

Package ‘openCyto’

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Type Package

Title Hierarchical Gating Pipeline for flow cytometry data

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Description This package is designed to facilitate the automated gating methods in sequential way to mimic the manual gating strategy.

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as.data.table	<i>convert a gatingTemplate object to a data.table</i>
---------------	--

Description

It is the inverse function of gatingTemplate constructor.

Usage

```
## S3 method for class 'gatingTemplate'
as.data.table(x, keep.rownames = FALSE)
```

Arguments

x	gatingTemplate object
keep.rownames	not used

Value

a data.table

boolMethod-class *A class to represent a boolean gating method.*

Description

It extends refGate class.

CytoExploreR_exports *CytoExploreR exports*

Description

Exported wrappers of internal functions for use by CytoExploreR

Usage

```
CytoExploreR_.argDeparser(args, split = TRUE)
CytoExploreR_.preprocess_csv(dt, strict = TRUE)
```

dims,gtMethod-method *get gating method dimensions*

Description

get gating method dimensions

Usage

```
## S4 method for signature 'gtMethod'
dims(x)
```

Arguments

x gtMethod

dummyMethod-class *A class to represent a dummy gating method that does nothing but serves as reference to be refered by other population*

Description

It is generated automatically by the csv template preprocessing to handle the gating function that returns multiple gates.

fast_rlm	<i>robust linear model using an M estimator</i>
----------	---

Description

rewritten in c++, till eval stats::lm.wfit r function in underlying cpp11 code It is internally used for singletGate, thus its output format may not be generic enough for common model fitting . e.g. it doesn't take formula as input

Usage

```
fast_rlm(x, y, maxit = 20)
```

Arguments

x	matrix with first column as weight (default can be 1s), the rest columns are predict variable
y	numeric vector as response
maxit	maximum iterations

fcEllipsoidGate	<i>constuctor for fcEllipsoidGate</i>
-----------------	---------------------------------------

Description

constuctor for fcEllipsoidGate

Usage

```
fcEllipsoidGate(x, priors, posts)
```

Arguments

x	a ellipsoidGate object
priors	a list storing priors
posts	a list storing posteriors

fcEllipsoidGate-class	<i>a concrete class that reprints the ellipsoidGate generated by flowClust</i>
-----------------------	--

Description

It stores priors and posteriors as well as the actual ellipsoidGate.

fcFilter-class	<i>a virtual class that represents the gating result generated by flowClust gating function</i>
----------------	---

Description

Basically it extends flowCore 'filter classes to have extra slot to store priors and posteriors

fcFilterList	<i>constructor for fcFilterList</i>
--------------	-------------------------------------

Description

constructor for fcFilterList

Usage

fcFilterList(x)

Arguments

x	list of fcFilter (i.e. fcPolygonGate or fcRectangleGate)
---	--

fcFilterList-class	<i>a class that extends filterList class.</i>
--------------------	---

Description

Each filter in the filterList must extends the fcFilter class

fcPolygonGate	<i>constructor for fcPolygonGate</i>
---------------	--------------------------------------

Description

constructor for fcPolygonGate

Usage

fcPolygonGate(x, priors, posts)

Arguments

x	a polygonGate object
priors	a list storing priors
posts	a list storing posteriors

fcPolygonGate-class *a concrete class that represents the polygonGate generated by flowClust*

Description

It stores priors and posteriors as well as the actual polygonGate.

fcRectangleGate *constructor for fcRectangleGate*

Description

constructor for fcRectangleGate

Usage

fcRectangleGate(x, priors, posts)

Arguments

x	a rectangleGate object
priors	a list storing priors
posts	a list storing posteriors

fcRectangleGate-class *a concrete class that represents the rectangleGate generated by flow-Clust*

Description

It stores priors and posteriors as well as the actual rectangleGate.

fcTree *constructor of fcTree*

Description

It adds an extra node data slot "fList"(which is a filterList object) to the gatingTemplate

Usage

fcTree(gt)

Arguments

gt	a gatingTemplate object
----	-------------------------

fcTree-class	<i>A class to represent a flowClust tree.</i>
--------------	---

Description

It is a graphNEL used as a container to store priors and posteriors for each flowClust gate that can be visualized for the purpose of fine-tuning parameters for flowClust algorithm

gate_flowclust_1d	<i>Applies flowClust to 1 feature to determine a cutpoint between the minimum cluster and all other clusters.</i>
-------------------	---

Description

We cluster the observations in fr into K clusters.

Usage

```
gate_flowclust_1d(
  fr,
  params,
  filterId = "",
  K = NULL,
  trans = 0,
  min.count = -1,
  max.count = -1,
  nstart = 1,
  prior = NULL,
  criterion = c("BIC", "ICL"),
  cutpoint_method = c("boundary", "min_density", "quantile", "posterior_mean",
    "prior_density"),
  neg_cluster = 1,
  cutpoint_min = NULL,
  cutpoint_max = NULL,
  min = NULL,
  max = NULL,
  quantile = 0.99,
  quantile_interval = c(0, 10),
  plot = FALSE,
  debug = FALSE,
  ...
)
```


Arguments

fr	a flowFrame object
params	character channel to be gated on
filterId	A character string that identifies the filter created.
K	the number of clusters to find
trans, min.count, max.count, nstart	some flowClust parameters. see flowClust
prior	list of prior parameters for the Bayesian flowClust . If NULL, no prior is used.
criterion	a character string stating the criterion used to choose the best model. May take either "BIC" or "ICL". This argument is only relevant when K is NULL or if length(K) > 1. The value selected is passed to flowClust .
cutpoint_method	How should the cutpoint be chosen from the fitted flowClust model? See Details.
neg_cluster	integer. The index of the negative cluster. The cutpoint is computed between clusters neg_cluster and neg_cluster + 1.
cutpoint_min	numeric value that sets a minimum threshold for the cutpoint. If a value is provided, any cutpoint below this value will be set to the given minimum value. If NULL (default), there is no minimum cutpoint value.
cutpoint_max	numeric value that sets a maximum threshold for the cutpoint. If a value is provided, any cutpoint above this value will be set to the given maximum value. If NULL (default), there is no maximum cutpoint value.
min	a numeric value that sets the lower bound for data filtering. If NULL (default), no truncation is applied.
max	a numeric value that sets the upper bound for data filtering. If NULL (default), no truncation is applied.
quantile	the quantile for which we will find the cutpoint using the quantile cutpoint_method. If the cutpoint_method is not set to quantile, this argument is ignored.
quantile_interval	a vector of length 2 containing the end-points of the interval of values to find the quantile cutpoint. If the cutpoint_method is not set to quantile, this argument is ignored.
plot	logical value indicating that the fitted flowClust model should be plotted along with the cutpoint
debug	logical indicating whether to carry the prior and posterior with the gate for debugging purpose. Default is FALSE.
...	additional arguments that are passed to flowClust

Details

By default, the cutpoint is chosen to be the boundary of the first two clusters. That is, between the first two cluster centroids, we find the midpoint between the largest observation from the first cluster and the smallest observations from the second cluster. Alternatively, if the cutpoint_method is min_density, then the cutpoint is the point at which the density between the first and second smallest cluster centroids is minimum.

