World Rank of a University

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The code below was used to determine if alumni and Awards account for a significantly greater proportion of variance in the total score for determining the world rank of a university after controlling Nature and Science Score.

```
library(SDSRegressionR)
```

```
## Loading required package: ggplot2
```

```
## Loading required package: grid
```

```
## Loading required package: plyr
```

```
## Loading required package: readr
```

```
## Loading required package: stringr
```

```
## Loading required package: tibble
```

```
library(psych)
```

```
##
## Attaching package: 'psych'
```

```
## The following objects are masked from 'package:ggplot2':
##
##     %+%, alpha
```

```
#Import the College Data
college <- read.csv("/Volumes/USB20FD/Applied Regression Analysis/Data/shanghaiData.csv")

#Run the Initial Model
college_lm <- lm(total_score ~ ns + pub + alumni + award, college)
summary(college_lm)
```

```
##
## Call:
## lm(formula = total_score ~ ns + pub + alumni + award, data = college)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -5.2165 -1.2321 -0.0233  1.1807  5.6281
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 1.334557   0.251810    5.30  1.4e-07 ***
## ns          0.415853   0.006447   64.50  < 2e-16 ***
## pub         0.235631   0.006215   37.91  < 2e-16 ***
## alumni      0.105988   0.004485   23.63  < 2e-16 ***
## award       0.228947   0.004508   50.79  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.742 on 1096 degrees of freedom
##   (3796 observations deleted due to missingness)
## Multiple R-squared:  0.9835, Adjusted R-squared:  0.9835
## F-statistic: 1.638e+04 on 4 and 1096 DF,  p-value: < 2.2e-16
```

```
#Remove the Outliers
library(car)
```

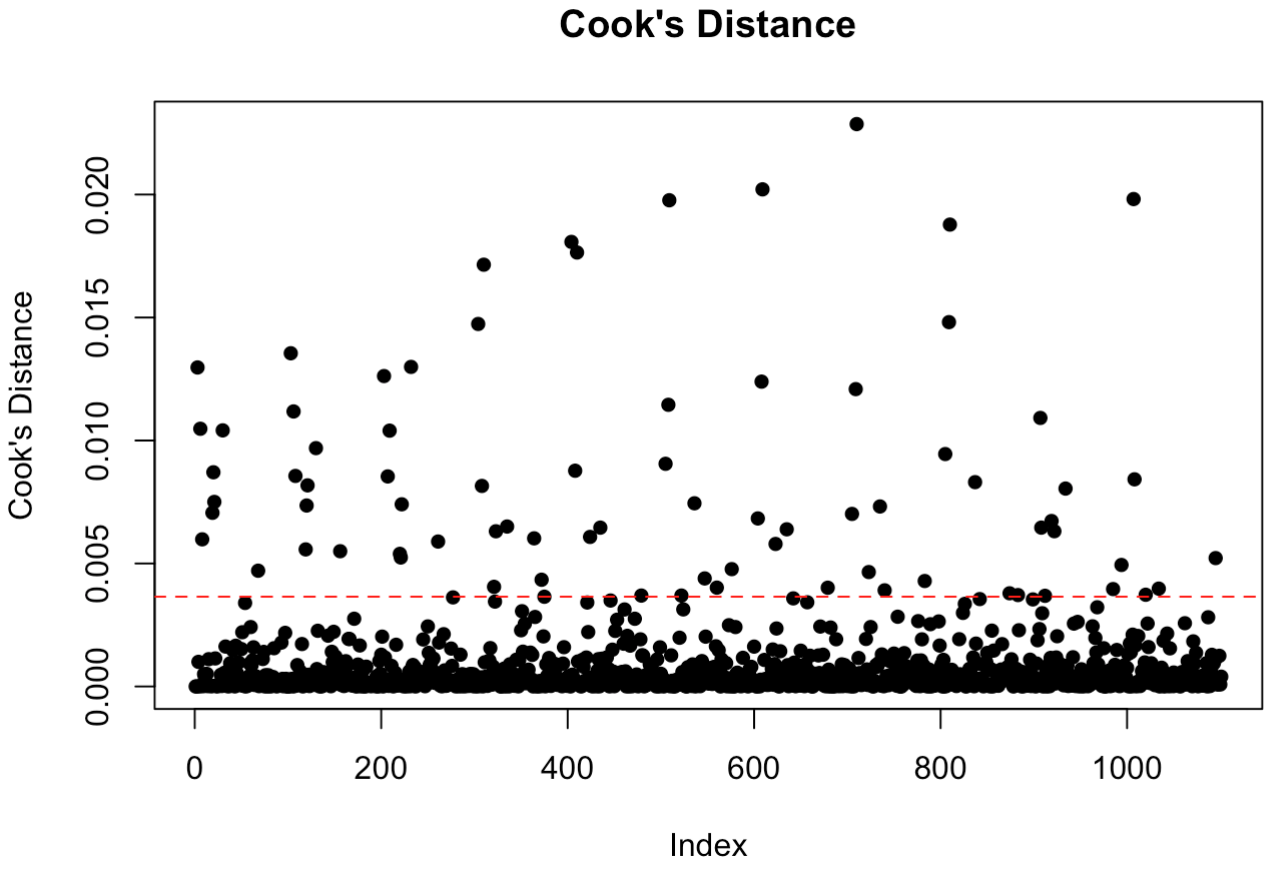
```
##
## Attaching package: 'car'
```

```
## The following object is masked from 'package:psych':
##
##     logit
```

```
vif(college_lm)
```

```
##       ns      pub   alumni    award
## 3.399103 2.111479 2.536606 3.572054
```

```
cooksPlot(college_lm, print.obs = TRUE, sort.obs = TRUE, save.cutoff=TRUE)
```



```
##    row.names total_score   ns  pub alumni award Predicted_Y Cooks_Distance
## 1       3521        62.1 44.4 44.5   52.3  91.3    56.73005    0.022863947
## 2       3021        61.2 43.8 43.4   56.7  87.1    55.72611    0.020210418
## 3       4403        61.0 43.0 42.4   53.3  93.4    56.23980    0.019816110
## 4       2521        60.8 43.3 44.3   56.4  84.8    55.17188    0.019767151
## 5       3805        61.9 45.8 44.0   52.9  89.2    56.77723    0.018777527
## 6       2015        73.1 67.3 70.1   39.0  78.7    67.99089    0.018073866
## 7       2021        60.2 41.5 45.7   57.8  85.2    54.99319    0.017643562
## 8       1518        58.9 40.5 44.8   59.3  80.4    53.42531    0.017147104
## 9       3804        62.9 62.0 45.2   47.8  67.2    58.21945    0.014811998
## 10      1512        73.7 68.9 71.6   40.0  78.7    69.11569    0.014737328
## 11       503        72.5 70.0 71.4   39.7  70.7    67.66263    0.013546931
## 12      1031        38.0 45.6 23.2   21.2  58.6    41.42734    0.012992334
## 13         3        73.4 70.9 72.3   41.1  72.2    68.74077    0.012969569
## 14      1002        73.7 69.6 70.3   42.0  78.7    69.31244    0.012620382
## 15      3020        64.7 65.0 46.5   52.6  68.8    60.64839    0.012393265
## 16      3520        64.1 64.8 46.2   48.5  68.8    60.05998    0.012088715
## 17      2520        64.4 64.8 46.9   50.3  68.8    60.41570    0.011451925
## 18       506        66.0 64.5 50.1   57.1  69.1    61.83436    0.011181237
## 19      3903        60.7 46.2 44.2   52.1  88.5    56.74565    0.010917931
## 20         6        67.1 65.8 52.5   59.2  68.6    63.04859    0.010477425
## 21        30        38.2 44.1 24.0   22.6  59.8    41.41518    0.010411889
## 22      1008        59.5 42.9 46.5   62.3  80.4    55.14189    0.010400583
## 23       530        38.3 44.8 24.1   21.8  58.6    41.37032    0.009689830
## 24      3800        72.6 68.7 69.4   40.0  80.7    