1893>`

getOperators()

Get the matrices associated with the eigenvalue problem.

Collective.

Returns

- **A** (petsc4py.PETSc.Mat) – The matrix associated with the eigensystem.
- **B** (petsc4py.PETSc.Mat) – The second matrix in the case of generalized eigenproblems.

Return type

tuple[*Mat*, *Mat*] | tuple[*Mat*, None]

See also

setOperators, EPSGetOperators

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1568 <slepc4py/SLEPc/EPS.pyx#L1568>`

getOptionsPrefix()

Get the prefix used for searching for all EPS options in the database.

Not collective.

Returns

The prefix string set for this EPS object.

Return type

str

See also

setOptionsPrefix, *appendOptionsPrefix*, EPSGetOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:513 <slepc4py/SLEPc/EPS.pyx#L513>`

getPowerShiftType()

Get the type of shifts used during the power iteration.

Not collective.

Returns

The type of shift.

Return type

PowerShiftType

See also

setPowerShiftType, EPSPowerGetShiftType

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2421 <slepc4py/SLEPc/EPS.pyx#L2421>`

getProblemType()

Get the problem type from the EPS object.

Not collective.

Returns
The problem type that was previously set.

Return type
ProblemType

See also

setProblemType, EPSGetProblemType

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:603 <slepc4py/SLEPc/EPS.pyx#L603>`

getPurify()

Get the flag indicating whether purification is activated or not.

Not collective.

Returns
Whether purification is activated or not.

Return type
bool

See also

setPurify, EPSGetPurify

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1182 <slepc4py/SLEPc/EPS.pyx#L1182>`

getRG()

Get the region object associated to the eigensolver.

Not collective.

Returns
The region context.

Return type
RG

See also

setRG, EPSGetRG

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1531 <slepc4py/SLEPc/EPS.pyx#L1531>`

getRQCGReset()

Get the reset parameter used in the RQCG method.

Not collective.

Returns
The number of iterations between resets.

Return type
int

See also

setRQCGReset, EPSRQCGGetReset

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3842 <slepc4py/SLEPc/EPS.pyx#L3842>`

getST()

Get the spectral transformation object associated to the eigensolver.

Not collective.

Returns
The spectral transformation.

Return type
ST

See also

setST, EPSGetST

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1420 <slepc4py/SLEPc/EPS.pyx#L1420>`

getStoppingTest()

Get the stopping test function.

Not collective.

Returns
The stopping test function.

Return type
EPSStoppingFunction

See also

setStoppingTest

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1758 <slepc4py/SLEPc/EPS.pyx#L1758>`

getTarget()

Get the value of the target.

Not collective.

Returns
The value of the target.

Return type
Scalar

Notes

If the target was not set by the user, then zero is returned.

See also

setTarget, EPSGetTarget

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:972 <slepc4py/SLEPc/EPS.pyx#L972>`

getThreshold()

Get the threshold used in the threshold stopping test.

Not collective.

Returns

- **thres** (float) – The threshold.
- **rel** (bool) – Whether the threshold is relative or not.

Return type
tuple[float, bool]

See also

setThreshold, EPSGetThreshold

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:921 <slepc4py/SLEPc/EPS.pyx#L921>`

getTolerances()

Get the tolerance and max. iter. count used for convergence tests.

Not collective.

Get the tolerance and iteration limit used by the default EPS convergence tests.

Returns

- **tol** (float) – The convergence tolerance.
- **max_it** (int) – The maximum number of iterations.

Return type
tuple[float, int]

See also

setTolerances, EPSGetTolerances

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1082 <slepc4py/SLEPc/EPS.pyx#L1082>`

getTrackAll()

Get the flag indicating if all residual norms must be computed or not.

Not collective.

Returns
Whether the solver computes all residuals or not.

Return type
bool

See also

setTrackAll, EPSGetTrackAll

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1303 <slepc4py/SLEPc/EPS.pyx#L1303>`

getTrueResidual()

Get the flag indicating if true residual must be computed explicitly.

Not collective.

Returns
Whether the solver computes true residuals or not.

Return type
bool

See also

setTrueResidual, EPSGetTrueResidual

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1266 <slepc4py/SLEPc/EPS.pyx#L1266>`

getTwoSided()

Get the flag indicating if a two-sided variant of the algorithm is being used.

Not collective.

Returns
Whether the two-sided variant is to be used or not.

Return type
bool

See also

setTwoSided, EPSGetTwoSided

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1135 <slepc4py/SLEPc/EPS.pyx#L1135>`

getType()

Get the EPS type of this object.

Not collective.

Returns
The solver currently being used.

Return type
str

See also

setType, EPSGetType

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:494 <slepc4py/SLEPc/EPS.pyx#L494>`

getWhichEigenpairs()

Get which portion of the spectrum is to be sought.

Not collective.

Returns
The portion of the spectrum to be sought by the solver.

Return type
Which

See also

setWhichEigenpairs, EPSGetWhichEigenpairs

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:865 <slepc4py/SLEPc/EPS.pyx#L865>`

isGeneralized()

Tell if the EPS object corresponds to a generalized eigenproblem.

Not collective.

Returns
True if the problem is generalized.

Return type
bool

See also

isHermitian, *isPositive*, *isStructured*, EPSIsGeneralized

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:658 <slepc4py/SLEPc/EPS.pyx#L658>`

isHermitian()

Tell if the EPS object corresponds to a Hermitian eigenproblem.

Not collective.

Returns
True if the problem is Hermitian.

Return type
bool

See also

isGeneralized, *isPositive*, *isStructured*, EPSIsHermitian

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:677 <slepc4py/SLEPc/EPS.pyx#L677>`

isPositive()

Eigenproblem requiring a positive (semi-) definite matrix B.

Not collective.

Tell if the EPS corresponds to an eigenproblem requiring a positive (semi-) definite matrix B.

Returns

`True` if the problem is positive (semi-) definite.

Return type

bool

See also

isGeneralized, *isHermitian*, *isStructured*, EPSIsPositive

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:696 <slepc4py/SLEPc/EPS.pyx#L696>`

isStructured()

Tell if the EPS object corresponds to a structured eigenvalue problem.

Not collective.

Returns

`True` if the problem is structured.

Return type

bool

Notes

The result will be `True` if the problem type has been set to some structured type such as *BSE*. This is independent of whether the input matrix has been built with a certain structure with a helper function.

See also

isGeneralized, *isHermitian*, *isPositive*, EPSIsStructured

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:718 <slepc4py/SLEPc/EPS.pyx#L718>`

reset()

Reset the EPS object.

Collective.

See also

EPSReset

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:434 <slepc4py/SLEPc/EPS.pyx#L434>`

Return type
None

setArbitrarySelection(*arbitrary*, *args=None*, *kargs=None*)

Set an arbitrary selection criterion function.

Logically collective.

Set a function to look for eigenvalues according to an arbitrary selection criterion. This criterion can be based on a computation involving the current eigenvector approximation.

See also

getArbitrarySelection, EPSSetArbitrarySelection

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1775 <slepc4py/SLEPc/EPS.pyx#L1775>`

Parameters

- **arbitrary** (EPSArbitraryFunction | *None*)
- **args** (*tuple[Any, ...]* | *None*)
- **kargs** (*dict[str, Any]* | *None*)

Return type
None

setArnoldiDelayed(*delayed=True*)

Set (toggle) delayed reorthogonalization in the Arnoldi iteration.

Logically collective.

Parameters
delayed (*bool*) – True if delayed reorthogonalization is to be used.

Return type
None

Notes

This call is only relevant if the type was set to *EPS.Type.ARNOLDI* with *setType()*.

Delayed reorthogonalization is an aggressive optimization for the Arnoldi eigensolver than may provide better scalability, but sometimes makes the solver converge more slowly compared to the default algorithm.

See also

getArnoldiDelayed, EPSArnoldiSetDelayed

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2440 <slepc4py/SLEPc/EPS.pyx#L2440>`

setBV(*bv*)

Set a basis vectors object associated to the eigensolver.

Collective.

Parameters
bv (BV) – The basis vectors context.

Return type
None

See also

getBV, EPSSetBV

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1477 <slepc4py/SLEPc/EPS.pyx#L1477>`

setBalance(*balance=None*, *iterations=None*, *cutoff=None*)

Set the balancing technique to be used by the eigensolver.

Logically collective.

Parameters

- **balance** (Balance | *None*) – The balancing method.
- **iterations** (*int* | *None*) – Number of iterations of the balancing algorithm.
- **cutoff** (*float* | *None*) – Cutoff value.

Return type
None

Notes

When balancing is enabled, the solver works implicitly with matrix DAD^{-1}, where D is an appropriate diagonal matrix. This improves the accuracy of the computed results in some cases.

Balancing makes sense only for non-Hermitian problems when the required precision is high (i.e., with a small tolerance).

By default, balancing is disabled. The two-sided method is much more effective than the one-sided counterpart, but it requires the system matrices to have the `Mat.multTranspose()` operation defined.

The parameter `iterations` is the number of iterations performed by the method. The `cutoff` value is used only in the two-side variant.

See also

setBalance, EPSGetBalance

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:768 <slepc4py/SLEPc/EPS.pyx#L768>`

setCISSExtraction(*extraction*)

Set the extraction technique used in the CISS solver.

Logically collective.

Parameters
extraction (CISSExtraction) – The extraction technique.

Return type
None

See also

getCISSExtraction, EPSCISSSetExtraction

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4041 <slepc4py/SLEPc/EPS.pyx#L4041>`

setCISSQuadRule(*quad*)

Set the quadrature rule used in the CISS solver.

Logically collective.

Parameters
quad (CISSQuadRule) – The quadrature rule.

Return type
None

See also

getCISSQuadRule, EPSCISSSetQuadRule

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4078 <slepc4py/SLEPc/EPS.pyx#L4078>`

setCISSRefinement(*inner=None*, *blsize=None*)

Set the values of various refinement parameters in the CISS solver.

Logically collective.

Parameters

- **inner** (*int* | *None*) – Number of iterative refinement iterations (inner loop).
- **blsize** (*int* | *None*) – Number of iterative refinement iterations (blocksize loop).

Return type
None

See also

getCISSRefinement, EPSCISSSetRefinement

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4295 <slepc4py/SLEPc/EPS.pyx#L4295>`

setCISSSizes(*ip=None*, *bs=None*, *ms=None*, *npart=None*, *bsmax=None*, *realmats=False*)

Set the values of various size parameters in the CISS solver.

Logically collective.

Parameters

- **ip** (*int* | *None*) – Number of integration points.
- **bs** (*int* | *None*) – Block size.
- **ms** (*int* | *None*) – Moment size.

- **npart** (*int | None*) – Number of partitions when splitting the communicator.
- **bsmax** (*int | None*) – Maximum block size.
- **realmats** (*bool*) – True if A and B are real.

Return type
None

Notes

The default number of partitions is 1. This means the internal petsc4py.PETSc.KSP object is shared among all processes of the *EPS* communicator. Otherwise, the communicator is split into npart communicators, so that npart petsc4py.PETSc.KSP solves proceed simultaneously.

See also

getCISSSizes, *setCISSThreshold*, *setCISSRefinement*, EPSCISSSetSizes

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4162 <slepc4py/SLEPc/EPS.pyx#L4162>`

setCISSStrategy(*strategy*)

Set the strategy for linear solves in the CISS solver.

Logically collective.

Parameters
strategy (CISSStrategy) – The strategy for solving the linear systems.

Return type
None

Notes

When the *USEST* strategy is selected, the linear solves can be configured by setting options for the petsc4py.PETSc.KSP object obtained with *ST.getKSP()*. Otherwise, several petsc4py.PETSc.KSP objects are created, which can be accessed with *getCISSKSPs()*.

The default is to use the *ST*, unless several partitions have been specified, see *setCISSSizes()*.

See also

getCISSStrategy, *getCISSKSPs*, *setCISSSizes*, EPSCISSSetStrategy

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4115 <slepc4py/SLEPc/EPS.pyx#L4115>`

setCISSThreshold(*delta=None*, *spur=None*)

Set the values of various threshold parameters in the CISS solver.

Logically collective.

Parameters
- **delta** (*float | None*) – Threshold for numerical rank.
- **spur** (*float | None*) – Spurious threshold (to discard spurious eigenpairs).

Return type
None

See also

getCISSThreshold, EPSCISSSetThreshold

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4250 <slepc4py/SLEPc/EPS.pyx#L4250>`

setCISSUseST(*usest=True*)

Deprecated, use setCISSStrategy()

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4340 <slepc4py/SLEPc/EPS.pyx#L4340>`

Parameters

usest (*bool*)

Return type

None

setConvergenceTest(*conv*)

Set how to compute the error estimate used in the convergence test.

Logically collective.

Parameters

conv (Conv) – The method used to compute the error estimate used in the convergence test.

Return type

None

See also

getConvergenceTest, EPSSetConvergenceTest

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1247 <slepc4py/SLEPc/EPS.pyx#L1247>`

setDS(*ds*)

Set a direct solver object associated to the eigensolver.

Collective.

Parameters

ds (DS) – The direct solver context.

Return type

None

See also

getDS, EPSSetDS

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1514 <slepc4py/SLEPc/EPS.pyx#L1514>`

setDeflationSpace(*space*)

Set vectors to form a basis of the deflation space.

Collective.

Parameters

space (*Vec | list[Vec]*) – Set of basis vectors of the deflation space.

Return type
None

Notes

When a deflation space is given, the eigensolver seeks the eigensolution in the restriction of the problem to the orthogonal complement of this space. This can be used for instance in the case that an invariant subspace is known beforehand (such as the nullspace of the matrix).

These vectors do not persist from one *solve()* call to the other, so the deflation space should be set every time.

The vectors do not need to be mutually orthonormal, since they are explicitly orthonormalized internally.

See also

setInitialSpace, EPSSetDeflationSpace

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1626 <slepc4py/SLEPc/EPS.pyx#L1626>`

setDimensions(*nev=None*, *ncv=None*, *mpd=None*)

Set number of eigenvalues to compute and the dimension of the subspace.

Logically collective.

Parameters

- **nev** (*int* | *None*) – Number of eigenvalues to compute.
- **ncv** (*int* | *None*) – Maximum dimension of the subspace to be used by the solver.
- **mpd** (*int* | *None*) – Maximum dimension allowed for the projected problem.

Return type
None

Notes

Use *DETERMINE* for ncv and mpd to assign a reasonably good value, which is dependent on the solution method.

The parameters ncv and mpd are intimately related, so that the user is advised to set one of them at most. Normal usage is the following:

- In cases where nev is small, the user sets ncv (a reasonable default is 2 * nev).
- In cases where nev is large, the user sets mpd.

The value of ncv should always be between nev and (nev + mpd), typically ncv = nev + mpd. If nev is not too large, mpd = nev is a reasonable choice, otherwise a smaller value should be used.

When computing all eigenvalues in an interval, see *setInterval()*, these parameters lose relevance, and tuning must be done with *setKrylovSchurDimensions()*.

See also

getDimensions, *setKrylovSchurDimensions*, EPSSetDimensions

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1365 <slepc4py/SLEPc/EPS.pyx#L1365>`

setEigenvalueComparison(*comparison*, *args=None*, *kargs=None*)

Set an eigenvalue comparison function.

Logically collective.

Notes

This eigenvalue comparison function is used when *setWhichEigenpairs()* is set to *EPS.Which.USER*.

See also

getEigenvalueComparison, EPSSetEigenvalueComparison

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1821 <slepc4py/SLEPc/EPS.pyx#L1821>`

Parameters

- **comparison** (*EPSEigenvalueComparison | None*)
- **args** (*tuple[Any, ...] | None*)
- **kargs** (*dict[str, Any] | None*)

Return type

None

setExtraction(*extraction*)

Set the extraction type used by the eigensolver.

Logically collective.

Parameters

extraction (*Extraction*) – The extraction method to be used by the solver.

Return type

None

Notes

Not all eigensolvers support all types of extraction.

By default, a standard Rayleigh-Ritz extraction is used. Other extractions may be useful when computing interior eigenvalues.

Harmonic-type extractions are used in combination with a *target*, see *setTarget()*.

See also

getExtraction, *setTarget*, EPSSetExtraction

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:837 <slepc4py/SLEPc/EPS.pyx#L837>`

setFromOptions()

Set EPS options from the options database.

Collective.

Notes

To see all options, run your program with the `-help` option.

This routine must be called before *setUp()* if the user is to be allowed to set the solver type.

See also

setOptionsPrefix, EPSSetFromOptions

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:582 <slepc4py/SLEPc/EPS.pyx#L582>`

Return type
None

setGDBOrth(*borth=True*)

Set the orthogonalization that will be used in the search subspace.

Logically collective.

Set the orthogonalization that will be used in the search subspace in case of generalized Hermitian problems.

Parameters
borth (*bool*) – Whether to B-orthogonalize the search subspace.

Return type
None

See also

getGDBOrth, EPSGDSetBOrth

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3415 <slepc4py/SLEPc/EPS.pyx#L3415>`

setGDBlockSize(*bs*)

Set the number of vectors to be added to the searching space.

Logically collective.

Set the number of vectors to be added to the searching space in every iteration.

Parameters
bs (*int*) – The number of vectors added to the search space in every iteration.

Return type
None

See also

getGDBlockSize, EPSGDSetBlockSize

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3274 <slepc4py/SLEPc/EPS.pyx#L3274>`

setGDDoubleExpansion(*doubleexp=True*)

Set that the search subspace is expanded with double expansion.

Logically collective.

Parameters
doubleexp (*bool*) – `True` if using double expansion.

Return type
None

Notes

In the double expansion variant the search subspace is expanded with $K[Ax, Bx]$ (double expansion) instead of the classic Kr, where K is the preconditioner, x the selected approximate eigenvector and r its associated residual vector.

See also

getGDDoubleExpansion, EPSGDSetDoubleExpansion

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3458 <slepc4py/SLEPc/EPS.pyx#L3458>`

setGDInitialSize(*initialsize*)

Set the initial size of the searching space.

Logically collective.

Parameters
initialsize (*int*) – The number of vectors of the initial searching subspace.

Return type
None

Notes

If the flag in *setGDKrylovStart()* is set to `False` and the user provides vectors with *setInitialSpace()*, up to `initialsize` vectors will be used; and if the provided vectors are not enough, the solver completes the subspace with random vectors. In case the *setGDKrylovStart()* flag is `True`, the solver gets the first vector provided by the user or, if not available, a random vector, and expands the Krylov basis up to `initialsize` vectors.

See also

setGDKrylovStart, *getGDInitialSize*, EPSGDSetInitialSize

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3368 <slepc4py/SLEPc/EPS.pyx#L3368>`

setGDKrylovStart(*krylovstart=True*)

Set (toggle) starting the search subspace with a Krylov basis.

Logically collective.

Parameters
krylovstart (*bool*) – `True` if starting the search subspace with a Krylov basis.

Return type
None

See also

setGDInitialSize, *getGDKrylovStart*, EPSGDSetKrylovStart

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3237 <slepc4py/SLEPc/EPS.pyx#L3237>`

setGDRestart(*minv=None*, *plusk=None*)

Set the number of vectors of the search space after restart.

Logically collective.

Set the number of vectors of the search space after restart and the number of vectors saved from the previous iteration.

Parameters

- **minv** (*int*) – The number of vectors of the search subspace after restart.
- **plusk** (*int*) – The number of vectors saved from the previous iteration.

Return type
None

See also

getGDRestart, EPSGDSetRestart

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3317 <slepc4py/SLEPc/EPS.pyx#L3317>`

setInitialSpace(*space*)

Set the initial space from which the eigensolver starts to iterate.

Collective.

Parameters
space (*Vec | list[Vec]*) – Set of basis vectors of the initial space.

Return type
None

Notes

Some solvers start to iterate on a single vector (initial vector). In that case, only the first vector is taken into account and the other vectors are ignored. But other solvers such as *SUBSPACE* are able to make use of the whole initial subspace as an initial guess.

These vectors do not persist from one *solve()* call to the other, so the initial space should be set every time.

The vectors do not need to be mutually orthonormal, since they are explicitly orthonormalized internally.

Common usage of this function is when the user can provide a rough approximation of the wanted eigenspace. Then, convergence may be faster.

See also

setDeflationSpace, *setLeftInitialSpace*, EPSSetInitialSpace

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1664 <slepc4py/SLEPc/EPS.pyx#L1664>`

setInterval(*inta*, *intb*)

Set the computational interval for spectrum slicing.

Logically collective.

Parameters

- **inta** (*float*) – The left end of the interval.
- **intb** (*float*) – The right end of the interval.

Return type
None

Notes

Spectrum slicing is a technique employed for computing all eigenvalues of symmetric eigenproblems in a given interval. This function provides the interval to be considered. It must be used in combination with *EPS.Which.ALL*, see *setWhichEigenpairs()*.

A computational interval is also needed when using polynomial filters, see STFILTER.

See also

getInterval, *setWhichEigenpairs*, EPSSetInterval, STFILTER

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1048 <slepc4py/SLEPc/EPS.pyx#L1048>`

setJDBOrth(*borth=True*)

Set the orthogonalization that will be used in the search subspace.

Logically collective.

Set the orthogonalization that will be used in the search subspace in case of generalized Hermitian problems.

Parameters
borth (*bool*) – Whether to B-orthogonalize the search subspace.

Return type
None

See also

getJDBOrth, EPSJDSetBOrth

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3774 <slepc4py/SLEPc/EPS.pyx#L3774>`

setJDBlockSize(*bs*)

Set the number of vectors to be added to the searching space.

Logically collective.

Set the number of vectors to be added to the searching space in every iteration.

Parameters
bs (*int*) – The number of vectors added to the search space in every iteration.

Return type
None

See also

getJDBlockSize, EPSJDSetBlockSize

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3545 <slepc4py/SLEPc/EPS.pyx#L3545>`

setJDConstCorrectionTol(*constant=True*)

Deactivate the dynamic stopping criterion.

Logically collective.

Parameters
constant (*bool*) – If `False`, the petsc4py.PETSc.KSP relative tolerance is set to `0.5**i`.

Return type
None

Notes

If this flag is set to `False`, then the petsc4py.PETSc.KSP relative tolerance is dynamically set to `0.5**i`, where `i` is the number of *EPS* iterations since the last converged value. By the default, a constant tolerance is used.

See also

getJDConstCorrectionTol, EPSJDSetConstCorrectionTol

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3729 <slepc4py/SLEPc/EPS.pyx#L3729>`

setJDFix(*fix*)

Set the threshold for changing the target in the correction equation.

Logically collective.

Parameters
fix (*float*) – The threshold for changing the target.

Return type
None

Notes

The target in the correction equation is fixed at the first iterations. When the norm of the residual vector is lower than the `fix` value, the target is set to the corresponding eigenvalue.

See also

getJDFix, EPSJDSetFix

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3686 <slepc4py/SLEPc/EPS.pyx#L3686>`

setJDInitialSize(*initialsize*)

Set the initial size of the searching space.

Logically collective.

Parameters
initialsize (*int*) – The number of vectors of the initial searching subspace.

Return type
None

Notes

If the flag in *setJDKrylovStart()* is set to `False` and the user provides vectors with *setInitialSpace()*, up to `initialsize` vectors will be used; and if the provided vectors are not enough, the solver completes the subspace with random vectors. In case the *setJDKrylovStart()* flag is `True`, the solver gets the first vector provided by the user or, if not available, a random vector, and expands the Krylov basis up to `initialsize` vectors.

See also

setJDKrylovStart, *getJDInitialSize*, EPSJDSetInitialSize

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3639 <slepc4py/SLEPc/EPS.pyx#L3639>`

setJDKrylovStart(*krylovstart=True*)

Set (toggle) starting the search subspace with a Krylov basis.

Logically collective.

Parameters
krylovstart (*bool*) – `True` if starting the search subspace with a Krylov basis.

Return type
None

See also

setJDInitialSize, *getJDKrylovStart*, EPSJDSetKrylovStart

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3508 <slepc4py/SLEPc/EPS.pyx#L3508>`

setJDRestart(*minv=None*, *plusk=None*)

Set the number of vectors of the search space after restart.

Logically collective.

Set the number of vectors of the search space after restart and the number of vectors saved from the previous iteration.

Parameters

- **minv** (*int | None*) – The number of vectors of the search subspace after restart.
- **plusk** (*int | None*) – The number of vectors saved from the previous iteration.

Return type
None

See also

getJDRestart, EPSJDSetRestart

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3588 <slepc4py/SLEPc/EPS.pyx#L3588>`

setKrylovSchurBSEType(*bse*)

Set the Krylov-Schur variant used for BSE structured eigenproblems.

Logically collective.

Parameters
bse (KrylovSchurBSEType) – The BSE method.

Return type
None

Notes

This call is only relevant if the type was set to *EPS.Type.KRYLOVSCHUR* with *setType()* and the problem type to *EPS.ProblemType.BSE* with *setProblemType()*.

See also

createMatBSE, *getKrylovSchurBSEType*, EPSKrylovSchurSetBSEType

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2532 <slepc4py/SLEPc/EPS.pyx#L2532>`

setKrylovSchurDetectZeros(*detect=True*)

Set the flag that enforces zero detection in spectrum slicing.

Logically collective.

Set a flag to enforce the detection of zeros during the factorizations throughout the spectrum slicing computation.

Parameters
detect (*bool*) – `True` if zeros must checked for.

Return type
None

Notes

This call makes sense only for spectrum slicing runs, that is, when an interval has been given with *setInterval()* and *SINVERT* is set.

A zero in the factorization indicates that a shift coincides with an eigenvalue.

This flag is turned off by default, and may be necessary in some cases, especially when several partitions are being used. This feature currently requires an external package for factorizations with support for zero detection, e.g., MUMPS.

See also

setInterval, *getKrylovSchurDetectZeros*, EPSKrylovSchurSetDetectZeros

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2759 <slepc4py/SLEPc/EPS.pyx#L2759>`

setKrylovSchurDimensions(*nev=None*, *ncv=None*, *mpd=None*)

Set the dimensions used for each subsolve step (spectrum slicing).

Logically collective.

Parameters

- **nev** (*int* | *None*) – Number of eigenvalues to compute.
- **ncv** (*int* | *None*) – Maximum dimension of the subspace to be used by the solver.
- **mpd** (*int* | *None*) – Maximum dimension allowed for the projected problem.

Return type

None

Notes

This call makes sense only for spectrum slicing runs, that is, when an interval has been given with *setInterval()* and *SINVERT* is set.

The meaning of the parameters is the same as in *setDimensions()*, but the ones here apply to every subsolve done by the child *EPS* object.

See also

setInterval, *getKrylovSchurDimensions*, EPSKrylovSchurSetDimensions

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2812 <slepc4py/SLEPc/EPS.pyx#L2812>`

setKrylovSchurLREPType(*lrep*)

Set the Krylov-Schur variant used for LREP structured eigenproblems.

Logically collective.

Parameters

lrep (KrylovSchurLREPType) – The LREP method.

Return type

None

Notes

This call is only relevant if the type was set to *EPS.Type.KRYLOVSCHUR* with *setType()* and the problem type to *EPS.ProblemType.LREP* with *setProblemType()*.

See also

createMatLREP, *getKrylovSchurLREPType*, EPSKrylovSchurSetLREPType

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2575 <slepc4py/SLEPc/EPS.pyx#L2575>`

setKrylovSchurLocking(*lock=True*)

Set (toggle) locking/non-locking variants of the Krylov-Schur method.

Logically collective.

Parameters
lock (*bool*) – `True` if the locking variant must be selected.

Return type
None

Notes

The default is to lock converged eigenpairs when the method restarts. This behavior can be changed so that all directions are kept in the working subspace even if already converged to working accuracy (the non-locking variant).

See also

getKrylovSchurLocking, EPSKrylovSchurSetLocking

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2661 <slepc4py/SLEPc/EPS.pyx#L2661>`

setKrylovSchurPartitions(*npart*)

Set the number of partitions of the communicator (spectrum slicing).

Logically collective.

Set the number of partitions for the case of doing spectrum slicing for a computational interval with the communicator split in several sub-communicators.

Parameters
npart (*int*) – The number of partitions.

Return type
None

Notes

This call makes sense only for spectrum slicing runs, that is, when an interval has been given with *setInterval()* and *SINVERT* is set.

By default, `npart=1` so all processes in the communicator participate in the processing of the whole interval. If `npart>1` then the interval is divided into `npart` subintervals, each of them being processed by a subset of processes.

The interval is split proportionally unless the separation points are specified with *setKrylovSchurSubintervals()*.

See also

setInterval, *getKrylovSchurPartitions*, EPSKrylovSchurSetPartitions

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2705 <slepc4py/SLEPc/EPS.pyx#L2705>`

setKrylovSchurRestart(*keep*)

Set the restart parameter for the Krylov-Schur method.

Logically collective.

It is the proportion of basis vectors that must be kept after restart.

Parameters
keep (*float*) – The number of vectors to be kept at restart.

Return type
None

Notes

Allowed values are in the range [0.1,0.9]. The default is 0.5.

See also

getKrylovSchurRestart, EPSKrylovSchurSetRestart

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2618 <slepc4py/SLEPc/EPS.pyx#L2618>`

setKrylovSchurSubintervals(*subint*)

Set the subinterval boundaries.

Logically collective.

Set the subinterval boundaries for spectrum slicing with a computational interval with several partitions.

Parameters
subint (*Sequence[float]*) – Real values specifying subintervals.

Return type
None

Notes

This call makes sense only for spectrum slicing runs, that is, when an interval has been given with *setInterval()* and *SINVERT* is set.

This function must be called after *setKrylovSchurPartitions()*. For `npart` partitions, the argument `subint` must contain `npart+1` real values sorted in ascending order: `subint_0`, `subint_1`, ..., `subint_npart`, where the first and last values must coincide with the interval endpoints set with *setInterval()*. The subintervals are then defined by two consecutive points: `[subint_0,subint_1]`, `[subint_1,subint_2]`, and so on.

See also

setInterval, *setKrylovSchurPartitions*, EPSKrylovSchurSetSubintervals

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3069 <slepc4py/SLEPc/EPS.pyx#L3069>`

setLOBPCGBlockSize(*bs*)

Set the block size of the LOBPCG method.

Logically collective.

Parameters
bs (*int*) – The block size.

Return type
None

See also

getLOBPCGBlockSize, EPSLOBPCGSetBlockSize

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3861 <slepc4py/SLEPc/EPS.pyx#L3861>`

setLOBPCGLocking(*lock=True*)

Toggle between locking and non-locking (LOBPCG method).

Logically collective.

Parameters
lock (*bool*) – `True` if the locking variant must be selected.

Return type
None

Notes

This flag refers to soft locking (converged vectors within the current block iterate), since hard locking is always used (when `nev` is larger than the block size).

See also

getLOBPCGLocking, EPSLOBPCGSetLocking

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3942 <slepc4py/SLEPc/EPS.pyx#L3942>`

setLOBPCGRestart(*restart*)

Set the restart parameter for the LOBPCG method.

Logically collective.

Parameters
restart (*float*) – The percentage of the block of vectors to force a restart.

Return type
None

Notes

The meaning of this parameter is the proportion of vectors within the current block iterate that must have converged in order to force a restart with hard locking. Allowed values are in the range [0.1,1.0]. The default is 0.9.

See also

getLOBPCGRestart, EPSLOBPCGSetRestart

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3898 <slepc4py/SLEPc/EPS.pyx#L3898>`

setLanczosReorthogType(*reorthog*)

Set the type of reorthogonalization used during the Lanczos iteration.

Logically collective.

Parameters
reorthog (LanczosReorthogType) – The type of reorthogonalization.

Return type
None

Notes

This call is only relevant if the type was set to *EPS.Type.LANCZOS* with *setType()*.

See also

getLanczosReorthogType, EPSLanczosSetReorthog

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2487 <slepc4py/SLEPc/EPS.pyx#L2487>`

setLeftInitialSpace(*space*)

Set a left initial space from which the eigensolver starts to iterate.

Collective.

Parameters
space (*Vec | list[Vec]*) – Set of basis vectors of the left initial space.

Return type
None

Notes

Left initial vectors are used to initiate the left search space in two-sided eigensolvers. Users should pass here an approximation of the left eigenspace, if available.

The same comments in *setInitialSpace()* are applicable here.

See also

setInitialSpace, *setTwoSided*, EPSSetLeftInitialSpace

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1702 <slepc4py/SLEPc/EPS.pyx#L1702>`

setLyapIIRanks(*rkc=None*, *rkl=None*)

Set the ranks used in the solution of the Lyapunov equation.

Logically collective.

Parameters

- **rkc** (*int | None*) – The compressed rank.
- **rkl** (*int | None*) – The Lyapunov rank.

Return type
None

Notes

Lyapunov inverse iteration needs to solve a large-scale Lyapunov equation at each iteration of the eigensolver. For this, an iterative solver (*LME*) is used, which requires to prescribe the rank of the solution matrix X. This is the meaning of parameter `rkl`. Later, this matrix is compressed into another matrix of rank `rkc`. If not provided, `rkl` is a small multiple of `rkc`.

See also

getLyapIIRanks, EPSLyapIISetRanks

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3985 <slepc4py/SLEPc/EPS.pyx#L3985>`

setMonitor(*monitor*, *args=None*, *kargs=None*)

Append a monitor function to the list of monitors.

Logically collective.

See also

getMonitor, *cancelMonitor*, EPSMonitorSet

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1868 <slepc4py/SLEPc/EPS.pyx#L1868>`

Parameters

- **monitor** (*EPSMonitorFunction | None*)
- **args** (*tuple[Any, ...] | None*)
- **kargs** (*dict[str, Any] | None*)

Return type

None

setOperators(*A*, *B=None*)

Set the matrices associated with the eigenvalue problem.

Collective.

Parameters

- **A** (*Mat*) – The matrix associated with the eigensystem.
- **B** (*Mat | None*) – The second matrix in the case of generalized eigenproblems; if not provided, a standard eigenproblem is assumed.

Return type

None

Notes

It must be called before *setUp()*. If it is called again after *setUp()* and the matrix sizes have changed then the *EPS* object is reset.

For structured eigenproblem types such as *BSE*, see *setProblemType()*, the provided matrices must have been created with the corresponding helper function, i.e., *createMatBSE()*.

See also

getOperators, *solve*, *setUp*, *reset*, *setProblemType*, EPSSetOperators

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1595 <slepc4py/SLEPc/EPS.pyx#L1595>`

setOptionsPrefix(*prefix=None*)

Set the prefix used for searching for all EPS options in the database.

Logically collective.

Parameters
prefix (*str | None*) – The prefix string to prepend to all EPS option requests.

Return type
None

Notes

A hyphen (-) must NOT be given at the beginning of the prefix name. The first character of all runtime options is AUTOMATICALLY the hyphen.

For example, to distinguish between the runtime options for two different EPS contexts, one could call:

```
E1.setOptionsPrefix("eig1_")
E2.setOptionsPrefix("eig2_")
```

See also

appendOptionsPrefix, *getOptionsPrefix*, EPSGetOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:532 <slepc4py/SLEPc/EPS.pyx#L532>`

setPowerShiftType(*shift*)

Set the type of shifts used during the power iteration.

Logically collective.

This can be used to emulate the Rayleigh Quotient Iteration (RQI) method.

Parameters
shift (PowerShiftType) – The type of shift.

Return type
None

Notes

This call is only relevant if the type was set to *EPS.Type.POWER* with *setType()*.

By default, shifts are constant (*EPS.PowerShiftType.CONSTANT*) and the iteration is the simple power method (or inverse iteration if a shift-and-invert transformation is being used).

A variable shift can be specified (*EPS.PowerShiftType.RAYLEIGH* or *EPS.PowerShiftType.WILKINSON*). In this case, the iteration behaves rather like a cubic converging method as RQI.

See also

getPowerShiftType, EPSPowerSetShiftType

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2385 <slepc4py/SLEPc/EPS.pyx#L2385>`

setProblemType(*problem_type*)

Set the type of the eigenvalue problem.

Logically collective.

Parameters
problem_type (ProblemType) – The problem type to be set.

Return type
None

Notes

This function must be used to instruct SLEPc to exploit symmetry or other kind of structure. If no problem type is specified, by default a non-Hermitian problem is assumed (either standard or generalized). If the user knows that the problem is Hermitian (i.e., $A = A^*$) or generalized Hermitian (i.e., $A = A^*$, $B = B^*$, and B positive definite) then it is recommended to set the problem type so that eigensolver can exploit these properties.

If the user does not call this function, the solver will use a reasonable guess.

For structured problem types such as *BSE*, the matrices passed in via *setOperators()* must have been created with the corresponding helper function, i.e., *createMatBSE()*.

See also

setOperators, *createMatBSE*, *getProblemType*, EPSSetProblemType

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:622 <slepc4py/SLEPc/EPS.pyx#L622>`

setPurify(*purify=True*)

Set (toggle) eigenvector purification.

Logically collective.

Parameters
purify (*bool*) – `True` to activate purification (default).

Return type
None

Notes

By default, eigenvectors of generalized symmetric eigenproblems are purified in order to purge directions in the nullspace of matrix B. If the user knows that B is non-singular, then purification can be safely deactivated and some computational cost is avoided (this is particularly important in interval computations).

See also

getPurify, *setInterval*, EPSSetPurify

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1201 <slepc4py/SLEPc/EPS.pyx#L1201>`

setRG(*rg*)

Set a region object associated to the eigensolver.

Collective.

Parameters
rg (RG) – The region context.

Return type
None

See also

getRG, EPSSetRG

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1551 <slepc4py/SLEPc/EPS.pyx#L1551>`

setRQCGReset(*nrest*)

Set the reset parameter of the RQCG iteration.

Logically collective.

Parameters
nrest (*int*) – The number of iterations between resets.

Return type
None

Notes

Every `nrest` iterations the solver performs a Rayleigh-Ritz projection step.

See also

getRQCGReset, EPSRQCGSetReset

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:3819 <slepc4py/SLEPc/EPS.pyx#L3819>`

setST(*st*)

Set a spectral transformation object associated to the eigensolver.

Collective.

Parameters
st (ST) – The spectral transformation.

Return type
None

See also

getST, EPSSetST

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1440 <slepc4py/SLEPc/EPS.pyx#L1440>`

setStoppingTest(*stopping*, *args=None*, *kargs=None*)

Set a function to decide when to stop the outer iteration of the eigensolver.

Logically collective.

See also

getStoppingTest, EPSSetStoppingTestFunction

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1734 <slepc4py/SLEPc/EPS.pyx#L1734>`

Parameters

- **stopping** (EPSStoppingFunction | *None*)
- **args** (*tuple[Any, ...]* | *None*)
- **kargs** (*dict[str, Any]* | *None*)

Return type

None

setTarget(*target*)

Set the value of the target.

Logically collective.

Parameters

target (Scalar) – The value of the target.

Return type

None

Notes

The target is a scalar value used to determine the portion of the spectrum of interest. It is used in combination with *setWhichEigenpairs()*.

When PETSc is built with real scalars, it is not possible to specify a complex target.

See also

getTarget, EPSSetTarget

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:995 <slepc4py/SLEPc/EPS.pyx#L995>`

setThreshold(*thres*, *rel=False*)

Set the threshold used in the threshold stopping test.

Logically collective.

Parameters

- **thres** (*float*) – The threshold.
- **rel** (*bool*) – Whether the threshold is relative or not.

Return type
None

Notes

This function internally sets a special stopping test based on the threshold, where eigenvalues are computed in sequence until one of the computed eigenvalues is below/above the threshold (depending on whether largest or smallest eigenvalues are computed). The details are given in EPSSetThreshold.

See also

setStoppingTest, *getThreshold*, EPSSetThreshold

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:943 <slepc4py/SLEPc/EPS.pyx#L943>`

setTolerances(*tol=None*, *max_it=None*)

Set the tolerance and max. iter. used by the default EPS convergence tests.

Logically collective.

Parameters

- **tol** (*float | None*) – The convergence tolerance.
- **max_it** (*int | None*) – The maximum number of iterations.

Return type
None

Notes

Use *DETERMINE* for `max_it` to assign a reasonably good value, which is dependent on the solution method.

See also

getTolerances, EPSSetTolerances

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1107 <slepc4py/SLEPc/EPS.pyx#L1107>`

setTrackAll(*trackall=True*)

Set if the solver must compute the residual of all approximate eigenpairs.

Logically collective.

Parameters
trackall (*bool*) – Whether to compute all residuals or not.

Return type
None

See also

getTrackAll, EPSSetTrackAll

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1322 <slepc4py/SLEPc/EPS.pyx#L1322>`

setTrueResidual(*trueres=True*)

Set if the solver must compute the true residual explicitly or not.

Logically collective.

Parameters
trueres (*bool*) – Whether the solver computes true residuals or not.

Return type
None

See also

getTrueResidual, EPSSetTrueResidual

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1285 <slepc4py/SLEPc/EPS.pyx#L1285>`

setTwoSided(*twosided=True*)

Set to use a two-sided variant that also computes left eigenvectors.

Logically collective.

Parameters
twosided (*bool*) – Whether the two-sided variant is to be used or not.

Return type
None

Notes

If the user sets `twosided` to `True` then the solver uses a variant of the algorithm that computes both right and left eigenvectors. This is usually much more costly. This option is not available in all solvers.

When using two-sided solvers, the problem matrices must have both the `Mat.mult` and `Mat.multTranspose` operations defined.

See also

getTwoSided, *getLeftEigenvector*, EPSSetTwoSided

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1154 <slepc4py/SLEPc/EPS.pyx#L1154>`

setType(*eps_type*)

Set the particular solver to be used in the EPS object.

Logically collective.

Parameters
eps_type (Type | *str*) – The solver to be used.

Return type
None

Notes

The default is *KRYLOVSCHUR*. Normally, it is best to use *setFromOptions()* and then set the EPS type from the options database rather than by using this routine. Using the options database provides the user with maximum flexibility in evaluating the different available methods.

See also

getType, EPSSetType

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:467 <slepc4py/SLEPc/EPS.pyx#L467>`

setUp()

Set up all the internal data structures.

Collective.

Notes

Sets up all the internal data structures necessary for the execution of the eigensolver. This includes the setup of the internal *ST* object.

This function need not be called explicitly in most cases, since *solve()* calls it. It can be useful when one wants to measure the set-up time separately from the solve time.

See also

solve, *setInitialSpace*, *setDeflationSpace*, EPSSetUp

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1925 <slepc4py/SLEPc/EPS.pyx#L1925>`

Return type
None

setWhichEigenpairs(*which*)

Set which portion of the spectrum is to be sought.

Logically collective.

Parameters
which (Which) – The portion of the spectrum to be sought by the solver.

Return type
None

Notes

Not all eigensolvers implemented in EPS account for all the possible values. Also, some values make sense only for certain types of problems. If SLEPc is compiled for real numbers *EPS.Which.LARGEST_IMAGINARY* and *EPS.Which.SMALLEST_IMAGINARY* use the absolute value of the imaginary part for eigenvalue selection.

The target is a scalar value provided with *setTarget()*.

The criterion *EPS.Which.TARGET_IMAGINARY* is available only in case PETSc and SLEPc have been built with complex scalars.

EPS.Which.ALL is intended for use in combination with an interval (see *setInterval()*), when all eigenvalues within the interval are requested, or in the context of the *EPS.Type.CISS* solver for computing all eigenvalues in a region.

See also

setTarget, *setInterval*, *getWhichEigenpairs*, EPSSetWhichEigenpairs

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:884 <slepc4py/SLEPc/EPS.pyx#L884>`

solve()

Solve the eigensystem.

Collective.

Notes

The problem matrices are specified with *setOperators()*.

solve() will return without generating an error regardless of whether all requested solutions were computed or not. Call *getConverged()* to get the actual number of computed solutions, and *getConvergedReason()* to determine if the solver converged or failed and why.

See also

setUp, *setOperators*, *getConverged*, *getConvergedReason*, EPSSolve

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:1947 <slepc4py/SLEPc/EPS.pyx#L1947>`

Return type
None

updateKrylovSchurSubcommMats(*s=1.0*, *a=1.0*, *Au=None*, *t=1.0*, *b=1.0*, *Bu=None*, *structure=None*, *globalup=False*)

Update the eigenproblem matrices stored internally in the communicator.

Collective.

Update the eigenproblem matrices stored internally in the subcommunicator to which the calling process belongs.

Parameters

- **s** (Scalar) – Scalar that multiplies the existing A matrix.
- **a** (Scalar) – Scalar used in the axpy operation on A.
- **Au** (*petsc4py.PETSc.Mat* | *None*) – The matrix used in the axpy operation on A.
- **t** (Scalar) – Scalar that multiplies the existing B matrix.
- **b** (Scalar) – Scalar used in the axpy operation on B.
- **Bu** (*petsc4py.PETSc.Mat* | *None*) – The matrix used in the axpy operation on B.
- **structure** (*petsc4py.PETSc.Mat.Structure* | *None*) – Either same, different, or a subset of the non-zero sparsity pattern.

- **globalup** (*bool*) – Whether global matrices must be updated or not.

Return type
None

Notes

This call makes sense only for spectrum slicing runs, that is, when an interval has been given with *setInterval()* and *SINVERT* is set. And is relevant only when the number of partitions (*setKrylovSchurPartitions()*) is larger than one.

This function modifies the eigenproblem matrices at subcommunicator level, and optionally updates the global matrices in the parent communicator. The updates are expressed as $A \leftarrow sA+aAu$, $B \leftarrow tB+bBu$.

It is possible to update one of the matrices, or both.

The matrices `Au` and `Bu` must be equal in all subcommunicators.

The `structure` flag is passed to the `petsc4py.PETSc.Mat.axpy` operations to perform the updates.

If `globalup` is `True`, communication is carried out to reconstruct the updated matrices in the parent communicator.

See also

setInterval, *setKrylovSchurPartitions*, EPSKrylovSchurUpdateSubcommMats

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2998 <slepc4py/SLEPc/EPS.pyx#L2998>`

valuesView(*viewer=None*)

Display the computed eigenvalues in a viewer.

Collective.

Parameters
viewer (*Viewer | None*) – Visualization context; if not provided, the standard output is used.

Return type
None

See also

solve, *vectorsView*, *errorView*, EPSValuesView

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2345 <slepc4py/SLEPc/EPS.pyx#L2345>`

vectorsView(*viewer=None*)

Output computed eigenvectors to a viewer.

Collective.

Parameters
viewer (*Viewer | None*) – Visualization context; if not provided, the standard output is used.

Return type
None

See also

solve, *valuesView*, *errorView*, EPSVectorsView

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:2364 <slepc4py/SLEPc/EPS.pyx#L2364>`

view(*viewer=None*)

Print the EPS data structure.

Collective.

Parameters

viewer (*Viewer* | *None*) – Visualization context; if not provided, the standard output is used.

Return type

None

See also

EPSView

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:401 <slepc4py/SLEPc/EPS.pyx#L401>`

Attributes Documentation

bv

The basis vectors (*BV*) object associated.

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4478 <slepc4py/SLEPc/EPS.pyx#L4478>`

ds

The direct solver (*DS*) object associated.

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4494 <slepc4py/SLEPc/EPS.pyx#L4494>`

extraction

The type of extraction technique to be employed.

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4398 <slepc4py/SLEPc/EPS.pyx#L4398>`

max_it

The maximum iteration count.

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4430 <slepc4py/SLEPc/EPS.pyx#L4430>`

problem_type

The type of the eigenvalue problem.

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4390 <slepc4py/SLEPc/EPS.pyx#L4390>`

purify

Eigenvector purification.

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4454 <slepc4py/SLEPc/EPS.pyx#L4454>`

rg

The region (*RG*) object associated.

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4486 <slepc4py/SLEPc/EPS.pyx#L4486>`

st

The spectral transformation (*ST*) object associated.

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4470 <slepc4py/SLEPc/EPS.pyx#L4470>`

target

The value of the target.

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4414 <slepc4py/SLEPc/EPS.pyx#L4414>`

tol

The tolerance.

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4422 <slepc4py/SLEPc/EPS.pyx#L4422>`

track_all

Compute the residual norm of all approximate eigenpairs.

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4462 <slepc4py/SLEPc/EPS.pyx#L4462>`

true_residual

Compute the true residual explicitly.

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4446 <slepc4py/SLEPc/EPS.pyx#L4446>`

two_sided

Two-sided that also computes left eigenvectors.

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4438 <slepc4py/SLEPc/EPS.pyx#L4438>`

which

The portion of the spectrum to be sought.

:sources:`Source code at slepc4py/SLEPc/EPS.pyx:4406 <slepc4py/SLEPc/EPS.pyx#L4406>`

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.FN

class slepc4py.SLEPc.**FN**

Bases: Object

Mathematical Function.

The *FN* package provides the functionality to represent a simple mathematical function such as an exponential, a polynomial or a rational function. This is used as a building block for defining the function associated to the nonlinear eigenproblem, as well as for specifying which function to use when computing the action of a matrix function on a vector.

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Table 40 – continued from previous page

Enumerations

CombineType	FN type of combination of child functions.
ParallelType	FN parallel types.
Type	FN type.

slepc4py.SLEPc.FN.CombineType

class slepc4py.SLEPc.FN.**CombineType**

Bases: object

FN type of combination of child functions.

- *ADD*: Addition $f(x) = f_1(x) + f_2(x)$
- *MULTIPLY*: Multiplication $f(x) = f_1(x)f_2(x)$
- *DIVIDE*: Division $f(x) = f_1(x)/f_2(x)$
- *COMPOSE*: Composition $f(x) = f_2(f_1(x))$

See also

FNCombineType

Attributes Summary

ADD	Constant ADD of type int
COMPOSE	Constant COMPOSE of type int
DIVIDE	Constant DIVIDE of type int
MULTIPLY	Constant MULTIPLY of type int

Attributes Documentation

ADD: int = ADD

Constant ADD of type int

COMPOSE: int = COMPOSE

Constant COMPOSE of type int

DIVIDE: int = DIVIDE

Constant DIVIDE of type int

MULTIPLY: int = MULTIPLY

Constant MULTIPLY of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.FN.ParallelType

class slepc4py.SLEPc.FN.**ParallelType**

Bases: object

FN parallel types.

- *REDUNDANT*: Every process performs the computation redundantly.
- *SYNCHRONIZED*: The first process sends the result to the rest.

See also

FNParallelType

Attributes Summary

REDUNDANT	Constant REDUNDANT of type int
SYNCHRONIZED	Constant SYNCHRONIZED of type int

Attributes Documentation

REDUNDANT: int = REDUNDANT

Constant REDUNDANT of type int

SYNCHRONIZED: int = SYNCHRONIZED

Constant SYNCHRONIZED of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.FN.Type

class slepc4py.SLEPc.FN.**Type**

Bases: object

FN type.

- *COMBINE*: A math function defined by combining two functions.
- *RATIONAL*: A rational function $f(x) = p(x)/q(x)$.
- *EXP*: The exponential function $f(x) = e^x$.
- *LOG*: The logarithm function $f(x) = \log x$.
- *PHI*: One of the Phi_k functions with index k.
- *SQRT*: The square root function $f(x) = \sqrt{x}$.
- *INVSQRT*: The inverse square root function.

See also

FNType

Attributes Summary

COMBINE	Object COMBINE of type str
EXP	Object EXP of type str
INVSQRT	Object INVSQRT of type str
LOG	Object LOG of type str
PHI	Object PHI of type str
RATIONAL	Object RATIONAL of type str
SQRT	Object SQRT of type str

Attributes Documentation

COMBINE: str = COMBINE

Object COMBINE of type str

EXP: str = EXP

Object EXP of type str

INVSQRT: str = INVSQRT

Object INVSQRT of type str

LOG: str = LOG

Object LOG of type str

PHI: str = PHI

Object PHI of type str

RATIONAL: str = RATIONAL

Object RATIONAL of type str

SQRT: str = SQRT

Object SQRT of type str

__init__()

classmethod __new__(**args*, ***kwargs*)

Methods Summary

appendOptionsPrefix([prefix])	Append to the prefix used for searching for all FN options in the database.
create([comm])	Create the FN object.
destroy()	Destroy the FN object.
duplicate([comm])	Duplicate the FN object copying all parameters.
evaluateDerivative(x)	Compute the value of the derivative $f'(x)$ for a given x.
evaluateFunction(x)	Compute the value of the function $f(x)$ for a given x.
evaluateFunctionMat(A[, B])	Compute the value of the function $f(A)$ for a given matrix A.
evaluateFunctionMatVec(A[, v])	Compute the first column of the matrix $f(A)$.
getCombineChildren()	Get the two child functions that constitute this combined function.
getMethod()	Get the method currently used for matrix functions.

continues on next page

Table 44 – continued from previous page

getOptionsPrefix()	Get the prefix used for searching for all FN options in the database.
getParallel()	Get the mode of operation in parallel runs.
getPhiIndex()	Get the index of the phi-function.
getRationalDenominator()	Get the coefficients of the denominator of the rational function.
getRationalNumerator()	Get the coefficients of the numerator of the rational function.
getScale()	Get the scaling parameters that define the matematical function.
getType()	Get the FN type of this object.
setCombineChildren(comb, f1, f2)	Set the two child functions that constitute this combined function.
setFromOptions()	Set FN options from the options database.
setMethod(meth)	Set the method to be used to evaluate functions of matrices.
setOptionsPrefix([prefix])	Set the prefix used for searching for all FN options in the database.
setParallel(pmode)	Set the mode of operation in parallel runs.
setPhiIndex(k)	Set the index of the phi-function.
setRationalDenominator(alpha)	Set the coefficients of the denominator of the rational function.
setRationalNumerator(alpha)	Set the coefficients of the numerator of the rational function.
setScale([alpha, beta])	Set the scaling parameters that define the matematical function.
setType(fn_type)	Set the type for the FN object.
view([viewer])	Print the FN data structure.

