

# Package ‘sights’

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**Type** Package

**Title** Statistics and dIagnostic Graphs for HTS

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**Description** SIGHTS is a suite of normalization methods, statistical tests, and diagnostic graphical tools for high throughput screening (HTS) assays. HTS assays use microtitre plates to screen large libraries of compounds for their biological, chemical, or biochemical activity.

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**URL** <https://eg-r.github.io/sights/>

**BugReports** <https://github.com/eg-r/sights/issues>

**Depends** R(>= 3.3)

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'normMedFil.R' 'normSights.R' 'plot3d.R' 'plotAutoco.R'  
'plotBox.R' 'plotHeatmap.R' 'plotHist.R' 'plotScatter.R'  
'statRVM.R' 'plotIGFit.R' 'plotSights.R' 'statFDR.R' 'statT.R'  
'statSights.R'

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|               |                                                      |
|---------------|------------------------------------------------------|
| ex_dataMatrix | <i>High-Throughput Screening example data - CMBA</i> |
|---------------|------------------------------------------------------|

---

Description

An example dataset containing High-Throughput Screening (HTS) output and experimental design information. See References for details.

Usage

data(ex\_dataMatrix)

## Format

A data frame with 80 rows and 9 columns:

- Wells. Plate well numbers for each sample
- Rows. Plate row identifiers for each sample
- Columns. Plate column identifiers for each sample
- S1\_R1. Screen 1 Replicate 1
- S1\_R2. Screen 1 Replicate 2
- S1\_R3. Screen 1 Replicate 3
- S2\_R1. Screen 2 Replicate 1
- S2\_R2. Screen 2 Replicate 2
- S2\_R3. Screen 2 Replicate 3

This example data matrix consists of 6 plates with 80 wells each. Although these are 96-well plates, only 80 wells in each plate contained the active compounds. Therefore, the subsequent data matrix for this package excludes the inactive wells.

## Details

The sights data format requires each plate matrix to be converted into a 1-dimensional vector. The plate wells in this vector should be arranged by row first. For example, this 3x3 plate matrix:

|       | Col 1 | Col 2 | Col 3 |
|-------|-------|-------|-------|
| Row A | A1    | A2    | A3    |
| Row B | B1    | B2    | B3    |
| Row C | C1    | C2    | C3    |

can be converted into its vector form as:

| Row | Col | Data |
|-----|-----|------|
| A   | 1   | A1   |
| A   | 2   | A2   |
| A   | 3   | A3   |
| B   | 1   | B1   |
| B   | 2   | B2   |
| B   | 3   | B3   |
| C   | 1   | C1   |
| C   | 2   | C2   |
| C   | 3   | C3   |

Here, number of columns in a plate is 3, and number of rows is 3 as well. Each such plate vector should form a column in the data matrix before application of sights functions. Only the active wells should be included in the data matrix; inactive wells containing mock/control compounds should be marked as NAs, or if they are in entire rows/columns they can be removed completely as in this example dataset and the arguments `plateRows` and `plateCols` modified accordingly.

**Value**

Dataframe of 80 rows and 9 columns as explained in Format

**References**

CMBA Titration series 10uM Tyr samples. Murie et al. (2015). Improving detection of rare biological events in high-throughput screens. *Journal of Biomolecular Screening*, 20(2), 230-241.

**Examples**

```
## load dataset
data(ex_dataMatrix)

## structure of dataset
str(ex_dataMatrix)
## summary of dataset
summary(ex_dataMatrix)

## See help pages of SIGHTS functions for examples of using this dataset
```

---

inglese

*High-Throughput Screening example data - Inglese*

---

**Description**

A published dataset containing High-Throughput Screening (HTS) output and experimental design information. See References for details.

**Usage**

```
data(inglese)
```

**Format**

A data frame with 1280 rows and 45 columns:

- Row. Plate row identifiers for each sample
- Col. Plate column identifiers for each sample
- Exp1R1. Screen 1 Replicate 1
- Exp1R2. Screen 1 Replicate 2
- Exp1R3. Screen 1 Replicate 3
- Exp2R1. Screen 2 Replicate 1
- Exp2R2. Screen 2 Replicate 2
- Exp2R3. Screen 2 Replicate 3

... and so on until Exp14 totaling to 14 screens in triplicate.

- Hits. Presence or absence of hits identified for each sample

**Value**

Dataframe of 1280 rows and 45 columns as explained in Format

**Note**

For information on how to arrange your dataset, please see ([ex\\_dataMatrix](#))

**References**

Titration series samples. Inglese et al. (2006). Quantitative High-Throughput Screening: A Titration-Based Approach That Efficiently Identifies Biological Activities in Large Chemical Libraries. *Proc. Natl. Acad. Sci. U. S. A.*, 103, 11473-11478.

**Examples**

```
## load dataset
data(inglese)

## structure of dataset
str(inglese)
## summary of dataset
summary(inglese)

## See SIGHTS vignette for examples of using this dataset and its analysis
```

---

normLoess

*Normalization by loess method*

---

**Description**

Apply loess normalization to data

**Usage**

```
normLoess(dataMatrix, plateRows, plateCols, dataRows = NULL,
          dataCols = NULL)
```

**Arguments**

**dataMatrix**      Data frame or numeric matrix. Columns are plates, and rows are plate wells.

**plateRows, plateCols**      Number of rows/columns in plate.

**dataRows, dataCols**      Optional integer vector. Indicate which row/column numbers from the dataMatrix should be normalized. If NULL then all rows/columns from the dataMatrix are used.

**Details**

Loess normalization adjusts each well by the fitted row and column values generated by calculating the loess curve for each row and column.

**Value**

Numeric matrix of normalized data in the same format as dataMatrix

**Note**

For information on how to arrange your dataset for dataMatrix, please see ([ex\\_dataMatrix](#))

**References**

Baryshnikova et al. (2010). Quantitative analysis of fitness and genetic interactions in yeast on a genome scale. *Nature Methods*, 7(12), 1017-1024.

