

Package ‘meta’

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Title Meta-Analysis with R

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Depends R (>= 2.9.1), grid

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Description Fixed and random effects meta-analysis. Functions for tests of bias, forest and funnel plot.

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addvar	<i>Additional functions for objects of class meta</i>
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Description

The `as.data.frame` method returns a data frame containing information on individual studies, e.g., estimated treatment effect and its standard error. The function `addvar` can be used to add a single variable to an object of class `meta` which for example is useful to conduct sub-group analysis or meta-regression.

Usage

```
## S3 method for class 'meta':
as.data.frame(x, row.names=NULL, optional=FALSE, ...)

addvar(x, y, varname, by.x="studlab", by.y=by.x)
```

Arguments

<code>x</code>	An object of class <code>meta</code> .
<code>row.names</code>	NULL or a character vector giving the row names for the data frame.
<code>optional</code>	logical. If TRUE, setting row names and converting column names (to syntactic names) is optional.
<code>y</code>	A data frame with an additional covariate
<code>varname</code>	A character specifying name of additional variable
<code>by.x</code> , <code>by.y</code>	Specifications of the common columns (see <code>merge</code>)
<code>...</code>	other arguments

Value

A data frame is returned by the function `as.data.frame`.

A single covariate is returned by the function `addvar` which can be added to an object of class `meta`. Internally, the `merge` function is utilised.

Author(s)

Guido Schwarzer <sc@imbi.uni-freiburg.de>

See Also

[metabin](#), [metacont](#), [metagen](#)

Examples

```
data(Fleiss93cont)
metal <- metacont(n.e, mean.e, sd.e, n.c, mean.c, sd.c, study,
                 data=Fleiss93cont, sm="SMD")
#
# Generate additional variable
#
Fleiss93cont$group <- c(1,2,1,1,2)
#
# Generate new variable by merging
# object 'metal' and data frame 'Fleiss93cont'
#
metal$group <- addvar(metal, Fleiss93cont, "group", by.y="study")
as.data.frame(metal)
summary(metal, byvar=group)
```

ci

Calculation of confidence intervals (normal approximation)

Description

Calculation of confidence intervals; based on normal approximation.

Usage

```
ci(TE, seTE, level=0.95)
```

Arguments

TE	Estimated treatment effect.
seTE	Standard error of treatment estimate.
level	The confidence level required.

Value

List with components

TE	Estimated treatment effect.
seTE	Standard error of treatment estimate.
lower	Lower confidence limits.

upper	Upper confidence limits.
zscore	Test statistic.
p	P-value of test with null hypothesis $T_E=0$.
level	The confidence level required.

Note

This function is primarily called from other functions of the library `meta`, e.g. `plot.meta`, `summary.meta`.

Author(s)

Guido Schwarzer <sc@imbi.uni-freiburg.de>

Examples

```
as.data.frame(ci(170, 10))
as.data.frame(ci(170, 10, 0.99))
```

Fleiss93

Aspirin after Myocardial Infarction

Description

Meta-analysis on Aspirin in Preventing Death after Myocardial Infarction

Usage

```
data(Fleiss93)
```

Format

A data frame with the following columns:

study study label
year year of publication
event.e number of events in experimental group
n.e number of observations in experimental group
event.c number of events in control group
n.c number of observations in control group

Source

Fleiss JL (1993), The statistical basis of meta-analysis. *Statistical Methods in Medical Research*, **2**, 121–145.

Examples

```
data(Fleiss93)
metabin(event.e, n.e, event.c, n.c,
        data=Fleiss93,
        studlab=paste(study, year),
        sm="OR", comb.random=FALSE)
```

Fleiss93cont	<i>Mental Health Treatment</i>
--------------	--------------------------------

Description

Meta-analysis on the Effect of Mental Health Treatment on Medical Utilisation

Usage

```
data(Fleiss93cont)
```

Format

A data frame with the following columns:

study study label
year year of publication
n.e number of observations in experimental group
mean.e estimated mean in experimental group
sd.e standard deviation in experimental group
n.c number of observations in control group
mean.c estimated mean in control group
sd.c standard deviation in control group

Source

Fleiss JL (1993), The statistical basis of meta-analysis. *Statistical Methods in Medical Research*, **2**, 121–145.

See Also

[Fleiss93](#)

Examples

```
data(Fleiss93cont)
metacont(n.e, mean.e, sd.e,
        n.c, mean.c, sd.c,
        data=Fleiss93cont,
        studlab=paste(study, year),
        comb.random=FALSE)
```

forest

*Forest plot (new plot function for objects of class meta)***Description**

Draws a forest plot in the active graphics window (using grid graphics system).

Usage

```
forest(x, byvar=x$byvar, bylab=x$bylab,
       print.byvar=x$print.byvar, sortvar, studlab=TRUE,
       level=x$level, level.comb=x$level.comb,
       comb.fixed=x$comb.fixed, comb.random=x$comb.random,
       overall=TRUE,
       text.fixed="Fixed effect model", text.random="Random effects model",
       lty.fixed=2, lty.random=3, xlab=NULL, xlab.pos=ref, xlim,
       allstudies=TRUE,
       weight,
       ref=ifelse(x$sm %in% c("RR", "OR", "HR"), 1, 0),
       leftcols=NULL, rightcols=NULL,
       leftlabs=NULL, rightlabs=NULL,
       lab.e=x$label.e, lab.c=x$label.c,
       lab.e.attach.to.col=NULL, lab.c.attach.to.col=NULL,
       lwd=1,
       at=NULL, label=TRUE,
       fontsize=12, boxsize=0.8,
       plotwidth=unit(6, "cm"), colgap=unit(2, "mm"),
       col.i="black", col.by="darkgray", digits=2)
```

Arguments

<code>x</code>	An object of class <code>meta</code> .
<code>byvar</code>	An optional vector containing grouping information (must be of same length as <code>x\$TE</code>). Parameter <code>byvar</code> can not be used if <code>x</code> is an object of class <code>metacum</code> or <code>metainf</code> .
<code>bylab</code>	A character string with a label for the grouping variable.
<code>print.byvar</code>	A logical indicating whether the name of the grouping variable should be printed in front of the group labels.
<code>sortvar</code>	An optional vector used to sort the individual studies (must be of same length as <code>x\$TE</code>).
<code>studlab</code>	A logical indicating whether study labels should be printed in the graph. A vector with study labels can also be provided (must be of same length as <code>x\$TE</code> then).
<code>level</code>	The level used to calculate confidence intervals for individual studies.
<code>level.comb</code>	The level used to calculate confidence intervals for pooled estimates.

<code>comb.fixed</code>	A logical indicating whether fixed effect estimate should be plotted.
<code>comb.random</code>	A logical indicating whether random effects estimate should be plotted.
<code>overall</code>	A logical indicating whether overall summaries should be plotted. This parameter is useful in combination with the parameter <code>byvar</code> if summaries should only be plotted on group level.
<code>text.fixed</code>	A character string used in the plot to label the pooled fixed effect estimate.
<code>text.random</code>	A character string used in the plot to label the pooled random effects estimate.
<code>lty.fixed</code>	Line type (pooled fixed effect estimate).
<code>lty.random</code>	Line type (pooled random effects estimate).
<code>xlab</code>	A label for the x axis.
<code>xlab.pos</code>	A numeric specifying the center of the label on the x axis.
<code>xlim</code>	The x limits (min,max) of the plot.
<code>allstudies</code>	A logical indicating whether studies with inestimable treatment effects should be plotted.
<code>weight</code>	A character string indicating which type of plotting symbols is to be used for individual treatment estimates. One of missing (see Details), "same", "fixed", or "random", can be abbreviated. Plot symbols have the same size for all studies or represent study weights from fixed effect or random effects model.
<code>ref</code>	A numerical giving the reference value to be plotted as a line in the forest plot. No reference line is plotted if parameter <code>ref</code> is equal to NA.
<code>leftcols</code>	A character vector specifying (additional) columns to be plotted on the left side of the forest plot (see Details).
<code>rightcols</code>	A character vector specifying (additional) columns to be plotted on the right side of the forest plot (see Details).
<code>leftlabs</code>	A character vector specifying labels for (additional) columns on left side of the forest plot (see Details).
<code>rightlabs</code>	A character vector specifying labels for (additional) columns on right side of the forest plot (see Details).
<code>lab.e</code>	Label to be used for experimental group in table heading.
<code>lab.c</code>	Label to be used for control group in table heading.
<code>lab.e.attach.to.col</code>	A character specifying the column name where label <code>lab.e</code> should be attached to in table heading.
<code>lab.c.attach.to.col</code>	A character specifying the column name where label <code>lab.c</code> should be attached to in table heading.
<code>lwd</code>	The line width, see <code>par</code> .
<code>at</code>	The points at which tick-marks are to be drawn, see <code>grid.xaxis</code> .
<code>label</code>	A logical value indicating whether to draw the labels on the tick marks, or an expression or character vector which specify the labels to use. See <code>grid.xaxis</code> .
<code>fontsize</code>	The size of text (in points), see <code>gpar</code> .

<code>boxsize</code>	A numeric used to increase or decrease the size of boxes in the forest plot.
<code>plotwidth</code>	A unit object specifying width of the forest plot.
<code>colgap</code>	A unit object specifying gap between columns printed on left and right side of forest plot.
<code>col.i</code>	The colour for individual study results and confidence limits.
<code>col.by</code>	A character specifying colour to print information on subgroups.
<code>digits</code>	Minimal number of significant digits, see <code>print.default</code> .

Details

A forest plot, also called confidence interval plot, is drawn in the active graphics window. Sub-group analyses are conducted and displayed in the plot if `byvar` is not missing.

The `forest` function is based on the grid graphics system. Therefore, to plot a new figure in an existing graphics window, one has to use the `grid.newpage` function. In order to print the forest plot, (i) resize the graphics window, (ii) either use `dev.copy2eps` or `dev.copy2pdf`. For basic forest plots, the `plot.meta` function can be used.

Information from object `x` is utilised if argument `weight` is missing. Weights from the fixed effect model are used (`weight="fixed"`) if parameter `x$comb.fixed` is TRUE; weights from the random effects model are used (`weight="random"`) if parameter `x$comb.random` is TRUE and `x$comb.fixed` is FALSE.

The parameters `leftcols` and `rightcols` can be used to specify columns which are plotted on the left and right side of the forest plot, respectively. If these parameters are NULL, the following default columns will be plotted.

Parameter `rightcols`: (i) estimated treatment effect with level-confidence interval, (ii) in addition, weights of the fixed and/or random effects model will be given, if `comb.fixed=TRUE` and/or `comb.random=TRUE`. For an object of class `metacum` or `metainf` only the estimated treatment effect with level-confidence interval are plotted.

Parameter `leftcols`: (i) `leftcols=c("studlab", "event.e", "n.e", "event.c", "n.c")` for an object of class `metabin`, (ii) `leftcols=c("studlab", "n.e", "mean.e", "sd.e", "n.c", "mean.c", "sd.c")` for an object of class `metacont`, (iii) `leftcols=c("studlab", "TE", "seTE")` for an object of class `metagen`, (iv) `leftcols=c("studlab", "event", "n")` for an object of class `metaprop`, (v) `leftcols=c("studlab")` for an object of class `metacum` or `metainf`.

The parameters `leftlabs` and `rightlabs` can be used to specify column headings which are plotted on left and right side of the forest plot, respectively. For certain columns predefined labels exist. If the parameters `leftlabs` and `rightlabs` are NULL, the following default labels will be used: for columns `c("studlab", "TE", "seTE", "n.e", "n.c", "event.e", "event.c", "mean.e", "mean.c", "sd.e", "sd.c", "effect", "ci", "w.fixed", "w.random")` the labels `c("Study", "TE", "seTE", "Total", "Total", "Events", "Events", "Mean", "Mean", "SD", "SD", summary measure, level for confidence interval, "W(fixed)", "W(random)")`. For additional columns the column name will be used as label. It is possible to only provide labels for new columns (see Examples).

