

Mediation with Bootstrapping

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Mediation Demo with Bootstrapping

A local college is hoping to understand what predicts how many events on average students will attend on campus per month. The board proposes that the best way to get higher attendance is to send a lot of e-mails. The more frequently that students are given information, the more they should attend. A student representative that sits in on board meetings believes there is more to the picture. While large weekly e-mail blasts may predict events attended on average, the interest a student has in attending the event should help explain how many events they attend. The board is looking to you to test these relationships.

Variables: Email - average e-mails read per week by students. Interest - average amount of interest a student has for events listed in e-mails. Events - average amount of events attended by students per month.

Load in that data and those libraries.

```
datboot <- read.csv('https://www.dropbox.com/s/qe8curup5safjy3/MedBootDemo.csv?dl=1')

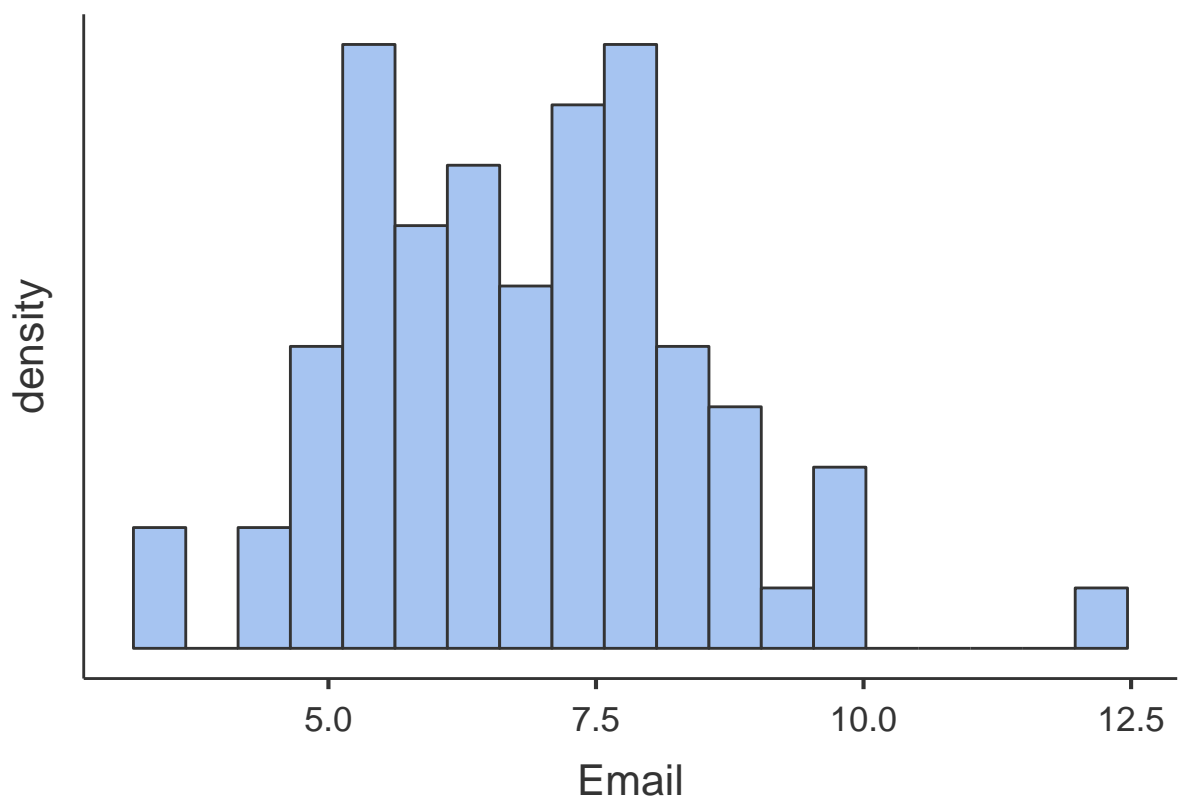
library(pacman)
p_load(psych, jmv, medmod, lavaan, multilevel)
```

