Multiple linear regression and binary logistic regression models

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Overview

This assignment is about to explore, to analyze and to model a data set containing approximately 8000 records representing a customer at an auto insurance company. Each record has two response variables. The first response variable, TARGET_FLAG, is a 1 or a 0. A "1" means that the person was in a car crash. A zero means that the person was not in a car crash. The second response variable is TARGET_AMT. This value is zero if the person did not crash their car. But if they did crash their car, this number will be a value greater than zero. Your objective is to build multiple linear regression and binary logistic regression models on the df1ing data to predict the probability that a person will crash their car and also the amount of money it will cost if the person does crash their car. You can only use the variables given to you (or variables that you derive from the variables provided).

Data exploration

Below is a short description of the variables of interest in the data set:

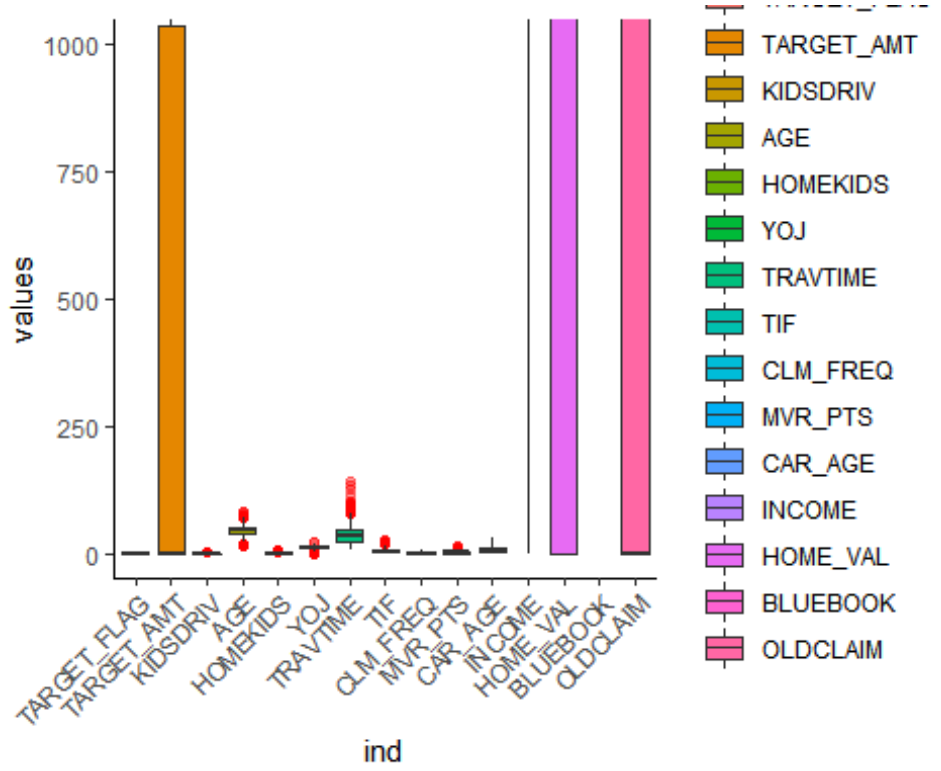
We need to make some cleaning of data such as removing the index, and special characters on certain variables. Below is the head of the data…

Summary table

Visualization

Outliers

The following diagram shows the outliers for all the variables(numerical), both dependent and independent.



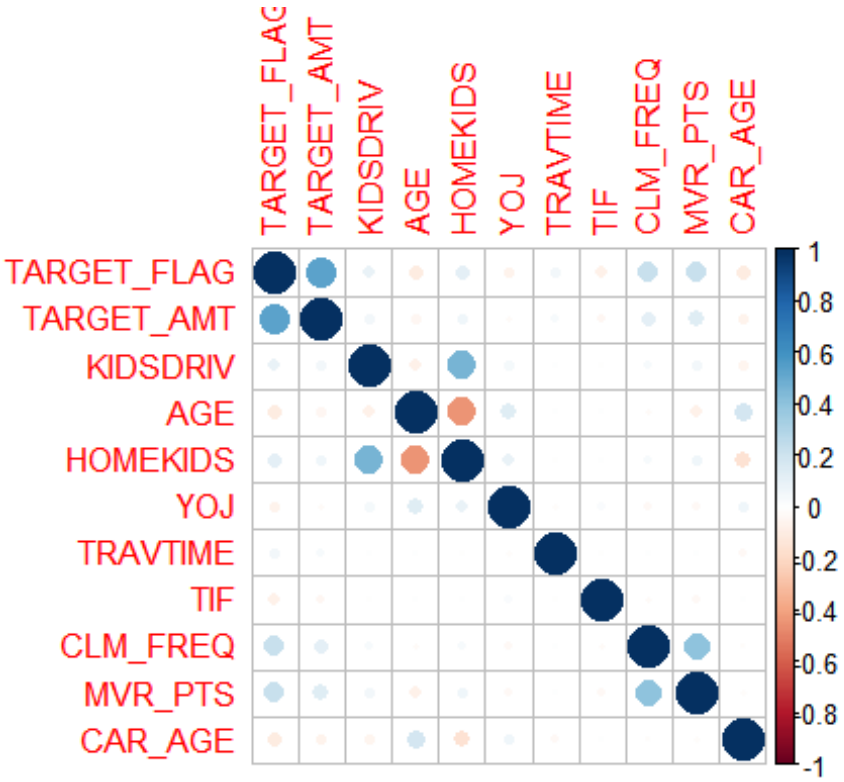
Correlation

Below is the correlation between the numerical variables...

```
##              TARGET_FLAG  TARGET_AMT     KIDSDRIV          AGE     HOMEKIDS
## TARGET_FLAG   1.00000000  0.53992929  0.097295404 -0.103649398  0.115481537
## TARGET_AMT    0.53992929  1.00000000  0.056857228 -0.046745810  0.068857861
## KIDSDRIV      0.09729540  0.05685723  1.000000000 -0.072361631  0.463046635
## AGE          -0.10364940 -0.04674581 -0.072361631  1.000000000 -0.442383841
## HOMEKIDS      0.11548154  0.06885786  0.463046635 -0.442383841  1.000000000
## YOJ          -0.06658661 -0.02144631  0.048112090  0.139566052  0.090416449
## TRAVTIME      0.05149130  0.03270817  0.008979590  0.004555303 -0.007787772
## TIF          -0.07718644 -0.04525925 -0.003423442  0.002871951  0.004673246
## CLM_FREQ      0.22338169  0.11515694  0.035087170 -0.026312189  0.030695809
## MVR_PTS       0.22526236  0.13770829  0.055019621 -0.073523273  0.062776101
## CAR_AGE      -0.10435770 -0.06283345 -0.055877063  0.182184524 -0.156534495
##                     YOJ     TRAVTIME          TIF     CLM_FREQ
MVR_PTS
```

```
## TARGET_FLAG -0.06658661  0.051491295 -0.077186438  0.223381685
0.225262361
## TARGET_AMT  -0.02144631  0.032708168 -0.045259254  0.115156936
0.137708292
## KIDSDRIV     0.04811209  0.008979590 -0.003423442  0.035087170
0.055019621
## AGE          0.13956605  0.004555303  0.002871951 -0.026312189 -
0.073523273
## HOMEKIDS     0.09041645 -0.007787772  0.004673246  0.030695809
0.062776101
## YOJ          1.00000000 -0.015762889  0.029302946 -0.030658029 -
0.039172617
## TRAVTIME    -0.01576289  1.000000000 -0.009343232  0.009306981
0.009937566
## TIF          0.02930295 -0.009343232  1.000000000 -0.024972898 -
0.037174513
## CLM_FREQ    -0.03065803  0.009306981 -0.024972898  1.000000000
0.400121265
## MVR_PTS     -0.03917262  0.009937566 -0.037174513  0.400121265
1.000000000
## CAR_AGE      0.06122969 -0.037055196  0.009125709 -0.011538390 -
0.019363647
##                  CAR_AGE
## TARGET_FLAG -0.104357704
## TARGET_AMT  -0.062833451
## KIDSDRIV    -0.055877063
## AGE          0.182184524
## HOMEKIDS    -0.156534495
## YOJ          0.061229694
## TRAVTIME    -0.037055196
## TIF          0.009125709
## CLM_FREQ    -0.011538390
## MVR_PTS     -0.019363647
## CAR_AGE      1.000000000
```

Here's the correlation matrix visualization…



There is a little bit of correlation between HomeKids and Kidsdriv, and MVR_PTS and CLM_FREQ

Data Preparation

Missing values

Let explore the number of missing values in each variable

```
##      CAR_AGE     HOME_VAL          YOJ       INCOME          AGE  URBANICITY
##          510          464          454          445            6            0
##     CAR_TYPE          JOB    EDUCATION          SEX      MSTATUS    OLDCLAIM
##            0            0            0            0            0            0
##     BLUEBOOK      MVR_PTS      REVOKED     CLM_FREQ      RED_CAR          TIF
##            0            0            0            0            0            0
##      CAR_USE     TRAVTIME      PARENT1     HOMEKIDS     KIDSDRIV   TARGET_AMT
##            0            0            0            0            0            0
## TARGET_FLAG
##            0

## [1] 1879
```

