arrrh

```
library(mediation)
```

```
## Warning: package 'mediation' was built under R version 4.2.3
```

```
## Loading required package: MASS
```

```
## Loading required package: Matrix
```

```
## Loading required package: mvtnorm
```

```
## Loading required package: sandwich
```

```
## Warning: package 'sandwich' was built under R version 4.2.3
```

```
## mediation: Causal Mediation Analysis
## Version: 4.5.0
```

```
df <- read.csv('C:/Users/lhi30/Haein/2023/YBIGTA/DA/Project/Share/Stat_Analysis/Data_Cleanup/Data_Stat/S
head(df)
```

```
##   X  kaptCode   Date     electC electComb Elec_Con   Elev_Num Park_Below
## 1 0 A13203302 202210 12384.9951  46682.88        0 0.03685504 0.85012285
## 2 1 A13203303 202210  4845.2439  30853.59        0 0.01941748 0.00000000
## 3 2 A13295201 202210 12872.0258  49366.99        0 0.03870968 0.94193548
## 4 3 A13286107 202210   770.2577  41554.16        0 0.03780069 0.25429553
## 5 4 A13287801 202210  5637.1289  41772.60        0 0.04529617 0.08013937
## 6 5 A13286203 202210  3505.9053  26752.80        1 0.01893939 0.00000000
##   Begin_Date
## 1       7146
## 2      12861
## 3       5532
## 4       7268
## 5       9750
## 6      12392
```

```
A = df$Elec_Con
M = df$electC
Y = df$electComb
C1 = df$Begin_Date
C2 = df$Elev_Num
C3 = df$Park_Below
```

```r
#models
med = lm(M~A+C1+C2+C3)
out = lm(Y~A+M+M*A)
summary(med)
```

```
##
## Call:
## lm(formula = M ~ A + C1 + C2 + C3)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -47715  -5525  -2264   1279  74341
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 7.658e+02  1.484e+03   0.516 0.605820
## A           3.591e+03  6.571e+02   5.465 5.41e-08 ***
## C1          3.065e-01  1.133e-01   2.704 0.006924 **
## C2          7.946e+04  2.141e+04   3.712 0.000213 ***
## C3          7.008e+03  7.731e+02   9.066  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 11250 on 1492 degrees of freedom
## Multiple R-squared:  0.1416, Adjusted R-squared:  0.1393
## F-statistic: 61.55 on 4 and 1492 DF,  p-value: < 2.2e-16
```

```r
summary(out)
```

```
##
## Call:
## lm(formula = Y ~ A + M + M * A)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -55932  -6179   1930   8341 148343
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.464e+04  7.955e+02  43.545  < 2e-16 ***
## A           7.631e+03  1.438e+03   5.305 1.29e-07 ***
## M           7.835e-01  5.545e-02  14.130  < 2e-16 ***
## A:M         3.684e-01  7.781e-02   4.734 2.41e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 17750 on 1493 degrees of freedom
## Multiple R-squared:  0.3996, Adjusted R-squared:  0.3984
## F-statistic: 331.2 on 3 and 1493 DF,  p-value: < 2.2e-16
```

```r
beta0 = coefficients(med)[1]
beta1 = coefficients(med)[2]
theta1 = coefficients(out)[2]
theta2 = coefficients(out)[3]
theta3 = coefficients(out)[4]

m = 10000
CDE = theta1 + theta3*m
print(CDE)
```

```
##     A
## 11315
```

```r
NDE = theta1 + theta3*beta0 + theta3*beta1*0
print(NDE)
```

```
##        A
## 7913.365
```

```r
NIE = beta1*theta2 + beta1*theta3*1
print(NIE)
```

```
##        A
## 4136.632
```

```r
set.seed(2019122035)
med.out = mediate(med, out, treat = "A", mediator = "M", robustSE = TRUE, sims = 1000)
print(summary(med.out))
```

```
##
## Causal Mediation Analysis
##
## Quasi-Bayesian Confidence Intervals
##
##                          Estimate 95% CI Lower 95% CI Upper p-value
## ACME (control)           2.82e+03     1.62e+03      4158.50  <2e-16 ***
## ACME (treated)           4.06e+03     2.04e+03      6568.56  <2e-16 ***
## ADE (control)            1.18e+04     9.52e+03     13827.51  <2e-16 ***
## ADE (treated)            1.30e+04     1.07e+04     15407.28  <2e-16 ***
## Total Effect             1.58e+04     1.34e+04     18441.79  <2e-16 ***
## Prop. Mediated (control) 1.74e-01     1.11e-01         0.25  <2e-16 ***
## Prop. Mediated (treated) 2.53e-01     1.40e-01         0.38  <2e-16 ***
## ACME (average)           3.44e+03     1.85e+03      5244.91  <2e-16 ***
## ADE (average)            1.24e+04     1.04e+04     14408.73  <2e-16 ***
## Prop. Mediated (average) 2.13e-01     1.33e-01         0.30  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Sample Size Used: 1497
##
##
## Simulations: 1000
```

```r
#C1
med = lm(M~C1+A+C2+C3)
out = lm(Y~C1+M+M*C1)
summary(med)
```

```
