

# Package ‘svd’

July 23, 2023

**Type** Package

**Imports** methods

**Suggests** testthat (>= 0.7)

**Title** Interfaces to Various State-of-Art SVD and Eigensolvers

**Version** 0.5.4.1

**Author** Anton Korobeynikov [aut, cre], Rasmus Munk Larsen [ctb, cph], Lawrence Berkeley National Laboratory [ctb, cph]

**Maintainer** Anton Korobeynikov <anton@korobeynikov.info>

**Description** R bindings to SVD and eigensolvers (PROPACK, nuTRLan).

**License** BSD\_3\_clause + file LICENSE

**Copyright** see file COPYRIGHTS

**URL** <https://github.com/as1/svd>

**NeedsCompilation** yes

**Repository** CRAN

**Date/Publication** 2023-07-23 10:40:20 UTC

## R topics documented:

eigen . . . . .	2
extmat . . . . .	3
extmat-class . . . . .	4
svd . . . . .	5
<b>Index</b>	<b>7</b>

---

eigen

*Generic Eigendecomposition of a Matrix*


---

### Description

Compute the set of eigenvalues and eigenvectors decomposition of a real rectangular matrix.

### Usage

```
trlan.eigen(X, neig = min(m, n), opts = list(), lambda = NULL, U = NULL)
```

### Arguments

X	the matrix to be decomposed. This can be either normal matrix or 'external matrix' object (e.g. one, created via 'extmat' function).
neig	number of desired eigentriples
opts	different options for eigensolver. See 'Details' section for more information
lambda	set of already computed singular values (used for continuation of the decomposition).
U	matrix of already computed eigenvectors (used for continuation of the decomposition).

### Details

These routines provides an interface to state-of-art implementation of eigensolver. In particular, nu-TRLAN does the thick-restart Lanczos eigendecomposition of a matrix.

'opts' is a list of different options which can be passed to the routines. Note that by default more or less suitable values for these options are set by the routines automatically.

The options for nu-TRLAN are:

**kmax** integer, maximum number of iterations.

**maxiter** integer. maximum number of matrix-vector products.

**tol** numeric, tolerance level.

**verbose** integer, verbosity level.

### Value

The returned value is a list with components

d	a vector containing the eigenvalues of 'X'
u	a matrix whose columns contain the eigenvectors of 'X'

## References

Wu, K. and Simon, H. (2000). *Thick-restart Lanczos method for large symmetric eigenvalue problems*. SIAM J. Matrix Anal. Appl. 22, 2, 602-616.

Yamazaki, I., Bai, Z., Simon, H., Wang, L.-W., and Wu, K. (2008). *Adaptive projection subspace dimension for the thick restart Lanczos method*. Tech. rep., Lawrence Berkeley National Laboratory, University of California, One Cyclotron road, Berkeley, California 94720.

Korobeynikov, A. (2010) *Computation- and space-efficient implementation of SSA*. Statistics and Its Interface, Vol. 3, No. 3, Pp. 257-268

---

extmat	<i>External matrices operations.</i>
--------	--------------------------------------

---

## Description

A set of routines to operate on "external" matrices.

## Usage

```
is.extmat(X)
extmat.ncol(X)
extmat.nrow(X)
extmat(mul, tmul, nrow, ncol, env = parent.frame())
ematmul(emat, v, transposed = FALSE)
```

## Arguments

X, emat	matrix to operate on
mul	function performing the multiplication of matrix to vector
tmul	function performing the multiplication of transposed matrix to vector
nrow	number of rows of the matrix
ncol	number of columns of the matrix
env	environment, where matrix-vector multiplication function call is evaluated in
transposed	logical, if 'TRUE' the multiplication is performed with the transposed matrix.
v	vector to multiply with.

## Details

These routines checks whether the given external pointer actually points to "external matrix" structure and allow to extract the number of columns and rows respectively.

'extmat' is a convenient wrapper which allows one provide just the routines which will multiply with matrix and the transposed one (e.g. if the matrix is sparse or structured) and allow to use the SVD routines of the package

**Value**

Object 'extmat' class

**See Also**

[extmat](#)

**Examples**

```
## Not run:
library(Matrix)
f <- function(v) as.numeric(A %*% v) # Convert Matrix object back to vector
tf <- function(v) as.numeric(tA %*% v) # Convert Matrix object back to vector

e <- new.env()
assign("A", USCounties, e)
assign("tA", t(USCounties), e)
environment(f) <- e
environment(tf) <- e

m <- extmat(f, tf, nrow(USCounties), ncol(USCounties))
system.time(v1 <- propack.svd(m, neig = 10))
# user system elapsed
# 0.252 0.007 0.259
system.time(v2 <- propack.svd(as.matrix(USCounties), neig = 10))
# user system elapsed
# 8.563 0.027 8.590

## End(Not run)

# The largest eigenvalue and the corresponding eigenvector of a Hilbert matrix
h <- outer(1:5000, 1:5000, function(i, j) 1 / (i + j - 1))
v1 <- trlan.eigen(h, neig = 1)
print(v1$d)
```

---

extmat-class

*Class "extmat"*

---

**Description**

'extmat' is a convenient wrapper which allows one provide just the routines which will multiply with matrix and the transposed one (e.g. if the matrix is sparse or structured) and allow to use the SVD routines of the package. This S4 wrapper allows the use of usual matrix operations on such objects.