**See Also**

Other normalization methods: [normMedFil](#), [normRobZ](#), [normR](#), [normSPAWN](#), [normZ](#)

**Examples**

```
## load dataset
data(ex_dataMatrix)

## apply Loess method
ex_normMatrix <- normLoess(dataMatrix = ex_dataMatrix, dataCols = 5:10,
plateRows = 8, plateCols = 10)
```

---

|            |                                              |
|------------|----------------------------------------------|
| normMedFil | <i>Normalization by median filter method</i> |
|------------|----------------------------------------------|

---

**Description**

Apply median filter normalization to data

**Usage**

```
normMedFil(dataMatrix, plateRows, plateCols, dataRows = NULL,
dataCols = NULL, seqFilter = TRUE)
```

## Arguments

**dataMatrix** Data frame or numeric matrix. Columns are plates, and rows are plate wells.

**plateRows, plateCols** Number of rows/columns in plate.

**dataRows, dataCols** Optional integer vector. Indicate which row/column numbers from the dataMatrix should be normalized. If NULL then all rows/columns from the dataMatrix are used.

**seqFilter** Optional logical. If TRUE apply initial row median filter then standard filter, else just apply standard filter.

## Details

Median Filter normalization uses a two-step median filter process where each well is adjusted by the median score of a neighbouring group of wells [Bushway et al (2011)]. The first median filter uses a neighbour set based on the Manhattan distance to each well. The second median filter uses a neighbour set based on the proximity along each row or column.

## Value

Numeric matrix of normalized data in the same format as dataMatrix

## Note

For information on how to arrange your dataset for dataMatrix, please see ([ex\\_dataMatrix](#))

## References

Bushway et al.(2011). Optimization and application of median filter corrections to relieve diverse spatial patterns in microtiter plate data. *Journal of Biomolecular Screening*, 16(9), 1068-1080.

## See Also

Other normalization methods: [normLoess](#), [normRobZ](#), [normR](#), [normSPAWN](#), [normZ](#)

## Examples

```
## load dataset
data(ex_dataMatrix)

## apply standard median filter method
ex_normMatrix <- normMedFil(dataMatrix = ex_dataMatrix, dataCols = 5:10,
plateRows = 8, plateCols = 10, seqFilter = FALSE)
## apply initial row median filter then standard filter
ex_normMatrix <- normMedFil(dataMatrix = ex_dataMatrix, dataCols = 5:10,
plateRows = 8, plateCols = 10, seqFilter = TRUE)
```

---

**normR***Normalization by R score method*

---

## Description

Apply Robust Regression model separately to each plate

## Usage

```
normR(dataMatrix, plateRows, plateCols, dataRows = NULL, dataCols = NULL)
```

## Arguments

**dataMatrix** Data frame or numeric matrix. Columns are plates, and rows are plate wells.

**plateRows, plateCols** Number of rows/columns in plate.

**dataRows, dataCols** Optional integer vector. Indicate which row/column numbers from the dataMatrix should be normalized. If NULL then all rows/columns from the dataMatrix are used.

## Details

R score normalization uses the robust regression method described by [Wu et al \(2008\)](#). Parameters are estimated through the `r1m` function. Data is pre-normalized by median normalization prior to applying the regression algorithm. R scores are the residuals produced by the model and rescaled by dividing with the standard deviation estimate from the regression function.

## Value

Numeric matrix of normalized data in the same format as dataMatrix

## Note

For information on how to arrange your dataset for dataMatrix, please see ([ex\\_dataMatrix](#))

## References

[Wu et al. \(2008\). Quantitative Assessment of Hit Detection and Confirmation in Single and Duplicate High-Throughput Screenings. Journal of Biomolecular Screening, 13\(2\), 159-167.](#)

## See Also

Other normalization methods: [normLoess](#), [normMedFil](#), [normRobZ](#), [normSPAWN](#), [normZ](#)

## Examples

```
## load dataset
data(ex_dataMatrix)

## apply R score
ex_normMatrix <- normR(dataMatrix = ex_dataMatrix, dataCols = 5:10,
plateRows = 8, plateCols = 10)
```

---

normRobZ

*Normalization by robust Z score method*

---

## Description

Apply robust Z score to data

## Usage

```
normRobZ(dataMatrix, dataRows = NULL, dataCols = NULL)
```

## Arguments

**dataMatrix**      Data frame or numeric matrix. Columns are plates, and rows are plate wells.

**dataRows, dataCols**      Optional integer vector. Indicate which row/column numbers from the dataMatrix should be normalized. If NULL then all rows/columns from the dataMatrix are used.

## Details

Robust Z score normalization subtracts the median of the raw well intensities of a given plate from the signal intensity of a given compound and divides it by the median absolute deviation of the raw well intensities of that plate.

## Value

Numeric matrix of normalized data in the same format as dataMatrix

## Note

For information on how to arrange your dataset for dataMatrix, please see ([ex\\_dataMatrix](#))

## References

Malo et al. (2006). Statistical practice in high-throughput screening data analysis. Nature Biotechnology, 24(2), 167-175.

