betaMC: Staging

Ivan Jacob Agaloos Pesigan

Staging...

1 Monte Carlo Simulation

```
# Fit the regression model
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
# Generate the sampling distribution of parameter estimates
mc <- MC(object, R = 20000, type = "mvn", seed = 42)
```

2 Standardized Regression Slopes

```
out <- BetaMC(mc)
# Methods ------------------------------------------------------------
print(out)

#> Call:
#> BetaMC(object = mc)
#>
#> Standardized regression slopes
#> type = "mvn"
#>            est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.4951 0.0765 20000 0.2376 0.2887 0.3371 0.6366 0.6771 0.7321
#> PCTGRT  0.3915 0.0768 20000 0.1392 0.1961 0.2392 0.5399 0.5856 0.6421
#> PCTSUPP 0.2632 0.0748 20000 0.0293 0.0783 0.1193 0.4103 0.4645 0.5240

summary(out)

#> Call:
#> BetaMC(object = mc)
#>
#> Standardized regression slopes
#> type = "mvn"
#>            est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.4951 0.0765 20000 0.2376 0.2887 0.3371 0.6366 0.6771 0.7321
```

```
#> PCTGRT  0.3915 0.0768 20000 0.1392 0.1961 0.2392 0.5399 0.5856 0.6421
#> PCTSUPP 0.2632 0.0748 20000 0.0293 0.0783 0.1193 0.4103 0.4645 0.5240

coef(out)

#>    NARTIC    PCTGRT   PCTSUPP
#> 0.4951451 0.3914887 0.2632477

vcov(out)

#>               NARTIC       PCTGRT      PCTSUPP
#> NARTIC   0.005851998 -0.003335854 -0.002171087
#> PCTGRT  -0.003335854  0.005902498 -0.001708398
#> PCTSUPP -0.002171087 -0.001708398  0.005594629

confint(out)

#>             2.5 %    97.5 %
#> NARTIC  0.3371443 0.6366083
#> PCTGRT  0.2392443 0.5398774
#> PCTSUPP 0.1193284 0.4103236
```

3 Multiple Correlation

```
out <- RSqMC(mc)
# Methods ------------------------------------------------------------
print(out)

#> Call:
#> RSqMC(object = mc)
#>
#> R-squared and adjusted R-squared
#> type = "mvn"
#>        est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> rsq 0.8045 0.0563 20000 0.5056 0.5981 0.6615 0.8820 0.9045 0.9307
#> adj 0.7906 0.0603 20000 0.4703 0.5694 0.6373 0.8736 0.8977 0.9257

summary(out)

#> Call:
#> RSqMC(object = mc)
#>
#> R-squared and adjusted R-squared
#> type = "mvn"
#>        est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
```

```
#> rsq 0.8045 0.0563 20000 0.5056 0.5981 0.6615 0.8820 0.9045 0.9307
#> adj 0.7906 0.0603 20000 0.4703 0.5694 0.6373 0.8736 0.8977 0.9257

coef(out)

#>       rsq       adj
#> 0.8045263 0.7905638

vcov(out)

#>             rsq         adj
#> rsq 0.003165946 0.003392085
#> adj 0.003392085 0.003634377

confint(out)

#>         2.5 %    97.5 %
#> rsq 0.6614659 0.8820167
#> adj 0.6372849 0.8735893
```

4 Semipartial Correlation

```
out <- SCorMC(mc)
# Methods ------------------------------------------------------------
print(out)

#> Call:
#> SCorMC(object = mc)
#>
#> Semipartial correlations
#> type = "mvn"
#>            est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.4312 0.0783 20000 0.1790 0.2237 0.2669 0.5730 0.6263 0.6963
#> PCTGRT  0.3430 0.0739 20000 0.1042 0.1580 0.1948 0.4855 0.5361 0.6012
#> PCTSUPP 0.2385 0.0699 20000 0.0266 0.0676 0.1025 0.3769 0.4278 0.4928

summary(out)

#> Call:
#> SCorMC(object = mc)
#>
#> Semipartial correlations
#> type = "mvn"
#>            est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.4312 0.0783 20000 0.1790 0.2237 0.2669 0.5730 0.6263 0.6963
```

```
#> PCTGRT  0.3430 0.0739 20000 0.1042 0.1580 0.1948 0.4855 0.5361 0.6012
#> PCTSUPP 0.2385 0.0699 20000 0.0266 0.0676 0.1025 0.3769 0.4278 0.4928

coef(out)

#>    NARTIC    PCTGRT   PCTSUPP
#> 0.4311525 0.3430075 0.2384789

vcov(out)

#>                NARTIC        PCTGRT       PCTSUPP
#> NARTIC   0.0061237502 -0.0012929802 -0.0009192207
#> PCTGRT  -0.0012929802  0.0054635342 -0.0007665133
#> PCTSUPP -0.0009192207 -0.0007665133  0.0048886940

confint(out)

#>             2.5 %    97.5 %
#> NARTIC  0.2668925 0.5730484
#> PCTGRT  0.1947919 0.4855078
#> PCTSUPP 0.1025149 0.3768784
```