Value

a rectangleGate object consisting of all values beyond the cutpoint calculated

Examples

```
## Not run:  
gate <- gate_flowclust_1d(fr, params = "APC-A", K = 2) # fr is a flowFrame  
  
## End(Not run)
```

gate_flowclust_2d	<i>Automatic identification of a population of interest via flowClust based on two markers</i>
-------------------	--

Description

We cluster the observations in `fr` into `K` clusters. We set the cutpoint to be the point at which the density between the first and second smallest cluster centroids is minimum.

Usage

```
gate_flowclust_2d(  
  fr,  
  xChannel,  
  yChannel,  
  filterId = "",  
  K = 2,  
  usePrior = "no",  
  prior = list(NA),  
  trans = 0,  
  min.count = -1,  
  max.count = -1,  
  nstart = 1,  
  plot = FALSE,  
  target = NULL,  
  transitional = FALSE,  
  quantile = 0.9,  
  translation = 0.25,  
  transitional_angle = NULL,  
  min = NULL,  
  max = NULL,  
  ...  
)
```

Arguments

fr	a flowFrame object
xChannel, yChannel	character specifying channels to be gated on
filterId	A character string that identifies the filter created.
K	the number of clusters to find
usePrior	Should we use the Bayesian version of <code>flowClust</code> ? Answers are "yes", "no", or "vague". The answer is passed along to <code>flowClust</code> .
prior	list of prior parameters for the Bayesian version of <code>flowClust</code> . If usePrior is set to no, then the list is unused.
trans, min.count, max.count, nstart	some flowClust parameters. see <code>flowClust</code>
plot	a logical value indicating if the fitted mixture model should be plotted. By default, no.
target	a numeric vector of length 2 (number of dimensions) containing the location of the cluster of interest. See details.
transitional	logical value indicating if a transitional gate should be constructed from the target <code>flowClust</code> cluster. By default, no.
quantile	the contour level of the target cluster from the <code>flowClust</code> fit to construct the gate
translation	a numeric value between 0 and 1 used to position a transitional gate if transitional = TRUE. This argument is ignored if transitional = FALSE. See details
transitional_angle	the angle (in radians) of the transitional gate. It is also used to determine which quadrant the final gate resides in. See details. Ignored if transitional = FALSE.
min	A vector of length 2. Truncate observations less than this minimum value. The first value truncates the xChannel, and the second value truncates the yChannel. By default, this vector is NULL and is ignored.
max	A vector of length 2. Truncate observations greater than this maximum value. The first value truncates the xChannel, and the second value truncates the yChannel. By default, this vector is NULL and is ignored.
...	additional arguments that are passed to <code>flowClust</code>

Details

The cluster for the population of interest is selected as the one with cluster centroid nearest the target in Euclidean distance. By default, the largest cluster (i.e., the cluster with the largest proportion of observations) is selected as the population of interest.

We also provide the option of constructing a transitional gate from the selected population of interest. The location of the gate can be controlled with the `translation` argument, which translates the gate along the major axis of the target cluster as a function of the appropriate chi-squared coefficient. The larger translation is, the more gate is shifted in a positive direction. Furthermore, the width of the transitional gate can be controlled with the `quantile` argument.

The direction of the transitional gate can be controlled with the `transitional_angle` argument. By default, it is `NULL`, and we use the eigenvector of the target cluster that points towards the first quadrant (has positive slope). If `transitional_angle` is specified, we rotate the eigenvectors so that the angle between the x-axis (with the cluster centroid as the origin) and the major eigenvector (i.e., the eigenvector with the larger eigenvalue) is `transitional_angle`. So based on range that the angle falls in, the final `rectangleGate` will be constructed at the corresponding quadrant. i.e. Clockwise, $[0, \pi/2]$ UR, $(\pi/2, \pi]$ LR, $(\pi, 3/2 * \pi]$ LL, $(3/2 * \pi, 2 * \pi]$ UL

Value

a `polygonGate` object containing the contour (ellipse) for 2D gating.

Examples

```
## Not run:
gate <- gate_flowclust_2d(fr, xChannel = "FSC-A", xChannel = "SSC-A", K = 3) # fr is a flowFrame

## End(Not run)
```

gate_mindensity	<i>Determines a cutpoint as the minimum point of a kernel density estimate between two peaks</i>
-----------------	--

Description

We fit a kernel density estimator to the cells in the `flowFrame` and identify the two largest peaks. We then select as the cutpoint the value at which the minimum density is attained between the two peaks of interest.

Usage

```
gate_mindensity(
  fr,
  channel,
  filterId = "",
  positive = TRUE,
  gate_range = NULL,
  min = NULL,
  max = NULL,
  peaks = NULL,
  ...
)
```

Arguments

fr	a <code>flowFrame</code> object
channel	TODO

filterId	TODO
positive	If TRUE, then the gate consists of the entire real line to the right of the cutpoint. Otherwise, the gate is the entire real line to the left of the cutpoint. (Default: TRUE)
gate_range	numeric vector of length 2. If given, this sets the bounds on the gate applied. If no gate is found within this range, we set the gate to the minimum value within this range if positive is TRUE and the maximum value of the range otherwise.
min	a numeric value that sets the lower boundary for data filtering
max	a numeric value that sets the upper boundary for data filtering
peaks	numeric vector. If not given, then perform peak detection first by .find_peaks
...	Additional arguments for peak detection.

