

# Package ‘Heatplus’

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**Title** Heatmaps with row and/or column covariates and colored clusters

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**Description** Display a rectangular heatmap (intensity plot) of a data matrix. By default, both samples (columns) and features (row) of the matrix are sorted according to a hierarchical clustering, and the corresponding dendrogram is plotted. Optionally, panels with additional information about samples and features can be added to the plot.

**Imports** graphics, grDevices, stats, RColorBrewer

**Suggests** Biobase, hgu95av2.db, limma

**biocViews** Microarray, Visualization

**License** GPL (>= 2)

**URL** <https://github.com/alexploner/Heatplus>

**BugReports** <https://github.com/alexploner/Heatplus/issues>

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| annHeatmap | <i>Annotated heatmaps</i> |
|------------|---------------------------|

---

## Description

Creating heatmaps with annotated columns

## Usage

```
annHeatmap(x, ...)

## Default S3 method:
annHeatmap(
  x,
  annotation,
  dendrogram = list(clustfun = hclust, distfun = dist, Col = list(status = "yes"), Row
    = list(status = "hidden")),
  cluster = NULL,
  labels = NULL,
  legend = TRUE,
  ...
)

## S3 method for class 'ExpressionSet'
annHeatmap(x, ...)
```

## Arguments

|            |  |
|------------|--|
| x          | either a numerical matrix with the data for the central heatmap (for the default method) or an object of class ExpressionSet   |
| ...        | extra options passed to annHeatmap2  |
| annotation | a data frame containing the annotation for the columns of x  |
| dendrogram | a list controlling the options for row- and column dendrogram, see annHeatmap2   |
| cluster    | a list controlling the options for clustering rows and columns of x, see annHeatmap2   |
| labels     | a list controlling the row- and column labels as well as their location and size, see annHeatmap2  |
| legend     | either a logical value, indicating whether to draw a legend at the default location determined by the function, or one of the sides of the plot (1-4), see annHeatmap2 |

## Details

These functions generate an object representing the heatmap; in order to produce graphical output, you have to invoke the plot method, see Examples.

## Value

An object of class annHeatmap

## Warning

These are currently simple convenience functions that allow quick plotting, but little control over the finer details. This may change in the future, but for now, if you want to do anything fancy, you should invoke annHeatmap2 directly.

## See Also

[annHeatmap2](#), [plot.annHeatmap](#)

## Examples

```
## Default method
set.seed(219)
mat = matrix(rnorm(100), ncol=5)
ann = data.frame(Class=c("A", "A", "B", "A", "B"))
map1 = annHeatmap(mat, ann)
plot(map1)

## Expression set
require(Biobase)
data(sample.ExpressionSet)
map2 = annHeatmap(sample.ExpressionSet)
plot(map2)
```

---

annHeatmap2

*Annotated heatmaps*


---

### Description

This function plots a data matrix as intensity heatmap, with optional dendrograms, annotation panels and clustering for both rows and columns. This is the actual working function called by numerous wrappers.

### Usage

```
annHeatmap2(
  x,
  dendrogram,
  annotation,
  cluster,
  labels,
  scale = c("row", "col", "none"),
  breaks = 256,
  col = g2r.colors,
  legend = FALSE
)
```

### Arguments

|            |   |
|------------|---|
| x          | the numerical matrix to be shown as heatmap   |
| dendrogram | a list that controls how row- and column diagrams are determined and displayed  |
| annotation | a list that controls the data and the way it is shown in row- and column annotation panels  |
| cluster    | a list that controls how many clusters are chosen, and how these clusters are labelled and colored  |
| labels     | a list that controls the row- and column labels, as well as their size and placement  |
| scale      | a character string indicating how the matrix x is standardized (by row, by column or not at all). This affects only display, not dendrograms or clustering  |
| breaks     | specifies the interval breaks for displaying the data in x; either a vector of explicit interval breaks, or just the desired number of intervals. See niceBreaks for details.   |
| col        | specifies a palette of colors for the heatmap intensities; either a vector of explicit color definitions (one less than breaks) or a palette function. See breakColors.   |
| legend     | whether and where to draw a legend for the colors/intervals in the heatmap. If TRUE, a legend is placed in a position determined by the function to be suitable; alternatively, integer values 1-4 indicate the side where the legend is to be drawn; and FALSE indicates that no legend should be drawn. |

## Details

Arguments `scale`, `breaks`, `col` and `legend` control different aspects of the whole plot directly as described. Arguments `dendrogram`, `annotation`, `cluster` and `labels` control aspects that may differ for the rows and columns of the central heatmap and have a special structure: each is a named list with different entries controlling e.g. the look of a dendrogram, the data for annotation etc. Additionally, they can contain two extra entries called simply `Row` and `Col`; these are again named lists that can contain all the same entries as the parent list. Entries specified directly in the list apply to both rows and columns; entries specified as part of `Row` or `Col` override these defaults for the rows or columns only.

Recognized parameters for argument `dendrogram`:

**clustfun** the clustering function for generating the dendrogram; defaults to `hclust` for rows and columns

**distfun** a function that returns the pairwise distances between samples/features as an object of class `dist`; defaults to `dist` for rows and columns

**status** a string that controls the display of the dendrogram: `yes` means use the dendrogram to re-order the rows/columns and display the dendrogram; `hidden` means re-order, but do not display; `no` means do not use the dendrogram at all.