5 Improvement in R-Squared

```
out <- DeltaRSqMC(mc)
# Methods ------------------------------------------------------------
print(out)

#> Call:
#> DeltaRSqMC(object = mc)
#>
#> Improvement in R-squared
#> type = "mvn"
#>            est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.1859 0.0665 20000 0.0320 0.0500 0.0712 0.3284 0.3923 0.4848
#> PCTGRT  0.1177 0.0509 20000 0.0108 0.0250 0.0379 0.2357 0.2874 0.3615
#> PCTSUPP 0.0569 0.0343 20000 0.0007 0.0046 0.0105 0.1420 0.1830 0.2429

summary(out)

#> Call:
#> DeltaRSqMC(object = mc)
#>
#> Improvement in R-squared
#> type = "mvn"
```

```
#>            est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.1859 0.0665 20000 0.0320 0.0500 0.0712 0.3284 0.3923 0.4848
#> PCTGRT  0.1177 0.0509 20000 0.0108 0.0250 0.0379 0.2357 0.2874 0.3615
#> PCTSUPP 0.0569 0.0343 20000 0.0007 0.0046 0.0105 0.1420 0.1830 0.2429

coef(out)

#>    NARTIC    PCTGRT   PCTSUPP
#> 0.1858925 0.1176542 0.0568722

vcov(out)

#>                NARTIC        PCTGRT       PCTSUPP
#> NARTIC   0.0044169712 -0.0007378813 -0.0003641421
#> PCTGRT  -0.0007378813  0.0025931894 -0.0002362706
#> PCTSUPP -0.0003641421 -0.0002362706  0.0011731083

confint(out)

#>              2.5 %    97.5 %
#> NARTIC  0.07123160 0.3283845
#> PCTGRT  0.03794389 0.2357178
#> PCTSUPP 0.01050931 0.1420373
```

6 Squared Partial Correlation

```
out <- PCorMC(mc)
# Methods ------------------------------------------------------
print(out)

#> Call:
#> PCorMC(object = mc)
#>
#> Squared partial correlations
#> type = "mvn"
#>            est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.4874 0.1059 20000 0.1161 0.1801 0.2436 0.6545 0.7082 0.7705
#> PCTGRT  0.3757 0.1082 20000 0.0516 0.1020 0.1480 0.5680 0.6355 0.7059
#> PCTSUPP 0.2254 0.0997 20000 0.0030 0.0206 0.0464 0.4297 0.5006 0.5909

summary(out)

#> Call:
#> PCorMC(object = mc)
#>
```

```
#> Squared partial correlations
#> type = "mvn"
#>            est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.4874 0.1059 20000 0.1161 0.1801 0.2436 0.6545 0.7082 0.7705
#> PCTGRT  0.3757 0.1082 20000 0.0516 0.1020 0.1480 0.5680 0.6355 0.7059
#> PCTSUPP 0.2254 0.0997 20000 0.0030 0.0206 0.0464 0.4297 0.5006 0.5909

coef(out)

#>    NARTIC    PCTGRT   PCTSUPP
#> 0.4874382 0.3757383 0.2253739

vcov(out)

#>               NARTIC       PCTGRT      PCTSUPP
#> NARTIC  0.0112189156 0.0006335928 0.0003243272
#> PCTGRT  0.0006335928 0.0116989184 0.0001980458
#> PCTSUPP 0.0003243272 0.0001980458 0.0099367382

confint(out)

#>              2.5 %    97.5 %
#> NARTIC  0.24357634 0.6545283
#> PCTGRT  0.14803875 0.5679568
#> PCTSUPP 0.04636146 0.4296954
```

