

Package ‘WrightMap’

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Type Package

Title IRT Item-Person Map with 'ConQuest' Integration

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Description A powerful yet simple graphical tool available in the field of psychometrics is the Wright Map (also known as item maps or item-person maps), which presents the location of both respondents and items on the same scale. Wright Maps are commonly used to present the results of dichotomous or polytomous item response models. The 'WrightMap' package provides functions to create these plots from item parameters and person estimates stored as R objects. Although the package can be used in conjunction with any software used to estimate the IRT model (e.g. 'TAM', 'mirt', 'eRm' or 'IRT-Tools' in 'R', or 'Stata', 'Mplus', etc.), 'WrightMap' features special integration with 'ConQuest' to facilitate reading and plotting its output directly. The 'wrightMap' function creates Wright Maps based on person estimates and item parameters produced by an item response analysis. The 'CQmodel' function reads output files created using 'ConQuest' software and creates a set of data frames for easy data manipulation, bundled in a 'CQmodel' object. The 'wrightMap' function can take a 'CQmodel' object as input or it can be used to create Wright Maps directly from data frames of person and item parameters.

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CCCfit	<i>Empirical category characteristic curve plot for the Partial Credit Model</i>
--------	--

Description

The CCCfit function is intended for contrasting a Rasch model's expected category characteristic curve against the empirical data from observed responses. The CCCfit function displays the expected probability associated with all response categories and plots the observed response proportions for all non-zero response categories.

Usage

```
CCCfit(itemNumber, observedResponses, personEstimates,
       itemParameters, xlim = c(-4, 4), method = "Quantile", NQtiles = 10)
```

Arguments

itemNumber	The position of the item in the test. This position is used to select the column of observed responses and the item difficulty among the item parameters.
observedResponses	Data frame or matrix with observed responses. The data frame or matrix should be of size N * I, where N is the number of respondents and I is the number of items in the model.
personEstimates	A vector of length N containing the model based person estimates or predictions.
itemParameters	A data frame or matrix with I rows (one for each item) and M columns, where M is equal to the maximum number of item scores minus 1. This matrix contains the model based estimates for the step parameters (deltas), where column 1 contains the parameter associated with the step between category 0 versus category 1, column 2 the step parameters of category 1 versus category 2, and so on.

xlim	Vector with two values indicating the minimum and maximum values to be used when plotting the item characteristic curve.
method	Selects the Quantile method to group the respondents (see ‘Details’).
NQtiles	This value controls how many grouping will be used: 4 groups cases groups respondents by quartiles, 5 by quintiles, 10 by deciles, etc.

Details

The function uses the step difficulty parameters to generate the model based curve. The observed responses are then grouped using the Quantile method in order to contrast the model predicted response probability with the observed proportion (this is the only method implemented so far). By default the function uses deciles to generate the respondent groups.

Author(s)

David Torres Irribarra

See Also

[ICCfit](#)

Examples

```
##---- Should be DIRECTLY executable !! ----
##-- ==> Define data, use random,
##--or do help(data=index) for the standard data sets.

## The function is currently defined as
function (itemNumber, observedResponses, personEstimates, itemParameters,
  xlim = c(-4, 4), method = "Quantile", NQtiles = 10)
{
  curve.cols <- paste(RColorBrewer::brewer.pal(n = 8, name = "Dark2"),
    "40", sep = "")
  points.cols <- RColorBrewer::brewer.pal(n = 8, name = "Dark2")
  deltas <- itemParameters[itemNumber, ]
  deltas <- deltas[!is.na(deltas)]
  maxCat <- length(deltas)
  probbCCC <- function(theta, deltas) {
    original.length <- length(deltas) + 1
    deltas <- deltas[!is.na(deltas)]
    deltas <- c(0, deltas)
    lN <- length(deltas)
    M <- matrix(rep(NA, lN), ncol = lN)
    CM <- matrix(rep(NA, lN), ncol = lN)
    M[, 1] <- 0
    CM[, 1] <- 1
    for (k in 2:lN) {
      M[, k] <- M[, (k - 1)] + theta - deltas[k]
      CM[, k] <- CM[, (k - 1)] + exp(M[, k])
    }
    output <- exp(M)/CM[, k]
  }
}
```

```

        length(output) <- original.length
        output
    }
    categoryProbs <- sapply(seq(xlim[1], xlim[2], length = 100),
        probCCC, deltas = deltas)
    plot(seq(xlim[1], xlim[2], length = 100), categoryProbs[1,
        ], type = "n", axes = FALSE, xlab = "Proficiency", ylab = "Proportion",
        ylim = c(0, 1))
    axis(2, las = 1)
    axis(1)
    lines(seq(xlim[1], xlim[2], length = 100), categoryProbs[1,
        ], type = "l", lwd = 3, lty = 1, col = "grey80")
    nCats <- length(deltas) + 1
    for (i in 2:nCats) {
        lines(seq(xlim[1], xlim[2], length = 100), categoryProbs[i,
            ], lwd = 3, col = curve.cols[i - 1])
    }
    if (method == "Quantile") {
        agg.data <- list()
        size.data <- list()
        for (i in 1:maxCat) {
            recodedResponses <- observedResponses == i
            cutPoints <- quantile(personEstimates, seq(0, 1,
                length = NQtiles + 1))
            agg.data[[i]] <- aggregate(recodedResponses, by = list(cut(personEstimates,
                cutPoints)), FUN = mean, na.rm = TRUE)
            breakMeans <- aggregate(personEstimates, by = list(cut(personEstimates,
                cutPoints)), FUN = mean, na.rm = TRUE)
            agg.data[[i]][, 1] <- breakMeans[, 2]
            agg.data[[i]][, -1][agg.data[[i]][, -1] == 1] <- 0.999
            agg.data[[i]][, -1][agg.data[[i]][, -1] == 0] <- 0.001
            size.data[[i]] <- aggregate(is.na(recodedResponses),
                by = list(cut(personEstimates, cutPoints)), FUN = length)
            size.data[[i]][, 1] <- breakMeans[, 2]
            points(agg.data[[i]][, 1], agg.data[[i]][, itemNumber +
                1], type = "b", pch = i, cex = 0.75, col = points.cols[i],
                lwd = 2)
        }
    }
    legend("right", horiz = FALSE, legend = paste("Cat", seq(1:maxCat)),
        col = points.cols[1:maxCat], pch = 1:maxCat, cex = 0.8,
        bty = "n")
    title(paste("Item", itemNumber))
}

```

Description

The CQmodel function reads ConQuest item parameter and person parameter output files and converts them into a list of data frames for more convenient data processing.

Usage

```
CQmodel(p.est = NULL, show = NULL, p.type = NULL, equation = NULL)
## S3 method for class 'CQmodel'
print(x,...)
## S3 method for class 'SOE'
print(x,...)
```

Arguments

p.est	Conquest person parameters file (EAPs, MLEs, etc.).
show	ConQuest show file.
p.type	Type of person parameter estimate (EAP, MLE or WLE). If not specified, will try to determine from the extension of the p.est file.
equation	String giving the model equation, if the Summary of Estimation table was not included in the show file.
x	Object that determines which function to call.
...	Additional arguments.

