

# Package: dendextend (via r-universe)

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**Type** Package

**Title** Extending 'dendrogram' Functionality in R

**Version** 1.18.0

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**Description** Offers a set of functions for extending 'dendrogram' objects in R, letting you visualize and compare trees of 'hierarchical clusterings'. You can (1) Adjust a tree's graphical parameters - the color, size, type, etc of its branches, nodes and labels. (2) Visually and statistically compare different 'dendrograms' to one another.

**Depends** R (>= 3.0.0)

**Imports** utils, stats, datasets, magrittr (>= 1.0.1), ggplot2, viridis

**Suggests** knitr, rmarkdown, testthat, seriation, colorspace, ape, microbenchmark, gplots, heatmaply, dynamicTreeCut, pvclust, corrplot, DendSer, MASS, cluster, fpc, circlize (>= 0.2.5), covr

**Enhances** gg dendro, dendroextras, Hmisc, data.table, rpart, WGCNA, moduleColor, distory, phangorn, zoo

**VignetteBuilder** knitr

**LazyData** true

**License** GPL-2 | GPL-3

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<https://www.r-statistics.com/tag/dendextend/>,  
<https://academic.oup.com/bioinformatics/article/31/22/3718/240978/dendextend-an-R-package-for-visualizing-adjusting>

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## Contents

dendextend-package	5
all.equal.dendrogram	6
all_couple_rotations_at_k	8
all_unique	9
as.dendlist	10
as.phylo.dendrogram	11
assign_dendextend_options	12
assign_values_to_branches_edgePar	12
assign_values_to_leaves_edgePar	14
assign_values_to_leaves_nodePar	15
assign_values_to_nodes_nodePar	17
as_hclust_fixed	18
bakers_gamma_for_2_k_matrix	19
Bk	20
Bk_permutations	21
Bk_plot	23
branches_attr_by_clusters	26
branches_attr_by_labels	29
branches_attr_by_lists	31
circlize_dendrogram	32
click_rotate	34
collapse_branch	36
collapse_labels	37
colored_bars	38
colored_dots	42
color_branches	46
color_labels	50
color_unique_labels	52
common_subtrees_clusters	53
cor.dendlist	54
cor_bakers_gamma	55
cor_common_nodes	58
cor_cophenetic	59
cor_FM_index	61
count_terminal_nodes	62
cutree	63
cutree_1h.dendrogram	67
cutree_1k.dendrogram	68
cut_lower_fun	70
dendextend_options	71

dendlist . . . . .	72
DendSer.dendrogram . . . . .	74
dend_diff . . . . .	75
dend_expend . . . . .	76
dist.dendlist . . . . .	77
distinct_edges . . . . .	78
dist_long . . . . .	79
duplicate_leaf . . . . .	80
entanglement . . . . .	81
fac2num . . . . .	83
find_dendrogram . . . . .	84
find_k . . . . .	85
fix_members_attr.dendrogram . . . . .	87
flatten.dendrogram . . . . .	88
flip_leaves . . . . .	88
FM_index . . . . .	89
FM_index_permutation . . . . .	91
FM_index_R . . . . .	94
get_branches_heights . . . . .	96
get_childrens_heights . . . . .	97
get_leaves_attr . . . . .	97
get_leaves_branches_attr . . . . .	98
get_leaves_branches_col . . . . .	99
get_leaves_edgePar . . . . .	100
get_leaves_nodePar . . . . .	101
get_nodes_attr . . . . .	102
get_nodes_xy . . . . .	104
get_root_branches_attr . . . . .	106
get_subdendrograms . . . . .	107
ggdend . . . . .	108
hang.dendrogram . . . . .	112
has_component_in_attribute . . . . .	113
heights_per_k.dendrogram . . . . .	114
highlight_branches_col . . . . .	115
highlight_distinct_edges . . . . .	117
identify.dendrogram . . . . .	119
intersect_trees . . . . .	121
is.natural.number . . . . .	122
is_null_list . . . . .	123
is_some_class . . . . .	124
khan . . . . .	125
labels<- . . . . .	127
labels_cex . . . . .	128
labels_colors . . . . .	129
ladderize . . . . .	131
leaf_Colors . . . . .	132
lowest_common_branch . . . . .	133
match_order_by_labels . . . . .	134

match_order_dendrogram_by_old_order . . . . .	135
min_depth . . . . .	136
na_locf . . . . .	137
nleaves . . . . .	138
nnodes . . . . .	139
noded_with_condition . . . . .	141
order.dendrogram<- . . . . .	142
order.hclust . . . . .	143
partition_leaves . . . . .	144
plot_horiz.dendrogram . . . . .	145
prune . . . . .	147
prune_common_subtrees.dendlist . . . . .	149
prune_leaf . . . . .	149
pvclust_edges . . . . .	150
pvclust_show_signif . . . . .	151
pvclust_show_signif_gradient . . . . .	152
pvrect2 . . . . .	154
raise.dendrogram . . . . .	156
rank_branches . . . . .	156
rank_order.dendrogram . . . . .	157
rank_values_with_clusters . . . . .	158
rect.dendrogram . . . . .	159
reindex_dend . . . . .	162
remove_branches_edgePar . . . . .	163
remove_leaves_nodePar . . . . .	164
remove_nodes_nodePar . . . . .	165
rllply . . . . .	166
rotate . . . . .	167
rotate_DendSer . . . . .	169
sample.dendrogram . . . . .	170
seriate_dendrogram . . . . .	172
set . . . . .	173
set_labels . . . . .	179
shuffle . . . . .	181
sort_2_clusters_vectors . . . . .	182
sort_dist_mat . . . . .	184
sort_levels_values . . . . .	184
tanglegram . . . . .	186
theme_dendro . . . . .	193
unbranch . . . . .	193
unclass_dend . . . . .	195
untangle . . . . .	196
untangle_DendSer . . . . .	198
untangle_random_search . . . . .	199
untangle_step_rotate_1side . . . . .	201
untangle_step_rotate_2side . . . . .	203
untangle_step_rotate_both_side . . . . .	205
which_leaf . . . . .	207

which\_node . . . . . 208

**Index** **209**

dendextend-package *Functions for extending dendrogram objects*

## Description

Offers a set of functions for extending 'dendrogram' objects in R, letting you visualize and compare trees of 'hierarchical clusterings'. You can (1) Adjust a tree's graphical parameters - the color, size, type, etc of its branches, nodes and labels. (2) Visually and statistically compare different 'dendrograms' to one another.

## Author(s)

**Maintainer:** Tal Galili <tal.galili@gmail.com> (<https://www.r-statistics.com>) [copyright holder]

Authors:

- Gregory Jefferis <jefferis@gmail.com> (imported code from his dendroextras package) [contributor]

Other contributors:

- Yoav Benjamini <ybenja@tau.ac.il> [thesis advisor]
- Gavin Simpson [contributor]
- Marco Gallotta (a.k.a: marcog) [contributor]
- Johan Renaudie (<https://github.com/plannapus>) [contributor]
- The R Core Team (Thanks for the Infrastructure, and code in the examples) [contributor]
- Kurt Hornik [contributor]
- Uwe Ligges [contributor]
- Andrej-Nikolai Spiess [contributor]
- Steve Horvath <SHorvath@mednet.ucla.edu> [contributor]
- Peter Langfelder <Peter.Langfelder@gmail.com> [contributor]
- skullkey [contributor]
- Mark Van Der Loo <mark.vanderloo@gmail.com> (<https://github.com/markvanderloo/d3dendrogram>) [contributor]
- Andrie de Vries <apdevries@gmail.com> (ggdendro author) [contributor]
- Zuguang Gu <z.gu@dkfz-heidelberg.de> (circlize author) [contributor]
- Cath (<https://github.com/CathG>) [contributor]
- John Ma (<https://github.com/JohnMCMa>) [contributor]
- Krzysiek G (<https://github.com/storaged>) [contributor]
- Manuela Hummel <m.hummel@dkfz.de> (<https://github.com/hummelma>) [contributor]

- Chase Clark (<https://github.com/chasemc>) [contributor]
- Lucas Graybuck (<https://github.com/hypercompetent>) [contributor]
- jdtribol (<https://github.com/jdtribol>) [contributor]
- Ben Ho <ben.ho@sickkids.ca> (<https://github.com/SplitInf>) [contributor]
- Samuel Perreault <samuel.perreault.3@ulaval.ca> (<https://github.com/samperochkin>) [contributor]
- Christian Hennig <c.hennig@ucl.ac.uk> (<http://www.homepages.ucl.ac.uk/~ucakche/>) [contributor]
- David Bradley (<https://github.com/DBradley27>) [contributor]
- Houyun Huang <houyunhuang@163.com> (<https://github.com/houyunhuang>) [contributor]
- Patrick Schupp <pschupp@sonic.net> (<https://github.com/pschupp>) [contributor]
- Alec Buetow <alecbuetow@gmail.com> (<https://github.com/alecbuetow>) [contributor]

### See Also

[dendrogram](#), [hclust](#) in [stats](#) package.

---

all.equal.dendrogram    *Global Comparison of two (or more) dendrograms*

---

### Description

This function makes a global comparison of two or more dendrograms trees.

The function can get two [dendlist](#) objects and compare them using [all.equal.list](#). If a dendlist is in only "target" (and not "current"), it will go through the dendlist and compare all of the dendrograms within it to one another.

### Usage

```
## S3 method for class 'equal.dendrogram'  
all(  
  target,  
  current,  
  use.edge.length = TRUE,  
  use.tip.label.order = FALSE,  
  use.tip.label = TRUE,  
  use.topology = TRUE,  
  tolerance = .Machine$double.eps^0.5,  
  scale = NULL,  
  ...  
)
```

**Arguments**

target	an object of type <a href="#">dendrogram</a> or <a href="#">dendlist</a>
current	an object of type <a href="#">dendrogram</a>
use.edge.length	logical (TRUE). If to check branches' heights.
use.tip.label.order	logical (FALSE). If to check labels are in the same and in identical order
use.tip.label	logical (TRUE). If to check that labels are the same (regardless of order)
use.topology	logical (TRUE). If to check the existence of distinct edges
tolerance	the numeric tolerance used to compare the branch lengths.
scale	a positive number (NULL as default), comparison of branch height is made after scaling (i.e., dividing) them by this number.
...	Ignored.

**Value**

Either TRUE (NULL for attr.all.equal) or a vector of mode "character" describing the differences between target and current.

**See Also**

[all.equal](#), [all.equal.phylo](#), [identical](#)

**Examples**

```
## Not run:

set.seed(23235)
ss <- sample(1:150, 10)
dend1 <- iris[ss, -5] %>%
  dist() %>%
  hclust("com") %>%
  as.dendrogram()
dend2 <- iris[ss, -5] %>%
  dist() %>%
  hclust("single") %>%
  as.dendrogram()
dend3 <- iris[ss, -5] %>%
  dist() %>%
  hclust("ave") %>%
  as.dendrogram()
dend4 <- iris[ss, -5] %>%
  dist() %>%
  hclust("centroid") %>%
  as.dendrogram()
#   cutree(dend1)

all.equal(dend1, dend1)
```

```

all.equal(dend1, dend2)
all.equal(dend1, dend2, use.edge.length = FALSE)
all.equal(dend1, dend2, use.edge.length = FALSE, use.topology = FALSE)

all.equal(dend2, dend4, use.edge.length = TRUE)
all.equal(dend2, dend4, use.edge.length = FALSE)

all.equal(dendlist(dend1, dend2, dend3, dend4))
all.equal(dendlist(dend1, dend2, dend3, dend4), use.edge.length = FALSE)
all.equal(dendlist(dend1, dend1, dend1))

## End(Not run)

```

---

```
all_couple_rotations_at_k
```

*Rotate tree branches for k*

---

### Description

Given a tree and a k number of clusters, the tree is rotated so that the extra clusters added from k-1 to k clusters are flipped.

This is useful for finding good trees for a [tanglegram](#).

### Usage

```
all_couple_rotations_at_k(dend, k, dend_heights_per_k, ...)
```

### Arguments

dend	a dendrogram object
k	integer scalar with the number of clusters the tree should be cut into.
dend_heights_per_k	a named vector that resulted from running <a href="#">heights_per_k.dendrogram</a> . When running the function many times, supplying this object will help improve the running time if using the <a href="#">cutree.dendrogram</a> method..
...	not used

### Value

A list with dendrogram objects with all the possible rotations for k clusters (beyond the k-1 clusters!).

### See Also

[tanglegram](#), [match\\_order\\_by\\_labels](#), [entanglement](#), [flip\\_leaves](#).



**Examples**

```
## Not run:
dend1 <- USArrests[1:5, ] %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
dend2 <- all_couple_rotations_at_k(dend1, k = 2)[[2]]
tanglegram(dend1, dend2)
entanglement(dend1, dend2, L = 2) # 0.5

dend2 <- all_couple_rotations_at_k(dend1, k = 3)[[2]]
tanglegram(dend1, dend2)
entanglement(dend1, dend2, L = 2) # 0.4

dend2 <- all_couple_rotations_at_k(dend1, k = 4)[[2]]
tanglegram(dend1, dend2)
entanglement(dend1, dend2, L = 2) # 0.05

## End(Not run)
```

---

**all\_unique***Check if all the elements in a vector are unique*

---

**Description**

Checks if all the elements in a vector are unique

**Usage**

```
all_unique(x, ...)
```

**Arguments**

x	a vector
...	ignored.

**Value**

logical (are all the elements in the vector unique)

**Source**

<https://www.mail-archive.com/r-help@r-project.org/msg77592.html> OLD (no longer working): <https://r.789695.n4.nabble.com/Is-there-a-function-to-test-if-all-the-elements-in-a-vector-are-unique-td931833.html>

**See Also**

[unique](#)

**Examples**

```

all_unique(c(1:5, 1, 1))
all_unique(c(1, 1, 2))
all_unique(c(1, 1, 2, 3, 3, 3, 3))
all_unique(c(1, 3, 2))
all_unique(c(1:10))

```

---

as.dendlist

*Try to coerce something into a dendlist*


---

**Description**

It removes stuff that are not dendrogram/dendlist and turns what is left into a dendlist

**Usage**

```
as.dendlist(x, ...)
```

**Arguments**

x	a list with several dendrogram/hclust/phylo or dendlist objects and other junk that should be omitted.
...	NOT USED

**Value**

A list of class dendlist where each item is a dendrogram

**Examples**

```

## Not run:

dend <- iris[, -5] %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
dend2 <- iris[, -5] %>%
  dist() %>%
  hclust(method = "single") %>%
  as.dendrogram()

x <- list(dend, 1, dend2)
as.dendlist(x)

## End(Not run)

```

---

as.phylo.dendrogram    *Convert a dendrogram into phylo*

---

### Description

Based on [as.hclust.dendrogram](#) with [as.phylo.hclust](#)  
In the future I hope a more direct link will be made.

### Usage

```
as.phylo.dendrogram(x, ...)
```

### Arguments

x	a dendrogram
...	ignored.

### Value

A phylo class object

### See Also

[as.dendrogram](#), [as.hclust](#), [as.phylo](#)

### Examples

```
## Not run:

library(dendextend)
library(ape)
dend <- iris[1:30, -5] %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
dend2 <- as.phylo(dend)
plot(dend2, type = "fan")

library(dendextend)
library(ggplot2)
# no longer needed: library(ggdendro)
dend <- iris[1:30, -5] %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
# there is a bug in the location of the labels
# If you want to solve it - please send a Pull Request to:
# https://github.com/talgalili/dendextend/
ggplot(dend) +
```

```

scale_y_reverse(expand = c(0.2, 0)) + coord_polar(start = 1, theta="x")

## End(Not run)

# see: https://github.com/klutometis/roxygen/issues/796
#

```

---

```
assign_dendextend_options
```

*Populates dendextend functions into dendextend\_options*

---

### Description

Populates dendextend functions into dendextend\_options

### Usage

```
assign_dendextend_options()
```

---

```
assign_values_to_branches_edgePar
```

*Assign values to edgePar of dendrogram's branches*

---

### Description

Go through the dendrogram branches and updates the values inside its edgePar

If the value has Inf then the value in edgePar will not be changed.

### Usage

```

assign_values_to_branches_edgePar(
  dend,
  value,
  edgePar,
  skip_leaves = FALSE,
  warn = dendextend_options("warn"),
  ...
)

```

**Arguments**

dend	a dendrogram object
value	a new value scalar for the edgePar attribute.
edgePar	a character indicating the value inside edgePar to adjust. Can be either "col", "lty", or "lwd".
skip_leaves	logical (FALSE) - should the leaves be skipped/ignored?
warn	logical (default from dendextend_options("warn") is FALSE). Set if warnings are to be issued, it is safer to keep this at TRUE, but for keeping the noise down, the default is FALSE.
...	not used

**Value**

A dendrogram, after adjusting the edgePar attribute in all of its branches,

**See Also**

[get\\_root\\_branches\\_attr](#)

**Examples**

```
# This failed before - now it works fine. (thanks to Martin Maechler)
dend <- 1:2 %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
dend %>%
  set("branches_lty", 1:2) %>%
  set("branches_col", c("topbranch_never_plots", "black", "orange")) %>%
  plot()
## Not run:

dend <- USArrests[1:5, ] %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
plot(dend)
dend <- assign_values_to_branches_edgePar(dend = dend, value = 2, edgePar = "lwd")
plot(dend)
dend <- assign_values_to_branches_edgePar(dend = dend, value = 2, edgePar = "col")
plot(dend)
dend <- assign_values_to_branches_edgePar(dend = dend, value = "orange", edgePar = "col")
plot(dend)
dend2 <- assign_values_to_branches_edgePar(dend = dend, value = 2, edgePar = "lty")
plot(dend2)

dend2 %>%
  unclass() %>%
  str()
```

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

---

```
assign_values_to_leaves_edgePar
  Assign values to edgePar of dendrogram's leaves
```

---

### Description

Go through the dendrogram leaves and updates the values inside its edgePar

If the value has Inf then the value in edgePar will not be changed.

### Usage

```
assign_values_to_leaves_edgePar(
  dend,
  value,
  edgePar,
  warn = dendextend_options("warn"),
  ...
)
```

### Arguments

dend	a dendrogram object
value	a new value vector for the edgePar attribute. It should be the same length as the number of leaves in the tree. If not, it will recycle the value and issue a warning.
edgePar	the value inside edgePar to adjust.
warn	logical (default from dendextend_options("warn") is FALSE). Set if warning are to be issued, it is safer to keep this at TRUE, but for keeping the noise down, the default is FALSE.
...	not used

### Value

A dendrogram, after adjusting the edgePar attribute in all of its leaves,

### See Also

[get\\_leaves\\_attr](#), [linkassign\\_values\\_to\\_leaves\\_nodePar](#)

**Examples**

```
## Not run:

dend <- USArrests[1:5, ] %>%
  dist() %>%
  hclust("ave") %>%
  as.dendrogram()

plot(dend)
dend <- assign_values_to_leaves_edgePar(dend = dend, value = c(3, 2), edgePar = "col")
plot(dend)
dend <- assign_values_to_leaves_edgePar(dend = dend, value = c(3, 2), edgePar = "lwd")
plot(dend)
dend <- assign_values_to_leaves_edgePar(dend = dend, value = c(3, 2), edgePar = "lty")
plot(dend)

get_leaves_attr(dend, "edgePar", simplify = FALSE)

## End(Not run)
```

---

assign\_values\_to\_leaves\_nodePar

*Assign values to nodePar of dendrogram's leaves*

---

**Description**

Go through the dendrogram leaves and updates the values inside its nodePar

If the value has Inf then the value in edgePar will not be changed.

**Usage**

```
assign_values_to_leaves_nodePar(
  dend,
  value,
  nodePar,
  warn = dendextend_options("warn"),
  ...
)
```

**Arguments**

dend	a dendrogram object
value	a new value vector for the nodePar attribute. It should be the same length as the number of leaves in the tree. If not, it will recycle the value and issue a warning.
nodePar	the value inside nodePar to adjust.

warn	logical (default from dendextend_options("warn") is FALSE). Set if warnings are to be issued, it is safer to keep this at TRUE, but for keeping the noise down, the default is FALSE.
...	not used

## Value

A dendrogram, after adjusting the nodePar attribute in all of its leaves,

## See Also

[get\\_leaves\\_attr](#)

## Examples

```
## Not run:

dend <- USArrests[1:5, ] %>%
  dist() %>%
  hclust("ave") %>%
  as.dendrogram()

# reproduces "labels_colors<-"
# although it does force us to run through the tree twice,
# hence "labels_colors<-" is better...
plot(dend)
dend <- assign_values_to_leaves_nodePar(dend = dend, value = c(3, 2), nodePar = "lab.col")
plot(dend)

dend <- assign_values_to_leaves_nodePar(dend, 1, "pch")
plot(dend)
# fix the annoying pch=1:
dend <- assign_values_to_leaves_nodePar(dend, NA, "pch")
plot(dend)
# adjust the cex:
dend <- assign_values_to_leaves_nodePar(dend, 19, "pch")
dend <- assign_values_to_leaves_nodePar(dend, 2, "lab.cex")
plot(dend)

str(unclass(dend))

get_leaves_attr(dend, "nodePar", simplify = FALSE)

## End(Not run)
```



---

 assign\_values\_to\_nodes\_nodePar

*Assign values to nodePar of dendrogram's nodes*


---

### Description

Go through the dendrogram nodes and updates the values inside its nodePar  
 If the value has Inf then the value in edgePar will not be changed.

### Usage

```
assign_values_to_nodes_nodePar(
  dend,
  value,
  nodePar = c("pch", "cex", "col", "xpd", "bg"),
  warn = dendextend_options("warn"),
  ...
)
```

### Arguments

dend	a dendrogram object
value	a new value vector for the nodePar attribute. It should be the same length as the number of nodes in the tree. If not, it will recycle the value and issue a warning.
nodePar	the value inside nodePar to adjust. This may contain components named pch, cex, col, xpd, and/or bg.
warn	logical (default from dendextend_options("warn") is FALSE). Set if warning are to be issued, it is safer to keep this at TRUE, but for keeping the noise down, the default is FALSE.
...	not used

### Value

A dendrogram, after adjusting the nodePar attribute in all of its nodes,

### See Also

[get\\_leaves\\_attr](#), [assign\\_values\\_to\\_leaves\\_nodePar](#)

### Examples

```
## Not run:

dend <- USArrests[1:5, ] %>%
  dist() %>%
  hclust("ave") %>%
```

```

as.dendrogram()

# reproduces "labels_colors<-"
# although it does force us to run through the tree twice,
# hence "labels_colors<-" is better...
plot(dend)
dend2 <- dend %>%
  assign_values_to_nodes_nodePar(value = 19, nodePar = "pch") %>%
  assign_values_to_nodes_nodePar(value = c(1, 2), nodePar = "cex") %>%
  assign_values_to_nodes_nodePar(value = c(2, 1), nodePar = "col")
plot(dend2)

### Making sure this works for NA with character.
dend %>%
  assign_values_to_nodes_nodePar(value = 19, nodePar = "pch") %>%
  assign_values_to_nodes_nodePar(value = c("red", NA), nodePar = "col") -> dend2
plot(dend2)

## End(Not run)

```

---

as\_hclust\_fixed

*Convert dendrogram Objects to Class hclust*


---

## Description

Convert dendrogram Objects to Class hclust while preserving the call/method/dist.method values of the original hclust object (hc)

## Usage

```
as_hclust_fixed(x, hc, ...)
```

## Arguments

x	any object which has an as.hclust method. (mostly used for dendrogram)
hc	an old hclust object from which to re-use the call/method/dist.method values
...	passed to as.hclust

## Value

An hclust object (from a dendrogram) with the original hclust call/method/dist.method values

## See Also

[as.hclust](#)

**Examples**

```
hc <- hclust(dist(USArrests[1:3, ]), "ave")
dend <- as.dendrogram(hc)

as.hclust(dend)
as_hclust_fixed(dend, hc)
```

---

```
bakers_gamma_for_2_k_matrix
```

*Bakers Gamma for two k matrices*

---

**Description**

Bakers Gamma for two k matrices

**Usage**

```
bakers_gamma_for_2_k_matrix(  
  k_matrix_dend1,  
  k_matrix_dend2,  
  to_plot = FALSE,  
  ...  
)
```

**Arguments**

`k_matrix_dend1` a matrix of k cluster groupings from a dendrogram  
`k_matrix_dend2` a (second) matrix of k cluster groupings from a dendrogram  
`to_plot` logical (FALSE). Should a scatterplot be plotted, showing the correlation between the lowest shared branch between two items in the two compared trees.  
... not used

**Value**

Baker's Gamma coefficient.

**See Also**

[cor\\_bakers\\_gamma](#)

---

Bk *Bk - Calculating Fowlkes-Mallows Index for two dendrogram*

---

### Description

Bk is the calculation of Fowlkes-Mallows index for a series of k cuts for two dendrograms.

### Usage

```
Bk(tree1, tree2, k, warn = dendextend_options("warn"), ...)
```

### Arguments

tree1	a dendrogram/hclust/phylo object.
tree2	a dendrogram/hclust/phylo object.
k	an integer scalar or vector with the desired number of cluster groups. If missing - the Bk will be calculated for a default k range of 2:(nleaves-1). No point in checking k=1/k=n, since both will give Bk=1.
warn	logical (default from dendextend_options("warn") is FALSE). Set if warning are to be issued, it is safer to keep this at TRUE, but for keeping the noise down, the default is FALSE.
...	Ignored (passed to FM_index_R).

### Details

From Wikipedia:

Fowlkes-Mallows index (see references) is an external evaluation method that is used to determine the similarity between two clusterings (clusters obtained after a clustering algorithm). This measure of similarity could be either between two hierarchical clusterings or a clustering and a benchmark classification. A higher the value for the Fowlkes-Mallows index indicates a greater similarity between the clusters and the benchmark classifications.

### Value

A list (of k's length) of Fowlkes-Mallows index between two dendrogram for a scalar/vector of k values. The names of the lists' items is the k for which it was calculated.

### References

Fowlkes, E. B.; Mallows, C. L. (1 September 1983). "A Method for Comparing Two Hierarchical Clusterings". *Journal of the American Statistical Association* 78 (383): 553.

[https://en.wikipedia.org/wiki/Fowlkes-Mallows\\_index](https://en.wikipedia.org/wiki/Fowlkes-Mallows_index)

### See Also

[FM\\_index](#), [cor\\_bakers\\_gamma](#), [Bk\\_plot](#)

**Examples**

```
## Not run:

set.seed(23235)
ss <- TRUE # sample(1:150, 10 )
hc1 <- hclust(dist(iris[ss, -5]), "com")
hc2 <- hclust(dist(iris[ss, -5]), "single")
tree1 <- as.dendrogram(hc1)
tree2 <- as.dendrogram(hc2)
#   cutree(tree1)

Bk(hc1, hc2, k = 3)
Bk(hc1, hc2, k = 2:10)
Bk(hc1, hc2)

Bk(tree1, tree2, k = 3)
Bk(tree1, tree2, k = 2:5)

system.time(Bk(hc1, hc2, k = 2:5)) # 0.01
system.time(Bk(hc1, hc2)) # 1.28
system.time(Bk(tree1, tree2, k = 2:5)) # 0.24 # after fixes.
system.time(Bk(tree1, tree2, k = 2:10)) # 0.31 # after fixes.
system.time(Bk(tree1, tree2)) # 7.85
Bk(tree1, tree2, k = 99:101)

y <- Bk(hc1, hc2, k = 2:10)
plot(unlist(y) ~ c(2:10), type = "b", ylim = c(0, 1))

# can take a few seconds
y <- Bk(hc1, hc2)
plot(unlist(y) ~ as.numeric(names(y)),
     main = "Bk plot", pch = 20,
     xlab = "k", ylab = "FM Index",
     type = "b", ylim = c(0, 1)
)
# we are still missing some hypothesis testing here.
# for this we'll have the Bk_plot function.

## End(Not run)
```

---

Bk\_permutations

*Bk permutation - Calculating Fowlkes-Mallows Index for two dendro-gram*


---

**Description**

Bk is the calculation of Fowlkes-Mallows index for a series of k cuts for two dendrograms.

Bk permutation calculates the Bk under the null hypothesis of no similarity between the two trees by randomly shuffling the labels of the two trees and calculating their Bk.

**Usage**

```
Bk_permutations(
  tree1,
  tree2,
  k,
  R = 1000,
  warn = dendextend_options("warn"),
  ...
)
```

**Arguments**

tree1	a dendrogram/hclust/phylo object.
tree2	a dendrogram/hclust/phylo object.
k	an integer scalar or vector with the desired number of cluster groups. If missing - the Bk will be calculated for a default k range of 2:(nleaves-1). No point in checking k=1/k=n, since both will give Bk=1.
R	integer (Default is 1000). The number of Bk permutation to perform for each k.
warn	logical (default from dendextend_options("warn") is FALSE). Set if warning are to be issued, it is safer to keep this at TRUE, but for keeping the noise down, the default is FALSE. If set to TRUE, extra checks are made to varify that the two clusters have the same size and the same labels.
...	Ignored (passed to FM_index_R).

**Details**

From Wikipedia:

Fowlkes-Mallows index (see references) is an external evaluation method that is used to determine the similarity between two clusterings (clusters obtained after a clustering algorithm). This measure of similarity could be either between two hierarchical clusterings or a clustering and a benchmark classification. A higher the value for the Fowlkes-Mallows index indicates a greater similarity between the clusters and the benchmark classifications.

**Value**

A list (of the length of k's), where each element of the list has R (number of permutations) calculations of Fowlkes-Mallows index between two dendrogram after having their labels shuffled.

The names of the lists' items is the k for which it was calculated.

**References**

Fowlkes, E. B.; Mallows, C. L. (1 September 1983). "A Method for Comparing Two Hierarchical Clusterings". *Journal of the American Statistical Association* 78 (383): 553.

[https://en.wikipedia.org/wiki/Fowlkes-Mallows\\_index](https://en.wikipedia.org/wiki/Fowlkes-Mallows_index)

**See Also**[FM\\_index](#), [Bk](#)**Examples**

```
## Not run:

set.seed(23235)
ss <- TRUE # sample(1:150, 10 )
hc1 <- hclust(dist(iris[ss, -5]), "com")
hc2 <- hclust(dist(iris[ss, -5]), "single")
# tree1 <- as.treerogram(hc1)
# tree2 <- as.treerogram(hc2)
#   cutree(tree1)

some_Bk <- Bk(hc1, hc2, k = 20)
some_Bk_permu <- Bk_permutations(hc1, hc2, k = 20)

# we can see that the Bk is much higher than the permutation Bks:
plot(
  x = rep(1, 1000), y = some_Bk_permu[[1]],
  main = "Bk distribution under H0",
  ylim = c(0, 1)
)
points(1, y = some_Bk, pch = 19, col = 2)

## End(Not run)
```

---

**Bk\_plot***Bk plot - plotting the Fowlkes-Mallows Index of two dendrogram for various k's*

---

**Description**

Bk is the calculation of Fowlkes-Mallows index for a series of k cuts for two dendrograms. A Bk plot is simply a scatter plot of Bk versus k. This plot helps in identifying the similarity between two dendrograms in different levels of k (number of clusters).

**Usage**

```
Bk_plot(
  tree1,
  tree2,
  k,
  add_E = TRUE,
  rejection_line_asymptotic = TRUE,
  rejection_line_permutation = FALSE,
  R = 1000,
  k_permutation,
```

```

conf.level = 0.95,
p.adjust.methods = c("none", "bonferroni"),
col_line_Bk = 1,
col_line_asymptotic = 2,
col_line_permutation = 4,
warn = dendextend_options("warn"),
main = "Bk plot",
xlab = "k (number of clusters)",
ylab = "Bk (Fowlkes-Mallows Index)",
xlim,
ylim = c(0, 1),
try_cutree_hclust = TRUE,
...
)

```

### Arguments

tree1	a dendrogram/hclust/phylo object.
tree2	a dendrogram/hclust/phylo object.
k	an integer scalar or vector with the desired number of cluster groups. If missing - the Bk will be calculated for a default k range of 2:(nleaves-1). No point in checking k=1/k=n, since both will give Bk=1.
add_E	logical (TRUE). Should we add a line of the Expected Bk value for each k, under the null hypothesis of no relation between the clusterings?
rejection_line_asymptotic	logical (TRUE). Should we add a line of the one sided rejection region based on the asymptotic distribution of Bk values, for each k, under the null hypothesis of no relation between the clusterings?
rejection_line_permutation	logical (FALSE). Should we add a line of the one sided rejection region based on the asymptotic distribution of Bk values, for each k, under the null hypothesis of no relation between the clusterings?
R	integer (Default is 1000). The number of Bk permutation to perform for each k. Applicable only if rejection_line_permutation is TRUE.
k_permutation	the k's to be used for permutation (sometimes we might be only interested in some k's and it is not important to run the simulation for all possible ks). If missing - k itself will be used.
conf.level	the level of one sided confidence interval used for creation of the rejection lines.
p.adjust.methods	a character scalar of either "none" (default), or "bonferroni". This controls the multiple correction method to use for the critical rejection values. Currently only the Bonferroni method is implemented (based on the number of different k values).
col_line_Bk	the color of the Bk line.
col_line_asymptotic	the color of the rejection asymptotic Bk line.



col_line_permutation	the color of the rejection asymptotic Bk line.
warn	logical (default from dendextend_options("warn") is FALSE). Set if warning are to be issued, it is safer to keep this at TRUE, but for keeping the noise down, the default is FALSE. If set to TRUE, extra checks are made to varify that the two clusters have the same size and the same labels.
main	passed to <a href="#">plot</a> .
xlab	passed to <a href="#">plot</a> .
ylab	passed to <a href="#">plot</a> .
xlim	passed to <a href="#">plot</a> . If missign, xlim is from 2 to nleaves-1
ylim	passed to <a href="#">plot</a> .
try_cutree_hclust	logical (TRUE). Since cutree for hclust is MUCH faster than for dendrogram - Bk_plot will first try to change the dendrogram into an hclust object. If it will fail (for example, with unbranched trees), it will continue using the cutree.dendrogram functions. If try_cutree_hclust=FALSE, it will force to use cutree.dendrogram and not cutree.hclust.
...	Ignored.

## Details

From Wikipedia:

Fowlkes-Mallows index (see references) is an external evaluation method that is used to determine the similarity between two clusterings (clusters obtained after a clustering algorithm). This measure of similarity could be either between two hierarchical clusterings or a clustering and a benchmark classification. A higher the value for the Fowlkes-Mallows index indicates a greater similarity between the clusters and the benchmark classifications.

The default Bk plot comes with a line with dots (type "b") of the Bk values. Also with a fragmented (lty=2) line (of the same color) of the expected Bk line under H0, And a solid red line of the upper critical Bk values for rejection

## Value

After plotting the Bk plot. Returns (invisible) the output of the elements used for constructing the plot: The Bk values, Bk permutations (if used), Bk theoretical values, etc.

## References

Fowlkes, E. B.; Mallows, C. L. (1 September 1983). "A Method for Comparing Two Hierarchical Clusterings". *Journal of the American Statistical Association* 78 (383): 553.

[https://en.wikipedia.org/wiki/Fowlkes-Mallows\\_index](https://en.wikipedia.org/wiki/Fowlkes-Mallows_index)

## See Also

[FM\\_index](#), [Bk](#), [Bk\\_permutations](#)

**Examples**

```

## Not run:

set.seed(23235)
ss <- TRUE # sample(1:150, 10 )
hc1 <- hclust(dist(iris[ss, -5]), "com")
hc2 <- hclust(dist(iris[ss, -5]), "single")
# tree1 <- as.treerogram(hc1)
# tree2 <- as.treerogram(hc2)
#   cutree(tree1)

Bk_plot(hc1, hc2, k = 2:20, xlim = c(2, 149))
Bk_plot(hc1, hc2)

Bk_plot(hc1, hc2, k = 3)
Bk_plot(hc1, hc2, k = 3:10)
Bk_plot(hc1, hc2)
Bk_plot(hc1, hc2, p.adjust.methods = "bonferroni") # higher rejection lines

# this one can take a bit of time:
Bk_plot(hc1, hc2,
  rejection_line_permutation = TRUE,
  k_permutation = c(2, 4, 6, 8, 10, 20, 30, 40, 50), R = 100
)
# we can see that the permutation line is VERY close to the asymptotic line.
# This is great since it means one can often use the asymptotic results
# Without having to do many simulations.

# works just as well for dendrograms:
dend1 <- as.dendrogram(hc1)
dend2 <- as.dendrogram(hc2)
Bk_plot(dend1, dend2, k = 2:3, try_cutree_hclust = FALSE) # slower than hclust, but works...
Bk_plot(hc1, dend2, k = 2:3, try_cutree_hclust = FALSE) # slower than hclust, but works...
Bk_plot(dend1, dend1, k = 2:3, try_cutree_hclust = TRUE) # slower than hclust, but works...
Bk_plot(hc1, hc1, k = 2:3) # slower than hclust, but works...
# for some reason it can't turn dend2 back to hclust :(
a <- Bk_plot(hc1, hc2, k = 2:3, try_cutree_hclust = TRUE) # slower than hclust, but works...

hc1_mixed <- as.hclust(sample(as.dendrogram(hc1)))
Bk_plot(
  tree1 = hc1, tree2 = hc1_mixed,
  add_E = FALSE,
  rejection_line_permutation = TRUE, k_permutation = c(2, 4, 6, 8, 10, 20, 30, 40, 50), R = 100
)

## End(Not run)

```

**Description**

The user supplies a dend, a vector of clusters, and what to modify (and how).

And the function returns a dendrogram with branches col/lwd/lty accordingly. (the function assumes unique labels)

**Usage**

```
branches_attr_by_clusters(
  dend,
  clusters,
  values,
  attr = c("col", "lwd", "lty"),
  branches_changed_have_which_labels = c("any", "all"),
  ...
)
```

**Arguments**

dend	a dendrogram dend
clusters	an integer vector of clusters. This HAS to be of the same length as the number of leaves. Items that belong to no cluster should get the value 0. The vector should be of the same order as that of the labels in the dendrogram. If you create the clusters from something like <a href="#">cutree</a> you would first need to use <a href="#">order.dendrogram</a> on it, before using it in the function.
values	the attributes to use for non 0 values. This should be of the same length as the number of unique non-0 clusters. If it is shorter, it is recycled. OR, this can also be of the same length as the number of leaves in the tree In which case, the values will be aggregated (i.e.: <a href="#">tapply</a> ), to match the number of clusters. The first value of each cluster will be used as the main value. TODO: So far, the function doesn't deal well with NA values. (this might be changed in the future)
attr	a character with one of the following values: col/lwd/lty
branches_changed_have_which_labels	character with either "any" (default) or "all". Indicates how the branches should be updated.
...	ignored.

**Details**

This is probably NOT a very fast implementation of the function, but it works.

This function was designed to enable the manipulation (mainly coloring) of branches, based on the results from the [cutreeDynamic](#) function.

**Value**

A dendrogram with modified branches (col/lwd/lty).

