

# Package ‘psychotree’

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**Title** Recursive Partitioning Based on Psychometric Models

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**Imports** graphics, grDevices, grid, stats, Formula

**Description** Recursive partitioning based on psychometric models, employing the general MOB algorithm (from package partykit) to obtain Bradley-Terry trees, Rasch trees, rating scale and partial credit trees, and MPT trees.

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

**NeedsCompilation** no

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bttree	<i>Bradley-Terry Trees</i>
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## Description

Recursive partitioning (also known as trees) based on Bradley-Terry models.

## Usage

```
bttree(formula, data, na.action, cluster,
       type = "loglin", ref = NULL, undecided = NULL, position = NULL, ...)
```

```
## S3 method for class 'bttree'
predict(object, newdata = NULL,
       type = c("worth", "rank", "best", "node"), ...)
```

## Arguments

formula	A symbolic description of the model to be fit. This should be of type $y \sim x1 + x2$ where $y$ should be an object of class <code>paircomp</code> and $x1$ and $x2$ are used as partitioning variables.
data	an optional data frame containing the variables in the model.
na.action	A function which indicates what should happen when the data contain NAs, defaulting to <code>na.pass</code> .
cluster	optional vector (typically numeric or factor) with a cluster ID to be employed for clustered covariances in the parameter stability tests.
type	character indicating the type of auxiliary model in <code>bttree</code> and the type of predictions in the <code>predict</code> method, respectively. For the auxiliary model see <code>btmodel</code> . For the <code>predict</code> method, four options are available: the fitted "worth" parameter for each alternative, the corresponding "rank", the "best" alternative or the predicted "node" number.
ref, undecided, position	arguments for the Bradley-Terry model passed on to <code>btmodel</code> .
...	arguments passed to <code>mob_control</code> .
object	fitted model object of class "bttree".
newdata	optionally, a data frame in which to look for variables with which to predict. If omitted, the original observations are used.

## Details

Bradley-Terry trees are an application of model-based recursive partitioning (implemented in [mob](#)) to Bradley-Terry models for paired comparison data (implemented in [btmodel](#)). Details about the underlying theory and further explanations of the illustrations in the example section can be found in Strobl, Wickelmaier, Zeileis (2011).

Various methods are provided for "btree" objects, most of them inherit their behavior from "mob" objects (e.g., `print`, `summary`, etc.). `itempar` behaves analogously to `coef` and extracts the worth/item parameters from the BT models in the nodes of the tree. The `plot` method employs the `node_btplot` panel-generating function.

## Value

An object of S3 class "btree" inheriting from class "modelparty".

## References

Strobl C, Wickelmaier F, Zeileis A (2011). Accounting for Individual Differences in Bradley-Terry Models by Means of Recursive Partitioning. *Journal of Educational and Behavioral Statistics*, **36**(2), 135–153. doi: [10.3102/1076998609359791](https://doi.org/10.3102/1076998609359791)

## See Also

[mob](#), [btmodel](#)

## Examples

```
o <- options(digits = 4)

## Germany's Next Topmodel 2007 data
data("Topmodel2007", package = "psychotree")

## BT tree
tm_tree <- btree(preference ~ ., data = Topmodel2007, minsize = 5, ref = "Barbara")
plot(tm_tree, abbreviate = 1, yscale = c(0, 0.5))

## parameter instability tests in root node
if(require("strucchange")) sctest(tm_tree, node = 1)

## worth/item parameters in terminal nodes
itempar(tm_tree)

## CEMS university choice data
data("CEMSChoice", package = "psychotree")
summary(CEMSChoice$preference)

## BT tree
cems_tree <- btree(preference ~ french + spanish + italian + study + work + gender + intdegree,
  data = CEMSChoice, minsize = 5, ref = "London")
plot(cems_tree, abbreviate = 1, yscale = c(0, 0.5))
itempar(cems_tree)
```

```
options(digits = o$digits)
```

---

CEMSChoice

*CEMS University Choice Data*


---

## Description

Preferences of 303 students from WU Wien for different CEMS universities.

## Usage

```
data("CEMSChoice")
```

## Format

A data frame containing 303 observations on 10 variables.

**preference** Paired comparison of class `paircomp`. Preferences for all 15 paired comparisons from 6 objects: London, Paris, Milano, St. Gallen, Barcelona, Stockholm.

**study** Factor coding main discipline of study: commerce, or other (economics, business administration, business education).

**english** Factor coding knowledge of English (good, poor).

**french** Factor coding knowledge of French (good, poor).

**spanish** Factor coding knowledge of Spanish (good, poor).

**italian** Factor coding knowledge of Italian (good, poor).

**work** Factor. Was the student working full-time while studying?

**gender** Factor coding gender.

**intdegree** Factor. Does the student intend to take an international degree?

**preference1998** Paired comparison of class `paircomp`. This is like preference but the comparisons between Barcelona and Stockholm are (erroneously) reversed, see below.

## Details

Students at Wirtschaftsuniversität Wien (<https://www.wu.ac.at/>) can study abroad visiting one of currently 17 CEMS universities (Community of European Management Schools and International Companies). Dittrich et al. (1998) conduct and analyze a survey of 303 students to examine the student's preferences for 6 universities: London School of Economics, HEC Paris, Università Commerciale Luigi Bocconi (Milano), Universität St. Gallen, ESADE (Barcelona), Handelshögskolan i Stockholm. To identify reasons for the preferences, several subject covariates (including foreign language competence, gender, etc.) have been assessed. Furthermore, several object covariates are attached to preference (and preference1998): the universities' field of specialization (economics, management science, finance) and location (Latin country, or other).