Value

CQmodel returns an object of type CQmodel. Usually contains: Tables:

RMP	A list of data frames containing the response model parameter estimates. One data frame is created for each table in the output. Each data frame contains parameter estimates, errors, and fit information.
GIN	A matrix containing the item thresholds (if included in the ConQuest output). The rows are items and the columns are steps.
p.est	A data frame containing the person parameter estimates

Summary of estimation:

SOE	A list of various parameters related to the estimation
-----	--

Items that may be in the SOE list include:

method	Estimation method
distribution	Assumed population distribution
constraint	Constraint
format	Specified format of the datafile
equation	A character string containing the item model (e.g. "item+item*step")
participants	Sample size

deviance	Final deviance of the model
parameters	Total number of estimated parameters
iterations	Number of iterations
seed	Random number generation seed
PV.nodes	Number of nodes used when drawing PVs
fit.nodes	Number of nodes used when computing fit
n.plausible.values	Number of plausible values drawn
max.iterations.no.improvement	Maximum number of iterations without a deviance improvement
max.steps	Maximum number of Newton steps in M-step
zero.perfect.value	Value for obtaining finite MLEs for zero/perfects
termination.reason	Reason for iteration termination
max.iterations	
parameter.change	
deviance.change	

Run details:

run.details	A list of details of the run
-------------	------------------------------

Items that may be included in the run.details list include:

date	The date of the ConQuest run
data.file	The name of the datafile used
format	The specified format of the datafile
names	Names of items and/or dimensions

Additional items:

deviance	The deviance of the model
equation	A character string containing the model specification (e.g. "item+item*step")
participants	The number of participants
parameters	The number of parameters
title	The run title
reg.coef	Regression coefficients
rel.coef	Reliability coefficients
variances	
nDim	Number of dimensions
dimensions	Dimension names
p.est.type	

Author(s)

Rebecca Freund and David Torres Irribarra

Examples

```
fpath <- system.file("extdata", package="WrightMap")

# Partial credit model
model1 <- CQmodel(p.est = file.path(fpath,"ex2.eap"),
  show = file.path(fpath,"ex2.shw"))
model1 #Shows what tables are available

model1$SOE #Summary of estimation
model1$equation # Model specification
model1$reg.coef # Regression coefficients
model1$rel.coef # Reliability coefficients
model1$variances # Variances

names(model1$RMP) # Names of parameter tables
head(model1$RMP$item) #Item parameters
head(model1$RMP$item*step) #Item by step parameters

# Complex model
model2 <- CQmodel(file.path(fpath,"ex4a.mle"),
  file.path(fpath,"ex4a.shw"))
model2$equation # Model specification
names(model2$RMP) # Names of parameter tables
head(model2$RMP$rater*topic*criteria*step) #An interaction table

model1$GIN #Item thresholds
model2$GIN #Item thresholds

head(model1$p.est) ##EAPs
head(model2$p.est) ##MLEs
```

extract.deltas	<i>Extract Master's Delta parameters from a TAM model.</i>
----------------	--

Description

This function takes as its input a TAM object. It adds reads the TAM item parameters and organizes them into a matrix that can be used as input in the [CCCfit](#) function.

Usage

```
extract.deltas(tamObject)
```

Arguments

tamObject TAM object containing the results of a a Rasch model or Partial Credit model.

Details

This function organizes the item parameter results into a matrix where each row is contains the parameters associated with an item and each columns is contains the parameters associated with a specific step (score 0 vs score 1, score 1 vs score 2, etc.). The resulting matrix will have as many rows as items and as many columns as the maximum number of steps among the items.

Value

A matrix in which each row is an item and each column is a step

Author(s)

David Torres Irribarra

References

Masters, G. N. (1982). A Rasch model for partial credit scoring. *Psychometrika*, 47(2), 149-174.

See Also

[CCCfit](#) [make.thresholds](#)

Examples

```
##---- Should be DIRECTLY executable !! ----
##-- ==> Define data, use random,
##--or do help(data=index) for the standard data sets.

## The function is currently defined as
function (tamObject)
{
  delta.long <- tamObject$xsi
  n.deltas <- apply(tamObject$B, 1, max)
  delta.mat <- matrix(NA, nrow = length(n.deltas), ncol = max(n.deltas))
  matCoords.row <- rep(1:length(n.deltas), n.deltas)
  matCoords.col <- c()
  for (i in 1:length(n.deltas)) {
    for (j in 1:n.deltas[i]) {
      matCoords.col <- c(matCoords.col, j)
    }
  }
  delta.long$matCoords.row <- matCoords.row
  delta.long$matCoords.col <- matCoords.col
  for (k in 1:nrow(delta.long)) {
    delta.mat[delta.long$matCoords.row[k], delta.long$matCoords.col[k]] <- delta.long$xsi[k]
  }
  delta.mat
}
```

```
}
```

fitgraph

Item Fit Graphs

Description

This function creates a graphical summary of the item fit information.

Usage

```
## Default S3 method:
fitgraph(fitEst, fitLB, fitUB, itemLabels, mainTitle = "Fit Plot",
pch = 18, fitColours = c("gray70", "gray60", "gray50", "gray40", "gray0"),
xlab = "Items", cex = 1.25, ...)
## S3 method for class 'numeric'
fitgraph(fitEst, fitLB, fitUB, itemLabels, mainTitle = "Fit Plot",
pch = 18, fitColours = c("gray70", "gray60", "gray50", "gray40", "gray0"),
xlab = "Items", cex = 1.25, ...)
## S3 method for class 'CQmodel'
fitgraph(fitEst, table = NULL, fit.type = "W", itemLabels = NULL, ...)
## S3 method for class 'character'
fitgraph(fitEst, ...)
```

Arguments

fitgraph arguments:

fitEst	vector of item fit estimates. Could also be a CQmodel object or name of a ConQuest show file.
fitLB	vector of lower bounds for critical intervals for each item.
fitUB	vector of upper bounds for critical intervals for each item.
itemLabels	vector of item labels.
mainTitle	string containing the title of the plot.
pch	number or vector indicating the type of symbols to be used for each item.
fitColours	Color that will be used to shade the critical interval area.
xlab	Label of the x-axis. The default is 'items'.
cex	Size of the x-axis label.
...	Additional parameters.

Argument to use when passing a CQmodel object:

table	Name of the RMP table that for which the fit will be plotted. By default fitgraph will plot the first RMP table of the CQmodel object, this argument overrides this default.
-------	--

`fit.type` Type of fit estimate that will be used, it can be W for Weighted Fit (i.e. Infit, the default), or U for Unweighted Fit (i.e. Outfit). Called `type` in previous versions; use of that parameter is deprecated to avoid collision with the `type` parameter in the `link{plot}` function.

Author(s)

David Torres Irribarra and Rebecca Freund.

References

Wilson, M. (2005). Constructing measures: An item response modeling approach.

Examples

```
# Generating mock data
sampleLabels <- paste('item',1:10)

fitBounds <- (abs(rnorm(10, mean = 0, sd = .05)) * 2)
fitEst <- rnorm(10, mean = 1, sd = .1)

fitLB <- 1 - fitBounds
fitUB <- 1 + fitBounds
par("mar")
# running fitgraph
fitgraph(fitEst,fitLB,fitUB,itemLabels=sampleLabels)

#From ConQuest output:

fpath <- system.file("extdata", package="WrightMap")

fitgraph(file.path(fpath,"ex2.shw"))
```

ICCfit

Empirical item characteristic curve plot for the Rasch Model~

Description

The `ICCfit` function is intended for contrasting a Rasch model's expected item characteristic curve against the empirical data from dichotomous responses. The `ICCfit` function displays a confidence interval for the model based curve and plots the confidence interval for the empirical proportions.

Usage

```
ICCfit(itemNumber, observedResponses, personEstimates,
       itemParameters, xlim = c(-4, 4), method = "Quantile", NQtiles = 10)
```

Arguments

<code>itemNumber</code>	The position of the item in the test. This position is used to select the column of observed responses and the item difficulty among the item parameters.
<code>observedResponses</code>	Data frame or matrix with observed responses. The data frame or matrix should be of size $N * I$, where N is the number of respondents and I is the number of items in the model.
<code>personEstimates</code>	A vector of length N containing the model based person estimates or predictions.
<code>itemParameters</code>	A data frame or matrix of dimensions $I * 2$ containing the model based item difficulty estimates in the first column and the parameter standard error in the second column.
<code>xlim</code>	Vector with two values indicating the minimum and maximum values to be used when plotting the item characteristic curve.
<code>method</code>	Selects the method used to group the respondents: Quantile (default), ByPersonEstimate, and Histogram (see 'Details').
<code>NQtiles</code>	When using the Quantile method this value controls how many grouping will be used: 4 groups cases groups respondents by quartiles, 5 by quintiles, 10 by deciles, etc.

