Variance-Covariance Matrix for Multivariate Meta-Analysis with R Package `metavcov'

Min Lu

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Type Package

Title Variance-Covariance Matrix for Multivariate Meta-Analysis

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Author Min Lu <m.lu6@umiami.edu>

Maintainer Min Lu <m.lu6@umiami.edu>

BugReports https://github.com/luminwin/metavcov/issues/new

Description Compute variance-covariance matrix for multivariate meta-analysis. Effect sizes include correlation (r), mean difference (MD), standardized mean difference (SMD), log odds ratio (logOR), log risk ratio (logRR), and risk difference (RD).

Depends corpcor

License GPL (>= 2)

LazyData TRUE

URL https://github.com/luminwin/metavcov

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R topics documented:

`metavcov-package` *Variances and Covariances for Multivariate Meta-Analysis*

Description

R package metavov computes variances and covariances for multivariate meta-analysis. Effect sizes include correlation (r), mean difference (MD), standardized mean difference (SMD), log odds ratio (logOR), log risk ratio (logRR), and risk difference (RD).

Author(s)

Min Lu (Maintainer,<m.lu6@umiami.edu>)

References

Ahn, S., Lu, M., Lefevor, G.T., Fedewa, A. & Celimli, S. (2016). Application of meta-analysis in sport and exercise science. In N. Ntoumanis, & N. Myers (Eds.), *An Introduction to Intermediate and Advanced Statistical Analyses for Sport and Exercise Scientists* (pp.233-253). Hoboken, NJ: John Wiley and Sons, Ltd.

Olkin, I., & Ishii, G. (1976). Asymptotic distribution of functions of a correlation matrix. In S. Ikeda (Ed.), *Essays in probability and statistics: A volume in honor of Professor Junjiro Ogawa* (pp.5-51). Tokyo, Japan: Shinko Tsusho.

Wei, Y., & Higgins, J. (2013). Estimating within study covariances in multivariate meta-analysis with multiple outcomes. *Statistics in Medicine, 32*(7), 119-1205.

Examples

```
#################################################
# Effect size : correlation coefficients
#################################################
data(Craft2003)
computvocv <- r.vcov(n = Craft2003$N,
                  corflat = subset(Craft2003, select = C1:C6),
                  method = "average")
# name transformed z scores as an input
Input <- computvocv$zr
# name variance covariance matrix of trnasformed z scores as covars
covars <- computvocv$zcov
```

```
# Next step: Overall analysis: Running random effects model
#                              using package "mvmeta"
#library(mvmeta)
#mvmeta_RE <- summary(mvmeta(cbind(C1, C2, C3, C4, C5, C6),
#                           S = covars, data = Input, method = "reml"))
#mvmeta_RE
```

Craft2003 *18 studies of correlation coefficients reported by Craft et al. (2003)*

Description

This dataset includes 18 studies of correlation coefficients reported by Craft, Magyar, Becker, and Feltz (2003).

Usage

```
data(Craft2003)
```

Details

The main purpose of Craft and colleagues (2003) meta-analysis was to examine the interrelationships between athletic performance and three subscales, cognitive anxiety, somatic anxiety, and self-concept, of the Competitive State Anxiety Inventory (CSAI 2; CITATION). In this meta-analysis, the correlation coefficient was the primary effect size measure. For the purpose of demonstration, I use a subset of the data, i.e., six correlation coefficients among cognitive anxiety, somatic anxiety, self-concept, and sport performance in athletes.

ID	ID for each study included
N	sample size from each study included
gender	gender
p_male	percentage of male
C1	Correlation coefficient between cognitive anxiety and somatic anxiety
C2	Correlation coefficient between cognitive anxiety and self concept
C3	Correlation coefficient between cognitive anxiety and athletic performance
C4	Correlation coefficient between somatic anxiety and self concept
C5	Correlation coefficient between somatic anxiety and athletic performance
C6	Correlation coefficient between self concept and athletic performance

Source

Ahn, S., Lu, M., Lefevor, G.T., Fedewa, A. & Celimli, S. (2016). Application of meta-analysis in sport and exercise science. In N. Ntoumanis, & N. Myers (Eds.), *An Introduction to Intermediate and Advanced Statistical Analyses for Sport and Exercise Scientists* (pp.233-253). Hoboken, NJ: John Wiley and Sons, Ltd.

Craft, L. L., Magyar, T. M., Becker, B. J., & Feltz, D. L. (2003). The relationship between the

competitive state anxiety inventory-2 and sport performance: a meta-analysis. *Journal of Sport and Exercise Psychology, 25*(1), 44-65.

Examples

```
data(Craft2003)
```

Geeganage2010	*17 studies of multivariate effect sizes reported by Geeganage et al. (2010)*

Description

This dataset includes 17 studies of multivariate effect sizes with four different outcomes reported by Geeganage and Bath (2010).

Usage

```
data(Geeganage2010)
```

Details

In a meta-analysis, Geeganage and Bath (2010) studied whether blood pressure (BP) should be actively altered during the acute phase of stroke, and assessed the effect of multiple vasoactive drugs on BP in acute stroke. Selection criteria included: Randomized trials of interventions that would be expected, on pharmacological grounds, to alter BP in patients within one week of the onset of acute stroke. There were four outcomes: systolic blood pressure (SBP, in mHg), diastolic blood pressure (DBP, in mHg), death (D), and death or disability (DD).

ID:	ID for each study included
ft_D	Number of early death within 1 month (D) in "1 Drug" Group
fc_D	Number of D in "control " Group
nt_D	Number of people in "1 Drug" Group reporting D status
nc_D	Number of people in "control " Group reporting D status
OR_D	Odds Ratio of D for "1 Drug" versus "control" group
ft_DD	Number of early death or deterioration within 1 month (DD) in "1 Drug" Group
fc_DD	Number of early DD in "control " Group
nt_DD	Number of people in "1 Drug" Group reporting DD status
nc_DD	Number of people in "control " Group reporting DD status
OR_DD	Odds Ratio of DD for "1 Drug" versus "control" group
nt_SBP	Number of people in "1 Drug" Group reporting Systolic blood pressure (SBP) status
nc_SBP	Number of people in "control " Group reporting SBP status
MD_SBP	Mean Difference of SBP for "1 Drug" versus "control" group
sdt_SBP	Standard Deviation of SBP in "1 Drug" Group
sdc_SBP	Standard Deviation of SBP in "control " Group
nt_DBP	Number of people in "1 Drug" Group reporting Diastolic blood pressure (DBP) status
nc_DBP	Number of people in "control " Group reporting DBP status
MD_DBP	Mean Difference of DBP for "1 Drug" versus "control" group

sdt_DBP	Standard Deviation of DBP in "1 Drug" Group
sdc_DBP	Standard Deviation of DBP in "control " Group
SMD_SBP	Standardized Mean Difference of SBP for "1 Drug" versus "control" group
SMD_DBP	Standardized Mean Difference of DBP for "1 Drug" versus "control" group

Source

Geeganage, C., & Bath, P. M. (2010). Vasoactive drugs for acute stroke. *The Cochrane Library*.

Examples

```
data(Geeganage2010)
```

`lgOR.vcov` *Covariance matrix for log odds ratios*

Description

Compute variance-covariance matrix for multivariate meta-analysis when effect size is log odds ratio.