Details

In the default case, the two peaks of interest are the two largest peaks obtained from the `link{density}` function.

In the special case that there is only one peak, we are conservative and set the cutpoint as the `min(x)` if `positive` is TRUE, and the `max(x)` otherwise.

Value

a `rectangleGate` object based on the minimum density cutpoint

Examples

```
## Not run:
gate <- gate_mindensity(fr, channel = "APC-A") # fr is a flowFrame

## End(Not run)
```

gate_mindensity2	<i>An improved version of mindensity used to determine a cutpoint as the minimum point of a kernel density estimate between two peaks.</i>
------------------	--

Description

Analogous to the original `openCyto::mindensity()`, `mindensity2` operates on a standard `flowFrame`. Its behavior is closely modeled on the original `mindensity()` whenever possible. However, the underlying peak-finding algorithm (`improvedMindensity`) behaves significantly differently.

Usage

```
gate_mindensity2(  
  fr,  
  channel,  
  filterId = "",  
  gate_range = NULL,  
  min = NULL,  
  max = NULL,  
  peaks = NULL,  
  ...  
)
```

Arguments

fr	a flowFrame object
channel	the channel to operate on
filterId	a name to refer to this filter
gate_range	numeric vector of length 2. If given, this sets the bounds on the gate applied.
min	a numeric value that sets the lower boundary for data filtering
max	a numeric value that sets the upper boundary for data filtering
peaks	numeric vector. If not given, then perform peak detection first by .find_peaks
...	Additional arguments for peak detection.

Value

a rectangleGate object based on the minimum density cutpoint

Author(s)

Greg Finak, Phu T. Van

Examples

```
## Not run:  
gate <- gate_mindensity2(fr, channel = "APC-A") # fr is a flowFrame  
  
## End(Not run)
```

gate_quad_sequential *sequential quadrant gating function*

Description

The order of 1d-gating is determined so that the gates better capture the distributions of flow data.

Usage

```
gate_quad_sequential(fr, channels, gFunc, min = NULL, max = NULL, ...)
```

Arguments

fr	flowFrame
channels	character two channels used for gating
gFunc	the name of the 1d-gating function to be used for either dimension
min	a numeric vector that sets the lower bounds for data filtering
max	a numeric vector that sets the upper bounds for data filtering
...	other arguments passed to <code>.find_peak</code> (e.g. 'num_peaks' and 'adjust'). see tailgate

Value

a filters that contains four rectangleGates

gate_quad_tmix *quadGate based on flowClust::tmixFiler*

Description

This gating method identifies two quadrants (first, and third quadrants) by fitting the data with tmixture model. It is particularly useful when the two markers are not well resolved thus the regular quadGate method based on 1d gating will not find the perfect cut points on both dimensions.

Usage

```
gate_quad_tmix(
  fr,
  channels,
  K,
  usePrior = "no",
  prior = list(NA),
  quantile1 = 0.8,
  quantile3 = 0.8,
```

```

    trans = 0,
    plot = FALSE,
    ...
)

```

Arguments

fr	flowFrame
channels	character vector specifies two channels
K	see gate_flowclust_2d
usePrior	see gate_flowclust_2d
prior	see gate_flowclust_2d
quantile1	numeric specifies the quantile level(see 'level' in flowClust) for the first quadrant (x-y+)
quantile3	numeric specifies the quantile level see 'level' in flowClust for third quadrant (x+y-)
trans	see gate_flowclust_2d
plot	logical whether to plot flowClust clustering results
...	other arguments passed to flowClust

Value

a filters object that contains four polygonGates following the order of (-+,++,+,-,-)

gate_quantile	<i>Determine the cutpoint by the events quantile.</i>
---------------	---

Description

It is possible that the cutpoint calculated by quantile function may not produce the exact the probability set by 'probs' argument if there are not enough cell events to reach that precision. Sometime the difference could be significant.

Usage

```

gate_quantile(
  fr,
  channel,
  probs = 0.999,
  plot = FALSE,
  filterId = "",
  min = NULL,
  max = NULL,
  ...
)

```


Arguments

fr	a flowFrame object
channel	the channel from which the cytokine gate is constructed
probs	probabilities passed to 'stats::quantile' function.
plot	whether to plot the gate result
filterId	the name of the filter
min	a numeric value that sets the lower boundary for data filtering
max	a numeric value that sets the upper boundary for data filtering
...	additional arguments passed to 'stats::quantile' function.

Value

a rectangleGate

Examples

```
## Not run:
gate <- gate_quantile(fr, Channel = "APC-A", probs = 0.995) # fr is a flowFrame

## End(Not run)
```

gate_singlet	<i>Creates a singlet polygon gate using the prediction bands from a robust linear model</i>
--------------	---

Description

We construct a singlet gate by applying a robust linear model. By default, we model the forward-scatter height (FSC-H) as a function of forward-scatter area (FSC-A). If sidescatter is given, forward-scatter height is as a function of $\text{area} + \text{sidescatter} + \text{sidescatter} / \text{area}$.

Usage

```
gate_singlet(
  x,
  area = "FSC-A",
  height = "FSC-H",
  sidescatter = NULL,
  prediction_level = 0.99,
  subsample_pct = NULL,
  wider_gate = FALSE,
  filterId = "singlet",
  maxit = 5,
  ...
)
```

Arguments

x	a <code>flowFrame</code> object
area	character giving the channel name that records the signal intensity as peak area
height	character giving the channel name that records the signal intensity as peak heightchannel name of height
sidescatter	character giving an optional channel name for the sidescatter signal. By default, ignored.
prediction_level	a numeric value between 0 and 1 specifying the level to use for the prediction bands
subsample_pct	a numeric value between 0 and 1 indicating the percentage of observations that should be randomly selected from x to construct the gate. By default, no subsampling is performed.
wider_gate	logical value. If TRUE, the prediction bands used to construct the singlet gate use the robust fitted weights, which increase prediction uncertainty, especially for large FSC-A. This leads to wider gates, which are sometimes desired.
filterId	the name for the filter that is returned
maxit	the limit on the number of IWLS iterations
...	additional arguments (not used)

Details

Because `r1m` relies on iteratively reweighted least squares (IRLS), the runtime to construct a singlet gate is dependent in part on the number of observations in `x`. To improve the runtime, we provide an option to subsample randomly a subset of `x`. A percentage of observations to subsample can be given in `subsample_pct`. By default, no subsampling is applied.