68.97202    0.009448971
## 25      2517        72.1 68.4 69.7   40.2  78.4    68.41257    0.009052810
## 26      2019        64.8 66.2 47.7   51.5  69.1    61.38227    0.008771454
## 27        20        46.7 52.1 86.5   36.0  14.4    50.49504    0.008708106
## 28       508        58.6 43.5 47.3   61.1  75.3    54.28510    0.008559419
## 29      1006        66.4 67.6 50.3   55.5  69.1    63.00106    0.008539657
## 30      4404        59.6 56.4 44.0   49.5  66.7    55.67362    0.008421593
## 31      3832        37.1 43.1 20.4   17.7  60.2    39.72329    0.008306657
## 32       521        44.5 41.6 76.9   41.5   0.0    41.15262    0.008176183
## 33      1516        65.4 66.1 49.7   52.8  69.1    61.94973    0.008153455
## 34      3930        37.6 44.2 20.8   17.5  59.8    40.16221    0.008045879
## 35        21        44.9 43.0 76.5   43.0   0.0    41.79954    0.007503650
## 36      2548        36.7 42.3 21.0   19.2  58.4    39.27887    0.007447260
## 37      1021        44.0 40.8 77.1   40.3   0.0    40.73988    0.007405944
## 38       520        46.6 52.2 68.8   49.5  27.8    50.86467    0.007357272
## 39      3546        37.0 41.8 20.2   18.0  61.6    39.48788    0.007317678
```

```
## 40        19        46.9 52.2 67.7   51.4  28.3    50.92133    0.007060851
## 41      3516        72.8 71.6 69.6   38.0  79.7    69.78420    0.007015222
## 42      3016        72.6 70.2 70.3   41.2  78.4    69.40848    0.006831439
## 43      3915        45.2 56.5 59.9    0.0  39.9    48.07957    0.006727258
## 44      1543        37.2 42.2 22.3   20.2  58.6    39.69538    0.006502601
## 45      3904        60.5 60.0 44.9   48.5  66.7    57.27677    0.006457894
## 46      2046        36.9 41.9 21.6   19.7  58.6    39.35269    0.006457195
## 47      3047        37.1 42.5 21.5   19.5  58.4    39.51165    0.006389639
## 48      3918        43.2 52.6 73.0   31.6  14.1    46.98691    0.006311711
## 49      1531        44.2 41.7 78.1   38.4   0.0    41.14840    0.006309402
## 50      2035        43.8 41.4 77.3   37.5   0.0    40.73975    0.006080014
## 51      1572        29.3 11.3 35.7   31.2  32.8    25.26202    0.006022076
## 52         8        60.9 48.7 48.5   63.4  76.8    57.31749    0.005982028
## 53      1060        30.0 12.0 36.7   32.8  32.8    25.95833    0.005892113
## 54      3035        44.6 52.7 75.8   35.3  14.1    48.08042    0.005794232
## 55       519        46.7 51.5 85.5   34.8  14.1    49.81403    0.005572485
## 56       556        30.5 12.7 37.5   33.7  32.8    26.53332    0.005498645
## 57      1019        46.1 50.9 67.9   48.1  27.8    49.96361    0.005391649
## 58      1020        45.9 52.7 80.9   33.8  14.1    49.12316    0.005243776
## 59      4491        24.5 33.9 29.0    0.0   0.0    22.26530    0.005219562
## 60      3990        24.7 34.3 29.4    0.0   0.0    22.52589    0.004940279
## 61      2588        27.9  9.6 52.4   46.8  34.1    30.44116    0.004770622
## 62        68        28.4  7.5 54.0   51.4  34.9    30.61558    0.004706284
## 63      3534        43.8 52.0 73.7   32.5  14.6    47.11220    0.004651984
## 64      2559        32.3 20.8 49.9   31.7  46.0    35.63368    0.004392186
## 65      1580        28.1  8.3 53.2   49.1  34.2    30.35572    0.004339080
## 66      3594        26.3  9.1 48.1   43.7  34.1    28.89145    0.004287559
## 67      1529        46.4 51.9 83.3   32.2  14.1    49.18641    0.004050786
## 68      2572        30.2 15.2 34.2   32.9  32.7    26.68769    0.004018168
## 69      3091        26.9 10.1 46.9   47.4  34.1    29.41670    0.004014160
## 70      4430        36.5 40.9 19.0   17.0  59.8    38.31276    0.003977517
## 71      3981        26.1  9.7 47.9   42.4  33.0    28.70421    0.003960026
## 72      3551        34.9 20.0 48.8   32.1  55.9    37.35077    0.003908825
## 73      3869        28.5 16.7 26.7   51.0  28.2    26.43235    0.003787892
## 74      4416        44.5 53.5 59.5    0.0  39.9    46.73775    0.003728944
## 75      3878        26.1  8.8 48.1   43.1  33.3    28.51995    0.003716277
## 76      2534        45.9 52.0 80.4   33.3  14.1    48.66125    0.003695739
## 77      2090        26.9  8.2 48.7   47.9  34.2    29.12661    0.003695530
## 78      3908        55.2 61.5 62.9   48.8  50.4    58.44188    0.003685612
```

