

# Package ‘qsvaR’

November 6, 2024

**Title** Generate Quality Surrogate Variable Analysis for Degradation Correction

**Version** 1.11.0

**Date** 2024-05-03

**Description** The qsvaR package contains functions for removing the effect of degradation in rna-seq data from postmortem brain tissue. The package is equipped to help users generate principal components associated with degradation. The components can be used in differential expression analysis to remove the effects of degradation.

**License** Artistic-2.0

**URL** <https://github.com/LieberInstitute/qsvaR>

**BugReports** <https://support.bioconductor.org/t/qsvaR>

**biocViews** Software, WorkflowStep, Normalization, BiologicalQuestion, DifferentialExpression, Sequencing, Coverage

**Encoding** UTF-8

**Roxygen** list(markdown = TRUE)

**RoxygenNote** 7.3.0

**Suggests** BiocFileCache, BiocStyle, covr, knitr, limma, RefManageR, rmarkdown, sessioninfo, testthat (>= 3.0.0)

**Config/testthat/edition** 3

**Imports** sva, stats, ggplot2, rlang, tidyverse, methods

**Depends** R (>= 4.2), SummarizedExperiment

**LazyData** true

**VignetteBuilder** knitr

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

**git\_branch** devel

**git\_last\_commit** 4754d53

**git\_last\_commit\_date** 2024-10-29

**Repository** Bioconductor 3.21

**Date/Publication** 2024-11-05

**Author** Joshua Stolz [aut] (ORCID: <<https://orcid.org/0000-0001-5694-5247>>),  
 Hedia Tnani [ctb, cre] (ORCID: <<https://orcid.org/0000-0002-0380-9740>>),  
 Leonardo Collado-Torres [ctb] (ORCID:  
 <<https://orcid.org/0000-0003-2140-308X>>)

**Maintainer** Hedia Tnani <hediatnani@gmail.com>

## Contents

check_tx_names . . . . .	2
covComb_tx_deg . . . . .	3
degradation_tstats . . . . .	3
DEqual . . . . .	4
getDegTx . . . . .	5
getPCs . . . . .	6
get_qsvs . . . . .	6
k_qsvs . . . . .	7
qSVA . . . . .	8
select_transcripts . . . . .	9
transcripts . . . . .	10

**Index** **11**

---

check_tx_names	<i>Check validity of transcript vectors</i>
----------------	---

---

## Description

This function is used to check if the tx1 and tx2 are GENCODE or ENSEMBL and print an error message if it's not and return a character vector of transcripts in tx2 that are in tx1.

## Usage

```
check_tx_names(tx1, tx2, arg_name1, arg_name2)
```

## Arguments

tx1	A character() vector of GENCODE or ENSEMBL transcripts.
tx2	A character() vector of GENCODE or ENSEMBL transcripts.
arg_name1	A character(1) vector of description of tx1
arg_name2	A character(1) vector of description of tx2

## Value

A character() vector of transcripts in tx2 that are in tx1.

**Examples**

```
sig_transcripts = select_transcripts("cell_component")
check_tx_names(rownames(covComb_tx_deg), sig_transcripts, 'rownames(covComb_tx_deg)', 'sig_transcripts')
```

---

covComb_tx_deg	<i>RSE object of RNA-seq data that serves as output for degradation analysis</i>
----------------	--

---

**Description**

This data was generated from an experiment using degraded RNA-seq samples post-mortem brain tissue. The transcripts included are the result of the qsva expanded framework study and will be used to remove the effect of degradation in bulk RNA-seq data.

**Format**

A [RangedSummarizedExperiment-class](#)

**See Also**

[getPCs](#) [k\\_qsvs](#) [getDegTx](#)

---

degradation_tstats	<i>Degradation time t-statistics</i>
--------------------	--------------------------------------

---

**Description**

These t-statistics are derived from the same data that was used for [covComb\\_tx\\_deg](#). They are the results from main model where we determined the relationship with degradation time adjusting for the brain region (so parallel degradation effects across brain regions). They are used for plotting in [DEqual\(\)](#).

**Format**

A `data.frame()` with the t statistics for degradation time. The `rownames()` are the GENCODE transcript IDs.

**See Also**

[DEqual](#)

---

**DEqual***Differential expression quality (DEqual) plot*

---

## Description

A DEqual plot compares the effect of RNA degradation from an independent degradation experiment on the y axis to the effect of the outcome of interest. They were originally described by Jaffe et al, PNAS, 2017 <https://doi.org/10.1073/pnas.1617384114>. Other DEqual versions are included in Collado-Torres et al, Neuron, 2019 <https://doi.org/10.1016/j.neuron.2019.05.013>. This function compares your t-statistics of interest computed on transcripts against the t-statistics from degradation time adjusting for the six brain regions from degradation experiment data used for determining covComb\_tx\_deg.