If parameters `lab.e` and `lab.c` are NULL, "Experimental" and "Control" are used as labels for experimental and control group, respectively.

For subgroups (argument `byvar` not `NULL`), results for the fixed effect model will be plotted if both arguments `comb.fixed` and `comb.random` are `TRUE`. In order to plot results for the random effects model within subgroups, use `comb.fixed==FALSE` and `comb.random==TRUE`.

Review Manager 5 (RevMan 5) is the current software used for preparing and maintaining Cochrane Reviews (<http://www.cc-ims.net/revman/>). In RevMan 5, subgroup analyses can be defined and data from a Cochrane review can be imported to R using the function `read.rm5`. If a meta-analysis is then conducted using function `metacr`, information on subgroups is available in R (components `byvar`, `bylab`, and `print.byvar`, `byvar` in an object of class "meta"). Accordingly, by using function `metacr` there is no need to define subgroups in order to redo the statistical analysis conducted in the Cochrane review.

Author(s)

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See Also

[plot.meta](#), [metabin](#), [metacont](#), [metagen](#)

Examples

```
data(Olkin95)
metal <- metabin(event.e, n.e, event.c, n.c,
                 data=Olkin95, subset=c(41,47,51,59),
                 sm="RR", meth="I",
                 studlab=paste(author, year))

grid.newpage()
##
## Do forest plot
##
forest(metal, comb.fixed=TRUE, comb.random=TRUE)

grid.newpage()
##
## Change set of columns printed on left side
## of forest plot
##
forest(metal, comb.fixed=TRUE, comb.random=FALSE,
       leftcols="studlab")

grid.newpage()
##
## 1. Change order of columns on left side
## 2. Attach labels to columns 'event.e' and 'event.c'
##    instead of columns 'n.e' and 'n.c'
##
forest(metal,
```

```

      leftcols=c("studlab", "n.e", "event.e", "n.c", "event.c"),
      lab.e.attach.to.col="event.e",
      lab.c.attach.to.col="event.c",
      comb.fixed=TRUE)

Olkin95$studlab <- paste(Olkin95$author, Olkin95$year)
##
## Add variables 'year' and 'author' to meta-analysis object
##
metal$year <- addvar(metal, Olkin95, "year")
metal$author <- addvar(metal, Olkin95, "author")

grid.newpage()
##
## Specify column labels only for newly created variables
## 'year' and 'author'
##
forest(metal,
      leftcols=c("studlab", "event.e", "n.e", "event.c", "n.c",
                 "author", "year"),
      leftlabs=c("Author", "Year of Publ"),
      comb.fixed=TRUE)

```

funnel

Generic function to produce a funnel plot.

Description

Draw a funnel or radial plot to assess funnel plot asymmetry in the active graphics window. A contour-enhanced funnel plot can be produced for assessing causes of funnel plot asymmetry.

Usage

```
funnel(x, y, ...)
```

Arguments

<code>x</code>	An object of class <code>meta</code> , or estimated treatment effect in individual studies.
<code>y</code>	Standard error of estimated treatment effect (mandatory if <code>x</code> not of class <code>meta</code>).
<code>...</code>	Graphical parameters as in <code>par</code> may also be passed as arguments.

Details

For simple funnel plots, `funnel.default` will be used. For an object of class `meta` the function `funnel.meta` will be used instead.

A funnel plot or radial plot, also called Galbraith plot, is drawn in the active graphics window. If `comb.fixed` is `TRUE`, the pooled estimate of the fixed effect model is plotted. If `level` is not `NULL`, the corresponding confidence limits are drawn.

In the funnel plot, if `yaxis` is "se", the standard error of the treatment estimates is plotted on the y axis which is likely to be the best choice (Sterne & Egger, 2001). Other possible choices for `yaxis` are "invvar" (inverse of the variance), "invse" (inverse of the standard error), and "size" (study size).

For `yaxis!="size"`, contour-enhanced funnel plots can be produced (Peters et al., 2008) by specifying the contour levels (argument `contour.levels`). By default (argument `col.contour` missing), suitable gray levels will be used to distinguish the contours. Different colours can be chosen by argument `col.contour`.

Author(s)

Guido Schwarzer <sc@imbi.uni-freiburg.de>, Petra Graham <pgraham@efs.mq.edu.au>

References

- Galbraith RF (1988a), Graphical display of estimates having differing standard errors. *Technometrics*, **30**, 271–281.
- Galbraith RF (1988b), A note on graphical presentation of estimated odds ratios from several clinical trials. *Statistics in Medicine*, **7**, 889–894.
- Light RJ & Pillemer DB (1984), *Summing Up. The Science of Reviewing Research*. Cambridge: Harvard University Press.
- Peters JL, Sutton AJ, Jones DR, Abrams KR, Rushton L (2008), Contour-enhanced meta-analysis funnel plots help distinguish publication bias from other causes of asymmetry. *Journal of Clinical Epidemiology*, **61**, 991–996.
- Sterne JAC & Egger M (2001), Funnel plots for detecting bias in meta-analysis: Guidelines on choice of axis. *Journal of Clinical Epidemiology*, **54**, 1046–1055.

See Also

[metabias](#), [funnel.default](#), [funnel.meta](#)

Examples

```
data(Olkin95)
meta1 <- metabin(event.e, n.e, event.c, n.c,
                 data=Olkin95, subset=c(41,47,51,59),
                 studlab=paste(author, year),
                 sm="RR", meth="I")

oldpar <- par(mfrow=c(2, 2))

##
## Funnel plots
##
funnel(meta1)
##
## Same result as code above:
##
```

```

funnel(metal$TE, metal$seTE, sm="RR")

##
## Funnel plot with confidence intervals,
## fixed effect estimate and contours
##
cc <- funnel(metal, comb.fixed=TRUE,
             level=0.95, contour=c(0.9, 0.95, 0.99))$col.contour
legend(0.05, 0.05,
      c("0.1 > p > 0.05", "0.05 > p > 0.01", "< 0.01"), fill=cc)
##
## Contour-enhanced funnel plot with user-chosen colours
##
funnel(metal, comb.fixed=TRUE,
      level=0.95, contour=c(0.9, 0.95, 0.99),
      col.contour=c("darkgreen", "green", "lightgreen"),
      lwd=2, cex=2, pch=16, studlab=TRUE, cex.studlab=1.25)
legend(0.05, 0.05,
      c("0.1 > p > 0.05", "0.05 > p > 0.01", "< 0.01"),
      fill=c("darkgreen", "green", "lightgreen"))

par(oldpar)

```

funnel.meta

Plot to assess funnel plot asymmetry

Description

Draw a funnel or radial plot to assess funnel plot asymmetry in the active graphics window.

A contour-enhanced funnel plot can be produced for assessing causes of funnel plot asymmetry.

Usage

```

## Default S3 method:
funnel(x, y,
      xlim=NULL, ylim=NULL, xlab=NULL, ylab=NULL,
      comb.fixed=FALSE, comb.random=FALSE,
      axes=TRUE,
      pch=21, text=NULL, cex=1,
      lty.fixed=2, lty.random=9,
      lwd=1, lwd.fixed=lwd, lwd.random=lwd,
      col="black", bg="darkgray",
      col.fixed="black", col.random="black",
      log="", yaxis="se", sm=NULL,
      contour.levels=NULL, col.contour,
      ref=ifelse(sm %in% c("RR", "OR", "HR"), 1, 0),
      level=NULL,
      studlab=FALSE, cex.studlab=0.8,

```

```

... )

## S3 method for class 'meta':
funnel(x, y,
      xlim=NULL, ylim=NULL, xlab=NULL, ylab=NULL,
      comb.fixed=x$comb.fixed, comb.random=x$comb.random,
      axes=TRUE,
      pch=21, text=NULL, cex=1,
      lty.fixed=2, lty.random=9,
      lwd=1, lwd.fixed=lwd, lwd.random=lwd,
      col="black", bg="darkgray",
      col.fixed="black", col.random="black",
      log="", yaxis="se", sm=NULL,
      contour.levels=NULL, col.contour,
      ref=ifelse(x$sm %in% c("RR", "OR", "HR"), 1, 0),
      level=x$level,
      studlab=FALSE, cex.studlab=0.8,
      ...)

radial(x, y, xlim=NULL, ylim=NULL,
      xlab="Inverse of standard error",
      ylab="Standardised treatment effect (z-score)",
      comb.fixed=TRUE, axes=TRUE,
      pch=1, text=NULL, cex=1, col=NULL,
      level=NULL, ...)

```

Arguments

<code>x</code>	An object of class <code>meta</code> , or estimated treatment effect in individual studies.
<code>y</code>	Standard error of estimated treatment effect (mandatory if <code>x</code> not of class <code>meta</code>).
<code>xlim</code>	The x limits (min,max) of the plot.
<code>ylim</code>	The y limits (min,max) of the plot.
<code>xlab</code>	A label for the x axis.
<code>ylab</code>	A label for the y axis.
<code>comb.fixed</code>	A logical indicating whether the pooled fixed effect estimate should be plotted.
<code>comb.random</code>	A logical indicating whether the pooled random effects estimate should be plotted.
<code>axes</code>	A logical indicating whether axes should be drawn on the plot.
<code>pch</code>	The plotting symbol used for individual studies.
<code>text</code>	A character vector specifying the text to be used instead of plotting symbol.
<code>cex</code>	The magnification to be used for plotting symbol.
<code>lty.fixed</code>	Line type (pooled fixed effect estimate).
<code>lty.random</code>	Line type (pooled random effects estimate).
<code>col</code>	A vector with colour of plotting symbols.

<code>bg</code>	A vector with background colour of plotting symbols (only used if <code>pch</code> in 21:25).
<code>col.fixed</code>	Color of line representign fixed effect estimate.
<code>col.random</code>	Color of line representign random effects estimate.
<code>lwd</code>	The line width for confidence intervals (if <code>level</code> is not NULL).
<code>lwd.fixed</code>	The line width for fixed effect estimate (if <code>comb.fixed</code> is not NULL).
<code>lwd.random</code>	The line width for random effects estimate (if <code>comb.random</code> is not NULL).
<code>log</code>	A character string which contains "x" if the x axis is to be logarithmic, "y" if the y axis is to be logarithmic and "xy" or "yx" if both axes are to be logarithmic (applies only to function <code>funnel</code>).
<code>yaxis</code>	A character string indicating which type of weights are to be used. Either "se", "invvar", "invse", or "size" (applies only to function <code>funnel</code>).
<code>sm</code>	A character string indicating underlying summary measure, e.g., "RD", "RR", "OR", "AS", "MD", "SMD" (applies only to function <code>funnel</code>).
<code>contour.levels</code>	A numeric vector specifying contour levels to produce contour-enhanced funnel plot.
<code>col.contour</code>	Colour of contours.
<code>ref</code>	Reference value (null effect) used to produce contour-enhanced funnel plot.
<code>level</code>	The confidence level utilised in the plot. For the funnel plot, confidence limits are not drawn if <code>yaxis="size"</code> .
<code>studlab</code>	A logical indicating whether study labels should be printed in the graph. A vector with study labels can also be provided (must be of same length as <code>x\$TE</code> then).
<code>cex.studlab</code>	Size of study labels.
<code>...</code>	Graphical parameters as in <code>par</code> may also be passed as arguments.

Details

A funnel plot or radial plot, also called Galbraith plot, is drawn in the active graphics window. If `comb.fixed` is TRUE, the pooled estimate of the fixed effect model is plotted. If `level` is not NULL, the corresponding confidence limits are drawn.

