Package ‘biobroom’
February 25, 2024

Title  Turn Bioconductor objects into tidy data frames
Version 1.34.0
Author Andrew J. Bass, David G. Robinson, Steve Lianoglou, Emily Nelson, John D. Storey, with contributions from Laurent Gatto
Maintainer John D. Storey <jstorey@princeton.edu> and Andrew J. Bass <ajbass@emory.edu>
Description This package contains methods for converting standard objects constructed by bioinformatics packages, especially those in Bioconductor, and converting them to tidy data. It thus serves as a complement to the broom package, and follows the same the tidy, augment, glance division of tidying methods. Tidying data makes it easy to recombine, reshape and visualize bioinformatics analyses.
biocViews MultipleComparison, DifferentialExpression, Regression, GeneExpression, Proteomics, DataImport
Depends R (>= 3.0.0), broom
License LGPL
LazyData true
Imports dplyr, tidyr, Biobase
Suggests limma, DESeq2, airway, ggplot2, plyr, GenomicRanges, testthat, magrittr, edgeR, qvalue, knitr, data.table, MSnbase, markdown, SummarizedExperiment
VignetteBuilder knitr
URL https://github.com/StoreyLab/biobroom
BugReports https://github.com/StoreyLab/biobroom/issues
RoxygenNote 5.0.1
git_url https://git.bioconductor.org/packages/biobroom
git_branch RELEASE_3_18
git_last_commit cd67b42
git_last_commit_date 2023-10-24
Repository Bioconductor 3.18
Date/Publication 2024-02-25
R topics documented:

- augment_sva .................................................. 2
- biobroom ..................................................... 3
- DESeq2_tidiers ............................................. 3
- edgeR_tidiers ................................................. 5
- ExpressionSet_tidiers .................................. 6
- hammer .......................................................... 7
- limma_tidiers ............................................... 8
- list_tidiers .................................................. 10
- MSnSet_tidiers ............................................. 11
- qvalue_tidiers ............................................. 12
- SummarizedExperiment_tidiers ..................... 14
- tidy.deSet .................................................. 15
- tidy.GRanges ................................................ 16

Index 18

augment_sva  Tidying methods for a sva list

Description

These are methods for turning a sva list, from the sva package, into a tidy data frame. `tidy` returns a `data.frame` of the estimated surrogate variables, `glance` returns a `data.frame` of the posterior probabilities, and `glance` returns a `data.frame` with only the number of surrogate variables.

Usage

```r
augment_sva(x, data, ...)

tidy_sva(x, addVar = NULL, ...)

glance_sva(x, ...)
```

Arguments

- `x` sva list
- `data` Original data
- `...` extra arguments (not used)
- `addVar` add additional coefficients to the estimated surrogate variables
**Value**

All tidying methods return a `data.frame` without rownames. The structure depends on the method chosen.

- **augment** returns one row per gene. It always contains the columns:
  - `pprob.gam`  Posterior probability each gene is affected by heterogeneity
  - `pprob.b`  Posterior probability each gene is affected by model

- **tidy** returns the estimate surrogate variables.
- **glance** returns the estimate surrogate variables.

---

**biobroom**  
*Convert Bioconductor Object into Tidy Data Frames*

**Description**

This package contains methods for converting standard objects constructed by bioinformatics packages, especially those in Bioconductor, and converting them to tidy data. It thus serves as a complement to the `broom` package, and follows the same tidy, augment, glance division of tidying methods. Tidying data makes it easy to recombine, reshape and visualize bioinformatics analyses.

---

**DESeq2_tidiers**  
*Tidying methods for DESeq2 DESeqDataSet objects*

**Description**

This reshapes a DESeq2 expressionset object into a tidy format. If the dataset contains hypothesis test results (p-values and estimates), this summarizes one row per gene per possible contrast.

**Usage**

```r
## S3 method for class 'DESeqDataSet'
tidy(x, colData = FALSE, intercept = FALSE, ...)

## S3 method for class 'DESeqResults'
tidy(x, ...)
```

**Arguments**

- `x`  
  - DESeqDataSet object

- `colData`  
  - whether colData should be included in the tidied output for those in the DESeq-DataSet object. If dataset includes hypothesis test results, this is ignored

- `intercept`  
  - whether to include hypothesis test results from the (Intercept) term. If dataset does not include hypothesis testing, this is ignored

- `...`  
  - extra arguments (not used)
Details

colDat=TRUE adds covariates from colData to the data frame.