Attributes Summary

method	The method to be used to evaluate functions of matrices.
parallel	The mode of operation in parallel runs.

Methods Documentation

appendOptionsPrefix(*prefix=None*)

Append to the prefix used for searching for all FN options in the database.

Logically collective.

Parameters

prefix (*str | None*) – The prefix string to prepend to all FN option requests.

Return type

None

See also

setOptionsPrefix, *getOptionsPrefix*, FNAppendOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/FN.pyx:269 <slepc4py/SLEPc/FN.pyx#L269>`

create(*comm=None*)

Create the FN object.

Collective.

Parameters
comm (*Comm* | *None*) – MPI communicator; if not provided, it defaults to all processes.

Return type
Self

See also

FNCreate

:sources:`Source code at slepc4py/SLEPc/FN.pyx:185 <slepc4py/SLEPc/FN.pyx#L185>`

destroy()

Destroy the FN object.

Collective.

See also

FNDestroy

:sources:`Source code at slepc4py/SLEPc/FN.pyx:171 <slepc4py/SLEPc/FN.pyx#L171>`

Return type
Self

duplicate(*comm=None*)

Duplicate the FN object copying all parameters.

Collective.

Duplicate the FN object copying all parameters, possibly with a different communicator.

Parameters
comm (*Comm* | *None*) – MPI communicator; if not provided, it defaults to the object's communicator.

Returns
The new object.

Return type
FN

See also

create, FNDuplicate

:sources:`Source code at slepc4py/SLEPc/FN.pyx:324 <slepc4py/SLEPc/FN.pyx#L324>`

evaluateDerivative(*x*)

Compute the value of the derivative $f'(x)$ for a given x.

Not collective.

Parameters
x (Scalar) – Value where the derivative must be evaluated.

Returns
The result of $f'(x)$.

Return type
Scalar

Notes

Scaling factors are taken into account, so the actual derivative evaluation will return $abf'(ax)$.

See also

evaluateFunction, *setScale*, FNEvaluateDerivative

:sources:`Source code at slepc4py/SLEPc/FN.pyx:385 <slepc4py/SLEPc/FN.pyx#L385>`

evaluateFunction(*x*)

Compute the value of the function $f(x)$ for a given x.

Not collective.

Parameters
x (Scalar) – Value where the function must be evaluated.

Returns
The result of $f(x)$.

Return type
Scalar

Notes

Scaling factors are taken into account, so the actual function evaluation will return $bf(ax)$.

See also

evaluateDerivative, *evaluateFunctionMat*, *setScale*, FNEvaluateFunction

:sources:`Source code at slepc4py/SLEPc/FN.pyx:355 <slepc4py/SLEPc/FN.pyx#L355>`

evaluateFunctionMat(*A*, *B=None*)

Compute the value of the function $f(A)$ for a given matrix A.

Logically collective.

Parameters

- **A** (*Mat*) – Matrix on which the function must be evaluated.
- **B** (*Mat | None*) – Placeholder for the result.

Returns

The result of $f(A)$.

Return type

petsc4py.PETSc.Mat

Notes

Scaling factors are taken into account, so the actual function evaluation will return $bf(aA)$.

See also

evaluateFunction, *evaluateFunctionMatVec*, FNEvaluateFunctionMat

:sources:`Source code at slepc4py/SLEPc/FN.pyx:415 <slepc4py/SLEPc/FN.pyx#L415>`

evaluateFunctionMatVec(*A*, *v=None*)

Compute the first column of the matrix $f(A)$.

Logically collective.

Parameters

- **A** (*Mat*) – Matrix on which the function must be evaluated.
- **v** (*Vec | None*)

Returns

The first column of the result $f(A)$.

Return type

petsc4py.PETSc.Vec

Notes

This operation is similar to *evaluateFunctionMat()* but returns only the first column of $f(A)$, hence saving computations in most cases.

See also

evaluateFunctionMat, FNEvaluateFunctionMatVec

:sources:`Source code at slepc4py/SLEPc/FN.pyx:446 <slepc4py/SLEPc/FN.pyx#L446>`

getCombineChildren()

Get the two child functions that constitute this combined function.

Not collective.

Get the two child functions that constitute this combined function, and the way they must be combined.

Returns

- **comb** (*CombineType*) – How to combine the functions (addition, multiplication, division, composition).
- **f1** (*FN*) – First function.
- **f2** (*FN*) – Second function.

Return type
tuple[*CombineType*, *FN*, *FN*]

See also

setCombineChildren, FNCombineGetChildren

:sources:`Source code at slepc4py/SLEPc/FN.pyx:728 <slepc4py/SLEPc/FN.pyx#L728>`

getMethod()

Get the method currently used for matrix functions.

Not collective.

Returns
An index identifying the method.

Return type
int

See also

setMethod, FNGetMethod

:sources:`Source code at slepc4py/SLEPc/FN.pyx:549 <slepc4py/SLEPc/FN.pyx#L549>`

getOptionsPrefix()

Get the prefix used for searching for all FN options in the database.

Not collective.

Returns
The prefix string set for this FN object.

Return type
str

See also

setOptionsPrefix, *appendOptionsPrefix*, FNGetOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/FN.pyx:288 <slepc4py/SLEPc/FN.pyx#L288>`

getParallel()

Get the mode of operation in parallel runs.

Not collective.

Returns
The parallel mode.

Return type
ParallelType

See also

setParallel, FNGetParallel

:sources:`Source code at slepc4py/SLEPc/FN.pyx:591 <slepc4py/SLEPc/FN.pyx#L591>`

getPhiIndex()

Get the index of the phi-function.

Not collective.

Returns
The index.

Return type
int

See also

setPhiIndex, FNPhiGetIndex

:sources:`Source code at slepc4py/SLEPc/FN.pyx:781 <slepc4py/SLEPc/FN.pyx#L781>`

getRationalDenominator()

Get the coefficients of the denominator of the rational function.

Not collective.

Returns
Coefficients.

Return type
ArrayScalar

See also

setRationalDenominator, FNRationalGetDenominator

:sources:`Source code at slepc4py/SLEPc/FN.pyx:677 <slepc4py/SLEPc/FN.pyx#L677>`

getRationalNumerator()

Get the coefficients of the numerator of the rational function.

Not collective.

Returns
Coefficients.

Return type
ArrayScalar

See also

setRationalNumerator, FNRationalGetNumerator

:sources:`Source code at slepc4py/SLEPc/FN.pyx:632 <slepc4py/SLEPc/FN.pyx#L632>`

getScale()

Get the scaling parameters that define the matematical function.

Not collective.

Returns

- **alpha** (*Scalar*) – Inner scaling (argument).
- **beta** (*Scalar*) – Outer scaling (result).

Return type

tuple[Scalar, Scalar]

See also

setScale, FNGetScale

:sources:`Source code at slepc4py/SLEPc/FN.pyx:499 <slepc4py/SLEPc/FN.pyx#L499>`

getType()

Get the FN type of this object.

Not collective.

Returns

The math function type currently being used.

Return type

str

See also

setType, FNGetType

:sources:`Source code at slepc4py/SLEPc/FN.pyx:225 <slepc4py/SLEPc/FN.pyx#L225>`

setCombineChildren(*comb*, *f1*, *f2*)

Set the two child functions that constitute this combined function.

Logically collective.

Set the two child functions that constitute this combined function, and the way they must be combined.

Parameters

- **comb** (CombineType) – How to combine the functions (addition, multiplication, division, composition).
- **f1** (FN) – First function.
- **f2** (FN) – Second function.

Return type
None

See also

getCombineChildren, FNCombineSetChildren

:sources:`Source code at slepc4py/SLEPc/FN.pyx:702 <slepc4py/SLEPc/FN.pyx#L702>`

setFromOptions()

Set FN options from the options database.

Collective.

Notes

To see all options, run your program with the `-help` option.

See also

setOptionsPrefix, FNSetFromOptions

:sources:`Source code at slepc4py/SLEPc/FN.pyx:307 <slepc4py/SLEPc/FN.pyx#L307>`

Return type
None

setMethod(*meth*)

Set the method to be used to evaluate functions of matrices.

Logically collective.

Parameters
meth (*int*) – An index identifying the method.

Return type
None

Notes

In some *FN* types there are more than one algorithms available for computing matrix functions. In that case, this function allows choosing the wanted method.

If `meth` is currently set to 0 and the input argument of *FN.evaluateFunctionMat()* is a symmetric/Hermitian matrix, then the computation is done via the eigendecomposition, rather than with the general algorithm.

See also

getMethod, FNSetMethod

:sources:`Source code at slepc4py/SLEPc/FN.pyx:520 <slepc4py/SLEPc/FN.pyx#L520>`

setOptionsPrefix(*prefix=None*)

Set the prefix used for searching for all FN options in the database.

Logically collective.

Parameters
prefix (*str | None*) – The prefix string to prepend to all FN option requests.

Return type
None

Notes

A hyphen (-) must NOT be given at the beginning of the prefix name. The first character of all runtime options is AUTOMATICALLY the hyphen.

See also

appendOptionsPrefix, *getOptionsPrefix*, FNGetOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/FN.pyx:244 <slepc4py/SLEPc/FN.pyx#L244>`

setParallel(*pmode*)

Set the mode of operation in parallel runs.

Logically collective.

Parameters
pmode (ParallelType) – The parallel mode.

Return type
None

Notes

This is relevant only when the function is evaluated on a matrix, with either *evaluateFunctionMat()* or *evaluateFunctionMatVec()*.

See also

evaluateFunctionMat, *getParallel*, FNSetParallel

:sources:`Source code at slepc4py/SLEPc/FN.pyx:568 <slepc4py/SLEPc/FN.pyx#L568>`

setPhiIndex(*k*)

Set the index of the phi-function.

Logically collective.

Parameters
k (*int*) – The index.

Return type
None

Notes

If not set, the default index is 1.

See also

getPhiIndex, FNPhiSetIndex

:sources:`Source code at slepc4py/SLEPc/FN.pyx:759 <slepc4py/SLEPc/FN.pyx#L759>`

setRationalDenominator(*alpha*)

Set the coefficients of the denominator of the rational function.

Logically collective.

Parameters
alpha (*Sequence*[Scalar]) – Coefficients.

Return type
None

See also

setRationalNumerator, FNRationalSetDenominator

:sources:`Source code at slepc4py/SLEPc/FN.pyx:657 <slepc4py/SLEPc/FN.pyx#L657>`

setRationalNumerator(*alpha*)

Set the coefficients of the numerator of the rational function.

Logically collective.

Parameters
alpha (*Sequence*[Scalar]) – Coefficients.

Return type
None

See also

setRationalDenominator, FNRationalSetNumerator

:sources:`Source code at slepc4py/SLEPc/FN.pyx:612 <slepc4py/SLEPc/FN.pyx#L612>`

setScale(*alpha=None*, *beta=None*)

Set the scaling parameters that define the matematical function.

Logically collective.

Parameters

- **alpha** (Scalar | *None*) – Inner scaling (argument), default is 1.0.
- **beta** (Scalar | *None*) – Outer scaling (result), default is 1.0.

Return type
None

See also

getScale, *evaluateFunction*, FNSetScale

:sources:`Source code at slepc4py/SLEPc/FN.pyx:476 <slepc4py/SLEPc/FN.pyx#L476>`

setType(*fn_type*)

Set the type for the FN object.

Logically collective.

Parameters
fn_type (*Type* | *str*) – The math function type to be used.

Return type
None

See also

getType, FNSetType

:sources:`Source code at slepc4py/SLEPc/FN.pyx:206 <slepc4py/SLEPc/FN.pyx#L206>`

view(*viewer=None*)

Print the FN data structure.

Collective.

Parameters
viewer (*Viewer* | *None*) – Visualization context; if not provided, the standard output is used.

Return type
None

See also

FNView

:sources:`Source code at slepc4py/SLEPc/FN.pyx:152 <slepc4py/SLEPc/FN.pyx#L152>`

Attributes Documentation

method

The method to be used to evaluate functions of matrices.

:sources:`Source code at slepc4py/SLEPc/FN.pyx:802 <slepc4py/SLEPc/FN.pyx#L802>`

parallel

The mode of operation in parallel runs.

:sources:`Source code at slepc4py/SLEPc/FN.pyx:810 <slepc4py/SLEPc/FN.pyx#L810>`

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.LME

class slepc4py.SLEPc.**LME**

Bases: Object

Linear Matrix Equation.

Linear Matrix Equation (*LME*) is the object provided by slepc4py for solving linear matrix equations such as Lyapunov or Sylvester where the solution has low rank.

Enumerations

ConvergedReason	LME convergence reasons.
ProblemType	LME problem type.
Type	LME type.

slepc4py.SLEPc.LME.ConvergedReason

class slepc4py.SLEPc.LME.**ConvergedReason**

Bases: object

LME convergence reasons.

- *CONVERGED_TOL*: All eigenpairs converged to requested tolerance.
- *DIVERGED_ITS*: Maximum number of iterations exceeded.
- *DIVERGED_BREAKDOWN*: Solver failed due to breakdown.
- *CONVERGED_ITERATING*: Iteration not finished yet.

See also

LMEConvergedReason

Attributes Summary

CONVERGED_ITERATING	Constant CONVERGED_ITERATING of type int
CONVERGED_TOL	Constant CONVERGED_TOL of type int
DIVERGED_BREAKDOWN	Constant DIVERGED_BREAKDOWN of type int
DIVERGED_ITS	Constant DIVERGED_ITS of type int
ITERATING	Constant ITERATING of type int

Attributes Documentation

CONVERGED_ITERATING: int = CONVERGED_ITERATING

Constant CONVERGED_ITERATING of type int

CONVERGED_TOL: int = CONVERGED_TOL

Constant CONVERGED_TOL of type int

DIVERGED_BREAKDOWN: int = DIVERGED_BREAKDOWN

Constant DIVERGED_BREAKDOWN of type int

DIVERGED_ITS: int = DIVERGED_ITS

Constant DIVERGED_ITS of type int

ITERATING: int = ITERATING

Constant ITERATING of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.LME.ProblemType

class slepc4py.SLEPc.LME.**ProblemType**

Bases: object

LME problem type.

- *LYAPUNOV*: Continuous-time Lyapunov.
- *SYLVESTER*: Continuous-time Sylvester.
- *GEN_LYAPUNOV*: Generalized Lyapunov.
- *GEN_SYLVESTER*: Generalized Sylvester.
- *DT_LYAPUNOV*: Discrete-time Lyapunov.
- *STEIN*: Stein.

See also

LMEProblemType

Attributes Summary

DT_LYAPUNOV	Constant DT_LYAPUNOV of type int
GEN_LYAPUNOV	Constant GEN_LYAPUNOV of type int
GEN_SYLVESTER	Constant GEN_SYLVESTER of type int
LYAPUNOV	Constant LYAPUNOV of type int
STEIN	Constant STEIN of type int
SYLVESTER	Constant SYLVESTER of type int

Attributes Documentation

DT_LYAPUNOV: int = DT_LYAPUNOV

Constant DT_LYAPUNOV of type int

GEN_LYAPUNOV: int = GEN_LYAPUNOV

Constant GEN_LYAPUNOV of type int

GEN_SYLVESTER: int = GEN_SYLVESTER

Constant GEN_SYLVESTER of type int

LYAPUNOV: int = LYAPUNOV

Constant LYAPUNOV of type int

STEIN: int = STEIN

Constant STEIN of type int

SYLVESTER: int = SYLVESTER

Constant SYLVESTER of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.LME.Type

class slepc4py.SLEPc.LME.**Type**

Bases: object

LME type.

- *KRYLOV*: Restarted Krylov solver.

See also

LMEType

Attributes Summary

KRYLOV	Object KRYLOV of type str

Attributes Documentation

KRYLOV: str = KRYLOV

Object KRYLOV of type str

__init__()

classmethod __new__(**args*, ***kwargs*)

Methods Summary

appendOptionsPrefix([prefix])	Append to the prefix used for searching in the database.
cancelMonitor()	Clear all monitors for an *LME* object.
computeError()	Compute the error associated with the last equation solved.
create([comm])	Create the LME object.
destroy()	Destroy the LME object.
getBV()	Get the basis vector object associated to the LME object.
getCoefficients()	Get the coefficient matrices of the matrix equation.
getConvergedReason()	Get the reason why the *solve()* iteration was stopped.
getDimensions()	Get the dimension of the subspace used by the solver.
getErrorEstimate()	Get the error estimate obtained during the solve.

continues on next page

Table 50 – continued from previous page

getErrorIfNotConverged()	Get if *solve()* generates an error if the solver does not converge.
getIterationNumber()	Get the current iteration number.
getMonitor()	Get the list of monitor functions.
getOptionsPrefix()	Get the prefix used for searching for all LME options in the database.
getProblemType()	Get the LME problem type of this object.
getRHS()	Get the right-hand side of the matrix equation.
getSolution()	Get the solution of the matrix equation.
getTolerances()	Get the tolerance and maximum iteration count.
getType()	Get the LME type of this object.
reset()	Reset the LME object.
setBV(bv)	Set a basis vector object to the LME object.
setCoefficients(A[, B, D, E])	Set the coefficient matrices.
setDimensions(ncv)	Set the dimension of the subspace to be used by the solver.
setErrorIfNotConverged([flg])	Set *solve()* to generate an error if the solver has not converged.
setFromOptions()	Set LME options from the options database.
setMonitor(monitor[, args, kargs])	Append a monitor function to the list of monitors.
setOptionsPrefix([prefix])	Set the prefix used for searching for all LME options in the database.
setProblemType(lme_problem_type)	Set the LME problem type of this object.
setRHS(C)	Set the right-hand side of the matrix equation.
setSolution([X])	Set the placeholder for the solution of the matrix equation.
setTolerances([tol, max_it])	Set the tolerance and maximum iteration count.
setType(lme_type)	Set the particular solver to be used in the LME object.
setUp()	Set up all the internal necessary data structures.
solve()	Solve the linear matrix equation.
view([viewer])	Print the LME data structure.

Attributes Summary

bv	The basis vectors (*BV*) object associated to the LME object.
fn	The math function (*FN*) object associated to the LME object.
max_it	The maximum iteration count used by the LME convergence tests.
tol	The tolerance value used by the LME convergence tests.

Methods Documentation

appendOptionsPrefix(*prefix=None*)

Append to the prefix used for searching in the database.

Logically collective.

Append to the prefix used for searching for all LME options in the database.

Parameters
prefix (*str* | *None*) – The prefix string to prepend to all LME option requests.

Return type
None

See also

setOptionsPrefix, *getOptionsPrefix*, LMEAppendOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/LME.pyx:516 <slepc4py/SLEPc/LME.pyx#L516>`

cancelMonitor()

Clear all monitors for an *LME* object.

Logically collective.

See also

LMEMonitorCancel

:sources:`Source code at slepc4py/SLEPc/LME.pyx:717 <slepc4py/SLEPc/LME.pyx#L717>`

Return type
None

computeError()

Compute the error associated with the last equation solved.

Collective.

Returns
The error.

Return type
float

Notes

The error is based on the residual norm.

This function is not scalable (in terms of memory or parallel communication), so it should not be called except in the case of small problem size. For large equations, use *getErrorEstimate()*.

See also

getErrorEstimate, LMEComputeError

:sources:`Source code at slepc4py/SLEPc/LME.pyx:439 <slepc4py/SLEPc/LME.pyx#L439>`

create(*comm=None*)

Create the LME object.

Collective.

Parameters
comm (*Comm* | *None*) – MPI communicator. If not provided, it defaults to all processes.

Return type
Self

See also

LMECreate

:sources:`Source code at slepc4py/SLEPc/LME.pyx:124 <slepc4py/SLEPc/LME.pyx#L124>`

`destroy()`

Destroy the LME object.

Collective.

See also

LMEDestroy

:sources:`Source code at slepc4py/SLEPc/LME.pyx:98 <slepc4py/SLEPc/LME.pyx#L98>`

Return type
Self

`getBV()`

Get the basis vector object associated to the LME object.

Not collective.

Returns
The basis vectors context.

Return type
BV

See also

setBV, LMEGetBV

:sources:`Source code at slepc4py/SLEPc/LME.pyx:642 <slepc4py/SLEPc/LME.pyx#L642>`

`getCoefficients()`

Get the coefficient matrices of the matrix equation.

Collective.

Returns

- **A** (petsc4py.PETSc.Mat) – First coefficient matrix.
- **B** (petsc4py.PETSc.Mat) – Second coefficient matrix, if available.
- **D** (petsc4py.PETSc.Mat) – Third coefficient matrix, if available.
- **E** (petsc4py.PETSc.Mat) – Fourth coefficient matrix, if available.

Return type
tuple[*Mat*, *Mat* | None, *Mat* | None, *Mat* | None]

See also

setCoefficients, LMEGetCoefficients

:sources:`Source code at slepc4py/SLEPc/LME.pyx:267 <slepc4py/SLEPc/LME.pyx#L267>`

getConvergedReason()

Get the reason why the *solve()* iteration was stopped.

Not collective.

Returns
Negative value indicates diverged, positive value converged.

Return type
ConvergedReason

See also

setTolerances, *solve*, *setErrorIfNotConverged*, LMEGetConvergedReason

:sources:`Source code at slepc4py/SLEPc/LME.pyx:784 <slepc4py/SLEPc/LME.pyx#L784>`

getDimensions()

Get the dimension of the subspace used by the solver.

Not collective.

Returns
Maximum dimension of the subspace to be used by the solver.

Return type
int

See also

setDimensions, LMEGetDimensions

:sources:`Source code at slepc4py/SLEPc/LME.pyx:605 <slepc4py/SLEPc/LME.pyx#L605>`

getErrorEstimate()

Get the error estimate obtained during the solve.

Not collective.

Returns
The error estimate.

Return type
float

Notes

This is the error estimated internally by the solver. The actual error bound can be computed with *computeError()*. Note that some solvers may not be able to provide an error estimate.

See also

computeError, LMEGetErrorEstimate

:sources:`Source code at slepc4py/SLEPc/LME.pyx:414 <slepc4py/SLEPc/LME.pyx#L414>`

getErrorIfNotConverged()

Get if *solve()* generates an error if the solver does not converge.

Not collective.

Get a flag indicating whether *solve()* will generate an error if the solver does not converge.

Returns
`True` indicates you want the error generated.

Return type
bool

See also

setErrorIfNotConverged, LMEGetErrorIfNotConverged

:sources:`Source code at slepc4py/SLEPc/LME.pyx:827 <slepc4py/SLEPc/LME.pyx#L827>`

getIterationNumber()

Get the current iteration number.

Not collective.

If the call to *solve()* is complete, then it returns the number of iterations carried out by the solution method.

Returns
Iteration number.

Return type
int

See also

getConvergedReason, LMEGetIterationNumber

:sources:`Source code at slepc4py/SLEPc/LME.pyx:762 <slepc4py/SLEPc/LME.pyx#L762>`

getMonitor()

Get the list of monitor functions.

Not collective.

Returns
The list of monitor functions.

Return type
LMEMonitorFunction

:sources:`Source code at slepc4py/SLEPc/LME.pyx:704 <slepc4py/SLEPc/LME.pyx#L704>`

getOptionsPrefix()

Get the prefix used for searching for all LME options in the database.

Not collective.

Returns
The prefix string set for this LME object.

Return type
str

See also

setOptionsPrefix, *appendOptionsPrefix*, LMEGetOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/LME.pyx:466 <slepc4py/SLEPc/LME.pyx#L466>`

getProblemType()

Get the LME problem type of this object.

Not collective.

Returns
The problem type currently being used.

Return type
ProblemType

See also

setProblemType, LMEGetProblemType

:sources:`Source code at slepc4py/SLEPc/LME.pyx:209 <slepc4py/SLEPc/LME.pyx#L209>`

getRHS()

Get the right-hand side of the matrix equation.

Collective.

Returns
C – The low-rank matrix.

Return type
petsc4py.PETSc.Mat

See also

setRHS, LMEGetRHS

:sources:`Source code at slepc4py/SLEPc/LME.pyx:331 <slepc4py/SLEPc/LME.pyx#L331>`

getSolution()

Get the solution of the matrix equation.

Collective.

Returns
X – The low-rank matrix.

Return type
petsc4py.PETSc.Mat

Notes

If called after *solve()*, `X` will contain the solution of the equation.

The matrix `X` may have been passed by the user via *setSolution()*, although this is not required.

See also

solve, *setSolution*, LMEGetSolution

:sources:`Source code at slepc4py/SLEPc/LME.pyx:386 <slepc4py/SLEPc/LME.pyx#L386>`

getTolerances()

Get the tolerance and maximum iteration count.

Not collective.

Returns

- **tol** (float) – The convergence tolerance.
- **max_it** (int) – The maximum number of iterations.

Return type
tuple[float, int]

See also

setTolerances, LMEGetTolerances

:sources:`Source code at slepc4py/SLEPc/LME.pyx:557 <slepc4py/SLEPc/LME.pyx#L557>`

getType()

Get the LME type of this object.

Not collective.

Returns
The solver currently being used.

Return type
str

See also

setType, LMEGetType

:sources:`Source code at slepc4py/SLEPc/LME.pyx:172 <slepc4py/SLEPc/LME.pyx#L172>`

reset()

Reset the LME object.

Collective.

See also

LMEReset

:sources:`Source code at slepc4py/SLEPc/LME.pyx:112 <slepc4py/SLEPc/LME.pyx#L112>`

Return type
None

setBV(*bv*)

Set a basis vector object to the LME object.

Collective.

Parameters
bv (BV) – The basis vectors context.

Return type
None

See also

getBV, LMESetBV

:sources:`Source code at slepc4py/SLEPc/LME.pyx:662 <slepc4py/SLEPc/LME.pyx#L662>`

setCoefficients(*A*, *B=None*, *D=None*, *E=None*)

Set the coefficient matrices.

Collective.

Set the coefficient matrices that define the linear matrix equation to be solved.

Parameters

- **A** (*Mat*) – First coefficient matrix
- **B** (*Mat* | *None*) – Second coefficient matrix, optional
- **D** (*Mat* | *None*) – Third coefficient matrix, optional
- **E** (*Mat* | *None*) – Fourth coefficient matrix, optional

Return type
None

Notes

The matrix equation takes the general form $AXE + DXB = C$, where matrix C is not provided here but with *setRHS()*. Not all four matrices must be passed.

This must be called before *setUp()*. If called again after *setUp()* then the *LME* object is reset.

See also

getCoefficients, *solve*, *setRHS*, *setUp*, LMESetCoefficients

:sources:`Source code at slepc4py/SLEPc/LME.pyx:228 <slepc4py/SLEPc/LME.pyx#L228>`

setDimensions(*ncv*)

Set the dimension of the subspace to be used by the solver.

Logically collective.

Parameters
ncv (*int*) – Maximum dimension of the subspace to be used by the solver.

Return type
None

See also

getDimensions, LMESetDimensions

:sources:`Source code at slepc4py/SLEPc/LME.pyx:624 <slepc4py/SLEPc/LME.pyx#L624>`

setErrorIfNotConverged(*flg=True*)

Set *solve()* to generate an error if the solver has not converged.

Logically collective.

Parameters
flg (*bool*) – `True` indicates you want the error generated.

Return type
None

Notes

Normally SLEPc continues if the solver fails to converge, you can call *getConvergedReason()* after a *solve()* to determine if it has converged.

See also

getConvergedReason, *solve*, LMESetErrorIfNotConverged

:sources:`Source code at slepc4py/SLEPc/LME.pyx:803 <slepc4py/SLEPc/LME.pyx#L803>`

setFromOptions()

Set LME options from the options database.

Collective.

Notes

To see all options, run your program with the `-help` option.

This routine must be called before *setUp()* if the user is to be allowed to set the solver type.

See also

setOptionsPrefix, LMESetFromOptions

:sources:`Source code at slepc4py/SLEPc/LME.pyx:538 <slepc4py/SLEPc/LME.pyx#L538>`

Return type
None

setMonitor(*monitor*, *args=None*, *kargs=None*)

Append a monitor function to the list of monitors.

Logically collective.

See also

getMonitor, *cancelMonitor*, LMEMonitorSet

:sources:`Source code at slepc4py/SLEPc/LME.pyx:679 <slepc4py/SLEPc/LME.pyx#L679>`

Parameters

- **monitor** (*LMEMonitorFunction | None*)
- **args** (*tuple[Any, ...] | None*)
- **kargs** (*dict[str, Any] | None*)

Return type
None

setOptionsPrefix(*prefix=None*)

Set the prefix used for searching for all LME options in the database.

Logically collective.

Parameters
prefix (*str | None*) – The prefix string to prepend to all LME option requests.

Return type
None

Notes

A hyphen (-) must NOT be given at the beginning of the prefix name. The first character of all runtime options is AUTOMATICALLY the hyphen.

For example, to distinguish between the runtime options for two different LME contexts, one could call:

```
L1.setOptionsPrefix("lme1_")
L2.setOptionsPrefix("lme2_")
```

See also

appendOptionsPrefix, *getOptionsPrefix*, LMEGetOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/LME.pyx:485 <slepc4py/SLEPc/LME.pyx#L485>`

setProblemType(*lme_problem_type*)

Set the LME problem type of this object.

Logically collective.

Parameters
lme_problem_type (ProblemType | *str*) – The problem type to be used.

Return type
None

See also

getProblemType, LMESetProblemType

:sources:`Source code at slepc4py/SLEPc/LME.pyx:191 <slepc4py/SLEPc/LME.pyx#L191>`

setRHS(*C*)

Set the right-hand side of the matrix equation.

Collective.

Parameters
C (*Mat*) – The right-hand side matrix

Return type
None

Notes

The matrix equation takes the general form $AXE+DXB = C$, where matrix C is given with this function. It must be a low-rank matrix of type petsc4py.PETSc.Mat.Type.LRC, that is, $C = UDV^*$ where D is diagonal of order k, and U, V are dense tall-skinny matrices with k columns. No sparse matrix must be provided when creating the LRC matrix.

In equation types that require C to be symmetric, such as Lyapunov, C must be created with $V = U$.

See also

getRHS, *setSolution*, LMESetRHS

:sources:`Source code at slepc4py/SLEPc/LME.pyx:302 <slepc4py/SLEPc/LME.pyx#L302>`

setSolution(*X=None*)

Set the placeholder for the solution of the matrix equation.

Collective.

Parameters
X (*Mat* | *None*) – The solution matrix

Return type
None

Notes

The matrix equation takes the general form $AXE + DXB = C$, where the solution matrix is of low rank and is written in factored form $X = UDV^*$. This function provides a matrix object of type `petsc4py.PETSc.Mat.Type.LRC` that stores U, V and (optionally) D. These factors will be computed during *solve()*.

In equation types whose solution X is symmetric, such as Lyapunov, `X` must be created with $V = U$.

If the user provides `X` with this function, then the solver will return a solution with rank at most the number of columns of U. Alternatively, it is possible to let the solver choose the rank of the solution, by passing `None` and then calling *getSolution()* after *solve()*.

See also

solve, *setRHS*, *getSolution*, `LMESetSolution`

:sources:`Source code at slepc4py/SLEPc/LME.pyx:351 <slepc4py/SLEPc/LME.pyx#L351>`

setTolerances(*tol=None*, *max_it=None*)

Set the tolerance and maximum iteration count.

Logically collective.

Set the tolerance and maximum iteration count used by the default LME convergence tests.

Parameters

- **tol** (*float* | *None*) – The convergence tolerance.
- **max_it** (*int* | *None*) – The maximum number of iterations.

Return type
None

See also

getTolerances, `LMESetTolerances`

:sources:`Source code at slepc4py/SLEPc/LME.pyx:579 <slepc4py/SLEPc/LME.pyx#L579>`

setType(*lme_type*)

Set the particular solver to be used in the LME object.

Logically collective.

Parameters
lme_type (`Type` | *str*) – The solver to be used.

Return type
None

Notes

The default is `KRYLOV`. Normally, it is best to use *setFromOptions()* and then set the LME type from the options database rather than by using this routine. Using the options database provides the user with maximum flexibility in evaluating the different available methods.

See also

getType, LMESetType

:sources:`Source code at slepc4py/SLEPc/LME.pyx:145 <slepc4py/SLEPc/LME.pyx#L145>`

setUp()

Set up all the internal necessary data structures.

Collective.

Set up all the internal data structures necessary for the execution of the eigensolver.

See also

solve, LMESetUp

:sources:`Source code at slepc4py/SLEPc/LME.pyx:730 <slepc4py/SLEPc/LME.pyx#L730>`

Return type
None

solve()

Solve the linear matrix equation.

Collective.

Notes

The matrix coefficients are specified with *setCoefficients()*. The right-hand side is specified with *setRHS()*. The placeholder for the solution is specified with *setSolution()*.

See also

setCoefficients, *setRHS*, *setSolution*, LMESolve

:sources:`Source code at slepc4py/SLEPc/LME.pyx:745 <slepc4py/SLEPc/LME.pyx#L745>`

Return type
None

view(*viewer=None*)

Print the LME data structure.

Collective.

Parameters
viewer (*Viewer* | *None*) – Visualization context; if not provided, the standard output is used.

Return type
None

See also

LMEView

:sources:`Source code at slepc4py/SLEPc/LME.pyx:79 <slepc4py/SLEPc/LME.pyx#L79>`

Attributes Documentation

bv

The basis vectors (*BV*) object associated to the LME object.

:sources:`Source code at slepc4py/SLEPc/LME.pyx:875 <slepc4py/SLEPc/LME.pyx#L875>`

fn

The math function (*FN*) object associated to the LME object.

:sources:`Source code at slepc4py/SLEPc/LME.pyx:867 <slepc4py/SLEPc/LME.pyx#L867>`

max_it

The maximum iteration count used by the LME convergence tests.

:sources:`Source code at slepc4py/SLEPc/LME.pyx:859 <slepc4py/SLEPc/LME.pyx#L859>`

tol

The tolerance value used by the LME convergence tests.

:sources:`Source code at slepc4py/SLEPc/LME.pyx:851 <slepc4py/SLEPc/LME.pyx#L851>`

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.MFN

class slepc4py.SLEPc.**MFN**

Bases: Object

Matrix Function.

Matrix Function (*MFN*) is the object provided by slepc4py for computing the action of a matrix function on a vector. Given a matrix A and a vector b, the call `mfn.solve(b,x)` computes $x = f(A)b$, where f is a function such as the exponential.

Enumerations

ConvergedReason	MFN convergence reasons.
Type	MFN type.

slepc4py.SLEPc.MFN.ConvergedReason

class slepc4py.SLEPc.MFN.**ConvergedReason**

Bases: object

MFN convergence reasons.

- *CONVERGED_TOL*: All eigenpairs converged to requested tolerance.

- *CONVERGED_ITS*: Solver completed the requested number of steps.
- *DIVERGED_ITS*: Maximum number of iterations exceeded.
- *DIVERGED_BREAKDOWN*: Generic breakdown in method.

See also

MFNConvergedReason

Attributes Summary

CONVERGED_ITERATING	Constant CONVERGED_ITERATING of type int
CONVERGED_ITS	Constant CONVERGED_ITS of type int
CONVERGED_TOL	Constant CONVERGED_TOL of type int
DIVERGED_BREAKDOWN	Constant DIVERGED_BREAKDOWN of type int
DIVERGED_ITS	Constant DIVERGED_ITS of type int
ITERATING	Constant ITERATING of type int

Attributes Documentation

CONVERGED_ITERATING: int = CONVERGED_ITERATING

Constant CONVERGED_ITERATING of type int

CONVERGED_ITS: int = CONVERGED_ITS

Constant CONVERGED_ITS of type int

CONVERGED_TOL: int = CONVERGED_TOL

Constant CONVERGED_TOL of type int

DIVERGED_BREAKDOWN: int = DIVERGED_BREAKDOWN

Constant DIVERGED_BREAKDOWN of type int

DIVERGED_ITS: int = DIVERGED_ITS

Constant DIVERGED_ITS of type int

ITERATING: int = ITERATING

Constant ITERATING of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.MFN.Type

class slepc4py.SLEPc.MFN.**Type**

Bases: object

MFN type.

- *KRYLOV*: Restarted Krylov solver.
- *EXPOKIT*: Implementation of the method in Expokit.

See also

MFNType

Attributes Summary

EXPOKIT	Object EXPOKIT of type str
KRYLOV	Object KRYLOV of type str

Attributes Documentation

EXPOKIT: str = EXPOKIT

Object EXPOKIT of type str

KRYLOV: str = KRYLOV

Object KRYLOV of type str

__init__()

classmethod __new__(**args*, ***kwargs*)

Methods Summary

appendOptionsPrefix([prefix])	Append to the prefix used for searching for all MFN options in the database.
cancelMonitor()	Clear all monitors for an *MFN* object.
create([comm])	Create the MFN object.
destroy()	Destroy the MFN object.
getBV()	Get the basis vector object associated to the MFN object.
getConvergedReason()	Get the reason why the *solve()* iteration was stopped.
getDimensions()	Get the dimension of the subspace used by the solver.
getErrorIfNotConverged()	Get if *solve()* generates an error if the solver does not converge.
getFN()	Get the math function object associated to the MFN object.
getIterationNumber()	Get the current iteration number.
getMonitor()	Get the list of monitor functions.
getOperator()	Get the matrix associated with the MFN object.
getOptionsPrefix()	Get the prefix used for searching for all MFN options in the database.
getTolerances()	Get the tolerance and maximum iteration count.
getType()	Get the MFN type of this object.
reset()	Reset the MFN object.
setBV(bv)	Set a basis vector object associated to the MFN object.
setDimensions(ncv)	Set the dimension of the subspace to be used by the solver.
setErrorIfNotConverged([flg])	Set *solve()* to generate an error if the solver does not converge.

continues on next page

Table 55 – continued from previous page

setFN(fn)	Set a math function object associated to the MFN object.
setFromOptions()	Set MFN options from the options database.
setMonitor(monitor[, args, kargs])	Append a monitor function to the list of monitors.
setOperator(A)	Set the matrix associated with the MFN object.
setOptionsPrefix([prefix])	Set the prefix used for searching for all MFN options in the database.
setTolerances([tol, max_it])	Set the tolerance and maximum iteration count.
setType(mfn_type)	Set the particular solver to be used in the MFN object.
setUp()	Set up all the necessary internal data structures.
solve(b, x)	Solve the matrix function problem.
solveTranspose(b, x)	Solve the transpose matrix function problem.
view([viewer])	Print the MFN data structure.

Attributes Summary

bv	The basis vectors (*BV*) object associated to the MFN object.
fn	The math function (*FN*) object associated to the MFN object.
max_it	The maximum iteration count used by the MFN convergence tests.
tol	The tolerance count used by the MFN convergence tests.

Methods Documentation

appendOptionsPrefix(*prefix=None*)

Append to the prefix used for searching for all MFN options in the database.

Logically collective.

Parameters
prefix (*str | None*) – The prefix string to prepend to all MFN option requests.

Return type
None

See also

setOptionsPrefix, *getOptionsPrefix*, MFNAppendOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:221 <slepc4py/SLEPc/MFN.pyx#L221>`

cancelMonitor()

Clear all monitors for an *MFN* object.

Logically collective.

See also

MFNMonitorCancel

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:500 <slepc4py/SLEPc/MFN.pyx#L500>`

Return type
None

create(*comm=None*)

Create the MFN object.

Collective.

Parameters
comm (*Comm* | *None*) – MPI communicator. If not provided, it defaults to all processes.

Return type
Self

See also

MFNCreate

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:104 <slepc4py/SLEPc/MFN.pyx#L104>`

destroy()

Destroy the MFN object.

Logically collective.

See also

MFNDestroy

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:78 <slepc4py/SLEPc/MFN.pyx#L78>`

Return type
Self

getBV()

Get the basis vector object associated to the MFN object.

Not collective.

Returns
The basis vectors context.

Return type
BV

See also

setBV, MFNGetBV

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:381 <slepc4py/SLEPc/MFN.pyx#L381>`

getConvergedReason()

Get the reason why the *solve()* iteration was stopped.

Not collective.

Returns
Negative value indicates diverged, positive value converged.

Return type
ConvergedReason

See also

setTolerances, *solve*, *setErrorIfNotConverged*, MFNGetConvergedReason

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:609 <slepc4py/SLEPc/MFN.pyx#L609>`

getDimensions()

Get the dimension of the subspace used by the solver.

Not collective.

Returns
Maximum dimension of the subspace to be used by the solver.

Return type
int

See also

setDimensions, MFNGetDimensions

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:307 <slepc4py/SLEPc/MFN.pyx#L307>`

getErrorIfNotConverged()

Get if *solve()* generates an error if the solver does not converge.

Not collective.

Get a flag indicating whether *solve()* will generate an error if the solver does not converge.

Returns
`True` indicates you want the error generated.

Return type
bool

See also

setErrorIfNotConverged, MFNGetErrorIfNotConverged

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:652 <slepc4py/SLEPc/MFN.pyx#L652>`

getFN()

Get the math function object associated to the MFN object.

Not collective.

Returns
The math function context.

Return type
FN

See also

setFN, MFNGetFN

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:344 <slepc4py/SLEPc/MFN.pyx#L344>`

getIterationNumber()

Get the current iteration number.

Not collective.

Get the current iteration number. If the call to *solve()* is complete, then it returns the number of iterations carried out by the solution method.

Returns
Iteration number.

Return type
int

See also

getConvergedReason, MFNGetIterationNumber

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:586 <slepc4py/SLEPc/MFN.pyx#L586>`

getMonitor()

Get the list of monitor functions.

Not collective.

Returns
The list of monitor functions.

Return type
MFNMonitorFunction

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:487 <slepc4py/SLEPc/MFN.pyx#L487>`

getOperator()

Get the matrix associated with the MFN object.

Collective.

Returns
The matrix for which the matrix function is to be computed.

Return type
petsc4py.PETSc.Mat

See also

setOperator, MFNGetOperator

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:418 <slepc4py/SLEPc/MFN.pyx#L418>`

getOptionsPrefix()

Get the prefix used for searching for all MFN options in the database.

Not collective.

Returns

The prefix string set for this MFN object.

Return type

str

See also

setOptionsPrefix, *appendOptionsPrefix*, MFNGetOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:171 <slepc4py/SLEPc/MFN.pyx#L171>`

getTolerances()

Get the tolerance and maximum iteration count.

Not collective.

Returns

- **tol** (float) – The convergence tolerance.
- **max_it** (int) – The maximum number of iterations.

Return type

tuple[float, int]

See also

setTolerances, MFNGetTolerances

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:259 <slepc4py/SLEPc/MFN.pyx#L259>`

getType()

Get the MFN type of this object.

Not collective.

Returns

The solver currently being used.

Return type

str

See also

setType, MFNGetType

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:152 <slepc4py/SLEPc/MFN.pyx#L152>`

reset()

Reset the MFN object.

Collective.

See also

MFNReset

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:92 <slepc4py/SLEPc/MFN.pyx#L92>`

Return type
None

setBV(*bv*)

Set a basis vector object associated to the MFN object.

Collective.

Parameters
bv (BV) – The basis vectors context.

Return type
None

See also

getBV, MFNSetBV

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:401 <slepc4py/SLEPc/MFN.pyx#L401>`

setDimensions(*ncv*)

Set the dimension of the subspace to be used by the solver.

Logically collective.

Parameters
ncv (*int*) – Maximum dimension of the subspace to be used by the solver.

Return type
None

See also

getDimensions, MFNSetDimensions

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:326 <slepc4py/SLEPc/MFN.pyx#L326>`

setErrorIfNotConverged(*flg=True*)

Set *solve()* to generate an error if the solver does not converge.

Logically collective.

Parameters
flg (*bool*) – True indicates you want the error generated.

Return type
None

Notes

Normally SLEPc continues if the solver fails to converge, you can call *getConvergedReason()* after a *solve()* to determine if it has converged.

See also

getConvergedReason, *solve*, MFNSetErrorIfNotConverged

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:628 <slepc4py/SLEPc/MFN.pyx#L628>`

setFN(*fn*)

Set a math function object associated to the MFN object.

Collective.

Parameters
fn (FN) – The math function context.

Return type
None

See also

getFN, MFNSetFN

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:364 <slepc4py/SLEPc/MFN.pyx#L364>`

setFromOptions()

Set MFN options from the options database.

Collective.

Notes

To see all options, run your program with the `-help` option.

This routine must be called before *setUp()* if the user is to be allowed to set the solver type.

See also

setOptionsPrefix, MFNSetFromOptions

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:240 <slepc4py/SLEPc/MFN.pyx#L240>`

Return type
None

setMonitor(*monitor*, *args=None*, *kargs=None*)

Append a monitor function to the list of monitors.

Logically collective.

See also

getMonitor, *cancelMonitor*, MFNMonitorSet

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:462 <slepc4py/SLEPc/MFN.pyx#L462>`

Parameters

- **monitor** (*MFNMonitorFunction | None*)
- **args** (*tuple[Any, ...] | None*)
- **kargs** (*dict[str, Any] | None*)

Return type
None

setOperator(*A*)

Set the matrix associated with the MFN object.

Collective.

Parameters
A (*Mat*) – The problem matrix.

Return type
None

Notes

This must be called before *setUp()*. If called again after *setUp()* then the *MFN* object is reset.

See also

getOperator, MFNSetOperator

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:438 <slepc4py/SLEPc/MFN.pyx#L438>`

setOptionsPrefix(*prefix=None*)

Set the prefix used for searching for all MFN options in the database.

Logically collective.

Parameters
prefix (*str | None*) – The prefix string to prepend to all MFN option requests.

Return type
None

Notes

A hyphen (-) must NOT be given at the beginning of the prefix name. The first character of all runtime options is AUTOMATICALLY the hyphen.

For example, to distinguish between the runtime options for two different MFN contexts, one could call:

```
M1.setOptionsPrefix("mfn1_")
M2.setOptionsPrefix("mfn2_")
```

See also

appendOptionsPrefix, *getOptionsPrefix*, MFNGetOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:190 <slepc4py/SLEPc/MFN.pyx#L190>`

setTolerances(*tol=None*, *max_it=None*)

Set the tolerance and maximum iteration count.

Logically collective.

Set the tolerance and maximum iteration count used by the default MFN convergence tests.

Parameters

- **tol** (*float* | *None*) – The convergence tolerance.
- **max_it** (*int* | *None*) – The maximum number of iterations.

Return type

None

See also

getTolerances, MFNSetTolerances

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:281 <slepc4py/SLEPc/MFN.pyx#L281>`

setType(*mfn_type*)

Set the particular solver to be used in the MFN object.

Logically collective.

Parameters

mfn_type (Type | *str*) – The solver to be used.

Return type

None

Notes

The default is KRYLOV. Normally, it is best to use *setFromOptions()* and then set the MFN type from the options database rather than by using this routine. Using the options database provides the user with maximum flexibility in evaluating the different available methods.

See also

getType, MFNSetType

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:125 <slepc4py/SLEPc/MFN.pyx#L125>`

setUp()

Set up all the necessary internal data structures.

Collective.

Set up all the internal data structures necessary for the execution of the eigensolver.

See also

solve, MFNSetUp

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:515 <slepc4py/SLEPc/MFN.pyx#L515>`

Return type
None

solve(b, x)

Solve the matrix function problem.

Collective.

Given a vector b, the vector $x = f(A)b$ is returned.

Parameters

- **b** (*Vec*) – The right hand side vector.
- **x** (*Vec*) – The solution.

Return type
None

Notes

The matrix A is specified with *setOperator()*. The function f is specified via the *FN* object obtained with *getFN()* or set with *setFN()*.

See also

setOperator, *getFN*, *solveTranspose*, MFNSolve

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:530 <slepc4py/SLEPc/MFN.pyx#L530>`

solveTranspose(b, x)

Solve the transpose matrix function problem.

Collective.

Given a vector b, the vector $x = f(A^T)b$ is returned.

Parameters

- **b** (*Vec*) – The right hand side vector.

- **x** (*Vec*) – The solution.

Return type
None

Notes

The matrix A is specified with *setOperator()*. The function f is specified via the *FN* object obtained with *getFN()* or set with *setFN()*.

See also

setOperator, *getFN*, *solve*, MFNSolveTranspose

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:558 <slepc4py/SLEPc/MFN.pyx#L558>`

view(*viewer=None*)

Print the MFN data structure.

Collective.

Parameters
viewer (*Viewer | None*) – Visualization context; if not provided, the standard output is used.

Return type
None

See also

MFNView

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:59 <slepc4py/SLEPc/MFN.pyx#L59>`

Attributes Documentation

bv

The basis vectors (*BV*) object associated to the MFN object.

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:700 <slepc4py/SLEPc/MFN.pyx#L700>`

fn

The math function (*FN*) object associated to the MFN object.

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:692 <slepc4py/SLEPc/MFN.pyx#L692>`

max_it

The maximum iteration count used by the MFN convergence tests.

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:684 <slepc4py/SLEPc/MFN.pyx#L684>`

tol

The tolerance count used by the MFN convergence tests.

:sources:`Source code at slepc4py/SLEPc/MFN.pyx:676 <slepc4py/SLEPc/MFN.pyx#L676>`

__init__()

classmethod **__new__**(**args*, ***kwargs*)

slepc4py.SLEPc.NEP

class slepc4py.SLEPc.**NEP**

Bases: Object

Nonlinear Eigenvalue Problem Solver.

The Nonlinear Eigenvalue Problem (*NEP*) solver is the object provided by slepc4py for specifying an eigenvalue problem that is nonlinear with respect to the eigenvalue (not the eigenvector). This is intended for general nonlinear problems (rather than polynomial eigenproblems) described as $T(\lambda)x = 0$.

Enumerations

CISSExtraction	NEP CISS extraction technique.
Conv	NEP convergence test.
ConvergedReason	NEP convergence reasons.
ErrorType	NEP error type to assess accuracy of computed solutions.
ProblemType	NEP problem type.
Refine	NEP refinement strategy.
RefineScheme	NEP scheme for solving linear systems during iterative refinement.
Stop	NEP stopping test.
Type	NEP type.
Which	NEP desired part of spectrum.

slepc4py.SLEPc.NEP.CISSExtraction

class slepc4py.SLEPc.NEP.**CISSExtraction**

Bases: object

NEP CISS extraction technique.

- *RITZ*: Ritz extraction.
- *HANKEL*: Extraction via Hankel eigenproblem.
- *CAA*: Communication-avoiding Arnoldi.

See also

NEPCISSExtraction

Attributes Summary

CAA	Constant CAA of type int
HANKEL	Constant HANKEL of type int
RITZ	Constant RITZ of type int

Attributes Documentation

CAA: int = CAA

Constant CAA of type int

HANKEL: int = HANKEL

Constant HANKEL of type int

RITZ: int = RITZ

Constant RITZ of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.NEP.Conv

class slepc4py.SLEPc.NEP.**Conv**

Bases: object

NEP convergence test.

- *ABS*: Absolute convergence test.
- *REL*: Convergence test relative to the eigenvalue.
- *NORM*: Convergence test relative to the matrix norms.
- *USER*: User-defined convergence test.

See also

NEPConv

Attributes Summary

ABS	Constant ABS of type int
NORM	Constant NORM of type int
REL	Constant REL of type int
USER	Constant USER of type int

Attributes Documentation

ABS: int = ABS

Constant ABS of type int

NORM: int = NORM

Constant NORM of type int

REL: int = REL

Constant REL of type int

USER: int = USER

Constant USER of type int

__init__()

classmethod **__new__**(**args*, ***kwargs*)

slepc4py.SLEPc.NEP.ConvergedReason

class slepc4py.SLEPc.NEP.**ConvergedReason**

Bases: object

NEP convergence reasons.