The correct data are available in the online complements to Dittrich et al. (1998). However, the accompanying analysis was based on an erroneous version of the data in which the choices for the last comparison pair (Barcelona : Stockholm) were accidentally reversed. See the corrigendum in

Dittrich et al. (2001) for further details. The variable `preference` provides the correct data and can thus be used to replicate the analysis from the corrigendum (Dittrich et al. 2001). For convenience, the erroneous version is provided in `preference1998` which can therefore be used to replicate the (incorrect) original analysis (Dittrich et al. 1998).

### Source

The Royal Statistical Society Datasets Website.

### References

Dittrich R, Hatzinger R, Katzenbeisser W (1998). Modelling the Effect of Subject-Specific Covariates in Paired Comparison Studies with an Application to University Rankings, *Journal of the Royal Statistical Society C*, **47**, 511–525.

Dittrich R, Hatzinger R, Katzenbeisser W (2001). Corrigendum: Modelling the Effect of Subject-Specific Covariates in Paired Comparison Studies with an Application to University Rankings, *Journal of the Royal Statistical Society C*, **50**, 247–249.

### See Also

[paircomp](#)

### Examples

```
data("CEMSChoice", package = "psychotree")
summary(CEMSChoice$preference)
covariates(CEMSChoice$preference)
```

---

DIFSim

*Artificial Data with Differential Item Functioning*

---

### Description

Artificial data simulated from a Rasch model and a partial credit model, respectively, where the items exhibit differential item functioning (DIF).

### Usage

```
data(DIFSim)
data(DIFSimPC)
```

### Format

Two data frames containing 200 and 500 observations, respectively, on 4 variables.

**resp** an `itemresp` matrix with binary or polytomous results for 20 or 8 items, respectively.

**age** age in years.

**gender** factor indicating gender.

**motivation** ordered factor indicating motivation level.

## Details

The data are employed for illustrations in Strobl et al. (2015) and Komboz et al. (2018). See the manual pages for [rasctree](#) and [pctree](#) for fitting the tree models..

## References

- Komboz B, Zeileis A, Strobl C (2018). Tree-Based Global Model Tests for Polytomous Rasch Models. *Educational and Psychological Measurement*, **78**(1), 128–166. doi: [10.1177/0013164416664394](https://doi.org/10.1177/0013164416664394)
- Strobl C, Kopf J, Zeileis A (2015). Rasch Trees: A New Method for Detecting Differential Item Functioning in the Rasch Model. *Psychometrika*, **80**(2), 289–316. doi: [10.1007/s1133601393883](https://doi.org/10.1007/s1133601393883)

## See Also

[rasctree](#), [pctree](#)

## Examples

```
## data
data("DIFSim", package = "psychotree")
data("DIFSimPC", package = "psychotree")

## summary of covariates
summary(DIFSim[, -1])
summary(DIFSimPC[, -1])

## empirical frequencies of responses
plot(DIFSim$resp)
plot(DIFSimPC$resp)

## histogram of raw scores
hist(rowSums(DIFSim$resp), breaks = 0:20 - 0.5)
hist(rowSums(DIFSimPC$resp), breaks = 0:17 - 0.5)
```

---

EuropeanValuesStudy    *European Values Study*

---

## Description

A sample of the 1999 European Values Study (EVS) containing an assessment of materialism/postmaterialism in 3584 respondents from 32 countries.

## Usage

```
data("EuropeanValuesStudy")
```

**Format**

A data frame containing 3584 observations on 10 variables.

**country** Factor coding the country of a respondent.

**gender** Factor coding gender.

**birthyear** Numeric. Year of birth.

**eduage** Numeric. Age when full time education was or will be completed.

**marital** Factor. Current legal marital status.

**employment** Ordered factor. Employment and number of working hours.

**occupation** Factor. What is/was your main job?

**income** Ordered factor. Income of household in ten categories from 10 percent lowest to 10 percent highest income category.

**paircomp** Paired comparison of class `paircomp`. Five pairwise choices among four important political goals derived from a double-choice task (see Details).

**country2** Factor. Country group according to postmaterialism (see Details).

**Details**

The data are part of a larger survey conducted in 1999 in 32 countries in Europe (see <https://europeanvaluesstudy.eu/>). Vermunt (2003) obtained a sample from 10 percent of the available cases per country, yielding 3584 valid cases.

The item in the 1999 European Values Study questionnaire aiming at recording materialism/postmaterialism reads as follows:

There is a lot of talk these days about what the aims of this country should be for the next ten years. On this card are listed some of the goals which different people would give top priority. If you had to choose, which of the things on this card would you say is most important? And which would be the next most important?

A Maintaining order in the nation

B Giving people more say in important government decisions

C Fighting rising prices

D Protecting freedom of speech

The double-choice task implies a partial ranking of the alternatives and (assuming transitivity) an incomplete set of paired comparisons for each respondent.

The country group according to postmaterialism was derived by Vermunt (2003) using a latent class model, and applied by Lee and Lee (2010) in a tree model.

**Source**

Latent GOLD Sample Data Sets Website.

**References**

Lee PH, Yu PLH (2010). Distance-Based Tree Models for Ranking Data. *Computational Statistics and Data Analysis*, **54**, 1672–1682.

Vermunt JK (2003). Multilevel Latent Class Models. *Sociological Methodology*, **33**, 213–239.