## Usage

```
DEqual(DE)
```

## Arguments

DE a `data.frame()` with one column containing the t-statistics from Differential Expression, typically generated with `limma::topTable()`. The `rownames(DE)` should be transcript GENCODE IDs.

## Value

a `ggplot` object of the DE t-statistic vs the DE statistic from degradation

## Examples

```
## Random differential expression t-statistics for the same transcripts
## we have degradation t-statistics for in `degradation_tstats`.
set.seed(101)
random_de <- data.frame(
  t = rt(nrow(degradation_tstats), 5),
  row.names = sample(
    rownames(degradation_tstats),
    nrow(degradation_tstats)
  )
)

## Create the DEqual plot
DEqual(random_de)
```

---

`getDegTx`*Obtain expression matrix for degraded transcripts*

---

## Description

This function is used to obtain a [RangedSummarizedExperiment-class](#) of transcripts and their expression values # These transcripts are selected based on a prior study of RNA degradation in postmortem brain tissues. This object can later be used to obtain the principle components necessary to remove the effect of degradation in differential expression.

## Usage

```
getDegTx(  
  rse_tx,  
  type = c("cell_component", "standard", "top1500"),  
  sig_transcripts = select_transcripts(type),  
  assayname = "tpm"  
)
```

## Arguments

<code>rse_tx</code>	A <a href="#">RangedSummarizedExperiment-class</a> object containing the transcript data desired to be studied.
<code>type</code>	A character(1) specifying the transcripts set type. These were determined by Joshua M. Stolz et al, 2022. Here the names "cell_component", "top1500", and "standard" refer to models that were determined to be effective in removing degradation effects. The "standard" model involves taking the union of the top 1000 transcripts associated with degradation from the interaction model and the main effect model. The "top1500" model is the same as the "standard model" except the union of the top 1500 genes associated with degradation is selected. The most effective of our models, "cell_component", involved deconvolution of the degradation matrix to determine the proportion of cell types within our studied tissue. These proportions were then added to our <code>model.matrix()</code> and the union of the top 1000 transcripts in the interaction model, the main effect model, and the cell proportions model were used to generate this model of qSVs.
<code>sig_transcripts</code>	A list of transcripts determined to have degradation signal in the qsva expanded paper.
<code>assayname</code>	character string specifying the name of the assay desired in <code>rse_tx</code>

## Value

A [RangedSummarizedExperiment-class](#) object.

**Examples**

```
getDegTx(covComb_tx_deg)
stopifnot(mean(rowMeans(assays(covComb_tx_deg)$tpm)) > 1)
```

---

getPCs	<i>PCs from transcripts</i>
--------	-----------------------------

---

**Description**

This function returns the pcs from the obtained RangedSummarizedExperiment object of selected transcripts

**Usage**

```
getPCs(rse_tx, assayname = "tpm")
```

**Arguments**

rse_tx	Ranged Summarized Experiment with only transcripts selected for qsva
assayname	character string specifying the name of the assay desired in rse_tx

**Value**

prcomp object generated by taking the pcs of degraded transcripts

**Examples**

```
getPCs(covComb_tx_deg, "tpm")
```

---

get_qsvs	<i>Generate matrix of qsvs</i>
----------	--------------------------------

---

**Description**

Using the pcs and the k number of components be included, we generate the qsva matrix.

**Usage**

```
get_qsvs(qsvPCs, k)
```

**Arguments**

qsvPCs	prcomp object generated by taking the pcs of degraded transcripts
k	number of qsvs to be included.

**Value**

matrix with k principal components for each sample.

**Examples**

```
qsv <- getPCs(covComb_tx_deg, "tpm")
get_qsvs(qsv, 2)
```

---

k\_qsvs

*Apply num.sv algorithm to determine the number of pcs to be included*


---

**Description**

Apply num.sv algorithm to determine the number of pcs to be included

**Usage**

```
k_qsvs(rse_tx, mod, assayname)
```

**Arguments**

rse_tx	A <a href="#">RangedSummarizedExperiment-class</a> object containing the transcript data desired to be studied.
mod	Model Matrix with necessary variables the you would model for in differential expression
assayname	character string specifying the name of the assay desired in rse_tx

**Value**

integer representing number of pcs to be included

**Examples**

```
## First we need to define a statistical model. We'll use the example
## covComb_tx_deg data. Note that the model you'll use in your own data
## might look different from this model.
mod <- model.matrix(~ mitoRate + Region + rRNA_rate + totalAssignedGene + RIN,
  data = colData(covComb_tx_deg)
)

## To ensure that the results are reproducible, you will need to set a
## random seed with the set.seed() function. Internally, we are using
## sva::num.sv() which needs a random seed to ensure reproducibility of the
## results.
set.seed(20230621)
k_qsvs(covComb_tx_deg, mod, "tpm")
```

qSVA

*A wrapper function used to perform qSVA in one step.***Description**

A wrapper function used to perform qSVA in one step.