Value

If the dataset contains results (p-values and log2 fold changes), the result is a data frame with the columns:

- **term**: The contrast being tested, as given to `results`
- **gene**: gene ID
- **baseMean**: mean abundance level
- **estimate**: estimated log2 fold change
- **stderr**: standard error in log2 fold change estimate
- **statistic**: test statistic
- **p.value**: p-value
- **p.adjusted**: adjusted p-value

If the dataset does not contain results (`DESeq` has not been run on it), `tidy` defaults to tidying the counts in the dataset:

- **gene**: gene ID
- **sample**: sample ID
- **count**: number of reads in this gene in this sample

If colData = TRUE, it also merges this with the columns present in colData(x).

Examples

# From DESeq2 documentation

```r
if (require("DESeq2")) {
  dds <- makeExampleDESeqDataSet(betaSD = 1)

  tidy(dds)
  # With design included
  tidy(dds, colData=TRUE)

  # add a noise confounding effect
  colData(dds)$noise <- rnorm(nrow(colData(dds)))
  design(dds) <- (~ condition + noise)

  # perform differential expression tests
  ddsres <- DESeq(dds, test = "Wald")
  # now results are per-gene, per-term
  tidied <- tidy(ddsres)
  tidied

  if (require("ggplot2")) {
    ggplot(tidied, aes(p.value)) + geom_histogram(binwidth = .05) +
  }
}
```
Description

Tidy, augment and glance methods for turning edgeR objects into tidy data frames, where each row represents one observation and each column represents one column.

Usage

```r
## S3 method for class 'DGEExact'
tidy(x, ...)

## S3 method for class 'DGEList'
tidy(x, addSamples = FALSE, ...)

## S3 method for class 'DGEList'
augment(x, data = NULL, ...)

## S3 method for class 'DGEExact'
glance(x, alpha = 0.05, p.adjust.method = "fdr", ...)
```

Arguments

- `x` : DGEExact, DGEList object
- `...` : extra arguments (not used)
- `addSamples` : Merge information from samples. Default is FALSE.
- `data` : merge data to augment. This is particularly useful when merging gene names or other per-gene information. Default is NULL.
- `alpha` : Confidence level to test for significance
- `p.adjust.method` : Method for adjusting p-values to determine significance; can be any in p.adjust.methods

Value

- `tidy` defaults to tidying the counts in the dataset:
  - `gene` : gene ID
  - `sample` : sample ID
  - `count` : number of reads in this gene in this sample
If `addSamples = TRUE`, it also merges this with the sample information present in `x$samples`.

`augment` returns per-gene information (DGEList only)
`glance` returns one row with the columns (DGEExact only)

`significant` number of significant genes using desired adjustment method and confidence level
`comparison` The pair of groups compared by edgeR, delimited by `/`

**Examples**

```r
if (require("edgeR")) {
  library(Biobase)
  data(hammer)
  hammer.counts <- exprs(hammer)[, 1:4]
  hammer.treatment <- phenoData(hammer)$protocol[1:4]

  y <- DGEList(counts=hammer.counts, group=hammer.treatment)
  y <- calcNormFactors(y)
  y <- estimateCommonDisp(y)
  y <- estimateTagwiseDisp(y)
  et <- exactTest(y)

  head(tidy(et))
  head(glance(et))
}
```

**ExpressionSet_tidiers**  
*Tidying methods for Biobase’s ExpressionSet objects*

**Description**

Tidying methods for Biobase’s ExpressionSet objects

**Usage**

```r
## S3 method for class 'ExpressionSet'
tidy(x, addPheno = FALSE,
     assay = Biobase::assayDataElementNames(x)[1L], ...)
```

**Arguments**

- `x`  
  ExpressionSet object
- `addPheno`  
  whether columns should be included in the tidied output for those in the ExpressionSet’s phenoData
- `assay`  
  The name of the `assayDataElement` to use as the values to tidy. Defaults to `assayDataElementNames(x)[1L]`, which is usually equivalent to `exprs(x)`.  
- `...`  
  extra arguments (not used)
Details

addPheno=TRUE adds columns that are redundant (since they add per-sample information to a per-sample-per-gene data frame), but that are useful for some kinds of graphs and analyses.

Value

tidy returns a data frame with one row per gene-sample combination, with columns:

- **gene**: gene name
- **sample**: sample name (from column names)
- **value**: expressions on log2 scale

Examples

```r
library(Biobase)
# import ExpressionSet object
data(hammer)

# Use tidy to extract genes, sample ids and measured value
 tidy(hammer)
# add phenoType data
 tidy(hammer, addPheno=TRUE)
```

---

**Description**

An ExpressionSet containing the results of the Hammer et al 2010 RNA-Seq study on the nervous system of rats (Hammer et al 2010).

