R Notebook

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Load libraries

```
library(tidyverse)
```

```
## Warning: package 'ggplot2' was built under R version 3.6.3
```

```
## Warning: package 'tibble' was built under R version 3.6.3
```

```
## Warning: package 'tidyr' was built under R version 3.6.3
```

```
## Warning: package 'dplyr' was built under R version 3.6.3
```

```
## Warning: package 'forcats' was built under R version 3.6.3
```

```
library(psych)
library(mediation)
```

```
## Warning: package 'mediation' was built under R version 3.6.3
```

```
## Warning: package 'sandwich' was built under R version 3.6.3
```

```
library(ppcor)
```

Read in data

```
med <- read_csv("mediate2.csv")
```

```
## Parsed with column specification:
## cols(
##   X1 = col_double(),
##   X2 = col_double(),
##   X3 = col_double(),
##   X4 = col_double(),
##   X5 = col_double(),
##   Y1 = col_double()
## )
```

Class Demo

Baron & Kenny Plausibility: Examine Correlations between variables

Analysis 1: Test the hypothesis that X4 mediates the relationship between X1 and Y1

```
cor(med)
```

```
##            X1          X2         X3         X4         X5         Y1
## X1 1.00000000  0.03946291 0.03657073 0.04344269  0.1020180  0.3465506
## X2 0.03946291  1.00000000 0.08889150 0.06447405 -0.1310097 -0.3227619
## X3 0.03657073  0.08889150 1.00000000 0.34246913  0.7331822  0.5053060
## X4 0.04344269  0.06447405 0.34246913 1.00000000  0.4068431  0.4104644
## X5 0.10201803 -0.13100973 0.73318217 0.40684310  1.0000000  0.6405100
## Y1 0.34655064 -0.32276194 0.50530603 0.41046440  0.6405100  1.0000000
```

r xy = 0.3465 (c path) r xm = 0.043 (a path) r my = 0.4105 (b path)

We do not have justification to test this mdiation hypothesis because the a path has a negligible effect.

Analysis 2: Test the hypothesis that X4 mediates the relationship between X3 and Y1

r xy = 0.5053 r xm = 0.3425 r my = 0.4105

We do have justifaction to test this mediation hypothesis because all paths have a moderate effect

```
spcor.test(x = med$X3, y = med$Y1, z = med$X4)
```

```
##    estimate      p.value statistic   n gp  Method
## 1 0.3999824 2.030191e-24  10.66313 600  1 pearson
```

r y(x.m) = 0.3999. This is 0.11 smaller than r xy (0.5053), indicating that partial mediation is plausible. In other words, there is a portion of the relation betweeen x and y that involves m.

Regression method

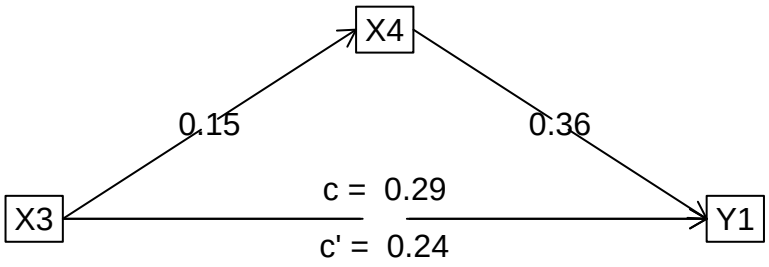
```
m1 <- lm(Y1 ~ X3      , data = med)
m2 <- lm(Y1 ~ X3 + X4 , data = med)

anova(m1,m2)
```

```
## Analysis of Variance Table
##
## Model 1: Y1 ~ X3
## Model 2: Y1 ~ X3 + X4
##   Res.Df    RSS Df Sum of Sq      F    Pr(>F)
## 1    598 373.91
## 2    597 341.85  1    32.062 55.993 2.617e-13 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

mediate in psych