**See Also**

[branches\\_attr\\_by\\_labels](#), [get\\_leaves\\_attr](#), [nnodes](#), [nleaves](#) [cutreeDynamic](#), [plotDendroAndColors](#)

**Examples**

```
## Not run:

### Getting the hc object
iris_dist <- iris[, -5] %>% dist()
hc <- iris_dist %>% hclust()
# This is how it looks without any colors:
dend <- as.dendrogram(hc)
plot(dend)

# Both functions give the same outcome
# options 1:
dend %>%
  set("branches_k_color", k = 4) %>%
  plot()
# options 2:
clusters <- cutree(dend, 4)[order.dendrogram(dend)]
dend %>%
  branches_attr_by_clusters(clusters) %>%
  plot()

# and the second option is much slower:
system.time(set(dend, "branches_k_color", k = 4)) # 0.26 sec
system.time(branches_attr_by_clusters(dend, clusters)) # 1.61 sec
# BUT, it also allows us to do more flaxible things!

#-----
#   Plotting dynamicTreeCut
#-----

# let's get the clusters
library(dynamicTreeCut)
clusters <- cutreeDynamic(hc, distM = as.matrix(iris_dist))
# we need to sort them to the order of the dendrogram:
clusters <- clusters[order.dendrogram(dend)]

# get some functions:
library(colorspace)
no0_unique <- function(x) {
  u_x <- unique(x)
  u_x[u_x != 0]
}

clusters_numbers <- no0_unique(clusters)
n_clusters <- length(clusters_numbers)
cols <- rainbow_hcl(n_clusters)
dend2 <- branches_attr_by_clusters(dend, clusters, values = cols)
# dend2 <- branches_attr_by_clusters(dend, clusters)
```

```

plot(dend2)
# add colored bars:
ord_cols <- rainbow_hcl(n_clusters)[order(clusters_numbers)]
tmp_cols <- rep(1, length(clusters))
tmp_cols[clusters != 0] <- ord_cols[clusters != 0][clusters]
colored_bars(tmp_cols, y_shift = -1.1, rowLabels = "")
# all of the ordering is to handle the fact that the cluster numbers are not ascending...

# How is this compared with the usual cutree?
dend3 <- color_branches(dend, k = n_clusters)
labels(dend2) <- as.character(labels(dend2))
# this needs fixing, since the labels are not character!
# Well, both cluster solutions are not perfect, but at least they are interesting...
tanglegram(dend2, dend3,
  main_left = "cutreeDynamic", main_right = "cutree",
  columns_width = c(5, .5, 5),
  color_lines = cols[iris[order.dendrogram(dend2), 5]]
)
# (Notice how the color_lines is of the true Species of each Iris)
# The main difference is at the bottom,

## End(Not run)

```

---

branches\_attr\_by\_labels

*Change col/lwd/lty of branches matching labels condition*

---

## Description

The user supplies a dend, labels, and type of condition (all/any), and TF\_values And the function returns a dendrogram with branches col/lwd/lty accordingly

## Usage

```

branches_attr_by_labels(
  dend,
  labels,
  TF_values = c(2, Inf),
  attr = c("col", "lwd", "lty"),
  type = c("all", "any"),
  ...
)

```

## Arguments

dend	a dendrogram dend
labels	a character vector of labels from the tree

TF_values	a two dimensional vector with the TF_values to use in case a branch fulfills the condition (TRUE) and in the case that it does not (FALSE). Defaults are 2/Inf for col, lwd and lty. (so it will insert the first value, and will not change all the FALSE cases)
attr	a character with one of the following values: col/lwd/lty
type	a character vector of either "all" or "any", indicating which of the branches should be painted: ones that all of their labels belong to the supplied labels, or also ones that even some of their labels are included in the labels vector.
...	ignored.

**Value**

A dendrogram with modified branches (col/lwd/lty).

**See Also**

[noded\\_with\\_condition](#), [get\\_leaves\\_attr](#), [nnodes](#), [nleaves](#)

**Examples**

```
## Not run:

library(dendextend)

set.seed(23235)
ss <- sample(1:150, 10)

# Getting the dend dend
dend <- iris[ss, -5] %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
dend %>% plot()

dend %>%
  branches_attr_by_labels(c("123", "126", "23", "29")) %>%
  plot()
dend %>%
  branches_attr_by_labels(c("123", "126", "23", "29"), "all") %>%
  plot() # the same as above
dend %>%
  branches_attr_by_labels(c("123", "126", "23", "29"), "any") %>%
  plot()

dend %>%
  branches_attr_by_labels(
    c("123", "126", "23", "29"),
    "any", "col", c("blue", "red")
  ) %>%
  plot()
dend %>%
```

```

branches_attr_by_labels(
  c("123", "126", "23", "29"),
  "any", "lwd", c(4, 1)
) %>%
plot()
dend %>%
branches_attr_by_labels(
  c("123", "126", "23", "29"),
  "any", "lty", c(2, 1)
) %>%
plot()

## End(Not run)

```

---

branches\_attr\_by\_lists

*Change col/lwd/lty of branches from the root down to clusters defined by list of labels of respective members*

---

### Description

The user supplies a dend, lists, and type of condition (all/any), and TF\_values And the function returns a dendrogram with branches col/lwd/lty accordingly

### Usage

```

branches_attr_by_lists(
  dend,
  lists,
  TF_values = c(2, 1),
  attr = c("col", "lwd", "lty"),
  ...
)

```

### Arguments

dend	a dendrogram dend
lists	a list where each element contains the labels of members in selected nodes down to which the branches shall be adapted
TF_values	a two dimensional vector with the TF_values to use in case a branch fulfills the condition (TRUE) and in the case that it does not (FALSE). Defaults are 2/1 for col, lwd and lty. (so it will insert the first value, and will not change all the FALSE cases)
attr	a character with one of the following values: col/lwd/lty
...	ignored.

**Value**

A dendrogram with modified branches (col/lwd/lty).

**See Also**

[branches\\_attr\\_by\\_labels](#)

**Examples**

```
## Not run:

library(dendextend)

set.seed(23235)
ss <- sample(1:150, 10)

# Getting the dend dend
dend <- iris[ss, -5] %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
dend %>% plot()

# define a list of nodes
L <- list(c("109", "123", "126", "145"), "29", c("59", "67", "97"))
dend %>%
  branches_attr_by_lists(L) %>%
  plot()

# choose different color, and also change lwd and lty
dend %>%
  branches_attr_by_lists(L, TF_value = "blue") %>%
  branches_attr_by_lists(L, attr = "lwd", TF_value = 4) %>%
  branches_attr_by_lists(L, attr = "lty", TF_value = 3) %>%
  plot()

## End(Not run)
```

---

`circlize_dendrogram` *Plot a circlized dendrograms*

---

**Description**

Plot a circlized dendrograms using the circlize package (must be installed for the function to work).

This type of plot is also sometimes called fan tree plot (although the name fan-plot is also used for a different plot in time series analysis), radial tree plot, polar tree plot, circular tree plot, and probably other names as well.

An advantage for using the circlize package directly is for plotting a circular dendrogram so that you can add more graphics for the elements in the tree just by adding more tracks using [circos.track](#).



**Usage**

```
circlize_dendrogram(  
  dend,  
  facing = c("outside", "inside"),  
  labels = TRUE,  
  labels_track_height = 0.1,  
  dend_track_height = 0.5,  
  ...  
)
```

**Arguments**

dend	a <a href="#">dendrogram</a> object
facing	Is the dendromgrams facing inside to the circle or outside.
labels	logical (TRUE) - should the labels be plotted as well.
labels_track_height	a value for adjusting the room for the labels. It is 0.2 by default, but if NULL or NA, it will adjust automatically based on the max width of the labels. However, if this is too long, the plot will give an error: Error in check.track.position(track.index, track.start, track.height) : not enough space for cells at track index '2'.
dend_track_height	a value for adjusting the room for the dendrogram.
...	Ignored.

**Value**

The dend that was used for plotting.

**Author(s)**

Zuguang Gu, Tal Galili

**Source**

This code is based on the work of Zuguang Gu. If you use the function, please cite both dendextend (see: [citation\("dendextend"\)](#)), as well as the circlize package (see: [citation\("circlize"\)](#)).

**See Also**

[circos.dendrogram](#)

**Examples**

```
## Not run:  
  
dend <- iris[1:40, -5] %>%  
  dist() %>%  
  hclust() %>%
```

```

as.dendrogram() %>%
set("branches_k_color", k = 3) %>%
set("branches_lwd", c(5, 2, 1.5)) %>%
set("branches_lty", c(1, 1, 3, 1, 1, 2)) %>%
set("labels_colors") %>%
set("labels_cex", c(.9, 1.2)) %>%
set("nodes_pch", 19) %>%
set("nodes_col", c("orange", "black", "plum", NA))

circlize_dendrogram(dend)
circlize_dendrogram(dend, labels = FALSE)
circlize_dendrogram(dend, facing = "inside", labels = FALSE)

# In the following we get the dendrogram but can also get extra information on top of it
circos.initialize("foo", xlim = c(0, 40))
circos.track(ylim = c(0, 1), panel.fun = function(x, y) {
  circos.rect(1:40 - 0.8, rep(0, 40), 1:40 - 0.2, runif(40), col = rand_color(40), border = NA)
}, bg.border = NA)
circos.track(ylim = c(0, 1), panel.fun = function(x, y) {
  circos.text(1:40 - 0.5, rep(0, 40), labels(dend),
    col = labels_colors(dend),
    facing = "clockwise", niceFacing = TRUE, adj = c(0, 0.5)
  )
}, bg.border = NA, track.height = 0.1)
max_height <- attr(dend, "height")
circos.track(ylim = c(0, max_height), panel.fun = function(x, y) {
  circos.dendrogram(dend, max_height = max_height)
}, track.height = 0.5, bg.border = NA)
circos.clear()

## End(Not run)

```

---

click\_rotate

*Interactively rotate a tree object*

---

### Description

Lets te user click a plot of dendrogram and rotates the tree based on the location of the click.

Code for mouse selection of (sub-)cluster to be rotated

### Usage

```
click_rotate(x, ...)
```

```
## Default S3 method:
```

```
click_rotate(x, ...)
```

```
## S3 method for class 'dendrogram'
```

```
click_rotate(  
  x,  
  plot = TRUE,  
  plot_after = plot,  
  horiz = FALSE,  
  continue = FALSE,  
  ...  
)
```

### Arguments

x	a tree object (either a dendrogram or hclust)
...	parameters passed to the plot
plot	(logical) should the dendrogram first be plotted.
plot_after	(logical) should the dendrogram be plotted after the rotation?
horiz	logical. Should the plot be normal or horizontal?
continue	logical. If TRUE, allows the user to keep clicking the plot until a click is made on the labels.

### Value

A rotated tree object

### Author(s)

Andrej-Nikolai Spiess, Tal Galili

### See Also

[rotate.dendrogram](#)

### Examples

```
# create the dend:  
dend <- USArrests %>%  
  dist() %>%  
  hclust("ave") %>%  
  as.dendrogram() %>%  
  color_labels()  
## Not run:  
# play with the rotation once  
dend <- click_rotate(dend)  
dend <- click_rotate(dend, horiz = TRUE)  
# keep playing with the rotation:  
while (TRUE) dend <- click_rotate(dend)  
# the same as  
dend <- click_rotate(dend, continue = TRUE)  
  
## End(Not run)
```

---

collapse_branch	<i>Collapse branches under a tolerance level</i>
-----------------	--

---

**Description**

Collapse branches under a tolerance level

**Usage**

```
collapse_branch(dend, tol = 1e-08, lower = TRUE, ...)
```

**Arguments**

dend	dendrogram object
tol	a numeric value giving the tolerance to consider a branch length significantly greater than zero
lower	logical (TRUE). collapse branches which are lower than tol?
...	passed on (not used)

**Value**

A dendrogram with both of the root's branches of the same height

**See Also**

[multi2di](#)

**Examples**

```
# # ladderize is like sort(..., type = "node")
dend <- iris[1:5, -5] %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
par(mfrow = c(1, 3))
dend %>%
  ladderize() %>%
  plot(horiz = TRUE)
abline(v = .2, col = 2, lty = 2)
dend %>%
  collapse_branch(tol = 0.2) %>%
  ladderize() %>%
  plot(horiz = TRUE)
dend %>%
  collapse_branch(tol = 0.2) %>%
  ladderize() %>%
  hang.dendrogram(hang = 0) %>%
  plot(horiz = TRUE)
```

```

par(mfrow = c(1, 2))
dend %>%
  collapse_branch(tol = 0.2, lower = FALSE) %>%
  plot(horiz = TRUE, main = "dendrogram")
library(ape)
dend %>%
  as.phylo() %>%
  di2multi(tol = 0.2) %>%
  plot(main = "phylo")

```

---

collapse_labels	<i>Collapse a sub dendrogram of adjacent labels within a dend</i>
-----------------	---

---

### Description

Given a dendrogram object, and a set of labels that are in the same sub-dendrogram, the function performs a recursive DFS algorithm to determine the sub-dendrogram which is composed of (exactly) all 'selected\_labels'. It then squashes this sub-dendrogram, and returns the original dendrogram with the squashed dendrogram with it.

### Usage

```
collapse_labels(dend, selected_labels, ...)
```

### Arguments

dend	a dendrogram object
selected_labels	A character vector with the labels we expect to have in the sub-dendrogram. This doesn't have to be in the same order as in the dendrogram.
...	elipsis (passed to squash_dendrogram)

### Value

Either the original dend. Or, if the labels properly are in the dend by each other, a dend with a squashed sub-dendrogram inside it.

### Examples

```

library("dendextend")

set.seed(23235)
ss <- sample(1:150, 5)

# Getting the dend object
dend25 <- iris[ss, -5] %>%
  dist() %>%
  hclust() %>%

```

```

as.dendrogram() %>%
  set("labels", letters[1:5])

par(mfrow = c(1,4))
plot(dend25)
plot(collapse_labels(dend25, c("d", "e")))
plot(collapse_labels(dend25, c("c", "d", "e")))
plot(collapse_labels(dend25, c("c", "d", "e"), squashed_original_height=TRUE))

```

---

colored\_bars

*Add colored bars to a dendrogram*


---

### Description

Add colored bars to a dendrogram, usually corresponding to either clusters or some outside categorization.

### Usage

```

colored_bars(
  colors,
  dend,
  rowLabels = NULL,
  cex.rowLabels = 0.9,
  add = TRUE,
  y_scale,
  y_shift,
  text_shift = 1,
  sort_by_labels_order = TRUE,
  horiz = FALSE,
  ...
)

```

### Arguments

colors	Coloring of objects on the dendrogram. Either a vector (one color per object) or a matrix (can also be an array or a data frame) with each column giving one group with color per object. Each column will be plotted as a horizontal row of colors (when <code>horiz = FALSE</code> ) under the dendrogram. As long as the <code>sort_by_labels_order</code> parameter is <code>TRUE</code> (default), the colors vector/matrix should be provided in the order of the original data order (and it will be re-ordered automaticall to the order of the dendrogram)
dend	a dendrogram object. If missing, the colors are plotted without and re-ordering (this assumes that the colors are already ordered based on the dend's labels) This is also important in order to get the correct height/location of the colored bars (i.e.: adjusting the <code>y_scale</code> and <code>y_shift</code> )

rowLabels	Labels for the colorings given in colors. The labels will be printed to the left of the color rows in the plot. If the argument is given, it must be a vector of length equal to the number of columns in colors. If not given, names(colors) will be used if available. If not, sequential numbers starting from 1 will be used.
cex.rowLabels	Font size scale factor for the row labels. See <a href="#">par</a> .
add	logical(TRUE), should the colored bars be added to an existing dendrogram plot?
y_scale	how much should the bars be stretched on the y axis? If no dend is supplied - the default will be 1
y_shift	where should the bars be plotted underneath the x axis? By default it will try to locate the bars underneath the labels (it may miss, in which case you would need to enter a number manually) If no dend is supplied - the default will be 0
text_shift	a dendrogram object
sort_by_labels_order	logical(TRUE) - if TRUE (default), then the order of the colored bars will be sorted based on the order needed to change the original order of the observations to the current order of the labels in the dendrogram. If FALSE the colored bars are plotted as-is, based on the order of the colors vector.
horiz	logical (FALSE by default). Set to TRUE when using plot(dend, horiz = TRUE)
...	ignored at this point.

### Details

You will often needs to adjust the `y_scale`, `y_shift` and the `text_shift` parameters, in order to get the bars in the location you would want.

(this can probably be done automatically, but will require more work. since it has to do with the current mar settings, the number of groups, and each computer's specific graphic device. patches for smarter defaults will be appreciated)

### Value

An invisible vector/matrix with the ordered colors.

### Author(s)

Steve Horvath <SHorvath@mednet.ucla.edu>, Peter Langfelder <Peter.Langfelder@gmail.com>, Tal Galili <Tal.Galili@gmail.com>

### Source

This function is based on the [plotHclustColors](#) from the moduleColor R package. It was modified so that it would work with dendrograms (and not just hclust objects), as well allow to add the colored bars on top of an existing plot (and not only as a seperate plot).

See: <https://cran.r-project.org/package=moduleColor> For more details.

**See Also**

[branches\\_attr\\_by\\_clusters](#), [plotDendroAndColors](#)

**Examples**

```

rows_picking <- c(1:5, 25:30)
dend <- (iris[rows_picking, -5] * 10) %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
odd_numbers <- rows_picking %% 2
cols <- c("gold", "grey")[odd_numbers + 1]
# scale is off
plot(dend)
colored_bars(cols, dend)
# move and scale a bit
plot(dend)
colored_bars(cols, dend,
  y_shift = -1,
  rowLabels = "Odd\n numbers"
)
# Now let's cut the tree and add that info to the plot:
k2 <- cutree(dend, k = 2)
cols2 <- c("#0082CE", "#CC476B")[k2]
plot(dend)
colored_bars(cbind(cols2, cols), dend,
  rowLabels = c("2 clusters", "Odd numbers")
)

# The same, but with an horizontal plot!
par(mar = c(6, 2, 2, 4))
plot(dend, horiz = TRUE)
colored_bars(cbind(cols2, cols), dend,
  rowLabels = c("2 clusters", "Odd numbers"),
  horiz = TRUE
)

# let's add clusters color
# notice how we need to play with the colors a bit
# this is because color_branches places colors from
# left to right. Which means we need to give colored_bars
# the colors of the items so that after sorting they would be
# from left to right. Here is how it can be done:
the_k <- 3
library(colorspace)
cols3 <- rainbow_hcl(the_k, c = 90, l = 50)
dend %>%
  set("branches_k_color", k = the_k, with = cols3) %>%
  plot()

```



```

kx <- cutree(dend, k = the_k)
ord <- order.dendrogram(dend)
kx <- sort_levels_values(kx[ord])
kx <- kx[match(seq_along(ord), ord)]

par(mar = c(5, 5, 2, 2))
plot(dend)
colored_bars(cbind(cols3[kx], cols2, cols), dend,
  rowLabels = c("3 clusters", "2 clusters", "Odd numbers")
)

## mtcars example

# Create the dend:
dend <- as.dendrogram(hclust(dist(mtcars)))

# Create a vector giving a color for each car to which company it belongs to
car_type <- rep("Other", length(rownames(mtcars)))
is_x <- grepl("Merc", rownames(mtcars))
car_type[is_x] <- "Mercedes"
is_x <- grepl("Mazda", rownames(mtcars))
car_type[is_x] <- "Mazda"
is_x <- grepl("Toyota", rownames(mtcars))
car_type[is_x] <- "Toyota"
car_type <- factor(car_type)
n_car_types <- length(unique(car_type))
col_car_type <- colorspace::rainbow_hcl(n_car_types, c = 70, l = 50)[car_type]

# extra: showing the various clusters cuts
k234 <- cutree(dend, k = 2:4)

# color labels by car company:
labels_colors(dend) <- col_car_type[order.dendrogram(dend)]
# color branches based on cutting the tree into 4 clusters:
dend <- color_branches(dend, k = 4)

### plots
par(mar = c(12, 4, 1, 1))
plot(dend)
colored_bars(cbind(k234[, 3:1], col_car_type), dend,
  rowLabels = c(paste0("k = ", 4:2), "Car Type")
)

# horiz version:
par(mar = c(4, 1, 1, 12))
plot(dend, horiz = TRUE)
colored_bars(cbind(k234[, 3:1], col_car_type), dend,
  rowLabels = c(paste0("k = ", 4:2), "Car Type"), horiz = TRUE
)

```

---

 colored\_dots

*Add colored dots beside a dendrogram*


---

### Description

Add colored dots next to a dendrogram, usually corresponding to either clusters or some outside categorization.

### Usage

```
colored_dots(
  colors,
  dend,
  rowLabels = NULL,
  cex.rowLabels = 0.9,
  add = TRUE,
  y_scale,
  y_shift,
  text_shift = 1,
  sort_by_labels_order = TRUE,
  horiz = FALSE,
  dot_size = 1,
  ...
)
```

### Arguments

colors	Coloring of the dots beside the dendrogram. Either a vector (one color per object) or a matrix (can also be an array or a data frame) with each column giving one group with color per object. Each column will be plotted as a colored point (when <code>horiz = FALSE</code> ) under the dendrogram. As long as the <code>sort_by_labels_order</code> parameter is <code>TRUE</code> (default), the colors vector/matrix should be provided in the order of the original data order (and it will be re-ordered automatically to the order of the dendrogram)
dend	a dendrogram object. If missing, the colors are plotted without and re-ordering (this assumes that the colors are already ordered based on the dend's labels) This is also important in order to get the correct height/location of the colored dots (i.e.: adjusting the <code>y_scale</code> and <code>y_shift</code> )
rowLabels	Labels for the colorings given in <code>colors</code> . The labels will be printed to the left of the color rows in the plot. If the argument is given, it must be a vector of length equal to the number of columns in <code>colors</code> . If not given, <code>names(colors)</code> will be used if available. If not, sequential numbers starting from 1 will be used.
cex.rowLabels	Font size scale factor for the row labels. See <a href="#">par</a> .
add	logical( <code>TRUE</code> ), should the colored dots be added to an existing dendrogram plot?

y_scale	how much should the dots be stretched on the y axis? If no dend is supplied - the default will be 1
y_shift	where should the dots be plotted underneath the x axis? By default it will try to locate the dots underneath the labels (it may miss, in which case you would need to enter a number manually) If no dend is supplied - the default will be 0
text_shift	a dendrogram object
sort_by_labels_order	logical(TRUE) - if TRUE (default), then the order of the colored dots will be sorted based on the order needed to change the original order of the observations to the current order of the labels in the dendrogram. If FALSE the colored dots are plotted as-is, based on the order of the colors vector.
horiz	logical (FALSE by default). Set to TRUE when using plot(dend, horiz = TRUE)
dot_size	numeric (1 by default). Passed to cex argument in points
...	ignored at this point.

### Details

The reason you might choose `colored_dots` over `colored_bars` is when you have a lot of group types and/or a really large dendrogram. Hint: Make a group for each categorical factor and color it one color when true, and assign a fully transparent color when false.

You will often need to adjust the `y_scale`, `y_shift` and the `text_shift` parameters, in order to get the dots in the location you would want.

(This can probably be done automatically, but will require more work. since it has to do with the current mar settings, the number of groups, and each computer's specific graphic device. patches for smarter defaults will be appreciated)

### Value

An invisible vector/matrix with the ordered colors.

### Author(s)

Steve Horvath <SHorvath@mednet.ucla.edu>, Tal Galili <Tal.Galili@gmail.com>, Peter Langfelder <Peter.Langfelder@gmail.com>, Chase Clark <chasec288@gmail.com>

### Source

This function is based on the [plotHclustColors](#) from the `moduleColor` R package. It was modified so that it would work with dendrograms (and not just hclust objects), as well allow to add the colored dots on top of an existing plot (and not only as a separate plot).

See: <https://cran.r-project.org/package=moduleColor> For more details.

### See Also

[branches\\_attr\\_by\\_clusters](#), [plotDendroAndColors](#)

**Examples**

```

rows_picking <- c(1:5, 25:30)
dend <- (iris[rows_picking, -5] * 10) %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
odd_numbers <- rows_picking %% 2
cols <- c("red", "white")[odd_numbers + 1]
plot(dend)
colored_dots(cols, dend)
# Example of adjusting position of dots
plot(dend)
colored_dots(cols, dend,
  y_shift = -1,
  rowLabels = "Odd\n numbers"
)

```

```

rows_picking <- c(1:5, 25:30)
dend <- (iris[rows_picking, -5] * 10) %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
odd_numbers <- rows_picking %% 2
# For leaves that shouldn't have dots, make them the same color as the background,
# or set the alpha value to fully transparent
cols <- c("black", "white")[odd_numbers + 1]
# scale is off
plot(dend)
colored_dots(cols, dend)
# move and scale a bit
plot(dend)
colored_dots(cols, dend,
  y_shift = -1,
  rowLabels = "Odd\n numbers"
)
# Now let's cut the tree and add that info to the plot:
k2 <- cutree(dend, k = 2)
cols2 <- c("#1b9e77", "#d95f02")[k2]

par(mar = c(5, 6, 1, 1))
plot(dend)
colored_dots(cbind(cols2, cols), dend,
  rowLabels = c("2 clusters", "Even numbers")
)

```

```

# The same, but with an horizontal plot!
par(mar = c(6, 2, 2, 4))
plot(dend, horiz = TRUE)
colored_dots(cbind(cols2, cols), dend,
  rowLabels = c("2 clusters", "Even numbers"),

```

```

    horiz = TRUE
  )

# =====
# =====

## mtcars example

# Create the dend:
dend <- as.dendrogram(hclust(dist(mtcars)))

# Get all company names
comp_names <- unlist(lapply(rownames(mtcars), function(x) strsplit(x, " ")[[1]][[1]]))
# Get the top three occurring companies
top_three <- sort(table(comp_names), decreasing = TRUE)[1:3]
# Match the top three companies to where they are found in the dendrogram labels
top_three <- sapply(names(top_three), function(x) grepl(x, labels(dend)))
top_three <- as.data.frame(top_three)
# "top_three" is now a data frame of the top three companies as columns.
# Each column represents a vector (rows) which is the length of labels(dend).
# The vector has values TRUE and FALSE, for whether the company name matched
# labels(dend)[i]

# Colorblind friendly vector of HEX colors
colorblind_friendly <- c("#1b9e77", "#d95f02", "#7570b3")

# If we run the for-loop on "top_three" we will turn the vectors into a character-type too early,
# so make a copy to "colored_dataframe" which we will work on
colored_dataframe <- top_three

for (i in 1:3) {
  # This replaces TRUE values with a color from our vector of colors
  colored_dataframe[top_three[, i], i] <- colorblind_friendly[[i]]
  # This replaces FALSE values with black HEX, but fully transparent (invisible on plot)
  colored_dataframe[!top_three[, i], i] <- "#00000000"
}

# Color branches and labels by "cutting" the dendrogram at an arbitrary height
dend <- color_branches(dend, h = 170)
dend <- color_labels(dend, h = 170)

### plots
par(mar = c(12, 4, 1, 1))
plot(dend)
colored_dots(colored_dataframe, dend,
  rowLabels = colnames(colored_dataframe), horiz = FALSE, sort_by_labels_order = FALSE
)
# Show a dotted line where tree was "cut"
abline(h = 170, lty = 3)

# horiz version:
par(mar = c(4, 1, 1, 12))
plot(dend, horiz = TRUE)

```

```

colored_dots(colored_dataframe, dend,
  rowLabels = colnames(colored_dataframe), horiz = TRUE, sort_by_labels_order = FALSE
)
# Show a dotted line where the tree was "cut"
abline(v = 170, lty = 3)

```

---

color\_branches

*Color tree's branches according to sub-clusters*


---

### Description

This function is for dendrogram and hclust objects. This function colors both the terminal leaves of a dend's cluster and the edges leading to those leaves. The edgePar attribute of nodes will be augmented by a new list item col. The groups will be defined by a call to [cutree](#) using the k or h parameters.

If col is a color vector with a different length than the number of clusters (k) - then a recycled color vector will be used.

### Usage

```

color_branches(
  dend,
  k = NULL,
  h = NULL,
  col,
  groupLabels = NULL,
  clusters,
  warn = dendextend_options("warn"),
  ...
)

```

### Arguments

dend	A dendrogram or hclust tree object
k	number of groups (passed to <a href="#">cutree</a> )
h	height at which to cut tree (passed to <a href="#">cutree</a> )
col	Function or vector of Colors. By default it tries to use <a href="#">rainbow_hcl</a> from the colorspace package. (with parameters c=90 and l=50). If colorspace is not available, It will fall back on the <a href="#">rainbow</a> function.
groupLabels	If TRUE add numeric group label - see Details for options
clusters	an integer vector of clusters. This is passed to <a href="#">branches_attr_by_clusters</a> . This HAS to be of the same length as the number of leaves. Items that belong to no cluster should get the value 0. The vector should be of the same order as that of the labels in the dendrogram. If you create the clusters from something like <a href="#">cutree</a> you would first need to use <a href="#">order.dendrogram</a> on it, before using it in the function.

warn	logical (default from <code>dendextend_options("warn")</code> is FALSE). Set if warnings are to be issued, it is safer to keep this at TRUE, but for keeping the noise down, the default is FALSE.
...	ignored.

### Details

If `groupLabels=TRUE` then numeric group labels will be added to each cluster. If a vector is supplied then these entries will be used as the group labels. If a function is supplied then it will be passed a numeric vector of groups (e.g. 1:5) and must return the formatted group labels.

If the `labels` of the dendrogram are NOT character (but, for example integers) - they are coerced into character. This step is essential for the proper operation of the function. A dendrogram labels might happen to be integers if they are based on an `hclust` performed on a `dist` of an object without `rownames`.

### Value

a tree object of class `dendrogram`.

### Author(s)

Tal Galili, extensively based on code by Gregory Jefferis

### Source

This function is a derived work from the `color_clusters` function, with some ideas from the `slice` function - both are from the `dendroextras` package by jefferis.

It extends it by using `cutree.dendrogram` - allowing the function to work for trees that `hclust` can not handle (unbranched and non-ultrametric trees). Also, it allows REPEATED cluster color assignments to branches on to the same tree. Something which the original function was not able to handle.

### See Also

`cutree.dendrogram`, `hclust`, `labels_colors`, `branches_attr_by_clusters`, `get_leaves_branches_col`, `color_labels`

### Examples

```
## Not run:
par(mfrow = c(1, 2))
dend <- USArrests %>%
  dist() %>%
  hclust(method = "ave") %>%
  as.dendrogram()
d1 <- color_branches(dend, k = 5, col = c(3, 1, 1, 4, 1))
plot(d1) # selective coloring of branches :)
d2 <- color_branches(dend, 5)
plot(d2)
```

```

par(mfrow = c(1, 2))
d1 <- color_branches(dend, 5, col = c(3, 1, 1, 4, 1), groupLabels = TRUE)
plot(d1) # selective coloring of branches :)
d2 <- color_branches(dend, 5, groupLabels = TRUE)
plot(d2)

par(mfrow = c(1, 3))
d5 <- color_branches(dend, 5)
plot(d5)
d5g <- color_branches(dend, 5, groupLabels = TRUE)
plot(d5g)
d5gr <- color_branches(dend, 5, groupLabels = as.roman)
plot(d5gr)

par(mfrow = c(1, 1))

# messy - but interesting:
dend_override <- color_branches(dend, 2, groupLabels = as.roman)
dend_override <- color_branches(dend_override, 4, groupLabels = as.roman)
dend_override <- color_branches(dend_override, 7, groupLabels = as.roman)
plot(dend_override)

d5 <- color_branches(dend = dend[[1]], k = 5)

library(dendextend)
data(iris, envir = environment())
d_iris <- dist(iris[, -5])
hc_iris <- hclust(d_iris)
dend_iris <- as.dendrogram(hc_iris)
dend_iris <- color_branches(dend_iris, k = 3)

library(colorspace)
labels_colors(dend_iris) <-
  rainbow_hcl(3)[sort_levels_values(
    as.numeric(iris[, 5])[order.dendrogram(dend_iris)]
  )]

plot(dend_iris,
     main = "Clustered Iris dataset",
     sub = "labels are colored based on the true cluster"
)

# cutree(dend_iris,k=3, order_clusters_as_data=FALSE,
# try_cutree_hclust=FALSE)
# cutree(dend_iris,k=3, order_clusters_as_data=FALSE)

library(colorspace)

data(iris, envir = environment())
d_iris <- dist(iris[, -5])

```



```

hc_iris <- hclust(d_iris)
labels(hc_iris) # no labels, because "iris" has no row names
dend_iris <- as.dendrogram(hc_iris)
is.integer(labels(dend_iris)) # this could cause problems...

iris_species <- rev(levels(iris[, 5]))
dend_iris <- color_branches(dend_iris, k = 3, groupLabels = iris_species)
is.character(labels(dend_iris)) # labels are no longer "integer"

# have the labels match the real classification of the flowers:
labels_colors(dend_iris) <-
  rainbow_hcl(3)[sort_levels_values(
    as.numeric(iris[, 5])[order.dendrogram(dend_iris)]
  )]

# We'll add the flower type
labels(dend_iris) <- paste(as.character(iris[, 5])[order.dendrogram(dend_iris)],
  "(", labels(dend_iris), ")",
  sep = ""
)

dend_iris <- hang.dendrogram(dend_iris, hang_height = 0.1)

# reduce the size of the labels:
dend_iris <- assign_values_to_leaves_nodePar(dend_iris, 0.5, "lab.cex")

par(mar = c(3, 3, 3, 7))
plot(dend_iris,
  main = "Clustered Iris dataset
  (the labels give the true flower species)",
  horiz = TRUE, nodePar = list(cex = .007)
)
legend("topleft", legend = iris_species, fill = rainbow_hcl(3))
a <- dend_iris[[1]]
dend_iris1 <- color_branches(a, k = 3)
plot(dend_iris1)

# str(dendrapply(d2, unclass))
# unclass(d1)

c(1:5) %>% # take some data
  dist() %>% # calculate a distance matrix,
  # on it compute hierarchical clustering using the "average" method,
  hclust(method = "single") %>%
  as.dendrogram() %>%
  color_branches(k = 3) %>%
  plot() # nice, returns the tree as is...

# Example of the "clusters" parameter
par(mfrow = c(1, 2))
dend <- c(1:5) %>%
  dist() %>%

```

```

hclust() %>%
  as.dendrogram()
dend %>%
  color_branches(k = 3) %>%
  plot()
dend %>%
  color_branches(clusters = c(1, 1, 2, 2, 3)) %>%
  plot()

# another example, based on the question here:
# https://stackoverflow.com/q/45432271/256662

library(cluster)
set.seed(999)
iris2 <- iris[sample(x = 1:150, size = 50, replace = F), ]
clust <- diana(iris2)
dend <- as.dendrogram(clust)

temp_col <- c("red", "blue", "green")[as.numeric(iris2$Species)]
temp_col <- temp_col[order.dendrogram(dend)]
temp_col <- factor(temp_col, unique(temp_col))

library(dendextend)
dend %>%
  color_branches(clusters = as.numeric(temp_col), col = levels(temp_col)) %>%
  set("labels_colors", as.character(temp_col)) %>%
  plot()

## End(Not run)

```

---

color\_labels

*Color dend's labels according to sub-clusters*

---

## Description

This function is for dendrogram and hclust objects. This function colors tree's labels.

The groups will be defined by a call to `cutree` using the `k` or `h` parameters.

If `col` is a color vector with a different length than the number of clusters (`k`) - then a recycled color vector will be used.

## Usage

```

color_labels(
  dend,
  k = NULL,
  h = NULL,

```

```

    labels,
    col,
    warn = dendextend_options("warn"),
    ...
  )

```

### Arguments

dend	A dendrogram or hclust tree object
k	number of groups (passed to <a href="#">cutree</a> )
h	height at which to cut tree (passed to <a href="#">cutree</a> )
labels	character vector. If not missing, it overrides k and h, and simply colors these labels in the tree based on "col" parameter.
col	Function or vector of Colors. By default it tries to use <a href="#">rainbow_hcl</a> from the <a href="#">colorspace</a> package. (with parameters c=90 and l=50). If <a href="#">colorspace</a> is not available, It will fall back on the <a href="#">rainbow</a> function.
warn	logical (default from <code>dendextend_options("warn")</code> is FALSE). Set if warnings are to be issued, it is safer to keep this at TRUE, but for keeping the noise down, the default is FALSE. (in case h/k/labels are not supplied, or if col is too short)
...	ignored.

### Value

a tree object of class dendrogram.

### Source

This function is in the style of [color\\_branches](#), and based on [labels\\_colors](#).

### See Also

[cutree](#), [dendrogram](#), [hclust](#), [labels\\_colors](#), [color\\_branches](#), [assign\\_values\\_to\\_leaves\\_edgePar](#)

### Examples

```

## Not run:
hc <- hclust(dist(USArrests), "ave")
dend <- as.dendrogram(hc)
dend <- color_labels(dend, 5, col = c(3, 1, 1, 4, 1))
dend <- color_branches(dend, 5, col = c(3, 1, 1, 4, 1))
plot(dend) # selective coloring of branches AND labels :)

# coloring some labels, based on label names:
dend <- color_labels(dend, col = "red", labels = labels(dend)[c(4, 16)])
plot(dend) # selective coloring of branches AND labels :)

d5 <- color_branches(dend, 5)
plot(d5)
d5g <- color_branches(dend, 5, groupLabels = TRUE)

```

```
plot(d5g)
d5gr <- color_branches(dend, 5, groupLabels = as.roman)
plot(d5gr)

## End(Not run)
```

---

color\_unique\_labels    *Color unique labels in a dendrogram*

---

### Description

Color unique labels in a dendrogram

### Usage

```
color_unique_labels(dend, ...)
```

### Arguments

dend	a dend object
...	NOT USED

### Value

A dendrogram after the colors of its labels have been updated (a different color for each unique label).

### Examples

```
x <- c(2011, 2011, 2012, 2012, 2015, 2015, 2015)
names(x) <- x
dend <- as.dendrogram(hclust(dist(x)))

par(mfrow = c(1, 2))
plot(dend)
dend2 <- color_unique_labels(dend)
plot(dend2)
```

---

`common_subtrees_clusters`*Find clusters of common subtrees*

---

**Description**

Gets a dend and the output from "nodes\_with\_shared\_labels" and returns a vector (length of labels), indicating the clusters forming shared subtrees

**Usage**

```
common_subtrees_clusters(dend1, dend2, leaves_get_0_cluster = TRUE, ...)
```

**Arguments**

<code>dend1</code>	a <a href="#">dendrogram</a> .
<code>dend2</code>	a <a href="#">dendrogram</a> .
<code>leaves_get_0_cluster</code>	logical (TRUE). Should the leaves which are not part of a larger common subtree get a unique cluster number, or the value 0.
<code>...</code>	not used.

