

# Package ‘scToppR’

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**Title** API Wrapper for ToppGene

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**Description** scToppR provides an easy-to-use API wrapper for the ToppGene web platform, used for gene ontology and functional enrichment research. The package also integrates visualization tools, making it a convenient tool directly connecting ToppGene to code-based workflows in R. The tool can also easily save results into different formats.

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## Contents

scToppR-package . . . . .	2
addToppData . . . . .	3
addToppData . . . . .	4
get_Entrez . . . . .	5
get_ToppCats . . . . .	5
ifnb.de . . . . .	6
ifnb.markers.df . . . . .	6
ifnb.markers.list.CD8T . . . . .	7
pbmc.markers . . . . .	8
toppBalloon . . . . .	8
toppdata.airway . . . . .	9
toppdata.ifnb . . . . .	10
toppdata.pbmc . . . . .	11
toppFun . . . . .	12
toppPlot . . . . .	14
toppSave . . . . .	15
<b>Index</b>	<b>17</b>

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scToppR-package

*scToppR: API Wrapper for ToppGene*

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## Description

scToppR provides an easy-to-use API wrapper for the ToppGene web platform, used for gene ontology and functional enrichment research. The package also integrates visualization tools, making it a convenient tool directly connecting ToppGene to code-based workflows in R. The tool can also easily save results into different formats.

## Author(s)

**Maintainer:** Bryan Granger <grangerb@musc.edu> ([ORCID](#))

## See Also

Useful links:

- <https://github.com/BioinformaticsMUSC/scToppR>
- Report bugs at <https://github.com/BioinformaticsMUSC/scToppR>

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addToppData	<i>Add toppData results to SingleCellExperiment or SummarizedExperiment metadata</i>
-------------	--

---

## Description

A convenience function to store `toppData` enrichment results in the metadata slot of a `SingleCellExperiment` or `SummarizedExperiment` object. Results are stored directly under the specified slot name, with optional analysis parameters stored in a separate `slot_name_params` slot.

## Usage

```
addToppData(  
  sce,  
  toppData_results,  
  slot_name = "toppData",  
  include_params = TRUE  
)
```

## Arguments

<code>sce</code>	A <code>SingleCellExperiment</code> or <code>SummarizedExperiment</code> object
<code>toppData_results</code>	A <code>data.frame</code> of <code>toppData</code> results from <code>toppFun()</code>
<code>slot_name</code>	Name for the metadata slot (default: "toppData")
<code>include_params</code>	Logical, whether to include analysis parameters and timestamp in a separate <code>slot_name_params</code> slot (default: TRUE)

## Value

`SingleCellExperiment` or `SummarizedExperiment` object with `toppData` stored in metadata

## Examples

```
library(airway)  
data("airway") # example SummarizedExperiment object  
data("toppdata.airway") # example toppData results  
se_with_topp <- addToppData(airway, toppdata.airway)  
  
# Access results directly  
topp_results <- S4Vectors::metadata(se_with_topp)$toppData  
  
# Access analysis parameters (if include_params = TRUE)  
topp_params <- S4Vectors::metadata(se_with_topp)$toppData_params
```

---

addToppData	<i>Add toppData results to SingleCellExperiment or SummarizedExperiment metadata</i>
-------------	--

---

## Description

A convenience function to store `toppData` enrichment results in the metadata slot of a `SingleCellExperiment` or `SummarizedExperiment` object. Results are stored directly under the specified slot name, with optional analysis parameters stored in a separate `slot_name_params` slot.

## Usage

```
addToppData(  
  sce,  
  toppData_results,  
  slot_name = "toppData",  
  include_params = TRUE  
)
```

## Arguments

<code>sce</code>	A <code>SingleCellExperiment</code> or <code>SummarizedExperiment</code> object
<code>toppData_results</code>	A <code>data.frame</code> of <code>toppData</code> results from <code>toppFun()</code>
<code>slot_name</code>	Name for the metadata slot (default: "toppData")
<code>include_params</code>	Logical, whether to include analysis parameters and timestamp in a separate <code>slot_name_params</code> slot (default: TRUE)

## Value

`SingleCellExperiment` or `SummarizedExperiment` object with `toppData` stored in metadata

## Examples

```
library(airway)  
data("airway") # example SummarizedExperiment object  
data("toppdata.airway") # example toppData results  
se_with_topp <- addToppData(airway, toppdata.airway)  
  
# Access results directly  
topp_results <- S4Vectors::metadata(se_with_topp)$toppData  
  
# Access analysis parameters (if include_params = TRUE)  
topp_params <- S4Vectors::metadata(se_with_topp)$toppData_params
```