In the funnel plot, if `yaxis` is "se", the standard error of the treatment estimates is plotted on the y axis which is likely to be the best choice (Sterne & Egger, 2001). Other possible choices for `yaxis` are "invvar" (inverse of the variance), "invse" (inverse of the standard error), and "size" (study size).

For `yaxis!="size"`, contour-enhanced funnel plots can be produced (Peters et al., 2008) by specifying the contour levels (argument `contour.levels`). By default (argument `col.contour` missing), suitable gray levels will be used to distinguish the contours. Different colours can be chosen by argument `col.contour`.

Author(s)

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References

- Galbraith RF (1988a), Graphical display of estimates having differing standard errors. *Technometrics*, **30**, 271–281.
- Galbraith RF (1988b), A note on graphical presentation of estimated odds ratios from several clinical trials. *Statistics in Medicine*, **7**, 889–894.
- Light RJ & Pillemer DB (1984), *Summing Up. The Science of Reviewing Research*. Cambridge: Harvard University Press.
- Peters JL, Sutton AJ, Jones DR, Abrams KR, Rushton L (2008), Contour-enhanced meta-analysis funnel plots help distinguish publication bias from other causes of asymmetry. *Journal of Clinical Epidemiology*, **61**, 991–996.
- Sterne JAC & Egger M (2001), Funnel plots for detecting bias in meta-analysis: Guidelines on choice of axis. *Journal of Clinical Epidemiology*, **54**, 1046–1055.

See Also

[metabias](#), [metabin](#), [metagen](#)

Examples

```
data(Olkin95)
metal <- metabin(event.e, n.e, event.c, n.c,
                 data=Olkin95, subset=c(41,47,51,59),
                 studlab=paste(author, year),
                 sm="RR", meth="I")

##
## Radial plot
##
radial(metal, level=0.95)

oldpar <- par(mfrow=c(2, 2))

##
## Funnel plots
##
funnel(metal)
##
## Same result as code above:
##
funnel(metal$TE, metal$seTE, sm="RR")

##
## Funnel plot with confidence intervals,
## fixed effect estimate and contours
##
cc <- funnel(metal, comb.fixed=TRUE,
             level=0.95, contour=c(0.9, 0.95, 0.99))$col.contour
legend(0.05, 0.05,
```

```

      c("0.1 > p > 0.05", "0.05 > p > 0.01", "< 0.01"), fill=cc)
##
## Contour-enhanced funnel plot with user-chosen colours
##
funnel(metal, comb.fixed=TRUE,
       level=0.95, contour=c(0.9, 0.95, 0.99),
       col.contour=c("darkgreen", "green", "lightgreen"),
       lwd=2, cex=2, pch=16, studlab=TRUE, cex.studlab=1.25)
legend(0.05, 0.05,
       c("0.1 > p > 0.05", "0.05 > p > 0.01", "< 0.01"),
       fill=c("darkgreen", "green", "lightgreen"))

par(oldpar)

```

labbe

L'Abbe plot

Description

Generic function for drawing a L'Abbe plot.

Usage

```
labbe(x, y, ...)
```

Arguments

x	The x coordinates of points of the L'Abbe plot. Alternatively, an object of class <code>metabin</code> .
y	The y coordinates of the L'Abbe plot, optional if x is an appropriate structure.
...	Parameters used in other L'Abbe plot functions.

Details

Generic function for drawing a L'Abbe plot.

Author(s)

Guido Schwarzer <sc@imbi.uni-freiburg.de>

References

L'Abbe KA, Detsky AS, O'Rourke K (1987), Meta-analysis in clinical research. *Annals of Internal Medicine*, **107**, 224–233.

See Also

[labbe.metabin](#), [metabin](#)

Examples

```

data(Olkin95)
metal <- metabin(event.e, n.e, event.c, n.c,
                 data=Olkin95,
                 studlab=paste(author, year),
                 sm="RR")

##
## L'Abbe plot
##
labbe(metal)

```

labbe.metabin	<i>L'Abbe plot</i>
---------------	--------------------

Description

Draw a L'Abbe plot.

Usage

```

## S3 method for class 'metabin':
labbe(x, y,
      xlim, ylim,
      xlab=NULL, ylab=NULL,
      TE.fixed=x$TE.fixed,
      TE.random=x$TE.random,
      comb.fixed=x$comb.fixed,
      comb.random=x$comb.random,
      axes=TRUE,
      pch=21, text=NULL, cex=1,
      col="black", bg="lightgray",
      lwd=1, lwd.fixed=lwd, lwd.random=lwd,
      lty.fixed=2, lty.random=9,
      sm=x$sm, weight,
      studlab=FALSE, cex.studlab=0.8,
      ...)

## Default S3 method:
labbe(x, y,
      xlim, ylim,
      xlab=NULL, ylab=NULL,
      TE.fixed, TE.random,
      comb.fixed=FALSE, comb.random=FALSE,
      axes=TRUE,
      pch=21, text=NULL, cex=1,

```

```
col="black", bg="lightgray",
lwd=1, lwd.fixed=lwd, lwd.random=lwd,
lty.fixed=2, lty.random=9,
sm=NULL, weight,
studlab=FALSE, cex.studlab=0.8,
...)
```

Arguments

<code>x</code>	The x coordinates of points of the L'Abbe plot. Alternatively, an object of class <code>metabin</code> .
<code>y</code>	The y coordinates of the L'Abbe plot, optional if <code>x</code> is an appropriate structure.
<code>xlim</code>	The x limits (min,max) of the plot.
<code>ylim</code>	The y limits (min,max) of the plot.
<code>xlab</code>	A label for the x axis.
<code>ylab</code>	A label for the y axis.
<code>TE.fixed</code>	A numeric or vector specifying combined fixed effect estimate(s).
<code>TE.random</code>	A numeric or vector specifying combined random effects estimate(s).
<code>comb.fixed</code>	A logical indicating whether the pooled fixed effect estimate should be plotted.
<code>comb.random</code>	A logical indicating whether the pooled random effects estimate should be plotted.
<code>axes</code>	A logical indicating whether axes should be drawn on the plot.
<code>pch</code>	The plotting symbol used for individual studies.
<code>text</code>	A character vector specifying the text to be used instead of plotting symbol.
<code>cex</code>	The magnification to be used for plotting symbol.
<code>col</code>	A vector with colour of plotting symbols.
<code>bg</code>	A vector with background colour of plotting symbols (only used if <code>pch</code> in 21:25).
<code>lwd</code>	The line width.
<code>lwd.fixed</code>	The line width for fixed effect estimate (if <code>comb.fixed</code> is not <code>NULL</code> or <code>FALSE</code>).
<code>lwd.random</code>	The line width for random effects estimate (if <code>comb.random</code> is not <code>NULL</code> or <code>FALSE</code>).
<code>lty.fixed</code>	Line type (pooled fixed effect estimate).
<code>lty.random</code>	Line type (pooled random effects estimate).
<code>sm</code>	A character string indicating underlying summary measure, i.e., "RD", "RR", "OR".
<code>weight</code>	Either a numeric vector specifying relative sizes of plotting symbols or a character string indicating which type of plotting symbols is to be used for individual treatment estimates. One of missing (see Details), "same", "fixed", or "random", can be abbreviated. Plot symbols have the same size for all studies or represent study weights from fixed effect or random effects model.

studlab A logical indicating whether study labels should be printed in the graph. A vector with study labels can also be provided (must be of same length as `x$event.e` then).

cex.studlab Size of study labels.

... Graphical parameters as in `par` may also be passed as arguments.

Details

A L'Abbe plot is drawn in the active graphics window.

If `comb.fixed` is TRUE, the pooled estimate of the fixed effect model is plotted as a line. If `comb.random` is TRUE, the pooled estimate of the random effects model is plotted as a line.

Information from object `x` is utilised if argument `weight` is missing. Weights from the fixed effect model are used (`weight="fixed"`) if parameter `x$comb.fixed` is TRUE; weights from the random effects model are used (`weight="random"`) if parameter `x$comb.random` is TRUE and `x$comb.fixed` is FALSE.

Author(s)

Guido Schwarzer <sc@imbi.uni-freiburg.de>

References

L'Abbe KA, Detsky AS, O'Rourke K (1987), Meta-analysis in clinical research. *Annals of Internal Medicine*, **107**, 224–233.

See Also

[metabin](#)

Examples

```
data(Olkin95)
metal <- metabin(event.e, n.e, event.c, n.c,
                 data=Olkin95,
                 studlab=paste(author, year),
                 sm="RR", meth="I")

##
## L'Abbe plot
##
labbe(metal)
```

metabias

*Test for funnel plot asymmetry***Description**

Test for funnel plot asymmetry, based on rank correlation or linear regression method.

Usage

```
metabias(x, seTE, TE.fixed, seTE.fixed,
         method = "rank",
         plotit = FALSE, correct = FALSE)
```

Arguments

<code>x</code>	An object of class <code>meta</code> or estimated treatment effect in individual studies.
<code>seTE</code>	Standard error of estimated treatment effect (mandatory if <code>x</code> not of class <code>meta</code>).
<code>TE.fixed</code>	Overall treatment estimate (mandatory if <code>x</code> not of class <code>meta</code> and <code>method = "rank"</code>).
<code>seTE.fixed</code>	Standard error of overall treatment estimate (mandatory if <code>x</code> not of class <code>meta</code> and <code>method = "rank"</code>).
<code>method</code>	A character string indicating which test is to be used. Either <code>"rank"</code> , <code>"linreg"</code> , <code>"mm"</code> , <code>"count"</code> , <code>"score"</code> , or <code>"peters"</code> , can be abbreviated.
<code>plotit</code>	A logical indicating whether a plot should be produced for method <code>"rank"</code> , <code>"linreg"</code> , <code>"mm"</code> , or <code>"score"</code> .
<code>correct</code>	A logical indicating whether a continuity corrected statistic is used for rank correlation methods <code>"rank"</code> and <code>"count"</code> .

Details

If `method` is `"rank"`, the test statistic is based on the rank correlation between standardised treatment estimates and variance estimates of estimated treatment effects; Kendall's tau is used as correlation measure (Begg & Mazumdar, 1994). The test statistic follows a standard normal distribution. By default (if `correct` is `FALSE`), no continuity correction is utilised (Kendall & Gibbons, 1990).

If `method` is `"linreg"`, the test statistic is based on a weighted linear regression of the treatment effect on its standard error (Egger et al., 1997). The test statistic follows a t distribution with number of studies - 2 degrees of freedom.

If `method` is `"mm"`, the test statistic is based on a weighted linear regression of the treatment effect on its standard error using the method of moments estimator for the additive between-study variance component (method 3a in Thompson, Sharp, 1999). The test statistic follows a t distribution with number of studies - 2 degrees of freedom.

If `method` is "count", the test statistic is based on the rank correlation between a standardised cell frequency and the inverse of the variance of the cell frequency; Kendall's tau is used as correlation measure (Schwarzer et al., 2007). The test statistic follows a standard normal distribution. By default (if `correct` is FALSE), no continuity correction is utilised (Kendall & Gibbons, 1990).

If `method` is "score", the test statistic is based on a weighted linear regression utilising efficient score and score variance (Harbord et al., 2006). The test statistic follows a t distribution with `number of studies - 2` degrees of freedom.

If `method` is "peters", the test statistic is based on a weighted linear regression of the treatment effect on the inverse of the total sample size using the variance of the average event rate as weights (Peters et al., 2006). The test statistic follows a t distribution with `number of studies - 2` degrees of freedom.

In order to calculate an arcsine test for funnel plot asymmetry (Ruecker et al., 2008), one has to use the `metabin` function with parameter `sm="AS"` as input to the `metabias` command. The three arcsine tests described in Ruecker et al. (2008) can be calculated by setting `method` to "rank", "linreg" and "mm", respectively.