**Value**

An integer vector, with values indicating which leaves in dend1 form a common subtree cluster, with ones available in dend2

**See Also**

[color\\_branches](#), [tanglegram](#)

**Examples**

```
library(dendextend)
dend1 <- 1:6 %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
dend2 <- dend1 %>% set("labels", c(1:4, 6:5))
tanglegram(dend1, dend2)

clusters1 <- common_subtrees_clusters(dend1, dend2)
dend1_2 <- color_branches(dend1, clusters = clusters1)
plot(dend1_2)
plot(dend1_2, horiz = TRUE)
tanglegram(dend1_2, dend2, highlight_distinct_edges = FALSE)
tanglegram(dend1_2, dend2)
```

---

cor.dendlist                      *Correlation matrix between a list of trees.*

---

### Description

A correlation matrix between a list of trees.

Assumes the labels in the two trees fully match. If they do not please first use [intersect\\_trees](#) to have them matched.

### Usage

```
cor.dendlist(
  dend,
  method = c("cophenetic", "baker", "common_nodes", "FM_index"),
  ...
)
```

### Arguments

dend	a <a href="#">dendlist</a> of trees
method	a character string indicating which correlation coefficient is to be computed. One of "cophenetic" (default), "baker", "common_nodes", or "FM_index". It can be abbreviated.
...	passed to cor functions.

### Value

A correlation matrix between the different trees

### See Also

[cophenetic](#), [cor\\_cophenetic](#), [cor\\_bakers\\_gamma](#), [cor\\_common\\_nodes](#), [cor\\_FM\\_index](#)

### Examples

```
## Not run:

set.seed(23235)
ss <- sample(1:150, 10)
dend1 <- iris[ss, -5] %>%
  dist() %>%
  hclust("com") %>%
  as.dendrogram()
dend2 <- iris[ss, -5] %>%
  dist() %>%
  hclust("single") %>%
  as.dendrogram()
dend3 <- iris[ss, -5] %>%
```

```

    dist() %>%
    hclust("ave") %>%
    as.dendrogram()
dend4 <- iris[ss, -5] %>%
  dist() %>%
  hclust("centroid") %>%
  as.dendrogram()
#   cutree(dend1)
cors <- cor.dendlist(dendlist(d1 = dend1, d2 = dend2, d3 = dend3, d4 = dend4))

cors

# a nice plot for them:
library(corrplot)
corrplot(cor.dendlist(dend1234), "pie", "lower")

## End(Not run)

```

---

cor\_bakers\_gamma

*Baker's Gamma correlation coefficient*


---

## Description

Calculate Baker's Gamma correlation coefficient for two trees (also known as Goodman-Kruskal-gamma index).

Assumes the labels in the two trees fully match. If they do not please first use [intersect\\_trees](#) to have them matched.

WARNING: this can be quite slow for medium/large trees.

## Usage

```

cor_bakers_gamma(dend1, ...)

## Default S3 method:
cor_bakers_gamma(dend1, dend2, ...)

## S3 method for class 'dendrogram'
cor_bakers_gamma(
  dend1,
  dend2,
  use_labels_not_values = TRUE,
  to_plot = FALSE,
  warn = dendextend_options("warn"),
  ...
)

## S3 method for class 'hclust'
cor_bakers_gamma(

```

```

    dend1,
    dend2,
    use_labels_not_values = TRUE,
    to_plot = FALSE,
    warn = dendextend_options("warn"),
    ...
)

## S3 method for class 'dendlist'
cor_bakers_gamma(dend1, which = c(1L, 2L), ...)

```

### Arguments

dend1	a tree (dendrogram/hclust/phylo)
...	Passed to <a href="#">cutree</a> .
dend2	a tree (dendrogram/hclust/phylo)
use_labels_not_values	logical (TRUE). Should labels be used in the k matrix when using cutree? Set to FALSE will make the function a bit faster BUT, it assumes the two trees have the exact same leaves order values for each labels. This can be assured by using <a href="#">match_order_by_labels</a> .
to_plot	logical (FALSE). Passed to <a href="#">bakers_gamma_for_2_k_matrix</a>
warn	logical (default from dendextend_options("warn") is FALSE). Set if warning are to be issued, it is safer to keep this at TRUE, but for keeping the noise down, the default is FALSE. should a warning be issued when using <a href="#">cutree</a> ?
which	an integer vector of length 2, indicating which of the trees in the dendlist object should be plotted (relevant for dendlist)

### Details

Baker's Gamma (see reference) is a measure of accosiation (similarity) between two trees of heirarchical clustering (dendrograms).

It is calculated by taking two items, and see what is the heighth possible level of k (number of cluster groups created when cutting the tree) for which the two item still belongs to the same tree. That k is returned, and the same is done for these two items for the second tree. There are  $n$  over 2 combinations of such pairs of items from the items in the tree, and all of these numbers are calculated for each of the two trees. Then, these two sets of numbers (a set for the items in each tree) are paired according to the pairs of items compared, and a spearman correlation is calculated.

The value can range between -1 to 1. With near 0 values meaning that the two trees are not statistically similar. For exact p-value one should result to a permutation test. One such option will be to permute over the labels of one tree many times, and calculating the distriubtion under the null hypothesis (keeping the trees topologies constant).

Notice that this measure is not affected by the height of a branch but only of its relative position compared with other branches.



**Value**

Baker's Gamma association Index between two trees (a number between -1 to 1)

**References**

Baker, F. B., Stability of Two Hierarchical Grouping Techniques Case 1: Sensitivity to Data Errors. Journal of the American Statistical Association, 69(346), 440 (1974).

**See Also**

[cor\\_cophenetic](#)

**Examples**

```
## Not run:

set.seed(23235)
ss <- sample(1:150, 10)
hc1 <- hclust(dist(iris[ss, -5]), "com")
hc2 <- hclust(dist(iris[ss, -5]), "single")
dend1 <- as.dendrogram(hc1)
dend2 <- as.dendrogram(hc2)
#   cutree(dend1)

cor_bakers_gamma(hc1, hc2)
cor_bakers_gamma(dend1, dend2)

dend1 <- match_order_by_labels(dend1, dend2) # if you are not sure
cor_bakers_gamma(dend1, dend2, use_labels_not_values = FALSE)

library(microbenchmark)
microbenchmark(
  with_labels = cor_bakers_gamma(dend1, dend2, try_cutree_hclust = FALSE),
  with_values = cor_bakers_gamma(dend1, dend2,
    use_labels_not_values = FALSE, try_cutree_hclust = FALSE
  ),
  times = 10
)

cor_bakers_gamma(dend1, dend1, use_labels_not_values = FALSE)
cor_bakers_gamma(dend1, dend1, use_labels_not_values = TRUE)

## End(Not run)
```

---

cor_common_nodes	<i>Proportion of commong nodes between two trees</i>
------------------	--

---

### Description

Calculates the number of nodes, in each tree, that are common (i.e.: that have the same exact list of labels). The correlation is between 0 (actually,  $2*(nnodes-1)/(2*nnodes)$ ), for two trees with the same list of labels - since the top node will always be identical for them). Where 1 means that every node in the one tree, has a node in the other tree with the exact same list of labels. Notice this measure is non-parametric (it ignores the heights and relative position of the nodes).

### Usage

```
cor_common_nodes(dend1, dend2, ...)
```

### Arguments

dend1	a dendrogram.
dend2	a dendrogram.
...	not used.

### Value

A correlation value between 0 to 1 (almost identical trees)

### See Also

[distinct\\_edges](#), [cor.dendlist](#)

### Examples

```
set.seed(23235)
ss <- sample(1:150, 10)
hc1 <- iris[ss, -5] %>%
  dist() %>%
  hclust("com")
hc2 <- iris[ss, -5] %>%
  dist() %>%
  hclust("single")
dend1 <- as.dendrogram(hc1)
dend2 <- as.dendrogram(hc2)

cor_cophenetic(dend1, dend2)
cor_common_nodes(dend1, dend2)
tanglegram(dend1, dend2)
# we can see we have only two nodes which are different...
```

---

cor_cophenetic	<i>Cophenetic correlation between two trees</i>
----------------	---

---

### Description

Cophenetic correlation coefficient for two trees.

Assumes the labels in the two trees fully match. If they do not please first use [intersect\\_trees](#) to have them matched.

### Usage

```
cor_cophenetic(dend1, ...)

## Default S3 method:
cor_cophenetic(
  dend1,
  dend2,
  method_coef = c("pearson", "kendall", "spearman"),
  ...
)

## S3 method for class 'dendlist'
cor_cophenetic(
  dend1,
  which = c(1L, 2L),
  method_coef = c("pearson", "kendall", "spearman"),
  ...
)
```

### Arguments

dend1	a tree (dendrogram/hclust/phylo, or dendlist)
...	Ignored.
dend2	Either a tree (dendrogram/hclust/phylo), or a <a href="#">dist</a> object (for example, from the original data matrix).
method_coef	a character string indicating which correlation coefficient is to be computed. One of "pearson" (default), "kendall", or "spearman", can be abbreviated. Passed to <a href="#">cor</a> .
which	an integer vector of length 2, indicating which of the trees in a dendlist object should have their cor_cophenetic calculated.

### Details

From [cophenetic](#): The cophenetic distance between two observations that have been clustered is defined to be the intergroup dissimilarity at which the two observations are first combined into a single cluster. Note that this distance has many ties and restrictions.

cor\_cophenetic calculates the correlation between two cophenetic distance matrices of the two trees. The value can range between -1 to 1. With near 0 values meaning that the two trees are not statistically similar. For exact p-value one should result to a permutation test. One such option will be to permute over the labels of one tree many times, and calculating the distribution under the null hypothesis (keeping the trees topologies constant).

Notice that this measure IS affected by the height of a branch.

## Value

The correlation between cophenetic

## References

Sokal, R. R. and F. J. Rohlf. 1962. The comparison of dendrograms by objective methods. *Taxon*, 11:33-40

Sneath, P.H.A. and Sokal, R.R. (1973) *Numerical Taxonomy: The Principles and Practice of Numerical Classification*, p. 278 ff; Freeman, San Francisco.

[https://en.wikipedia.org/wiki/Cophenetic\\_correlation](https://en.wikipedia.org/wiki/Cophenetic_correlation)

## See Also

[cophenetic](#), [cor\\_bakers\\_gamma](#)

## Examples

```
## Not run:

set.seed(23235)
ss <- sample(1:150, 10)
hc1 <- iris[ss, -5] %>%
  dist() %>%
  hclust("com")
hc2 <- iris[ss, -5] %>%
  dist() %>%
  hclust("single")
dend1 <- as.dendrogram(hc1)
dend2 <- as.dendrogram(hc2)
#   cutree(dend1)

cophenetic(hc1)
cophenetic(hc2)
# notice how the dist matrix for the dendrograms have different orders:
cophenetic(dend1)
cophenetic(dend2)

cor(cophenetic(hc1), cophenetic(hc2)) # 0.874
cor(cophenetic(dend1), cophenetic(dend2)) # 0.16
# the difference is because the order of the distance table in the case of
# stats::cophenetic.dendrogram will change between dendrograms!
```

```

# however, this is consistant (since I force-sort the rows/columns):
cor_cophenetic(hc1, hc2)
cor_cophenetic(dend1, dend2)

cor_cophenetic(dendlist(dend1, dend2))

# we can also use different cor methods (almost the same result though):
cor_cophenetic(hc1, hc2, method = "spearman") # 0.8456014
cor_cophenetic(dend1, dend2, method = "spearman") #

# cophenetic correlation is about 10 times (!) faster than bakers_gamma cor:
library(microbenchmark)
microbenchmark(
  cor_bakers_gamma = cor_bakers_gamma(dend1, dend2, try_cutree_hclust = FALSE),
  cor_cophenetic = cor_cophenetic(dend1, dend2),
  times = 10
)

# but only because of the cutree for dendrogram. When allowing hclust cutree
# it is only about twice as fast:
microbenchmark(
  cor_bakers_gamma = cor_bakers_gamma(dend1, dend2, try_cutree_hclust = TRUE),
  cor_cophenetic = cor_cophenetic(dend1, dend2),
  times = 10
)

## End(Not run)

```

---

cor\_FM\_index

*Correlation of FM\_index for some k*


---

## Description

Calculates the FM\_index Correlation for some k.

## Usage

```
cor_FM_index(dend1, dend2, k, ...)
```

## Arguments

dend1	a dendrogram.
dend2	a dendrogram.
k	an integer (number of clusters to cut the tree)
...	not used.

**Value**

A correlation value between 0 to 1 (almost identical clusters for some k)

**See Also**

[FM\\_index](#), [cor.dendlist](#), [Bk](#)

**Examples**

```
set.seed(23235)
ss <- sample(1:150, 10)
hc1 <- iris[ss, -5] %>%
  dist() %>%
  hclust("com")
hc2 <- iris[ss, -5] %>%
  dist() %>%
  hclust("single")
dend1 <- as.dendrogram(hc1)
dend2 <- as.dendrogram(hc2)

cor_FM_index(dend1, dend2, k = 2)
cor_FM_index(dend1, dend2, k = 3)
cor_FM_index(dend1, dend2, k = 4)
```

---

count\_terminal\_nodes *Counts the number of terminal nodes (merging 0 nodes!)*

---

**Description**

This function counts the number of "practical" terminal nodes (nodes which are not leaves, but has 0 height to them are considered "terminal" nodes). If the tree is standard, that would simply be the number of leaves (only the leaves will have height 0). However, in cases where the tree has several nodes (before the leaves) with 0 height, the count\_terminal\_nodes counts such nodes as terminal nodes

The function is recursive in that it either returns 1 if it reached a terminal node (either a leaf or a 0 height node), else: it will count the number of terminal nodes in each of its sub-nodes, sum them up, and return them.

**Usage**

```
count_terminal_nodes(dend_node, ...)
```

**Arguments**

dend_node	a dendrogram object for which to count its number of terminal nodes (leaves or 0 height nodes).
...	not used

**Value**

The number of terminal nodes (excluding the leaves of nodes of height 0)

**Examples**

```
# define dendrogram object to play with:
hc <- hclust(dist(USArrests[1:3, ]), "ave")
dend <- as.dendrogram(hc)

###
# Trivial case
count_terminal_nodes(dend) # 3 terminal nodes
length(labels(dend)) # 3 - the same number
plot(dend,
     main = "This is considered a tree \n with THREE terminal nodes (leaves)"
)

###
# NON-Trivial case
str(dend)
attr(dend[[2]], "height") <- 0
count_terminal_nodes(dend) # 2 terminal nodes, why? see this plot:
plot(dend,
     main = "This is considered a tree \n with TWO terminal nodes only"
)
# while we have 3 leaves, in practice we have only 2 terminal nodes
# (this is a feature, not a bug.)
```

---

cutree

*Cut a Tree (Dendrogram/hclust/phylo) into Groups of Data*


---

**Description**

Cuts a dendrogram tree into several groups by specifying the desired number of clusters  $k(s)$ , or cut height(s).

For `hclust.dendrogram` - In case there exists no such  $k$  for which exists a relevant split of the dendrogram, a warning is issued to the user, and NA is returned.

**Usage**

```
cutree(tree, k = NULL, h = NULL, ...)

## Default S3 method:
cutree(tree, k = NULL, h = NULL, ...)

## S3 method for class 'hclust'
cutree(
  tree,
```

```

    k = NULL,
    h = NULL,
    use_labels_not_values = TRUE,
    order_clusters_as_data = TRUE,
    warn = dendextend_options("warn"),
    NA_to_0L = TRUE,
    ...
)

## S3 method for class 'phylo'
cutree(tree, k = NULL, h = NULL, ...)

## S3 method for class 'phylo'
cutree(tree, k = NULL, h = NULL, ...)

## S3 method for class 'agnes'
cutree(tree, k = NULL, h = NULL, ...)

## S3 method for class 'diana'
cutree(tree, k = NULL, h = NULL, ...)

## S3 method for class 'dendrogram'
cutree(
  tree,
  k = NULL,
  h = NULL,
  dend_heights_per_k = NULL,
  use_labels_not_values = TRUE,
  order_clusters_as_data = TRUE,
  warn = dendextend_options("warn"),
  try_cutree_hclust = TRUE,
  NA_to_0L = TRUE,
  ...
)

```

### Arguments

tree	a dendrogram object
k	numeric scalar (OR a vector) with the number of clusters the tree should be cut into.
h	numeric scalar (OR a vector) with a height where the tree should be cut.
...	(not currently in use)
use_labels_not_values	logical, defaults to TRUE. If the actual labels of the clusters do not matter - and we want to gain speed (say, 10 times faster) - then use FALSE (gives the "leaves order" instead of their labels.). This is passed to cutree_1h.dendrogram.
order_clusters_as_data	logical, defaults to TRUE. There are two ways by which to order the clusters: 1)



	By the order of the original data. 2) by the order of the labels in the dendrogram. In order to be consistent with <code>cutree</code> , this is set to TRUE. This is passed to <code>cutree_1h.dendrogram</code> .
<code>warn</code>	logical (default from <code>dendextend_options("warn")</code> is FALSE). Set if warning are to be issued, it is safer to keep this at TRUE, but for keeping the noise down, the default is FALSE. Should the function send a warning in case the desired <code>k</code> is not available?
<code>NA_to_0L</code>	logical. default is TRUE. When no clusters are possible, Should the function return 0 (TRUE, default), or NA (when set to FALSE).
<code>dend_heights_per_k</code>	a named vector that resulted from running <code>heights_per_k.dendrogram</code> . When running the function many times, supplying this object will help improve the running time if using <code>k!=NULL</code> .
<code>try_cutree_hclust</code>	logical. default is TRUE. Since <code>cutree</code> for <code>hclust</code> is MUCH faster than for <code>dendrogram</code> - <code>cutree.dendrogram</code> will first try to change the dendrogram into an <code>hclust</code> object. If it will fail (for example, with unbranched trees), it will continue using the <code>cutree.dendrogram</code> function. If <code>try_cutree_hclust=FALSE</code> , it will force to use <code>cutree.dendrogram</code> and not <code>cutree.hclust</code> .

## Details

At least one of `k` or `h` must be specified, `k` overrides `h` if both are given.

as opposed to `cutree` for `hclust`, `cutree.dendrogram` allows the cutting of trees at a given height also for non-ultrametric trees (ultrametric tree == a tree with monotone clustering heights).

## Value

If `k` or `h` are scalar - `cutree.dendrogram` returns an integer vector with group memberships. Otherwise a matrix with group memberships is returned where each column corresponds to the elements of `k` or `h`, respectively (which are also used as column names).

In case there exists no such `k` for which exists a relevant split of the dendrogram, a warning is issued to the user, and NA is returned.

## Author(s)

`cutree.dendrogram` was written by Tal Galili. `cutree.hclust` is redirecting the function to `cutree` from base R.

## See Also

[hclust](#), [cutree](#), [cutree\\_1h.dendrogram](#), [cutree\\_1k.dendrogram](#),

## Examples

```
## Not run:
hc <- hclust(dist(USArrests[c(1, 6, 13, 20, 23), ]), "ave")
dend <- as.dendrogram(hc)
```

```

unbranch_dend <- unbranch(dend, 2)

cutree(hc, k = 2:4) # on hclust
cutree(dend, k = 2:4) # on dendrogram

cutree(hc, k = 2) # on hclust
cutree(dend, k = 2) # on dendrogram

cutree(dend, h = c(20, 25.5, 50, 170))
cutree(hc, h = c(20, 25.5, 50, 170))

# the default (ordered by original data's order)
cutree(dend, k = 2:3, order_clusters_as_data = FALSE)
labels(dend)

# as.hclust(unbranch_dend) # ERROR - can not do this...
cutree(unbranch_dend, k = 2) # all NA's
cutree(unbranch_dend, k = 1:4)
cutree(unbranch_dend, h = c(20, 25.5, 50, 170))
cutree(dend, h = c(20, 25.5, 50, 170))

library(microbenchmark)
## this shows how as.hclust is expensive - but still worth it if possible
microbenchmark(
  cutree(hc, k = 2:4),
  cutree(as.hclust(dend), k = 2:4),
  cutree(dend, k = 2:4),
  cutree(dend, k = 2:4, try_cutree_hclust = FALSE)
)
# the dendrogram is MUCH slower...

# Unit: microseconds
##          expr      min       lq   median       uq      max neval
##   cutree(hc, k = 2:4)  91.270   96.589   99.3885  107.5075  338.758   100
##   tree(as.hclust(dend),
##     k = 2:4)      1701.629 1767.700 1854.4895 2029.1875  8736.591   100
##   cutree(dend, k = 2:4) 1807.456 1869.887 1963.3960 2125.2155  5579.705   100
##   cutree(dend, k = 2:4,
##     try_cutree_hclust = FALSE) 8393.914 8570.852 8755.3490 9686.7930 14194.790   100

# and trying to "hclust" is not expensive (which is nice...)
microbenchmark(
  cutree_unbranch_dend = cutree(unbranch_dend, k = 2:4),
  cutree_unbranch_dend_not_trying_to_hclust =
    cutree(unbranch_dend, k = 2:4, try_cutree_hclust = FALSE)
)

## Unit: milliseconds
##          expr      min       lq   median       uq      max neval
## cutree_unbranch_dend  7.309329 7.428314 7.494107 7.752234 17.59581   100
## cutree_unbranch_dend_not

```

```
## _trying_to_hclust      6.945375 7.079198 7.148629 7.577536 16.99780 100
## There were 50 or more warnings (use warnings() to see the first 50)

# notice that if cutree can't find clusters for the desired k/h, it will produce 0's instead!
# (It will produce a warning though...)
# This is a different behaviour than stats::cutree
# For example:
cutree(as.dendrogram(hclust(dist(c(1, 1, 1, 2, 2)))),
      k = 5
    )

## End(Not run)
```

---

cutree\_1h.dendrogram *cutree for dendrogram (by 1 height only!)*

---

## Description

Cuts a dendrogram tree into several groups by specifying the desired cut height (only a single height!).

## Usage

```
cutree_1h.dendrogram(
  dend,
  h,
  order_clusters_as_data = TRUE,
  use_labels_not_values = TRUE,
  warn = dendextend_options("warn"),
  ...
)
```

## Arguments

dend	a dendrogram object
h	numeric scalar (NOT a vector) with a height where the dend should be cut.
order_clusters_as_data	logical, defaults to TRUE. There are two ways by which to order the clusters: 1) By the order of the original data. 2) by the order of the labels in the dendrogram. In order to be consistent with <a href="#">cutree</a> , this is set to TRUE.
use_labels_not_values	logical, defaults to TRUE. If the actual labels of the clusters do not matter - and we want to gain speed (say, 10 times faster) - then use FALSE (gives the "leaves order" instead of their labels.).
warn	logical (default from <code>dendextend_options("warn")</code> is FALSE). Set if warning are to be issued, it is safer to keep this at TRUE, but for keeping the noise down, the default is FALSE.
...	(not currently in use)

**Value**

cutree\_1h.dendrogram returns an integer vector with group memberships

**Author(s)**

Tal Galili

**See Also**

[hclust](#), [cutree](#)

**Examples**

```
hc <- hclust(dist(USArrests[c(1, 6, 13, 20, 23), ]), "ave")
dend <- as.dendrogram(hc)
cutree(hc, h = 50) # on hclust
cutree_1h.dendrogram(dend, h = 50) # on a dendrogram

labels(dend)

# the default (ordered by original data's order)
cutree_1h.dendrogram(dend, h = 50, order_clusters_as_data = TRUE)

# A different order of labels - order by their order in the tree
cutree_1h.dendrogram(dend, h = 50, order_clusters_as_data = FALSE)

# make it faster
## Not run:
library(microbenchmark)
microbenchmark(
  cutree_1h.dendrogram(dend, h = 50),
  cutree_1h.dendrogram(dend, h = 50, use_labels_not_values = FALSE)
)
# 0.8 vs 0.6 sec - for 100 runs

## End(Not run)
```

---

cutree\_1k.dendrogram *cutree for dendrogram (by 1 k value only!)*

---

**Description**

Cuts a dendrogram tree into several groups by specifying the desired number of clusters *k* (only a single *k* value!).

In case there exists no such *k* for which exists a relevant split of the dendrogram, a warning is issued to the user, and NA is returned.

**Usage**

```
cutree_1k.dendrogram(
  dend,
  k,
  dend_heights_per_k = NULL,
  use_labels_not_values = TRUE,
  order_clusters_as_data = TRUE,
  warn = dendextend_options("warn"),
  ...
)
```

**Arguments**

dend	a dendrogram object
k	numeric scalar (not a vector!) with the number of clusters the tree should be cut into.
dend_heights_per_k	a named vector that resulted from running <code>heights_per_k.dendrogram</code> . When running the function many times, supplying this object will help improve the running time.
use_labels_not_values	logical, defaults to TRUE. If the actual labels of the clusters do not matter - and we want to gain speed (say, 10 times faster) - then use FALSE (gives the "leaves order" instead of their labels.). This is passed to <code>cutree_1h.dendrogram</code> .
order_clusters_as_data	logical, defaults to TRUE. There are two ways by which to order the clusters: 1) By the order of the original data. 2) by the order of the labels in the dendrogram. In order to be consistent with <code>cutree</code> , this is set to TRUE. This is passed to <code>cutree_1h.dendrogram</code> .
warn	logical (default from <code>dendextend_options("warn")</code> is FALSE). Set if warning are to be issued, it is safer to keep this at TRUE, but for keeping the noise down, the default is FALSE. Should the function send a warning in case the desired k is not available?
...	(not currently in use)

**Value**

`cutree_1k.dendrogram` returns an integer vector with group memberships.

In case there exists no such k for which exists a relevant split of the dendrogram, a warning is issued to the user, and NA is returned.

**Author(s)**

Tal Galili

**See Also**

[hclust](#), [cutree](#), [cutree\\_1h.dendrogram](#)

**Examples**

```

hc <- hclust(dist(USArrests[c(1, 6, 13, 20, 23), ]), "ave")
dend <- as.dendrogram(hc)
cutree(hc, k = 3) # on hclust
cutree_1k.dendrogram(dend, k = 3) # on a dendrogram

labels(dend)

# the default (ordered by original data's order)
cutree_1k.dendrogram(dend, k = 3, order_clusters_as_data = TRUE)

# A different order of labels - order by their order in the tree
cutree_1k.dendrogram(dend, k = 3, order_clusters_as_data = FALSE)

# make it faster
## Not run:
library(microbenchmark)
dend_ks <- heights_per_k.dendrogram
microbenchmark(
  cutree_1k.dendrogram = cutree_1k.dendrogram(dend, k = 4),
  cutree_1k.dendrogram_no_labels = cutree_1k.dendrogram(dend,
    k = 4, use_labels_not_values = FALSE
  ),
  cutree_1k.dendrogram_no_labels_per_k = cutree_1k.dendrogram(dend,
    k = 4, use_labels_not_values = FALSE,
    dend_heights_per_k = dend_ks
  )
)
# the last one is the fastest...

## End(Not run)

```

---

cut\_lower\_fun

*Cut a dendrogram - and run a function on the output*


---

**Description**

Cuts the dend at height *h* and returns a list with the FUN function implemented on all the sub trees created by cut at height *h*. This is used for creating a [cutree.dendrogram](#) function, by using the labels function as FUN.

This is the Rcpp version of the function, offering a 10-60 times improvement in speed (depending on the tree size it is used on).

**Usage**

```
cut_lower_fun(dend, h, FUN = labels, warn = dendextend_options("warn"), ...)
```

**Arguments**

dend	a dendrogram object.
h	a scalar of height to cut the dend by.
FUN	a function to run. (default is "labels")
warn	logical (default from dendextend_options("warn") is FALSE). Set if warning are to be issued, it is safer to keep this at TRUE, but for keeping the noise down, the default is FALSE. Should the user be warned if reverting to default?
...	passed to FUN.

**Value**

A list with the output of running FUN on each of the sub dendes derived from cutting "dend"

**Author(s)**

Tal Galili

**See Also**

[labels](#), [dendrogram](#), [cutree.dendrogram](#)

**Examples**

```
dend <- as.dendrogram(hclust(dist(iris[1:4, -5])))  
# this is really cool!  
cut_lower_fun(dend, .4, labels)  
lapply(cut(dend, h = .4)$lower, labels)  
cut_lower_fun(dend, .4, order.dendrogram)
```

---

dendextend\_options      *Access to dendextend\_options*

---

**Description**

This is a function inside its own environment. This enables a bunch of functions to be manipulated outside the package, even when they are called from function within the dendextend package.

TODO: describe options.

A new "warn" dendextend\_options parameter. logical (FALSE). Should warning be issued?

**Usage**

```
dendextend_options(option, value)
```

**Arguments**

option	a character scalar of the value of the options we would like to access or update.
value	any value that we would like to update into the "option" element in dendextend_options

**Value**

a list with functions

**Author(s)**

Kurt Hornik

**Examples**

```
dendextend_options("a")
dendextend_options("a", 1)
dendextend_options("a")
dendextend_options("a", NULL)
dendextend_options("a")
dendextend_options()
```

---

dendlist

---

*Creating a dendlist object from several dendrograms*


---

**Description**

It accepts several dendrograms and or dendlist objects and chain them all together. This function aim to help with the usability of comparing two or more dendrograms.

**Usage**

```
dendlist(..., which)
```

```
## S3 method for class 'dendlist'
plot(x, which = c(1L, 2L), ...)
```

**Arguments**

...	several dendrogram/hclust/phylo or dendlist objects If an object is hclust or phylo - it will be converted into a dendrogram.
which	an integer vector of length 2, indicating which of the trees in the dendlist object should be plotted (relevant for dendlist) When used inside dendlist, which is still an integer, but it can be of any length, and it can be used to create a smaller dendlist.
x	a dendlist object



## Details

It there are list() in the ..., they are omitted. If ... is missing, it returns an empty dendlist.

## Value

A list of class dendlist where each item is a dendrogram

## Examples

```
## Not run:

dend <- iris[, -5] %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
dend2 <- iris[, -5] %>%
  dist() %>%
  hclust(method = "single") %>%
  as.dendrogram()
dendlist(1:4, 5, a = dend) # Error
# dendlist <- function (...) list(...)
dendlist(dend)
dendlist(dend, dend)
dendlist(dend, dend, dendlist(dend))
# notice how the order of
dendlist(dend, dend2)
dendlist(dend) %>% dendlist(dend2)
dendlist(dend) %>%
  dendlist(dend2) %>%
  dendlist(dend)
dendlist(dend, dend2) %>% tanglegram()
tanglegram(tree1 = dendlist(dend, dend2))

dend <- iris[1:20, -5] %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
dend2 <- iris[1:20, -5] %>%
  dist() %>%
  hclust(method = "single") %>%
  as.dendrogram()

x <- dendlist(dend, dend2)
plot(x)

## End(Not run)
```

---

DendSer.dendrogram     *Tries to run DendSer on a dendrogram*

---

### Description

Implements dendrogram seriation. The function tries to turn the dend into hclust, on which it runs [DendSer](#).

Also, if a distance matrix is missing, it will try to use the [cophenetic](#) distance.

### Usage

```
DendSer.dendrogram(dend, ser_weight, ...)
```

### Arguments

dend	An object of class dendrogram
ser_weight	Used by cost function to evaluate ordering. For cost=costLS, this is a vector of object weights. Otherwise is a dist or symmetric matrix. passed to DendSer. If it is missing, the cophenetic distance is used instead.
...	parameters passed to <a href="#">DendSer</a>

### Value

Numeric vector giving an optimal dendrogram order

### See Also

[DendSer](#), [DendSer.dendrogram](#) , [untangle\\_DendSer](#), [rotate\\_DendSer](#)

### Examples

```
## Not run:  
library(DendSer) # already used from within the function  
hc <- hclust(dist(USArrests[1:4, ]), "ave")  
dend <- as.dendrogram(hc)  
DendSer.dendrogram(dend)  
  
## End(Not run)
```

---

dend_diff	<i>Plots two trees side by side, highlighting edges unique to each tree in red.</i>
-----------	---

---

### Description

Plots two trees side by side, highlighting edges unique to each tree in red.

### Usage

```
dend_diff(dend, ...)  
  
## S3 method for class 'dendrogram'  
dend_diff(dend, dend2, horiz = TRUE, ...)  
  
## S3 method for class 'dendlist'  
dend_diff(dend, ..., which = c(1L, 2L))
```

### Arguments

dend	a dendrogram or <a href="#">dendlist</a> to compare with
...	passed to <a href="#">plot.dendrogram</a>
dend2	a dendrogram to compare with
horiz	logical (TRUE) indicating if the dendrogram should be drawn horizontally or not.
which	an integer vector indicating, in the case "dend" is a dendlist, on which of the trees should the modification be performed. If missing - the change will be performed on all of objects in the dendlist.

### Value

Invisible [dendlist](#) of both trees.

### Source

A [dendrogram](#) implementation for [phylo.diff](#) from the distory package

### See Also

[distinct\\_edges](#), [highlight\\_distinct\\_edges](#), [dist.dendlist](#), [tanglegram](#) [assign\\_values\\_to\\_branches\\_edgePar](#), [distinct.edges](#),

**Examples**

```
x <- 1:5 %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
y <- set(x, "labels", 5:1)

dend_diff(x, y)
dend_diff(dendlist(x, y))
dend_diff(dendlist(y, x))

dend1 <- 1:10 %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
dend2 <- dend1 %>% set("labels", c(1, 3, 2, 4, 5:10))
dend_diff(dend1, dend2)
```

---

dend\_expend

*Finds a "good" dendrogram for a dist*


---

**Description**

There are many options for choosing distance and linkage functions for `hclust`. This function goes through various combinations of the two and helps find the one that is most "similar" to the original distance matrix.

**Usage**

```
dend_expend(
  x,
  dist_methods = c("euclidean", "maximum", "manhattan", "canberra", "binary",
    "minkowski"),
  hclust_methods = c("ward.D", "ward.D2", "single", "complete", "average", "mcquitty",
    "median", "centroid"),
  hclust_fun = hclust,
  optim_fun = cor_cophenetic,
  ...
)

find_dend(x, ...)
```

**Arguments**

`x` A matrix or a data.frame. Can also be a [dist](#) object.

`dist_methods` A vector of possible [dist](#) methods.

`hclust_methods` A vector of possible [hclust](#) methods.

hclust_fun	By default <a href="#">hclust</a> .
optim_fun	A function that accepts a dend and a dist and returns how the two are in agreement. Default is <a href="#">cor_cophenetic</a> .
...	options passed from find_dend to dend_expend.

### Value

dend\_expend: A list with three items. The first item is called "dends" and includes a dendlist with all the possible dendrogram combinations. The second is "dists" and includes a list with all the possible distance matrix combination. The third, "performance", is data.frame with three columns: dist\_methods, hclust\_methods, and optim. optim is calculated (by default) as the cophenetic correlation (see: [cor\\_cophenetic](#)) between the distance matrix and the [cophenetic](#) distance of the hclust object.

find\_dend: A dendrogram which is "optimal" based on the output from dend\_expend.

### Examples

```
x <- datasets::mtcars
out <- dend_expend(x, dist_methods = c("euclidean", "manhattan"))
out$performance

dend_expend(dist(x))$performance

best_dend <- find_dend(x, dist_methods = c("euclidean", "manhattan"))
plot(best_dend)
```

---

dist.dendlist                      *Topological Distances Between Two dendrograms*

---

### Description

This function seems to bring different results than ape - checking this out is still an open issue: [github issue](#)

This function computes the **Robinson-Foulds distance** (also known as symmetric difference) between two dendrograms. This is the number of edges (branches) in tree\_1 with a combination of labels that exist in it but not in any subtree of tree2, plus the same calculation of tree2 when compared to tree1. This is the sum of length of [distinct\\_edges\(x,y\)](#) with [distinct\\_edges\(y,x\)](#).

This function might implement other topological distances in the future.

### Usage

```
dist.dendlist(dend, method = c("edgeset"), ...)
```

### Arguments

dend	a <a href="#">dendlist</a>
method	currently only 'edgeset' is implemented.
...	Ignored.

**Value**

A [dist](#) object with topological distances between all trees

**See Also**

[distinct\\_edges](#), [dist.topo](#), [dist.multiPhylo](#), [treedist](#),

**Examples**

```
x <- 1:5 %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
y <- set(x, "labels", 5:1)

dist.dendlist(dendlist(x1 = x, x2 = x, y1 = y))
dend_diff(x, y)

# Larger trees
x <- 1:6 %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
y <- set(x, "labels", c(1:3, 6, 4, 5))

dend_diff(x, y)
dist.dendlist(dendlist(x, y))
distinct_edges(x, y)
distinct_edges(y, x)
length(distinct_edges(x, y)) + length(distinct_edges(y, x)) # dist.dendlist
```

---

distinct\_edges

*Finds distinct edges in one tree compared to another*

---

**Description**

Finds the edges present in the first tree but not in the second

**Usage**

```
distinct_edges(dend, dend2, ...)
```

**Arguments**

dend	a dendrogram to find unique edges in
dend2	a dendrogram to compare with
...	Ignored.

**Value**

A numeric vector of edge ids for the first tree (dend) that are not present in the second tree (dend2).

**Source**

A [dendrogram](#) implementation for [distinct.edges](#) from the distory package

**See Also**

[distinct\\_edges](#), [highlight\\_distinct\\_edges](#), [dist.dendlist](#), [tanglegram](#) [distinct.edges](#)

**Examples**

```
x <- 1:5 %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
y <- set(x, "labels", 5:1)
distinct_edges(x, y)
distinct_edges(y, x)
dend_diff(x, y)
# tanglegram(x, y)
```

---

 dist\_long

*Turns a dist object to a "long" table*


---

**Description**

Turns a dist object from a "wide" to a "long" table

**Usage**

```
dist_long(d, ...)
```

**Arguments**

d	a distance object
...	not used

**Value**

A data.frame with two columns of rows and column names of the dist object and a third column (distance) with the distance between the two.

**Examples**

```

data(iris)
iris[2:6, -5] %>%
  dist() %>%
  data.matrix()
iris[2:6, -5] %>%
  dist() %>%
  as.vector()
iris[2:6, -5] %>%
  dist() %>%
  dist_long()
# This can later be used to making a network plot based on the distances.

```

---

duplicate_leaf	<i>Duplicate a leaf X times</i>
----------------	---------------------------------

---

**Description**

Duplicates a leaf in a tree. Useful for non-parametric bootstrapping trees since it emulates what would have happened if the tree was constructed based on a row-sample with replacements from the original data matrix.

**Usage**

```

duplicate_leaf(
  dend,
  leaf_label,
  times,
  fix_members = TRUE,
  fix_order = TRUE,
  fix_midpoint = TRUE,
  ...
)

```

**Arguments**

dend	a dendrogram object
leaf_label	the label of the leaf to replicate.
times	the number of times we will have this leaf after replication
fix_members	logical (TRUE). Fix the number of members in attr using <a href="#">fix_members_attr.dendrogram</a>
fix_order	logical (TRUE). Fix the leaves order
fix_midpoint	logical (TRUE). Fix the midpoint value. If TRUE, it overrides "fix_members" and turns it into TRUE (since it must have a correct number of members in order to work). values using <a href="#">rank_order.dendrogram</a>
...	not used



**Value**

A dendrogram, after duplicating one of its leaves.

