

# Package ‘scaper’

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**Title** Single Cell Transcriptomics-Level Cytokine Activity Prediction and Estimation

**Version** 0.2.0

**Maintainer** Azka Javaid <azka.javaid.gr@dartmouth.edu>

**Description** Generates cell-level cytokine activity estimates using relevant information from gene sets constructed with the 'CytoSig' and the 'Reactome' databases and scored using the modified 'Variance-adjusted Mahalanobis (VAM)' framework for single-cell RNA-sequencing (scRNA-seq) data. 'CytoSig' database is described in: Jiang et al., (2021) <doi:10.1038/s41592-021-01274-5>. 'Reactome' database is described in: Gillespie et al., (2021) <doi:10.1093/nar/gkab1028>. The 'VAM' method is outlined in: Frost (2020) <doi:10.1093/nar/gkaa582>.

**Suggests** knitr, pheatmap, rmarkdown, usethis

**Imports** magrittr, xml2, stringr, dplyr, Seurat, SeuratObject, VAM, utils

**License** GPL (>= 2)

**Encoding** UTF-8

**RoxygenNote** 7.2.3

**VignetteBuilder** knitr

**Depends** R (>= 3.5.0)

**NeedsCompilation** no

**Author** H. Robert Frost [aut],  
Azka Javaid [aut, cre]

**Repository** CRAN

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genesetCytoSig      *CytoSig gene set construction.*

---

**Description**

Returns the gene set associated with input cytokine(s) from the CytoSig database given manually specified cytokine-specific output csv file(s) under the extdata directory with file name beginning with the specified cytokine (i.e., 'IL6\_output.csv') as currently provided for the IL6 cytokine.

**Usage**

```
genesetCytoSig(cytokine.eval, file.name)
```

**Arguments**

cytokine.eval    Cytokine(s) associated with the query.  
file.name        List of XML file(s) associated with the cytokine(s) beginning with the specific cytokine name.

**Value**

Dataframe consisting of genes and the associated log2 fold change values associated with the specific cytokine(s).

**Examples**

```
file.name.cytosig1 <- system.file("extdata", "IL6_output.csv", package = "scaper")
genesetCytoSig(cytokine.eval = "IL6", file.name = file.name.cytosig1) %>% head(10)
```

---

genesetReactome      *Reactome gene set construction.*

---

**Description**

Returns the gene set consisting of genes on the Reactome pathway hierarchy given input cytokine(s) and specified list of pathway hierarchy xml file(s) with file name beginning with the specified cytokine (i.e., 'IL6\_Interleukin6\_signaling.xml') as currently provided for the IL6 cytokine.

**Usage**

```
genesetReactome(cytokine.eval, file.name)
```

**Arguments**

`cytokine.eval` Cytokine(s) associated with the query.  
`file.name` List of XML file(s) associated with the cytokine(s) beginning with the specific cytokine name.

**Value**

Dataframe consisting of list of genes on the molecular pathway associated with the specified cytokine(s).

**Examples**

```
file.name.reactome1 <- system.file("extdata", "IL6_Interleukin6_signaling.xml",
package = "scaper")
genesetReactome(cytokine.eval = "IL6", file.name = file.name.reactome1) %>% head(10)
```

---

scape *Cytokine activity scores for a normalized matrix.*

---

**Description**

Computes cell-level estimates of cytokine activity for a normalized scRNA-seq count matrix using the SCAPE method. SCAPE activity estimates are computed by scoring weighted genes sets from the CytoSig or Reactome databases using the [VAM::vamForCollection\(\)](#) function. Individual gene sets for subsequent scoring can be reconstructed using the [genesetCytoSig](#) and the [genesetReactome](#) functions for the CytoSig and the Reactome database, respectively.

**Usage**

```
scape(counts.matrix, database = "cytosig", cytokine = "all")
```

**Arguments**

`counts.matrix` A  $m \times n$  normalized counts matrix with  $m$  samples and  $n$  genes.  
`database` Database used for gene set construction and set scoring.

- "cytosig" performs scoring for up to 41 cytokines using the CytoSig database.
- "reactome" performs scoring for up to 30 cytokines using the Reactome database.

