

# Package ‘ScaledMatrix’

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**Title** Creating a DelayedMatrix of Scaled and Centered Values

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

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

**biocViews** Software, DataRepresentation

**Description** Provides delayed computation of a matrix of scaled and centered values.  
The result is equivalent to using the scale() function but avoids explicit  
realization of a dense matrix during block processing. This permits greater  
efficiency in common operations, most notably matrix multiplication.

**License** GPL-3

**VignetteBuilder** knitr

**RoxygenNote** 7.3.1

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

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ScaledMatrix

*The ScaledMatrix class***Description**

Defines the ScaledMatrixSeed and ScaledMatrix classes and their associated methods. These classes support delayed centering and scaling of the columns in the same manner as [scale](#), but preserving the original data structure for more efficient operations like matrix multiplication.

**Usage**

```
ScaledMatrix(x, center = NULL, scale = NULL)
```

**Arguments**

|        |                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| x      | A matrix or any matrix-like object (e.g., from the <b>Matrix</b> package).<br>This can alternatively be a ScaledMatrixSeed, in which case any values of center and scale are ignored.                                                                                                                                                                                                                                                              |
| center | A numeric vector of length equal to <code>ncol(x)</code> , where each element is to be subtracted from the corresponding column of x. A NULL value indicates that no subtraction is to be performed. Alternatively TRUE, in which case it is set to the column means of x.                                                                                                                                                                         |
| scale  | A numeric vector of length equal to <code>ncol(x)</code> , where each element is to be divided from the corresponding column of x (after subtraction). A NULL value indicates that no division is to be performed. Alternatively TRUE, in which case it is set to the column-wise root-mean-squared differences from center (interpretable as standard deviations if center is set to the column means, see <a href="#">scale</a> for commentary). |

**Value**

The ScaledMatrixSeed constructor will return a ScaledMatrixSeed object.

The ScaledMatrix constructor will return a ScaledMatrix object equivalent to `t((t(x) - center)/scale)`.

**Methods for ScaledMatrixSeed objects**

ScaledMatrixSeed objects are implemented as [DelayedMatrix](#) backends. They support standard operations like `dim`, `dimnames` and `extract_array`.

Passing a ScaledMatrixSeed object to the [DelayedArray](#) constructor will create a ScaledMatrix object.

It is possible for x to contain a ScaledMatrix, thus nesting one ScaledMatrix inside another. This can occasionally be useful in combination with transposition to achieve centering/scaling in both dimensions.

**Methods for ScaledMatrix objects**

ScaledMatrix objects are derived from [DelayedMatrix](#) objects and support all of valid operations on the latter. Several functions are specialized for greater efficiency when operating on ScaledMatrix instances, including:

- Subsetting, transposition and replacement of row/column names. These will return a new ScaledMatrix rather than a DelayedMatrix.
- Matrix multiplication via `%*%`, `crossprod` and `tcrossprod`. These functions will return a DelayedMatrix.
- Calculation of row and column sums and means by `colSums`, `rowSums`, etc.

All other operations applied to a ScaledMatrix will use the underlying **DelayedArray** machinery. Unary or binary operations will generally create a new DelayedMatrix instance containing a ScaledMatrixSeed.

Tranposition can effectively be used to allow centering/scaling on the rows if the input `x` is transposed.

### Efficiency vs precision

The *raison d'être* of the ScaledMatrix is that it can offer faster matrix multiplication by avoiding the **DelayedArray** block processing. This is done by refactoring the scaling/centering operations to use the (hopefully more efficient) multiplication operator of the original matrix `x`. Unfortunately, the speed-up comes at the cost of increasing the risk of catastrophic cancellation. The procedure requires subtraction of one large intermediate number from another to obtain the values of the final matrix product. This could result in a loss of numerical precision that compromises the accuracy of downstream algorithms. In practice, this does not seem to be a major concern though one should be careful if the input `x` contains very large positive/negative values.

### Author(s)

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### Examples

```
library(Matrix)
y <- ScaledMatrix(rsparsematrix(10, 20, 0.1),
  center=rnorm(20), scale=1+runif(20))
y

crossprod(y)
tcrossprod(y)
y %*% rnorm(20)
```

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