Value

A list with class "htest" containing the following components:

<code>estimate</code>	The estimated degree of funnel plot asymmetry, with name "ks" or "bias" corresponding to the method employed, i.e., rank correlation or regression method.
<code>statistic</code>	The value of the test statistic.
<code>parameter</code>	The degrees of freedom of the test statistic in the case that it follows a t distribution.
<code>p.value</code>	The p-value for the test.
<code>alternative</code>	A character string describing the alternative hypothesis.
<code>method</code>	A character string indicating what type of test was used.
<code>data.name</code>	A character string giving the names of the data.

Author(s)

Guido Schwarzer <sc@imbi.uni-freiburg.de>

References

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- Harbord RM, Egger M & Sterne J (2006), A modified test for small-study effects in meta-analyses of controlled trials with binary endpoints. *Statistics in Medicine*, **25**, 3443–3457.
- Kendall M & Gibbons JD (1990), *Rank Correlation Methods*. London: Edward Arnold.
- Peters JL, Sutton AJ, Jones DR, Abrams KR & Rushton L (2006), Comparison of two methods to detect publication bias in meta-analysis. *Journal of the American Medical Association*, **295**, 676–680.

Ruecker G, Schwarzer G, Carpenter JR (2008) Arcsine test for publication bias in meta-analyses with binary outcomes. *Statistics in Medicine*, **27**,746–763.

Schwarzer G, Antes G & Schumacher M (2007), A test for publication bias in meta-analysis with sparse binary data. *Statistics in Medicine*, **26**, 721–733.

Thompson SG & Sharp, SJ (1999), Explaining heterogeneity in meta-analysis: A comparison of methods, *Statistics in Medicine*, **18**, 2693–2708.

See Also

[funnel](#), [funnel.meta](#), [metabin](#), [metacont](#), [metagen](#)

Examples

```
data(Olkin95)
metal <- metabin(event.e, n.e, event.c, n.c,
                data=Olkin95, subset=c(41,47,51,59),
                sm="RR", meth="I")

metabias(metal)
metabias(metal, correct=TRUE)

metabias(metal, method="linreg")
metabias(metal, method="linreg", plotit=TRUE)

metabias(metal, method="count")

##
## Same result:
##
metabias(metal, method="linreg")$p.value
metabias(metal$TE, metal$seTE, method="linreg")$p.value

##
## Arcsine test:
##
metal.as <- metabin(event.e, n.e, event.c, n.c,
                  data=Olkin95, subset=c(41,47,51,59),
                  sm="AS", meth="I")
metabias(metal.as, method="linreg")
```

Description

Calculation of fixed and random effects estimates (relative risk, odds ratio, risk difference or arcsine difference) for meta-analyses with binary outcome data. Mantel-Haenszel, inverse variance and Peto method are available for pooling.

Usage

```
metabin(event.e, n.e, event.c, n.c, studlab,
        data = NULL, subset = NULL, method = "MH",
        sm = ifelse(!is.na(charmatch(method, c("Peto", "peto"), nomatch = NA)), "OR", "RR"),
        incr = 0.5, allincr = FALSE, addincr = FALSE, allstudies = FALSE,
        MH.exact = FALSE, RR.cochrane = FALSE,
        level = 0.95, level.comb = level,
        comb.fixed=TRUE, comb.random=TRUE,
        title="", complab="", outclab="",
        label.e="Experimental", label.c="Control",
        byvar, bylab, print.byvar=TRUE,
        warn = TRUE)
```

Arguments

<code>event.e</code>	Number of events in experimental group.
<code>n.e</code>	Number of observations in experimental group.
<code>event.c</code>	Number of events in control group.
<code>n.c</code>	Number of observations in control group.
<code>studlab</code>	An optional vector with study labels.
<code>data</code>	An optional data frame containing the study information, i.e., <code>event.e</code> , <code>n.e</code> , <code>event.c</code> , and <code>n.c</code> .
<code>subset</code>	An optional vector specifying a subset of studies to be used.
<code>method</code>	A character string indicating which method is to be used for pooling of studies. One of "Inverse", "MH", or "Peto", can be abbreviated.
<code>sm</code>	A character string indicating which summary measure ("RR", "OR", "RD", or "AS") is to be used for pooling of studies, see Details.
<code>incr</code>	Could be either a numerical value which is added to each cell frequency for studies with a zero cell count or the character string "TA" which stands for treatment arm continuity correction, see Details.
<code>allincr</code>	A logical indicating if <code>incr</code> is added to each cell frequency of all studies if at least one study has a zero cell count. If false, <code>incr</code> is added only to each cell frequency of studies with a zero cell count.
<code>addincr</code>	A logical indicating if <code>incr</code> is added to each cell frequency of all studies irrespective of zero cell counts.
<code>allstudies</code>	A logical indicating if studies with zero or all events in both groups are to be included in the meta-analysis (applies only if <code>sm</code> = "RR" or "OR").

<code>MH.exact</code>	A logical indicating if <code>incr</code> is not to be added to all cell frequencies for studies with a zero cell count to calculate the pooled estimate based on the Mantel-Haenszel method.
<code>RR.cochrane</code>	A logical indicating if <code>2*incr</code> instead of <code>1*incr</code> is to be added to <code>n.e</code> and <code>n.c</code> in the calculation of the relative risk (i.e., <code>sm="RR"</code>) for studies with a zero cell. This is used in RevMan 5, the Cochrane Collaboration's program for preparing and maintaining Cochrane reviews.
<code>level</code>	The level used to calculate confidence intervals for individual studies.
<code>level.comb</code>	The level used to calculate confidence intervals for pooled estimates.
<code>comb.fixed</code>	A logical indicating whether a fixed effect meta-analysis should be conducted.
<code>comb.random</code>	A logical indicating whether a random effects meta-analysis should be conducted.
<code>title</code>	Title of meta-analysis / systematic review.
<code>complab</code>	Comparison label.
<code>outclab</code>	Outcome label.
<code>label.e</code>	Label for experimental group.
<code>label.c</code>	Label for control group.
<code>byvar</code>	An optional vector containing grouping information (must be of same length as <code>event.e</code>).
<code>bylab</code>	A character string with a label for the grouping variable.
<code>print.byvar</code>	A logical indicating whether the name of the grouping variable should be printed in front of the group labels.
<code>warn</code>	A logical indicating whether the addition of <code>incr</code> to studies with zero cell frequencies should result in a warning.

Details

Treatment estimates and standard errors are calculated for each study. The following measures of treatment effect are available: relative risk (if `sm="RR"`), odds ratio (`sm="OR"`), risk difference (`sm="RD"`), and arcsine difference (`sm="AS"`).

For studies with a zero cell count, by default, 0.5 is added to all cell frequencies of these studies; if `incr` is "TA" a treatment arm continuity correction is used instead (Sweeting et al., 2004; Diamond et al., 2007). Treatment estimates and standard errors are only calculated for studies with zero or all events in both groups if `allstudies` is TRUE.

Internally, both fixed effect and random effects models are calculated regardless of values chosen for arguments `comb.fixed` and `comb.random`. Accordingly, the estimate for the random effects model can be extracted from component `TE.random` of an object of class "meta" even if `comb.random=FALSE`. However, all functions in R package `meta` will adequately consider the values for `comb.fixed` and `comb.random`. E.g. function `print.meta` will not print results for the random effects model if `comb.random=FALSE`.

By default, both fixed effect and random effects models are considered (arguments `comb.fixed=TRUE` and `comb.random=TRUE`). If `method` is "MH" (default), the Mantel-Haenszel method is used to calculate the fixed effect estimate; if `method` is "Inverse", inverse variance weighting is used

for pooling; finally, if `method` is "Peto", the Peto method is used for pooling. The DerSimonian-Laird estimate is used in the random effects model. For the Peto method, Peto's log odds ratio, i.e. $(O-E)/V$ and its standard error $\sqrt{1/V}$ with $O-E$ and V denoting "Observed minus Expected" and " V ", are utilised in the random effects model. Accordingly, results of a random effects model using `sm="Peto"` can be (slightly) different to results from a random effects model using `sm="MH"` or `sm="Inverse"`.

For the Mantel-Haenszel method, by default (if `MH.exact` is `FALSE`), 0.5 is added to all cell frequencies of a study with a zero cell count in the calculation of the pooled estimate. This approach is also used in other software, e.g. RevMan 5 and the Stata procedure `metan`. According to Fleiss (in Cooper & Hedges, 1994), there is no need to add 0.5 to a cell frequency of zero to calculate the Mantel-Haenszel estimate and he advocates the exact method (`MH.exact=TRUE`). Note, the estimate based on the exact method is not defined if the number of events is zero in all studies either in the experimental or control group.

Value

An object of class `c("metabin", "meta")` with corresponding `print`, `summary`, `plot` function. The object is a list containing the following components:

```
event.e, n.e, event.c, n.c, studlab,
sm, method, incr, allincr, addincr,
allstudies, MH.exact, RR.cochrane, warn,
level, level.comb, comb.fixed, comb.random,
byvar, bylab, print.byvar
    As defined above.
TE, seTE      Estimated treatment effect and standard error of individual studies.
w.fixed, w.random
    Weight of individual studies (in fixed and random effects model).
TE.fixed, seTE.fixed
    Estimated overall treatment effect and standard error (fixed effect model).
TE.random, seTE.random
    Estimated overall treatment effect and standard error (random effects model).
k            Number of studies combined in meta-analysis.
Q           Heterogeneity statistic Q.
tau         Square-root of between-study variance (moment estimator of DerSimonian-Laird).
Q.CMH      Cochrane-Mantel-Haenszel heterogeneity statistic.
incr.e, incr.c
    Increment added to cells in the experimental and control group, respectively
sparse      Logical flag indicating if any study included in meta-analysis has any zero cell
            frequencies.
call       Function call.
```

Author(s)

Guido Schwarzer <sc@imbi.uni-freiburg.de>

References

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Diamond GA, Bax L, Kaul S (2007), Uncertain Effects of Rosiglitazone on the Risk for Myocardial Infarction and Cardiovascular Death. *Annals of Internal Medicine*, **147**, 578–581.

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Fleiss JL (1993), The statistical basis of meta-analysis. *Statistical Methods in Medical Research*, **2**, 121–145.

Greenland S & Robins JM (1985), Estimation of a common effect parameter from sparse follow-up data. *Biometrics*, **41**, 55–68.

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Sweeting MJ, Sutton AJ, Lambert PC (2004), What to add to nothing? Use and avoidance of continuity corrections in meta-analysis of sparse data. *Statistics in Medicine*, **23**, 1351–1375.

See Also

[funnel](#), [metabias](#), [metacont](#), [metagen](#), [print.meta](#)

Examples

```
metabin(10, 20, 15, 20, sm="OR")

##
## Different results:
##
metabin(0, 10, 0, 10, sm="OR")
metabin(0, 10, 0, 10, sm="OR", allstudies=TRUE)

data(Olkin95)

meta1 <- metabin(event.e, n.e, event.c, n.c,
                 data=Olkin95, subset=c(41,47,51,59),
                 sm="RR", meth="I")
summary(meta1)
funnel(meta1)

meta2 <- metabin(event.e, n.e, event.c, n.c,
                 data=Olkin95, subset=Olkin95$year<1970,
```

```
summary(meta2, sm="RR", meth="I")
```

 metacont

Meta-analysis of continuous outcome data

Description

Calculation of fixed and random effects estimates for meta-analyses with continuous outcome data; inverse variance weighting is used for pooling.