**See Also**[paircomp](#)**Examples**

```
## data
data("EuropeanValuesStudy", package = "psychotree")
summary(EuropeanValuesStudy$paircomp)

## Not run:
## Bradley-Terry tree resulting in similar results compared to
## the (different) tree approach of Lee and Lee (2010)
evs <- na.omit(EuropeanValuesStudy)
bt <- btree(paircomp ~ gender + eduage + birthyear + marital + employment + income + country2,
  data = evs, alpha = 0.01)
plot(bt, abbreviate = 2)

## End(Not run)
```

mpttree

*MPT Trees***Description**

Recursive partitioning (also known as trees) based on multinomial processing tree (MPT) models.

**Usage**

```
mpttree(formula, data, na.action, cluster, spec, treeid = NULL,
  optimargs = list(control = list(reltol = .Machine$double.eps^(1/1.2),
    maxit = 1000)), ...)
```

**Arguments**

formula	a symbolic description of the model to be fit. This should be of type $y \sim x_1 + x_2$ where $y$ should be a matrix of response frequencies and $x_1$ and $x_2$ are used as partitioning variables.
data	an optional data frame containing the variables in the model.
na.action	a function which indicates what should happen when the data contain NAs, defaulting to <a href="#">na.pass</a> .
cluster	optional vector (typically numeric or factor) with a cluster ID to be employed for clustered covariances in the parameter stability tests.
spec, treeid, optimargs	arguments for the MPT model passed on to <a href="#">mptmodel</a> .
...	arguments passed to <a href="#">mob_control</a> .



## Details

MPT trees (Wickelmaier & Zeileis, 2018) are an application of model-based recursive partitioning (implemented in `mob`) to MPT models (implemented in `mptmodel`).

Various methods are provided for "mpttree" objects, most of them inherit their behavior from "mob" objects (e.g., `print`, `summary`, etc.). The `plot` method employs the `node_mptplot` panel-generating function.

## Value

An object of S3 class "mpttree" inheriting from class "modelparty".

## References

Wickelmaier F, Zeileis A (2018). Using Recursive Partitioning to Account for Parameter Heterogeneity in Multinomial Processing Tree Models. *Behavior Research Methods*, **50**(3), 1217–1233. doi: [10.3758/s134280170937z](https://doi.org/10.3758/s134280170937z)

## See Also

`mob`, `mptmodel`.

## Examples

```
o <- options(digits = 4)

## Source Monitoring data
data("SourceMonitoring", package = "psychotools")

## MPT tree
sm_tree <- mpttree(y ~ sources + gender + age, data = SourceMonitoring,
  spec = mptspec("SourceMon", .restr = list(d1 = d, d2 = d)))
plot(sm_tree, index = c("D1", "D2", "d", "b", "g"))

## extract parameter estimates
coef(sm_tree)

## parameter instability tests in root node
if(require("strucchange")) sctest(sm_tree, node = 1)

## storage and retrieval deficits in psychiatric patients
data("MemoryDeficits", package = "psychotools")
MemoryDeficits$trial <- ordered(MemoryDeficits$trial)

## MPT tree
sr_tree <- mpttree(cbind(E1, E2, E3, E4) ~ trial + group,
  data = MemoryDeficits, cluster = ID, spec = mptspec("SR2"), alpha = 0.1)

## extract parameter estimates
coef(sr_tree)

options(digits = o$digits)
```

---

node\_btplot

*Panel-Generating Function for Visualizing Bradley-Terry Tree Models*


---

### Description

Panel-generating function for visualizing the worth parameters from the nodes in Bradley-Terry tree models.

### Usage

```
node_btplot(mobobj, id = TRUE,
            worth = TRUE, names = TRUE, abbreviate = TRUE, index = TRUE, ref = TRUE,
            col = "black", refcol = "lightgray", bg = "white", cex = 0.5, pch = 19,
            xscale = NULL, yscale = NULL, ylines = 1.5)
```

### Arguments

mobobj	an object of class "mob" based on Bradley-Terry models fitted by <a href="#">btmodel</a> .
id	logical. Should the node ID be displayed?
worth	logical. Should worth parameters (or their logs) be visualized?
names	logical. Should the names for the objects be displayed?
abbreviate	logical or numeric. Should object names be abbreviated? If numeric this controls the length of the abbreviation.
index	logical. Should different indexes for different stimuli be used?
ref	logical. Should a horizontal line for the reference level be drawn? Alternatively, ref can also be numeric or character to employ a reference level different from that stored in the model object.
col, cex, pch	graphical appearance of plotting symbols.
refcol	line color for reference line (if ref).
bg	color for background filling.
xscale, yscale	x and y axis limits.
ylines	numeric. Number of lines used for y-axis labels.

### Details

The panel-generating function node\_btplot is called by the plot method for "bttree" objects and does not have to be called by the user directly.

### Value

A panel function which can be supplied to the plot method for "mob" objects.

### See Also

[bttree](#)

---

`node_mptplot`*Panel-Generating Function for Visualizing MPT Tree Models*

---

## Description

Panel-generating function for visualizing the model parameters from the nodes in MPT tree models.