We will use mean and BoxCox transformation for data imputation, but we need to transform little the data for BoxCox transformation… BoxCox needs variable to have value greater or equal to 1

BoxCox iputation prep

Prepare for BoxCox imputation...

```
##           TARGET_FLAG             TARGET_AMT               KIDSDRIV
##                   "0"        "     0.00000"                    "0"
##                   AGE               HOMEKIDS                    YOJ
##                  "16"                    "0"                   " 0"
##               PARENT1               TRAVTIME                 CAR_USE
##                  "No"                  "  5"            "Commercial"
##                   TIF                RED_CAR                CLM_FREQ
##                  " 1"                   "no"                    "0"
##               REVOKED                MVR_PTS                 CAR_AGE
##                  "No"                  " 0"                      NA
##                INCOME               HOME_VAL                BLUEBOOK
##              "     0"              "     0"                 " 1500"
##              OLDCLAIM                MSTATUS                     SEX
##               "    0"                   "No"                    "F"
##             EDUCATION                    JOB                CAR_TYPE
##        "<High School"                     ""               "Minivan"
##            URBANICITY
## "Highly Rural/ Rural"

## $TIF
## Box-Cox Transformation
##
## 7650 data points used to estimate Lambda
##
## Input data summary:
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    1.00    1.00    4.00    5.36    7.00   25.00
##
## Largest/Smallest: 25
## Sample Skewness: 0.89
##
## Estimated Lambda: 0.2
##
##
## $BLUEBOOK
## Box-Cox Transformation
##
## 7650 data points used to estimate Lambda
##
## Input data summary:
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    1500    9315   14440   15720   20820   69740
##
## Largest/Smallest: 46.5
## Sample Skewness: 0.802
##
```

```
## Estimated Lambda: 0.5
##
##
## $TRAVTIME
## Box-Cox Transformation
##
## 7650 data points used to estimate Lambda
##
## Input data summary:
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    5.00   23.00   33.00   33.55   44.00  142.00
##
## Largest/Smallest: 28.4
## Sample Skewness: 0.452
##
## Estimated Lambda: 0.7
##
##
## $AGE
## Box-Cox Transformation
##
## 7650 data points used to estimate Lambda
##
## Input data summary:
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   16.00   39.00   45.00   44.81   51.00   81.00
##
## Largest/Smallest: 5.06
## Sample Skewness: -0.0247
##
## Estimated Lambda: 1
## With fudge factor, no transformation is applied
##
##
## $CAR_AGE
## Box-Cox Transformation
##
## 7650 data points used to estimate Lambda
##
## Input data summary:
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    1.00    2.00    9.00    9.33   13.00   29.00
##
## Largest/Smallest: 29
## Sample Skewness: 0.282
##
## Estimated Lambda: 0.5
##
##
## $YOJ
```

```
## Box-Cox Transformation
##
## 7650 data points used to estimate Lambda
##
## Input data summary:
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    1.00   10.00   12.00   11.55   14.00   24.00
##
## Largest/Smallest: 24
## Sample Skewness: -1.26
##
## Estimated Lambda: 1.6
##
##
## $INCOME
## Box-Cox Transformation
##
## 7650 data points used to estimate Lambda
##
## Input data summary:
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##       1   29701   54029   61450   83302  367031
##
## Largest/Smallest: 367000
## Sample Skewness: 1.25
##
## Estimated Lambda: 0.4
```

Build Models

Multiple Linear Regression Models

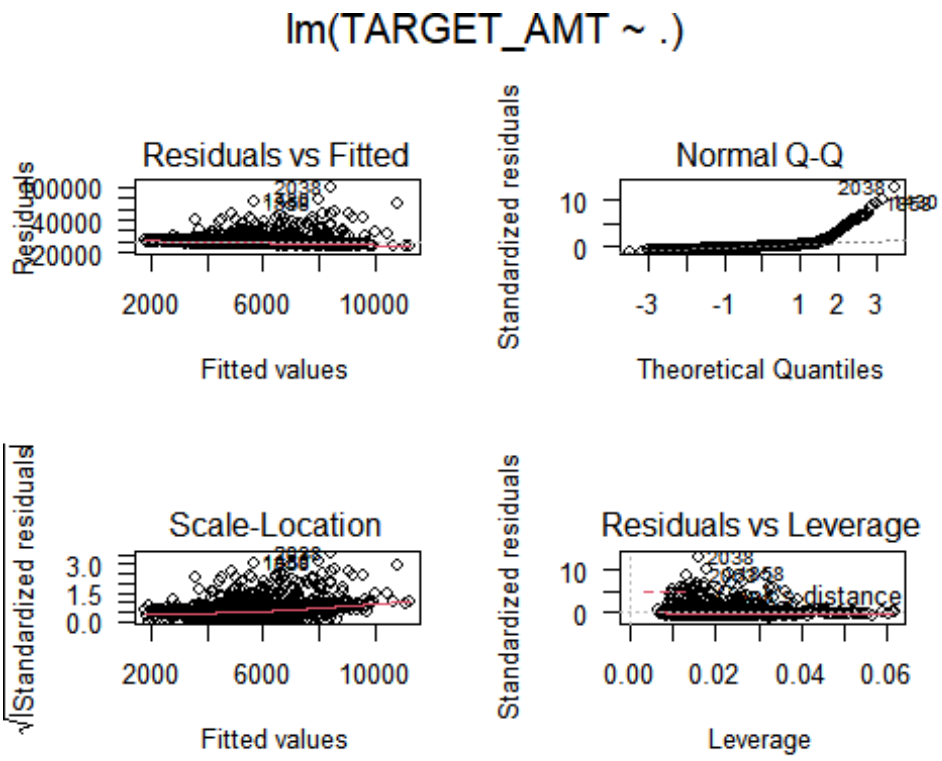
Model 1: Mean full model

Building the first model using all the variables...

```
##
## Call:
## lm(formula = TARGET_AMT ~ ., data = df_lm)
##
## Residuals:
##    Min     1Q Median     3Q    Max
##  -8934  -3199  -1537    493  99141
##
## Coefficients:
##                               Estimate Std. Error t value Pr(>|t|)
## (Intercept)                  3.025e+03  2.095e+03   1.444 0.148807
## KIDSDRIV                    -1.167e+02  3.378e+02  -0.346 0.729696
## AGE                          1.272e+01  2.236e+01   0.569 0.569617
## HOMEKIDS                     2.288e+02  2.169e+02   1.055 0.291669
```

```
## YOJ                                2.451e+01  5.173e+01   0.474 0.635662
## PARENT1Yes                         1.406e+02  6.166e+02   0.228 0.819623
## TRAVTIME                           3.617e+00  1.169e+01   0.309 0.757114
## CAR_USEPrivate                    -5.479e+02  5.487e+02  -0.999 0.318094
## TIF                               -3.882e+01  4.482e+01  -0.866 0.386583
## RED_CARyes                        -2.473e+02  5.214e+02  -0.474 0.635302
## CLM_FREQ                          -1.463e+02  1.662e+02  -0.880 0.378836
## REVOKEDYes                        -1.192e+03  5.427e+02  -2.197 0.028162 *
## MVR_PTS                            1.088e+02  7.231e+01   1.504 0.132743
## CAR_AGE                           -9.230e+01  4.617e+01  -1.999 0.045712 *
## INCOME                            -9.670e-03  7.073e-03  -1.367 0.171729
## HOME_VAL                           1.671e-03  2.112e-03   0.791 0.429070
## BLUEBOOK                           1.227e-01  3.196e-02   3.840 0.000127 ***
## OLDCLAIM                           3.257e-02  2.364e-02   1.378 0.168373
## MSTATUSYes                        -8.493e+02  5.218e+02  -1.628 0.103786
## SEXM                               1.397e+03  6.880e+02   2.030 0.042451 *
## EDUCATIONBachelors                 2.182e+02  6.777e+02   0.322 0.747551
## EDUCATIONHigh School              -5.850e+02  5.389e+02  -1.086 0.277780
## EDUCATIONMasters                   9.636e+02  1.152e+03   0.836 0.403142
## EDUCATIONPhD                       2.460e+03  1.396e+03   1.762 0.078207 .
## JOBBlue Collar                     6.499e+02  1.205e+03   0.539 0.589660
## JOBClerical                        3.778e+02  1.263e+03   0.299 0.764818
## JOBDoctor                         -2.073e+03  1.812e+03  -1.144 0.252835
## JOBHome Maker                      1.686e+02  1.333e+03   0.126 0.899392
## JOBLawyer                          4.172e+02  1.075e+03   0.388 0.697950
## JOBManager                        -7.283e+02  1.128e+03  -0.646 0.518587
## JOBProfessional                    1.389e+03  1.181e+03   1.176 0.239802
## JOBStudent                         1.484e+02  1.355e+03   0.110 0.912816
## CAR_TYPEPanel Truck               -5.584e+02  1.004e+03  -0.556 0.578258
## CAR_TYPEPickup                    -2.292e+02  6.279e+02  -0.365 0.715141
## CAR_TYPESports Car                 1.074e+03  7.867e+02   1.365 0.172386
## CAR_TYPESUV                        9.386e+02  6.968e+02   1.347 0.178104
## CAR_TYPEVan                        3.322e+02  8.104e+02   0.410 0.681889
## URBANICITYHighly Urban/ Urban      1.499e+02  7.962e+02   0.188 0.850687
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 7817 on 1973 degrees of freedom
##   (142 observations deleted due to missingness)
## Multiple R-squared:  0.03181,    Adjusted R-squared:  0.01366
## F-statistic: 1.752 on 37 and 1973 DF,  p-value: 0.003512
```

Visualization...