Value

a `polygonGate` object with the singlet gate

`gatingTemplate-class` *a class storing the gating method and population information in a `graphNEL` object*

Description

Each cell population is stored in graph node and is connected with its parent population or its reference node for `boolGate` or `refGate`.

It parses the csv file that specifies the gating scheme for a particular staining panel.

Usage

```
gatingTemplate(x, ...)

## S4 method for signature 'character'
gatingTemplate(
  x,
  name = "default",
  strict = TRUE,
  strip_extra_quotes = FALSE,
  ...
)

## S4 method for signature 'data.table'
gatingTemplate(
  x,
  name = "default",
  strict = TRUE,
  strip_extra_quotes = FALSE,
  ...
)
```

Arguments

<code>x</code>	character csv file name or a <code>data.table</code>
<code>...</code>	other arguments passed to <code>data.table::fread</code>
<code>name</code>	character the label of the gating template
<code>strict</code>	logical whether to perform validity check(special characters) on the alias column. By default it is(and should be) turned on for the regular template parsing. But sometime it is useful to turned it off to bypass the check for the dummy nodes(e.g. the csv template generated by <code>'gh_generate_template'</code> with some existing boolean gates that has <code>'!</code> or <code>':'</code> symbol).
<code>strip_extra_quotes</code>	logical Extra quotes are added to strings by <code>fread</code> . This causes problems with parsing R strings to expressions in some cases. Default FALSE for usual behaviour. TRUE should be passed if parsing <code>gating_args</code> fails.

Details

This csv must have the following columns:

`'alias'`: a name used label the cell population, the path composed by the alias and its precedent nodes (e.g. `/root/A/B/alias`) has to be uniquely identifiable. So alias can not contain `'/'` character, which is reserved as path delimiter.

`'pop'`: population patterns of `'+/-'` or `'+/-+/-'`, which tells the algorithm which side (postive or negative) of 1d gate or which quadrant of 2d gate to be kept.

`'parent'`: the parent population alias, its path has to be uniquely identifiable.

'dims': characters separated by comma specifying the dimensions(1d or 2d) used for gating. It can be either channel name or stained marker name (or the substrings of channel/marker names as long as they are uniquely identifiable.).

'gating_method': the name of the gating function (e.g. 'flowClust'). It is invoked by a wrapper function that has the identical function name prefixed with a dot.(e.g. '.flowClust')

'gating_args': the named arguments passed to gating function (Note that double quotes are often used as text delimiter by some csv editors. So try to use single quote instead if needed.)

'collapseDataForGating': When TRUE, data is collapsed (within groups if 'groupBy' specified) before gating and the gate is replicated across collapsed samples. When set FALSE (or blank),then 'groupBy' argument is only used by 'preprocessing' and ignored by gating.

'groupBy': If given, samples are split into groups by the unique combinations of study variable (i.e. column names of pData,e.g."PTID:VISITNO"). when split is numeric, then samples are grouped by every N samples

'preprocessing_method': the name of the preprocessing function(e.g. 'prior_flowclust'). It is invoked by a wrapper function that has the identical function name prefixed with a dot.(e.g. '.prior_flowclust') the preprocessing results are then passed to gating wrapper function through 'pps_res' argument.

'preprocessing_args': the named arguments passed to preprocessing function.

Examples

```
## Not run:
gt <- gatingTemplate(system.file("extdata/gating_template/tcell.csv",package = "openCyto"))
plot(gt)

## End(Not run)
```

getGate,fcTree,character-method
get gates saved in fcTree

Description

get gates saved in fcTree

Usage

```
## S4 method for signature 'fcTree,character'
getGate(obj, y, ...)
```

Arguments

obj	fcTree
y	character node name
...	other arguments (not used)

getNodes, fcTree-method
get nodes from fcTree

Description

get nodes from fcTree

Usage

```
## S4 method for signature 'fcTree'  
getNodes(x, y)
```

Arguments

x	fcTree
y	character node name

gh_generate_template *generate a partially complete csv template from the existing gating hierarchy*

Description

To ease the process of replicating the existing (usually a manual one) gating schemes, this function populate an empty gating template with the 'alias', 'pop', 'parent' and 'dims' columns that exacted from an GatingHierarchy, and leave the other columns (e.g. 'gating_method') blank. So users can make changes to that template instead of writing from scratch.

Usage

```
gh_generate_template(gh)
```

Arguments

gh	a GatingHierarchy likely parsed from a xml workspace
----	--

Value

a gating template in data.frame format that requires further edition after output to csv

Examples

```
library(flowWorkspace)  
dataDir <- system.file("extdata", package="flowWorkspaceData")  
gs <- load_gs(list.files(dataDir, pattern = "gs_manual", full = TRUE))  
gh_generate_template(gs[[1]])
```

```
groupBy,gtMethod-method
```

get the grouping variable for the gating method

Description

When specified, the flow data is grouped by the grouping variable (column names in pData). Within each group, when isCollapse is set to TRUE, the gating method is applied to the collapsed data. Otherwise, it is done independently for each individual sample(flowFrame). Grouping variable is also used by preprocessing method.

Usage

```
## S4 method for signature 'gtMethod'
groupBy(object)
```

Arguments

```
object          gtMethod
```

```
gs_add_gating_method  apply a gating method to the GatingSet
```

Description

When interacting with the existing gated data, this function provides an alternative way to interact with the GatingSet by supplying the gating description directly through arguments without the need to write the complete csv gating template.

Usage

```
gs_add_gating_method(
  gs,
  alias = "*",
  pop = "+",
  parent,
  dims = NA,
  gating_method,
  gating_args = NA,
  collapseDataForGating = NA,
  groupBy = NA,
  preprocessing_method = NA,
  preprocessing_args = NA,
  strip_extra_quotes = FALSE,
  ...
)
```

Arguments

gs GatingSet or GatingSetList

alias, pop, parent, dims, gating_method, gating_args,
collapseDataForGating, groupBy, preprocessing_method,
preprocessing_args
 see details in [gatingTemplate](#)

strip_extra_quotes
 logical Extra quotes are added to strings by fread. This causes problems with
 parsing R strings to expressions in some cases. Default FALSE for usual be-
 haviour. TRUE should be passed if parsing gating_args fails.