- *CONVERGED_TOL*: All eigenpairs converged to requested tolerance.
- *CONVERGED_USER*: User-defined convergence criterion satisfied.
- *DIVERGED_ITS*: Maximum number of iterations exceeded.
- *DIVERGED_BREAKDOWN*: Solver failed due to breakdown.
- *DIVERGED_LINEAR_SOLVE*: Inner linear solve failed.
- *DIVERGED_SUBSPACE_EXHAUSTED*: Run out of space for the basis in an unrestarted solver.
- *CONVERGED_ITERATING*: Iteration not finished yet.

See also

NEPConvergedReason

Attributes Summary

CONVERGED_ITERATING	Constant CONVERGED_ITERATING of type int
CONVERGED_TOL	Constant CONVERGED_TOL of type int
CONVERGED_USER	Constant CONVERGED_USER of type int
DIVERGED_BREAKDOWN	Constant DIVERGED_BREAKDOWN of type int
DIVERGED_ITS	Constant DIVERGED_ITS of type int
DIVERGED_LINEAR_SOLVE	Constant DIVERGED_LINEAR_SOLVE of type int
DIVERGED_SUBSPACE_EXHAUSTED	Constant DIVERGED_SUBSPACE_EXHAUSTED of type int
ITERATING	Constant ITERATING of type int

Attributes Documentation

CONVERGED_ITERATING: int = CONVERGED_ITERATING

Constant CONVERGED_ITERATING of type int

CONVERGED_TOL: int = CONVERGED_TOL

Constant CONVERGED_TOL of type int

CONVERGED_USER: int = CONVERGED_USER

Constant CONVERGED_USER of type int

DIVERGED_BREAKDOWN: int = DIVERGED_BREAKDOWN

Constant DIVERGED_BREAKDOWN of type int

DIVERGED_ITS: int = DIVERGED_ITS

Constant DIVERGED_ITS of type int

DIVERGED_LINEAR_SOLVE: int = DIVERGED_LINEAR_SOLVE

Constant DIVERGED_LINEAR_SOLVE of type int

DIVERGED_SUBSPACE_EXHAUSTED: int = DIVERGED_SUBSPACE_EXHAUSTED

Constant DIVERGED_SUBSPACE_EXHAUSTED of type int

ITERATING: int = ITERATING

Constant ITERATING of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.NEP.ErrorType

class slepc4py.SLEPc.NEP.**ErrorType**

Bases: object

NEP error type to assess accuracy of computed solutions.

- *ABSOLUTE*: Absolute error.
- *RELATIVE*: Relative error.
- *BACKWARD*: Backward error.

See also

NEPErrorType

Attributes Summary

ABSOLUTE	Constant ABSOLUTE of type int
BACKWARD	Constant BACKWARD of type int
RELATIVE	Constant RELATIVE of type int

Attributes Documentation

ABSOLUTE: int = ABSOLUTE

Constant ABSOLUTE of type int

BACKWARD: int = BACKWARD

Constant BACKWARD of type int

RELATIVE: int = RELATIVE

Constant RELATIVE of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.NEP.ProblemType

class slepc4py.SLEPc.NEP.**ProblemType**

Bases: object

NEP problem type.

- *GENERAL*: General nonlinear eigenproblem.
- *RATIONAL*: NEP defined in split form with all f_i rational.

See also

NEPProblemType

Attributes Summary

GENERAL	Constant GENERAL of type int
RATIONAL	Constant RATIONAL of type int

Attributes Documentation

GENERAL: int = GENERAL

Constant GENERAL of type int

RATIONAL: int = RATIONAL

Constant RATIONAL of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.NEP.Refine

class slepc4py.SLEPc.NEP.**Refine**

Bases: object

NEP refinement strategy.

- *NONE*: No refinement.
- *SIMPLE*: Refine eigenpairs one by one.
- *MULTIPLE*: Refine all eigenpairs simultaneously (invariant pair).

See also

NEPRefine

Attributes Summary

MULTIPLE	Constant MULTIPLE of type int
NONE	Constant NONE of type int

continues on next page

Table 63 – continued from previous page

SIMPLE	Constant SIMPLE of type int

Attributes Documentation

MULTIPLE: int = MULTIPLE

Constant MULTIPLE of type int

NONE: int = NONE

Constant NONE of type int

SIMPLE: int = SIMPLE

Constant SIMPLE of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.NEP.RefineScheme

class slepc4py.SLEPc.NEP.**RefineScheme**

Bases: object

NEP scheme for solving linear systems during iterative refinement.

- *SCHUR*: Schur complement.
- *MBE*: Mixed block elimination.
- *EXPLICIT*: Build the explicit matrix.

See also

NEPRefineScheme

Attributes Summary

EXPLICIT	Constant EXPLICIT of type int
MBE	Constant MBE of type int
SCHUR	Constant SCHUR of type int

Attributes Documentation

EXPLICIT: int = EXPLICIT

Constant EXPLICIT of type int

MBE: int = MBE

Constant MBE of type int

SCHUR: int = SCHUR

Constant SCHUR of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.NEP.Stop

class slepc4py.SLEPc.NEP.**Stop**

Bases: object

NEP stopping test.

- *BASIC*: Default stopping test.
- *USER*: User-defined stopping test.

See also

NEPStop

Attributes Summary

BASIC	Constant BASIC of type int
USER	Constant USER of type int

Attributes Documentation

BASIC: int = BASIC

Constant BASIC of type int

USER: int = USER

Constant USER of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.NEP.Type

class slepc4py.SLEPc.NEP.**Type**

Bases: object

NEP type.

- *RII*: Residual inverse iteration.
- *SLP*: Successive linear problems.
- *NARNOLDI*: Nonlinear Arnoldi.
- *NLEIGS*: Fully rational Krylov method for nonlinear eigenproblems.
- *CISS*: Contour integral spectrum slice.
- *INTERPOL*: Polynomial interpolation.

See also

NEPType

Attributes Summary

CISS	Object CISS of type str
INTERPOL	Object INTERPOL of type str
NARNOLDI	Object NARNOLDI of type str
NLEIGS	Object NLEIGS of type str
RII	Object RII of type str
SLP	Object SLP of type str

Attributes Documentation

CISS: str = CISS

Object CISS of type str

INTERPOL: str = INTERPOL

Object INTERPOL of type str

NARNOLDI: str = NARNOLDI

Object NARNOLDI of type str

NLEIGS: str = NLEIGS

Object NLEIGS of type str

RII: str = RII

Object RII of type str

SLP: str = SLP

Object SLP of type str

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.NEP.Which

class slepc4py.SLEPc.NEP.**Which**

Bases: object

NEP desired part of spectrum.

- *LARGEST_MAGNITUDE*: Largest magnitude (default).
- *SMALLEST_MAGNITUDE*: Smallest magnitude.
- *LARGEST_REAL*: Largest real parts.
- *SMALLEST_REAL*: Smallest real parts.
- *LARGEST_IMAGINARY*: Largest imaginary parts in magnitude.
- *SMALLEST_IMAGINARY*: Smallest imaginary parts in magnitude.
- *TARGET_MAGNITUDE*: Closest to target (in magnitude).
- *TARGET_REAL*: Real part closest to target.
- *TARGET_IMAGINARY*: Imaginary part closest to target.
- *ALL*: All eigenvalues in a region.
- *USER*: User defined selection.

See also

NEPWhich

Attributes Summary

ALL	Constant ALL of type int
LARGEST_IMAGINARY	Constant LARGEST_IMAGINARY of type int
LARGEST_MAGNITUDE	Constant LARGEST_MAGNITUDE of type int
LARGEST_REAL	Constant LARGEST_REAL of type int
SMALLEST_IMAGINARY	Constant SMALLEST_IMAGINARY of type int
SMALLEST_MAGNITUDE	Constant SMALLEST_MAGNITUDE of type int
SMALLEST_REAL	Constant SMALLEST_REAL of type int
TARGET_IMAGINARY	Constant TARGET_IMAGINARY of type int
TARGET_MAGNITUDE	Constant TARGET_MAGNITUDE of type int
TARGET_REAL	Constant TARGET_REAL of type int
USER	Constant USER of type int

Attributes Documentation

ALL: int = ALL

Constant ALL of type int

LARGEST_IMAGINARY: int = LARGEST_IMAGINARY

Constant LARGEST_IMAGINARY of type int

LARGEST_MAGNITUDE: int = LARGEST_MAGNITUDE

Constant LARGEST_MAGNITUDE of type int

LARGEST_REAL: int = LARGEST_REAL

Constant LARGEST_REAL of type int

SMALLEST_IMAGINARY: int = SMALLEST_IMAGINARY

Constant SMALLEST_IMAGINARY of type int

SMALLEST_MAGNITUDE: int = SMALLEST_MAGNITUDE

Constant SMALLEST_MAGNITUDE of type int

SMALLEST_REAL: int = SMALLEST_REAL

Constant SMALLEST_REAL of type int

TARGET_IMAGINARY: int = TARGET_IMAGINARY

Constant TARGET_IMAGINARY of type int

TARGET_MAGNITUDE: int = TARGET_MAGNITUDE

Constant TARGET_MAGNITUDE of type int

TARGET_REAL: int = TARGET_REAL

Constant TARGET_REAL of type int

USER: int = USER

Constant USER of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

Methods Summary

appendOptionsPrefix([prefix])	Append to the prefix used for searching for all NEP options in the database.
applyResolvent(omega, v, r[, rg])	Apply the resolvent $T^{-1}(z)$ to a given vector.
cancelMonitor()	Clear all monitors for a *NEP* object.
computeError(i[, etype])	Compute the error associated with the i-th computed eigenpair.
create([comm])	Create the NEP object.
destroy()	Destroy the NEP object.
errorView([etype, viewer])	Display the errors associated with the computed solution.
getBV()	Get the basis vectors object associated to the eigensolver.
getCISSExtraction()	Get the extraction technique used in the CISS solver.
getCISSKSPs()	Get the list of linear solver objects associated with the CISS solver.
getCISSRefinement()	Get the values of various refinement parameters in the CISS solver.
getCISSSizes()	Get the values of various size parameters in the CISS solver.
getCISSThreshold()	Get the values of various threshold parameters in the CISS solver.
getConverged()	Get the number of converged eigenpairs.
getConvergedReason()	Get the reason why the *solve()* iteration was stopped.
getConvergenceTest()	Get the method used to compute the error estimate used in the convergence test.
getDS()	Get the direct solver associated to the eigensolver.
getDimensions()	Get the number of eigenvalues to compute.
getEigenpair(i[, Vr, Vi])	Get the i-th solution of the eigenproblem as computed by *solve()*.
getEigenvalueComparison()	Get the eigenvalue comparison function.
getErrorEstimate(i)	Get the error estimate associated to the i-th computed eigenpair.
getFunction()	Get the function to compute the nonlinear Function $T(\lambda)$.
getInterpolInterpolation()	Get the tolerance and maximum degree for the interpolation polynomial.
getInterpolPEP()	Get the associated polynomial eigensolver object.
getIterationNumber()	Get the current iteration number.
getJacobian()	Get the function to compute the Jacobian $T'(\lambda)$ and J.
getLeftEigenvector(i, Wr[, Wi])	Get the i-th left eigenvector as computed by *solve()*.
getMonitor()	Get the list of monitor functions.
getNArnoldiKSP()	Get the linear solver object associated with the nonlinear eigensolver.
getNArnoldiLagPreconditioner()	Get how often the preconditioner is rebuilt.
getNLEIGSEPS()	Get the linear eigensolver object associated with the nonlinear eigensolver.
getNLEIGSFullBasis()	Get the flag that indicates if NLEIGS is using the full-basis variant.

continues on next page

Table 68 – continued from previous page

getNLEIGSInterpolation()	Get the tolerance and maximum degree for the interpolation polynomial.
getNLEIGSKSPs()	Get the list of linear solver objects associated with the NLEIGS solver.
getNLEIGSLocking()	Get the locking flag used in the NLEIGS method.
getNLEIGSRKShifts()	Get the list of shifts used in the Rational Krylov method.
getNLEIGSRestart()	Get the restart parameter used in the NLEIGS method.
getOptionsPrefix()	Get the prefix used for searching for all NEP options in the database.
getProblemType()	Get the problem type from the *NEP* object.
getRG()	Get the region object associated to the eigensolver.
getRIIConstCorrectionTol()	Get the constant tolerance flag.
getRIIDeflationThreshold()	Get the threshold value that controls deflation.
getRIIHermitian()	Get if the Hermitian version must be used by the solver.
getRIIKSP()	Get the linear solver object associated with the nonlinear eigensolver.
getRIILagPreconditioner()	Get how often the preconditioner is rebuilt.
getRIIMaximumIterations()	Get the maximum number of inner iterations of RII.
getRefine()	Get the refinement strategy used by the NEP object.
getRefineKSP()	Get the KSP object used by the eigensolver in the refinement phase.
getSLPDeflationThreshold()	Get the threshold value that controls deflation.
getSLPEPS()	Get the linear eigensolver object associated with the nonlinear eigensolver.
getSLPEPSLeft()	Get the left eigensolver.
getSLPKSP()	Get the linear solver object associated with the nonlinear eigensolver.
getSplitOperator()	Get the operator of the nonlinear eigenvalue problem in split form.
getSplitPreconditioner()	Get the operator of the split preconditioner.
getStoppingTest()	Get the stopping test function.
getTarget()	Get the value of the target.
getTolerances()	Get the tolerance and maximum iteration count.
getTrackAll()	Get the flag indicating whether all residual norms must be computed.
getTwoSided()	Get the flag indicating if a two-sided variant is being used.
getType()	Get the NEP type of this object.
getWhichEigenpairs()	Get which portion of the spectrum is to be sought.
reset()	Reset the NEP object.
setBV(bv)	Set the basis vectors object associated to the eigensolver.
setCISSExtraction(extraction)	Set the extraction technique used in the CISS solver.
setCISSRefinement([inner, blsize])	Set the values of various refinement parameters in the CISS solver.
setCISSSizes([ip, bs, ms, npart, bsmax, ...])	Set the values of various size parameters in the CISS solver.
setCISSThreshold([delta, spur])	Set the values of various threshold parameters in the CISS solver.

continues on next page

Table 68 – continued from previous page

setConvergenceTest(conv)	Set how to compute the error estimate used in the convergence test.
setDS(ds)	Set a direct solver object associated to the eigensolver.
setDimensions([nev, ncv, mpd])	Set the number of eigenvalues to compute.
setEigenvalueComparison(comparison[, args, ...])	Set an eigenvalue comparison function.
setFromOptions()	Set NEP options from the options database.
setFunction(function[, F, P, args, kargs])	Set the function to compute the nonlinear Function $T(\lambda)$.
setInitialSpace(space)	Set the initial space from which the eigensolver starts to iterate.
setInterpolInterpolation([tol, deg])	Set the tolerance and maximum degree for the interpolation polynomial.
setInterpolPEP(pep)	Set a polynomial eigensolver object associated to the nonlinear eigensolver.
setJacobian(jacobian[, J, args, kargs])	Set the function to compute the Jacobian $T'(\lambda)$.
setMonitor(monitor[, args, kargs])	Append a monitor function to the list of monitors.
setNArnoldiKSP(ksp)	Set a linear solver object associated to the nonlinear eigensolver.
setNArnoldiLagPreconditioner(lag)	Set when the preconditioner is rebuilt in the nonlinear solve.
setNLEIGSEPS(eps)	Set a linear eigensolver object associated to the nonlinear eigensolver.
setNLEIGSFullBasis([fullbasis])	Set TOAR-basis (default) or full-basis variants of the NLEIGS method.
setNLEIGSInterpolation([tol, deg])	Set the tolerance and maximum degree for the interpolation polynomial.
setNLEIGSLocking([lock])	Toggle between locking and non-locking variants of the NLEIGS method.
setNLEIGSRKShifts(shifts)	Set a list of shifts to be used in the Rational Krylov method.
setNLEIGSRestart(keep)	Set the restart parameter for the NLEIGS method.
setOptionsPrefix([prefix])	Set the prefix used for searching for all NEP options in the database.
setProblemType(problem_type)	Set the type of the eigenvalue problem.
setRG(rg)	Set a region object associated to the eigensolver.
setRIIConstCorrectionTol([cct])	Set a flag to keep the tolerance used in the linear solver constant.
setRIIDeflationThreshold(deftol)	Set the threshold used to switch between deflated and non-deflated.
setRIIHermitian([herm])	Set a flag to use the Hermitian version of the solver.
setRIIKSP(ksp)	Set a linear solver object associated to the nonlinear eigensolver.
setRIILagPreconditioner(lag)	Set when the preconditioner is rebuilt in the nonlinear solve.
setRIIMaximumIterations(its)	Set the max.
setRefine(ref[, npart, tol, its, scheme])	Set the refinement strategy used by the NEP object.
setSLPDeflationThreshold(deftol)	Set the threshold used to switch between deflated and non-deflated.
setSLPEPS(eps)	Set a linear eigensolver object associated to the nonlinear eigensolver.

continues on next page

Table 68 – continued from previous page

setSLPEPSLeft(eps)	Set a linear eigensolver object associated to the nonlinear eigensolver.
setSLPKSP(ksp)	Set a linear solver object associated to the nonlinear eigensolver.
setSplitOperator(A, f[, structure])	Set the operator of the nonlinear eigenvalue problem in split form.
setSplitPreconditioner(P[, structure])	Set the operator in split form.
setStoppingTest(stopping[, args, kargs])	Set a function to decide when to stop the outer iteration of the eigensolver.
setTarget(target)	Set the value of the target.
setTolerances([tol, maxit])	Set the tolerance and max.
setTrackAll([trackall])	Set if the solver must compute the residual of all approximate eigenpairs.
setTwoSided([twosided])	Set the solver to use a two-sided variant.
setType(nep_type)	Set the particular solver to be used in the NEP object.
setUp()	Set up all the internal data structures.
setWhichEigenpairs(which)	Set which portion of the spectrum is to be sought.
solve()	Solve the nonlinear eigenproblem.
valuesView([viewer])	Display the computed eigenvalues in a viewer.
vectorsView([viewer])	Output computed eigenvectors to a viewer.
view([viewer])	Print the NEP data structure.

Attributes Summary

bv	The basis vectors (*BV*) object associated.
ds	The direct solver (*DS*) object associated.
max_it	The maximum iteration count used by the NEP convergence tests.
problem_type	The problem type from the NEP object.
rg	The region (*RG*) object associated.
target	The value of the target.
tol	The tolerance used by the NEP convergence tests.
track_all	Compute the residual of all approximate eigenpairs.
which	The portion of the spectrum to be sought.

Methods Documentation

appendOptionsPrefix(*prefix=None*)

Append to the prefix used for searching for all NEP options in the database.

Logically collective.

Parameters
prefix (*str | None*) – The prefix string to prepend to all NEP option requests.

Return type
None

See also

setOptionsPrefix, *getOptionsPrefix*, NEPAppendOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:395 <slepc4py/SLEPc/NEP.pyx#L395>`

applyResolvent(*omega*, *v*, *r*, *rg=None*)

Apply the resolvent $T^{-1}(z)$ to a given vector.

Collective.

Parameters

- **omega** (*Scalar*) – Value where the resolvent must be evaluated.
- **v** (*Vec*) – Input vector.
- **r** (*Vec*) – Placeholder for the result vector.
- **rg** (*RG | None*) – Region.

Return type

None

Notes

The resolvent $T^{-1}(z) = \sum_i (z-\lambda_i)^{-1} x_i y_i^*$ is evaluated at $z = \omega$ and the matrix-vector product $r = T^{-1}(\omega)v$ is computed. Vectors x_i, y_i are right and left eigenvectors, respectively, normalized so that $y_i^* T'(\lambda_i) x_i = 1$. The sum contains only eigenvectors that have been previously computed with *solve()*, and if a region `rg` is given then only those corresponding to eigenvalues inside the region are considered.

See also

solve, *getLeftEigenvector*, NEPApplyResolvent

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1849 <slepc4py/SLEPc/NEP.pyx#L1849>`

cancelMonitor()

Clear all monitors for a *NEP* object.

Logically collective.

See also

NEPMonitorCancel

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1169 <slepc4py/SLEPc/NEP.pyx#L1169>`

Return type

None

computeError(*i*, *etype=None*)

Compute the error associated with the i-th computed eigenpair.

Collective.

Compute the error (based on the residual norm) associated with the i-th computed eigenpair.

Parameters

- **i** (*int*) – Index of the solution to be considered.
- **etype** (*ErrorType* | *None*) – The error type to compute.

Returns

The error bound, computed in various ways from the residual norm $\|T(\lambda)x\|_2$ where λ is the eigenvalue and x is the eigenvector.

Return type

float

Notes

The index `i` should be a value between `0` and `nconv-1` (see *getConverged()*).

If the computation of left eigenvectors was enabled with *setTwoSided()*, then the error will be computed using the maximum of the value above and the left residual norm $\|y^*T(\lambda)\|_2$, where y is the approximate left eigenvector.

See also

getErrorEstimate, *setTwoSided*, NEPComputeError

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1398 <slepc4py/SLEPc/NEP.pyx#L1398>`

create(*comm=None*)

Create the NEP object.

Collective.

Parameters

comm (*Comm* | *None*) – MPI communicator. If not provided, it defaults to all processes.

Return type

Self

See also

NEPCreate

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:278 <slepc4py/SLEPc/NEP.pyx#L278>`

destroy()

Destroy the NEP object.

Collective.

See also

NEPDestroy

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:252 <slepc4py/SLEPc/NEP.pyx#L252>`

Return type

Self

errorView(*etype=None*, *viewer=None*)

Display the errors associated with the computed solution.

Collective.

Display the errors and the eigenvalues.

Parameters

- **etype** (*ErrorType* | *None*) – The error type to compute.
- **viewer** (*petsc4py.PETSc.Viewer* | *None*) – Visualization context; if not provided, the standard output is used.

Return type
None

Notes

By default, this function checks the error of all eigenpairs and prints the eigenvalues if all of them are below the requested tolerance. If the viewer has format `ASCII_INFO_DETAIL` then a table with eigenvalues and corresponding errors is printed.

See also

solve, *valuesView*, *vectorsView*, NEPErrorView

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1442 <slepc4py/SLEPc/NEP.pyx#L1442>`

getBV()

Get the basis vectors object associated to the eigensolver.

Not collective.

Returns
The basis vectors context.

Return type
BV

See also

setBV, NEPGetBV

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:887 <slepc4py/SLEPc/NEP.pyx#L887>`

getCISSExtraction()

Get the extraction technique used in the CISS solver.

Not collective.

Returns
The extraction technique.

Return type
CISSExtraction

See also

setCISSExtraction, NEPCISSGetExtraction

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2807 <slepc4py/SLEPc/NEP.pyx#L2807>`

getCISSKSPs()

Get the list of linear solver objects associated with the CISS solver.

Collective.

Returns
The linear solver objects.

Return type
list of petsc4py.PETSc.KSP

Notes

The number of petsc4py.PETSc.KSP solvers is equal to the number of integration points divided by the number of partitions. This value is halved in the case of real matrices with a region centered at the real axis.

See also

setCISSSizes, NEPCISSGetKSPs

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:3004 <slepc4py/SLEPc/NEP.pyx#L3004>`

getCISSRefinement()

Get the values of various refinement parameters in the CISS solver.

Not collective.

Returns

- **inner** (int) – Number of iterative refinement iterations (inner loop).
- **blsize** (int) – Number of iterative refinement iterations (blocksize loop).

Return type
tuple[int, int]

See also

setCISSRefinement, NEPCISSGetRefinement

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2982 <slepc4py/SLEPc/NEP.pyx#L2982>`

getCISSSizes()

Get the values of various size parameters in the CISS solver.

Not collective.

Returns

- **ip** (int) – Number of integration points.

- **bs** (int) – Block size.
- **ms** (int) – Moment size.
- **npart** (int) – Number of partitions when splitting the communicator.
- **bsmax** (int) – Maximum block size.
- **realmats** (bool) – True if A and B are real.

Return type
tuple[int, int, int, int, int, bool]

See also

setCISSSizes, NEPCISSGetSizes

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2880 <slepc4py/SLEPc/NEP.pyx#L2880>`

getCISSThreshold()

Get the values of various threshold parameters in the CISS solver.

Not collective.

Returns

- **delta** (float) – Threshold for numerical rank.
- **spur** (float) – Spurious threshold (to discard spurious eigenpairs.

Return type
tuple[float, float]

See also

setCISSThreshold, NEPCISSGetThreshold

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2937 <slepc4py/SLEPc/NEP.pyx#L2937>`

getConverged()

Get the number of converged eigenpairs.

Not collective.

Returns
nconv – Number of converged eigenpairs.

Return type
int

Notes

This function should be called after *solve()* has finished.

The value nconv may be different from the number of requested solutions nev, but not larger than ncv, see *setDimensions()*.

See also

setDimensions, *solve*, *getEigenpair*, NEPGetConverged

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1266 <slepc4py/SLEPc/NEP.pyx#L1266>`

getConvergedReason()

Get the reason why the *solve()* iteration was stopped.

Not collective.

Returns
Negative value indicates diverged, positive value converged.

Return type
ConvergedReason

See also

setTolerances, *solve*, NEPGetConvergedReason

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1247 <slepc4py/SLEPc/NEP.pyx#L1247>`

getConvergenceTest()

Get the method used to compute the error estimate used in the convergence test.

Not collective.

Returns
The method used to compute the error estimate used in the convergence test.

Return type
Conv

See also

setConvergenceTest, NEPGetConvergenceTest

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:634 <slepc4py/SLEPc/NEP.pyx#L634>`

getDS()

Get the direct solver associated to the eigensolver.

Not collective.

Returns
The direct solver context.

Return type
DS

See also

setDS, NEPGetDS

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:961 <slepc4py/SLEPc/NEP.pyx#L961>`

getDimensions()

Get the number of eigenvalues to compute.

Not collective.

Get the number of eigenvalues to compute, and the dimension of the subspace.

Returns

- **nev** (int) – Number of eigenvalues to compute.
- **ncv** (int) – Maximum dimension of the subspace to be used by the solver.
- **mpd** (int) – Maximum dimension allowed for the projected problem.

Return type
tuple[int, int, int]

See also

setDimensions, NEPGetDimensions

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:805 <slepc4py/SLEPc/NEP.pyx#L805>`

getEigenpair(*i*, *Vr=None*, *Vi=None*)

Get the i-th solution of the eigenproblem as computed by *solve()*.

Collective.

The solution consists of both the eigenvalue and the eigenvector.

Parameters

- **i** (*int*) – Index of the solution to be obtained.
- **Vr** (*Vec | None*) – Placeholder for the returned eigenvector (real part).
- **Vi** (*Vec | None*) – Placeholder for the returned eigenvector (imaginary part).

Returns
The computed eigenvalue.

Return type
complex

Notes

The index `i` should be a value between `0` and `nconv-1` (see *getConverged()*). Eigenpairs are indexed according to the ordering criterion established with *setWhichEigenpairs()*.

The eigenvector is normalized to have unit norm.

See also

solve, *getConverged*, *setWhichEigenpairs*, NEPGetEigenpair

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1292 <slepc4py/SLEPc/NEP.pyx#L1292>`

getEigenvalueComparison()

Get the eigenvalue comparison function.

Not collective.

Returns
The eigenvalue comparison function.

Return type
NEPEigenvalueComparison

See also

setEigenvalueComparison

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1110 <slepc4py/SLEPc/NEP.pyx#L1110>`

getErrorEstimate(*i*)

Get the error estimate associated to the i-th computed eigenpair.

Not collective.

Parameters
i (*int*) – Index of the solution to be considered.

Returns
Error estimate.

Return type
float

Notes

This is the error estimate used internally by the eigensolver. The actual error bound can be computed with *computeError()*.

See also

computeError, NEPGetErrorEstimate

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1368 <slepc4py/SLEPc/NEP.pyx#L1368>`

getFunction()

Get the function to compute the nonlinear Function $T(\lambda)$.

Collective.

Get the function to compute the nonlinear Function $T(\lambda)$ and the matrix.

Returns

- **F** (petsc4py.PETSc.Mat) – Function matrix.
- **P** (petsc4py.PETSc.Mat) – Preconditioner matrix (usually the same as the F).
- **function** (*NEPFunction*) – Function evaluation routine.

Return type
tuple[petsc4py.PETSc.Mat, petsc4py.PETSc.Mat, *NEPFunction*]

See also

setFunction, NEPGetFunction

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1554 <slepc4py/SLEPc/NEP.pyx#L1554>`

getInterpolInterpolation()

Get the tolerance and maximum degree for the interpolation polynomial.

Not collective.

Returns

- **tol** (float) – The tolerance to stop computing polynomial coefficients.
- **deg** (int) – The maximum degree of interpolation.

Return type
tuple[float, int]

See also

setInterpolInterpolation, NEPInterpolGetInterpolation

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2459 <slepc4py/SLEPc/NEP.pyx#L2459>`

getInterpolPEP()

Get the associated polynomial eigensolver object.

Collective.

Returns
The polynomial eigensolver.

Return type
PEP

See also

setInterpolPEP, NEPInterpolGetPEP

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2416 <slepc4py/SLEPc/NEP.pyx#L2416>`

getIterationNumber()

Get the current iteration number.

Not collective.

If the call to *solve()* is complete, then it returns the number of iterations carried out by the solution method.

Returns
Iteration number.

Return type
int

See also

getConvergedReason, *setTolerances*, NEPGetIterationNumber

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1225 <slepc4py/SLEPc/NEP.pyx#L1225>`

getJacobian()

Get the function to compute the Jacobian $T'(\lambda)$ and J.

Collective.

Get the function to compute the Jacobian $T'(\lambda)$ and the matrix.

Returns

- **J** (petsc4py.PETSc.Mat) – Jacobian matrix.
- **jacobian** (*NEPJacobian*) – Jacobian evaluation routine.

Return type
tuple[petsc4py.PETSc.Mat, *NEPJacobian*]

See also

setJacobian, NEPGetJacobian

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1620 <slepc4py/SLEPc/NEP.pyx#L1620>`

getLeftEigenvector(*i*, *Wr*, *Wi=None*)

Get the i-th left eigenvector as computed by *solve()*.

Collective.

Parameters

- **i** (*int*) – Index of the solution to be obtained.
- **Wr** (*Vec*) – Placeholder for the returned eigenvector (real part).
- **Wi** (*Vec | None*) – Placeholder for the returned eigenvector (imaginary part).

Return type
None

Notes

The index i should be a value between 0 and nconv-1 (see *getConverged()*). Eigensolutions are indexed according to the ordering criterion established with *setWhichEigenpairs()*.

Left eigenvectors are available only if the twosided flag was set with *setTwoSided()*.

See also

getEigenpair, *getConverged*, *setTwoSided*, NEPGetLeftEigenvector

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1334 <slepc4py/SLEPc/NEP.pyx#L1334>`

getMonitor()

Get the list of monitor functions.

Not collective.

Returns
The list of monitor functions.

Return type
NEPMonitorFunction

See also

setMonitor

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1152 <slepc4py/SLEPc/NEP.pyx#L1152>`

getNArnoldiKSP()

Get the linear solver object associated with the nonlinear eigensolver.

Collective.

Returns
The linear solver object.

Return type
petsc4py.PETSc.KSP

See also

setNArnoldiKSP, NEPNArnoldiGetKSP

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2333 <slepc4py/SLEPc/NEP.pyx#L2333>`

getNArnoldiLagPreconditioner()

Get how often the preconditioner is rebuilt.

Not collective.

Returns
The lag parameter.

Return type
int

See also

setNArnoldiLagPreconditioner, NEPNArnoldiGetLagPreconditioner

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2378 <slepc4py/SLEPc/NEP.pyx#L2378>`

getNLEIGSEPS()

Get the linear eigensolver object associated with the nonlinear eigensolver.

Collective.

Returns
The linear eigensolver.

Return type
EPS

See also

setNLEIGSEPS, NEPNLEIGSGetEPS

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2690 <slepc4py/SLEPc/NEP.pyx#L2690>`

getNLEIGSFullBasis()

Get the flag that indicates if NLEIGS is using the full-basis variant.

Not collective.

Returns
True if the full-basis variant is selected.

Return type
bool

See also

setNLEIGSFullBasis, NEPNLEIGSGetFullBasis

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2654 <slepc4py/SLEPc/NEP.pyx#L2654>`

getNLEIGSInterpolation()

Get the tolerance and maximum degree for the interpolation polynomial.

Not collective.

Get the tolerance and maximum degree when building the interpolation via divided differences.

Returns

- **tol** (float) – The tolerance to stop computing divided differences.
- **deg** (int) – The maximum degree of interpolation.

Return type
tuple[float, int]

See also

setNLEIGSInterpolation, NEPNLEIGSGetInterpolation

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2596 <slepc4py/SLEPc/NEP.pyx#L2596>`

getNLEIGSKSPs()

Get the list of linear solver objects associated with the NLEIGS solver.

Collective.

Returns
The linear solver objects.

Return type
list of petsc4py.PETSc.KSP

Notes

The number of petsc4py.PETSc.KSP solvers is equal to the number of shifts provided by the user, or 1 if the user did not provide shifts.

See also

setNLEIGSRKShifts, NEPNLEIGSGetKSPs

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2762 <slepc4py/SLEPc/NEP.pyx#L2762>`

getNLEIGSLocking()

Get the locking flag used in the NLEIGS method.

Not collective.

Returns
The locking flag.

Return type
bool

See also

setNLEIGSLocking, NEPNLEIGSGetLocking

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2551 <slepc4py/SLEPc/NEP.pyx#L2551>`

getNLEIGSRKShifts()

Get the list of shifts used in the Rational Krylov method.

Not collective.

Returns
The shift values.

Return type
ArrayScalar

See also

setNLEIGSRKShifts, NEPNLEIGSGetRKShifts

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2737 <slepc4py/SLEPc/NEP.pyx#L2737>`

getNLEIGSRestart()

Get the restart parameter used in the NLEIGS method.

Not collective.

Returns
The number of vectors to be kept at restart.

Return type
float

See also

setNLEIGSRestart, NEPNLEIGSGetRestart

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2507 <slepc4py/SLEPc/NEP.pyx#L2507>`

getOptionsPrefix()

Get the prefix used for searching for all NEP options in the database.

Not collective.

Returns
The prefix string set for this NEP object.

Return type
str

See also

setOptionsPrefix, *appendOptionsPrefix*, NEPGetOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:345 <slepc4py/SLEPc/NEP.pyx#L345>`

getProblemType()

Get the problem type from the *NEP* object.

Not collective.

Returns
The problem type that was previously set.

Return type
ProblemType

See also

setProblemType, NEPGetProblemType

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:433 <slepc4py/SLEPc/NEP.pyx#L433>`

getRG()

Get the region object associated to the eigensolver.

Not collective.

Returns
The region context.

Return type
RG

See also

setRG, NEPGetRG

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:924 <slepc4py/SLEPc/NEP.pyx#L924>`

getRIIConstCorrectionTol()

Get the constant tolerance flag.

Not collective.

Returns
If True, the petsc4py.PETSc.KSP relative tolerance is constant.

Return type
bool

See also

setRIIConstCorrectionTol, NEPRIIGetConstCorrectionTol

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1957 <slepc4py/SLEPc/NEP.pyx#L1957>`

getRIIDeflationThreshold()

Get the threshold value that controls deflation.

Not collective.

Returns
The threshold value.

Return type
float

See also

setRIIDeflationThreshold, NEPRIIGetDeflationThreshold

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2096 <slepc4py/SLEPc/NEP.pyx#L2096>`

getRIIHermitian()

Get if the Hermitian version must be used by the solver.

Not collective.

Returns
If True, the Hermitian version is used.

Return type
bool

See also

setRIIHermitian, NEPRIIGetHermitian

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2046 <slepc4py/SLEPc/NEP.pyx#L2046>`

getRIIKSP()

Get the linear solver object associated with the nonlinear eigensolver.

Collective.

Returns
The linear solver object.

Return type
petsc4py.PETSc.KSP

See also

setRIIKSP, NEPRIIGetKSP

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2132 <slepc4py/SLEPc/NEP.pyx#L2132>`

getRIILagPreconditioner()

Get how often the preconditioner is rebuilt.

Not collective.

Returns
The lag parameter.

Return type
int

See also

setRIILagPreconditioner, NEPRIIGetLagPreconditioner

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1913 <slepc4py/SLEPc/NEP.pyx#L1913>`

getRIIMaximumIterations()

Get the maximum number of inner iterations of RII.

Not collective.

Returns
Maximum inner iterations.

Return type
int

See also

setRIIMaximumIterations, NEPRIIGetMaximumIterations

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1998 <slepc4py/SLEPc/NEP.pyx#L1998>`

getRefine()

Get the refinement strategy used by the NEP object.

Not collective.

Returns

- **ref** (*Refine*) – The refinement type.
- **npart** (int) – The number of partitions of the communicator.
- **tol** (float) – The convergence tolerance.

- **its** (int) – The maximum number of refinement iterations.
- **scheme** (*RefineScheme*) – Scheme for solving linear systems.

Return type
tuple[*Refine*, int, float, int, *RefineScheme*]

See also

setRefine, NEPGetRefine

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:673 <slepc4py/SLEPc/NEP.pyx#L673>`

getRefineKSP()

Get the KSP object used by the eigensolver in the refinement phase.

Collective.

Returns
The linear solver object.

Return type
petsc4py.PETSc.KSP

See also

setRefine, NEPRefineGetKSP

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:748 <slepc4py/SLEPc/NEP.pyx#L748>`

getSLPDeflationThreshold()

Get the threshold value that controls deflation.

Not collective.

Returns
The threshold value.

Return type
float

See also

setSLPDeflationThreshold, NEPSLPGetDeflationThreshold

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2182 <slepc4py/SLEPc/NEP.pyx#L2182>`

getSLPEPS()

Get the linear eigensolver object associated with the nonlinear eigensolver.

Collective.

Returns
The linear eigensolver.

Return type
EPS

See also

setSLPEPS, NEPSLPGetEPS

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2218 <slepc4py/SLEPc/NEP.pyx#L2218>`

getSLPEPSLeft()

Get the left eigensolver.

Collective.

Returns
The linear eigensolver.

Return type
EPS

See also

setSLPEPSLeft, NEPSLPGetEPSLeft

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2257 <slepc4py/SLEPc/NEP.pyx#L2257>`

getSLPKSP()

Get the linear solver object associated with the nonlinear eigensolver.

Collective.

Returns
The linear solver object.

Return type
petsc4py.PETSc.KSP

See also

setSLPKSP, NEPSLPGetKSP

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2294 <slepc4py/SLEPc/NEP.pyx#L2294>`

getSplitOperator()

Get the operator of the nonlinear eigenvalue problem in split form.

Collective.

Returns

- **A** (list of petsc4py.PETSc.Mat) – Coefficient matrices of the split form.
- **f** (list of *FN*) – Scalar functions of the split form.
- **structure** (petsc4py.PETSc.Mat.Structure) – Structure flag for matrices.

Return type
tuple[list[petsc4py.PETSc.Mat], list[*FN*], petsc4py.PETSc.Mat.Structure]

See also

setSplitOperator, NEPGetSplitOperatorInfo, NEPGetSplitOperatorTerm

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1698 <slepc4py/SLEPc/NEP.pyx#L1698>`

getSplitPreconditioner()

Get the operator of the split preconditioner.

Not collective.

Returns

- **P** (list of petsc4py.PETSc.Mat) – Coefficient matrices of the split preconditioner.
- **structure** (petsc4py.PETSc.Mat.Structure) – Structure flag for matrices.

Return type

tuple[list[petsc4py.PETSc.Mat], petsc4py.PETSc.Mat.Structure]

See also

setSplitPreconditioner, NEPGetSplitPreconditionerTerm

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1767 <slepc4py/SLEPc/NEP.pyx#L1767>`

getStoppingTest()

Get the stopping test function.

Not collective.

Returns

The stopping test function.

Return type

NEPStoppingFunction

See also

setStoppingTest

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1063 <slepc4py/SLEPc/NEP.pyx#L1063>`

getTarget()

Get the value of the target.

Not collective.

Returns

The value of the target.

Return type

Scalar

Notes

If the target was not set by the user, then zero is returned.

See also

setTarget, NEPGetTarget

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:531 <slepc4py/SLEPc/NEP.pyx#L531>`

getTolerances()

Get the tolerance and maximum iteration count.

Not collective.

Get the tolerance and maximum iteration count used by the default NEP convergence tests.

Returns

- **tol** (float) – The convergence tolerance.
- **maxit** (int) – The maximum number of iterations.

Return type

tuple[float, int]

See also

setTolerances, NEPGetTolerances

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:581 <slepc4py/SLEPc/NEP.pyx#L581>`

getTrackAll()

Get the flag indicating whether all residual norms must be computed.

Not collective.

Returns

Whether the solver computes all residuals or not.

Return type

bool

See also

setTrackAll, NEPGetTrackAll

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:768 <slepc4py/SLEPc/NEP.pyx#L768>`

getTwoSided()

Get the flag indicating if a two-sided variant is being used.

Not collective.

Get the flag indicating whether a two-sided variant of the algorithm is being used or not.

Returns

Whether the two-sided variant is to be used or not.

Return type
bool

See also

setTwoSided, NEPGetTwoSided

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1796 <slepc4py/SLEPc/NEP.pyx#L1796>`

getType()

Get the NEP type of this object.

Not collective.

Returns
The solver currently being used.

Return type
str

See also

setType, NEPGetType

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:326 <slepc4py/SLEPc/NEP.pyx#L326>`

getWhichEigenpairs()

Get which portion of the spectrum is to be sought.

Not collective.

Returns
The portion of the spectrum to be sought by the solver.

Return type
Which

See also

setWhichEigenpairs, NEPGetWhichEigenpairs

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:477 <slepc4py/SLEPc/NEP.pyx#L477>`

reset()

Reset the NEP object.

Collective.

See also

NEPReset

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:266 <slepc4py/SLEPc/NEP.pyx#L266>`

Return type
None

setBV(*bv*)

Set the basis vectors object associated to the eigensolver.

Collective.

Parameters
bv (BV) – The basis vectors context.

Return type
None

See also

getBV, NEPSetBV

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:907 <slepc4py/SLEPc/NEP.pyx#L907>`

setCISSExtraction(*extraction*)

Set the extraction technique used in the CISS solver.

Logically collective.

Parameters
extraction (CISSExtraction) – The extraction technique.

Return type
None

See also

getCISSExtraction, NEPCISSSetExtraction

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2789 <slepc4py/SLEPc/NEP.pyx#L2789>`

setCISSRefinement(*inner=None*, *blsize=None*)

Set the values of various refinement parameters in the CISS solver.

Logically collective.

Parameters

- **inner** (*int | None*) – Number of iterative refinement iterations (inner loop).
- **blsize** (*int | None*) – Number of iterative refinement iterations (blocksize loop).

Return type
None

See also

getCISSRefinement, NEPCISSSetRefinement

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2959 <slepc4py/SLEPc/NEP.pyx#L2959>`

setCISSSizes(*ip=None*, *bs=None*, *ms=None*, *npart=None*, *bsmax=None*, *realmats=False*)

Set the values of various size parameters in the CISS solver.

Logically collective.

Parameters

- **ip** (*int | None*) – Number of integration points.
- **bs** (*int | None*) – Block size.
- **ms** (*int | None*) – Moment size.
- **npart** (*int | None*) – Number of partitions when splitting the communicator.
- **bsmax** (*int | None*) – Maximum block size.
- **realmats** (*bool*) – `True` if A and B are real.

Return type

None

Notes

The default number of partitions is 1. This means the internal `petsc4py.PETSc.KSP` object is shared among all processes of the *NEP* communicator. Otherwise, the communicator is split into `npart` communicators, so that `npart` `petsc4py.PETSc.KSP` solves proceed simultaneously.

See also

getCISSSizes, *setCISSThreshold*, *setCISSRefinement*, `NEPCISSSetSizes`

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2826 <slepc4py/SLEPc/NEP.pyx#L2826>`

setCISSThreshold(*delta=None*, *spur=None*)

Set the values of various threshold parameters in the CISS solver.

Logically collective.

Parameters

- **delta** (*float | None*) – Threshold for numerical rank.
- **spur** (*float | None*) – Spurious threshold (to discard spurious eigenpairs).

Return type

None

See also

getCISSThreshold, `NEPCISSSetThreshold`

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2914 <slepc4py/SLEPc/NEP.pyx#L2914>`

setConvergenceTest(*conv*)

Set how to compute the error estimate used in the convergence test.

Logically collective.

Parameters

conv (Conv) – The method used to compute the error estimate used in the convergence test.

Return type
None

See also

getConvergenceTest, NEPSetConvergenceTest

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:654 <slepc4py/SLEPc/NEP.pyx#L654>`

setDS(*ds*)

Set a direct solver object associated to the eigensolver.

Collective.

Parameters
ds (DS) – The direct solver context.

Return type
None

See also

getDS, NEPSetDS

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:981 <slepc4py/SLEPc/NEP.pyx#L981>`

setDimensions(*nev=None*, *ncv=None*, *mpd=None*)

Set the number of eigenvalues to compute.

Logically collective.

Set the number of eigenvalues to compute and the dimension of the subspace.

Parameters

- **nev** (*int* | *None*) – Number of eigenvalues to compute.
- **ncv** (*int* | *None*) – Maximum dimension of the subspace to be used by the solver.
- **mpd** (*int* | *None*) – Maximum dimension allowed for the projected problem.

Return type
None

Notes

Use *DETERMINE* for ncv and mpd to assign a reasonably good value, which is dependent on the solution method.

The parameters ncv and mpd are intimately related, so that the user is advised to set one of them at most. Normal usage is the following:

- In cases where nev is small, the user sets ncv (a reasonable default is 2 * nev).
- In cases where nev is large, the user sets mpd.

The value of ncv should always be between nev and (nev + mpd), typically ncv = nev + mpd. If nev is not too large, mpd = nev is a reasonable choice, otherwise a smaller value should be used.

See also

getDimensions, NEPSetDimensions

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:833 <slepc4py/SLEPc/NEP.pyx#L833>`

setEigenvalueComparison(*comparison*, *args=None*, *kargs=None*)

Set an eigenvalue comparison function.

Logically collective.

Notes

This eigenvalue comparison function is used when *setWhichEigenpairs()* is set to *NEP.Which.USER*.

See also

getEigenvalueComparison, NEPSetEigenvalueComparison

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1080 <slepc4py/SLEPc/NEP.pyx#L1080>`

Parameters

- **comparison** (*NEPEigenvalueComparison | None*)
- **args** (*tuple[Any, ...] | None*)
- **kargs** (*dict[str, Any] | None*)

Return type

None

setFromOptions()

Set NEP options from the options database.

Collective.

Notes

To see all options, run your program with the `-help` option.

This routine must be called before *setUp()* if the user is to be allowed to set the solver type.

See also

setOptionsPrefix, NEPSetFromOptions

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:414 <slepc4py/SLEPc/NEP.pyx#L414>`

Return type

None

setFunction(*function*, *F=None*, *P=None*, *args=None*, *kargs=None*)

Set the function to compute the nonlinear Function $T(\lambda)$.

Collective.

Set the function to compute the nonlinear Function $T(\lambda)$ as well as the location to store the matrix.

Parameters

- **function** (*NEPFunction*) – Function evaluation routine.
- **F** (*petsc4py.PETSc.Mat | None*) – Function matrix.
- **P** (*petsc4py.PETSc.Mat | None*) – Preconditioner matrix (usually the same as F).
- **args** (*tuple[Any, ...] | None*)
- **kargs** (*dict[str, Any] | None*)

Return type
None

See also

setJacobian, *getFunction*, NEPSetFunction

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1514 <slepc4py/SLEPc/NEP.pyx#L1514>`

setInitialSpace(*space*)

Set the initial space from which the eigensolver starts to iterate.

Collective.

Parameters
space (*Vec*) – The initial space.

Return type
None

Notes

Some solvers start to iterate on a single vector (initial vector). In that case, only the first vector is taken into account and the other vectors are ignored.

These vectors do not persist from one *solve()* call to the other, so the initial space should be set every time.

The vectors do not need to be mutually orthonormal, since they are explicitly orthonormalized internally.

Common usage of this function is when the user can provide a rough approximation of the wanted eigenspace. Then, convergence may be faster.

See also

setUp, NEPSetInitialSpace

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1000 <slepc4py/SLEPc/NEP.pyx#L1000>`

setInterpolInterpolation(*tol=None*, *deg=None*)

Set the tolerance and maximum degree for the interpolation polynomial.

Collective.

Parameters

- **tol** (*float | None*) – The tolerance to stop computing polynomial coefficients.
- **deg** (*int | None*) – The maximum degree of interpolation.

Return type
None

See also

getInterpolInterpolation, NEPInterpolSetInterpolation

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2436 <slepc4py/SLEPc/NEP.pyx#L2436>`

setInterpolPEP(*pep*)

Set a polynomial eigensolver object associated to the nonlinear eigensolver.

Collective.

Parameters
pep (PEP) – The polynomial eigensolver.

Return type
None

See also

getInterpolPEP, NEPInterpolSetPEP

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2399 <slepc4py/SLEPc/NEP.pyx#L2399>`

setJacobian(*jacobian*, *J=None*, *args=None*, *kargs=None*)

Set the function to compute the Jacobian $T'(\lambda)$.

Collective.

Set the function to compute the Jacobian $T'(\lambda)$ as well as the location to store the matrix.

Parameters

- **jacobian** (NEPJacobian) – Jacobian evaluation routine.
- **J** (*petsc4py.PETSc.Mat | None*) – Jacobian matrix.
- **args** (*tuple[Any, ...] | None*)
- **kargs** (*dict[str, Any] | None*)

Return type
None

See also

setFunction, *getJacobian*, NEPSetJacobian

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1584 <slepc4py/SLEPc/NEP.pyx#L1584>`

setMonitor(*monitor*, *args=None*, *kargs=None*)

Append a monitor function to the list of monitors.

Logically collective.

See also

getMonitor, *cancelMonitor*, NEPMonitorSet

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1127 <slepc4py/SLEPc/NEP.pyx#L1127>`

Parameters

- **monitor** (*NEPMonitorFunction | None*)
- **args** (*tuple[Any, ...] | None*)
- **kargs** (*dict[str, Any] | None*)

Return type
None

setNArnoldiKSP(*ksp*)

Set a linear solver object associated to the nonlinear eigensolver.

Collective.

Parameters
ksp (*KSP*) – The linear solver object.

Return type
None

See also

getNArnoldiKSP, NEPNArnoldiSetKSP

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2316 <slepc4py/SLEPc/NEP.pyx#L2316>`

setNArnoldiLagPreconditioner(*lag*)

Set when the preconditioner is rebuilt in the nonlinear solve.

Logically collective.

Parameters
lag (*int*) – 0 indicates NEVER rebuild, 1 means rebuild every time the Jacobian is computed within the nonlinear iteration, 2 means every second time the Jacobian is built, etc.

Return type
None

Notes

The default is 1. The preconditioner is ALWAYS built in the first iteration of a nonlinear solve.

See also

getNArnoldiLagPreconditioner, NEPNArnoldiSetLagPreconditioner

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2353 <slepc4py/SLEPc/NEP.pyx#L2353>`

setNLEIGSEPS(*eps*)

Set a linear eigensolver object associated to the nonlinear eigensolver.

Collective.

Parameters
eps (EPS) – The linear eigensolver.

Return type
None

See also

getNLEIGSEPS, NEPNLEIGSSetEPS

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2673 <slepc4py/SLEPc/NEP.pyx#L2673>`

setNLEIGSFullBasis(*fullbasis=True*)

Set TOAR-basis (default) or full-basis variants of the NLEIGS method.

Logically collective.

Toggle between TOAR-basis (default) and full-basis variants of the NLEIGS method.

Parameters
fullbasis (*bool*) – `True` if the full-basis variant must be selected.

Return type
None

Notes

The default is to use a compact representation of the Krylov basis, that is, $V = (I \otimes U)S$, with a *BV* of type *TENSOR*. This behavior can be changed so that the full basis V is explicitly stored and operated with. This variant is more expensive in terms of memory and computation, but is necessary in some cases, particularly for two-sided computations, see *setTwoSided()*.

In the full-basis variant, the NLEIGS solver uses an *EPS* object to explicitly solve the linearized eigenproblem, see *getNLEIGSEPS()*.