---

get_Entrez	<i>Convert genes into Entrez format</i>
------------	---

---

**Description**

Convert genes into Entrez format

**Usage**

```
get_Entrez(genes)
```

**Arguments**

genes            A list of genes

**Value**

a vector of genes in Entrez format

**Examples**

```
get_Entrez(genes = c("IFNG", "FOXP3"))
```

---

get_TopCats	<i>Get a vector of ToppFun categories</i>
-------------	---

---

**Description**

Get a vector of ToppFun categories

**Usage**

```
get_TopCats()
```

**Value**

a vector

**Examples**

```
get_TopCats()
```

ifnb.de

*IFNB DE results*

---

**Description**

A dataframe of differentially expressed genes generated using the FindMarkers function for each cluster from the Kang 2018 IFNB dataset Created using the IFNB dataset from the SeuratData package

**Usage**

```
data("ifnb.de")
```

**Format**

A dataframe with 92,860 rows and 7 columns

**p\_val** P values

**avg\_log2FC** avg log 2 fc values

**pct.1** percentage of cells expressing gene in group 1

**pct.2** percentage of cells expressing gene in group 2

**p\_val\_adj** adjusted p-value (FDR)

**cluster** cell group name

**gene** gene name

**Source**

<https://www.nature.com/articles/nbt.4042>

---

ifnb.markers.df*IFNB Marker DF*

---

**Description**

A dataframe of 100 top markers for each class in 'seurat\_annotatons' column using presto::wilcoxauc() and presto::top\_markers() Created using the IFNB dataset from the SeuratData package

**Usage**

```
data("ifnb.markers.df")
```

**Format**

A dataframe with 100 rows and 14 columns

**rank** rank of marker

**B** cell group name

**B Activated** cell group name

**CD14 Mono** cell group name

**CD16 Mono** cell group name

**CD4 Memory T** cell group name

**CD4 Naive T** cell group name

**CD8 T** cell group name

**DC** cell group name

**Eryth** cell group name

**Mk** cell group name

**CNK** cell group name

**pDC** cell group name

**T activated** cell group name

**Source**

<https://www.nature.com/articles/nbt.4042>

Kang HM, Subramaniam M, Targ S, et al. Multiplexed droplet single-cell RNA-sequencing using natural genetic variation. Nat Biotechnol. 2018;36(1):89-94. doi:10.1038/nbt.4042

---

ifnb.markers.list.CD8T

*IFNB Marker DF*

---

**Description**

A list of the 100 top markers for CD8 T cells in ifnb dataset using `presto::wilcoxauc()` and `presto::top_markers()`  
Created using the IFNB dataset from the SeuratData package

**Usage**

```
data("ifnb.markers.list.CD8T")
```

**Format**

A character vector with 100 genes

**ifnb.markers.list.CD8T** rank of marker

**Source**

<https://www.nature.com/articles/nbt.4042>

Kang HM, Subramaniam M, Targ S, et al. Multiplexed droplet single-cell RNA-sequencing using natural genetic variation. Nat Biotechnol. 2018;36(1):89-94. doi:10.1038/nbt.4042

---

pbmc.markers

*PBMC markers*

---

### Description

A dataframe of marker genes generated using the FindMarkers function for each cluster from the PBMC 3k dataset

### Usage

```
data("pbmc.markers")
```

### Format

A dataframe with 11,629 rows and 7 columns

**p\_val** P values

**avg\_log2FC** avg log 2 fc values

**pct.1** percentage of cells expressing gene in group 1

**pct.2** percentage of cells expressing gene in group 2

**p\_val\_adj** adjusted p-value (FDR)

**cluster** cell group name

**gene** gene name

### Source

10X Genomics PBMC 3k dataset. Available from <https://www.10xgenomics.com/resources/datasets/>. Analysis following Seurat PBMC tutorial: [https://satijalab.org/seurat/articles/pbmc3k\\_tutorial.html](https://satijalab.org/seurat/articles/pbmc3k_tutorial.html)

---

toppBalloon

*Create a balloon plot from toppdata results*

---

### Description

This function creates balloon plots from ToppGene enrichment results. It accepts either a data.frame with toppData results, or a SummarizedExperiment/SingleCellExperiment object with toppData stored in the metadata.