See Also

Other normalization methods: [normLoess](#), [normMedFil](#), [normR](#), [normSPAWN](#), [normZ](#)

Examples

```
## load dataset
data(ex_dataMatrix)

## apply robust Z score
ex_normMatrix <- normRobZ(dataMatrix = ex_dataMatrix, dataCols = 5:10)
```

---

|            |                              |
|------------|------------------------------|
| normSights | <i>Normalization methods</i> |
|------------|------------------------------|

---

Description

Apply any of the available SIGHTS normalization methods

Usage

```
normSights(normMethod, dataMatrix, plateRows, plateCols, dataRows = NULL,
  dataCols = NULL, trimFactor = 0.2, wellCorrection = FALSE,
  biasMatrix = NULL, biasCols = NULL, seqFilter = TRUE)
```

Arguments

- |                      |                                                                                                                                                                                                                         |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| normMethod           | Normalization method name from SIGHTS ('Z', 'RobZ', 'R', 'SPAWN', 'Loess', or 'MedFil')                                                                                                                                 |
| dataMatrix           | Data frame or numeric matrix. Columns are plates, and rows are plate wells.                                                                                                                                             |
| plateRows, plateCols | Number of rows/columns in plate. Applies to normMethods 'R', 'SPAWN', 'Loess', and 'MedFil'.                                                                                                                            |
| dataRows, dataCols   | Optional integer vector. Indicate which row/column numbers from the dataMatrix should be normalized. If NULL then all rows/columns from the dataMatrix are used.                                                        |
| trimFactor           | Optional trim value to be used in trimmed mean polish. It should be between 0 and 0.5. Default is 0.2. Applies to normMethod 'SPAWN'.                                                                                   |
| wellCorrection       | Optional logical. If TRUE then individual wells are corrected based on spatial bias. Applies to normMethod 'SPAWN'.                                                                                                     |
| biasMatrix           | Optional data frame or numeric matrix, in the same format as dataMatrix and with the same plateRows and plateCols specifications. If NULL then normalized data is used as bias template. Applies to normMethod 'SPAWN'. |

|           |                                                                                                                                                                                                                                                                                                                                                          |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| biasCols  | Optional integer vector. Indicate which column numbers from biasMatrix or normalized dataMatrix (subset of dataCols) should be used to calculate bias template. Control plates or selection of dataMatrix plates to be used for well correction. If NULL then all plates of biasMatrix or normalized dataMatrix are used. Applies to normMethod 'SPAWN'. |
| seqFilter | Optional logical. If TRUE apply initial row median filter then standard filter, else just apply standard filter. Applies to normMethod 'MedFil'.                                                                                                                                                                                                         |

### Details

One of the following SIGHTS normalization methods may be chosen: [normZ](#), [normRobZ](#), [normR](#), [normSPAWN](#), [normLoess](#), or [normMedFil](#). See their individual help pages for more details.

### Value

Numeric matrix of normalized data in the same format as dataMatrix

### Note

For information on how to arrange your dataset for dataMatrix, please see ([ex\\_dataMatrix](#))

### References

Murie et al. (2015). Improving detection of rare biological events in high-throughput screens. *Journal of Biomolecular Screening*, 20(2), 230-241.

### See Also

Other SIGHTS functions: [plotSights](#), [statSights](#)

### Examples

```
## load dataset
data(ex_dataMatrix)

## choose a normalization method and provide relevant information
ex_normMatrix <- normSights(dataMatrix = ex_dataMatrix, dataCols = 5:10,
normMethod = 'RobZ')
```

---

normSPAWN

*Normalization by SPAWN method*

---

### Description

Apply trimmed mean polish to data

**Usage**

```
normSPAWN(dataMatrix, plateRows, plateCols, dataRows = NULL,
  dataCols = NULL, trimFactor = 0.2, wellCorrection = FALSE,
  biasMatrix = NULL, biasCols = NULL)
```

**Arguments**

|                                   |                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>dataMatrix</code>           | Data frame or numeric matrix. Columns are plates, and rows are plate wells.                                                                                                                                                                                                                                                                                                                                           |
| <code>plateRows, plateCols</code> | Number of rows/columns in plate.                                                                                                                                                                                                                                                                                                                                                                                      |
| <code>dataRows, dataCols</code>   | Optional integer vector. Indicate which row/column numbers from the <code>dataMatrix</code> should be normalized. If <code>NULL</code> then all rows/columns from the <code>dataMatrix</code> are used.                                                                                                                                                                                                               |
| <code>trimFactor</code>           | Optional trim value to be used in trimmed polish. It should be between 0 and 0.5. Default is 0.2.                                                                                                                                                                                                                                                                                                                     |
| <code>wellCorrection</code>       | Optional logical. If <code>TRUE</code> then individual wells are corrected based on spatial bias.                                                                                                                                                                                                                                                                                                                     |
| <code>biasMatrix</code>           | Optional data frame or numeric matrix, in the same format as <code>dataMatrix</code> and with the same <code>plateRows</code> and <code>plateCols</code> specifications. If <code>NULL</code> then normalized data is used as bias template.                                                                                                                                                                          |
| <code>biasCols</code>             | Optional integer vector. Indicate which column numbers from <code>biasMatrix</code> or normalized <code>dataMatrix</code> (subset of <code>dataCols</code> ) should be used to calculate bias template. Control plates or selection of <code>dataMatrix</code> plates to be used for well correction. If <code>NULL</code> then all plates of <code>biasMatrix</code> or normalized <code>dataMatrix</code> are used. |

**Details**

Spatial Polish And Well Normalization (SPAWN) uses a trimmed mean polish on individual plates to remove row and column effects. Data from each well location on each plate are initially fitted to the same model as the **R score**. Model parameters are estimated with an iterative polish technique but with a trimmed mean, rather than a median, as a measure of central tendency for row and column effects. The residuals are rescaled by dividing by the median average deviation of their respective plates. Well correction uses a bias template, which can either be the normalized plates themselves or be supplied externally (and SPAWN normalized before application). At each well location of this bias template, a median of all plates is calculated and subtracted from the normalized plates, thus correcting for well location bias.

**Value**

Numeric matrix of normalized data in the same format as `dataMatrix`

**Note**

For information on how to arrange your dataset for `dataMatrix`, please see ([ex\\_dataMatrix](#))

## References

SPAWN: Murie et al. (2015). Improving detection of rare biological events in high-throughput screens. *Journal of Biomolecular Screening*, 20(2), 230-241.

R score: Wu et al. (2008). Quantitative Assessment of Hit Detection and Confirmation in Single and Duplicate High-Throughput Screenings. *Journal of Biomolecular Screening*, 13(2), 159-167.

Trimmed Mean: Malo et al. (2010). Experimental design and statistical methods for improved hit detection in high-throughput screening. *Journal of Biomolecular Screening*, 15(8), 990-1000.