See also

setTwoSided, *getNLEIGSFullBasis*, *getNLEIGSEPS*, NEPNLEIGSSetFullBasis

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2621 <slepc4py/SLEPc/NEP.pyx#L2621>`

setNLEIGSInterpolation(*tol=None*, *deg=None*)

Set the tolerance and maximum degree for the interpolation polynomial.

Collective.

Set the tolerance and maximum degree when building the interpolation via divided differences.

Parameters

- **tol** (*float* | *None*) – The tolerance to stop computing divided differences.
- **deg** (*int* | *None*) – The maximum degree of interpolation.

Return type
None

See also

getNLEIGSInterpolation, NEPNLEIGSSetInterpolation

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2570 <slepc4py/SLEPc/NEP.pyx#L2570>`

setNLEIGSLocking(*lock=True*)

Toggle between locking and non-locking variants of the NLEIGS method.

Logically collective.

Parameters
lock (*bool*) – True if the locking variant must be selected.

Return type
None

Notes

The default is to lock converged eigenpairs when the method restarts. This behavior can be changed so that all directions are kept in the working subspace even if already converged to working accuracy (the non-locking variant).

See also

getNLEIGSLocking, NEPNLEIGSSetLocking

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2526 <slepc4py/SLEPc/NEP.pyx#L2526>`

setNLEIGSRKShifts(*shifts*)

Set a list of shifts to be used in the Rational Krylov method.

Collective.

Parameters
shifts (*Sequence[Scalar]*) – Values specifying the shifts.

Return type
None

Notes

If only one shift is provided, the built subspace is equivalent to shift-and-invert Krylov-Schur (provided that the absolute convergence criterion is used). Otherwise, the rational Krylov variant is run.

See also

getNLEIGSRKShifts, *getNLEIGSKSPs*, NEPNLEIGSSetRKShifts

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2710 <slepc4py/SLEPc/NEP.pyx#L2710>`

setNLEIGSRestart(*keep*)

Set the restart parameter for the NLEIGS method.

Logically collective.

The proportion of basis vectors that must be kept after restart.

Parameters
keep (*float*) – The number of vectors to be kept at restart.

Return type
None

Notes

Allowed values are in the range [0.1,0.9]. The default is 0.5.

See also

getNLEIGSRestart, NEPNLEIGSSetRestart

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2483 <slepc4py/SLEPc/NEP.pyx#L2483>`

setOptionsPrefix(*prefix=None*)

Set the prefix used for searching for all NEP options in the database.

Logically collective.

Parameters
prefix (*str | None*) – The prefix string to prepend to all NEP option requests.

Return type
None

Notes

A hyphen (-) must NOT be given at the beginning of the prefix name. The first character of all runtime options is AUTOMATICALLY the hyphen.

For example, to distinguish between the runtime options for two different NEP contexts, one could call:

```
N1.setOptionsPrefix("nep1_")
N2.setOptionsPrefix("nep2_")
```

See also

appendOptionsPrefix, *getOptionsPrefix*, NEPGetOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:364 <slepc4py/SLEPc/NEP.pyx#L364>`

setProblemType(*problem_type*)

Set the type of the eigenvalue problem.

Logically collective.

Parameters
problem_type (ProblemType) – The problem type to be set.

Return type
None

Notes

This function is used to provide a hint to the *NEP* solver to exploit certain properties of the nonlinear eigenproblem. This hint may be used or not, depending on the solver. By default, no particular structure is assumed.

See also

getProblemType, NEPSetProblemType

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:452 <slepc4py/SLEPc/NEP.pyx#L452>`

setRG(*rg*)

Set a region object associated to the eigensolver.

Collective.

Parameters
rg (RG) – The region context.

Return type
None

See also

getRG, NEPSetRG

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:944 <slepc4py/SLEPc/NEP.pyx#L944>`

setRIIConstCorrectionTol(*cct=True*)

Set a flag to keep the tolerance used in the linear solver constant.

Logically collective.

Parameters
cct (*bool*) – If `True`, the `petsc4py.PETSc.KSP` relative tolerance is constant.

Return type
None

Notes

By default, an exponentially decreasing tolerance is set in the `KSP` used within the nonlinear iteration, so that each Newton iteration requests better accuracy than the previous one. The constant correction tolerance flag stops this behavior.

See also

getRIIConstCorrectionTol, NEPRIISetConstCorrectionTol

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1932 <slepc4py/SLEPc/NEP.pyx#L1932>`

setRIIDeflationThreshold(*deftol*)

Set the threshold used to switch between deflated and non-deflated.

Logically collective.

Set the threshold value used to switch between deflated and non-deflated iteration.

Parameters
deftol (*float*) – The threshold value.

Return type
None

Notes

Normally, the solver iterates on the extended problem in order to deflate previously converged eigenpairs. If this threshold is set to a nonzero value, then once the residual error is below this threshold the solver will continue the iteration without deflation. The intention is to be able to improve the current eigenpair further, despite having previous eigenpairs with somewhat bad precision.

See also

getRIIDeflationThreshold, NEPRIISetDeflationThreshold

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2065 <slepc4py/SLEPc/NEP.pyx#L2065>`

setRIIHermitian(*herm=True*)

Set a flag to use the Hermitian version of the solver.

Logically collective.

Set a flag to indicate if the Hermitian version of the scalar nonlinear equation must be used by the solver.

Parameters
herm (*bool*) – If `True`, the Hermitian version is used.

Return type
None

Notes

By default, the scalar nonlinear equation $x^*T(\sigma)^{-1}T(z)x = 0$ is solved at each step of the nonlinear iteration. When this flag is set the simpler form $x^*T(z)x = 0$ is used, which is supposed to be valid only for Hermitian problems.

See also

getRIIHermitian, NEPRIISetHermitian

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2017 <slepc4py/SLEPc/NEP.pyx#L2017>`

setRIIKSP(*ksp*)

Set a linear solver object associated to the nonlinear eigensolver.

Collective.

Parameters
ksp (*KSP*) – The linear solver object.

Return type
None

See also

getRIIKSP, NEPRIISetKSP

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2115 <slepc4py/SLEPc/NEP.pyx#L2115>`

setRIILagPreconditioner(*lag*)

Set when the preconditioner is rebuilt in the nonlinear solve.

Logically collective.

Parameters
lag (*int*) – 0 indicates NEVER rebuild, 1 means rebuild every time the Jacobian is computed within the nonlinear iteration, 2 means every second time the Jacobian is built, etc.

Return type
None

See also

getRIILagPreconditioner, NEPRIISetLagPreconditioner

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1893 <slepc4py/SLEPc/NEP.pyx#L1893>`

setRIIMaximumIterations(*its*)

Set the max. number of inner iterations to be used in the RII solver.

Logically collective.

These are the Newton iterations related to the computation of the nonlinear Rayleigh functional.

Parameters
its (*int*) – Maximum inner iterations.

Return type
None

See also

getRIIMaximumIterations, NEPRIISetMaximumIterations

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1977 <slepc4py/SLEPc/NEP.pyx#L1977>`

setRefine(*ref*, *npart=None*, *tol=None*, *its=None*, *scheme=None*)

Set the refinement strategy used by the NEP object.

Logically collective.

Set the refinement strategy used by the NEP object and the associated parameters.

Parameters

- **ref** (Refine) – The refinement type.
- **npart** (*int* | *None*) – The number of partitions of the communicator.

- **tol** (*float* | *None*) – The convergence tolerance.
- **its** (*int* | *None*) – The maximum number of refinement iterations.
- **scheme** (RefineScheme | *None*) – Scheme for solving linear systems.

Return type
None

See also

getRefine, NEPSetRefine

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:704 <slepc4py/SLEPc/NEP.pyx#L704>`

setSLPDeflationThreshold(*deftol*)

Set the threshold used to switch between deflated and non-deflated.

Logically collective.

Parameters
deftol (*float*) – The threshold value.

Return type
None

Notes

Normally, the solver iterates on the extended problem in order to deflate previously converged eigenpairs. If this threshold is set to a nonzero value, then once the residual error is below this threshold the solver will continue the iteration without deflation. The intention is to be able to improve the current eigenpair further, despite having previous eigenpairs with somewhat bad precision.

See also

getSLPDeflationThreshold, NEPSLPSetDeflationThreshold

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2154 <slepc4py/SLEPc/NEP.pyx#L2154>`

setSLPEPS(*eps*)

Set a linear eigensolver object associated to the nonlinear eigensolver.

Collective.

Parameters
eps (EPS) – The linear eigensolver.

Return type
None

See also

getSLPEPS, NEPSLPSetEPS

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2201 <slepc4py/SLEPc/NEP.pyx#L2201>`

setSLPEPSLeft(*eps*)

Set a linear eigensolver object associated to the nonlinear eigensolver.

Collective.

Used to compute left eigenvectors in the two-sided variant of SLP.

Parameters
eps (EPS) – The linear eigensolver.

Return type
None

See also

setTwoSided, *setSLPEPS*, *getSLPEPSLeft*, NEPSLPSetEPSLeft

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2238 <slepc4py/SLEPc/NEP.pyx#L2238>`

setSLPKSP(*ksp*)

Set a linear solver object associated to the nonlinear eigensolver.

Collective.

Parameters
ksp (*KSP*) – The linear solver object.

Return type
None

See also

getSLPKSP, NEPSLPSetKSP

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:2277 <slepc4py/SLEPc/NEP.pyx#L2277>`

setSplitOperator(*A*, *f*, *structure=None*)

Set the operator of the nonlinear eigenvalue problem in split form.

Collective.

Parameters

- **A** (*petsc4py.PETSc.Mat | list[petsc4py.PETSc.Mat]*) – Coefficient matrices of the split form.
- **f** (FN | *list[FN]*) – Scalar functions of the split form.
- **structure** (*petsc4py.PETSc.Mat.Structure | None*) – Structure flag for matrices.

Return type
None

Notes

The nonlinear operator is written as $T(\lambda) = \sum_i A_i f_i(\lambda)$, for $i = 1, \ldots, n$. The derivative $T'(\lambda)$ can be obtained using the derivatives of f_i.

The `structure` flag provides information about A_i's nonzero pattern.

This function must be called before *setUp()*. If it is called again after *setUp()* then the *NEP* object is reset.

See also

getSplitOperator, NEPSetSplitOperator

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1646 <slepc4py/SLEPc/NEP.pyx#L1646>`

setSplitPreconditioner(*P*, *structure=None*)

Set the operator in split form.

Collective.

Set the operator in split form from which to build the preconditioner to be used when solving the nonlinear eigenvalue problem in split form.

Parameters

- **P** (*petsc4py.PETSc.Mat | list[petsc4py.PETSc.Mat]*) – Coefficient matrices of the split preconditioner.
- **structure** (*petsc4py.PETSc.Mat.Structure | None*) – Structure flag for matrices.

Return type

None

See also

getSplitPreconditioner, NEPSetSplitPreconditioner

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1734 <slepc4py/SLEPc/NEP.pyx#L1734>`

setStoppingTest(*stopping*, *args=None*, *kargs=None*)

Set a function to decide when to stop the outer iteration of the eigensolver.

Logically collective.

See also

getStoppingTest, NEPSetStoppingTestFunction

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1039 <slepc4py/SLEPc/NEP.pyx#L1039>`

Parameters

- **stopping** (NEPStoppingFunction | *None*)
- **args** (*tuple[Any, ...] | None*)
- **kargs** (*dict[str, Any] | None*)

Return type

None

setTarget(*target*)

Set the value of the target.

Logically collective.

Parameters
target (Scalar) – The value of the target.

Return type
None

Notes

The target is a scalar value used to determine the portion of the spectrum of interest. It is used in combination with *setWhichEigenpairs()*.

When PETSc is built with real scalars, it is not possible to specify a complex target.

See also

getTarget, *setWhichEigenpairs*, NEPSetTarget

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:554 <slepc4py/SLEPc/NEP.pyx#L554>`

setTolerances(*tol=None*, *maxit=None*)

Set the tolerance and max. iteration count used in convergence tests.

Logically collective.

Parameters

- **tol** (*float* | *None*) – The convergence tolerance.
- **maxit** (*int* | *None*) – The maximum number of iterations.

Return type
None

Notes

Use *DETERMINE* for max_it to assign a reasonably good value, which is dependent on the solution method.

See also

getTolerances, NEPSetTolerances

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:606 <slepc4py/SLEPc/NEP.pyx#L606>`

setTrackAll(*trackall=True*)

Set if the solver must compute the residual of all approximate eigenpairs.

Logically collective.

Parameters
trackall (*bool*) – Whether to compute all residuals or not.

Return type
None

See also

getTrackAll, NEPSetTrackAll

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:787 <slepc4py/SLEPc/NEP.pyx#L787>`

setTwoSided(*twosided=True*)

Set the solver to use a two-sided variant.

Logically collective.

Set the solver to use a two-sided variant so that left eigenvectors are also computed.

Parameters
twosided (*bool*) – Whether the two-sided variant is to be used or not.

Return type
None

Notes

If the user sets `twosided` to `True` then the solver uses a variant of the algorithm that computes both right and left eigenvectors. This is usually much more costly. This option is not available in all solvers.

When using two-sided solvers, the problem matrices must have both the `Mat.mult` and `Mat.multTranspose` operations defined.

See also

getTwoSided, *getLeftEigenvector*, NEPSetTwoSided

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1818 <slepc4py/SLEPc/NEP.pyx#L1818>`

setType(*nep_type*)

Set the particular solver to be used in the NEP object.

Logically collective.

Parameters
nep_type (Type | *str*) – The solver to be used.

Return type
None

Notes

The default is *RII*. Normally, it is best to use *setFromOptions()* and then set the NEP type from the options database rather than by using this routine. Using the options database provides the user with maximum flexibility in evaluating the different available methods.

See also

getType, NEPSetType

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:299 <slepc4py/SLEPc/NEP.pyx#L299>`

setUp()

Set up all the internal data structures.

Collective.

Notes

Sets up all the internal data structures necessary for the execution of the eigensolver.

This function need not be called explicitly in most cases, since *solve()* calls it. It can be useful when one wants to measure the set-up time separately from the solve time.

See also

solve, NEPSetUp

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1184 <slepc4py/SLEPc/NEP.pyx#L1184>`

Return type
None

setWhichEigenpairs(*which*)

Set which portion of the spectrum is to be sought.

Logically collective.

Parameters
which (Which) – The portion of the spectrum to be sought by the solver.

Return type
None

Notes

Not all eigensolvers implemented in NEP account for all the possible values. Also, some values make sense only for certain types of problems. If SLEPc is compiled for real numbers *NEP.Which.LARGEST_IMAGINARY* and *NEP.Which.SMALLEST_IMAGINARY* use the absolute value of the imaginary part for eigenvalue selection.

The target is a scalar value provided with *setTarget()*.

The criterion *NEP.Which.TARGET_IMAGINARY* is available only in case PETSc and SLEPc have been built with complex scalars.

NEP.Which.ALL is intended for use in the context of the *PEP.Type.CISS* solver for computing all eigenvalues in a region.

See also

getWhichEigenpairs, *setTarget*, PEPSetWhichEigenpairs

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:496 <slepc4py/SLEPc/NEP.pyx#L496>`

solve()

Solve the nonlinear eigenproblem.

Collective.

Notes

solve() will return without generating an error regardless of whether all requested solutions were computed or not. Call *getConverged()* to get the actual number of computed solutions, and *getConvergedReason()* to determine if the solver converged or failed and why.

See also

setUp, *getConverged*, *getConvergedReason*, NEPSolve

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1205 <slepc4py/SLEPc/NEP.pyx#L1205>`

Return type
None

valuesView(*viewer=None*)

Display the computed eigenvalues in a viewer.

Collective.

Parameters
viewer (*Viewer* | *None*) – Visualization context; if not provided, the standard output is used.

Return type
None

See also

solve, *vectorsView*, *errorView*, NEPValuesView

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1474 <slepc4py/SLEPc/NEP.pyx#L1474>`

vectorsView(*viewer=None*)

Output computed eigenvectors to a viewer.

Collective.

Parameters
viewer (*Viewer* | *None*) – Visualization context; if not provided, the standard output is used.

Return type
None

See also

solve, *valuesView*, *errorView*, NEPVectorsView

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:1493 <slepc4py/SLEPc/NEP.pyx#L1493>`

view(*viewer=None*)

Print the NEP data structure.

Collective.

Parameters

viewer (*Viewer | None*) – Visualization context; if not provided, the standard output is used.

Return type

None

See also

`NEPView`

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:233 <slepc4py/SLEPc/NEP.pyx#L233>`

Attributes Documentation

bv

The basis vectors (*BV*) object associated.

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:3079 <slepc4py/SLEPc/NEP.pyx#L3079>`

ds

The direct solver (*DS*) object associated.

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:3095 <slepc4py/SLEPc/NEP.pyx#L3095>`

max_it

The maximum iteration count used by the NEP convergence tests.

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:3063 <slepc4py/SLEPc/NEP.pyx#L3063>`

problem_type

The problem type from the NEP object.

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:3031 <slepc4py/SLEPc/NEP.pyx#L3031>`

rg

The region (*RG*) object associated.

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:3087 <slepc4py/SLEPc/NEP.pyx#L3087>`

target

The value of the target.

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:3047 <slepc4py/SLEPc/NEP.pyx#L3047>`

tol

The tolerance used by the NEP convergence tests.

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:3055 <slepc4py/SLEPc/NEP.pyx#L3055>`

track_all

Compute the residual of all approximate eigenpairs.

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:3071 <slepc4py/SLEPc/NEP.pyx#L3071>`

which

The portion of the spectrum to be sought.

:sources:`Source code at slepc4py/SLEPc/NEP.pyx:3039 <slepc4py/SLEPc/NEP.pyx#L3039>`

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.PEP

class slepc4py.SLEPc.**PEP**

Bases: Object

Polynomial Eigenvalue Problem Solver.

The Polynomial Eigenvalue Problem (*PEP*) solver is the object provided by slepc4py for specifying a polynomial eigenvalue problem. Apart from the specific solvers for this type of problems, there is an *EPS*-based solver, i.e., it uses a solver from *EPS* to solve a generalized eigenproblem obtained after linearization.

Enumerations

Basis	PEP basis type for the representation of the polynomial.
CISSExtraction	PEP CISS extraction technique.
Conv	PEP convergence test.
ConvergedReason	PEP convergence reasons.
ErrorType	PEP error type to assess accuracy of computed solutions.
Extract	PEP extraction strategy used.
JDProjection	PEP type of projection to be used in the Jacobi-Davidson solver.
ProblemType	PEP problem type.
Refine	PEP refinement strategy.
RefineScheme	PEP scheme for solving linear systems during iterative refinement.
Scale	PEP scaling strategy.
Stop	PEP stopping test.
Type	PEP type.
Which	PEP desired part of spectrum.

slepc4py.SLEPc.PEP.Basis

class slepc4py.SLEPc.PEP.**Basis**

Bases: object

PEP basis type for the representation of the polynomial.

- *MONOMIAL*: Monomials (default).
- *CHEBYSHEV1*: Chebyshev polynomials of the 1st kind.
- *CHEBYSHEV2*: Chebyshev polynomials of the 2nd kind.
- *LEGENDRE*: Legendre polynomials.
- *LAGUERRE*: Laguerre polynomials.
- *HERMITE*: Hermite polynomials.

See also

PEPBasis

Attributes Summary

CHEBYSHEV1	Constant CHEBYSHEV1 of type int
CHEBYSHEV2	Constant CHEBYSHEV2 of type int
HERMITE	Constant HERMITE of type int
LAGUERRE	Constant LAGUERRE of type int
LEGENDRE	Constant LEGENDRE of type int
MONOMIAL	Constant MONOMIAL of type int

Attributes Documentation

CHEBYSHEV1: int = CHEBYSHEV1

Constant CHEBYSHEV1 of type int

CHEBYSHEV2: int = CHEBYSHEV2

Constant CHEBYSHEV2 of type int

HERMITE: int = HERMITE

Constant HERMITE of type int

LAGUERRE: int = LAGUERRE

Constant LAGUERRE of type int

LEGENDRE: int = LEGENDRE

Constant LEGENDRE of type int

MONOMIAL: int = MONOMIAL

Constant MONOMIAL of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.PEP.CISSExtraction

class slepc4py.SLEPc.PEP.**CISSExtraction**

Bases: object

PEP CISS extraction technique.

- *RITZ*: Ritz extraction.
- *HANKEL*: Extraction via Hankel eigenproblem.
- *CAA*: Communication-avoiding Arnoldi.

See also

PEPCISSExtraction

Attributes Summary

CAA	Constant CAA of type int
HANKEL	Constant HANKEL of type int
RITZ	Constant RITZ of type int

Attributes Documentation

CAA: int = CAA

Constant CAA of type int

HANKEL: int = HANKEL

Constant HANKEL of type int

RITZ: int = RITZ

Constant RITZ of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.PEP.Conv

class slepc4py.SLEPc.PEP.**Conv**

Bases: object

PEP convergence test.

- *ABS*: Absolute convergence test.
- *REL*: Convergence test relative to the eigenvalue.
- *NORM*: Convergence test relative to the matrix norms.
- *USER*: User-defined convergence test.

See also

PEPConv

Attributes Summary

ABS	Constant ABS of type int
NORM	Constant NORM of type int
REL	Constant REL of type int
USER	Constant USER of type int

Attributes Documentation

ABS: int = ABS

Constant ABS of type int

NORM: int = NORM

Constant NORM of type int

REL: int = REL

Constant REL of type int

USER: int = USER

Constant USER of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.PEP.ConvergedReason

class slepc4py.SLEPc.PEP.**ConvergedReason**

Bases: object

PEP convergence reasons.

- *CONVERGED_TOL*: All eigenpairs converged to requested tolerance.
- *CONVERGED_USER*: User-defined convergence criterion satisfied.
- *DIVERGED_ITS*: Maximum number of iterations exceeded.
- *DIVERGED_BREAKDOWN*: Solver failed due to breakdown.
- *DIVERGED_SYMMETRY_LOST*: Lanczos-type method could not preserve symmetry.
- *CONVERGED_ITERATING*: Iteration not finished yet.

See also

PEPConvergedReason

Attributes Summary

CONVERGED_ITERATING	Constant CONVERGED_ITERATING of type int
CONVERGED_TOL	Constant CONVERGED_TOL of type int
CONVERGED_USER	Constant CONVERGED_USER of type int
DIVERGED_BREAKDOWN	Constant DIVERGED_BREAKDOWN of type int
DIVERGED_ITS	Constant DIVERGED_ITS of type int
DIVERGED_SYMMETRY_LOST	Constant DIVERGED_SYMMETRY_LOST of type int
ITERATING	Constant ITERATING of type int

Attributes Documentation

CONVERGED_ITERATING: int = CONVERGED_ITERATING

Constant CONVERGED_ITERATING of type int

CONVERGED_TOL: int = CONVERGED_TOL

Constant CONVERGED_TOL of type int

CONVERGED_USER: int = CONVERGED_USER

Constant CONVERGED_USER of type int

DIVERGED_BREAKDOWN: int = DIVERGED_BREAKDOWN

Constant DIVERGED_BREAKDOWN of type int

DIVERGED_ITS: int = DIVERGED_ITS

Constant DIVERGED_ITS of type int

DIVERGED_SYMMETRY_LOST: int = DIVERGED_SYMMETRY_LOST

Constant DIVERGED_SYMMETRY_LOST of type int

ITERATING: int = ITERATING

Constant ITERATING of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.PEP.ErrorType

class slepc4py.SLEPc.PEP.**ErrorType**

Bases: object

PEP error type to assess accuracy of computed solutions.

- *ABSOLUTE*: Absolute error.
- *RELATIVE*: Relative error.
- *BACKWARD*: Backward error.

See also

PEPErrorType

Attributes Summary

ABSOLUTE	Constant ABSOLUTE of type int
BACKWARD	Constant BACKWARD of type int
RELATIVE	Constant RELATIVE of type int

Attributes Documentation

ABSOLUTE: int = ABSOLUTE

Constant ABSOLUTE of type int

BACKWARD: int = BACKWARD

Constant BACKWARD of type int

RELATIVE: int = RELATIVE

Constant RELATIVE of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.PEP.Extract

class slepc4py.SLEPc.PEP.**Extract**

Bases: object

PEP extraction strategy used.

PEP extraction strategy used to obtain eigenvectors of the PEP from the eigenvectors of the linearization.

- *NONE*: Use the first block.
- *NORM*: Use the first or last block depending on norm of H.
- *RESIDUAL*: Use the block with smallest residual.
- *STRUCTURED*: Combine all blocks in a certain way.

See also

PEPExtract

Attributes Summary

NONE	Constant NONE of type int
NORM	Constant NORM of type int
RESIDUAL	Constant RESIDUAL of type int
STRUCTURED	Constant STRUCTURED of type int

Attributes Documentation

NONE: int = NONE

Constant NONE of type int

NORM: int = NORM

Constant NORM of type int

RESIDUAL: int = RESIDUAL

Constant RESIDUAL of type int

STRUCTURED: int = STRUCTURED

Constant STRUCTURED of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.PEP.JDProjection

class slepc4py.SLEPc.PEP.**JDProjection**

Bases: object

PEP type of projection to be used in the Jacobi-Davidson solver.

- *HARMONIC*: Harmonic projection.
- *ORTHOGONAL*: Orthogonal projection.

See also

PEPJDProjection

Attributes Summary

HARMONIC	Constant HARMONIC of type int
ORTHOGONAL	Constant ORTHOGONAL of type int

Attributes Documentation

HARMONIC: int = HARMONIC

Constant HARMONIC of type int

ORTHOGONAL: int = ORTHOGONAL

Constant ORTHOGONAL of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.PEP.ProblemType

class slepc4py.SLEPc.PEP.**ProblemType**

Bases: object

PEP problem type.

- *GENERAL*: No structure.
- *HERMITIAN*: Hermitian structure.
- *HYPERBOLIC*: QEP with Hermitian matrices, $M > 0$, $(x^TCx)^2 > 4(x^TMx)(x^TKx)$.
- *GYROSCOPIC*: QEP with M, K Hermitian, $M > 0$, C skew-Hermitian.

See also

PEPProblemType

Attributes Summary

GENERAL	Constant GENERAL of type int
GYROSCOPIC	Constant GYROSCOPIC of type int
HERMITIAN	Constant HERMITIAN of type int
HYPERBOLIC	Constant HYPERBOLIC of type int

Attributes Documentation

GENERAL: int = GENERAL

Constant GENERAL of type int

GYROSCOPIC: int = GYROSCOPIC

Constant GYROSCOPIC of type int

HERMITIAN: int = HERMITIAN

Constant HERMITIAN of type int

HYPERBOLIC: int = HYPERBOLIC

Constant HYPERBOLIC of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.PEP.Refine

class slepc4py.SLEPc.PEP.**Refine**

Bases: object

PEP refinement strategy.

- *NONE*: No refinement.
- *SIMPLE*: Refine eigenpairs one by one.
- *MULTIPLE*: Refine all eigenpairs simultaneously (invariant pair).

See also

PEPRefine

Attributes Summary

MULTIPLE	Constant MULTIPLE of type int
NONE	Constant NONE of type int
SIMPLE	Constant SIMPLE of type int

Attributes Documentation

MULTIPLE: int = MULTIPLE

Constant MULTIPLE of type int

NONE: int = NONE

Constant NONE of type int

SIMPLE: int = SIMPLE

Constant SIMPLE of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.PEP.RefineScheme

class slepc4py.SLEPc.PEP.**RefineScheme**

Bases: object

PEP scheme for solving linear systems during iterative refinement.

- *SCHUR*: Schur complement.
- *MBE*: Mixed block elimination.
- *EXPLICIT*: Build the explicit matrix.

See also

PEPRefineScheme

Attributes Summary

EXPLICIT	Constant EXPLICIT of type int
MBE	Constant MBE of type int
SCHUR	Constant SCHUR of type int

Attributes Documentation

EXPLICIT: int = EXPLICIT

Constant EXPLICIT of type int

MBE: int = MBE

Constant MBE of type int

SCHUR: int = SCHUR

Constant SCHUR of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.PEP.Scale

class slepc4py.SLEPc.PEP.**Scale**

Bases: object

PEP scaling strategy.

- *NONE*: No scaling.
- *SCALAR*: Parameter scaling.
- *DIAGONAL*: Diagonal scaling.
- *BOTH*: Both parameter and diagonal scaling.

See also

PEPScale

Attributes Summary

BOTH	Constant BOTH of type int

continues on next page

Table 81 – continued from previous page

DIAGONAL	Constant DIAGONAL of type int
NONE	Constant NONE of type int
SCALAR	Constant SCALAR of type int

Attributes Documentation

BOTH: int = BOTH

Constant BOTH of type int

DIAGONAL: int = DIAGONAL

Constant DIAGONAL of type int

NONE: int = NONE

Constant NONE of type int

SCALAR: int = SCALAR

Constant SCALAR of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.PEP.Stop

class slepc4py.SLEPc.PEP.**Stop**

Bases: object

PEP stopping test.

- *BASIC*: Default stopping test.
- *USER*: User-defined stopping test.

See also

PEPStop

Attributes Summary

BASIC	Constant BASIC of type int
USER	Constant USER of type int

Attributes Documentation

BASIC: int = BASIC

Constant BASIC of type int

USER: int = USER

Constant USER of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.PEP.Type

class slepc4py.SLEPc.PEP.**Type**

Bases: object

PEP type.

- *TOAR*: Two-level orthogonal Arnoldi.
- *STOAR*: Symmetric TOAR.
- *QARNOLDI*: Q-Arnoldi for quadratic problems.
- *LINEAR*: Linearization via EPS.
- *JD*: Polynomial Jacobi-Davidson.
- *CISS*: Contour integral spectrum slice.

See also

PEPType

Attributes Summary

CISS	Object CISS of type str
JD	Object JD of type str
LINEAR	Object LINEAR of type str
QARNOLDI	Object QARNOLDI of type str
STOAR	Object STOAR of type str
TOAR	Object TOAR of type str

Attributes Documentation

CISS: str = CISS

Object CISS of type str

JD: str = JD

Object JD of type str

LINEAR: str = LINEAR

Object LINEAR of type str

QARNOLDI: str = QARNOLDI

Object QARNOLDI of type str

STOAR: str = STOAR

Object STOAR of type str

TOAR: str = TOAR

Object TOAR of type str

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.PEP.Which

class slepc4py.SLEPc.PEP.**Which**

Bases: object

PEP desired part of spectrum.

- *LARGEST_MAGNITUDE*: Largest magnitude (default).
- *SMALLEST_MAGNITUDE*: Smallest magnitude.
- *LARGEST_REAL*: Largest real parts.
- *SMALLEST_REAL*: Smallest real parts.
- *LARGEST_IMAGINARY*: Largest imaginary parts in magnitude.
- *SMALLEST_IMAGINARY*: Smallest imaginary parts in magnitude.
- *TARGET_MAGNITUDE*: Closest to target (in magnitude).
- *TARGET_REAL*: Real part closest to target.
- *TARGET_IMAGINARY*: Imaginary part closest to target.
- *ALL*: All eigenvalues in an interval.
- *USER*: User-defined criterion.

See also

PEPWhich

Attributes Summary

ALL	Constant ALL of type int
LARGEST_IMAGINARY	Constant LARGEST_IMAGINARY of type int
LARGEST_MAGNITUDE	Constant LARGEST_MAGNITUDE of type int
LARGEST_REAL	Constant LARGEST_REAL of type int
SMALLEST_IMAGINARY	Constant SMALLEST_IMAGINARY of type int
SMALLEST_MAGNITUDE	Constant SMALLEST_MAGNITUDE of type int
SMALLEST_REAL	Constant SMALLEST_REAL of type int
TARGET_IMAGINARY	Constant TARGET_IMAGINARY of type int
TARGET_MAGNITUDE	Constant TARGET_MAGNITUDE of type int
TARGET_REAL	Constant TARGET_REAL of type int
USER	Constant USER of type int

Attributes Documentation

ALL: int = ALL

Constant ALL of type int

LARGEST_IMAGINARY: int = LARGEST_IMAGINARY

Constant LARGEST_IMAGINARY of type int

LARGEST_MAGNITUDE: int = LARGEST_MAGNITUDE

Constant LARGEST_MAGNITUDE of type int

LARGEST_REAL: int = LARGEST_REAL

Constant LARGEST_REAL of type int

SMALLEST_IMAGINARY: int = SMALLEST_IMAGINARY

Constant SMALLEST_IMAGINARY of type int

SMALLEST_MAGNITUDE: int = SMALLEST_MAGNITUDE

Constant SMALLEST_MAGNITUDE of type int

SMALLEST_REAL: int = SMALLEST_REAL

Constant SMALLEST_REAL of type int

TARGET_IMAGINARY: int = TARGET_IMAGINARY

Constant TARGET_IMAGINARY of type int

TARGET_MAGNITUDE: int = TARGET_MAGNITUDE

Constant TARGET_MAGNITUDE of type int

TARGET_REAL: int = TARGET_REAL

Constant TARGET_REAL of type int

USER: int = USER

Constant USER of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

Methods Summary

appendOptionsPrefix([prefix])	Append to the prefix used for searching for all PEP options in the database.
cancelMonitor()	Clear all monitors for a *PEP* object.
computeError(i[, etype])	Compute the error associated with the i-th computed eigenpair.
create([comm])	Create the PEP object.
destroy()	Destroy the PEP object.
errorView([etype, viewer])	Display the errors associated with the computed solution.
getBV()	Get the basis vectors object associated to the eigensolver.
getBasis()	Get the type of polynomial basis used.
getCISSExtraction()	Get the extraction technique used in the CISS solver.
getCISSKSPs()	Get the array of linear solver objects associated with the CISS solver.
getCISSRefinement()	Get the values of various refinement parameters in the CISS solver.
getCISSSizes()	Get the values of various size parameters in the CISS solver.
getCISSThreshold()	Get the values of various threshold parameters in the CISS solver.
getConverged()	Get the number of converged eigenpairs.
getConvergedReason()	Get the reason why the *solve()* iteration was stopped.

continues on next page

Table 85 – continued from previous page

getConvergenceTest()	Get the method used to compute the error estimate used in the convergence test.
getDS()	Get the direct solver associated to the eigensolver.
getDimensions()	Get the number of eigenvalues to compute and the dimension of the subspace.
getEigenpair(i[, Vr, Vi])	Get the i-th solution of the eigenproblem as computed by *solve()*.
getEigenvalueComparison()	Get the eigenvalue comparison function.
getErrorEstimate(i)	Get the error estimate associated to the i-th computed eigenpair.
getExtract()	Get the extraction technique used by the *PEP* object.
getInterval()	Get the computational interval for spectrum slicing.
getIterationNumber()	Get the current iteration number.
getJDFix()	Get threshold for changing the target in the correction equation.
getJDMinimalityIndex()	Get the maximum allowed value of the minimality index.
getJDProjection()	Get the type of projection to be used in the Jacobi-Davidson solver.
getJDRestart()	Get the restart parameter used in the Jacobi-Davidson method.
getJDReusePreconditioner()	Get the flag for reusing the preconditioner.
getLinearEPS()	Get the eigensolver object associated to the polynomial eigenvalue solver.
getLinearExplicitMatrix()	Get if the matrices for the linearization are built explicitly.
getLinearLinearization()	Get the coeffs.
getMonitor()	Get the list of monitor functions.
getOperators()	Get the matrices associated with the eigenvalue problem.
getOptionsPrefix()	Get the prefix used for searching for all PEP options in the database.
getProblemType()	Get the problem type from the PEP object.
getQArnoldiLocking()	Get the locking flag used in the Q-Arnoldi method.
getQArnoldiRestart()	Get the restart parameter used in the Q-Arnoldi method.
getRG()	Get the region object associated to the eigensolver.
getRefine()	Get the refinement strategy used by the PEP object.
getRefineKSP()	Get the KSP object used by the eigensolver in the refinement phase.
getST()	Get the spectral transformation object associated to the eigensolver.
getSTOARCheckEigenvalueType()	Get the flag for the eigenvalue type check in spectrum slicing.
getSTOARDetectZeros()	Get the flag that enforces zero detection in spectrum slicing.
getSTOARDimensions()	Get the dimensions used for each subsolve step.
getSTOARInertias()	Get the values of the shifts and their corresponding inertias.
getSTOARLinearization()	Get the coefficients that define the linearization of a quadratic eigenproblem.
getSTOARLocking()	Get the locking flag used in the STOAR method.

continues on next page

Table 85 – continued from previous page

getScale([Dl, Dr])	Get the strategy used for scaling the polynomial eigenproblem.
getStoppingTest()	Get the stopping test function.
getTOARLocking()	Get the locking flag used in the TOAR method.
getTOARRestart()	Get the restart parameter used in the TOAR method.
getTarget()	Get the value of the target.
getTolerances()	Get the tolerance and maximum iteration count.
getTrackAll()	Get the flag indicating whether all residual norms must be computed.
getType()	Get the PEP type of this object.
getWhichEigenpairs()	Get which portion of the spectrum is to be sought.
reset()	Reset the PEP object.
setBV(bv)	Set a basis vectors object associated to the eigensolver.
setBasis(basis)	Set the type of polynomial basis used.
setCISSExtraction(extraction)	Set the extraction technique used in the CISS solver.
setCISSRefinement([inner, blsize])	Set the values of various refinement parameters in the CISS solver.
setCISSSizes([ip, bs, ms, npart, bsmax, ...])	Set the values of various size parameters in the CISS solver.
setCISSThreshold([delta, spur])	Set the values of various threshold parameters in the CISS solver.
setConvergenceTest(conv)	Set how to compute the error estimate used in the convergence test.
setDS(ds)	Set a direct solver object associated to the eigensolver.
setDimensions([nev, ncv, mpd])	Set the number of eigenvalues to compute and the dimension of the subspace.
setEigenvalueComparison(comparison[, args, ...])	Set an eigenvalue comparison function.
setExtract(extract)	Set the extraction strategy to be used.
setFromOptions()	Set PEP options from the options database.
setInitialSpace(space)	Set the initial space from which the eigensolver starts to iterate.
setInterval(inta, intb)	Set the computational interval for spectrum slicing.
setJDFix(fix)	Set the threshold for changing the target in the correction equation.
setJDMinimalityIndex(flag)	Set the maximum allowed value for the minimality index.
setJDProjection(proj)	Set the type of projection to be used in the Jacobi-Davidson solver.
setJDRestart(keep)	Set the restart parameter for the Jacobi-Davidson method.
setJDReusePreconditioner([flag])	Set a flag indicating whether the preconditioner must be reused or not.
setLinearEPS(eps)	Set an eigensolver object associated to the polynomial eigenvalue solver.
setLinearExplicitMatrix([flag])	Set flag to explicitly build the matrices for the linearization.
setLinearLinearization([alpha, beta])	Set the coefficients that define the linearization of a quadratic eigenproblem.
setMonitor(monitor[, args, kargs])	Append a monitor function to the list of monitors.

continues on next page

Table 85 – continued from previous page

setOperators(operators)	Set the matrices associated with the eigenvalue problem.
setOptionsPrefix([prefix])	Set the prefix used for searching for all PEP options in the database.
setProblemType(problem_type)	Set the type of the polynomial eigenvalue problem.
setQArnoldiLocking([lock])	Toggle between locking and non-locking variants of the Q-Arnoldi method.
setQArnoldiRestart(keep)	Set the restart parameter for the Q-Arnoldi method.
setRG(rg)	Set a region object associated to the eigensolver.
setRefine(ref[, npart, tol, its, scheme])	Set the refinement strategy used by the PEP object.
setST(st)	Set a spectral transformation object associated to the eigensolver.
setSTOARCheckEigenvalueType([flag])	Set flag to check if all eigenvalues have the same definite type.
setSTOARDetectZeros([detect])	Set flag to enforce detection of zeros during the factorizations.
setSTOARDimensions([nev, ncv, mpd])	Set the dimensions used for each subsolve step.
setSTOARLinearization([alpha, beta])	Set the coefficients that define the linearization of a quadratic eigenproblem.
setSTOARLocking([lock])	Toggle between locking and non-locking variants of the STOAR method.
setScale(scale[, alpha, Dl, Dr, its, lbda])	Set the scaling strategy to be used.
setStoppingTest(stopping[, args, kargs])	Set a function to decide when to stop the outer iteration of the eigensolver.
setTOARLocking([lock])	Toggle between locking and non-locking variants of the TOAR method.
setTOARRestart(keep)	Set the restart parameter for the TOAR method.
setTarget(target)	Set the value of the target.
setTolerances([tol, max_it])	Set the tolerance and maximum iteration count.
setTrackAll([trackall])	Set flag to compute the residual of all approximate eigenpairs.
setType(pep_type)	Set the particular solver to be used in the PEP object.
setUp()	Set up all the internal data structures.
setWhichEigenpairs(which)	Set which portion of the spectrum is to be sought.
solve()	Solve the polynomial eigenproblem.
valuesView([viewer])	Display the computed eigenvalues in a viewer.
vectorsView([viewer])	Output computed eigenvectors to a viewer.
view([viewer])	Print the PEP data structure.

Attributes Summary

bv	The basis vectors (BV) object associated.
ds	The direct solver (DS) object associated.
extract	The type of extraction technique to be employed.
max_it	The maximum iteration count.
problem_type	The type of the eigenvalue problem.
rg	The region (RG) object associated.
st	The spectral transformation (ST) object associated.
target	The value of the target.
tol	The tolerance.

continues on next page

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track_all	Compute the residual norm of all approximate eigenpairs.
which	The portion of the spectrum to be sought.

Methods Documentation

appendOptionsPrefix(*prefix=None*)

Append to the prefix used for searching for all PEP options in the database.

Logically collective.

Parameters
prefix (*str* | *None*) – The prefix string to prepend to all PEP option requests.

Return type
None

See also

setOptionsPrefix, *getOptionsPrefix*, PEPAppendOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:481 <slepc4py/SLEPc/PEP.pyx#L481>`

cancelMonitor()

Clear all monitors for a *PEP* object.

Logically collective.

See also

PEPMonitorCancel

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1603 <slepc4py/SLEPc/PEP.pyx#L1603>`

Return type
None

computeError(*i*, *etype=None*)

Compute the error associated with the i-th computed eigenpair.

Collective.

Compute the error (based on the residual norm) associated with the i-th computed eigenpair.

Parameters

- **i** (*int*) – Index of the solution to be considered.
- **etype** (ErrorType | *None*) – The error type to compute.

Returns
The error bound, computed in various ways from the residual norm $\|P(\lambda)x\|_2$ where λ is the eigenvalue and x is the eigenvector.

Return type
float

Notes

The index `i` should be a value between `0` and `nconv-1` (see *getConverged()*).

See also

getErrorEstimate, PEPComputeError

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1801 <slepc4py/SLEPc/PEP.pyx#L1801>`

create(*comm=None*)

Create the PEP object.

Collective.

Parameters

comm (*Comm | None*) – MPI communicator. If not provided, it defaults to all processes.

Return type

Self

See also

PEPCreate

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:364 <slepc4py/SLEPc/PEP.pyx#L364>`

destroy()

Destroy the PEP object.

Collective.

See also

PEPDestroy

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:338 <slepc4py/SLEPc/PEP.pyx#L338>`

Return type

Self

errorView(*etype=None*, *viewer=None*)

Display the errors associated with the computed solution.

Collective.

Display the errors and the eigenvalues.

Parameters

- **etype** (ErrorType | *None*) – The error type to compute.
- **viewer** (*petsc4py.PETSc.Viewer | None*) – Visualization context; if not provided, the standard output is used.

Return type

None

Notes

By default, this function checks the error of all eigenpairs and prints the eigenvalues if all of them are below the requested tolerance. If the viewer has format `ASCII_INFO_DETAIL` then a table with eigenvalues and corresponding errors is printed.

See also

solve, *valuesView*, *vectorsView*, PEPErrorView

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1840 <slepc4py/SLEPc/PEP.pyx#L1840>`

getBV()

Get the basis vectors object associated to the eigensolver.

Not collective.

Returns
The basis vectors context.

Return type
BV

See also

setBV, PEPGetBV

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1264 <slepc4py/SLEPc/PEP.pyx#L1264>`

getBasis()

Get the type of polynomial basis used.

Not collective.

Returns
The basis that was previously set.

Return type
Basis

See also

setBasis, PEPGetBasis

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:519 <slepc4py/SLEPc/PEP.pyx#L519>`

getCISSExtraction()

Get the extraction technique used in the CISS solver.

Not collective.

Returns
The extraction technique.

Return type
CISSExtraction

See also

setCISSExtraction, PEPCISSGetExtraction

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2746 <slepc4py/SLEPc/PEP.pyx#L2746>`

getCISSKSPs()

Get the array of linear solver objects associated with the CISS solver.

Collective.

Returns
The linear solver objects.

Return type
list of petsc4py.PETSc.KSP

Notes

The number of petsc4py.PETSc.KSP solvers is equal to the number of integration points divided by the number of partitions. This value is halved in the case of real matrices with a region centered at the real axis.

See also

setCISSSizes, PEPCISSGetKSPs

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2943 <slepc4py/SLEPc/PEP.pyx#L2943>`

getCISSRefinement()

Get the values of various refinement parameters in the CISS solver.

Not collective.

Returns

- **inner** (int) – Number of iterative refinement iterations (inner loop).
- **blsize** (int) – Number of iterative refinement iterations (blocksize loop).

Return type
tuple[int, int]

See also

setCISSRefinement, PEPCISSGetRefinement

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2921 <slepc4py/SLEPc/PEP.pyx#L2921>`

getCISSSizes()

Get the values of various size parameters in the CISS solver.

Not collective.

Returns

- **ip** (int) – Number of integration points.

- **bs** (int) – Block size.
- **ms** (int) – Moment size.
- **npart** (int) – Number of partitions when splitting the communicator.
- **bsmax** (int) – Maximum block size.
- **realmats** (bool) – True if A and B are real.

Return type
tuple[int, int, int, int, int, bool]

See also

setCISSSizes, PEPCISSGetSizes

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2819 <slepc4py/SLEPc/PEP.pyx#L2819>`

getCISSThreshold()

Get the values of various threshold parameters in the CISS solver.

Not collective.

Returns

- **delta** (float) – Threshold for numerical rank.
- **spur** (float) – Spurious threshold (to discard spurious eigenpairs.

Return type
tuple[float, float]

See also

setCISSThreshold, PEPCISSGetThreshold

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2876 <slepc4py/SLEPc/PEP.pyx#L2876>`

getConverged()

Get the number of converged eigenpairs.

Not collective.

Returns
nconv – Number of converged eigenpairs.

Return type
int

Notes

This function should be called after *solve()* has finished.

The value nconv may be different from the number of requested solutions nev, but not larger than ncv, see *setDimensions()*.

See also

setDimensions, *solve*, *getEigenpair*, PEPGetConverged

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1703 <slepc4py/SLEPc/PEP.pyx#L1703>`

getConvergedReason()

Get the reason why the *solve()* iteration was stopped.

Not collective.

Returns
Negative value indicates diverged, positive value converged.

Return type
ConvergedReason

See also

setTolerances, *solve*, PEPGetConvergedReason

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1684 <slepc4py/SLEPc/PEP.pyx#L1684>`

getConvergenceTest()

Get the method used to compute the error estimate used in the convergence test.

Not collective.

Returns
The method used to compute the error estimate used in the convergence test.

Return type
Conv

See also

setConvergenceTest, PEPGetConvergenceTest

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:834 <slepc4py/SLEPc/PEP.pyx#L834>`

getDS()

Get the direct solver associated to the eigensolver.

Not collective.

Returns
The direct solver context.

Return type
DS

See also

setDS, PEPGetDS

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1338 <slepc4py/SLEPc/PEP.pyx#L1338>`

getDimensions()

Get the number of eigenvalues to compute and the dimension of the subspace.

Not collective.

Returns

- **nev** (int) – Number of eigenvalues to compute.
- **ncv** (int) – Maximum dimension of the subspace to be used by the solver.
- **mpd** (int) – Maximum dimension allowed for the projected problem.

Return type
tuple[int, int, int]

See also

setDimensions, PEPGetDimensions

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1052 <slepc4py/SLEPc/PEP.pyx#L1052>`

getEigenpair(*i*, *Vr=None*, *Vi=None*)

Get the i-th solution of the eigenproblem as computed by *solve()*.

Collective.

The solution consists of both the eigenvalue and the eigenvector.

Parameters

- **i** (*int*) – Index of the solution to be obtained.
- **Vr** (*Vec | None*) – Placeholder for the returned eigenvector (real part).
- **Vi** (*Vec | None*) – Placeholder for the returned eigenvector (imaginary part).

Returns
The computed eigenvalue.

Return type
complex

Notes

The index `i` should be a value between `0` and `nconv-1` (see *getConverged()*). Eigenpairs are indexed according to the ordering criterion established with *setWhichEigenpairs()*.

The eigenvector is normalized to have unit norm.

See also

solve, *getConverged*, *setWhichEigenpairs*, PEPGetEigenpair

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1729 <slepc4py/SLEPc/PEP.pyx#L1729>`

getEigenvalueComparison()

Get the eigenvalue comparison function.

Not collective.

Returns
The eigenvalue comparison function.

Return type
PEPEigenvalueComparison

See also

setEigenvalueComparison

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1544 <slepc4py/SLEPc/PEP.pyx#L1544>`

getErrorEstimate(*i*)

Get the error estimate associated to the i-th computed eigenpair.

Not collective.

Parameters
i (*int*) – Index of the solution to be considered.

Returns
Error estimate.

Return type
float

Notes

This is the error estimate used internally by the eigensolver. The actual error bound can be computed with *computeError()*.

See also

computeError, PEPGetErrorEstimate

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1771 <slepc4py/SLEPc/PEP.pyx#L1771>`

getExtract()

Get the extraction technique used by the *PEP* object.

Not collective.

Returns
The extraction strategy.

Return type
Extract

See also

setExtract, PEPGetExtract

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:993 <slepc4py/SLEPc/PEP.pyx#L993>`

`getInterval`()

Get the computational interval for spectrum slicing.

Not collective.

Returns

- **inta** (`float`) – The left end of the interval.
- **intb** (`float`) – The right end of the interval.

Return type
tuple[float, float]

Notes

If the interval was not set by the user, then zeros are returned.

See also

setInterval, PEPGetInterval

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:778 <slepc4py/SLEPc/PEP.pyx#L778>`

`getIterationNumber`()

Get the current iteration number.

Not collective.

If the call to *solve()* is complete, then it returns the number of iterations carried out by the solution method.

Returns
Iteration number.

Return type
`int`

See also

getConvergedReason, *setTolerances*, PEPGetIterationNumber

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1662 <slepc4py/SLEPc/PEP.pyx#L1662>`

`getJDFix`()

Get threshold for changing the target in the correction equation.

Not collective.

Returns
The threshold for changing the target.

Return type
`float`

See also

setJDFix, PEPJDGetFix

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2583 <slepc4py/SLEPc/PEP.pyx#L2583>`

getJDMinimalityIndex()

Get the maximum allowed value of the minimality index.

Not collective.

Returns
The maximum minimality index.

Return type
int

See also

setJDMinimalityIndex, PEPJDGetMinimalityIndex

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2670 <slepc4py/SLEPc/PEP.pyx#L2670>`

getJDProjection()

Get the type of projection to be used in the Jacobi-Davidson solver.

Not collective.

Returns
The type of projection.

Return type
JDProjection

See also

setJDProjection, PEPJDGetProjection

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2707 <slepc4py/SLEPc/PEP.pyx#L2707>`

getJDRestart()

Get the restart parameter used in the Jacobi-Davidson method.

Not collective.

Returns
The number of vectors to be kept at restart.

Return type
float

See also

setJDRestart, PEPJDGetRestart

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2540 <slepc4py/SLEPc/PEP.pyx#L2540>`

getJDReusePreconditioner()

Get the flag for reusing the preconditioner.

Not collective.

Returns
The reuse flag.

Return type
bool

See also

setJDReusePreconditioner, PEPJDGetReusePreconditioner

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2627 <slepc4py/SLEPc/PEP.pyx#L2627>`

getLinearEPS()

Get the eigensolver object associated to the polynomial eigenvalue solver.

Collective.

Returns
The linear eigensolver.

Return type
EPS

See also

setLinearEPS, PEPLinearGetEPS

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1929 <slepc4py/SLEPc/PEP.pyx#L1929>`

getLinearExplicitMatrix()

Get if the matrices for the linearization are built explicitly.

Not collective.

Returns
Boolean flag indicating if the matrices are built explicitly.