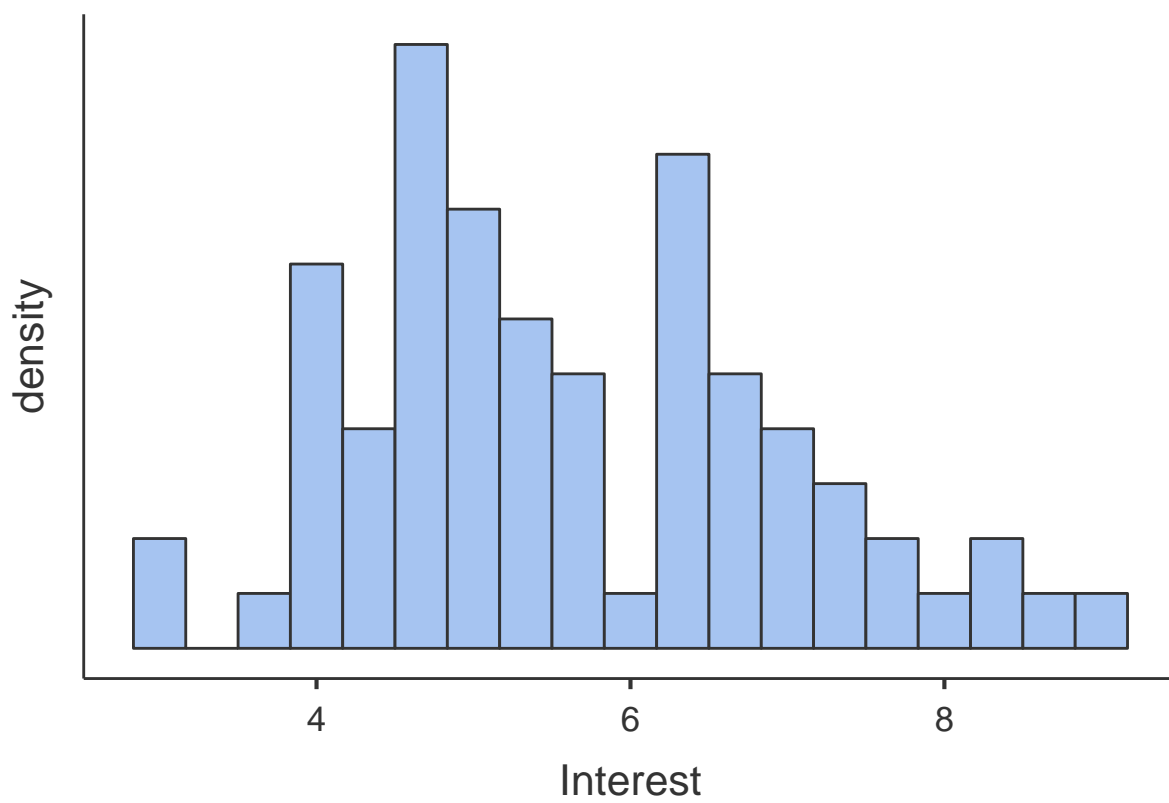
Descriptives

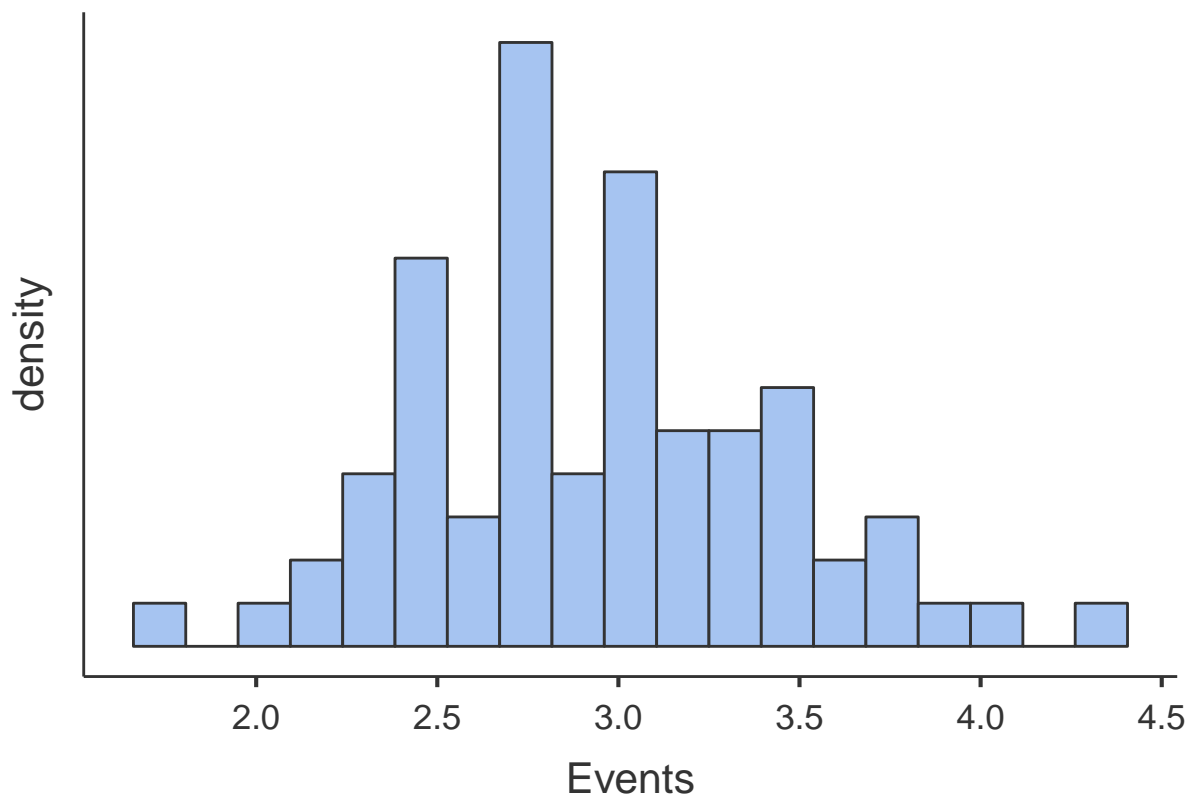
```
desc <- descriptives(datboot,
  vars = c('Email', 'Interest', 'Events'),
  hist = TRUE,
  sd = TRUE,
  min = TRUE,
  max = TRUE,
  skew = TRUE,
  kurt = TRUE)
```

desc

```
##
## DESCRIPTIVES
##
## Descriptives
## -----
##           Email      Interest      Events
## -----
##      N           73           73           73
##      Missing         0           0           0
##      Mean          6.83          5.65          2.94
##      Median          6.70          5.30          2.90
##      Standard deviation  1.63          1.36          0.504
##      Minimum          3.20          3.00          1.70
##      Maximum          12.0          9.00          4.30
##      Skewness          0.409          0.452          0.234
##      Std. error skewness  0.281          0.281          0.281
##      Kurtosis          0.508         -0.381          0.114
##      Std. error kurtosis  0.555          0.555          0.555
## -----
```







Correlation matrix

```
corr <- corrMatrix(datboot,
  vars = c('Email', 'Interest', 'Events'),
  flag = TRUE)
```

```
corr
```

```
##
## CORRELATION MATRIX
##
## Correlation Matrix
## -----
##               Email    Interest    Events
## -----
##   Email    Pearson's r    -    0.362    0.394
##             p-value      -    0.002    < .001
##
##   Interest  Pearson's r          -    0.893
##             p-value          -    < .001
##
##   Events    Pearson's r          -
##             p-value          -
## -----
##   Note. * p < .05, ** p < .01, *** p < .001
```

