

Package ‘chameleon’

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Title Automatic Colors for Multi-Dimensional Data

Description Assign distinct colors to arbitrary multi-dimensional data, considering its structure.

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Imports clue, ggplot2, grDevices, stats, umap

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data_colors	<i>Compute colors for multi-dimensional data.</i>
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Description

Given a matrix of observation/element rows and variable/measurement columns, compute a color for each row (or group of rows) such that the colors are distinct, and where more-similar colors roughly designate more-similar data rows (or groups of rows).

Usage

```
data_colors(
  data,
  run_umap = TRUE,
  groups = NULL,
  minimal_saturation = 33,
  minimal_lightness = 20,
  maximal_lightness = 80
)
```

Arguments

data	A matrix whose rows represent elements/observations and columns represent variables/measurements.
run_umap	A boolean specifying whether to run UMAP on the data to convert it to 3D (by default, TRUE). If FALSE, the data matrix must have exactly 3 columns and will be used as-is.
groups	An optional array with an entry per row containing the identifier of the group the row belongs to.
minimal_saturation	Exclude colors whose saturation (hypot(a,b) in CIELAB color space) is less than this value (by default, 33).
minimal_lightness	Exclude colors whose lightness (l in CIELAB color space) is less than this value (by default, 20).
maximal_lightness	Exclude colors whose lightness (l in CIELAB color space) is more than this value (by default, 80).

Details

This is intended to provide a "reasonable" set of colors to "arbitrary" data, for use as a convenient default when investigating unknown data sets. It is not meant to replace hand-picked colors tailored for specific data (e.g. using red colors for "bad" rows and green colors for "good" rows).

This ensures all colors are distinct by packing the (visible part) of the CIELAB color space with the needed number of spheres. To assign the colors to the data, it uses UMAP to reduce the data to 3D.

It then uses principal component analysis to represent both the chosen colors (3D sphere centers) and the (3D UMAP) data as point clouds with coordinates in the range 0-1, and finally uses a stable matching algorithm to map these point clouds to each other, thereby assigning a color to each data row. If the data is grouped, then the center of gravity of each group is used to generate a color for each group.

Value

An array with one entry per row, whose names are the matrix rownames, containing the color of each row. If groups was specified, the array will contain one entry per unique group identifier, whose names are the `as.character` group identifiers, containing the color of each group.

Examples

```
chameleon::data_colors(stackloss)
```

distinct_colors	<i>Pick a number of distinct colors.</i>
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Description

This ensures all colors are distinct by packing the (visible part) of the CIELAB color space with the needed number of spheres, and using their centers to generate the colors.

Usage

```
distinct_colors(  
  n,  
  minimal_saturation = 33,  
  minimal_lightness = 20,  
  maximal_lightness = 80  
)
```

Arguments

n	The requested (positive) number of colors.
minimal_saturation	Exclude colors whose saturation ($\text{hypot}(a,b)$ in CIELAB color space) is less than this value (by default, 33).
minimal_lightness	Exclude colors whose lightness (l in CIELAB color space) is less than this value (by default, 20).
maximal_lightness	Exclude colors whose lightness (l in CIELAB color space) is more than this value (by default, 80).

Value

A list with two elements, `name` containing the color names and `lab` containing a matrix with a row per color and three columns containing the l, a and b coordinates of each color.

Examples

```
chameleon::distinct_colors(8)
```

pbmc

Sample scRNA data of PBMC metacells.

Description

This is a list with the following elements:

Usage

```
data(pbmc)
```

Format

A list with the three elements described above.

Details

‘`umis`’ - a matrix, containing ~1.5K metacells (rows), and for each one, the UMI count (# of detected RNA molecules) for each of ~600 different "feature" genes (columns).

‘`types`’ - a vector of cell type names assigned to each metacell using a supervised analysis pipeline.

‘`umap`’ - a matrix with 2 columns containing 2D UMAP x,y coordinates for each metacell.

Examples

```
data(pbmc)
fractions <- pbmc$umis / rowSums(pbmc$umis)
log_fractions <- log2(fractions + 1e-5)
type_colors <- chameleon::data_colors(log_fractions, group=pbmc$types)
plot(pbmc$umap, col=type_colors[pbmc$types], pch=19, cex=0.6)
legend('topleft', legend=names(type_colors), col=type_colors, lty=1, lwd=3, cex=0.8)
```

scale_color_chameleon *Setup a color scale of distinct discrete colors in ggplot2.*

Description

This is a thin wrapper to `ggplot2::discrete_scale('colour', 'chameleon', ...)`, which uses the colors chosen by invoking `distinct_colors`. The order of the colors is arbitrary. If the data has some structure the colors should reflect, use one of the many palettes available in R, or using `data_colors` for automatically matching the colors to the structure of multi-dimensional data.

Usage

```
scale_color_chameleon(  
  minimal_saturation = 33,  
  minimal_lightness = 20,  
  maximal_lightness = 80,  
  ...  
)
```

Arguments

<code>minimal_saturation</code>	Exclude colors whose saturation ($\text{hypot}(a,b)$ in CIELAB color space) is less than this value (by default, 33).
<code>minimal_lightness</code>	Exclude colors whose lightness (l in CIELAB color space) is less than this value (by default, 20).
<code>maximal_lightness</code>	Exclude colors whose lightness (l in CIELAB color space) is more than this value (by default, 80).
<code>...</code>	Additional parameters for <code>discrete_scale</code> .

Examples

```
library(ggplot2)  
data(pbm) # pbmc in the original source  
frame <- as.data.frame(pbm$umap)  
frame$type <- pbm$types  
ggplot(frame, aes(x=xs, y=ys, color=type)) +  
  geom_point(size=0.75) +  
  scale_color_chameleon() +  
  theme(legend.text=element_text(size=12), legend.key.height=unit(14, 'pt'))
```

scale_fill_chameleon *Setup a fill scale of distinct discrete colors in ggplot2.*

Description

This is a thin wrapper to `ggplot2::discrete_scale('fill', 'chameleon', ...)`, which uses the colors chosen by invoking `distinct_colors`. The order of the colors is arbitrary. If the data has some structure the colors should reflect, use one of the many palettes available in R, or using `data_colors` for automatically matching the colors to the structure of multi-dimensional data.

Usage

```
scale_fill_chameleon(  
  minimal_saturation = 33,  
  minimal_lightness = 20,  
  maximal_lightness = 80,  
  ...  
)
```

Arguments

<code>minimal_saturation</code>	Exclude colors whose saturation (hypot(a,b) in CIELAB color space) is less than this value (by default, 33).
<code>minimal_lightness</code>	Exclude colors whose lightness (l in CIELAB color space) is less than this value (by default, 20).
<code>maximal_lightness</code>	Exclude colors whose lightness (l in CIELAB color space) is more than this value (by default, 80).
<code>...</code>	Additional parameters for <code>discrete_scale</code> .

Examples

```
library(ggplot2)  
data(pbm)   
frame <- as.data.frame(pbm$umap)  
frame$type <- pbm$types  
ggplot(frame, aes(x=xs, y=ys, fill=type)) +  
  geom_point(size=0.75, shape=21, color="black", stroke=0.1) +  
  scale_fill_chameleon() +  
  theme(legend.text=element_text(size=12), legend.key.height=unit(14, 'pt'))
```

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