## See Also

Other normalization methods: [normLoess](#), [normMedFil](#), [normRobZ](#), [normR](#), [normZ](#)

## Examples

```
## load dataset
data(ex_dataMatrix)

## apply SPAWN method with default trim factor and without well correction
ex_normMatrix <- normSPAWN(dataMatrix = ex_dataMatrix, dataCols = 5:10,
plateRows = 8, plateCols = 10, trimFactor = 0.2)
## apply SPAWN method with default trim factor and with well correction
ex_normMatrix <- normSPAWN(dataMatrix = ex_dataMatrix, dataCols = 5:10,
plateRows = 8, plateCols = 10, trimFactor = 0.2, wellCorrection = TRUE)
```

---

|       |                                        |
|-------|----------------------------------------|
| normZ | <i>Normalization by Z score method</i> |
|-------|----------------------------------------|

---

## Description

Apply Z score to data

## Usage

```
normZ(dataMatrix, dataRows = NULL, dataCols = NULL)
```

## Arguments

|                    |                                                                                                                                                                  |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| dataMatrix         | Data frame or numeric matrix. Columns are plates, and rows are plate wells.                                                                                      |
| dataRows, dataCols | Optional integer vector. Indicate which row/column numbers from the dataMatrix should be normalized. If NULL then all rows/columns from the dataMatrix are used. |

## Details

Z score normalization subtracts the mean of the raw well intensities of a given plate from the signal intensity of a given compound and divides it by the standard deviation of the raw well intensities of that plate.

**Value**

Numeric matrix of normalized data in the same format as dataMatrix

**Note**

For information on how to arrange your dataset for dataMatrix, please see ([ex\\_dataMatrix](#))

**See Also**

Other normalization methods: [normLoess](#), [normMedFil](#), [normRobZ](#), [normR](#), [normSPAWN](#)

**Examples**

```
## load dataset
data(ex_dataMatrix)

## apply Z score
ex_normMatrix <- normZ(dataMatrix = ex_dataMatrix, dataCols = 5:10)
```

---

plot3d

3D plot

---

**Description**

Plot a three-dimensional plot for each plate

**Usage**

```
plot3d(plotMatrix, plateRows, plateCols, plotRows = NULL, plotCols = NULL,
       plotName = NULL)
```

**Arguments**

|                      |                                                                                                                                                               |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| plotMatrix           | Data frame or numeric matrix. Columns are plates, and rows are plate wells.                                                                                   |
| plateRows, plateCols | Number of rows/columns in plate.                                                                                                                              |
| plotRows, plotCols   | Optional integer vector. Indicate which row/column numbers from the plotMatrix should be plotted. If NULL then all rows/columns from the plotMatrix are used. |
| plotName             | Optional. Name of plotMatrix for plot title.                                                                                                                  |

**Details**

3d plots can be used to assess the existence of spatial bias on a plate by plate basis. Spatial bias can be visually subtle, however, and sometimes difficult to detect with 3d plots. Auto-correlation plots ([plotAutoco](#)) can circumvent this problem.

**Value**

List of lattice objects

**See Also**

Other graphical devices: [plotAutoco](#), [plotBox](#), [plotHeatmap](#), [plotHist](#), [plotIGFit](#), [plotScatter](#)

**Examples**

```
## load dataset
data(ex_dataMatrix)

## plot raw data
plot3d(plotMatrix = ex_dataMatrix, plotCols = 5:10,
plotName = 'Example', plateRows = 8, plateCols = 10)
## normalize data matrix using any method and store in new variable
ex_normMatrix <- normZ(dataMatrix = ex_dataMatrix, dataCols = 5:10)
## plot normalized data
plot3d(plotMatrix = ex_normMatrix, plotName = 'Example',
plateRows = 8, plateCols = 10)
```

---

plotAutoco

*Auto-correlation*


---

**Description**

Plot auto-correlation for each plate

**Usage**

```
plotAutoco(plotMatrix, plateRows, plateCols, plotRows = NULL,
plotCols = NULL, plotName = NULL, plotSep = TRUE, ...)
```

**Arguments**

|                      |                                                                                                                                                               |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| plotMatrix           | Data frame or numeric matrix. Columns are plates, and rows are plate wells.                                                                                   |
| plateRows, plateCols | Number of rows/columns in plate.                                                                                                                              |
| plotRows, plotCols   | Optional integer vector. Indicate which row/column numbers from the plotMatrix should be plotted. If NULL then all rows/columns from the plotMatrix are used. |
| plotName             | Optional. Name of plotMatrix for plot title.                                                                                                                  |
| plotSep              | Optional logical. Should plots be presented in separate windows? Default is TRUE.                                                                             |
| ...                  | Optional. Additional parameters passed to <a href="#">geom_path</a> .                                                                                         |

## Details

Auto-correlation plots can be used to identify spatial bias. Non-zero auto-correlations indicate within-plate bias, namely that proximal wells within-plates are correlated and that the measured intensity of a feature depends partially on its well location in the plate. Cyclical patterns of auto-correlation, in particular indicate within-plate spatial bias. Normalization methods that produce auto-correlations close to zero indicate the removal of spatial bias.