## Usage

```
node_mptplot(mobobj, id = TRUE,
             names = TRUE, abbreviate = TRUE, index = TRUE, ref = TRUE,
             col = "black", linecol = "lightgray", bg = "white", cex = 0.5, pch = 19,
             xscale = NULL, yscale = c(0, 1), ylines = 1.5)
```

## Arguments

<code>mobobj</code>	an object of class "mob" based on MPT models fitted by <a href="#">mptmodel</a> .
<code>id</code>	logical. Should the node ID be displayed?
<code>names</code>	logical or character. Should the names for the parameters be displayed? If character, this sets the names.
<code>abbreviate</code>	logical or numeric. Should parameter names be abbreviated? If numeric this controls the length of the abbreviation.
<code>index</code>	logical or character. Should different indexes for different parameters be used? If character, this controls the order of labels given in names.
<code>ref</code>	logical. Should a horizontal line for the reference level be drawn?
<code>col, cex, pch</code>	graphical appearance of plotting symbols.
<code>linecol</code>	line color for reference line (if ref).
<code>bg</code>	color for background filling.
<code>xscale, yscale</code>	x and y axis limits.
<code>ylines</code>	numeric. Number of lines used for y-axis labels.

## Details

The panel-generating function `node_mptplot` is called by the `plot` method for "mpttree" objects and does not have to be called by the user directly.

## Value

A panel function which can be supplied to the `plot` method for "mob" objects.

## See Also

[mpttree](#)

---

node\_profileplot      *Panel-Generating Function for Visualizing IRT Tree Models*

---

### Description

Panel-generating function for visualizing the parameters from the nodes in Rasch, rating scale or partial credit tree models.

### Usage

```
node_profileplot(mobobj, what = c("items", "thresholds", "discriminations"),
  parg = list(type = NULL, ref = NULL, alias = TRUE), id = TRUE,
  names = FALSE, abbreviate = TRUE, index = TRUE, ref = TRUE, col = "black",
  border = col, linecol = "black", refcol = "lightgray", bg = "white",
  cex = 0.5, pch = 21, xscale = NULL, yscale = NULL, ylines = 2, ...)
```

### Arguments

mobobj	an object of class "mob" based on rasch models fitted by <a href="#">raschmodel</a> , rating scale models fitted by <a href="#">rsmode1</a> or partial credit models fitted by <a href="#">pcmodel</a> .
what	character, specifying the type of parameters to be plotted.
parg	list of arguments passed over to internal calls of <a href="#">itempar</a> , <a href="#">threshpar</a> or <a href="#">discrpar</a> .
id	logical. Should the node ID be displayed?
names	logical or character. If TRUE, the names of the items are displayed on the x-axis. If FALSE, numbers of items are shown. Alternatively a character vector of the same length as the number of items can be supplied.
abbreviate	logical. Should item names be abbreviated? If numeric this controls the length of the abbreviation.
index	logical. Should different indexes for different items be used?
ref	logical. Should a horizontal line for the reference level be drawn?
col, border, pch, cex	graphical appearance of plotting symbols.
linecol, refcol	character, specifying the line color to use for the profile lines and reference line, respectively.
bg	color for background filling.
xscale, yscale	x and y axis limits.
ylines	numeric. Number of lines used for y-axis labels.
...	further arguments currently not used.

### Details

The panel-generating function node\_profileplot is called by the plot method for "raschtree" objects and does not have to be called by the user directly.

Prior to version 0.13-1, node\_profileplot was called node\_raschplot.

**Value**

A panel function which can be supplied to the plot method for "mob" objects.

**See Also**

[raschtree](#)

---

node_regionplot	<i>Panel-Generating Function for Visualizing Rasch, Rating Scale and Partial Credit Tree Models</i>
-----------------	---

---

**Description**

Panel-generating function for visualizing the absolute item threshold parameters from the nodes in rasch, rating scale and partial credit tree models.

**Usage**

```
node_regionplot(mobobj, names = FALSE, abbreviate = TRUE,
  type = c("mode", "median", "mean"), ref = NULL, ylim = NULL,
  off = 0.1, col_fun = gray.colors, bg = "white", uo_show = TRUE, uo_col = "red",
  uo_lty = 2, uo_lwd = 1.25, ylines = 2)
```

**Arguments**

mobobj	an object of class "mob" based on rasch models fitted by <a href="#">raschmodel</a> , rating scale models fitted by <a href="#">rsmode1</a> or partial credit models fitted by <a href="#">pcmodel</a> .
names	logical or character. If TRUE, the names of the items are displayed on the x-axis. If FALSE, numbers of items are shown. Alternatively a character vector of the same length as the number of items can be supplied.
abbreviate	logical. Should item names be abbreviated? If numeric this controls the length of the abbreviation.
type	character, specifying which type of threshold parameters are to be used to mark the category regions per item in the plot (see <a href="#">regionplot</a> for details).
ref	a vector of labels or position indices of item parameters which should be used as restriction/for normalization. If NULL (the default), all items are used (sum zero restriction). See <a href="#">threspar</a> for more details.
ylim	y axis limits
off	numeric, the distance (in scale units) between two item rectangles.
col_fun	function. Function to use for creating the color palettes for the rectangles. Per default <code>gray.colors</code> is used. Be aware that <code>col_fun</code> should accept as first argument an integer specifying the number of colors to create.
bg	color for background filling.
uo_show	logical. If set to TRUE (the default), disordered absolute item threshold parameters are indicated by a horizontal line (only if type is set to "mode").

uo_col	character, color of indication lines (if uo_show).
uo_lty	numeric. Line typ of indication lines (if uo_show).
uo_lwd	numeric. Line width of indication lines (if uo_show).
ylines	numeric. Number of lines used for y-axis labels.

### Details

The panel-generating function `node_regionplot` is called by the `plot` method of `"rstree"` and `"pctree"` objects by default and does not have to be called by the user directly.

See [regionplot](#) for details and references of the drawn region plots and possible values and their meaning for the argument type (taken by `node_regionplot`).

Prior to version 0.13-1, `node_regionplot` was called `node_effects`.