**lwd** the line width of the branches of the dendrogram; defaults to 3.

**dendro** an override argument that allows to pass in a dendrogram directly, bypassing the `clustfun` and `distfun` mechanism; defaults to `NULL` (i.e. is not used)

Recognized entries for argument `annotation`:

**data** a data frame containing the annotation data; defaults to `NULL`, i.e. no annotation is displayed

**control** a list of fine-tuning parameters that is passed directly to `picketPlot`; defaults to an empty list, i.e. the default settings in `picketPlot`

**asIs** logical value indicating whether the annotation data needs to be pre-processed via `convAnnData` or not; defaults to `TRUE`

**inclRef** logical value indicating whether to include all levels of factor variables in `data`, or whether to drop the reference level (i.e. the first level). Defaults to `TRUE`

Recognized entries for argument `cluster`:

**cuth** the height at which to cut through the dendrogram to define groups of similar features/samples; defaults to `NULL`, i.e. no cutting

**label** labels for the clusters; defaults to `NULL`, i.e. no labels

**col** colors for the different clusters; the colors are used for coloring both the sub-trees of the dendrogram and the corresponding area in the annotation plot (if there is one). This is either a vector of colors, or a palette function that takes a number and returns a vector of colors of the specified length; defaults to `BrewerClusterCol`

**grp** an override argument that directly specifies group memberships for the features/samples, completely bypassing the whole dendrogram and `cuth` mechanism. This probably only works for `dendrogram$status="no"`.

Recognized entries for argument `labels`:

- cex** size of the text for the labels; defaults to NULL, i.e. use a hard-coded default guess
- nrow** amount of space available for the labels between the central heatmap and the dendrogram, expressed as lines of text; defaults to 3.
- side** side at which to draw the labels, coded as integer between 1 and 4 in the usual way (1 = below the plot, continuing clockwise). A common default for rows and columns does not make sense: rows only work with 2 and 4, columns only with 1 and 3. Defaults try to make use of empty space, depending on the presence of a dendrogram.
- labels** labels for rows and columns; defaults to NULL, i.e. using the row- and column names of `x`. Note that these labels are applied *after* re-sorting rows and columns as per dendrogram, so these have to be already sorted accordingly. If you want to change the labels *before* re-sorting, it is easier to re-set the row- and/or column names of `x`.

### Value

An object of class `annHeatmap`. Use `plot` to display it graphically.

### See Also

[heatmapLayout](#), [niceBreaks](#), [breakColors](#), [g2r.colors](#), [BrewerClusterCol](#)

### Examples

```
require(Biobase)
data(sample.ExpressionSet)
ex1 = sample.ExpressionSet[51:85,]
map1 = annHeatmap2(exprs(ex1), ann=list(Col=list(data=pData(ex1))),
                  cluster=list(Col=list(cuth=3000)))
plot(map1)
```

---

breakColors

*Color palette for (symmetric) breaks*

---

### Description

Given a vector of breaks specifying a set of intervals, this function provides a vector of colors for the indicating the intervals graphically. If the intervals are arranged symmetrically around a specified value, the colors try to reflect this.

### Usage

```
breakColors(breaks, colors, center = 0, tol = 0.001)
```

**Arguments**

|        |   |
|--------|---|
| breaks | a vector of breaks  |
| colors | either an explicit vector of colors, or a palette function that takes a number and returns a vector of colors |
| center | optional center around which to check for symmetry  |
| tol    | tolerance (as relative error) for deviation from mathematically exact symmetry                                |

**Details**

The meaning of symmetrical is rather generous here: it is enough that the intervals specified by breaks are of equal length and that center is one of the breaks. This means we allow for more or less intervals on one side of center.

This really only works well if colors is specified as `g2r.colors`, which returns a symmetrical color vector (from green to red) if an even number of colors is requested. The whole point is then that if there are more classes to one side of center than to the other, this will be reflected by deeper shades of red or green on the appropriate side.

**Value**

A vector of colors, of length one less than the number of breaks.

**See Also**

[g2r.colors](#)

**Examples**

```
## Fully symmetrical breaks
br1 = (-3) : 3
co1 = breakColors(br1, g2r.colors)
co1
doLegend(br1, co1, 1)

## Truncated on one side
br2 = (-2) : 4
co2 = breakColors(br2, g2r.colors)
co2
doLegend(br2, co2, 1)

## Does not work with other color schemes
co3 = breakColors(br2, heat.colors)
co3
doLegend(br2, co3, 1)
```

---

BrewerClusterCol      *Color scheme for clusters*

---

### Description

This function returns a color vector based on one of the qualitative palettes supported by RColorBrewer. This allows visually distinct coloring of clusters and ensures sure that adjacent clusters have different colors.

### Usage

```
BrewerClusterCol(n, name = "Pastell1")
```

### Arguments

|      |  |
|------|--|
| n    | desired number of colors   |
| name | name of the qualitative palette from which colors are taken, see <a href="#">brewer.pal.info</a> |

### Details

This is just a wrapper for [brewer.pal](#) that checks that the specified palette is qualitative, and allows for an arbitrary number of colors: for less than three colors, it just returns the first and second colors of the palette; for more than `maxcolors` colors, it recycles the basic palette as often as required. This is ok, because the main point is to have different colors for neighboring clusters.

### Value

A character vector of length n of hexadecimal color codes.

### See Also

[brewer.pal](#)

### Examples

```
## A Color Wheel: default palette with maximum number of colors
pie(rep(1,9), col=BrewerClusterCol(9))

## Double the number of colors
pie(rep(1,18), col=BrewerClusterCol(18))

## Only two clusters/colors
pie(rep(1,2), col=BrewerClusterCol(2))

## Different qualitative palette: stronger colors
pie(rep(1,12), col=BrewerClusterCol(12, "Paired"))
```



---

`convAnnData`*Converting data frames for display as annotation*

---

### Description

Converts a data frames for display as annotation in a heatmap. This is mostly intended as an internal function, but might be useful for finetuning an annotation data frame manually.