## Value

Modifiable ggplot2 object or list of objects

## See Also

Other graphical devices: [plot3d](#), [plotBox](#), [plotHeatmap](#), [plotHist](#), [plotIGFit](#), [plotScatter](#)

## Examples

```
## load dataset
data(ex_dataMatrix)

## plot raw data
plotAutoco(plotMatrix = ex_dataMatrix, plateRows = 8, plateCols = 10,
plotCols = 5:10, plotName = 'Example')
## normalize data matrix using any method and store in new variable
ex_normMatrix <- normZ(dataMatrix = ex_dataMatrix, dataCols = 5:10)
## plot normalized data
plotAutoco(plotMatrix = ex_normMatrix, plotName = 'Example',
plateRows = 8, plateCols = 10, plotSep = FALSE)
```

---

plotBox

*Boxplot*

---

## Description

Construct an ordered boxplot for each plate

## Usage

```
plotBox(plotMatrix, plotRows = NULL, plotCols = NULL, plotName = NULL,
repIndex = NULL, plotSep = TRUE, ...)
```

## Arguments

**plotMatrix** Data frame or numeric matrix. Columns are plates, and rows are plate wells.

**plotRows, plotCols** Optional integer vector. Indicate which row/column numbers from the plotMatrix should be plotted. If NULL then all rows/columns from the plotMatrix are used.

|          |                                                                                                                                                                                                |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| plotName | Optional. Name of plotMatrix for plot title.                                                                                                                                                   |
| repIndex | Optional. Vector of labels indicating replicate group. Each index in the vector matches the corresponding column of plotMatrix. If NULL then all plates are plotted together without grouping. |
| plotSep  | Optional logical. Should plots of different replicate groups be presented in separate windows? Default is TRUE. Does not apply if repIndex is NULL.                                            |
| ...      | Optional. Additional parameters passed to <a href="#">geom_boxplot</a> .                                                                                                                       |

### Details

Box plots can be used to identify scaling shifts among replicates and view the general distribution of data among all plates.

### Value

Modifiable ggplot2 object or list of objects

### See Also

Other graphical devices: [plot3d](#), [plotAutoco](#), [plotHeatmap](#), [plotHist](#), [plotIGFit](#), [plotScatter](#)

### Examples

```
## load dataset
data(ex_dataMatrix)

## plot raw data
plotBox(plotMatrix = ex_dataMatrix, repIndex = c(1,1,1,2,2,2), plotCols = 5:10,
plotName = 'Example')
## normalize data matrix using any method and store in new variable
ex_normMatrix <- normZ(dataMatrix = ex_dataMatrix, dataCols = 5:10)
## plot normalized data
plotBox(plotMatrix = ex_normMatrix, repIndex = c(1,1,1,2,2,2), plotName = 'Example')
```

---

plotHeatmap

*Heat map*


---

### Description

Plot heat map for each plate

### Usage

```
plotHeatmap(plotMatrix, plateRows, plateCols, plotRows = NULL,
plotCols = NULL, plotName = NULL, plotSep = TRUE, ...)
```

**Arguments**

|                      |                                                                                                                                                               |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| plotMatrix           | Data frame or numeric matrix. Columns are plates, and rows are plate wells.                                                                                   |
| plateRows, plateCols | Number of rows/columns in plate.                                                                                                                              |
| plotRows, plotCols   | Optional integer vector. Indicate which row/column numbers from the plotMatrix should be plotted. If NULL then all rows/columns from the plotMatrix are used. |
| plotName             | Optional. Name of plotMatrix for plot title.                                                                                                                  |
| plotSep              | Optional logical. Should plots be presented in separate windows? Default is TRUE.                                                                             |
| ...                  | Optional. Additional parameters passed to <a href="#">geom_tile</a> .                                                                                         |

**Details**

Heat maps can be used to assess the existence of spatial bias on a plate by plate basis. Spatial bias can be visually subtle, however, and sometimes difficult to detect with heat maps. Auto-correlation plots ([plotAutoco](#)) can circumvent this problem.

**Value**

Modifiable ggplot2 object or list of objects

**See Also**

Other graphical devices: [plot3d](#), [plotAutoco](#), [plotBox](#), [plotHist](#), [plotIGFit](#), [plotScatter](#)

**Examples**

```
## load dataset
data(ex_dataMatrix)

## plot raw data with graphs separated
plotHeatmap(plotMatrix = ex_dataMatrix, plotCols = 5:10,
plotName = 'Example', plateRows = 8, plateCols = 10)
## normalize data matrix using any method and store in new variable
ex_normMatrix <- normZ(dataMatrix = ex_dataMatrix, dataCols = 5:10)
## plot normalized data with graphs together
plotHeatmap(plotMatrix = ex_normMatrix, plotName = 'Example',
plateRows = 8, plateCols = 10, plotSep = FALSE)
```

---

|          |                  |
|----------|------------------|
| plotHist | <i>Histogram</i> |
|----------|------------------|

---

## Description

Plot histogram of p-values or q-values for each plate or all plates together

## Usage

```
plotHist(plotMatrix, plotRows = NULL, plotCols = NULL, plotAll = FALSE,
         plotSep = TRUE, plotName = NULL, colNames = NULL, ...)
```

## Arguments

|                    |                                                                                                                                                               |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| plotMatrix         | Data frame or numeric matrix consisting only of p-values or q-values. Columns are samples, and rows are plate wells.                                          |
| plotRows, plotCols | Optional integer vector. Indicate which row/column numbers from the plotMatrix should be plotted. If NULL then all rows/columns from the plotMatrix are used. |
| plotAll            | Optional logical. Should all p-values or q-values be plotted together? Default is FALSE.                                                                      |
| plotSep            | Optional logical. If plotAll is FALSE, should plots be presented in separate windows? Default is TRUE.                                                        |
| plotName           | Optional. Name of plotMatrix for plot title.                                                                                                                  |
| colNames           | Optional. If plotAll is FALSE, names of plotCols for plot titles.                                                                                             |
| ...                | Optional. Additional parameters passed to <a href="#">geom_histogram</a> .                                                                                    |

## Details

Histograms can be used to compare actual to expected p-value distributions obtained from statistical tests of replicated features. In the presence of rare biological events, the p-value distribution should be approximately uniformly distributed with somewhat more small p-values. Deviations from these patterns indicate that the activity measurements are incorrect and/or that the statistical model is incorrectly specified.

## Value

Modifiable ggplot2 object or list of objects

## Note

If using output from [statT](#), [statRVM](#), [statFDR](#) or [statSights](#), please only select the plotCols corresponding to p-value and/or q-value columns, i.e., every 5th and/or 6th column in that output. Also, the x-axis label is derived from these column names indicating either 'p-values' or 'q-values'.