**Examples**

```
## Not run:
# define dendrogram object to play with:
dend <- USArrests[1:3, ] %>%
  dist() %>%
  hclust(method = "ave") %>%
  as.dendrogram()
plot(dend)
duplicate_leaf(dend, "Alaska", 3)
duplicate_leaf(dend, "Arizona", 2, fix_members = FALSE, fix_order = FALSE)
plot(duplicate_leaf(dend, "Alaska", 2))
plot(duplicate_leaf(dend, "Alaska", 4))
plot(duplicate_leaf(dend, "Arizona", 2))
plot(duplicate_leaf(dend, "Arizona", 4))

## End(Not run)
```

---

 entanglement

*Measures entanglement between two trees*


---

**Description**

Measures the entanglement between two trees. Entanglement is a measure between 1 (full entanglement) and 0 (no entanglement). The exact behavior of the number depends on the L norm which is chosen.

**Usage**

```
entanglement(dend1, ...)

## S3 method for class 'hclust'
entanglement(dend1, dend2, ...)

## S3 method for class 'phylo'
entanglement(dend1, dend2, ...)

## S3 method for class 'dendlist'
entanglement(dend1, which = c(1L, 2L), ...)

## S3 method for class 'dendrogram'
entanglement(
  dend1,
  dend2,
```

```

L = 1.5,
leaves_matching_method = c("labels", "order"),
...
)

```

### Arguments

dend1	a tree object (of class dendrogram/hclust/phylo).
...	not used
dend2	a tree object (of class dendrogram/hclust/phylo).
which	an integer vector of length 2, indicating which of the trees in a dendlist object should have their entanglement calculated
L	the distance norm to use for measuring the distance between the two trees. It can be any positive number, often one will want to use 0, 1, 1.5, 2 (see 'details' for more).
leaves_matching_method	<p>a character scalar, either "order" or "labels" (default) . If using "labels", then we use the labels for matching the leaves order value (safer).</p> <p>And if "order" then we use the old leaves order value for matching the leaves order value.</p> <p>Using "order" is faster, but "labels" is safer. "order" will assume that the original two trees had their labels and order values MATCHED.</p> <p>Hence, it is best to make sure that the trees used here have the same labels and the SAME values matched to these values - and then use "order" (for fastest results).</p>

### Details

Entanglement is measured by giving the left tree's labels the values of 1 till tree size, and then match these numbers with the right tree. Now, entanglement is the L norm distance between these two vectors. That is, we take the sum of the absolute difference (each one in the power of L). e.g:  $\sum(\text{abs}(x-y)^L)$ . And this is divided by the "worst case" entanglement level (e.g: when the right tree is the complete reverse of the left tree).

L tells us which penalty level we are at (L0, L1, L2, partial L's etc).  $L > 1$  means that we give a big penalty for sharp angles. While  $L \rightarrow 0$  means that any time something is not a straight horizontal line, it gets a large penalty. If  $L = 0.1$  it means that we much prefer straight lines over non straight lines

### Value

The number of leaves in the tree

### See Also

[tanglegram](#), [match\\_order\\_by\\_labels](#).

**Examples**

```

## Not run:
dend1 <- iris[, -5] %>%
  dist() %>%
  hclust("com") %>%
  as.dendrogram()
dend2 <- iris[, -5] %>%
  dist() %>%
  hclust("sin") %>%
  as.dendrogram()
dend12 <- dendlist(dend1, dend2)
tanglegram(dend12)

entanglement(dend12)
entanglement(dend12, L = 0)
entanglement(dend12, L = 0.25)
entanglement(dend1, dend2, L = 0) # 1
entanglement(dend1, dend2, L = 0.25) # 0.97
entanglement(dend1, dend2, L = 1) # 0.93
entanglement(dend1, dend2, L = 2) # 0.88

# a somewhat better tanglegram
tanglegram(sort(dend1), sort(dend2))
# and also a MUCH better entanglement
entanglement(sort(dend1), sort(dend2), L = 1.5) # 0.0811
# but not that much, for L=0.25
entanglement(sort(dend1), sort(dend2), L = .25) # 0.579

#####
#####
#####
# messing up the order of leaves is dangerous:
entanglement(dend1, dend2, 1.5, "order") # 0.91
order.dendrogram(dend2) <- seq_len(nleaves(dend2))
# this 0.95 number is NO LONGER correct!!
entanglement(dend1, dend2, 1.5, "order") # 0.95
# but if we use the "labels" method - we still get the correct number:
entanglement(dend1, dend2, 1.5, "labels") # 0.91

# however, we can fix our dend2, as follows:
dend2 <- match_order_by_labels(dend2, dend1)
# Now that labels and order are matched - entanglement is back at working fine:
entanglement(dend1, dend2, 1.5, "order") # 0.91

## End(Not run)

```

**Description**

Turning a factor into a number is not trivial. Using `as.numeric` would only return to us the indicator numbers and NOT the factor levels turned into a number. `fac2num` simply turns a factor into a number, as we often need.

**Usage**

```
fac2num(x, force_integer = FALSE, keep_names = TRUE, ...)
```

**Arguments**

<code>x</code>	an object.
<code>force_integer</code>	logical (FALSE). Should the values returned be integers?
<code>keep_names</code>	logical (TRUE). Should the values returned keep the <a href="#">names</a> of the original vector?
<code>...</code>	ignored.

**Value**

if `x` is an object - it returns logical - is the object of class `dendrogram`.

**Examples**

```
x <- factor(3:5)
as.numeric(x) # 1 2 3
fac2num(x) # 3 4 5
```

---

<code>find_dendrogram</code>	<i>Search for the sub-dendrogram structure composed of selected labels</i>
------------------------------	--

---

**Description**

Given a dendrogram object, the function performs a recursive DFS algorithm to determine the sub-dendrogram which is composed of (exactly) all 'selected\_labels'.

**Usage**

```
find_dendrogram(dend, selected_labels)
```

**Arguments**

<code>dend</code>	a dendrogram object
<code>selected_labels</code>	A character vector with the labels we expect to have in the sub-dendrogram. This doesn't have to be in the same order as in the dendrogram.

**Value**

Either a sub-dendrogram composed of only members of `selected_labels`. If such a sub-dendrogram doesn't exist, the function returns `NULL`.

**Examples**

```
## Not run:
# define dendrogram object to play with:
dend <- iris[, -5] %>%
  dist() %>%
  hclust() %>%
  as.dendrogram() %>%
  set("labels_to_character") %>%
  color_branches(k = 5)
first.subdend.only <- names(cutree(dend, 4)[cutree(dend, 4) == 1])
sub.dend <- find_dendrogram(dend, first.subdend.only)
# Plotting the result
par(mfrow = c(1, 2))
plot(dend, main = "Original dendrogram")
plot(sub.dend, main = "First subdendrogram")

dend <- 1:10 %>%
dist() %>%
hclust() %>%
as.dendrogram() %>%
set("labels_to_character") %>%
color_branches(k = 5)

selected_labels <- as.character(1:4)
sub_dend <- find_dendrogram(dend, selected_labels)
plot(dend, main = "Original dendrogram")
plot(sub_dend, main = "First subdendrogram")

## End(Not run)
```

---

find\_k

*Find the (estimated) number of clusters for a dendrogram using average silhouette width*

---

**Description**

This function estimates the number of clusters based on the maximal average [silhouette](#) width derived from running [pam](#) on the [cophenetic](#) distance matrix of the [dendrogram](#). The output is based on the [pamk](#) output.

**Usage**

```
find_k(dend, krange = 2:min(10, (nleaves(dend) - 1)), ...)

## S3 method for class 'find_k'
plot(
  x,
  xlab = "Number of clusters (k)",
  ylab = "Average silhouette width",
  main = "Estimating the number of clusters using\n average silhouette width",
  ...
)
```

**Arguments**

dend	A dendrogram (or hclust) tree object
krange	integer vector. Numbers of clusters which are to be compared by the average silhouette width criterion. Note: average silhouette width and Calinski-Harabasz can't estimate number of clusters $nc=1$ . If 1 is included, a Duda-Hart test is applied and 1 is estimated if this is not significant.
...	passed to <a href="#">pamk</a> (the current defaults criterion="asw" and usepam=TRUE can not be changes).
x	An object of class "find_k" (has its own S3 plot method).
xlab, ylab, main	parameters passed to plot.

**Value**

A [pamk](#) output. This is a list with the following components: 1) pamobject - The output of the optimal run of the pam-function. 2) nc - the optimal number of clusters. 3) crit - vector of criterion values for numbers of clusters. crit[1] is the p-value of the Duda-Hart test if 1 is in krange and diss=FALSE. 4) k - a copy of nc (just to make it easier to extract - since k is often used in other functions)

**See Also**

[pamk](#), [pam](#), [silhouette](#).

**Examples**

```
dend <- iris[, -5] %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
dend_k <- find_k(dend)
plot(dend_k)
plot(color_branches(dend, k = dend_k$nc))

library(cluster)
sil <- silhouette(dend_k$pamobject)
```

```

plot(sil)

dend <- USArrests %>%
  dist() %>%
  hclust(method = "ave") %>%
  as.dendrogram()
dend_k <- find_k(dend)
plot(dend_k)
plot(color_branches(dend, k = dend_k$nc))

```

---

```
fix_members_attr.dendrogram
```

*Fix members attr in a dendrogram*

---

### Description

Fix members attr in a dendrogram after (for example), the tree was pruned or manipulated.

### Usage

```
fix_members_attr.dendrogram(dend, ...)
```

### Arguments

dend	a dendrogram object
...	not used

### Value

A dendrogram, after adjusting the members attr in all of its nodes.

### Examples

```

# define dendrogram object to play with:
hc <- hclust(dist(USArrests[1:3, ]), "ave")
dend <- as.dendrogram(hc)
# plot(dend)
# prune one leaf
dend[[2]] <- dend[[2]][[1]]
# plot(dend)
dend # but it is NO LONGER true that it has 3 members total!
fix_members_attr.dendrogram(dend) # it now knows it has only 2 members :)

hc <- hclust(dist(USArrests[1:3, ]), "ave")
dend <- as.dendrogram(hc)

identical(prune_leaf(dend, "Alaska"), fix_members_attr.dendrogram(prune_leaf(dend, "Alaska")))
str(unclass(prune_leaf(dend, "Alaska")))
str(unclass(fix_members_attr.dendrogram(prune_leaf(dend, "Alaska"))))

```

---

flatten.dendrogram      *Flatten the branches of a dendrogram's root*

---

### Description

The function makes sure the two branches of the root of a dendrogram will have the same height. The user can choose how to decide which height to use.

### Usage

```
flatten.dendrogram(dend, FUN = max, new_height, ...)
```

### Arguments

dend	dendrogram object
FUN	how to choose the new height of both branches (defaults to taking the max between the two)
new_height	overrides FUN, and sets the new height of the two branches manually
...	passed on (not used)

### Value

A dendrogram with both of the root's branches of the same height

### Examples

```
hc <- hclust(dist(USArrests[2:9, ]), "com")
dend <- as.dendrogram(hc)
attr(dend[[1]], "height") <- 150 # make the height un-equal

par(mfrow = c(1, 2))
plot(dend, main = "original tree")
plot(flatten.dendrogram(dend), main = "Raised tree")
```

---

flip\_leaves      *Flip leaves*

---

### Description

Rotate a branch in a tree so that the locations of two bundles of leaves are flipped.

### Usage

```
flip_leaves(dend, leaves1, leaves2, ...)
```



**Arguments**

dend	a dendrogram object
leaves1	a vector of leaves order value to flip.
leaves2	a (second) vector of leaves order value to flip.
...	not used

**Details**

This function is based on a bunch of string manipulation functions. There may be a smarter/better way for doing it...

**Value**

A dendrogram object with flipped leaves.

**See Also**

[tanglegram](#), [match\\_order\\_by\\_labels](#), [entanglement](#).

**Examples**

```
## Not run:
dend1 <- USArrests[1:5, ] %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
dend2 <- flip_leaves(dend1, c(3, 5), c(1, 2))
tanglegram(dend1, dend2)
entanglement(dend1, dend2, L = 2) # 0.4

## End(Not run)
```

**Description**

Calculating Fowlkes-Mallows index.

The FM\_index\_R function calculates the expectancy and variance of the FM Index under the null hypothesis of no relation.

**Usage**

```
FM_index(
  A1_clusters,
  A2_clusters,
  assume_sorted_vectors = FALSE,
  warn = dendextend_options("warn"),
  ...
)
```

**Arguments**

<code>A1_clusters</code>	a numeric vector of cluster grouping (numeric) of items, with a name attribute of item name for each element from group A1. These are often obtained by using some k cut on a dendrogram.
<code>A2_clusters</code>	a numeric vector of cluster grouping (numeric) of items, with a name attribute of item name for each element from group A2. These are often obtained by using some k cut on a dendrogram.
<code>assume_sorted_vectors</code>	logical (FALSE). Can we assume to two group vectors are sorter so that they have the same order of items? IF FALSE (default), then the vectors will be sorted based on their name attribute.
<code>warn</code>	logical (default from <code>dendextend_options("warn")</code> is FALSE). Set if warning are to be issued, it is safer to keep this at TRUE, but for keeping the noise down, the default is FALSE.
<code>...</code>	Ignored

**Details**

From Wikipedia:

Fowlkes-Mallows index (see references) is an external evaluation method that is used to determine the similarity between two clusterings (clusters obtained after a clustering algorithm). This measure of similarity could be either between two hierarchical clusterings or a clustering and a benchmark classification. A higher the value for the Fowlkes-Mallows index indicates a greater similarity between the clusters and the benchmark classifications.

**Value**

The Fowlkes-Mallows index between two vectors of clustering groups.

Includes the attributes `E_FM` and `V_FM` for the relevant expectancy and variance under the null hypothesis of no-relation.

**References**

Fowlkes, E. B.; Mallows, C. L. (1 September 1983). "A Method for Comparing Two Hierarchical Clusterings". *Journal of the American Statistical Association* 78 (383): 553.

[https://en.wikipedia.org/wiki/Fowlkes-Mallows\\_index](https://en.wikipedia.org/wiki/Fowlkes-Mallows_index)

**See Also**[cor\\_bakers\\_gamma](#)**Examples**

```
## Not run:

set.seed(23235)
ss <- TRUE # sample(1:150, 10 )
hc1 <- hclust(dist(iris[ss, -5]), "com")
hc2 <- hclust(dist(iris[ss, -5]), "single")
# dend1 <- as.dendrogram(hc1)
# dend2 <- as.dendrogram(hc2)
#   cutree(dend1)

FM_index(cutree(hc1, k = 3), cutree(hc1, k = 3)) # 1 with EV

# checking speed gains
library(microbenchmark)
microbenchmark(
  FM_index(cutree(hc1, k = 3), cutree(hc1, k = 3)),
  FM_index(cutree(hc1, k = 3), cutree(hc1, k = 3),
    assume_sorted_vectors = TRUE
  ),
  FM_index(cutree(hc1, k = 3), cutree(hc1, k = 3),
    assume_sorted_vectors = TRUE
  )
)
# C code is 1.2-1.3 times faster.

set.seed(1341)
FM_index(cutree(hc1, k = 3), sample(cutree(hc1, k = 3)),
  assume_sorted_vectors = TRUE
) # 0.38037
FM_index(cutree(hc1, k = 3), sample(cutree(hc1, k = 3)),
  assume_sorted_vectors = FALSE
) # 1 again :)
FM_index(cutree(hc1, k = 3), cutree(hc2, k = 3)) # 0.8059
FM_index(cutree(hc1, k = 30), cutree(hc2, k = 30)) # 0.4529

fo <- function(k) FM_index(cutree(hc1, k), cutree(hc2, k))
lapply(1:4, fo)
ks <- 1:150
plot(sapply(ks, fo) ~ ks, type = "b", main = "Bk plot for the iris dataset")

## End(Not run)
```

**Description**

Calculating Fowlkes-Mallows index under the null hypothesis of no relation between the clusterings (random order of the items labels).

**Usage**

```
FM_index_permutation(
  A1_clusters,
  A2_clusters,
  warn = dendextend_options("warn"),
  ...
)
```

**Arguments**

A1_clusters	a numeric vector of cluster grouping (numeric) of items, with a name attribute of item name for each element from group A1. These are often obtained by using some k cut on a dendrogram.
A2_clusters	a numeric vector of cluster grouping (numeric) of items, with a name attribute of item name for each element from group A2. These are often obtained by using some k cut on a dendrogram.
warn	logical (default from dendextend_options("warn") is FALSE). Set if warning are to be issued, it is safer to keep this at TRUE, but for keeping the noise down, the default is FALSE.
...	Ignored

**Value**

The Fowlkes-Mallows index between two vectors of clustering groups. Under H0. (a double without attr)

**References**

Fowlkes, E. B.; Mallows, C. L. (1 September 1983). "A Method for Comparing Two Hierarchical Clusterings". *Journal of the American Statistical Association* 78 (383): 553.

[https://en.wikipedia.org/wiki/Fowlkes-Mallows\\_index](https://en.wikipedia.org/wiki/Fowlkes-Mallows_index)

**See Also**

[cor\\_bakers\\_gamma](#), [FM\\_index\\_R](#), [FM\\_index](#)

**Examples**

```
## Not run:

set.seed(23235)
ss <- TRUE # sample(1:150, 10 )
hc1 <- hclust(dist(iris[ss, -5]), "com")
```

```

hc2 <- hclust(dist(iris[ss, -5]), "single")
# dend1 <- as.dendrogram(hc1)
# dend2 <- as.dendrogram(hc2)
#   cutree(dend1)

# small k
A1_clusters <- cutree(hc1, k = 3) # will give a right tailed distribution
# large k
A1_clusters <- cutree(hc1, k = 50) # will give a discrete distribution
# "medium" k
A1_clusters <- cutree(hc1, k = 25) # gives almost the normal distribution!
A2_clusters <- A1_clusters

R <- 10000
set.seed(414130)
FM_index_H0 <- replicate(R, FM_index_permutation(A1_clusters, A2_clusters)) # can take 10 sec
plot(density(FM_index_H0), main = "FM Index distribution under H0\n (10000 permutation)")
abline(v = mean(FM_index_H0), col = 1, lty = 2)

# The permutation distribution is with a heavy right tail:
# Source of the skew functions is based on: library(psych)

skew <- function (x, na.rm = TRUE) {
  x <- na.omit(x)
  sum((x - mean(x))^3)/(length(x) * sd(x)^3)
}
skew(FM_index_H0) # 1.254

mean(FM_index_H0)
var(FM_index_H0)
the_FM_index <- FM_index(A1_clusters, A2_clusters)
the_FM_index
our_dnorm <- function(x) {
  dnorm(x,
    mean = attr(the_FM_index, "E_FM"),
    sd = sqrt(attr(the_FM_index, "V_FM"))
  )
}
# our_dnorm(0.35)
curve(our_dnorm,
  col = 4,
  from = -1, to = 1, n = R, add = TRUE
)
abline(v = attr(the_FM_index, "E_FM"), col = 4, lty = 2)

legend("topright", legend = c("asymptotic", "permutation"), fill = c(4, 1))

## End(Not run)

```

**Description**

Calculating Fowlkes-Mallows index.

The FM\_index\_R function also calculates the expectancy and variance of the FM Index under the null hypothesis of no relation.

**Usage**

```
FM_index_R(
  A1_clusters,
  A2_clusters,
  assume_sorted_vectors = FALSE,
  warn = dendextend_options("warn"),
  ...
)
```

**Arguments**

A1_clusters	a numeric vector of cluster grouping (numeric) of items, with a name attribute of item name for each element from group A1. These are often obtained by using some k cut on a dendrogram.
A2_clusters	a numeric vector of cluster grouping (numeric) of items, with a name attribute of item name for each element from group A2. These are often obtained by using some k cut on a dendrogram.
assume_sorted_vectors	logical (FALSE). Can we assume to two group vectors are sorter so that they have the same order of items? IF FALSE (default), then the vectors will be sorted based on their name attribute.
warn	logical (default from dendextend_options("warn") is FALSE). Set if warning are to be issued, it is safer to keep this at TRUE, but for keeping the noise down, the default is FALSE.
...	Ignored.

**Details**

From Wikipedia:

Fowlkes-Mallows index (see references) is an external evaluation method that is used to determine the similarity between two clusterings (clusters obtained after a clustering algorithm). This measure of similarity could be either between two hierarchical clusterings or a clustering and a benchmark classification. A higher the value for the Fowlkes-Mallows index indicates a greater similarity between the clusters and the benchmark classifications.

**Value**

The Fowlkes-Mallows index between two vectors of clustering groups.

Includes the attributes E\_FM and V\_FM for the relevant expectancy and variance under the null hypothesis of no-relation.

**References**

Fowlkes, E. B.; Mallows, C. L. (1 September 1983). "A Method for Comparing Two Hierarchical Clusterings". *Journal of the American Statistical Association* 78 (383): 553.

[https://en.wikipedia.org/wiki/Fowlkes-Mallows\\_index](https://en.wikipedia.org/wiki/Fowlkes-Mallows_index)

**See Also**

[cor\\_bakers\\_gamma](#)

**Examples**

```
## Not run:

set.seed(23235)
ss <- TRUE # sample(1:150, 10 )
hc1 <- hclust(dist(iris[ss, -5]), "com")
hc2 <- hclust(dist(iris[ss, -5]), "single")
# dend1 <- as.dendrogram(hc1)
# dend2 <- as.dendrogram(hc2)
#   cutree(dend1)

FM_index_R(cutree(hc1, k = 3), cutree(hc1, k = 3)) # 1
set.seed(1341)
FM_index_R(cutree(hc1, k = 3),
            sample(cutree(hc1, k = 3)),
            assume_sorted_vectors = TRUE) # 0.38037
FM_index_R(cutree(hc1, k = 3),
            sample(cutree(hc1, k = 3)),
            assume_sorted_vectors = FALSE) # 1 again :)
FM_index_R(cutree(hc1, k = 3),
            cutree(hc2, k = 3)) # 0.8059
FM_index_R(cutree(hc1, k = 30),
            cutree(hc2, k = 30)) # 0.4529

fo <- function(k) FM_index_R(cutree(hc1, k), cutree(hc2, k))
lapply(1:4, fo)
ks <- 1:150
plot(sapply(ks, fo) ~ ks, type = "b", main = "Bk plot for the iris dataset")

clu_1 <- cutree(hc2, k = 100) # this is a lie - since this one is NOT well defined!
clu_2 <- cutree(as.dendrogram(hc2), k = 100) # We see that we get a vector of NAs for this...

FM_index_R(clu_1, clu_2) # NA

## End(Not run)
```

---

get\_branches\_heights *Get height attributes from a dendrogram*

---

### Description

Get height attributes of a dendrogram's branches

### Usage

```
get_branches_heights(  
  dend,  
  sort = TRUE,  
  decreasing = FALSE,  
  include_leaves = FALSE,  
  ...  
)
```

### Arguments

dend	a dendrogram.
sort	logical. Should the heights be sorted?
decreasing	logical. Should the sort be increasing or decreasing? Not available for partial sorting.
include_leaves	logical (FALSE). Should the output include the leaves value (0's).
...	not used.

### Value

a vector of the dendrogram's nodes heights (excluding leaves).

### Examples

```
hc <- hclust(dist(USArrests[1:4, ]), "ave")  
dend <- as.dendrogram(hc)  
get_branches_heights(dend)
```



---

get\_childrens\_heights *Get height attributes from a dendrogram's children*

---

**Description**

Get height attributes from a dendrogram's children nodes

**Usage**

```
get_childrens_heights(dend, ...)
```

**Arguments**

dend	a dendrogram.
...	not used.

**Value**

a vector of the heights of a dendrogram's current node's (first level) children.

**See Also**

[get\\_branches\\_heights](#)

**Examples**

```
hc <- hclust(dist(USArrests[1:4, ]), "ave")
dend <- as.dendrogram(hc)
get_childrens_heights(dend)
```

---

get\_leaves\_attr *Get/set attributes of dendrogram's leaves*

---

**Description**

Get/set attributes of dendrogram's leaves

**Usage**

```
get_leaves_attr(dend, attribute, simplify = TRUE, ...)
```

**Arguments**

dend	a dendrogram object
attribute	character scalar of the attribute (attr) we wish to get/set from the leaves
simplify	logical. If TRUE (default), then the return vector is after using unlist on it.
...	not used

**Value**

A vector (or a list) with the dendrogram's leaves attribute

**Source**

Heavily inspired by the code in the function `labels.dendrogram`, so credit should go to Martin Maechler.

**See Also**

[get\\_nodes\\_attr](#), [nnodes](#), [nleaves](#), [assign\\_values\\_to\\_leaves\\_nodePar](#)

**Examples**

```
# define dendrogram object to play with:
hc <- hclust(dist(USArrests[1:3, ]), "ave")
dend <- as.dendrogram(hc)

# get_leaves_attr(dend) # error :)
get_leaves_attr(dend, "label")
labels(dend, "label")
get_leaves_attr(dend, "height") # should be 0's
get_nodes_attr(dend, "height")

get_leaves_attr(dend, "nodePar")

get_leaves_attr(dend, "leaf") # should be TRUE's
get_nodes_attr(dend, "leaf") # conatins NA's

get_leaves_attr(dend, "members") # should be 1's
get_nodes_attr(dend, "members") #

get_leaves_attr(dend, "members", simplify = FALSE) # should be 1's
```

---

```
get_leaves_branches_attr
```

*Get an attribute of the branches of a dendrogram's leaves*

---

**Description**

This is helpful to get the attributes of branches of the leaves. For example, after we use [color\\_branches](#), to get the colors of the labels to match (since getting the colors of branches to match those of the labels can be tricky). This is based on [get\\_leaves\\_edgePar](#).

**Usage**

```
get_leaves_branches_attr(dend, attr = c("col", "lwd", "lty"), ...)
```

**Arguments**

dend	a dendrogram object
attr	character, the attr to get. Can be either "col", "lwd", or "lty".
...	not used

**Value**

A vector with the dendrogram's leaves nodePar attribute

**See Also**

[get\\_nodes\\_attr](#), [assign\\_values\\_to\\_leaves\\_nodePar](#), [labels\\_colors](#) [get\\_leaves\\_nodePar](#), [get\\_leaves\\_edgePar](#)

**Examples**

```
# define dendrogram object to play with:
hc <- hclust(dist(USArrests[1:5, ]), "ave")
dend <- as.dendrogram(hc)

dend <- dend %>%
  color_branches(k = 3) %>%
  set("branches_lwd", c(2, 1, 2)) %>%
  set("branches_lty", c(1, 2, 1))

plot(dend)

get_leaves_branches_attr(dend, "col")
get_leaves_branches_attr(dend, "lwd")
get_leaves_branches_attr(dend, "lty")

labels_colors(dend) <- get_leaves_branches_attr(dend, "col")
plot(dend)
```

---

get\_leaves\_branches\_col

*Get the colors of the branches of a dendrogram's leaves*

---

**Description**

It is useful to get the colors of branches of the leaves, after we use [color\\_branches](#), so to then match the colors of the labels to that of the branches (since getting the colors of branches to match those of the labels can be tricky). This is based on [get\\_leaves\\_branches\\_attr](#) which is based on [get\\_leaves\\_edgePar](#).

TODO: The function `get_leaves_branches_col` may behave oddly when extracting colors with missing col attributes when the lwd attribute is available. This may result in a vector with the wrong length (with omitted NA values). This might need to be fixed in the future, and attention should be given to this case.

**Usage**

```
get_leaves_branches_col(dend, ...)
```

**Arguments**

```
dend          a dendrogram object
...           not used
```

**Value**

A vector with the dendrogram's leaves' branches' colors

**See Also**

[get\\_nodes\\_attr](#), [assign\\_values\\_to\\_leaves\\_nodePar](#), [labels\\_colors](#) [get\\_leaves\\_nodePar](#), [get\\_leaves\\_edgePar](#), [get\\_leaves\\_branches\\_attr](#)

**Examples**

```
# define dendrogram object to play with:
hc <- hclust(dist(USArrests[1:5, ]), "ave")
dend <- as.dendrogram(hc)

par(mfrow = c(1, 2), mar = c(5, 2, 1, 0))
dend <- dend %>%
  color_branches(k = 3) %>%
  set("branches_lwd", c(2, 1, 2)) %>%
  set("branches_lty", c(1, 2, 1))

plot(dend)

labels_colors(dend) <- get_leaves_branches_col(dend)
plot(dend)
```

---

get\_leaves\_edgePar      *Get edgePar of dendrogram's leaves*

---

**Description**

This is helpful to get the attributes of branches of the leaves. For example, after we use [color\\_branches](#), to get the colors of the labels to match (since getting the colors of branches to match those of the labels can be tricky).

**Usage**

```
get_leaves_edgePar(dend, simplify = FALSE, ...)
```

**Arguments**

dend	a dendrogram object
simplify	logical (default is FALSE). If TRUE, then the return vector is after using <code>unlist</code> on it.
...	not used

**Value**

A list (or a vector) with the dendrogram's leaves `edgePar` attribute

**See Also**

[get\\_nodes\\_attr](#), [assign\\_values\\_to\\_leaves\\_nodePar](#), [labels\\_colors](#) [get\\_leaves\\_nodePar](#)

**Examples**

```
# define dendrogram object to play with:
hc <- hclust(dist(USArrests[1:5, ]), "ave")
dend <- as.dendrogram(hc)

# get_leaves_edgePar(dend) # error :)
get_leaves_edgePar(dend)
dend <- color_branches(dend, k = 3)
get_leaves_edgePar(dend)
get_leaves_edgePar(dend, TRUE)

dend <- dend %>% set("branches_lwd", c(2, 1, 2))
get_leaves_edgePar(dend)

plot(dend)
```

---

get\_leaves\_nodePar      *Get nodePar of dendrogram's leaves*

---

**Description**

Get the `nodePar` attributes of dendrogram's leaves (includes `pch`, `color`, and `cex`)

**Usage**

```
get_leaves_nodePar(dend, simplify = FALSE, ...)
```

**Arguments**

dend	a dendrogram object
simplify	logical (default is FALSE). If TRUE, then the return vector is after using <code>unlist</code> on it.
...	not used

**Value**

A list (or a vector) with the dendrogram's leaves nodePar attribute

**See Also**

[get\\_nodes\\_attr](#), [assign\\_values\\_to\\_leaves\\_nodePar](#), [labels\\_colors](#) [get\\_leaves\\_edgePar](#)

**Examples**

```
# define dendrogram object to play with:
hc <- hclust(dist(USArrests[1:3, ]), "ave")
dend <- as.dendrogram(hc)

# get_leaves_attr(dend) # error :)
get_leaves_nodePar(dend)
labels_colors(dend) <- 1:3
get_leaves_nodePar(dend)

dend <- assign_values_to_leaves_nodePar(dend, 2, "lab.cex")
get_leaves_nodePar(dend)

plot(dend)
```

---

get\_nodes\_attr

*Get attributes of dendrogram's nodes*

---

**Description**

Allows easy access to attributes of branches and/or leaves, with option of returning a vector with/withough NA's (for marking the missing attr value)

**Usage**

```
get_nodes_attr(
  dend,
  attribute,
  id,
  include_leaves = TRUE,
  include_branches = TRUE,
  simplify = TRUE,
  na.rm = FALSE,
  ...
)
```

**Arguments**

dend	a dendrogram object
attribute	character scalar of the attribute (attr) we wish to get from the nodes
id	integer vector. If given - only the attr of these nodes id will be returned (via depth first search)
include_leaves	logical. Should leaves attributes be included as well?
include_branches	logical. Should non-leaf (branch node) attributes be included as well?
simplify	logical (default is TRUE). should the result be simplified to a vector (using <a href="#">simplify2array</a> ) if possible? If it is not possible it will return a matrix. When FALSE, a list is returned.
na.rm	logical. Should NA attributes be REMOVED from the resulting vector?
...	not used

**Value**

A vector with the dendrogram's nodes attribute. If an attribute is missing from some nodes, it will return NA in that vector.

**Source**

Heavily inspired by the code in the function `labels.dendrogram`, so credit should go to Martin Maechler.

**See Also**

[get\\_leaves\\_attr](#), [nnodes](#), [nleaves](#)

**Examples**

```
# define dendrogram object to play with:
hc <- hclust(dist(USArrests[1:3, ]), "ave")
dend <- as.dendrogram(hc)

# get_leaves_attr(dend) # error :)
get_leaves_attr(dend, "label")
labels(dend, "label")
get_leaves_attr(dend, "height") # should be 0's
get_nodes_attr(dend, "height")

get_leaves_attr(dend, "leaf") # should be TRUE's
get_nodes_attr(dend, "leaf") # conatins NA's

get_leaves_attr(dend, "members") # should be 1's
get_nodes_attr(dend, "members", include_branches = FALSE, na.rm = TRUE) #
get_nodes_attr(dend, "members") #
```

```

get_nodes_attr(dend, "members", simplify = FALSE)
get_nodes_attr(dend, "members", include_leaves = FALSE, na.rm = TRUE) #

get_nodes_attr(dend, "members", id = c(1, 3), simplify = FALSE)
get_nodes_attr(dend, "members", id = c(1, 3)) #

hang_dend <- hang.dendrogram(dend)
get_leaves_attr(hang_dend, "height") # no longer 0!
get_nodes_attr(hang_dend, "height") # does not include any 0s!

# does not include leaves values:
get_nodes_attr(hang_dend, "height", include_leaves = FALSE)
# remove leaves values all together:
get_nodes_attr(hang_dend, "height", include_leaves = FALSE, na.rm = TRUE)
## Not run:
library(microbenchmark)
# get_leaves_attr is twice faster than get_nodes_attr
microbenchmark(
  get_leaves_attr(dend, "members"), # should be 1's
  get_nodes_attr(dend, "members", include_branches = FALSE, na.rm = TRUE)
)

## End(Not run)

```

---

get\_nodes\_xy

*Get the x-y coordinates of a dendrogram's nodes*


---

## Description

Get the x-y coordinates of a dendrogram's nodes. Can be used to add text or images on the tree.

## Usage

```

get_nodes_xy(
  dend,
  type = c("rectangle", "triangle"),
  center = FALSE,
  horiz = FALSE,
  ...
)

```

## Arguments

dend	a dendrogram object
type	type of plot.
center	logical; if TRUE, nodes are plotted centered with respect to the leaves in the branch. Otherwise (default), plot them in the middle of all direct child nodes.



horiz	logical indicating if the dendrogram should be drawn horizontally or not.
...	not used

**Value**

A 2-dimensional matrix, with rows as the number of nodes, and the first column is the x location, while the second is the y location.

**Source**

This is a striped down version of the function `plot.dendrogram`. It performs (almost) the same task, only it does not do any plotting but it does save the x-y coordinates of the nodes.

**See Also**

[get\\_nodes\\_attr](#), [nnodes](#), [nleaves](#)

**Examples**

```
## Not run:

# If we would like to see the numbers from plot:
# ?getOption("verbose")
# options(verbose=TRUE)
# options(verbose=FALSE)

# -----
# Draw a depth first search illustration
# -----

dend <- 1:5 %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
get_nodes_xy(dend)

# polygon(get_nodes_xy(dend), col = 2)
plot(dend,
     leaflab = "none",
     main = "Depth-first search in a dendrogram"
)
xy <- get_nodes_xy(dend)
for (i in 1:(nrow(xy) - 1)) {
  arrows(xy[i, 1], xy[i, 2],
        angle = 17,
        length = .5,
        xy[i + 1, 1], xy[i + 1, 2],
        lty = 1, col = 3, lwd = 1.5
  )
}
points(xy, pch = 19, cex = 4)
text(xy, labels = 1:nnodes(dend), cex = 1.2, col = "white", adj = c(0.4, 0.4))
```

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

---

```
get_root_branches_attr
```

```
get attributes from the dendrogram's root(!) branches
```

---

### Description

get attributes from the dendrogram's root(!) branches

### Usage

```
get_root_branches_attr(dend, the_attr, warn = dendextend_options("warn"), ...)
```

### Arguments

dend	dendrogram object
the_attr	the attribute to get from the branches (for example "height")
warn	logical (default from <code>dendextend_options("warn")</code> is FALSE). Set if warnings are to be issued, it is safer to keep this at TRUE, but for keeping the noise down, the default is FALSE. Should a warning be printed when the function is used on an object which is NOT a dendrogram.
...	passed on to attr

### Value

The attributes of the branches (often two) of the dendrogram's root

### See Also

[attr](#)

### Examples

```
hc <- hclust(dist(USArrests[2:9, ]), "com")
dend <- as.dendrogram(hc)

get_root_branches_attr(dend, "height") # 0.00000 71.96247
# plot(dend)
str(dend, 2)
```

---

get\_subdendrograms      *Extract a list of k subdendrograms from a given dendrogram object*

---

### Description

Extracts a list ([dendlist](#)) of subdendrogram structures based on the cutree [cutree.dendrogram](#) function from a given dendrogram object. It can be useful in case we're interested in a visual investigation of specific clustering results.

### Usage

```
get_subdendrograms(dend, k, order_clusters_as_data = FALSE, ...)
```

### Arguments

dend	a dendrogram object
k	the number of subdendrograms that should be extracted
order_clusters_as_data	passed to <a href="#">cutree</a> , default is FALSE (while the cutree default is TRUE). The reason is since it's easier to look at the dendrogram plot and then get subtrees that are in the same order as in the plot/dendrogram object. This is in contrast to more traditional use of cutree, where it is used with the original order or rows from the data.
...	parameters that should be passed to the cutree <a href="#">cutree.dendrogram</a>

### Value

A list of *k* subdendrograms, based on the cutree [cutree.dendrogram](#) clustering clusters.

### Examples

```
# needed packages:
# install.packages(gplots)
# install.packages(viridis)
# install.packages(devtools)
# devtools::install_github('talgalili/dendextend') #' dendextend from github

# define dendrogram object to play with:
dend <- iris[1:20, -5] %>%
  dist() %>%
  hclust() %>%
  as.dendrogram() %>%
  # set("labels_to_character") %>%
  color_branches(k = 5)
labels(dend) <- letters[1:20]
plot(dend)
dend_list <- get_subdendrograms(dend, 5)
lapply(dend_list, labels)
```

```

# [[1]]
# [1] "a" "b"
#
# [[2]]
# [1] "c" "d" "e" "f" "g"
#
# [[3]]
# [1] "h" "i"
#
# [[4]]
# [1] "j" "k" "l" "m"
#
# [[5]]
# [1] "n" "o" "p" "q" "r" "s" "t"

# define dendrogram object to play with:
dend <- iris[, -5] %>%
  dist() %>%
  hclust() %>%
  as.dendrogram() %>%
  set("labels_to_character") %>%
  color_branches(k = 5)
dend_list <- get_subdendrograms(dend, 5)

# Plotting the result
par(mfrow = c(2, 3))
plot(dend, main = "Original dendrogram")
sapply(dend_list, plot)

# plot a heatmap of only one of the sub dendrograms
par(mfrow = c(1, 1))
library(gplots)
sub_dend <- dend_list[[1]] #' get the sub dendrogram
# make sure of the size of the dend
nleaves(sub_dend)
length(order.dendrogram(sub_dend))
# get the subset of the data
subset_iris <- as.matrix(iris[order.dendrogram(sub_dend), -5])
# update the dendrogram's internal order so to not cause an error in heatmap.2
order.dendrogram(sub_dend) <- as.integer(rank(order.dendrogram(sub_dend)))
heatmap.2(subset_iris, Rowv = sub_dend, trace = "none", col = viridis::viridis(100))

```

---

ggdend

*Creates dendrogram plot using ggplot.*


---

## Description

Several functions for creating a dendrogram plot using ggplot2. The core process is to transform a dendrogram into a ggdend object using `as.ggdend`, and then plot it using `ggplot`. These two steps can be done in one command with either the function `ggplot` or `ggdend`.