### Usage

```
toppBalloon(
  toppData,
  categories = NULL,
  balloons = 3,
  x_axis_text_size = 6,
  cluster_col = "Cluster",
  filename = "toppBalloon",
```

```

    save = FALSE,
    save_dir = tempdir(),
    height = 6,
    width = 8,
    slot_name = "toppData",
    ...
  )

```

### Arguments

toppData	A toppData results dataframe, SummarizedExperiment, or SingleCellExperiment object
categories	The topp categories to plot
balloons	Number of balloons per group to plot
x_axis_text_size	Size of the text on the x axis
cluster_col	The column name for clusters (default: "Cluster")
filename	Filename of the saved balloon plot
save	Save the balloon plot if TRUE
save_dir	Directory to save the balloon plot
height	Height of the saved balloon plot
width	Width of the saved balloon plot
slot_name	For SE/SCE objects, the metadata slot name containing toppData (default: "toppData")
...	Additional parameters for future use

### Value

ggplot object or list of ggplot objects

### Examples

```

data("toppdata.pbmc")

# With data.frame
toppBalloon(toppdata.pbmc, balloons = 3, save = FALSE)

# With SummarizedExperiment (if toppData stored in metadata)
# toppBalloon(se_object, categories = "GeneOntologyMolecularFunction")

```

---

toppdata.airway

*toppData example using the airway dataset results*

---

### Description

A dataframe of of sample toppData results created from the ifnb.de dataset using the toppFun() function

**Usage**

```
data("toppdata.airway")
```

**Format**

A dataframe with 902 rows and 14 columns

**Category** ToppGene category

**ID** ToppGene Term ID

**Name** ToppGene Term Name

**PValue** P value

**QValueFDRBH** adjusted p-value (FDR)

**QValueFDRBY** adjusted p-value (BY)

**QValueBonferroni** adjusted p-value (Bonferroni)

**TotalGenes** Total genes in background

**GenesInTerm** Genes in ToppGene Term

**GenesInQuery** Genes in submitted query

**GenesInTermQuery** Intersection of genes in Term and in Query

**Source** ToppGene result source

**URL** ToppGene associated URL

**Cluster** cell group name

**Source**

<https://toppgene.cchmc.org>

Generated using ToppGene API (<https://toppgene.cchmc.org/>). Chen J, Bardes EE, Aronow BJ, Jegga AG. ToppGene Suite for gene list enrichment analysis and candidate gene prioritization. *Nucleic Acids Res.* 2009;37(Web Server issue):W305-11. doi: 10.1093/nar/gkp427.

Himes, E. B, Jiang, X., Wagner, P., Hu, R., Wang, Q., Klanderma, B., Whitaker, M. R, Duan, Q., Lasky-Su, J., Nikolos, C., Jester, W., Johnson, M., Panettieri, A. R, Tantisira, G. K, Weiss, T. S, Lu, Q. (2014). "RNA-Seq Transcriptome Profiling Identifies CRISPLD2 as a Glucocorticoid Responsive Gene that Modulates Cytokine Function in Airway Smooth Muscle Cells." *PLoS ONE*, 9(6), e99625. <http://www.ncbi.nlm.nih.gov/pubmed/24926665>.

<https://www.bioconductor.org/packages/release/data/experiment/html/airway.html>

---

toppdata.ifnb

*toppData example for ifnb.de*

---

**Description**

A dataframe of of sample toppData results created from the ifnb.de dataset using the toppFun() function

**Usage**

```
data("toppdata.ifnb")
```

**Format**

A dataframe with 12,227 rows and 14 columns

**Category** ToppGene category

**ID** ToppGene Term ID

**Name** ToppGene Term Name

**PValue** P value

**QValueFDRBH** adjusted p-value (FDR)

**QValueFDRBY** adjusted p-value (BY)

**QValueBonferroni** adjusted p-value (Bonferroni)

**TotalGenes** Total genes in background

**GenesInTerm** Genes in ToppGene Term

**GenesInQuery** Genes in submitted query

**GenesInTermQuery** Intersection of genes in Term and in Query

**Source** ToppGene result source

**URL** ToppGene associated URL

**Cluster** cell group name

**Source**

Generated using ToppGene API (<https://toppgene.cchmc.org/>). Chen J, Bardes EE, Aronow BJ, Jegga AG. ToppGene Suite for gene list enrichment analysis and candidate gene prioritization. Nucleic Acids Res. 2009;37(Web Server issue):W305-11. doi: 10.1093/nar/gkp427.