Usage

```
lgOR.vcov(r, nt, nc, st, sc, n_rt = 0, n_rc = 0)
```

Arguments

`r`	A list of correlation coefficient matrices of the outcomes from the studies. r[[k]][i,j] reports the correlation coefficient between outcome i and outcome j from study k.
`nt`	A matrix with sample sizes in the treatment group reporting each of the outcome. nt[i,j] reports the sample size from study i reporting outcome j.
`nc`	Defined in a similar way as nt for control group.
`st`	A matrix with number of participants with event for all outcomes (dichotomous) in treatment group. st[i,j] is number of participants with event for outcome j in treatment group.
`sc`	Defined in a similar way as st for control group.
`n_rt`	A list of matrices storing sample sizes in the treatment group reporting pairwised outcomes in the off diagonal elements. n_rt[[k]][i,j] is the sample size reporting both outcome i and outcome j from study k. Diagonal elements of these matrices are not used. The default value is zero, which means the smaller sample size reporting the corresponding two outcomes: i.e. n_rt[[k]][i,j]=min(nt[k,i],nt[k,j]).
`n_rc`	Defined in a similar way as n_rt for control group.

Value

lgOR	Computed log odds ratio from input.
list.lgOR.cov	A list of computed variance-covariance matrices.
lgOR.cov	A matrix whose rows are computed variance-covariance vectors.

Author(s)

Min Lu

References

Ahn, S., Lu, M., Lefevor, G.T., Fedewa, A. & Celimli, S. (2016). Application of meta-analysis in sport and exercise science. In N. Ntoumanis, & N. Myers (Eds.), *An Introduction to Intermediate and Advanced Statistical Analyses for Sport and Exercise Scientists* (pp.233-253). Hoboken, NJ: John Wiley and Sons, Ltd.

Wei, Y., & Higgins, J. (2013). Estimating within study covariances in multivariate meta-analysis with multiple outcomes. *Statistics in Medicine, 32*(7), 119-1205.

Examples

```
#########################################################################
# Example: Geeganage2010 data
# Preparing log odds ratios and covariances for multivariate meta-analysis
#########################################################################
data(Geeganage2010)
## set the correlation coefficients list r
r12 <- 0.71
r.Gee <- lapply(1:nrow(Geeganage2010), function(i){matrix(c(1, r12, r12, 1), 2, 2)})


computvocv <- lgOR.vcov(nt = subset(Geeganage2010, select = c(nt_DD, nt_D)),
                     nc = subset(Geeganage2010, select = c(nc_DD, nc_D)),
                     st = subset(Geeganage2010, select = c(st_DD, st_D)),
                     sc = subset(Geeganage2010, select = c(sc_DD, sc_D)),
                     r = r.Gee)
# name computed log odds ratio as an input
Input <- computvocv$lgOR
colnames(Input) <- c("lgOR.DD", "lgOR.D")
# name variance-covariance matrix of trnasformed z scores as covars
covars <- computvocv$lgOR.cov
#####################################################
# Running random-effects model using package "mvmeta"
#####################################################
#library(mvmeta)
#mvmeta_RE <- summary(mvmeta(cbind(lgOR.DD, lgOR.D),
#                            S = covars,
#                            data = as.data.frame(Input),
#                            method = "reml"))
#mvmeta_RE
```

lgor_lgrr — *Covariance between log odds ratio and log risk ratio*

Description

Compute covariance between log odds ratio and log risk ratio, when the two outcomes are binary.

Usage

```
lgor_lgrr(r, n1c, n2c, n1t, n2t,
          n12c = min(n1c, n2c),
          n12t = min(n1t, n2t),
          s2c, s2t, f2c, f2t, s1c, s1t, f1t, f1c)
```

Arguments

`r`	Correlation coefficient of the two outcomes.
`n1c`	Number of participants reporting outcome 1 in control group.
`n2c`	Number of participants reporting outcome 2 in control group.
`n1t`	Number of participants reporting outcome 1 in treatment group.
`n2t`	Number of participants reporting outcome 2 in treatment group.
`n12c`	Number of participants reporting both outcome 1 and outcome 2 in control group. By default, it is equal to the smaller number between n1c and n2c.
`n12t`	Defined in a similar way as n12c for treatment group.
`s2c`	Number of participants with event for outcome 2 (dichotomous) in control group.
`s2t`	Defined in a similar way as s2c for treatment group.
`f2c`	Number of participants without event for outcome 2 (dichotomous) in control group.
`f2t`	Defined in a similar way as f2c for treatment group.
`s1c`	Number of participants with event for outcome 1 (dichotomous) in control group.
`s1t`	Defined in a similar way as s1c for treatment group.
`f1c`	Number of participants without event for outcome 1 (dichotomous) in control group.
`f1t`	Defined in a similar way as f1c for treatment group.

Value

Return the computed covariance.

Author(s)

Min Lu

References

Ahn, S., Lu, M., Lefevor, G.T., Fedewa, A. & Celimli, S. (2016). Application of meta-analysis in sport and exercise science. In N. Ntoumanis, & N. Myers (Eds.), *An Introduction to Intermediate and Advanced Statistical Analyses for Sport and Exercise Scientists* (pp.233-253). Hoboken, NJ: John Wiley and Sons, Ltd.

Wei, Y., & Higgins, J. (2013). Estimating within study covariances in multivariate meta-analysis with multiple outcomes. *Statistics in Medicine, 32*(7), 119-1205.

Examples

```
## simple example
lgor_lgrr(r = 0.71,
          n1c = 30, n2c = 35, n1t = 28, n2t = 32,
          s2c = 5, s2t = 8, f2c = 30, f2t = 24,
          s1c = 5, s1t = 8, f1c = 25, f1t = 20)
## calculate covariances for variable D and DD in Geeganage2010 data
attach(Geeganage2010)
D_DD <- unlist(lapply(1:nrow(Geeganage2010),
              function(i){lgor_lgrr(r = 0.71, n1c = nc_SBP[i], n2c = nc_DD[i],
                 n1t = nt_SBP[i], n2t = nt_DD[i], s2t = st_DD[i], s2c = sc_DD[i],
                 f2c = nc_DD[i] - sc_DD[i], f2t = nt_DD[i] - st_DD[i],
                 s1t = st_D[i], s1c = sc_D[i],
                 f1c = nc_D[i] - sc_D[i], f1t = nt_D[i] - st_D[i])}))
D_DD
```

---

lgor_rd *Covariance between log odds ratio and risk difference*

Description

Compute covariance between log odds ratio and risk difference, when the two outcomes are binary.

Usage

```
lgor_rd(r, n1c, n2c, n1t, n2t,
        n12c = min(n1c, n2c), n12t = min(n1t, n2t),
        s2c, s2t, f2c, f2t, s1c, s1t, f1t, f1c)
```

Arguments

r	Correlation coefficient of the two outcomes.
n1c	Number of participants reporting outcome 1 in control group.
n2c	Number of participants reporting outcome 2 in control group.
n1t	Number of participants reporting outcome 1 in treatment group.
n2t	Number of participants reporting outcome 2 in treatment group.

n12c	Number of participants reporting both outcome 1 and outcome 2 in control group. By default, it is equal to the smaller number between n1c and n2c.
n12t	Number defined in a similar way as n12c for treatment group.
s2c	Number of participants with event for outcome 2 (dichotomous) in control group.
s2t	Defined in a similar way as s2c for treatment group.
f2c	Number of participants without event for outcome 2 (dichotomous) in control group.
f2t	Defined in a similar way as f2c for treatment group
s1c	Number of participants with event for outcome 1 (dichotomous) in control group.
s1t	Defined in a similar way as s1c for treatment group.
f1c	Number of participants without event for outcome 1 (dichotomous) in control group.
f1t	Defined in a similar way as f1c for treatment group.