### Usage

```
convAnnData(x, nval.fac = 3, inclRef = TRUE, asIs = FALSE)
```

### Arguments

|                       |   |
|-----------------------|---|
| <code>x</code>        | the data frame to be converted  |
| <code>nval.fac</code> | lower limit for unique values in numerical variables  |
| <code>inclRef</code>  | logical value indicating whether to include the reference level among the dummy variables for factors   |
| <code>asIs</code>     | logical value indicating whether to perform a conversion; if TRUE, the input <code>x</code> is simply returned, provided it is a numerical matrix (otherwise, the function stops with an error message) |

### Details

Logical variables are converted to factors. So are numerical variables with less than `nval.fac` unique values.

### Value

`convAnnData` returns the converted data frame, which is a numerical matrix

### See Also

[annHeatmap2](#)

### Examples

```
data(mtcars)
summary(mtcars)
summary(convAnnData(mtcars))
summary(convAnnData(mtcars, nval.fac=2))
summary(convAnnData(mtcars, nval.fac=2, inclRef=FALSE))
```

---

`doLegend`*A simple legend*

---

**Description**

Add a simple legend in form of a color bar to a plot.

**Usage**

```
doLegend(breaks, col, side)
```

**Arguments**

|                     |  |
|---------------------|--|
| <code>breaks</code> | a vector of breaks defining a set of intervals for the data  |
| <code>col</code>    | a vector of colors corresponding to the intervals.   |
| <code>side</code>   | integer between 1 and 4, indicating on which side of the main plot the legend is supposed to be drawn. Standard interpretation: 1 = below, continuing clockwise. |

**Details**

This is an extremely simple way of giving a visual impression of what numerical values correspond to a given color. The actual plot is done via a call to [image](#) and [axis](#).

**Value**

The locations of the ticks returned by the call to [axis](#)

**See Also**

[plot.annHeatmap](#), [niceBreaks](#), [g2r.colors](#)

**Examples**

```
## Set up data
doLegend(1:9, g2r.colors(8), 2)
```

---

`g2r.colors`*Palette from green to red via black*

---

**Description**

Returns a color vector of the requested length, ranging from pure red to pure green via slightly tinted black.

**Usage**

```
g2r.colors(n = 12, min.tinge = 0.33)
```

**Arguments**

|                        |   |
|------------------------|---|
| <code>n</code>         | the number of requested colors  |
| <code>min.tinge</code> | the proportion of red/green added to black to make it recognizably green or red |

**Details**

If `n` is even, the colors range from pure green to green-tinted black to red-tinted black to pure red. If `n` is odd, the colors range from pure red to pure green, with full black for the median class.

**Value**

A vector of (RGB-) colors of the specified length

**See Also**

[breakColors](#)

**Examples**

```
## Even number: residual tint shows left/right of center
co_even = g2r.colors(10)
co_even
doLegend(1:11, co_even, 1)

## Odd number: central class all black
co_odd = g2r.colors(9)
co_odd
doLegend(1:10, co_odd, 1)

## Lighter tint in the middle
co_light = g2r.colors(10, min.tinge=0.50)
co_light
doLegend(1:11, co_light, 1)
```

---

|               |   |
|---------------|---|
| heatmapLayout | <i>Generate a layout for an (annotated) heatmap</i> |
|---------------|---|

---

### Description

Generate a layout for an (annotated) heatmap. This function will generally not be called directly, but only via `annHeatmap2`.

### Usage

```
heatmapLayout(dendrogram, annotation, leg.side = NULL, show = FALSE)
```

### Arguments

|                         |   |
|-------------------------|---|
| <code>dendrogram</code> | A list with named entries <code>Row</code> and <code>Col</code> . Each of these is a list with a named entry <code>status</code> . If the value of <code>status</code> is the string "yes", space will be set aside for drawing a row- and/or column dendrogram.  |
| <code>annotation</code> | A list with named entries <code>Row</code> and <code>Col</code> . Each of these is a list with a named entry <code>data</code> . If the value of <code>data</code> is not <code>NULL</code> , space will be set aside for a picket plot showing the row- and/or column annotation.  |
| <code>leg.side</code>   | An integer indicating on where to reserve space for the legend: values 1-4 correspond to below, to the left, above and to the right, as in e.g. <code>axis</code> . For a value of <code>NULL</code> , the function provides a reasonable default where there is space left in the layout. For any other value, no space for a legend is put aside. |
| <code>show</code>       | A logical value; if <code>TRUE</code> , the layout defined by the arguments is displayed graphically.   |

### Details

Space for plots is reserved via the layout mechanism. The function starts with an empty maximum layout, fills in the plot, dendrograms, annotation plots and legend as required, and compresses the resulting layout by removing empty slots.

### Value

A list with the following entries:

|                          |  |
|--------------------------|--|
| <code>plot</code>        | A matrix describing the plot layout; see <code>layout</code> |
| <code>width</code>       | relative widths of plots (i.e. columns)                      |
| <code>height</code>      | relative heights of plots (i.e. rows)                        |
| <code>legend.side</code> | side where to draw the legend                                |

### See Also

[annHeatmap2](#), [picketPlot](#), [layout](#)

**Examples**

```

def.par = par(no.readonly = TRUE) # save default, for resetting

## Heatmap with column dendrogram, column annotation, default legend
dnd = list(Row=list(status="no"), Col=list(status="yes"))
ann = list(Row=list(data=NULL), Col=list(data=1))
## 1 = heatmap, 2=dendrogram, 3=annotation, 4=legend
ll = heatmapLayout(dendrogram=dnd, annotation=ann, leg.side=NULL, show=TRUE)
ll

par(def.par) #- reset to default

```

heatmap\_2

*Display Data as Heatmap***Description**

This function displays an expression data matrix as a heatmap. It is based on an old version of heatmap in the stats package, but offers more flexibility (e.g. skipping dendrograms, skipping row/column labelling, adding a legend).