This was downloaded from the ReCount database of analysis-ready RNA-Seq datasets (Frazee et al 2011).


**Usage**

hammer
Format
An object of class ExpressionSet with 29516 rows and 8 columns.

Value
ExpressionSet

limma_tidiers Tidiers for the output of limma (linear models for microarray analysis)

Description
Tidy, augment, and glance methods for MArrayLM objects, which contain the results of gene-wise linear models to microarray datasets. This class is the output of the lmFit and eBayes functions.

Usage
```r
## S3 method for class 'MArrayLM'
tidy(x, intercept = FALSE, ...)
## S3 method for class 'MArrayLM'
augment(x, data, ...)
## S3 method for class 'MArrayLM'
glance(x, ...)
## S3 method for class 'MAList'
tidy(x, ...)
## S3 method for class 'EList'
tidy(x, addTargets = FALSE, ...)
```

Arguments
- **x** MArrayLM, MAList, EList object
- **intercept** whether the (Intercept) term should be included (default FALSE)
- **...** extra arguments, not used
- **data** original expression matrix; if missing, augment returns only the computed per-gene statistics
- **addTargets** Add sample level information. Default is FALSE.

Details
Tidying this fit computes one row per coefficient per gene, while augmenting returns one row per gene, with per-gene statistics included. (This is thus a rare case where the augment output has more rows than the tidy output. This is a side effect of the fact that the input to limma is not tidy but rather a one-row-per-gene matrix).
Value

The output of tidying functions is always a data frame without rownames. tidy returns one row per gene per coefficient. It always contains the columns
gene The name of the gene (extracted from the rownames of the input matrix)
term The coefficient being estimated
estimate The estimate of each per-gene coefficient

Depending on whether the object comes from eBayes, it may also contain

statistic Empirical Bayes t-statistic
p.value p-value computed from t-statistic
lod log-of-odds score

augment returns one row per gene, containing the original gene expression matrix if provided. It then adds columns containing the per-gene statistics included in the MArrayLM object, each prepended with a .:

.gene gene ID, obtained from the rownames of the input
.sigma per-gene residual standard deviation
.df.residual per-gene residual degrees of freedom

The following columns may also be included, depending on which have been added by lmFit and eBayes:

.AMean average intensity across probes
.statistic moderated F-statistic
.p.value p-value generated from moderated F-statistic
.df.total total degrees of freedom per gene
.df.residual residual degrees of freedom per gene
.s2.prior prior estimate of residual variance
.s2.post posterior estimate of residual variance

glance returns one row, containing

rank rank of design matrix
df.prior empirical Bayesian prior degrees of freedom
s2.prior empirical Bayesian prior residual standard deviation

tidy returns a data frame with one row per gene-sample combination, with columns
gene gene name
sample sample name (from column names)
value expressions on log2 scale

tidy returns a data frame with one row per gene-sample combination, with columns
Examples

```r
if (require("limma")) {
  # create random data and design
  set.seed(2014)
  dat <- matrix(rnorm(1000), ncol=4)
  dat[, 1:2] <- dat[, 1:2] + .5 # add an effect
  rownames(dat) <- paste0("g", 1:nrow(dat))
  des <- data.frame(treatment = c("a", "a", "b", "b"),
                    confounding = rnorm(4))

  lfit <- lmFit(dat, model.matrix(~ treatment + confounding, des))
  eb <- eBayes(lfit)
  head(tidy(lfit))
  head(tidy(eb))

  if (require("ggplot2")) {
    # the tidied form puts it in an ideal form for plotting
    ggplot(tidy(lfit), aes(estimate)) + geom_histogram(binwidth=1) +
    facet_wrap(~ term)
    ggplot(tidy(eb), aes(p.value)) + geom_histogram(binwidth=.2) +
    facet_wrap(~ term)
  }
}
```

Description

This method handles the return values of functions that return lists rather than S3 objects, such as sva, and therefore cannot be handled by S3 dispatch.

Usage

```r
# S3 method for class 'list'
tidy(x, ...)

# S3 method for class 'list'
glance(x, ...)
```
Arguments

- **x**: list object
- **...**: extra arguments, passed to the tidying function

Details

Those tiders themselves are implemented as functions of the form tidy_<function> that are not exported.