Value

Return the computed covariance.

Author(s)

Min Lu

References

Ahn, S., Lu, M., Lefevor, G.T., Fedewa, A. & Celimli, S. (2016). Application of meta-analysis in sport and exercise science. In N. Ntoumanis, & N. Myers (Eds.), *An Introduction to Intermediate and Advanced Statistical Analyses for Sport and Exercise Scientists* (pp.233-253). Hoboken, NJ: John Wiley and Sons, Ltd.

Wei, Y., & Higgins, J. (2013). Estimating within study covariances in multivariate meta-analysis with multiple outcomes. *Statistics in Medicine, 32*(7), 119-1205.

Examples

```
## simple example
lgor_rd(r = 0.71, n1c = 30, n2c = 35, n1t = 28, n2t = 32,
        s2c = 5, s2t = 8, f2c = 30, f2t = 24,
        s1c = 5, s1t = 8, f1c = 25, f1t = 20)
## calculate covariances for variable D and DD in Geeganage2010 data
attach(Geeganage2010)
D_DD <- unlist(lapply(1:nrow(Geeganage2010), function(i){lgor_rd(r = 0.71,
              n1c = nc_SBP[i], n2c = nc_DD[i],
              n1t = nt_SBP[i], n2t = nt_DD[i], s2t = st_DD[i], s2c = sc_DD[i],
              f2c = nc_DD[i] - sc_DD[i], f2t = nt_DD[i] - st_DD[i],
              s1t = st_D[i], s1c = sc_D[i],
              f1c = nc_D[i] - sc_D[i], f1t = nt_D[i] - st_D[i])}))
D_DD
```

`lgRR.vcov` *Covariance matrix for log risk ratios*

Description

Compute variance-covariance matrix for multivariate meta-analysis when effect size is log risk ratio (or log relative risk).

Usage

```
lgRR.vcov(r, nt, nc, st, sc, n_rt = 0, n_rc = 0)
```

Arguments

`r`	A list of correlation coefficient matrices of the outcomes from the studies. r[[k]][i,j] is the correlation coefficient between outcome i and outcome j from study k.
`nt`	A matrix with sample sizes in the treatment group reporting each of the outcome. nt[i,j] is the sample size from study i reporting outcome j.
`nc`	Defined in a similar way as nt for control group.
`st`	Number of participants with event for all outcomes (dichotomous) in treatment group. st[i,j] is number of participants with event for outcome j in treatment group.
`sc`	Defined in a similar way as st for control group.
`n_rt`	A list of matrices storing sample sizes in the treatment group reporting pair-wised outcomes in the off diagonal elements. n_rt[[k]][i,j] stores the sample size reporting both outcome i and outcome j from the kth study. Diagonal elements of these matrices are not used. The default value is zero, which means the smaller sample size reporting the corresponding two outcomes: i.e. n_rt[[k]][i,j]=min(nt[k,i],nt[k,j]).
`n_rc`	Defined in a similar way as n_rt for control group.

Value

lgRR	Computed log risk ratio from input.
list.lgOR.cov	A list of computed variance-covariance matrices.
lgOR.cov	A matrix whose rows are computed variance-covariance vectors.

Author(s)

Min Lu

References

Ahn, S., Lu, M., Lefevor, G.T., Fedewa, A. & Celimli, S. (2016). Application of meta-analysis in sport and exercise science. In N. Ntoumanis, & N. Myers (Eds.), *An Introduction to Intermediate and Advanced Statistical Analyses for Sport and Exercise Scientists* (pp.233-253). Hoboken, NJ: John Wiley and Sons, Ltd.

Wei, Y., & Higgins, J. (2013). Estimating within study covariances in multivariate meta-analysis with multiple outcomes. *Statistics in Medicine, 32*(7), 119-1205.

Examples

```
##########################################################################
# Example: Geeganage2010 data
# Preparing log risk ratios and covariances for multivariate meta-analysis
##########################################################################
data(Geeganage2010)
## set the correlation coefficients list r
r12 <- 0.71
r.Gee <- lapply(1:nrow(Geeganage2010), function(i){matrix(c(1, r12, r12, 1), 2, 2)})


computvocv <- lgRR.vcov(nt = subset(Geeganage2010, select = c(nt_DD, nt_D)),
                      nc = subset(Geeganage2010, select = c(nc_DD, nc_D)),
                      st = subset(Geeganage2010, select=c(st_DD, st_D)),
                      sc = subset(Geeganage2010, select=c(sc_DD, sc_D)),
                      r = r.Gee)
# name computed log risk ratio as an input
Input <- computvocv$lgRR
colnames(Input) = c("lgRR.DD", "lgRR.D")
# name variance-covariance matrix of trnasformed z scores as covars
covars <- computvocv$lgRR.cov
###############################################################
# Running random-effects model using package "mvmeta"
################################################################
#library(mvmeta)
#mvmeta_RE = summary(mvmeta(cbind(lgRR.DD, lgRR.D),
#                             S = covars, data = as.data.frame(Input),
#                             method = "reml"))
#mvmeta_RE
```

---

lgrr_rd *Covariance between log risk ratio and risk difference*

Description

Compute covariance between log risk ratio and risk difference, when the two outcomes are binary.

Usage

```
lgrr_rd(r, n1c, n2c, n1t, n2t,
        n12c = min(n1c, n2c),
        n12t = min(n1t, n2t),
        s2c, s2t, f2c, f2t,
        s1c, s1t, f1c, f1t)
```

Arguments

`r`	Correlation coefficient of the two outcomes.
`n1c`	Number of participants reporting outcome 1 in control group.
`n2c`	Number of participants reporting outcome 2 in control group.
`n1t`	Number of participants reporting outcome 1 in treatment group.
`n2t`	Number of participants reporting outcome 2 in treatment group.
`n12c`	Number of participants reporting both outcome 1 and outcome 2 in control group. By default, it is equal to the smaller number between n1c and n2c.
`n12t`	Number defined in a similar way as n12c for treatment group.
`s2c`	Number of participants with event for outcome 2 (dichotomous) in control group.
`s2t`	Defined in a similar way as s2c for treatment group.
`f2c`	Number of participants without event for outcome 2 (dichotomous) in control group.
`f2t`	Defined in a similar way as f2c for treatment group.
`s1c`	Number of participants with event for outcome 1 (dichotomous) in control group.
`s1t`	Defined in a similar way as s1c for treatment group.
`f1c`	Number of participants without event for outcome 1 (dichotomous) in control group.
`f1t`	Defined in a similar way as f1c for treatment group.

Value

Return the computed covariance.

Author(s)

Min Lu

References

Ahn, S., Lu, M., Lefevor, G.T., Fedewa, A. & Celimli, S. (2016). Application of meta-analysis in sport and exercise science. In N. Ntoumanis, & N. Myers (Eds.), *An Introduction to Intermediate and Advanced Statistical Analyses for Sport and Exercise Scientists* (pp.233-253). Hoboken, NJ: John Wiley and Sons, Ltd.

Wei, Y., & Higgins, J. (2013). Estimating within study covariances in multivariate meta-analysis with multiple outcomes. *Statistics in Medicine, 32*(7), 119-1205.