Usage

```
metacont(n.e, mean.e, sd.e, n.c, mean.c, sd.c, studlab,
         data=NULL, subset=NULL, sm="MD",
         level = 0.95, level.comb = level,
         comb.fixed=TRUE, comb.random=TRUE,
         title="", complab="", outclab="",
         label.e="Experimental", label.c="Control",
         byvar, bylab, print.byvar=TRUE)
```

Arguments

n.e	Number of observations in experimental group.
mean.e	Estimated mean in experimental group.
sd.e	Standard deviation in experimental group.
n.c	Number of observations in control group.
mean.c	Estimated mean in control group.
sd.c	Standard deviation in control group.
studlab	An optional vector with study labels.
data	An optional data frame containing the study information.
subset	An optional vector specifying a subset of studies to be used.
level	The level used to calculate confidence intervals for individual studies.
level.comb	The level used to calculate confidence intervals for pooled estimates.
comb.fixed	A logical indicating whether a fixed effect meta-analysis should be conducted.
comb.random	A logical indicating whether a random effects meta-analysis should be conducted.
title	Title of meta-analysis / systematic review.
complab	Comparison label.
outclab	Outcome label.
label.e	Label for experimental group.
label.c	Label for control group.

<code>sm</code>	A character string indicating which summary measure ("MD" or "SMD") is to be used for pooling of studies.
<code>byvar</code>	An optional vector containing grouping information (must be of same length as <code>n.e</code>).
<code>bylab</code>	A character string with a label for the grouping variable.
<code>print.byvar</code>	A logical indicating whether the name of the grouping variable should be printed in front of the group labels.

Details

Calculation of fixed and random effects estimates for meta-analyses with continuous outcome data; inverse variance weighting is used for pooling. The DerSimonian-Laird estimate is used in the random effects model. The mean difference is used as measure of treatment effect if `sm="MD"` – which correspond to `sm="WMD"` in older versions (<0.9) of the meta package. For the summary measure "SMD", Hedges' adjusted *g* is utilised for pooling.

Internally, both fixed effect and random effects models are calculated regardless of values chosen for arguments `comb.fixed` and `comb.random`. Accordingly, the estimate for the random effects model can be extracted from component `TE.random` of an object of class "meta" even if `comb.random=FALSE`. However, all functions in R package meta will adequately consider the values for `comb.fixed` and `comb.random`. E.g. function `print.meta` will not print results for the random effects model if `comb.random=FALSE`.

The function `metagen` is called internally to calculate individual and overall treatment estimates and standard errors.

Value

An object of class `c("metacont", "meta")` with corresponding `print`, `summary`, `plot` function. The object is a list containing the following components:

<code>n.e</code> , <code>mean.e</code> , <code>sd.e</code> ,	
<code>n.c</code> , <code>mean.c</code> , <code>sd.c</code> ,	
<code>studlab</code> , <code>sm</code> , <code>level</code> , <code>level.comb</code> ,	
<code>comb.fixed</code> , <code>comb.random</code> ,	
<code>byvar</code> , <code>bylab</code> , <code>print.byvar</code>	As defined above.
<code>TE</code> , <code>seTE</code>	Estimated treatment effect and standard error of individual studies.
<code>w.fixed</code> , <code>w.random</code>	Weight of individual studies (in fixed and random effects model).
<code>TE.fixed</code> , <code>seTE.fixed</code>	Estimated overall treatment effect and standard error (fixed effect model).
<code>TE.random</code> , <code>seTE.random</code>	Estimated overall treatment effect and standard error (random effects model).
<code>k</code>	Number of studies combined in meta-analysis.

Q	Heterogeneity statistic.
tau	Square-root of between-study variance (moment estimator of DerSimonian-Laird).
method	Pooling method: "Inverse".
call	Function call.

Author(s)

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References

Cooper H & Hedges LV (1994), *The Handbook of Research Synthesis*. Newbury Park, CA: Russell Sage Foundation.

See Also

[metabin](#), [metagen](#)

Examples

```
data(Fleiss93cont)
meta1 <- metacont(n.e, mean.e, sd.e, n.c, mean.c, sd.c, data=Fleiss93cont, sm="SMD")
meta1

meta2 <- metacont(Fleiss93cont$n.e, Fleiss93cont$mean.e,
                  Fleiss93cont$sd.e,
                  Fleiss93cont$n.c, Fleiss93cont$mean.c,
                  Fleiss93cont$sd.c,
                  sm="SMD")
meta2
```

metacr

Meta-analysis of outcome data from Cochrane review

Description

Wrapper function to perform meta-analysis for a single outcome of a Cochrane Intervention review.

Usage

```
metacr(x, comp.no=1, outcome.no=1, smother="", logscale=TRUE)
```

Arguments

<code>x</code>	An object of class <code>rm5</code> created by R function <code>read.rm5</code> .
<code>comp.no</code>	Comparison number.
<code>outcome.no</code>	Outcome number.
<code>smother</code>	A character specifying the summary measure to use instead of the value "OTHER"
<code>logscale</code>	A logical indicating whether treatment effects have been entered on the log scale in RevMan5. Only relevant for an outcome with summary measure equal to "OTHER".

Details

Cochrane Intervention reviews are based on the comparison of two interventions. Each Cochrane Intervention review can have a variable number of comparisons. For each comparison, a variable number of outcomes can be define. For each outcome, a seperate meta-analysis is conducted. Review Manager 5 (RevMan 5) is the current software used for preparing and maintaining Cochrane Reviews (<http://www.cc-ims.net/revman/>).

This wrapper function can be used to perform meta-analysis for a single outcome of a Cochrane Intervention review. Internally, R functions `metabin`, `metacont`, and `metagen` are called - depending on the definition of the outcome in RevMan 5.

Value

An object of class "meta" and "metabin", "metacont", or "metagen" depending on outcome type utilised in Cochrane Intervention review for selected outcome.

Author(s)

Guido Schwarzer <sc@imbi.uni-freiburg.de>

References

Review Manager (RevMan) [Computer program]. Version 5.0, The Nordic Cochrane Centre, The Cochrane Collaboration, 2008.

See Also

[metabin](#), [metacont](#), [metagen](#), [read.rm5](#)

Examples

```
## Locate export data file "Fleiss93_CR.csv" or "Fleiss93_CR_Windows.csv"
## in sub-directory of package "meta"
##
filename <- paste(searchpaths()[seq(along=search())[search()==
      "package:meta"]], "/data/Fleiss93_CR",
      if (Sys.info()[["sysname"]]=="Windows") "_Windows" else "",
      ".csv", sep="")
Fleiss93_CR <- read.rm5(filename)
```

```
## Same result: example(Fleiss93)
##
metacr(Fleiss93_CR)

## Same result: example(Fleiss93cont)
##
metacr(Fleiss93_CR, 1, 2)
```

metacum

Cumulative meta-analysis

Description

Performs a cumulative meta-analysis.

Usage

```
metacum(x, pooled, sortvar, level=x$level, level.comb=x$level.comb)
```

Arguments

<code>x</code>	An object of class <code>meta</code> .
<code>pooled</code>	A character string indicating whether a fixed effect or random effects model is used for pooling. Either missing (see Details), "fixed", or "random", can be abbreviated.
<code>sortvar</code>	An optional vector used to sort the individual studies (must be of same length as <code>x\$TE</code>).
<code>level</code>	The level used to calculate confidence intervals for individual studies.
<code>level.comb</code>	The level used to calculate confidence intervals for pooled estimates.

Details

A cumulative meta-analysis is performed. Studies are included sequentially as defined by `sortvar`. Information from object `x` is utilised if argument `pooled` is missing. A fixed effect model is assumed (`pooled="fixed"`) if parameter `x$comb.fixed` is `TRUE`; a random effects model is assumed (`pooled="random"`) if parameter `x$comb.random` is `TRUE` and `x$comb.fixed` is `FALSE`.

Value

An object of class `c("metacum", "meta")` with corresponding `print`, `plot` function. The object is a list containing the following components:

<code>TE</code> , <code>seTE</code>	Estimated treatment effect and standard error of pooled estimate in cumulative meta-analyses.
<code>studlab</code>	Study label describing addition of studies.

p.value	P-value for test of overall effect.
I ²	Heterogeneity statistic I ² .
tau	Square-root of between-study variance.
sm	Summary measure.
method	Method used for pooling.
k	Number of studies combined in meta-analysis.
pooled	As defined above.
TE.fixed, seTE.fixed	Value is NA.
TE.random, seTE.random	Value is NA.
Q	Value is NA.
tau	Value is NA.
level	The level used to calculate confidence intervals for individual studies.
level.comb	The level used to calculate confidence intervals for pooled estimates.

Author(s)

Guido Schwarzer <sc@imbi.uni-freiburg.de>

References

Cooper H & Hedges LV (1994), *The Handbook of Research Synthesis*. Newbury Park, CA: Russell Sage Foundation.

See Also

[metabin](#), [metacont](#), [print.meta](#)

Examples

```
data(Fleiss93)
meta1 <- metabin(event.e, n.e, event.c, n.c,
                data=Fleiss93, studlab=study,
                sm="RR", meth="I")
meta1

metacum(meta1)
metacum(meta1, pooled="random")

grid.newpage()
forest(metacum(meta1, pooled="random"))
```

metagen

Generic inverse variance meta-analysis

Description

Fixed and random effects meta-analysis based on estimates (e.g. log hazard ratios) and their standard errors; inverse variance weighting is used for pooling.

Usage

```
metagen(TE, seTE, studlab, data=NULL, subset=NULL, sm="",
        level = 0.95, level.comb = level,
        comb.fixed=TRUE, comb.random=TRUE,
        title="", complab="", outclab="",
        label.e="Experimental", label.c="Control",
        byvar, bylab, print.byvar=TRUE)
```

Arguments

TE	Estimate of treatment effect.
seTE	Standard error of treatment estimate.
studlab	An optional vector with study labels.
data	An optional data frame containing the study information.
subset	An optional vector specifying a subset of studies to be used.
sm	A character string indicating underlying summary measure, e.g., "RD", "RR", "OR", "AS", "MD", "SMD".
level	The level used to calculate confidence intervals for individual studies.
level.comb	The level used to calculate confidence intervals for pooled estimates.
comb.fixed	A logical indicating whether a fixed effect meta-analysis should be conducted.
comb.random	A logical indicating whether a random effects meta-analysis should be conducted.
title	Title of meta-analysis / systematic review.
complab	Comparison label.
outclab	Outcome label.
label.e	Label for experimental group.
label.c	Label for control group.
byvar	An optional vector containing grouping information (must be of same length as TE).
bylab	A character string with a label for the grouping variable.
print.byvar	A logical indicating whether the name of the grouping variable should be printed in front of the group labels.

Details

Generic method for meta-analysis, only treatment estimates and their standard error are needed. The method is useful, e.g., for pooling of survival data (using log hazard ratio and standard errors as input). The inverse variance method is used for pooling. Random effects estimate is based on the DerSimonian-Laird method.

Internally, both fixed effect and random effects models are calculated regardless of values chosen for arguments `comb.fixed` and `comb.random`. Accordingly, the estimate for the random effects model can be extracted from component `TE.random` of an object of class "meta" even if `comb.random=FALSE`. However, all functions in R package `meta` will adequately consider the values for `comb.fixed` and `comb.random`. E.g. function `print.meta` will not print results for the random effects model if `comb.random=FALSE`.

Value

An object of class `c("metagen", "meta")` with corresponding `print`, `summary`, `plot` function. The object is a list containing the following components:

<code>TE</code> , <code>seTE</code> , <code>studlab</code> ,	
<code>sm</code> , <code>level</code> , <code>level.comb</code> ,	
<code>comb.fixed</code> , <code>comb.random</code> ,	
<code>byvar</code> , <code>bylab</code> , <code>print.byvar</code>	As defined above.
<code>w.fixed</code> , <code>w.random</code>	Weight of individual studies (in fixed and random effects model).
<code>TE.fixed</code> , <code>seTE.fixed</code>	Estimated overall treatment effect and standard error (fixed effect model).
<code>TE.random</code> , <code>seTE.random</code>	Estimated overall treatment effect and standard error (random effects model).
<code>k</code>	Number of studies combined in meta-analysis.
<code>Q</code>	Heterogeneity statistic.
<code>tau</code>	Square-root of between-study variance (moment estimator of DerSimonian-Laird).
<code>method</code>	Pooling method: "Inverse".
<code>call</code>	Function call.