**Usage**

```

heatmap_2(
  x,
  Rowv,
  Colv,
  distfun = dist,
  hclustfun = hclust,
  add.expr,
  scale = c("row", "column", "none"),
  na.rm = TRUE,
  do.dendro = c(TRUE, TRUE),
  legend = 0,
  legfrac = 8,
  col = heat.colors(12),
  trim,
  ...
)

```

**Arguments**

|         |   |
|---------|---|
| x       | the numerical data matrix to be displayed.                                    |
| Rowv    | either a dendrogram or a vector of reordering indexes for the rows.           |
| Colv    | either a dendrogram or a vector of reordering indexes for the columns.        |
| distfun | function to compute the distances between rows and columns. Defaults to dist. |

|                        |  |
|------------------------|--|
| <code>hclustfun</code> | function used to cluster rows and columns. Defaults to <code>hclust</code> .   |
| <code>add.expr</code>  | Expression to be evaluated after the call to <code>image</code> . See <code>Details</code> .                         |
| <code>scale</code>     | indicates whether values should be scaled by either by row, column, or not at all. Defaults to <code>row</code> .    |
| <code>na.rm</code>     | logical indicating whether to remove NAs.  |
| <code>do.dendro</code> | logical vector of length two, indicating (in this order) whether to draw the row and column dendrograms.             |
| <code>legend</code>    | integer between 1 and 4, indicating on which side of the plot the legend should be drawn, as in <code>mtext</code> . |
| <code>legfrac</code>   | fraction of the plot that is taken up by the legend; larger values correspond to smaller legends.                    |
| <code>col</code>       | the color scheme for <code>image</code> . The default sucks.   |
| <code>trim</code>      | Percentage of values to be trimmed. This helps to keep an informative color scale, see <code>Details</code> .        |
| <code>...</code>       | extra arguments to <code>image</code> .  |

### Details

This function is deprecated. Please use `regHeatmap` for new projects.

With all parameters at their default, this gives the same result as a very old version of `heatmap` that was the base for the modifications. All parameters of the same name have the same function as in `heatmap`, though `add.expr`, which can be used for adding graphical elements after the call to `image`, will probably not produce useful results. Note also that row- and column labels are optional, i.e. if the corresponding `dimname` of `x` is `NULL`, no labels are displayed.

Note that setting `Rowv` or `Colv` to `NA` completely suppresses re-ordering of rows or columns as well as the corresponding dendrogram. Setting both to `NA` works basically like `image` (though you can still add a legend).

Setting `trim` to a number between 0 and 1 uses equidistant classes between the `(trim)`- and `(1-trim)`-quantile, and lumps the values below and above this range into separate open-ended classes. If the data comes from a heavy-tailed distribution, this can save the display from putting too many values into too few classes.

### Value

Same as `heatmap` with `keep.dendro=FALSE`: an invisible list giving the reordered indices of the row- and column-elements as `rowInd` and `colInd`.

### Author(s)

Original by Andy Liaw, with revisions by Robert Gentleman and Martin Maechler.  
Alexander Ploner for this version.

### See Also

[heatmap](#), [hclust](#), [heatmap\\_plus](#), [regHeatmap](#), [annHeatmap](#)

## Examples

```
## Not run:
# create data
mm = matrix(rnorm(1000, m=1), 100,10)
mm = cbind(mm, matrix(rnorm(2000), 100, 20))
mm = cbind(mm, matrix(rnorm(1500, m=-1), 100, 15))
mm2 = matrix(rnorm(450), 30, 15)
mm2 = cbind(mm2, matrix(rnorm(900,m=1.5), 30,30))
mm=rbind(mm, mm2)
colnames(mm) = paste("Sample", 1:45)
rownames(mm) = paste("Gene", 1:130)

# similar to base heatmap
heatmap_2(mm)

# remove column dendrogram
heatmap_2(mm, do.dendro=c(TRUE, FALSE))

# add a legend under the plot
heatmap_2(mm, legend=1)
# make it smaller
heatmap_2(mm, legend=1, legfrac=10)
# ... on the left side
heatmap_2(mm, legend=2, legfrac=10)

# remove the column labels by removing the column names
colnames(mm)=NULL
heatmap_2(mm, legend=1, legfrac=10)

# truncate the data drastically
heatmap_2(mm, legend=1, legfrac=10, trim=0.1)

## End(Not run) ## end dontrun
```

---

heatmap\_plus

*Display an Annotated Heatmap*

---

## Description

This function displays an expression data matrix as a heatmap with a column dendrogram. A given clustering will be shown in color. Additionally, a number of binary and interval scaled covariates can be added to characterize these clusters.

## Usage

```
heatmap_plus(  
  x,  
  addvar,
```

```

covariate = NULL,
picket.control = list(),
h,
clus,
cluscol,
cluslabel = NULL,
Rowv,
Colv,
reorder = c(TRUE, TRUE),
distfun = dist,
hclustfun = hclust,
scale = c("row", "column", "none"),
na.rm = TRUE,
do.dendro = TRUE,
col = heat.colors(12),
trim,
equalize = FALSE,
...
)