Examples

```
## simple example
lgrr_rd(r = 0.71, n1c = 30, n2c = 35, n1t = 28, n2t = 32,
        s2c = 5, s2t = 8, f2c = 30, f2t = 24,
        s1c = 5, s1t = 8, f1c = 25, f1t = 20)
## calculate covariances for variable D and DD in Geeganage2010 data
attach(Geeganage2010)
D_DD <- unlist(lapply(1:nrow(Geeganage2010), function(i){lgrr_rd(r = 0.71,
        n1c = nc_SBP[i], n2c = nc_DD[i],
        n1t = nt_SBP[i], n2t = nt_DD[i], s2t = st_DD[i], s2c = sc_DD[i],
        f2c = nc_DD[i] - sc_DD[i], f2t = nt_DD[i] - st_DD[i],
       s1t = st_D[i], s1c = sc_D[i], f1c = nc_D[i] - sc_D[i], f1t = nt_D[i] - st_D[i])}))
D_DD
```

---

md.vcov *Covariance matrix for mean differences*

Description

Compute variance-covariance matrix for multivariate meta-analysis when effect size is mean difference.

Usage

```
md.vcov(r, nt, nc, n_rt = 0, n_rc = 0, sdt, sdc)
```

Arguments

r	A list of correlation coefficient matrices of the outcomes from the studies. r[[k]][i,j] is the correlation coefficient between outcome i and outcome j from study k.
nt	A matrix with sample sizes in the treatment group reporting each of the outcome. nt[i,j] is the sample size from study i reporting the outcome j.
nc	Defined in a similar way as nt for control group.
n_rt	A list of matrices storing sample sizes in the treatment group reporting pairwised outcomes in the off diagonal elements. n_rt[[k]][i,j] is the sample size reporting both outcome i and outcome j from study k. Diagonal elements of these matrices are not used. The default value is zero, which means the smaller sample size reporting the corresponding two outcomes: i.e. n_rt[[k]][i,j]=min(nt[k,i],nt[k,j]).
n_rc	Defined in a similar way as n_rt for control group.
sdt	Sample standard deviation from each of the outcome. sdt[i,j] is the sample standard deviation from study i for outcome j.
sdc	Defined in a similar way as sdt for control group.

Value

list.md.cov	A list of computed variance-covariance matrices.
md.cov	A matrix whose rows are computed variance-covariance vectors.

Author(s)

Min Lu

References

Ahn, S., Lu, M., Lefevor, G.T., Fedewa, A. & Celimli, S. (2016). Application of meta-analysis in sport and exercise science. In N. Ntoumanis, & N. Myers (Eds.), *An Introduction to Intermediate and Advanced Statistical Analyses for Sport and Exercise Scientists* (pp.233-253). Hoboken, NJ: John Wiley and Sons, Ltd.

Wei, Y., & Higgins, J. (2013). Estimating within study covariances in multivariate meta-analysis with multiple outcomes. *Statistics in Medicine, 32*(7), 119-1205.

Examples

```
#######################################################
# Example: Geeganage2010 data
# Preparing covariances for multivariate meta-analysis
#######################################################
## set the correlation coefficients list r
r12 <- 0.71
r.Gee <- lapply(1:nrow(Geeganage2010), function(i){matrix(c(1, r12, r12, 1), 2, 2)})

computvocv <- md.vcov(nt = subset(Geeganage2010, select = c(nt_SBP, nt_DBP)),
                    nc = subset(Geeganage2010, select = c(nc_SBP, nc_DBP)),
                    sdt = subset(Geeganage2010, select=c(sdt_SBP, sdt_DBP)),
                    sdc = subset(Geeganage2010, select=c(sdc_SBP, sdc_DBP)),
                    r = r.Gee)
# name variance-covariance matrix as covars
covars <- computvocv$md.cov

######################################################
# Running random-effects model using package "mvmeta"
######################################################
#library(mvmeta)
#mvmeta_RE <- summary(mvmeta(cbind(MD_SBP, MD_DBP), S = covars,
#                          data = subset(Geeganage2010, select = c(MD_SBP, MD_DBP)),
#                          method = "reml"))
#mvmeta_RE
```

`md_lgor` *Covariance between mean difference and log odds ratio*

Description

Compute covariance between mean difference and log odds ratio, when effect sizes are different.

Usage

```
md_lgor(r, n1c, n2c, n1t, n2t,
        n12c = min(n1c, n2c), n12t = min(n1t, n2t),
        s2c, s2t, f2c, f2t, sd1c, sd1t)
```

Arguments

`r`	Correlation coefficient of the two outcomes.
`n1c`	Number of participants reporting outcome 1 in control group.
`n2c`	Number of participants reporting outcome 2 in control group.
`n1t`	Number of participants reporting outcome 1 in treatment group.
`n2t`	Number of participants reporting outcome 2 in treatment group.
`n12c`	Number of participants reporting both outcome 1 and outcome 2 in control group. By default, it is equal to the smaller number between n1c and n2c.
`n12t`	Number defined in a similar way as n12c for treatment group.
`s2c`	Number of participants with event for outcome 2 (dichotomous) in control group.
`s2t`	Defined in a similar way as s2c for treatment group.
`f2c`	Number of participants without event for outcome 2 (dichotomous) in control group.
`f2t`	Defined in a similar way as f2c for treatment group.
`sd1c`	Sample standard deviation of outcome 1.
`sd1t`	Defined in a similar way as sd1c for treatment group.

Value

Return the computed covariance.

Author(s)

Min Lu

References

Ahn, S., Lu, M., Lefevor, G.T., Fedewa, A. & Celimli, S. (2016). Application of meta-analysis in sport and exercise science. In N. Ntoumanis, & N. Myers (Eds.), *An Introduction to Intermediate and Advanced Statistical Analyses for Sport and Exercise Scientists* (pp.233-253). Hoboken, NJ: John Wiley and Sons, Ltd.

Wei, Y., & Higgins, J. (2013). Estimating within study covariances in multivariate meta-analysis with multiple outcomes. *Statistics in Medicine, 32*(7), 119-1205.

Examples

```
## simple example
md_lgor(r = 0.71, n1c = 34, n2c = 35, n1t = 25, n2t = 32,
        s2c = 5, s2t = 8, f2c = 30, f2t = 24, sd1t = 0.4, sd1c = 8)
## calculate covariances for variable SBP and DD in Geeganage2010 data
attach(Geeganage2010)
SBP_DD <- unlist(lapply(1:nrow(Geeganage2010), function(i){md_lgor(r = 0.71,
               n1c = nc_SBP[i], n2c = nc_DD[i], n1t = nt_SBP[i], n2t = nt_DD[i],
               sd1t = sdt_SBP[i], s2t = st_DD[i], sd1c = sdc_SBP[i], s2c = sc_DD[i],
               f2c = nc_DD[i] - sc_DD[i], f2t = nt_DD[i] - st_DD[i])}))
SBP_DD
```

---

md_lgrr *Covariance between mean difference and log risk ratio*

Description

Compute covariance between mean difference and log risk ratio, when effect sizes are different.