7 Differences of Standardized Slopes

```
out <- DiffBetaMC(mc)
# Methods ------------------------------------------------------
print(out)

#> Call:
#> DiffBetaMC(object = mc)
#>
#> Differences of standardized regression slopes
#> type = "mvn"
#>                    est     se     R   0.05%    0.5%    2.5%  97.5%  99.5% 99.95%
#> NARTIC-PCTGRT  0.1037 0.1357 20000 -0.3369 -0.2526 -0.1699 0.3618 0.4396 0.5073
#> NARTIC-PCTSUPP 0.2319 0.1257 20000 -0.2073 -0.1073 -0.0245 0.4672 0.5429 0.6127
#> PCTGRT-PCTSUPP 0.1282 0.1221 20000 -0.2550 -0.1874 -0.1141 0.3676 0.4400 0.5277

summary(out)

#> Call:
```

```
#> DiffBetaMC(object = mc)
#>
#> Differences of standardized regression slopes
#> type = "mvn"
#>                    est     se     R   0.05%    0.5%    2.5%  97.5%  99.5% 99.95%
#> NARTIC-PCTGRT  0.1037 0.1357 20000 -0.3369 -0.2526 -0.1699 0.3618 0.4396 0.5073
#> NARTIC-PCTSUPP 0.2319 0.1257 20000 -0.2073 -0.1073 -0.0245 0.4672 0.5429 0.6127
#> PCTGRT-PCTSUPP 0.1282 0.1221 20000 -0.2550 -0.1874 -0.1141 0.3676 0.4400 0.5277

coef(out)

#>  NARTIC-PCTGRT NARTIC-PCTSUPP PCTGRT-PCTSUPP
#>      0.1036564      0.2318974      0.1282410

vcov(out)

#>                NARTIC-PCTGRT NARTIC-PCTSUPP PCTGRT-PCTSUPP
#> NARTIC-PCTGRT    0.018426204    0.009650542   -0.008775662
#> NARTIC-PCTSUPP   0.009650542    0.015788801    0.006138260
#> PCTGRT-PCTSUPP  -0.008775662    0.006138260    0.014913922

confint(out)

#>                       2.5 %    97.5 %
#> NARTIC-PCTGRT  -0.16991529 0.3618458
#> NARTIC-PCTSUPP -0.02449571 0.4672422
#> PCTGRT-PCTSUPP -0.11414782 0.3676482
```

8 Monte Carlo Simulation - Multiple Imputation

```
nas1982_missing <- mice::ampute(nas1982, mech = "MCAR")$amp
# Fit the regression model
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982_missing)
# Generate the sampling distribution of parameter estimates
mi <- mice::mice(nas1982_missing, m = 100, seed = 42, print = FALSE)
mc <- MCMI(object, mi = mi, R = 20000, type = "mvn",
           seed = 42)
```

9 Standardized Regression Slopes

```r
out <- BetaMC(mc)
# Methods ------------------------------------------------------
print(out)

#> Call:
#> BetaMC(object = mc)
#>
#> Standardized regression slopes
#> type = "mvn"
#>            est     se     R   0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.4930 0.0837 20000  0.2049 0.2704 0.3201 0.6492 0.6978 0.7463
#> PCTGRT  0.3974 0.0832 20000  0.1119 0.1798 0.2284 0.5559 0.6039 0.6611
#> PCTSUPP 0.2427 0.0846 20000 -0.0301 0.0294 0.0802 0.4128 0.4654 0.5344

summary(out)

#> Call:
#> BetaMC(object = mc)
#>
#> Standardized regression slopes
#> type = "mvn"
#>            est     se     R   0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.4930 0.0837 20000  0.2049 0.2704 0.3201 0.6492 0.6978 0.7463
#> PCTGRT  0.3974 0.0832 20000  0.1119 0.1798 0.2284 0.5559 0.6039 0.6611
#> PCTSUPP 0.2427 0.0846 20000 -0.0301 0.0294 0.0802 0.4128 0.4654 0.5344

coef(out)

#>    NARTIC    PCTGRT   PCTSUPP
#> 0.4929845 0.3973692 0.2427459

vcov(out)

#>               NARTIC       PCTGRT      PCTSUPP
#> NARTIC   0.007002768 -0.003750411 -0.002894797
#> PCTGRT  -0.003750411  0.006922144 -0.002033649
#> PCTSUPP -0.002894797 -0.002033649  0.007160281

confint(out)

#>             2.5 %    97.5 %
#> NARTIC  0.3200581 0.6492466
#> PCTGRT  0.2283692 0.5559488
#> PCTSUPP 0.0801568 0.4127532
```