The reason we want to have `as.ggdend` (and not only `ggplot.dendrogram`), is (1) so that you could create your own mapping of `ggdend` and, (2) since `as.ggdend` might be slow for large trees, it is probably better to be able to run it only once for such cases.

A `ggdend` class object is a list with 3 components: `segments`, `labels`, `nodes`. Each one contains the graphical parameters from the original dendrogram, but in a tabular form that can be used by `ggplot2+geom_segment+geom_text` to create a dendrogram plot.

## Usage

```
ggdend(...)

as.ggdend(dend, ...)

## S3 method for class 'dendrogram'
as.ggdend(dend, type = c("rectangle", "triangle"), edge.root = FALSE, ...)

prepare.ggdend(data, ...)

## S3 method for class 'ggdend'
ggplot(
  data = NULL,
  mapping = aes(),
  ...,
  segments = TRUE,
  labels = TRUE,
  nodes = TRUE,
  horiz = FALSE,
  theme = theme_dendro(),
  offset_labels = 0,
  na.rm = TRUE,
  environment = parent.frame()
)

## S3 method for class 'dendrogram'
ggplot(data, ...)

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

## Arguments

<code>...</code>	mostly ignored.
<code>dend</code>	a <a href="#">dendrogram</a> tree (to be turned into a <code>ggdend</code> object)
<code>type</code>	The type of plot, indicating the shape of the dendrogram. "rectangle" will draw rectangular lines, while "triangle" will draw triangular lines.
<code>edge.root</code>	currently ignored. One day it might do the following: logical; if true, draw an edge to the root node.
<code>data, x</code>	a <code>ggdend</code> class object (passed to <code>ggplot.dendrogram</code> or <code>print.ggdend</code> ).

mapping	(passed in <code>ggplot.ggdend</code> ) Default list of aesthetic mappings to use for plot. If not specified, must be supplied in each layer added to the plot.
segments	a logical (TRUE) if to plot the segments (branches).
labels	a logical (TRUE) if to plot the labels.
nodes	a logical (TRUE) if to plot the nodes (points).
horiz	a logical (TRUE) indicating if the dendrogram should be drawn horizontally or not.
theme	the <code>ggplot2</code> theme to use (default is <code>theme_dendro</code> , can also be NULL for the default <code>ggplot2</code> theme)
offset_labels	a numeric value to offset the labels from the leaves
na.rm	A logical (TRUE) to control removal of missing values. Passed to <code>geom_line</code> and <code>geom_point</code>
environment	(passed in <code>ggplot.ggdend</code> ) deprecated / ignored.

### Details

`prepare.ggdend` is used by `plot.ggdend` to take the `ggdend` object and prepare it for plotting. This is because the defaults of various parameters in `dendrogram`'s are not always stored in the object itself, but are built-in into the `plot.dendrogram` function. For example, the color of the labels is not (by default) specified in the `dendrogram` (only if we change it from black to something else). Hence, when taking the object into a different plotting engine (say `ggplot2`), we want to prepare the object by filling-in various defaults. This function is automatically invoked within the `plot.ggdend` function. You would probably use it only if you'd wish to build your own `ggplot2` mapping.

### Value

- `as.ggdend` - returns an object of class `ggdend` which is a list with 3 components: `segments`, `labels`, `nodes`. Each one contains the graphical parameters from the original `dendrogram`, but in a tabular form that can be used by `ggplot2+geom_segment+geom_text` to create a `dendrogram` plot.
- `prepare.ggdend` - a `ggdend` object (after filling it with various default values)
- `ggplot.ggdend` - a `ggplot` object

### Author(s)

Tal Galili, using code modified from Andrie de Vries

### Source

These are extended versions of the functions `ggdendrogram`, `dendro_data` (and the hidden `dendrogram_data`) from Andrie de Vries's `ggdendro` package. The motivation for this fork is the need to add more graphical parameters to the plotted tree. This required a strong mixer of functions from `ggdendro` and `dendextend` (to the point that it seemed better to just fork the code into its current form)

**See Also**

[dendrogram](#), [get\\_nodes\\_attr](#), [get\\_leaves\\_nodePar](#), [ggplot](#), [ggdendrogram](#), [dendro\\_data](#),

**Examples**

```
## Not run:

library(dendextend)
# library(ggdendro)
# Create a complex dend:
dend <- iris[1:30, -5] %>%
  dist() %>%
  hclust() %>%
  as.dendrogram() %>%
  set("branches_k_color", k = 3) %>%
  set("branches_lwd", c(1.5, 1, 1.5)) %>%
  set("branches_lty", c(1, 1, 3, 1, 1, 2)) %>%
  set("labels_colors") %>%
  set("labels_cex", c(.9, 1.2))
# plot the dend in usual "base" plotting engine:
plot(dend)
# Now let's do it in ggplot2 :)
ggd1 <- as.ggdend(dend)
library(ggplot2)
ggplot(ggd1) # reproducing the above plot in ggplot2 :)

# Triangle version:
plot(dend, type = "triangle")
ggd2 <- as.ggdend(dend, type = "triangle")
ggplot(ggd2)

# More modifications:
labels(dend) <- paste0(labels(dend), "0000")
ggd1 <- as.ggdend(dend)
# Use ylim to deal with long labels in ggplot2
ggplot(ggd1) + ylim(-.4, max(get_branches_heights(dend)))

ggplot(ggd1, horiz = TRUE) # horiz plot in ggplot2
# Adding some extra spice to it...
# creating a radial plot:
ggplot(ggd1) + scale_y_reverse(expand = c(0.2, 0)) + coord_polar(theta = "x")
# The text doesn't look so great, so let's remove it:
ggplot(ggd1, labels = FALSE) + scale_y_reverse(expand = c(0.2, 0)) + coord_polar(theta = "x")

# This can now be sent to plot.ly - which adds zoom-in abilities, and more.
# Here is how it might look like: https://plot.ly/~talgalili/6/y-vs-x/

## Quick guide:
# install.packages("devtools")
# library("devtools")
```

```
# devtools::install_github("ropensci/plotly")
# library(plotly)
# set_credentials_file(...)
# you'll need to get it from here: https://plot.ly/ggplot2/getting-started/

# ggplot(ggd1)
# py <- plotly()
# py$ggplotly()

# And you'll get something like this: https://plot.ly/~talgalili/6/y-vs-x/

# Another example: https://plot.ly/ggplot2/

## End(Not run)
```

---

hang.dendrogram	<i>Hang dendrogram leaves</i>
-----------------	-------------------------------

---

### Description

Adjust the height attr in all of the dendrogram leaves so that the tree will hang. This is similar to `as.dendrogram(hclust, hang=0.1)` Only that it now works on other object than `hclust` turned into a dendrogram. For example, this allows us to hang non-binary trees.

### Usage

```
hang.dendrogram(dend, hang = 0.1, hang_height, ...)
```

### Arguments

dend	a dendrogram object
hang	The fraction of the plot height by which labels should hang below the rest of the plot. A negative value will cause the labels to hang down from 0.
hang_height	is missing, then using "hang". If a number is given, it overrides "hang" (except if "hang" is negative)
...	not used

### Value

A dendrogram, after adjusting the height attr in all of its leaves, so that the tree will hang.

### Source

Noticing that `as.dendrogram` has a "hang" parameter was thanks to Enrique Ramos's answer here: <https://stackoverflow.com/questions/17088136/plot-horizontal-dendrogram-with-hanging-leaves-r>



**Examples**

```
# define dendrogram object to play with:
hc <- hclust(dist(USArrests[1:5, ]), "ave")
dend <- as.dendrogram(hc)

par(mfrow = c(1, 2))
plot(hang.dendrogram(dend))
plot(hc)
# identical(as.dendrogram(hc, hang = 0.1), hang.dendrogram(dend, hang = 0.1))
# TRUE!!

par(mfrow = c(1, 4))

plot(dend)
plot(hang.dendrogram(dend, hang = 0.1))
plot(hang.dendrogram(dend, hang = 0))
plot(hang.dendrogram(dend, hang = -0.1))

par(mfrow = c(1, 1))
plot(hang.dendrogram(dend), horiz = TRUE)
```

---

has\_component\_in\_attribute

*Does a dendrogram has an edgePar/nodePar component?*

---

**Description**

Does a dendrogram has an edgePar/nodePar component?

**Usage**

```
has_component_in_attribute(dend, component, the_attrib = "edgePar", ...)
```

**Arguments**

dend	a <a href="#">dendrogram</a> object.
component	a character value to be checked if exists in the tree. For edgePar the list: "col", "lty" and "lwd" (for the segments), "p.col", "p.lwd", and "p.lty" (for the polygon around the text) and "t.col" for the text color. For edgePar "pch", "cex", "col", "xpd", and/or "bg".
the_attrib	A character of the attribute for which to check the existence of the component. Often either "edgePar" or "nodePar".
...	ignored

**Value**

Logical. TRUE if such a component is defined somewhere in the tree, FALSE otherwise. If dend is not a dendrogram, the function will return FALSE.

**See Also**[get\\_nodes\\_attr](#), [set](#)**Examples**

```

dat <- iris[1:20, -5]
hca <- hclust(dist(dat))
hca2 <- hclust(dist(dat), method = "single")
dend <- as.dendrogram(hca)
dend2 <- as.dendrogram(hca2)

dend %>%
  set("branches_lwd", 2) %>%
  set("branches_lty", 2) %>%
  plot()
dend %>%
  set("branches_lwd", 2) %>%
  set("branches_lty", 2) %>%
  has_edgePar("lty")
dend %>%
  set("branches_lwd", 2) %>%
  has_edgePar("lty")
dend %>%
  set("branches_lwd", 2) %>%
  has_edgePar("lwd")

dend %>%
  set("branches_lwd", 2) %>%
  set("clear_branches") %>%
  has_edgePar("lwd")

```

---

heights\_per\_k.dendrogram

*Which height will result in which k for a dendrogram*

---

**Description**

Which height will result in which k for a dendrogram. This helps with speeding up the [cutree.dendrogram](#) function.

**Usage**

```
heights_per_k.dendrogram(dend, ...)
```

**Arguments**

dend	a dendrogram.
...	not used.

**Value**

a vector of heights, with its names being the k clusters that will result for cutting the dendrogram at each height.

**Examples**

```
## Not run:
hc <- hclust(dist(USArrests[1:4, ]), "ave")
dend <- as.dendrogram(hc)
heights_per_k.dendrogram(dend)
##      1      2      3      4
## 86.47086 68.84745 45.98871 28.36531

cutree(hc, h = 68.8) # and indeed we get 2 clusters

unbranch_dend <- unbranch(dend, 2)
plot(unbranch_dend)
heights_per_k.dendrogram(unbranch_dend)
# 1      3      4
# 97.90023 57.41808 16.93594
# we do NOT have a height for k=2 because of the tree's structure.

## End(Not run)
```

---

highlight\_branches\_col

*Highlight a dendrogram's branches heights via color and line-width*

---

**Description**

Highlights (update) the color (col) and/or line width (lwd) of each branch in a dendrogram based on its node's height. This is a powerful pre-processing for a [tanglegram](#) plot of two dendrograms, as it emphasizes the topological structure of each tree (and hence, their similarity and differences).

The colors are based on the viridis palette, and the line width is on the range of 1 to 10. These can be manually changed when using highlight\_branches\_col and highlight\_branches\_lwd respectively.

**Usage**

```
highlight_branches_col(dend, values = rev(viridis(1000, end = 0.9)), ...)
```

```
highlight_branches_lwd(dend, values = seq(1, 10, length.out = 1000), ...)
```

```
highlight_branches(dend, type = c("col", "lwd"), ...)
```

**Arguments**

dend	a <a href="#">dendrogram</a> tree (to be turned into a <code>ggdend</code> object)
values	the gradient of values to be used for each branch. The colors are based on the <a href="#">viridis</a> palette, and the line width is on the range of 1 to 10. These can be manually changed when using <code>highlight_branches_col</code> and <code>highlight_branches_lwd</code> respectively.
...	Currently ignored.
type	a character vector. Either "col", "lwd", or both. Based on whichever is chosen the dendrogram's branches will be updated.

**Value**

A modified [dendrogram](#), with colors/line-width in the branches that are proportional to each branch's height (measured by its lower tip).

**See Also**

[set\\_color\\_branches](#), [get\\_branches\\_heights](#), [viridis](#)

**Examples**

```
dat <- iris[1:20, -5]
hca <- hclust(dist(dat))
hca2 <- hclust(dist(dat), method = "single")
dend <- as.dendrogram(hca)
dend2 <- as.dendrogram(hca2)

par(mfrow = c(1, 3))
dend %>%
  highlight_branches_col() %>%
  plot(main = "Coloring branches")
dend %>%
  highlight_branches_lwd() %>%
  plot(main = "Emphasizing line-width")
dend %>%
  highlight_branches() %>%
  plot(main = "Emphasizing color\n and line-width")

library(viridis)
par(mfrow = c(1, 3))
dend %>%
  highlight_branches_col() %>%
  plot(main = "Coloring branches \n(default is reversed viridis)")
dend %>%
  highlight_branches_col(viridis(100)) %>%
  plot(main = "It is better to use\nlighter colors in the leaves")
dend %>%
  highlight_branches_col(rev(magma(1000))) %>%
  plot(main = "The magma color pallatte\n is also good")
```

```

dl <- dendlist(dend, dend2)
tanglegram(dl,
  sort = TRUE, common_subtrees_color_lines = FALSE,
  highlight_distinct_edges = FALSE, highlight_branches_lwd = FALSE
)
tanglegram(dl)
tanglegram(dl, fast = TRUE)

dl <- dendlist(highlight_branches(dend), highlight_branches(dend2))
tanglegram(dl, sort = TRUE, common_subtrees_color_lines = FALSE, highlight_distinct_edges = FALSE)

dend %>%
  set("highlight_branches_col") %>%
  plot()

dl <- dendlist(dend, dend2) %>% set("highlight_branches_col")
tanglegram(dl, sort = TRUE, common_subtrees_color_lines = FALSE, highlight_distinct_edges = FALSE)

# This is also useful for heatmaps
# -----
# library(dendextend)

x <- as.matrix(datasets::mtcars)

Rowv <- x %>%
  dist() %>%
  hclust() %>%
  as.dendrogram() %>%
  set("branches_k_color", k = 3) %>%
  set("highlight_branches_lwd") %>%
  ladderize()
# rotate_DendSer(ser_weight = dist(x))
Colv <- x %>%
  t() %>%
  dist() %>%
  hclust() %>%
  as.dendrogram() %>%
  set("branches_k_color", k = 2) %>%
  set("highlight_branches_lwd") %>%
  ladderize()
# rotate_DendSer(ser_weight = dist(t(x)))

library(gplots)
heatmap.2(x, Rowv = Rowv, Colv = Colv)

```

---

highlight\_distinct\_edges

*Highlight distinct edges in a tree (compared to another one)*


---

**Description**

Highlight distinct edges in a tree (compared to another one) by changing the branches' color, line width, or line type.

This function enables this feature in [dend\\_diff](#) and [tanglegram](#)

**Usage**

```
highlight_distinct_edges(dend, ...)

## S3 method for class 'dendrogram'
highlight_distinct_edges(
  dend,
  dend2,
  value = 2,
  edgePar = c("col", "lty", "lwd"),
  ...
)

## S3 method for class 'dendlist'
highlight_distinct_edges(dend, ..., which = c(1L, 2L))
```

**Arguments**

dend	a dendrogram or <a href="#">dendlist</a> to find unique edges in (to highlight)
...	Ignored.
dend2	a dendrogram to compare with
value	a new value scalar for the edgePar attribute.
edgePar	a character indicating the value inside edgePar to adjust. Can be either "col", "lty", or "lwd".
which	an integer vector indicating, in the case "dend" is a dendlist, on which of the trees should the modification be performed. If missing - the change will be performed on all of objects in the dendlist.

**Value**

A dendrogram with modified edges - the distinct ones are changed (color, line width, or line type)

**See Also**

[distinct\\_edges](#), [highlight\\_distinct\\_edges](#), [dist.dendlist](#), [tanglegram](#) [assign\\_values\\_to\\_branches\\_edgePar](#), [distinct.edges](#),

**Examples**

```
x <- 1:5 %>%
  dist() %>%
  hclust() %>%
```

```

    as.dendrogram()
y <- set(x, "labels", 5:1)
distinct_edges(x, y)
distinct_edges(y, x)

par(mfrow = c(1, 2))
plot(highlight_distinct_edges(x, y))
plot(y)

# tanglegram(highlight_distinct_edges(x, y),y)
# dend_diff(x, y)
## Not run:

# using highlight_distinct_edges combined with dendlist and set
# to clearly highlight "stable" branches.
data(iris)
ss <- c(1:5, 51:55, 101:105)
iris1 <- iris[ss, -5] %>%
  dist() %>%
  hclust(method = "single") %>%
  as.dendrogram()
iris2 <- iris[ss, -5] %>%
  dist() %>%
  hclust(method = "complete") %>%
  as.dendrogram()
iris12 <- dendlist(iris1, iris2) %>%
  set("branches_k_color", k = 3) %>%
  set("branches_lwd", 3) %>%
  highlight_distinct_edges(value = 1, edgePar = "lwd")
iris12 %>%
  untangle(method = "step2side") %>%
  tanglegram(
    sub = "Iris dataset", main_left = "'single' clustering",
    main_right = "'complete' clustering"
  )

## End(Not run)

```

---

identify.dendrogram     *Identify Clusters in a Dendrogram (not hclust)*

---

### Description

Just like [identify.hclust](#): reads the position of the graphics pointer when the (first) mouse button is pressed. It then cuts the tree at the vertical position of the pointer and highlights the cluster containing the horizontal position of the pointer. Optionally a function is applied to the index of data points contained in the cluster.

**Usage**

```
## S3 method for class 'dendrogram'
identify(
  x,
  FUN = NULL,
  N = 20,
  MAXCLUSTER,
  DEV.FUN = NULL,
  horiz = FALSE,
  stop_if_out = FALSE,
  ...
)
```

**Arguments**

x	a <a href="#">dendrogram</a> object.
FUN	(optional) function to be applied to the index numbers of the data points in a cluster (see 'Details' below).
N	the maximum number of clusters to be identified.
MAXCLUSTER	the maximum number of clusters that can be produced by a cut (limits the effective vertical range of the pointer).
DEV.FUN	(optional) integer scalar. If specified, the corresponding graphics device is made active before FUN is applied.
horiz	logical (FALSE), indicating if the rectangles should be drawn horizontally or not (for when using <code>plot(dend, horiz = TRUE)</code> ).
stop_if_out	logical (default is FALSE). This default makes the function NOT stop if k of the locator is outside the range (this default is different than the behavior of the <code>identify.hclust</code> function - but it is nicer for the user.).
...	further arguments to FUN.

**Details**

By default clusters can be identified using the mouse and an invisible list of indices of the respective data points is returned. If FUN is not NULL, then the index vector of data points is passed to this function as first argument, see the examples below. The active graphics device for FUN can be specified using DEV.FUN. The identification process is terminated by pressing any mouse button other than the first, see also `identify`.

**Value**

(Invisibly) returns a list where each element contains a vector of data points contained in the respective cluster.

**Source**

This function is based on [identify.hclust](#), with slight modifications to have it work with a dendrogram, as well as adding "horiz"



**See Also**

[identify.hclust](#), [rect.hclust](#), [order.dendrogram](#), [cutree.dendrogram](#)

**Examples**

```
## Not run:
set.seed(23235)
ss <- sample(1:150, 10)
hc <- iris[ss, -5] %>%
  dist() %>%
  hclust()
dend <- hc %>% as.dendrogram()

plot(dend)
identify(dend)

plot(dend, horiz = TRUE)
identify(dend, horiz = TRUE)

## End(Not run)
```

---

intersect\_trees

*Intersect trees*

---

**Description**

Return two trees after pruning them so that the only leaves left are the intersection of their labels.

**Usage**

```
intersect_trees(dend1, dend2, warn = dendextend_options("warn"), ...)
```

**Arguments**

dend1	tree object (dendrogram/hclust/phylo)
dend2	tree object (dendrogram/hclust/phylo)
warn	logical (default from <code>dendextend_options("warn")</code> is FALSE). Set if warnings are to be issued, it is safer to keep this at TRUE, but for keeping the noise down, the default is FALSE. Should a warning be issued if there was a need to perform intersection.
...	passed on

**Value**

A [dendlist](#) with two pruned trees

**See Also**

[prune](#), [intersect](#), [labels](#)

**Examples**

```
hc <- hclust(dist(USArrests[1:5, ]), "ave")
dend <- as.dendrogram(hc)
labels(dend) <- 1:5
dend1 <- prune(dend, 1)
dend2 <- prune(dend, 5)
intersect_dend <- intersect_trees(dend1, dend2)

layout(matrix(c(1, 1, 2, 3, 4, 5), 3, 2, byrow = TRUE))
plot(dend, main = "Original tree")
plot(dend1, main = "Tree 1:\n original with label 1 pruned")
plot(dend2, main = "Tree 2:\n original with label 2 pruned")
plot(intersect_dend[[1]],
      main = "Tree 1 pruned
            with the labels that intersected with those of Tree 2"
      )
plot(intersect_dend[[2]],
      main = "Tree 2 pruned
            with the labels that intersected with those of Tree 1"
      )
```

---

is.natural.number      *Check if numbers are natural*

---

**Description**

Vectorized function for checking if numbers are natural or not. Helps in checking if a vector is of type "order".

**Usage**

```
is.natural.number(x, tol = .Machine$double.eps^0.5, ...)
```

**Arguments**

x	a vector of numbers
tol	tolerance to floating point issues.
...	(not currently in use)

**Value**

logical - is the entered number natural or not.

**Author(s)**

Marco Gallotta (a.k.a: marcog), Tal Galili

**Source**

This function was written by marcog, as an answer to my question here: <https://stackoverflow.com/questions/4562257/what-is-the-fastest-way-to-check-if-a-number-is-a-positive-natural-number-in-r>

**See Also**

[is.numeric](#), [is.double](#), [is.integer](#)

**Examples**

```
is.natural.number(1) # is TRUE
(x <- seq(-1, 5, by = 0.5))
is.natural.number(x)
# is.natural.number( "a" )
all(is.natural.number(x))
```

---

is\_null\_list

*Checks if the value is and empty list()*

---

**Description**

Checks if the value is and empty list(). Can be useful.

**Usage**

```
is_null_list(x)
```

**Arguments**

x                    whatever object to check

**Value**

logical

**Examples**

```
# I can run this only if I'd make is_null_list exported
## Not run:
# TRUE:
is_null_list(list())
# FALSE
is_null_list(list(1))
is_null_list(1)
```

```
x <- list(1, list(), 123)
ss_list <- sapply(x, is_null_list)
x <- x[!ss_list]
x

x <- list(1, list(), 123)
ss_list <- sapply(x, is_null_list)
x <- list(list())
x

## End(Not run)

## Not run:
# error
is_null_list()

## End(Not run)
```

---

is\_some\_class

*Is the object of some class*

---

## Description

Returns TRUE if some class (based on the name of the function).

## Usage

is.hclust(x)

is.dendrogram(x)

is.phylo(x)

is.dendlist(x)

is.dist(x)

## Arguments

x                    an object.

## Value

Returns TRUE if some class (based on the name of the function).

## Examples

```
# TRUE:
is.dendlist(dendlist())
# FALSE
is.dendlist(1)
# TRUE:
is.dist(dist(mtcars))
# FALSE
is.dist(mtcars)
```

---

khan	<i>Microarray gene expression dataset from Khan et al., 2001. Subset of 306 genes.</i>
------	--

---

## Description

Khan contains gene expression profiles of four types of small round blue cell tumours of childhood (SRBCT) published by Khan et al. (2001). It also contains further gene annotation retrieved from SOURCE at <http://source.stanford.edu/>.

## Usage

```
khan
```

## Format

Khan is dataset containing the following:

- train:[data.frame](#) of 306 rows and 64 columns. The training dataset of 64 arrays and 306 gene expression values
- test:[data.frame](#), of 306 rows and 25 columns. The test dataset of 25 arrays and 306 genes expression values
- gene.labels.imagesID:vector of 306 Image clone identifiers corresponding to the rownames of train and test.
- train.classes:[factor](#) with 4 levels "EWS", "BL-NHL", "NB" and "RMS", which correspond to the four groups in the train dataset
- test.classes:[factor](#) with 5 levels "EWS", "BL-NHL", "NB", "RMS" and "Norm" which correspond to the five groups in the test dataset
- annotation:[data.frame](#) of 306 rows and 8 columns. This table contains further gene annotation retrieved from SOURCE <http://SOURCE.stanford.edu> in May 2004. For each of the 306 genes, it contains:
  - CloneIDImage Clone ID
  - UGClusterThe Unigene cluster to which the gene is assigned
  - SymbolThe HUGO gene symbol
  - LLIDThe locus ID

- UGRepAccNucleotide sequence accession number
- LLRepProtAccProtein sequence accession number
- Chromosomechromosome location
- Cytobandcytoband location

## Details

Khan et al., 2001 used cDNA microarrays containing 6567 clones of which 3789 were known genes and 2778 were ESTs to study the expression of genes in of four types of small round blue cell tumours of childhood (SRBCT). These were neuroblastoma (NB), rhabdomyosarcoma (RMS), Burkitt lymphoma, a subset of non-Hodgkin lymphoma (BL), and the Ewing family of tumours (EWS). Gene expression profiles from both tumour biopsy and cell line samples were obtained and are contained in this dataset. The dataset downloaded from the website contained the filtered dataset of 2308 gene expression profiles as described by Khan et al., 2001. This dataset is available from the <http://bioinf.ucd.ie/people/aedin/R/>.

In order to reduce the size of the MADE4 package, and produce small example datasets, the top 50 genes from the ends of 3 axes following bga were selected. This produced a reduced datasets of 306 genes.

## Source

khan contains a filtered data of 2308 gene expression profiles as published and provided by Khan et al. (2001) on the supplementary web site to their publication OLD (site no longer found): <https://research.nhgri.nih.gov/microarray/>

The data was copied from the made4 package (<https://www.bioconductor.org/packages/release/bioc/html/made4.html>)

## References

Culhane AC, et al., 2002 Between-group analysis of microarray data. *Bioinformatics*. 18(12):1600-8.

Khan,J., Wei,J.S., Ringner,M., Saal,L.H., Ladanyi,M., Westermann,F., Berthold,F., Schwab,M., Antonescu,C.R., Peterson,C. et al. (2001) Classification and diagnostic prediction of cancers using gene expression profiling and artificial neural networks. *Nat. Med.*, 7, 673-679.

## Examples

```
data(khan)
summary(khan)
```

---

labels<-                                    *"label" assignment operator*

---

### Description

"label" assignment operator for vectors, dendrogram, and hclust classes.

### Usage

```
labels(object, ...) <- value

## Default S3 replacement method:
labels(object, ...) <- value

## S3 replacement method for class 'dendrogram'
labels(object, ...) <- value

## S3 method for class 'hclust'
labels(object, order = TRUE, ...)

## S3 replacement method for class 'hclust'
labels(object, ...) <- value

## S3 method for class 'phylo'
labels(object, ...)

## S3 replacement method for class 'phylo'
labels(object, ...) <- value
```

### Arguments

object	a variable name (possibly quoted) whose label are to be updated
...	parameters passed (not currently in use)
value	a value to be assigned to object's label
order	default is FALSE. Only relevant for extracting labels from an <a href="#">hclust</a> object (with <code>labels.hclust</code> ). Setting <code>order=TRUE</code> will return labels in their order in the dendrogram, instead of the original labels order retained from <code>object\$labels</code> - which usually corresponding to the row or column names of the <a href="#">dist</a> object provided to the <a href="#">hclust</a> function.

### Details

#####

### Value

The updated object

**Author(s)**

Gavin Simpson, Tal Galili (with some ideas from Gregory Jefferis's dendroextras package)

**Source**

The functions here are based on code by Gavin and kohnske from (adopted to dendrogram by Tal Galili): <https://stackoverflow.com/questions/4614223/how-to-have-the-following-work-labelsx-some-values>  
Also with some ideas from Gregory Jefferis's dendroextras package.

**See Also**

[labels](#)

**Examples**

```
x <- 1:3
labels(x)
labels(x) <- letters[1:3]
labels(x) # [1] "a" "b" "c"
x
# a b c
# 1 2 3

# get("labels<-")

#####
# Example for using the assignment with dendrogram and hclust objects:
hc <- hclust(dist(USArrests[1:3, ]), "ave")
dend <- as.dendrogram(hc)

labels(hc) # "Arizona" "Alabama" "Alaska"
labels(hc) <- letters[1:3]
labels(hc) # "a" "b" "c"
labels(dend) # "Arizona" "Alabama" "Alaska"
labels(dend) <- letters[1:3]
labels(dend) # "a" "b" "c"
suppressWarnings(labels(dend) <- LETTERS[1:2]) # will produce a warning
labels(dend) # "A" "B" "A"
labels(dend) <- LETTERS[4:6] # will replace the labels correctly
# (the fact the tree had duplicate labels will not cause a problem)
labels(dend) # "D" "E" "F"
```

---

labels\_cex

*Retrieve/assign cex to the labels of a dendrogram*

---

**Description**

Retrieve/assign cex to the labels of a dendrogram



**Usage**

```
labels_cex(dend, ...)  
  
labels_cex(dend, ...) <- value
```

**Arguments**

dend	a dendrogram object
...	not used
value	a vector of cex to be used as new label's size for the dendrogram

**Value**

A vector with the dendrogram's labels sizes (NULL if none are supplied).

**Examples**

```
# define dendrogram object to play with:  
dend <- as.dendrogram(hclust(dist(USArrests[1:3, ]), "ave"))  
  
# Defaults:  
labels_cex(dend)  
plot(dend)  
  
# let's add some color:  
labels_cex(dend) <- 1:3  
labels_cex(dend)  
plot(dend)  
  
labels_cex(dend) <- 1  
labels_cex(dend)  
plot(dend)
```

---

labels\_colors

*Retrieve/assign colors to the labels of a dendrogram*

---

**Description**

Retrieve/assign colors to the labels of a dendrogram. Note that usually dend objects come without any color assignment (and the output will be NULL, until colors are assigned).

**Usage**

```
labels_colors(dend, labels = TRUE, ...)  
  
labels_col(dend, labels = TRUE, ...)  
  
labels_colors(dend, ...) <- value
```

**Arguments**

dend	a dendrogram object
labels	Boolean (default is TRUE), should the returned vector of colors return with the leaves labels as names.
...	not used
value	a vector of colors to be used as new label's colors for the dendrogram

**Value**

A vector with the dendrogram's labels colors (or a colored dendrogram, in case assignment is used). The colors are labeled.

**Source**

Heavily inspired by the code in the example of [dendrapply](#), so credit should go to Martin Maechler. I also implemented some ideas from Gregory Jefferis's dendroextras package (having the "names" of the returned vector be the labels).

**See Also**

[cutree](#), [dendrogram](#), [hclust](#), [color\\_labels](#), [color\\_branches](#), [assign\\_values\\_to\\_leaves\\_edgePar](#), [get\\_leaves\\_branches\\_col](#)

**Examples**

```
# define dendrogram object to play with:
hc <- hclust(dist(USArrests[1:3, ]), "ave")
dend <- as.dendrogram(hc)

# Defaults:
labels_colors(dend)
plot(dend)

# let's add some color:
labels_colors(dend) <- 2:4
labels_colors(dend)
plot(dend)

# doesn't work...
# get_nodes_attr(dend, "nodePar", include_branches = FALSE)

# changing color to black
labels_colors(dend) <- 1
labels_colors(dend)
plot(dend)

# removing color (and the nodePar completely - if it has no other attributed but lab.col)
suppressWarnings(labels_colors(dend) <- NULL)
labels_colors(dend)
```

```
plot(dend)
```

---

ladderize

*Ladderize a Tree*

---

## Description

This function reorganizes the internal structure of the tree to get the ladderized effect when plotted.

## Usage

```
ladderize(x, right = TRUE, ...)  
  
## S3 method for class 'dendrogram'  
ladderize(x, right = TRUE, ...)  
  
## S3 method for class 'phylo'  
ladderize(x, right = TRUE, phy, ...)  
  
## S3 method for class 'dendlist'  
ladderize(x, right = TRUE, which, ...)
```

## Arguments

x	a tree object (either a <a href="#">dendrogram</a> , <a href="#">dendlist</a> , or <a href="#">phylo</a> )
right	a logical (TRUE) specifying whether the smallest clade is on the right-hand side (when the tree is plotted upwards), or the opposite (if FALSE).
...	Currently ignored.
phy	a placeholder in case the user uses "phy ="
which	an integer (can have any number of elements). It indicates the elements in the <a href="#">dendlist</a> to ladderize. If missing, it will ladderize all the dendrograms in the dendlist.

## Value

A rotated tree object

## See Also

[ladderize](#), [rev.dendrogram](#), [rotate](#) (dendextend), [rotate](#) (ape)

**Examples**

```
dend <- USArrests[1:8, ] %>%
  dist() %>%
  hclust() %>%
  as.dendrogram() %>%
  set("labels_colors") %>%
  set("branches_k_color", k = 5)
set.seed(123)
dend <- shuffle(dend)

par(mfrow = c(1, 3))
dend %>% plot(main = "Original")
dend %>%
  ladderize(TRUE) %>%
  plot(main = "Right (default)")
dend %>%
  ladderize(FALSE) %>%
  plot(main = "Left (rev of right)")
```

---

**leaf\_Colors***Return the leaf Colors of a dendrogram*

---

**Description**

The returned Colors will be in dendrogram order.

**Usage**

```
leaf_Colors(d, col_to_return = c("edge", "node", "label"))
```

**Arguments**

**d** the dendrogram  
**col\_to\_return** Character scalar - kind of Color attribute to return

**Value**

named character vector of Colors, NA\_character\_ where missing

**Author(s)**

jefferis

**See Also**

[slice](#), [color\\_branches](#)

**Examples**

```
dend <- USArrests %>%
  dist() %>%
  hclust(method = "ave") %>%
  as.dendrogram()
d5 <- color_branches(dend, 5)
leaf_Colors(d5)
```

---

lowest\_common\_branch *Find lowest common branch were the two items are shared*

---

**Description**

Given two vectors, for two items, of cluster belonging - the function finds the lowest branch (e.g: largest number of k clusters) for which the two items are in the same cluster for the two trees.

**Usage**

```
lowest_common_branch(item1, item2, ...)
```

**Arguments**

item1	a named numeric vector (of cluster group with names of k level)
item2	a named numeric vector (of cluster group with names of k level)
...	not used

**Value**

The first location (from left) where the two vectors have the same A dendrogram, after adjusting the members attr in all of its nodes.

**See Also**

[cor\\_bakers\\_gamma](#)

**Examples**

```
item1 <- structure(c(1L, 1L, 1L, 1L), .Names = c("1", "2", "3", "4"))
item2 <- structure(c(1L, 1L, 2L, 2L), .Names = c("1", "2", "3", "4"))
lowest_common_branch(item1, item2)
```

---

match\_order\_by\_labels *Adjust the order of one dendrogram based on another (using labels)*

---

### Description

Takes one dendrogram and adjusts its order leaves values based on the order of another dendrogram. The values are matched based on the labels of the two dendrograms.

This allows for faster [entanglement](#) running time, since we can be sure that the leaves order is just as using their labels.

### Usage

```
match_order_by_labels(
  dend_change,
  dend_template,
  check_that_labels_match = TRUE
)
```

### Arguments

dend\_change     tree object (dendrogram)  
dend\_template    tree object (dendrogram)  
check\_that\_labels\_match  
                  logical (TRUE). If to check that the labels in the two dendrogram match. (if they do not, the function aborts)

### Value

Returns dend\_change after adjusting its order values to be like dend\_template.

### See Also

[entanglement](#) , [tanglegram](#)

### Examples

```
## Not run:

dend <- USArrests[1:4, ] %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
order.dendrogram(dend) # c(4L, 3L, 1L, 2L)

dend_changed <- dend
order.dendrogram(dend_changed) <- 1:4
order.dendrogram(dend_changed) # c(1:4)
```

```
# now let's fix the order of the new object to be as it was:
dend_changed <- match_order_by_labels(dend_changed, dend)
# these two are now the same:
order.dendrogram(dend_changed)
order.dendrogram(dend)

## End(Not run)
```

---

```
match_order_dendrogram_by_old_order
```

*Adjust the order of one dendrogram based on another (using order)*

---

## Description

Takes one dendrogram and adjusts its order leaves values based on the order of another dendrogram. The values are matched based on the order of the two dendrograms.

This allows for faster [entanglement](#) running time, since we can be sure that the leaves order is just as using their labels.

This is a function is FASTER than [match\\_order\\_by\\_labels](#), but it assumes that the order and the labels of the two trees are matching!!

This will allow for a faster calculation of [entanglement](#).

## Usage

```
match_order_dendrogram_by_old_order(
  dend_change,
  dend_template,
  dend_change_old_order,
  check_that_labels_match = FALSE,
  check_that_leaves_order_match = FALSE
)
```

## Arguments

dend\_change      tree object (dendrogram)

dend\_template    tree object (dendrogram)

dend\_change\_old\_order

a numeric vector with the order of leaves in dend\_change (at least before it was changes for some reason). This is the vector based on which we adjust the new values of dend\_change.

check\_that\_labels\_match

logical (FALSE). If to check that the labels in the two dendrogram match. (if they do not, the function aborts)

check\_that\_leaves\_order\_match

logical (FALSE). If to check that the order in the two dendrogram match. (if they do not, the function aborts)

**Value**

Returns dend\_change after adjusting its order values to be like dend\_template.

**See Also**

[entanglement](#) , [tanglegram](#), [match\\_order\\_by\\_labels](#)

**Examples**

```
## Not run:

dend <- USArrests[1:4, ] %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
order.dendrogram(dend) # c(4L, 3L, 1L, 2L)

# Watch this!
dend_changed <- dend
dend_changed <- rev(dend_changed)
expect_false(identical(order.dendrogram(dend_changed), order.dendrogram(dend)))
# we keep the order of dend_change, so that the leaves order are synced
# with their labels JUST LIKE dend:
old_dend_changed_order <- order.dendrogram(dend_changed)
# now we change dend_changed leaves order values:
order.dendrogram(dend_changed) <- 1:4
# and we can fix them again, based on their old kept leaves order:
dend_changed <- match_order_dendrogram_by_old_order(
  dend_changed, dend,
  old_dend_changed_order
)
expect_identical(order.dendrogram(dend_changed), order.dendrogram(dend))

## End(Not run)
```

---

min\_depth

*Find minimum/maximum depth of a dendrogram*


---

**Description**

As the name implies. This can also work for non-dendrogram nested lists.

**Usage**

```
min_depth(dend, ...)
```

```
max_depth(dend, ...)
```



**Arguments**

dend                    Any nested list object (including [dendrogram](#)).  
 ...                    unused at the moment.

**Value**

Integer, the (min/max) number of nodes from the root to the leafs

**Examples**

```
hc <- hclust(dist(USArrests), "ave")
(dend1 <- as.dendrogram(hc)) # "print()" method
is.list(dend1)
is.list(dend1[[1]][[1]][[1]])
dend1[[1]][[1]][[1]]
plot(dend1)
min_depth(dend1)
max_depth(dend1)
```

---

na\_locf

*Last Observation Carried Forward*


---

**Description**

A function for replacing each NA with the most recent non-NA prior to it.

**Usage**

```
na_locf(x, first_na_value = 0, recursive = TRUE, ...)
```

**Arguments**

x                    some vector  
 first\_na\_value    If the first observation is NA, fill it with "first\_na\_value"  
 recursive        logical (TRUE). Should na\_locf be re-run until all NA values are filled?  
 ...                ignored.

**Value**

The original vector, but with all the missing values filled by the value before them.

**Source**

<https://stat.ethz.ch/pipermail/r-help/2003-November/042126.html> <https://stackoverflow.com/questions/5302049/last-observation-carried-forward-na-locf-on-panel-cross-section-time-series>

This could probably be solved MUCH faster using Rcpp.

**See Also**[na.locf](#)**Examples**

```

na_locf(c(NA, NA))
na_locf(c(1, NA))
na_locf(c(1, NA, NA, NA))
na_locf(c(1, NA, NA, NA, 2, 2, NA, 3, NA, 4))
na_locf(c(1, NA, NA, NA, 2, 2, NA, 3, NA, 4), recursive = FALSE)
## Not run:

# library(microbenchmark)
# library(zoo)

# microbenchmark(
#   na_locf = na_locf(c(1, NA, NA, NA, 2, 2, NA, 3, NA, 4)),
#   na.locf = na.locf(c(1, NA, NA, NA, 2, 2, NA, 3, NA, 4))
# ) # my implementation is 6 times faster :)

#microbenchmark(
#   na_locf = na_locf(rep(c(1, NA, NA, NA, 2, 2, NA, 3, NA, 4), 1000)),
#   na.locf = na.locf(rep(c(1, NA, NA, NA, 2, 2, NA, 3, NA, 4), 1000))
# ) # my implementation is 3 times faster

## End(Not run)

```

---

**nleaves***Counts the number of leaves in a tree*

---

**Description**

Counts the number of leaves in a tree (dendrogram or hclust).

**Usage**

```

nleaves(x, ...)