Model 2: Stepwise

```
## Start:  AIC=36091.11
## TARGET_AMT ~ KIDSDRIV + AGE + HOMEKIDS + YOJ + PARENT1 + TRAVTIME +
##     CAR_USE + TIF + RED_CAR + CLM_FREQ + REVOKED + MVR_PTS +
##     CAR_AGE + INCOME + HOME_VAL + BLUEBOOK + OLDCLAIM + MSTATUS +
##     SEX + EDUCATION + JOB + CAR_TYPE + URBANICITY
##
##               Df Sum of Sq        RSS   AIC
## - JOB          8 469943135 1.2103e+11 36083
## - CAR_TYPE     5 253319413 1.2082e+11 36085
## - URBANICITY   1   2165878 1.2057e+11 36089
## - PARENT1      1   3178268 1.2057e+11 36089
## - TRAVTIME     1   5846477 1.2057e+11 36089
## - KIDSDRIV     1   7297697 1.2057e+11 36089
## - YOJ          1  13720342 1.2058e+11 36089
## - RED_CAR      1  13749572 1.2058e+11 36089
## - AGE          1  19763912 1.2058e+11 36089
## - HOME_VAL     1  38228288 1.2060e+11 36090
## - EDUCATION    4 405041171 1.2097e+11 36090
## - TIF          1  45829844 1.2061e+11 36090
## - CLM_FREQ     1  47346961 1.2061e+11 36090
## - CAR_USE      1  60940121 1.2062e+11 36090
## - HOMEKIDS     1  67981141 1.2063e+11 36090
## - INCOME       1 114217654 1.2068e+11 36091
## - OLDCLAIM     1 116027467 1.2068e+11 36091
## <none>                     1.2056e+11 36091
```

```
## - MVR_PTS     1 138223654 1.2070e+11 36091
## - MSTATUS     1 161861282 1.2073e+11 36092
## - CAR_AGE     1 244258656 1.2081e+11 36093
## - SEX         1 251910571 1.2082e+11 36093
## - REVOKED     1 294856563 1.2086e+11 36094
## - BLUEBOOK    1 901120949 1.2146e+11 36104
##
## Step:  AIC=36082.94
## TARGET_AMT ~ KIDSDRIV + AGE + HOMEKIDS + YOJ + PARENT1 + TRAVTIME +
##     CAR_USE + TIF + RED_CAR + CLM_FREQ + REVOKED + MVR_PTS +
##     CAR_AGE + INCOME + HOME_VAL + BLUEBOOK + OLDCLAIM + MSTATUS +
##     SEX + EDUCATION + CAR_TYPE + URBANICITY
##
##              Df Sum of Sq        RSS   AIC
## - CAR_TYPE    5 236966467 1.2127e+11 36077
## - EDUCATION   4 308229999 1.2134e+11 36080
## - URBANICITY  1    965617 1.2103e+11 36081
## - PARENT1     1   5312998 1.2104e+11 36081
## - TRAVTIME    1   8714537 1.2104e+11 36081
## - KIDSDRIV    1   8789882 1.2104e+11 36081
## - RED_CAR     1  17718790 1.2105e+11 36081
## - AGE         1  22400164 1.2106e+11 36081
## - TIF         1  35799007 1.2107e+11 36082
## - YOJ         1  43615339 1.2108e+11 36082
## - CLM_FREQ    1  46060690 1.2108e+11 36082
## - HOMEKIDS    1  50786527 1.2108e+11 36082
## - HOME_VAL    1  55459128 1.2109e+11 36082
## - OLDCLAIM    1  93964699 1.2113e+11 36082
## - CAR_USE     1 109054463 1.2114e+11 36083
## - INCOME      1 112628408 1.2115e+11 36083
## <none>                    1.2103e+11 36083
## - MVR_PTS     1 164427107 1.2120e+11 36084
## - MSTATUS     1 165584306 1.2120e+11 36084
## - CAR_AGE     1 240391833 1.2127e+11 36085
## - SEX         1 248609327 1.2128e+11 36085
## - REVOKED     1 249404349 1.2128e+11 36085
## - BLUEBOOK    1 892963211 1.2193e+11 36096
##
## Step:  AIC=36076.87
## TARGET_AMT ~ KIDSDRIV + AGE + HOMEKIDS + YOJ + PARENT1 + TRAVTIME +
##     CAR_USE + TIF + RED_CAR + CLM_FREQ + REVOKED + MVR_PTS +
##     CAR_AGE + INCOME + HOME_VAL + BLUEBOOK + OLDCLAIM + MSTATUS +
##     SEX + EDUCATION + URBANICITY
##
##              Df  Sum of Sq        RSS   AIC
## - EDUCATION   4  293028995 1.2156e+11 36074
## - URBANICITY  1     856675 1.2127e+11 36075
## - PARENT1     1    6956166 1.2128e+11 36075
## - TRAVTIME    1   10004549 1.2128e+11 36075
## - KIDSDRIV    1   15091560 1.2129e+11 36075
```

```
## - RED_CAR     1   22955445 1.2129e+11 36075
## - TIF         1   31683557 1.2130e+11 36075
## - YOJ         1   40394006 1.2131e+11 36076
## - CLM_FREQ    1   48329600 1.2132e+11 36076
## - AGE         1   49960692 1.2132e+11 36076
## - HOMEKIDS    1   55516846 1.2133e+11 36076
## - HOME_VAL    1   58416578 1.2133e+11 36076
## - CAR_USE     1   62849650 1.2133e+11 36076
## - OLDCLAIM    1   94247726 1.2136e+11 36076
## - INCOME      1  102728766 1.2137e+11 36077
## <none>                     1.2127e+11 36077
## - SEX         1  126458571 1.2140e+11 36077
## - MSTATUS     1  155747969 1.2143e+11 36077
## - MVR_PTS     1  166354304 1.2144e+11 36078
## - REVOKED     1  246739099 1.2152e+11 36079
## - CAR_AGE     1  255944523 1.2153e+11 36079
## - BLUEBOOK    1 1191468027 1.2246e+11 36095
##
## Step:  AIC=36073.72
## TARGET_AMT ~ KIDSDRIV + AGE + HOMEKIDS + YOJ + PARENT1 + TRAVTIME +
##     CAR_USE + TIF + RED_CAR + CLM_FREQ + REVOKED + MVR_PTS +
##     CAR_AGE + INCOME + HOME_VAL + BLUEBOOK + OLDCLAIM + MSTATUS +
##     SEX + URBANICITY
##
##              Df  Sum of Sq        RSS   AIC
## - URBANICITY  1    1842097 1.2157e+11 36072
## - PARENT1     1    5746780 1.2157e+11 36072
## - TRAVTIME    1   11362492 1.2158e+11 36072
## - KIDSDRIV    1   12710883 1.2158e+11 36072
## - CAR_USE     1   18809855 1.2158e+11 36072
## - RED_CAR     1   19154959 1.2158e+11 36072
## - YOJ         1   19249674 1.2158e+11 36072
## - INCOME      1   30009939 1.2159e+11 36072
## - TIF         1   33478524 1.2160e+11 36072
## - CLM_FREQ    1   43826138 1.2161e+11 36072
## - HOMEKIDS    1   56286122 1.2162e+11 36073
## - HOME_VAL    1   64738692 1.2163e+11 36073
## - AGE         1   68188686 1.2163e+11 36073
## - OLDCLAIM    1   89443723 1.2165e+11 36073
## - CAR_AGE     1  106343391 1.2167e+11 36073
## <none>                     1.2156e+11 36074
## - SEX         1  149903559 1.2171e+11 36074
## - MSTATUS     1  182520593 1.2175e+11 36075
## - MVR_PTS     1  183291459 1.2175e+11 36075
## - REVOKED     1  245461948 1.2181e+11 36076
## - BLUEBOOK    1 1297078713 1.2286e+11 36093
##
## Step:  AIC=36071.75
## TARGET_AMT ~ KIDSDRIV + AGE + HOMEKIDS + YOJ + PARENT1 + TRAVTIME +
##     CAR_USE + TIF + RED_CAR + CLM_FREQ + REVOKED + MVR_PTS +
```

```
##     CAR_AGE + INCOME + HOME_VAL + BLUEBOOK + OLDCLAIM + MSTATUS +
##     SEX
##
##            Df  Sum of Sq        RSS   AIC
## - PARENT1   1    5693754 1.2157e+11 36070
## - TRAVTIME  1   10766761 1.2158e+11 36070
## - KIDSDRIV  1   12739425 1.2158e+11 36070
## - CAR_USE   1   18874900 1.2158e+11 36070
## - RED_CAR   1   19054285 1.2158e+11 36070
## - YOJ       1   19438380 1.2158e+11 36070
## - INCOME    1   29169043 1.2159e+11 36070
## - TIF       1   33102736 1.2160e+11 36070
## - CLM_FREQ  1   42851795 1.2161e+11 36070
## - HOMEKIDS  1   55811739 1.2162e+11 36071
## - HOME_VAL  1   64662586 1.2163e+11 36071
## - AGE       1   67542493 1.2163e+11 36071
## - OLDCLAIM  1   88398537 1.2165e+11 36071
## - CAR_AGE   1  105826822 1.2167e+11 36072
## <none>                   1.2157e+11 36072
## - SEX       1  148981133 1.2171e+11 36072
## - MSTATUS   1  181291557 1.2175e+11 36073
## - MVR_PTS   1  185108458 1.2175e+11 36073
## - REVOKED   1  243957432 1.2181e+11 36074
## - BLUEBOOK  1 1302879099 1.2287e+11 36091
##
## Step:  AIC=36069.85
## TARGET_AMT ~ KIDSDRIV + AGE + HOMEKIDS + YOJ + TRAVTIME + CAR_USE +
##     TIF + RED_CAR + CLM_FREQ + REVOKED + MVR_PTS + CAR_AGE +
##     INCOME + HOME_VAL + BLUEBOOK + OLDCLAIM + MSTATUS + SEX
##
##            Df  Sum of Sq        RSS   AIC
## - TRAVTIME  1   10583155 1.2158e+11 36068
## - KIDSDRIV  1   12026440 1.2158e+11 36068
## - CAR_USE   1   18142211 1.2159e+11 36068
## - RED_CAR   1   19040049 1.2159e+11 36068
## - YOJ       1   19348550 1.2159e+11 36068
## - INCOME    1   29818379 1.2160e+11 36068
## - TIF       1   33585592 1.2160e+11 36068
## - CLM_FREQ  1   43050354 1.2161e+11 36069
## - AGE       1   64223029 1.2164e+11 36069
## - HOME_VAL  1   65317881 1.2164e+11 36069
## - OLDCLAIM  1   88804959 1.2166e+11 36069
## - HOMEKIDS  1   90944370 1.2166e+11 36069
## - CAR_AGE   1  105327287 1.2168e+11 36070
## <none>                   1.2157e+11 36070
## - SEX       1  147371685 1.2172e+11 36070
## - MVR_PTS   1  187176286 1.2176e+11 36071
## - REVOKED   1  245828287 1.2182e+11 36072
## - MSTATUS   1  312899566 1.2188e+11 36073
## - BLUEBOOK  1 1303707132 1.2287e+11 36089
```

```
##
## Step:  AIC=36068.02
## TARGET_AMT ~ KIDSDRIV + AGE + HOMEKIDS + YOJ + CAR_USE + TIF +
##     RED_CAR + CLM_FREQ + REVOKED + MVR_PTS + CAR_AGE + INCOME +
##     HOME_VAL + BLUEBOOK + OLDCLAIM + MSTATUS + SEX
##
##            Df  Sum of Sq        RSS   AIC
## - KIDSDRIV  1   12717116 1.2159e+11 36066
## - CAR_USE   1   15900397 1.2160e+11 36066
## - RED_CAR   1   18818620 1.2160e+11 36066
## - YOJ       1   19663593 1.2160e+11 36066
## - INCOME    1   28657692 1.2161e+11 36066
## - TIF       1   34495010 1.2162e+11 36067
## - CLM_FREQ  1   41430585 1.2162e+11 36067
## - HOME_VAL  1   64787510 1.2165e+11 36067
## - AGE       1   65838971 1.2165e+11 36067
## - OLDCLAIM  1   86104148 1.2167e+11 36067
## - HOMEKIDS  1   90316554 1.2167e+11 36068
## - CAR_AGE   1  103997897 1.2169e+11 36068
## <none>                   1.2158e+11 36068
## - SEX       1  148338358 1.2173e+11 36068
## - MVR_PTS   1  188617256 1.2177e+11 36069
## - REVOKED   1  243714639 1.2183e+11 36070
## - MSTATUS   1  309146076 1.2189e+11 36071
## - BLUEBOOK  1 1309357711 1.2289e+11 36088
##
## Step:  AIC=36066.23
## TARGET_AMT ~ AGE + HOMEKIDS + YOJ + CAR_USE + TIF + RED_CAR +
##     CLM_FREQ + REVOKED + MVR_PTS + CAR_AGE + INCOME + HOME_VAL +
##     BLUEBOOK + OLDCLAIM + MSTATUS + SEX
##
##            Df  Sum of Sq        RSS   AIC
## - CAR_USE   1   17681725 1.2161e+11 36065
## - RED_CAR   1   18235722 1.2161e+11 36065
## - YOJ       1   20575176 1.2162e+11 36065
## - INCOME    1   31431047 1.2163e+11 36065
## - TIF       1   34132616 1.2163e+11 36065
## - CLM_FREQ  1   42623742 1.2164e+11 36065
## - AGE       1   56669663 1.2165e+11 36065
## - HOME_VAL  1   64015480 1.2166e+11 36065
## - HOMEKIDS  1   79558260 1.2167e+11 36066
## - OLDCLAIM  1   87579344 1.2168e+11 36066
## - CAR_AGE   1  102810967 1.2170e+11 36066
## <none>                   1.2159e+11 36066
## - SEX       1  145934102 1.2174e+11 36067
## - MVR_PTS   1  188017744 1.2178e+11 36067
## - REVOKED   1  250237302 1.2184e+11 36068
## - MSTATUS   1  307680961 1.2190e+11 36069
## - BLUEBOOK  1 1300629748 1.2290e+11 36086
##
```