**Objects from the Class**

Objects can be created by calls of the form `extmat(mul, tmul, nrow, ncol, env = parent.frame())`.

**See Also**[extmat](#)**Examples**

```
## Not run:
library(Matrix)
f <- function(v) as.numeric(A %*% v) # Convert Matrix object back to vector
tf <- function(v) as.numeric(tA %*% v) # Convert Matrix object back to vector

e <- new.env()
assign("A", USCounties, e)
assign("tA", t(USCounties), e)
environment(f) <- e
environment(tf) <- e

m <- extmat(f, tf, nrow(USCounties), ncol(USCounties))
system.time(v1 <- propack.svd(m, neig = 10))
# user system elapsed
# 0.252 0.007 0.259
system.time(v2 <- propack.svd(as.matrix(USCounties), neig = 10))
# user system elapsed
# 8.563 0.027 8.590

## End(Not run)
```

svd

*Generic Singular Value Decomposition of a Matrix***Description**

Compute the singular-value decomposition of a real or complex rectangular matrix.

**Usage**

```
propack.svd(X, neig = min(m, n), opts = list())
trlan.svd(X, neig = min(m, n), opts = list(), lambda = NULL, U = NULL)
ztrlan.svd(X, neig = min(m, n), opts = list(), lambda = NULL, U = NULL)
```

**Arguments**

X	the matrix to be decomposed. This can be either normal matrix or 'external matrix' object (e.g. one, created via 'extmat' function).
neig	number of desired eigentriples
opts	different options for eigensolver. See 'Details' section for more information
lambda	set of already computed singular values (used for continuation of the decomposition).
U	matrix of already computed eigenvectors (used for continuation of the decomposition).

## Details

These routines provides an interface to two state-of-art implementations of truncated SVD.

PROPACK does this via the implicitly restarted Lanczos bidiagonalization with partial reorthogonalization. nu-TRLAN does the thick-restart Lanczos eigendecomposition of cross-product matrix.

'opts' is a list of different options which can be passed to the routines. Note that by default more or less suitable values for these options are set by the routines automatically.

The options for PROPACK are:

**kmax** integer, maximum number of iterations.

**dim** integer, dimension of Krylov subspace.

**p** integer, number of shifts per restart.

**maxiter** integer. maximum number of restarts.

**tol** numeric, tolerance level.

**verbose** logical, if 'TRUE', provide verbose output.

The options for nu-TRLAN are:

**kmax** integer, maximum number of iterations.

**maxiter** integer. maximum number of matrix-vector products.

**tol** numeric, tolerance level.

**verbose** integer, verbosity level.

## Value

The returned value is a list with components

d	a vector containing the singular values of 'x'
u	a matrix whose columns contain the left singular vectors of 'X'
v	a matrix whose columns contain the right singular vectors of 'X' (only for 'propack.svd')

## References

Wu, K. and Simon, H. (2000). *Thick-restart Lanczos method for large symmetric eigenvalue problems*. SIAM J. Matrix Anal. Appl. 22, 2, 602-616.

Yamazaki, I., Bai, Z., Simon, H., Wang, L.-W., and Wu, K. (2008). *Adaptive projection subspace dimension for the thick restart Lanczos method*. Tech. rep., Lawrence Berkeley National Laboratory, University of California, One Cyclotron road, Berkeley, California 94720.

Larsen, R. M. (1998). *Efficient algorithms for helioseismic inversion*. Ph.D. thesis, University of Aarhus, Denmark.

Korobeynikov, A. (2010) *Computation- and space-efficient implementation of SSA*. Statistics and Its Interface, Vol. 3, No. 3, Pp. 257-268

# Index

- \* **algebra**
  - eigen, 2
  - svd, 5
- \* **array**
  - eigen, 2
  - svd, 5
- \* **classes**
  - extmat-class, 4
- %%, extmat, extmat-method (extmat-class), 4
- %%, extmat, matrix-method (extmat-class), 4
- %%, extmat, numeric-method (extmat-class), 4
- %%, matrix, extmat-method (extmat-class), 4
- %%, numeric, extmat-method (extmat-class), 4
- as.array, extmat-method (extmat-class), 4
- as.integer, extmat-method (extmat-class), 4
- as.logical, extmat-method (extmat-class), 4
- as.matrix, extmat-method (extmat-class), 4
- as.numeric, extmat-method (extmat-class), 4
- as.vector, extmat-method (extmat-class), 4
- crossprod, ANY, extmat-method (extmat-class), 4
- crossprod, extmat, ANY-method (extmat-class), 4
- crossprod, extmat, extmat-method (extmat-class), 4
- crossprod, extmat, missing-method (extmat-class), 4
- dim, extmat-method (extmat-class), 4
- eigen, 2
- ematmul (extmat), 3
- extmat, 3, 4, 5
- extmat-class, 4
- is.extmat (extmat), 3
- length, extmat-method (extmat-class), 4
- propack.svd (svd), 5
- svd, 5
- t, extmat-method (extmat-class), 4
- tcrossprod, ANY, extmat-method (extmat-class), 4
- tcrossprod, extmat, ANY-method (extmat-class), 4
- tcrossprod, extmat, extmat-method (extmat-class), 4
- tcrossprod, extmat, missing-method (extmat-class), 4
- trlan.eigen (eigen), 2
- trlan.svd (svd), 5
- ztrlan.svd (svd), 5