Details

The function uses the item difficulty parameter to generate the model based curve and the item difficulty parameter standard error to plot a confidence interval around the curve. The observed responses are then grouped using the selected method in order to contrast the model predicted response probability with the observed proportion. By default the function uses deciles to generate the respondent groups. The function allows the method `ByPersonEstimate` in order to make a different group for each observed person estimate (potentially useful when analyzing test data with large numbers with no missing data), and the `Histogram` method, which uses the Freedman-Diaconis algorithm to select the width of the bands used for grouping.

Author(s)

David Torres Irribarra

See Also

[CCCfit](#)

Examples

```
# Simulate 1000 persons and 5 items with 2 levels (Rasch model)
set.seed(123)
simulated_data <- sim.PCM(pN = 1000, iN = 5, lN = 2)

# Extract simulated item responses and abilities
observed_responses <- simulated_data$resp - 1
person_abilities <- simulated_data$theta
```

```

item_params <- cbind(simulated_data$delta[,2],rep(0.08),5)
# Defining a 0.08 of error for the item parameters,
# this usually would be estimated.

# Plot the ICC for the first item using the Quantile method
ICCfit(itemNumber = 1,
      observedResponses = observed_responses,
      personEstimates = person_abilities,
      itemParameters = item_params,
      method = "Quantile",
      NQtiles = 10)

```

item.person.data

Processing CQmodel objects for plotting

Description

The `itemData` and `personData` functions take `CQmodel` objects (or ConQuest output files) as inputs and return a vector or matrix. They were originally developed for use by [wrightMap](#), but are separated out here to allow the outputs to be sent to other plotting functions.

Usage

```

itemData(thresholds, ...)
## Default S3 method:
itemData(thresholds, item.type = "deltas",...)
## S3 method for class 'character'
itemData(thresholds, p.type = NULL, equation = NULL, ...)
## S3 method for class 'CQmodel'
itemData(thresholds, item.table = NULL, interactions = NULL,
step.table = NULL, item.type = "default", throld = 0.5, ...)

personData(thetas,...)
## Default S3 method:
personData(thetas,...)
## S3 method for class 'character'
personData(thetas, p.type = NULL,...)
## S3 method for class 'CQmodel'
personData(thetas,...)

```

Arguments

`itemData` arguments:

thresholds	Usually, a CQmodel object or the name of a ConQuest show file. Will also accept a matrix, but this is only really for use within other functions. In general make.thresholds should be used instead.
item.type	Indicates whether to use thresholds or deltas.
equation	string giving the model equation, if the Summary of Estimation table was not included in the show file.
item.table	Name of RMP table to use for the main effect of the item parameters.
interactions	Name of RMP interaction table to use in addition to item.table.
step.table	Name of RMP table to use in addition to item.table.
throid	The probability level to be used for calculating thresholds.
...	Additional parameters to pass to make.thresholds .

personData arguments:

thetas	a CQModel object or the name of the Conquest person parameters file (EAPs, MLEs, etc.)
p.type	Type of person parameter estimate (EAP, MLE or WLE).

Details

The itemData and personData functions are usually called by [wrightMap](#). They can also be called directly.

For the itemData function, note that the item.table, interactions, and step.table parameters must be the exact name of specific RMP tables. You cannot specify an interactions table or a step table without also specifying an item table (although JUST an item table is fine). If your model equation is more complicated, you will have to either use a GIN table or specify in the function call which tables to use for what. A model of the form item + item * step + booklet, for example, will not run unless there is a GIN table or you have defined at least the item.table.

Value

The itemData functions return a vector of item parameters, or a matrix in which the rows are items and the columns are steps. The personData functions return a vector of person parameters, or a matrix in which the rows are persons and the columns are dimensions.

Author(s)

Rebecca Freund and David Torres Irribarra

See Also

[item.side](#) [person.side](#) [make.thresholds](#) [make.deltas](#) [wrightMap](#)

Examples

```
#As a call from wrightMap:

fpath <- system.file("extdata", package="WrightMap")

model1 <- CQmodel(file.path(fpath,"ex2a.eap"), file.path(fpath,"ex2a.shw"))
# Making thresholds if there are no GIN tables (partial credit model)
wrightMap(model1, type = "thresholds")

#Complex model:

model2 <- CQmodel(file.path(fpath,"ex4a.mle"), file.path(fpath,"ex4a.shw"))
wrightMap(model2, item.table = "rater")
wrightMap(model2, item.table = "rater", interactions = "rater*topic",
  step.table = "topic")

# Plotting item results

fpath <- system.file("extdata", package="WrightMap")
model3 <- CQmodel(file.path(fpath,"ex2a.eap"), file.path(fpath,"ex2a.shw"))
m3.item <- itemData(model3)

dev.new(width=10, height=10)

#control of oma allows us to give more space to longer item names
itemModern(m3.item, label.items.srt= 90, oma = c(2,0,0,2))
itemClassic(m3.item)
itemHist(m3.item)

m3.person <- personData(model3)
personHist(m3.person)
personDens(m3.person)
```

item.side

Wright Map Item Sides

Description

Draw the item side of a Wright Map in a variety of styles. Intended to be primarily called by [wrightMap](#), but also available for use on their own.

Usage

```
itemModern(thr, yRange = NULL, axis.items = "Items", show.thr.sym = TRUE
, thr.sym.cex = 0.8, thr.sym.lwd = 1, thr.sym.pch = 23
, thr.sym.col.fg = rgb(0, 0, 0, 0.3), thr.sym.col.bg = rgb(0, 0, 0, 0.3)
, show.thr.lab = TRUE, thr.lab.pos = c(2, 4), thr.lab.text = NULL
```

```
, thr.lab.col = "black", thr.lab.cex = 0.5, thr.lab.font = 2, label.items.rows = 1
, label.items.srt = 0, label.items = NULL, label.items.cex = 0.6
, label.items.ticks = TRUE, axis.logits = "Logits", show.axis.logits = "R"
, axis.logits.cex = 0.7, oma = c(0, 0, 0, 3), cutpoints = NULL
, vertLines = FALSE, vertLines.par = list(), cutpoints.par = list()
, thr.sym.par = list(), thr.lab.par = list(), label.items.par = list()
, axis.logits.par = list(), logits.text.par = list(), ...)

itemClassic(thr, yRange = NULL, axis.items = "Items", axis.logits = "Logits"
, show.axis.logits = "R", axis.logits.cex = 0.7, oma = c(0, 0, 0, 3)
, cutpoints = NULL, cutpoints.par = list(), label.items = NULL, label.steps = NULL
, label.sep = ".", thr.lab.sep = " | ", thr.lab.par = list(), axis.logits.par = list()
, logits.text.par = list(), pad.char = "_", font.family = "mono", ...)

itemHist(thr, yRange = NULL, axis.items = "Items", axis.logits = "Logits"
, show.axis.logits = "R", axis.logits.cex = 0.7, oma = c(0, 0, 0, 3)
, cutpoints = NULL, axis.logits.par = list(), logits.text.par = list()
, cutpoints.par = list(), ...)
```

Arguments

General arguments:

thr	A vector or matrix of threshold parameters. If a matrix, items should be in rows and steps in columns.
yRange	A vector with 2 elements specifying the lower and upper limits of the plot's y-axis.
label.items	A vector of strings representing the item labels used in itemModern and itemClassic
axis.items	The title of the x-axis.
axis.logits	The title of the y-axis.
axis.logits.cex	The size of the logit values on the y-axis.
show.axis.logits	If set to "R" or "L", draws a logit axis on the right or left. Will also draw an axis on the right if the value is TRUE. If any other value, the axis is not drawn.
oma	Values to use for the oma parameter (see par).
cutpoints	Values at which to draw horizontal lines (see cutLines).
label.items.par	A list of parameters to further customize item labels.
axis.logits.par	A list of parameters for customizing the logit axis.
logits.text.par	A list of parameters for customizing the logit axis text.
...	Additional arguments passed to cutLines .