10 Multiple Correlation

```
out <- RSqMC(mc)
# Methods ------------------------------------------------------
print(out)

#> Call:
#> RSqMC(object = mc)
#>
#> R-squared and adjusted R-squared
#> type = "mvn"
#>        est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> rsq 0.7867 0.0652 20000 0.4322 0.5586 0.6262 0.8799 0.9087 0.9382
#> adj 0.7715 0.0719 20000 0.3734 0.5129 0.5876 0.8675 0.8993 0.9318

summary(out)

#> Call:
#> RSqMC(object = mc)
#>
#> R-squared and adjusted R-squared
#> type = "mvn"
#>        est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> rsq 0.7867 0.0652 20000 0.4322 0.5586 0.6262 0.8799 0.9087 0.9382
#> adj 0.7715 0.0719 20000 0.3734 0.5129 0.5876 0.8675 0.8993 0.9318

coef(out)

#>       rsq       adj
#> 0.7867234 0.7714893

vcov(out)

#>              rsq         adj
#> rsq 0.004245977 0.004685216
#> adj 0.004685216 0.005169893

confint(out)

#>         2.5 %    97.5 %
#> rsq 0.6262241 0.8798885
#> adj 0.5875576 0.8674632
```

11 Semipartial Correlation

```r
out <- SCorMC(mc)
# Methods ------------------------------------------------------
print(out)

#> Call:
#> SCorMC(object = mc)
#>
#> Semipartial correlations
#> type = "mvn"
#>            est     se     R   0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.4232 0.0851 20000  0.1551 0.2014 0.2472 0.5803 0.6370 0.7006
#> PCTGRT  0.3510 0.0804 20000  0.0939 0.1415 0.1878 0.5014 0.5579 0.6260
#> PCTSUPP 0.2190 0.0787 20000 -0.0222 0.0244 0.0684 0.3770 0.4332 0.4943

summary(out)

#> Call:
#> SCorMC(object = mc)
#>
#> Semipartial correlations
#> type = "mvn"
#>            est     se     R   0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.4232 0.0851 20000  0.1551 0.2014 0.2472 0.5803 0.6370 0.7006
#> PCTGRT  0.3510 0.0804 20000  0.0939 0.1415 0.1878 0.5014 0.5579 0.6260
#> PCTSUPP 0.2190 0.0787 20000 -0.0222 0.0244 0.0684 0.3770 0.4332 0.4943

coef(out)

#>    NARTIC    PCTGRT   PCTSUPP
#> 0.4232313 0.3509918 0.2189535

vcov(out)

#>               NARTIC       PCTGRT      PCTSUPP
#> NARTIC   0.007247553 -0.001554738 -0.001367987
#> PCTGRT  -0.001554738  0.006456763 -0.001178817
#> PCTSUPP -0.001367987 -0.001178817  0.006188656

confint(out)

#>             2.5 %    97.5 %
#> NARTIC  0.2471657 0.5802803
#> PCTGRT  0.1878162 0.5014294
#> PCTSUPP 0.0683932 0.3770499
```

12 Improvement in R-Squared

```
out <- DeltaRSqMC(mc)
# Methods ------------------------------------------------------
print(out)

#> Call:
#> DeltaRSqMC(object = mc)
#>
#> Improvement in R-squared
#> type = "mvn"
#>            est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.1791 0.0713 20000 0.0241 0.0406 0.0611 0.3367 0.4057 0.4908
#> PCTGRT  0.1232 0.0562 20000 0.0088 0.0200 0.0353 0.2514 0.3113 0.3918
#> PCTSUPP 0.0479 0.0361 20000 0.0000 0.0007 0.0047 0.1422 0.1876 0.2444

summary(out)

#> Call:
#> DeltaRSqMC(object = mc)
#>
#> Improvement in R-squared
#> type = "mvn"
#>            est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.1791 0.0713 20000 0.0241 0.0406 0.0611 0.3367 0.4057 0.4908
#> PCTGRT  0.1232 0.0562 20000 0.0088 0.0200 0.0353 0.2514 0.3113 0.3918
#> PCTSUPP 0.0479 0.0361 20000 0.0000 0.0007 0.0047 0.1422 0.1876 0.2444

coef(out)

#>     NARTIC     PCTGRT    PCTSUPP
#> 0.17912477 0.12319522 0.04794063

vcov(out)

#>                NARTIC        PCTGRT       PCTSUPP
#> NARTIC   0.0050787545 -0.0008867177 -0.0004782472
#> PCTGRT  -0.0008867177  0.0031622647 -0.0003411482
#> PCTSUPP -0.0004782472 -0.0003411482  0.0013024844

confint(out)

#>              2.5 %    97.5 %
#> NARTIC  0.06109090 0.3367253
#> PCTGRT  0.03527492 0.2514314
#> PCTSUPP 0.00467763 0.1421666
```