```

### Arguments

|                             |   |
|-----------------------------|---|
| <code>x</code>              | the numerical data matrix to be displayed.  |
| <code>addvar</code>         | data frame with (mostly binary) covariates.   |
| <code>covariate</code>      | integer indicating the one column in <code>addvar</code> that is interval scaled.   |
| <code>picket.control</code> | list of option for drawing the covariates, passed to <code>oldPicketplot</code> .   |
| <code>h</code>              | height at which to cut the dendrogram, as in <code>oldCuttree</code> ; overrides <code>clus</code> .  |
| <code>clus</code>           | an explicit vector of cluster memberships for the columns of <code>x</code> , if no dendrogram is used; ignored if <code>do.dendro=TRUE</code> and <code>h</code> is specified. |
| <code>cluscol</code>        | a vector of colors used to indicate clusters.   |
| <code>cluslabel</code>      | labels to designate cluster names.  |
| <code>Rowv</code>           | either a dendrogram or a vector of reordering indexes for the rows.   |
| <code>Colv</code>           | either a dendrogram or a vector of reordering indexes for the columns.  |
| <code>reorder</code>        | logical vector of length two, indicating whether the rows and columns (in this order) should be reordered using <code>order.dendrogram</code> .                                 |
| <code>distfun</code>        | function to compute the distances between rows and columns. Defaults to <code>dist</code> .   |
| <code>hclustfun</code>      | function used to cluster rows and columns. Defaults to <code>hclust</code> .  |
| <code>scale</code>          | indicates whether values should be scaled by either by row, column, or not at all. Defaults to <code>row</code> .   |
| <code>na.rm</code>          | logical indicating whether to remove NAs.   |
| <code>do.dendro</code>      | logical indicating whether to draw the column dendrogram.   |
| <code>col</code>            | the color scheme for image. The default sucks.  |
| <code>trim</code>           | Percentage of values to be trimmed. This helps to keep an informative color scale, see <code>Details</code> .   |



|          |   |
|----------|---|
| equalize | logical indicating whether to use the ranks of the data for setting the color scheme; alternative to <code>trim</code> , see Details. |
| ...      | extra arguments to <code>image</code> .   |

### Details

This function is deprecated. Please use functions `annHeatmap` or `annHeatmap2` for new projects.

This is a heavily modified version of `heatmap_2`, which is a heavily modified version of an old version of `heatmap` in package `stats`, so some of the arguments are described in more detail there. The main distinguishing feature of this routine is the possibility to color a cluster solution, and to add a covariate display.

Covariates are assumed to be binary, coded as 0 and 1 (or FALSE and TRUE respectively). One of the covariates can be interval scaled, the column index of this variable is supplied via argument `covariate`. The details of the added display are handled by the function `picketplot`.

Setting `trim` to a number between 0 and 1 uses equidistant classes between the `(trim)-` and `(1-trim)-` quantile, and lumps the values below and above this range into separate open-ended classes. If the data comes from a heavy-tailed distribution, this can save the display from putting too many values into too few classes. Alternatively, you can set `equal=TRUE`, which uses an equidistant color scheme for the ranks of the values.

### Value

A list with components

|                     |   |
|---------------------|---|
| <code>rowInd</code> | indices of the rows of the display in terms of the rows of <code>x</code> . |
| <code>colInd</code> | ditto for the columns of the display.                                       |
| <code>clus</code>   | the cluster indices of the columns of the display.                          |

### Author(s)

Original by Andy Liaw, with revisions by Robert Gentleman and Martin Maechler.

Alexander Ploner for the modifications documented here.

### See Also

[heatmap\\_2](#), [heatmap](#), [oldPicketplot](#), [oldCutplot](#), [dendrogram](#), [RGBColVec](#), [annHeatmap](#), [annHeatmap2](#)

### Examples

```
## Not run:
# create data
mm = matrix(rnorm(1000, m=1), 100,10)
mm = cbind(mm, matrix(rnorm(2000), 100, 20))
mm = cbind(mm, matrix(rnorm(1500, m=-1), 100, 15))
mm2 = matrix(rnorm(450), 30, 15)
mm2 = cbind(mm2, matrix(rnorm(900,m=1.5), 30,30))
mm=rbind(mm, mm2)
colnames(mm) = paste("Sample", 1:45)
rownames(mm) = paste("Gene", 1:130)
```

```

addvar = data.frame(Var1=rep(c(0,1,0),c(10,20,15)),
                    Var2=rep(c(1,0,0),c(10,20,15)),
                    Var3=rep(c(1,0), c(15,30)),
                    Var4=rep(seq(0,1,length=4), c(10,5,15,15))+rnorm(45, sd=0.5))
addvar[3,3] = addvar[17,2] = addvar[34,1] =NA
colnames(addvar) = c("Variable X", "Variable Y", "ZZ", "Interval")

# the lame default, without clustering
# Labels do not look too hot that way
heatmap_plus(mm)

# without labels, but with cluster
dimnames(mm)=NULL
heatmap_plus(mm, h=40)

# add some covariates, with nice names
heatmap_plus(mm, addvar=addvar, cov=4)

# covariates and clustering
heatmap_plus(mm, addvar=addvar, cov=4, h=20, col=RGBColVec(64), equal=TRUE)

# Clustering without the dendrogram
cc = cutree(hclust(dist(t(mm))), k=5)
heatmap_plus(mm, addvar=addvar, cov=4, clus=cc, do.dendro=FALSE)

## End(Not run) ## end dontrun

```

---

modifyExistingList      *Override existing list entries*

---

## Description

Override existing list entries and extract arguments that are specified as named lists

## Usage

```

modifyExistingList(x, val)

extractArg(arglist, deflist)

```

## Arguments

|         |   |
|---------|---|
| x       | a named list, the target for replacing with entries with the same name from val             |
| val     | a named list that serves as template for filling in values in x                             |
| arglist | a named list; these are the specified arguments that override the defaults.                 |
| deflist | a named list whose entries are all possible slots (with default values) that can be filled. |

**Details**

`modifyExistingList` is a general function that recursively overwrites named items in `x` with the value of items of `val` with the same name. Items in `val` that have no name, or do not correspond to an item in `x` with the same name, are ignored.