```
threeOuts(college_lm)
```

```
##     row.names total_score    ns   pub alumni award Predicted_Y
## 1        3521        62.1  44.4  44.5   52.3  91.3    56.73005
## 2        3021        61.2  43.8  43.4   56.7  87.1    55.72611
## 3        4403        61.0  43.0  42.4   53.3  93.4    56.23980
## 4        2521        60.8  43.3  44.3   56.4  84.8    55.17188
## 5        3805        61.9  45.8  44.0   52.9  89.2    56.77723
## 6        2015        73.1  67.3  70.1   39.0  78.7    67.99089
## 7        2021        60.2  41.5  45.7   57.8  85.2    54.99319
## 8        3804        62.9  62.0  45.2   47.8  67.2    58.21945
## 9        1512        73.7  68.9  71.6   40.0  78.7    69.11569
## 10       1002        73.7  69.6  70.3   42.0  78.7    69.31244
## 11       3020        64.7  65.0  46.5   52.6  68.8    60.64839
## 12       3520        64.1  64.8  46.2   48.5  68.8    60.05998
## 13       2520        64.4  64.8  46.9   50.3  68.8    60.41570
## 14        506        66.0  64.5  50.1   57.1  69.1    61.83436
## 15       3903        60.7  46.2  44.2   52.1  88.5    56.74565
## 16          6        67.1  65.8  52.5   59.2  68.6    63.04859
## 17       3800        72.6  68.7  69.4   40.0  80.7    68.97202
## 18       2517        72.1  68.4  69.7   40.2  78.4    68.41257
## 19       1518        58.9  40.5  44.8   59.3  80.4    53.42531
## 20        503        72.5  70.0  71.4   39.7  70.7    67.66263
## 21       1031        38.0  45.6  23.2   21.2  58.6    41.42734
## 22          3        73.4  70.9  72.3   41.1  72.2    68.74077
## 23         30        38.2  44.1  24.0   22.6  59.8    41.41518
## 24       1008        59.5  42.9  46.5   62.3  80.4    55.14189
## 25        530        38.3  44.8  24.1   21.8  58.6    41.37032
## 26       2019        64.8  66.2  47.7   51.5  69.1    61.38227
## 27         20        46.7  52.1  86.5   36.0  14.4    50.49504
## 28        508        58.6  43.5  47.3   61.1  75.3    54.28510
## 29       1006        66.4  67.6  50.3   55.5  69.1    63.00106
## 30       4404        59.6  56.4  44.0   49.5  66.7    55.67362
## 31       3832        37.1  43.1  20.4   17.7  60.2    39.72329
## 32        521        44.5  41.6  76.9   41.5   0.0    41.15262
## 33       1516        65.4  66.1  49.7   52.8  69.1    61.94973
## 34       3930        37.6  44.2  20.8   17.5  59.8    40.16221
## 35         21        44.9  43.0  76.5   43.0   0.0    41.79954
## 36       2548        36.7  42.3  21.0   19.2  58.4    39.27887
## 37       1021        44.0  40.8  77.1   40.3   0.0    40.73988
## 38        520        46.6  52.2  68.8   49.5  27.8    50.86467
## 39       3546        37.0  41.8  20.2   18.0  61.6    39.48788
```

```
## 40         19        46.9  52.2  67.7   51.4  28.3    50.92133
## 41       3516        72.8  71.6  69.6   38.0  79.7    69.78420
## 42       3016        72.6  70.2  70.3   41.2  78.4    69.40848
## 43       3915        45.2  56.5  59.9    0.0  39.9    48.07957
## 44       1543        37.2  42.2  22.3   20.2  58.6    39.69538
## 45       3904        60.5  60.0  44.9   48.5  66.7    57.27677
## 46       2046        36.9  41.9  21.6   19.7  58.6    39.35269
## 47       3047        37.1  42.5  21.5   19.5  58.4    39.51165
## 48       3918        43.2  52.6  73.0   31.6  14.1    46.98691
## 49       1531        44.2  41.7  78.1   38.4   0.0    41.14840
## 50       2035        43.8  41.4  77.3   37.5   0.0    40.73975
## 51       1572        29.3  11.3  35.7   31.2  32.8    25.26202
## 52          8        60.9  48.7  48.5   63.4  76.8    57.31749
## 53       1060        30.0  12.0  36.7   32.8  32.8    25.95833
## 54       3035        44.6  52.7  75.8   35.3  14.1    48.08042
## 55        519        46.7  51.5  85.5   34.8  14.1    49.81403
## 56        556        30.5  12.7  37.5   33.7  32.8    26.53332
## 57       1019        46.1  50.9  67.9   48.1  27.8    49.96361
## 58       1020        45.9  52.7  80.9   33.8  