`cytokine` Vector of cytokine names to score for activity. The default value of "all" will score all 41 cytokines supported by CytoSig or 31 supported by Reactome. Please see function [supportedCytokines](#) to view all the CytoSig or the Reactome specific scored cytokines.

**Value**

A  $m \times p$  matrix consisting of the cell-level cytokine activity scores for  $p$  cytokines.

## See Also

[genesetCytoSig](#), [genesetReactome](#)

## Examples

```
library(Seurat)
library(SeuratObject)
pbmc_small <- NormalizeData(pbmc_small)
counts.matrix <- as.data.frame(t(as.matrix(pbmc_small@assays$RNA@data)))
CytoSig.score.output <- scape(counts.matrix = counts.matrix,
  database = "cytosig")
head(CytoSig.score.output)[,1:3]
CytoSig.score.output.specific <- scape(counts.matrix = counts.matrix,
  database = "cytosig", cytokine = c("IL4", "IL13"))
head(CytoSig.score.output.specific)
```

---

scapeForSeurat

*Cytokine activity scores for a Seurat matrix.*

---

## Description

Computes cell-level estimates of cytokine activity for a scRNA-seq Seurat count matrix using the `scapeForSeurat` method. SCAPE activity estimates are computed by scoring weighted gene sets from the CytoSig or Reactome databases using the Variance-adjusted Mahalanobis (VAM) method as implemented in the `VAM::vamForSeurat()` function. Individual gene sets for subsequent scoring can be reconstructed using the [genesetCytoSig](#) and the [genesetReactome](#) functions for the CytoSig and the Reactome database, respectively.

## Usage

```
scapeForSeurat(
  seurat.object,
  database = "cytosig",
  cytokine = "all",
  normalize = TRUE
)
```

## Arguments

`seurat.object` Seurat counts matrix.

`database` Database used for gene set construction and set scoring.

- "cytosig" (default) performs scoring for up to 41 cytokines using the CytoSig database.
- "reactome" performs scoring for up to 30 cytokines using the Reactome database.

|           |  |
|-----------|--|
| cytokine  | Vector of cytokine names to score for activity. The default value of "all" will score all 41 cytokines supported by CytoSig or 31 supported by Reactome. Please see function <a href="#">supportedCytokines</a> to view all the CytoSig or the Reactome specific scored cytokines. |
| normalize | Boolean indicator for whether normalization should be performed before performing gene set scoring.  |

**Value**

Seurat object consisting of cell-level cytokine activity scores returned as a separate assay (scape for scoring via the CytoSig database and VAMcdf for scoring via the Reactome database).

**See Also**

[genesetCytoSig](#), [genesetReactome](#), [scape](#)

**Examples**

```
library(SeuratObject)
CytoSig.score.output.all <- scapeForSeurat(seurat.object = pbmc_small,
database = "cytosig", cytokine = "all", normalize=TRUE)
(as.data.frame(CytoSig.score.output.all@assays$scape@data))[1:6,1:3]
CytoSig.score.output.specific <- scapeForSeurat(seurat.object = pbmc_small,
database = "cytosig", cytokine = c("IL4", "IL13"), normalize=TRUE)
(as.data.frame(CytoSig.score.output.specific@assays$scape@data))[,1:3]
```

---

supportedCytokines      *Gene set to score for the CytoSig or the Reactome databases.*

---

**Description**

Returns the names of the cytokines supported by either the CytoSig or the Reactome databases.

**Usage**

```
supportedCytokines(database = "cytosig")
```

**Arguments**

- |          |   |
|----------|---|
| database | Database used for gene set construction and set scoring. <ul style="list-style-type: none"> <li>• "cytosig" returns the 41 cytokines scored using the CytoSig database.</li> <li>• "reactome" returns the 30 cytokines scored using the Reactome database.</li> </ul> |
|----------|---|

**Value**

List of cytokines associated with the CytoSig or the Reactome databases.

**Examples**

```
supportedCytokines(database = "cytosig")  
supportedCytokines(database = "reactome")
```

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