Usage

```
md_lgrr(r, n1c, n2c, n1t, n2t,
        n12c = min(n1c, n2c), n12t = min(n1t, n2t),
        s2c, s2t, f2c, f2t, sd1c, sd1t)
```

Arguments

`r`	Correlation coefficient of the two outcomes.
`n1c`	Number of participants reporting outcome 1 in control group.
`n2c`	Number of participants reporting outcome 2 in control group.
`n1t`	Number of participants reporting outcome 1 in treatment group.
`n2t`	Number of participants reporting outcome 2 in treatment group.
`n12c`	Number of participants reporting both outcome 1 and outcome 2 in control group. By default, it is equal to the smaller number between n1c and n2c.
`n12t`	Number defined in a similar way as n12c for treatment group.
`s2c`	Number of participants with event for outcome 2 (dichotomous) in control group.
`s2t`	Defined in a similar way as s2c for treatment group.
`f2c`	Number of participants without event for outcome 2 (dichotomous) in control group.
`f2t`	Defined in a similar way as f2c for treatment group.
`sd1c`	Sample standard deviation of outcome 1.
`sd1t`	Defined in a similar way as sd1c for treatment group.

Value

Return the computed covariance.

Author(s)

Min Lu

References

Ahn, S., Lu, M., Lefevor, G.T., Fedewa, A. & Celimli, S. (2016). Application of meta-analysis in sport and exercise science. In N. Ntoumanis, & N. Myers (Eds.), *An Introduction to Intermediate and Advanced Statistical Analyses for Sport and Exercise Scientists* (pp.233-253). Hoboken, NJ: John Wiley and Sons, Ltd.

Wei, Y., & Higgins, J. (2013). Estimating within study covariances in multivariate meta-analysis with multiple outcomes. *Statistics in Medicine, 32*(7), 119-1205.

Examples

```
## simple example
md_lgrr(r = 0.71, n1c = 34, n2c = 35, n1t = 25, n2t = 32,
        s2c = 5, s2t = 8, f2c = 30, f2t = 24, sd1t = 0.4, sd1c = 8)
## calculate covariances for variable SBP and DD in Geeganage2010 data
attach(Geeganage2010)
SBP_DD <- unlist(lapply(1:nrow(Geeganage2010), function(i){md_lgrr(r = 0.71,
                n1c = nc_SBP[i], n2c = nc_DD[i], n1t = nt_SBP[i], n2t = nt_DD[i],
                sd1t = sdt_SBP[i], s2t = st_DD[i], sd1c = sdc_SBP[i], s2c = sc_DD[i],
                f2c = nc_DD[i] - sc_DD[i], f2t = nt_DD[i] - st_DD[i])}))
SBP_DD
```

`md_rd` *Covariance between mean difference and risk difference*

Description

Compute covariance between mean difference and risk difference, when effect sizes are different.

Usage

```
md_rd(r, n1c, n2c, n1t, n2t,
      n12c = min(n1c, n2c), n12t = min(n1t, n2t),
      s2c, s2t, f2c, f2t, sd1c, sd1t)
```

Arguments

r	Correlation coefficient of the two outcomes.
n1c	Number of participants reporting outcome 1 in control group.
n2c	Number of participants reporting outcome 2 in control group.
n1t	Number of participants reporting outcome 1 in treatment group.
n2t	Number of participants reporting outcome 2 in treatment group.
n12c	Number of participants reporting both outcome 1 and outcome 2 in control group. By default, it is equal to the smaller number between n1c and n2c.
n12t	Number defined in a similar way as n12c for treatment group.
s2c	Number of participants with event for outcome 2 (dichotomous) in control group.
s2t	Defined in a similar way as s2c for treatment group.
f2c	Number of participants without event for outcome 2 (dichotomous) in control group.
f2t	Defined in a similar way as f2c for treatment group.
sd1c	Sample standard deviation of outcome 1.
sd1t	Defined in a similar way as sd1c for treatment group.

Value

Return the computed covariance.

Author(s)

Min Lu

References

Ahn, S., Lu, M., Lefevor, G.T., Fedewa, A. & Celimli, S. (2016). Application of meta-analysis in sport and exercise science. In N. Ntoumanis, & N. Myers (Eds.), *An Introduction to Intermediate and Advanced Statistical Analyses for Sport and Exercise Scientists* (pp.233-253). Hoboken, NJ: John Wiley and Sons, Ltd.

Wei, Y., & Higgins, J. (2013). Estimating within study covariances in multivariate meta-analysis with multiple outcomes. *Statistics in Medicine, 32*(7), 119-1205.

Examples

```
## simple example
md_rd(r = 0.71, n1c = 34, n2c = 35, n1t = 25, n2t = 32,
      s2c = 5, s2t = 8, f2c = 30, f2t = 24, sd1t = 0.4, sd1c = 8)
## calculate covariances for variable SBP and DD in Geeganage2010 data
attach(Geeganage2010)
SBP_DD <- unlist(lapply(1:nrow(Geeganage2010), function(i){md_rd(r = 0.71,
               n1c = nc_SBP[i], n2c = nc_DD[i], n1t = nt_SBP[i], n2t = nt_DD[i],
               sd1t = sdt_SBP[i], s2t = st_DD[i], sd1c = sdc_SBP[i], s2c = sc_DD[i],
               f2c = nc_DD[i] - sc_DD[i], f2t = nt_DD[i] - st_DD[i])}))
SBP_DD
```

md_smd *Covariance between mean difference and standardized mean difference*

Description

Compute covariance between mean difference and standardized mean difference, when effect sizes are different.

Usage

```
md_smd(r, n1c, n2c, n1t, n2t,
       n12c = min(n1c, n2c), n12t = min(n1t, n2t),
       sd1t, sd2t, sd1c, sd2c)
```

Arguments

r	Correlation coefficient of the two outcomes.
n1c	Number of participants reporting outcome 1 in control group.
n2c	Number of participants reporting outcome 2 in control group.
n1t	Number of participants reporting outcome 1 in treatment group.
n2t	Number of participants reporting outcome 2 in treatment group.
n12c	Number of participants reporting both outcome 1 and outcome 2 in control group. By default, it is equal to the smaller number between n1c and n2c.
n12t	Number defined in a similar way as n12c for treatment group.
sd1t	Sample standard deviation of outcome 1.
sd2t	Sample standard deviation of outcome 2.
sd1c	Defined in a similar way as sd1t for control group.
sd2c	Defined in a similar way as sd2t for control group.

Value

Return the computed covariance.

Author(s)

Min Lu

References

Ahn, S., Lu, M., Lefevor, G.T., Fedewa, A. & Celimli, S. (2016). Application of meta-analysis in sport and exercise science. In N. Ntoumanis, & N. Myers (Eds.), *An Introduction to Intermediate and Advanced Statistical Analyses for Sport and Exercise Scientists* (pp.233-253). Hoboken, NJ: John Wiley and Sons, Ltd.

Wei, Y., & Higgins, J. (2013). Estimating within study covariances in multivariate meta-analysis with multiple outcomes. *Statistics in Medicine, 32*(7), 119-1205.

Examples

```
## simple example
md_smd(r = 0.71, n1c = 34, n2c = 35, n1t = 25, n2t = 32,
       sd1t = 0.6, sd2t = 0.4, sd1c = 8, sd2c = 0.9)
## calculate covariances for variable SBP and DBP in Geeganage2010 data
attach(Geeganage2010)
SBP_DBP <- unlist(lapply(1:nrow(Geeganage2010), function(i){md_smd(r = 0.71,
                 n1c = nc_SBP[i], n2c = nc_DBP[i], n1t = nt_SBP[i], n2t = nt_DBP[i],
                 sd1t = sdt_SBP[i], sd2t = sdt_DBP[i],
                 sd1c = sdc_SBP[i], sd2c = sdc_SBP[i])}))
SBP_DBP
```

---

mix.vcov *Covariance matrix for mixed effect sizes*

Description

Compute variance-covariance matrices between different effect sizes. Effect sizes include mean difference (MD), standardized mean difference (SMD), log odds ratio (logOR), log risk ratio (logRR), and risk difference (RD). Formulas are in Table I of Wei et al.'s paper.