14.1    49.12316
## 59       4491        24.5  33.9  29.0    0.0   0.0    22.26530
## 60       3990        24.7  34.3  29.4    0.0   0.0    22.52589
## 61       2588        27.9   9.6  52.4   46.8  34.1    30.44116
## 62         68        28.4   7.5  54.0   51.4  34.9    30.61558
## 63       3534        43.8  52.0  73.7   32.5  14.6    47.11220
## 64       2559        32.3  20.8  49.9   31.7  46.0    35.63368
## 65       1580        28.1   8.3  53.2   49.1  34.2    30.35572
## 66       3594        26.3   9.1  48.1   43.7  34.1    28.89145
## 67       1529        46.4  51.9  83.3   32.2  14.1    49.18641
## 68       2572        30.2  15.2  34.2   32.9  32.7    26.68769
## 69       3091        26.9  10.1  46.9   47.4  34.1    29.41670
## 70       4430        36.5  40.9  19.0   17.0  59.8    38.31276
## 71       3981        26.1   9.7  47.9   42.4  33.0    28.70421
## 72       3551        34.9  20.0  48.8   32.1  55.9    37.35077
## 73       3869        28.5  16.7  26.7   51.0  28.2    26.43235
## 74       4416        44.5  53.5  59.5    0.0  39.9    46.73775
## 75       3878        26.1   8.8  48.1   43.1  33.3    28.51995
## 76       2534        45.9  52.0  80.4   33.3  14.1    48.66125
## 77       2090        26.9   8.2  48.7   47.9  34.2    29.12661
## 78       3908        55.2  61.5  62.9   48.8  50.4    58.44188
## 79         51        31.4  30.4  51.9   37.1  21.1    34.96870
## 80         60        29.9  28.7  49.1   25.9  32.9    35.11649
```

```
## 81          85        25.6  22.7  52.2   25.1  15.8    29.35205
## 82          97        24.5  21.8  54.6   16.6  15.8    28.64240
## 83         565        29.3  24.6  49.3   25.0  32.2    33.20296
## 84         601        23.5  19.4  53.3   16.0  15.5    27.20575
## 85        1066        28.8  23.6  49.1   24.3  32.2    32.66579
## 86        1604        24.5  24.5  48.2   13.7  18.9    28.65953
## 87        2110        24.2  24.0  47.6   13.4  18.9    28.27843
## 88        2612        24.2  23.5  48.4   13.1  18.9    28.22721
## 89        3100        25.4  24.3  49.3   13.2  22.1    29.51519
## 90        3600        25.5  23.9  50.8   12.1  22.8    29.74597
## 91        3879        26.0  25.6  50.9   12.0  22.2    30.32852
## 92        3971        27.4  26.7  51.9   11.8  22.1    30.97749
## 93           1       100.0 100.0 100.0  100.0 100.0    99.97651
## 94           2        73.6  56.6  70.9   99.8  93.4    73.53935
## 95           7        62.3  54.2  69.5   79.4  60.6    62.53981
## 96           9        60.1  44.7  56.4   75.6  81.9    59.97624
## 97          18        47.8  57.9  58.8    0.0  37.6    47.87599
## 98          93        24.6  18.1  27.2   47.8  25.0    26.06057
## 99         501       100.0 100.0 100.0  100.0 100.0    99.97651
## 100        502        72.6  59.5  67.1   96.3  91.5    73.04397
## 101        509        58.6  43.7  54.1   72.9  80.2    58.34306
## 102        518        47.7  54.8  61.1    0.0  36.8    46.94564
## 103        571        27.9   5.6  54.3   49.5  34.2    29.53451
## 104        599        23.6  14.8  27.3   46.1  24.5    24.41717
## 105       1001       100.0 100.0 100.0  100.0 100.0    99.97651
## 106       1004        71.6  58.2  65.4   93.6  91.5    71.81662
## 107       1005        70.0  68.4  61.7   74.6  80.6    70.67719
## 108       1018        46.8  53.7  59.8    0.0  36.8    46.18188
## 109       1076        27.1   7.5  48.5   51.6  34.2    29.18054
## 110       1084        25.5  16.8  25.8   48.5  31.6    26.77532
## 111       1511       100.0 100.0 100.0  100.0 100.0    99.97651
## 112       1514        70.4  56.0  64.1   90.3  91.5    70.24566
## 113       1519        57.1  39.5  51.9   67.4  81.9    55.88436
## 114       1528        46.6  51.5  60.8    0.0  36.8    45.50263
## 115       1583        27.7  17.2  25.9   53.4  24.5    25.85904
## 116       2014       100.0 100.0 100.0  100.0 100.0    99.97651
## 117       2017        70.2  53.9  65.4   89.4  91.5    69.58330
## 118       2022        57.0  38.6  51.6   65.8  84.3    55.81929
## 119       2031        45.9  49.7  59.9    0.0  36.8    44.54203
## 120       2083        28.1  17.9  27.6   52.1  24.5    26.41293
## 121       2515       100.0 100.0 100.0  100.0 100.0    99.97651
```