### Value

A panel function which can be supplied to the `plot` method for `"mob"` objects.

### See Also

[rashtree](#), [rstree](#), [pctree](#), [regionplot](#)

---

pctree

*Partial Credit Trees*

---

### Description

Recursive partitioning (also known as trees) based on partial credit models.

### Usage

```
pctree(formula, data, na.action, nullcats = c("keep", "downcode", "ignore"),
       reltol = 1e-10, deriv = c("sum", "diff"), maxit = 100L, ...)
```

```
## S3 method for class 'pctree'
predict(object, newdata = NULL,
       type = c("probability", "cumprobability", "mode", "median", "mean",
              "category-information", "item-information", "test-information", "node"),
       personpar = 0, ...)
```

```
## S3 method for class 'pctree'
plot(x, type = c("regions", "profile"), terminal_panel = NULL,
     tp_args = list(...), tnex = 2L, drop_terminal = TRUE, ...)
```

## Arguments

<code>formula</code>	A symbolic description of the model to be fit. This should be of type $y \sim x_1 + x_2$ where $y$ should be a matrix with items in the columns and observations in the rows and $x_1$ and $x_2$ are used as partitioning variables.
<code>data</code>	a data frame containing the variables in the model.
<code>na.action</code>	a function which indicates what should happen when the data contain missing values (NAs).
<code>nullcats</code>	character. How null categories should be treated. See <a href="#">pcmodel</a> for details.
<code>deriv</code>	character. If "sum" (the default), the first derivatives of the elementary symmetric functions are calculated with the sum algorithm. Otherwise ("diff") the difference algorithm (faster but numerically unstable) is used.
<code>reltol, maxit</code>	arguments passed via <a href="#">pcmodel</a> to <a href="#">optim</a> .
<code>...</code>	arguments passed to the underlying functions, i.e., to <a href="#">mob_control</a> for <code>pctree</code> , and to the underlying <code>predict</code> and <code>plot</code> methods, respectively.
<code>object, x</code>	an object of class "raschtree".
<code>newdata</code>	optional data frame with partitioning variables for which predictions should be computed. By default the learning data set is used.
<code>type</code>	character specifying the type of predictions or plot. For the <code>predict</code> method, either just the ID of the terminal "node" can be predicted or some property of the model at a given person parameter (specified by <code>personpar</code> ).
<code>personpar</code>	numeric person parameter (of length 1) at which the predictions are evaluated.
<code>terminal_panel, tp_args, tnex, drop_terminal</code>	arguments passed to <a href="#">plot.modelparty/plot.party</a> .

## Details

Partial credit trees are an application of model-based recursive partitioning (implemented in [mob](#)) to partial credit models (implemented in [pcmodel](#)).

Various methods are provided for "pctree" objects, most of them inherit their behavior from "modelparty" objects (e.g., `print`, `summary`, etc.). For the PCMs in the nodes of a tree, `coef` extracts all item and threshold parameters except those restricted to be zero. `itempar` and `threshpar` extract all item and threshold parameters (including the restricted ones). The `plot` method by default employs the [node\\_regionplot](#) panel-generating function and the [node\\_profileplot](#) panel-generating function is provided as an alternative.

## Value

An object of S3 class "pctree" inheriting from class "modelparty".

## References

Komboz B, Zeileis A, Strobl C (2018). Tree-Based Global Model Tests for Polytomous Rasch Models. *Educational and Psychological Measurement*, **78**(1), 128–166. doi: [10.1177/0013164416664394](https://doi.org/10.1177/0013164416664394)

**See Also**

[mob](#), [pcmodel](#), [rstree](#), [raschtree](#)

**Examples**

```
o <- options(digits = 4)

## verbal aggression data from package psychotools
data("VerbalAggression", package = "psychotools")

## use response to the second other-to-blame situation (train)
VerbalAggression$s2 <- VerbalAggression$resp[, 7:12]

## exclude subjects who only scored in the highest or the lowest categories
VerbalAggression <- subset(VerbalAggression, rowSums(s2) > 0 & rowSums(s2) < 12)

## fit partial credit tree model
pct <- pctree(s2 ~ anger + gender, data = VerbalAggression)

## print tree (with and without parameters)
print(pct)
print(pct, FUN = function(x) " *")

## show summary for terminal panel nodes
summary(pct)

## visualization
plot(pct, type = "regions")
plot(pct, type = "profile")

## extract item and threshold parameters
coef(pct)
itempar(pct)
threshpar(pct)

## inspect parameter stability tests in the splitting node
if(require("strucchange")) sctest(pct, node = 1)

options(digits = o$digits)

## partial credit tree on artificial data from Komboz et al. (2018)
data("DIFSimPC", package = "psychotree")
pct2 <- pctree(resp ~ gender + age + motivation, data = DIFSimPC)
plot(pct2, ylim = c(-4.5, 4.5), names = paste("I", 1:8))
```



**Description**

Recursive partitioning (also known as trees) based on Rasch models.