Return type
bool

See also

getLinearExplicitMatrix, PEPLinearSetExplicitMatrix

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2010 <slepc4py/SLEPc/PEP.pyx#L2010>`

getLinearLinearization()

Get the coeffs. defining the linearization of a quadratic eigenproblem.

Not collective.

Returns

- **alpha** (`float`) – First parameter of the linearization.
- **beta** (`float`) – Second parameter of the linearization.

Return type
tuple[float, float]

See also
setLinearLinearization, PEPLinearGetLinearization

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1970 <slepc4py/SLEPc/PEP.pyx#L1970>`

getMonitor()

Get the list of monitor functions.

Not collective.

Returns
The list of monitor functions.

Return type
PEPMonitorFunction

See also
setMonitor

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1586 <slepc4py/SLEPc/PEP.pyx#L1586>`

getOperators()

Get the matrices associated with the eigenvalue problem.

Collective.

Returns
The matrices associated with the eigensystem.

Return type
`list` of `petsc4py.PETSc.Mat`

See also
setOperators, PEPGetOperators

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1375 <slepc4py/SLEPc/PEP.pyx#L1375>`

getOptionsPrefix()

Get the prefix used for searching for all PEP options in the database.

Not collective.

Returns
The prefix string set for this PEP object.

Return type
`str`

See also

setOptionsPrefix, *appendOptionsPrefix*, PEPGetOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:431 <slepc4py/SLEPc/PEP.pyx#L431>`

getProblemType()

Get the problem type from the PEP object.

Not collective.

Returns
The problem type that was previously set.

Return type
ProblemType

See also

setProblemType, PEPGetProblemType

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:567 <slepc4py/SLEPc/PEP.pyx#L567>`

getQArnoldiLocking()

Get the locking flag used in the Q-Arnoldi method.

Not collective.

Returns
The locking flag.

Return type
bool

See also

setQArnoldiLocking, PEPQArnoldiGetLocking

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2101 <slepc4py/SLEPc/PEP.pyx#L2101>`

getQArnoldiRestart()

Get the restart parameter used in the Q-Arnoldi method.

Not collective.

Returns
The number of vectors to be kept at restart.

Return type
float

See also

setQArnoldiRestart, PEPQArnoldiGetRestart

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2057 <slepc4py/SLEPc/PEP.pyx#L2057>`

getRG()

Get the region object associated to the eigensolver.

Not collective.

Returns
The region context.

Return type
RG

See also

setRG, PEPGetRG

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1301 <slepc4py/SLEPc/PEP.pyx#L1301>`

getRefine()

Get the refinement strategy used by the PEP object.

Not collective.

Returns

- **ref** (*Refine*) – The refinement type.
- **npart** (int) – The number of partitions of the communicator.
- **tol** (float) – The convergence tolerance.
- **its** (int) – The maximum number of refinement iterations.
- **scheme** (*RefineScheme*) – Scheme for solving linear systems.

Return type
tuple[*Refine*, int, float, int, *RefineScheme*]

See also

setRefine, PEPGetRefine

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:873 <slepc4py/SLEPc/PEP.pyx#L873>`

getRefineKSP()

Get the KSP object used by the eigensolver in the refinement phase.

Collective.

Returns
The linear solver object.

Return type
petsc4py.PETSc.KSP

See also

setRefine, PEPRefineGetKSP

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:948 <slepc4py/SLEPc/PEP.pyx#L948>`

getST()

Get the spectral transformation object associated to the eigensolver.

Not collective.

Returns
The spectral transformation.

Return type
ST

See also

setST, PEPGetST

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1128 <slepc4py/SLEPc/PEP.pyx#L1128>`

getSTOARCheckEigenvalueType()

Get the flag for the eigenvalue type check in spectrum slicing.

Not collective.

Returns
Whether the eigenvalue type is checked or not.

Return type
bool

See also

setSTOARCheckEigenvalueType, PEPSTOARGetCheckEigenvalueType

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2493 <slepc4py/SLEPc/PEP.pyx#L2493>`

getSTOARDetectZeros()

Get the flag that enforces zero detection in spectrum slicing.

Not collective.

Returns
The zero detection flag.

Return type
bool

See also

setSTOARDetectZeros, PEPSTOARGetDetectZeros

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2333 <slepc4py/SLEPc/PEP.pyx#L2333>`

`getSTOARDimensions()`

Get the dimensions used for each subsolve step.

Not collective.

Returns

- **nev** (`int`) – Number of eigenvalues to compute.
- **ncv** (`int`) – Maximum dimension of the subspace to be used by the solver.
- **mpd** (`int`) – Maximum dimension allowed for the projected problem.

Return type
tuple[int, int, int]

See also

setSTOARDimensions, PEPSTOARGetDimensions

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2392 <slepc4py/SLEPc/PEP.pyx#L2392>`

`getSTOARInertias()`

Get the values of the shifts and their corresponding inertias.

Not collective.

Get the values of the shifts and their corresponding inertias in case of doing spectrum slicing for a computational interval.

Returns

- **shifts** (*ArrayReal*) – The values of the shifts used internally in the solver.
- **inertias** (*ArrayInt*) – The values of the inertia in each shift.

Return type
tuple[ArrayReal, ArrayInt]

Notes

This call makes sense only for spectrum slicing runs, that is, when an interval has been given with *setInterval()* and *SINVERT* is set.

If called after *solve()*, all shifts used internally by the solver are returned (including both endpoints and any intermediate ones). If called before *solve()* and after *setUp()* then only the information of the endpoints of subintervals is available.

See also

setInterval, PEPSTOARGetInertias

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2417 <slepc4py/SLEPc/PEP.pyx#L2417>`

`getSTOARLinearization()`

Get the coefficients that define the linearization of a quadratic eigenproblem.

Not collective.

Returns

- **alpha** (float) – First parameter of the linearization.
- **beta** (float) – Second parameter of the linearization.

Return type
tuple[float, float]

See also

setSTOARLinearization, PEPSTOARGetLinearization

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2234 <slepc4py/SLEPc/PEP.pyx#L2234>`

getSTOARLocking()

Get the locking flag used in the STOAR method.

Not collective.

Returns
The locking flag.

Return type
bool

See also

setSTOARLocking, PEPSTOARGetLocking

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2281 <slepc4py/SLEPc/PEP.pyx#L2281>`

getScale(*Dl=None*, *Dr=None*)

Get the strategy used for scaling the polynomial eigenproblem.

Not collective.

Parameters
- **Dl** (*petsc4py.PETSc.Vec* | *None*) – Placeholder for the returned left diagonal matrix.
- **Dr** (*petsc4py.PETSc.Vec* | *None*) – Placeholder for the returned right diagonal matrix.

Returns
- **scale** (*Scale*) – The scaling strategy.
- **alpha** (float) – The scaling factor.
- **its** (int) – The number of iterations of diagonal scaling.
- **lbda** (float) – Approximation of the wanted eigenvalues (modulus).

Return type
tuple[*Scale*, float, int, float]

See also

setScale, PEPGetScale

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1165 <slepc4py/SLEPc/PEP.pyx#L1165>`

getStoppingTest()

Get the stopping test function.

Not collective.

Returns
The stopping test function.

Return type
PEPStoppingFunction

See also

setStoppingTest

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1497 <slepc4py/SLEPc/PEP.pyx#L1497>`

getTOARLocking()

Get the locking flag used in the TOAR method.

Not collective.

Returns
The locking flag.

Return type
bool

See also

setTOARLocking, PEPTOARGetLocking

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2192 <slepc4py/SLEPc/PEP.pyx#L2192>`

getTOARRestart()

Get the restart parameter used in the TOAR method.

Not collective.

Returns
The number of vectors to be kept at restart.

Return type
float

See also

setTOARRestart, PEPTOARGetRestart

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2148 <slepc4py/SLEPc/PEP.pyx#L2148>`

getTarget()

Get the value of the target.

Not collective.

Returns
The value of the target.

Return type
Scalar

Notes

If the target was not set by the user, then zero is returned.

See also

setTarget, PEPGetTarget

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:672 <slepc4py/SLEPc/PEP.pyx#L672>`

getTolerances()

Get the tolerance and maximum iteration count.

Not collective.

Get the tolerance and maximum iteration count used by the default PEP convergence tests.

Returns

- **tol** (float) – The convergence tolerance.
- **max_it** (int) – The maximum number of iterations.

Return type
tuple[float, int]

See also

setTolerances, PEPGetTolerances

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:722 <slepc4py/SLEPc/PEP.pyx#L722>`

getTrackAll()

Get the flag indicating whether all residual norms must be computed.

Not collective.

Returns
Whether the solver computes all residuals or not.

Return type
bool

See also

setTrackAll, PEPGetTrackAll

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1012 <slepc4py/SLEPc/PEP.pyx#L1012>`

getType()

Get the PEP type of this object.

Not collective.

Returns
The solver currently being used.

Return type
str

See also

setType, PEPGetType

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:412 <slepc4py/SLEPc/PEP.pyx#L412>`

getWhichEigenpairs()

Get which portion of the spectrum is to be sought.

Not collective.

Returns
The portion of the spectrum to be sought by the solver.

Return type
Which

See also

setWhichEigenpairs, PEPGetWhichEigenpairs

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:616 <slepc4py/SLEPc/PEP.pyx#L616>`

reset()

Reset the PEP object.

Collective.

See also

PEPReset

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:352 <slepc4py/SLEPc/PEP.pyx#L352>`

Return type
None

setBV(*bv*)

Set a basis vectors object associated to the eigensolver.

Collective.

Parameters
bv (BV) – The basis vectors context.

Return type
None

See also

getBV, PEPSetBV

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1284 <slepc4py/SLEPc/PEP.pyx#L1284>`

setBasis(*basis*)

Set the type of polynomial basis used.

Logically collective.

Set the type of polynomial basis used to describe the polynomial eigenvalue problem.

Parameters

basis (Basis) – The basis to be set.

Return type

None

Notes

By default, the coefficient matrices passed via *setOperators()* are expressed in the monomial basis, i.e. $P(\lambda) = A_0 + \lambda A_1 + \lambda^2 A_2 + \cdots + \lambda^d A_d$. Other polynomial bases may have better numerical behavior, but the user must then pass the coefficient matrices accordingly.

See also

getBasis, *setOperators*, PEPSetBasis

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:538 <slepc4py/SLEPc/PEP.pyx#L538>`

setCISSExtraction(*extraction*)

Set the extraction technique used in the CISS solver.

Logically collective.

Parameters

extraction (CISSExtraction) – The extraction technique.

Return type

None

See also

getCISSExtraction, PEPCISSSetExtraction

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2728 <slepc4py/SLEPc/PEP.pyx#L2728>`

setCISSRefinement(*inner=None*, *blsize=None*)

Set the values of various refinement parameters in the CISS solver.

Logically collective.

Parameters

- **inner** (*int* | *None*) – Number of iterative refinement iterations (inner loop).
- **blsize** (*int* | *None*) – Number of iterative refinement iterations (blocksize loop).

Return type
None

See also

getCISSRefinement, PEPCISSSetRefinement

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2898 <slepc4py/SLEPc/PEP.pyx#L2898>`

setCISSSizes(*ip=None*, *bs=None*, *ms=None*, *npart=None*, *bsmax=None*, *realmats=False*)

Set the values of various size parameters in the CISS solver.

Logically collective.

Parameters

- **ip** (*int* | *None*) – Number of integration points.
- **bs** (*int* | *None*) – Block size.
- **ms** (*int* | *None*) – Moment size.
- **npart** (*int* | *None*) – Number of partitions when splitting the communicator.
- **bsmax** (*int* | *None*) – Maximum block size.
- **realmats** (*bool*) – True if A and B are real.

Return type
None

Notes

The default number of partitions is 1. This means the internal petsc4py.PETSc.KSP object is shared among all processes of the *PEP* communicator. Otherwise, the communicator is split into npart communicators, so that npart petsc4py.PETSc.KSP solves proceed simultaneously.

See also

getCISSSizes, *setCISSThreshold*, *setCISSRefinement*, PEPCISSSetSizes

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2765 <slepc4py/SLEPc/PEP.pyx#L2765>`

setCISSThreshold(*delta=None*, *spur=None*)

Set the values of various threshold parameters in the CISS solver.

Logically collective.

Parameters

- **delta** (*float* | *None*) – Threshold for numerical rank.
- **spur** (*float* | *None*) – Spurious threshold (to discard spurious eigenpairs).

Return type
None

See also

getCISSThreshold, PEPCISSSetThreshold

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2853 <slepc4py/SLEPc/PEP.pyx#L2853>`

setConvergenceTest(*conv*)

Set how to compute the error estimate used in the convergence test.

Logically collective.

Parameters

conv (Conv) – The method used to compute the error estimate used in the convergence test.

Return type

None

See also

getConvergenceTest, PEPSetConvergenceTest

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:854 <slepc4py/SLEPc/PEP.pyx#L854>`

setDS(*ds*)

Set a direct solver object associated to the eigensolver.

Collective.

Parameters

ds (DS) – The direct solver context.

Return type

None

See also

getDS, PEPSetDS

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1358 <slepc4py/SLEPc/PEP.pyx#L1358>`

setDimensions(*nev=None*, *ncv=None*, *mpd=None*)

Set the number of eigenvalues to compute and the dimension of the subspace.

Logically collective.

Parameters

- **nev** (*int* | *None*) – Number of eigenvalues to compute.
- **ncv** (*int* | *None*) – Maximum dimension of the subspace to be used by the solver.
- **mpd** (*int* | *None*) – Maximum dimension allowed for the projected problem.

Return type

None

Notes

Use *DETERMINE* for `ncv` and `mpd` to assign a reasonably good value, which is dependent on the solution method.

The parameters `ncv` and `mpd` are intimately related, so that the user is advised to set one of them at most. Normal usage is the following:

- In cases where `nev` is small, the user sets `ncv` (a reasonable default is 2 * `nev`).
- In cases where `nev` is large, the user sets `mpd`.

The value of `ncv` should always be between `nev` and (`nev` + `mpd`), typically `ncv` = `nev` + `mpd`. If `nev` is not too large, `mpd` = `nev` is a reasonable choice, otherwise a smaller value should be used.

See also

getDimensions, PEPSetDimensions

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1077 <slepc4py/SLEPc/PEP.pyx#L1077>`

setEigenvalueComparison(*comparison*, *args=None*, *kargs=None*)

Set an eigenvalue comparison function.

Logically collective.

Notes

This eigenvalue comparison function is used when *setWhichEigenpairs()* is set to *PEP.Which.USER*.

See also

getEigenvalueComparison, PEPSetEigenvalueComparison

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1514 <slepc4py/SLEPc/PEP.pyx#L1514>`

Parameters

- **comparison** (PEPEigenvalueComparison | *None*)
- **args** (*tuple[Any, ...]* | *None*)
- **kargs** (*dict[str, Any]* | *None*)

Return type

None

setExtract(*extract*)

Set the extraction strategy to be used.

Logically collective.

Parameters

extract (Extract) – The extraction strategy.

Return type

None

Notes

This is relevant for solvers based on linearization. Once the solver has converged, the polynomial eigenvectors can be extracted from the eigenvectors of the linearized problem in different ways.

See also

getExtract, PEPSetExtract

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:968 <slepc4py/SLEPc/PEP.pyx#L968>`

setFromOptions()

Set PEP options from the options database.

Collective.

Notes

To see all options, run your program with the `-help` option.

This routine must be called before *setUp()* if the user is to be allowed to set the solver type.

See also

setOptionsPrefix, PEPSetFromOptions

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:500 <slepc4py/SLEPc/PEP.pyx#L500>`

Return type
None

setInitialSpace(*space*)

Set the initial space from which the eigensolver starts to iterate.

Collective.

Parameters
space (*Vec | list[Vec]*) – The initial space.

Return type
None

Notes

Some solvers start to iterate on a single vector (initial vector). In that case, only the first vector is taken into account and the other vectors are ignored.

These vectors do not persist from one *solve()* call to the other, so the initial space should be set every time.

The vectors do not need to be mutually orthonormal, since they are explicitly orthonormalized internally.

Common usage of this function is when the user can provide a rough approximation of the wanted eigenspace. Then, convergence may be faster.

See also

setUp, PEPSetInitialSpace

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1434 <slepc4py/SLEPc/PEP.pyx#L1434>`

setInterval(*inta*, *intb*)

Set the computational interval for spectrum slicing.

Logically collective.

Parameters

- **inta** (*float*) – The left end of the interval.
- **intb** (*float*) – The right end of the interval.

Return type

None

Notes

Spectrum slicing is a technique employed for computing all eigenvalues of symmetric quadratic eigenproblems in a given interval. This function provides the interval to be considered. It must be used in combination with *PEP.Which.ALL*, see *setWhichEigenpairs()*. Note that in polynomial eigenproblems spectrum slicing is implemented in *STOAR* only.

See also

getInterval, PEPSetInterval

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:804 <slepc4py/SLEPc/PEP.pyx#L804>`

setJDFix(*fix*)

Set the threshold for changing the target in the correction equation.

Logically collective.

Parameters

fix (*float*) – Threshold for changing the target.

Return type

None

Notes

The target in the correction equation is fixed at the first iterations. When the norm of the residual vector is lower than the fix value, the target is set to the corresponding eigenvalue.

See also

getJDFix, PEPJDSetFix

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2559 <slepc4py/SLEPc/PEP.pyx#L2559>`

setJDMinimalityIndex(*flag*)

Set the maximum allowed value for the minimality index.

Logically collective.

Parameters
flag (*int*) – The maximum minimality index.

Return type
None

Notes

The default value is equal to the degree of the polynomial. A smaller value can be used if the wanted eigenvectors are known to be linearly independent.

See also

getJDMinimalityIndex, PEPJDSetMinimalityIndex

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2646 <slepc4py/SLEPc/PEP.pyx#L2646>`

setJDProjection(*proj*)

Set the type of projection to be used in the Jacobi-Davidson solver.

Logically collective.

Parameters
proj (JDProjection) – The type of projection.

Return type
None

See also

getJDProjection, PEPJDSetProjection

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2689 <slepc4py/SLEPc/PEP.pyx#L2689>`

setJDRestart(*keep*)

Set the restart parameter for the Jacobi-Davidson method.

Logically collective.

Set the restart parameter for the Jacobi-Davidson method, in particular the proportion of basis vectors that must be kept after restart.

Parameters
keep (*float*) – The number of vectors to be kept at restart.

Return type
None

Notes

Allowed values are in the range [0.1,0.9]. The default is 0.5.

See also

getJDRestart, PEPJDSetRestart

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2514 <slepc4py/SLEPc/PEP.pyx#L2514>`

setJDReusePreconditioner(*flag=True*)

Set a flag indicating whether the preconditioner must be reused or not.

Logically collective.

Parameters
flag (*bool*) – The reuse flag.

Return type
None

Notes

The default value is `False`. If set to `True`, the preconditioner is built only at the beginning, using the target value. Otherwise, it may be rebuilt (depending on the `fix` parameter) at each iteration from the Ritz value.

See also

setJDFix, *getJDReusePreconditioner*, PEPJDSetReusePreconditioner

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2602 <slepc4py/SLEPc/PEP.pyx#L2602>`

setLinearEPS(*eps*)

Set an eigensolver object associated to the polynomial eigenvalue solver.

Collective.

Parameters
eps (EPS) – The linear eigensolver.

Return type
None

See also

getLinearEPS, PEPLinearSetEPS

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1912 <slepc4py/SLEPc/PEP.pyx#L1912>`

setLinearExplicitMatrix(*flag=True*)

Set flag to explicitly build the matrices for the linearization.

Logically collective.

Parameters
flag (*bool*) – Boolean flag indicating if the matrices are built explicitly.

Return type
None

See also

getLinearExplicitMatrix, PEPLinearSetExplicitMatrix

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1992 <slepc4py/SLEPc/PEP.pyx#L1992>`

setLinearLinearization(*alpha=1.0*, *beta=0.0*)

Set the coefficients that define the linearization of a quadratic eigenproblem.

Logically collective.

Parameters

- **alpha** (*float*) – First parameter of the linearization.
- **beta** (*float*) – Second parameter of the linearization.

Return type
None

See also

getLinearLinearization, PEPLinearSetLinearization

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1949 <slepc4py/SLEPc/PEP.pyx#L1949>`

setMonitor(*monitor*, *args=None*, *kargs=None*)

Append a monitor function to the list of monitors.

Logically collective.

See also

getMonitor, *cancelMonitor*, PEPMonitorSet

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1561 <slepc4py/SLEPc/PEP.pyx#L1561>`

Parameters

- **monitor** (PEPMonitorFunction | *None*)
- **args** (*tuple[Any, ...]* | *None*)
- **kargs** (*dict[str, Any]* | *None*)

Return type
None

setOperators(*operators*)

Set the matrices associated with the eigenvalue problem.

Collective.

Parameters
operators (*list[Mat]*) – The matrices associated with the eigensystem.

Return type
None

Notes

The polynomial eigenproblem is defined as $P(\lambda)x = 0$, where λ is the eigenvalue, x is the eigenvector, and P is defined as $P(\lambda) = A_0 + \lambda A_1 + \cdots + \lambda^d A_d$, with d = `nmat`-1 (the degree of P). For non-monomial bases, this expression is different.

See also

getOperators, PEPSetOperators

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1401 <slepc4py/SLEPc/PEP.pyx#L1401>`

setOptionsPrefix(*prefix=None*)

Set the prefix used for searching for all PEP options in the database.

Logically collective.

Parameters
prefix (*str | None*) – The prefix string to prepend to all PEP option requests.

Return type
None

Notes

A hyphen (-) must NOT be given at the beginning of the prefix name. The first character of all runtime options is AUTOMATICALLY the hyphen.

For example, to distinguish between the runtime options for two different PEP contexts, one could call:

```
P1.setOptionsPrefix("pep1_")
P2.setOptionsPrefix("pep2_")
```

See also

appendOptionsPrefix, *getOptionsPrefix*, PEPGetOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:450 <slepc4py/SLEPc/PEP.pyx#L450>`

setProblemType(*problem_type*)

Set the type of the polynomial eigenvalue problem.

Logically collective.

Parameters
problem_type (ProblemType) – The problem type to be set.

Return type
None

Notes

This function is used to instruct SLEPc to exploit certain structure in the polynomial eigenproblem. By default, no particular structure is assumed.

If the problem matrices are Hermitian (symmetric in the real case) or Hermitian/skew-Hermitian then the solver can exploit this fact to perform less operations or provide better stability. Hyperbolic problems are a particular case of Hermitian problems, some solvers may treat them simply as Hermitian.

See also

setOperators, *setType*, *getProblemType*, PEPSetProblemType

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:586 <slepc4py/SLEPc/PEP.pyx#L586>`

setQArnoldiLocking(*lock=True*)

Toggle between locking and non-locking variants of the Q-Arnoldi method.

Logically collective.

Parameters
lock (*bool*) – `True` if the locking variant must be selected.

Return type
None

Notes

The default is to lock converged eigenpairs when the method restarts. This behavior can be changed so that all directions are kept in the working subspace even if already converged to working accuracy (the non-locking variant).

See also

getQArnoldiLocking, PEPQArnoldiSetLocking

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2076 <slepc4py/SLEPc/PEP.pyx#L2076>`

setQArnoldiRestart(*keep*)

Set the restart parameter for the Q-Arnoldi method.

Logically collective.

Set the restart parameter for the Q-Arnoldi method, in particular the proportion of basis vectors that must be kept after restart.

Parameters
keep (*float*) – The number of vectors to be kept at restart.

Return type
None

Notes

Allowed values are in the range [0.1,0.9]. The default is 0.5.

See also

getQArnoldiRestart, PEPQArnoldiSetRestart

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2031 <slepc4py/SLEPc/PEP.pyx#L2031>`

setRG(*rg*)

Set a region object associated to the eigensolver.

Collective.

Parameters

rg (RG) – The region context.

Return type

None

See also

getRG, PEPSetRG

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1321 <slepc4py/SLEPc/PEP.pyx#L1321>`

setRefine(*ref*, *npart=None*, *tol=None*, *its=None*, *scheme=None*)

Set the refinement strategy used by the PEP object.

Logically collective.

Set the refinement strategy used by the PEP object, and the associated parameters.

Parameters

- **ref** (Refine) – The refinement type.
- **npart** (*int* | *None*) – The number of partitions of the communicator.
- **tol** (*float* | *None*) – The convergence tolerance.
- **its** (*int* | *None*) – The maximum number of refinement iterations.
- **scheme** (RefineScheme | *None*) – Scheme for solving linear systems.

Return type

None

See also

getRefine, PEPSetRefine

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:904 <slepc4py/SLEPc/PEP.pyx#L904>`

setST(*st*)

Set a spectral transformation object associated to the eigensolver.

Collective.

Parameters

st (ST) – The spectral transformation.

Return type
None

See also

getST, PEPSetST

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1148 <slepc4py/SLEPc/PEP.pyx#L1148>`

setSTOARCheckEigenvalueType(*flag=True*)

Set flag to check if all eigenvalues have the same definite type.

Logically collective.

Set a flag to check that all the eigenvalues obtained throughout the spectrum slicing computation have the same definite type.

Parameters
flag (*bool*) – Whether the eigenvalue type is checked or not.

Return type
None

Notes

This option is relevant only for spectrum slicing computations, but is ignored in *slepc4py.SLEPc.PEP.ProblemType.HYPERBOLIC* problems.

This flag is turned on by default, to guarantee that the computed eigenvalues have the same type (otherwise the computed solution might be wrong). But since the check is computationally quite expensive, the check may be turned off if the user knows for sure that all eigenvalues in the requested interval have the same type.

See also

getSTOARCheckEigenvalueType, PEPSTOARSetCheckEigenvalueType

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2461 <slepc4py/SLEPc/PEP.pyx#L2461>`

setSTOARDetectZeros(*detect=True*)

Set flag to enforce detection of zeros during the factorizations.

Logically collective.

Set a flag to enforce detection of zeros during the factorizations throughout the spectrum slicing computation.

Parameters
detect (*bool*) – `True` if zeros must checked for.

Return type
None

Notes

This call makes sense only for spectrum slicing runs, that is, when an interval has been given with *setInterval()* and *SINVERT* is set.

A zero in the factorization indicates that a shift coincides with an eigenvalue.

This flag is turned off by default, and may be necessary in some cases. This feature currently requires an external package for factorizations with support for zero detection, e.g. MUMPS.

See also

setInterval, *getSTOARDetectZeros*, PEPSTOARSetDetectZeros

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2300 <slepc4py/SLEPc/PEP.pyx#L2300>`

setSTOARDimensions(*nev=None*, *ncv=None*, *mpd=None*)

Set the dimensions used for each subsolve step.

Logically collective.

Parameters

- **nev** (*int* | *None*) – Number of eigenvalues to compute.
- **ncv** (*int* | *None*) – Maximum dimension of the subspace to be used by the solver.
- **mpd** (*int* | *None*) – Maximum dimension allowed for the projected problem.

Return type

None

Notes

This call makes sense only for spectrum slicing runs, that is, when an interval has been given with *setInterval()* and *SINVERT* is set.

The meaning of the parameters is the same as in *setDimensions()*, but the ones here apply to every subsolve done by the child *PEP* object.

See also

setInterval, *setDimensions*, *getSTOARDimensions*, PEPSTOARSetDimensions

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2352 <slepc4py/SLEPc/PEP.pyx#L2352>`

setSTOARLinearization(*alpha=1.0*, *beta=0.0*)

Set the coefficients that define the linearization of a quadratic eigenproblem.

Logically collective.

Parameters

- **alpha** (*float*) – First parameter of the linearization.
- **beta** (*float*) – Second parameter of the linearization.

Return type

None

See also

getSTOARLinearization, PEPSTOARSetLinearization

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2213 <slepc4py/SLEPc/PEP.pyx#L2213>`

setSTOARLocking(*lock=True*)

Toggle between locking and non-locking variants of the STOAR method.

Logically collective.

Parameters

lock (*bool*) – `True` if the locking variant must be selected.

Return type

None

Notes

The default is to lock converged eigenpairs when the method restarts. This behavior can be changed so that all directions are kept in the working subspace even if already converged to working accuracy (the non-locking variant).

See also

getSTOARLocking, PEPSTOARSetLocking

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2256 <slepc4py/SLEPc/PEP.pyx#L2256>`

setScale(*scale*, *alpha=None*, *Dl=None*, *Dr=None*, *its=None*, *lbda=None*)

Set the scaling strategy to be used.

Collective.

Parameters

- **scale** (Scale) – The scaling strategy.
- **alpha** (*float* | *None*) – The scaling factor.
- **Dl** (*petsc4py.PETSc.Vec* | *None*) – The left diagonal matrix.
- **Dr** (*petsc4py.PETSc.Vec* | *None*) – The right diagonal matrix.
- **its** (*int* | *None*) – The number of iterations of diagonal scaling.
- **lbda** (*float* | *None*) – Approximation of the wanted eigenvalues (modulus).

Return type

None

See also

getScale, PEPSetScale

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1218 <slepc4py/SLEPc/PEP.pyx#L1218>`

setStoppingTest(*stopping*, *args=None*, *kargs=None*)

Set a function to decide when to stop the outer iteration of the eigensolver.

Logically collective.

See also

getStoppingTest, PEPSetStoppingTestFunction

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1473 <slepc4py/SLEPc/PEP.pyx#L1473>`

Parameters

- **stopping** (PEPStoppingFunction | *None*)
- **args** (*tuple[Any, ...]* | *None*)
- **kargs** (*dict[str, Any]* | *None*)

Return type

None

setTOARLocking(*lock=True*)

Toggle between locking and non-locking variants of the TOAR method.

Logically collective.

Parameters

lock (*bool*) – `True` if the locking variant must be selected.

Return type

None

Notes

The default is to lock converged eigenpairs when the method restarts. This behavior can be changed so that all directions are kept in the working subspace even if already converged to working accuracy (the non-locking variant).

See also

getTOARLocking, PEPTOARSetLocking

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2167 <slepc4py/SLEPc/PEP.pyx#L2167>`

setTOARRestart(*keep*)

Set the restart parameter for the TOAR method.

Logically collective.

Set the restart parameter for the TOAR method, in particular the proportion of basis vectors that must be kept after restart.

Parameters

keep (*float*) – The number of vectors to be kept at restart.

Return type

None

Notes

Allowed values are in the range [0.1,0.9]. The default is 0.5.

See also

getTOARRestart, PEPTOARSetRestart

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2122 <slepc4py/SLEPc/PEP.pyx#L2122>`

setTarget(*target*)

Set the value of the target.

Logically collective.

Parameters

target (Scalar) – The value of the target.

Return type

None

Notes

The target is a scalar value used to determine the portion of the spectrum of interest. It is used in combination with *setWhichEigenpairs()*.

When PETSc is built with real scalars, it is not possible to specify a complex target.

See also

getTarget, *setWhichEigenpairs*, PEPSetTarget

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:695 <slepc4py/SLEPc/PEP.pyx#L695>`

setTolerances(*tol=None*, *max_it=None*)

Set the tolerance and maximum iteration count.

Logically collective.

Set the tolerance and maximum iteration count used by the default PEP convergence tests.

Parameters

- **tol** (*float* | *None*) – The convergence tolerance.
- **max_it** (*int* | *None*) – The maximum number of iterations

Return type

None

Notes

Use *DETERMINE* for `max_it` to assign a reasonably good value, which is dependent on the solution method.

See also

getTolerances, PEPSetTolerances

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:747 <slepc4py/SLEPc/PEP.pyx#L747>`

setTrackAll(*trackall=True*)

Set flag to compute the residual of all approximate eigenpairs.

Logically collective.

Set if the solver must compute the residual of all approximate eigenpairs or not.

Parameters
trackall (*bool*) – Whether to compute all residuals or not.

Return type
None

See also

getTrackAll, PEPSetTrackAll

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1031 <slepc4py/SLEPc/PEP.pyx#L1031>`

setType(*pep_type*)

Set the particular solver to be used in the PEP object.

Logically collective.

Parameters
pep_type (Type | *str*) – The solver to be used.

Return type
None

Notes

The default is *TOAR*. Normally, it is best to use *setFromOptions()* and then set the PEP type from the options database rather than by using this routine. Using the options database provides the user with maximum flexibility in evaluating the different available methods.

See also

getType, PEPSetType

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:385 <slepc4py/SLEPc/PEP.pyx#L385>`

setUp()

Set up all the internal data structures.

Collective.

Notes

Sets up all the internal data structures necessary for the execution of the eigensolver. This includes the setup of the internal *ST* object.

This function need not be called explicitly in most cases, since *solve()* calls it. It can be useful when one wants to measure the set-up time separately from the solve time.

See also

solve, PEPSetUp

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1618 <slepc4py/SLEPc/PEP.pyx#L1618>`

Return type
None

setWhichEigenpairs(*which*)

Set which portion of the spectrum is to be sought.

Logically collective.

Parameters
which (Which) – The portion of the spectrum to be sought by the solver.

Return type
None

Notes

Not all eigensolvers implemented in PEP account for all the possible values. Also, some values make sense only for certain types of problems. If SLEPc is compiled for real numbers *PEP.Which.LARGEST_IMAGINARY* and *PEP.Which.SMALLEST_IMAGINARY* use the absolute value of the imaginary part for eigenvalue selection.

The target is a scalar value provided with *setTarget()*.

The criterion *PEP.Which.TARGET_IMAGINARY* is available only in case PETSc and SLEPc have been built with complex scalars.

PEP.Which.ALL is intended for use in combination with an interval (see *setInterval()*), when all eigenvalues within the interval are requested, or in the context of the *PEP.Type.CISS* solver for computing all eigenvalues in a region.

See also

getWhichEigenpairs, *setTarget*, *setInterval*, PEPSetWhichEigenpairs

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:635 <slepc4py/SLEPc/PEP.pyx#L635>`

solve()

Solve the polynomial eigenproblem.

Collective.

Notes

The problem matrices are specified with *setOperators()*.

solve() will return without generating an error regardless of whether all requested solutions were computed or not. Call *getConverged()* to get the actual number of computed solutions, and *getConvergedReason()* to determine if the solver converged or failed and why.

See also

setUp, *setOperators*, *getConverged*, *getConvergedReason*, PEPSolve

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1640 <slepc4py/SLEPc/PEP.pyx#L1640>`

Return type
None

valuesView(*viewer=None*)

Display the computed eigenvalues in a viewer.

Collective.

Parameters
viewer (*Viewer | None*) – Visualization context; if not provided, the standard output is used.

Return type
None

See also

solve, *vectorsView*, *errorView*, PEPValuesView

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1872 <slepc4py/SLEPc/PEP.pyx#L1872>`

vectorsView(*viewer=None*)

Output computed eigenvectors to a viewer.

Collective.

Parameters
viewer (*Viewer | None*) – Visualization context; if not provided, the standard output is used.

Return type
None

See also

solve, *valuesView*, *errorView*, PEPVectorsView

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:1891 <slepc4py/SLEPc/PEP.pyx#L1891>`

view(*viewer=None*)

Print the PEP data structure.

Collective.

Parameters

viewer (*Viewer | None*) – Visualization context; if not provided, the standard output is used.

Return type

None

See also

`PEPView`

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:319 <slepc4py/SLEPc/PEP.pyx#L319>`

Attributes Documentation

bv

The basis vectors (*BV*) object associated.

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:3036 <slepc4py/SLEPc/PEP.pyx#L3036>`

ds

The direct solver (*DS*) object associated.

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:3052 <slepc4py/SLEPc/PEP.pyx#L3052>`

extract

The type of extraction technique to be employed.

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2996 <slepc4py/SLEPc/PEP.pyx#L2996>`

max_it

The maximum iteration count.

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:3012 <slepc4py/SLEPc/PEP.pyx#L3012>`

problem_type

The type of the eigenvalue problem.

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2972 <slepc4py/SLEPc/PEP.pyx#L2972>`

rg

The region (*RG*) object associated.

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:3044 <slepc4py/SLEPc/PEP.pyx#L3044>`

st

The spectral transformation (*ST*) object associated.

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:3028 <slepc4py/SLEPc/PEP.pyx#L3028>`

target

The value of the target.

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2988 <slepc4py/SLEPc/PEP.pyx#L2988>`

tol

The tolerance.

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:3004 <slepc4py/SLEPc/PEP.pyx#L3004>`

track_all

Compute the residual norm of all approximate eigenpairs.

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:3020 <slepc4py/SLEPc/PEP.pyx#L3020>`

which

The portion of the spectrum to be sought.

:sources:`Source code at slepc4py/SLEPc/PEP.pyx:2980 <slepc4py/SLEPc/PEP.pyx#L2980>`

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.RG

class slepc4py.SLEPc.**RG**

Bases: Object

Region.

The *RG* package provides a way to define a region of the complex plane. This is used in various eigensolvers to specify where the wanted eigenvalues are located.

Enumerations

QuadRule	RG quadrature rule for contour integral methods.
Type	RG type.

slepc4py.SLEPc.RG.QuadRule

class slepc4py.SLEPc.RG.**QuadRule**

Bases: object

RG quadrature rule for contour integral methods.

- *TRAPEZOIDAL*: Trapezoidal rule.
- *CHEBYSHEV*: Chebyshev points.

See also

RGQuadRule

Attributes Summary

CHEBYSHEV	Constant CHEBYSHEV of type int
TRAPEZOIDAL	Constant TRAPEZOIDAL of type int

Attributes Documentation

CHEBYSHEV: int = CHEBYSHEV

Constant CHEBYSHEV of type int

TRAPEZOIDAL: int = TRAPEZOIDAL

Constant TRAPEZOIDAL of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.RG.Type

class slepc4py.SLEPc.RG.**Type**

Bases: object

RG type.

- *INTERVAL*: A (generalized) interval.
- *POLYGON*: A polygonal region defined by its vertices.
- *ELLIPSE*: An ellipse defined by its center, radius and vertical scale.
- *RING*: A ring region.

See also

RGType

Attributes Summary

ELLIPSE	Object ELLIPSE of type str
INTERVAL	Object INTERVAL of type str
POLYGON	Object POLYGON of type str
RING	Object RING of type str

Attributes Documentation

ELLIPSE: str = ELLIPSE

Object ELLIPSE of type str

INTERVAL: str = INTERVAL

Object INTERVAL of type str

POLYGON: str = POLYGON

Object POLYGON of type str

RING: str = RING

Object RING of type str

__init__()

classmethod __new__(**args*, ***kwargs*)

Methods Summary

appendOptionsPrefix([prefix])	Append to the prefix used for searching for all RG options in the database.
canUseConjugates([realmats])	Half of integration points can be avoided (use their conjugates).
checkInside(a)	Determine if a set of given points are inside the region or not.
computeBoundingBox()	Compute box containing the region.
computeContour(n)	Compute points on the contour of the region.
computeQuadrature(quad, n)	Compute the values of the parameters used in a quadrature rule.
create([comm])	Create the RG object.
destroy()	Destroy the RG object.
getComplement()	Get the flag indicating whether the region is complemented or not.
getEllipseParameters()	Get the parameters that define the ellipse region.
getIntervalEndpoints()	Get the parameters that define the interval region.
getOptionsPrefix()	Get the prefix used for searching for all RG options in the database.
getPolygonVertices()	Get the parameters that define the interval region.
getRingParameters()	Get the parameters that define the ring region.
getScale()	Get the scaling factor.
getType()	Get the RG type of this object.
isAxisymmetric([vertical])	Determine if the region is axisymmetric.
isTrivial()	Tell whether it is the trivial region (whole complex plane).
setComplement([comp])	Set a flag to indicate that the region is the complement of the specified one.
setEllipseParameters(center, radius[, vscale])	Set the parameters defining the ellipse region.
setFromOptions()	Set RG options from the options database.
setIntervalEndpoints(a, b, c, d)	Set the parameters defining the interval region.
setOptionsPrefix([prefix])	Set the prefix used for searching for all RG options in the database.
setPolygonVertices(v)	Set the vertices that define the polygon region.
setRingParameters(center, radius, vscale, ...)	Set the parameters defining the ring region.
setScale([sfactor])	Set the scaling factor to be used.
setType(rg_type)	Set the type for the RG object.
view([viewer])	Print the RG data structure.

Attributes Summary

complement	If the region is the complement of the specified one.
scale	The scaling factor to be used.

Methods Documentation

appendOptionsPrefix(*prefix=None*)

Append to the prefix used for searching for all RG options in the database.

Logically collective.

Parameters

prefix (*str | None*) – The prefix string to prepend to all RG option requests.

Return type
None

See also

setOptionsPrefix, *getOptionsPrefix*, RGAppendOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/RG.pyx:192 <slepc4py/SLEPc/RG.pyx#L192>`

canUseConjugates(*realmats=True*)

Half of integration points can be avoided (use their conjugates).

Not collective.

Used in contour integral methods to determine whether half of integration points can be avoided (use their conjugates).

Parameters
realmats (*bool*) – `True` if the problem matrices are real.

Returns
Whether it is possible to use conjugates.

Return type
bool

Notes

If some integration points are the conjugates of other points, then the associated computational cost can be saved. This depends on the problem matrices being real and also the region being symmetric with respect to the horizontal axis. The result is `false` if using real arithmetic or in the case of a flat region (height equal to zero).

See also

isAxisymmetric, RGCanUseConjugates

:sources:`Source code at slepc4py/SLEPc/RG.pyx:460 <slepc4py/SLEPc/RG.pyx#L460>`

checkInside(*a*)

Determine if a set of given points are inside the region or not.

Not collective.

Parameters
a (*Sequence[complex]*) – The coordinates of the points.

Returns
Computed result for each point (1=inside, 0=on the contour, -1=outside).

Return type
ArrayInt

Notes

If a scaling factor was set, the points are scaled before checking.

See also

setScale, *setComplement*, RGCheckInside

:sources:`Source code at slepc4py/SLEPc/RG.pyx:357 <slepc4py/SLEPc/RG.pyx#L357>`

computeBoundingBox()

Compute box containing the region.

Not collective.

Determine the endpoints of a rectangle in the complex plane that contains the region.

Returns

- **a** (float) – The left endpoint of the bounding box in the real axis.
- **b** (float) – The right endpoint of the bounding box in the real axis.
- **c** (float) – The bottom endpoint of the bounding box in the imaginary axis.
- **d** (float) – The top endpoint of the bounding box in the imaginary axis.

Return type
tuple[float, float, float, float]

See also

computeContour, *setScale*, RGComputeBoundingBox

:sources:`Source code at slepc4py/SLEPc/RG.pyx:432 <slepc4py/SLEPc/RG.pyx#L432>`

computeContour(*n*)

Compute points on the contour of the region.

Not collective.

Compute the coordinates of several points lying on the contour of the region.

Parameters
n (*int*) – The number of points to compute.

Returns
Computed points.

Return type
list of complex

See also

computeBoundingBox, *setScale*, RGComputeContour

:sources:`Source code at slepc4py/SLEPc/RG.pyx:397 <slepc4py/SLEPc/RG.pyx#L397>`

computeQuadrature(*quad*, *n*)

Compute the values of the parameters used in a quadrature rule.

Not collective.

Compute the values of the parameters used in a quadrature rule for a contour integral around the boundary of the region.

Parameters

- **quad** (QuadRule) – The type of quadrature.
- **n** (*int*) – The number of quadrature points to compute.

Returns

- **z** (*ArrayScalar*) – Quadrature points.
- **zn** (*ArrayScalar*) – Normalized quadrature points.
- **w** (*ArrayScalar*) – Quadrature weights.

Return type

tuple[*ArrayScalar*, *ArrayScalar*, *ArrayScalar*]

Notes

In complex scalars, the values returned in `z` are often the same as those computed by *computeContour()*, but this is not the case in real scalars where all output arguments are real.

The computed values change for different quadrature rules.

See also

computeContour, RGComputeQuadrature

:sources:`Source code at slepc4py/SLEPc/RG.pyx:496 <slepc4py/SLEPc/RG.pyx#L496>`

create(*comm=None*)

Create the RG object.

Collective.

Parameters

comm (*Comm* | *None*) – MPI communicator; if not provided, it defaults to all processes.

Return type

Self

See also

RGCreate

:sources:`Source code at slepc4py/SLEPc/RG.pyx:89 <slepc4py/SLEPc/RG.pyx#L89>`

destroy()

Destroy the RG object.

Collective.

See also

RGDestroy

:sources:`Source code at slepc4py/SLEPc/RG.pyx:75 <slepc4py/SLEPc/RG.pyx#L75>`

Return type
Self

`getComplement()`

Get the flag indicating whether the region is complemented or not.

Not collective.

Returns
Whether the region is complemented or not.

Return type
bool

See also

setComplement, RGGetComplement

:sources:`Source code at slepc4py/SLEPc/RG.pyx:279 <slepc4py/SLEPc/RG.pyx#L279>`

`getEllipseParameters()`

Get the parameters that define the ellipse region.

Not collective.

Returns

- **center** (*Scalar*) – The center.
- **radius** (float) – The radius.
- **vscale** (float) – The vertical scale.

Return type
tuple[Scalar, float, float]

See also

setEllipseParameters, RGEllipseGetParameters

:sources:`Source code at slepc4py/SLEPc/RG.pyx:574 <slepc4py/SLEPc/RG.pyx#L574>`

`getIntervalEndpoints()`

Get the parameters that define the interval region.

Not collective.

Returns

- **a** (float) – The left endpoint in the real axis.
- **b** (float) – The right endpoint in the real axis.

- **c** (float) – The bottom endpoint in the imaginary axis.
- **d** (float) – The top endpoint in the imaginary axis.

Return type
tuple[float, float, float, float]

See also

setIntervalEndpoints, RGIntervalGetEndpoints

:sources:`Source code at slepc4py/SLEPc/RG.pyx:636 <slepc4py/SLEPc/RG.pyx#L636>`

getOptionsPrefix()

Get the prefix used for searching for all RG options in the database.

Not collective.

Returns
The prefix string set for this RG object.

Return type
str

See also

setOptionsPrefix, *appendOptionsPrefix*, RGGetOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/RG.pyx:173 <slepc4py/SLEPc/RG.pyx#L173>`

getPolygonVertices()

Get the parameters that define the interval region.

Not collective.

Returns
The vertices.

Return type
ArrayComplex

See also

setPolygonVertices, RGPolygonGetVertices

:sources:`Source code at slepc4py/SLEPc/RG.pyx:692 <slepc4py/SLEPc/RG.pyx#L692>`

getRingParameters()

Get the parameters that define the ring region.

Not collective.

Returns

- **center** (*Scalar*) – The center.
- **radius** (float) – The radius.

- **vscale** (float) – The vertical scale.
- **start_ang** (float) – The right-hand side angle.
- **end_ang** (float) – The left-hand side angle.
- **width** (float) – The width of the ring.

Return type
tuple[Scalar, float, float, float, float, float]

See also

setRingParameters, RGRingGetParameters

:sources:`Source code at slepc4py/SLEPc/RG.pyx:777 <slepc4py/SLEPc/RG.pyx#L777>`

getScale()

Get the scaling factor.

Not collective.

Returns
The scaling factor.

Return type
float

See also

setScale, RGGetScale

:sources:`Source code at slepc4py/SLEPc/RG.pyx:338 <slepc4py/SLEPc/RG.pyx#L338>`

getType()

Get the RG type of this object.

Not collective.

Returns
The region type currently being used.

Return type
str

See also

setType, RGGetType

:sources:`Source code at slepc4py/SLEPc/RG.pyx:129 <slepc4py/SLEPc/RG.pyx#L129>`

isAxisymmetric(*vertical=False*)

Determine if the region is axisymmetric.

Not collective.

Determine if the region is symmetric with respect to the real or imaginary axis.

Parameters
vertical (*bool*) – `True` if symmetry must be checked against the vertical axis.

Returns
`True` if the region is axisymmetric.

Return type
bool

See also
canUseConjugates, RGIsAxisymmetric

:sources:`Source code at slepc4py/SLEPc/RG.pyx:251 <slepc4py/SLEPc/RG.pyx#L251>`

isTrivial()

Tell whether it is the trivial region (whole complex plane).

Not collective.

Returns
`True` if the region is equal to the whole complex plane, e.g., an interval region with all four endpoints unbounded or an ellipse with infinite radius.

Return type
bool

See also
checkInside, RGIsTrivial

:sources:`Source code at slepc4py/SLEPc/RG.pyx:230 <slepc4py/SLEPc/RG.pyx#L230>`

setComplement(*comp=True*)

Set a flag to indicate that the region is the complement of the specified one.

Logically collective.

Parameters
comp (*bool*) – Activate/deactivate the complementation of the region.

Return type
None

See also
getComplement, RGSetComplement

:sources:`Source code at slepc4py/SLEPc/RG.pyx:298 <slepc4py/SLEPc/RG.pyx#L298>`

setEllipseParameters(*center*, *radius*, *vscale=None*)

Set the parameters defining the ellipse region.

Logically collective.

Parameters

- **center** (*Scalar*) – The center.
- **radius** (*float*) – The radius.
- **vscale** (*float | None*) – The vertical scale.

Return type
None

Notes

When PETSc is built with real scalars, the center is restricted to a real value.

See also

getEllipseParameters, RGEllipseSetParameters

:sources:`Source code at slepc4py/SLEPc/RG.pyx:544 <slepc4py/SLEPc/RG.pyx#L544>`

setFromOptions()

Set RG options from the options database.

Collective.

Notes

To see all options, run your program with the `-help` option.

See also

setOptionsPrefix, RGSetFromOptions

:sources:`Source code at slepc4py/SLEPc/RG.pyx:211 <slepc4py/SLEPc/RG.pyx#L211>`

Return type
None

setIntervalEndpoints(*a*, *b*, *c*, *d*)

Set the parameters defining the interval region.

Logically collective.

Parameters

- **a** (*float*) – The left endpoint in the real axis.
- **b** (*float*) – The right endpoint in the real axis.
- **c** (*float*) – The bottom endpoint in the imaginary axis.
- **d** (*float*) – The top endpoint in the imaginary axis.

Return type
None

Notes

The region is defined as $[a, b]x[c, d]$. Particular cases are an interval on the real axis ($c = d = 0$), similarly for the imaginary axis ($a = b = 0$), the whole complex plane ($a = -\infty, b = \infty, c = -\infty, d = \infty$), and so on.

When PETSc is built with real scalars, the region must be symmetric with respect to the real axis.

See also

getIntervalEndpoints, RGIntervalSetEndpoints

:sources:`Source code at slepc4py/SLEPc/RG.pyx:599 <slepc4py/SLEPc/RG.pyx#L599>`

setOptionsPrefix(*prefix=None*)

Set the prefix used for searching for all RG options in the database.

Logically collective.

Parameters
prefix (*str | None*) – The prefix string to prepend to all RG option requests.

Return type
None

Notes

A hyphen (-) must NOT be given at the beginning of the prefix name. The first character of all runtime options is AUTOMATICALLY the hyphen.

See also

appendOptionsPrefix, *getOptionsPrefix*, RGGetOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/RG.pyx:148 <slepc4py/SLEPc/RG.pyx#L148>`

setPolygonVertices(*v*)

Set the vertices that define the polygon region.

Logically collective.

Parameters
v (*Sequence[float] | Sequence[Scalar]*) – The vertices.

Return type
None

See also

getPolygonVertices, RGPolygonSetVertices

:sources:`Source code at slepc4py/SLEPc/RG.pyx:664 <slepc4py/SLEPc/RG.pyx#L664>`

setRingParameters(*center*, *radius*, *vscale*, *start_ang*, *end_ang*, *width*)

Set the parameters defining the ring region.

Logically collective.

Parameters

- **center** (*Scalar*) – The center.
- **radius** (*float*) – The radius.
- **vscale** (*float*) – The vertical scale.
- **start_ang** (*float*) – The right-hand side angle.
- **end_ang** (*float*) – The left-hand side angle.
- **width** (*float*) – The width of the ring.

Return type
None

Notes

The values of `center`, `radius` and `vscale` have the same meaning as in the ellipse region. The `start_ang` and `end_ang` define the span of the ring (by default it is the whole ring), while the `width` is the separation between the two concentric ellipses (above and below the radius by `width/2`).

The start and end angles are expressed as a fraction of the circumference. The allowed range is $[0, \ldots, 1]$, with `0` corresponding to 0 radians, `0.25` to $\pi/2$ radians, and so on. It is allowed to have `start_ang > end_ang`, in which case the ring region crosses over the zero angle.

When PETSc is built with real scalars, the center is restricted to a real value, and the start and end angles must be such that the region is symmetric with respect to the real axis.