Regression

```
# X -> Y
model1 <- linReg(data = datboot,
  dep = 'Events',
  covs = 'Email',
  blocks = list(c('Email')),
  modelTest = TRUE,
  stdEst = TRUE,
  ci = TRUE,
  ciWidth = 95)
model1
```

```
##
## LINEAR REGRESSION
##
## Model Fit Measures
## -----
##      Model      R      R2      F      df1      df2      p
## -----
##           1      0.394      0.155      13.0       1      71      < .001
## -----
##
##
## MODEL SPECIFIC RESULTS
##
## MODEL 1
##
## Model Coefficients
## -----
##      Predictor      Estimate      SE      Lower      Upper      t      p      Stand. Estimate
## -----
##      Intercept          2.106      0.2366      1.6344      2.578      8.90      < .001
##      Email              0.122      0.0337      0.0545      0.189      3.61      < .001      0.394
## -----
```

```
# X -> M
model2 <- linReg(data = datboot,
  dep = 'Interest',
  covs = 'Email',
  blocks = list(c('Email')),
  modelTest = TRUE,
  stdEst = TRUE,
  ci = TRUE,
  ciWidth = 95)
model2
```

```
##
## LINEAR REGRESSION
##
## Model Fit Measures
## -----
##      Model      R      R2      F      df1      df2      p
## -----
##           1      0.362      0.131      10.7       1      71      0.002
## -----
##
```

```
##
## MODEL SPECIFIC RESULTS
##
## MODEL 1
##
## Model Coefficients
## -----
##      Predictor      Estimate      SE      Lower      Upper      t      p      Stand. Estimate
## -----
##      Intercept      3.593      0.6448      2.308      4.879      5.57      < .001
##      Email           0.301      0.0919      0.118      0.484      3.27      0.002      0.362
## -----
```

```
# X + M -> Y
model3 <- linReg(data = datboot,
  dep = 'Events',
  covs = c('Email', 'Interest'),
  blocks = list(c('Email', 'Interest')),
  modelTest = TRUE,
  stdEst = TRUE,
  ci = TRUE,
  ciWidth = 95)
model3
```

```
##
## LINEAR REGRESSION
##
## Model Fit Measures
## -----
##      Model      R      R²      F      df1      df2      p
## -----
##           1      0.896      0.803      143      2      70      < .001
## -----
```

```
##
##
## MODEL SPECIFIC RESULTS
##
## MODEL 1
##
## Model Coefficients
## -----
##      Predictor      Estimate      SE      Lower      Upper      t      p      Stand. Estimate
## -----
##      Intercept      0.9514      0.1378      0.67654      1.2262      6.90      < .001
##      Email           0.0251      0.0176      -0.00999      0.0601      1.43      0.158      0.0811
##      Interest        0.3214      0.0212      0.27916      0.3635      15.19      < .001      0.8638
## -----
```