## Default S3 method:
nleaves(x, ...)

## S3 method for class 'dendrogram'
nleaves(x, method = c("members", "order"), ...)

## S3 method for class 'dendlist'
nleaves(x, ...)

```

```
## S3 method for class 'hclust'
nleaves(x, ...)

## S3 method for class 'phylo'
nleaves(x, ...)
```

### Arguments

x	tree object (dendrogram/hclust/phylo, <a href="#">dendlist</a> )
...	not used
method	a character scalar (default is "members"). If "order" than nleaves is based on length of <a href="#">order.dendrogram</a> . If "members", than length is trusting what is written in the dendrogram's root <a href="#">attr</a> . "members" is about 4 times faster than "order".

### Details

The idea for the name is from functions like ncol, and nrow.

Also, it is worth noting that the nleaves.dendrogram is based on order.dendrogram instead of labels.dendrogram since the first is MUCH faster than the later.

The phylo method is based on turning the phylo to hclust and than to dendrogram. It may not work for complex phylo trees.

### Value

The number of leaves in the tree

### See Also

[nrow](#), [count\\_terminal\\_nodes](#)

### Examples

```
hc <- hclust(dist(USArrests[1:5, ]), "ave")
dend <- as.dendrogram(hc)

nleaves(dend) # 5
nleaves(hc) # 5
```

---

nnodes

*Counts the number of nodes (Vertices) in a tree*

---

### Description

Counts the number of nodes in a tree (dendrogram, hclust, phylo).

**Usage**

```
nnodes(x, ...)  
  
## Default S3 method:  
nnodes(x, ...)  
  
## S3 method for class 'dendrogram'  
nnodes(x, ...)  
  
## S3 method for class 'hclust'  
nnodes(x, ...)  
  
## S3 method for class 'phylo'  
nnodes(x, ...)
```

**Arguments**

x	tree object (dendrogram or hclust)
...	not used

**Details**

The idea for the name is from functions like `ncol`, and `nrow`.

The phylo method is based on turning the phylo to hclust and than to dendrogram. It may not work for complex phylo trees.

**Value**

The number of leaves in the tree

**See Also**

[nrow](#), [count\\_terminal\\_nodes](#), [nleaves](#)

**Examples**

```
hc <- hclust(dist(USArrests[1:5, ]), "ave")  
dend <- as.dendrogram(hc)  
  
nnodes(dend) # 9  
nnodes(hc) # 9
```

---

noded\_with\_condition *Find which nodes satisfies a condition*

---

### Description

Goes through a tree's nodes in order to return a vector with whether (TRUE/FALSE) each node satisfies some condition (function)

### Usage

```
noded_with_condition(  
  dend,  
  condition,  
  include_leaves = TRUE,  
  include_branches = TRUE,  
  na.rm = FALSE,  
  ...  
)
```

### Arguments

dend	a dendrogram dend
condition	a function that gets a node and return TRUE or FALSE (based on whether or not that node/tree fulfills the "condition")
include_leaves	logical. Should leaves attributes be included as well?
include_branches	logical. Should non-leaf (branch node) attributes be included as well?
na.rm	logical. Should NA attributes be REMOVED from the resulting vector?
...	passed to the condition function

### Value

A logical vector with TRUE/FALSE, specifying for each of the dendrogram's nodes if it fulfills the condition or not.

### See Also

[branches\\_attr\\_by\\_labels](#), [get\\_leaves\\_attr](#), [nnodes](#), [nleaves](#)

### Examples

```
## Not run:  
  
library(dendextend)  
  
set.seed(23235)  
ss <- sample(1:150, 10)
```

```

# Getting the dend dend
dend <- iris[ss, -5] %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
dend %>% plot()

# this is the basis for branches_attr_by_labels
has_any_labels <- function(sub_dend, the_labels) any(labels(sub_dend) %in% the_labels)
cols <- noded_with_condition(dend, has_any_labels,
  the_labels = c("126", "109", "59")
) %>%
  ifelse(2, 1)
set(dend, "branches_col", cols) %>% plot()

# Similar to branches_attr_by_labels - but for heights!
high_enough <- function(sub_dend, height) attr(sub_dend, "height") > height
cols <- noded_with_condition(dend, high_enough, height = 1) %>% ifelse(2, 1)
set(dend, "branches_col", cols) %>% plot()

## End(Not run)

```

---

*order.dendrogram<-*      *order.dendrogram<- assignment operator*

---

## Description

*order.dendrogram<-* assignment operator. This is useful in cases where some object is turned into a dendrogram but its leaves values (the order) are all mixed up.

## Usage

```
order.dendrogram(object, ...) <- value
```

## Arguments

<code>object</code>	a variable name (possibly quoted) whose label are to be updated
<code>...</code>	parameters passed (not currently in use)
<code>value</code>	a value to be assigned to object's leaves value (their "order")

## Value

dendrogram with updated order leaves values

**See Also**

[order.dendrogram](#), [labels<-](#)

**Examples**

```
#####
# Example for using the assignment with dendrogram and hclust objects:
hc <- hclust(dist(USArrests[1:4, ]), "ave")
dend <- as.dendrogram(hc)

str(dend)
order.dendrogram(dend) # 4 3 1 2
order.dendrogram(dend) <- 1:4
order.dendrogram(dend) # 1 2 3 4
str(dend) # the structure is still fine.

# This function is very useful if we try playing with subtrees
# For example:
hc <- hclust(dist(USArrests[1:6, ]), "ave")
dend <- as.dendrogram(hc)
sub_dend <- dend[[1]]
order.dendrogram(sub_dend) # 4 6
# now using as.hclust(sub_dend) will cause trouble:
# labels(as.hclust(sub_dend)) # As of R 3.1.1-patched - this will produce an Error (as it should :)
# let's fix it:

order.dendrogram(sub_dend) <- rank(order.dendrogram(sub_dend), ties.method = "first")
labels(as.hclust(sub_dend)) # We now have labels :)
```

---

order.hclust

*Ordering of the Leaves in a hclust Dendrogram*

---

**Description**

Ordering of the Leaves in a hclust Dendrogram. Like [order.dendrogram](#).

**Usage**

```
order.hclust(x, ...)
```

**Arguments**

x                    ab hclust object a distance matrix.  
 ...                  Ignored.

**Value**

A vector with length equal to the number of leaves in the hclust dendrogram is returned. From `r <- order.hclust()`, each element is the index into the original data (from which the hclust was computed).

**See Also**[order.dendrogram](#)**Examples**

```
set.seed(23235)
ss <- sample(1:150, 10)
hc <- iris[ss, -5] %>%
  dist() %>%
  hclust()
# dend <- hc %>% as.dendrogram
order.hclust(hc)
```

---

partition_leaves	<i>A list with labels for each subtree (edge)</i>
------------------	---

---

**Description**

Returns the set of all bipartitions from all edges, that is: a list with the labels for each of the nodes in the dendrogram.

**Usage**

```
partition_leaves(dend, ...)
```

**Arguments**

dend	a dendrogram
...	Ignored.

**Value**

A list with the labels for each of the nodes in the dendrogram.

**Source**

A [dendrogram](#) implementation for [partition.leaves](#) from the [distory](#) package

**See Also**

[distinct\\_edges](#), [highlight\\_distinct\\_edges](#), [dist.dendlist](#), [tanglegram](#), [partition.leaves](#)



**Examples**

```

x <- 1:3 %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
plot(x)
partition_leaves(x)
## Not run:
set.seed(23235)
ss <- sample(1:150, 10)
dend1 <- iris[ss, -5] %>%
  dist() %>%
  hclust("com") %>%
  as.dendrogram()
dend2 <- iris[ss, -5] %>%
  dist() %>%
  hclust("single") %>%
  as.dendrogram()

partition_leaves(dend1)
partition_leaves(dend2)

## End(Not run)

```

---

plot\_horiz.dendrogram *Plotting a left-tip-adjusted horizontal dendrogram*

---

**Description**

The default `plot(dend, horiz = TRUE)`, gives us a dendrogram tree plot with the tips turned right. The current function enables the creation of the same tree, but with the tips turned left. The main challenge in doing this is finding the distance of the labels from the leaves tips - which is solved with this function.

**Usage**

```

plot_horiz.dendrogram(
  x,
  type = c("rectangle", "triangle"),
  center = FALSE,
  edge.root = is.leaf(x) || !is.null(attr(x, "edgetext")),
  dLeaf = NULL,
  horiz = TRUE,
  xaxt = "n",
  yaxt = "s",
  xlim = NULL,
  ylim = NULL,

```

```

nodePar = NULL,
edgePar = list(),
leaflab = c("perpendicular", "textlike", "none"),
side = TRUE,
text_pos = 2,
...
)

```

### Arguments

x	tree object (dendrogram)
type	a character vector with either "rectangle" or "triangle" (passed to <a href="#">plot.dendrogram</a> )
center	logical; if TRUE, nodes are plotted centered with respect to the leaves in the branch. Otherwise (default), plot them in the middle of all direct child nodes.
edge.root	logical; if true, draw an edge to the root node.
dLeaf	a number specifying the distance in user coordinates between the tip of a leaf and its label. If NULL as per default, 3/4 of a letter width is used.
horiz	logical indicating if the dendrogram should be drawn horizontally or not. In this function it MUST be TRUE!
xaxt	graphical parameters, or arguments for other methods.
yaxt	graphical parameters, or arguments for other methods.
xlim	(NULL) optional x- and y-limits of the plot, passed to plot.default. The defaults for these show the full dendrogram.
ylim	(NULL) optional x- and y-limits of the plot, passed to plot.default. The defaults for these show the full dendrogram.
nodePar	NULL.
edgePar	list()
leaflab	c("perpendicular", "textlike", "none")
side	logical (TRUE). Should the tips of the drawn tree be facing the left side. This is the important feature of this function.
text_pos	integer from either 1 to 4 (2). Two relevant values are 2 and 4. 2 (default) means that the labels are alligned to the tips of the tree leaves. 4 will have the labels allign to the left, making them look like they were when the tree was on the left side (with leaves tips facing to the right).
...	passed to <a href="#">plot</a> .

### Value

The invisible dLeaf value.

### Source

This function is based on replicating [plot.dendrogram](#). In fact, I'd be happy if in the future, some tweaks could be made to [plot.dendrogram](#), so that it would replace the need for this function.

**See Also**

[plot.dendrogram](#), [tanglegram](#)

**Examples**

```
## Not run:
dend <- USArrests[1:10, ] %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()

par(mfrow = c(1, 2), mar = rep(6, 4))
plot_horiz.dendrogram(dend, side = FALSE)
plot_horiz.dendrogram(dend, side = TRUE)
# plot_horiz.dendrogram(dend, side=TRUE, dLeaf= 0)
# plot_horiz.dendrogram(dend, side=TRUE, nodePar = list(pos = 1))
# sadly, lab.pos is not implemented yet,
## so the labels can not be right aligned...

plot_horiz.dendrogram(dend, side = F)
plot_horiz.dendrogram(dend, side = TRUE, dLeaf = 0, xlim = c(100, -10)) # bad
plot_horiz.dendrogram(dend, side = TRUE, text_offset = 0)
plot_horiz.dendrogram(dend, side = TRUE, text_offset = 0, text_pos = 4)

## End(Not run)
```

---

prune

*Prunes a tree (using leaves' labels)*


---

**Description**

Trims a tree (dendrogram, hclust) from a set of leaves based on their labels.

**Usage**

```
prune(dend, ...)
```

## Default S3 method:

```
prune(dend, ...)
```

## S3 method for class 'dendrogram'

```
prune(dend, leaves, reindex_dend = TRUE, ...)
```

## S3 method for class 'hclust'

```
prune(dend, leaves, ...)
```

## S3 method for class 'phylo'

```
prune(dend, ...)

## S3 method for class 'rpart'
prune(dend, ...)
```

### Arguments

dend	tree object (dendrogram/hclust/phylo)
...	passed on
leaves	a character vector of the label(S) of the tip(s) (leaves) we wish to prune off the tree.
reindex_dend	logical (default is TRUE). If TRUE, the leaves of the new dendrograms include the rank of the old order.dendrogram. This insures that their values are just like the number of leaves. When FALSE, the values in the leaves is that of the original dendrogram. This is useful if pruning a dendrogram but then wanting to use <a href="#">order.dendrogram</a> with the original values. When using <a href="#">prune.hclust</a> , then <code>reindex_dend</code> is used by default since otherwise the <a href="#">as.hclust</a> function would return an error.

### Details

I was not sure if to call this function `drop.tip` (from `ape`), `snip/prune` (from `rpart`) or just `remove.leaves`. I ended up deciding on `prune`.

### Value

A pruned tree

### See Also

[prune\\_leaf](#), [drop.tip](#) `ape`

### Examples

```
hc <- hclust(dist(USArrests[1:5, ]), "ave")
dend <- as.dendrogram(hc)

par(mfrow = c(1, 2))
plot(dend, main = "original tree")
plot(prune(dend, c("Alaska", "California")), main = "tree without Alaska and California")

# this works because prune uses reindex_dend = TRUE by default
as.hclust(prune(dend, c("Alaska", "California")))
prune(hc, c("Alaska", "California"))
```

---

prune\_common\_subtrees.dendlist  
*Prune trees to their common subtrees*

---

**Description**

Prune trees to their common subtrees

**Usage**

```
prune_common_subtrees.dendlist(dend, ...)
```

**Arguments**

dend	a <a href="#">dendlist</a> of length two
...	ignored

**Value**

A dendlist after pruning the labels to only include those that are part of common subtrees in both dendrograms.

**See Also**

[common\\_subtrees\\_clusters](#)

**Examples**

```
# NULL
```

---

prune\_leaf *Trims one leaf from a dendrogram*

---

**Description**

Trims (prunes) one leaf from a dendrogram.

**Usage**

```
prune_leaf(dend, leaf_name, ...)
```

**Arguments**

dend	dendrogram object
leaf_name	a character string as the label of the tip we wish to prune
...	passed on

**Details**

Used through [prune](#)

**Value**

A dendrogram with a leaf pruned

**Examples**

```
hc <- hclust(dist(USArrests[1:5, ]), "ave")
dend <- as.dendrogram(hc)

par(mfrow = c(1, 2))
plot(dend, main = "original tree")
plot(prune_leaf(dend, "Alaska"), main = "tree without Alaska")
```

---

pvclust\_edges

*Get Pvclust Edges Information*

---

**Description**

Get pvclust edges information such as au and bp and return dataframe with proper sample labels. This function is useful when there are a lot of samples involved.

**Usage**

```
pvclust_edges(pvclust_obj)
```

**Arguments**

pvclust\_obj    pvclust object

**Value**

data.frame with leaves on column 1 and 2, followed by the rest of the information from edge

**References**

hclust object descriptions <https://stat.ethz.ch/R-manual/R-patched/library/stats/html/hclust.html>

**Examples**

```
## Not run:

library(pvclust)
data(lung) # 916 genes for 73 subjects
set.seed(13134)
result <- pvclust(lung[, 1:20], method.dist = "cor", method.hclust = "average", nboot = 100)
pvclust_edges(result)

## End(Not run)
```

---

pvclust\_show\_signif     *The significant branches in a dendrogram, based on a pvclust object*

---

**Description**

Shows the significant branches in a dendrogram, based on a pvclust object

**Usage**

```
pvclust_show_signif(
  dend,
  pvclust_obj,
  signif_type = c("bp", "au"),
  alpha = 0.05,
  signif_value = c(5, 1),
  show_type = c("lwd", "col"),
  ...
)
```

**Arguments**

dend	a dendrogram object
pvclust_obj	a pvclust object
signif_type	a character scalar (either "bp" or "au"), indicating which of the two should be used to update the dendrogram.
alpha	a number between 0 to 1, default is .05. Indicates what is the cutoff from which branches will be updated.
signif_value	a 2d vector (default: c(5,1)), with the first element tells us what the significant branches will get, and the second element which value the non-significant branches will get.
show_type	a character scalar (either "lwd" or "col"), indicating which parameter of the branches should be updated based on significance.
...	not used

**Value**

A dendrogram with updated branches

**See Also**

[pvclust\\_show\\_signif](#), [pvclust\\_show\\_signif\\_gradient](#)

**Examples**

```
## Not run:
library(pvclust)
data(lung) # 916 genes for 73 subjects
set.seed(13134)
result <- pvclust(lung[, 1:20], method.dist = "cor", method.hclust = "average", nboot = 100)

dend <- as.dendrogram(result)
result %>%
  as.dendrogram() %>%
  hang.dendrogram() %>%
  plot(main = "Cluster dendrogram with AU/BP values (%)")
result %>% text()
result %>% pvrect(alpha = 0.95)

dend %>%
  pvclust_show_signif(result) %>%
  plot()
dend %>%
  pvclust_show_signif(result, show_type = "lwd") %>%
  plot()
result %>% text()
result %>% pvrect(alpha = 0.95)

dend %>%
  pvclust_show_signif_gradient(result) %>%
  plot()

dend %>%
  pvclust_show_signif_gradient(result) %>%
  pvclust_show_signif(result) %>%
  plot(main = "Cluster dendrogram with AU/BP values (%) \n bp values are highlighted by signif")
result %>% text()
result %>% pvrect(alpha = 0.95)

## End(Not run)
```

---

`pvclust_show_signif_gradient`

*Significance gradient of branches in a dendrogram (via pvclust)*

---



**Description**

Shows the gradient of significance of branches in a dendrogram, based on a pvclust object

**Usage**

```
pvclust_show_signif_gradient(
  dend,
  pvclust_obj,
  signif_type = c("bp", "au"),
  signif_col_fun = colorRampPalette(c("black", "darkred", "red")),
  ...
)
```

**Arguments**

dend	a dendrogram object
pvclust_obj	a pvclust object
signif_type	a character scalar (either "bp" or "au"), indicating which of the two should be used to update the dendrogram.
signif_col_fun	a function to create colors for the significant gradient. Default is: colorRampPalette(c("black", "darkred", "red"))
...	not used

**Value**

A dendrogram with updated branches

**See Also**

[pvclust\\_show\\_signif](#), [pvclust\\_show\\_signif\\_gradient](#)

**Examples**

```
## Not run:
library(pvclust)
data(lung) # 916 genes for 73 subjects
set.seed(13134)
result <- pvclust(lung[, 1:20], method.dist = "cor", method.hclust = "average", nboot = 100)

dend <- as.dendrogram(result)
result %>%
  as.dendrogram() %>%
  hang.dendrogram() %>%
  plot(main = "Cluster dendrogram with AU/BP values (%)")
result %>% text()
result %>% pvrect(alpha = 0.95)

dend %>%
  pvclust_show_signif(result) %>%
```

```

    plot()
dend %>%
  pvclust_show_signif(result, show_type = "lwd") %>%
  plot()
result %>% text()
result %>% pvrect(alpha = 0.95)

dend %>%
  pvclust_show_signif_gradient(result) %>%
  plot()

dend %>%
  pvclust_show_signif_gradient(result) %>%
  pvclust_show_signif(result) %>%
  plot(main = "Cluster dendrogram with AU/BP values (%) \n bp values are highlighted by signif")
result %>% text()
result %>% pvrect(alpha = 0.95)

## End(Not run)

```

---

pvrect2

---

*Draw Rectangles Around a Dendrogram's Clusters with High/Low P-values*


---

## Description

Draws rectangles around the branches of a dendrogram highlighting the corresponding clusters with low p-values. This is based on [pvrect](#), allowing to draw the rects till the bottom of the labels.

## Usage

```

pvrect2(
  x,
  alpha = 0.95,
  pv = "au",
  type = "geq",
  max.only = TRUE,
  border = 2,
  xpd = TRUE,
  lower_rect,
  ...
)

```

## Arguments

**x** object of class pvclust.

**alpha** threshold value for p-values., Default: 0.95

pv	character string which specifies the p-value to be used. It should be either of "au" or "bp", corresponding to AU p-value or BP value, respectively. See plot.pvclust for details. , Default: 'au'
type	one of "geq", "leq", "gt" or "lt". If "geq" is specified, clusters with p-value greater than or equals the threshold given by "alpha" are returned or displayed. Likewise "leq" stands for lower than or equals, "gt" for greater than and "lt" for lower than the threshold value. The default is "geq"., Default: 'geq'
max.only	logical. If some of clusters with high/low p-values have inclusion relation, only the largest cluster is returned (or displayed) when max.only=TRUE., Default: TRUE
border	numeric value which specifies the color of borders of rectangles., Default: 2
xpd	A logical value (or NA.), passed to par. Default is TRUE, in order to allow the rect to be below the labels. If FALSE, all plotting is clipped to the plot region, if TRUE, all plotting is clipped to the figure region, and if NA, all plotting is clipped to the device region. See also clip., Default: TRUE
lower_rect	a (scalar) value of how low should the lower part of the rect be. If missing, it will take the value of par("usr")[3L] (or par("usr")[2L], depending if horiz = TRUE or not), with also the width of the labels. (notice that we would like to keep xpd = TRUE if we want the rect to be after the labels!) You can use a value such as 0, to get the rect above the labels.
...	passed to <a href="#">rect</a>

### See Also

[pvrect](#), [pvclust\\_show\\_signif](#)

### Examples

```
## Not run:

library(dendextend)
library(pvclust)
data(lung) # 916 genes for 73 subjects
set.seed(13134)
result <- pvclust(lung[, 1:20], method.dist = "cor", method.hclust = "average", nboot = 10)

par(mar = c(9, 2.5, 2, 0))
dend <- as.dendrogram(result)
dend %>%
  pvclust_show_signif(result, signif_value = c(3, .5)) %>%
  pvclust_show_signif(result, signif_value = c("black", "grey"), show_type = "col") %>%
  plot(main = "Cluster dendrogram with AU/BP values (%)")
pvrect2(result, alpha = 0.95)
# getting the rects to the tips / above the labels
pvrect2(result, lower_rect = .15, border = 4, alpha = 0.95, lty = 2)
# Original function
# pvrect(result, alpha=0.95)
text(result, alpha = 0.95)
```

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

---

```
raise.dendrogram      Raise the height of a dendrogram tree
```

---

### Description

Raise the height of nodes in a dendrogram tree.

### Usage

```
raise.dendrogram(dend, heiget_to_add, ...)
```

### Arguments

dend	dendrogram object
heiget_to_add	how much height to add to all the branches (not leaves) in the dendrogram
...	passed on (not used)

### Value

A raised dendrogram

### Examples

```
hc <- hclust(dist(USArrests[2:9, ]), "com")
dend <- as.dendrogram(hc)

par(mfrow = c(1, 2))
plot(dend, main = "original tree")
plot(raise.dendrogram(dend, 100), main = "Raised tree")
```

---

```
rank_branches      Rank branches' heights
```

---

### Description

Adjust the height attr in all of the dendrogram nodes so that the tree will have a distance of 1 unit between each parent/child nodes. It can be thought of as ranking the branches between themselves.

This is intended for easier comparison of the topology of two trees.

Notice that this function changes the height of all the leaves into 0, thus erasing the effect of [hang.dendrogram](#) (which should be run again, if that is the visualization you are interested in).

**Usage**

```
rank_branches(dend, diff_height = 1, ...)
```

**Arguments**

dend	a dendrogram object
diff_height	Numeric scalar (1). Affects the difference in height between two branches.
...	not used

**Value**

A dendrogram, after adjusting the height attr in all of its branches.

**See Also**

[get\\_branches\\_heights](#), [get\\_childrens\\_heights](#), [hang.dendrogram](#), [tanglegram](#)

**Examples**

```
# define dendrogram object to play with:
dend <- USArrests[1:5, ] %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()

par(mfrow = c(1, 3))

plot(dend)
plot(rank_branches(dend))
plot(hang.dendrogram(rank_branches(dend)))
```

---

rank\_order.dendrogram *Fix rank of leaves order values in a dendrogram*

---

**Description**

Generally, leaves order value should be a sequence of integer values. From 1 to nleaves(dend). This function fixes trees by using [rank](#) on existing leaves order values.

**Usage**

```
rank_order.dendrogram(dend, ...)
```

**Arguments**

dend	a dendrogram object
...	not used

**Value**

A dendrogram, after fixing its leaves order values.

**See Also**

[prune](#)

**Examples**

```
# define dendrogram object to play with:
dend <- USArrests[1:4, ] %>%
  dist() %>%
  hclust(method = "ave") %>%
  as.dendrogram()
# plot(dend)
order.dendrogram(dend)
dend2 <- prune(dend, "Alaska")
order.dendrogram(dend2)
order.dendrogram(rank_order.dendrogram(dend2))
```

---

rank\_values\_with\_clusters

*Rank a vector based on clusters*

---

**Description**

Rank a vector based on clusters

**Usage**

```
rank_values_with_clusters(x, ignore0 = FALSE, ...)
```

**Arguments**

x	numeric vector
ignore0	logical (FALSE). If TRUE, will ignore the 0's in the vector
...	not used

**Value**

an integer vector with the number of unique values as the number of uniques in the original vector. And the values are ranked from 1 (in the beginning of the vector) to the number of unique clusters.

**Examples**

```

rank_values_with_clusters(c(1, 2, 3))
rank_values_with_clusters(c(1, 1, 3))
rank_values_with_clusters(c(0.1, 0.1, 3000))
rank_values_with_clusters(c(3, 1, 2))
rank_values_with_clusters(c(1, 3, 3, 3, 3, 3, 3, 4, 2, 2))

rank_values_with_clusters(c(3, 1, 2), ignore0 = TRUE)
rank_values_with_clusters(c(3, 1, 2), ignore0 = FALSE)
rank_values_with_clusters(c(3, 1, 0, 2), ignore0 = TRUE)
rank_values_with_clusters(c(3, 1, 0, 2), ignore0 = FALSE)

```

rect.dendrogram

*Draw Rectangles Around a Dendrogram's Clusters***Description**

Draws rectangles around the branches of a dendrogram highlighting the corresponding clusters. First the dendrogram is cut at a certain level, then a rectangle is drawn around selected branches.

**Usage**

```

rect.dendrogram(
  tree,
  k = NULL,
  which = NULL,
  x = NULL,
  h = NULL,
  border = 2,
  cluster = NULL,
  horiz = FALSE,
  density = NULL,
  angle = 45,
  text = NULL,
  text_cex = 1,
  text_col = 1,
  xpd = TRUE,
  lower_rect,
  upper_rect = 0,
  prop_k_height = 0.5,
  stop_if_out = FALSE,
  ...
)

```

**Arguments**

tree            a [dendrogram](#) object.

k	Scalar. Cut the dendrogram such that exactly k clusters (if possible) are produced.
which	A vector selecting the clusters around which a rectangle should be drawn. which selects clusters by number (from left to right in the tree), Default is which = 1:k.
x	A vector selecting the clusters around which a rectangle should be drawn. x selects clusters containing the respective horizontal coordinates.
h	Scalar. Cut the dendrogram by cutting at height h. (k overrides h)
border	Vector with border colors for the rectangles.
cluster	Optional vector with cluster memberships as returned by cutree(dend_obj, k = k), can be specified for efficiency if already computed.
horiz	logical (FALSE), indicating if the rectangles should be drawn horizontally or not (for when using plot(dend, horiz = TRUE) ).
density	Passed to <a href="#">rect</a> : the density of shading lines, in lines per inch. The default value of NULL means that no shading lines are drawn. A zero value of density means no shading lines whereas negative values (and NA) suppress shading (and so allow color filling). If border is a vector of colors, the color of density will default to 1.
angle	Passed to <a href="#">rect</a> : angle (in degrees) of the shading lines. (default is 45)
text	a character vector of labels to plot underneath the clusters. When NULL (default), no text is displayed.
text_cex	a numeric (scalar) value of the text's cex value.
text_col	a (scalar) value of the text's col(or) value.
xpd	A logical value (or NA.), passed to <a href="#">par</a> . Default is TRUE, in order to allow the rect to be below the labels. If FALSE, all plotting is clipped to the plot region, if TRUE, all plotting is clipped to the figure region, and if NA, all plotting is clipped to the device region. See also <a href="#">clip</a> .
lower_rect	a (scalar) value of how low should the lower part of the rect be. If missing, it will take the value of par("usr")[3L] (or par("usr")[2L], depending if horiz = TRUE or not), with also the width of the labels. (notice that we would like to keep xpd = TRUE if we want the rect to be after the labels!) You can use a value such as 0, to get the rect above the labels. Notice that for a plot with small margins, it would be better to set this parameter manually.
upper_rect	a (scalar) value to add (default is 0) to how high should the upper part of the rect be.
prop_k_height	a (scalar) value (should be between 0 to 1), indicating what proportion of the height our rect will be between the height needed for k and k+1 clustering.
stop_if_out	logical (default is TRUE). This makes the function stop if k of the locator is outside the range (this default reproduces the behavior of the rect.hclust function).
...	parameters passed to rect (such as lwd, lty, etc.)

### Value

(Invisibly) returns a list where each element contains a vector of data points contained in the respective cluster.



**Source**

This function is based on [rect.hclust](#), with slight modifications to have it work with a dendrogram, as well as a few added features (e.g: ... to rect, and horiz)

The idea of adding text and shading lines under the clusters comes from skullkey from here: <https://stackoverflow.com/questions/4720307/change-dendrogram-leaves>

**See Also**

[rect.hclust](#), [order.dendrogram](#), [cutree.dendrogram](#)

**Examples**

```
set.seed(23235)
ss <- sample(1:150, 10)
hc <- iris[ss, -5] %>%
  dist() %>%
  hclust()
dend <- hc %>% as.dendrogram()

plot(dend)
rect.dendrogram(dend, 2, border = 2)
rect.dendrogram(dend, 3, border = 4)
Vectorize(rect.dendrogram, "k")(dend, 4:5, border = 6)

plot(dend)
rect.dendrogram(dend, 3,
  border = 1:3,
  density = 2, text = c("1", "b", "miao"), text_cex = 3
)

plot(dend)
rect.dendrogram(dend, 4, which = c(1, 3), border = c(2, 3))
rect.dendrogram(dend, 4, x = 5, border = c(4))
rect.dendrogram(dend, 3, border = 3, lwd = 2, lty = 2)
# now THIS, you can not do with the old rect.hclust
plot(dend, horiz = TRUE)
rect.dendrogram(dend, 2, border = 2, horiz = TRUE)
rect.dendrogram(dend, 4, border = 4, lty = 2, lwd = 3, horiz = TRUE)

# This had previously failed since it worked with a wrong k.

dend15 <- c(1:5) %>%
  dist() %>%
  hclust(method = "average") %>%
  as.dendrogram()
# dend15 <- c(1:25) %>% dist %>% hclust(method = "average") %>% as.dendrogram
dend15 %>%
  set("branches_k_color") %>%
  plot()
dend15 %>% rect.dendrogram(
  k = 3,
```

```
border = 8, lty = 5, lwd = 2
)
```

---

reindex\_dend

*Reindexing a pruned dendrogram*


---

### Description

prune\_leaf does not update leaf indices as it prune leaves. As a result, some leaves of the pruned dendrogram may have leaf indices larger than the number of leaves in the pruned dendrogram, which may cause errors in downstream functions such as `as.hclust`.

This function re-indexes the leaves such that the leaf indices are no larger than the total number of leaves.

### Usage

```
reindex_dend(dend)
```

### Arguments

```
dend          dendrogram object
```

### Value

A dendrogram object with the leaf reindexed

### Examples

```
hc <- hclust(dist(USArrests[1:5, ]), "ave")
dend <- as.dendrogram(hc)

dend_pruned <- prune(dend, c("Alaska", "California"), reindex_dend = FALSE)

## A leave have an index larger than the number of leaves:
unlist(dend_pruned)
# [1] 4 3 1
#'
dend_pruned_reindexed <- reindex_dend(dend_pruned)

## All leaf indices are no larger than the number of leaves:
unlist(dend_pruned_reindexed)
# [1] 3 2 1

## The dendrograms are equal:
all.equal(dend_pruned, dend_pruned_reindexed)
# TRUE
```

---

`remove_branches_edgePar`*Remove all edgePar values from a dendrogram's branches*

---

**Description**

Go through the dendrogram branches and remove its edgePar.

**Usage**

```
remove_branches_edgePar(dend, ...)
```

**Arguments**

dend	a dendrogram object
...	not used

**Value**

A dendrogram, after removing the edgePar attribute in all of its branches,

**See Also**

[get\\_root\\_branches\\_attr](#), [assign\\_values\\_to\\_branches\\_edgePar](#)

**Examples**

```
## Not run:  
  
dend <- USArrests[1:5, ] %>%  
  dist() %>%  
  hclust() %>%  
  as.dendrogram()  
dend <- color_branches(dend, 3)  
par(mfrow = c(1, 2))  
plot(dend)  
plot(remove_branches_edgePar(dend))  
  
## End(Not run)
```

remove\_leaves\_nodePar *Remove all nodePar values from a dendrogram's leaves*

---

### Description

Go through the dendrogram leaves and remove its nodePar.

### Usage

```
remove_leaves_nodePar(dend, ...)
```

### Arguments

dend	a dendrogram object
...	not used

### Value

A dendrogram, after removing the nodePar attribute in all of its leaves,

### See Also

[get\\_leaves\\_attr](#), [assign\\_values\\_to\\_leaves\\_nodePar](#)

### Examples

```
## Not run:

dend <- USArrests[1:5, ] %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()

dend <- color_labels(dend, 3)
par(mfrow = c(1, 2))
plot(dend)
plot(remove_leaves_nodePar(dend))

get_leaves_attr(dend, "nodePar")
get_leaves_attr(remove_leaves_nodePar(dend), "nodePar")

## End(Not run)
```

---

remove\_nodes\_nodePar *Remove all nodePar values from a dendrogram's nodes*

---

### Description

Go through the dendrogram nodes and remove its nodePar

### Usage

```
remove_nodes_nodePar(dend, ...)
```

### Arguments

dend	a dendrogram object
...	not used

### Value

A dendrogram, after removing the nodePar attribute in all of its nodes,

### See Also

[get\\_root\\_branches\\_attr](#), [assign\\_values\\_to\\_branches\\_edgePar](#)

### Examples

```
## Not run:  
  
dend <- USArrests[1:5, ] %>%  
  dist() %>%  
  hclust() %>%  
  as.dendrogram()  
dend <- color_branches(dend, 3)  
par(mfrow = c(1, 2))  
plot(dend)  
plot(remove_branches_edgePar(dend))  
  
## End(Not run)
```

---

`rllply`*recursively apply a function on a list*

---

### Description

recursively apply a function on a list - and returns the output as a list, following the naming convention in the plyr package the big difference between this and rapply is that this will also apply the function on EACH element of the list, even if it's not a "terminal node" inside the list tree. An attribute is added to indicate if the value returned is from a branch or a leaf.

### Usage

```
rllply(x, FUN, add_notation = FALSE, ...)
```

### Arguments

<code>x</code>	a list.
<code>FUN</code>	a function to apply on each element of the list
<code>add_notation</code>	logical. Should each node be added a "position_type" attribute, stating if it is a "Branch" or a "Leaf".
<code>...</code>	not used.

### Value

a list with ALL of the nodes (from the original "x" list), that FUN was applied on.

### Examples

```
## Not run:
x <- list(1)
x
rllply(x, function(x) {
  x
}, add_notation = TRUE)

x <- list(1, 2, list(31))
x
rllply(x, function(x) {
  x
}, add_notation = TRUE)
# the first element is the entire tree
# after FUN was applied to its root element.

hc <- hclust(dist(USArrests[1:4, ]), "ave")
dend <- as.dendrogram(hc)
rllply(dend, function(x) {
  attr(x, "height")
})
```

```
rllply(dend, function(x) {
  attr(x, "members")
})

## End(Not run)
```

---

rotate	<i>Rotate a tree object</i>
--------	-----------------------------

---

### Description

Rotates, rev and sort the branches of a tree object (dendrogram, hclust) based on a vector - either of labels order (numbers) or the labels in their new order (character).

### Usage