See also

getRingParameters, RGRingSetParameters

:sources:`Source code at slepc4py/SLEPc/RG.pyx:718 <slepc4py/SLEPc/RG.pyx#L718>`

setScale(*sfactor=None*)

Set the scaling factor to be used.

Logically collective.

Set the scaling factor to be used when checking that a point is inside the region and when computing the contour.

Parameters
sfactor (*float*) – The scaling factor (default=1).

Return type
None

See also

getScale, *checkInside*, *computeContour*, RGSetScale

:sources:`Source code at slepc4py/SLEPc/RG.pyx:316 <slepc4py/SLEPc/RG.pyx#L316>`

setType(*rg_type*)

Set the type for the RG object.

Logically collective.

Parameters
rg_type (*Type | str*) – The region type to be used.

Return type
None

See also

getType, RGSetType

:sources:`Source code at slepc4py/SLEPc/RG.pyx:110 <slepc4py/SLEPc/RG.pyx#L110>`

view(*viewer=None*)

Print the RG data structure.

Collective.

Parameters
viewer (*Viewer | None*) – Visualization context; if not provided, the standard output is used.

Return type
None

See also

RGView

:sources:`Source code at slepc4py/SLEPc/RG.pyx:56 <slepc4py/SLEPc/RG.pyx#L56>`

Attributes Documentation

complement

If the region is the complement of the specified one.

:sources:`Source code at slepc4py/SLEPc/RG.pyx:813 <slepc4py/SLEPc/RG.pyx#L813>`

scale

The scaling factor to be used.

:sources:`Source code at slepc4py/SLEPc/RG.pyx:821 <slepc4py/SLEPc/RG.pyx#L821>`

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.ST

class slepc4py.SLEPc.**ST**

Bases: Object

Spectral Transformation.

The Spectral Transformation (*ST*) class encapsulates the functionality required for acceleration techniques based on the transformation of the spectrum. The eigensolvers implemented in *EPS* work by applying an operator to a set of vectors and this operator can adopt different forms. The *ST* object handles all the different possibilities in a uniform way, so that the solver can proceed without knowing which transformation has been selected. Polynomial eigensolvers in *PEP* also support spectral transformation.

Enumerations

FilterDamping	ST filter damping.
FilterType	ST filter type.
MatMode	ST matrix mode.
Type	ST type.

slepc4py.SLEPc.ST.FilterDamping

class slepc4py.SLEPc.ST.**FilterDamping**

Bases: object

ST filter damping.

- *NONE*: No damping
- *JACKSON*: Jackson damping
- *LANCZOS*: Lanczos damping
- *FEJER*: Fejer damping

See also

STFilterDamping

Attributes Summary

FEJER	Constant FEJER of type int
JACKSON	Constant JACKSON of type int
LANCZOS	Constant LANCZOS of type int
NONE	Constant NONE of type int

Attributes Documentation

FEJER: int = FEJER

Constant FEJER of type int

JACKSON: int = JACKSON

Constant JACKSON of type int

LANCZOS: int = LANCZOS

Constant LANCZOS of type int

NONE: int = NONE

Constant NONE of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.ST.FilterType

class slepc4py.SLEPc.ST.**FilterType**

Bases: object

ST filter type.

- FILTLAN: An adapted implementation of the Filtered Lanczos Package.
- CHEBYSEV: A polynomial filter based on a truncated Chebyshev series.

See also

STFilterType

Attributes Summary

CHEBYSHEV	Constant CHEBYSHEV of type int
FILTLAN	Constant FILTLAN of type int

Attributes Documentation

CHEBYSHEV: int = CHEBYSHEV

Constant CHEBYSHEV of type int

FILTLAN: int = FILTLAN

Constant FILTLAN of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.ST.MatMode

class slepc4py.SLEPc.ST.**MatMode**

Bases: object

ST matrix mode.

- *COPY*: A working copy of the matrix is created.
- *INPLACE*: The operation is computed in-place.
- *SHELL*: The matrix $A - \sigma B$ is handled as an implicit matrix.

See also

STMatMode

Attributes Summary

COPY	Constant COPY of type int
INPLACE	Constant INPLACE of type int

continues on next page

Table 95 – continued from previous page

SHELL	Constant SHELL of type int

Attributes Documentation

COPY: int = COPY

Constant COPY of type int

INPLACE: int = INPLACE

Constant INPLACE of type int

SHELL: int = SHELL

Constant SHELL of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.ST.Type

class slepc4py.SLEPc.ST.**Type**

Bases: object

ST type.

- *SHIFT*: Shift from origin.
- *SINVERT*: Shift-and-invert.
- *CAYLEY*: Cayley transform.
- *PRECOND*: Preconditioner.
- *FILTER*: Polynomial filter.
- *SHELL*: User-defined.

See also

STType

Attributes Summary

CAYLEY	Object CAYLEY of type str
FILTER	Object FILTER of type str
PRECOND	Object PRECOND of type str
SHELL	Object SHELL of type str
SHIFT	Object SHIFT of type str
SINVERT	Object SINVERT of type str

Attributes Documentation

CAYLEY: str = CAYLEY

Object CAYLEY of type str

FILTER: str = FILTER

Object FILTER of type str

PRECOND: str = PRECOND

Object PRECOND of type str

SHELL: str = SHELL

Object SHELL of type str

SHIFT: str = SHIFT

Object SHIFT of type str

SINVERT: str = SINVERT

Object SINVERT of type str

__init__()

classmethod __new__(**args*, ***kwargs*)

Methods Summary

appendOptionsPrefix([prefix])	Append to the prefix used for searching for all ST options in the database.
apply(x, y)	Apply the spectral transformation operator to a vector.
applyHermitianTranspose(x, y)	Apply the Hermitian-transpose of the operator to a vector.
applyMat(X, Y)	Apply the spectral transformation operator to a matrix.
applyTranspose(x, y)	Apply the transpose of the operator to a vector.
create([comm])	Create the ST object.
destroy()	Destroy the ST object.
getCayleyAntishift()	Get the value of the anti-shift for the Cayley spectral transformation.
getFilterDamping()	Get the type of damping used in the polynomial filter.
getFilterDegree()	Get the degree of the filter polynomial.
getFilterInterval()	Get the interval containing the desired eigenvalues.
getFilterRange()	Get the interval containing all eigenvalues.
getFilterType()	Get the method to be used to build the polynomial filter.
getKSP()	Get the KSP object associated with the spectral transformation.
getMatMode()	Get a flag that indicates how the matrix is being shifted.
getMatStructure()	Get the internal matrix structure attribute.
getMatrices()	Get the matrices associated with the eigenvalue problem.
getOperator()	Get a shell matrix that represents the operator of the spectral transformation.
getOptionsPrefix()	Get the prefix used for searching for all ST options in the database.
getPreconditionerMat()	Get the matrix previously set by *setPreconditionerMat()*.

continues on next page

Table 97 – continued from previous page

getShift()	Get the shift associated with the spectral transformation.
getSplitPreconditioner()	Get the matrices to be used to build the preconditioner.
getTransform()	Get the flag indicating whether the transformed matrices are computed or not.
getType()	Get the ST type of this object.
reset()	Reset the ST object.
restoreOperator(op)	Restore the previously seized operator matrix.
setCayleyAntishift(mu)	Set the value of the anti-shift for the Cayley spectral transformation.
setFilterDamping(damping)	Set the type of damping to be used in the polynomial filter.
setFilterDegree(deg)	Set the degree of the filter polynomial.
setFilterInterval(inta, intb)	Set the interval containing the desired eigenvalues.
setFilterRange(left, right)	Set the numerical range (or field of values) of the matrix.
setFilterType(filter_type)	Set the method to be used to build the polynomial filter.
setFromOptions()	Set ST options from the options database.
setKSP(ksp)	Set the KSP object associated with the spectral transformation.
setMatMode(mode)	Set a flag related to management of transformed matrices.
setMatStructure(structure)	Set the matrix structure attribute.
setMatrices(operators)	Set the matrices associated with the eigenvalue problem.
setOptionsPrefix([prefix])	Set the prefix used for searching for all ST options in the database.
setPreconditionerMat([P])	Set the matrix to be used to build the preconditioner.
setShift(shift)	Set the shift associated with the spectral transformation.
setSplitPreconditioner(operators[, structure])	Set the matrices to be used to build the preconditioner.
setTransform([flag])	Set a flag to indicate whether the transformed matrices are computed or not.
setType(st_type)	Set the particular spectral transformation to be used.
setUp()	Prepare for the use of a spectral transformation.
view([viewer])	Print the ST data structure.

Attributes Summary

ksp	KSP object associated with the spectral transformation.
mat_mode	How the transformed matrices are being stored in the ST.
mat_structure	Relation of the sparsity pattern of all ST matrices.
shift	Value of the shift.
transform	If the transformed matrices are computed.

Methods Documentation

appendOptionsPrefix(*prefix=None*)

Append to the prefix used for searching for all ST options in the database.

Logically collective.

Parameters

prefix (*str | None*) – The prefix string to prepend to all ST option requests.

Return type

None

See also

setOptionsPrefix, *getOptionsPrefix*, STAppendOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/ST.pyx:260 <slepc4py/SLEPc/ST.pyx#L260>`

apply(*x*, *y*)

Apply the spectral transformation operator to a vector.

Collective.

Apply the spectral transformation operator to a vector, for instance $y = (A - \sigma B)^{-1} B x$ in the case of the shift-and-invert transformation and generalized eigenproblem.

Parameters

- **x** (*Vec*) – The input vector.
- **y** (*Vec*) – The result vector.

Return type

None

See also

applyTranspose, *applyHermitianTranspose*, *applyMat*, STApply

:sources:`Source code at slepc4py/SLEPc/ST.pyx:765 <slepc4py/SLEPc/ST.pyx#L765>`

applyHermitianTranspose(*x*, *y*)

Apply the Hermitian-transpose of the operator to a vector.

Collective.

Apply the Hermitian-transpose of the operator to a vector, for instance $y = B^*(A - \sigma B)^{-*} x$ in the case of the shift-and-invert transformation and generalized eigenproblem.

Parameters

- **x** (*Vec*) – The input vector.
- **y** (*Vec*) – The result vector.

Return type

None

See also

apply, *applyTranspose*, STApplyHermitianTranspose

:sources:`Source code at slepc4py/SLEPc/ST.pyx:811 <slepc4py/SLEPc/ST.pyx#L811>`

applyMat(*X*, *Y*)

Apply the spectral transformation operator to a matrix.

Collective.

Apply the spectral transformation operator to a matrix, for instance $Y = (A - \sigma B)^{-1} BX$ in the case of the shift-and-invert transformation and generalized eigenproblem.

Parameters

- **X** (*Mat*) – The input matrix.
- **Y** (*Mat*) – The result matrix.

Return type

None

See also

apply, STApplyMat

:sources:`Source code at slepc4py/SLEPc/ST.pyx:834 <slepc4py/SLEPc/ST.pyx#L834>`

applyTranspose(*x*, *y*)

Apply the transpose of the operator to a vector.

Collective.

Apply the transpose of the operator to a vector, for instance $y = B^T (A - \sigma B)^{-T} x$ in the case of the shift-and-invert transformation and generalized eigenproblem.

Parameters

- **x** (*Vec*) – The input vector.
- **y** (*Vec*) – The result vector.

Return type

None

See also

apply, *applyHermitianTranspose*, STApplyTranspose

:sources:`Source code at slepc4py/SLEPc/ST.pyx:788 <slepc4py/SLEPc/ST.pyx#L788>`

create(*comm=None*)

Create the ST object.

Collective.

Parameters

comm (*Comm* | *None*) – MPI communicator; if not provided, it defaults to all processes.

Return type
Self

See also

STCreate

:sources:`Source code at slepc4py/SLEPc/ST.pyx:149 <slepc4py/SLEPc/ST.pyx#L149>`

destroy()

Destroy the ST object.

Collective.

See also

STDestroy

:sources:`Source code at slepc4py/SLEPc/ST.pyx:123 <slepc4py/SLEPc/ST.pyx#L123>`

Return type
Self

getCayleyAntishift()

Get the value of the anti-shift for the Cayley spectral transformation.

Not collective.

Returns
The anti-shift.

Return type
Scalar

See also

setCayleyAntishift, STCayleyGetAntishift

:sources:`Source code at slepc4py/SLEPc/ST.pyx:949 <slepc4py/SLEPc/ST.pyx#L949>`

getFilterDamping()

Get the type of damping used in the polynomial filter.

Not collective.

Returns
The type of damping.

Return type
FilterDamping

See also

setFilterDamping, STFilterGetDamping

:sources:`Source code at slepc4py/SLEPc/ST.pyx:1171 <slepc4py/SLEPc/ST.pyx#L1171>`

getFilterDegree()

Get the degree of the filter polynomial.

Not collective.

Returns
The polynomial degree.

Return type
int

See also

setFilterDegree, STFilterGetDegree

:sources:`Source code at slepc4py/SLEPc/ST.pyx:1130 <slepc4py/SLEPc/ST.pyx#L1130>`

getFilterInterval()

Get the interval containing the desired eigenvalues.

Not collective.

Returns

- **inta** (float) – The left end of the interval.
- **intb** (float) – The right end of the interval.

Return type
tuple[float, float]

See also

setFilterInterval, STFilterGetInterval

:sources:`Source code at slepc4py/SLEPc/ST.pyx:1038 <slepc4py/SLEPc/ST.pyx#L1038>`

getFilterRange()

Get the interval containing all eigenvalues.

Not collective.

Returns

- **left** (float) – The left end of the spectral range.
- **right** (float) – The right end of the spectral range.

Return type
tuple[float, float]

See also

getFilterInterval, STFilterGetRange

:sources:`Source code at slepc4py/SLEPc/ST.pyx:1090 <slepc4py/SLEPc/ST.pyx#L1090>`

getFilterType()

Get the method to be used to build the polynomial filter.

Not collective.

Returns
The type of filter.

Return type
FilterType

See also

setFilterType, STFilterGetType

:sources:`Source code at slepc4py/SLEPc/ST.pyx:986 <slepc4py/SLEPc/ST.pyx#L986>`

getKSP()

Get the KSP object associated with the spectral transformation.

Collective.

Returns
The linear solver object.

Return type
petsc4py.PETSc.KSP

See also

setKSP, STGetKSP

:sources:`Source code at slepc4py/SLEPc/ST.pyx:589 <slepc4py/SLEPc/ST.pyx#L589>`

getMatMode()

Get a flag that indicates how the matrix is being shifted.

Not collective.

Get a flag that indicates how the matrix is being shifted in the shift-and-invert and Cayley spectral transformations.

Returns
The mode flag.

Return type
MatMode

See also

setMatMode, STGetMatMode

:sources:`Source code at slepc4py/SLEPc/ST.pyx:434 <slepc4py/SLEPc/ST.pyx#L434>`

getMatStructure()

Get the internal matrix structure attribute.

Not collective.

Get the internal petsc4py.PETSc.Mat.Structure attribute to indicate which is the relation of the sparsity pattern of the matrices.

Returns
The structure flag.

Return type
petsc4py.PETSc.Mat.Structure

See also

setMatStructure, STGetMatStructure

:sources:`Source code at slepc4py/SLEPc/ST.pyx:549 <slepc4py/SLEPc/ST.pyx#L549>`

getMatrices()

Get the matrices associated with the eigenvalue problem.

Collective.

Returns
The matrices associated with the eigensystem.

Return type
list of petsc4py.PETSc.Mat

See also

setMatrices, STGetNumMatrices, STGetMatrix

:sources:`Source code at slepc4py/SLEPc/ST.pyx:490 <slepc4py/SLEPc/ST.pyx#L490>`

getOperator()

Get a shell matrix that represents the operator of the spectral transformation.

Collective.

Returns
Operator matrix.

Return type
petsc4py.PETSc.Mat

Notes

The operator is defined in linear eigenproblems only, not in polynomial ones, so the call will fail if more than 2 matrices were passed in *setMatrices()*.

The returned shell matrix is essentially a wrapper to the *apply()* and *applyTranspose()* operations. The operator can often be expressed as

$$Op = DK^{-1}MD^{-1}$$

where D is the balancing matrix, and M and K are two matrices corresponding to the numerator and denominator for spectral transformations that represent a rational matrix function.

The preconditioner matrix K typically depends on the value of the shift, and its inverse is handled via an internal KSP object. Normal usage does not require explicitly calling *getOperator()*, but it can be used to force the creation of K and M, and then K is passed to the KSP. This is useful for setting options associated with the PCFactor (to set MUMPS options, for instance).

The returned matrix must NOT be destroyed by the user. Instead, when no longer needed it must be returned with *restoreOperator()*. In particular, this is required before modifying the *ST* matrices or the shift.

See also

apply, *setMatrices*, *setShift*, *restoreOperator*, STGetOperator

:sources:`Source code at slepc4py/SLEPc/ST.pyx:857 <slepc4py/SLEPc/ST.pyx#L857>`

getOptionsPrefix()

Get the prefix used for searching for all ST options in the database.

Not collective.

Returns
The prefix string set for this ST object.

Return type
str

See also

setOptionsPrefix, *appendOptionsPrefix*, STGetOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/ST.pyx:241 <slepc4py/SLEPc/ST.pyx#L241>`

getPreconditionerMat()

Get the matrix previously set by *setPreconditionerMat()*.

Not collective.

Returns
The matrix that will be used in constructing the preconditioner.

Return type
petsc4py.PETSc.Mat

See also

setPreconditionerMat, STGetPreconditionerMat

:sources:`Source code at slepc4py/SLEPc/ST.pyx:653 <slepc4py/SLEPc/ST.pyx#L653>`

getShift()

Get the shift associated with the spectral transformation.

Not collective.

Returns
The value of the shift.

Return type
Scalar

See also

setShift, STGetShift

:sources:`Source code at slepc4py/SLEPc/ST.pyx:327 <slepc4py/SLEPc/ST.pyx#L327>`

getSplitPreconditioner()

Get the matrices to be used to build the preconditioner.

Not collective.

Returns

- list of petsc4py.PETSc.Mat – The list of matrices associated with the preconditioner.
- petsc4py.PETSc.Mat.Structure – The structure flag.

Return type
tuple[list[petsc4py.PETSc.Mat], petsc4py.PETSc.Mat.Structure]

See also

STGetSplitPreconditionerInfo, STGetSplitPreconditionerTerm

:sources:`Source code at slepc4py/SLEPc/ST.pyx:723 <slepc4py/SLEPc/ST.pyx#L723>`

getTransform()

Get the flag indicating whether the transformed matrices are computed or not.

Not collective.

Returns
This flag is intended for the case of polynomial eigenproblems solved via linearization. If this flag is `False` (default) the spectral transformation is applied to the linearization (handled by the eigensolver), otherwise it is applied to the original problem.

Return type
bool

See also

setTransform, STGetTransform

:sources:`Source code at slepc4py/SLEPc/ST.pyx:368 <slepc4py/SLEPc/ST.pyx#L368>`

getType()

Get the ST type of this object.

Not collective.

Returns
The spectral transformation currently being used.

Return type
str

See also

setType, STGetType

:sources:`Source code at slepc4py/SLEPc/ST.pyx:197 <slepc4py/SLEPc/ST.pyx#L197>`

reset()

Reset the ST object.

Collective.

See also

STReset

:sources:`Source code at slepc4py/SLEPc/ST.pyx:137 <slepc4py/SLEPc/ST.pyx#L137>`

Return type
None

restoreOperator(*op*)

Restore the previously seized operator matrix.

Logically collective.

Parameters
op (*Mat*) – Operator matrix previously obtained with *getOperator()*.

Return type
None

See also

getOperator, STRestoreOperator

:sources:`Source code at slepc4py/SLEPc/ST.pyx:905 <slepc4py/SLEPc/ST.pyx#L905>`

setCayleyAntishift(*mu*)

Set the value of the anti-shift for the Cayley spectral transformation.

Logically collective.

Parameters
mu (Scalar) – The anti-shift.

Return type
None

Notes

In the generalized Cayley transform, the operator can be expressed as $(A-\sigma B)^{-1}(A+\mu B)$. This function sets the value of mu. Use *setShift()* for setting σ.

See also

setShift, *getCayleyAntishift*, STCayleySetAntishift

:sources:`Source code at slepc4py/SLEPc/ST.pyx:925 <slepc4py/SLEPc/ST.pyx#L925>`

setFilterDamping(*damping*)

Set the type of damping to be used in the polynomial filter.

Logically collective.

Parameter

damping
The type of damping.

Notes

Only used in *FilterType.CHEBYSHEV* filters.

See also

getFilterDamping, STFilterSetDamping

:sources:`Source code at slepc4py/SLEPc/ST.pyx:1149 <slepc4py/SLEPc/ST.pyx#L1149>`

Parameters
damping (FilterDamping)

Return type
None

setFilterDegree(*deg*)

Set the degree of the filter polynomial.

Logically collective.

Parameters
deg (*int*) – The polynomial degree.

Return type
None

See also

getFilterDegree, STFilterSetDegree

:sources:`Source code at slepc4py/SLEPc/ST.pyx:1112 <slepc4py/SLEPc/ST.pyx#L1112>`

setFilterInterval(*inta*, *intb*)

Set the interval containing the desired eigenvalues.

Logically collective.

Parameters

- **inta** (*float*) – The left end of the interval.
- **intb** (*float*) – The right end of the interval.

Return type

None

Notes

The filter will be configured to emphasize eigenvalues contained in the given interval, and damp out eigenvalues outside it. If the interval is open, then the filter is low- or high-pass, otherwise it is mid-pass.

Common usage is to set the interval in *EPS* with *EPS.setInterval()*.

The interval must be contained within the numerical range of the matrix, see *setFilterRange()*.

See also

getFilterInterval, *setFilterRange*, STFilterSetInterval

:sources:`Source code at slepc4py/SLEPc/ST.pyx:1005 <slepc4py/SLEPc/ST.pyx#L1005>`

setFilterRange(*left*, *right*)

Set the numerical range (or field of values) of the matrix.

Logically collective.

Set the numerical range (or field of values) of the matrix, that is, the interval containing all eigenvalues.

Parameters

- **left** (*float*) – The left end of the spectral range.
- **right** (*float*) – The right end of the spectral range.

Return type

None

Notes

The filter will be most effective if the numerical range is tight, that is, `left` and `right` are good approximations to the leftmost and rightmost eigenvalues, respectively.

See also

setFilterInterval, *getFilterRange*, STFilterSetRange

:sources:`Source code at slepc4py/SLEPc/ST.pyx:1060 <slepc4py/SLEPc/ST.pyx#L1060>`

setFilterType(*filter_type*)

Set the method to be used to build the polynomial filter.

Logically collective.

Parameter

filter_type
The type of filter.

See also

getFilterType, STFilterSetType

:sources:`Source code at slepc4py/SLEPc/ST.pyx:968 <slepc4py/SLEPc/ST.pyx#L968>`

Parameters
filter_type (FilterType)

Return type
None

setFromOptions()

Set ST options from the options database.

Collective.

Notes

To see all options, run your program with the `-help` option.

This routine must be called before *setUp()* if the user is to be allowed to set the solver type.

See also

setOptionsPrefix, STSetFromOptions

:sources:`Source code at slepc4py/SLEPc/ST.pyx:279 <slepc4py/SLEPc/ST.pyx#L279>`

Return type
None

setKSP(*ksp*)

Set the KSP object associated with the spectral transformation.

Collective.

Parameters
ksp (*KSP*) – The linear solver object.

Return type
None

See also

getKSP, STSetKSP

:sources:`Source code at slepc4py/SLEPc/ST.pyx:572 <slepc4py/SLEPc/ST.pyx#L572>`

setMatMode(*mode*)

Set a flag related to management of transformed matrices.

Logically collective.

The flag indicates how the transformed matrices are being stored in the spectral transformation.

Parameters
mode (MatMode) – The mode flag.

Return type
None

Notes

By default (*ST.MatMode.COPY*), a copy of matrix A is made and then this copy is modified explicitly, e.g., $A \leftarrow (A - \sigma B)$.

With *ST.MatMode.INPLACE*, the original matrix A is modified at *setUp()* and reverted at the end of the computations. With respect to the previous one, this mode avoids a copy of matrix A. However, a backdraw is that the recovered matrix might be slightly different from the original one (due to roundoff).

With *ST.MatMode.SHELL*, the solver works with an implicit shell matrix that represents the shifted matrix. This mode is the most efficient in creating the transformed matrix but it places serious limitations to the linear solves performed in each iteration of the eigensolver (typically, only iterative solvers with Jacobi preconditioning can be used).

In the two first modes the efficiency of this computation can be controlled with *setMatStructure()*.

See also

setMatrices, *setMatStructure*, *getMatMode*, STSetMatMode

:sources:`Source code at slepc4py/SLEPc/ST.pyx:391 <slepc4py/SLEPc/ST.pyx#L391>`

setMatStructure(*structure*)

Set the matrix structure attribute.

Logically collective.

Set an internal petsc4py.PETSc.Mat.Structure attribute to indicate which is the relation of the sparsity pattern of all the *ST* matrices.

Parameters
structure (*petsc4py.PETSc.Mat.Structure*) – The matrix structure specification.

Return type
None

Notes

By default, the sparsity patterns are assumed to be different. If the patterns are equal or a subset then it is recommended to set this attribute for efficiency reasons (in particular, for internal `Mat.axpy()` operations).

This function has no effect in the case of standard eigenproblems.

In case of polynomial eigenproblems, the flag applies to all matrices relative to the first one.

See also

getMatStructure, *setMatrices*, STSetMatStructure

:sources:`Source code at slepc4py/SLEPc/ST.pyx:516 <slepc4py/SLEPc/ST.pyx#L516>`

setMatrices(*operators*)

Set the matrices associated with the eigenvalue problem.

Collective.

Parameters
operators (*list[Mat]*) – The matrices associated with the eigensystem.

Return type
None

Notes

It must be called before *setUp()*. If it is called again after *setUp()* then the *ST* object is reset.

In standard eigenproblems only one matrix is passed, while in generalized problems two matrices are provided. The number of matrices is larger in polynomial eigenproblems.

In normal usage, matrices are provided via the corresponding *EPS* of *PEP* interface function.

See also

getMatrices, *setUp*, *reset*, STSetMatrices

:sources:`Source code at slepc4py/SLEPc/ST.pyx:456 <slepc4py/SLEPc/ST.pyx#L456>`

setOptionsPrefix(*prefix=None*)

Set the prefix used for searching for all ST options in the database.

Logically collective.

Parameters
prefix (*str | None*) – The prefix string to prepend to all ST option requests.

Return type
None

Notes

A hyphen (-) must NOT be given at the beginning of the prefix name. The first character of all runtime options is AUTOMATICALLY the hyphen.

See also

appendOptionsPrefix, *getOptionsPrefix*, STGetOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/ST.pyx:216 <slepc4py/SLEPc/ST.pyx#L216>`

setPreconditionerMat(*P=None*)

Set the matrix to be used to build the preconditioner.

Collective.

Parameters
P (*Mat | None*) – The matrix that will be used in constructing the preconditioner.

Return type
None

Notes

This matrix will be passed to the internal KSP object (via the last argument of `KSP.setOperators()`) as the matrix to be used when constructing the preconditioner. If no matrix is set then $A - \sigma B$ will be used to build the preconditioner, being σ the value set by *setShift()*.

More precisely, this is relevant for spectral transformations that represent a rational matrix function, and use a KSP object for the denominator. It includes also the *PRECOND* case. If the user has a good approximation to matrix that can be used to build a cheap preconditioner, it can be passed with this function. Note that it affects only the `Pmat` argument of `KSP.setOperators()`, not the `Amat` argument.

If a preconditioner matrix is set, the default is to use an iterative KSP rather than a direct method.

An alternative to pass an approximation of $A - \sigma B$ with this function is to provide approximations of A and B via *setSplitPreconditioner()*. The difference is that when σ changes the preconditioner is recomputed.

A call with no matrix argument will remove a previously set matrix.

See also

getPreconditionerMat, STSetPreconditionerMat

:sources:`Source code at slepc4py/SLEPc/ST.pyx:609 <slepc4py/SLEPc/ST.pyx#L609>`

setShift(*shift*)

Set the shift associated with the spectral transformation.

Collective.

Parameters
shift (Scalar) – The value of the shift.

Return type
None

Notes

In some spectral transformations, changing the shift may have associated a lot of work, for example recomputing a factorization.

This function is normally not directly called by users, since the shift is indirectly set by *EPS.setTarget()*.

See also

getShift, STSetShift

:sources:`Source code at slepc4py/SLEPc/ST.pyx:300 <slepc4py/SLEPc/ST.pyx#L300>`

setSplitPreconditioner(*operators*, *structure=None*)

Set the matrices to be used to build the preconditioner.

Collective.

Parameters

- **operators** (*list[petsc4py.PETSc.Mat]*) – The matrices associated with the preconditioner.
- **structure** (*petsc4py.PETSc.Mat.Structure* | *None*) – The matrix structure specification.

Return type
None

Notes

The number of matrices passed here must be the same as in *setMatrices()*.

For linear eigenproblems, the preconditioner matrix is computed as $P(\sigma) = A_0 - \sigma B_0$, where A_0, B_0 are approximations of A, B (the eigenproblem matrices) provided via the `operators` argument in this function. Compared to *setPreconditionerMat()*, this function allows setting a preconditioner in a way that is independent of the shift σ. Whenever the value of σ changes the preconditioner is recomputed.

Similarly, for polynomial eigenproblems the matrix for the preconditioner is expressed as $P(\sigma) = \sum_i P_i \phi_i(\sigma)$, for $i = 1, \ldots, n$, where P_i are given in `operators` and the ϕ_i's are the polynomial basis functions.

The `structure` flag provides information about the relative nonzero pattern of the `operators` matrices, in the same way as in *setMatStructure()*.

See also

getSplitPreconditioner, *setPreconditionerMat*, STSetSplitPreconditioner

:sources:`Source code at slepc4py/SLEPc/ST.pyx:673 <slepc4py/SLEPc/ST.pyx#L673>`

setTransform(*flag=True*)

Set a flag to indicate whether the transformed matrices are computed or not.

Logically collective.

Parameters
flag (*bool*) – This flag is intended for the case of polynomial eigenproblems solved via

linearization. If this flag is `False` (default) the spectral transformation is applied to the linearization (handled by the eigensolver), otherwise it is applied to the original problem.

Return type
None

See also

getTransform, STSetTransform

:sources:`Source code at slepc4py/SLEPc/ST.pyx:346 <slepc4py/SLEPc/ST.pyx#L346>`

setType(*st_type*)

Set the particular spectral transformation to be used.

Logically collective.

Parameters
st_type (*Type* | *str*) – The spectral transformation to be used.

Return type
None

Notes

The default is *SHIFT* with a zero shift. Normally, it is best to use *setFromOptions()* and then set the ST type from the options database rather than by using this routine. Using the options database provides the user with maximum flexibility in evaluating the different available methods.

See also

getType, STSetType

:sources:`Source code at slepc4py/SLEPc/ST.pyx:170 <slepc4py/SLEPc/ST.pyx#L170>`

setUp()

Prepare for the use of a spectral transformation.

Collective.

See also

apply, STSetUp

:sources:`Source code at slepc4py/SLEPc/ST.pyx:753 <slepc4py/SLEPc/ST.pyx#L753>`

Return type
None

view(*viewer=None*)

Print the ST data structure.

Collective.

Parameters
viewer (*Viewer* | *None*) – Visualization context; if not provided, the standard output is used.

Return type
None

See also

`STView`

:sources:`Source code at slepc4py/SLEPc/ST.pyx:104 <slepc4py/SLEPc/ST.pyx#L104>`

Attributes Documentation

ksp

KSP object associated with the spectral transformation.

:sources:`Source code at slepc4py/SLEPc/ST.pyx:1224 <slepc4py/SLEPc/ST.pyx#L1224>`

mat_mode

How the transformed matrices are being stored in the ST.

:sources:`Source code at slepc4py/SLEPc/ST.pyx:1208 <slepc4py/SLEPc/ST.pyx#L1208>`

mat_structure

Relation of the sparsity pattern of all ST matrices.

:sources:`Source code at slepc4py/SLEPc/ST.pyx:1216 <slepc4py/SLEPc/ST.pyx#L1216>`

shift

Value of the shift.

:sources:`Source code at slepc4py/SLEPc/ST.pyx:1192 <slepc4py/SLEPc/ST.pyx#L1192>`

transform

If the transformed matrices are computed.

:sources:`Source code at slepc4py/SLEPc/ST.pyx:1200 <slepc4py/SLEPc/ST.pyx#L1200>`

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.SVD

class slepc4py.SLEPc.**SVD**

Bases: `Object`

Singular Value Decomposition Solver.

The Singular Value Decomposition Solver (*SVD*) is very similar to the *EPS* object, but intended for the computation of the partial SVD of a rectangular matrix. With this type of object, the user can specify an SVD problem and solve it with any of the different solvers encapsulated by the package. Some of these solvers are actually implemented through calls to *EPS* eigensolvers.

Enumerations

Conv	SVD convergence test.
ConvergedReason	SVD convergence reasons.

continues on next page

Table 99 – continued from previous page

ErrorType	SVD error type to assess accuracy of computed solutions.
ProblemType	SVD problem type.
Stop	SVD stopping test.
TRLanczosGBidiag	SVD TRLanczos bidiagonalization choices for the GSVD case.
Type	SVD type.
Which	SVD desired part of spectrum.

slepc4py.SLEPc.SVD.Conv

class slepc4py.SLEPc.SVD.**Conv**

Bases: object

SVD convergence test.

- *ABS*: Absolute convergence test.
- *REL*: Convergence test relative to the singular value.
- *NORM*: Convergence test relative to the matrix norms.
- *MAXIT*: No convergence until maximum number of iterations has been reached.
- *USER*: User-defined convergence test.

See also

SVDConv

Attributes Summary

ABS	Constant ABS of type int
MAXIT	Constant MAXIT of type int
NORM	Constant NORM of type int
REL	Constant REL of type int
USER	Constant USER of type int

Attributes Documentation

ABS: int = ABS

Constant ABS of type int

MAXIT: int = MAXIT

Constant MAXIT of type int

NORM: int = NORM

Constant NORM of type int

REL: int = REL

Constant REL of type int

USER: int = USER

Constant USER of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.SVD.ConvergedReason

class slepc4py.SLEPc.SVD.**ConvergedReason**

Bases: object

SVD convergence reasons.

- *CONVERGED_TOL*: All eigenpairs converged to requested tolerance.
- *CONVERGED_USER*: User-defined convergence criterion satisfied.
- *CONVERGED_MAXIT*: Maximum iterations completed in case MAXIT convergence criterion.
- *DIVERGED_ITS*: Maximum number of iterations exceeded.
- *DIVERGED_BREAKDOWN*: Solver failed due to breakdown.
- *DIVERGED_SYMMETRY_LOST*: Underlying indefinite eigensolver was not able to keep symmetry.
- *CONVERGED_ITERATING*: Iteration not finished yet.

See also

SVDConvergedReason

Attributes Summary

CONVERGED_ITERATING	Constant CONVERGED_ITERATING of type int
CONVERGED_MAXIT	Constant CONVERGED_MAXIT of type int
CONVERGED_TOL	Constant CONVERGED_TOL of type int
CONVERGED_USER	Constant CONVERGED_USER of type int
DIVERGED_BREAKDOWN	Constant DIVERGED_BREAKDOWN of type int
DIVERGED_ITS	Constant DIVERGED_ITS of type int
DIVERGED_SYMMETRY_LOST	Constant DIVERGED_SYMMETRY_LOST of type int
ITERATING	Constant ITERATING of type int

Attributes Documentation

CONVERGED_ITERATING: int = CONVERGED_ITERATING

Constant CONVERGED_ITERATING of type int

CONVERGED_MAXIT: int = CONVERGED_MAXIT

Constant CONVERGED_MAXIT of type int

CONVERGED_TOL: int = CONVERGED_TOL

Constant CONVERGED_TOL of type int

CONVERGED_USER: int = CONVERGED_USER

Constant CONVERGED_USER of type int

DIVERGED_BREAKDOWN: int = DIVERGED_BREAKDOWN

Constant DIVERGED_BREAKDOWN of type int

DIVERGED_ITS: int = DIVERGED_ITS

Constant DIVERGED_ITS of type int

DIVERGED_SYMMETRY_LOST: int = DIVERGED_SYMMETRY_LOST

Constant DIVERGED_SYMMETRY_LOST of type int

ITERATING: int = ITERATING

Constant ITERATING of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.SVD.ErrorType

class slepc4py.SLEPc.SVD.**ErrorType**

Bases: object

SVD error type to assess accuracy of computed solutions.

- *ABSOLUTE*: Absolute error.
- *RELATIVE*: Relative error.
- *NORM*: Error relative to the matrix norm.

See also

SVDErrorType

Attributes Summary

ABSOLUTE	Constant ABSOLUTE of type int
NORM	Constant NORM of type int
RELATIVE	Constant RELATIVE of type int

Attributes Documentation

ABSOLUTE: int = ABSOLUTE

Constant ABSOLUTE of type int

NORM: int = NORM

Constant NORM of type int

RELATIVE: int = RELATIVE

Constant RELATIVE of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.SVD.ProblemType

class slepc4py.SLEPc.SVD.**ProblemType**

Bases: object

SVD problem type.

- *STANDARD*: Standard SVD.
- *GENERALIZED*: Generalized singular value decomposition (GSVD).
- *HYPERBOLIC* : Hyperbolic singular value decomposition (HSVD).

See also

SVDProblemType

Attributes Summary

GENERALIZED	Constant GENERALIZED of type int
HYPERBOLIC	Constant HYPERBOLIC of type int
STANDARD	Constant STANDARD of type int

Attributes Documentation

GENERALIZED: int = GENERALIZED

Constant GENERALIZED of type int

HYPERBOLIC: int = HYPERBOLIC

Constant HYPERBOLIC of type int

STANDARD: int = STANDARD

Constant STANDARD of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.SVD.Stop

class slepc4py.SLEPc.SVD.**Stop**

Bases: object

SVD stopping test.

- *BASIC*: Default stopping test.
- *USER*: User-defined stopping test.
- *THRESHOLD*: Threshold stopping test.

See also

SVDStop

Attributes Summary

BASIC	Constant BASIC of type int
THRESHOLD	Constant THRESHOLD of type int
USER	Constant USER of type int

Attributes Documentation

BASIC: int = BASIC

Constant BASIC of type int

THRESHOLD: int = THRESHOLD

Constant THRESHOLD of type int

USER: int = USER

Constant USER of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.SVD.TRLanczosGBidiag

class slepc4py.SLEPc.SVD.**TRLanczosGBidiag**

Bases: object

SVD TRLanczos bidiagonalization choices for the GSVD case.

- *SINGLE*: Single bidiagonalization (Q_A).
- *UPPER*: Joint bidiagonalization, both Q_A and Q_B in upper bidiagonal form.
- *LOWER*: Joint bidiagonalization, Q_A lower bidiagonal, Q_B upper bidiagonal.

See also

SVDTRLanczosGBidiag

Attributes Summary

LOWER	Constant LOWER of type int
SINGLE	Constant SINGLE of type int
UPPER	Constant UPPER of type int

Attributes Documentation

LOWER: int = LOWER

Constant LOWER of type int

SINGLE: int = SINGLE

Constant SINGLE of type int

UPPER: int = UPPER

Constant UPPER of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.SVD.Type

class slepc4py.SLEPc.SVD.**Type**

Bases: object

SVD type.

Native singular value solvers.

- *CROSS*: Eigenproblem with the cross-product matrix.
- *CYCLIC*: Eigenproblem with the cyclic matrix.
- *LANCZOS*: Explicitly restarted Lanczos.
- *TRLANCZOS*: Thick-restart Lanczos.
- *RANDOMIZED*: Iterative RSVD for low-rank matrices.

Wrappers to external SVD solvers (should be enabled during installation of SLEPc).

- *LAPACK*: Sequential dense SVD solver.
- *SCALAPACK*: Parallel dense SVD solver.
- *KSVD*: Parallel dense SVD solver.
- *ELEMENTAL*: Parallel dense SVD solver.
- *PRIMME*: Iterative SVD solvers of Davidson type.

See also

SVDType

Attributes Summary

CROSS	Object CROSS of type str
CYCLIC	Object CYCLIC of type str
ELEMENTAL	Object ELEMENTAL of type str
KSVD	Object KSVD of type str
LANCZOS	Object LANCZOS of type str
LAPACK	Object LAPACK of type str
PRIMME	Object PRIMME of type str
RANDOMIZED	Object RANDOMIZED of type str
SCALAPACK	Object SCALAPACK of type str
TRLANCZOS	Object TRLANCZOS of type str

Attributes Documentation

CROSS: str = CROSS

Object CROSS of type str

CYCLIC: str = CYCLIC

Object CYCLIC of type str

ELEMENTAL: str = ELEMENTAL

Object ELEMENTAL of type str

KSVD: str = KSVD

Object KSVD of type str

LANCZOS: str = LANCZOS

Object LANCZOS of type str

LAPACK: str = LAPACK

Object LAPACK of type str

PRIMME: str = PRIMME

Object PRIMME of type str

RANDOMIZED: str = RANDOMIZED

Object RANDOMIZED of type str

SCALAPACK: str = SCALAPACK

Object SCALAPACK of type str

TRLANCZOS: str = TRLANCZOS

Object TRLANCZOS of type str

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.SVD.Which

class slepc4py.SLEPc.SVD.**Which**

Bases: object

SVD desired part of spectrum.

- *LARGEST*: Largest singular values.
- *SMALLEST*: Smallest singular values.

See also

SVDWhich

Attributes Summary

LARGEST	Constant LARGEST of type int
SMALLEST	Constant SMALLEST of type int

Attributes Documentation

LARGEST: int = LARGEST

Constant LARGEST of type int

SMALLEST: int = SMALLEST

Constant SMALLEST of type int

__init__()

classmethod __new__(**args*, ***kwargs*)

Methods Summary

appendOptionsPrefix([prefix])	Append to the prefix used for searching for all SVD options in the database.
cancelMonitor()	Clear all monitors for an *SVD* object.
computeError(i[, etype])	Compute the error associated with the i-th singular triplet.
create([comm])	Create the SVD object.
destroy()	Destroy the SVD object.
errorView([etype, viewer])	Display the errors associated with the computed solution.
getBV()	Get the basis vectors objects associated to the SVD object.
getConverged()	Get the number of converged singular triplets.
getConvergedReason()	Get the reason why the *solve()* iteration was stopped.
getConvergenceTest()	Get the method used to compute the error estimate used in the convergence test.
getCrossEPS()	Get the eigensolver object associated to the singular value solver.
getCrossExplicitMatrix()	Get the flag indicating if A^*A is built explicitly.
getCyclicEPS()	Get the eigensolver object associated to the singular value solver.
getCyclicExplicitMatrix()	Get the flag indicating if $H(A)$ is built explicitly.
getDS()	Get the direct solver associated to the singular value solver.
getDimensions()	Get the number of singular values to compute and the dimension of the subspace.
getImplicitTranspose()	Get the mode used to handle the transpose of the associated matrix.
getIterationNumber()	Get the current iteration number.
getLanczosOneSide()	Get if the variant of the Lanczos method to be used is one-sided or two-sided.
getMonitor()	Get the list of monitor functions.
getOperators()	Get the matrices associated with the singular value problem.
getOptionsPrefix()	Get the prefix used for searching for all SVD options in the database.
getProblemType()	Get the problem type from the SVD object.
getSignature([omega])	Get the signature matrix defining a hyperbolic singular value problem.
getSingularTriplet(i[, U, V])	Get the i-th triplet of the singular value decomposition.
getStoppingTest()	Get the stopping test function.
getTRLanczosExplicitMatrix()	Get the flag indicating if $Z = [A^*, B^*]^*$ is built explicitly.

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Table 108 – continued from previous page

getTRLanczosGBidiag()	Get bidiagonalization choice used in the GSVD TR-Lanczos solver.
getTRLanczosKSP()	Get the linear solver object associated with the SVD solver.
getTRLanczosLocking()	Get the locking flag used in the thick-restart Lanczos method.
getTRLanczosOneSide()	Get if the variant of the method to be used is one-sided or two-sided.
getTRLanczosRestart()	Get the restart parameter used in the thick-restart Lanczos method.
getThreshold()	Get the threshold used in the threshold stopping test.
getTolerances()	Get the tolerance and maximum iteration count.
getTrackAll()	Get the flag indicating if all residual norms must be computed or not.
getType()	Get the SVD type of this object.
getValue(i)	Get the i-th singular value as computed by *solve()*.
getVectors(i, U, V)	Get the i-th left and right singular vectors as computed by *solve()*.
getWhichSingularTriplets()	Get which singular triplets are to be sought.
isGeneralized()	Tell if the SVD corresponds to a generalized singular value problem.
isHyperbolic()	Tell whether the SVD object corresponds to a hyperbolic singular value problem.
reset()	Reset the SVD object.
setBV(V[, U])	Set basis vectors objects associated to the SVD solver.
setConvergenceTest(conv)	Set how to compute the error estimate used in the convergence test.
setCrossEPS(eps)	Set an eigensolver object associated to the singular value solver.
setCrossExplicitMatrix([flag])	Set if the eigensolver operator A^*A must be computed.
setCyclicEPS(eps)	Set an eigensolver object associated to the singular value solver.
setCyclicExplicitMatrix([flag])	Set if the eigensolver operator $H(A)$ must be computed explicitly.
setDS(ds)	Set a direct solver object associated to the singular value solver.
setDimensions([nsv, ncv, mpd])	Set the number of singular values to compute and the dimension of the subspace.
setFromOptions()	Set SVD options from the options database.
setImplicitTranspose([mode])	Set how to handle the transpose of the associated matrix.
setInitialSpace([spaceright, spaceleft])	Set the initial spaces from which the SVD solver starts to iterate.
setLanczosOneSide([flag])	Set if the variant of the Lanczos method to be used is one-sided or two-sided.
setMonitor(monitor[, args, kargs])	Append a monitor function to the list of monitors.
setOperators(A[, B])	Set the matrices associated with the singular value problem.
setOptionsPrefix([prefix])	Set the prefix used for searching for all SVD options in the database.
setProblemType(problem_type)	Set the type of the singular value problem.

continues on next page

Table 108 – continued from previous page

setSignature([omega])	Set the signature matrix defining a hyperbolic singular value problem.
setStoppingTest(stopping[, args, kargs])	Set a function to decide when to stop the outer iteration of the eigensolver.
setTRLanczosExplicitMatrix([flag])	Set if the matrix $Z = [A^*, B^*]^*$ must be built explicitly.
setTRLanczosGBidiag(bidiag)	Set the bidiagonalization choice to use in the GSVD TRLanczos solver.
setTRLanczosKSP(ksp)	Set a linear solver object associated to the SVD solver.
setTRLanczosLocking([lock])	Toggle between locking and non-locking variants of TRLanczos.
setTRLanczosOneSide([flag])	Set if the variant of the method to be used is one-sided or two-sided.
setTRLanczosRestart(keep)	Set the restart parameter for the thick-restart Lanczos method.
setThreshold(thres[, rel])	Set the threshold used in the threshold stopping test.
setTolerances([tol, max_it])	Set the tolerance and maximum iteration count used.
setTrackAll([trackall])	Set flag to compute the residual of all singular triplets.
setType(svd_type)	Set the particular solver to be used in the SVD object.
setUp()	Set up all the internal data structures.
setWhichSingularTriplets(which)	Set which singular triplets are to be sought.
solve()	Solve the singular value problem.
valuesView([viewer])	Display the computed singular values in a viewer.
vectorsView([viewer])	Output computed singular vectors to a viewer.
view([viewer])	Print the SVD data structure.

Attributes Summary

ds	The direct solver (*DS*) object associated.
max_it	The maximum iteration count.
problem_type	The type of the eigenvalue problem.
tol	The tolerance.
track_all	Compute the residual norm of all approximate eigenpairs.
transpose_mode	How to handle the transpose of the matrix.
which	The portion of the spectrum to be sought.

Methods Documentation

appendOptionsPrefix(*prefix=None*)

Append to the prefix used for searching for all SVD options in the database.

Logically collective.

Parameters
prefix (*str | None*) – The prefix string to prepend to all SVD option requests.

Return type
None

See also

setOptionsPrefix, *getOptionsPrefix*, SVDAppendOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:365 <slepc4py/SLEPc/SVD.pyx#L365>`

cancelMonitor()

Clear all monitors for an *SVD* object.

Logically collective.

See also

SVDMonitorCancel

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1157 <slepc4py/SLEPc/SVD.pyx#L1157>`

Return type
None

computeError(*i*, *etype=None*)

Compute the error associated with the i-th singular triplet.

Collective.

Compute the error (based on the residual norm) associated with the i-th singular triplet.

Parameters

- **i** (*int*) – Index of the solution to be considered.
- **etype** (ErrorType | *None*) – The error type to compute.

Returns

The error bound, computed in various ways from the residual norm $\sqrt{\eta_1^2+\eta_2^2}$ where $\eta_1 = \|Av-\sigma u\|_2$, $\eta_2 = \|A^*u-\sigma v\|_2$, σ is the approximate singular value, u and v are the left and right singular vectors.

Return type
float

Notes

The index `i` should be a value between `0` and `nconv-1` (see *getConverged()*).

In the case of the GSVD, the two components of the residual norm are $\eta_1 = \|s^2A^*u - cB^*Bx\|_2$ and $\eta_2 = ||c^2B^*v - sA^*Ax||_2$, where (σ,u,v,x) is the approximate generalized singular quadruple, with $\sigma = c/s$.

See also

solve, SVDComputeError

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1388 <slepc4py/SLEPc/SVD.pyx#L1388>`

create(*comm=None*)

Create the SVD object.

Collective.

Parameters

comm (*Comm | None*) – MPI communicator; if not provided, it defaults to all processes.

Return type

Self

See also

SVDCreate

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:248 <slepc4py/SLEPc/SVD.pyx#L248>`

destroy()

Destroy the SVD object.

Collective.

See also

SVDDestroy

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:222 <slepc4py/SLEPc/SVD.pyx#L222>`

Return type

Self

errorView(*etype=None*, *viewer=None*)

Display the errors associated with the computed solution.

Collective.

Display the errors and the singular values.

Parameters

- **etype** (ErrorType | *None*) – The error type to compute.
- **viewer** (*petsc4py.PETSc.Viewer | None*) – Visualization context; if not provided, the standard output is used.

Return type

None

Notes

By default, this function checks the error of all singular triplets and prints the singular values if all of them are below the requested tolerance. If the viewer has format ASCII_INFO_DETAIL then a table with singular values and corresponding errors is printed.

See also

solve, *valuesView*, *vectorsView*, SVDErrorView

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1436 <slepc4py/SLEPc/SVD.pyx#L1436>`

getBV()

Get the basis vectors objects associated to the SVD object.

Not collective.

Returns

- **V** (*BV*) – The basis vectors context for right singular vectors.
- **U** (*BV*) – The basis vectors context for left singular vectors.

Return type

tuple[BV, BV]

See also

setBV, SVDGetBV

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:837 <slepc4py/SLEPc/SVD.pyx#L837>`

getConverged()

Get the number of converged singular triplets.

Not collective.

Returns

nconv – Number of converged singular triplets.

Return type

int

Notes

This function should be called after *solve()* has finished.

The value nconv may be different from the number of requested solutions nsv, but not larger than ncv, see *setDimensions()*.

See also

setDimensions, *solve*, *getValue*, SVDGetConverged

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1256 <slepc4py/SLEPc/SVD.pyx#L1256>`

getConvergedReason()

Get the reason why the *solve()* iteration was stopped.

Not collective.

Returns

Negative value indicates diverged, positive value converged.

Return type
ConvergedReason

See also

setTolerances, *solve*, SVDGetConvergedReason

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1237 <slepc4py/SLEPc/SVD.pyx#L1237>`

getConvergenceTest()

Get the method used to compute the error estimate used in the convergence test.

Not collective.

Returns
The method used to compute the error estimate used in the convergence test.

Return type
Conv

See also

setConvergenceTest, SVDGetConvergenceTest

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:682 <slepc4py/SLEPc/SVD.pyx#L682>`

getCrossEPS()

Get the eigensolver object associated to the singular value solver.

Collective.

Returns
The eigensolver object.

Return type
EPS

See also

setCrossEPS, SVDCrossGetEPS

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1525 <slepc4py/SLEPc/SVD.pyx#L1525>`

getCrossExplicitMatrix()

Get the flag indicating if A^*A is built explicitly.

Not collective.

Returns
`True` if A^*A is built explicitly.