Specific to itemModern:

<code>show.thr.sym</code>	Logical. If TRUE (default), the plot will show symbols for the item thresholds.
<code>thr.sym.cex</code>	An integer, vector, or matrix of numerical values indicating the magnification of the threshold symbols.
<code>thr.sym.lwd</code>	An integer, vector, or matrix of positive numbers specifying the width of the lines used in the threshold symbols.
<code>thr.sym.pch</code>	An integer, vector, or matrix specifying a symbol or single character used to represent item thresholds.
<code>thr.sym.col.fg</code>	An integer, vector, or matrix of numerical values indicating the foreground color for the threshold symbols.
<code>thr.sym.col.bg</code>	An integer, vector, or matrix of numerical values indicating the background color for the threshold symbols.
<code>show.thr.lab</code>	Logical. If TRUE (default), the plot will show labels for the item thresholds.
<code>thr.lab.pos</code>	An integer, vector, or matrix indicating the position for displaying the threshold labels. Values 1, 2, 3, and 4 indicate below, left, above, and right, respectively.
<code>thr.lab.text</code>	A matrix containing the text labels for the item thresholds, where each row represents an item, and each column represents a level.
<code>thr.lab.col</code>	A matrix specifying the color for each threshold label.
<code>thr.lab.cex</code>	A numerical value indicating the magnification factor for the threshold labels.
<code>thr.lab.font</code>	An integer or matrix specifying the font type for the threshold labels. 1 = plain, 2 = bold, 3 = italic, 4 = bold italic.
<code>label.items.rows</code>	An integer specifying the number of rows used to display the item labels (default: 1). Useful when item labels overlap.
<code>label.items.srt</code>	Angle of rotation for item labels. Only applicable if <code>label.items.rows</code> is set to 1.
<code>label.items.cex</code>	A numerical value specifying the magnification factor for the item labels.
<code>label.items.ticks</code>	Logical. If TRUE (default), ticks are drawn on the x-axis for the item side.
<code>vertLines</code>	Logical. If TRUE, vertical lines are drawn to mark all symbols associated with an item.
<code>vertLines.par</code>	A list of parameters (e.g., <code>col</code> , <code>lwd</code> , <code>lty</code>) to control the appearance of the vertical lines.
<code>cutpoints.par</code>	A list of parameters (e.g., <code>col</code> , <code>lwd</code> , <code>lty</code>) to customize the cutpoint lines.
<code>thr.sym.par</code>	A list of parameters to further customize threshold symbols.
<code>thr.lab.par</code>	A list of parameters to further customize threshold labels.
Specific to <code>itemClassic</code> :	
<code>label.steps</code>	A vector specifying the labels for the threshold steps.
<code>label.sep</code>	A string indicating the separator used between item labels and step labels.
<code>thr.lab.sep</code>	A string indicating the separator used between threshold labels for different items.
<code>pad.char</code>	A character used to pad item labels to a fixed width.
<code>font.family</code>	A string specifying the font family for the item labels (default: <code>mono</code>).

Details

These functions are designed as helper functions for `wrightMap` to draw the item side of a map. When called outside of that function, they can be used to create more customized maps. Possible uses include:

- Draw an item map on its own.
- Compare two item maps in a single figure.
- Draw a Wright Map with the item side on the left and the person side on the right.

Note

When combining with a `person.side` function, note that those functions use `split.screen`, which are incompatible with `layout` and some other plotting functions. Ensure that all graphs on a single plot have their `yRange` explicitly specified to maintain comparable values across plots.

Author(s)

Rebecca Freund and David Torres Irribarra

See Also

`wrightMap`, `person.side`, `itemData`

Examples

```
#As a call from wrightMap:

## Mock results
uni.proficiency <- rnorm(1000, mean = -0.5, sd = 1)

items.loc <- sort(rnorm(20))
thresholds <- data.frame(
  l1 = items.loc - 0.5,
  l2 = items.loc - 0.25,
  l3 = items.loc + 0.25,
  l4 = items.loc + 0.5
)

## Setting up labels, colors, and symbols
thresholds.labels <- data.frame(
  l1 = paste('Lev', rep(1, 20), sep = ''),
  l2 = paste('Lev', rep(2, 20), sep = ''),
  l3 = paste('Lev', rep(3, 20), sep = ''),
  l4 = paste('Lev', rep(4, 20), sep = '')
)

thresholds.colors <- data.frame(
  l1 = rep('green', 20),
  l2 = rep('red', 20),
  l3 = rep('yellow', 20),
  l4 = rep('blue', 20)
```

```

)

thresholds.symbols <- data.frame(
  l1 = rep(15, 20),
  l2 = rep(16, 20),
  l3 = rep(17, 20),
  l4 = rep(18, 20)
)

wrightMap(uni.proficiency, thresholds,
  thr.lab.text = thresholds.labels,
  thr.lab.col = as.vector(as.matrix(thresholds.colors)),
  thr.sym.pch = thresholds.symbols
)

# Direct call:

## Plotting results of a unidimensional Rating Scale Model
items.loc <- sort(rnorm(20))
thresholds <- data.frame(
  l1 = items.loc - 0.5,
  l2 = items.loc - 0.25,
  l3 = items.loc + 0.25,
  l4 = items.loc + 0.5
)

itemModern(thresholds)
itemClassic(thresholds)
itemHist(thresholds)

```

make.deltas

Calculate Master's Delta parameters.

Description

This function takes as its input a CQmodel object or the name of a ConQuest show file. It adds together the parameters as specified by the user, or if no tables are specified it reads the model equation to determine the appropriate tables to sum. This function is used by wrightMap to draw the item side of the map when a CQmodel is passed to wrightMap.

Usage

```

make.deltas(item.params, ...)
## S3 method for class 'character'
make.deltas(item.params, ...)
## S3 method for class 'CQmodel'
make.deltas(item.params, item.table = NULL, interactions = NULL,
  step.table = NULL, item.sign = NULL, inter.sign = NULL,
  step.sign = NULL, ...)

```

```
## Default S3 method:
make.deltas(item.params, cross.params = 0, step.params = 0,
item.sign = 1, step.sign = 1, inter.sign = 1, ...)
```

Arguments

<code>item.params</code>	The item parameters. Can either be a vector, a CQmodel object, or a path to a ConQuest show file
<code>item.table</code>	If <code>item.params</code> is a CQmodel object or a path to a ConQuest show file, <code>item.table</code> is the name of the items table. Commonly "item" but can be any string representing the name of a table in the ConQuest show file. This identifies what variable will form the rows of the delta matrix. If not specified, will be the first variable mentioned in the model equation.
<code>interactions</code>	If <code>item.params</code> is a CQmodel object or a path to a ConQuest show file, <code>item.table</code> is the name of the table with the interactions (if present). Commonly "item*step" but can be any string containing "*" that is the name of a table in the ConQuest show file. Should be the product of the <code>item.table</code> variable and the <code>step.table</code> variable (if present). If not specified, will be the product term of the model equation.
<code>step.table</code>	If <code>item.params</code> is a CQmodel object or a path to a ConQuest show file, <code>step.table</code> is the name of the steps table (if present). Commonly "step" but can be any string representing the name of a table in the ConQuest show file. This identifies what variable will form the columns of the delta matrix. If not specified, will be the second variable mentioned in the model equation.
<code>item.sign</code>	Can be 1 or -1. Indicates whether the item parameters should be added or subtracted.
<code>inter.sign</code>	Can be 1 or -1. Indicates whether the interaction parameters should be added or subtracted.
<code>step.sign</code>	Can be 1 or -1. Indicates whether the step parameters should be added or subtracted.
<code>cross.params</code>	If <code>item.params</code> is a vector, use this parameter to pass a matrix of interaction parameters.
<code>step.params</code>	If <code>item.params</code> is a vector, use this parameter to pass a matrix of step parameters.
<code>...</code>	Additional parameters

Details

This function reshapes the tables in the ConQuest show file and adds the step parameters to the appropriate items. The vector version of this is rarely called by the user.