`extractArg` is a specific helper function for setting default values for the `annHeatmap2`-family of functions, where arguments are given as a list with two named items, `Row` and `Col`. Each of these items is again a named list of actual parameters. At the same time, all items with other names than `Row` and `Col` at the top level are assumed to be shared items with the same value for both sub-lists. `extractArg` uses `modifyExistingList` to overwrite the default values specified in `deflist` with the actual values specified in `arglist`, see Examples.

**Value**

`modifyExistingList` returns `x`, with values replaced from `val` where names match. `extractArg` returns a list with items `Row` and `Col` fully specified according to both `deflist` and `arglist`.

**See Also**

[annHeatmap2](#)

**Examples**

```
## Replace items with matching names recursively
x = list(a=1, b=2, c=list(a=31, b=32), 135)
val = list(a=2, c=list(b=1114), d=92)
modifyExistingList(x, val)

## Same defaults for rows/columns, no arguments specified
defs = list(a="A", b="B", c="C")
extractArg(NULL, defs)

## Shared and non-shared defaults
defs = list(common.1=134, common.2=72, Row=list(row.only=14), Col=list(col.only=134))
args = list(common.1 = -1, Row=list(row.only=94, common.2=-15))
extractArg(args, defs)
```

---

niceBreaks

*Get nice (symmetric) breaks for an interval*

---

**Description**

Given a minimum and a maximum, this function returns a vector of equidistant breaks that covers this interval, and has a pretty interval length (1, 2, or 5 times a power of 10). If the interval contains zero, it will be one of the breaks, so that the intervals are arranged somewhat symmetrically around it.

**Usage**

```
niceBreaks(xr, breaks)
```

**Arguments**

xr                    the range to be covered, as `c(min, max)`  
breaks                either the desired number of breaks, or a pre-specified vector of breaks

**Details**

The number of desired breaks is honored as far as possible, which is not actually that often in practice. However, major deviations of three or more are reasonably rare.

The function allows the specification of a set of breaks instead of the desired number of breaks, somewhat like in `cut`. However, if the length of breaks is greater than one, the function just sorts the values and returns them otherwise unchanged.

**Value**

A vector of pretty breaks covering the specified interval, more or less of the desired length.

**See Also**

[pretty](#)

**Examples**

```
## Niceness overrules specified number  
niceBreaks(c(-1,1), 5)  
niceBreaks(c(-1,1), 6)  
  
## Zero appears always as break  
niceBreaks(c(-2.75, 1.12), 8)  
  
## Not invariant to translation (of course)  
niceBreaks(3.27 + c(-2.75, 1.12), 8)
```

---

oldCutplot.dendrogram *Plot Subtrees of a Dendrogram in Different Colors*

---

**Description**

Plot a dendrogram, cut the tree at a given height, and draw the resulting subtrees in different colors (OLD version, to be deprecated)

**Usage**

```
oldCutplot.dendrogram(  
  x,  
  h,  
  cluscol,  
  leaflab = "none",  
  horiz = FALSE,  
  lwd = 3,  
  ...  
)
```

**Arguments**

|         |   |
|---------|---|
| x       | a dendrogram.   |
| h       | the height at which the dendrogram is cut.                                    |
| cluscol | the colors used for the subtrees; defaults to rainbow.                        |
| leaflab | indicates how leaf labels are to be drawn< defaults to 'perpendicular'.       |
| horiz   | logical indicating whether to plot the dendrogram horizontally or vertically. |
| lwd     | the line width used for the color subtrees.                                   |
| ...     | arguments to plot.dendrogram.   |

**Details**

This routine makes use of the functions plot.dendrogram and plotNode in package stats.

**Author(s)**

Alexander Ploner <Alexander.Ploner@ki.se>

**See Also**

[as.dendrogram](#)

**Examples**

```
## Not run:  
data(swiss)  
cc = as.dendrogram(hclust(dist(swiss)))  
oldCutplot.dendrogram(cc, h=80)  
  
## End(Not run)
```

oldPicketplot

*Barplots for Several Binary Variables***Description**

Display one or more binary variables by using black bars for presence/validity of a condition, empty space for absence/invalidity, and an extra color for missing values. Additionally, an index plot for one interval scaled variable can be added, possibly with a smoothing function (OLD version, to be deprecated).

**Usage**

```
oldPicketplot(
  x,
  covariate = NULL,
  grp = NULL,
  grpcol,
  grplabel = NULL,
  add = FALSE,
  control = list()
)
```

**Arguments**

|                        |   |
|------------------------|---|
| <code>x</code>         | a matrix or data frame containing the data.   |
| <code>covariate</code> | the index of the column in <code>x</code> that contains the interval scaled variable, if any.   |
| <code>grp</code>       | cluster indices for the rows of <code>x</code> , used for assigning background color.           |
| <code>grpcol</code>    | colors corresponding to the clusters.   |
| <code>grplabel</code>  | cluster names.  |
| <code>add</code>       | logical indicating whether to start a new plot, or whether to add the plot to the existing one. |
| <code>control</code>   | a list of parameters controlling the appearance of the plot, see Details.                       |

**Details**

This routine is primarily intended for augmenting heatmaps. It might be useful in other contexts, but misses most frills for using it comfortably.

The following named list elements can be set to change the appearance of the plot:

**boxw** the relative width of a marking box.

**boxh** the relative height of a marking box.

**hbuff** the horizontal separation around marking boxes; equals half the horizontal distance between two marking boxes.

**vbuff** ditto for vertical separation.

**span** passed on to loess used for the smoothing curve.

**nacol** color for missing values of binary variables.

**degree** if 0, no smoothing line is drawn; otherwise passed on to loess used for the smoothing curve.

**cex.label** the character size for grplabel.

### Note

The plot looks like a more or less derelict picket fence, and 'picketplot' sounds somewhat like the 'pocketplot' used in geostatistics.

