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 0.2361 0.2875 0.3368 0.6354 0.6813 0.7353
#> PCTGRT  0.3915 0.0761 20000 0.1416 0.1937 0.2379 0.5368 0.5819 0.6398
#> PCTSUPP 0.2632 0.0747 20000 0.0267 0.0779 0.1178 0.4093 0.4589 0.5320

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 0.2361 0.2875 0.3368 0.6354 0.6813 0.7353
```

```
#> PCTGRT  0.3915 0.0761 20000 0.1416 0.1937 0.2379 0.5368 0.5819 0.6398
#> PCTSUPP 0.2632 0.0747 20000 0.0267 0.0779 0.1178 0.4093 0.4589 0.5320

coef(out)

#>    NARTIC    PCTGRT   PCTSUPP
#> 0.4951451 0.3914887 0.2632477

vcov(out)

#>               NARTIC       PCTGRT      PCTSUPP
#> NARTIC   0.005849298 -0.003297148 -0.002165995
#> PCTGRT  -0.003297148  0.005796229 -0.001703916
#> PCTSUPP -0.002165995 -0.001703916  0.005574450

confint(out)

#>              2.5%     97.5%
#> NARTIC  0.3368306 0.6354279
#> PCTGRT  0.2378812 0.5368376
#> PCTSUPP 0.1177538 0.4092548
```

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 0.0560 20000 0.5397 0.6006 0.6623 0.8789 0.9038 0.9266
#> adj 0.7906 0.0601 20000 0.5069 0.5721 0.6382 0.8702 0.8969 0.9214

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 0.0560 20000 0.5397 0.6006 0.6623 0.8789 0.9038 0.9266
#> adj 0.7906 0.0601 20000 0.5069 0.5721 0.6382 0.8702 0.8969 0.9214

coef(out)

#>       rsq       adj
#> 0.8045263 0.7905638

vcov(out)

#>             rsq         adj
#> rsq 0.003141591 0.003365990
#> adj 0.003365990 0.003606418

confint(out)

#>          2.5%     97.5%
#> rsq 0.6623081 0.8788682
#> adj 0.6381872 0.8702159
```

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 0.1758 0.2242 0.2678 0.5736 0.6241 0.6966
#> PCTGRT  0.3430 0.0731 20000 0.1104 0.1577 0.1948 0.4805 0.5356 0.5935
#> PCTSUPP 0.2385 0.0699 20000 0.0228 0.0675 0.1016 0.3748 0.4250 0.4978

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 0.1758 0.2242 0.2678 0.5736 0.6241 0.6966
```

```
#> PCTGRT  0.3430 0.0731 20000 0.1104 0.1577 0.1948 0.4805 0.5356 0.5935
#> PCTSUPP 0.2385 0.0699 20000 0.0228 0.0675 0.1016 0.3748 0.4250 0.4978

coef(out)

#>    NARTIC    PCTGRT   PCTSUPP
#> 0.4311525 0.3430075 0.2384789

vcov(out)

#>                NARTIC        PCTGRT       PCTSUPP
#> NARTIC   0.0061321623 -0.0012528441 -0.0009082182
#> PCTGRT  -0.0012528441  0.0053483029 -0.0007484783
#> PCTSUPP -0.0009082182 -0.0007484783  0.0048837434

confint(out)