Description

Tidying methods for Biobase’s ExpressionSet objects

Usage

```r
## S3 method for class 'MSnSet'
tidy(x, addPheno = FALSE, ...)
```

Arguments

- **x**: MSnSet object
- **addPheno**: whether columns should be included in the tidied output for those in the MSnSet’s phenoData
- **...**: extra arguments (not used)

Details

addPheno=TRUE adds columns that are redundant (since they add per-sample information to a per-sample-per-gene data frame), but that are useful for some kinds of graphs and analyses.

Value

tidy returns a data frame with one row per gene-sample combination, with columns

- **protein**: protein name
- **sample**: sample name (from column names)
- **value**: protein quantitation data
Examples

```r
if (require("MSnbase")) {
  library(MSnbase)
  # import MSnSet object
data(msnset)

  # Use tidy to extract genes, sample ids and measured value
tidy(msnset)
  # add phenoType data
tidy(msnset, addPheno=TRUE)
}
```

---

**qvalue_tidiers**

*Tidying methods for a qvalue object*

**Description**

These are methods for turning a qvalue object, from the qvalue package for false discovery rate control, into a tidy data frame. `augment` returns a data.frame of the original p-values combined with the computed q-values and local false discovery rates, `tidy` constructs a table showing how the estimate of pi0 (the proportion of true nulls) depends on the choice of the tuning parameter lambda, and `glance` returns a data.frame with only the chosen pi0 value.

**Usage**

```r
## S3 method for class 'qvalue'
tidy(x, ...)

## S3 method for class 'qvalue'
augment(x, data, ...)

## S3 method for class 'qvalue'
glance(x, ...)
```

**Arguments**

- `x` qvalue object
- `...` extra arguments (not used)
- `data` Original data

**Value**

All tidying methods return a data.frame without rownames. The structure depends on the method chosen.

`tidy` returns one row for each choice of the tuning parameter lambda that was considered (argument `lambda` to `qvalue`), containing


\[ \text{lambda} \quad \text{the tuning parameter} \]
\[ \pi_0 \quad \text{corresponding estimate of } \pi_0 \]
\[ \text{smoothed} \quad \text{whether the estimate has been spline-smoothed} \]

If \( \pi_0.\text{method} = \text{"smooth"} \), the \( \pi_0 \) estimates and smoothed values both appear in the table. If \( \pi_0.\text{method} = \text{"bootstrap"} \), \( \text{smoothed} \) is FALSE for all entries.

\text{augment} \ returns a data.frame with

\[ \text{p.value} \quad \text{the original p-values given to } \text{qvalue} \]
\[ \text{q.value} \quad \text{the computed q-values} \]
\[ \text{lfdr} \quad \text{the local false discovery rate} \]

\text{glance} \ returns a one-row data.frame containing

\[ \pi_0 \quad \text{the estimated } \pi_0 \text{ (proportion of nulls)} \]
\[ \text{lambda} \quad \text{lambda used to compute } \pi_0. \text{ Note that if } \pi_0 \text{ is 1, this may be NA since it can be ambiguous which lambda was used} \]

\textbf{Examples}

\begin{verbatim}
library(ggplot2)
if (require("qvalue")) {
  set.seed(2014)

  # generate p-values from many one sample t-tests: half of them null
  oracle <- rep(c(0, .5), each=1000)
  pvals <- sapply(oracle, function(mu) t.test(rnorm(15, mu)$p.value)
                   qplot(pvals)

  q <- qvalue(pvals)

  tidy(q)
  head(augment(q))
  glance(q)

  # use augmented data to compare p-values to q-values
  ggplot(augment(q), aes(p.value, q.value)) + geom_point()

  # use tidy see how \( \pi_0 \) estimate changes with lambda, comparing
  # to smoothed version
  g <- ggplot(tidy(q), aes(lambda, pi0, color=smoothed)) + geom_line()
g

  # show the chosen value
  g + geom_hline(yintercept=q$pi0, lty=2)
}
\end{verbatim}
SummarizedExperiment_tidiers

Tidying methods for Biobase’s SummarizedExperiment objects

Description

Tidying methods for Biobase’s SummarizedExperiment objects

Usage

## S3 method for class 'RangedSummarizedExperiment'
tidy(x, addPheno = FALSE,
    assay = SummarizedExperiment::assayNames(x)[1L], ...)

Arguments

x          SummarizedExperiment object
addPheno   whether columns should be included in the tidied output for those in the Sum-
assay     marizedExperiment colData
...        Which assay to return as the value column. Defaults to assays(x)[[1L]]
extra arguments (not used)

Details

addPheno=TRUE adds columns that are redundant (since they add per-sample information to a per-
sample-per-gene data frame), but that are useful for some kinds of graphs and analyses.