### Author(s)

Alexander Ploner <Alexander.Ploner@ki.se>

### See Also

[heatmap\\_plus](#)

### Examples

```
## Not run:
# without covariate
mm = cbind(sample(0:1, 42, rep=TRUE), sample(0:1, 42, rep=TRUE))
mm[sample(42, 5), 1] = NA
oldPicketplot(mm)

# with clustering
cl = rep(1:3, c(10,22,10))
cn = c("Cluster I","Cluster II","Cluster III")
cc = c("lightblue","lightgreen","lightpink") # windows palette
oldPicketplot(mm, grp=cl, grplabel=cn, grpcol=cc)

# add a covariate; setting the colnames makes the variable labels
mm = cbind(mm, rnorm(42) + cl/2)
colnames(mm) = c("State A","State B", "X")
oldPicketplot(mm, covariate=3,grp=cl, grplabel=cn, grpcol=cc)

# using extra controls
oldPicketplot(mm, covariate=3,grp=cl, grplabel=cn, grpcol=cc, control=list(nacol="white", degree=0))

## End(Not run) ## end dontrun
```

---

picketPlot

*Display a data frame of annotation information*

---

### Description

Displays a data frame of both factor and numerical variables in parallel panels. Factors levels are indicated by black rectangles, using dummy variables for more than two levels. Numerical variables are shown as simple index plots with an optional loess smoother. Panels can be arranged horizontally or vertically, and different groups of subjects can be indicated through different background colors.

### Usage

```
picketPlot(
  x,
  grp = NULL,
  grpcol,
  grplabel = NULL,
  horizontal = TRUE,
  asIs = FALSE,
  control = list()
)
```

### Arguments

|                         |  |
|-------------------------|--|
| <code>x</code>          | usually a data frame, which is passed to <code>convAnnData</code> to be converted to a numerical matrix with dummy coding for the factor levels. Alternatively, such a numerical matrix can be constructed manually and passed in as <code>x</code> , see argument <code>asIs</code> |
| <code>grp</code>        | an optional vector of cluster memberships, in the same order as the rows of <code>x</code>   |
| <code>grpcol</code>     | an optional vector of background colors for the clusters specified in <code>grp</code>   |
| <code>grplabel</code>   | an optional vector of names for the clusters specified in <code>grp</code>   |
| <code>horizontal</code> | logical value whether to plot variables horizontally (default) or vertically   |
| <code>asIs</code>       | a logical value indicating whether <code>x</code> should be passed to <code>convAnnData</code> for pre-processing or not. Defaults to <code>FALSE</code> .   |
| <code>control</code>    | a named list of control parameters that determines the visual appearance of the plot; see <code>picketPlotControl</code> for details.  |

### Details

Missing values are indicated by a box marking in `naCol` for factor values.

### Value

Invisibly, a list containing the data and parameters used for plotting each binary indicator and numerical variable, respectively. This is an internal data structure, mostly useful for debugging. Irrelevant, as the main desired effect is a plot to the current graphical device.



**See Also**

[annHeatmap2](#), [convAnnData](#), [par](#), [picketPlotControl](#)

**Examples**

```
## Standard call
data(mtcars)
picketPlot(mtcars)

## Pre-process the data for display
mm = convAnnData(mtcars, inclRef=FALSE)
picketPlot(mm, asIs=TRUE)

## Higher panels for continous traits
picketPlot(mm, asIs=TRUE, control=list(numfac=3))

## With clusters
picketPlot(mtcars, grp = rep(1:2, c(16, 16)), grpcol = c("pink", "lightblue"), grplabel=c("Cluster 1", "Cluster 2"))
```

---

picketPlotControl      *Default parameter settings for picketPlot*

---

**Description**

This function returns a named list of parameters that affect how a picketPlot is generated. This list can be used as a template for overriding the defaults partially or completely.

**Usage**

```
picketPlotControl()
```

**Details**

The following parameter affects the overall appearance of the plot:

- `cex.label` is the expansion factor for the size of the cluster labels at the bottom of the plot; default is 1.5.

The following parameters directly affect how binary indicator variables are displayed:

- `boxw` is the relative length of the short side of a box marking (width for a horizontal plot); default is 1.
- `boxh` is the relative length of the long side of a box marking (default: 4)
- `hbuff` is the relative distance between two box markings for the same variable (horizontal buffer for a horizontal plot); default is 0.1
- `vbuff` is the relative distance between two box markings for the same subject, but different variables (default: 0.1)

- `nacol` is the color for box markings indicating missing values (default: `gray(0.85)`)

Note that `boxh` and `vbuff` also affect the display of numerical variables as a scatter plot: as the amount of vertical space allowed for a single numerical variable (see also `numfac` below) and the vertical space between two neighboring variable panels (binary or `ornumerical`), respectively.

The following parameters only affect the display of a numerical variable:

- `numfac` is the expansion factor indicating how much higher (for a horizontal plot) or wider (for a vertical plot) panels with numerical variables are than a panels for a single binary indicator
- `span` is the `span` argument for the loess smoother. Default is `1/3`; setting this to zero switches off smoothing.
- `degree` is the degree of loess smoothing. Default is `1`; setting this to zero switches off smoothing
- `pch` is the plotting character for numerical variables; uses the device default.
- `cex.pch` is the size of the plotting character for numerical variables; uses the device default.
- `col.pch` is the color of the plotting character for numerical variables; uses the device default.
- `label_axis_shrink` controls the range of the axis for which axis ticks are labeled: by default, labels covering the whole observed range are defined (via a call to `pretty`); if set to a number between zero and one, the range covered by labels is shortened by that fraction and centered within the observed range (and the fed to `pretty`); this can be used to avoid overlapping labels for multiple adjacent panes with numerical variables.
- `plot_baseline` is a logical value indicating whether to draw a baseline for panes showing numerical variables: `FALSE` by default, this can be useful to visually separate multiple adjacent panes with numerical variables.