```
fitmed <- psych::mediate(Y1 ~ X3 + (X4), data = med)
```




```
summary(fitmed)
```

```
## Call: psych::mediate(y = Y1 ~ X3 + (X4), data = med)
##
## Direct effect estimates (traditional regression)    (c')
##             Y1   se     t  df     Prob
## Intercept 1.52 0.16  9.47 597 6.57e-20
## X3        0.24 0.02 11.50 597 9.08e-28
## X4        0.36 0.05  7.48 597 2.62e-13
##
## R = 0.56 R2 = 0.32   F = 139.95 on 2 and 597 DF   p-value:  1.44e-50
##
##  Total effect estimates (c)
##      Y1   se     t  df     Prob
## X3 0.29 0.02 14.33 599 2.88e-40
##
##  'a'  effect estimates
##             X4   se     t  df     Prob
## Intercept 2.15 0.10 20.89 598 3.34e-73
## X3        0.15 0.02  8.91 598 5.94e-18
##
##  'b'  effect estimates
##      Y1   se    t  df    Prob
## X4 0.36 0.05 7.49 598 2.5e-13
##
##  'ab'  effect estimates (through mediators)
```

```
##      Y1 boot   sd lower upper
## X3 0.05 0.05 0.01  0.04  0.07
```

Mediate in mediation package

```
fitM <- lm(X4 ~ X3, data = med)
fitY <- lm(Y1 ~ X3 + X4, data = med)


fitmed <- mediation::mediate(fitM, fitY, treat = "X3", mediator = "X4")
summary(fitmed)
```

```
##
## Causal Mediation Analysis
##
## Quasi-Bayesian Confidence Intervals
##
##                Estimate 95% CI Lower 95% CI Upper p-value
## ACME             0.0535       0.0358         0.07  <2e-16 ***
## ADE              0.2418       0.2007         0.28  <2e-16 ***
## Total Effect     0.2954       0.2545         0.34  <2e-16 ***
## Prop. Mediated   0.1810       0.1231         0.25  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Sample Size Used: 600
##
##
## Simulations: 1000
```

```
cor(med)
```

```
##            X1          X2         X3         X4         X5         Y1
## X1 1.00000000  0.03946291 0.03657073 0.04344269  0.1020180  0.3465506
## X2 0.03946291  1.00000000 0.08889150 0.06447405 -0.1310097 -0.3227619
## X3 0.03657073  0.08889150 1.00000000 0.34246913  0.7331822  0.5053060
## X4 0.04344269  0.06447405 0.34246913 1.00000000  0.4068431  0.4104644
## X5 0.10201803 -0.13100973 0.73318217 0.40684310  1.0000000  0.6405100
## Y1 0.34655064 -0.32276194 0.50530603 0.41046440  0.6405100  1.0000000
```

Analysis 3: Test the hypothesis that X4 mediates the relationship between X5 and Y1

r xy = 0.6405 r xm = 0.4068 r my = 0.4105

We do have justifaction to test this mediation hypothesis because all paths have a moderate effect

```
spcor.test(x = med$X5, y = med$Y1, z = med$X4)
```

```
##    estimate      p.value statistic   n gp  Method
## 1 0.5192757 1.150621e-42  14.84632 600  1 pearson
```

r y(x.m) = 0.5192. This is 0.12 smaller than r xy (0.6405), indicating that partial mediation is plausible. In other words, there is a portion of the relation betweeen x and y that involves m.

Regression method

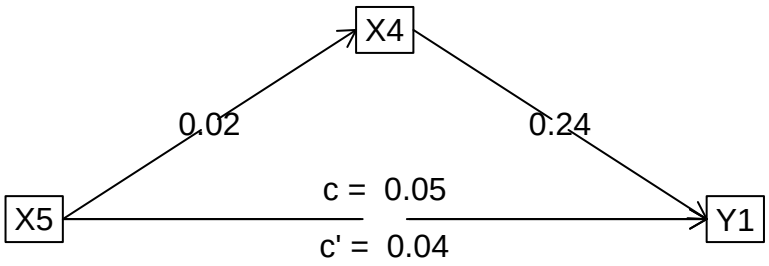
```
m1 <- lm(Y1 ~ X5      , data = med)
m2 <- lm(Y1 ~ X5 + X4 , data = med)

