

# Package ‘ResidualMatrix’

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**Title** Creating a DelayedMatrix of Regression Residuals

**Imports** methods, Matrix, S4Vectors, DelayedArray

**Suggests** testthat, BiocStyle, knitr, rmarkdown, BiocSingular

**biocViews** Software, DataRepresentation, Regression, BatchEffect,  
ExperimentalDesign

**Description** Provides delayed computation of a matrix of residuals after fitting a linear model to each column of an input matrix. Also supports partial computation of residuals where selected factors are to be preserved in the output matrix. Implements a number of efficient methods for operating on the delayed matrix of residuals, most notably matrix multiplication and calculation of row/column sums or means.

**License** GPL-3

**VignetteBuilder** knitr

**RoxygenNote** 7.3.1

**BugReports** <https://github.com/LTLA/ResidualMatrix/issues>

**URL** <https://github.com/LTLA/ResidualMatrix>

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### ResidualMatrix-package

*The ResidualMatrix package*

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## Description

Originally implemented in the **BiocSingular** package, the **ResidualMatrix** class has been placed into its own package to enable greater re-use. This class provides delayed computation of residuals from a linear model fit, allowing us to represent large matrices of residuals without actually calculating them in memory. The idea is to allow us to easily regress out uninteresting factors for big datasets, much like a delayed, scalable version of **limma**'s venerable `removeBatchEffect` function.

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### ResidualMatrix-class *The ResidualMatrix class*

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## Description

The **ResidualMatrix** class supports delayed calculation of the residuals from a linear model fit. This serves as a light-weight representation of what would otherwise be a large dense matrix in memory. It also enables efficient matrix multiplication based on features of the the original matrix (e.g., sparsity).

## Construction

`ResidualMatrix(x, design=NULL, keep=NULL)` returns a **ResidualMatrix** object, given:

- `x`, a matrix-like object. This can alternatively be a **ResidualMatrixSeed**, in which case `design` and `keep` are ignored.
- `design`, a numeric matrix containing the experimental design, to be used for linear model fitting on each *column* of `x`. This defaults to an intercept-only matrix.
- `keep`, an integer vector specifying the columns of `design` to *not* regress out. By default, all columns of `design` are regressed out.
- `restrict`, an integer or logical vector specifying the rows of `x` to use for model fitting. If `NULL`, all rows of `x` are used.

When `keep=NULL`, the **ResidualMatrix** contains values equivalent to `lm.fit(x=design, y=x)$residuals`.

## Methods

In the following code chunks, `x` is a `ResidualMatrix` object:

- `x[i, j, ..., drop=FALSE]` will return a `ResidualMatrix` object for the specified row and column subsets, or a numeric vector if either `i` or `j` are of length 1.
- `t(x)` will return a `ResidualMatrix` object with transposed contents.
- `dimnames(x) <- value` will return a `ResidualMatrix` object where the rows and columns are renamed by `value`, a list of two character vectors (or `NULL`).

`colSums(x)`, `colMeans(x)`, `rowSums(x)` and `rowMeans(x)` will return the relevant statistics for a `ResidualMatrix` `x`.

`%%*`, `crossprod` and `tcrossprod` can also be applied where one or both of the arguments are `ResidualMatrix` objects.

`ResidualMatrix` objects are derived from `DelayedMatrix` objects and support all of valid operations on the latter. All operations not listed here will use the underlying `DelayedArray` machinery. Unary or binary operations will generally create a new `DelayedMatrix` instance containing a `ResidualMatrixSeed`.

## Author(s)

Aaron Lun

## Examples

```
design <- model.matrix(~gl(5, 50))

library(Matrix)
y0 <- rsparsematrix(nrow(design), 200, 0.1)
y <- ResidualMatrix(y0, design)
y

# For comparison:
fit <- lm.fit(x=design, y=as.matrix(y0))
DelayedArray(fit$residuals)

# Keeping some of the factors:
y2 <- ResidualMatrix(y0, design, keep=1:2)
y2
DelayedArray(fit$residuals + design[,1:2] %% fit$coefficients[1:2,])

# Matrix multiplication:
crossprod(y)
tcrossprod(y)
y %% rnorm(200)
```

## ResidualMatrixSeed-class

*The ResidualMatrixSeed class***Description**

This is a seed class that powers the **DelayedArray** machinery underlying the **ResidualMatrix**.

**Construction**

`ResidualMatrixSeed(x, design=NULL, keep=NULL)` returns a `ResidualMatrixSeed` object, given:

- `x`, a matrix-like object. This can alternatively be a `ResidualMatrixSeed`, in which case `design` is ignored.
- `design`, a numeric matrix containing the experimental design, to be used for linear model fitting on each *column* of `x`. This defaults to an intercept-only matrix.
- `keep`, an integer vector specifying the columns of `design` to *not* regress out. By default, all columns of `design` are regressed out.
- `restrict`, an integer or logical vector specifying the rows of `x` to use for model fitting. If `NULL`, all rows of `x` are used.

**Methods**

`ResidualMatrixSeed` objects are implemented as **DelayedMatrix** backends. They support standard operations like `dim`, `dimnames` and `extract_array`.

Passing a `ResidualMatrixSeed` object to the **DelayedArray** or **ResidualMatrix** constructors will create a **ResidualMatrix** (which is what most users should be working with, anyway).

**Author(s)**

Aaron Lun

**Examples**

```
design <- model.matrix(~gl(5, 50))

library(Matrix)
y0 <- rsparsematrix(nrow(design), 200, 0.1)
s <- ResidualMatrixSeed(y0, design)
s

ResidualMatrix(s)

DelayedArray(s)
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