```
## 122      2518        71.4  70.1  61.4   70.5  80.3    70.81022
## 123      2519        69.6  54.3  65.7   88.5  92.6    69.97678
## 124      2523        57.3  39.8  50.5   65.5  83.9    55.93575
## 125      2533        46.0  51.8  60.7    0.0  40.1    46.35935
## 126      2536        44.2  43.4  79.8   36.5   0.0    42.05455
## 127      2585        28.3  18.7  27.9   50.8  24.4    26.65562
## 128      3015       100.0 100.0 100.0  100.0 100.0    99.97651
## 129      3017        72.0  70.6  60.6   72.8  81.9    71.43973
## 130      3019        70.0  54.1  65.1   87.1  96.7    70.54253
## 131      3023        57.5  40.4  50.9   65.0  83.9    56.22652
## 132      3031        46.7  54.2  62.0    0.0  40.1    47.66372
## 133      3036        44.1  45.0  77.7   36.7   0.0    42.24628
## 134      3083        28.7  19.4  27.4   54.2  24.4    27.18926
## 135      3515       100.0 100.0 100.0  100.0 100.0    99.97651
## 136      3519        69.8  55.0  65.9   80.3  97.2    70.49906
## 137      3523        57.2  40.6  49.2   61.8  85.3    55.89048
## 138      3532        46.6  54.1  60.6    0.0  41.2    47.54409
## 139      3536        43.4  44.6  76.2   33.9   0.0    41.42973
## 140      3587        27.6  17.4  27.3   50.0  24.4    25.88884
## 141      3609        24.6  32.0  28.4   13.3  16.8    26.58974
## 142      3799       100.0 100.0 100.0  100.0 100.0    99.97651
## 143      3803        69.6  54.0  66.2   79.1  97.3    70.04960
## 144      3816        46.2  54.1  59.3    0.0  40.2    47.00882
## 145      3837        34.5  19.7  48.7   31.6  54.7    36.87472
## 146      3894        24.9  33.5  28.4   13.1  16.4    27.10075
## 147      3898       100.0 100.0 100.0  100.0 100.0    99.97651
## 148      3899        72.1  71.1  70.9   41.8  82.8    70.99508
## 149      3900        70.5  73.6  61.5   68.4  80.7    72.15827
## 150      3902        69.2  56.2  66.5   79.1  96.6    70.87491
## 151      3906        57.4  43.0  50.7   61.4  86.3    57.42853
## 152      3920        42.3  42.4  77.3   35.3   0.0    40.92243
## 153      3939        34.2  18.5  48.4   31.1  54.3    36.16044
## 154      3964        28.3  16.8  26.8   50.2  28.0    26.36692
## 155      4398       100.0 100.0 100.0  100.0 100.0    99.97651
## 156      4399        73.3  70.1  70.6   40.7  89.6    71.94879
## 157      4400        70.4  73.1  61.1   68.2  80.7    71.83490
## 158      4402        68.8  55.6  66.4   77.1  96.6    70.38986
## 159      4406        57.1  42.9  49.8   59.8  86.3    57.00529
## 160      4439        33.6  17.4  47.3   30.3  54.3    35.35901
## 161      4469        27.6  19.5  26.4   48.9  28.0    27.25769
## 162      4483        25.3   7.7  46.4   41.4  33.0    27.41307
```

```
##     Student_Resid  Hat_Values Cooks_Distance inThree
## 1        3.100839 0.011749781    0.022863947       1
## 2        3.158109 0.010030279    0.020210418       1
## 3        2.750381 0.012928594    0.019816110       1
## 4        3.245885 0.009293790    0.019767151       1
## 5        2.956426 0.010627575    0.018777527       1
## 6        2.948045 0.010291067    0.018073866       1
## 7        3.003496 0.009684466    0.017643562       1
## 8        2.700433 0.010053760    0.014811998       1
## 9        2.645398 0.010419761    0.014737328       1
## 10       2.531010 0.009754335    0.012620382       1
## 11       2.338923 0.011200363    0.012393265       1
## 12       2.331988 0.010992515    0.012088715       1
## 13       2.299500 0.010712827    0.011451925       1
## 14       2.402792 0.009590526    0.011181237       1
## 15       2.281826 0.010375658    0.010917931       1
## 16       2.336800 0.009502431    0.010477425       1
## 17       2.093798 0.010661785    0.009448971       1
## 18       2.127290 0.009903248    0.009052810       1
## 19       3.156188          NA    0.017147104      NA
## 20       2.788909          NA    0.013546931      NA
## 21             NA 0.016241834    