anova(m1,m2)
```

```
## Analysis of Variance Table
##
## Model 1: Y1 ~ X5
## Model 2: Y1 ~ X5 + X4
##   Res.Df    RSS Df Sum of Sq      F    Pr(>F)
## 1    598 296.12
## 2    597 282.61  1    13.517 28.553 1.299e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

mediate in psych

```
fitmed <- psych::mediate(Y1 ~ X5 + (X4), data = med)
```




```
summary(fitmed)
```

```
## Call: psych::mediate(y = Y1 ~ X5 + (X4), data = med)
##
## Direct effect estimates (traditional regression)    (c')
##             Y1   se     t  df     Prob
```

```
## Intercept 0.37 0.18  2.14 597 3.28e-02
## X5        0.04 0.00 16.88 597 1.46e-52
## X4        0.24 0.05  5.34 597 1.30e-07
##
## R = 0.66 R2 = 0.44   F = 231.86 on 2 and 597 DF   p-value:  3.07e-75
##
##  Total effect estimates (c)
##      Y1 se     t  df     Prob
## X5 0.05  0 20.41 599 1.05e-70
##
##  'a'  effect estimates
##             X4   se     t  df     Prob
## Intercept 1.47 0.15 10.02 598 5.86e-22
## X5        0.02 0.00 10.89 598 2.53e-25
##
##  'b'  effect estimates
##      Y1   se    t  df     Prob
## X4 0.24 0.05 5.35 598 1.27e-07
##
##  'ab'  effect estimates (through mediators)
##      Y1 boot sd lower upper
## X5 0.01 0.01  0     0  0.01
```

Mediate in mediation package

```
fitM <- lm(X4 ~ X5, data = med)
fitY <- lm(Y1 ~ X5 + X4, data = med)


fitmed <- mediation::mediate(fitM, fitY, treat = "X5", mediator = "X4")
summary(fitmed)
```

```
##
## Causal Mediation Analysis
##
## Quasi-Bayesian Confidence Intervals
##
##                Estimate 95% CI Lower 95% CI Upper p-value
## ACME            0.00549      0.00339         0.01  <2e-16 ***
## ADE             0.04278      0.03819         0.05  <2e-16 ***
## Total Effect    0.04827      0.04387         0.05  <2e-16 ***
## Prop. Mediated  0.11358      0.07070         0.16  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Sample Size Used: 600
##
##
## Simulations: 1000
```

Class Activity

Read data

```
slp <- read_csv("slpdata.csv")
```

```
## Parsed with column specification:
## cols(
##   cond = col_double(),
##   prior = col_double(),
##   age = col_double(),
##   anxiety = col_double(),
##   hygiene = col_double(),
##   support = col_double(),
##   sleep = col_double(),
##   lifesat = col_double(),
##   sex = col_double(),
##   id = col_double()
## )
```

