Assignment\_2\_Q1

2024-10-11

#Question 1

#Part a.  
dat <- read.csv('C:/Users/Michael Le/Desktop/STA5MA\_Assignment\_2/means\_data.csv')  
  
dat

## Study m1 n1 sd1 m2 n2 sd2  
## 1 Azzi et al.(2007) 10.9 25 3.1 12.7 49 4.1  
## 2 Cao et al.(2020) 11.1 82 2.0 18.4 98 3.7  
## 3 Mehra et al.(2016) 13.1 21 2.3 12.0 35 3.3  
## 4 Silvapulle et al.(2019) 11.3 62 2.0 11.4 69 3.5  
## 5 Wang et al.(2016) 15.5 65 3.4 10.1 79 3.0

#sample sizes  
n1 <- dat$n1  
n2<- dat$n2  
  
#sample variances  
v1 <- (dat$sd1)^2  
v2 <- (dat$sd2)^2  
  
nu.1<-dat$n1 - 1  
nu.2<-dat$n2 - 1  
  
#log of ratios of variances and variance of log ratios  
log.ratios <- log(v1/v2)  
v.log.ratios <- 2\*(nu.1+nu.2 - 2)/nu.1/(nu.2-4)  
  
# The below carries out a bias adjustment so that the expected value  
# is closer to the log ratio of variances. The adjustment term is  
# obtained from the approximate expression of the mean of the log of   
# sample variance ratios following Eq. 15 in Prendergast & Staudte (2016).  
log.ratios.adj <- log.ratios - log(nu.2/(nu.2 - 2)) + v.log.ratios/2  
  
# SET METHOD. NOTE IN THE BELOW WE SELECT THE FIXED EFFECTS ANALYSIS FOR  
# EXAMPLE ONLY. IT IS USUALLY ADVISABLE TO USE A RANDOM EFFECTS META-ANALYSIS  
library(metafor)

## Warning: package 'metafor' was built under R version 4.3.3

## Loading required package: Matrix

## Loading required package: metadat

## Warning: package 'metadat' was built under R version 4.3.3

## Loading required package: numDeriv

##   
## Loading the 'metafor' package (version 4.6-0). For an  
## introduction to the package please type: help(metafor)

method <- "REML"  
res <- rma(yi = log.ratios.adj, vi = v.log.ratios, method = method)  
res

##   
## Random-Effects Model (k = 5; tau^2 estimator: REML)  
##   
## tau^2 (estimated amount of total heterogeneity): 0.3186 (SE = 0.2883)  
## tau (square root of estimated tau^2 value): 0.5644  
## I^2 (total heterogeneity / total variability): 80.25%  
## H^2 (total variability / sampling variability): 5.06  
##   
## Test for Heterogeneity:  
## Q(df = 4) = 24.2236, p-val < .0001  
##   
## Model Results:  
##   
## estimate se zval pval ci.lb ci.ub   
## -0.6700 0.2858 -2.3440 0.0191 -1.2301 -0.1098 \*   
##   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

meta\_data <- read.csv('C:/Users/Michael Le/Desktop/STA5MA\_Assignment\_2/means\_data.csv')  
  
#The log ratio of means for each study  
meta\_data$log\_r <- log(meta\_data$m1 / meta\_data$m2)  
  
  
#with the associated variances  
meta\_data$log\_r\_var = meta\_data$sd1^2 /(meta\_data$n1 \* meta\_data$m1 ^2) + meta\_data$sd2 ^ 2 /  
(meta\_data$n2 \* meta\_data$m2 ^ 2)  
  
  
meta\_data$ci\_lb = meta\_data$log\_r - qnorm(0.975) \* sqrt(meta\_data$log\_r\_var)  
  
meta\_data$ci\_ub = meta\_data$log\_r + qnorm(0.975) \* sqrt(meta\_data$log\_r\_var)  
  
meta\_data$weight = (1 / meta\_data$log\_r\_var)  
meta\_data$weight\_prop = (1 / meta\_data$log\_r\_var) / sum(1 / meta\_data$log\_r\_var)  
  
#SOLUTION: Part ai. Meta-estimate for FE. The estimate for the overall mean log ratio of variances  
theta <- sum(meta\_data$log\_r \* meta\_data$weight) / sum(meta\_data$weight)  
round(theta,5)

## [1] -0.14557

# Variance for the Meta-estimate  
var\_theta <- 1/sum(meta\_data$weight)  
round(var\_theta,10)

## [1] 0.000360782

#SOLUTION: Part b  
# For the log ratio of means for the last study is   
# and the associated variance, refer from the   
meta\_data[5,8:9]

## log\_r log\_r\_var  
## 5 0.4283046 0.001857048

meta\_data[5,8]

## [1] 0.4283046

meta\_data[5,9]

## [1] 0.001857048

#Part c  
meta\_data <- read.csv('C:/Users/Michael Le/Desktop/STA5MA\_Assignment\_2/means\_data.csv')  
rom.data <- escalc( n1i = dat$n1, n2i = dat$n2, m1i = dat$m1, m2i = dat$m2,  
sd1i = dat$sd1, sd2i = dat$sd2, measure = "ROM",slab = dat$Study,  
data = meta\_data)  
  
meta\_data\_model <- rma(yi = yi, vi = vi,data = rom.data, method = "REML")  
meta\_data\_model

##   
## Random-Effects Model (k = 5; tau^2 estimator: REML)  
##   
## tau^2 (estimated amount of total heterogeneity): 0.1160 (SE = 0.0839)  
## tau (square root of estimated tau^2 value): 0.3406  
## I^2 (total heterogeneity / total variability): 98.28%  
## H^2 (total variability / sampling variability): 58.21  
##   
## Test for Heterogeneity:  
## Q(df = 4) = 362.4884, p-val < .0001  
##   
## Model Results:  
##   
## estimate se zval pval ci.lb ci.ub   
## -0.0307 0.1541 -0.1993 0.8420 -0.3327 0.2713   
##   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

#Part d  
#Convert back to ratio scale  
#Transformed values  
  
#Estimate mean ratio  
est\_mu\_ratio <- exp(-0.0307)  
est\_mu\_ratio

## [1] 0.9697665

#Upper\_bound  
est\_lb <- exp(-0.3327)  
est\_lb

## [1] 0.7169853

#Lower\_bound  
est\_ub <- exp( 0.2713)  
est\_ub

## [1] 1.311669

#Continuing Part d  
  
#predict  
predict(meta\_data\_model)

##   
## pred se ci.lb ci.ub pi.lb pi.ub   
## -0.0307 0.1541 -0.3327 0.2713 -0.7635 0.7021

#Continuing Part d  
#transform back to ratio scale   
pred\_lb<-exp(-0.7635)  
pred\_lb

## [1] 0.4660325

pred\_ub<-exp(0.7021)  
pred\_ub

## [1] 2.017986