Author(s)

Guido Schwarzer <sc@imbi.uni-freiburg.de>

References

Cooper H & Hedges LV (1994), *The Handbook of Research Synthesis*. Newbury Park, CA: Russell Sage Foundation.

See Also

[metabin](#), [metacont](#), [print.meta](#)

Examples

```
data(Fleiss93)
meta1 <- metabin(event.e, n.e, event.c, n.c, data=Fleiss93, sm="RR", meth="I")
meta1

##
## Identical results by using the following commands:
##
meta1
metagen(meta1$TE, meta1$seTE, sm="RR")

##
## Meta-analysis of survival data:
##
logHR <- log(c(0.95, 1.5))
selogHR <- c(0.25, 0.35)

metagen(logHR, selogHR, sm="HR")
```

metainf

Influence analysis in meta-analysis

Description

Performs an influence analysis. Pooled estimates are calculated omitting one study at a time.

Usage

```
metainf(x, pooled, sortvar, level=x$level, level.comb=x$level.comb)
```

Arguments

x	An object of class meta.
pooled	A character string indicating whether a fixed effect or random effects model is used for pooling. Either missing (see Details), "fixed" or "random", can be abbreviated.
sortvar	An optional vector used to sort the individual studies (must be of same length as x\$TE).
level	The level used to calculate confidence intervals for individual studies.
level.comb	The level used to calculate confidence intervals for pooled estimates.

Details

Performs an influence analysis; pooled estimates are calculated omitting one study at a time. Studies are sorted according to `sortvar`.

Information from object `x` is utilised if argument `pooled` is missing. A fixed effect model is assumed (`pooled="fixed"`) if parameter `x$comb.fixed` is TRUE; a random effects model is assumed (`pooled="random"`) if parameter `x$comb.random` is TRUE and `x$comb.fixed` is FALSE.

Value

An object of class `c("metainf", "meta")` with corresponding `print`, `plot` function. The object is a list containing the following components:

<code>TE, seTE</code>	Estimated treatment effect and standard error of pooled estimate in influence analysis.
<code>studlab</code>	Study label describing omission of studies.
<code>p.value</code>	P-value for test of overall effect.
<code>w</code>	Sum of weights from fixed effect or random effects model.
<code>I2</code>	Heterogeneity statistic I2.
<code>tau</code>	Square-root of between-study variance.
<code>sm</code>	Summary measure.
<code>method</code>	Method used for pooling.
<code>k</code>	Number of studies combined in meta-analysis.
<code>pooled</code>	As defined above.
<code>TE.fixed, seTE.fixed</code>	Value is NA.
<code>TE.random, seTE.random</code>	Value is NA.
<code>Q</code>	Value is NA.
<code>tau</code>	Value is NA.
<code>level</code>	The level used to calculate confidence intervals for individual studies.
<code>level.comb</code>	The level used to calculate confidence intervals for pooled estimates.

Author(s)

Guido Schwarzer <sc@imbi.uni-freiburg.de>

References

Cooper H & Hedges LV (1994), *The Handbook of Research Synthesis*. Newbury Park, CA: Russell Sage Foundation.

See Also

[metabin](#), [metacont](#), [print.meta](#)

Examples

```

data(Fleiss93)
metal <- metabin(event.e, n.e, event.c, n.c,
                data=Fleiss93, studlab=study,
                sm="RR", meth="I")

metal

metainf(metal)
metainf(metal, pooled="random")

grid.newpage()
forest(metainf(metal, pooled="random"), comb.random=TRUE)

```

metaprop

Meta-analysis of single proportions

Description

Calculation of an overall proportion from studies reporting a single proportion.

Usage

```

metaprop(event, n, studlab,
          data = NULL, subset = NULL,
          freeman.tukey=TRUE,
          level = 0.95, level.comb = level,
          comb.fixed=TRUE, comb.random=TRUE,
          title="", complab="", outclab="",
          byvar, bylab, print.byvar=TRUE)

```

Arguments

event	Number of events.
n	Number of observations.
studlab	An optional vector with study labels.
data	An optional data frame containing the study information, i.e., event and n.
subset	An optional vector specifying a subset of studies to be used.
freeman.tukey	A logical indicating if the Freeman-Tukey Double arcsine transformation should be used; otherwise the arcsine transformation is used.
level	The level used to calculate confidence intervals for individual studies.
level.comb	The level used to calculate confidence intervals for pooled estimates.
comb.fixed	A logical indicating whether a fixed effect meta-analysis should be conducted.
comb.random	A logical indicating whether a random effects meta-analysis should be conducted.

<code>title</code>	Title of meta-analysis / systematic review.
<code>complab</code>	Comparison label.
<code>outclab</code>	Outcome label.
<code>byvar</code>	An optional vector containing grouping information (must be of same length as <code>event.e</code>).
<code>bylab</code>	A character string with a label for the grouping variable.
<code>print.byvar</code>	A logical indicating whether the name of the grouping variable should be printed in front of the group labels.

Details

Fixed effect and random effects meta-analysis of single proportions using either the Freeman-Tukey Double arcsine transformation or the arcsine transformation of proportions to calculate an overall proportion.

Internally, both fixed effect and random effects models are calculated regardless of values chosen for arguments `comb.fixed` and `comb.random`. Accordingly, the estimate for the random effects model can be extracted from component `TE.random` of an object of class "meta" even if `comb.random=FALSE`. However, all functions in R package `meta` will adequately consider the values for `comb.fixed` and `comb.random`. E.g. function `print.meta` will not print results for the random effects model if `comb.random=FALSE`.

Value

An object of class `c("metaprop", "meta")` with corresponding `print`, `summary`, `plot` function. The object is a list containing the following components:

`event`, `n`, `studlab`,

`freeman.tukey`, `level`, `level.comb`,

`comb.fixed`, `comb.random`,

`byvar`, `bylab`, `print.byvar`
As defined above.

`TE`, `seTE` Arcsine transformation of proportion and its standard error for individual studies.

`w.fixed`, `w.random`

Weight of individual studies (in fixed and random effects model).

`TE.fixed`, `seTE.fixed`

Estimated overall arcsine transformed proportion and standard error (fixed effect model).

`TE.random`, `seTE.random`

Estimated overall arcsine transformed proportion and standard error (random effects model).

`k` Number of studies combined in meta-analysis.

`Q` Heterogeneity statistic Q .

tau	Square-root of between-study variance (moment estimator of DerSimonian-Laird).
sm	A character string: "proportion"
method	A character string indicating method used for pooling: "Inverse"
call	Function call.

Author(s)

Guido Schwarzer <sc@imbi.uni-freiburg.de>

References

Freeman MF & Tukey JW (1950), Transformations related to the angular and the square root. *Annals of Mathematical Statistics*, **21**, 607–611.

Miller JJ (1978), The inverse of the Freeman-Tukey double arcsine transformation. *The American Statistician*, **32**, 138.

See Also

[metacont](#), [metagen](#), [print.meta](#)

Examples

```
metaprop(0, 10)
metaprop(0, 10, freeman.tukey=FALSE)
```

Olkin95

Thrombolytic Therapy after Acute Myocardial Infarction

Description

Meta-analysis on Thrombolytic Therapy after Acute Myocardial Infarction

Usage

```
data(Olkin95)
```

Format

A data frame with the following columns:

author first author

year year of publication

event.e number of events in experimental group

n.e number of observations in experimental group

event.c number of events in control group

n.c number of observations in control group

Source

Olkin I (1995), Statistical and theoretical considerations in meta-analysis. *Journal of Clinical Epidemiology*, **48**, 133–146.

Examples

```
data(Olkin95)
summary(metabin(event.e, n.e, event.c, n.c, data=Olkin95))
```

plot.meta

Plot function for objects of class meta

Description

Draws a forest plot in the active graphics window.

Usage

```
## S3 method for class 'meta':
plot(x, byvar=x$byvar, bylab=x$bylab,
     print.byvar=x$print.byvar,
     sortvar, studlab=TRUE, level=x$level, level.comb=x$level.comb,
     comb.fixed=x$comb.fixed, comb.random=x$comb.random, overall=TRUE,
     text.fixed="Fixed effect model", text.random="Random effects model",
     lty.fixed=2, lty.random=3, xlab=NULL, xlim, ylim, lwd=1, cex=1,
     cex.comb=1.2 * cex, cex.axis=cex, cex.lab=cex,
     log=ifelse(x$sm %in% c("RR", "OR", "HR"), "x", ""),
     axes=TRUE, allstudies=TRUE,
     weight=ifelse(comb.random, "random", "fixed"), scale.diamond=1,
     scale.square= 1, col.i="black",
     clim=xlim, arrow.length=0.1,
     ref=ifelse(x$sm %in% c("RR", "OR", "HR"), 1, 0),
     ...)
```

Arguments

x	An object of class meta.
byvar	An optional vector containing grouping information (must be of same length as x\$TE).
bylab	A character string with a label for the grouping variable.
print.byvar	A logical indicating whether the name of the grouping variable should be printed in front of the group labels.
sortvar	An optional vector used to sort the individual studies (must be of same length as x\$TE).

studlab	A logical indicating whether study labels should be printed in the graph. A vector with study labels can also be provided (must be of same length as <code>x\$TE</code> then).
level	The level used to calculate confidence intervals for individual studies.
level.comb	The level used to calculate confidence intervals for pooled estimates.
comb.fixed	A logical indicating whether fixed effect estimate should be plotted.
comb.random	A logical indicating whether random effects estimate should be plotted.
overall	A logical indicating whether overall summaries should be plotted. This parameter is useful in combination with the parameter <code>byvar</code> if summaries should only be plotted on group level.
text.fixed	A character string used in the plot to label the pooled fixed effects estimate.
text.random	A character string used in the plot to label the pooled random effects estimate.
lty.fixed	Line type (pooled fixed effect estimate).
lty.random	Line type (pooled random effects estimate).
xlab	A label for the x axis.
xlim	The x limits (min,max) of the plot.
ylim	The y limits (min,max) of the plot.
lwd	The line width.
cex	A numerical value giving the amount by which plotting text and symbols should be scaled relative to the default.
cex.comb	A numerical value giving the amount by which plotting text and symbols for pooled fixed and random effects estimates should be scaled.
cex.axis	The magnification to be used for axis annotation relative to the current setting of <code>cex</code> .
cex.lab	The magnification to be used for x and y labels relative to the current setting of <code>cex</code> .
log	A character string which contains "x" if the x axis is to be logarithmic (other values for <code>log</code> are not reasonable).
axes	A logical indicating whether the x axis should be drawn on the plot.
allstudies	A logical indicating whether studies with inestimable treatment effects should be plotted.
weight	A character string indicating which type of plotting symbols is to be used for individual treatment estimates. One of "same", "fixed", or "random", can be abbreviated. Plot symbols have the same size for all studies or represent study weights from fixed effect or random effects model.
scale.diamond	A numerical value giving the amount by which the diamond representing pooled treatment effects should be scaled relative to the default.
scale.square	A numerical value giving the amount by which the square representing treatment effects in individual studies should be scaled relative to the default.
...	Graphical parameters as in <code>par</code> may also be passed as arguments.