```
rotate(x, ...)
```

## Default S3 method:  
rotate(x, order, ...)

## S3 method for class 'dendrogram'  
rotate(x, order, ...)

## S3 method for class 'hclust'  
rotate(x, order, ...)

## S3 method for class 'phylo'  
rotate(x, ..., phy)

## S3 method for class 'dendrogram'  
sort(x, decreasing = FALSE, type = c("labels", "nodes"), ...)

## S3 method for class 'hclust'  
sort(x, decreasing = FALSE, ...)

## S3 method for class 'dendlist'  
sort(x, ...)

## S3 method for class 'hclust'  
rev(x, ...)

### Arguments

x	a tree object (either a dendrogram or hclust)
...	parameters passed (for example, in case of sort)

order	Either numeric or character vector. Is numeric: it is a numeric vector with the order of the value to be assigned to object's label. The numbers say are just like when you use <a href="#">order</a> : which of the items on the tree-plot should be "first" (e.g: most left), second etc. (this is relevant only to <a href="#">rotate</a> ) Is character: it must be a vector with the content of <code>labels(x)</code> , in the order we'd like to have the new tree.
phy	a placeholder in case the user uses "phy ="
decreasing	logical. Should the sort be increasing or decreasing? Not available for partial sorting. (relevant only to <code>sort</code> )
type	a character indicating how to sort. If "labels" then by lexicographic order of the labels. If "nodes", then by using <a href="#">ladderize</a> (order so that recursively, the leftmost branch will be the smallest)

## Details

The motivation for this function came from the function [order.dendrogram](#) NOT being very intuitive. What `rotate` aims to do is give a simple tree rotation function which is based on the order which the user would like to see the tree rotated by (just as [order](#) works for numeric vectors).

[rev.dendrogram](#) is part of base R, and returns the tree object after rotating it so that the order of the labels is reversed. Here we added an S3 method for `hclust` objects.

The `sort` methods sort the labels of the tree (using `order`) and then attempts to rotate the tree to fit that order.

The `hclust` method of "rotate" works by first changing the object into `dendrogram`, performing the rotation, and then changing it back to `hclust`. Special care is taken in preserving some of the properties of the `hclust` object.

The `ape` package has its own [rotate\(ape\)](#) function (Which is sadly not S3, so cannot be easily connected with the current implementation). Still, there is an S3 plug that makes sure people loading first `ape` and then `dendextend` will still be able to use `rotate` without a problem. Notice that if you will first load `ape` and only then `dendextend`, using "rotate" will fail with the error: "Error in `rotate(dend, _____)` : object "phy" is not of class "phylo" - this is because `rotate` in `ape` is not S3 and will fail to find the `rotate.dendrogram` function. In such a case simply run `unloadNamespace(ape)`. Or, you can run: `unloadNamespace("dendextend"); attachNamespace("dendextend")` The solution for this is that if you have `ape` installed on your machine, It will be loaded when you load `dendextend` (but after it). This way, `rotate` will work fine for both `dendrogram` AND `phylo` objects.

## Value

A rotated tree object

## See Also

[order.dendrogram](#), [order](#), [rev.dendrogram](#), [rotate](#) (`ape`), [ladderize](#)

## Examples

```
hc <- hclust(dist(USArrests[,c(1, 6, 13, 20, 23)], ), "ave")
dend <- as.dendrogram(hc)
```



```

# For dendrogram objects:
labels_colors(dend) <- rainbow(nleaves(dend))
# let's color the labels to make the followup of the rotation easier
par(mfrow = c(1, 2))
plot(dend, main = "Original tree")
plot(rotate(dend, c(2:5, 1)),
     main =
       "Rotates the left most leaf \n into the right side of the tree"
)
par(mfrow = c(1, 2))
plot(dend, main = "Original tree")
plot(sort(dend), main = "Sorts the labels by alphabetical order \n
and rotates the tree to give the best fit possible")
par(mfrow = c(1, 2))
plot(dend, main = "Original tree")
plot(rev(dend), main = "Reverses the order of the tree labels")

# For hclust objects:
plot(hc)
plot(rotate(hc, c(2:5, 1)), main = "Rotates the left most leaf \n
into the right side of the tree")

par(mfrow = c(1, 3))
dend %>% plot(main = "Original tree")
dend %>%
  sort() %>%
  plot(main = "labels sort")
dend %>%
  sort(type = "nodes") %>%
  plot(main = "nodes (ladderize) sort")

```

---

rotate\_DendSer

*Rotates dend based on DendSer*


---

### Description

Rotates a dendrogram based on its seriation

The function tries to turn the dend into hclust using [DendSer.dendrogram](#) (based on [DendSer](#))

Also, if a distance matrix is missing, it will try to use the [cophenetic](#) distance.

### Usage

```
rotate_DendSer(dend, ser_weight, ...)
```

### Arguments

dend                    An object of class dendrogram

`ser_weight` Used by cost function to evaluate ordering. For `cost=costLS`, this is a vector of object weights. Otherwise is a dist or symmetric matrix. passed to `DendSer.dendrogram` and from there to `DendSer`.  
If it is missing, the cophenetic distance is used instead.

... parameters passed to `DendSer`

**Value**

Numeric vector giving an optimal dendrogram order

**See Also**

`DendSer`, `DendSer.dendrogram`, `untangle_DendSer`, `rotate_DendSer`

**Examples**

```
## Not run:
library(DendSer) # already used from within the function

dend <- USArrests[1:4, ] %>%
  dist() %>%
  hclust("ave") %>%
  as.dendrogram()
DendSer.dendrogram(dend)

tanglegram(dend, rotate_DendSer(dend))

## End(Not run)
```

---

`sample.dendrogram`      *Sample a tree*

---

**Description**

Samples a tree, either by permuting the labels (which is useful for a permutation test), or by repeated sampling of the same labels (essential for bootstrapping when we don't have access to the original data which produced the tree).

Duplicates a leaf in a tree. Useful for non-parametric bootstrapping trees since it emulates what would have happened if the tree was constructed based on a row-sample with replacements from the original data matrix.

**Usage**

```
sample.dendrogram(
  dend,
  replace = FALSE,
  dend_labels,
  sampled_labels,
```

```

    fix_members = TRUE,
    fix_order = TRUE,
    fix_midpoint = TRUE,
    ...
)

```

### Arguments

dend	a dendrogram object
replace	logical (FALSE). Should we shuffle the labels (if FALSE), or should we replicate the same leaf over and over, while omitting other leaves? (this is when set to TRUE).
dend_labels	a character vector of the tree's labels. This can save the time it takes for getting the tree labels (in case we run a simulating, computing this once might save some running time). If missing, it uses <a href="#">labels</a> in order to get the labels.
sampled_labels	a character vector of the tree's sampled labels. This can help us if we wish to compare two trees. In such a case we'd like to be able to have the same sample of labels used on both trees. If missing, it uses <a href="#">sample</a> in order to get the sampled labels. Only works when replace=TRUE!
fix_members	logical (TRUE). Fix the number of members in attr using <a href="#">fix_members_attr.dendrogram</a>
fix_order	logical (TRUE). Fix the leaves order
fix_midpoint	logical (TRUE). Fix the midpoint value. If TRUE, it overrides "fix_members" and turns it into TRUE (since it must have a correct number of members in order to work). values using <a href="#">rank_order.dendrogram</a>
...	not used

### Value

A dendrogram, after "sampling" its leaves.

### See Also

[sample](#), [duplicate\\_leaf](#)

### Examples

```

## Not run:
# define dendrogram object to play with:
dend <- USArrests[1:5, ] %>%
  dist() %>%
  hclust(method = "ave") %>%
  as.dendrogram()
plot(dend)

# # same tree, with different order of labels
plot(sample.dendrogram(dend, replace = FALSE))

```

```
## A different tree (!), with some labels duplicated,
## while others are pruned
plot(sample.dendrogram(dend, replace = TRUE))

## End(Not run)
```

---

seriate\_dendrogram      *Rotates a dendrogram based on a seriation of a distance matrix*

---

### Description

Rotates a dendrogram so it conforms to an order of a provided distance object. The seriation algorithm is based on [seriate](#), which tries to find a linear order for objects using data in form of a dissimilarity matrix (one mode data).

This is useful for heatmap visualization.

### Usage

```
seriate_dendrogram(dend, x, method = c("OLO", "GW"), ...)
```

### Arguments

dend	An object of class <a href="#">dendrogram</a> or <a href="#">hclust</a>
x	a <a href="#">dist</a> object.
method	a character vector of either "OLO" or "GW": "OLO" - Optimal leaf ordering, optimizes the Hamiltonian path length that is restricted by the dendrogram structure - works in $O(n^4)$ "GW" - Gruvaeus and Wainer heuristic to optimize the Hamiltonian path length that is restricted by the dendrogram structure
...	parameters passed to <a href="#">seriate</a>

### Value

A dendrogram that is rotated based on the optimal ordering of the distance matrix

### See Also

[rotate](#), [seriate](#)

### Examples

```
## Not run:
# library(dendextend)
d <- dist(USArrests)
hc <- hclust(d, "ave")
dend <- as.dendrogram(hc)

heatmap(as.matrix(USArrests))
```

```
dend2 <- seriate_dendrogram(dend, d)
heatmap(as.matrix(USArrests), Rowv = dend)

## End(Not run)
```

---

set

*Set (/update) features to a dendrogram*


---

## Description

a master function for updating various attributes and features of dendrogram objects.

## Usage

```
set(dend, ...)
```

```
## S3 method for class 'dendrogram'
set(
  dend,
  what = c("labels", "labels_colors", "labels_cex", "labels_to_character", "leaves_pch",
    "leaves_cex", "leaves_col", "leaves_bg", "nodes_pch", "nodes_cex", "nodes_col",
    "nodes_bg", "hang_leaves", "rank_branches", "branches_k_color", "branches_k_lty",
    "branches_col", "branches_lwd", "branches_lty", "by_labels_branches_col",
    "by_labels_branches_lwd", "by_labels_branches_lty", "by_lists_branches_col",
    "by_lists_branches_lwd", "by_lists_branches_lty", "highlight_branches_col",
    "highlight_branches_lwd", "clear_branches",
    "clear_leaves"),
  value,
  order_value = FALSE,
  ...
)
```

```
## S3 method for class 'dendlist'
set(dend, ..., which)
```

```
## S3 method for class 'data.table'
set(...)
```

## Arguments

dend	a tree ( <a href="#">dendrogram</a> , or <a href="#">dendlist</a> )
...	passed to the specific function for more options.
what	a character indicating what is the property of the tree that should be set/updated. (see the usage and the example section for the different options)
value	an object with the value to set in the dendrogram tree. (the type of the value depends on the "what")

order_value	logical. Default is FALSE. If TRUE, it means the order of the value is in the order of the data which produced the <a href="#">hclust</a> or <a href="#">dendrogram</a> - and will reorder the value to conform with the order of the labels in the dendrogram.
which	an integer vector indicating, in the case "dend" is a dendlist, on which of the trees should the modification be performed. If missing - the change will be performed on all of dends in the dendlist.

## Details

This is a wrapper function for many of the main tasks we might wish to perform on a dendrogram before plotting.

The options of `by_labels_branches_col`, `by_labels_branches_lwd`, `by_labels_branches_lty` have extra parameters: `type`, `attr`, `TF_value`, and `by_lists_branches_col`, `by_lists_branches_lwd`, `by_lists_branches_lty` have extra parameters: `attr`, `TF_value`. You can read more about them here: [branches\\_attr\\_by\\_labels](#) and [branches\\_attr\\_by\\_lists](#)

The "what" parameter" can accept the following options:

- `labels` - set the labels ([labels<-dendrogram](#))
- `labels_colors` - set the labels' colors ([color\\_labels](#))
- `labels_cex` - set the labels' size ([assign\\_values\\_to\\_leaves\\_nodePar](#))
- `labels_to_character` - set the labels' to be characters
- `leaves_pch` - set the leaves' point type ([assign\\_values\\_to\\_leaves\\_nodePar](#)). A leaf is the terminal node of the tree.
- `leaves_cex` - set the leaves' point size ([assign\\_values\\_to\\_leaves\\_nodePar](#)). For using this you MUST also set `leaves_pch`, a good value to use is 19.
- `leaves_col` - set the leaves' point color ([assign\\_values\\_to\\_leaves\\_nodePar](#)). For using this you MUST also set `leaves_pch`, a good value to use is 19.
- `leaves_bg` - set the leaves' point fill color ([assign\\_values\\_to\\_leaves\\_nodePar](#)). For using this you MUST also set `leaves_pch` with values from 21-25.
- `nodes_pch` - set the nodes' point type ([assign\\_values\\_to\\_nodes\\_nodePar](#))
- `nodes_cex` - set the nodes' point size ([assign\\_values\\_to\\_nodes\\_nodePar](#))
- `nodes_col` - set the nodes' point color ([assign\\_values\\_to\\_nodes\\_nodePar](#))
- `nodes_bg` - set the nodes' point fill color ([assign\\_values\\_to\\_nodes\\_nodePar](#)). For using this you MUST also set `leaves_pch` with values from 21-25.
- `hang_leaves` - hang the leaves ([hang.dendrogram](#))
- `branches_k_color` - color the branches ([color\\_branches](#)), a `k` parameter needs to be supplied.
- `branches_k_lty` - updates the `lwd` of the branches (similar to `branches_k_color`), a `k` parameter needs to be supplied.
- `branches_col` - set the color of branches ([assign\\_values\\_to\\_branches\\_edgePar](#))
- `branches_lwd` - set the line width of branches ([assign\\_values\\_to\\_branches\\_edgePar](#))
- `branches_lty` - set the line type of branches ([assign\\_values\\_to\\_branches\\_edgePar](#))
- `by_labels_branches_col` - set the color of branches with specific labels ([branches\\_attr\\_by\\_labels](#))

- `by_labels_branches_lwd` - set the line width of branches with specific labels ([branches\\_attr\\_by\\_labels](#))
- `by_labels_branches_lty` - set the line type of branches with specific labels ([branches\\_attr\\_by\\_labels](#))
- `by_lists_branches_col` - set the color of branches from the root of the tree down to (possibly inner) nodes with specified members ([branches\\_attr\\_by\\_lists](#))
- `by_lists_branches_lwd` - set the line width of branches from the root of the tree down to (possibly inner) nodes with specified members ([branches\\_attr\\_by\\_lists](#))
- `by_lists_branches_lty` - set the line type of branches from the root of the tree down to (possibly inner) nodes with specified members ([branches\\_attr\\_by\\_lists](#))
- `highlight_branches_col` - highlight branches color based on branches' heights ([highlight\\_branches\\_col](#))
- `highlight_branches_lwd` - highlight branches line-width based on branches' heights ([highlight\\_branches\\_lwd](#))
- `clear_branches` - clear branches' attributes ([remove\\_branches\\_edgePar](#))
- `clear_leaves` - clear leaves' attributes ([remove\\_branches\\_edgePar](#))

### Value

An updated dendrogram (or dendlist), with some change to the parameters of it

### See Also

[labels<-dendrogram](#), [labels\\_colors<-](#), [hang.dendrogram](#), [color\\_branches](#), [assign\\_values\\_to\\_leaves\\_nodePar](#), [assign\\_values\\_to\\_branches\\_edgePar](#), [remove\\_branches\\_edgePar](#), [remove\\_leaves\\_nodePar](#), [noded\\_with\\_condition](#), [branches\\_attr\\_by\\_labels](#), [branches\\_attr\\_by\\_lists](#), [dendrogram](#)

### Examples

```
## Not run:

set.seed(23235)
ss <- sample(1:150, 10)

# Getting the dend object
dend <- iris[ss, -5] %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
dend %>% plot()

dend %>% labels()
dend %>%
  set("labels", 1:10) %>%
  labels()
dend %>%
  set("labels", 1:10) %>%
  plot()
dend %>%
  set("labels_color") %>%
  plot()
dend %>%
```

```

    set("labels_col", c(1, 2)) %>%
    plot() # Works also with partial matching :)
dend %>%
    set("labels_cex", c(1, 1.2)) %>%
    plot()
dend %>%
    set("leaves_pch", NA) %>%
    plot()
dend %>%
    set("leaves_pch", c(1:5)) %>%
    plot()
dend %>%
    set("leaves_pch", c(19, 19, NA)) %>%
    set("leaves_cex", c(1, 2)) %>%
    plot()
dend %>%
    set("leaves_pch", c(19, 19, NA)) %>%
    set("leaves_cex", c(1, 2)) %>%
    set("leaves_col", c(1, 1, 2, 2)) %>%
    plot()
dend %>%
    set("hang") %>%
    plot()

# using bg for leaves and nodes

set.seed(23235)
ss <- sample(1:150, 25)

# Getting the dend object
dend25 <- iris[ss, -5] %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()

dend25 %>%
  set("labels", 1:25) %>%
  set("nodes_pch", 21) %>% # set all nodes to be pch 21
  set("nodes_col", "darkred") %>%
  set("nodes_bg", "gold") %>%
  set("leaves_pch", 1:25) %>% # Change the leaves pch to move from 1 to 25
  set("leaves_col", "darkred") %>%
  set("leaves_bg", "gold") %>%
  plot(main = "pch 21 to 25 supports the\nnodes_bg and leaves_bg parameters")

dend %>%
  set("branches_k_col") %>%
  plot()
dend %>%
  set("branches_k_col", c(1, 2)) %>%
  plot()
dend %>%

```



```

    set("branches_k_col", c(1, 2, 3), k = 3) %>%
    plot()
dend %>%
  set("branches_k_col", k = 3) %>%
  plot()

dend %>%
  set("branches_k_lty", k = 3) %>%
  plot()
dend %>%
  set("branches_k_col", k = 3) %>%
  set("branches_k_lty", k = 3) %>%
  plot()

dend %>%
  set("branches_col", c(1, 2, 1, 2, NA)) %>%
  plot()
dend %>%
  set("branches_lwd", c(2, 1, 2)) %>%
  plot()
dend %>%
  set("branches_lty", c(1, 2, 1)) %>%
  plot()

# clears all of the things added to the leaves
dend %>%
  set("labels_color", c(19, 19, NA)) %>%
  set("leaves_pch", c(19, 19, NA)) %>% # plot
  set("clear_leaves") %>% # remove all of what was done until this point
  plot()
# Different order
dend %>%
  set("leaves_pch", c(19, 19, NA)) %>%
  set("labels_color", c(19, 19, NA)) %>%
  set("clear_leaves") %>%
  plot()

# doing this without chaining (%>%) will NOT be fun:
dend %>%
  set("labels", 1:10) %>%
  set("labels_color") %>%
  set("branches_col", c(1, 2, 1, 2, NA)) %>%
  set("branches_lwd", c(2, 1, 2)) %>%
  set("branches_lty", c(1, 2, 1)) %>%
  set("hang") %>%
  plot()

par(mfrow = c(1, 3))
dend %>%
  set("highlight_branches_col") %>%
  plot()
dend %>%

```

```

    set("highlight_branches_lwd") %>%
    plot()
dend %>%
    set("highlight_branches_col") %>%
    set("highlight_branches_lwd") %>%
    plot()
par(mfrow = c(1, 1))

#-----
# Examples for: by_labels_branches_col, by_labels_branches_lwd, by_labels_branches_lty

old_labels <- labels(dend)
dend %>%
    set("labels", seq_len(nleaves(dend))) %>%
    set("by_labels_branches_col", c(1:4, 7)) %>%
    set("by_labels_branches_lwd", c(1:4, 7)) %>%
    set("by_labels_branches_lty", c(1:4, 7)) %>%
    set("labels", old_labels) %>%
    plot()

dend %>%
    set("labels", seq_len(nleaves(dend))) %>%
    set("by_labels_branches_col", c(1:4, 7), type = "any", TF_values = c(4, 2)) %>%
    set("by_labels_branches_lwd", c(1:4, 7), type = "all", TF_values = c(4, 1)) %>%
    set("by_labels_branches_lty", c(1:4, 7), TF_values = c(4, 1)) %>%
    plot()

#---- using order_value
# This is probably not what you want, since cutree
# returns clusters in the order of the original data:
dend %>%
    set("labels_colors", cutree(dend, k = 3)) %>%
    plot()
# The way to fix it, is to use order_value = TRUE
# so that value is assumed to be in the order of the data:
dend %>%
    set("labels_colors", cutree(dend, k = 3), order_value = TRUE) %>%
    plot()

#-----
# Example for: by_lists_branches_col, by_lists_branches_lwd, by_lists_branches_lty

L <- list(c("109", "123", "126", "145"), "29", c("59", "67", "97"))
dend %>%
    set("by_lists_branches_col", L, TF_value = "blue") %>%
    set("by_lists_branches_lwd", L, TF_value = 4) %>%
    set("by_lists_branches_lty", L, TF_value = 3) %>%
    plot()

#-----
# A few dendlist examples:

```

```

dendlist(dend, dend) %>%
  set("hang") %>%
  plot()
dendlist(dend, dend) %>%
  set("branches_k_col", k = 3) %>%
  plot()
dendlist(dend, dend) %>%
  set("labels_col", c(1, 2)) %>%
  plot()

dendlist(dend, dend) %>%
  set("hang") %>%
  set("labels_col", c(1, 2), which = 1) %>%
  set("branches_k_col", k = 3, which = 2) %>%
  set("labels_cex", 1.2) %>%
  plot()

#-----
# example of modifying the dendrogram in a heatmap:

library(gplots)
data(mtcars)
x <- as.matrix(mtcars)
rc <- rainbow(nrow(x), start = 0, end = .3)
cc <- rainbow(ncol(x), start = 0, end = .3)

##
##' demonstrate the effect of row and column dendrogram options
##
Rowv_dend <- x %>%
  dist() %>%
  hclust() %>%
  as.dendrogram() %>%
  set("branches_k", k = 3) %>%
  set("branches_lwd", 2) %>%
  ladderize() # rotate_DendSer
Colv_dend <- t(x) %>%
  dist() %>%
  hclust() %>%
  as.dendrogram() %>%
  set("branches_k", k = 3) %>%
  set("branches_lwd", 2) %>%
  ladderize() # rotate_DendSer
heatmap.2(x, Rowv = Rowv_dend, Colv = Colv_dend)

## End(Not run)

```

## Description

Convenience functions for updating the labels of a dendrogram. `set_labels` and `place_labels` differs in their assumption about the order of the labels. \* `set_labels` assumes the labels are in the same order as that of the labels in the dendrogram. \* `place_labels` assumes the labels has the same order as that of the items in the original data matrix. This is useful for renaming labels based on some other columns in the data matrix.

## Usage

```
set_labels(dend, labels, ...)
```

## Arguments

<code>dend</code>	a <a href="#">dendrogram</a> object
<code>labels</code>	A vector of values to insert in the labels of a dendrogram.
<code>...</code>	Currently ignored.

## Value

The updated [dendrogram](#) object

## Author(s)

Tal Galili, Garrett Grolemond

## See Also

[labels](#), [set](#)

## Examples

```
ss <- c(
  50, 114, 17, 102, 76, 10, 107, 84, 31, 37, 49, 106, 44, 119,
  104, 145, 67, 85, 12, 77, 22, 136, 38, 135, 70
)

small_iris <- iris[ss, ]

small_iris[, -5] %>%
  dist() %>%
  hclust(method = "complete") %>%
  as.dendrogram() %>%
  color_branches(k = 3) %>%
  color_labels(k = 3) %>%
  plot()

# example for using place_labels
small_iris[, -5] %>%
  dist() %>%
  hclust(method = "complete") %>%
```

```

as.dendrogram() %>%
color_branches(k = 3) %>%
color_labels(k = 3) %>%
place_labels(paste(small_iris$Species, 1:25, sep = "_")) %>%
plot()

# example for using set_labels
small_iris[, -5] %>%
dist() %>%
hclust(method = "complete") %>%
as.dendrogram() %>%
color_branches(k = 3) %>%
color_labels(k = 3) %>%
set_labels(1:25) %>%
plot()

```

---

shuffle

*Random rotation of trees*


---

## Description

'shuffle' randomly rotates ("shuffles") a tree, changing its presentation while preserving its topology. 'shuffle' is based on [rotate](#) and through its methods can work for any of the major tree objects in R ([dendrogram/hclust/phylo](#)).

This function is useful in combination with [tanglegram](#) and [entanglement](#).

## Usage

```

shuffle(dend, ...)

## Default S3 method:
shuffle(dend, ...)

## S3 method for class 'dendrogram'
shuffle(dend, ...)

## S3 method for class 'dendlist'
shuffle(dend, which, ...)

## S3 method for class 'hclust'
shuffle(dend, ...)

## S3 method for class 'phylo'
shuffle(dend, ...)

```

**Arguments**

dend	a tree object ( <a href="#">dendrogram/hclust/phylo</a> )
...	Ignored.
which	an integer vector for indicating which of the trees in the dendlist object should be plotted default is missing, in which case all the dends in dendlist will be shuffled

**Details**

'shuffle' is a function that randomly rotates ("shuffles") a tree. a dendrogram leaves order (by means of rotation)

**Value**

A randomly rotated tree object

**See Also**

[tanglegram](#), [entanglement](#), [rotate](#)

**Examples**

```
dend <- USArrests %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
set.seed(234238)
dend2 <- shuffle(dend)

tanglegram(dend, dend2, margin_inner = 7)
entanglement(dend, dend2) # 0.3983

# although these ARE the SAME tree:
tanglegram(sort(dend), sort(dend2), margin_inner = 7)
```

---

sort\_2\_clusters\_vectors

*Sorts two clusters vector by their names*

---

**Description**

Sorts two clusters vector by their names and returns a list with the sorted vectors.

**Usage**

```
sort_2_clusters_vectors(
  A1_clusters,
  A2_clusters,
  assume_sorted_vectors = FALSE,
  warn = dendextend_options("warn"),
  ...
)
```

**Arguments**

<code>A1_clusters</code>	a numeric vector of cluster grouping (numeric) of items, with a name attribute of item name for each element from group A1. These are often obtained by using some <code>k</code> cut on a dendrogram.
<code>A2_clusters</code>	a numeric vector of cluster grouping (numeric) of items, with a name attribute of item name for each element from group A2. These are often obtained by using some <code>k</code> cut on a dendrogram.
<code>assume_sorted_vectors</code>	logical (FALSE). Can we assume to two group vectors are sorter so that they have the same order of items? IF FALSE (default), then the vectors will be sorted based on their name attribute.
<code>warn</code>	logical (default from <code>dendextend_options("warn")</code> is FALSE). Set if warning are to be issued, it is safer to keep this at TRUE, but for keeping the noise down, the default is FALSE.
<code>...</code>	Ignored.

**Value**

A list with two elements, corresponding to the two clustering vectors.

**Examples**

```
## Not run:

set.seed(23235)
ss <- sample(1:150, 4)
hc1 <- hclust(dist(iris[ss, -5]), "com")
hc2 <- hclust(dist(iris[ss, -5]), "single")
# dend1 <- as.dendrogram(hc1)
# dend2 <- as.dendrogram(hc2)
#   cutree(dend1)

A1_clusters <- cutree(hc1, k = 3)
A2_clusters <- sample(cutree(hc1, k = 3))

sort_2_clusters_vectors(A1_clusters, A2_clusters, assume_sorted_vectors = TRUE) # no sorting
sort_2_clusters_vectors(A1_clusters, A2_clusters, assume_sorted_vectors = FALSE) # Sorted

## End(Not run)
```

---

sort_dist_mat	<i>Sorts a distance matrix by rows and columns names</i>
---------------	--

---

**Description**

Sorts a distance matrix by the names of the rows and columns.

**Usage**

```
sort_dist_mat(dist_mat, by_rows = TRUE, by_cols = TRUE, ...)
```

**Arguments**

dist_mat	a distance matrix.
by_rows	logical (TRUE). Sort the distance matrix by rows?
by_cols	logical (TRUE). Sort the distance matrix by columns?
...	Ignored.

**Value**

A distance matrix (after sorting)

**See Also**

[dist](#), [cor\\_cophenetic](#)

---

sort_levels_values	<i>Sort the values level in a vector</i>
--------------------	--

---

**Description**

Takes a numeric vector and sort its values so that they would be increasing from left to right. It is different from [sort](#) in that the function will only "sort" the values levels, and not the vector itself.

This function is useful for [cutree](#) - making the sort\_cluster\_numbers parameter possible. Using that parameter with TRUE makes the clusters id's from cutree to be ordered from left to right. e.g: the left most cluster in the tree will be numbered "1", the one after it will be "2" etc...).

**Usage**

```
sort_levels_values(
  x,
  MARGIN = 2,
  decreasing = FALSE,
  force_integer = FALSE,
  warn = dendextend_options("warn"),
  ...
)
```



**Arguments**

x	a numeric vector.
MARGIN	passed to <a href="#">apply</a> . It is a vector giving the subscripts which the function will be applied over. E.g., for a matrix 1 indicates rows, 2 indicates columns, c(1, 2) indicates rows and columns. Where X has named dimnames, it can be a character vector selecting dimension names.
decreasing	logical (FALSE). Should the sort be increasing or decreasing?
force_integer	logical (FALSE). Should the values returned be integers?
warn	logical (default from <code>dendextend_options("warn")</code> is FALSE). Set if warnings are to be issued, it is safer to keep this at TRUE, but for keeping the noise down, the default is FALSE. (for example when x had NA values in it)
...	ignored.

**Value**

if x is an object - it returns logical - is the object of class dendrogram.

**See Also**

[sort](#), [fac2num](#), [cutree](#)

**Examples**

```
x <- 1:4
sort_levels_values(x) # 1 2 3 4

x <- c(4:1)
names(x) <- letters[x]
attr(x, "keep_me") <- "a cat"
sort_levels_values(x) # 1 2 3 4

x <- c(4:1, 4, 2)
sort_levels_values(x) # 1 2 3 4 1 3

x <- c(2, 2, 3, 2, 1)
sort_levels_values(x) # 1 1 2 1 3

x <- matrix(16:1, 4, 4)
rownames(x) <- letters[1:4]
x
apply(x, 2, sort_levels_values)
```

---

tanglegram	<i>Tanglegram plot</i>
------------	------------------------

---

**Description**

Plots a tanglegram plot of a side by side trees.

**Usage**

```
tanglegram(dend1, ...)

## Default S3 method:
tanglegram(dend1, ...)

## S3 method for class 'hclust'
tanglegram(dend1, ...)

## S3 method for class 'phylo'
tanglegram(dend1, ...)

## S3 method for class 'dendlist'
tanglegram(
  dend1,
  which = c(1L, 2L),
  main_left,
  main_right,
  just_one = TRUE,
  ...
)

## S3 method for class 'dendrogram'
tanglegram(
  dend1,
  dend2,
  sort = FALSE,
  color_lines,
  lwd = 3.5,
  edge.lwd = NULL,
  columns_width = c(5, 3, 5),
  margin_top = 3,
  margin_bottom = 2.5,
  margin_inner = 3,
  margin_outer = 0.5,
  left_dendo_mar = c(margin_bottom, margin_outer, margin_top, margin_inner),
  right_dendo_mar = c(margin_bottom, margin_inner, margin_top, margin_outer),
  intersecting = TRUE,
  dLeaf = NULL,
```

```
dLeaf_left = dLeaf,
dLeaf_right = dLeaf,
axes = TRUE,
type = "r",
lab.cex = NULL,
remove_nodePar = FALSE,
main = "",
main_left = "",
main_right = "",
sub = "",
k_labels = NULL,
k_branches = NULL,
rank_branches = FALSE,
hang = FALSE,
match_order_by_labels = TRUE,
cex_main = 2,
cex_main_left = cex_main,
cex_main_right = cex_main,
cex_sub = cex_main,
highlight_distinct_edges = TRUE,
common_subtrees_color_lines = TRUE,
common_subtrees_color_lines_default_single_leaf_color = "grey",
common_subtrees_color_branches = FALSE,
highlight_branches_col = FALSE,
highlight_branches_lwd = TRUE,
faster = FALSE,
just_one = TRUE,
...
)

dendbackback(
  dend1,
  dend2,
  sort = FALSE,
  color_lines,
  lwd = 3.5,
  edge.lwd = NULL,
  columns_width = c(5, 3, 5),
  margin_top = 3,
  margin_bottom = 2.5,
  margin_inner = 3,
  margin_outer = 0.5,
  left_dendo_mar = c(margin_bottom, margin_outer, margin_top, margin_inner),
  right_dendo_mar = c(margin_bottom, margin_inner, margin_top, margin_outer),
  intersecting = TRUE,
  dLeaf = NULL,
  dLeaf_left = dLeaf,
  dLeaf_right = dLeaf,
```

```

axes = TRUE,
type = "r",
lab.cex = NULL,
remove_nodePar = FALSE,
main = "",
main_left = "",
main_right = "",
sub = "",
k_labels = NULL,
k_branches = NULL,
rank_branches = FALSE,
hang = FALSE,
match_order_by_labels = TRUE,
cex_main = 2,
cex_main_left = cex_main,
cex_main_right = cex_main,
cex_sub = cex_main,
highlight_distinct_edges = TRUE,
common_subtrees_color_lines = TRUE,
common_subtrees_color_lines_default_single_leaf_color = "grey",
common_subtrees_color_branches = FALSE,
highlight_branches_col = FALSE,
highlight_branches_lwd = TRUE,
faster = FALSE,
just_one = TRUE,
...
)

```

### Arguments

dend1	tree object (dendrogram/dendlist/hclust/phylo), plotted on the left
...	not used.
which	an integer vector of length 2, indicating which of the trees in the dendlist object should be plotted
main_left	Character. Title of the left dendrogram.
main_right	Character. Title of the right dendrogram.
just_one	logical (TRUE). If FALSE, it means at least two tanglegrams will be plotted on the same page and so <code>layout</code> is not passed. See: <a href="https://stackoverflow.com/q/39784746/4137985">https://stackoverflow.com/q/39784746/4137985</a>
dend2	tree object (dendrogram/hclust/phylo), plotted on the right
sort	logical (FALSE). Should the dendrogram's labels be "sorted"? (might give a better tree in some cases).
color_lines	a vector of colors for the lines connected the labels. If the colors are shorter than the number of labels, they are recycled (and a warning is issued). The colors in the vector are applied on the lines from the bottom up.
lwd	width of the lines connecting the labels. (default is 3.5)

<code>edge.lwd</code>	width of the dendrograms lines. Default is NULL. If set, then it switches 'highlight_branches_lwd' to FALSE. If you want thicker lines which reflect the height, please use <a href="#">highlight_branches_lwd</a> on the dendrograms/dendlist.
<code>columns_width</code>	a vector with three elements, giving the relative sizes of the the three plots (left dendrogram, connecting lines, right dendrogram). This is passed to <a href="#">layout</a> if parameter <code>just_one</code> is TRUE. The default is: <code>c(5,3,5)</code>
<code>margin_top</code>	the number of lines of margin to be specified on the top of the plots.
<code>margin_bottom</code>	the number of lines of margin to be specified on the bottom of the plots.
<code>margin_inner</code>	<code>margin_bottom</code> the number of lines of margin to be specified on the inner distance between the dendrograms and the connecting lines.
<code>margin_outer</code>	<code>margin_bottom</code> the number of lines of margin to be specified on the outer distance between the dendrograms and the connecting lines.
<code>left_dendo_mar</code>	mar parameters of the left dendrogram.
<code>right_dendo_mar</code>	mar parameters of the right dendrogram.
<code>intersecting</code>	logical (TRUE). Should the leaves of the two dendrograms be pruned so that the two trees will have the same labels?
<code>dLeaf</code>	a number specifying the distance in user coordinates between the tip of a leaf and its label. If NULL, as per default, 3/4 of a letter width or height is used. Notice that if we are comparing two dendrograms with different heights, manually changing <code>dLeaf</code> will affect both trees differently. In such a case, it is recommended to manually change <code>dLeaf_left</code> and <code>dLeaf_right</code> . This can be especially important when changing the <code>lab.cex</code> of the dendrogram's labels. Alternatively, one could manually set the <code>xlim</code> parameter for both trees, which will force the proportion of distances of the labels from the trees to remain the same.
<code>dLeaf_left</code>	<code>dLeaf</code> of the left dendrogram, by default it is equal to <code>dLeaf</code> (often negative).
<code>dLeaf_right</code>	<code>dLeaf</code> of the right dendrogram, by default it is equal to minus <code>dLeaf</code> (often positive).
<code>axes</code>	logical (TRUE). Should plot axes be plotted?
<code>type</code>	type of plot ("t"/"r" = triangle or rectangle)
<code>lab.cex</code>	numeric scalar, influencing the cex size of the labels.
<code>remove_nodePar</code>	logical (FALSE). Should the nodePar of the leaves be removed? (useful when the trees' leaves has too many parameters on them)
<code>main</code>	Character. Title above the connecting lines.
<code>sub</code>	Character. Title below the connecting lines.
<code>k_labels</code>	integer. Number of groups by which to color the leaves.
<code>k_branches</code>	integer. Number of groups by which to color the branches.
<code>rank_branches</code>	logical (FALSE). Should the branches heights be adjusted? (setting this to TRUE - can make it easier for comparing topological differences)
<code>hang</code>	logical (FALSE). Should we hang the leaves of the trees?

- `match_order_by_labels`  
 logical (TRUE). Should the leaves value order be matched between the two trees based on labels? This is a MUST in order to have the lines connect the correct labels. Set this to FALSE if you want to make the plotting a bit faster, and only after you are sure the labels and orders are correctly aligned.
- `cex_main`      A numerical value giving the amount by which plotting title should be magnified relative to the default.
- `cex_main_left`    see `cex_main`.
- `cex_main_right`    see `cex_main`.
- `cex_sub`          see `cex_main`.
- `highlight_distinct_edges`  
 logical (default is TRUE). If to highlight distinct edges in each tree (by changing their line types to 2). (notice that this can be slow on large trees)  
 This parameter will automatically be turned off if the tree already comes with a "lty" edgePar (this is checked using `has_edgePar`). A "lty" can be removed by using `set("clear_branches")`, by removing all of the edgePar parameters of the dendrogram.
- `common_subtrees_color_lines`  
 logical (default is TRUE). color the connecting line based on the common subtrees of both dends. This only works if (notice that this can be slow on large trees)
- `common_subtrees_color_lines_default_single_leaf_color`  
 When representing edges between common subtrees (i.e. `common_subtrees_color_branches = TRUE`), this parameter sets the color of edges for subtrees that are NOT common. Default is "grey"
- `common_subtrees_color_branches`  
 logical (default is FALSE). Color the branches of both dends based on the common subtrees. (notice that this can be slow on large trees) This is FALSE by default since it will override the colors of the existing tree.
- `highlight_branches_col`  
 logical (default is FALSE). Should `highlight_branches_col` be used on the dendrograms.  
 This parameter will automatically be turned off if the tree already comes with a "col" edgePar (this is checked using `has_edgePar`). A "lty" can be removed by using `set("clear_branches")`, by removing all of the edgePar parameters of the dendrogram.
- `highlight_branches_lwd`  
 logical (default is TRUE). Should `highlight_branches_lwd` be used on the dendrograms.  
 This parameter will automatically be turned off if the tree already comes with a "lwd" edgePar (this is checked using `has_edgePar`). A "lty" can be removed by using `set("clear_branches")`, by removing all of the edgePar parameters of the dendrogram.
- `faster`          logical (FALSE). If TRUE, it overrides some other parameters to have them turned off so that the plotting will go a tiny bit faster.

## Details

Notice that tanglegram does not "resize" well. In case you are resizing your window you would need to re-run the function.

## Value

An invisible [dendlist](#), with two trees after being modified during the creation of the tanglegram.

## Author(s)

Tal Galili, Johan Renaudie

## Source

The function is based on code from Johan Renaudie (plannapus), after major revisions. See: [https://stackoverflow.com/questions/12456768/duelling-dendrograms-in-r-placing-dendrograms-back-to-back-](https://stackoverflow.com/questions/12456768/duelling-dendrograms-in-r-placing-dendrograms-back-to-back)

As far as I could tell, this code was originally inspired by Dylan Beaudette function `duelling.dendrograms` from the `sharpshootR` package: <https://CRAN.R-project.org/package=sharpshootR> `tanglegram`

## See Also

[remove\\_leaves\\_nodePar](#), [plot\\_horiz.dendrogram](#), [rank\\_branches](#), [hang.dendrogram](#)

## Examples

```
## Not run:
set.seed(23235)
ss <- sample(1:150, 10)
dend1 <- iris[ss, -5] %>%
  dist() %>%
  hclust("com") %>%
  as.dendrogram()
dend2 <- iris[ss, -5] %>%
  dist() %>%
  hclust("sin") %>%
  as.dendrogram()
dend12 <- dendlist(dend1, dend2)

dend12 %>% tanglegram()

tanglegram(dend1, dend2)
tanglegram(dend1, dend2, sort = TRUE)
tanglegram(dend1, dend2, remove_nodePar = TRUE)
tanglegram(dend1, dend2, k_labels = 6, k_branches = 4)

tanglegram(dend1, dend2,
  lab.cex = 2, edge.lwd = 3,
  margin_inner = 5, type = "t", center = TRUE
)
```

```

## works nicely:
tanglegram(dend1, dend2,
  lab.cex = 2, edge.lwd = 3,
  margin_inner = 3.5, type = "t", center = TRUE,
  dLeaf = -0.1, xlim = c(7, 0),
  k_branches = 3
)

# using rank_branches can make the comparison even easier
tanglegram(rank_branches(dend1), rank_branches(dend2),
  lab.cex = 2, edge.lwd = 3,
  margin_inner = 3.5, type = "t", center = TRUE,
  dLeaf = -0.1, xlim = c(5.1, 0), columns_width = c(5, 1, 5),
  k_branches = 3
)

#####
## Nice example of some colored trees

# see the coloring of common sub trees:
set.seed(23235)
ss <- sample(1:150, 10)
dend1 <- iris[ss, -5] %>%
  dist() %>%
  hclust("com") %>%
  as.dendrogram()
dend2 <- iris[ss, -5] %>%
  dist() %>%
  hclust("sin") %>%
  as.dendrogram()
dend12 <- dendlist(dend1, dend2)
# dend12 %>% untangle %>% tanglegram
dend12 %>% tanglegram(common_subtrees_color_branches = TRUE)

set.seed(22133513)
ss <- sample(1:150, 10)
dend1 <- iris[ss, -5] %>%
  dist() %>%
  hclust("com") %>%
  as.dendrogram()
dend2 <- iris[ss, -5] %>%
  dist() %>%
  hclust("sin") %>%
  as.dendrogram()
dend12 <- dendlist(dend1, dend2)
# dend12 %>% untangle %>% tanglegram
dend12 %>% tanglegram(common_subtrees_color_branches = TRUE)
dend12 %>% tanglegram()

```



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

---

theme_dendro	<i>Creates completely blank theme in ggplot</i>
--------------	---

---

### Description

Sets most of the ggplot options to blank, by returning blank theme elements for the panel grid, panel background, axis title, axis text, axis line and axis ticks.

### Usage

```
theme_dendro()
```

### Author(s)

Andrie de Vries

### Source

This function is from Andrie de Vries's `ggdendro` package.

The motivation for this fork is the need to add more graphical parameters to the plotted tree. This required a strong mixer of functions from `ggdendro` and `dendextend` (to the point that it seemed better to just fork the code into its current form)

### See Also

[ggdend](#)

---

unbranch	<i>unbranch trees</i>
----------	-----------------------

---

### Description

unbranch trees and merges the subtree to the parent node.

**Usage**

```

unbranch(dend, ...)