Value

A matrix in which each row is an item and each column is a step

Author(s)

Rebecca Freund & David Torres Irribarra

See Also

[make.thresholds CQmodel wrightMap](#)

Examples

```
fpath <- system.file("extdata", package="WrightMap")

# Partial credit model
model1 <- CQmodel(file.path(fpath,"ex2a.eap"), file.path(fpath,"ex2a.shw"))
make.deltas(model1)

# Rating scale model
model2 <- CQmodel(file.path(fpath,"ex2b.eap"), file.path(fpath,"ex2b-2.shw"))
make.deltas(model2)

# Raters, criteria, topics
model3 <- CQmodel(file.path(fpath,"ex4a.mle"), file.path(fpath,"ex4a.shw"))
make.deltas(model3, item.table = "rater")
make.deltas(model3, item.table = "rater", interactions = "rater*topic", step.table = "topic")
```

make.thresholds

Calculate Thurstonian thresholds.

Description

This function accepts a matrix of delta parameters and converts them to thresholds (using a threshold of .5). It can also take as input a CQmodel object or a filename of a ConQuest show file.

Usage

```
make.thresholds(item.params, ...)
## S3 method for class 'character'
make.thresholds(item.params, design.matrix = "normal",...)
## S3 method for class 'CQmodel'
make.thresholds(item.params,item.table = NULL, interactions = NULL
,step.table = NULL, design.matrix = "normal", throld = 0.5, alpha = 1,...)
## Default S3 method:
make.thresholds(item.params, design.matrix = "normal"
, make.from = "deltas", theta.interval = c(-10, 10), throld = 0.5, alpha = 1
, c.params = 0,...)
## S3 method for class 'matrix'
make.thresholds(item.params, design.matrix = "normal"
, make.from = "deltas", theta.interval = c(-10, 10), throld = 0.5
, alpha = 1, c.params = 0,...)
```

Arguments

<code>item.params</code>	The item parameters. Can either be a matrix, a CQmodel object, or a path to a ConQuest show file
<code>design.matrix</code>	Can be "normal" or "ConQuest". Note that for a CQmodel object or ConQuest file, should be normal, NOT ConQuest.
<code>make.from</code>	Specifies whether the item.params matrix contains threshold or delta parameters.
<code>item.table</code>	If item.params is a CQmodel object or a path to a ConQuest show file, item.table is the name of the items table. Commonly "item" but can be any string representing the name of a table in the ConQuest show file. This identifies what variable will form the rows of the thresholds matrix. If not specified, will be the first variable mentioned in the model equation.
<code>interactions</code>	If item.params is a CQmodel object or a path to a ConQuest show file, item.table is the name of the table with the interactions (if present). Commonly "item*step" but can be any string containing "*" that is the name of a table in the ConQuest show file. Should be the product of the item.table variable and the step.table variable (if present). If not specified, will be the product term of the model equation.
<code>step.table</code>	If item.params is a CQmodel object or a path to a ConQuest show file, step.table is the name of the steps table (if present). Commonly "step" but can be any string representing the name of a table in the ConQuest show file. This identifies what variable will form the columns of the thresholds matrix. If not specified, will be the second variable mentioned in the model equation.
<code>theta.interval</code>	If item.params is a matrix, theta.interval specifies over what interval to search for the parameters.
<code>throlld</code>	The probability level to use for calculating the thresholds.
<code>alpha</code>	A vector or single value for the slope parameter or parameters.
<code>c.params</code>	A vector or single value for the guessing parameter or parameters.
<code>...</code>	Additional parameters.

Value

A matrix of threshold parameters.

Author(s)

Daniel Coulter Furr, Rebecca Freund, & David Torres Irribarra

See Also

[make.deltas](#) [itemData](#) [CQmodel](#) [wrightMap](#)

Examples

```
fpath <- system.file("extdata", package="WrightMap")
# Partial credit model
```

```

model1 <- CQmodel(file.path(fpath,"ex2a.eap"), file.path(fpath,"ex2a.shw"))
deltas <- make.deltas(model1)
make.thresholds(deltas)
make.thresholds(model1)

```

person.side

Wright Map person sides

Description

Draw the person side of a Wright Map in a variety of styles. Intended to be primarily called by [wrightMap](#), but also available for use on their own.

Usage

```

personHist(thetas, yRange = NULL, breaks = "FD", dim.lab.cex = 0.6, dim.lab.side = 3
, dim.lab.adj = 0.5, dim.names = NULL, dim.color = "white", person.points = NULL
, person.range = NULL, p.point.col = "gray45", p.range.col = "gray75"
, axis.persons = "Respondents", show.axis.persons = FALSE
, axis.persons.par = list(), oma = c(0, 5, 0, 5), axis.logits = "Logits"
, show.axis.logits = TRUE,...)

```

```

personDens(thetas, yRange = NULL, dim.lab.cex = 0.6, dim.lab.side = 3, dim.lab.adj = 0.5
, dim.names = NULL, dim.color = "black", person.points = NULL, person.range = NULL
, p.point.col = "black", p.range.col = "gray70", oma = c(0, 5, 0, 5)
, axis.logits = "Logits", show.axis.logits = TRUE
, axis.persons = "Respondents",...)

```

Arguments

thetas	vector or matrix of person parameters. If a matrix, persons should be the rows and dimensions the columns.
yRange	vector with 2 elements specifying the lower and upper limits of the plot's y-axis.
dim.lab.cex	An integer specifying the amount the dimension labels should be magnified relative to the default.
dim.lab.side	An integer specifying which side to plot the dimension names. Values of 1, 2, 3 (default), and 4, respectively, indicate positions below, to the left of, above, and to the right of the person distributions.
dim.lab.adj	A numerical value adjusting the position of the dimension names.
dim.names	A string or a vector of strings containing the names of each dimension.
dim.color	A numerical value or vector indicating the colors to be used for representing each dimension.
person.points	A vector of individual values to highlight.

person.range	A pair of values, an even-length vector, or a matrix with two rows. Values indicate the start and endpoints of ranges to highlight. If a matrix, the first row should be lower bounds and the second row upper bounds of the ranges. If a vector, the values should alternate: (lower1, upper1, lower2, upper2, ...).
p.point.col	A string or vector of strings indicating the color to use for the highlighted points.
p.range.col	A string or vector of strings indicating the color to use for the highlighted ranges.
axis.persons	The title of the y-axis on the left side.
show.axis.persons	Logical indicating whether to show the persons axis on the left side. Default is FALSE.
axis.persons.par	A list of parameters to customize the appearance of the persons axis. This can include options such as <code>cex.axis</code> , <code>las</code> , and others as supported by the axis function.
oma	Values to use for the oma parameter (see par).
show.axis.logits	Logical indicating whether to show the logit axis.
axis.logits	The title of the y-axis on the right side.
...	Additional arguments passed to other methods (e.g., cutLines).
For personHist:	
breaks	A parameter passed to the hist function to define the binning of the histogram.