### Value

A named list

### See Also

[picketPlot](#), [par](#), [pretty](#)

---

plot.annHeatmap

*Plotting method for annotated heatmaps*

---

### Description

Plotting method for annotated heatmaps

### Usage

```
## S3 method for class 'annHeatmap'
plot(x, widths, heights, ...)
```

**Arguments**

|         |  |
|---------|--|
| x       | an object of class annHeatmap  |
| widths  | a numerical vector giving the widths of the sub-plots currently defined  |
| heights | a numerical vector giving the heights of the sub-plots currently defined |
| ...     | extra graphical parameters, currently ignored                            |

**Details**

This function displays an annotated heatmap object that has been previously generated by `annHeatmap2` or one of its wrappers. The arguments `widths` and `heights` work as in `layout`.

**Value**

x, invisibly returned. If `widths` or `heights` have been specified, they overwrite the corresponding items `x$layout$width` and `x$layout$height` in x.

**See Also**

[annHeatmap2](#), [heatmapLayout](#), [layout](#)

**Examples**

```
## Define the map
require(Biobase)
data(sample.ExpressionSet)
ex1 = sample.ExpressionSet[51:85,]
map1 = annHeatmap2(exprs(ex1), ann=list(Col=list(data=pData(ex1))),
                  cluster=list(Col=list(cuth=3000)))

## Plot it
plot(map1)

## More heatmap, smaller dendrogram/annotation
map2 = plot(map1, heights = c(1,6,1))

## Compare layout before/after
with(map1$layout, layout(plot, width, height))
layout.show(4)
with(map2$layout, layout(plot, width, height))
layout.show(4)
```

---

|                  |  |
|------------------|--|
| print.annHeatmap | <i>Printing information about annotated heatmaps</i> |
|------------------|--|

---

### Description

Printing method for annotated heatmaps

### Usage

```
## S3 method for class 'annHeatmap'  
print(x, ...)
```

### Arguments

|     |                                    |
|-----|------------------------------------|
| x   | an object of class annHeatmap      |
| ... | extra arguments, currently ignored |

### Details

A very simple printing method, displaying a minimum of information about dendrograms and annotation

### Value

x is returned invisibly

### See Also

[annHeatmap](#), [annHeatmap2](#), [plot.annHeatmap](#)

### Examples

```
set.seed(219)  
mat = matrix(rnorm(100), ncol=5)  
ann = data.frame(Class=c("A", "A", "B", "A", "B"))  
map1 = annHeatmap(mat, ann)  
map1
```

---

|            |                                       |
|------------|---------------------------------------|
| regHeatmap | <i>Regular heatmaps with a legend</i> |
|------------|---------------------------------------|

---

## Description

Creating regular heatmaps, without annotation, but allowing for a legend

## Usage

```
regHeatmap(x, ...)

## Default S3 method:
regHeatmap(
  x,
  dendrogram = list(clustfun = hclust, distfun = dist, status = "yes"),
  labels = NULL,
  legend = TRUE,
  ...
)
```

## Arguments

|            |  |
|------------|--|
| x          | a numerical matrix   |
| ...        | extra options passed to annHeatmap2  |
| dendrogram | a list controlling the options for row- and column dendrogram, see annHeatmap2   |
| labels     | a list controlling the row- and column labels as well as their location and size, see annHeatmap2  |
| legend     | either a logical value, indicating whether to draw a legend at the default location determined by the function, or one of the sides of the plot (1-4), see annHeatmap2 |

## Details

A gilded wrapper for annHeatmap2 that allows for heatmaps without annotation or clustering on the dendrograms, but still offer some control over dendrograms, labels and legend.

These functions generate an object representing the heatmap; in order to produce graphical output, you have to invoke the plot method, see Examples.

## Value

An object of class annHeatmap

## See Also

[annHeatmap](#), [annHeatmap2](#), [plot.annHeatmap](#)

## Examples

```
## Default
set.seed(219)
mat = matrix(rnorm(100), ncol=5)
map1 = regHeatmap(mat)
plot(map1)
```

---

RGBColVec

*Alternative color schemes*

---

## Description

RGBColVec returns a vector of colors that is equally spaced from red through black to green, suitable for heatmaps.

## Usage

```
RGBColVec(nrgcols = 12)
```

```
RainbowPastel(n, blanche = 200, ...)
```

## Arguments

|            |  |
|------------|--|
| nrgcols, n | desired number of colors                               |
| blanche    | the amount of whiteness added; value between 0 and 255 |
| ...        | extra arguments to rainbow                             |

## Details

RainbowPastel returns a vector of colors like rainbow, but more pastelly.

## Value

A character vector of length nrgcols or n giving the RGB codes for the colors.

## Author(s)

RGBColVec is based on function rgcolors.func in package sma by Sandrine Dudoit and Jane Fridlyand.

RGBColVec as documented and RainbowPastel by Alexander Ploner

## See Also

[heat.colors](#)

**Examples**

```
## Not run:
# A Color Wheel
pie(rep(1,12), col=RGBColVec(12))

# A color wheel in the original rainbow
pie(rep(1,6), col=rainbow(6))

# Pastel
pie(rep(1,6), col=RainbowPastel(6))

# Less whiteness
pie(rep(1,6), col=RainbowPastel(6, blanche=127))

# More steps require less whiteness
pie(rep(1,12), col=RainbowPastel(12, blanche=60))

# Test your screen & eyes: any differences?
pie(rep(1,12), col=RainbowPastel(12, blanche=80))

## End(Not run) ## end dontrun
```

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