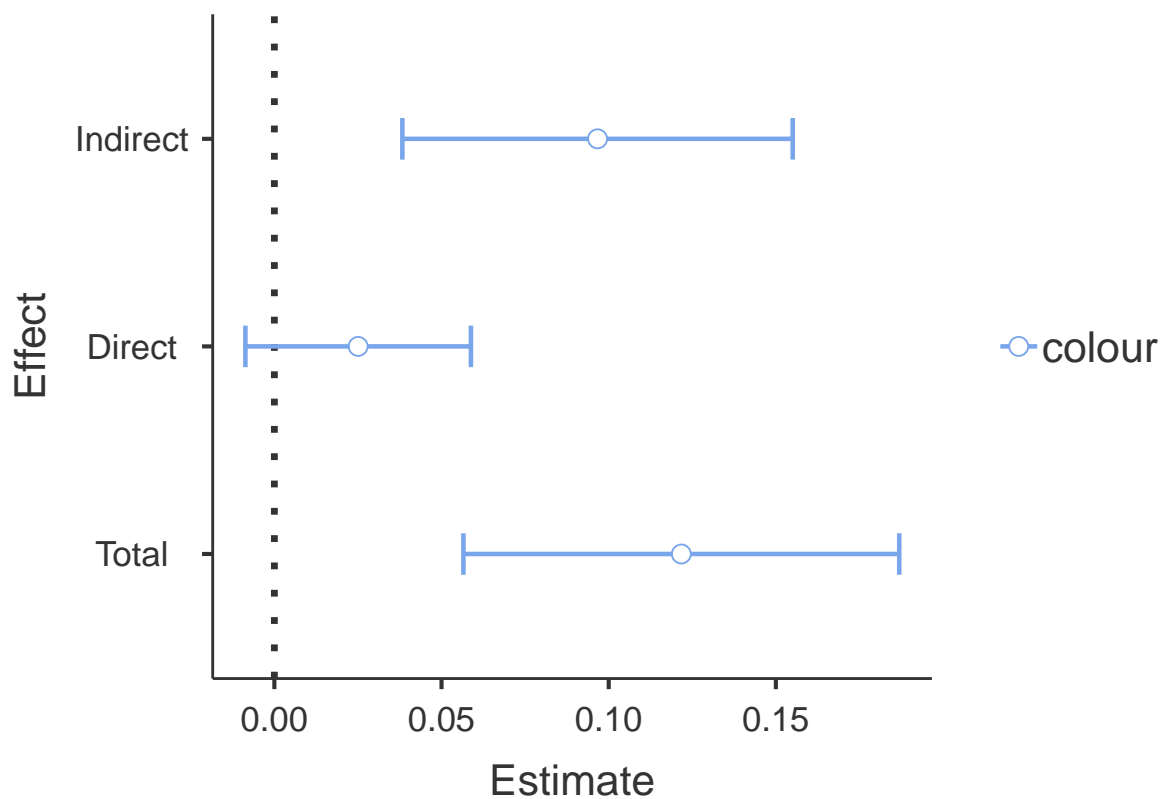
Mediation model - *without* bootstrapping

```
# (a * b) = (c - c') = Indirect Effect [i.e., amount of mediation]
# Z = Sobel test
# a = Path Estimate from X to M
# b = Path Estimate from M to Y
# c = Total Estimate (Direct Estimate + Indirect Estimate)
# c' = Direct Estimate
```

```
med <- medmod::med(datboot,
  dep = 'Events',
  pred = 'Email',
  med = 'Interest',
  pm = TRUE,
  paths = TRUE,
  label = TRUE,
  estPlot = TRUE)
med
```

```
##
## MEDIATION
##
## Mediation Estimates
## -----
##      Effect      Label      Estimate      SE      Z      p      % Mediation
## -----
##      Indirect    a × b      0.0967      0.0298      3.25      0.001      79.4
##      Direct      c      0.0251      0.0172      1.46      0.145      20.6
##      Total      c + a × b    0.1217      0.0333      3.66      < .001      100.0
## -----
##
##
## Path Estimates
## -----
##                                     Label      Estimate      SE      Z      p
## -----
##      Email      <U+2192>      Interest    a      0.3008      0.0906      3.32      < .001
##      Interest   <U+2192>      Events      b      0.3214      0.0207      15.51      < .001
##      Email      <U+2192>      Events      c      0.0251      0.0172      1.46      0.145
## -----

## Scale for 'colour' is already present. Adding another scale for
## 'colour', which will replace the existing scale.
```



Mediation model - *with* bootstrapping

```
boot <- medmod::med(datboot,
  dep = 'Events',
  pred = 'Email',
  med = 'Interest',
  estMethod = 'bootstrap',
  bootstrap = 1000,
  pm = TRUE,
  paths = TRUE,
  label = TRUE,
  estPlot = TRUE)
```