... other arguments

- mc.cores passed to multicore package for parallel computing
- parallel_type character specifying the parallel type. The valid options are "none", "multicore", "cluster".
- cl cluster object passed to parallel package (when parallel_type is "cluster")

Details

Calls to `gs_add_gating_method` can also be easily reversed with `gs_remove_gating_method`. Note, however, that it is not possible to differentiate between different `GatingSet` objects loaded from the same directory with `load_gs` within a session. Thus, to guarantee a clean history for `gs_remove_gating_method`, it is necessary to call `gs_add_gating_method_init` on the loaded `GatingSet` immediately after re-loading it. See the documentation for `gs_add_gating_method_init` for more details. This will not be an issue for `GatingSet` objects created directly using the constructor.

See Also

[gs_remove_gating_method](#) [gs_add_gating_method_init](#)

Examples

```
## Not run:
# add quad gates
gs_add_gating_method(gs, gating_method = "mindensity", dims = "CCR7,CD45RA", parent = "cd4-cd8+", pop = "CCR7+/-CD

# polyfunctional gates (boolean combinations of existing marginal gates)
gs_add_gating_method(gs, gating_method = "polyFunctions", parent = "cd8", gating_args = "cd8/IFNg:cd8/IL2:cd8/TNF

#boolGate method
gs_add_gating_method(gs, alias = "IL2orIFNg", gating_method = "boolGate", parent = "cd4", gating_args = "cd4/IL2|c

## End(Not run)
```

`gs_add_gating_method_init`

Clear history of `gs_add_gating_method` calls for a given GatingSet or GatingSetList

Description

Repeated calls to the `load_gs` method in the same session will yield indistinguishable objects that can result in overlapping history of `gs_add_gating_method` calls. This method allows for the history to be cleared if the user would like to reload the GatingSet and start fresh. Calling `gs_add_gating_method_init` without an argument will clear the entire `gs_add_gating_method` history.

Usage

```
gs_add_gating_method_init(gs)
```

Arguments

`gs` a GatingSet or GatingSetList. Can be omitted to clean entire `gs_add_gating_method` history.

Examples

```
## Not run:
# load in a GatingSet
gs <- load_gs(path)
# Add some nodes using gs_add_gating_method
gs_add_gating_method(gs, gating_method = "mindensity", dims = "CCR7,CD45RA", parent = "cd4-cd8+", pop = "CCR7+/-CD
gs_add_gating_method(gs, gating_method = "polyFunctions", parent = "cd8", gating_args = "cd8/IFNg:cd8/IL2:cd8/TNF
# Remove the effect of the last gs_add_gating_method call using gs_remove_gating_method (note that the first call's
gs_remove_gating_method(gs)
# Re-load the GatingSet to start over
gs <- load_gs(path)

# At this point, gs will still see the history of the first gs_add_gating_method call above
# which will cause problems for later calls to gs_remove_gating_method.
# To fix that, just call gs_add_gating_method_init() to start a clean history
gs_add_gating_method_init(gs)
# Now you can continue using gs_add_gating_method and gs_remove_gating_method from scratch
gs_add_gating_method(gs, gating_method = "mindensity", dims = "CCR7,CD45RA", parent = "cd4-cd8+", pop = "CCR7+/-CD

## End(Not run)
```

 gs_remove_gating_method

*Reverse the action of gating methods applied via
gs_add_gating_method*

Description

This function provides an easy way to remove the gates and nodes created by the most recent call to [gs_add_gating_method](#) on the specified GatingSet or GatingSetList, with a separate history being maintained for each such object. [gs_remove_gating_method](#) allows for repeated use, effectively serving as a multi-level undo function for [gs_add_gating_method](#).

Usage

```
gs_remove_gating_method(gs)
```

Arguments

gs The GatingSet or GatingSetList for which the most recent [gs_add_gating_method](#) call should be reversed.

See Also

[gs_add_gating_method](#) [gs_add_gating_method_init](#)

Examples

```
## Not run:
# add quad gates
gs_add_gating_method(gs, gating_method = "mindensity", dims = "CCR7,CD45RA", parent = "cd4-cd8+", pop = "CCR7+/-CD45RA")
# Remove the gates and nodes resulting from that gs_add_gating_method call
gs_remove_gating_method(gs)

## End(Not run)
```

 gtMethod-class

A class to represent a gating method.

Description

A gating method object contains the specifics for generating the gates.

Slots

- name** a character specifying the name of the gating method
- dims** a character vector specifying the dimensions (channels or markers) of the gate
- args** a list specifying the arguments passed to gating function
- groupBy** a character or integer specifying how to group the data. If character, group the data by the study variables (columns in pData). If integer, group the data by every N samples.
- collapse** a logical specifying whether to collapse the data within group before gating. it is only valid when groupBy is specified

Examples

```
## Not run:
gt <- gatingTemplate(system.file("extdata/gating_template/tcell.csv", package = "openCyto"))
gh_pop_get_gate(gt, '2', '3')

## End(Not run)
```

gtPopulation-class	<i>A class to represent a cell population that will be generated by a gating method.</i>
--------------------	--

Description

A class to represent a cell population that will be generated by a gating method.

Slots

- id** numeric unique ID that is consistent with node label of graphNEL in gating template
- name** character the name of population
- alias** character the more user friendly name of population

Examples

```
## Not run:
gt <- gatingTemplate(system.file("extdata/gating_template/tcell.csv", package = "openCyto"))

gt_get_nodes(gt, '2')

## End(Not run)
```

gtSubsets-class	<i>A class representing a group of cell populations.</i>
-----------------	--

Description

It extends gtPopulation class.

 gt_gating

Applies a gatingTemplate to a GatingSet.

Description

It loads the gating methods by topological order and applies them to GatingSet.