#>              2.5%     97.5%
#> NARTIC  0.2677757 0.5736470
#> PCTGRT  0.1947635 0.4804929
#> PCTSUPP 0.1015873 0.3747518
```

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 0.0309 0.0502 0.0717 0.3291 0.3895 0.4852
#> PCTGRT  0.1177 0.0501 20000 0.0122 0.0249 0.0379 0.2309 0.2869 0.3522
#> PCTSUPP 0.0569 0.0341 20000 0.0005 0.0046 0.0103 0.1404 0.1807 0.2478

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 0.0309 0.0502 0.0717 0.3291 0.3895 0.4852
#> PCTGRT  0.1177 0.0501 20000 0.0122 0.0249 0.0379 0.2309 0.2869 0.3522
#> PCTSUPP 0.0569 0.0341 20000 0.0005 0.0046 0.0103 0.1404 0.1807 0.2478

coef(out)

#>    NARTIC    PCTGRT   PCTSUPP
#> 0.1858925 0.1176542 0.0568722

vcov(out)

#>                NARTIC        PCTGRT       PCTSUPP
#> NARTIC   0.0044289021 -0.0007116463 -0.0003586200
#> PCTGRT  -0.0007116463  0.0025137273 -0.0002249326
#> PCTSUPP -0.0003586200 -0.0002249326  0.0011662150

confint(out)

#>               2.5%     97.5%
#> NARTIC  0.07170384 0.3290709
#> PCTGRT  0.03793281 0.2308734
#> PCTSUPP 0.01031999 0.1404389
```

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 0.1057 20000 0.1107 0.1774 0.2463 0.6536 0.7115 0.7651
#> PCTGRT  0.3757 0.1070 20000 0.0506 0.1029 0.1466 0.5626 0.6249 0.6973
#> PCTSUPP 0.2254 0.0989 20000 0.0029 0.0192 0.0459 0.4256 0.5040 0.6004

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 0.1057 20000 0.1107 0.1774 0.2463 0.6536 0.7115 0.7651
#> PCTGRT  0.3757 0.1070 20000 0.0506 0.1029 0.1466 0.5626 0.6249 0.6973
#> PCTSUPP 0.2254 0.0989 20000 0.0029 0.0192 0.0459 0.4256 0.5040 0.6004

coef(out)

#>    NARTIC    PCTGRT   PCTSUPP
#> 0.4874382 0.3757383 0.2253739

vcov(out)

#>               NARTIC       PCTGRT      PCTSUPP
#> NARTIC  0.0111704616 6.346398e-04 2.324141e-04
#> PCTGRT  0.0006346398 1.144963e-02 6.321237e-05
#> PCTSUPP 0.0002324141 6.321237e-05 9.771910e-03

confint(out)

#>               2.5%     97.5%
#> NARTIC  0.24631873 0.6535594
#> PCTGRT  0.14663732 0.5625980
#> PCTSUPP 0.04591214 0.4255732
```

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 0.1351 20000 -0.3222 -0.2492 -0.1646 0.3636 0.4396 0.5234
#> NARTIC-PCTSUPP 0.2319 0.1255 20000 -0.2169 -0.1058 -0.0219 0.4673 0.5376 0.6141
#> PCTGRT-PCTSUPP 0.1282 0.1216 20000 -0.2715 -0.1853 -0.1120 0.3615 0.4424 0.5251

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 0.1351 20000 -0.3222 -0.2492 -0.1646 0.3636 0.4396 0.5234
#> NARTIC-PCTSUPP 0.2319 0.1255 20000 -0.2169 -0.1058 -0.0219 0.4673 0.5376 0.6141
#> PCTGRT-PCTSUPP 0.1282 0.1216 20000 -0.2715 -0.1853 -0.1120 0.3615 0.4424 0.5251

coef(out)

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

vcov(out)

#>                 NARTIC-PCTGRT NARTIC-PCTSUPP PCTGRT-PCTSUPP
#> NARTIC-PCTGRT    0.018239823    0.009608525   -0.008631298
#> NARTIC-PCTSUPP   0.009608525    0.015755737    0.006147212
#> PCTGRT-PCTSUPP  -0.008631298    0.006147212    0.014778510

confint(out)

#>                        2.5%     97.5%
#> NARTIC-PCTGRT  -0.16461689 0.3636014
#> NARTIC-PCTSUPP -0.02186839 0.4672556
#> PCTGRT-PCTSUPP -0.11203309 0.3615385
```