Return type
bool

See also

setCrossExplicitMatrix, SVDCrossGetExplicitMatrix

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1572 <slepc4py/SLEPc/SVD.pyx#L1572>`

getCyclicEPS()

Get the eigensolver object associated to the singular value solver.

Collective.

Returns
The eigensolver object.

Return type
EPS

See also

setCyclicEPS, SVDCyclicGetEPS

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1608 <slepc4py/SLEPc/SVD.pyx#L1608>`

getCyclicExplicitMatrix()

Get the flag indicating if $H(A)$ is built explicitly.

Not collective.

Get the flag indicating if $H(A) = [0\ A; A^T\ 0]$ is built explicitly.

Returns
`True` if $H(A)$ is built explicitly.

Return type
bool

See also

setCyclicExplicitMatrix, SVDCyclicGetExplicitMatrix

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1657 <slepc4py/SLEPc/SVD.pyx#L1657>`

getDS()

Get the direct solver associated to the singular value solver.

Not collective.

Returns
The direct solver context.

Return type
DS

See also

setDS, SVDGetDS

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:882 <slepc4py/SLEPc/SVD.pyx#L882>`

getDimensions()

Get the number of singular values to compute and the dimension of the subspace.

Not collective.

Returns

- **nsv** (int) – Number of singular values to compute.
- **ncv** (int) – Maximum dimension of the subspace to be used by the solver.
- **mpd** (int) – Maximum dimension allowed for the projected problem.

Return type

tuple[int, int, int]

See also

setDimensions, SVDGetDimensions

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:761 <slepc4py/SLEPc/SVD.pyx#L761>`

getImplicitTranspose()

Get the mode used to handle the transpose of the associated matrix.

Not collective.

Returns

How to handle the transpose (implicitly or not).

Return type

bool

See also

setImplicitTranspose, SVDGetImplicitTranspose

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:486 <slepc4py/SLEPc/SVD.pyx#L486>`

getIterationNumber()

Get the current iteration number.

Not collective.

If the call to *solve()* is complete, then it returns the number of iterations carried out by the solution method.

Returns

Iteration number.

Return type

int

See also

getConvergedReason, *setTolerances*, SVDGetIterationNumber

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1215 <slepc4py/SLEPc/SVD.pyx#L1215>`

getLanczosOneSide()

Get if the variant of the Lanczos method to be used is one-sided or two-sided.

Not collective.

Returns
`True` if the method is one-sided.

Return type
bool

See also

setLanczosOneSide, SVDLanczosGetOneSide

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1705 <slepc4py/SLEPc/SVD.pyx#L1705>`

getMonitor()

Get the list of monitor functions.

Not collective.

Returns
The list of monitor functions.

Return type
SVDMonitorFunction

See also

setMonitor

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1140 <slepc4py/SLEPc/SVD.pyx#L1140>`

getOperators()

Get the matrices associated with the singular value problem.

Collective.

Returns

- **A** (petsc4py.PETSc.Mat) – The matrix associated with the singular value problem.
- **B** (petsc4py.PETSc.Mat) – The second matrix in the case of GSVD.

Return type
tuple[*Mat*, *Mat*] | tuple[*Mat*, None]

See also

setOperators, SVDGetOperators

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:919 <slepc4py/SLEPc/SVD.pyx#L919>`

getOptionsPrefix()

Get the prefix used for searching for all SVD options in the database.

Not collective.

Returns
The prefix string set for this SVD object.

Return type
str

See also

setOptionsPrefix, *appendOptionsPrefix*, SVDGetOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:315 <slepc4py/SLEPc/SVD.pyx#L315>`

getProblemType()

Get the problem type from the SVD object.

Not collective.

Returns
The problem type that was previously set.

Return type
ProblemType

See also

setProblemType, SVDGetProblemType

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:403 <slepc4py/SLEPc/SVD.pyx#L403>`

getSignature(*omega=None*)

Get the signature matrix defining a hyperbolic singular value problem.

Collective.

Parameters
omega (*Vec* | *None*) – Optional vector to store the diagonal elements of the signature matrix.

Returns
A vector containing the diagonal elements of the signature matrix.

Return type
petsc4py.PETSc.Vec

See also

setSignature, SVDGetSignature

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:966 <slepc4py/SLEPc/SVD.pyx#L966>`

getSingularTriplet(*i*, *U=None*, *V=None*)

Get the i-th triplet of the singular value decomposition.

Collective.

Get the i-th triplet of the singular value decomposition as computed by *solve()*. The solution consists of the singular value and its left and right singular vectors.

Parameters

- **i** (*int*) – Index of the solution to be obtained.
- **U** (*Vec | None*) – Placeholder for the returned left singular vector.
- **V** (*Vec | None*) – Placeholder for the returned right singular vector.

Returns

The computed singular value.

Return type

float

Notes

The index `i` should be a value between `0` and `nconv-1` (see *getConverged()*. Singular triplets are indexed according to the ordering criterion established with *setWhichSingularTriplets()*.

See also

getConverged, *setWhichSingularTriplets*, SVDGetSingularTriplet

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1344 <slepc4py/SLEPc/SVD.pyx#L1344>`

getStoppingTest()

Get the stopping test function.

Not collective.

Returns

The stopping test function.

Return type

SVDStoppingFunction

See also

setStoppingTest

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1096 <slepc4py/SLEPc/SVD.pyx#L1096>`

getTRLanczosExplicitMatrix()

Get the flag indicating if $Z = [A^*, B^*]^*$ is built explicitly.

Not collective.

Returns
`True` if $Z = [A^*, B^*]^*$ is built explicitly.

Return type
`bool`

See also

setTRLanczosExplicitMatrix, SVDTRLanczosGetExplicitMatrix

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1960 <slepc4py/SLEPc/SVD.pyx#L1960>`

getTRLanczosGBidiag()

Get bidiagonalization choice used in the GSVD TRLanczos solver.

Not collective.

Returns
The bidiagonalization choice.

Return type
TRLanczosGBidiag

See also

setTRLanczosGBidiag, SVDTRLanczosGetGBidiag

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1792 <slepc4py/SLEPc/SVD.pyx#L1792>`

getTRLanczosKSP()

Get the linear solver object associated with the SVD solver.

Collective.

Returns
The linear solver object.

Return type
petsc4py.PETSc.KSP

See also

setTRLanczosKSP, SVDTRLanczosGetKSP

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1917 <slepc4py/SLEPc/SVD.pyx#L1917>`

getTRLanczosLocking()

Get the locking flag used in the thick-restart Lanczos method.

Not collective.

Returns
The locking flag.

Return type
bool

See also

setTRLanczosLocking, SVDTRLanczosGetLocking

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1881 <slepc4py/SLEPc/SVD.pyx#L1881>`

getTRLanczosOneSide()

Get if the variant of the method to be used is one-sided or two-sided.

Not collective.

Get if the variant of the thick-restart Lanczos method to be used is one-sided or two-sided.

Returns
`True` if the method is one-sided.

Return type
bool

See also

setTRLanczosOneSide, SVDLanczosGetOneSide

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1752 <slepc4py/SLEPc/SVD.pyx#L1752>`

getTRLanczosRestart()

Get the restart parameter used in the thick-restart Lanczos method.

Not collective.

Returns
The number of vectors to be kept at restart.

Return type
float

See also

setTRLanczosRestart, SVDTRLanczosGetRestart

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1837 <slepc4py/SLEPc/SVD.pyx#L1837>`

getThreshold()

Get the threshold used in the threshold stopping test.

Not collective.

Returns

- **thres** (float) – The threshold.
- **rel** (bool) – Whether the threshold is relative or not.

Return type
tuple[float, bool]

See also

setThreshold, SVDGetThreshold

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:569 <slepc4py/SLEPc/SVD.pyx#L569>`

getTolerances()

Get the tolerance and maximum iteration count.

Not collective.

Get the tolerance and maximum iteration count used by the default SVD convergence tests.

Returns

- **tol** (float) – The convergence tolerance.
- **max_it** (int) – The maximum number of iterations.

Return type
tuple[float, int]

See also

setTolerances, SVDGetTolerances

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:626 <slepc4py/SLEPc/SVD.pyx#L626>`

getTrackAll()

Get the flag indicating if all residual norms must be computed or not.

Not collective.

Returns
Whether the solver computes all residuals or not.

Return type
bool

See also

setTrackAll, SVDGetTrackAll

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:721 <slepc4py/SLEPc/SVD.pyx#L721>`

getType()

Get the SVD type of this object.

Not collective.

Returns
The solver currently being used.

Return type
str

See also

setType, SVDGetType

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:296 <slepc4py/SLEPc/SVD.pyx#L296>`

getValue(*i*)

Get the i-th singular value as computed by *solve()*.

Collective.

Parameters

i (*int*) – Index of the solution to be obtained.

Returns

The computed singular value.

Return type

float

Notes

The index `i` should be a value between `0` and `nconv-1` (see *getConverged()*. Singular triplets are indexed according to the ordering criterion established with *setWhichSingularTriplets()*.

See also

getConverged, *setWhichSingularTriplets*, SVDGetSingularTriplet

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1282 <slepc4py/SLEPc/SVD.pyx#L1282>`

getVectors(*i*, *U*, *V*)

Get the i-th left and right singular vectors as computed by *solve()*.

Collective.

Parameters

- **i** (*int*) – Index of the solution to be obtained.
- **U** (*Vec*) – Placeholder for the returned left singular vector.
- **V** (*Vec*) – Placeholder for the returned right singular vector.

Return type

None

Notes

The index `i` should be a value between `0` and `nconv-1` (see *getConverged()*. Singular triplets are indexed according to the ordering criterion established with *setWhichSingularTriplets()*.

See also

getConverged, *setWhichSingularTriplets*, SVDGetSingularTriplet

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1314 <slepc4py/SLEPc/SVD.pyx#L1314>`

getWhichSingularTriplets()

Get which singular triplets are to be sought.

Not collective.

Returns
The singular values to be sought (either largest or smallest).

Return type
Which

See also

setWhichSingularTriplets, SVDGetWhichSingularTriplets

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:532 <slepc4py/SLEPc/SVD.pyx#L532>`

isGeneralized()

Tell if the SVD corresponds to a generalized singular value problem.

Not collective.

Returns
True if two matrices were set with *setOperators()*.

Return type
bool

See also

setProblemType, *isHyperbolic*, SVDIsGeneralized

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:446 <slepc4py/SLEPc/SVD.pyx#L446>`

isHyperbolic()

Tell whether the SVD object corresponds to a hyperbolic singular value problem.

Not collective.

Returns
True if the problem was specified as hyperbolic.

Return type
bool

See also

setProblemType, *isGeneralized*, SVDIsHyperbolic

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:465 <slepc4py/SLEPc/SVD.pyx#L465>`

reset()

Reset the SVD object.

Collective.

See also

SVDReset

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:236 <slepc4py/SLEPc/SVD.pyx#L236>`

Return type
None

setBV(*V*, *U=None*)

Set basis vectors objects associated to the SVD solver.

Collective.

Parameters

- **V** (BV) – The basis vectors context for right singular vectors.
- **U** (BV | *None*) – The basis vectors context for left singular vectors.

Return type
None

See also

getBV, SVDSetBV

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:861 <slepc4py/SLEPc/SVD.pyx#L861>`

setConvergenceTest(*conv*)

Set how to compute the error estimate used in the convergence test.

Logically collective.

Parameters
conv (Conv) – The method used to compute the error estimate used in the convergence test.

Return type
None

See also

getConvergenceTest, SVDSetConvergenceTest

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:702 <slepc4py/SLEPc/SVD.pyx#L702>`

setCrossEPS(*eps*)

Set an eigensolver object associated to the singular value solver.

Collective.

Parameters
eps (EPS) – The eigensolver object.

Return type
None

See also

getCrossEPS, SVDCrossSetEPS

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1508 <slepc4py/SLEPc/SVD.pyx#L1508>`

setCrossExplicitMatrix(*flag=True*)

Set if the eigensolver operator A^*A must be computed.

Logically collective.

Parameters
flag (*bool*) – `True` to build A^*A explicitly.

Return type
None

Notes

In GSVD there are two cross product matrices, A^*A and B^*B. In HSVD the expression for the cross product matrix is different, $A^*\Omega A$.

By default the matrices are not built explicitly, but handled as shell matrices

See also

getCrossExplicitMatrix, SVDCrossSetExplicitMatrix

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1545 <slepc4py/SLEPc/SVD.pyx#L1545>`

setCyclicEPS(*eps*)

Set an eigensolver object associated to the singular value solver.

Collective.

Parameters
eps (EPS) – The eigensolver object.

Return type
None

See also

getCyclicEPS, SVDCyclicSetEPS

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1591 <slepc4py/SLEPc/SVD.pyx#L1591>`

setCyclicExplicitMatrix(*flag=True*)

Set if the eigensolver operator $H(A)$ must be computed explicitly.

Logically collective.

Set if the eigensolver operator $H(A) = [0\ A; A^T\ 0]$ must be computed explicitly.

Parameters
flag (*bool*) – `True` if $H(A)$ must be built explicitly.

Return type
None

Notes

In GSVD and HSVD the equivalent eigenvalue problem has generalized form, and hence two matrices are built.

By default the matrices are not built explicitly, but handled as shell matrices.

See also

getCyclicExplicitMatrix, SVDCyclicSetExplicitMatrix

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1628 <slepc4py/SLEPc/SVD.pyx#L1628>`

setDS(*ds*)

Set a direct solver object associated to the singular value solver.

Collective.

Parameters
ds (DS) – The direct solver context.

Return type
None

See also

getDS, SVDSetDS

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:902 <slepc4py/SLEPc/SVD.pyx#L902>`

setDimensions(*nsv=None*, *ncv=None*, *mpd=None*)

Set the number of singular values to compute and the dimension of the subspace.

Logically collective.

Parameters

- **nsv** (*int* | *None*) – Number of singular values to compute.
- **ncv** (*int* | *None*) – Maximum dimension of the subspace to be used by the solver.
- **mpd** (*int* | *None*) – Maximum dimension allowed for the projected problem.

Return type
None

Notes

Use *DETERMINE* for ncv and mpd to assign a reasonably good value, which is dependent on the solution method.

The parameters ncv and mpd are intimately related, so that the user is advised to set one of them at most. Normal usage is the following:

- In cases where nsv is small, the user sets ncv (a reasonable default is 2 * nsv).
- In cases where nsv is large, the user sets mpd.

The value of `ncv` should always be between `nsv` and (`nsv` + `mpd`), typically `ncv` = `nsv` + `mpd`. If `nsv` is not too large, `mpd` = `nsv` is a reasonable choice, otherwise a smaller value should be used.

See also

getDimensions, SVDSetDimensions

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:786 <slepc4py/SLEPc/SVD.pyx#L786>`

setFromOptions()

Set SVD options from the options database.

Collective.

Notes

To see all options, run your program with the `-help` option.

This routine must be called before *setUp()* if the user is to be allowed to set the solver type.

See also

setOptionsPrefix, SVDSetFromOptions

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:384 <slepc4py/SLEPc/SVD.pyx#L384>`

Return type
None

setImplicitTranspose(*mode=True*)

Set how to handle the transpose of the associated matrix.

Logically collective.

Parameters

- **impl** – How to handle the transpose (implicitly or not).
- **mode** (*bool*)

Return type
None

Notes

By default, the transpose of the matrix is explicitly built (if the matrix has defined the `Mat.transpose()` operation).

If this flag is set to `True`, the solver does not build the transpose, but handles it implicitly via `Mat.multTranspose()` (or `Mat.multHermitianTranspose()` in the complex case).

See also

getImplicitTranspose, SVDSetImplicitTranspose

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:505 <slepc4py/SLEPc/SVD.pyx#L505>`

setInitialSpace(*spaceright=None*, *spaceleft=None*)

Set the initial spaces from which the SVD solver starts to iterate.

Collective.

Parameters

- **spaceright** (*list[Vec] | None*) – The right initial space.
- **spaceleft** (*list[Vec] | None*) – The left initial space.

Return type
None

Notes

The initial right and left spaces are rough approximations to the right and/or left singular subspaces from which the solver starts to iterate. It is not necessary to provide both sets of vectors.

Some solvers start to iterate on a single vector (initial vector). In that case, the other vectors are ignored.

These vectors do not persist from one *solve()* call to the other, so the initial spaces should be set every time.

The vectors do not need to be mutually orthonormal, since they are explicitly orthonormalized internally.

Common usage of this function is when the user can provide a rough approximation of the wanted singular spaces. Then, convergence may be faster.

See also

SVDSetInitialSpaces

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1015 <slepc4py/SLEPc/SVD.pyx#L1015>`

setLanczosOneSide(*flag=True*)

Set if the variant of the Lanczos method to be used is one-sided or two-sided.

Logically collective.

Parameters
flag (*bool*) – `True` if the method is one-sided.

Return type
None

Notes

By default, a two-sided variant is selected, which is sometimes slightly more robust. However, the one-sided variant is faster because it avoids the orthogonalization associated to left singular vectors. It also saves the memory required for storing such vectors.

See also

getLanczosOneSide, SVDLanczosSetOneSide

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1679 <slepc4py/SLEPc/SVD.pyx#L1679>`

setMonitor(*monitor*, *args=None*, *kargs=None*)

Append a monitor function to the list of monitors.

Logically collective.

See also

getMonitor, *cancelMonitor*, SVDMonitorSet

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1115 <slepc4py/SLEPc/SVD.pyx#L1115>`

Parameters

- **monitor** (*SVDMonitorFunction | None*)
- **args** (*tuple[Any, ...] | None*)
- **kargs** (*dict[str, Any] | None*)

Return type

None

setOperators(*A*, *B=None*)

Set the matrices associated with the singular value problem.

Collective.

Parameters

- **A** (*Mat*) – The matrix associated with the singular value problem.
- **B** (*Mat | None*) – The second matrix in the case of GSVD.

Return type

None

See also

getOperators, SVDSetOperators

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:946 <slepc4py/SLEPc/SVD.pyx#L946>`

setOptionsPrefix(*prefix=None*)

Set the prefix used for searching for all SVD options in the database.

Logically collective.

Parameters

prefix (*str | None*) – The prefix string to prepend to all SVD option requests.

Return type

None

Notes

A hyphen (-) must NOT be given at the beginning of the prefix name. The first character of all runtime options is AUTOMATICALLY the hyphen.

For example, to distinguish between the runtime options for two different SVD contexts, one could call:

```
S1.setOptionsPrefix("svd1_")
S2.setOptionsPrefix("svd2_")
```

See also

appendOptionsPrefix, *getOptionsPrefix*, SVDGetOptionsPrefix

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:334 <slepc4py/SLEPc/SVD.pyx#L334>`

setProblemType(*problem_type*)

Set the type of the singular value problem.

Logically collective.

Parameters
problem_type (ProblemType) – The problem type to be set.

Return type
None

Notes

The GSVD requires that two matrices have been passed via *setOperators()*. The HSVD requires that a signature matrix has been passed via *setSignature()*.

See also

setOperators, *setSignature*, *getProblemType*, SVDSetProblemType

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:422 <slepc4py/SLEPc/SVD.pyx#L422>`

setSignature(*omega=None*)

Set the signature matrix defining a hyperbolic singular value problem.

Collective.

Parameters
omega (*Vec* | *None*) – A vector containing the diagonal elements of the signature matrix.

Return type
None

See also

getSignature, SVDSetSignature

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:995 <slepc4py/SLEPc/SVD.pyx#L995>`

setStoppingTest(*stopping*, *args=None*, *kargs=None*)

Set a function to decide when to stop the outer iteration of the eigensolver.

Logically collective.

See also

getStoppingTest, SVDSetStoppingTestFunction

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1072 <slepc4py/SLEPc/SVD.pyx#L1072>`

Parameters

- **stopping** (SVDStoppingFunction | *None*)
- **args** (*tuple[Any, ...]* | *None*)
- **kargs** (*dict[str, Any]* | *None*)

Return type
None

setTRLanczosExplicitMatrix(*flag=True*)

Set if the matrix $Z = [A^*, B^*]^*$ must be built explicitly.

Logically collective.

Parameters
flag (*bool*) – `True` if $Z = [A^*, B^*]^*$ is built explicitly.

Return type
None

Notes

This option is relevant for the GSVD case only. Z is the coefficient matrix of the least-squares solver used internally.

See also

getTRLanczosExplicitMatrix, SVDTRLanczosSetExplicitMatrix

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1937 <slepc4py/SLEPc/SVD.pyx#L1937>`

setTRLanczosGBidiag(*bidiag*)

Set the bidiagonalization choice to use in the GSVD TRLanczos solver.

Logically collective.

Parameters
bidiag (TRLanczosGBidiag) – The bidiagonalization choice.

Return type
None

See also

getTRLanczosGBidiag, SVDTRLanczosSetGBidiag

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1774 <slepc4py/SLEPc/SVD.pyx#L1774>`

setTRLanczosKSP(*ksp*)

Set a linear solver object associated to the SVD solver.

Collective.

Parameters
ksp (*KSP*) – The linear solver object.

Return type
None

See also

getTRLanczosKSP, SVDTRLanczosSetKSP

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1900 <slepc4py/SLEPc/SVD.pyx#L1900>`

setTRLanczosLocking(*lock=True*)

Toggle between locking and non-locking variants of TRLanczos.

Logically collective.

Parameters
lock (*bool*) – `True` if the locking variant must be selected.

Return type
None

Notes

The default is to lock converged singular triplets when the method restarts. This behavior can be changed so that all directions are kept in the working subspace even if already converged to working accuracy (the non-locking variant).

See also

getTRLanczosLocking, SVDTRLanczosSetLocking

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1856 <slepc4py/SLEPc/SVD.pyx#L1856>`

setTRLanczosOneSide(*flag=True*)

Set if the variant of the method to be used is one-sided or two-sided.

Logically collective.

Set if the variant of the thick-restart Lanczos method to be used is one-sided or two-sided.

Parameters
flag (*bool*) – `True` if the method is one-sided.

Return type
None

Notes

By default, a two-sided variant is selected, which is sometimes slightly more robust. However, the one-sided variant is faster because it avoids the orthogonalization associated to left singular vectors.

See also

getTRLanczosOneSide, SVDLanczosSetOneSide

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1724 <slepc4py/SLEPc/SVD.pyx#L1724>`

setTRLanczosRestart(*keep*)

Set the restart parameter for the thick-restart Lanczos method.

Logically collective.

Set the restart parameter for the thick-restart Lanczos method, in particular the proportion of basis vectors that must be kept after restart.

Parameters

keep (*float*) – The number of vectors to be kept at restart.

Return type

None

Notes

Allowed values are in the range [0.1,0.9]. The default is 0.5.

See also

getTRLanczosRestart, SVDTRLanczosSetRestart

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1811 <slepc4py/SLEPc/SVD.pyx#L1811>`

setThreshold(*thres*, *rel=False*)

Set the threshold used in the threshold stopping test.

Logically collective.

Parameters

- **thres** (*float*) – The threshold.
- **rel** (*bool*) – Whether the threshold is relative or not.

Return type

None

Notes

This function internally sets a special stopping test based on the threshold, where singular values are computed in sequence until one of the computed singular values is below/above the threshold (depending on whether largest or smallest singular values are computed).

In the case of largest singular values, the threshold can be made relative with respect to the largest singular value (i.e., the matrix norm).

The details are given in SVDSetThreshold.

See also

setStoppingTest, *getThreshold*, SVDSetThreshold

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:591 <slepc4py/SLEPc/SVD.pyx#L591>`

setTolerances(*tol=None*, *max_it=None*)

Set the tolerance and maximum iteration count used.

Logically collective.

Set the tolerance and maximum iteration count used by the default SVD convergence tests.

Parameters

- **tol** (*float* | *None*) – The convergence tolerance.
- **max_it** (*int* | *None*) – The maximum number of iterations

Return type

None

Notes

Use *DETERMINE* for `max_it` to assign a reasonably good value, which is dependent on the solution method.

See also

getTolerances, SVDSetTolerances

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:651 <slepc4py/SLEPc/SVD.pyx#L651>`

setTrackAll(*trackall=True*)

Set flag to compute the residual of all singular triplets.

Logically collective.

Set if the solver must compute the residual of all approximate singular triplets or not.

Parameters

trackall (*bool*) – Whether to compute all residuals or not.

Return type

None

See also

getTrackAll, SVDSetTrackAll

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:740 <slepc4py/SLEPc/SVD.pyx#L740>`

setType(*svd_type*)

Set the particular solver to be used in the SVD object.

Logically collective.

Parameters

svd_type (Type | *str*) – The solver to be used.

Return type
None

Notes

The default is *CROSS*. Normally, it is best to use *setFromOptions()* and then set the SVD type from the options database rather than by using this routine. Using the options database provides the user with maximum flexibility in evaluating the different available methods.

See also

getType, SVDSetType

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:269 <slepc4py/SLEPc/SVD.pyx#L269>`

setUp()

Set up all the internal data structures.

Collective.

Notes

Sets up all the internal data structures necessary for the execution of the singular value solver.

This function need not be called explicitly in most cases, since *solve()* calls it. It can be useful when one wants to measure the set-up time separately from the solve time.

See also

solve, SVDSetUp

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1172 <slepc4py/SLEPc/SVD.pyx#L1172>`

Return type
None

setWhichSingularTriplets(*which*)

Set which singular triplets are to be sought.

Logically collective.

Parameters
which (Which) – The singular values to be sought (either largest or smallest).

Return type
None

See also

getWhichSingularTriplets, SVDSetWhichSingularTriplets

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:551 <slepc4py/SLEPc/SVD.pyx#L551>`

solve()

Solve the singular value problem.

Collective.

Notes

The problem matrices are specified with *setOperators()*.

solve() will return without generating an error regardless of whether all requested solutions were computed or not. Call *getConverged()* to get the actual number of computed solutions, and *getConvergedReason()* to determine if the solver converged or failed and why.

See also

setUp, *setOperators*, *getConverged*, *getConvergedReason*, SVDSolve

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1193 <slepc4py/SLEPc/SVD.pyx#L1193>`

Return type
None

valuesView(*viewer=None*)

Display the computed singular values in a viewer.

Collective.

Parameters
viewer (*Viewer | None*) – Visualization context; if not provided, the standard output is used.

Return type
None

See also

solve, *vectorsView*, *errorView*, SVDValuesView

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1468 <slepc4py/SLEPc/SVD.pyx#L1468>`

vectorsView(*viewer=None*)

Output computed singular vectors to a viewer.

Collective.

Parameters
viewer (*Viewer | None*) – Visualization context; if not provided, the standard output is used.

Return type
None

See also

solve, *valuesView*, *errorView*, SVDVectorsView

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1487 <slepc4py/SLEPc/SVD.pyx#L1487>`

view(*viewer=None*)

Print the SVD data structure.

Collective.

Parameters

viewer (*Viewer* | *None*) – Visualization context; if not provided, the standard output is used.

Return type

None

See also

SVDView

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:203 <slepc4py/SLEPc/SVD.pyx#L203>`

Attributes Documentation

ds

The direct solver (*DS*) object associated.

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:2031 <slepc4py/SLEPc/SVD.pyx#L2031>`

max_it

The maximum iteration count.

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:2015 <slepc4py/SLEPc/SVD.pyx#L2015>`

problem_type

The type of the eigenvalue problem.

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1983 <slepc4py/SLEPc/SVD.pyx#L1983>`

tol

The tolerance.

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:2007 <slepc4py/SLEPc/SVD.pyx#L2007>`

track_all

Compute the residual norm of all approximate eigenpairs.

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:2023 <slepc4py/SLEPc/SVD.pyx#L2023>`

transpose_mode

How to handle the transpose of the matrix.

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1991 <slepc4py/SLEPc/SVD.pyx#L1991>`

which

The portion of the spectrum to be sought.

:sources:`Source code at slepc4py/SLEPc/SVD.pyx:1999 <slepc4py/SLEPc/SVD.pyx#L1999>`

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.Sys

class slepc4py.SLEPc.**Sys**

Bases: object

System utilities.

Methods Summary

getVersion([devel, date, author])	Return SLEPc version information.
getVersionInfo()	Return SLEPc version information.
hasExternalPackage(package)	Return whether SLEPc has support for external package.
isFinalized()	Return whether SLEPc has been finalized.
isInitialized()	Return whether SLEPc has been initialized.

Methods Documentation

classmethod getVersion(*devel=False*, *date=False*, *author=False*)

Return SLEPc version information.

Not collective.

Parameters

- **devel** (*bool*) – Additionally, return whether using an in-development version.
- **date** (*bool*) – Additionally, return date information.
- **author** (*bool*) – Additionally, return author information.

Returns

- **major** (int) – Major version number.
- **minor** (int) – Minor version number.
- **micro** (int) – Micro (or patch) version number.

Return type

tuple[int, int, int]

See also

SlepcGetVersion, SlepcGetVersionNumber

:sources:`Source code at slepc4py/SLEPc/Sys.pyx:8 <slepc4py/SLEPc/Sys.pyx#L8>`

classmethod getVersionInfo()

Return SLEPc version information.

Not collective.

Returns
info – Dictionary with version information.

Return type
dict

See also

SlepcGetVersion, SlepcGetVersionNumber

:sources:`Source code at slepc4py/SLEPc/Sys.pyx:64 <slepc4py/SLEPc/Sys.pyx#L64>`

classmethod hasExternalPackage(*package*)

Return whether SLEPc has support for external package.

Not collective.

Parameters
package (*str*) – The external package name.

Return type
bool

See also

SlepcHasExternalPackage

:sources:`Source code at slepc4py/SLEPc/Sys.pyx:118 <slepc4py/SLEPc/Sys.pyx#L118>`

classmethod isFinalized()

Return whether SLEPc has been finalized.

Not collective.

See also

isInitialized

:sources:`Source code at slepc4py/SLEPc/Sys.pyx:103 <slepc4py/SLEPc/Sys.pyx#L103>`

Return type
bool

classmethod isInitialized()

Return whether SLEPc has been initialized.

Not collective.

See also

isFinalized

:sources:`Source code at slepc4py/SLEPc/Sys.pyx:90 <slepc4py/SLEPc/Sys.pyx#L90>`

Return type
bool

__init__()

classmethod __new__(**args*, ***kwargs*)

slepc4py.SLEPc.Util

class slepc4py.SLEPc.**Util**

Bases: object

Other utilities such as the creation of structured matrices.

Methods Summary

createMatBSE(R, C)	Create a matrix that can be used to define a BSE type problem.
createMatHamiltonian(A, B, C)	Create matrix to be used for a structured Hamiltonian eigenproblem.
createMatLREP(AK, BM[, red])	Create a matrix that can be used to define a LREP type problem.

Methods Documentation

classmethod createMatBSE(*R*, *C*)

Create a matrix that can be used to define a BSE type problem.

Collective.

Create a matrix that can be used to define a structured eigenvalue problem of type BSE (Bethe-Salpeter Equation).

Parameters

- **R** (*petsc4py.PETSc.Mat*) – The matrix for the diagonal block (resonant).
- **C** (*petsc4py.PETSc.Mat*) – The matrix for the off-diagonal block (coupling).

Returns

The matrix with the block form $H = [R\ C; -C^*\ -R^T]$.

Return type
petsc4py.PETSc.Mat

See also

MatCreateBSE

:sources:`Source code at slepc4py/SLEPc/Util.pyx:8 <slepc4py/SLEPc/Util.pyx#L8>`

classmethod createMatHamiltonian(*A*, *B*, *C*)

Create matrix to be used for a structured Hamiltonian eigenproblem.

Collective.

Parameters

- **A** (*petsc4py.PETSc.Mat*) – The matrix for (0,0) block.
- **B** (*petsc4py.PETSc.Mat*) – The matrix for (0,1) block, must be real symmetric or Hermitian.
- **C** (*petsc4py.PETSc.Mat*) – The matrix for (1,0) block, must be real symmetric or Hermitian.

Returns

The matrix with the block form $H = [A\ B; C\ -A^*]$.

Return type

petsc4py.PETSc.Mat

See also

MatCreateHamiltonian

:sources:`Source code at slepc4py/SLEPc/Util.pyx:38 <slepc4py/SLEPc/Util.pyx#L38>`

classmethod createMatLREP(*AK*, *BM*, *red=False*)

Create a matrix that can be used to define a LREP type problem.

Collective.

Create a matrix that can be used to define a structured Linear Response eigenvalue problem.

Parameters

- **AK** (*petsc4py.PETSc.Mat*) – The matrix for the diagonal block or the top block.
- **BM** (*petsc4py.PETSc.Mat*) – The matrix for the off-diagonal block or the bottom block.
- **red** (*bool*) – Whether the reduced form should be built.

Returns

The matrix with the block form $H = [A\ B; -B\ -A]$ (non-reduced) or $H = [0\ K; M\ 0]$ (reduced).

Return type

petsc4py.PETSc.Mat

See also

MatCreateLREP

:sources:`Source code at slepc4py/SLEPc/Util.pyx:67 <slepc4py/SLEPc/Util.pyx#L67>`

__init__()

classmethod __new__(**args*, ***kwargs*)

Attributes

DECIDE	Constant DECIDE of type int
DEFAULT	Constant DEFAULT of type int
DETERMINE	Constant DETERMINE of type int
CURRENT	Constant CURRENT of type int

slepc4py.SLEPc.DECIDE

slepc4py.SLEPc.**DECIDE**: int = **DECIDE**

Constant DECIDE of type int

slepc4py.SLEPc.DEFAULT

slepc4py.SLEPc.**DEFAULT**: int = **DEFAULT**

Constant DEFAULT of type int

slepc4py.SLEPc.DETERMINE

slepc4py.SLEPc.**DETERMINE**: int = **DETERMINE**

Constant DETERMINE of type int

slepc4py.SLEPc.CURRENT

slepc4py.SLEPc.**CURRENT**: int = **CURRENT**

Constant CURRENT of type int

3.7 slepc4py demos

ex1.py: Standard symmetric eigenproblem for the 1-D Laplacian

This example computes eigenvalues and eigenvectors of the discrete Laplacian on a one-dimensional domain with finite differences.

The full source code for this demo can be downloaded here.

The first thing to do is initialize the libraries. This is normally not required, as it is done automatically at import time. However, if you want to gain access to the facilities for setting command-line options, the following lines must be executed by the main script prior to any petsc4py or slepc4py calls:

```
import sys
import slepc4py

slepc4py.init(sys.argv)
```

Next, we have to import the relevant modules. Normally, both PETSc and SLEPc modules have to be imported in all slepc4py programs.

```
from petsc4py import PETSc
from slepc4py import SLEPc
```

At this point, we can use any petsc4py and slepc4py operations. For instance, the following lines allow the user to specify an integer command-line argument `n` with a default value of 30 (see below for example usage of command-line options):

```
opts = PETSc.Options()
n = opts.getInt('n', 30)
```

It is necessary to build a matrix to define an eigenproblem (or two in the case of generalized eigenproblems). The following fragment of code creates the matrix object and then fills the non-zero elements one by one. The matrix of this particular example is tridiagonal, with value 2 in the diagonal, and -1 in off-diagonal positions. See petsc4py documentation for details about matrix objects:

```
A = PETSc.Mat().create()
A.setSizes([n, n])
A.setFromOptions()

rstart, rend = A.getOwnershipRange()

# first row
if rstart == 0:
    A[0, :2] = [2, -1]
    rstart += 1
# last row
if rend == n:
    A[n - 1, -2:] = [-1, 2]
    rend -= 1
# other rows
for i in range(rstart, rend):
    A[i, i - 1 : i + 2] = [-1, 2, -1]

A.assemble()
```

The solver object is created in a similar way as other objects in petsc4py:

```
E = SLEPc.EPS().create()
```

Once the object is created, the eigenvalue problem must be specified. At least one matrix must be provided. The problem type must be indicated as well, in this case it is HEP (Hermitian eigenvalue problem). Apart from these, other settings could be provided here (for instance, the tolerance for the computation). After all options have been set, the user should call the *setFromOptions()* operation, so that any options specified at run time in the command line are passed to the solver object:

```
E.setOperators(A)
E.setProblemType(SLEPc.EPS.ProblemType.HEP)

history = []


def monitor(eps, its, nconv, eig, err):
    if nconv < len(err):
        history.append(err[nconv])


E.setMonitor(monitor)

E.setFromOptions()
```

After that, the *solve()* method will run the selected eigensolver, keeping the solution stored internally:

```
E.solve()
```

Once the computation has finished, we are ready to print the results. First, some informative data can be retrieved from the solver object:

```
Print = PETSc.Sys.Print

Print()
Print('******************************')
Print('*** SLEPc Solution Results ***')
Print('******************************')
Print()

its = E.getIterationNumber()
Print(f'Number of iterations of the method: {its}')

eps_type = E.getType()
Print(f'Solution method: {eps_type}')

nev, ncv, mpd = E.getDimensions()
Print(f'Number of requested eigenvalues: {nev}')

tol, maxit = E.getTolerances()
Print(f'Stopping condition: tol={tol:.4g}, maxit={maxit}')
```

For retrieving the solution, it is necessary to find out how many eigenpairs have converged to the requested precision:

```
nconv = E.getConverged()
Print(f'Number of converged eigenpairs {nconv}')
```

For each of the `nconv` eigenpairs, we can retrieve the eigenvalue `k`, and the eigenvector, which is represented by means of two petsc4py vectors `vr` and `vi` (the real and imaginary part of the eigenvector, since for real matrices the eigenvalue and eigenvector may be complex). In this example we know that both the eigenvalue and eigenvector are real, so only one vector `v` is needed. We also compute the corresponding relative errors in order to make sure that the computed solution is indeed correct:

```
if nconv > 0:
    # Create the results vectors
    v, _ = A.createVecs()
    Print()
    Print('        k          ||Ax-kx||/||kx|| ')
    Print('----------------- ------------------')
    for i in range(nconv):
        k = E.getEigenpair(i, v)
        error = E.computeError(i)
        Print(f'     {k:.6f}        {error:.6g}')
    Print()
```

Example of command-line usage

Now we illustrate how to specify command-line options in order to extract the full potential of slepc4py.

A simple execution of the `demo/ex1.py` script will result in the following output:

```
$ python demo/ex1.py

******************************
*** SLEPc Solution Results ***
******************************

Number of iterations of the method: 4
Solution method: krylovschur
Number of requested eigenvalues: 1
Stopping condition: tol=1e-07, maxit=100
Number of converged eigenpairs 4

    k          ||Ax-kx||/||kx||
----------------- ------------------
     3.989739          5.76012e-09
     3.959060          1.41957e-08
     3.908279          6.74118e-08
     3.837916          8.34269e-08
```

For specifying different setting for the solver parameters, we can use SLEPc command-line options with the `-eps` prefix. For instance, to change the number of requested eigenvalues and the tolerance:

```
$ python demo/ex1.py -eps_nev 10 -eps_tol 1e-11
```

The method used by the solver object can also be set at run time:

```
$ python demo/ex1.py -eps_type subspace
```

All the above settings can also be changed within the source code by making use of the appropriate slepc4py method. Since options can be set from within the code and the command-line, it is often useful to view the particular settings that are currently being used:

```
$ python demo/ex1.py -eps_view

EPS Object: 1 MPI process
  type: krylovschur
    50% of basis vectors kept after restart
    using the locking variant
  problem type: symmetric eigenvalue problem
  selected portion of the spectrum: largest eigenvalues in magnitude
  number of eigenvalues (nev): 1
  number of column vectors (ncv): 16
  maximum dimension of projected problem (mpd): 16
  maximum number of iterations: 100
  tolerance: 1e-08
  convergence test: relative to the eigenvalue
BV Object: 1 MPI process
  type: mat
  17 columns of global length 30
  orthogonalization method: classical Gram-Schmidt
  orthogonalization refinement: if needed (eta: 0.7071)
  block orthogonalization method: GS
  doing matmult as a single matrix-matrix product
```

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```
DS Object: 1 MPI process
  type: hep
  solving the problem with: Implicit QR method (_steqr)
ST Object: 1 MPI process
  type: shift
  shift: 0
  number of matrices: 1
```

Note that for computing eigenvalues of smallest magnitude we can use the option `-eps_smallest_magnitude`, but for interior eigenvalues things are not so straightforward. One possibility is to try with harmonic extraction, for instance to get the eigenvalues closest to 0.6:

```
$ python demo/ex1.py -eps_harmonic -eps_target 0.6
```

Depending on the problem, harmonic extraction may fail to converge. In those cases, it is necessary to specify a spectral transformation other than the default. In the command-line, this is indicated with the `-st_` prefix. For example, shift-and-invert with a value of the shift equal to 0.6 would be:

```
$ python demo/ex1.py -st_type sinvert -eps_target 0.6
```

ex2.py: Standard symmetric eigenproblem for the 2-D Laplacian

This example computes eigenvalues and eigenvectors of the discrete Laplacian on a two-dimensional domain with finite differences.

The full source code for this demo can be downloaded here.

Initialization is similar to previous examples.

```
import sys
import slepc4py

slepc4py.init(sys.argv)

from petsc4py import PETSc
from slepc4py import SLEPc

Print = PETSc.Sys.Print
```

In this example we have organized the code in several functions. This one builds the finite-difference Laplacian matrix by computing the indices of each entry. An alternative would be to use the functionality offered by DMDA.

```
def construct_operator(m, n):
    # Create matrix for 2D Laplacian operator
    A = PETSc.Mat().create()
    A.setSizes([m * n, m * n])
    A.setFromOptions()
    # Fill matrix
    hx = 1.0 / (m - 1)  # x grid spacing
    hy = 1.0 / (n - 1)  # y grid spacing
    diagv = 2.0 * hy / hx + 2.0 * hx / hy
    offdx = -1.0 * hy / hx
    offdy = -1.0 * hx / hy
    Istart, Iend = A.getOwnershipRange()
```

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```
    for i in range(Istart, Iend):
        A[i, i] = diagv
        gi = i // n  # map row number to
        gj = i - gi * n  # grid coordinates
        if gi > 0:
            j = i - n
            A[i, j] = offdx
        if gi < m - 1:
            j = i + n
            A[i, j] = offdx
        if gj > 0:
            j = i - 1
            A[i, j] = offdy
        if gj < n - 1:
            j = i + 1
            A[i, j] = offdy
    A.assemble()
    return A
```

This function receives the matrix and the problem type, then solves the eigenvalue problem and prints information about the computed solution. Although we know that eigenvalues and eigenvectors are real in this example, the function is prepared to solve it as a non-symmetric problem, by passing *SLEPc.EPS.ProblemType.NHEP*, that is why the code handles possibly complex eigenvalues and eigenvectors.

```
def solve_eigensystem(A, problem_type=SLEPc.EPS.ProblemType.HEP):
    # Create the result vectors
    xr, xi = A.createVecs()

    # Setup the eigensolver
    E = SLEPc.EPS().create()
    E.setOperators(A, None)
    E.setDimensions(3, PETSc.DECIDE)
    E.setProblemType(problem_type)
    E.setFromOptions()

    # Solve the eigensystem
    E.solve()

    Print('')
    its = E.getIterationNumber()
    Print(f'Number of iterations of the method: {its}')
    sol_type = E.getType()
    Print(f'Solution method: {sol_type}')
    nev, _ncv, _mpd = E.getDimensions()
    Print(f'Number of requested eigenvalues: {nev}')
    tol, maxit = E.getTolerances()
    Print(f'Stopping condition: tol={tol:.4g}, maxit={maxit}')
    nconv = E.getConverged()
    Print(f'Number of converged eigenpairs: {nconv}')
    if nconv > 0:
        Print('')
        Print('        k          ||Ax-kx||/||kx|| ')
```

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```
        Print('----------------- ------------------')
        for i in range(nconv):
            k = E.getEigenpair(i, xr, xi)
            error = E.computeError(i)
            if k.imag != 0.0:
                Print(f' {k.real:9f}{k.imag:+9f} j  {error:12g}')
            else:
                Print(f' {k.real:12f}       {error:12g}')
        Print('')
```

The main program simply processes three user-defined command-line options and calls the other two functions.

```
def main():
    opts = PETSc.Options()
    N = opts.getInt('N', 32)
    m = opts.getInt('m', N)
    n = opts.getInt('n', m)
    Print(f'Symmetric Eigenproblem (sparse matrix), N={m * n} ({m}x{n} grid)')
    A = construct_operator(m, n)
    solve_eigensystem(A)


if __name__ == '__main__':
    main()
```

ex3.py: Matrix-free eigenproblem for the 2-D Laplacian

This example solves the eigenproblem for the 2-D discrete Laplacian without building the matrix explicitly.

The full source code for this demo can be downloaded here.

Initialization is similar to previous examples.

```
import sys
import slepc4py

slepc4py.init(sys.argv)

from petsc4py import PETSc
from slepc4py import SLEPc
import numpy as np
```

In this case, the program cannot be run in parallel, so we check that the number of MPI processes is 1. In order to enable parallelism, we should implement a parallel matrix-vector operation ourselves, which is not done in this example.

```
Print = PETSc.Sys.Print

if PETSc.COMM_WORLD.getSize() > 1:
    Print('Demo should only be executed with one MPI process')
    sys.exit(0)
```

This function computes the matrix-vector product f = L*x where the Laplacian L is not built explicitly, and the vectors x,f are viewed as two-dimensional arrays associated to grid points.

```
def laplace2d(U, x, f):
    U[:, :] = 0
    U[1:-1, 1:-1] = x
    # Grid spacing
    m, n = x.shape
    hx = 1.0 / (m - 1)  # x grid spacing
    hy = 1.0 / (n - 1)  # y grid spacing
    # Setup 5-points stencil
    u = U[1:-1, 1:-1]  # center
    uN = U[1:-1, :-2]  # north
    uS = U[1:-1, 2:]  # south
    uW = U[:-2, 1:-1]  # west
    uE = U[2:, 1:-1]  # east
    # Apply Laplacian
    f[:, :] = (2 * u - uE - uW) * (hy / hx) + (2 * u - uN - uS) * (hx / hy)
```

For a matrix-free solution in slepc4py we have to create a class that wraps the matrix-vector operation and optionally other operations of the matrix. In this case, we provide the constructor and the `mult` operation, that simply calls the `laplace2d` function above.

```
class Laplacian2D:
    def __init__(self, m, n):
        self.m, self.n = m, n
        scalar = PETSc.ScalarType
        self.U = np.zeros([m + 2, n + 2], dtype=scalar)

    def mult(self, A, x, y):
        m, n = self.m, self.n
        xx = x.getArray(readonly=1).reshape(m, n)
        yy = y.getArray(readonly=0).reshape(m, n)
        laplace2d(self.U, xx, yy)
```

In this example, building the matrix amounts to creating an object of the class defined above, and passing it to a special petsc4py matrix with `createPython()`.

```
def construct_operator(m, n):
    # Create shell matrix
    context = Laplacian2D(m, n)
    return PETSc.Mat().createPython([m * n, m * n], context)
```

This function receives the matrix and the problem type, then solves the eigenvalue problem and prints information about the computed solution. Although we know that eigenvalues and eigenvectors are real in this example, the function is prepared to solve it as a non-symmetric problem, by passing *SLEPc.EPS.ProblemType.NHEP*, that is why the code handles possibly complex eigenvalues and eigenvectors.

```
def solve_eigensystem(A, problem_type=SLEPc.EPS.ProblemType.HEP):
    # Create the result vectors
    xr, xi = A.createVecs()

    # Setup the eigensolver
    E = SLEPc.EPS().create()
    E.setOperators(A, None)
    E.setDimensions(3, PETSc.DECIDE)
```

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```
    E.setProblemType(problem_type)
    E.setFromOptions()

    # Solve the eigensystem
    E.solve()
    Print('')
    its = E.getIterationNumber()
    Print(f'Number of iterations of the method:{its}')
    sol_type = E.getType()
    Print(f'Solution method: {sol_type}')
    nev, _ncv, _mpd = E.getDimensions()
    Print(f'Number of requested eigenvalues: {nev}')
    tol, maxit = E.getTolerances()
    Print(f'Stopping condition: tol={tol:.4g}, maxit={maxit}')
    nconv = E.getConverged()
    Print(f'Number of converged eigenpairs: {nconv}')
    if nconv > 0:
        Print('')
        Print('        k          ||Ax-kx||/||kx|| ')
        Print('----------------- ------------------')
        for i in range(nconv):
            k = E.getEigenpair(i, xr, xi)
            error = E.computeError(i)
            if k.imag != 0.0:
                Print(f' {k.real:9f}{k.imag:+9f} j  {error:12g}')
            else:
                Print(f' {k.real:12f}       {error:12g}')
        Print('')
```

The main program simply processes three user-defined command-line options and calls the other two functions.

```
def main():
    opts = PETSc.Options()
    N = opts.getInt('N', 32)
    m = opts.getInt('m', N)
    n = opts.getInt('n', m)
    Print(f'Symmetric Eigenproblem (sparse matrix), N={m * n} ({m}x{n} grid)')
    A = construct_operator(m, n)
    solve_eigensystem(A)


if __name__ == '__main__':
    main()
```

ex4.py: Singular value decomposition of the Lauchli matrix

This example illustrates the use of the SVD solver in slepc4py. It computes singular values and vectors of the Lauchli matrix, whose condition number depends on a parameter `mu`.

The full source code for this demo can be downloaded here.

Initialization is similar to previous examples.

```
import sys
import slepc4py

slepc4py.init(sys.argv)

from petsc4py import PETSc
from slepc4py import SLEPc

Print = PETSc.Sys.Print
```

This example takes two command-line arguments, the matrix size `n` and the `mu` parameter.

```
opts = PETSc.Options()
n = opts.getInt('n', 30)
mu = opts.getReal('mu', 1e-6)

Print(f'Lauchli singular value decomposition, ({n + 1} x {n}) mu={mu}\n')
```

Create the matrix and fill its nonzero entries. Every MPI process will insert its locally owned part only.

```
A = PETSc.Mat().create()
A.setSizes([n + 1, n])
A.setFromOptions()

rstart, rend = A.getOwnershipRange()

for i in range(rstart, rend):
    if i == 0:
        for j in range(n):
            A[0, j] = 1.0
    else:
        A[i, i - 1] = mu

A.assemble()
```

The singular value solver is similar to the eigensolver used in previous examples. In this case, we select the thick-restart Lanczos bidiagonalization method.

```
S = SLEPc.SVD().create()

S.setOperator(A)
S.setType(S.Type.TRLANCZOS)
S.setFromOptions()

S.solve()
```

After solve, we print some informative data and extract the computed solution, showing the list of singular values and the corresponding residual errors.

```
Print('******************************')
Print('*** SLEPc Solution Results ***')
Print('******************************\n')
```

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```
svd_type = S.getType()
Print(f'Solution method: {svd_type}')

its = S.getIterationNumber()
Print(f'Number of iterations of the method: {its}')

nsv, _ncv, _mpd = S.getDimensions()
Print(f'Number of requested singular values: {nsv}')

tol, maxit = S.getTolerances()
Print(f'Stopping condition: tol={tol:.4g}, maxit={maxit}')

nconv = S.getConverged()
Print(f'Number of converged approximate singular triplets {nconv}')

if nconv > 0:
    v, u = A.createVecs()
    Print()
    Print('    sigma       residual norm ')
    Print('-------------  ---------------')
    for i in range(nconv):
        sigma = S.getSingularTriplet(i, u, v)
        error = S.computeError(i)
        Print(f'   {sigma:6f}     {error:12g}')
    Print()
```

ex5.py: Simple quadratic eigenvalue problem

This example solves a polynomial eigenvalue problem of degree 2, which is the most commonly found in applications. Larger degree polynomials are handled similarly. The coefficient matrices in this example do not come from an application, they are just simple matrices that are easy to build, just to illustrate how it works. The eigenvalues in this example are purely imaginary and come in conjugate pairs.

The full source code for this demo can be downloaded here.

Initialization is similar to previous examples.

```
import sys
import slepc4py

slepc4py.init(sys.argv)

from petsc4py import PETSc
from slepc4py import SLEPc

Print = PETSc.Sys.Print
```

A function to build the matrices. The lowest degree coefficient is the 2-D Laplacian, the highest degree one is the identity matrix, and the other matrix is set to zero (which means that this problem could have been solved as a linear eigenproblem).