Usage

```
gt_gating(x, y, ...)
```

Arguments

- | | |
|-----|--|
| x | a gatingTemplate object |
| y | a GatingSet object |
| ... | <ul style="list-style-type: none"> • start a character that specifies the population (corresponding to 'alias' column in csv template) where the gating process will start from. It is useful to quickly skip some gates and go directly to the target population in the testing run. Default is "root". • stop.at a character that specifies the population (corresponding to 'alias' column in csv template) where the gating process will stop at. Default is NULL, indicating the end of gating tree. • keep.helperGates a logical flag indicating whether to keep the intermediate helper gates that are automatically generated by openCyto. Default is TRUE. • mc.cores passed to multicore package for parallel computing • parallel_type character specifying the parallel type. The valid options are "none", "multicore", "cluster". • cl cluster object passed to parallel package (when parallel_type is "cluster") |

Value

Nothing. As the side effect, gates generated by gating methods are saved in GatingSet.

Examples

```
## Not run:
gt <- gatingTemplate(file.path(path, "data/ICSemplate.csv"), "ICS")
gs <- GatingSet(fs) #fs is a flowSet/ncdfFlowSet
gt_gating(gt, gs)
gt_gating(gt, gs, stop.at = "v") #proceed the gating until population 'v'
gt_gating(gt, gs, start = "v") # start from 'v'
gt_gating(gt, gs, parallel_type = "multicore", mc.cores = 8) #parallel gating using multicore
#parallel gating by using cluster
cl1 <- makeCluster (8, type = "MPI")
gt_gating(gt, gs, parallel_type = "cluster", cl = cl1)
```

```
stopCluster ( cl1 )
## End(Not run)
```

```
gt_get_children      get children nodes
```

Description

get children nodes

Usage

```
gt_get_children(obj, y)
```

Arguments

```
obj      gatingTemplate
y        character parent node path
```

Examples

```
## Not run:
gt <- gatingTemplate(system.file("extdata/gating_template/tcell.csv", package = "openCyto"))

gt_get_nodes(gt, "/nonDebris")
gt_get_children(gt, "/nonDebris")

## End(Not run)
```

```
gt_get_gate          get gating method from the node
```

Description

get gating method from the node

Usage

```
gt_get_gate(obj, y, z)
```

Arguments

```
obj      gatingTemplate
y        character parent node path
z        character child node path
```

Examples

```
## Not run:
gt <- gatingTemplate(system.file("extdata/gating_template/tcell.csv", package = "openCyto"))
gt_get_nodes(gt, only.names = TRUE)
gt_get_nodes(gt, "/nonDebris")
gt_get_children(gt, "/nonDebris")
gt_get_gate(gt, "/nonDebris", "/nonDebris/singlets")

## End(Not run)
```

gt_get_nodes	<i>get nodes from gatingTemplate object</i>
--------------	---

Description

get nodes from [gatingTemplate](#) object

Usage

```
gt_get_nodes(
  x,
  y,
  order = c("default", "bfs", "dfs", "tsort"),
  only.names = FALSE
)
```

Arguments

x	<code>gatingTemplate</code>
y	character node index. When missing, return all the nodes
order	character specifying the order of nodes. options are "default", "bfs", "dfs", "tsort"
only.names	logical specifying whether user wants to get the entire gtPopulation object or just the name of the population node

Examples

```
## Not run:
gt <- gatingTemplate(system.file("extdata/gating_template/tcell.csv", package = "openCyto"))
gt_get_nodes(gt)[1:2]
gt_get_nodes(gt, only.names = TRUE)
gt_get_nodes(gt, "/nonDebris")

## End(Not run)
```

gt_get_parent	<i>get parent nodes</i>
---------------	-------------------------

Description

get parent nodes

Usage

```
gt_get_parent(obj, y, isRef = FALSE)
```

Arguments

obj	gatingTemplate
y	character child node path
isRef	logical whether show the reference node besides the parent node

Examples

```
## Not run:  
gt <- gatingTemplate(system.file("extdata/gating_template/tcell.csv", package = "openCyto"))  
  
gt_get_nodes(gt, "/nonDebris")  
gt_get_parent(gt, "/nonDebris/singlets")  
  
## End(Not run)
```

gt_list_methods	<i>Print a list of the registered gating methods</i>
-----------------	--

Description

Print a list of the registered gating methods

Usage

```
gt_list_methods()
```

Value

Does not return anything. Prints a list of the available gating methods.

gt_toggle_helpergates *toggle/delete the hidden flag of the helper gates*

Description

The helper gates are defined as the referred gates in csv template. And all the children of referred gates are also referred gates thus they are considered the helper gates and can usually be hidden to simply the final gating tree.

Usage

```
gt_toggle_helpergates(gt, gs)
```

```
gt_get_helpergates(gt, gs)
```

```
gt_delete_helpergates(gt, gs)
```

Arguments

gt	gatingTemplate object
gs	GatingSet

Details

Note that delete action is NOT reversible.

Examples

```
## Not run:  
gt <- gatingTemplate(gtFile)  
#run the gating  
gt_gating(gt, gs)  
#hide the gates that are not of interest  
gt_toggle_helpergates(gt, gs)  
#or simply remove them if you are sure they will not be useful in future  
gt_delete_helpergates(gt, gs)  
  
## End(Not run)
```

isCollapse,gtMethod-method

get the flag that determines whether gating method is applied on collapsed data

Description

When TRUE, the flow data(multiple flowFrames) is collapsed into one and the gating method is applied on the collapsed data. Once the gate is generated, it is then replicated and applied to the each single flowFrame.

Usage

```
## S4 method for signature 'gtMethod'
isCollapse(object)
```

Arguments

object gtMethod

Value

logical

names,gtMethod-method *get gating method name*

Description

get gating method name

Usage

```
## S4 method for signature 'gtMethod'
names(x)
```

Arguments

x gtMethod

Examples

```
## Not run:
gt <- gatingTemplate(system.file("extdata/gating_template/tcell.csv", package = "openCyto"))

gtMthd <- gt_get_gate(gt, "/nonDebris/singlets", "/nonDebris/singlets/lymph")
names(gtMthd)
dims(gtMthd)
parameters(gtMthd)
isCollapse(gtMthd)
groupBy(gtMthd)

gtPop <- gt_get_nodes(gt, "/nonDebris/singlets/lymph/cd3/cd4+cd8-/CD38+")
names(gtPop)
alias(gtPop)

## End(Not run)
```

names.gtPopulation-method

get population name

Description

get population name

Usage

```
## S4 method for signature 'gtPopulation'
names(x)
```

Arguments

x gtPopulation object

ocRectangleGate-class *the class that carries event indices as well*

Description

the class that carries event indices as well

ocRectRefGate	<i>constructor for ocRectRefGate</i>
---------------	--------------------------------------

Description

constructor for ocRectRefGate

Usage

```
ocRectRefGate(rectGate, boolExprs)
```

Arguments

rectGate	rectangleGate
boolExprs	character boolean expression of reference nodes

ocRectRefGate-class	<i>special gate type that mix the rectangleGate with boolean gate</i>
---------------------	---

Description

special gate type that mix the rectangleGate with boolean gate

openCyto	<i>Hierarchical Gating Pipeline for flow cytometry data</i>
----------	---

Description

Hierarchical Gating Pipeline for flow cytometry data.