See Also

Other graphical devices: [plot3d](#), [plotAutoco](#), [plotBox](#), [plotHeatmap](#), [plotIGFit](#), [plotScatter](#)

Examples

```
## load dataset
data(ex_dataMatrix)

## normalize data matrix using any method and store in new variable
ex_normMatrix <- normZ(dataMatrix = ex_dataMatrix, dataCols = 5:10)
## apply any test to normalized data and store in new variable
ex_testMatrix <- statRVM(normMatrix = ex_normMatrix,
  repIndex = c(1,1,1,2,2,2))
## plot p-value data by selecting the p-value columns from test result matrix
plotHist(plotMatrix = ex_testMatrix, plotCols = c(5,10), plotName = 'Example',
  colNames = c('Set_A', 'Set_B'))
```

---

|           |                      |
|-----------|----------------------|
| plotIGFit | <i>Inverse gamma</i> |
|-----------|----------------------|

---

Description

Plot an inverse gamma fit plot for all plates together

Usage

```
plotIGFit(plotMatrix, repIndex, plotRows = NULL, plotCols = NULL,
  plotName = NULL, ...)
```

Arguments

|                    |                                                                                                                                                                                                |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| plotMatrix         | Data frame or numeric matrix. Columns are plates, and rows are plate wells.                                                                                                                    |
| repIndex           | Optional. Vector of labels indicating replicate group. Each index in the vector matches the corresponding column of plotMatrix. If NULL then all plates are plotted together without grouping. |
| plotRows, plotCols | Optional integer vector. Indicate which row/column numbers from the plotMatrix should be plotted. If NULL then all rows/columns from the plotMatrix are used.                                  |
| plotName           | Optional. Name of plotMatrix for plot title.                                                                                                                                                   |
| ...                | Optional. Additional parameters passed to <a href="#">geom_step</a> .                                                                                                                          |

Details

Inverse gamma fit plot can be used to check if RVM test ([statRVM](#)) assumptions are valid and it can be applied to the data.

**Value**

Modifiable ggplot2 object

**See Also**

Other graphical devices: [plot3d](#), [plotAutoco](#), [plotBox](#), [plotHeatmap](#), [plotHist](#), [plotScatter](#)

**Examples**

```
## load dataset
data(ex_dataMatrix)

## normalize data matrix using any method and store in new variable
ex_normMatrix <- normSights(dataMatrix = ex_dataMatrix, dataCols = 5:10,
normMethod = 'normZ')
## plot normalized data
plotIGFit(plotMatrix = ex_normMatrix, repIndex = c(1,1,1,2,2,2),
plotName = 'Example')
```

---

plotScatter

*Scatter plot*


---

**Description**

Construct a scatter plot of all pairwise combinations of replicates

**Usage**

```
plotScatter(plotMatrix, repIndex, plotRows = NULL, plotCols = NULL,
plotName = NULL, ...)
```

**Arguments**

|                    |                                                                                                                                                                                                |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| plotMatrix         | Data frame or numeric matrix. Columns are plates, and rows are plate wells.                                                                                                                    |
| repIndex           | Optional. Vector of labels indicating replicate group. Each index in the vector matches the corresponding column of plotMatrix. If NULL then all plates are plotted together without grouping. |
| plotRows, plotCols | Optional integer vector. Indicate which row/column numbers from the plotMatrix should be plotted. If NULL then all rows/columns from the plotMatrix are used.                                  |
| plotName           | Optional. Name of plotMatrix for plot title.                                                                                                                                                   |
| ...                | Optional. Additional parameters passed to <a href="#">geom_point</a> .                                                                                                                         |

**Details**

Scatter plots with robust regression lines of replicate plates can reveal a kind of bias which acts independently of within-plate biases and which cannot be detected by heat maps ([plotHeatmap](#)) or auto-correlation plots ([plotAutoco](#)). A mixture of active and inactive features should produce a zero-correlation flat regression line within most of the range and a positively sloped line within the active range(s) at the extreme(s) of the distribution.

**Value**

List of modifiable ggplot2 objects

**See Also**

Other graphical devices: [plot3d](#), [plotAutoco](#), [plotBox](#), [plotHeatmap](#), [plotHist](#), [plotIGFit](#)

**Examples**

```
## load dataset
data(ex_dataMatrix)

## plot raw data
plotScatter(plotMatrix = ex_dataMatrix, repIndex = c(1,1,1), plotCols = 5:7,
plotName = 'Example')
## normalize data matrix using any method and store in new variable
ex_normMatrix <- normZ(dataMatrix = ex_dataMatrix, dataCols = 5:10)
## plot normalized data
plotScatter(plotMatrix = ex_normMatrix, repIndex = c(1,1,1), plotCols = 1:3,
plotName = 'Example')
```

---

plotSights

*Graphical devices*


---

**Description**

Apply any of the available SIGHTS graphical devices

**Usage**

```
plotSights(plotMethod, plotMatrix, plateRows, plateCols, repIndex = NULL,
plotRows = NULL, plotCols = NULL, plotName = NULL, plotSep = TRUE,
plotAll = FALSE, colNames = NULL, ...)
```