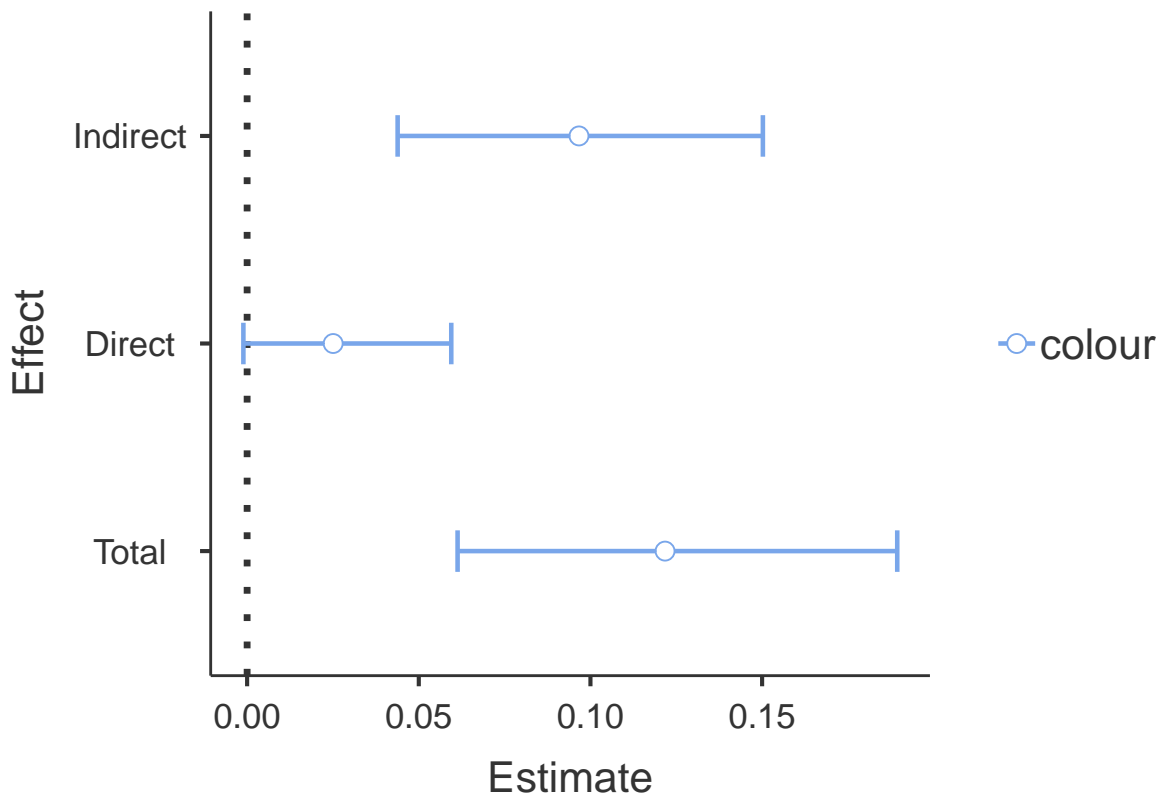
boot

```
##
## MEDIATION
##
## Mediation Estimates
## -----
##      Effect      Label      Estimate      SE      Z      p      % Mediation
## -----
##      Indirect    a x b      0.0967      0.0264    3.66    < .001    79.4
##      Direct      c          0.0251      0.0152    1.65    0.099    20.6
##      Total       c + a x b  0.1217      0.0322    3.78    < .001    100.0
## -----
##
##
```



```
## Path Estimates
## -----
##           Label      Estimate    SE        Z        p
## -----
##   Email    <U+2192>   Interest    a        0.3008    0.0852    3.53    < .001
##   Interest <U+2192>   Events      b        0.3214    0.0212   15.19    < .001
##   Email    <U+2192>   Events      c        0.0251    0.0152    1.65    0.099
## -----

## Scale for 'colour' is already present. Adding another scale for
## 'colour', which will replace the existing scale.
```



```
# Check the z-values, SE, and p-values for pathways to see differences (X -> Y for this one).
```

Sobel test

```
# Look at this in comparison to the indirect mediation estimate.
# X = Email
# M = Interest
# Y = Events
sobel(datboot$Email, datboot$Interest, datboot$Events)
```

```
## $`Mod1: Y~X`
##           Estimate Std. Error  t value    Pr(>|t|)
## (Intercept) 2.1060936 0.23655159 8.903316 3.542334e-13
## pred        0.1217242 0.03371743 3.610127 5.665353e-04
```

```

##
## $`Mod2: Y~X+M`
##           Estimate Std. Error  t value    Pr(>|t|)
## (Intercept) 0.95136375 0.13779468  6.904213 1.866237e-09
## pred        0.02506033 0.01757446  1.425952 1.583268e-01
## med         0.32135585 0.02115430 15.191044 7.479798e-24
##
## $`Mod3: M~X`
##           Estimate Std. Error  t value    Pr(>|t|)
## (Intercept) 3.5933058 0.64478005  5.572917 4.227826e-07
## pred        0.3008001 0.09190522  3.272938 1.645702e-03
##
## $Indirect.Effect
## [1] 0.09666386
##
## $SE
## [1] 0.03021199
##
## $z.value
## [1] 3.19952
##
## $N
## [1] 73

```