```
## Step:  AIC=36064.53
## TARGET_AMT ~ AGE + HOMEKIDS + YOJ + TIF + RED_CAR + CLM_FREQ +
##     REVOKED + MVR_PTS + CAR_AGE + INCOME + HOME_VAL + BLUEBOOK +
##     OLDCLAIM + MSTATUS + SEX
##
##            Df  Sum of Sq        RSS   AIC
## - RED_CAR   1   18131672 1.2163e+11 36063
## - YOJ       1   18515875 1.2163e+11 36063
## - INCOME    1   28249484 1.2164e+11 36063
## - TIF       1   30953795 1.2164e+11 36063
## - CLM_FREQ  1   40604710 1.2165e+11 36063
## - AGE       1   51155104 1.2166e+11 36063
## - HOME_VAL  1   63614498 1.2168e+11 36064
## - HOMEKIDS  1   75609382 1.2169e+11 36064
## - OLDCLAIM  1   85221119 1.2170e+11 36064
## - CAR_AGE   1  113267333 1.2173e+11 36064
## <none>                   1.2161e+11 36065
## - SEX       1  185303260 1.2180e+11 36066
## - MVR_PTS   1  197769471 1.2181e+11 36066
## - REVOKED   1  241532321 1.2185e+11 36067
## - MSTATUS   1  301138160 1.2191e+11 36068
## - BLUEBOOK  1 1430529112 1.2304e+11 36086
##
## Step:  AIC=36062.83
## TARGET_AMT ~ AGE + HOMEKIDS + YOJ + TIF + CLM_FREQ + REVOKED +
##     MVR_PTS + CAR_AGE + INCOME + HOME_VAL + BLUEBOOK + OLDCLAIM +
##     MSTATUS + SEX
##
##            Df  Sum of Sq        RSS   AIC
## - YOJ       1   20029097 1.2165e+11 36061
## - INCOME    1   28847085 1.2166e+11 36061
## - TIF       1   30758533 1.2166e+11 36061
## - CLM_FREQ  1   39971637 1.2167e+11 36061
## - AGE       1   53552250 1.2168e+11 36062
## - HOME_VAL  1   64187132 1.2169e+11 36062
## - HOMEKIDS  1   75837247 1.2171e+11 36062
## - OLDCLAIM  1   82877633 1.2171e+11 36062
## - CAR_AGE   1  115339012 1.2175e+11 36063
## <none>                   1.2163e+11 36063
## - MVR_PTS   1  194860176 1.2183e+11 36064
## - SEX       1  208618206 1.2184e+11 36064
## - REVOKED   1  238490978 1.2187e+11 36065
## - MSTATUS   1  302094286 1.2193e+11 36066
## - BLUEBOOK  1 1428900494 1.2306e+11 36084
##
## Step:  AIC=36061.16
## TARGET_AMT ~ AGE + HOMEKIDS + TIF + CLM_FREQ + REVOKED + MVR_PTS +
##     CAR_AGE + INCOME + HOME_VAL + BLUEBOOK + OLDCLAIM + MSTATUS +
##     SEX
##
```

```
##             Df  Sum of Sq        RSS   AIC
## - INCOME     1   19115469 1.2167e+11 36059
## - TIF        1   29924316 1.2168e+11 36060
## - CLM_FREQ   1   41351255 1.2169e+11 36060
## - AGE        1   61834474 1.2171e+11 36060
## - HOME_VAL   1   73217972 1.2172e+11 36060
## - OLDCLAIM   1   83923138 1.2173e+11 36061
## - HOMEKIDS   1   89680817 1.2174e+11 36061
## <none>                    1.2165e+11 36061
## - CAR_AGE    1  127930245 1.2178e+11 36061
## - MVR_PTS    1  193196473 1.2184e+11 36062
## - SEX        1  213453598 1.2186e+11 36063
## - REVOKED    1  234184361 1.2188e+11 36063
## - MSTATUS    1  294639752 1.2195e+11 36064
## - BLUEBOOK   1 1432597492 1.2308e+11 36083
##
## Step:  AIC=36059.47
## TARGET_AMT ~ AGE + HOMEKIDS + TIF + CLM_FREQ + REVOKED + MVR_PTS +
##     CAR_AGE + HOME_VAL + BLUEBOOK + OLDCLAIM + MSTATUS + SEX
##
##             Df  Sum of Sq        RSS   AIC
## - TIF        1   28608666 1.2170e+11 36058
## - CLM_FREQ   1   41330543 1.2171e+11 36058
## - HOME_VAL   1   54237900 1.2172e+11 36058
## - AGE        1   59356258 1.2173e+11 36058
## - OLDCLAIM   1   84070404 1.2175e+11 36059
## - HOMEKIDS   1   90047387 1.2176e+11 36059
## <none>                    1.2167e+11 36059
## - CAR_AGE    1  180542974 1.2185e+11 36060
## - MVR_PTS    1  193870373 1.2186e+11 36061
## - SEX        1  204643732 1.2187e+11 36061
## - REVOKED    1  235054611 1.2190e+11 36061
## - MSTATUS    1  276135658 1.2195e+11 36062
## - BLUEBOOK   1 1467753477 1.2314e+11 36082
##
## Step:  AIC=36057.95
## TARGET_AMT ~ AGE + HOMEKIDS + CLM_FREQ + REVOKED + MVR_PTS +
##     CAR_AGE + HOME_VAL + BLUEBOOK + OLDCLAIM + MSTATUS + SEX
##
##             Df  Sum of Sq        RSS   AIC
## - CLM_FREQ   1   44067998 1.2174e+11 36057
## - HOME_VAL   1   55524616 1.2175e+11 36057
## - AGE        1   59659792 1.2176e+11 36057
## - OLDCLAIM   1   84734409 1.2178e+11 36057
## - HOMEKIDS   1   90426149 1.2179e+11 36057
## <none>                    1.2170e+11 36058
## - CAR_AGE    1  177870390 1.2188e+11 36059
## - MVR_PTS    1  200822202 1.2190e+11 36059
## - SEX        1  205447327 1.2190e+11 36059
## - REVOKED    1  234411359 1.2193e+11 36060
```

```
## - MSTATUS   1  270025675 1.2197e+11 36060
## - BLUEBOOK  1 1466813096 1.2316e+11 36080
##
## Step:  AIC=36056.67
## TARGET_AMT ~ AGE + HOMEKIDS + REVOKED + MVR_PTS + CAR_AGE + HOME_VAL +
##     BLUEBOOK + OLDCLAIM + MSTATUS + SEX
##
##            Df  Sum of Sq        RSS   AIC
## - OLDCLAIM  1   48636304 1.2179e+11 36055
## - HOME_VAL  1   55667628 1.2180e+11 36056
## - AGE       1   58174981 1.2180e+11 36056
## - HOMEKIDS  1   91125091 1.2183e+11 36056
## <none>                   1.2174e+11 36057
## - MVR_PTS   1  167280814 1.2191e+11 36057
## - CAR_AGE   1  188399330 1.2193e+11 36058
## - REVOKED   1  198124852 1.2194e+11 36058
## - SEX       1  203997706 1.2195e+11 36058
## - MSTATUS   1  269490060 1.2201e+11 36059
## - BLUEBOOK  1 1471542457 1.2321e+11 36079
##
## Step:  AIC=36055.48
## TARGET_AMT ~ AGE + HOMEKIDS + REVOKED + MVR_PTS + CAR_AGE + HOME_VAL +
##     BLUEBOOK + MSTATUS + SEX
##
##            Df  Sum of Sq        RSS   AIC
## - HOME_VAL  1   58740059 1.2185e+11 36054
## - AGE       1   59261910 1.2185e+11 36054
## - HOMEKIDS  1   88684255 1.2188e+11 36055
## <none>                   1.2179e+11 36055
## - REVOKED   1  150394814 1.2194e+11 36056
## - CAR_AGE   1  184351389 1.2198e+11 36057
## - SEX       1  197901853 1.2199e+11 36057
## - MVR_PTS   1  212421634 1.2200e+11 36057
## - MSTATUS   1  267708130 1.2206e+11 36058
## - BLUEBOOK  1 1452132145 1.2324e+11 36077
##
## Step:  AIC=36054.45
## TARGET_AMT ~ AGE + HOMEKIDS + REVOKED + MVR_PTS + CAR_AGE + BLUEBOOK +
##     MSTATUS + SEX
##
##            Df  Sum of Sq        RSS   AIC
## - AGE       1   71370786 1.2192e+11 36054
## - HOMEKIDS  1   83747039 1.2193e+11 36054
## <none>                   1.2185e+11 36054
## - CAR_AGE   1  154513388 1.2200e+11 36055
## - REVOKED   1  155653552 1.2201e+11 36055
## - MVR_PTS   1  203955706 1.2205e+11 36056
## - SEX       1  208593868 1.2206e+11 36056
## - MSTATUS   1  209106117 1.2206e+11 36056
## - BLUEBOOK  1 1645147417 1.2349e+11 36079
```

```
##
## Step:  AIC=36053.62
## TARGET_AMT ~ HOMEKIDS + REVOKED + MVR_PTS + CAR_AGE + BLUEBOOK +
##     MSTATUS + SEX
##
##            Df  Sum of Sq        RSS   AIC
## - HOMEKIDS  1   38484030 1.2196e+11 36052
## <none>                   1.2192e+11 36054
## - CAR_AGE   1  131131760 1.2205e+11 36054
## - REVOKED   1  148060934 1.2207e+11 36054
## - MSTATUS   1  175086472 1.2210e+11 36055
## - SEX       1  202608661 1.2212e+11 36055
## - MVR_PTS   1  202828770 1.2212e+11 36055
## - BLUEBOOK  1 1746551592 1.2367e+11 36080
##
## Step:  AIC=36052.26
## TARGET_AMT ~ REVOKED + MVR_PTS + CAR_AGE + BLUEBOOK + MSTATUS +
##     SEX
##
##            Df  Sum of Sq        RSS   AIC
## <none>                   1.2196e+11 36052
## - CAR_AGE   1  140440225 1.2210e+11 36053
## - REVOKED   1  141378251 1.2210e+11 36053
## - MSTATUS   1  164261705 1.2212e+11 36053
## - SEX       1  188329377 1.2215e+11 36053
## - MVR_PTS   1  210544699 1.2217e+11 36054
## - BLUEBOOK  1 1724209476 1.2368e+11 36078

##
## Call:
## lm(formula = TARGET_AMT ~ REVOKED + MVR_PTS + CAR_AGE + BLUEBOOK +
##     MSTATUS + SEX, data = df_lm)
##
## Residuals:
##    Min     1Q Median     3Q    Max
##  -8263  -3162  -1574    325 100465
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) 4281.91344  503.98221   8.496  < 2e-16 ***
## REVOKEDYes  -656.16299  430.50600  -1.524   0.1276
## MVR_PTS      125.73815   67.60109   1.860   0.0630 .
## CAR_AGE      -48.79606   32.12165  -1.519   0.1289
## BLUEBOOK       0.11376    0.02137   5.323 1.14e-07 ***
## MSTATUSYes  -573.12750  348.85252  -1.643   0.1006
## SEXM         618.26245  351.45734   1.759   0.0787 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 7801 on 2004 degrees of freedom
```