Usage

```
mix.vcov(d, r, nt, nc, st, sc, n_rt = 0, n_rc = 0, sdt, sdc, type)
```

Arguments

`d`	A matrix with standard mean differences from each of the outcome. d[i,j] is the value from study i for outcome j. If outcome j is not mean difference, NA has to be imputed in column j.
`r`	A list of correlation coefficient matrices of the outcomes from the studies. r[[k]][i,j] is the correlation coefficient between outcome i and outcome j from study k.
`nt`	A matrix with sample sizes in the treatment group reporting each of the outcome. nt[i,j] is the sample size from study i reporting outcome j.
`nc`	Defined in a similar way as nt for control group.
`st`	Number of participants with event for all outcomes (dichotomous) in treatment group. st[i,j] reports number of participants with event for outcome j in treatment group. If outcome j is not dichotomous, NA has to be imputed in column j.
`sc`	Defined in a similar way as st for control group.
`n_rt`	A list of matrices storing sample sizes in the treatment group reporting pairwised outcomes in the off diagonal elements. n_rt[[k]][i,j] is the sample size reporting both outcome i and outcome j from study k. Diagonal elements of these matrices are not used. The default value is zero, which means the smaller sample size reporting the corresponding two outcomes: i.e. n_rt[[k]][i,j]=min(nt[k,i],nt[k,j]).
`n_rc`	Defined in a similar way as n_rt for control group.

sdt
: Sample standard deviation from each of the outcome. sdt[i,j] is the sample standard deviation from study i for outcome j. If outcome j is not mean difference, NA has to be imputed in the jth column.

sdc
: Defined in a similar way as sdt for control group.

type
: A vector indicating types of effect sizes. "MD" stands for mean difference, "SMD" stands for standardized mean difference,"logOR" stands for log odds ratio, "logRR" stands for log risk ratio, and "RD" stands for risk difference.

Value

list.mix.cov A list of computed variance-covariance matrices.
mix.cov A matrix whose rows are computed variance-covariance vectors.

Author(s)

Min Lu

References

Wei, Y., & Higgins, J. (2013). Estimating within study covariances in multivariate meta-analysis with multiple outcomes. *Statistics in Medicine, 32*(7), 119-1205.

Examples

```
########################################################################
# Example: Geeganage2010 data
# Preparing covariances for multivariate meta analysis
# Choose variable SBP, DBP, DD, D with effect sizes "MD","MD","RD","lgOR"
########################################################################
data(Geeganage2010)
## set the correlation coefficients list r
r12 <- 0.71
r13 <- 0.5
r14 <- 0.25
r23 <- 0.6
r24 <- 0.16
r34 <- 0.16
r <- vec2sm(c(r12, r13, r14, r23, r24, r34), diag = FALSE)
diag(r) <- 1
mix.r <- lapply(1:nrow(Geeganage2010), function(i){r})
attach(Geeganage2010)
## compute variance co-variances
computvocv <- mix.vcov(type = c("MD", "MD", "RD", "lgOR"),
                     d = cbind(MD_SBP, MD_DBP, NA, NA),
                     sdt = cbind(sdt_SBP, sdt_DBP, NA, NA),
                     sdc = cbind(sdc_SBP, sdc_DBP, NA, NA),
                     nt = cbind(nt_SBP, nt_DBP, nt_DD, nt_D),
```

```
                     nc = cbind(nc_SBP, nc_DBP, nc_DD, nc_D),
                     st = cbind(NA, NA, st_DD, st_D),
                     sc = cbind(NA, NA, sc_DD, sc_D),
                     r = mix.r)
# name different effect sizes as an input
Input <- subset(Geeganage2010, select = c(MD_SBP, MD_DBP))
Input$RD_DD <- st_DD/nt_DD - sc_DD/nc_DD
Input$lgOR_D <- log((st_D/(nt_D - st_D))/(sc_D/(nc_D - sc_D)))
# name variance-covariance matrix as covars
covars <- computvocv$mix.cov
###############################################
# Running random-effects model using package "mvmeta"
###############################################
#library(mvmeta)
#mvmeta_RE <- summary(mvmeta(cbind(MD_SBP, MD_DBP, RD_DD, lgOR_D),
#                            S = covars, data = Input, method = "reml"))
#mvmeta_RE
```

`r.vcov` *Covariance matrix for correlation coefficients*

Description

Compute variance-covariance matrix for multivariate meta-analysis when effect size is correlation coefficient.

Usage

```
r.vcov(n, corflat, method = "average")
```

Arguments

`n`	Sample sizes from studies.
`corflat`	Correlation coefficients from studies.
`method`	Method "average" computes variance covariances with sample-size weighted mean correlation coefficients from all studies; method "each" computes variance covariances with each of the corresponding correlation coefficients.

Details

How to arrange correlation coefficients of each study from matrix to vector is in Cooper et al book page 385 to 386. Details for average method are in book of Cooper et al page 388.

Value

`list.rcov`	A list of computed Variance-covariance matrices.
`rcov`	A matrix whose rows are computed Variance-covariance vectors.
`zr`	Z transformed correlation coefficients from input "corflat".

list.rcov	A list of computed Variance-covariance matrices from z transformed correlation coefficients.
zcov	A matrix whose rows are computed Variance-covariance vectors from z transformed correlation coefficients.

Author(s)

Min Lu

References

Ahn, S., Lu, M., Lefevor, G.T., Fedewa, A. & Celimli, S. (2016). Application of meta-analysis in sport and exercise science. In N. Ntoumanis, & N. Myers (Eds.), *An Introduction to Intermediate and Advanced Statistical Analyses for Sport and Exercise Scientists* (pp.233-253). Hoboken, NJ: John Wiley and Sons, Ltd.

Cooper, H., Hedges, L.V., & Valentine, J.C. (Eds.) (2009). *The handbook of research synthesis and meta-analysis.* New York: Russell Sage Foundation.

Olkin, I., & Ishii, G. (1976). Asymptotic distribution of functions of a correlation matrix. In S. Ikeda (Ed.), *Essays in probability and statistics: A volume in honor of Professor Junjiro Ogawa* (pp.5-51). Tokyo, Japan: Shinko Tsusho.

Examples

```
  #######################################################
  # Example: Craft2003 data
  # Preparing covariances for multivariate meta-analysis
  #######################################################
  data(Craft2003)
  #extract correlation from the dataset (craft)
  corflat <- subset(Craft2003, select=C1:C6)
  # transform correlations to z and compute variance-covariance matrix.
  computvocv <- r.vcov(n = Craft2003$N, corflat = corflat, method = "average")
  # name transformed z scores as an input
  Input <- computvocv$zr
  # name variance-covariance matrix of trnasformed z scores as covars
  covars <- computvocv$zcov
  ######################################################
  # Running random-effects model using package "mvmeta"
  ######################################################
  #library(mvmeta)
  #mvmeta_RE <- summary(mvmeta(cbind(C1, C2, C3, C4, C5, C6),
  #                            S = covars, data = Input, method = "reml"))
  #mvmeta_RE
  ##############################################################
  # Another example:
  # Checking the example in Harris Cooper et al.'s book page 388
  ##############################################################
r1 <- c(-0.074, -0.127, 0.324, 0.523, -0.416, -0.414)
r <- rbind(r1, r1) ### the r.vcov is to handle at least two studies
n <- c(142, 142)
computvcov <- r.vcov(n = n, corflat = r, method = "average")
```

```
round(computvcov$list.rcov[[1]], 4)
round(computvcov$list.zcov[[1]], 4)
```

---

rd.vcov *Covariance matrix for risk differences*

Description

Compute variance-covariance matrix for multivariate meta-analysis when effect size is risk difference.