## Default S3 method:
unbranch(dend, ...)

## S3 method for class 'dendrogram'
unbranch(dend, branch_becoming_root = 1, new_root_height, ...)

## S3 method for class 'hclust'
unbranch(dend, branch_becoming_root = 1, new_root_height, ...)

## S3 method for class 'phylo'
unbranch(dend, ...)

```

**Arguments**

dend	a dendrogram (or hclust) object
...	passed on
branch_becoming_root	a numeric choosing the branch of the root which will become the new root (from left to right)
new_root_height	the new height of the branch which will become the new root. If the parameter is not given - the height of the original root is used.

**Value**

An unbranched dendrogram

**See Also**

[unroot](#) ape

**Examples**

```

hc <- hclust(dist(USArrests[2:9, ]), "com")
dend <- as.dendrogram(hc)

par(mfrow = c(1, 3))
plot(dend, main = "original tree")
plot(unbranch(dend, 1), main = "unbranched tree (left branch)")
plot(unbranch(dend, 2), main = "tree without (right branch)")

```

---

unclass_dend	<i>unclass an entire dendrogram tree</i>
--------------	--

---

### Description

unclass all the nodes in a dendrogram tree. (Helps in cases when a dendrapply function was used wrongly)

### Usage

```
unclass_dend(dend, ...)
```

### Arguments

dend	a dendrogram object
...	not used

### Value

The list which was the dendrogram (but without a class)

### See Also

[nleaves](#)

### Examples

```
# define dendrogram object to play with:
hc <- hclust(dist(USArrests[1:3, ]), "ave")
dend <- as.dendrogram(hc)

itself <- function(x) x
dend <- dendrapply(dend, itself)
unclass(dend) # this only returns a list with
# two dendrogram objects inside it.
str(dend) # this is a great way to show a dendrogram,
# but it doesn't help us understand how the R object is built.
str(unclass(dend)) # this is a great way to show a dendrogram,
# but it doesn't help us understand how the R object is built.
unclass_dend(dend) # this only returns a list
# with two dendrogram objects inside it.
str(unclass_dend(dend)) # NOW we can more easily understand
# how the dendrogram object is structured...
```

---

untangle

*untangle dendrograms*


---

### Description

One untangle function to rule them all.

This function untangles dendrogram lists (dendlist), Using various heuristics.

### Usage

```
untangle(dend1, ...)

## Default S3 method:
untangle(dend1, ...)

untangle_labels(dend1, dend2, ...)

## S3 method for class 'dendrogram'
untangle(
  dend1,
  dend2,
  method = c("labels", "ladderize", "random", "step1side", "step2side", "stepBothSides",
            "DendSer"),
  ...
)

## S3 method for class 'dendlist'
untangle(
  dend1,
  method = c("labels", "ladderize", "random", "step1side", "step2side", "DendSer"),
  which = c(1L, 2L),
  ...
)
```

### Arguments

dend1	a dendrogram or a dendlist object
...	passed to the relevant untangle function
dend2	A second dendrogram (to untangle against)
method	a character indicating the type of untangle heuristic to use. The options are: ("labels", "ladderize", "random", "step1side", "step2side", "stepBothSides", "DendSer")
which	an integer vector of length 2, indicating which of the trees in the dendlist object should be plotted

**Details**

This function wraps all of the untangle functions, in order to make it easier to find our about (and use) them.

**Value**

A [dendlist](#), with two trees after they have been untangled.

If the dendlist was originally larger than 2, it will return the original dendlist but with the relevant trees properly rotate.

**Author(s)**

Tal Galili

**See Also**

[tanglegram](#), [untangle\\_random\\_search](#), [untangle\\_step\\_rotate\\_1side](#), [untangle\\_step\\_rotate\\_2side](#), [untangle\\_DendSer](#), [entanglement](#)

**Examples**

```
## Not run:
set.seed(23235)
ss <- sample(1:150, 10)
dend1 <- iris[ss, -5] %>%
  dist() %>%
  hclust("com") %>%
  as.dendrogram()
dend2 <- iris[ss, -5] %>%
  dist() %>%
  hclust("sin") %>%
  as.dendrogram()
dend12 <- dendlist(dend1, dend2)

dend12 %>% tanglegram()

untangle(dend1, dend2, method = "random", R = 5) %>% tanglegram()

# it works, and we get something different:
set.seed(1234)
dend12 %>%
  untangle(method = "random", R = 5) %>%
  tanglegram()

set.seed(1234)
# fixes it completely:
dend12 %>%
  untangle(method = "random", R = 5) %>%
  untangle(method = "step1") %>%
  tanglegram()
# not good enough
```

```

dend12 %>%
  untangle(method = "step1") %>%
  tanglegram()
# not good enough
dend12 %>%
  untangle(method = "step2") %>%
  tanglegram()
# How we might wish to use it:
set.seed(12777)
dend12 %>%
  untangle(method = "random", R = 1) %>%
  untangle(method = "step2") %>%
  tanglegram()

## End(Not run)

```

---

untangle_DendSer	<i>Tries to run DendSer on a dendrogram</i>
------------------	---

---

## Description

The function tries to turn the dend into hclust. It then uses the [cophenetic](#) distance matrix for optimizing the tree's rotation.

This is a good (and fast) starting point for `linkuntangle_step_rotate_2side`

## Usage

```
untangle_DendSer(dend, ...)
```

## Arguments

dend	An object of class <a href="#">dendlist</a>
...	NOT USED

## Value

A dendlist object with ordered dendis

## See Also

[DendSer](#), [DendSer.dendrogram](#), [untangle\\_DendSer](#), [rotate\\_DendSer](#)

**Examples**

```
## Not run:
set.seed(232)
ss <- sample(1:150, 20)
dend1 <- iris[ss, -5] %>%
  dist() %>%
  hclust("com") %>%
  as.dendrogram()
dend2 <- iris[ss, -5] %>%
  dist() %>%
  hclust("sin") %>%
  as.dendrogram()
dend12 <- dendlist(dend1, dend2)

# bad solutions
dend12 %>% tanglegram()
dend12 %>%
  untangle("step2") %>%
  tanglegram()
dend12 %>%
  untangle_DendSer() %>%
  tanglegram()
# but the combination is quite awesome:
dend12 %>%
  untangle_DendSer() %>%
  untangle("step2") %>%
  tanglegram()

## End(Not run)
```

---

untangle\_random\_search

*Untangle - random search*


---

**Description**

Searches for two untangled dendrogram by randomly shuffling them and each time checking if their entanglement was improved.

**Usage**

```
untangle_random_search(
  dend1,
  dend2,
  R = 100L,
  L = 1,
  leaves_matching_method = c("labels", "order"),
  ...
)
```

**Arguments**

dend1	a tree object (of class dendrogram/hclust/phylo).
dend2	a tree object (of class dendrogram/hclust/phylo).
R	numeric (default is 100). The number of shuffles to perform.
L	the distance norm to use for measuring the distance between the two trees. It can be any positive number, often one will want to use 0, 1, 1.5, 2 (see 'details' for more). It is passed to <a href="#">entanglement</a> .
leaves_matching_method	a character scalar passed to <a href="#">entanglement</a> . It can be either "order" or "labels" (default). If using "labels", then we use the labels for matching the leaves order value. And if "order" then we use the old leaves order value for matching the leaves order value.  Using "order" is faster, but "labels" is safer. "order" will assume that the original two trees had their labels and order values MATCHED.  Hence, it is best to make sure that the trees used here have the same labels and the SAME values matched to these values - and then use "order" (for fastest results).  If "order" is used, the function first calls <a href="#">match_order_by_labels</a> in order to make sure that the two trees have their labels synced with their leaves order values.
...	not used

**Details**

Untangling two trees is a hard combinatorical problem without a closed form solution. One way for doing it is to run through a random spectrum of options and look for the "best" two trees. This is what this function offers.

**Value**

A dendlist with two trees with the best entanglement that was found.

**See Also**

[tanglegram](#), [match\\_order\\_by\\_labels](#), [entanglement](#).

**Examples**

```
## Not run:
dend1 <- iris[, -5] %>%
  dist() %>%
  hclust("com") %>%
  as.dendrogram()
dend2 <- iris[, -5] %>%
  dist() %>%
  hclust("sin") %>%
  as.dendrogram()
tanglegram(dend1, dend2)
```



```

set.seed(65168)
dend12 <- untangle_random_search(dend1, dend2, R = 10)
tanglegram(dend12[[1]], dend12[[2]])
tanglegram(dend12)

entanglement(dend1, dend2, L = 2) # 0.8894
entanglement(dend12[[1]], dend12[[2]], L = 2) # 0.0998

## End(Not run)

```

---

untangle\_step\_rotate\_1side

*Stepwise untangle one tree compared to another*

---

### Description

Given a fixed tree and a tree we wish to rotate, this function goes through all of the k number of clusters (from 2 onward), and each time rotates the branch which was introduced in the new k'th cluster. This rotated tree is compared with the fixed tree, and if it has a better entanglement, it will be used for the following iterations.

This is a greedy forward selection algorithm for rotating the tree and looking for a better match.

This is useful for finding good trees for a [tanglegram](#).

### Usage

```

untangle_step_rotate_1side(
  dend1,
  dend2_fixed,
  L = 1.5,
  direction = c("forward", "backward"),
  k_seq = NULL,
  dend_heights_per_k,
  leaves_matching_method = c("labels", "order"),
  ...
)

```

### Arguments

dend1	a dendrogram object. The one we will rotate to best fit dend2_fixed.
dend2_fixed	a dendrogram object. This one is kept fixed.
L	the distance norm to use for measuring the distance between the two trees. It can be any positive number, often one will want to use 0, 1, 1.5, 2 (see 'details' in <a href="#">entanglement</a> ).
direction	a character scalar, either "forward" (default) or "backward". Impacts the direction of clustering that are tried. Either from 2 and up (in case of "forward"), or from nleaves to down (in case of "backward") If k_seq is not NULL, then it overrides "direction".

k_seq	a sequence of k clusters to go through for improving dend1. If NULL (default), then we use the "direction" parameter.
dend_heights_per_k	a numeric vector of values which indicate which height will produce which number of clusters (k)
leaves_matching_method	a character scalar passed to <a href="#">entanglement</a> . It can be either "order" or "labels" (default). If using "labels", then we use the labels for matching the leaves order value. And if "order" then we use the old leaves order value for matching the leaves order value.  Using "order" is faster, but "labels" is safer. "order" will assume that the original two trees had their labels and order values MATCHED.  Hence, it is best to make sure that the trees used here have the same labels and the SAME values matched to these values - and then use "order" (for fastest results).  If "order" is used, the function first calls <a href="#">match_order_by_labels</a> in order to make sure that the two trees have their labels synced with their leaves order values.
...	not used

**Value**

A dendlist with 1) dend1 after it was rotated to best fit dend2\_fixed. 2) dend2\_fixed.

**See Also**

[tanglegram](#), [match\\_order\\_by\\_labels](#), [entanglement](#), [flip\\_leaves](#), [all\\_couple\\_rotations\\_at\\_k](#), [untangle\\_step\\_rotate\\_2side](#).

**Examples**

```
## Not run:
dend1 <- USArrests[1:10, ] %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
set.seed(3525)
dend2 <- shuffle(dend1)
tanglegram(dend1, dend2)
entanglement(dend1, dend2, L = 2) # 0.4727

dend2_corrected <- untangle_step_rotate_1side(dend2, dend1)[[1]]
tanglegram(dend1, dend2_corrected) # FIXED.
entanglement(dend1, dend2_corrected, L = 2) # 0

## End(Not run)
```

---

untangle\_step\_rotate\_2side

*Stepwise untangle two trees one at a time*


---

## Description

This is a greedy forward selection algorithm for rotating the tree and looking for a better match.

This is useful for finding good trees for a [tanglegram](#).

It goes through rotating dend1, then dend2, and so on - until a locally optimal solution is found.

Similar to "step1side", one tree is held fixed and the other tree is rotated. This function goes through all of the k number of clusters (from 2 onward), and each time rotates the branch which was introduced in the new k'th cluster. This rotated tree is compared with the fixed tree, and if it has a better entanglement, it will be used for the following iterations. Once finished the rotated tree is held fixed, and the fixed tree is now rotated. This continues until a local optimal solution is reached.

## Usage

```
untangle_step_rotate_2side(
  dend1,
  dend2,
  L = 1.5,
  direction = c("forward", "backward"),
  max_n_iterations = 10L,
  print_times = dendextend_options("warn"),
  k_seq = NULL,
  ...
)
```

## Arguments

dend1	a dendrogram object. The one we will rotate to best fit dend2.
dend2	a dendrogram object. The one we will rotate to best fit dend1.
L	the distance norm to use for measuring the distance between the two trees. It can be any positive number, often one will want to use 0, 1, 1.5, 2 (see 'details' in <a href="#">entanglement</a> ).
direction	a character scalar, either "forward" (default) or "backward". Impacts the direction of clustering that are tried. Either from 2 and up (in case of "forward"), or from nleaves to down (in case of "backward") If k_seq is not NULL, then it overrides "direction".
max_n_iterations	integer. The maximal number of times to switch between optimizing one tree with another.
print_times	logical (TRUE), should we print how many times we switched between rotating the two trees?

k_seq	a sequence of k clusters to go through for improving dend1. If NULL (default), then we use the "direction" parameter.
...	not used

### Value

A list with two dendrograms (dend1/dend2), after they are rotated to best fit one another.

### See Also

[tanglegram](#), [match\\_order\\_by\\_labels](#), [entanglement](#), [flip\\_leaves](#), [all\\_couple\\_rotations\\_at\\_k](#), [untangle\\_step\\_rotate\\_1side](#).

### Examples

```
## Not run:
dend1 <- USArrests[1:20, ] %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
dend2 <- USArrests[1:20, ] %>%
  dist() %>%
  hclust(method = "single") %>%
  as.dendrogram()
set.seed(3525)
dend2 <- shuffle(dend2)
tanglegram(dend1, dend2, margin_inner = 6.5)
entanglement(dend1, dend2, L = 2) # 0.79

dend2_corrected <- untangle_step_rotate_1side(dend2, dend1)
tanglegram(dend1, dend2_corrected, margin_inner = 6.5) # Good.
entanglement(dend1, dend2_corrected, L = 2) # 0.0067
# it is better, but not perfect. Can we improve it?

dend12_corrected <- untangle_step_rotate_2side(dend1, dend2)
tanglegram(dend12_corrected[[1]], dend12_corrected[[2]], margin_inner = 6.5) # Better...
entanglement(dend12_corrected[[1]], dend12_corrected[[2]], L = 2) # 0.0045

# best combination:
dend12_corrected_1 <- untangle_random_search(dend1, dend2)
dend12_corrected_2 <- untangle_step_rotate_2side(dend12_corrected_1[[1]], dend12_corrected_1[[2]])
tanglegram(dend12_corrected_2[[1]], dend12_corrected_2[[2]], margin_inner = 6.5) # Better...
entanglement(dend12_corrected_2[[1]], dend12_corrected_2[[2]], L = 2) # 0 - PERFECT.

## End(Not run)
```

---

 untangle\_step\_rotate\_both\_side

*Stepwise untangle two trees at the same time*


---

### Description

This is a greedy forward selection algorithm for rotating the tree and looking for a better match.

This is useful for finding good trees for a [tanglegram](#).

It goes through simultaneously rotating branches of dend1 and dend2 until a locally optimal solution is found.

Step 1: The algorithm begins by executing the 'step2side' operation on the pair of dendograms.

Step 2: The algorithm generates new alternative tanglegrams by simultaneously rotating one branch from tree 1 and one branch from tree 2. This rotation is applied to every possible combination of branches between tree 1 and tree 2, resulting in a set of new alternative tanglegrams. The tanglegram with the lowest entanglement is retained.

Step 3: Steps 1 and 2 are repeated until either a locally optimal solution is found or the maximum number of iterations is reached.

### Usage

```
untangle_step_rotate_both_side(
  dend1,
  dend2,
  L = 1.5,
  max_n_iterations = 10L,
  print_times = dendextend_options("warn"),
  ...
)
```

### Arguments

dend1	a dendrogram object. The one we will rotate to best fit dend2.
dend2	a dendrogram object. The one we will rotate to best fit dend1.
L	the distance norm to use for measuring the distance between the two trees. It can be any positive number, often one will want to use 0, 1, 1.5, 2 (see 'details' in <a href="#">entanglement</a> ).
max_n_iterations	integer. The maximal number of times to switch between optimizing one tree with another.
print_times	logical (TRUE), should we print how many times we executed steps 1 and 2?
...	not used

### Value

A list with two dendrograms (dend1/dend2), after they are rotated to best fit one another.

## References

Nghia Nguyen, Kurdistan Chawshin, Carl Fredrik Berg, Damiano Varagnolo, Shuffle & untangle: novel untangle methods for solving the tanglegram layout problem, *Bioinformatics Advances*, Volume 2, Issue 1, 2022, vbac014, <https://doi.org/10.1093/bioadv/vbac014>

## See Also

[tanglegram](#), [match\\_order\\_by\\_labels](#), [entanglement](#), [flip\\_leaves](#), [all\\_couple\\_rotations\\_at\\_k](#), [untangle\\_step\\_rotate\\_1side](#), [untangle\\_step\\_rotate\\_2side](#).

## Examples

```
## Not run:
# Figures recreated from 'Shuffle & untangle: novel untangle methods for solving the tanglegram layout problem' (Ng
library(tidyverse)
example_labels <- c("Versicolor 90", "Versicolor 54", "Versicolor 81", "Versicolor 63", "Versicolor 72", "Versicol

iris_modified <-
  iris %>%
    mutate(Row = row_number()) %>%
    mutate(Label = paste(str_to_title(Species), Row)) %>%
    filter(Label %in% example_labels)
iris_numeric <- iris_modified[,1:4]
rownames(iris_numeric) <- iris_modified$Label

# Single Linkage vs. Complete Linkage comparison (Fig. 1)
dend1 <- as.dendrogram(hclust(dist(iris_numeric), method = "single"))
dend2 <- as.dendrogram(hclust(dist(iris_numeric), method = "complete"))
tanglegram(dend1, dend2,
  color_lines = TRUE,
  lwd = 2,
  margin_inner = 6) # Good.
entanglement(dend1, dend2, L = 2) # 0.207

# The step2side algorithm (Fig. 2)
result <- untangle_step_rotate_2side(dend1, dend2)
tanglegram(result[[1]], result[[2]],
  color_lines = TRUE,
  lwd = 2,
  margin_inner = 6) # Better...
entanglement(result[[1]], result[[2]], L = 2) # 0.185

# The stepBothSides algorithm (Fig. 4)
result <- untangle_step_rotate_both_side(dend1, dend2)
tanglegram(result[[1]], result[[2]],
  color_lines = TRUE,
  lwd = 2,
  margin_inner = 6,
  lty = 1) # PERFECT.
entanglement(result[[1]], result[[2]], L = 2) # 0.000

## End(Not run)
```

---

which_leaf	<i>Which node is a leaf?</i>
------------	------------------------------

---

### Description

Gives a vector as the number of nodes (`nnodes`), which gives a TRUE when a node is a leaf.

### Usage

```
which_leaf(dend, ...)
```

### Arguments

dend	a dendrogram dend
...	ignored.

### Value

A logical vector with the length of `nnodes`, which gives a TRUE when a node is a leaf.

### See Also

[noded\\_with\\_condition](#), [is.leaf](#), [nnodes](#)

### Examples

```
## Not run:

library(dendextend)

# Getting the dend dend
set.seed(23235)
ss <- sample(1:150, 10)
dend <- iris[ss, -5] %>%
  dist() %>%
  hclust() %>%
  as.dendrogram()
dend %>% plot()

which_leaf(dend)

## End(Not run)
```

---

which_node	<i>Which node id is common to a group of labels</i>
------------	---

---

### Description

This function identifies which edge(s) in a tree has group of labels ("tips") in common. By default it only returns the edge (node) with the heighest id.

### Usage

```
which_node(dend, labels, max_id = TRUE, ...)
```

### Arguments

dend	a dendrogram dend
labels	a character vector of labels from the tree
max_id	logical (TRUE) - if to return only the max id
...	ignored.

### Value

An integer with the id(s) of the nodes which includes all of the labels.

### See Also

[noded\\_with\\_condition](#), [branches\\_attr\\_by\\_clusters](#), [nnodes](#), [branches\\_attr\\_by\\_labels](#), [get\\_nodes\\_attr](#)  
[which.edge](#)

### Examples

```
dend <- iris[1:10, -5] %>%
  dist() %>%
  hclust() %>%
  as.dendrogram() %>%
  set("labels", 1:10)
dend %>% plot()

which_node(dend, c(1, 2), max_id = FALSE)
which_node(dend, c(2, 3), max_id = FALSE)
which_node(dend, c(2, 3))

dend %>% plot()
the_h <- get_nodes_attr(dend, "height", which_node(dend, c(4, 6)))
the_h
abline(h = the_h, lty = 2, col = 2)
get_nodes_attr(dend, "height", which_node(dend, c(4, 6)))
get_nodes_attr(dend, "members", which_node(dend, c(4, 6)))
```



# Index

- \* **clustering**
    - dendextend-package, 5
  - \* **datasets**
    - khan, 125
  - \* **dendrogram**
    - dendextend-package, 5
  - \* **package**
    - dendextend-package, 5
  - \* **visualization**
    - dendextend-package, 5
- all.equal, 7
- all.equal.dendlist  
(all.equal.dendrogram), 6
- all.equal.dendrogram, 6
- all.equal.list, 6
- all.equal.phylo, 7
- all\_couple\_rotations\_at\_k, 8, 202, 204, 206
- all\_unique, 9
- apply, 185
- as.dendlist, 10
- as.dendrogram, 11
- as.ggdend (ggdend), 108
- as.hclust, 11, 18, 148
- as.hclust.dendrogram, 11
- as.phylo, 11
- as.phylo.dendrogram, 11
- as.phylo.hclust, 11
- as\_hclust\_fixed, 18
- assign\_dendextend\_options, 12
- assign\_values\_to\_branches\_edgePar, 12, 75, 118, 163, 165, 174, 175
- assign\_values\_to\_leaves\_edgePar, 14, 51, 130
- assign\_values\_to\_leaves\_nodePar, 15, 17, 98–102, 164, 174, 175
- assign\_values\_to\_nodes\_nodePar, 17, 174
- attr, 106, 139
- bakers\_gamma\_for\_2\_k\_matrix, 19, 56
- Bk, 20, 23, 25, 62
- Bk\_permutations, 21, 25
- Bk\_plot, 20, 23
- branches\_attr\_by\_clusters, 26, 40, 43, 46, 47, 208
- branches\_attr\_by\_labels, 28, 29, 32, 141, 174, 175, 208
- branches\_attr\_by\_lists, 31, 174, 175
- branches\_color (color\_branches), 46
- circlize\_dendrogram, 32
- circos.dendrogram, 33
- circos.track, 32
- click\_rotate, 34
- clip, 160
- collapse\_branch, 36
- collapse\_labels, 37
- color\_branches, 46, 51, 53, 98–100, 116, 130, 132, 174, 175
- color\_clusters, 47
- color\_labels, 47, 50, 130, 174
- color\_unique\_labels, 52
- colored\_bars, 38
- colored\_dots, 42
- colour\_branches (color\_branches), 46
- colour\_labels (color\_labels), 50
- common\_subtrees\_clusters, 53, 149
- cophenetic, 54, 59, 60, 74, 77, 85, 169, 198
- cor, 59
- cor.dendlist, 54, 58, 62
- cor\_bakers\_gamma, 19, 20, 54, 55, 60, 91, 92, 95, 133
- cor\_common\_nodes, 54, 58
- cor\_cophenetic, 54, 57, 59, 77, 184
- cor\_FM\_index, 54, 61
- count\_terminal\_nodes, 62, 139, 140
- cut\_lower\_fun, 70
- cutree, 27, 46, 47, 50, 51, 56, 63, 65, 67–69, 107, 130, 184, 185

- cutree.dendrogram, [8](#), [47](#), [70](#), [71](#), [107](#), [114](#), [121](#), [161](#)
- cutree\_1h.dendrogram, [65](#), [67](#), [69](#)
- cutree\_1k.dendrogram, [65](#), [68](#)
- cutreeDynamic, [27](#), [28](#)
- data.frame, [125](#)
- dend\_diff, [75](#), [118](#)
- dend\_expend, [76](#)
- dendbackback (tanglegram), [186](#)
- dendextend (dendextend-package), [5](#)
- dendextend-package, [5](#)
- dendextend\_cut\_lower\_fun (cut\_lower\_fun), [70](#)
- dendextend\_heights\_per\_k.dendrogram (heights\_per\_k.dendrogram), [114](#)
- dendextend\_options, [71](#)
- dendlist, [6](#), [7](#), [54](#), [72](#), [75](#), [77](#), [107](#), [118](#), [121](#), [131](#), [139](#), [149](#), [173](#), [191](#), [197](#), [198](#)
- dendrapply, [130](#)
- dendro\_data, [110](#), [111](#)
- dendrogram, [6](#), [7](#), [33](#), [47](#), [51](#), [53](#), [71](#), [75](#), [79](#), [85](#), [109–111](#), [113](#), [116](#), [120](#), [130](#), [131](#), [137](#), [144](#), [159](#), [172–175](#), [180–182](#)
- DendSer, [74](#), [169](#), [170](#), [198](#)
- DendSer.dendrogram, [74](#), [74](#), [169](#), [170](#), [198](#)
- dist, [47](#), [59](#), [76](#), [78](#), [127](#), [172](#), [184](#)
- dist.dendlist, [75](#), [77](#), [79](#), [118](#), [144](#)
- dist.multiPhylo, [78](#)
- dist.topo, [78](#)
- dist\_long, [79](#)
- distinct.edges, [75](#), [79](#), [118](#)
- distinct\_edges, [58](#), [75](#), [77](#), [78](#), [78](#), [79](#), [118](#), [144](#)
- drop.tip, [148](#)
- duplicate\_leaf, [80](#), [171](#)
- entanglement, [8](#), [81](#), [89](#), [134–136](#), [181](#), [182](#), [197](#), [200–206](#)
- fac2num, [83](#), [185](#)
- factor, [125](#)
- find\_dend (dend\_expend), [76](#)
- find\_dendrogram, [84](#)
- find\_k, [85](#)
- fix\_members\_attr.dendrogram, [80](#), [87](#), [171](#)
- flatten.dendrogram, [88](#)
- flip\_leaves, [8](#), [88](#), [202](#), [204](#), [206](#)
- FM\_index, [20](#), [23](#), [25](#), [62](#), [89](#), [92](#)
- FM\_index\_permutation, [91](#)
- FM\_index\_R, [92](#), [94](#)
- geom\_line, [110](#)
- geom\_point, [110](#)
- get\_branches\_heights, [96](#), [97](#), [116](#), [157](#)
- get\_childrens\_heights, [97](#), [157](#)
- get\_leaves\_attr, [14](#), [16](#), [17](#), [28](#), [30](#), [97](#), [103](#), [141](#), [164](#)
- get\_leaves\_branches\_attr, [98](#), [99](#), [100](#)
- get\_leaves\_branches\_col, [47](#), [99](#), [130](#)
- get\_leaves\_edgePar, [98–100](#), [100](#), [102](#)
- get\_leaves\_nodePar, [99–101](#), [101](#), [111](#)
- get\_nodes\_attr, [98–102](#), [102](#), [105](#), [111](#), [114](#), [208](#)
- get\_nodes\_xy, [104](#)
- get\_root\_branches\_attr, [13](#), [106](#), [163](#), [165](#)
- get\_subdendrograms, [107](#)
- ggdend, [108](#), [193](#)
- ggdendrogram, [110](#), [111](#)
- ggplot, [110](#), [111](#)
- ggplot.dendrogram (ggdend), [108](#)
- ggplot.ggdend (ggdend), [108](#)
- hang.dendrogram, [112](#), [156](#), [157](#), [174](#), [175](#), [191](#)
- has\_component\_in\_attribute, [113](#)
- has\_edgePar, [190](#)
- has\_edgePar (has\_component\_in\_attribute), [113](#)
- has\_nodePar (has\_component\_in\_attribute), [113](#)
- hclust, [6](#), [47](#), [51](#), [65](#), [68](#), [69](#), [76](#), [77](#), [127](#), [130](#), [172](#), [174](#), [181](#), [182](#)
- heights\_per\_k.dendrogram, [8](#), [114](#)
- highlight\_branches (highlight\_branches\_col), [115](#)
- highlight\_branches\_col, [115](#), [175](#), [190](#)
- highlight\_branches\_lwd, [175](#), [189](#), [190](#)
- highlight\_branches\_lwd (highlight\_branches\_col), [115](#)
- highlight\_distinct\_edges, [75](#), [79](#), [117](#), [118](#), [144](#)
- identical, [7](#)
- identify.dendrogram, [119](#)

- identify.hclust, [119–121](#)
- intersect, [122](#)
- intersect\_trees, [54, 55, 59, 121](#)
- is.dendlist(is\_some\_class), [124](#)
- is.dendrogram(is\_some\_class), [124](#)
- is.dist(is\_some\_class), [124](#)
- is.double, [123](#)
- is.hclust(is\_some\_class), [124](#)
- is.integer, [123](#)
- is.leaf, [207](#)
- is.natural.number, [122](#)
- is.numeric, [123](#)
- is.phylo(is\_some\_class), [124](#)
- is\_null\_list, [123](#)
- is\_some\_class, [124](#)
  
- khan, [125](#)
  
- labels, [47, 71, 122, 128, 171, 180](#)
- labels.hclust(labels<-), [127](#)
- labels.phylo(labels<-), [127](#)
- labels<-, [127](#)
- labels<- dendrogram, [174, 175](#)
- labels\_cex, [128](#)
- labels\_cex<(labels\_cex), [128](#)
- labels\_col(labels\_colors), [129](#)
- labels\_colors, [47, 51, 99–102, 129](#)
- labels\_colors<-, [175](#)
- labels\_colors<(labels\_colors), [129](#)
- ladderize, [131, 131, 168](#)
- layout, [188, 189](#)
- leaf\_Colors, [132](#)
- leaf\_colors(leaf\_Colors), [132](#)
- lowest\_common\_branch, [133](#)
  
- match\_order\_by\_labels, [8, 56, 82, 89, 134, 135, 136, 200, 202, 204, 206](#)
- match\_order\_dendrogram\_by\_old\_order, [135](#)
- max\_depth(min\_depth), [136](#)
- min\_depth, [136](#)
- multi2di, [36](#)
  
- na.locf, [138](#)
- na\_locf, [137](#)
- names, [84](#)
- nleaves, [28, 30, 98, 103, 105, 138, 140, 141, 195](#)
- nnodes, [28, 30, 98, 103, 105, 139, 141, 207, 208](#)
  
- noded\_with\_condition, [30, 141, 175, 207, 208](#)
- nrow, [139, 140](#)
  
- order, [168](#)
- order.dendrogram, [27, 46, 121, 139, 143, 144, 148, 161, 168](#)
- order.dendrogram<-, [142](#)
- order.hclust, [143](#)
  
- pam, [85, 86](#)
- pamk, [85, 86](#)
- par, [39, 42, 160](#)
- partition.leaves, [144](#)
- partition\_leaves, [144](#)
- phylo, [131, 181, 182](#)
- phylo.diff, [75](#)
- place\_labels(set\_labels), [179](#)
- plot, [25, 146](#)
- plot.dendlist(dendlist), [72](#)
- plot.dendrogram, [75, 105, 110, 146, 147](#)
- plot.find\_k(find\_k), [85](#)
- plot\_horiz.dendrogram, [145, 191](#)
- plotDendroAndColors, [28, 40, 43](#)
- plotHclustColors, [39, 43](#)
- prepare.ggdend(ggdend), [108](#)
- print.ggdend(ggdend), [108](#)
- prune, [122, 147, 150, 158](#)
- prune\_common\_subtrees.dendlist, [149](#)
- prune\_leaf, [148, 149](#)
- pvclust\_edges, [150](#)
- pvclust\_show\_signif, [151, 152, 153, 155](#)
- pvclust\_show\_signif\_gradient, [152, 152, 153](#)
- pvrect, [154, 155](#)
- pvrect2, [154](#)
  
- rainbow, [46, 51](#)
- rainbow\_hcl, [46, 51](#)
- raise.dendrogram, [156](#)
- rank, [157](#)
- rank\_branches, [156, 191](#)
- rank\_order.dendrogram, [80, 157, 171](#)
- rank\_values\_with\_clusters, [158](#)
- rect, [155, 160](#)
- rect.dendrogram, [159](#)
- rect.hclust, [121, 161](#)
- reindex\_dend, [162](#)
- remove\_branches\_edgePar, [163, 175](#)

remove\_leaves\_nodePar, [164](#), [175](#), [191](#)  
remove\_nodes\_nodePar, [165](#)  
rev.dendrogram, [131](#), [168](#)  
rev.hclust (rotate), [167](#)  
rllply, [166](#)  
rotate, [131](#), [167](#), [168](#), [172](#), [181](#), [182](#)  
rotate.dendrogram, [35](#)  
rotate\_DendSer, [74](#), [169](#), [170](#), [198](#)  
rownames, [47](#)

sample, [171](#)  
sample.dendrogram, [170](#)  
seriate, [172](#)  
seriate\_dendrogram, [172](#)  
set, [114](#), [116](#), [173](#), [180](#)  
set\_labels, [179](#)  
shuffle, [181](#)  
silhouette, [85](#), [86](#)  
simplify2array, [103](#)  
slice, [47](#), [132](#)  
sort, [184](#), [185](#)  
sort.dendlist (rotate), [167](#)  
sort.dendrogram (rotate), [167](#)  
sort.hclust (rotate), [167](#)  
sort\_2\_clusters\_vectors, [182](#)  
sort\_dist\_mat, [184](#)  
sort\_levels\_values, [184](#)  
stats, [6](#)

tanglegram, [8](#), [53](#), [75](#), [79](#), [82](#), [89](#), [115](#), [118](#),  
[134](#), [136](#), [144](#), [147](#), [157](#), [181](#), [182](#),  
[186](#), [197](#), [200–206](#)

tapply, [27](#)  
theme\_dendro, [110](#), [193](#)  
treedist, [78](#)

unbranch, [193](#)  
unclass\_dend, [195](#)  
unique, [9](#)  
unroot, [194](#)  
untangle, [196](#)  
untangle\_DendSer, [74](#), [170](#), [197](#), [198](#), [198](#)  
untangle\_labels (untangle), [196](#)  
untangle\_random\_search, [197](#), [199](#)  
untangle\_step\_rotate\_1side, [197](#), [201](#),  
[204](#), [206](#)  
untangle\_step\_rotate\_2side, [197](#), [202](#),  
[203](#), [206](#)  
untangle\_step\_rotate\_both\_side, [205](#)

viridis, [116](#)  
which.edge, [208](#)  
which\_leaf, [207](#)  
which\_node, [208](#)