# Network Meta-Analysis

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```
require(mvmeta)
```

```
## Loading required package: mvmeta
```

```
## This is mvmeta 0.4.7. For an overview type: help('mvmeta-package').
```

```
require(metaSEM)
```

```
## Loading required package: metaSEM
```

```
## Loading required package: OpenMx
```

```
## To take full advantage of multiple cores, use:
##   mxOption(NULL, 'Number of Threads', parallel::detectCores()) #now
##   Sys.setenv(OMP_NUM_THREADS=parallel::detectCores()) #before library(OpenMx)
```

```
## "SLSQP" is set as the default optimizer in OpenMx.
```

```
## mxOption(NULL, "Gradient algorithm") is set at "central".
```

```
## mxOption(NULL, "Optimality tolerance") is set at "6.3e-14".
```

```
## mxOption(NULL, "Gradient iterations") is set at "2".
```

```
net_dat <- read.csv("Data_for_metaSEM_forum.csv", header = TRUE)

# Within each outcome, there are values for implicit_measure that are 0 and 1
table(!is.na(net_dat[, "red_act_dir"]), net_dat[, "implicit_measure"])
```

```
##
##           0   1
##   FALSE 119 208
##   TRUE   28  84
```

```
table(!is.na(net_dat[, "red_act_ind"]), net_dat[, "implicit_measure"])
```

```
##
##           0   1
##   FALSE 118 215
##   TRUE   29  77
```

```
table(!is.na(net_dat[, "red_goal"]), net_dat[, "implicit_measure"])
```

```
##
##           0   1
##   FALSE 112 261
##   TRUE   35  31
```

```
table(!is.na(net_dat[, "affirm"]), net_dat[, "implicit_measure"])
```

```
##
##           0   1
##   FALSE 145 279
##   TRUE    2  13
```

```r
table(!is.na(net_dat[, "pos_mood"]), net_dat[, "implicit_measure"])
```

```
##
##           0   1
##   FALSE 137 283
##   TRUE   10   9
```

```r
table(!is.na(net_dat[, "neg_mood"]), net_dat[, "implicit_measure"])
```

```
##
##           0   1
##   FALSE 131 283
##   TRUE   16   9
```

```r
table(!is.na(net_dat[, "threat"]), net_dat[, "implicit_measure"])
```

```
##
##           0   1
##   FALSE 131 245
##   TRUE   16  47
```

```r
table(!is.na(net_dat[, "deplete"]), net_dat[, "implicit_measure"])
```

```
##
##           0   1
##   FALSE 135 281
##   TRUE   12  11
```

```r
table(!is.na(net_dat[, "inc_goal"]), net_dat[, "implicit_measure"])
```

```
##
##           0   1
##   FALSE 125 278
##   TRUE   22  14
```

```r
table(!is.na(net_dat[, "inc_act_dir"]), net_dat[, "implicit_measure"])
```

```
##
##           0   1
##   FALSE 123 220
##   TRUE   24  72
```

```r
table(!is.na(net_dat[, "inc_act_ind"]), net_dat[, "implicit_measure"])
```

```
##
##           0   1
##   FALSE 135 246
##   TRUE   12  46
```

```r
n <- 11
mat <- matrix(NA, ncol = n, nrow = n)
cov_names <- which(lower.tri(mat, diag = TRUE), arr.ind = TRUE)
cov_names <- apply(cov_names, 1, function(x) paste("cov", paste(x, collapse = "_"),
                                                   sep = "_"))

con <- matrix(NA, nrow = n, ncol = n)
diag(con) <- ".063*a"
con[lower.tri(con)] <- ".029*b"
con[upper.tri(con)] <- ".029*b"
```

```r
# Test overall model without covariates.  This works
mod <- meta(y = net_dat[, 2:12],
            v = net_dat[, cov_names],
            RE.constraints = con)
summary(mod)
```