0.012992334      NA
## 22       2.686573          NA    0.012969569      NA
## 23             NA 0.014832804    0.010411889      NA
## 24       2.512015          NA    0.010400583      NA
## 25             NA 0.015128439    0.009689830      NA
## 26             NA 0.011141635    0.008771454      NA
## 27      -2.188385          NA    0.008708106      NA
## 28       2.485492          NA    0.008559419      NA
## 29             NA 0.010971237    0.008539657      NA
## 30       2.263146          NA    0.008421593      NA
## 31             NA 0.017673767    0.008306657      NA
## 32             NA 0.010833398    0.008176183      NA
## 33             NA 0.010181961    0.008153455      NA
## 34             NA 0.017935349    0.008045879      NA
## 35             NA 0.011571697    0.007503650      NA
## 36             NA 0.016437194    0.007447260      NA
## 37             NA 0.010355156    0.007405944      NA
## 38      -2.455549          NA    0.007357272      NA
## 39             NA 0.017322931    0.007317678      NA
## 40      -2.315988          NA    0.007060851      NA
```

```
## 41             NA 0.011437466    0.007015222      NA
## 42             NA 0.009974578    0.006831439      NA
## 43             NA 0.012016253    0.006727258      NA
## 44             NA 0.015362139    0.006502601      NA
## 45             NA 0.009257964    0.006457894      NA
## 46             NA 0.015777239    0.006457195      NA
## 47             NA 0.016136249    0.006389639      NA
## 48      -2.181037          NA    0.006311711      NA
## 49             NA 0.010074495    0.006309402      NA
## 50             NA 0.009661470    0.006080014      NA
## 51       2.324413          NA    0.006022076      NA
## 52       2.063716          NA    0.005982028      NA
## 53       2.326388          NA    0.005892113      NA
## 54      -2.005086          NA    0.005794232      NA
## 55             NA          NA    0.005572485      NA
## 56       2.283031          NA    0.005498645      NA
## 57      -2.223904          NA    0.005391649      NA
## 58             NA          NA    0.005243776      NA
## 59             NA 0.015375236    0.005219562      NA
## 60             NA 0.015375042    0.004940279      NA
## 61             NA 0.010965293    0.004770622      NA
## 62             NA 0.014139064    0.004706284      NA
## 63             NA          NA    0.004651984      NA
## 64             NA          NA    0.004392186      NA
## 65             NA 0.012614949    0.004339080      NA
## 66             NA 0.009504170    0.004287559      NA
## 67             NA          NA    0.004050786      NA
## 68       2.021161          NA    0.004018168      NA
## 69             NA 0.009435846    0.004014160      NA
## 70             NA 0.017720884    0.003977517      NA
## 71             NA          NA    0.003960026      NA
## 72             NA 0.009684410    0.003908825      NA
## 73             NA 0.013094290    0.003787892      NA
## 74             NA 0.011050827    0.003728944      NA
## 75             NA 0.009447926    0.003716277      NA
## 76             NA          NA    0.003695739      NA
## 77             NA 0.011061476    0.003695530      NA
## 78             NA          NA    0.003685612      NA
## 79      -2.051260          NA             NA      NA
## 80      -2.996486          NA             NA      NA
## 81      -2.155626          NA             NA      NA
```

```
## 82      -2.380187          NA             NA      NA
## 83      -2.242610          NA             NA      NA
## 84      -2.129623          NA             NA      NA
## 85      -2.221508          NA             NA      NA
## 86      -2.389405          NA             NA      NA
## 87      -2.342877          NA             NA      NA
## 88      -2.313528          NA             NA      NA
## 89      -2.364309          NA             NA      NA
## 90      -2.439946          NA             NA      NA
## 91      -2.487036          NA             NA      NA
## 92      -2.055514          NA             NA      NA
## 93             NA 0.023221422             NA      NA
## 94             NA 