<https://toppgene.cchmc.org>

Kang HM, Subramaniam M, Targ S, et al. Multiplexed droplet single-cell RNA-sequencing using natural genetic variation. Nat Biotechnol. 2018;36(1):89-94. doi:10.1038/nbt.4042

---

toppdata.pbmc

*toppData example*

---

**Description**

A dataframe of of sample toppData results created from the pbmc.markers dataset using the topp-Fun() function

**Usage**

```
data("toppdata.pbmc")
```

**Format**

A dataframe with 8,550 rows and 14 columns

**Category** ToppGene category

**ID** ToppGene Term ID

**Name** ToppGene Term Name

**PValue** P value

**QValueFDRBH** adjusted p-value (FDR)

**QValueFDRBY** adjusted p-value (BY)

**QValueBonferroni** adjusted p-value (Bonferroni)

**TotalGenes** Total genes in background

**GenesInTerm** Genes in ToppGene Term

**GenesInQuery** Genes in submitted query

**GenesInTermQuery** Intersection of genes in Term and in Query

**Source** ToppGene result source

**URL** ToppGene associated URL

**Cluster** cell group name

**Source**

<https://toppgene.cchmc.org>

Generated using ToppGene API (<https://toppgene.cchmc.org/>). Chen J, Bardes EE, Aronow BJ, Jegga AG. ToppGene Suite for gene list enrichment analysis and candidate gene prioritization. *Nucleic Acids Res.* 2009;37(Web Server issue):W305-11. doi: 10.1093/nar/gkp427.

10X Genomics PBMC 3k dataset. Available from <https://www.10xgenomics.com/resources/datasets/>. Analysis following Seurat PBMC tutorial: [https://satijalab.org/seurat/articles/pbmc3k\\_tutorial.html](https://satijalab.org/seurat/articles/pbmc3k_tutorial.html)

---

toppFun

*Get results from ToppFun*

---

**Description**

The `toppFun()` function takes a `data.frame` or other tabular data structure and selects genes to use in querying ToppGene.

**Usage**

```
toppFun(
  input_data,
  type = "degs",
  topp_categories = NULL,
  cluster_col = "cluster",
  gene_col = "gene",
  p_val_col = "adj_p_val_col",
  logFC_col = "avg_logFC",
```

```

direction_mode = "all",
num_genes = 1000,
pval_cutoff = 0.5,
fc_cutoff = 0,
fc_filter = "ALL",
clusters = NULL,
correction = "FDR",
key_type = "SYMBOL",
min_genes = 2,
max_genes = 1500,
max_results = 50,
verbose = TRUE
)

```

### Arguments

input_data	A vector of markers or dataframe with columns as cluster labels
type	One of c("degs", "marker_list", or "marker_df). If "degs" is selected, the input_data is assumed to be a data.frame with logfoldchange, pvalue, and gene name columns. If "marker_list" is selected, input_data is assumed to be a list of genes with no other stats, and any thresholds pertaining to "degs" will be ignored. If "marker_df" is selected, the input_data is assumed to be a data.frame with columns as clusters/celltypes, and entries are lists of markers.
topp_categories	A string or vector with specific toppfun categories for the query
cluster_col	Column name for the groups of cells (e.g. cluster or celltype)
gene_col	Column name for genes (e.g. gene or feature)
p_val_col	Column name for the p-value or adjusted p-value (preferred)
logFC_col	Column name for the avg log FC column
direction_mode	One of c("all", "split"). Whether to use all genes in the pathway analysis, or to split by up and down regulated genes
num_genes	Number of genes per group to use for toppGene query
pval_cutoff	(adjusted) P-value cutoff for filtering differentially expressed genes
fc_cutoff	Avg log fold change cutoff for filtering differentially expressed genes
fc_filter	Include "ALL" genes, or only "UPREG" or "DOWNREG" for each cluster
clusters	Which clusters to include in toppGene query
correction	P-value correction method ("FDR" is "BH")
key_type	Gene name format
min_genes	Minimum number of genes to match in a query
max_genes	Maximum number of genes to match in a query
max_results	Maximum number of results per cluster
verbose	Verbosity setting, TRUE or FALSE

### Details

The use of data from ToppGene is governed by their Terms of Use: <https://toppgene.cchmc.org/navigation/termsfuse.jsp>

**Value**

data.frame

**Examples**

```
data("ifnb.de")
toppData <- toppFun(ifnb.de,
  topp_categories = NULL,
  cluster_col = "celltype",
  gene_col = "gene",
  p_val_col = "p_val_adj",
  logFC_col = "avg_log2FC"
)
```

toppPlot

*Create a dotplot from toppdata results***Description**

This function creates dotplots from ToppGene enrichment results. It accepts either a data.frame with toppData results, or a SummarizedExperiment/SingleCellExperiment object with toppData stored in the metadata.