Baron & Kenny Plausibility: Examine Correlations between variables

```
cor(slp)
```

```
##                 cond        prior          age     anxiety    hygiene
## cond     1.000000000  0.068444409  0.004446171  0.05154855 0.61637991
## prior    0.068444409  1.000000000 -0.016566360  0.01506977 0.04664105
## age      0.004446171 -0.016566360  1.000000000  0.03946291 0.03657073
## anxiety  0.051548555  0.015069770  0.039462908  1.00000000 0.08889150
## hygiene  0.616379910  0.046641049  0.036570734  0.08889150 1.00000000
## support  0.569239448  0.045848239  0.043442690  0.06447405 0.34246913
## sleep    0.509063445  0.052377594  0.102018032 -0.13100973 0.73318217
## lifesat  0.455975162  0.004333669  0.346550635 -0.32276194 0.50530603
## sex     -0.045624959  0.025259767 -0.059929571  0.10363554 0.37554788
## id       0.443050154  0.045343149 -0.053016709  0.11956136 0.63578231
##             support       sleep      lifesat         sex          id
## cond    0.56923945  0.50906344  0.455975162 -0.04562496  0.44305015
## prior   0.04584824  0.05237759  0.004333669  0.02525977  0.04534315
## age     0.04344269  0.10201803  0.346550635 -0.05992957 -0.05301671
## anxiety 0.06447405 -0.13100973 -0.322761945  0.10363554  0.11956136
## hygiene 0.34246913  0.73318217  0.505306031  0.37554788  0.63578231
## support 1.00000000  0.40684310  0.410464400  0.07211491  0.36036724
## sleep   0.40684310  1.00000000  0.640509980  0.42814386  0.62822002
## lifesat 0.41046440  0.64050998  1.000000000  0.04842789  0.25696941
## sex     0.07211491  0.42814386  0.048427889  1.00000000  0.85240465
## id      0.36036724  0.62822002  0.256969408  0.85240465  1.00000000
```

Analysis 1: Test the hypothesis that sleep efficiency mediates the relationship between sleep hygiene and life satisfaction.

r xy = 0.5053 r xm = 0.7332 r my = 0.6405

We do have justifaction to test this mediation hypothesis because all paths have a moderate to large effect

```
spcor.test(x = slp$hygiene, y = slp$lifesat, z = slp$sleep)
```

```
##    estimate   p.value statistic   n gp  Method
## 1 0.0464816 0.2560191  1.136941 600  1 pearson
```

r y(x.m) = 0.0464. This is 0.12 smaller than r xy (0.5053), indicating that partial mediation is plausible. In other words, there is a portion of the relation betweeen x and y that involves m.

Regression method

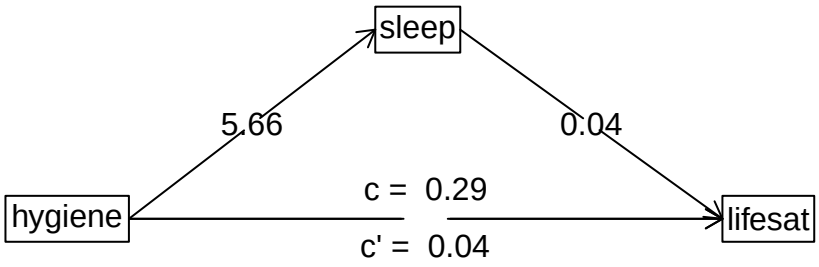
```
m1 <- lm(lifesat ~ hygiene         , data = slp)
m2 <- lm(lifesat ~ hygiene + sleep , data = slp)

anova(m1,m2)
```

```
## Analysis of Variance Table
##
## Model 1: lifesat ~ hygiene
## Model 2: lifesat ~ hygiene + sleep
##   Res.Df    RSS Df Sum of Sq      F    Pr(>F)
## 1    598 373.91
## 2    597 294.74  1    79.171 160.36 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

mediate in psych

```
fitmed <- psych::mediate(lifesat ~ hygiene + (sleep), data = slp)
```




```
summary(fitmed)
```

```
## Call: psych::mediate(y = lifesat ~ hygiene + (sleep), data = slp)
##
## Direct effect estimates (traditional regression)    (c')
##           lifesat   se     t  df     Prob
## Intercept    0.75 0.17  4.54 597 6.79e-06
## hygiene      0.04 0.03  1.67 597 9.47e-02
## sleep        0.04 0.00 12.66 597 1.01e-32
##
## R = 0.64 R2 = 0.41   F = 210.03 on 2 and 597 DF   p-value:  8.64e-70
##
##  Total effect estimates (c)
##         lifesat   se     t  df     Prob
## hygiene    0.29 0.02 14.33 599 2.88e-40
##
##  'a'  effect estimates
##           sleep   se     t  df      Prob
## Intercept 34.98 1.33 26.31 598 5.99e-102
## hygiene    5.66 0.21 26.37 598 3.16e-102
##
##  'b'  effect estimates
##       lifesat se     t  df     Prob
## sleep    0.04  0 12.67 598 8.96e-33
##
##  'ab'  effect estimates (through mediators)
```