```
##
## Call:
## meta(y = net_dat[, 2:12], v = net_dat[, cov_names], RE.constraints = con)
##
## 95% confidence intervals: z statistic approximation
## Coefficients:
##               Estimate  Std.Error     lbound     ubound z value  Pr(>|z|)
## Intercept1  -0.2027657  0.0433266 -0.2876842 -0.1178472 -4.6799 2.870e-06
## Intercept2  -0.3415005  0.0462986 -0.4322441 -0.2507569 -7.3760 1.630e-13
## Intercept3  -0.2960616  0.0551322 -0.4041187 -0.1880045 -5.3700 7.872e-08
## Intercept4  -0.0923674  0.1138230 -0.3154563  0.1307215 -0.8115  0.417078
## Intercept5  -0.0919509  0.1514019 -0.3886931  0.2047913 -0.6073  0.543632
## Intercept6  -0.1986121  0.1309089 -0.4551887  0.0579646 -1.5172  0.129222
## Intercept7   0.0576875  0.0582595 -0.0564991  0.1718740  0.9902  0.322086
## Intercept8   0.2725811  0.0931579  0.0899949  0.4551673  2.9260  0.003433
## Intercept9   0.1710940  0.0731922  0.0276400  0.3145480  2.3376  0.019408
## Intercept10  0.2517622  0.0472683  0.1591180  0.3444064  5.3262 1.003e-07
## Intercept11  0.1829489  0.0623312  0.0607820  0.3051157  2.9351  0.003334
## a            0.1130759  0.0144787  0.0846983  0.1414536  7.8098 5.773e-15
## b            0.0436056  0.0187699  0.0068172  0.0803939  2.3232  0.020171
##
## Intercept1  ***
## Intercept2  ***
## Intercept3  ***
## Intercept4
## Intercept5
## Intercept6
## Intercept7
## Intercept8  **
## Intercept9  *
## Intercept10 ***
## Intercept11 **
## a           ***
## b           *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Q statistic on the homogeneity of effect sizes: 1503.775
## Degrees of freedom of the Q statistic: 608
## P value of the Q statistic: 0
##
## Heterogeneity indices (based on the estimated Tau2):
##                                Estimate
## Intercept1: I2 (Q statistic)    0.6896
## Intercept2: I2 (Q statistic)    0.5870
## Intercept3: I2 (Q statistic)    0.6068
## Intercept4: I2 (Q statistic)    0.4465
```

```
## Intercept5: I2 (Q statistic)    0.2023
## Intercept6: I2 (Q statistic)    0.1939
## Intercept7: I2 (Q statistic)    0.6021
## Intercept8: I2 (Q statistic)    0.7652
## Intercept9: I2 (Q statistic)    0.6643
## Intercept10: I2 (Q statistic)   0.5710
## Intercept11: I2 (Q statistic)   0.4840
##
## Number of studies (or clusters): 439
## Number of observed statistics: 619
## Number of estimated parameters: 13
## Degrees of freedom: 606
## -2 log likelihood: 1606.245
## OpenMx status1: 0 ("0" or "1": The optimization is considered fine.
## Other values may indicate problems.)
```

```
# Test model with implicit_measure as a covariate.  This does not work
mod1 <- meta(y = net_dat[, 2:12],
             v = net_dat[, cov_names],
             x = net_dat[, "implicit_measure"],
             RE.constraints = con)
summary(mod1)
```