0.017024779             NA      NA
## 95             NA 0.009275730             NA      NA
## 96             NA 0.009853669             NA      NA
## 97             NA 0.012306754             NA      NA
## 98             NA 0.012385277             NA      NA
## 99             NA 0.023221422             NA      NA
## 100            NA 0.014449533             NA      NA
## 101            NA 0.009156171             NA      NA
## 102            NA 0.010924078             NA      NA
## 103            NA 0.015167586             NA      NA
## 104            NA 0.011482145             NA      NA
## 105            NA 0.023221422             NA      NA
## 106            NA 0.013637753             NA      NA
## 107            NA 0.009272689             NA      NA
## 108            NA 0.010554320             NA      NA
## 109            NA 0.012383647             NA      NA
## 110            NA 0.011781255             NA      NA
## 111            NA 0.023221422             NA      NA
## 112            NA 0.012928097             NA      NA
## 113            NA 0.009888073             NA      NA
## 114            NA 0.009974237             NA      NA
## 115            NA 0.015819747             NA      NA
## 116            NA 0.023221422             NA      NA
## 117            NA 0.013303782             NA      NA
## 118            NA 0.010815899             NA      NA
## 119            NA 0.009503949             NA      NA
## 120            NA 0.014261188             NA      NA
## 121            NA 0.023221422             NA      NA
## 122            NA 0.009152110             NA      NA
```

```
## 123          NA 0.013219638          NA      NA
## 124          NA 0.010107051          NA      NA
## 125          NA 0.010742211          NA      NA
## 126          NA 0.010121336          NA      NA
## 127          NA 0.013602039          NA      NA
## 128          NA 0.023221422          NA      NA
## 129          NA 0.009865075          NA      NA
## 130          NA 0.013841708          NA      NA
## 131          NA 0.009896603          NA      NA
## 132          NA 0.011416006          NA      NA
## 133          NA 0.010197702          NA      NA
## 134          NA 0.015696100          NA      NA
## 135          NA 0.023221422          NA      NA
## 136          NA 0.012865811          NA      NA
## 137          NA 0.010044074          NA      NA
## 138          NA 0.011536562          NA      NA
## 139          NA 0.009270332          NA      NA
## 140          NA 0.013399988          NA      NA
## 141          NA 0.009932443          NA      NA
## 142          NA 0.023221422          NA      NA
## 143          NA 0.013219808          NA      NA
## 144          NA 0.011281568          NA      NA
## 145          NA 0.009382628          NA      NA
## 146          NA 0.010850212          NA      NA
## 147          NA 0.023221422          NA      NA
## 148          NA 0.011323650          NA      NA
## 149          NA 0.010155751          NA      NA
## 150          NA 0.012314599          NA      NA
## 151          NA 0.009737918          NA      NA
## 152          NA 0.009258767          NA      NA
## 153          NA 0.009895269          NA      NA
## 154          NA 0.012743077          NA      NA
## 155          NA 0.023221422          NA      NA
## 156          NA 0.014098074          NA      NA
## 157          NA 0.010033907          NA      NA
## 158          NA 0.012335791          NA      NA
## 159          NA 0.009723516          NA      NA
## 160          NA 0.010332913          NA      NA
## 161          NA 0.012685466          NA      NA
## 162          NA 0.009382125          NA      NA
```

```
# Three Outs Outliers = 18
g_college <- college[!row.names(college) %in%c(3521,3021,4403,2521,3805,2015,2021,3804,1512,1002,3020,3520,2520,5
06,3903,6,3800,2517),]
```

```
#Rerun the Final Model
new_college_lm<-lm(total_score ~ ns + pub + alumni + award, g_college)
summary(new_college_lm)
```

```