**Usage**

```
qSVA(
  rse_tx,
  type = c("cell_component", "standard", "top1500"),
  sig_transcripts = select_transcripts(type),
  mod,
  assayname
)
```

**Arguments**

rse_tx	A <a href="#">RangedSummarizedExperiment-class</a> object containing the transcript data desired to be studied.
type	a character string specifying which model you would like to use when selecting a degradation matrix.
sig_transcripts	A list of transcripts that are associated with degradation signal. Use <code>select_transcripts()</code> to select sets of transcripts identified by the qSVA expanded paper. Specifying a <code>character()</code> input of ENSEMBL transcript IDs (or whatever values you have at <code>rownames(rse_tx)</code> ) obtained outside of <code>select_transcripts()</code> overrides the user friendly <code>type</code> argument. That is, this argument provides more fine tuning options for advanced users.
mod	Model Matrix with necessary variables the you would model for in differential expression
assayname	character string specifying the name of the assay desired in <code>rse_tx</code>

**Value**

matrix with k principal components for each sample

**Examples**

```
## First we need to define a statistical model. We'll use the example
## covComb_tx_deg data. Note that the model you'll use in your own data
## might look different from this model.
mod <- model.matrix(~ mitoRate + Region + rRNA_rate + totalAssignedGene + RIN,
  data = colData(covComb_tx_deg)
)
```



```
## To ensure that the results are reproducible, you will need to set a
## random seed with the set.seed() function. Internally, we are using
## sva::num.sv() which needs a random seed to ensure reproducibility of the
## results.
set.seed(20230621)
qSVA(rse_tx = covComb_tx_deg, type = "cell_component", mod = mod, assayname = "tpm")
```

---

select\_transcripts      *Select transcripts associated with degradation*

---

### Description

Helper function to select which experimental model will be used to generate the qSVs.

### Usage

```
select_transcripts(type = c("cell_component", "top1500", "standard"))
```

### Arguments

**type**                    A character(1) specifying the transcripts set type. These were determined by Joshua M. Stolz et al, 2022. Here the names "cell\_component", "top1500", and "standard" refer to models that were determined to be effective in removing degradation effects. The "standard" model involves taking the union of the top 1000 transcripts associated with degradation from the interaction model and the main effect model. The "top1500" model is the same as the "standard model" except the union of the top 1500 genes associated with degradation is selected. The most effective of our models, "cell\_component", involved deconvolution of the degradation matrix to determine the proportion of cell types within our studied tissue. These proportions were then added to our `model.matrix()` and the union of the top 1000 transcripts in the interaction model, the main effect model, and the cell proportions model were used to generate this model of qSVs.

### Value

A character() with the transcript IDs.

### Examples

```
## Default set of transcripts associated with degradation
sig_transcripts <- select_transcripts()
length(sig_transcripts)
head(sig_transcripts)

## Example where match.arg() auto-completes
select_transcripts("top")
```

---

`transcripts`*Transcripts for Degradation Models*

---

**Description**

An object storing three lists of transcripts each corresponding to a model used in the degradation experiment. These were determined by Joshua M. Stolz et al, 2022. Here the names "cell\_component", "top1500", and "standard" refer to models that were determined to be effective in removing degradation effects. The "standard" model involves taking the union of the top 1000 transcripts associated with degradation from the interaction model and the main effect model. The "top1500" model is the same as the "standard" model except the union of the top 1500 genes associated with degradation is selected. The most effective of our models, "cell\_component", involved deconvolution of the degradation matrix to determine the proportion of cell types within our studied tissue. These proportions were then added to our `model.matrix()` and the union of the top 1000 transcripts in the interaction model, the main effect model, and the cell proportions model were used to generate this model of qSVs.

**Usage**

```
transcripts
```

**Format**

A `list()` with character strings containing the transcripts selected by each model. Each string is a GENCODE transcript IDs.

**See Also**

[select\\_transcripts](#)

# Index

## \* datasets

- covComb\_tx\_deg, [3](#)
- degradation\_tstats, [3](#)
- transcripts, [10](#)

- check\_tx\_names, [2](#)
- covComb\_tx\_deg, [3](#), [3](#)

- degradation\_tstats, [3](#)
- DEqual, [3](#), [4](#)

- get\_qsvs, [6](#)
- getDegTx, [3](#), [5](#)
- getPCs, [3](#), [6](#)

- k\_qsvs, [3](#), [7](#)

- qSVA, [8](#)

- RangedSummarizedExperiment-class, [3](#), [5](#),  
[7](#), [8](#)

- select\_transcripts, [9](#), [10](#)

- transcripts, [10](#)