**Usage**

```
rasctree(formula, data, na.action,
  reltol = 1e-10, deriv = c("sum", "diff", "numeric"), maxit = 100L,
  ...)

## S3 method for class 'rasctree'
predict(object, newdata = NULL,
  type = c("probability", "cumprobability", "mode", "median", "mean",
  "category-information", "item-information", "test-information", "node"),
  personpar = 0, ...)

## S3 method for class 'rasctree'
plot(x, type = c("profile", "regions"), terminal_panel = NULL,
  tp_args = list(...), tnex = 2L, drop_terminal = TRUE, ...)
```

**Arguments**

formula	A symbolic description of the model to be fit. This should be of type $y \sim x_1 + x_2$ where $y$ should be a binary 0/1 item response matrix and $x_1$ and $x_2$ are used as partitioning variables.
data	a data frame containing the variables in the model.
na.action	a function which indicates what should happen when the data contain missing values (NAs).
deriv	character. Which type of derivatives should be used for computing gradient and Hessian matrix? Analytical with sum algorithm ("sum"), analytical with difference algorithm ("diff", faster but numerically unstable), or numerical. Passed to <a href="#">raschmodel</a> .
reltol, maxit	arguments passed via <a href="#">raschmodel</a> to <a href="#">optim</a> .
...	arguments passed to the underlying functions, i.e., to <a href="#">mob_control</a> for <a href="#">rasctree</a> , and to the underlying <a href="#">predict</a> and <a href="#">plot</a> methods, respectively.
object, x	an object of class "rasctree".
newdata	optional data frame with partitioning variables for which predictions should be computed. By default the learning data set is used.
type	character specifying the type of predictions or plot. For the <a href="#">predict</a> method, either just the ID of the terminal "node" can be predicted or some property of the model at a given person parameter (specified by <a href="#">personpar</a> ).
personpar	numeric person parameter (of length 1) at which the predictions are evaluated.
terminal_panel, tp_args, tnex, drop_terminal	arguments passed to <a href="#">plot.modelparty/plot.party</a> .

## Details

Rasch trees are an application of model-based recursive partitioning (implemented in [mob](#)) to Rasch models (implemented in [raschmodel](#)).

Various methods are provided for "rashtree" objects, most of them inherit their behavior from "modelparty" objects (e.g., `print`, `summary`, etc.). For the Rasch models in the nodes of a tree, `coef` extracts all item parameters except the first one which is always restricted to be zero. `itempar` extracts all item parameters (including the first one) and by default restricts their sum to be zero (but other restrictions can be used as well). The `plot` method by default employs the `node_profileplot` panel-generating function and the `node_regionplot` panel-generating function is provided as an alternative.

Rasch tree models are introduced in Strobl et al. (2015), whose analysis for the SPISA data is replicated in `vignette("rashtree", package = "psychotree")`. Their illustration employing artificial data is replicated below.

## Value

An object of S3 class "rashtree" inheriting from class "modelparty".

## References

Strobl C, Kopf J, Zeileis A (2015). Rasch Trees: A New Method for Detecting Differential Item Functioning in the Rasch Model. *Psychometrika*, **80**(2), 289–316. doi: [10.1007/s1133601393883](https://doi.org/10.1007/s1133601393883)

## See Also

[mob](#), [raschmodel](#), [rstree](#), [pctree](#)

## Examples

```
o <- options(digits = 4)

## artificial data
data("DIFSim", package = "psychotree")

## fit Rasch tree model
rt <- rashtree(resp ~ age + gender + motivation, data = DIFSim)
plot(rt)

## extract item parameters
itempar(rt)

## inspect parameter stability tests in all splitting nodes
if(require("strucchange")) {
  sctest(rt, node = 1)
  sctest(rt, node = 2)
}

## highlight items 3 and 14 with DIF
ix <- rep(1, 20)
ix[c(3, 14)] <- 2
```

```
plot(rt, ylines = 2.5, cex = c(0.4, 0.8)[ix],
     pch = c(19, 19)[ix], col = gray(c(0.5, 0))[ix])

options(digits = o$digits)
```

---

rstree

*Rating Scale Trees*


---

## Description

Recursive partitioning (also known as trees) based on rating scale models.

## Usage

```
rstree(formula, data, na.action, reltol = 1e-10,
       deriv = c("sum", "diff"), maxit = 100L, ...)

## S3 method for class 'rstree'
predict(object, newdata = NULL,
       type = c("probability", "cumprobability", "mode", "median", "mean",
              "category-information", "item-information", "test-information", "node"),
       personpar = 0, ...)

## S3 method for class 'rstree'
plot(x, type = c("regions", "profile"), terminal_panel = NULL,
     tp_args = list(...), tnex = 2L, drop_terminal = TRUE, ...)
```

## Arguments

formula	A symbolic description of the model to be fit. This should be of type $y \sim x_1 + x_2$ where $y$ should be a matrix with items in the columns and observations in the rows and $x_1$ and $x_2$ are used as partitioning variables. Additionally each item (column) should have the same maximum value (see <a href="#">pctree</a> for a way to handle variable maximum values).
data	a data frame containing the variables in the model.
na.action	a function which indicates what should happen when the data contain missing values (NAs).
deriv	character. If "sum" (the default), the first derivatives of the elementary symmetric functions are calculated with the sum algorithm. Otherwise ("diff") the difference algorithm (faster but numerically unstable) is used.
reltol, maxit	arguments passed via <a href="#">rsmodel</a> to <a href="#">optim</a> .
...	arguments passed to the underlying functions, i.e., to <a href="#">mob_control</a> for <a href="#">rstree</a> , and to the underlying <a href="#">predict</a> and <a href="#">plot</a> methods, respectively.
object, x	an object of class "raschtree".
newdata	optional data frame with partitioning variables for which predictions should be computed. By default the learning data set is used.

type character specifying the type of predictions or plot. For the predict method, either just the ID of the terminal "node" can be predicted or some property of the model at a given person parameter (specified by personpar).

personpar numeric person parameter (of length 1) at which the predictions are evaluated.

terminal\_panel, tp\_args, tnex, drop\_terminal arguments passed to [plot.modelparty/plot.party](#).