```
def construct_operators(m, n):
    Print(f'Quadratic Eigenproblem, N={m * n} ({m}x{n} grid)')
```

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```
    # K is the 2-D Laplacian
    K = PETSc.Mat().create()
    K.setSizes([n * m, n * m])
    K.setFromOptions()
    Istart, Iend = K.getOwnershipRange()
    for i in range(Istart, Iend):
        v = -1.0
        gi = i // n
        gj = i - gi * n
        if gi > 0:
            j = i - n
            K[i, j] = v
        if gi < m - 1:
            j = i + n
            K[i, j] = v
        if gj > 0:
            j = i - 1
            K[i, j] = v
        if gj < n - 1:
            j = i + 1
            K[i, j] = v
        v = 4.0
        K[i, i] = v
    K.assemble()
    # C is the zero matrix
    C = PETSc.Mat().create()
    C.setSizes([n * m, n * m])
    C.setFromOptions()
    C.assemble()
    # M is the identity matrix
    M = PETSc.Mat().createConstantDiagonal([n * m, n * m], 1.0)

    return M, C, K
```

The polynomial eigenvalue solver is similar to the linear eigensolver used in previous examples. The main difference is that we must provide a list of matrices, from lowest to highest degree.

```
def solve_eigensystem(M, C, K):
    # Setup the eigensolver
    Q = SLEPc.PEP().create()
    Q.setOperators([K, C, M])
    Q.setDimensions(6)
    Q.setProblemType(SLEPc.PEP.ProblemType.GENERAL)
    Q.setFromOptions()
    # Solve the eigensystem
    Q.solve()
    # Create the result vectors
    xr, xi = K.createVecs()

    its = Q.getIterationNumber()
    Print(f'Number of iterations of the method: {its}')
    sol_type = Q.getType()
```

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```
    Print(f'Solution method: {sol_type}')
    nev, _ncv, _mpd = Q.getDimensions()
    Print('')
    Print(f'Number of requested eigenvalues: {nev}')
    tol, maxit = Q.getTolerances()
    Print(f'Stopping condition: tol={tol:.4g}, maxit={maxit}')
    nconv = Q.getConverged()
    Print(f'Number of converged approximate eigenpairs: {nconv}')
    if nconv > 0:
        Print('')
        Print('          k           ||(k^2M+Ck+K)x||/||kx|| ')
        Print('--------------------- -------------------------')
        for i in range(nconv):
            k = Q.getEigenpair(i, xr, xi)
            error = Q.computeError(i)
            if k.imag != 0.0:
                Print(f'{k.real:9f}{k.imag:+9f} j    {error:12g}')
            else:
                Print(f'{k.real:12f}         {error:12g}')
    Print('')
```

The main program simply processes two user-defined command-line options (the dimensions of the mesh) and calls the other two functions.

```
if __name__ == '__main__':
    opts = PETSc.Options()
    m = opts.getInt('m', 32)
    n = opts.getInt('n', m)
    M, C, K = construct_operators(m, n)
    solve_eigensystem(M, C, K)
    M = C = K = None
```

ex6.py: Compute exp(t*A)*v for a matrix from a Markov model

This example illustrates the functionality in slepc4py for computing matrix functions, or more precisely, the application of a matrix function on a given vector. The example works with the exponential function, which is most commonly found in applications.

The main focus of slepc4py is eigenvalue and singular value problems, but it has some codes to deal with matrix functions, which sometimes are needed in the context of eigenproblems, but have interest on their own.

The full source code for this demo can be downloaded here.

Initialization is similar to previous examples.

```
import sys
import slepc4py

slepc4py.init(sys.argv)

from petsc4py import PETSc
from slepc4py import SLEPc

Print = PETSc.Sys.Print
```

This function builds a matrix that implements a Markov model of a random walk on a triangular grid. The entries of the matrix represent probabilities of moving to neighboring cells in the grid.

```
def build_matrix(m):
    N = m * (m + 1) / 2
    Print(f'Markov y=exp(t*A)*e_1, N={N} (m={m})')
    A = PETSc.Mat().create()
    A.setSizes([N, N])
    A.setFromOptions()
    Istart, Iend = A.getOwnershipRange()
    ix = 0
    cst = 0.5 / (m - 1)
    for i in range(1, m + 1):
        jmax = m - i + 1
        for j in range(1, jmax + 1):
            ix = ix + 1
            if ix - 1 < Istart or ix > Iend:
                continue  # compute only owned rows
            if j != jmax:
                pd = cst * (i + j - 1)
                # north
                if i == 1:
                    A[ix - 1, ix] = 2 * pd
                else:
                    A[ix - 1, ix] = pd
                # east
                if j == 1:
                    A[ix - 1, ix + jmax - 1] = 2 * pd
                else:
                    A[ix - 1, ix + jmax - 1] = pd
            # south
            pu = 0.5 - cst * (i + j - 3)
            if j > 1:
                A[ix - 1, ix - 2] = pu
            # west
            if i > 1:
                A[ix - 1, ix - jmax - 2] = pu

    A.assemble()
    return A
```

The following function solves the problem. This case is quite different from eigenproblems, and is more similar to solving a linear system of equations with KSP. To configure the problem we must provide the matrix and the function (the exponential in this case). Note how the internal *FN* object is extracted from the *MFN* solver. Also, it is often necessary to specify a scale factor, which in this case represents the time for which we want to obtain the evolved state. Once the solver is set up, we call *solve()* passing the right-hand side vector `b` and the solution vector `x`.

```
def solve_exp(t, A, b, x):
    # Setup the solver
    M = SLEPc.MFN().create()
    M.setOperator(A)
    f = M.getFN()
    f.setType(SLEPc.FN.Type.EXP)
    f.setScale(t)
```

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```
    M.setTolerances(1e-7)
    M.setFromOptions()
    # Solve the problem
    M.solve(b, x)

    its = M.getIterationNumber()
    Print(f'Number of iterations of the method: {its}')
    sol_type = M.getType()
    Print(f'Solution method: {sol_type}')
    ncv = M.getDimensions()
    Print('')
    Print(f'Subspace dimension: {ncv}')
    tol, maxit = M.getTolerances()
    Print(f'Stopping condition: tol={tol:.4g}, maxit={maxit}')
    Print(f'Computed vector at time t={t.real:.4g} has norm {x.norm():g}')
    Print('')
```

The main program processes the command-line option `m` (size of the grid), builds the matrix and calls the solver. Note how the vectors are created from the matrix. In this case, the right-hand side vector is the first element of the canonical basis.

```
if __name__ == '__main__':
    opts = PETSc.Options()
    m = opts.getInt('m', 15)
    A = build_matrix(m)  # transition probability matrix
    x, b = A.createVecs()
    x.set(0)
    b.set(0)
    b[0] = 1
    b.assemble()
    t = 2
    solve_exp(t, A, b, x)  # compute x=exp(t*A)*b
    A = None
    b = x = None
```

ex7.py: Nonlinear eigenproblem with callback functions

This example solves a nonlinear eigenvalue problem arising from the the discretization of a PDE on a one-dimensional domain with finite differences. The nonlinearity comes from the boundary conditions. The PDE is

$$-u'' = \lambda u$$

defined on the interval [0,1] and subject to the boundary conditions

$$u(0) = 0, u'(1) = u(1)\lambda\frac{\kappa}{\kappa - \lambda},$$

where λ is the eigenvalue and κ is a parameter.

The full source code for this demo can be downloaded here.

Initialization is similar to previous examples.

```
import sys
import slepc4py

slepc4py.init(sys.argv)

from petsc4py import PETSc
from slepc4py import SLEPc
from numpy import sqrt, sin

Print = PETSc.Sys.Print
```

When implementing a nonlinear eigenproblem with callback functions we must provide code that builds the function matrix $T(\lambda)$ for a given λ and optionally the Jacobian matrix $T'(\lambda)$, i.e., the derivative with respect to the eigenvalue.

In slepc4py the callbacks are integrated in a class. In this example, apart from the constructor, we have three methods:

- `formFunction` to fill the function matrix `F`. Note that `F` is received as an argument and we just need to fill its entries using the value of the parameter `mu`. Matrix `B` is used to build the preconditioner, and is usually equal to `F`.
- `formJacobian` to fill the Jacobian matrix `J`. Some eigensolvers do not need this, but it is recommended to implement it.
- `checkSolution` is just a convenience method to check that a given solution satisfies the PDE.

```
class MyPDE:
    def __init__(self, kappa, h):
        self.kappa = kappa
        self.h = h

    def formFunction(self, nep, mu, F, B):
        n, _ = F.getSize()
        Istart, Iend = F.getOwnershipRange()
        i1 = Istart
        if Istart == 0:
            i1 = i1 + 1
        i2 = Iend
        if Iend == n:
            i2 = i2 - 1
        h = self.h
        c = self.kappa / (mu - self.kappa)
        d = n

        # Interior grid points
        for i in range(i1, i2):
            val = -d - mu * h / 6.0
            F[i, i - 1] = val
            F[i, i] = 2.0 * (d - mu * h / 3.0)
            F[i, i + 1] = val

        # Boundary points
        if Istart == 0:
            F[0, 0] = 2.0 * (d - mu * h / 3.0)
            F[0, 1] = -d - mu * h / 6.0
        if Iend == n:
```

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```
            F[n - 1, n - 2] = -d - mu * h / 6.0
            F[n - 1, n - 1] = d - mu * h / 3.0 + mu * c

        F.assemble()
        if B != F:
            B.assemble()
        return PETSc.Mat.Structure.SAME_NONZERO_PATTERN

    def formJacobian(self, nep, mu, J):
        n, _ = J.getSize()
        Istart, Iend = J.getOwnershipRange()
        i1 = Istart
        if Istart == 0:
            i1 = i1 + 1
        i2 = Iend
        if Iend == n:
            i2 = i2 - 1
        h = self.h
        c = self.kappa / (mu - self.kappa)

        # Interior grid points
        for i in range(i1, i2):
            J[i, i - 1] = -h / 6.0
            J[i, i] = -2.0 * h / 3.0
            J[i, i + 1] = -h / 6.0

        # Boundary points
        if Istart == 0:
            J[0, 0] = -2.0 * h / 3.0
            J[0, 1] = -h / 6.0
        if Iend == n:
            J[n - 1, n - 2] = -h / 6.0
            J[n - 1, n - 1] = -h / 3.0 - c * c

        J.assemble()
        return PETSc.Mat.Structure.SAME_NONZERO_PATTERN

    def checkSolution(self, mu, y):
        nu = sqrt(mu)
        u = y.duplicate()
        Istart, Iend = J.getOwnershipRange()
        h = self.h
        for i in range(Istart, Iend):
            x = (i + 1) * h
            u[i] = sin(nu * x)
        u.assemble()
        u.normalize()
        u.axpy(-1.0, y)
        return u.norm()
```

We use an auxiliary function `FixSign` to force the computed eigenfunction to be real and positive, since some eigensolvers may return the eigenvector multiplied by a complex number of modulus one.

```
def FixSign(x):
    comm = x.getComm()
    rank = comm.getRank()
    n = 1 if rank == 0 else 0
    aux = PETSc.Vec().createMPI((n, PETSc.DECIDE), comm=comm)
    if rank == 0:
        aux[0] = x[0]
    aux.assemble()
    x0 = aux.sum()
    sign = x0 / abs(x0)
    x.scale(1.0 / sign)
```

The main program processes two command-line options, `n` (size of the grid) and `kappa` (the parameter of the PDE), then creates an object of the class we have defined previously.

```
opts = PETSc.Options()
n = opts.getInt('n', 128)
kappa = opts.getReal('kappa', 1.0)
pde = MyPDE(kappa, 1.0 / n)
```

In order to set up the solver we have to pass the two callback functions (methods of the class) together with the matrix objects that will be used every time these methods are called. In this simple example we can do a preallocation of the matrices, although this is not necessary.

```
nep = SLEPc.NEP().create()
F = PETSc.Mat().create()
F.setSizes([n, n])
F.setType('aij')
F.setPreallocationNNZ(3)
nep.setFunction(pde.formFunction, F)

J = PETSc.Mat().create()
J.setSizes([n, n])
J.setType('aij')
J.setPreallocationNNZ(3)
nep.setJacobian(pde.formJacobian, J)
```

After setting some options, we can solve the problem. Here we also illustrate how to pass an initial guess to the solver.

```
nep.setTolerances(tol=1e-9)
nep.setDimensions(1)
nep.setFromOptions()

x = F.createVecs('right')
x.set(1.0)
nep.setInitialSpace(x)
nep.solve()
```

Once the solver has finished, we print some information together with the computed solution. For each computed eigenpair, we print the residual norm and also the error estimated with the class method `checkSolution`.

```
its = nep.getIterationNumber()
Print(f'Number of iterations of the method: {its}')
```

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```
sol_type = nep.getType()
Print(f'Solution method: {sol_type}')
_nev, ncv, _mpd = nep.getDimensions()
Print('')
Print(f'Subspace dimension: {ncv}')
tol, maxit = nep.getTolerances()
Print(f'Stopping condition: tol={tol:.4g}')
Print('')

nconv = nep.getConverged()
Print(f'Number of converged eigenpairs {nconv}')

if nconv > 0:
    Print()
    Print('        k              ||T(k)x||          error ')
    Print('----------------- ------------------ ------------------')
    for i in range(nconv):
        k = nep.getEigenpair(i, x)
        FixSign(x)
        res = nep.computeError(i)
        error = pde.checkSolution(k.real, x)
        if k.imag != 0.0:
            Print(f' {k.real:9f}{k.imag:+9f} j {res:12g}     {error:12g}')
        else:
            Print(f' {k.real:12f}       {res:12g}     {error:12g}')
    Print()
```

ex8.py: Nonlinear eigenproblem with split form

This example solves a nonlinear eigenvalue problem where the nonlinear function is expressed in split form.

We want to solve the following parabolic partial differential equation with time delay τ

$$\begin{aligned} u_t &= u_{xx} + au(t) + bu(t-\tau) \\ u(0,t) &= u(\pi,t) = 0 \end{aligned}$$

with $a = 20$ and $b(x) = -4.1 + x(1 - e^{x-\pi})$.

Discretization leads to a DDE of dimension n

$$-u' = Au(t) + Bu(t-\tau)$$

which results in the nonlinear eigenproblem

$$(-\lambda I + A + e^{-\tau\lambda}B)u = 0.$$

The full source code for this demo can be downloaded here.

Initialization is similar to previous examples. In this case we also need to import some math symbols.

```
import sys
import slepc4py

slepc4py.init(sys.argv)
```

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```
from petsc4py import PETSc
from slepc4py import SLEPc
from numpy import exp
from math import pi

Print = PETSc.Sys.Print
```

This script has two command-line options: the discretization size `n` and the time delay `tau`.

```
opts = PETSc.Options()
n = opts.getInt('n', 128)
tau = opts.getReal('tau', 0.001)
a = 20
h = pi / (n + 1)
```

Next we have to set up the solver. In this case, we are going to represent the nonlinear problem in split form, i.e., as a sum of terms made of a constant matrix multiplied by a scalar nonlinear function.

```
nep = SLEPc.NEP().create()
```

The first term involves the identity matrix.

```
Id = PETSc.Mat().createConstantDiagonal([n, n], 1.0)
```

The second term has a tridiagonal matrix obtained from the discretization, $A = \frac{1}{h^2}\,\mathrm{tridiag}(1,-2,1) + aI$.

```
A = PETSc.Mat().create()
A.setSizes([n, n])
A.setFromOptions()
rstart, rend = A.getOwnershipRange()
vd = -2.0 / (h * h) + a
vo = 1.0 / (h * h)
if rstart == 0:
    A[0, :2] = [vd, vo]
    rstart += 1
if rend == n:
    A[n - 1, -2:] = [vo, vd]
    rend -= 1
for i in range(rstart, rend):
    A[i, i - 1 : i + 2] = [vo, vd, vo]
A.assemble()
```

The third term includes a diagonal matrix $B = \mathrm{diag}(b(x_i))$.

```
B = PETSc.Mat().create()
B.setSizes([n, n])
B.setFromOptions()
rstart, rend = B.getOwnershipRange()
for i in range(rstart, rend):
    xi = (i + 1) * h
    B[i, i] = -4.1 + xi * (1.0 - exp(xi - pi))
```

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```
B.assemble()
B.setOption(PETSc.Mat.Option.HERMITIAN, True)
```

Apart from the matrices, we have to create the functions, represented with *FN* objects: $f_1 = -\lambda, f_2 = 1, f_3 = \exp(-\tau\lambda)$.

```
f1 = SLEPc.FN().create()
f1.setType(SLEPc.FN.Type.RATIONAL)
f1.setRationalNumerator([-1, 0])
f2 = SLEPc.FN().create()
f2.setType(SLEPc.FN.Type.RATIONAL)
f2.setRationalNumerator([1])
f3 = SLEPc.FN().create()
f3.setType(SLEPc.FN.Type.EXP)
f3.setScale(-tau)
```

Put all the information together to define the split operator. Note that `A` is passed first so that `SUBSET` nonzero_pattern can be used.

```
nep.setSplitOperator([A, Id, B], [f2, f1, f3], PETSc.Mat.Structure.SUBSET)
```

Now we can set some options and call the solver.

```
nep.setTolerances(tol=1e-9)
nep.setDimensions(1)
nep.setFromOptions()

nep.solve()
```

Once the solver has finished, we print some information together with the computed solution. For each computed eigenpair, we print the eigenvalue and the residual norm.

```
its = nep.getIterationNumber()
Print(f'Number of iterations of the method: {its}')
sol_type = nep.getType()
Print(f'Solution method: {sol_type}')
_nev, ncv, _mpd = nep.getDimensions()
Print('')
Print(f'Subspace dimension: {ncv}')
tol, maxit = nep.getTolerances()
Print(f'Stopping condition: tol={tol:.4g}')
Print('')

nconv = nep.getConverged()
Print(f'Number of converged eigenpairs {nconv}')

if nconv > 0:
    x = Id.createVecs('right')
    x.set(1.0)
    Print()
    Print('        k              ||T(k)x||')
    Print('----------------- ------------------')
    for i in range(nconv):
```

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```
        k = nep.getEigenpair(i, x)
        res = nep.computeError(i)
        if k.imag != 0.0:
            Print(f' {k.real:9f}{k.imag:+9f} j {res:12g}')
        else:
            Print(f' {k.real:12f}       {res:12g}')
    Print()
```

ex9.py: Generalized symmetric-definite eigenproblem

This example computes eigenvalues and eigenvectors of a generalized symmetric-definite eigenvalue problem, where the first matrix is the discrete Laplacian in two dimensions and the second matrix is quasi diagonal.

The full source code for this demo can be downloaded here.

Initialization is similar to previous examples.

```
import sys
import slepc4py

slepc4py.init(sys.argv)

from petsc4py import PETSc
from slepc4py import SLEPc

Print = PETSc.Sys.Print
```

This function builds the discretized Laplacian operator in 2 dimensions.

```
def Laplacian2D(m, n):
    # Create matrix for 2D Laplacian operator
    A = PETSc.Mat().create()
    A.setSizes([m * n, m * n])
    A.setFromOptions()
    # Fill matrix
    hx = 1.0 / (m - 1)  # x grid spacing
    hy = 1.0 / (n - 1)  # y grid spacing
    diagv = 2.0 * hy / hx + 2.0 * hx / hy
    offdx = -1.0 * hy / hx
    offdy = -1.0 * hx / hy
    Istart, Iend = A.getOwnershipRange()
    for i in range(Istart, Iend):
        A[i, i] = diagv
        gi = i // n  # map row number to
        gj = i - gi * n  # grid coordinates
        if gi > 0:
            j = i - n
            A[i, j] = offdx
        if gi < m - 1:
            j = i + n
            A[i, j] = offdx
        if gj > 0:
            j = i - 1
```

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```
            A[i, j] = offdy
        if gj < n - 1:
            j = i + 1
            A[i, j] = offdy
    A.assemble()
    return A
```

This function builds a quasi-diagonal matrix. It is two times the identity matrix except for the 2x2 leading submatrix `[6 -1; -1 1]`.

```
def QuasiDiagonal(N):
    # Create matrix
    B = PETSc.Mat().create()
    B.setSizes([N, N])
    B.setFromOptions()
    # Fill matrix
    Istart, Iend = B.getOwnershipRange()
    for i in range(Istart, Iend):
        B[i, i] = 2.0
    if Istart == 0:
        B[0, 0] = 6.0
        B[0, 1] = -1.0
        B[1, 0] = -1.0
        B[1, 1] = 1.0
    B.assemble()
    return B
```

The following function receives the two matrices and solves the eigenproblem. In this example we illustrate how to pass objects that have been created beforehand, instead of extracting the internal objects. We are using a spectral transformation of type *ST.Type.PRECOND* and a Block Jacobi preconditioner. We want to compute the leftmost eigenvalues. The selected eigensolver is LOBPCG, which is appropriate for this use case. After the solve, we print the computed solution.

```
def solve_eigensystem(A, B, problem_type=SLEPc.EPS.ProblemType.GHEP):
    # Create the results vectors
    xr, xi = A.createVecs()

    pc = PETSc.PC().create()
    # pc.setType(pc.Type.HYPRE)
    pc.setType(pc.Type.BJACOBI)

    ksp = PETSc.KSP().create()
    ksp.setType(ksp.Type.PREONLY)
    ksp.setPC(pc)

    F = SLEPc.ST().create()
    F.setType(F.Type.PRECOND)
    F.setKSP(ksp)
    F.setShift(0)

    # Setup the eigensolver
    E = SLEPc.EPS().create()
```

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```
    E.setST(F)
    E.setOperators(A, B)
    E.setType(E.Type.LOBPCG)
    E.setDimensions(10, PETSc.DECIDE)
    E.setWhichEigenpairs(E.Which.SMALLEST_REAL)
    E.setProblemType(problem_type)
    E.setFromOptions()

    # Solve the eigensystem
    E.solve()

    Print('')
    its = E.getIterationNumber()
    Print(f'Number of iterations of the method: {its}')
    sol_type = E.getType()
    Print(f'Solution method: {sol_type}')
    nev, _ncv, _mpd = E.getDimensions()
    Print(f'Number of requested eigenvalues: {nev}')
    tol, maxit = E.getTolerances()
    Print(f'Stopping condition: tol={tol:.4g}, maxit={maxit}')
    nconv = E.getConverged()
    Print(f'Number of converged eigenpairs: {nconv}')
    if nconv > 0:
        Print('')
        Print('        k          ||Ax-kx||/||kx|| ')
        Print('----------------- ------------------')
        for i in range(nconv):
            k = E.getEigenpair(i, xr, xi)
            error = E.computeError(i)
            if k.imag != 0.0:
                Print(f' {k.real:9f}{k.imag:+9f} j  {error:12g}')
            else:
                Print(f' {k.real:12f}       {error:12g}')
        Print('')
```

The main program simply processes three user-defined command-line options and calls the other functions.

```
def main():
    opts = PETSc.Options()
    N = opts.getInt('N', 10)
    m = opts.getInt('m', N)
    n = opts.getInt('n', m)
    Print(f'Symmetric-definite Eigenproblem, N={m * n} ({m}x{n} grid)')
    A = Laplacian2D(m, n)
    B = QuasiDiagonal(m * n)
    solve_eigensystem(A, B)


if __name__ == '__main__':
    main()
```

ex10.py: Laplace problem using the Proper Orthogonal Decomposition

This example program solves the Laplace problem using the Proper Orthogonal Decomposition (POD) reduced-order modeling technique. For a full description of the technique the reader is referred to[1],[2].

The method is split into an offline (computationally intensive) and an online (computationally cheap) phase. This has many applications including real-time simulation, uncertainty quantification and inverse problems, where similar models must be evaluated quickly and many times.

Offline phase:

1. A set of solution snapshots of the 1D Laplace problem in the full problem space are constructed and assembled into the columns of a dense matrix S.
2. A standard eigenvalue decomposition is performed on the matrix $S^T S$.
3. The eigenvectors and eigenvalues are projected back to the original eigenvalue problem S.
4. The leading eigenvectors then form the POD basis.

Online phase:

1. The operator corresponding to the discrete Laplacian is projected onto the POD basis.
2. The operator corresponding to the right-hand side is projected onto the POD basis.
3. The reduced (dense) problem expressed in the POD basis is solved.
4. The reduced solution is projected back to the full problem space.

Contributed by: Elisa Schenone, Jack S. Hale.

The full source code for this demo can be downloaded here.

Initialization is similar to previous examples, but importing some additional modules.

```
import sys
import slepc4py

slepc4py.init(sys.argv)

from petsc4py import PETSc
from slepc4py import SLEPc
import numpy as np

import random
import math

Print = PETSc.Sys.Print

if PETSc.COMM_WORLD.getSize() > 1:
    Print('Demo should only be executed with one MPI process')
    sys.exit(0)
```

This function builds the discrete Laplacian operator in 1 dimension with homogeneous Dirichlet boundary conditions.

[1] K. Kunisch and S. Volkwein. Galerkin proper orthogonal decomposition methods for a general equation in fluid dynamics. SIAM Journal on Numerical Analysis, 40(2):492-515, 2003.

[2] S. Volkwein, Optimal control of a phase-field model using the proper orthogonal decomposition, Z. Angew. Math. Mech., 81:83-97, 2001.

```
def construct_operator(m):
    # Create matrix for 1D Laplacian operator
    A = PETSc.Mat().create()
    A.setSizes([m, m])
    A.setFromOptions()
    # Fill matrix
    hx = 1.0 / (m - 1)  # x grid spacing
    diagv = 2.0 / hx
    offdx = -1.0 / hx
    Istart, Iend = A.getOwnershipRange()
    for i in range(Istart, Iend):
        if i != 0 and i != (m - 1):
            A[i, i] = diagv
            if i > 1:
                A[i, i - 1] = offdx
            if i < m - 2:
                A[i, i + 1] = offdx
        else:
            A[i, i] = 1.0

    A.assemble()

    return A
```

Set bell-shape function as the solution of the Laplacian problem in 1 dimension with homogeneous Dirichlet boundary conditions and compute the associated discrete RHS.

```
def set_problem_rhs(m):
    # Create 1D mass matrix operator
    M = PETSc.Mat().create()
    M.setSizes([m, m])
    M.setFromOptions()
    # Fill matrix
    hx = 1.0 / (m - 1)  # x grid spacing
    diagv = hx / 3
    offdx = hx / 6
    Istart, Iend = M.getOwnershipRange()
    for i in range(Istart, Iend):
        if i != 0 and i != (m - 1):
            M[i, i] = 2 * diagv
        else:
            M[i, i] = diagv
        if i > 1:
            M[i, i - 1] = offdx
        if i < m - 2:
            M[i, i + 1] = offdx

    M.assemble()

    x_0 = 0.3
    x_f = 0.7
    mu = x_0 + (x_f - x_0) * random.random()
    sigma = 0.1**2
```

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```
    uex, f = M.createVecs()
    for j in range(Istart, Iend):
        value = (
            2
            / sigma
            * math.exp(-((hx * j - mu) ** 2) / sigma)
            * (1 - 2 / sigma * (hx * j - mu) ** 2)
        )
        f.setValue(j, value)
        value = math.exp(-((hx * j - mu) ** 2) / sigma)
        uex.setValue(j, value)
    f.assemble()
    uex.assemble()

    RHS = f.duplicate()
    M.mult(f, RHS)
    RHS.setValue(0, 0.0)
    RHS.setValue(m - 1, 0.0)
    RHS.assemble()

    return RHS, uex
```

Solve 1D Laplace problem with FEM.

```
def solve_laplace_problem(A, RHS):
    u = A.createVecs('right')
    r, c = A.getOrdering('natural')
    A.factorILU(r, c)
    A.solve(RHS, u)
    A.setUnfactored()
    return u
```

Solve 1D Laplace problem with POD (dense matrix).

```
def solve_laplace_problem_pod(A, RHS, u):
    ksp = PETSc.KSP().create()
    ksp.setOperators(A)
    ksp.setType('preonly')
    pc = ksp.getPC()
    pc.setType('none')
    ksp.setFromOptions()

    ksp.solve(RHS, u)

    return u
```

Set `N` solution of the 1D Laplace problem as columns of a matrix (snapshot matrix).

Note: For simplicity we do not perform a linear solve, but use some analytical solution: $z(x) = \exp(-(x-\mu)^2/\sigma)$.

```
def construct_snapshot_matrix(A, N, m):
    snapshots = PETSc.Mat().create()
    snapshots.setSizes([m, N])
```

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```
    snapshots.setType('dense')

    Istart, Iend = snapshots.getOwnershipRange()
    hx = 1.0 / (m - 1)
    x_0 = 0.3
    x_f = 0.7
    sigma = 0.1**2
    for i in range(N):
        mu = x_0 + (x_f - x_0) * random.random()
        for j in range(Istart, Iend):
            value = math.exp(-((hx * j - mu) ** 2) / sigma)
            snapshots.setValue(j, i, value)
    snapshots.assemble()

    return snapshots
```

Solve the eigenvalue problem: the eigenvectors of this problem form the POD basis.

```
def solve_eigenproblem(snapshots, N):
    Print('Solving POD basis eigenproblem using eigensolver...')

    Es = SLEPc.EPS().create()
    Es.setDimensions(N)
    Es.setProblemType(SLEPc.EPS.ProblemType.NHEP)
    Es.setTolerances(1.0e-8, 500)
    Es.setKrylovSchurRestart(0.6)
    Es.setWhichEigenpairs(SLEPc.EPS.Which.LARGEST_REAL)
    Es.setOperators(snapshots)
    Es.setFromOptions()

    Es.solve()
    Print('Solved POD basis eigenproblem.')
    return Es
```

Function to project $S^T S$ eigenvectors to S eigenvectors.

```
def project_STS_eigenvectors_to_S_eigenvectors(bvEs, S):
    sizes = S.getSizes()[0]
    N = bvEs.getActiveColumns()[1]
    bv = SLEPc.BV().create()
    bv.setSizes(sizes, N)
    bv.setActiveColumns(0, N)
    bv.setFromOptions()

    tmpvec2 = S.createVecs('left')
    for i in range(N):
        tmpvec = bvEs.getColumn(i)
        S.mult(tmpvec, tmpvec2)
        bv.insertVec(i, tmpvec2)
        bvEs.restoreColumn(i, tmpvec)

    return bv
```

Function to project the reduced space to the full space.

```
def project_reduced_to_full_space(alpha, bv):
    uu = bv.getColumn(0)
    uPOD = uu.duplicate()
    bv.restoreColumn(0, uu)

    scatter, Wr = PETSc.Scatter.toAll(alpha)
    scatter.begin(alpha, Wr, PETSc.InsertMode.INSERT, PETSc.ScatterMode.FORWARD)
    scatter.end(alpha, Wr, PETSc.InsertMode.INSERT, PETSc.ScatterMode.FORWARD)
    PODcoeff = Wr.getArray(readonly=1)

    bv.multVec(1.0, 0.0, uPOD, PODcoeff)

    return uPOD
```

The main function realizes the full procedure.

```
def main():
    problem_dim = 200
    num_snapshots = 30
    num_pod_basis_functions = 8

    if num_pod_basis_functions > num_snapshots:
        raise Exception('Should have num_pod_basis_functions <= num_snapshots')

    A = construct_operator(problem_dim)
    S = construct_snapshot_matrix(A, num_snapshots, problem_dim)

    # Instead of solving the SVD of S, we solve the standard
    # eigenvalue problem on S.T*S
    STS = S.transposeMatMult(S)

    Es = solve_eigenproblem(STS, num_pod_basis_functions)
    nconv = Es.getConverged()
    Print(f'Number of converged eigenvalues: {nconv}')
    Es.view()

    # get the EPS solution in a BV object
    bvEs = Es.getBV()
    bvEs.setActiveColumns(0, num_pod_basis_functions)

    # set the bv POD basis
    bv = project_STS_eigenvectors_to_S_eigenvectors(bvEs, S)
    # rescale the eigenvectors
    for i in range(num_pod_basis_functions):
        ll = Es.getEigenvalue(i)
        Print(f'Eigenvalue {i}: {ll.real}')
        bv.scaleColumn(i, 1.0 / math.sqrt(ll.real))

    Print('--------------------------------')
    # Verify that the active columns of bv form an orthonormal subspace, i.e. that X^H*X␣
↪= Id
    Print('Check that bv.dot(bv) is close to the identity matrix')
```

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```
    XtX = bv.dot(bv)
    XtX.view()
    XtX_array = XtX.getDenseArray()
    n, m = XtX_array.shape
    if not np.allclose(XtX_array, np.eye(n, m)):
        raise Exception('Failed comparison')
    Print('--------------------------------')
    Print('Solve the problem with POD')

    # Project the linear operator A
    Ared = bv.matProject(A, bv)

    # Set the RHS and the exact solution
    RHS, uex = set_problem_rhs(problem_dim)

    # Project the RHS on the POD basis
    RHSred = PETSc.Vec().createWithArray(bv.dotVec(RHS))

    # Solve the problem with POD
    alpha = Ared.createVecs('right')
    alpha = solve_laplace_problem_pod(Ared, RHSred, alpha)

    # Project the POD solution back to the FE space
    uPOD = project_reduced_to_full_space(alpha, bv)

    # Compute the L2 and Linf norm of the error
    error = uex.copy()
    error.axpy(-1, uPOD)
    errorL2 = math.sqrt(error.dot(error).real)
    Print(f'The L2-norm of the error is: {errorL2}')

    Print('NORMAL END')


if __name__ == '__main__':
    main()
```

ex11.py: 2-D Laplacian eigenproblem solved with contour integral

This example is similar to `ex2.py`, but employs a contour integral solver. It illustrates how to define a region of the complex plane using an *RG* object.

The full source code for this demo can be downloaded here.

Initialization is similar to previous examples.

```
import sys
import slepc4py

slepc4py.init(sys.argv)

from petsc4py import PETSc
from slepc4py import SLEPc
```

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```
Print = PETSc.Sys.Print
```

Build the finite-difference 2-D Laplacian matrix.

```
def construct_operator(m, n):
    # Create matrix for 2D Laplacian operator
    A = PETSc.Mat().create()
    A.setSizes([m * n, m * n])
    A.setFromOptions()
    # Fill matrix
    hx = 1.0 / (m - 1)  # x grid spacing
    hy = 1.0 / (n - 1)  # y grid spacing
    diagv = 2.0 * hy / hx + 2.0 * hx / hy
    offdx = -1.0 * hy / hx
    offdy = -1.0 * hx / hy
    Istart, Iend = A.getOwnershipRange()
    for i in range(Istart, Iend):
        A[i, i] = diagv
        gi = i // n  # map row number to
        gj = i - gi * n  # grid coordinates
        if gi > 0:
            j = i - n
            A[i, j] = offdx
        if gi < m - 1:
            j = i + n
            A[i, j] = offdx
        if gj > 0:
            j = i - 1
            A[i, j] = offdy
        if gj < n - 1:
            j = i + 1
            A[i, j] = offdy
    A.assemble()
    return A
```

In the main function, first two command-line options are processed to set the grid dimensions. Then the matrix is built and passed to the solver object. In this case, the solver is configured to use the contour integral method. Next, the region of interest is defined, in this case an ellipse centered at the origin, with radius 0.2 and vertical scaling of 0.1. Finally, the solver is run. In this example, we illustrate how to print the solution using the solver method *errorView()*.

```
def main():
    opts = PETSc.Options()
    n = opts.getInt('n', 32)
    m = opts.getInt('m', 32)
    Print(
        '2-D Laplacian Eigenproblem solved with contour integral, '
        f'N={m * n} ({m}x{n} grid)\n'
    )
    A = construct_operator(m, n)

    E = SLEPc.EPS().create()
```

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```
    E.setOperators(A)
    E.setProblemType(SLEPc.EPS.ProblemType.HEP)
    E.setType(SLEPc.EPS.Type.CISS)

    R = E.getRG()
    R.setType(SLEPc.RG.Type.ELLIPSE)
    R.setEllipseParameters(0.0, 0.2, 0.1)
    E.setFromOptions()

    E.solve()

    vw = PETSc.Viewer.STDOUT()
    vw.pushFormat(PETSc.Viewer.Format.ASCII_INFO_DETAIL)
    E.errorView(viewer=vw)
    vw.popFormat()


if __name__ == '__main__':
    main()
```

ex12.py: Illustrate the use of arbitrary selection

This example solves a simple tridiagonal eigenproblem. It illustrates how to set up the arbitrary selection of eigenvalues, where the decision of which is the preferred eigenvalue is made based not only on the value of the approximate eigenvalue but also on the approximate eigenvector.

In this example, the selection criterion is based on the projection of the approximate eigenvector onto a precomputed eigenvector. That is why we solve the problem twice.

The full source code for this demo can be downloaded here.

Initialization is similar to previous examples.

```
import sys
import slepc4py

slepc4py.init(sys.argv)

from petsc4py import PETSc
from slepc4py import SLEPc
```

The matrix size `n` can be specified at the command line.

```
opts = PETSc.Options()
n = opts.getInt('n', 30)
```

Create the matrix `tridiag([-1 0 -1])`.

```
A = PETSc.Mat().create()
A.setSizes([n, n])
A.setFromOptions()
rstart, rend = A.getOwnershipRange()
for i in range(rstart, rend):
    if i > 0:
```

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```
        A[i, i - 1] = -1
    if i < n - 1:
        A[i, i + 1] = -1
A.assemble()
```

Configure the linear eigensolver initially to compute leftmost eigenvalues.

```
E = SLEPc.EPS().create()
E.setOperators(A)
E.setProblemType(SLEPc.EPS.ProblemType.HEP)
E.setWhichEigenpairs(SLEPc.EPS.Which.SMALLEST_REAL)
E.setFromOptions()
```

Solve the eigenproblem and store the first computed eigenvector in `sx` to be used later. For the second solve, we configure the solver to select largest magnitude values with an arbitrary selection callback function `myArbitrarySel()`. It means that instead of sorting eigenvalues, the solver will sort the approximations according to the largest values of the result of `myArbitrarySel()` evaluated on the approximate eigenvectors. In this way, the same eigenvalue should be computed again.

```
E.solve()
nconv = E.getConverged()
Print = PETSc.Sys.Print
vw = PETSc.Viewer.STDOUT()
if nconv > 0:
    sx, _ = A.createVecs()
    E.getEigenpair(0, sx)
    vw.pushFormat(PETSc.Viewer.Format.ASCII_INFO_DETAIL)
    E.errorView(viewer=vw)

    def myArbitrarySel(evalue, xr, xi, sx):
        return abs(xr.dot(sx))

    E.setArbitrarySelection(myArbitrarySel, sx)
    E.setWhichEigenpairs(SLEPc.EPS.Which.LARGEST_MAGNITUDE)
    E.solve()
    E.errorView(viewer=vw)
    vw.popFormat()
else:
    Print('No eigenpairs converged')
```

ex13.py: Nonlinear eigenproblem with contour integral

This example solves a nonlinear eigenvalue problem with the *NEP* module configured to apply a contour integral method.

The problem arises from the PDE

$$u_{xx}(x) + n_c^2\lambda^2 u(x) + g(\lambda)D_0\lambda^2 u(x) = 0$$

where

$$\begin{aligned} g(\lambda) &= g_t/(\lambda - k_a + ig_t), \\ k_a &= 8.0, \\ g_t &= 0.5, \\ D_0 &= 0.5, \\ n_c &= 1.2, \end{aligned}$$

and the boundary conditions are

$$\begin{aligned} u(0) &= 0 \\ u_x(1) &= i\lambda u(1). \end{aligned}$$

For the discretization, n grid points are used, $x_1 = 0, \ldots, x_n = 1$, with step size $h = 1/(n-1)$. Hence,

$$\begin{aligned} u_{xx}(x_i) &= \frac{1}{h^2}(u_{i-1} - 2u_i + u_{i+1}) \\ &= \frac{1}{h^2}[1, -2, 1][u_{i-1}, u_i, u_{i+1}]^T. \end{aligned}$$

The boundary condition at $x = 0$ is $u_1 = 0$, and at $x = 1$:

$$\begin{aligned} u'(1) &= 1/2(u'(1 + h/2) + u'(1 - h/2)) \\ &= 1/2((u_{n+1} - u_n)/h + (u_n - u_{n-1})/h) \\ &= 1/(2h)(u_{n+1} - u_{n-1}) = i\lambda u_n, \end{aligned}$$

and therefore

$$u_{n+1} = 2ih\lambda u_n + u_{n-1}.$$

The Laplace term for u_n is

$$\begin{aligned} &= \frac{1}{h^2}(u_{n-1} - 2u_n + u_{n+1}) \\ &= \frac{1}{h^2}(u_{n-1} - 2u_n + 2ih\lambda u_n + u_{n-1}) \\ &= \frac{1}{h^2}(2u_{n-1} + (2ih\lambda - 2)u_n) \\ &= \frac{1}{h^2}[2, 2ih\lambda - 2][u_{n-1}, u_n]^T. \end{aligned}$$

The above discretization allows us to write the nonlinear PDE in the following split-operator form

$$\{A + \lambda^2 n_c^2 I_d + g(\lambda)\lambda^2 D_0 I_d + 2i\lambda/hD\}u = 0$$

so $f_1 = 1$, $f_2 = n_c^2\lambda^2$, $f_3 = g(\lambda)\lambda^2 D_0$, $f_4 = 2i\lambda/h$, with coefficient matrices

$$A = \begin{bmatrix} 1 & 0 & 0 & \ldots & 0 \\ 0 & * & * & \ldots & 0 \\ 0 & * & * & \ldots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \ldots & * \end{bmatrix}, I_d = \begin{bmatrix} 0 & 0 & 0 & \ldots & 0 \\ 0 & 1 & 0 & \ldots & 0 \\ 0 & 0 & 1 & \ldots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \ldots & 0 \end{bmatrix}, D = \begin{bmatrix} 0 & 0 & 0 & \ldots & 0 \\ 0 & 0 & 0 & \ldots & 0 \\ 0 & 0 & 0 & \ldots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \ldots & 1 \end{bmatrix}.$$

Contributed by: Thomas Hisch.

The full source code for this demo can be downloaded here.

Initialization by importing slepc4py, petsc4py, numpy and scipy.

```
import sys
import slepc4py

slepc4py.init(sys.argv)  # isort:skip

import numpy as np

try:
    import scipy
    import scipy.optimize
except ImportError:
    scipy = None

from petsc4py import PETSc
from slepc4py import SLEPc

Print = PETSc.Sys.Print
```

Check that the selected PETSc/SLEPc are built with complex scalars.

```
if not np.issubdtype(PETSc.ScalarType, np.complexfloating):
    Print('Demo should only be executed with complex PETSc scalars')
    sys.exit(0)
```

Long function that defines the nonlinear eigenproblem and solves it.

```
def solve(n):
    L = 1.0
    h = L / (n - 1)
    nc = 1.2
    ka = 10.0
    gt = 4.0
    D0 = 0.5

    A = PETSc.Mat().create()
    A.setSizes([n, n])
    A.setFromOptions()
    A.setOption(PETSc.Mat.Option.HERMITIAN, False)

    rstart, rend = A.getOwnershipRange()
    d0, d1, d2 = (
        1 / h**2,
        -2 / h**2,
        1 / h**2,
    )
    Print(f'dterms={(d0, d1, d2)}')

    if rstart == 0:
        # dirichlet boundary condition at the left lead
        A[0, 0] = 1.0
        A[0, 1] = 0.0
        A[1, 0] = 0.0
```

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```
        A[1, 1] = d1
        A[1, 2] = d2
        rstart += 2
    if rend == n:
        # at x=1.0 neumann boundary condition (not handled here but in a
        # different matrix (D))
        A[n - 1, n - 2] = 2.0 / h**2
        A[n - 1, n - 1] = (-2) / h**2  # + 2j*k*h / h**2 (neumann)
        rend -= 1

    for i in range(rstart, rend):
        A[i, i - 1 : i + 2] = [d0, d1, d2]

    A.assemble()

    Id = PETSc.Mat().create()
    Id.setSizes([n, n])
    Id.setFromOptions()
    Id.setOption(PETSc.Mat.Option.HERMITIAN, True)
    rstart, rend = Id.getOwnershipRange()
    if rstart == 0:
        # due to dirichlet BC
        rstart += 1
    for i in range(rstart, rend):
        Id[i, i] = 1.0
    Id.assemble()

    D = PETSc.Mat().create()
    D.setSizes([n, n])
    D.setFromOptions()
    D.setOption(PETSc.Mat.Option.HERMITIAN, True)
    _, rend = D.getOwnershipRange()
    if rend == n:
        D[n - 1, n - 1] = 1
    D.assemble()

    Print(f'DOF: {A.getInfo()["nz_used"]}, MEM: {A.getInfo()["memory"]}')

    f1 = SLEPc.FN().create()
    f1.setType(SLEPc.FN.Type.RATIONAL)
    f1.setRationalNumerator([1.0])
    f2 = SLEPc.FN().create()
    f2.setType(SLEPc.FN.Type.RATIONAL)
    f2.setRationalNumerator([nc**2, 0.0, 0.0])
    f3 = SLEPc.FN().create()
    f3.setType(SLEPc.FN.Type.RATIONAL)
    f3.setRationalNumerator([D0 * gt, 0.0, 0.0])
    f3.setRationalDenominator([1.0, -ka + 1j * gt])
    f4 = SLEPc.FN().create()
    f4.setType(SLEPc.FN.Type.RATIONAL)
    f4.setRationalNumerator([2j / h, 0])
```

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```
    # Setup the solver
    nep = SLEPc.NEP().create()

    nep.setSplitOperator(
        [A, Id, Id, D],
        [f1, f2, f3, f4],
        PETSc.Mat.Structure.SUBSET,
    )

    # Customize options
    nep.setTolerances(tol=1e-7)

    nep.setDimensions(nev=24)
    nep.setType(SLEPc.NEP.Type.CISS)

    # the rg params are chosen s.t. the singularity at k = ka - 1j*gt is
    # outside of the contour.
    radius = 3 * gt
    vscale = 0.5 * gt / radius
    rg_params = (ka, 3 * gt, vscale)
    R = nep.getRG()
    R.setType(SLEPc.RG.Type.ELLIPSE)
    Print(f'RG params: {rg_params}')
    R.setEllipseParameters(*rg_params)

    nep.setFromOptions()

    # Solve the problem
    nep.solve()

    its = nep.getIterationNumber()
    Print(f'Number of iterations of the method: {its}')
    sol_type = nep.getType()
    Print(f'Solution method: {sol_type}')
    _nev, ncv, _mpd = nep.getDimensions()
    Print('')
    Print(f'Subspace dimension: {ncv}')
    tol, _maxit = nep.getTolerances()
    Print(f'Stopping condition: tol={tol:.4g}')
    Print('')

    nconv = nep.getConverged()
    Print(f'Number of converged eigenpairs {nconv}')

    x = A.createVecs('right')

    evals = []
    modes = []
    if nconv > 0:
        Print()
        Print('        lam            ||T(lam)x||   |lam-lam_exact|/|lam_exact| ')
        Print('---------------------- ------------- -----------------------------')
```

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```
        for i in range(nconv):
            lam = nep.getEigenpair(i, x)
            error = nep.computeError(i)

            def eigenvalue_error_term(k):
                gkmu = gt / (k - ka + 1j * gt)
                nceff = np.sqrt(nc**2 + gkmu * D0)
                return -1j / np.tan(nceff * k * L) - 1 / nceff

            # compute the expected_eigenvalue

            # we assume that the numerically calculated eigenvalue is close to
            # the exact one, which we can determine using a Newton-Raphson
            # method.
            if scipy:
                expected_lam = scipy.optimize.newton(
                    eigenvalue_error_term, np.complex128(lam), rtol=1e-11
                )
                rel_err = abs(lam - expected_lam) / abs(expected_lam)
                rel_err = f'{rel_err:6g}'
            else:
                rel_err = 'scipy not installed'

            Print(f' {lam.real:9f}{lam.imag:+9f} j {error:12g}   {rel_err}')

            evals.append(lam)
            modes.append(x.getArray().copy())
        Print()

    return np.asarray(evals), rg_params, ka, gt
```

The main function reads the problem size `n` from the command line, solves the problem with the above function, and then plots the computed eigenvalues.

```
def main():
    opts = PETSc.Options()
    n = opts.getInt('n', 256)
    Print(f'n={n}')

    evals, rg_params, _ka, _gt = solve(n)

    if not opts.getBool('ploteigs', True) or PETSc.COMM_WORLD.getRank():
        return

    try:
        import matplotlib.pyplot as plt
        from matplotlib.patches import Ellipse
    except ImportError:
        Print('plot is not shown, because matplotlib is not installed')
    else:
        _fig, ax = plt.subplots()
        ax.plot(evals.real, evals.imag, 'x')
```

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```
        height = 2 * rg_params[1] * rg_params[2]
        ellipse = Ellipse(
            xy=(rg_params[0], 0.0),
            width=rg_params[1] * 2,
            height=height,
            edgecolor='r',
            fc='None',
            lw=2,
        )
        ax.add_patch(ellipse)

        ax.grid()
        ax.legend()
        plt.show()


if __name__ == '__main__':
    main()
```

ex14.py: Lyapunov equation with the shifted 2-D Laplacian

This example illustrates the use of slepc4py linear matrix equations solver object. In particular, a Lyapunov equation is solved, where the coefficient matrix is the shifted 2-D Laplacian.

The full source code for this demo can be downloaded here.

Initialization is similar to previous examples.

```
import sys
import slepc4py

slepc4py.init(sys.argv)

from petsc4py import PETSc
from slepc4py import SLEPc

Print = PETSc.Sys.Print
```

Once again, a function to build the discretized Laplacian operator in two dimensions. In this case, we build the shifted negative Laplacian because the Lyapunov equation requires the coefficient matrix being stable.

```
def Laplacian2D(m, n, sigma):
    # Create matrix for 2D Laplacian operator
    A = PETSc.Mat().create()
    A.setSizes([m * n, m * n])
    A.setFromOptions()
    # Fill matrix
    Istart, Iend = A.getOwnershipRange()
    for i in range(Istart, Iend):
        A[i, i] = -4.0 - sigma
        gi = i // n  # map row number to
        gj = i - gi * n  # grid coordinates
```

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```
        if gi > 0:
            j = i - n
            A[i, j] = 1.0
        if gi < m - 1:
            j = i + n
            A[i, j] = 1.0
        if gj > 0:
            j = i - 1
            A[i, j] = 1.0
        if gj < n - 1:
            j = i + 1
            A[i, j] = 1.0
    A.assemble()
    return A
```

The following function solves the continuous-time Lyapunov equation

$$AX + XA^* = -C$$

where C is supposed to have low rank. The solution X also has low rank, which will be restricted to `rk` if it was provided as an argument of the function. After solving the equation, this function computes and prints a residual norm.

```
def solve_lyap(A, C, rk=0):
    # Setup the solver
    L = SLEPc.LME().create()
    L.setProblemType(SLEPc.LME.ProblemType.LYAPUNOV)
    L.setCoefficients(A)
    L.setRHS(C)

    N = C.size[0]
    if rk > 0:
        X1 = PETSc.Mat().createDense((N, rk))
        X1.assemble()
        X = PETSc.Mat().createLRC(None, X1, None, None)
        L.setSolution(X)

    L.setTolerances(1e-7)
    L.setFromOptions()

    # Solve the problem
    L.solve()

    if rk == 0:
        X = L.getSolution()

    its = L.getIterationNumber()
    Print(f'Number of iterations of the method: {its}')
    sol_type = L.getType()
    Print(f'Solution method: {sol_type}')
    tol, maxit = L.getTolerances()
    Print(f'Stopping condition: tol={tol}, maxit={maxit}')
    Print(f'Error estimate reported by the solver: {L.getErrorEstimate()}')
    if N < 500:
```

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```
        Print(f'Computed residual norm: {L.computeError()}')
    Print('')

    return X
```

The main function processes several command-line arguments such as the grid dimension (`n`, `m`), the shift `sigma` and the rank of the solution, `rank`.

The coefficient matrix `A` is built with the function above, while the right-hand side matrix `C` must be built as a low-rank matrix using `Mat.createLRC()`.

```
if __name__ == '__main__':
    opts = PETSc.Options()
    n = opts.getInt('n', 15)
    m = opts.getInt('m', n)
    N = m * n
    sigma = opts.getScalar('sigma', 0.0)
    rk = opts.getInt('rank', 0)

    # Coefficient matrix A
    A = Laplacian2D(m, n, sigma)

    # Create a low-rank Mat to store the right-hand side C = C1*C1'
    C1 = PETSc.Mat().createDense((N, 2))
    rstart, rend = C1.getOwnershipRange()
    v = C1.getDenseArray()
    for i in range(rstart, rend):
        if i < N // 2:
            v[i - rstart, 0] = 1.0
        if i == 0:
            v[i - rstart, 1] = -2.0
        if i in {1, 2}:
            v[i - rstart, 1] = -1.0
    C1.assemble()
    C = PETSc.Mat().createLRC(None, C1, None, None)

    X = solve_lyap(A, C, rk)
```

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