Usage

```
rd.vcov(r, nt, nc, st, sc, n_rt = 0, n_rc = 0)
```

Arguments

r	A list of correlation coefficient matrices of the outcomes from the studies. r[[k]][i,j] is the correlation coefficient between outcome i and outcome j from study k.
nt	Sample sizes in the treatment group reporting each of the outcome. nt[i,j] means the sample size from study i reporting outcome j.
nc	Defined in a similar way as nt for control group.
st	Number of participants with event for all outcomes (dichotomous) in treatment group. st[i,j] is number of participants with event for outcome j in treatment group.
sc	Defined in a similar way as st for control group.
n_rt	A list of matrices storing sample sizes in the treatment group reporting pairwised outcomes in the off diagonal elements. n_rt[[k]][i,j] means the sample size reporting both outcome i and outcome j from study k. Diagonal elements of these matrices are not used. The default value is zero, which means the smaller sample size reporting the corresponding two outcomes: i.e. n_rt[[k]][i,j]=min(nt[k,i],nt[k,j]).
n_rc	Defined in a similar way as n_rt for control group.

Value

rd	Computed risk difference from input.
list.lgOR.cov	A list of computed variance-covariance matrices.
lgOR.cov	A matrix whose rows are computed variance-covariance vectors.

Author(s)

Min Lu

References

Ahn, S., Lu, M., Lefevor, G.T., Fedewa, A. & Celimli, S. (2016). Application of meta-analysis in sport and exercise science. In N. Ntoumanis, & N. Myers (Eds.), *An Introduction to Intermediate and Advanced Statistical Analyses for Sport and Exercise Scientists* (pp.233-253). Hoboken, NJ: John Wiley and Sons, Ltd.

Wei, Y., & Higgins, J. (2013). Estimating within study covariances in multivariate meta-analysis with multiple outcomes. *Statistics in Medicine, 32*(7), 119-1205.

Examples

```
#############################################################################
# Example: Geeganage2010 data
# Preparing risk differences and covariances for multivariate meta-analysis
#############################################################################
data(Geeganage2010)
## set the correlation coefficients list r
r12 <- 0.71
r.Gee <- lapply(1:nrow(Geeganage2010), function(i){matrix(c(1, r12, r12, 1), 2, 2)})


computvocv <- rd.vcov(nt = subset(Geeganage2010, select = c(nt_DD, nt_D)),
                      nc = subset(Geeganage2010, select = c(nc_DD, nc_D)),
                      st = subset(Geeganage2010, select = c(st_DD, st_D)),
                      sc = subset(Geeganage2010, select = c(sc_DD, sc_D)),
                      r = r.Gee)
# name computed relative risk as an input
Input <- computvocv$rd
colnames(Input) <- c("rd.DD", "rd.D")
# name variance-covariance matrix of trnasformed z scores as covars
covars <- computvocv$rd.cov
#################################################################
# Running random-effects model using package "mvmeta"
##################################################################
#library(mvmeta)
#mvmeta_RE <- summary(mvmeta(cbind(rd.DD, rd.D),
#                           S = covars, data = as.data.frame(Input),
#                           method = "reml"))
#mvmeta_RE
```

---

smd.vcov *Covariance matrix for standardized mean differences*

Description

Compute variance-covariance matrix for multivariate meta-analysis when effect size is standardized mean difference.

Usage

```
smd.vcov(nt, nc, d, r, n_rt = 0, n_rc = 0)
```

Arguments

nt	A matrix with sample sizes in the treatment group reporting each of the outcome. nt[i,j] is the sample size from study i reporting outcome j.
nc	Defined in a similar way as nt for control group.
d	A matrix with standardized mean differences from each of the outcome. d[i,j] is the value from study i for outcome j.
r	A list of correlation coefficient matrices of the outcomes from the studies. r[[k]][i,j] is the correlation coefficient between outcome i and outcome j from study k.
n_rt	A list of matrices storing sample sizes in the treatment group reporting pairwised outcomes in the off diagonal elements. n_rt[[k]][i,j] is the sample size reporting both outcome i and outcome j from study k. Diagonal elements of these matrices are not used. The default value is zero, which means the smaller sample size reporting the corresponding two outcomes: i.e. n_rt[[k]][i,j]=min(nt[k,i],nt[k,j]).
n_rc	Defined in a similar way as n_rt for control group.

Value

list.mix.cov	A list of computed variance-covariance matrices.
mix.cov	A matrix whose rows are computed variance-covariance vectors.

Author(s)

Min Lu

References

Ahn, S., Lu, M., Lefevor, G.T., Fedewa, A. & Celimli, S. (2016). Application of meta-analysis in sport and exercise science. In N. Ntoumanis, & N. Myers (Eds.), *An Introduction to Intermediate and Advanced Statistical Analyses for Sport and Exercise Scientists* (pp.233-253). Hoboken, NJ: John Wiley and Sons, Ltd.

Wei, Y., & Higgins, J. (2013). Estimating within study covariances in multivariate meta-analysis with multiple outcomes. *Statistics in Medicine, 32*(7), 119-1205.

Examples

```
#######################################################
# Example: Geeganage2010 data
# Preparing covarianceS for multivariate meta-analysis
#######################################################
data(Geeganage2010)
## set the correlation coefficients list r
r12 <- 0.71
r.Gee <- lapply(1:nrow(Geeganage2010), function(i){matrix(c(1, r12, r12, 1), 2, 2)})
```

```
computvocv <- smd.vcov(nt = subset(Geeganage2010, select = c(nt_SBP, nt_DBP)),
               nc = subset(Geeganage2010, select = c(nc_SBP, nc_DBP)),
               d = subset(Geeganage2010, select = c(SMD_SBP, SMD_DBP)), r = r.Gee)
# name variance-covariance matrix as covars
covars <- computvocv$smd.cov
#####################################################
# Running random-effects model using package "mvmeta"
#####################################################
#library(mvmeta)
#mvmeta_RE <- summary(mvmeta(cbind(SMD_SBP, SMD_DBP),
#                      S = covars,
#                      data = subset(Geeganage2010, select = c(SMD_SBP, SMD_DBP)),
#                      method = "reml"))
#mvmeta_RE
```

---

smd_lgor *Covariance between standardized mean difference and log odds ratio*

Description

Compute covariance between standardized mean difference and log odds ratio, when effect sizes are different.

Usage

```
smd_lgor(r, n1c, n2c, n1t, n2t,
          n12c = min(n1c, n2c), n12t = min(n1t, n2t),
          s2c, s2t, f2c, f2t, sd1c, sd1t)
```

Arguments

r	Correlation coefficient of the two outcomes.
n1c	Number of participants reporting outcome 1 in control group.
n2c	Number of participants reporting outcome 2 in control group.
n1t	Number of participants reporting outcome 1 in treatment group.
n2t	Number of participants reporting outcome 2 in treatment group.
n12c	Number of participants reporting both outcome 1 and outcome 2 in control group. By default, it is equal to the smaller number between n1c and n2c.
n12t	Number defined in a similar way as n12c for treatment group.
s2c	Number of participants with event for outcome 2 (dichotomous) in control group.
s2t	Defined in a similar way as s2c for treatment group.
f2c	Number of participants without event for outcome 2 (dichotomous) in control group.
f2t	Defined in a similar way as f2c for treatment group.
sd1c	Sample standard deviation of outcome 1.
sd1t	Defined in a similar way as sd1c for treatment group.