Details

openCyto is a package designed to facilitate the automated gating methods in sequential way to mimic the manual gating strategy.

Package:	openCyto
Type:	Package
Version:	1.2.8
Date:	2014-04-10
License:	GPL (>= 2)
LazyLoad:	yes

Author(s)

Mike Jiang <wjiang2@fhcrc.org>, John Ramey <jramey@fhcrc.org>, Greg Finak <gfinak@fhcrc.org>
Maintainer: Mike Jiang <wjiang2@fhcrc.org>

See Also

See [gt_gating](#), [gate_flowclust_1d](#), for an overview of gating functions.

Examples

```
## Not run: gatingTemplate('test.csv')
```

openCyto-deprecated *Deprecated functions in package openCyto.*

Description

add_pop -> [gs_add_gating_method](#)
add_pop_init -> [gs_add_gating_method_init](#)
prior_flowClust -> [prior_flowclust](#)
templateGen -> [gh_generate_template](#)
gate_flowClust_1d -> [gate_flowclust_1d](#)
gate_flowClust_2d -> [gate_flowclust_2d](#)
quantileGate -> [gate_quantile](#)
quadGate.seq -> [gate_quad_sequential](#)
quadGate.tmix -> [gate_quad_tmix](#)
gating -> [gt_gating](#)
getNode -> [gt_get_nodes](#)
getChildren -> [gt_get_children](#)
getParent -> [gt_get_parent](#)
getGate -> [gt_get_gate](#)
listgtMethods -> [gt_list_methods](#)
registerPlugins -> [register_plugins](#)
remove_pop -> [gs_remove_gating_method](#)
toggle.helperGates -> [gt_toggle_helpergates](#)
get.helperGates -> [gt_get_helpergates](#)
delete.helperGates -> [gt_delete_helpergates](#)

openCyto.options *Some global options for openCyto See examples for the meaning of these options and how to get/set them.*

Description

Get/set some global options for openCyto

Examples

```
opt <- getOption("openCyto")
#the threshold of minimum cell events required for the gating algorithm to proceed
opt[["gating"]][["minEvents"]]
#to change the threshold
opt[["gating"]][["minEvents"]] <- 100
options(openCyto = opt)

#switch off the validity check flags(Not recommended)
opt[["check.pop"]] <- FALSE
options(openCyto = opt)
```

parameters.gtMethod-method
get parameters of the gating method/function

Description

get parameters of the gating method/function

Usage

```
## S4 method for signature 'gtMethod'
parameters(object)
```

Arguments

object gtMethod

```
plot,fcFilterList,ANY-method
      plot a fcFilterList
```

Description

It is usually called by plot method for fcTree instead of directly by users.

Usage

```
## S4 method for signature 'fcFilterList,ANY'
plot(
  x,
  y,
  samples = NULL,
  posteriors = FALSE,
  xlim = NULL,
  ylim = NULL,
  node = NULL,
  data = NULL,
  breaks = 20,
  lwd = 1,
  ...
)
```

Arguments

x	fcFilterList
y	character channel name
samples	character a vector of sample names to be plotted
posteriors	logical indicating whether posteriors should be plotted
xlim, ylim	scale settings for x,y axes
node	character population name associated with the fcFilterList
data	GatingSet object
breaks	passed to hist
lwd	line width
...	other arguments passed to base plot

Examples

```
## Not run:
env1<-new.env(parent=emptyenv())
#gt is a gatingTemplate, gs is a GatingSet
gt_gating(gt,gs,env1) #the flowClust gating results are stored in env1
plot(env1$fct,"nonDebris",post=T) #plot the priors as well as posteriors for the "nonDebris" gate
```

```
## End(Not run)
```

```
plot,fcTree,character-method
plot the flowClust gating results
```

Description

This provides the priors and posteriors as well as the gates for the purpose of debugging flowClust gating algorithm

Usage

```
## S4 method for signature 'fcTree,character'
plot(x, y, channel = NULL, data = NULL, ...)
```

Arguments

x	fcTree
y	character node name in the fcTree
channel	character specifying the channel.
data	GatingSet that the fcTree is associated with
...	other arguments

```
plot,gatingTemplate,missing-method
plot the gating scheme
```

Description

plot the gating scheme using Rgraphviz

Usage

```
## S4 method for signature 'gatingTemplate,missing'
plot(x, y, ...)
```

Arguments

x gatingTemplate object

y either character specifying the root node which can be used to visualize only the subgraph or missing which display the entire gating scheme

... other arguments

graphAttr, nodeAttr: graph rendering attributes passed to [renderGraph](#) showRef logical: whether to display the reference gates. Sometime it maybe helpful to hide all those reference gates which are not the cell population of interest and used primarily for generating other population nodes.

Examples

```
## Not run:
gt <- gatingTemplate(system.file("extdata/gating_template/tcell.csv", package = "openCyto"))
plot(gt) #plot entire tree
plot(gt, "lymph") #only plot the subtree rooted from "lymph"

## End(Not run)
```

polyFunctions-class *A class to represent a polyFunctions gating method.*

Description

It extends boolMethod class and will be expanded to multiple boolMethod object.

pop_add.ocRectangleGate
bypass the default flowWorkspace:::addGate

Description

to support adding gate along with indices without loading flow data and computing
to support adding rectangleGate yet gating through boolean operations without loading flow data

Usage

```
## S3 method for class 'ocRectangleGate'
pop_add(gate, gh, recompute, ...)
```

```
## S3 method for class 'ocRectRefGate'
pop_add(gate, gh, recompute, ...)
```

Arguments

gate	ocRectangleGate or logicalFilterResult
gh	GatingHierarchy see add in flowWorkspace package
recompute	logical see add in flowWorkspace package
...	see add in flowWorkspace package