Details

These functions are designed as helper functions for [wrightMap](#) and [ppPlot](#) to draw the person side of a map. When called outside of those functions, they can be used to create more customized maps. Possible uses include:

- Drawing a person map on its own
- Comparing two person maps in a single figure
- Drawing a Wright Map with the item side on the left and the person side on the right

The `personHist` style, the default, draws the person distribution as a histogram. The `personDens` style draws a density plot.

The `person.points`, `person.range`, `p.point.col`, and `p.range.col` parameters can highlight specific values or ranges, either when called directly or via [ppPlot](#).

Author(s)

Rebecca Freund and David Torres Irribarra

See Also

[item.side](#) [personData](#) [wrightMap](#) [ppPlot](#)

Examples

```
# Creating a Wright Map with item side on the left

multi.proficiency <- data.frame(
  d1 = rnorm(1000, mean = -0.5, sd = 1),
  d2 = rnorm(1000, mean = 0.0, sd = 1),
  d3 = rnorm(1000, mean = +0.5, sd = 1))

items.loc <- sort( rnorm( 20))
thresholds <- data.frame(
  l1 = items.loc - 0.5 ,
  l2 = items.loc - 0.25,
  l3 = items.loc + 0.25,
  l4 = items.loc + 0.5)

# split.screen: Set up a split screen with the left side 80 percent of the screen
# yRange = c(-3,4): Set the yRange to be the same for both sides
# axis.logits.side = "L": Move the item logit axis to the left
# oma = c(0,0,0,2): Adjust the spacing between the graphs
# mtext("Wright Map", side = 3, font = 2, line = 1): add a title
# screen(2): Start drawing on the second screen

split.screen(figs = matrix(c(0,.8,0,1,.8,1,0,1),ncol = 4, byrow = TRUE))
itemModern(thresholds, yRange = c(-3,4), show.axis.logits = "L", oma = c(0,0,0,2))
mtext("Wright Map", side = 3, font = 2, line = 1)
screen(2)
personHist(multi.proficiency, axis.persons = "", yRange = c(-3,4)
, axis.logits = "Persons", show.axis.logits = FALSE)

## Creating a multidimensional Wright Map with each dimension separate

## Mock results

d1 = rnorm(1000, mean = -0.5, sd = 1)
d2 = rnorm(1000, mean = 0.0, sd = 1)

dim1.diff <- rnorm(5)
dim2.diff <- rnorm(5)

split.screen(figs = matrix(c(0,.1,0,1, .12,.6,0,1, .5,.6,0,1, .5,1,0,1)
,ncol = 4,byrow = TRUE))

personDens(d1, yRange = c(-3,3), show.axis.logits = FALSE, axis.logits = "")
screen(2)
itemModern(dim1.diff, yRange = c(-3,3), show.axis.logits = FALSE)
mtext("Wright Map", side = 3, font = 2, line = 1)
screen(3)
personDens(d2, yRange = c(-3,3), show.axis.logits = FALSE
, axis.logits = "", axis.persons = "", dim.names = "Dim2")
screen(4)
itemModern(dim2.diff, yRange = c(-3,3), show.axis.logits = FALSE
```

```
, label.items = paste("Item", 6:10))
```

plotCI

Plotting confidence intervals and DIF

Description

The plotCI function is intended for graphing confidence intervals. The difplot function is a wrapper for plotCI specifically intended for examining Differential Item Functioning from ConQuest output.

Usage

```
plotCI(ests, errors, labels = "", zeroline = TRUE, incol = "gray", outcol = "blue"
, main.title = "Statistical Significance Plot", axes = FALSE, xlab = "", pch = 16, ...)
## Default S3 method:
difplot(data, grouptype = NULL, group = NULL, item.names = NULL
, ylim = c(-1, 1), ylab = NULL, ...)
## S3 method for class 'CQmodel'
difplot(data, table.name = NULL, grouptype = NULL
, group = NULL, ...)
## S3 method for class 'character'
difplot(data, equation, ...)
```

Arguments

plotCI parameters:

ests	vector of point estimates.
errors	vector of standard errors.
labels	vector of labels for the items.
zeroline	logical indicating whether to draw a line at zero.
incol	color of intervals containing zero.
outcol	color of intervals not containing zero.
main.title	title of the plot.
axes, xlab, pch	parameters passed to plot .

difplot parameters:

data	A CQmodel object or the name of a ConQuest show file. Can also be a table of parameters taken from ConQuest output.
table.name	The RMP table to use for parameters. Should be an interactions table.
grouptype	The name of the demographic variable (e.g. "gender").
group	The name of the group to test for DIF (e.g. "male").

<code>item.names</code>	vector of item names.
<code>equation</code>	string specifying the model equation, if the Summary of Estimation table was not included in the show file.
<code>ylim, ylab</code>	more parameters passed to <code>plot</code> .
<code>...</code>	additional parameters to pass to <code>plot</code> .

Details

The `plotCI` function takes point estimates and standard errors as inputs and plots 95 percent confidence intervals in relation to a zero-line. By default, it colors the intervals gray if they include zero, and blue if they do not. The `difplot` function is a wrapper for `plotCI` specifically intended for examining Differential Item Functioning from ConQuest output and expects tables formatted exactly like ConQuest output to work correctly. For plotting DIF from other statistical packages, it is recommended to use `plotCI` directly.

Author(s)

David Torres Irribarra and Rebecca Freund

Examples

```
#Plotting confidence intervals

ests <- rnorm(10,sd = .5)
errors <- runif(10,min = .1,max = .5)
plotCI(ests,errors,ylim = c(-3,3))

#DIF plot:

fpath <- system.file("extdata", package="WrightMap")

# equation must be specified because there is no summary of estimation
# table in this example
difplot(file.path(fpath,"ex6a.shw"), equation = "item-gender+item*gender")
```

ppPlot

Person probability plots

Description

Plots a Wright Map for a single person (similar to a kidmap). On the person side, highlights their estimated ability and a range of one standard error. On the item side, draws lines representing item difficulties at which they are expected to have a 20%, 40%, 50%, 60%, and 80% chance of success.

Usage

```
ppPlot(thetas, thresholds, est, SE, main.title = "Person Probability Plot"
, cut.left = 0, cut.right = .94, cut.lab.adj = c(1,.5),...)

cutLines(cutpoints = NULL, cut.left = 0, cut.right = 1, cut.lab.text = NULL
, cut.lab.adj = c(0,1),...)
```

Arguments

thetas	a vector, matrix or data frame of person parameter estimates. Can also be a character string specifying a ConQuest output file of person parameter estimates, or a CQmodel object. Will be sent to the function personData .
thresholds	matrix or data frame of item parameter estimates. Can also be a character string specifying a ConQuest show file. Will be sent to the function itemData .
est	estimated ability of the person
SE	standard error of the estimate
main.title	title of the Person Probability Plot.
cut.left	value between 0 and 1 describing where to place the lefthand side of the cutpoints, as a fraction of the item plot.
cut.right	value between 0 and 1 describing where to place the righthand side of the cutpoints, as a fraction of the item plot.
cut.lab.adj	similar to the adj parameter in text , describes where to place the text for the cutpoints as a pair of values between 0 and 1 in terms of left-right and up-down alignment. Left-right alignment is 0 for the left side of the item plot and 1 for the right side, while up-down alignment is 0 for below the line and 1 for above the line.
cutpoints	argument to cutLines when called through wrightMap or one of the item.side functions. Specifies locations of cutlines. When cutLines is called through ppPlot, the cutpoints are calculated rather than specified.
cut.lab.text	argument to cutLines when called through wrightMap or one of the item.side functions. Specifies text to appear for each cut line. When cutLines is called through ppPlot, the text is always the percent chance of success given the estimated ability level and difficulty location.
...	additional arguments to pass to wrightMap or its associated functions.