```
##
## Call:
## meta(y = net_dat[, 2:12], v = net_dat[, cov_names], x = net_dat[,
##     "implicit_measure"], RE.constraints = con)
##
## 95% confidence intervals: z statistic approximation
## Coefficients:
##               Estimate  Std.Error     lbound     ubound z value  Pr(>|z|)
## Intercept1  -0.2109650  0.0897997 -0.3869693 -0.0349608 -2.3493 0.0188095
## Intercept2  -0.2578582  0.0788417 -0.4123851 -0.1033314 -3.2706 0.0010733
## Intercept3  -0.1577604  0.0758480 -0.3064198 -0.0091009 -2.0800 0.0375298
## Intercept4  -0.0500887  0.2965706 -0.6313563  0.5311789 -0.1689 0.8658808
## Intercept5  -0.3819812  0.2444423 -0.8610792  0.0971169 -1.5627 0.1181316
## Intercept6  -0.3676466  0.1887201 -0.7375312  0.0022380 -1.9481 0.0514024
## Intercept7   0.1991309  0.1133433 -0.0230178  0.4212796  1.7569 0.0789377
## Intercept8   0.4372882  0.1316592  0.1792410  0.6953355  3.3214 0.0008958
## Intercept9   0.1176734  0.0915059 -0.0616749  0.2970217  1.2860 0.1984553
## Intercept10  0.1346010  0.0983722 -0.0582050  0.3274069  1.3683 0.1712236
## Intercept11  0.2509409  0.1205428  0.0146813  0.4872005  2.0818 0.0373646
## Slope1_1     0.0057903  0.1017686 -0.1936725  0.2052531  0.0569 0.9546273
## Slope2_1    -0.1251728  0.0966455 -0.3145946  0.0642490 -1.2952 0.1952602
## Slope3_1    -0.2785622  0.1077855 -0.4898180 -0.0673064 -2.5844 0.0097545
## Slope4_1    -0.0755864  0.3197649 -0.7023141  0.5511413 -0.2364 0.8131370
## Slope5_1     0.5505034  0.3089480 -0.0550235  1.1560303  1.7819 0.0747713
## Slope6_1     0.4094138  0.2670013 -0.1138991  0.9327266  1.5334 0.1251828
## Slope7_1    -0.2086637  0.1318182 -0.4670227  0.0496952 -1.5830 0.1134293
## Slope8_1    -0.3201655  0.1826517 -0.6781562  0.0378252 -1.7529 0.0796236
## Slope9_1     0.1556875  0.1468842 -0.1322001  0.4435752  1.0599 0.2891745
## Slope10_1    0.1499413  0.1113483 -0.0682974  0.3681800  1.3466 0.1781102
## Slope11_1   -0.1024665  0.1402228 -0.3772980  0.1723651 -0.7307 0.4649376
## a            0.1071071  0.0138687  0.0799249  0.1342893  7.7229 1.132e-14
## b            0.0446010  0.0175896  0.0101261  0.0790760  2.5356 0.0112239
```

```
##
## Intercept1  *
## Intercept2  **
## Intercept3  *
## Intercept4
## Intercept5
## Intercept6  .
## Intercept7  .
## Intercept8  ***
## Intercept9
## Intercept10
## Intercept11 *
## Slope1_1
## Slope2_1
## Slope3_1    **
## Slope4_1
## Slope5_1    .
## Slope6_1
## Slope7_1
## Slope8_1    .
## Slope9_1
## Slope10_1
## Slope11_1
## a           ***
## b           *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Q statistic on the homogeneity of effect sizes: 1503.775
## Degrees of freedom of the Q statistic: 608
## P value of the Q statistic: 0
##
## Explained variances (R2):
##                             y1      y2      y3      y4      y5      y6
## Tau2 (no predictor)    0.17067 0.18236 0.19911 0.13282 0.12049 0.14493
## Tau2 (with predictors)      NA      NA      NA      NA      NA      NA
## R2                          NA      NA      NA      NA      NA      NA
##                             y7      y8      y9     y10    y11
## Tau2 (no predictor)    0.14255 0.14334 0.11750 0.18562 0.1359
## Tau2 (with predictors)      NA      NA      NA      NA     NA
## R2                          NA      NA      NA      NA     NA
##
## Number of studies (or clusters): 439
## Number of observed statistics: 619
## Number of estimated parameters: 24
## Degrees of freedom: 595
## -2 log likelihood: 1581.615
## OpenMx status1: 0 ("0" or "1": The optimization is considered fine.
## Other values may indicate problems.)
```

```r
# Test model with implicit_measure as a covariate in mvmeta.  This works
mod2 <- mvmeta(cbind(red_act_dir, red_act_ind, red_goal, affirm, pos_mood,
                     neg_mood, threat, deplete, inc_goal, inc_act_dir, inc_act_ind) ~ implicit_measure,
               S = as.matrix(net_dat[, cov_names]),
```

```
              bscov = "cs",
              control = list(inputna = TRUE),
              data = net_dat)
summary(mod2)
```