##
## Call:
## lm(formula = M ~ C1 + A + C2 + C3)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -47715  -5525  -2264   1279  74341
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 7.658e+02  1.484e+03   0.516 0.605820
## C1          3.065e-01  1.133e-01   2.704 0.006924 **
## A           3.591e+03  6.571e+02   5.465 5.41e-08 ***
## C2          7.946e+04  2.141e+04   3.712 0.000213 ***
## C3          7.008e+03  7.731e+02   9.066  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 11250 on 1492 degrees of freedom
## Multiple R-squared:  0.1416, Adjusted R-squared:  0.1393
## F-statistic: 61.55 on 4 and 1492 DF,  p-value: < 2.2e-16
```

```r
summary(out)
```

```
##
## Call:
## lm(formula = Y ~ C1 + M + M * C1)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -59533  -4870   1513   7893 143798
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  4.306e+04  1.507e+03  28.583  < 2e-16 ***
## C1          -8.595e-01  1.746e-01  -4.922 9.51e-07 ***
## M            1.217e+00  6.825e-02  17.827  < 2e-16 ***
## C1:M        -3.497e-05  8.834e-06  -3.959 7.89e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 18010 on 1493 degrees of freedom
## Multiple R-squared:  0.3818, Adjusted R-squared:  0.3805
## F-statistic: 307.3 on 3 and 1493 DF,  p-value: < 2.2e-16
```

```r
beta0 = coefficients(med)[1]
beta1 = coefficients(med)[2]
```

```r
theta1 = coefficients(out)[2]
theta2 = coefficients(out)[3]
theta3 = coefficients(out)[4]

m = 10000
CDE = theta1 + theta3*m
print(CDE)
```

```
##       C1
## -1.20919
```

```r
NDE = theta1 + theta3*beta0 + theta3*beta1*0
print(NDE)
```

```
##         C1
## -0.8862587
```

```r
NIE = beta1*theta2 + beta1*theta3*1
print(NIE)
```

```
##        C1
## 0.3728298
```

```r
set.seed(2019122035)
med.out = mediate(med, out, treat = "C1", mediator = "M", robustSE = TRUE, sims = 1000)
print(summary(med.out))
```

```
##
## Causal Mediation Analysis
##
## Quasi-Bayesian Confidence Intervals
##
##                          Estimate 95% CI Lower 95% CI Upper p-value
## ACME (control)            0.37904     -0.00316         0.86   0.056 .
## ACME (treated)            0.37903     -0.00316         0.86   0.056 .
## ADE (control)            -1.20426     -1.51233        -0.89  <2e-16 ***
## ADE (treated)            -1.20427     -1.51233        -0.89  <2e-16 ***
## Total Effect             -0.82523     -1.36529        -0.10   0.030 *
## Prop. Mediated (control) -0.38910     -3.79169         0.06   0.086 .
## Prop. Mediated (treated) -0.38909     -3.79162         0.06   0.086 .
## ACME (average)            0.37903     -0.00316         0.86   0.056 .
## ADE (average)            -1.20427     -1.51233        -0.89  <2e-16 ***
## Prop. Mediated (average) -0.38910     -3.79166         0.06   0.086 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Sample Size Used: 1497
##
##
## Simulations: 1000
```

```r
#C2
med = lm(M~C2+A+C1+C3)
out = lm(Y~C2+M+M*C2)
summary(med)
```

```
##
## Call:
## lm(formula = M ~ C2 + A + C1 + C3)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -47715  -5525  -2264   1279  74341
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 7.658e+02  1.484e+03   0.516 0.605820
## C2          7.946e+04  2.141e+04   3.712 0.000213 ***
## A           3.591e+03  6.571e+02   5.465 5.41e-08 ***
## C1          3.065e-01  1.133e-01   2.704 0.006924 **
## C3          7.008e+03  7.731e+02   9.066  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 11250 on 1492 degrees of freedom
## Multiple R-squared:  0.1416, Adjusted R-squared:  0.1393
## F-statistic: 61.55 on 4 and 1492 DF,  p-value: < 2.2e-16
```

```r
summary(out)
```

```
##
## Call:
## lm(formula = Y ~ C2 + M + M * C2)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -80639  -6298    813   7718 112843
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 2.608e+04  1.273e+03  20.490  < 2e-16 ***
## C2          3.640e+05  3.765e+04   9.669  < 2e-16 ***
## M           7.936e-01  5.816e-02  13.645  < 2e-16 ***
## C2:M        4.752e+00  1.138e+00   4.177 3.13e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 17570 on 1493 degrees of freedom
## Multiple R-squared:  0.4114, Adjusted R-squared:  0.4102
## F-statistic: 347.8 on 3 and 1493 DF,  p-value: < 2.2e-16
```

```r
beta0 = coefficients(med)[1]
beta1 = coefficients(med)[2]
```

```r
theta1 = coefficients(out)[2]
theta2 = coefficients(out)[3]