Details

The ppPlot function is a wrapper for [wrightMap](#) that is specifically designed for person probability plots, and as such has access to all the parameters of wrightMap and its associated functions. It uses the person.points, person.range, p.point.col, and p.range.col parameters on the [person.side](#) function to draw a range of one standard error around the estimated ability level. On the item side, it calculates at what item difficulty the respondent is expected to have a 20%, 40%, 50%, 60%, and 80% chance of success and then uses the cutLines function to illustrate these cutpoints. The cutLines function should not be called on its own and may be hidden in future versions. It is included here to show the available parameters, which can be included in a call to wrightMap or any of the item.side functions.

Author(s)

David Torres Irribarra and Rebecca Freund

See Also

[wrightMap](#)

Examples

```
fpath <- system.file("extdata", package="WrightMap")
model1 <- CQmodel(p.est = file.path(fpath,"ex2.eap"), show = file.path(fpath,"ex2.shw"))

#Person histogram, modern item
ppPlot(model1,est = 0, SE = 1)

#Person density, classic item
ppPlot(model1,est = 0, SE = 1, person.side = personDens,item.side = itemClassic)
```

sim.PCM	<i>Simulate Item Responses for Partial Credit and Rasch Models with Varying Levels</i>
---------	--

Description

Simulate polytomous item responses based on item difficulty thresholds (`delta`) and person abilities (`theta`) for the Partial Credit Model (PCM) and the Rasch Model as a special case. The function allows items to have varying numbers of levels, making it useful for generating data in contexts such as item response theory (IRT) models for polytomous items (e.g., Likert scales).

Usage

```
sim.PCM(pN, iN, lN, itemLevels = NULL, delta = NULL, delta.l = NULL, theta = NULL)
```

Arguments

<code>pN</code>	integer. The number of people (respondents) to simulate.
<code>iN</code>	integer. The number of items in the test or survey.
<code>lN</code>	integer. The default number of levels (categories) for each polytomous item. Must be greater than or equal to 2. This is used if <code>itemLevels</code> is not provided.
<code>itemLevels</code>	integer vector. An optional vector specifying the number of levels for each item. If provided, the length must equal <code>iN</code> . If not provided, all items are assumed to have <code>lN</code> levels.
<code>delta</code>	matrix. An optional matrix of item thresholds with dimensions <code>iN</code> by the maximum number of levels in <code>itemLevels</code> . If not provided, the function will generate thresholds internally. The first column must contain zeros or the function will automatically prepend a column of zeros. If provided as a vector, it will be converted into a single-column matrix.

<code>delta.l</code>	numeric vector. An optional vector of common level thresholds (with length $1N - 1$). This vector represents the difficulty of each level. If not provided, the function will generate it.
<code>theta</code>	numeric vector. An optional vector of person abilities. If not provided, abilities will be drawn from a standard normal distribution (mean = 0, sd = 1).

Details

This function generates polytomous item responses using a logistic IRT model. It first creates or uses given person abilities (`theta`) and item thresholds (`delta`). Responses are simulated by computing the probability of a person responding in each category of an item based on their ability and the item's threshold. The function allows for items to have different numbers of response categories through the `itemLevels` argument.

Value

A list with the following components:

<code>pN</code>	The number of people (respondents).
<code>iN</code>	The number of items.
<code>1N</code>	The default number of levels (categories) for the polytomous items.
<code>itemLevels</code>	A vector specifying the number of levels for each item.
<code>M</code>	A list of <code>iN</code> matrices containing logits (differences between person ability and item threshold) for each person and item.
<code>CM</code>	A list of <code>iN</code> matrices containing cumulative probabilities for each person and item.
<code>U</code>	A <code>pN</code> by <code>iN</code> matrix of uniform random values used to generate the responses.
<code>theta</code>	A numeric vector of person abilities.
<code>delta.l</code>	(Optional) A vector of common level thresholds if it was generated internally.
<code>delta.il</code>	(Optional) A matrix of item-specific deviations for thresholds if <code>delta.l</code> was generated internally.
<code>delta</code>	A matrix of item thresholds.
<code>resp</code>	A <code>pN</code> by <code>iN</code> matrix of simulated responses. Each entry corresponds to the level chosen by the person for the respective item.

Author(s)

David Torres Irribarra

See Also

[runif](#), [rnorm](#)

Examples

```
# Simulate 100 respondents, 5 items, and 3 levels (e.g., Likert scale with 3 options)
simulated_data <- sim.PCM(pN = 100, iN = 5, lN = 3)

# Simulate with custom item thresholds
custom_delta <- matrix(c(-0.5, -1, -2, 1, 0.5, 1), nrow = 3)
simulated_data_custom <- sim.PCM(pN = 50, iN = 3, lN = 3, delta = custom_delta)

# Simulate with custom person abilities
custom_theta <- rnorm(100, mean = 0, sd = 1.5)
simulated_data_theta <- sim.PCM(pN = 100, iN = 5, lN = 3, theta = custom_theta)

# Rasch model simulation (dichotomous items)
# 50 persons with abilities ranging from -3 to 3
rasch_theta <- seq(-3, 3, length.out = 50)
rasch_delta <- matrix(c(0,1.5,0,-1,0,0.5,0,-0.5,0,1,0,-1.5,0,2,0,-2,0,0.8,0,-0.8)
, ncol = 2, byrow = TRUE)
simulated_rasch <- sim.PCM(pN = 50, iN = 10, lN = 2, delta = rasch_delta, theta = rasch_theta)

# Simulation with items having different numbers of levels
# 4 items with 5 levels, 3 items with dichotomous responses, and 3 items with 3 levels
# Simulate with a total of 10 items and varying levels
simulated_mixed_levels <- sim.PCM(pN = 50, iN = 10, lN = 5,
itemLevels = c(5, 5, 5, 5, 2, 2, 2, 3, 3, 3))
```

WrightMap

Wright Map: IRT Item-Person Map

Description

This package allows the easy generation of ‘Wright Maps’ (named after Ben Wright), also known as item-person maps to display unidimensional and multidimensional assessment results. These maps represent simultaneously the proficiency distribution of respondents and the item difficulty parameters as estimated by a model of the Rasch Family. The package contains several other functions for graphing common IRT statistics.

Additionally, the package contains the CQmodel function, which reads output files created using ConQuest software and creates a set of data frames for easy data manipulation, bundled in a CQmodel object. The wrightMap function can take a CQmodel object as input or it can be used to create Wright Maps directly from data frames of person and item parameters.

Details

```
Package: WrightMap
Type: Package
Version: 1.0
Date: 2014-03-02
License: BSD_3_clause | LICENSE
```

The `wrightMap` function relies on two main inputs: (a) `thetas`: a vector or matrix of respondent proficiencies, and (b) `thresholds`: a vector or matrix of item thresholds. In the simplest case, say for a unidimensional Rasch model, `thetas` can be a vector of person proficiencies and `thresholds` a vector of item difficulties.

To plot multiple dimensions of person proficiency, simply provide them as a matrix where the results for each dimension is stored in a different column, such that for a 3-dimensional model with 1,000 persons, `theta` is a matrix of 1000 rows and 3 columns.

To plot polytomous items, the thresholds for each level must be passed to the functions through the `thresholds` matrix, where each row represents an item and each column represents a level. For instance, if the results of a Rating Scale model with 5 response categories and 10 items is being plotted, the `thresholds` matrix will have 10 rows and 4 columns (column one represents the thresholds between the 1 and 2 response category, column 2 the threshold between categories 2 and 3, etc.).

Alternatively, `wrightMap` can read directly the `.shw` and `.eap/.mle/.wle` output files from a Conquest analysis, and will automatically generate the `thetas` and `thresholds` matrices.