```
## Call:  mvmeta(formula = cbind(red_act_dir, red_act_ind, red_goal, affirm,
##     pos_mood, neg_mood, threat, deplete, inc_goal, inc_act_dir,
##     inc_act_ind) ~ implicit_measure, S = as.matrix(net_dat[,
##     cov_names]), data = net_dat, bscov = "cs", control = list(inputna = TRUE))
##
## Multivariate random-effects meta-regression
## Dimension: 11
## Estimation method: REML
##
## Fixed-effects coefficients
## red_act_dir :
##                   Estimate  Std. Error        z  Pr(>|z|)  95%ci.lb
## (Intercept)        -0.2133      0.0922  -2.3128    0.0207   -0.3940
## implicit_measure    0.0077      0.1046   0.0732    0.9416   -0.1973
##                   95%ci.ub
## (Intercept)        -0.0325  *
## implicit_measure    0.2126
## red_act_ind :
##                   Estimate  Std. Error        z  Pr(>|z|)  95%ci.lb
## (Intercept)        -0.2577      0.0809  -3.1854    0.0014   -0.4163
## implicit_measure   -0.1274      0.0991  -1.2858    0.1985   -0.3216
##                   95%ci.ub
## (Intercept)        -0.0991  **
## implicit_measure    0.0668
## red_goal :
##                   Estimate  Std. Error        z  Pr(>|z|)  95%ci.lb
## (Intercept)        -0.1580      0.0777  -2.0338    0.0420   -0.3103
## implicit_measure   -0.2805      0.1106  -2.5366    0.0112   -0.4972
##                   95%ci.ub
## (Intercept)        -0.0057  *
## implicit_measure   -0.0638  *
## affirm :
##                   Estimate  Std. Error        z  Pr(>|z|)  95%ci.lb
## (Intercept)        -0.0486      0.3052  -0.1592    0.8735   -0.6469
## implicit_measure   -0.0770      0.3295  -0.2336    0.8153   -0.7227
##                   95%ci.ub
## (Intercept)         0.5497
## implicit_measure    0.5688
## pos_mood :
##                   Estimate  Std. Error        z  Pr(>|z|)  95%ci.lb
## (Intercept)        -0.3870      0.2519  -1.5365    0.1244   -0.8807
## implicit_measure    0.5556      0.3176   1.7493    0.0802   -0.0669
##                   95%ci.ub
## (Intercept)         0.1067
## implicit_measure    1.1780  .
## neg_mood :
##                   Estimate  Std. Error        z  Pr(>|z|)  95%ci.lb
## (Intercept)        -0.3676      0.1945  -1.8896    0.0588   -0.7488
## implicit_measure    0.4079      0.2742   1.4876    0.1368   -0.1295
```

```
##                   95%ci.ub
## (Intercept)         0.0137  .
## implicit_measure    0.9453
## threat :
##                   Estimate  Std. Error        z  Pr(>|z|)  95%ci.lb
## (Intercept)         0.1989      0.1164   1.7087    0.0875   -0.0292
## implicit_measure   -0.2089      0.1351  -1.5464    0.1220   -0.4738
##                   95%ci.ub
## (Intercept)         0.4270  .
## implicit_measure    0.0559
## deplete :
##                   Estimate  Std. Error        z  Pr(>|z|)  95%ci.lb
## (Intercept)         0.4405      0.1346   3.2720    0.0011    0.1766
## implicit_measure   -0.3221      0.1872  -1.7206    0.0853   -0.6890
##                   95%ci.ub
## (Intercept)         0.7043  **
## implicit_measure    0.0448   .
## inc_goal :
##                   Estimate  Std. Error       z  Pr(>|z|)  95%ci.lb
## (Intercept)         0.1194      0.0940  1.2704    0.2039   -0.0648
## implicit_measure    0.1563      0.1511  1.0346    0.3009   -0.1398
##                   95%ci.ub
## (Intercept)         0.3037
## implicit_measure    0.4525
## inc_act_dir :
##                   Estimate  Std. Error       z  Pr(>|z|)  95%ci.lb
## (Intercept)         0.1340      0.1010  1.3262    0.1848   -0.0640
## implicit_measure    0.1519      0.1144  1.3281    0.1842   -0.0723
##                   95%ci.ub
## (Intercept)         0.3320
## implicit_measure    0.3762
## inc_act_ind :
##                   Estimate  Std. Error        z  Pr(>|z|)  95%ci.lb
## (Intercept)         0.2511      0.1239   2.0270    0.0427    0.0083
## implicit_measure   -0.1036      0.1441  -0.7193    0.4720   -0.3860
##                   95%ci.ub
## (Intercept)         0.4940  *
## implicit_measure    0.1787
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Between-study random-effects (co)variance components
##  Structure: Compound symmetry
##              Std. Dev         Corr
## red_act_dir    0.3401  red_act_dir  red_act_ind  red_goal  affirm
## red_act_ind    0.3401       0.4016
## red_goal       0.3401       0.4016       0.4016
## affirm         0.3401       0.4016       0.4016    0.4016
## pos_mood       0.3401       0.4016       0.4016    0.4016  0.4016
## neg_mood       0.3401       0.4016       0.4016    0.4016  0.4016
## threat         0.3401       0.4016       0.4016    0.4016  0.4016
## deplete        0.3401       0.4016       0.4016    0.4016  0.4016
## inc_goal       0.3401       0.4016       0.4016    0.4016  0.4016
## inc_act_dir    0.3401       0.4016       0.4016    0.4016  0.4016
```