<code>col.i</code>	The colour for individual study results and confidence limits.
<code>clim</code>	Limits (min,max) where to cut confidence limits; arrows are plotted if confidence limits are outside the range of <code>clim</code> .
<code>arrow.length</code>	Length of the edges of the arrow head (in inches) which is plotted if confidence limits are outside the range of <code>clim</code> . See also function <code>arrows</code> .
<code>ref</code>	A numerical value defining a reference value which is plotted as a vertical line.

Details

A forest plot, also called confidence interval plot, is drawn in the active graphics window. Sub-group analyses are conducted and displayed in the plot if `byvar` is not missing.

The `plot.meta` function produces basic forest plots. For nicer looking forest plots the `forest` function can be used.

Review Manager 5 (RevMan 5) is the current software used for preparing and maintaining Cochrane Reviews (<http://www.cc-ims.net/revman/>). In RevMan 5, subgroup analyses can be defined and data from a Cochrane review can be imported to R using the function `read.rm5`. If a meta-analysis is then conducted using function `metacr`, information on subgroups is available in R (components `byvar`, `bylab`, and `print.byvar`, `byvar` in an object of class "meta"). Accordingly, by using function `metacr` there is no need to define subgroups in order to redo the statistical analysis conducted in the Cochrane review.

Author(s)

Guido Schwarzer <sc@imbi.uni-freiburg.de>

See Also

[forest](#), [metabin](#), [metacont](#), [metagen](#)

Examples

```
data(Olkin95)
metal <- metabin(event.e, n.e, event.c, n.c,
                data=Olkin95, subset=c(41,47,51,59),
                sm="RR", meth="I")

oldpar <- par(mfrow=c(2, 2))

plot(metal)
plot(metal, byvar=c(1,2,1,2), bylab="label")
plot(metal, byvar=1:4, xlim=c(0.02, 10))

par(oldpar)
```

```
print.meta
```

Print and summary method for objects of class meta

Description

Print and summary method for objects of class meta.

Usage

```
## S3 method for class 'meta':
print(x, sortvar, level=x$level, level.comb=x$level.comb,
      comb.fixed=x$comb.fixed, comb.random=x$comb.random,
      details=FALSE, ma=TRUE, digits=max(4, .Options$digits - 3), ...)

## S3 method for class 'metabias':
print(x, ...)

## S3 method for class 'meta':
summary(object, byvar=object$byvar,
        bylab=object$bylab, print.byvar=object$print.byvar,
        bystud=FALSE,
        level=object$level, level.comb=object$level.comb,
        comb.fixed=object$comb.fixed, comb.random=object$comb.random,
        warn=TRUE, ...)

## S3 method for class 'summary.meta':
print(x, digits = max(3, .Options$digits - 3),
      print.byvar,
      comb.fixed=x$comb.fixed, comb.random=x$comb.random,
      header=TRUE, ...)
```

Arguments

x	An object of class meta, metabias, or summary.meta.
object	An object of class meta.
sortvar	An optional vector used to sort the individual studies (must be of same length as x\$TE).
level	The level used to calculate confidence intervals for individual studies.
level.comb	The level used to calculate confidence intervals for pooled estimates.
comb.fixed	A logical indicating whether a fixed effect meta-analysis should be conducted.
comb.random	A logical indicating whether a random effects meta-analysis should be conducted.
header	A logical indicating whether information on title of meta-analysis, comparison and outcome should be printed at the beginning of the printout.
details	A logical indicating whether further details of individual studies should be printed.

ma	A logical indicating whether the summary results of the meta-analysis should be printed.
byvar	An optional vector containing grouping information (must be of same length as x\$TE).
bylab	A character string with a label for the grouping variable.
bystud	A logical indicating whether results of individual studies should be printed by grouping variable.
digits	Minimal number of significant digits, see print.default.
print.byvar	A logical indicating whether the name of the grouping variable should be printed in front of the group labels. By default, the value of print.byvar is set to TRUE.
warn	A logical indicating whether the use of summary.meta in connection with metacum or metaInf should result in a warning.
...	other arguments

Details

Review Manager 5 (RevMan 5) is the current software used for preparing and maintaining Cochrane Reviews (<http://www.cc-ims.net/revman/>). In RevMan 5, subgroup analyses can be defined and data from a Cochrane review can be imported to R using the function `read.rm5`. If a meta-analysis is then conducted using function `metacr`, information on subgroups is available in R (components `byvar`, `bylab`, and `print.byvar`, `byvar` in an object of class "meta"). Accordingly, by using function `metacr` there is no need to define subgroups in order to redo the statistical analysis conducted in the Cochrane review.

For subgroups (argument `byvar` not NULL), results for the fixed effect model will be printed if both arguments `comb.fixed` and `comb.random` are TRUE. In order to get results for the random effects model within subgroups, use `comb.fixed==FALSE` and `comb.random==TRUE`.

Value

A list is returned by the function `summary.meta` with the following elements:

study	Results for individual studies (a list with elements TE, seTE, lower, upper, z, p, level).
fixed	Results for fixed effect model (a list with elements TE, seTE, lower, upper, z, p, level).
random	Results for random effects model (a list with elements TE, seTE, lower, upper, z, p, level).
k	Number of studies combined in meta-analysis.
Q	Heterogeneity statistic Q.
tau	Square-root of between-study variance (moment estimator of DerSimonian-Laird).
H	Heterogeneity statistic H (a list with elements TE, lower, upper).
I2	Heterogeneity statistic I2 (a list with elements TE, lower, upper), see Higgins & Thompson (2002).

k.all	Total number of trials.
Q.CMH	Cochrane-Mantel-Haenszel heterogeneity statistic.
sm	A character string indicating underlying summary measure.
method	A character string with the pooling method.
call	Function call.
ci.lab	Label for confidence interval.
within.fixed	Result for fixed effect model within groups (a list with elements TE, seTE, lower, upper, z, p, level) - if byvar is not missing.
within.random	Result for random effects model within groups (a list with elements TE, seTE, lower, upper, z, p, level) - if byvar is not missing.
k.w	Number of studies combined within groups - if byvar is not missing.
Q.w	Heterogeneity statistic Q within groups - if byvar is not missing.
bylab	Label for grouping variable - if byvar is not missing.
by.levs	Levels of grouping variable - if byvar is not missing.
comb.fixed, comb.random	As defined above.

Author(s)

Guido Schwarzer <sc@imbi.uni-freiburg.de>

References

Cooper H & Hedges LV (1994), *The Handbook of Research Synthesis*. Newbury Park, CA: Russell Sage Foundation.

Higgins JPT & Thompson SG (2002), Quantifying heterogeneity in a meta-analysis. *Statistics in Medicine*, **21**, 1539–1558.

See Also

[metabin](#), [metacont](#), [metagen](#)

Examples

```
data(Fleiss93cont)
meta1 <- metacont(n.e, mean.e, sd.e, n.c, mean.c, sd.c, data=Fleiss93cont, sm="SMD")
summary(meta1)
summary(meta1, byvar=c(1,2,1,1,2), bylab="group")
```

read.mtv	<i>Import RevMan 4 data files (.mtv)</i>
----------	--

Description

Reads a file created with RevMan 4 and creates a data frame from it.

Usage

```
read.mtv(file)
```

Arguments

file	The name of a file to read data values from.
------	--

Details

Reads a file created with RevMan 4 (Menu: "File" - "Export" - "Analysis data file...") and creates a data frame from it.

Value

A data frame containing the following components:

comp.no	Comparison number.
outcome.no	Outcome number.
group.no	Group number.
studlab	Study label.
year	Year of publication.
event.e	Number of events in experimental group.
n.e	Number of observations in experimental group.
event.c	Number of events in control group.
n.c	Number of observations in control group.
mean.e	Estimated mean in experimental group.
sd.e	Standard deviation in experimental group.
mean.c	Estimated mean in control group.
sd.c	Standard deviation in control group.
O.E	Observed minus expected (IPD analysis).
V	Variance of O.E (IPD analysis).
order	Ordering of studies.
conceal	Concealment of treatment allocation.
grplab	Group label.

type	Type of outcome. D = dichotomous, C = continuous, P = IPD.
outclab	Outcome label.
graph.exp	Graph label for experimental group.
graph.cont	Graph label for control group.
label.exp	Label for experimental group.
label.cont	Label for control group.
complab	Comparison label.

Author(s)

Guido Schwarzer <sc@imbi.uni-freiburg.de>

References

Review Manager (RevMan) [Computer program]. Version 4.2 for Windows. Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2003.

See Also

[metabin](#), [metacont](#), [metagen](#)

Examples

```
## Locate MTV-data file "FLEISS93.MTV" in sub-directory of package "meta"
##
filename <- paste(searchpaths()[seq(along=search())[search()==
      "package:meta"]], "/data/FLEISS93.MTV", sep="")
##
fleiss93.cc <- read.mtv(filename)

## Same result: example(Fleiss93)
##
metabin(event.e, n.e, event.c, n.c,
        data=fleiss93.cc, subset=type=="D",
        studlab=paste(studlab, year))

## Same result: example(Fleiss93cont)
##
metacont(n.e, mean.e, sd.e, n.c, mean.c, sd.c,
         data=fleiss93.cc, subset=type=="C",
         studlab=paste(studlab, year))
```

read.rm5 *Import RevMan 5 data files (.csv)*

Description

Reads data file from Cochrane Intervention review created with RevMan 5 and creates a data frame from it.

Usage

```
read.rm5(file, sep=",", quote = "\"", title,
          numbers.in.labels=TRUE)
```

Arguments

file	The name of a file to read data values from.
sep	The field separator character. Values on each line of the file are separated by this character. The comma is the default field separator character in RevMan 5.
quote	The set of quoting characters. In RevMan 5 a "\"" is the default quoting character.
title	Title of the Cochrane review.
numbers.in.labels	A logical indicating whether comparison number and outcome number should be printed at the beginning of the comparison (parameter <code>complab</code>) and outcome label (parameter <code>outclab</code>); this is the default in RevMan 5.

Details

Review Manager 5 (RevMan 5) is the current software used for preparing and maintaining Cochrane Reviews (<http://www.cc-ims.net/revman/>). RevMan 5 includes the ability to write Systematic reviews of interventions, Diagnostic test accuracy reviews, Methodology reviews and Overviews of reviews.

This function provides the ability to read a data file from a Cochrane Intervention review created with RevMan 5; a data frame is created from it. Cochrane Intervention reviews are based on the comparison of two interventions.

In order to generate a data analysis file in RevMan 5 use the following Menu points: "File" - "Export" - "Data and analyses". It is mandatory to include the following fields in the exported data file by selecting them with the mouse cursor in the Export Analysis Data Wizard: (i) Comparison Number, (ii) Outcome Number, (iii) Subgroup Number. When these fields are not selected a corresponding error message will be printed in R. It is recommended to include all fields in the exported data file. For example, in order to redo the meta-analysis in R for the RevMan 5 data type "O-E and Variance" the fields "O-E" and "Variance" have to be selected in the Export Analysis Data Wizard.

By default in RevMan 5, the name of the exported data file is the title of the Cochrane Review. Accordingly, information on the title is extracted from the name of the exported data file (parameter: `file`) if parameter `title` is missing (default).

Each respective meta-analysis for parameters `event.e.pooled - df.pooled` is defined by values for `"comp.no"` and `"outcome.no"`, and `"grp.no"`.