**Arguments**

|                      |                                                                                                                                                                                                                                                                |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| plotMethod           | Plotting method name from SIGHTS ('3d', 'Autoco', 'Box', 'Heatmap', 'Hist', 'IGFit', or 'Scatter').                                                                                                                                                            |
| plotMatrix           | Data frame or numeric matrix. Columns are plates, and rows are plate wells. For plotMethod 'Hist', this is a p-value matrix with each column a single sample.                                                                                                  |
| plateRows, plateCols | Number of rows/columns in plate. Applies to plotMethods '3d', 'Autoco' and 'Heatmap'.                                                                                                                                                                          |
| repIndex             | Vector of labels indicating replicate group. Each index in the vector matches the corresponding column of plotMatrix. Applies to plotMethods 'Box', 'Scatter' and 'IGFit'.                                                                                     |
| plotRows, plotCols   | Optional integer vector. Indicate which row/column numbers from the plotMatrix should be plotted. If NULL then all rows/columns from the plotMatrix are used.                                                                                                  |
| plotName             | Optional. Name of plotMatrix for plot title.                                                                                                                                                                                                                   |
| plotSep              | Optional logical. Should plots be presented in separate windows? Default is TRUE. Applies to plotMethods 'Autoco', 'Box', 'Hist' and 'Heatmap'. For 'Box', each replicate group is presented in a separate window and it only applies if repIndex is not NULL. |
| plotAll              | Optional logical. Should all p-values be plotted together? Default is FALSE. Applies to plotMethod 'Hist'.                                                                                                                                                     |
| colNames             | Optional. Names of plotCols for plot title. Applies to plotMethod 'Hist'.                                                                                                                                                                                      |
| ...                  | Optional. Additional parameters passed to <a href="#">ggplot</a> functions.                                                                                                                                                                                    |

**Details**

One of the following SIGHTS graphical devices may be chosen: [plot3d](#), [plotAutoco](#), [plotBox](#), [plotHeatmap](#), [plotHist](#), [plotIGFit](#), or [plotScatter](#). See their individual help pages for more details.

**Value**

List of lattice objects for 'plot3d'. Modifiable ggplot2 object or list of objects for all others.

**References**

Murie et al. (2015). Improving detection of rare biological events in high-throughput screens. *Journal of Biomolecular Screening*, 20(2), 230-241.

**See Also**

Other SIGHTS functions: [normSights](#), [statSights](#)

Examples

```
## load dataset
data(ex_dataMatrix)

## normalize data matrix using any method and store in new variable
ex_normMatrix <- normSights(normMethod = 'RobZ', dataMatrix = ex_dataMatrix,
dataCols = 5:10, wellCorrection = TRUE)
## choose a graphical device and provide relevant information
plotSights(plotMethod = 'Autoco', plotMatrix = ex_normMatrix,
plotName = 'Example', plateRows = 8, plateCols = 10)
```

---

|         |                    |
|---------|--------------------|
| statFDR | <i>FDR control</i> |
|---------|--------------------|

---

Description

Apply Storey’s FDR control to p-values

Usage

```
statFDR(testMatrix, ctrlMethod = "smoother", ...)
```

Arguments

|            |                                                                                                                                                                                                                                                    |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| testMatrix | Data frame or numeric matrix consisting of output from <a href="#">statT</a> or <a href="#">statRVM</a> functions. P-value columns from this matrix are automatically selected for FDR calculation. Columns are samples, and rows are plate wells. |
| ctrlMethod | Optional. Method to use either ‘smoother’ or ‘bootstrap’ to estimate null. Default is ‘smoother’.                                                                                                                                                  |
| ...        | Optional. Additional parameters passed to <a href="#">qvalue</a> function.                                                                                                                                                                         |

Details

False Discovery Rate procedure is used to control the proportion of false positives in the results. This is an implementation of the positive false discovery (pFDR) procedure of the [qvalue](#) function.

Value

A matrix of parameters for each replicate group is returned:

|                                |                                                      |
|--------------------------------|------------------------------------------------------|
| T-statistic or RVM T-statistic | Value of the t-statistic.                            |
| Mean_Difference                | Difference between the calculated and the true mean. |
| Standard_Error                 | Standard error of the difference between means.      |
| Degrees_Of_Freedom             | Degrees of freedom for the t-statistic.              |

|         |                              |
|---------|------------------------------|
| P-value | P-value for the t-test.      |
| q-value | FDR q-value for the P-value. |

**Note**

Please install the package 'qvalue' from Bioconductor, if not already installed.

**References**

Storey (2002). A direct approach to false discovery rates. Journal of the Royal Statistical Society: Series B, 64, 479-498.

**See Also**

Other statistical methods: [statRVM](#), [statT](#)

**Examples**

```
## load dataset
data(ex_dataMatrix)

## normalize data matrix using any method and store in new variable
ex_normMatrix <- normSights(dataMatrix = ex_dataMatrix, dataCols = 5:10,
normMethod = 'normZ')
## test normalized data matrix using either the RVM or T test and store in new variable
ex_testMatrix <- statT(normMatrix = ex_normMatrix, trueMean = 0,
repIndex = c(1,1,1,2,2,2))
## apply FDR control to test matrix with bootstrap control method
ex_ctrlMatrix <- statFDR(testMatrix = ex_testMatrix,
ctrlMethod = 'bootstrap')
```

---

|         |                 |
|---------|-----------------|
| statRVM | <i>RVM Test</i> |
|---------|-----------------|

---

**Description**

Apply one-sample RVM t-test separately to each plate

**Usage**

```
statRVM(normMatrix, repIndex, normRows = NULL, normCols = NULL,
testSide = "two.sided")
```

**Arguments**

|                                 |                                                                                                                                                                                                                                                                        |
|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>normMatrix</code>         | Data frame or numeric matrix of normalized data. Columns are plates, and rows are plate wells.                                                                                                                                                                         |
| <code>repIndex</code>           | Integer vector indicating replicates in <code>normMatrix</code> . Which plates are replicates of each other? Provide the same number for plates belonging to a replicate group. Each index in the vector matches the corresponding column of <code>normMatrix</code> . |
| <code>normRows, normCols</code> | Optional integer vector. Indicate which row/column numbers from the <code>normMatrix</code> should be tested. If NULL then all rows/columns from the <code>normMatrix</code> are used.                                                                                 |
| <code>testSide</code>           | Optional. Type of t-test: 'two.sided', 'less', or 'greater'. Default is 'two.sided'.                                                                                                                                                                                   |

**Details**

Random Variance Model one-sample t-test is applied to the normalized data. RVM assumes that the across replicate variances are distributed according to an inverse gamma distribution. This can be checked by using the [plotIGFit](#) function.