Value

Return the computed covariance.

Author(s)

Min Lu

References

Ahn, S., Lu, M., Lefevor, G.T., Fedewa, A. & Celimli, S. (2016). Application of meta-analysis in sport and exercise science. In N. Ntoumanis, & N. Myers (Eds.), *An Introduction to Intermediate and Advanced Statistical Analyses for Sport and Exercise Scientists* (pp.233-253). Hoboken, NJ: John Wiley and Sons, Ltd.

Wei, Y., & Higgins, J. (2013). Estimating within study covariances in multivariate meta-analysis with multiple outcomes. *Statistics in Medicine, 32*(7), 119-1205.

Examples

```
## simple example
smd_lgor(r = 0.71, n1c = 34, n2c = 35, n1t = 25, n2t = 32,
        s2c = 5, s2t = 8, f2c = 30, f2t = 24, sd1t = 0.4, sd1c = 8)
## calculate covariances for variable SBP and DD in Geeganage2010 data
attach(Geeganage2010)
SBP_DD <- unlist(lapply(1:nrow(Geeganage2010), function(i){smd_lgor(r = 0.71,
                n1c = nc_SBP[i], n2c = nc_DD[i], n1t = nt_SBP[i], n2t = nt_DD[i],
                sd1t = sdt_SBP[i], s2t = st_DD[i], sd1c = sdc_SBP[i], s2c = sc_DD[i],
                f2c = nc_DD[i] - sc_DD[i], f2t = nt_DD[i] - st_DD[i])}))
SBP_DD
```

---

smd_lgrr *Covariance between standardized mean difference and log risk ratio*

Description

Compute covariance between standardized mean difference and log risk ratio, when effect sizes are different.

Usage

```
smd_lgrr(r, n1c, n2c, n1t, n2t,
        n12c = min(n1c, n2c), n12t = min(n1t, n2t),
        s2c, s2t, f2c, f2t, sd1c, sd1t)
```

Arguments

r	Correlation coefficient of the two outcomes.
n1c	Number of participants reporting outcome 1 in control group.
n2c	Number of participants reporting outcome 2 in control group.
n1t	Number of participants reporting outcome 1 in treatment group.
n2t	Number of participants reporting outcome 2 in treatment group.
n12c	Number of participants reporting both outcome 1 and outcome 2 in control group. By default, it is equal to the smaller number between n1c and n2c.
n12t	Number defined in a similar way as n12c for treatment group.
s2c	Number of participants with event for outcome 2 (dichotomous) in control group.
s2t	Defined in a similar way as s2c for treatment group
f2c	Number of participants without event for outcome 2 (dichotomous) in control group.
f2t	Defined in a similar way as f2c for treatment group
sd1c	Sample standard deviation of outcome 1.
sd1t	Defined in a similar way as sd1c for treatment group.

Value

Return the computed covariance.

Author(s)

Min Lu

References

Ahn, S., Lu, M., Lefevor, G.T., Fedewa, A. & Celimli, S. (2016). Application of meta-analysis in sport and exercise science. In N. Ntoumanis, & N. Myers (Eds.), *An Introduction to Intermediate and Advanced Statistical Analyses for Sport and Exercise Scientists* (pp.233-253). Hoboken, NJ: John Wiley and Sons, Ltd.

Wei, Y., & Higgins, J. (2013). Estimating within study covariances in multivariate meta-analysis with multiple outcomes. *Statistics in Medicine, 32*(7), 119-1205.

Examples

```
## simple example
smd_lgrr(r = 0.3, n1c = 34, n2c = 35, n1t = 25, n2t = 32,
         s2c = 5, s2t = 8, f2c = 30, f2t = 24, sd1t = 0.4, sd1c = 8)
## calculate covariances for variable SBP and DD in Geeganage2010 data
attach(Geeganage2010)
SBP_DD <- unlist(lapply(1:nrow(Geeganage2010), function(i){smd_lgrr(r = 0.3,
                 n1c = nc_SBP[i], n2c = nc_DD[i], n1t = nt_SBP[i], n2t = nt_DD[i],
                 sd1t = sdt_SBP[i], s2t = st_DD[i], sd1c = sdc_SBP[i], s2c = sc_DD[i],
                 f2c = nc_DD[i] - sc_DD[i], f2t = nt_DD[i] - st_DD[i])}))
SBP_DD
```

smd_rd *Covariance between standardized mean difference and risk difference*

Description

Compute covariance between standardized mean difference and risk difference, when effect sizes are different.

Usage

```
smd_rd(r, n1c, n2c, n1t, n2t,
       n12c = min(n1c, n2c), n12t = min(n1t, n2t),
       s2c, s2t, f2c, f2t, sd1c, sd1t)
```

Arguments

r	Correlation coefficient of the two outcomes.
n1c	Number of participants reporting outcome 1 in control group.
n2c	Number of participants reporting outcome 2 in control group.
n1t	Number of participants reporting outcome 1 in treatment group.
n2t	Number of participants reporting outcome 2 in treatment group.
n12c	Number of participants reporting both outcome 1 and outcome 2 in control group. By default, it is equal to the smaller number between n1c and n2c.
n12t	Number defined in a similar way as n12c for treatment group.
s2c	Number of participants with event for outcome 2 (dichotomous) in control group.
s2t	Defined in a similar way as s2c for treatment group.
f2c	Number of participants without event for outcome 2 (dichotomous) in control group.
f2t	Defined in a similar way as f2c for treatment group.
sd1c	Sample standard deviation of outcome 1.
sd1t	Defined in a similar way as sd1c for treatment group.

Value

Return the computed covariance.

Author(s)

Min Lu

References

Ahn, S., Lu, M., Lefevor, G.T., Fedewa, A. & Celimli, S. (2016). Application of meta-analysis in sport and exercise science. In N. Ntoumanis, & N. Myers (Eds.), *An Introduction to Intermediate and Advanced Statistical Analyses for Sport and Exercise Scientists* (pp.233-253). Hoboken, NJ: John Wiley and Sons, Ltd.

Wei, Y., & Higgins, J. (2013). Estimating within study covariances in multivariate meta-analysis with multiple outcomes. *Statistics in Medicine, 32*(7), 119-1205.

Examples

```
## simple example
smd_rd(r = 0.71, n1c = 34, n2c = 35, n1t = 25, n2t = 32,
       s2c = 5, s2t = 8, f2c = 30, f2t = 24, sd1t = 0.4, sd1c = 8)
## calculate covariances for variable SBP and DD in Geeganage2010 data
attach(Geeganage2010)
SBP_DD <- unlist(lapply(1:nrow(Geeganage2010), function(i){smd_rd(r = 0.71,
                n1c = nc_SBP[i], n2c = nc_DD[i], n1t = nt_SBP[i], n2t = nt_DD[i],
                sd1t = sdt_SBP[i], s2t = st_DD[i], sd1c = sdc_SBP[i], s2c = sc_DD[i],
                f2c = nc_DD[i] - sc_DD[i], f2t = nt_DD[i] - st_DD[i])}))
SBP_DD
```

Index