13 Squared Partial Correlation

```
out <- PCorMC(mc)
# Methods ------------------------------------------------------
print(out)

#> Call:
#> PCorMC(object = mc)
#>
#> Squared partial correlations
#> type = "mvn"
#>            est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.4573 0.1194 20000 0.0840 0.1373 0.1935 0.6576 0.7223 0.8209
#> PCTGRT  0.3677 0.1186 20000 0.0314 0.0746 0.1234 0.5825 0.6590 0.7368
#> PCTSUPP 0.1860 0.1052 20000 0.0001 0.0030 0.0193 0.4203 0.5071 0.6227

summary(out)

#> Call:
#> PCorMC(object = mc)
#>
#> Squared partial correlations
#> type = "mvn"
#>            est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.4573 0.1194 20000 0.0840 0.1373 0.1935 0.6576 0.7223 0.8209
#> PCTGRT  0.3677 0.1186 20000 0.0314 0.0746 0.1234 0.5825 0.6590 0.7368
#> PCTSUPP 0.1860 0.1052 20000 0.0001 0.0030 0.0193 0.4203 0.5071 0.6227

coef(out)

#>    NARTIC    PCTGRT   PCTSUPP
#> 0.4572612 0.3676734 0.1859643

vcov(out)

#>               NARTIC       PCTGRT      PCTSUPP
#> NARTIC  0.0142620747 0.0019618742 0.0005255032
#> PCTGRT  0.0019618742 0.0140571214 0.0004846195
#> PCTSUPP 0.0005255032 0.0004846195 0.0110758267

confint(out)

#>              2.5 %    97.5 %
#> NARTIC  0.19349140 0.6576123
#> PCTGRT  0.12335919 0.5825345
#> PCTSUPP 0.01934744 0.4202882
```

14 Differences of Standardized Slopes

```
out <- DiffBetaMC(mc)
# Methods ------------------------------------------------------
print(out)

#> Call:
#> DiffBetaMC(object = mc)
#>
#> Differences of standardized regression slopes
#> type = "mvn"
#>                    est     se     R   0.05%    0.5%    2.5%  97.5%  99.5% 99.95%
#> NARTIC-PCTGRT  0.0956 0.1464 20000 -0.3757 -0.2774 -0.1928 0.3789 0.4642 0.5573
#> NARTIC-PCTSUPP 0.2502 0.1413 20000 -0.2476 -0.1302 -0.0406 0.5158 0.5974 0.6967
#> PCTGRT-PCTSUPP 0.1546 0.1347 20000 -0.2915 -0.1973 -0.1178 0.4122 0.4930 0.5863

summary(out)

#> Call:
#> DiffBetaMC(object = mc)
#>
#> Differences of standardized regression slopes
#> type = "mvn"
#>                    est     se     R   0.05%    0.5%    2.5%  97.5%  99.5% 99.95%
#> NARTIC-PCTGRT  0.0956 0.1464 20000 -0.3757 -0.2774 -0.1928 0.3789 0.4642 0.5573
#> NARTIC-PCTSUPP 0.2502 0.1413 20000 -0.2476 -0.1302 -0.0406 0.5158 0.5974 0.6967
#> PCTGRT-PCTSUPP 0.1546 0.1347 20000 -0.2915 -0.1973 -0.1178 0.4122 0.4930 0.5863

coef(out)

#>  NARTIC-PCTGRT NARTIC-PCTSUPP PCTGRT-PCTSUPP
#>     0.09561529     0.25023858     0.15462329

vcov(out)

#>                NARTIC-PCTGRT NARTIC-PCTSUPP PCTGRT-PCTSUPP
#> NARTIC-PCTGRT    0.021425734    0.011614327   -0.009811407
#> NARTIC-PCTSUPP   0.011614327    0.019952643    0.008338316
#> PCTGRT-PCTSUPP  -0.009811407    0.008338316    0.018149723

confint(out)

#>                       2.5 %    97.5 %
#> NARTIC-PCTGRT  -0.19281315 0.3789082
#> NARTIC-PCTSUPP -0.04063052 0.5157603
#> PCTGRT-PCTSUPP -0.11783046 0.4122433
```

References

R Core Team. (2023). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. Vienna, Austria. https://www.R-project.org/