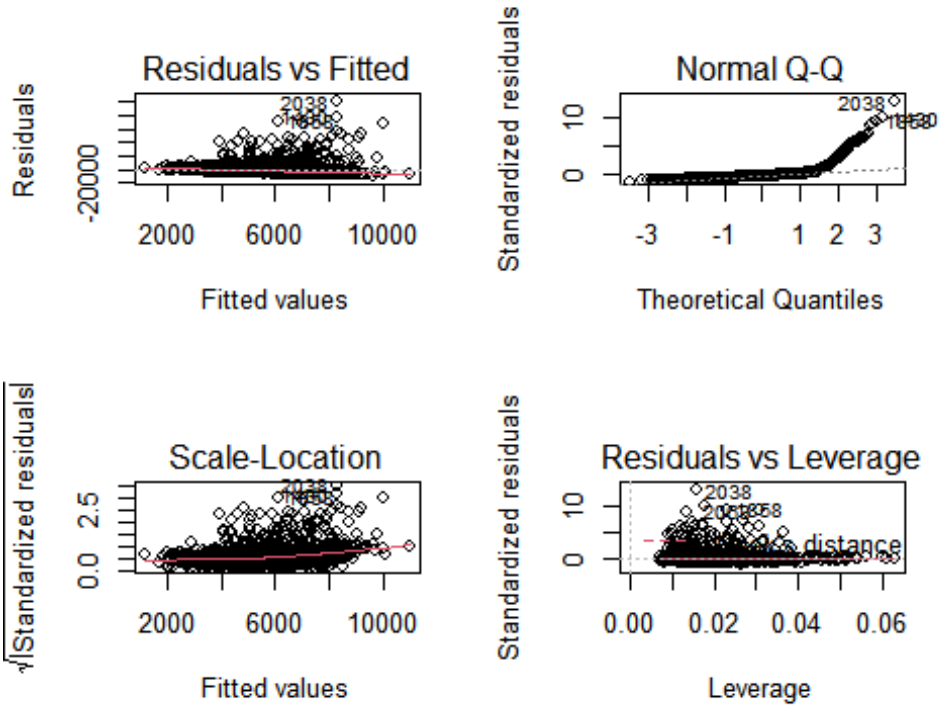
```
##   (142 observations deleted due to missingness)
## Multiple R-squared:  0.02061,    Adjusted R-squared:  0.01767
## F-statistic: 7.027 on 6 and 2004 DF,  p-value: 2.043e-07
```

