

# Package ‘CONSTANd’

September 16, 2021

**Type** Package

**Title** Data normalization by matrix raking

**Version** 1.0.0

**Date** 2020-10-30

**Description** Normalizes a data matrix `data` by raking (using the RAS method by Bacharach, see references) the Nrows by Ncols matrix such that the row means and column means equal 1. The result is a normalized data matrix `K=RAS`, a product of row multipliers `R` and column multipliers `S` with the original matrix `A`. Missing information needs to be presented as `NA` values and not as zero values, because CONSTANd is able to ignore missing values when calculating the mean. Using CONSTANd normalization allows for the direct comparison of values between samples within the same and even across different CONSTANd-normalized data matrices.

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**Encoding** UTF-8

**LazyData** true

**biocViews** MassSpectrometry, Cheminformatics, Normalization,  
Preprocessing, DifferentialExpression, Genetics,  
Transcriptomics, Proteomics

**NeedsCompilation** no

**Depends** R (>= 4.1)

**Suggests** BiocStyle, knitr, rmarkdown, tidy, ggplot2, gridExtra,  
magick, Cairo, limma

**SystemRequirements**

**BugReports** <https://github.com/PDiracDelta/CONSTANd/issues>

**URL** qcquan.net/constand

**VignetteBuilder** knitr

**git\_url** <https://git.bioconductor.org/packages/CONSTANd>

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CONSTANd	<i>Data normalization by matrix raking</i>
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### Description

Normalizes the data matrix by raking the Nrows by Ncols matrix such that the row means and column means equal Ncols and Nrows, respectively.

### Usage

```
CONSTANd(data, precision=1e-5, maxIterations=50, target=1)
```

### Arguments

data	Nrows by Ncols matrix.
precision	Combined allowed deviation (residual error) of col and row means from target value.
maxIterations	Maximum amount of iterations (1x row and 1x col per iteration).
target	The mean value of quantifications in each row and column after normalization.

### Details

Normalizes the data matrix <data> by raking (using the RAS method by Bacharach, see references) the Nrows by Ncols matrix such that the row means and column means equal 1. The result is a normalized data matrix  $K=RAS$ , a product of row multipliers  $R$  and column multipliers  $S$  with the original matrix  $A$ . Missing information needs to be presented as nan values and not as zero values, because CONSTANd is able to ignore nan-values when calculating the mean. The variable <maxIterations> is an integer value that denotes the number of raking cycles. The variable <precision> defines the stopping criteria based on the L1-norm as defined by Friedrich Pukelsheim, Bruno Simeone in "On the Iterative Proportional Fitting Procedure: Structure of Accumulation Points and L1-Error Analysis".

**Value**

normalized_data	Normalized data matrix 'K=RAS' in the RAS-formulation of the problem.
convergence_trail	Precision acquired after each raking iteration (last value is the final precision).
R	Row multipliers in the 'K=RAS' formulation of the problem.
S	Column multipliers in the 'K=RAS' formulation of the problem.

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**References**

Maes, Evelyne, et al. "CONSTANd: A normalization method for isobaric labeled spectra by constrained optimization." *Molecular & Cellular Proteomics* 15.8 (2016): 2779-2790. <https://doi.org/10.1074/mcp.M115.056911>. Accessed 18 Oct. 2020.

Bacharach, Michael. "Estimating Nonnegative Matrices from Marginal Data." *International Economic Review*, vol. 6, no. 3, 1965, pp. 294–310. JSTOR, <https://doi.org/10.2307%2F2525582>. Accessed 18 Oct. 2020.

**Examples**

```
# generic use (mock data)
data_matrix <- matrix(runif(20), c(5,4))
normalized_matrix <- CONSTANd(data_matrix)$normalized_data

# customize parameters
result <- CONSTANd(data_matrix, precision=1e-3, maxIterations=30)

# explore parts of the result object
normalized_matrix <- result$normalized_data
num_iterations_performed <- length(result$convergence_trail)
attained_precision <- result$convergence_trail[num_iterations_performed]
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