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
mc <- MCMI(object, R = 20000, type = "mvn",
           seed_mc = 42, seed_mi = 42, m = 1000)
```

9 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  0.4935 0.0819 20000  0.2069 0.2706 0.3248 0.6431 0.6905 0.7379
#> PCTGRT  0.3981 0.0831 20000  0.1101 0.1793 0.2286 0.5552 0.6048 0.6571
#> PCTSUPP 0.2432 0.0831 20000 -0.0276 0.0319 0.0833 0.4091 0.4578 0.5244
```

```
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  0.4935 0.0819 20000  0.2069 0.2706 0.3248 0.6431 0.6905 0.7379
#> PCTGRT  0.3981 0.0831 20000  0.1101 0.1793 0.2286 0.5552 0.6048 0.6571
#> PCTSUPP 0.2432 0.0831 20000 -0.0276 0.0319 0.0833 0.4091 0.4578 0.5244
```

```
coef(out)
```

```
#>    NARTIC    PCTGRT   PCTSUPP
#> 0.4935338 0.3981062 0.2431837
```

```
vcov(out)
```

```
#>               NARTIC       PCTGRT      PCTSUPP
#> NARTIC   0.006714560 -0.003713350 -0.002703474
#> PCTGRT  -0.003713350  0.006903433 -0.002011154
#> PCTSUPP -0.002703474 -0.002011154  0.006900111
```

```
confint(out)
```

```
#>               2.5%     97.5%
#> NARTIC  0.32476308 0.6431075
#> PCTGRT  0.22857806 0.5552475
#> PCTSUPP 0.08334396 0.4091082
```

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 0.7881 0.0630 20000 0.4883 0.5738 0.6324 0.8788 0.9075 0.9336
#> adj 0.7730 0.0695 20000 0.4353 0.5298 0.5943 0.8662 0.8979 0.9267

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 0.7881 0.0630 20000 0.4883 0.5738 0.6324 0.8788 0.9075 0.9336
#> adj 0.7730 0.0695 20000 0.4353 0.5298 0.5943 0.8662 0.8979 0.9267

coef(out)

#>       rsq       adj
#> 0.7881029 0.7729674

vcov(out)

#>              rsq         adj
#> rsq 0.003966544 0.004376876
#> adj 0.004376876 0.004829656

confint(out)

#>          2.5%     97.5%
#> rsq 0.6323655 0.8787752
#> adj 0.5943344 0.8662347
```

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  0.4246 0.0834 20000  0.1530 0.2053 0.2526 0.5758 0.6327 0.7021
#> PCTGRT  0.3517 0.0804 20000  0.0955 0.1443 0.1872 0.5023 0.5580 0.6243
#> PCTSUPP 0.2195 0.0770 20000 -0.0232 0.0273 0.0705 0.3712 0.4250 0.4920

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  0.4246 0.0834 20000  0.1530 0.2053 0.2526 0.5758 0.6327 0.7021
#> PCTGRT  0.3517 0.0804 20000  0.0955 0.1443 0.1872 0.5023 0.5580 0.6243
#> PCTSUPP 0.2195 0.0770 20000 -0.0232 0.0273 0.0705 0.3712 0.4250 0.4920

coef(out)

#>    NARTIC    PCTGRT   PCTSUPP
#> 0.4246330 0.3517262 0.2195280

vcov(out)

#>               NARTIC       PCTGRT      PCTSUPP
#> NARTIC   0.006951442 -0.001469694 -0.001232556
#> PCTGRT  -0.001469694  0.006469858 -0.001095727
#> PCTSUPP -0.001232556 -0.001095727  0.005932516

confint(out)

#>               2.5%     97.5%
#> NARTIC  0.25256000 0.5758345
#> PCTGRT  0.18719390 0.5022948
#> PCTSUPP 0.07050632 0.3711759
```

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  0.1803 0.0699 20000 0.0234 0.0421 0.0638 0.3316 0.4003 0.4929
#> PCTGRT  0.1237 0.0563 20000 0.0091 0.0208 0.0350 0.2523 0.3114 0.3898
#> PCTSUPP 0.0482 0.0351 20000 0.0000 0.0009 0.0050 0.1378 0.1806 0.2420