Details

however it is proven that logical indices are too big to be efficiently passed around

posteriors,fcFilter,ANY-method
get posteriors from a fcFilter object

Description

get posteriors from a fcFilter object

Usage

```
## S4 method for signature 'fcFilter,ANY'
posteriors(x, y = "missing")
```

Arguments

x	fcFilter
y	character or missing that specify which channel to look for

ppMethod,gatingTemplate,character-method
get preprocessing method from the node

Description

get preprocessing method from the node

Usage

```
## S4 method for signature 'gatingTemplate,character'
ppMethod(obj, y, z)
```


Arguments

obj	gatingTemplate
y	character parent node path
z	character child node path

Examples

```
## Not run:
gt <- gatingTemplate(system.file("extdata/gating_template/tcell.csv", package = "openCyto"))
ppMethod(gt, "/nonDebris/singlets", "/nonDebris/singlets/lymph")

## End(Not run)
```

ppMethod-class	<i>A class to represent a preprocessing method.</i>
----------------	---

Description

It extends gtMethod class.

Examples

```
## Not run:
gt <- gatingTemplate(system.file("extdata/gating_template/tcell.csv", package = "openCyto"))
ppMethod(gt, '3', '4')

## End(Not run)
```

preprocessing, ppMethod, GatingSet-method	<i>apply a ppMethod to the GatingSet</i>
---	--

Description

apply a [ppMethod](#) to the GatingSet

Usage

```
## S4 method for signature 'ppMethod,GatingSet'
preprocessing(x, y, ...)
```

Arguments

x	ppMethod
y	GatingSet or GatingSetList
...	other arguments

priors, fcFilter, ANY-method
get priors from a fcFilter object

Description

get priors from a fcFilter object

Usage

```
## S4 method for signature 'fcFilter,ANY'
priors(x, y = "missing")
```

Arguments

x	fcFilter object
y	character specifying channel name. if missing then extract priors for all the channels

prior_flowclust *Elicits data-driven priors from a flowSet object for specified channels*

Description

We elicit data-driven prior parameters from a flowSet object for specified channels. For each sample in the flowSet object, we apply the given prior_method to elicit the priors parameters.

Usage

```
prior_flowclust(
  flow_set,
  channels,
  prior_method = c("kmeans"),
  K = 2,
  nu0 = 4,
  w0 = c(10, 10),
  shrink = 1e-06,
  ...
)
```

Arguments

flow_set	a flowSet object
channels	a character vector containing the channels in the flowSet from which we elicit the prior parameters for the Student's t mixture
prior_method	the method to elicit the prior parameters
K	the number of mixture components to identify
nu0	prior degrees of freedom of the Student's t mixture components.
w0	the number of prior pseudocounts of the Student's t mixture components. (only the first element is used and the rest is ignored at the moment)
shrink	the amount of eigenvalue shrinkage to add in the case the prior covariance matrices are singular. See details.
...	Additional arguments passed to the prior elicitation method selected

Details

Currently, we have implemented only two methods. In the case that one channel is given, we use the kernel-density estimator (KDE) approach for each sample to obtain K peaks from which we elicit prior parameters. Otherwise, if more than one channel is specified, we apply K-Means to each of the samples in the flowSet and aggregate the clusters to elicit the prior parameters.

In the rare case that a prior covariance matrix is singular, we shrink the eigenvalues of the matrix slightly to ensure that it is positive definite. For instance, if the flow_set has two samples, this case can occur. The amount of shrinkage is controlled in shrink.

Value

list of the necessary prior parameters

Examples

```
## Not run:
library(flowCore)
data(GvHD)
prior_flowclust(GvHD[1:3], c("FSC-H", "SSC-H"))

## End(Not run)
```

refGate-class	<i>A class to represent a reference gating method.</i>
---------------	--

Description

It extends gtMethod class.

Slots

refNodes character specifying the reference nodes

register_plugins	<i>Register a gating or preprocessing function with OpenCyto</i>
------------------	--

Description

Function registers a new gating or preprocessing method with openCyto so that it may be used in the csv template.

Usage

```
register_plugins(fun = NA, methodName, dep = NA, ...)
```

Arguments

fun	function to be registered
methodName	character name of the gating or preprocessing method
dep	character name of the library dependency required for the plugin method to work.
...	other arguments type character specifying the type of registering method. Should be either "gating" or "preprocessing".

Details

The fun argument should be a wrapper function definition for the gating or preprocessing method. Gating method must have formal arguments:

fr a flowFrame

pp_res a pre-processing result

xChannel character (optional)

yChannel character (required)

filterId character

... ellipses for the additional parameters.

Preprocessing method must have formal arguments:

fs a flowSet that stores the flow data (could be subgrouped data if groupBy column is defined in the csv template)

gs a GatingSet

gm a gtMethod object that stores the information from gating method

xChannel character (required)

yChannel character (required)

... ellipses for the additional parameters.

The gating function must return a filter (i.e. polygonGate or other instance) from flowCore. The preprocessing can return anything and it will be passed on to the gating function. So it is up to gating function to use and interpret the results of preprocessing. Not all formal parameters need to be used. Additional arguments are passed via the ... and can be processed in the wrapper

Value

logical TRUE if successful and prints a message. FALSE otherwise.

```
robust_m_estimator    rewrite huber estimator
```

Description

rewrite huber estimator

Usage

```
robust_m_estimator(x, sd)
```

```
show, boolMethod-method    show method for boolMethod
```

Description

show method for boolMethod

Usage

```
## S4 method for signature 'boolMethod'
show(object)
```

Arguments

```
object          boolMethod
```

```
show, fcFilter-method    show method for fcFilter
```

Description

show method for fcFilter

Usage

```
## S4 method for signature 'fcFilter'
show(object)
```

Arguments

```
object          fcFilter show method for fcFilter
```

show,gatingTemplate-method
show method for gatingTemplate

Description

show method for gatingTemplate

Usage

```
## S4 method for signature 'gatingTemplate'  
show(object)
```

Arguments

object gatingTemplate

show,gtMethod-method *show method for gtMethod*

Description

show method for gtMethod

Usage

```
## S4 method for signature 'gtMethod'  
show(object)
```

Arguments

object gtMethod show method for gtMethod

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