## Details

Rating scale trees are an application of model-based recursive partitioning (implemented in [mob](#)) to rating scale models (implemented in [rsmode1](#)).

Various methods are provided for "rstree" objects, most of them inherit their behavior from "mob" objects (e.g., print, summary, etc.). For the rating scale models in the nodes of a tree, coef extracts all item parameters. The plot method employs the [node\\_regionplot](#) panel-generating function by default.

Various methods are provided for "rstree" objects, most of them inherit their behavior from "modelparty" objects (e.g., print, summary, etc.). For the RSMs in the nodes of a tree, coef extracts all item and threshold parameters except those restricted to be zero. itempar and threshpar extract all item and threshold parameters (including the restricted ones). The plot method by default employs the [node\\_regionplot](#) panel-generating function and the [node\\_profileplot](#) panel-generating function is provided as an alternative.

## Value

An object of S3 class "rstree" inheriting from class "modelparty".

## References

Komboz B, Zeileis A, Strobl C (2018). Tree-Based Global Model Tests for Polytomous Rasch Models. *Educational and Psychological Measurement*, **78**(1), 128–166. doi: [10.1177/0013164416664394](https://doi.org/10.1177/0013164416664394)

## See Also

[mob](#), [rsmode1](#), [pctree](#), [raschtree](#)

## Examples

```
## IGNORE_RDIFF_BEGIN
o <- options(digits = 4)

## verbal aggression data from package psychotools
data("VerbalAggression", package = "psychotools")

## responses to the first other-to-blame situation (bus)
VerbalAggression$s1 <- VerbalAggression$resp[, 1:6]

## exclude subjects who only scored in the highest or the lowest categories
VerbalAggression <- subset(VerbalAggression, rowSums(s1) > 0 & rowSums(s1) < 12)

## fit rating scale tree model for the first other-to-blame situation
```

```
rst <- rmtree(s1 ~ anger + gender, data = VerbalAggression)

## print tree (with and without parameters)
print(rst)
print(rst, FUN = function(x) " *")

## show summary for terminal panel nodes
summary(rst)

## visualization
plot(rst, type = "regions")
plot(rst, type = "profile")

## extract item and threshold parameters
coef(rst)
itempar(rst)
threshpar(rst)

## inspect parameter stability tests in all splitting nodes
if(require("strucchange")) {
  sctest(rst, node = 1)
  sctest(rst, node = 2)
}

options(digits = o$digits)
## IGNORE_RDIFF_END
```

---

SPISA

*SPIEGEL Studentenpisa Data (Subsample)*

---

## Description

A subsample from the general knowledge quiz “Studentenpisa” conducted online by the German weekly news magazine SPIEGEL. The data contain the quiz results from 45 questions as well as sociodemographic data for 1075 university students from Bavaria.

## Usage

```
data("SPISA")
```

## Format

A data frame containing 1075 observations on 6 variables.

**spisa** matrix with 0/1 results from 45 questions in the quiz (indicating wrong/correct answers).

**gender** factor indicating gender.

**age** age in years.

**semester** numeric indicating semester of university enrollment.

**elite** factor indicating whether the university the student is enrolled in has been granted “elite” status by the German “excellence initiative”.

**spn** ordered factor indicating frequency of accessing the SPIEGEL online (SPON) magazine.

### Details

An online quiz for testing one’s general knowledge was conducted by the German weekly news magazine SPIEGEL in 2009. Overall, about 700,000 participants answered the quiz and a set of sociodemographic questions. The general knowledge quiz consisted of a total of 45 items from five different topics: politics, history, economy, culture and natural sciences. For each topic, four different sets of nine items were available, that were randomly assigned to the participants. A thorough analysis and discussion of the original data set is provided in Trepte and Verbeet (2010).

Here, we provide the subsample of university students enrolled in the federal state of Bavaria, who had been assigned questionnaire number 20 (so that all subjects have answered the same set of items). Excluding all incomplete records, this subsample contains 1075 observations.

The data are analyzed in Strobl et al. (2010), whose analysis is replicated in vignette(“raschtree”, package = “psychotree”).

The full list of items in questionnaire 20 is given below.

#### Politics:

Who determines the rules of action in German politics according to the constitution? – The Bundeskanzler (federal chancellor).

What is the function of the second vote in the elections to the German Bundestag (federal parliament)? – It determines the allocation of seats in the Bundestag.

How many people were killed by the RAF (Red Army Faction)? – 33.

Where is Hessen (i.e., the German federal country Hesse) located? – (Indicate location on a map.)

What is the capital of Rheinland-Pfalz (i.e., the German federal country Rhineland-Palatinate)? – Mainz.

Who is this? – (Picture of Horst Seehofer.)

Which EU institution is elected in 2009 by the citizens of EU member countries? – European Parliament.

How many votes does China have in the UNO general assembly? – 1.

Where is Somalia located? – (Indicate location on a map.)

#### History:

The Roman naval supremacy was established through... – ... the abolition of Carthage.

In which century did the Thirty Years’ War take place? – The 17th century.

Which form of government is associated with the French King Louis XIV? – Absolutism.

What island did Napoleon die on in exile? – St. Helena.

How many percent of the votes did the NSDAP receive in the 1928 elections of the German Reichstag? – About 3 percent.

How many Jews were killed by the Nazis during the Holocaust? – About 6 Million.

Who is this? – (Picture of Johannes Rau, former German federal president.)

Which of the following countries is not a member of the EU? – Croatia.

How did Mao Zedong expand his power in China? – The Long March.