```
## inc_act_ind    0.3401       0.4016       0.4016    0.4016  0.4016
##
## red_act_dir  pos_mood  neg_mood  threat  deplete  inc_goal  inc_act_dir
## red_act_ind
## red_goal
## affirm
## pos_mood
## neg_mood       0.4016
## threat         0.4016    0.4016
## deplete        0.4016    0.4016  0.4016
## inc_goal       0.4016    0.4016  0.4016   0.4016
## inc_act_dir    0.4016    0.4016  0.4016   0.4016    0.4016
## inc_act_ind    0.4016    0.4016  0.4016   0.4016    0.4016       0.4016
##
## Multivariate Cochran Q-test for residual heterogeneity:
## Q = 1440.5680 (df = 597), p-value = 0.0000
## I-square statistic = 58.6%
##
## 439 studies, 619 observations, 22 fixed and 2 random-effects parameters
##      logLik          AIC          BIC
## -34749.9483   69547.8966   69653.3026
```

```
sessionInfo()
```

```
## R version 3.4.3 (2017-11-30)
## Platform: x86_64-pc-linux-gnu (64-bit)
## Running under: Linux Mint 18.2
##
## Matrix products: default
## BLAS: /usr/lib/openblas-base/libblas.so.3
## LAPACK: /usr/lib/libopenblasp-r0.2.18.so
##
## locale:
##  [1] LC_CTYPE=en_SG.UTF-8       LC_NUMERIC=C
##  [3] LC_TIME=en_SG.UTF-8        LC_COLLATE=en_SG.UTF-8
##  [5] LC_MONETARY=en_SG.UTF-8    LC_MESSAGES=en_SG.UTF-8
##  [7] LC_PAPER=en_SG.UTF-8       LC_NAME=C
##  [9] LC_ADDRESS=C               LC_TELEPHONE=C
## [11] LC_MEASUREMENT=en_SG.UTF-8 LC_IDENTIFICATION=C
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets  methods   base
##
## other attached packages:
## [1] metaSEM_0.9.16 OpenMx_2.8.3   mvmeta_0.4.7
##
## loaded via a namespace (and not attached):
##  [1] Rcpp_0.12.14    mvtnorm_1.0-6   lattice_0.20-35 digest_0.6.12
##  [5] rprojroot_1.3-2 MASS_7.3-48     grid_3.4.3      backports_1.1.2
##  [9] magrittr_1.5    ellipse_0.4.1   evaluate_0.10.1 stringi_1.1.6
## [13] Matrix_1.2-12   rmarkdown_1.8   tools_3.4.3     stringr_1.2.0
## [17] yaml_2.1.16     parallel_3.4.3  compiler_3.4.3  htmltools_0.3.6
## [21] knitr_1.18
```