Model 3: BoxCox imputation

```
##
## Call:
## lm(formula = TARGET_AMT ~ KIDSDRIV + AGE + HOMEKIDS + I(YOJ^1.6) +
##     PARENT1 + I(TRAVTIME^0.7) + CAR_USE + I(TIF^0.2) + RED_CAR +
##     CLM_FREQ + REVOKED + MVR_PTS + I(CAR_AGE^0.5) + I(INCOME^0.4) +
##     HOME_VAL + I(BLUEBOOK^0.5) + OLDCLAIM + MSTATUS + SEX + EDUCATION +
##     JOB + CAR_TYPE + URBANICITY, data = df_lm)
##
## Residuals:
##    Min     1Q Median     3Q    Max
##  -8792  -3250  -1499    530  99271
##
## Coefficients:
##                                Estimate Std. Error t value Pr(>|t|)
## (Intercept)                   1.950e+03  2.476e+03   0.788   0.4310
## KIDSDRIV                     -1.437e+02  3.390e+02  -0.424   0.6717
## AGE                           1.214e+01  2.265e+01   0.536   0.5921
## HOMEKIDS                      2.291e+02  2.205e+02   1.039   0.2989
## I(YOJ^1.6)                    1.451e+00  9.802e+00   0.148   0.8823
## PARENT1Yes                    1.700e+02  6.172e+02   0.276   0.7830
## I(TRAVTIME^0.7)               1.111e+01  4.701e+01   0.236   0.8132
## CAR_USEPrivate               -4.413e+02  5.489e+02  -0.804   0.4214
## I(TIF^0.2)                   -4.381e+02  7.321e+02  -0.598   0.5497
## RED_CARyes                   -2.595e+02  5.217e+02  -0.497   0.6190
## CLM_FREQ                     -1.520e+02  1.663e+02  -0.914   0.3610
## REVOKEDYes                   -1.167e+03  5.430e+02  -2.149   0.0317 *
## MVR_PTS                       1.135e+02  7.243e+01   1.566   0.1174
## I(CAR_AGE^0.5)               -3.511e+02  2.122e+02  -1.655   0.0982 .
## I(INCOME^0.4)                -2.820e+00  1.120e+01  -0.252   0.8012
## HOME_VAL                      1.132e-03  2.066e-03   0.548   0.5837
## I(BLUEBOOK^0.5)               2.917e+01  7.245e+00   4.026 5.89e-05 ***
## OLDCLAIM                      3.307e-02  2.366e-02   1.397   0.1624
## MSTATUSYes                   -7.339e+02  5.226e+02  -1.404   0.1604
## SEXM                          1.386e+03  6.789e+02   2.042   0.0413 *
## EDUCATIONBachelors            1.807e+01  6.843e+02   0.026   0.9789
## EDUCATIONHigh School         -6.488e+02  5.425e+02  -1.196   0.2319
## EDUCATIONMasters              4.820e+02  1.130e+03   0.426   0.6699
## EDUCATIONPhD                  1.746e+03  1.349e+03   1.294   0.1957
## JOBBlue Collar                7.549e+02  1.200e+03   0.629   0.5294
## JOBClerical                   5.742e+02  1.255e+03   0.457   0.6474
## JOBDoctor                    -2.158e+03  1.814e+03  -1.189   0.2345
## JOBHome Maker                 4.477e+02  1.391e+03   0.322   0.7477
## JOBLawyer                     4.032e+02  1.074e+03   0.375   0.7075
## JOBManager                   -7.432e+02  1.129e+03  -0.659   0.5103
## JOBProfessional               1.439e+03  1.179e+03   1.221   0.2223
```

```
## JOBStudent                        4.161e+02  1.411e+03   0.295   0.7681
## CAR_TYPEPanel Truck              -3.759e+02  9.639e+02  -0.390   0.6966
## CAR_TYPEPickup                   -1.729e+02  6.290e+02  -0.275   0.7835
## CAR_TYPESports Car                1.111e+03  7.840e+02   1.417   0.1567
## CAR_TYPESUV                       9.021e+02  6.886e+02   1.310   0.1903
## CAR_TYPEVan                       2.934e+02  8.101e+02   0.362   0.7172
## URBANICITYHighly Urban/ Urban     9.856e+01  7.962e+02   0.124   0.9015
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 7821 on 1972 degrees of freedom
##   (143 observations deleted due to missingness)
## Multiple R-squared:  0.03108,    Adjusted R-squared:  0.0129
## F-statistic:  1.71 on 37 and 1972 DF,  p-value: 0.00508
```