**Usage**

```
toppPlot(
  toppData,
  category = NULL,
  clusters = NULL,
  cluster_col = "Cluster",
  p_val_adj = "QValueFDRBH",
  p_val_display = "FDR_BH",
  num_terms = 10,
  save = FALSE,
  save_dir = tempdir(),
  width = 8,
  height = 6,
  file_prefix = "toppPlot",
  combine = FALSE,
  ncols = 2,
  y_axis_text_size = 10,
  slot_name = "toppData",
  ...
)
```

**Arguments**

toppData	A toppData results dataframe, SummarizedExperiment, or SingleCellExperiment object
category	The topp categories to plot
clusters	The cluster(s) to plot

cluster_col	The column name for clusters (default: "Cluster")
p_val_adj	The P-value correction method: "BH", "Bonferroni", "BY", or "none"
p_val_display	If "log", display the p-value in terms of $-\log_{10}(p\_value)$
num_terms	The number of terms from the toppData results to be plotted, per cluster
save	Whether to save the file automatically
save_dir	Directory to save file
width	width of the saved file (inches)
height	height of the saved file (inches)
file_prefix	file prefix if saving the plot - the cluster name is also added automatically
combine	If TRUE and multiple clusters selected, return a patchwork object of all plots; if FALSE return list of plots
ncols	If patchwork element returned, number of columns for subplots
y_axis_text_size	Size of the Y axis text - for certain categories, it's helpful to decrease this
slot_name	For SE/SCE objects, the metadata slot name containing toppData (default: "toppData")
...	Additional parameters for future use

**Value**

ggplot object or list of ggplot objects

**Examples**

```
data("toppdata.pbmc")

# With data.frame
toppPlot(toppdata.pbmc,
  category = "GeneOntologyMolecularFunction",
  clusters = 0,
  save = FALSE
)

# With SummarizedExperiment (if toppData stored in metadata)
# toppPlot(se_object, category = "GeneOntologyMolecularFunction")
```

---

toppSave

*Save toppData results (optionally) split by celltype/cluster*


---

**Description**

Save toppData results (optionally) split by celltype/cluster

**Usage**

```
toppSave(  
  toppData,  
  filename = "toppData_results",  
  save_dir = NULL,  
  split = TRUE,  
  format = "xlsx",  
  cluster_col = "Cluster",  
  verbose = TRUE  
)
```

**Arguments**

toppData	Results from toppFun as a dataframe
filename	filename prefix for each split file
save_dir	the directory to save files
split	Boolean, whether to split the dataframe by celltype/cluster
format	Saved file format, one of c("xlsx", "csv", "tsv")
cluster_col	Column name for the groups of cells (e.g. cluster or celltype), usually "Cluster"
verbose	Verbosity setting, TRUE or FALSE

**Value**

A saved file

**Examples**

```
data("toppdata.ifnb")  
toppSave(toppdata.ifnb,  
  filename = "toppFun_results",  
  save_dir = tempdir(),  
  split = TRUE,  
  format = "xlsx")
```

# Index

## \* datasets

- ifnb.de, [6](#)
- ifnb.markers.df, [6](#)
- ifnb.markers.list.CD8T, [7](#)
- pbmc.markers, [8](#)
- toppdata.airway, [9](#)
- toppdata.ifnb, [10](#)
- toppdata.pbmc, [11](#)

## \* internal

- scToppR-package, [2](#)

[addToppData](#), [3](#), [4](#)

[get\\_Entrez](#), [5](#)

[get\\_ToppCats](#), [5](#)

[ifnb.de](#), [6](#)

[ifnb.markers.df](#), [6](#)

[ifnb.markers.list.CD8T](#), [7](#)

[pbmc.markers](#), [8](#)

[scToppR \(scToppR-package\)](#), [2](#)

[scToppR-package](#), [2](#)

[toppBalloon](#), [8](#)

[toppdata.airway](#), [9](#)

[toppdata.ifnb](#), [10](#)

[toppdata.pbmc](#), [11](#)

[toppFun](#), [12](#)

[toppPlot](#), [14](#)

[toppSave](#), [15](#)