##
## Call:
## lm(formula = total_score ~ ns + pub + alumni + award, data = g_college)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -5.0611 -1.1353  0.0595  1.1224  6.0705
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 1.244374   0.238944   5.208 2.29e-07 ***
## ns          0.410574   0.006180  66.436  < 2e-16 ***
## pub         0.242120   0.005943  40.741  < 2e-16 ***
## alumni      0.109702   0.004260  25.753  < 2e-16 ***
## award       0.218962   0.004365  50.166  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.638 on 1078 degrees of freedom
##   (3796 observations deleted due to missingness)
## Multiple R-squared:  0.9845, Adjusted R-squared:  0.9844
## F-statistic: 1.706e+04 on 4 and 1078 DF,  p-value: < 2.2e-16
```

```
#Tag the Observation in the model. Keep the observation in the model
g_college$in_new_college_lm<- tagObs(new_college_lm)
g_college_full<- g_college[which(g_college$in_new_college_lm == 1), ]
sum(g_college_full$in_new_college_lm) #Double Check
```

```
## [1] 1083
```

```
#Now I will perform the sequential regression. First we will perform the model with just our nuisance variables.
m1_seq<- lm(total_score ~ ns + pub, g_college_full)
summary(m1_seq)
```

```
##
## Call:
## lm(formula = total_score ~ ns + pub, data = g_college_full)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -13.0084  -3.1556  -0.0978   2.4618  17.5806
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  5.32279    0.66173   8.044 2.28e-15 ***
## ns           0.76845    0.01287  59.703  < 2e-16 ***
## pub          0.10881    0.01541   7.062 2.93e-12 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.772 on 1080 degrees of freedom
## Multiple R-squared:  0.8678, Adjusted R-squared:  0.8675
## F-statistic:  3544 on 2 and 1080 DF,  p-value: < 2.2e-16
```

```
summary(m1_seq)$r.squared
```

```
## [1] 0.8677743
```

```
lmBeta(m1_seq)
```

```
##        ns       pub
## 0.8626399 0.1020410
```

```
pCorr(m1_seq)
```

```
##     Partial_Corr Partial_Corr_sq  Part_Corr Part_Corr_sq
## ns     0.8760507      0.76746485 0.66060654  0.436401001
## pub    0.2101003      0.04414214 0.07814261  0.006106268
```

```
#Now we will perform the model with the variable of interest.
m2_seq <- lm(total_score ~ ns + pub + alumni + award , g_college_full)
summary(m2_seq)
```

```
##
## Call:
## lm(formula = total_score ~ ns + pub + alumni + award, data = g_college_full)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -5.0611 -1.1353  0.0595  1.1224  6.0705
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 1.244374   0.238944   5.208 2.29e-07 ***
## ns          0.410574   0.006180  66.436  < 2e-16 ***
## pub         0.242120   0.005943  40.741  < 2e-16 ***
## alumni      0.109702   0.004260  25.753  < 2e-16 ***
## award       0.218962   0.004365  50.166  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.638 on 1078 degrees of freedom
## Multiple R-squared:  0.9845, Adjusted R-squared:  0.9844
## F-statistic: 1.706e+04 on 4 and 1078 DF,  p-value: < 2.2e-16
```

```
summary(m2_seq)$r.squared
```

```
## [1] 0.9844529
```

```
summary(m2_seq)$r.squared - summary(m1_seq)$r.squared #Difference of Variance between the variables of interest a
nd the nuisance variables.
```

```
## [1] 0.1166785
```

```
#Perform the anova to find the significance of variance change
anova(m1_seq, m2_seq)
```

```
## Analysis of Variance Table
##
## Model 1: total_score ~ ns + pub
## Model 2: total_score ~ ns + pub + alumni + award
##   Res.Df     RSS Df Sum of Sq      F    Pr(>F)
## 1   1080 24598.2
## 2   1078  2892.3  2     21706 4045.1 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#Find the Best Predictor of total score for college ranking
lmBeta(m2_seq)
```

```
##        ns       pub    alumni     award
## 0.4609014 0.2270609 0.1549163 0.3523259
```

```
#How much unique variance of total college score
pCorr(m2_seq)
```

```
##        Partial_Corr Partial_Corr_sq  Part_Corr Part_Corr_sq
## ns        0.8964970       0.8037068 0.25230249  0.063656547
## pub       0.7786279       0.6062615 0.15472173  0.023938813
## alumni    0.6171708       0.3808998 0.09780255  0.009565338
## award     0.8367233       0.7001059 0.19051238  0.036294966
```