Residual analysis...



Logistic Regression Models

Model 1: Mean full model

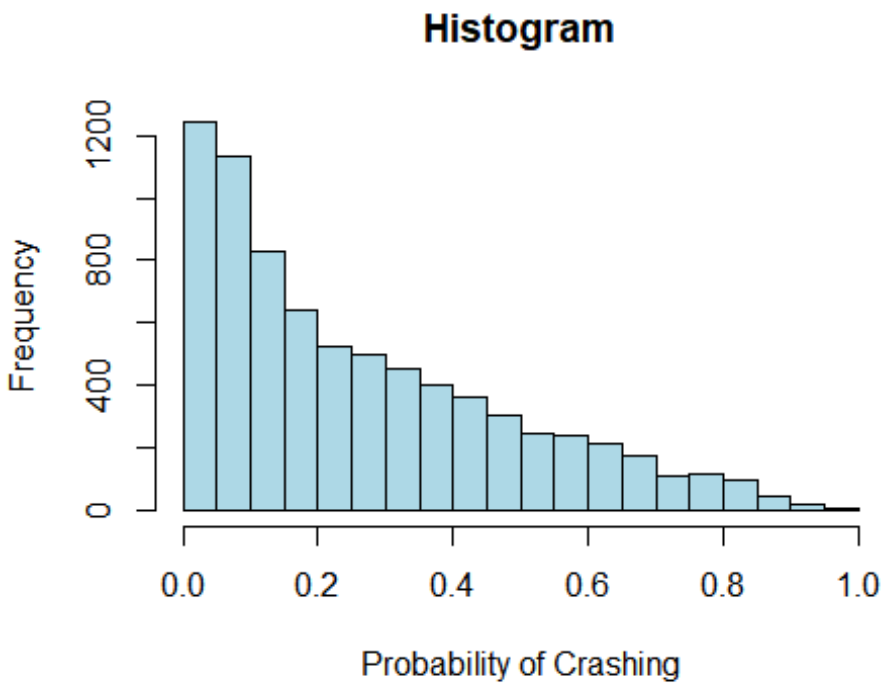
Let build the first full model for logistiv regression...

```
##
## Call:
## glm(formula = TARGET_FLAG ~ ., family = "binomial", data = df_rm)
##
```

```
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -2.5654  -0.7168  -0.3972   0.6148   3.1535
##
## Coefficients:
##                                Estimate Std. Error z value Pr(>|z|)
## (Intercept)                  -2.994e+00  3.520e-01  -8.506  < 2e-16 ***
## KIDSDRIV                      3.455e-01  6.381e-02   5.414 6.16e-08 ***
## AGE                           3.193e-04  4.145e-03   0.077 0.938603
## HOMEKIDS                      6.304e-02  3.822e-02   1.649 0.099118 .
## YOJ                          -1.136e-02  8.872e-03  -1.280 0.200450
## PARENT1Yes                    3.853e-01  1.131e-01   3.406 0.000659 ***
## TRAVTIME                      1.492e-02  1.953e-03   7.641 2.16e-14 ***
## CAR_USEPrivate               -7.534e-01  9.459e-02  -7.965 1.65e-15 ***
## TIF                          -5.512e-02  7.590e-03  -7.261 3.83e-13 ***
## RED_CARyes                    1.800e-03  8.927e-02   0.020 0.983911
## CLM_FREQ                      2.025e-01  2.938e-02   6.892 5.51e-12 ***
## REVOKEDYes                    8.804e-01  9.439e-02   9.327  < 2e-16 ***
## MVR_PTS                       1.142e-01  1.405e-02   8.132 4.22e-16 ***
## CAR_AGE                      -4.559e-03  7.797e-03  -0.585 0.558745
## INCOME                       -3.107e-06  1.116e-06  -2.783 0.005386 **
## HOME_VAL                     -1.290e-06  3.525e-07  -3.658 0.000254 ***
## BLUEBOOK                     -2.147e-05  5.439e-06  -3.949 7.86e-05 ***
## OLDCLAIM                     -1.288e-05  4.011e-06  -3.211 0.001324 **
## MSTATUSYes                   -4.902e-01  8.656e-02  -5.663 1.49e-08 ***
## SEXM                          8.549e-02  1.154e-01   0.741 0.458957
## EDUCATIONBachelors           -3.626e-01  1.198e-01  -3.027 0.002470 **
## EDUCATIONHigh School          3.528e-02  9.786e-02   0.361 0.718470
## EDUCATIONMasters             -2.129e-01  1.865e-01  -1.141 0.253692
## EDUCATIONPhD                 -1.214e-01  2.231e-01  -0.544 0.586367
## JOBBlue Collar                3.198e-01  1.922e-01   1.664 0.096189 .
## JOBClerical                   4.362e-01  2.034e-01   2.144 0.031997 *
## JOBDoctor                    -3.528e-01  2.716e-01  -1.299 0.193892
## JOBHome Maker                 2.764e-01  2.176e-01   1.270 0.204072
## JOBLawyer                     1.035e-01  1.749e-01   0.592 0.554008
## JOBManager                   -6.151e-01  1.784e-01  -3.449 0.000563 ***
## JOBProfessional               1.439e-01  1.842e-01   0.781 0.434798
## JOBStudent                    1.991e-01  2.226e-01   0.894 0.371160
## CAR_TYPEPanel Truck           6.109e-01  1.669e-01   3.661 0.000251 ***
## CAR_TYPEPickup                5.267e-01  1.041e-01   5.058 4.24e-07 ***
## CAR_TYPESports Car            9.979e-01  1.341e-01   7.440 1.01e-13 ***
## CAR_TYPESUV                   7.535e-01  1.147e-01   6.570 5.03e-11 ***
## CAR_TYPEVan                   5.872e-01  1.304e-01   4.503 6.71e-06 ***
## URBANICITYHighly Urban/ Urban  2.373e+00  1.164e-01  20.385  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 8814.1  on 7650  degrees of freedom
```

```
## Residual deviance: 6831.7  on 7613  degrees of freedom
##   (510 observations deleted due to missingness)
## AIC: 6907.7
##
## Number of Fisher Scoring iterations: 5
```

Confusion matrix and the curve…

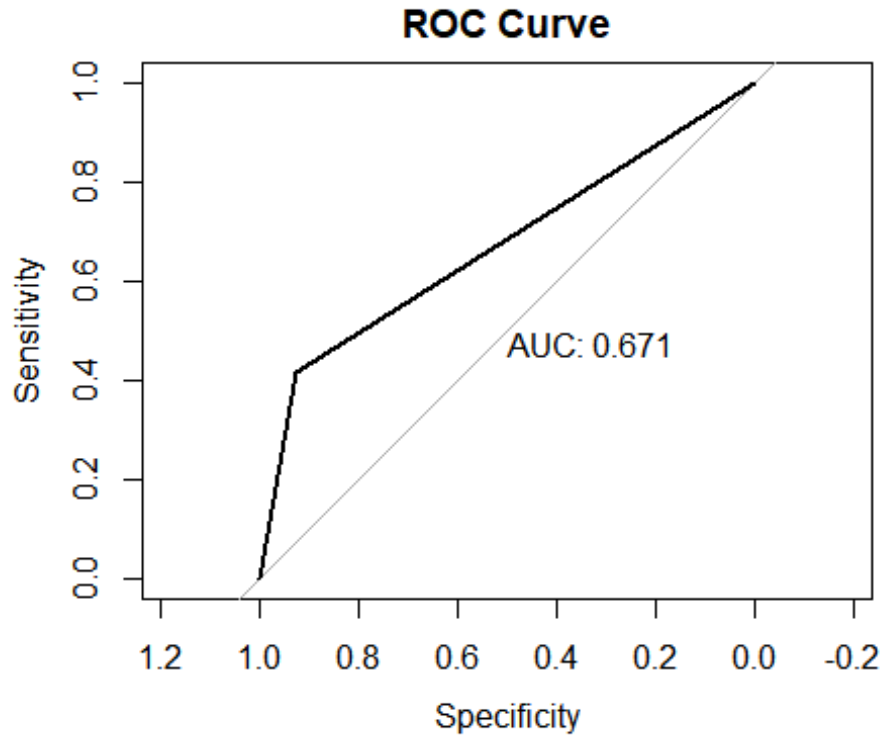



```
probabilities <- predict(rm_model1, df_rm, type = "response")
predicted1.classes <- ifelse(probabilities > 0.5, 1, 0)
df_rm$pred1.class <- predicted1.classes
table("Predictions" = df_rm$pred1.class, "Actual" = df_rm$TARGET_FLAG)
```

```
##            Actual
## Predictions    0    1
##           0 5216 1172
##           1  424  839

## Confusion Matrix and Statistics
##
##           Reference
## Prediction    0    1
##          0 5216 1172
##          1  424  839
##
##                Accuracy : 0.7914
##                  95% CI : (0.7821, 0.8005)
```

```
##     No Information Rate : 0.7372
##     P-Value [Acc > NIR] : < 2.2e-16
##
##                   Kappa : 0.3885
##
##  Mcnemar's Test P-Value : < 2.2e-16
##
##             Sensitivity : 0.9248
##             Specificity : 0.4172
##          Pos Pred Value : 0.8165
##          Neg Pred Value : 0.6643
##              Prevalence : 0.7372
##          Detection Rate : 0.6817
##    Detection Prevalence : 0.8349
##       Balanced Accuracy : 0.6710
##
##        'Positive' Class : 0
##
```

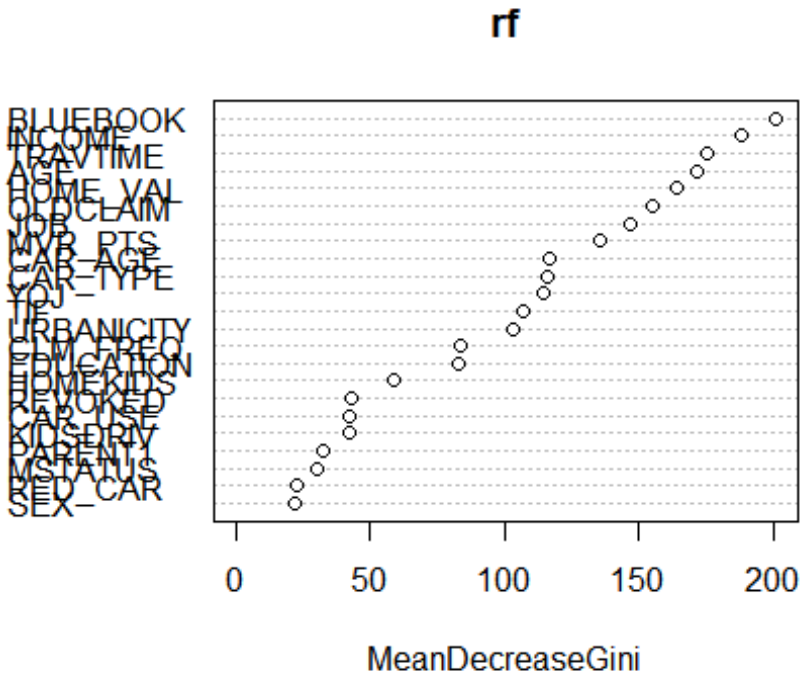


Model 2: Random forest

Logistic regression with Random forest...

```
##
## Call:
##  randomForest(formula = factor(TARGET_FLAG) ~ ., data = rf_train,
na.action = na.omit)
```

```
##                Type of random forest: classification
##                      Number of trees: 500
## No. of variables tried at each split: 4
##
##         OOB estimate of  error rate: 21.16%
## Confusion matrix:
##      0   1 class.error
## 0 4233 284  0.06287359
## 1 1014 604  0.62669963
```



Confusion matrix...