Author(s)

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References

Andrich, D. (1978). A rating formulation for ordered response categories. *Psychometrika*, 43(4), 561–573. Masters, G. N. (1982). A Rasch model for partial credit scoring. *Psychometrika*, 47(2), 149–174. Wilson, M. (2005). Constructing measures: An item response modeling approach. Wright, B. D., & Stone, M. H. (1979). *Best test design*. Chicago: Mesa Press.

Examples

```
# Plotting results of a unidimensional Rasch Model

## Mock results
uni.proficiency <- rnorm(1000, mean = -0.5, sd = 1)
difficulties <- sort( rnorm( 20))

## Default map
wrightMap( uni.proficiency, difficulties)

## Density version
wrightMap( uni.proficiency, difficulties, person.side = personDens)

# Plotting results of a multidimensional Rasch Model

## Mock results
multi.proficiency <- data.frame(
  d1 = rnorm(1000, mean = -0.5, sd = 1),
```

```

d2 = rnorm(1000, mean = 0.0, sd = 1),
d3 = rnorm(1000, mean = +0.5, sd = 1))

difficulties <- sort( rnorm( 20))

dev.new(width=10, height=10)
wrightMap( multi.proficiency, difficulties)

# Plotting results of a unidimensional Rating Scale Model

## Mock results
uni.proficiency <- rnorm(1000, mean = -0.5, sd = 1)

items.loc <- sort( rnorm( 20))
thresholds <- data.frame(
  l1 = items.loc - 0.5,
  l2 = items.loc - 0.25,
  l3 = items.loc + 0.25,
  l4 = items.loc + 0.5)

dev.new(width=10, height=10)
wrightMap( uni.proficiency, thresholds)

## Setting up labels, colors and symbols

thresholds.labels <- data.frame(
  l1 = paste('Lev',rep(1,20),sep = ''),
  l2 = paste('Lev',rep(2,20),sep = ''),
  l3 = paste('Lev',rep(3,20),sep = ''),
  l4 = paste('Lev',rep(4,20),sep = ''))

thresholds.colors <- data.frame(
  l1 = rep( 'green',20),
  l2 = rep( 'red',20),
  l3 = rep( 'yellow',20),
  l4 = rep( 'blue',20))

thresholds.symbols <- data.frame(
  l1 = rep( 15,20),
  l2 = rep( 16,20),
  l3 = rep( 17,20),
  l4 = rep( 18,20))

dev.new(width=10, height=10)
wrightMap( uni.proficiency, thresholds
, thr.lab.text = thresholds.labels
, thr.lab.col = as.vector(as.matrix(thresholds.colors))
, thr.sym.pch = thresholds.symbols
)

```

wrightMap

wrightMap: item-person maps

Description

This function allows the easy generation of ‘Wright Maps’ (named after Ben Wright), also known as item-person maps. They are used to display unidimensional and multidimensional assessment results. These maps represent simultaneously the proficiency distribution of respondents and the item difficulty parameters as estimated by a model of the Rasch family.

Usage

```
wrightMap(thetas, thresholds = NULL, item.side = itemModern, person.side = personHist
, main.title = "Wright Map", min.logit.pad = 0.25, max.logit.pad = 0.25, min.l = NULL
, max.l = NULL, item.prop = 0.8, return.thresholds = TRUE, new.quartz = FALSE
, use.hist = NULL,...)
## S3 method for class 'CQmodel'
plot(x, ...)
```

Arguments

The parameters documented here do not include many of the options included in the Wright Map family of functions. For graphical parameters, see [item.side](#) and [person.side](#). For data handling, see [item.person.data](#) and [CQmodel](#).

wrightMap parameters:

thetas	a vector, matrix or data frame of person parameter estimates. Can also be a character string specifying a ConQuest output file of person parameter estimates, or a CQmodel object. Will be sent to the function personData .
thresholds	matrix or data frame of item parameter estimates. Can also be a character string specifying a ConQuest show file. Will be sent to the function itemData .
item.side	function to use to draw the item side of the map. Currently included options are itemModern (default), itemClassic (for ConQuest-style Wright Maps) and itemHist. See item.side for details.
person.side	function to use to draw the person side of the map. Currently included options are personHist (default), to draw the person distribution as a histogram, and personDens, which draws a density plot. See person.side for details.
main.title	title of the Wright Map.
min.logit.pad	numeric value indicating how much of the lower end of the logit scale should be included in the plot.
max.logit.pad	numeric value indicating how much of the upper end of the logit scale should be included in the plot.
min.l	numeric value for fixing the lower end of the logit scale. It overrides the automatic detection of the range and the min.logit.pad correction.

<code>max.l</code>	numeric value for fixing the upper end of the logit scale. It overrides the automatic detection of the range and the <code>max.logit.pad</code> correction.
<code>item.prop</code>	numeric value greater than 0 and smaller than 1 indicating the proportion of the plot to be allocated to the item part of the Wright Map.
<code>return.thresholds</code>	logical. Determines whether to return or not the numeric values used to position the parameters on the item side of the Wright Map. Enabled by default.
<code>new.quartz</code>	logical. Determines whether the <code>wrightMap</code> will be created on a new graphical device or if it will reuse one already open. By default is set to FALSE to avoid creating new devices.
<code>use.hist</code>	deprecated. Use the <code>person.side</code> parameter instead
<code>...</code>	Additional arguments to pass to <code>personData</code> , <code>itemData</code> , <code>person.side</code> , or <code>item.side</code>

`wrightMap` can also be called by passing a CQmodel object to plot:

<code>x</code>	CQmodel object to pass to plot
----------------	--------------------------------

Author(s)

David Torres Irribarra and Rebecca Freund

References

Wilson, M. (2005). Constructing measures: An item response modeling approach. Wright, B. D., & Stone, M. H. (1979). *Best test design*. Chicago: Mesa Press.

See Also

[person.side](#) [item.side](#) [personData](#) [itemData](#)

Examples

```
# Plotting results of a unidimensional Rasch Model

## Mock results
uni.proficiency <- rnorm(1000, mean = -0.5, sd = 1)
difficulties <- sort( rnorm( 20))

## Default map
wrightMap( uni.proficiency, difficulties)

## Density version
wrightMap( uni.proficiency, difficulties, person.side = personDens)

# Plotting results of a multidimensional Rasch Model

## Mock results
multi.proficiency <- data.frame(
  d1 = rnorm(1000, mean = -0.5, sd = 1),
```

```

    d2 = rnorm(1000, mean = 0.0, sd = 1),
    d3 = rnorm(1000, mean = +0.5, sd = 1))

difficulties <- sort( rnorm( 20))

dev.new(width=10, height=10)
wrightMap( multi.proficiency, difficulties)

# Plotting results of a unidimensional Rating Scale Model

## Mock results
uni.proficiency <- rnorm(1000, mean = -0.5, sd = 1)

items.loc <- sort( rnorm( 20))
thresholds <- data.frame(
  l1 = items.loc - 0.5 ,
  l2 = items.loc - 0.25,
  l3 = items.loc + 0.25,
  l4 = items.loc + 0.5)

wrightMap( uni.proficiency, thresholds)

####ConQuest integration####

fpath <- system.file("extdata", package="WrightMap")

#Partial credit model:

model1 <- CQmodel(p.est = file.path(fpath,"ex2.eap"), show = file.path(fpath,"ex2.shw"))
wrightMap(model1)

# Rating scale model:
model2 <- CQmodel(file.path(fpath,"ex2b.eap"), file.path(fpath,"ex2b-2.shw"))
wrightMap(model2, label.items.row = 2)

# Complex model
model3 <- CQmodel(file.path(fpath,"ex4a.mle"), file.path(fpath,"ex4a.shw"))
wrightMap(model3, min.logit.pad = -29, person.side = personDens)

### Skip CQmodel
wrightMap(file.path(fpath,"ex2a.eap"), file.path(fpath,"ex2a.shw"),
  label.items.row = 3)

```

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