**Value**

A matrix of parameters for each replicate group is returned:

|                                 |                                                      |
|---------------------------------|------------------------------------------------------|
| <code>RVM T-statistic</code>    | Value of the RVM t-statistic.                        |
| <code>Mean_Difference</code>    | Difference between the calculated and the true mean. |
| <code>Standard_Error</code>     | Standard error of the difference between means.      |
| <code>Degrees_Of_Freedom</code> | Degrees of freedom for the t-statistic.              |
| <code>P-value</code>            | P-value for the RVM test.                            |

**References**

Malo et al. (2006). Statistical practice in high-throughput screening data analysis. *Nature Biotechnology*, 24(2), 167-175.

Wright & Simon (2003). A random variance model for detection of differential gene expression in small microarray experiments. *Bioinformatics*, 19(18), 2448-2455.

**See Also**

Other statistical methods: [statFDR](#), [statT](#)

## Examples

```
## load dataset
data(ex_dataMatrix)

## normalize data matrix using any method and store in new variable
ex_normMatrix <- normSights(dataMatrix = ex_dataMatrix, dataCols = 5:10,
normMethod = 'normZ')
## apply RVM test to normalized data matrix and get the p-values
ex_testMatrix <- statRVM(normMatrix = ex_normMatrix, repIndex = c(1,1,1,2,2,2))
```

---

statSights

*Statistical methods*


---

## Description

Apply any of the available SIGHTS statistical methods

## Usage

```
statSights(statMethod, normMatrix, repIndex, normRows = NULL,
normCols = NULL, ctrlMethod = NULL, testSide = "two.sided",
trueMean = 0, ...)
```

## Arguments

|                    |                                                                                                                                                                                                                                            |
|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| statMethod         | Statistical testing method to use either 'T' or 'RVM'.                                                                                                                                                                                     |
| normMatrix         | Data frame or numeric matrix of normalized data. Columns are plates, and rows are plate wells.                                                                                                                                             |
| repIndex           | Integer vector indicating replicates in normMatrix. Which plates are replicates of each other? Provide the same number for plates belonging to a replicate group. Each index in the vector matches the corresponding column of normMatrix. |
| normRows, normCols | Optional integer vector. Indicate which row/column numbers from the normMatrix should be tested. If NULL then all rows/columns from the normMatrix are used.                                                                               |
| ctrlMethod         | Optional. FDR method to use either 'smoother' or 'bootstrap' to estimate null. Default is NULL, which does not apply FDR control to the statistical testing output.                                                                        |
| testSide           | Optional. Type of t-test: 'two.sided', 'less', or 'greater'. Default is 'two.sided'.                                                                                                                                                       |
| trueMean           | Optional. Number indicating true value of mean. Applies to statMethod 'T'. Default is 0.                                                                                                                                                   |
| ...                | Optional. Additional parameters passed to <a href="#">qvalue</a> function.                                                                                                                                                                 |

Details

One of the two SIGHTS statistical testing methods may be chosen: [statT](#) or [statRVM](#), and FDR control may be applied by [statFDR](#). See their individual help pages for more details.

Value

A matrix of parameters for each replicate group including p-values and q-values, if FDR control is applied.

References

Murie et al. (2015). Improving detection of rare biological events in high-throughput screens. *Journal of Biomolecular Screening*, 20(2), 230-241.

See Also

Other SIGHTS functions: [normSights](#), [plotSights](#)

Examples

```
## load dataset
data(ex_dataMatrix)

## normalize data matrix using any method and store in new variable
ex_normMatrix <- normSights(normMethod = 'RobZ', dataMatrix = ex_dataMatrix,
dataCols = 5:10, wellCorrection = TRUE)
## choose a statistical testing method, indicate FDR control
## and provide relevant information
ex_statMatrix <- statSights(normMatrix = ex_normMatrix, statMethod = 'RVM',
ctrlMethod = 'smoother', repIndex = c(1,1,1,2,2,2))
```

---

|       |               |
|-------|---------------|
| statT | <i>t-test</i> |
|-------|---------------|

---

Description

Apply one-sample t-test separately to each plate

Usage

```
statT(normMatrix, repIndex, normRows = NULL, normCols = NULL,
testSide = "two.sided", trueMean = 0)
```

**Arguments**

|                    |                                                                                                                                                                                                                                            |
|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| normMatrix         | Data frame or numeric matrix of normalized data. Columns are plates, and rows are plate wells.                                                                                                                                             |
| repIndex           | Integer vector indicating replicates in normMatrix. Which plates are replicates of each other? Provide the same number for plates belonging to a replicate group. Each index in the vector matches the corresponding column of normMatrix. |
| normRows, normCols | Optional integer vector. Indicate which row/column numbers from the normMatrix should be tested. If NULL then all rows/columns from the normMatrix are used.                                                                               |
| testSide           | Optional. Type of t-test: 'two.sided', 'less', or 'greater'. Default is 'two.sided'.                                                                                                                                                       |
| trueMean           | Optional. Number indicating true value of mean. Default is 0.                                                                                                                                                                              |

**Details**

Standard one-sample t-test is applied to the normalized data.

**Value**

A matrix of parameters for each replicate group is returned:

|                    |                                                      |
|--------------------|------------------------------------------------------|
| T-statistic        | Value of the t-statistic.                            |
| Mean_Difference    | Difference between the calculated and the true mean. |
| Standard_Error     | Standard error of the difference between means.      |
| Degrees_Of_Freedom | Degrees of freedom for the t-statistic.              |
| P-value            | P-value for the t-test.                              |

**See Also**

Other statistical methods: [statFDR](#), [statRVM](#)

**Examples**

```
## load dataset
data(ex_dataMatrix)

## normalize data matrix using any method and store in new variable
ex_normMatrix <- normSights(dataMatrix = ex_dataMatrix, dataCols = 5:10,
normMethod = 'normZ')
## apply T test to normalized data matrix and get the p-values
ex_testMatrix <- statT(normMatrix = ex_normMatrix, trueMean = 0,
repIndex = c(1,1,1,2,2,2))
```

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