Value

tidy returns a data frame with one row per gene-sample combination, with columns
gene        gene name
sample      sample name (from column names)
value       expressions

If addPheno is TRUE then information from colData is added.

Examples

if (require("SummarizedExperiment", "airway")) {
  data(airway)
  se <- airway
tidy(se)
}
tidy.deSet

Tidying methods for edge’s deSet object

Description

Tidying methods for edge’s deSet object

Usage

## S3 method for class 'deSet'
tidy(x, addPheno = FALSE, ...)

## S3 method for class 'deSet'
augment(x, data, ...)

## S3 method for class 'deSet'
glance(x, ...)

Arguments

x               deSet object
addPheno        whether columns should be included in the tidied output for those in the ExpressionSet’s phenoData
...             extra arguments (not used)
data            Original data can be added. Default is NULL.

Details

addPheno=TRUE adds columns that are redundant (since they add per-sample information to a per-sample-per-gene data frame), but that are useful for some kinds of graphs and analyses.

Value

tidy returns a data frame with one row per gene-sample combination, with columns
gene            gene name
sample          sample name (from column names)
value           expressions on log2 scale

augment returns a data.frame with
p.value         the original p-values given to qvalue
q.value         the computed q-values
lfdr            the local false discovery rate

glance returns a data.frame with the model fits
tidy.GRanges

Tidying methods for GRanges and GRangesList objects.

Description

Tidying methods for GRanges and GRangesList objects.

Usage

```r
## S3 method for class 'GRanges'
tidy(x, ...)

## S3 method for class 'GRangesList'
tidy(x, ...)

## S3 method for class 'GRanges'
glance(x, ...)

## S3 method for class 'GRangesList'
glance(x, ...)
```

Arguments

- `x` GRanges or GRangesList object
- `...` Not used.

Value

All tidying methods return a data.frame without rownames. `tidy` returns one row for each range, which contains

- start of the range
- end of the range
- width (or length) of the range
- names of the range
- strand
- seqname Name of the sequence from which the range comes (usually the chromosome)
- metadata Any included metadata, (ie, score, GC content)

For GRangesList, there will also be a column representing which group the ranges comes from. `glance` returns a data.frame with the number of ranges, the number of sequences, and the number of groups (if applicable).
Examples

if (require("GenomicRanges", "airway")) {
  data(airway)

  # GRangesList object
  air_gr <- rowRanges(airway)

  tidy(air_gr)
  glance(air_gr)

  # GRanges object
  air_gr <- rowRanges(airway)$unlistData

  tidy(air_gr)
  glance(air_gr)
}

Index

* datasets
    hammer, 7

assayDataElement, 6
augment.deSet ( tidy.deSet ), 15
augment.DGEList ( edgeR_tidiers ), 5
augment.MArrayLM ( limma_tidiers ), 8
augment.qvalue ( qvalue_tidiers ), 12
augment_sva, 2
biobroom, 3
biobroom-package ( biobroom ), 3
DESeq2_tidiers, 3
edgeR_tidiers, 5
ExpressionSet_tidiers, 6
glance.deSet ( tidy.deSet ), 15
glance.DGEE ( edgeR_tidiers ), 5
glance.GRans ( tidy.GRanges ), 16
glance.GRanList ( tidy.GRanges ), 16
glance.list ( list_tidiers ), 10
glance.MArrayLM ( limma_tidiers ), 8
glance.qvalue ( qvalue_tidiers ), 12
glance_sva ( augment_sva ), 2

hammer, 7
limma_tidiers, 8
list_tidiers, 10
MSnSet_tidiers, 11
qvalue_tidiers, 12
SummarizedExperiment_tidiers, 14
tidy.DESeqDataSet ( DESeq2_tidiers ), 3
tidy.DESeqResults ( DESeq2_tidiers ), 3
tidy.deSet, 15
tidy.DGEE ( edgeR_tidiers ), 5
tidy.DGEList ( edgeR_tidiers ), 5
tidy.EList ( limma_tidiers ), 8
tidy.ExpressionSet
    ( ExpressionSet_tidiers ), 6
tidy.GRanges, 16
tidy.GRanList ( tidy.GRanges ), 16
tidy.list ( list_tidiers ), 10
tidy.MAL ( limma_tidiers ), 8
tidy.MArrayLM ( limma_tidiers ), 8
tidy.MSnaSet ( MSnSet_tidiers ), 11
tidy.qvalue ( qvalue_tidiers ), 12
tidy.RangedSummarizedExperiment
    ( SummarizedExperiment_tidiers ), 14
tidy_sva ( augment_sva ), 2