theta3 = coefficients(out)[4]

m = 10000
CDE = theta1 + theta3*m
print(CDE)
```

```
##       C2
## 411549.8
```

```r
NDE = theta1 + theta3*beta0 + theta3*beta1*0
print(NDE)
```

```
##       C2
## 367664.1
```

```r
NIE = beta1*theta2 + beta1*theta3*1
print(NIE)
```

```
##       C2
## 440684.1
```

```r
set.seed(2019122035)
med.out = mediate(med, out, treat = "C2", mediator = "M", robustSE = TRUE, sims = 1000)
print(summary(med.out))
```

```
##
## Causal Mediation Analysis
##
## Quasi-Bayesian Confidence Intervals
##
##                            Estimate 95% CI Lower 95% CI Upper p-value
## ACME (control)             6.64e+04    -1.06e+04     2.01e+05    0.12
## ACME (treated)             3.24e+05    -2.47e+06     3.30e+06    0.80
## ADE (control)              4.14e+05     3.06e+05     5.12e+05  <2e-16 ***
## ADE (treated)              6.71e+05    -2.22e+06     3.65e+06    0.54
## Total Effect               7.38e+05    -2.04e+06     3.68e+06    0.51
## Prop. Mediated (control)   1.89e-02    -7.69e-01     7.30e-01    0.63
## Prop. Mediated (treated)   7.31e-01    -3.58e+00     4.38e+00    0.29
## ACME (average)             1.95e+05    -1.15e+06     1.65e+06    0.75
## ADE (average)              5.42e+05    -9.08e+05     2.03e+06    0.37
## Prop. Mediated (average)   3.75e-01    -1.29e+00     1.81e+00    0.24
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Sample Size Used: 1497
##
##
## Simulations: 1000
```

```r
#C3

med = lm(M~C3+A+C1+C2)
out = lm(Y~C3+M+M*C3)
summary(med)
```

```
##
## Call:
## lm(formula = M ~ C3 + A + C1 + C2)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -47715  -5525  -2264   1279  74341
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 7.658e+02  1.484e+03   0.516 0.605820
## C3          7.008e+03  7.731e+02   9.066  < 2e-16 ***
## A           3.591e+03  6.571e+02   5.465 5.41e-08 ***
## C1          3.065e-01  1.133e-01   2.704 0.006924 **
## C2          7.946e+04  2.141e+04   3.712 0.000213 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 11250 on 1492 degrees of freedom
## Multiple R-squared:  0.1416, Adjusted R-squared:  0.1393
## F-statistic: 61.55 on 4 and 1492 DF,  p-value: < 2.2e-16
```

```r
summary(out)
```

```
##
## Call:
## lm(formula = Y ~ C3 + M + M * C3)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -55576  -5580    963   7699 103894
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 2.811e+04  8.181e+02  34.356   <2e-16 ***
## C3          1.469e+04  8.703e+02  16.884   <2e-16 ***
## M           4.017e-01  4.669e-02   8.604   <2e-16 ***
## C3:M        3.270e-01  2.981e-02  10.969   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 14670 on 1493 degrees of freedom
## Multiple R-squared:  0.5898, Adjusted R-squared:  0.589
## F-statistic: 715.7 on 3 and 1493 DF,  p-value: < 2.2e-16
```

```r
beta0 = coefficients(med)[1]
beta1 = coefficients(med)[2]
theta1 = coefficients(out)[2]
theta2 = coefficients(out)[3]
theta3 = coefficients(out)[4]

m = 10000
CDE = theta1 + theta3*m
CDE
```

```
##       C3
## 17964.35
```

```r
NDE = theta1 + theta3*beta0 + theta3*beta1*0
NDE
```

```
##       C3
## 14944.85
```

```r
NIE = beta1*theta2 + beta1*theta3*1
NIE
```

```
##       C3
## 5107.385
```

```r
set.seed(2019122035)
med.out = mediate(med, out, treat = "C3", mediator = "M", robustSE = TRUE, sims = 1000)
summary(med.out)
```

```
##
## Causal Mediation Analysis
##
## Quasi-Bayesian Confidence Intervals
##
##                          Estimate 95% CI Lower 95% CI Upper p-value
## ACME (control)           2.83e+03     1.54e+03      4360.86  <2e-16 ***
## ACME (treated)           5.12e+03     3.24e+03      7027.69  <2e-16 ***
## ADE (control)            1.69e+04     1.51e+04     18803.15  <2e-16 ***
## ADE (treated)            1.92e+04     1.74e+04     21001.48  <2e-16 ***
## Total Effect             2.20e+04     1.99e+04     24116.66  <2e-16 ***
## Prop. Mediated (control) 1.26e-01     7.10e-02         0.19  <2e-16 ***
## Prop. Mediated (treated) 2.30e-01     1.56e-01         0.31  <2e-16 ***
## ACME (average)           3.97e+03     2.42e+03      5686.30  <2e-16 ***
## ADE (average)            1.81e+04     1.63e+04     19862.40  <2e-16 ***
## Prop. Mediated (average) 1.78e-01     1.16e-01         0.24  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Sample Size Used: 1497
##
##
## Simulations: 1000
```