#### Economy:

Who is this? – (Picture of Dieter Zetsche, CEO of Mercedes-Benz.)

What is the current full Hartz IV standard rate (part of the social welfare) for adults? – 351 Euro.

What was the average per capita gross national product in Germany in 2007? – About 29,400 Euro.

What is a CEO? – A Chief Executive Officer.  
 What is the meaning of the hexagonal “organic” logo? – Synthetic pesticides are prohibited.  
 Which company does this logo represent? – Deutsche Bank.  
 Which German company took over the British automobile manufacturers Rolls-Royce? – BMW.  
 Which internet company took over the media group Time Warner? – AOL.  
 What is the historic meaning of manufacturies? – Manufacturies were the precursors of industrial mass production.

#### Culture:

Which painter created this painting? – Andy Warhol.  
 What do these four buildings have in common? – All four were designed by the same architects.  
 Roman numbers: What is the meaning of CLVI? – 156.  
 What was the German movie with the most viewers since 1990? – Der Schuh des Manitu.  
 In which TV series was the US president portrayed by an African American actor for a long time? – 24.  
 What is the name of the bestselling novel by Daniel Kehlmann? – Die Vermessung der Welt (Measuring The World).  
 Which city is the setting for the novel ‘Buddenbrooks’? – Lübeck.  
 In which city is this building located? – Paris.  
 Which one of the following operas is not by Mozart? – Aida.

#### Natural sciences:

Why does an ice floe not sink in the water? – Due to the lower density of ice.  
 What is ultrasound not used for? – Radio.  
 Which sensory cells in the human eye make color vision possible? – Cones.  
 What is also termed Trisomy 21? – Down syndrome.  
 Which element is the most common in the Earth’s atmosphere? – Nitrogen.  
 Which kind of tree does this leaf belong to? – Maple.  
 Which kind of bird is this? – Blackbird.  
 Where is the stomach located? – (Indicate location on a map of the body.)  
 What is the sum of interior angles in a triangle? – 180 degrees.

#### References

- Strobl C, Kopf J, Zeileis A (2015). Rasch Trees: A New Method for Detecting Differential Item Functioning in the Rasch Model. *Psychometrika*, **80**(2), 289–316. doi: [10.1007/s1133601393883](https://doi.org/10.1007/s1133601393883)
- SPIEGEL Online (2009). Studentenpisa – Alle Fragen, alle Antworten. In German. Accessed 2010-10-26. <https://www.spiegel.de/lebenundlernen/uni/studentenpisa-alle-fragen-alle-antworten-a-620101.html>
- Trepte S, Verbeet M (2010). Allgemeinbildung in Deutschland – Erkenntnisse aus dem SPIEGEL-Studentenpisa-Test. ISBN 978-3-531-17218-7. VS Verlag, Wiesbaden.

#### See Also

[raschtree](#)

#### Examples

## data

```

data("SPISA", package = "psychotree")

## summary of covariates
summary(SPISA[,-1])

## histogram of raw scores
hist(rowSums(SPISA$spisa), breaks = 0:45 + 0.5)

## Not run:
## See the following vignette for a tree-based DIF analysis
vignette("raschtree", package = "psychotree")

## End(Not run)

```

---

Topmodel2007

*Attractiveness of Germany's Next Topmodels 2007*


---

## Description

Preferences of 192 respondents judging the attractiveness of the top six contestants of the TV show *Germany's Next Topmodel 2007* (second cycle).

## Usage

```
data("Topmodel2007")
```

## Format

A data frame containing 192 observations on 6 variables.

**preference** Paired comparison of class `paircomp`. Preferences for all 15 paired comparisons from 6 contestants: Barbara, Anni, Hana, Fiona, Mandy, and Anja.

**gender** Factor coding gender.

**age** Integer. Age of the respondents in years.

**q1** Factor. Do you recognize the women on the pictures?/Do you know the TV show Germany's Next Topmodel?

**q2** Factor. Did you watch Germany's Next Topmodel regularly?

**q3** Factor. Did you watch the final show of Germany's Next Topmodel?/Do you know who won Germany's Next Topmodel?

## Details

Germany's Next Topmodel is a German casting television show (based on a concept introduced in the United States) hosted by Heidi Klum (see Wikipedia 2009). The second season of the show aired March–May 2007.

A survey was conducted at the Department of Psychology, Universität Tübingen, in 2007 shortly after the final show. The sample was stratified by gender and age (younger versus older than 30 years) with 48 participants in each group.



Digital photographs (resolution 303 times 404 pixels) of the top six contestants were available from the ProSieben web page at the time of the survey. The photos were selected to be comparable, showing the contestant's face and the upper part of the body, all women being casually dressed.

Participants were presented with all 15 pairs of photographs. On each trial, their task was to judge which of the two women on the photos was the more attractive. In order to assess the participants' expertise, additional questions regarding their familiarity with the show were asked after the pairwise comparisons were completed.

The actual ranking, as resulting from sequential elimination during the course of the show, was (from first to sixth place): Barbara, Anni, Hana, Fiona, Mandy, Anja.

## References

Wikipedia (2009). Germany's Next Topmodel – Wikipedia, The Free Encyclopedia. [https://en.wikipedia.org/wiki/Germany's\\_Next\\_Topmodel](https://en.wikipedia.org/wiki/Germany's_Next_Topmodel), accessed 2009-02-06.

## See Also

[paircomp](#)

## Examples

```
data("Topmodel2007", package = "psychotree")
summary(Topmodel2007$preference)
xtabs(~ gender + I(age < 30), data = Topmodel2007)
```

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