Value

A data frame containing the following components:

<code>comp.no</code>	Comparison number.
<code>outcome.no</code>	Outcome number.
<code>group.no</code>	Group number.
<code>studlab</code>	Study label.
<code>year</code>	Year of publication.
<code>event.e</code>	Number of events in experimental group.
<code>n.e</code>	Number of observations in experimental group.
<code>event.c</code>	Number of events in control group.
<code>n.c</code>	Number of observations in control group.
<code>mean.e</code>	Estimated mean in experimental group.
<code>sd.e</code>	Standard deviation in experimental group.
<code>mean.c</code>	Estimated mean in control group.
<code>sd.c</code>	Standard deviation in control group.
<code>O.E</code>	Observed minus expected (IPD analysis).
<code>V</code>	Variance of <code>O.E</code> (IPD analysis).
<code>TE, seTE</code>	Estimated treatment effect and standard error of individual studies.
<code>lower.TE, upper.TE</code>	Lower and upper limit of 95% confidence interval for treatment effect in individual studies.
<code>weight</code>	Weight of individual studies (according to meta-analytical method used in respective meta-analysis - see below for details).
<code>order</code>	Ordering of studies.
<code>grplab</code>	Group label.
<code>type</code>	Type of outcome. D = dichotomous, C = continuous, P = IPD.
<code>method</code>	A character string indicating which method has been used for pooling of studies. One of "Inverse", "MH", or "Peto".
<code>sm</code>	A character string indicating which summary measure has been used for pooling of studies.
<code>model</code>	A character string indicating which meta-analytical model has been used (either "Fixed" or "Random").
<code>comb.fixed</code>	A logical indicating whether fixed effect meta-analysis has been used in respective meta-analysis (see below for details).
<code>comb.random</code>	A logical indicating whether random effects meta-analysis has been used in respective meta-analysis (see below for details).

outclab	Outcome label.
k	Total number of studies combined in respective meta-analysis).
event.e.pooled	Number of events in experimental group in respective meta-analysis (see below for details).
n.e.pooled	Number of observations in experimental group in respective meta-analysis (see below for details).
event.c.pooled	Number of events in control group in respective meta-analysis (see below for details).
n.c.pooled	Number of observations in control group in respective meta-analysis (see below for details).
TE.pooled	Estimated treatment effect in respective meta-analysis (see below for details).
lower.TE, upper.TE	Lower and upper limit of 95% confidence interval for treatment effect in respective meta-analysis (see below for details).
weight.pooled	Total weight in respective meta-analysis (see below for details).
Z.pooled	Z-score for test of overall treatment effect in respective meta-analysis (see below for details).
pval.TE.pooled	P-value for test of overall treatment effect in respective meta-analysis (see below for details).
Q	Heterogeneity statistic Q in respective meta-analysis (see below for details).
pval.Q	P-value of heterogeneity statistic Q in respective meta-analysis (see below for details).
I2	Heterogeneity statistic I2 in respective meta-analysis (see below for details).
tau2	Between-study variance (moment estimator of DerSimonian-Laird) in respective meta-analysis (see below for details).
Q.w	Heterogeneity statistic Q within groups in respective meta-analysis (see below for details).
pval.Q.w	P-value of heterogeneity statistic Q within groups in respective meta-analysis (see below for details).
I2.w	Heterogeneity statistic I2 within groups in respective meta-analysis (see below for details).
label.e	Label for experimental group.
label.c	Label for control group.
label.left	Graph label on left side of forest plot.
label.right	Graph label on right side of forest plot.
RR.cochrane	A logical indicating if 2*incr instead of 1*incr is to be added to n.e and n.c in the calculation of the relative risk (i.e., sm="RR") for studies with a zero cell. This is used in RevMan 5.
complab	Comparison label.

Author(s)

Guido Schwarzer <sc@imbi.uni-freiburg.de>

References

Review Manager (RevMan) [Computer program]. Version 5.0, The Nordic Cochrane Centre, The Cochrane Collaboration, 2008.

See Also

[metabin](#), [metacont](#), [metagen](#), [metacr](#)

Examples

```
## Locate export data file "Fleiss93_CR.csv" or "Fleiss93_CR_Windows.csv"
## in sub-directory of package "meta"
##
filename <- paste(searchpaths()[seq(along=search())[search()==
  "package:meta"]], "/data/Fleiss93_CR",
  if (Sys.info()[["sysname"]]=="Windows") "_Windows" else "",
  ".csv", sep="")
Fleiss93_CR <- read.rm5(filename)

## Same result: example(Fleiss93)
##
metacr(Fleiss93_CR)

## Same result: example(Fleiss93cont)
##
metacr(Fleiss93_CR, 1, 2)
```

trimfill

Generic function for trim-and-fill method

Description

Trim and fill method for estimating and adjusting for the number and outcomes of missing studies in a meta-analysis.

Usage

```
trimfill(x, seTE, ...)
```

Arguments

<code>x</code>	An object of class <code>meta</code> , or estimated treatment effect in individual studies.
<code>seTE</code>	Standard error of estimated treatment effect (mandatory if <code>x</code> not of class <code>meta</code>).
<code>...</code>	Additional arguments.

Details

The trim and fill method can be used for estimating and adjusting for the number and outcomes of missing studies in a meta-analysis. The method relies on scrutiny of one side of a funnel plot for asymmetry assumed due to publication bias.

Value

An object of class `c("metagen", "meta", "trimfill")`. The object is a list containing the following components:

```
studlab, sm, left, ma.fixed, type

n.iter.max, level, level.comb,
                As defined above.
comb.fixed, comb.random

TE, seTE      Estimated treatment effect and standard error of individual studies.
w.fixed, w.random
                Weight of individual studies (in fixed and random effects model).
TE.fixed, seTE.fixed
                Estimated overall treatment effect and standard error (fixed effect model).
TE.random, seTE.random
                Estimated overall treatment effect and standard error (random effects model).
k            Number of studies combined in meta-analysis.
Q            Heterogeneity statistic Q.
tau         Square-root of between-study variance (moment estimator of DerSimonian-Laird).
method      Pooling method: "Inverse".
call        Function call.
n.iter      Actual number of iterations to estimate number of missing studies.
trimfill    A logical vector indicating studies that have been added by trim and fill method.
k0          Number of studies added by trim and fill.
```

Author(s)

Guido Schwarzer <sc@imbi.uni-freiburg.de>

References

- Duval S & Tweedie R (2000), A nonparametric "Trim and Fill" method of accounting for publication bias in meta-analysis. *Journal of the American Statistical Association*, **95**, 89–98.
- Duval S & Tweedie R (2000), Trim and Fill: A simple funnel-plot-based method of testing and adjusting for publication bias in meta-analysis. *Biometrics*, **56**, 455–463.

See Also

[metagen](#), [metabias](#), [trimfill.meta](#), [funnel](#)

Examples

```

data(Fleiss93)
meta1 <- metabin(event.e, n.e, event.c, n.c,
                 data=Fleiss93, sm="OR")
tf1 <- trimfill(meta1)
summary(tf1)
funnel(tf1, pch=ifelse(tf1$trimfill, 1, 16),
       level=0.95, comb.fixed=TRUE)

trimfill(meta1$TE, meta1$seTE, sm=meta1$sm)

```

```
trimfill.meta      Trim and fill method for meta-analysis
```

Description

Trim and fill method for estimating and adjusting for the number and outcomes of missing studies in a meta-analysis.

Usage

```

## Default S3 method:
trimfill(x, seTE, left=NULL, ma.fixed=TRUE, type="L", n.iter.max=50,
         sm=NULL, studlab=NULL, level=0.95, level.comb=0.95,
         comb.fixed=TRUE, comb.random=TRUE, silent=TRUE, ...)

## S3 method for class 'meta':
trimfill(x, seTE, left=NULL, ma.fixed=TRUE, type="L", n.iter.max=50,
         sm=NULL, studlab=NULL, level=x$level, level.comb=x$level.comb,
         comb.fixed=x$comb.fixed, comb.random=x$comb.random, silent=TRUE, ...)

```

Arguments

<code>x</code>	An object of class <code>meta</code> , or estimated treatment effect in individual studies.
<code>seTE</code>	Standard error of estimated treatment effect (mandatory if <code>x</code> not of class <code>meta</code>).
<code>left</code>	A logical indicating whether studies are supposed to be missing on the left or right side of the funnel plot. If <code>NULL</code> , the linear regression test for funnel plot symmetry (i.e., function <code>metabias(..., meth="linreg")</code>) is used to determine whether trials are missing on the left or right side.
<code>ma.fixed</code>	A logical indicating whether a fixed effect or random effects model is used to estimate the number of missing studies.
<code>type</code>	A character indicating which method is used to estimate the number of missing studies. Either "L" or "R".
<code>n.iter.max</code>	Maximum number of iterations to estimate number of missing studies.
<code>sm</code>	An optional character string indicating underlying summary measure, e.g., "RD", "RR", "OR", "AS", "MD", "SMD"; ignored if <code>x</code> is of class <code>meta</code> .

<code>studlab</code>	An optional vector with study labels; ignored if <code>x</code> is of class <code>meta</code> .
<code>level</code>	The level used to calculate confidence intervals for individual studies. If existing, <code>x\$level</code> is used as value for <code>level</code> ; otherwise 0.95 is used.
<code>level.comb</code>	The level used to calculate confidence interval for the pooled estimate. If existing, <code>x\$level.comb</code> is used as value for <code>level.comb</code> ; otherwise 0.95 is used.
<code>comb.fixed</code>	A logical indicating whether a fixed effect meta-analysis should be conducted.
<code>comb.random</code>	A logical indicating whether a random effects meta-analysis should be conducted.
<code>silent</code>	A logical indicating whether basic information on iterations shown.
<code>...</code>	other arguments

Details

The trim and fill method can be used for estimating and adjusting for the number and outcomes of missing studies in a meta-analysis. The method relies on scrutiny of one side of a funnel plot for asymmetry assumed due to publication bias.

Internally, both fixed effect and random effects models are calculated regardless of values chosen for arguments `comb.fixed` and `comb.random`. Accordingly, the estimate for the random effects model can be extracted from component `TE.random` of an object of class `"meta"` even if `comb.random=FALSE`. However, all functions in R package `meta` will adequately consider the values for `comb.fixed` and `comb.random`. E.g. function `print.meta` will not print results for the random effects model if `comb.random=FALSE`.

The function `metagen` is called internally.

Value

An object of class `c("metagen", "meta", "trimfill")`. The object is a list containing the following components:

`studlab`, `sm`, `left`, `ma.fixed`, `type`

`n.iter.max`, `level`, `level.comb`,

As defined above.

`comb.fixed`, `comb.random`

`TE`, `seTE` Estimated treatment effect and standard error of individual studies.

`w.fixed`, `w.random`

Weight of individual studies (in fixed and random effects model).

`TE.fixed`, `seTE.fixed`

Estimated overall treatment effect and standard error (fixed effect model).

`TE.random`, `seTE.random`

Estimated overall treatment effect and standard error (random effects model).

`k` Number of studies combined in meta-analysis.

`Q` Heterogeneity statistic Q .

tau	Square-root of between-study variance (moment estimator of DerSimonian-Laird).
method	Pooling method: "Inverse".
call	Function call.
n.iter	Actual number of iterations to estimate number of missing studies.
trimfill	A logical vector indicating studies that have been added by trim and fill method.
k0	Number of studies added by trim and fill.

Author(s)

Guido Schwarzer <sc@imbi.uni-freiburg.de>

References

Duval S & Tweedie R (2000), A nonparametric "Trim and Fill" method of accounting for publication bias in meta-analysis. *Journal of the American Statistical Association*, **95**, 89–98.

Duval S & Tweedie R (2000), Trim and Fill: A simple funnel-plot-based method of testing and adjusting for publication bias in meta-analysis. *Biometrics*, **56**, 455–463.

See Also

[metagen](#), [metabias](#), [funnel](#)

Examples

```
data(Fleiss93)
meta1 <- metabin(event.e, n.e, event.c, n.c,
                data=Fleiss93, sm="OR")
tf1 <- trimfill(meta1)
summary(tf1)
funnel(tf1, pch=ifelse(tf1$trimfill, 1, 16),
       level=0.95, comb.fixed=TRUE)

trimfill(meta1$TE, meta1$seTE, sm=meta1$sm)
```

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