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  0.1803 0.0699 20000 0.0234 0.0421 0.0638 0.3316 0.4003 0.4929
#> PCTGRT  0.1237 0.0563 20000 0.0091 0.0208 0.0350 0.2523 0.3114 0.3898
#> PCTSUPP 0.0482 0.0351 20000 0.0000 0.0009 0.0050 0.1378 0.1806 0.2420

coef(out)

#>     NARTIC     PCTGRT    PCTSUPP
#> 0.18031319 0.12371129 0.04819255

vcov(out)

#>                NARTIC        PCTGRT       PCTSUPP
#> NARTIC   0.0048907794 -0.0008486049 -0.0004397811
#> PCTGRT  -0.0008486049  0.0031643009 -0.0003083971
#> PCTSUPP -0.0004397811 -0.0003083971  0.0012301550

confint(out)

#>                2.5%     97.5%
#> NARTIC  0.063786555 0.3315854
#> PCTGRT  0.035041558 0.2523000
#> PCTSUPP 0.004971141 0.1377716
```

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  0.4603 0.1162 20000 0.0769 0.1410 0.2034 0.6528 0.7146 0.7997
#> PCTGRT  0.3698 0.1170 20000 0.0345 0.0782 0.1267 0.5796 0.6553 0.7315
#> PCTSUPP 0.1875 0.1041 20000 0.0001 0.0038 0.0212 0.4190 0.5012 0.6203

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  0.4603 0.1162 20000 0.0769 0.1410 0.2034 0.6528 0.7146 0.7997
#> PCTGRT  0.3698 0.1170 20000 0.0345 0.0782 0.1267 0.5796 0.6553 0.7315
#> PCTSUPP 0.1875 0.1041 20000 0.0001 0.0038 0.0212 0.4190 0.5012 0.6203

coef(out)

#>    NARTIC    PCTGRT   PCTSUPP
#> 0.4602984 0.3697748 0.1874718

vcov(out)

#>               NARTIC       PCTGRT      PCTSUPP
#> NARTIC  0.0135136853 0.0016420466 0.0006346634
#> PCTGRT  0.0016420466 0.0136851423 0.0003740788
#> PCTSUPP 0.0006346634 0.0003740788 0.0108315030

confint(out)

#>               2.5%     97.5%
#> NARTIC  0.20338011 0.6527765
#> PCTGRT  0.12670148 0.5795790
#> PCTSUPP 0.02120482 0.4189970
```

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  0.0954 0.1451 20000 -0.3826 -0.2797 -0.1899 0.3781 0.4659 0.5519
#> NARTIC-PCTSUPP 0.2504 0.1379 20000 -0.2358 -0.1162 -0.0343 0.5094 0.5905 0.6715
#> PCTGRT-PCTSUPP 0.1549 0.1335 20000 -0.2808 -0.1974 -0.1168 0.4098 0.4884 0.5707

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  0.0954 0.1451 20000 -0.3826 -0.2797 -0.1899 0.3781 0.4659 0.5519
#> NARTIC-PCTSUPP 0.2504 0.1379 20000 -0.2358 -0.1162 -0.0343 0.5094 0.5905 0.6715
#> PCTGRT-PCTSUPP 0.1549 0.1335 20000 -0.2808 -0.1974 -0.1168 0.4098 0.4884 0.5707

coef(out)

#>  NARTIC-PCTGRT NARTIC-PCTSUPP PCTGRT-PCTSUPP
#>     0.09542757     0.25035013     0.15492256

vcov(out)

#>                NARTIC-PCTGRT NARTIC-PCTSUPP PCTGRT-PCTSUPP
#> NARTIC-PCTGRT    0.021044693    0.011120230   -0.009924463
#> NARTIC-PCTSUPP   0.011120230    0.019021619    0.007901389
#> PCTGRT-PCTSUPP  -0.009924463    0.007901389    0.017825852

confint(out)

#>                       2.5%     97.5%
#> NARTIC-PCTGRT  -0.1899209 0.3780546
#> NARTIC-PCTSUPP -0.0343208 0.5094155
#> PCTGRT-PCTSUPP -0.1167732 0.4098412
```

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/