Package 'RationalMatrix'

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Type Package

Title Exact Matrix Algebra for Rational Matrices

Version 1.0.0

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Description Provides functions to deal with matrix algebra for matrices with rational entries: determinant, rank, image and kernel, inverse, Cholesky decomposition. All computations are exact.

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URL https://github.com/stla/RationalMatrix

BugReports https://github.com/stla/RationalMatrix/issues

Imports gmp, Rcpp (>= 1.0.9)

LinkingTo BH, Rcpp, RcppEigen

Encoding UTF-8

RoxygenNote 7.2.3

SystemRequirements C++ 17, gmp

NeedsCompilation yes

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Repository CRAN

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Contents

`QcholUtDU` *'UtDU' decomposition of a rational matrix*

Description

Cholesky-'UtDU' decomposition of a symmetric rational matrix.

Usage

```
QcholUtDU(M)
```

Arguments

`M`	a square matrix such that `as.character(Mij)` is a quoted integer or a quoted fraction for each entry `Mij`

Value

The Cholesky-'UtDU' decomposition of `M` in a list (see example).

Note

Symmetry is not checked! Only the lower triangular part of `M` is used.

Examples

```
library(RationalMatrix)
x <- matrix(c(1:5, (1:5)^2), 5, 2)
x <- cbind(x, x[, 1L] + 3L*x[, 2L])
M <- crossprod(x)
UtDU <- QcholUtDU(M)
library(gmp)
U <- as.bigq(UtDU$U)
D <- matrix("0", 3L, 3L)
diag(D) <- UtDU$D
D <- as.bigq(D)
perm <- UtDU$perm
UP <- U[, perm]
t(UP) %*% D %*% UP # this is `M`
```

Qdet *Determinant of a rational matrix*

Description

Determinant of a square matrix with rational entries.

Usage

```
Qdet(M)
```

Arguments

M	a square matrix such that `as.character(Mij)` is a quoted integer or a quoted fraction for each entry `Mij`

Value

A string: quoted rational number representing the determinant.

Examples

```
library(RationalMatrix)
M <- cbind(c("1/2", "3"), c("5/3", "-2/7"))
Qdet(M)
```

Qinverse *Inverse of a rational matrix*

Description

Inverse matrix of a square rational matrix.

Usage

```
Qinverse(M)
```

Arguments

M	a square matrix such that `as.character(Mij)` is a quoted integer or a quoted fraction for each entry `Mij`

Value

A character matrix representing the inverse of `M`.

Examples

```
library(RationalMatrix)
M <- cbind(c("1/2", "3", "1"), c("5/3", "-2/7", "10/3"), c("0", "1", "2"))
Qinverse(M)
```

`QisInjective` *Check injectivity*

Description

Checks whether a rational matrix represents an injective linear map (i.e. has trivial kernel).

Usage

```
QisInjective(M)
```

Arguments

`M`	a matrix such that `as.character(Mij)` is a quoted integer or a quoted fraction for each entry `Mij`

Value

A Boolean value indicating whether the linear map corresponding to `M` is injective.

Examples

```
library(RationalMatrix)
set.seed(666L)
M <- matrix(rpois(35L, 1), 5L, 7L)
QisInjective(M)
```

`QisInvertible` *Check invertibility*

Description

Checks whether a square rational matrix is invertible.

Usage

```
QisInvertible(M)
```

Arguments

`M`	a square matrix such that `as.character(Mij)` is a quoted integer or a quoted fraction for each entry `Mij`

Value

A Boolean value indicating whether `M` is invertible.

Examples

```
library(RationalMatrix)
set.seed(666L)
M <- matrix(rpois(25L, 1), 5L, 5L)
QisInvertible(M)
```

`QisSurjective` *Check surjectivity*

Description

Checks whether a rational matrix represents a surjective linear map.

Usage

```
QisSurjective(M)
```

Arguments

`M`	a matrix such that `as.character(Mij)` is a quoted integer or a quoted fraction for each entry `Mij`

Value

A Boolean value indicating whether the linear map corresponding to `M` is surjective.

Examples

```
library(RationalMatrix)
set.seed(666L)
M <- matrix(rpois(35L, 1), 7L, 5L)
QisSurjective(M)
```

Qkernel *Kernel of a rational matrix*

Description

Kernel (null-space) of a rational matrix.

Usage

```
Qkernel(M)
```

Arguments

M	a matrix such that `as.character(Mij)` is a quoted integer or a quoted fraction for each entry `Mij`

Value

A character matrix representing a basis of the kernel of `M`. Note that this basis is not orthogonal.

Examples

```
library(RationalMatrix)
set.seed(666L)
M <- matrix(rpois(30L, 6), 10L, 3L)
M <- cbind(M, M[,1] + M[,2], M[,2] + 2L*M[,3])
Qkernel(M)
```

Qrange *Range of a rational matrix*

Description

Range (column-space, image, span) of a rational matrix.

Usage

```
Qrange(M)
```

Arguments

M	a matrix such that `as.character(Mij)` is a quoted integer or a quoted fraction for each entry `Mij`

Value

A character matrix representing a basis of the range of `M`. Note that this basis is not orthogonal.

Examples

```
library(RationalMatrix)
set.seed(666L)
M <- matrix(rpois(15L, 6), 3L, 5L)
Qrange(M)
```

`Qrank` *Rank of a rational matrix*

Description

Returns the rank of a rational matrix.

Usage

```
Qrank(M)
```

Arguments

`M`	a matrix such that `as.character(Mij)` is a quoted integer or a quoted fraction for each entry `Mij`

Value

An integer, the rank of `M`.

Examples

```
library(RationalMatrix)
M <- cbind(c("1/2", "3", "1"), c("5/3", "-2/7", "10/3"), c("1", "1", "2"))
Qrank(M)
```

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