```
##         lifesat boot   sd lower upper
## hygiene    0.25 0.25 0.02  0.21  0.29
```

Mediate in mediation package

```
fitM <- lm(sleep   ~ hygiene        , data = slp)
fitY <- lm(lifesat ~ hygiene + sleep, data = slp)


fitmed <- mediation::mediate(fitM, fitY, treat = "hygiene", mediator = "sleep")
summary(fitmed)
```

```
##
## Causal Mediation Analysis
##
## Quasi-Bayesian Confidence Intervals
##
##                Estimate 95% CI Lower 95% CI Upper p-value
## ACME            0.24948      0.20575         0.30  <2e-16 ***
## ADE             0.04465     -0.00812         0.10   0.098 .
## Total Effect    0.29413      0.25515         0.33  <2e-16 ***
## Prop. Mediated  0.84584      0.68894         1.03  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Sample Size Used: 600
##
##
## Simulations: 1000
```

Analysis 2: Test the hypothesis that sleep efficiency mediates the relationship between anxiety and life satisfaction.

Baron & Kenny Plausibility: Examine Correlations between variables

```
cor(slp)
```

```
##                cond        prior          age     anxiety    hygiene
## cond     1.000000000  0.068444409  0.004446171  0.05154855 0.61637991
## prior    0.068444409  1.000000000 -0.016566360  0.01506977 0.04664105
## age      0.004446171 -0.016566360  1.000000000  0.03946291 0.03657073
## anxiety  0.051548555  0.015069770  0.039462908  1.00000000 0.08889150
## hygiene  0.616379910  0.046641049  0.036570734  0.08889150 1.00000000
## support  0.569239448  0.045848239  0.043442690  0.06447405 0.34246913
## sleep    0.509063445  0.052377594  0.102018032 -0.13100973 0.73318217
## lifesat  0.455975162  0.004333669  0.346550635 -0.32276194 0.50530603
## sex     -0.045624959  0.025259767 -0.059929571  0.10363554 0.37554788
## id       0.443050154  0.045343149 -0.053016709  0.11956136 0.63578231
##             support       sleep      lifesat         sex          id
## cond    0.56923945  0.50906344  0.455975162 -0.04562496  0.44305015
## prior   0.04584824  0.05237759  0.004333669  0.02525977  0.04534315
## age     0.04344269  0.10201803  0.346550635 -0.05992957 -0.05301671
## anxiety 0.06447405 -0.13100973 -0.322761945  0.10363554  0.11956136
## hygiene 0.34246913  0.73318217  0.505306031  0.37554788  0.63578231
```

```
## support 1.00000000  0.40684310  0.410464400  0.07211491  0.36036724
## sleep   0.40684310  1.00000000  0.640509980  0.42814386  0.62822002
## lifesat 0.41046440  0.64050998  1.000000000  0.04842789  0.25696941
## sex     0.07211491  0.42814386  0.048427889  1.00000000  0.85240465
## id      0.36036724  0.62822002  0.256969408  0.85240465  1.00000000
```

r xy = -0.3228 r xm = -0.1310 r my = 0.6405

We do NOT have justifaction to test this mediation hypothesis because path a has a negligible correlation effect size (-.1310)

```
spcor.test(x = slp$anxiety, y = slp$lifesat, z = slp$sleep)
```

```
##     estimate      p.value statistic   n gp  Method
## 1 -0.3110215 6.689264e-15 -7.995945 600  1 pearson
```

r y(x.m) = -0.3110. This is 0.0118 only slighlty larger (closer to zero) than r xy (-0.3228), indicating that partial mediation is NOT plausible.