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction    0    1
##          0 1062  262
##          1   61  131
##
##                Accuracy : 0.7869
##                  95% CI : (0.7655, 0.8073)
##     No Information Rate : 0.7408
##     P-Value [Acc > NIR] : 1.63e-05
##
##                   Kappa : 0.3346
##
##  Mcnemar's Test P-Value : < 2.2e-16
```

```
##
##             Sensitivity : 0.33333
##             Specificity : 0.94568
##          Pos Pred Value : 0.68229
##          Neg Pred Value : 0.80211
##              Prevalence : 0.25923
##          Detection Rate : 0.08641
##    Detection Prevalence : 0.12665
##       Balanced Accuracy : 0.63951
##
##        'Positive' Class : 1
##
```

Model 3: Stepwise

The stepwise model...

```
## Start:  AIC=5567.73
## TARGET_FLAG ~ KIDSDRIV + AGE + HOMEKIDS + YOJ + PARENT1 + TRAVTIME +
##     CAR_USE + TIF + RED_CAR + CLM_FREQ + REVOKED + MVR_PTS +
##     CAR_AGE + INCOME + HOME_VAL + BLUEBOOK + OLDCLAIM + MSTATUS +
##     SEX + EDUCATION + JOB + CAR_TYPE + URBANICITY
##
##               Df Deviance    AIC
## - RED_CAR      1   5491.8 5565.8
## - SEX          1   5491.8 5565.8
## - AGE          1   5491.9 5565.9
## - HOMEKIDS     1   5492.0 5566.0
## - YOJ          1   5492.4 5566.4
## - CAR_AGE      1   5492.5 5566.5
## <none>             5491.7 5567.7
## - OLDCLAIM     1   5499.8 5573.8
## - EDUCATION    4   5508.6 5576.6
## - BLUEBOOK     1   5503.9 5577.9
## - HOME_VAL     1   5504.0 5578.0
## - MSTATUS      1   5505.6 5579.6
## - PARENT1      1   5506.5 5580.5
## - INCOME       1   5508.4 5582.4
## - KIDSDRIV     1   5516.5 5590.5
## - CLM_FREQ     1   5522.5 5596.5
## - JOB          8   5541.5 5601.5
## - TIF          1   5534.4 5608.4
## - CAR_TYPE     5   5544.2 5610.2
## - TRAVTIME     1   5539.6 5613.6
## - CAR_USE      1   5547.7 5621.7
## - MVR_PTS      1   5553.4 5627.4
## - REVOKED      1   5564.9 5638.9
## - URBANICITY   1   5966.0 6040.0
##
## Step:  AIC=5565.75
```

```
## TARGET_FLAG ~ KIDSDRIV + AGE + HOMEKIDS + YOJ + PARENT1 + TRAVTIME +
##     CAR_USE + TIF + CLM_FREQ + REVOKED + MVR_PTS + CAR_AGE +
##     INCOME + HOME_VAL + BLUEBOOK + OLDCLAIM + MSTATUS + SEX +
##     EDUCATION + JOB + CAR_TYPE + URBANICITY
##
##              Df Deviance    AIC
## - SEX         1   5491.8 5563.8
## - AGE         1   5491.9 5563.9
## - HOMEKIDS    1   5492.1 5564.1
## - YOJ         1   5492.4 5564.4
## - CAR_AGE     1   5492.5 5564.5
## <none>            5491.8 5565.8
## - OLDCLAIM    1   5499.8 5571.8
## - EDUCATION   4   5508.7 5574.7
## - BLUEBOOK    1   5503.9 5575.9
## - HOME_VAL    1   5504.0 5576.0
## - MSTATUS     1   5505.6 5577.6
## - PARENT1     1   5506.6 5578.6
## - INCOME      1   5508.4 5580.4
## - KIDSDRIV    1   5516.6 5588.6
## - CLM_FREQ    1   5522.5 5594.5
## - JOB         8   5541.6 5599.6
## - TIF         1   5534.4 5606.4
## - CAR_TYPE    5   5544.3 5608.3
## - TRAVTIME    1   5539.6 5611.6
## - CAR_USE     1   5547.8 5619.8
## - MVR_PTS     1   5553.4 5625.4
## - REVOKED     1   5565.0 5637.0
## - URBANICITY  1   5966.0 6038.0
##
## Step:  AIC=5563.77
## TARGET_FLAG ~ KIDSDRIV + AGE + HOMEKIDS + YOJ + PARENT1 + TRAVTIME +
##     CAR_USE + TIF + CLM_FREQ + REVOKED + MVR_PTS + CAR_AGE +
##     INCOME + HOME_VAL + BLUEBOOK + OLDCLAIM + MSTATUS + EDUCATION +
##     JOB + CAR_TYPE + URBANICITY
##
##              Df Deviance    AIC
## - AGE         1   5491.9 5561.9
## - HOMEKIDS    1   5492.1 5562.1
## - YOJ         1   5492.4 5562.4
## - CAR_AGE     1   5492.5 5562.5
## <none>            5491.8 5563.8
## - OLDCLAIM    1   5499.8 5569.8
## - EDUCATION   4   5508.7 5572.7
## - HOME_VAL    1   5504.0 5574.0
## - MSTATUS     1   5505.6 5575.6
## - PARENT1     1   5506.6 5576.6
## - BLUEBOOK    1   5507.0 5577.0
## - INCOME      1   5508.5 5578.5
## - KIDSDRIV    1   5516.6 5586.6
```

```
## - CLM_FREQ    1   5522.5 5592.5
## - JOB         8   5541.6 5597.6
## - TIF         1   5534.4 5604.4
## - TRAVTIME    1   5539.7 5609.7
## - CAR_USE     1   5547.8 5617.8
## - CAR_TYPE    5   5557.8 5619.8
## - MVR_PTS     1   5553.4 5623.4
## - REVOKED     1   5565.0 5635.0
## - URBANICITY  1   5966.0 6036.0
##
## Step:  AIC=5561.91
## TARGET_FLAG ~ KIDSDRIV + HOMEKIDS + YOJ + PARENT1 + TRAVTIME +
##     CAR_USE + TIF + CLM_FREQ + REVOKED + MVR_PTS + CAR_AGE +
##     INCOME + HOME_VAL + BLUEBOOK + OLDCLAIM + MSTATUS + EDUCATION +
##     JOB + CAR_TYPE + URBANICITY
##
##              Df Deviance    AIC
## - HOMEKIDS    1   5492.5 5560.5
## - CAR_AGE     1   5492.7 5560.7
## - YOJ         1   5492.7 5560.7
## <none>            5491.9 5561.9
## - OLDCLAIM    1   5499.9 5567.9
## - EDUCATION   4   5508.8 5570.8
## - HOME_VAL    1   5504.4 5572.4
## - MSTATUS     1   5505.8 5573.8
## - PARENT1     1   5507.1 5575.1
## - BLUEBOOK    1   5507.6 5575.6
## - INCOME      1   5508.6 5576.6
## - KIDSDRIV    1   5516.8 5584.8
## - CLM_FREQ    1   5522.6 5590.6
## - JOB         8   5542.1 5596.1
## - TIF         1   5534.6 5602.6
## - TRAVTIME    1   5539.7 5607.7
## - CAR_USE     1   5547.8 5615.8
## - CAR_TYPE    5   5557.8 5617.8
## - MVR_PTS     1   5553.7 5621.7
## - REVOKED     1   5565.2 5633.2
## - URBANICITY  1   5966.6 6034.6
##
## Step:  AIC=5560.47
## TARGET_FLAG ~ KIDSDRIV + YOJ + PARENT1 + TRAVTIME + CAR_USE +
##     TIF + CLM_FREQ + REVOKED + MVR_PTS + CAR_AGE + INCOME + HOME_VAL +
##     BLUEBOOK + OLDCLAIM + MSTATUS + EDUCATION + JOB + CAR_TYPE +
##     URBANICITY
##
##              Df Deviance    AIC
## - YOJ         1   5493.1 5559.1
## - CAR_AGE     1   5493.2 5559.2
## <none>            5492.5 5560.5
## - OLDCLAIM    1   5500.6 5566.6
```

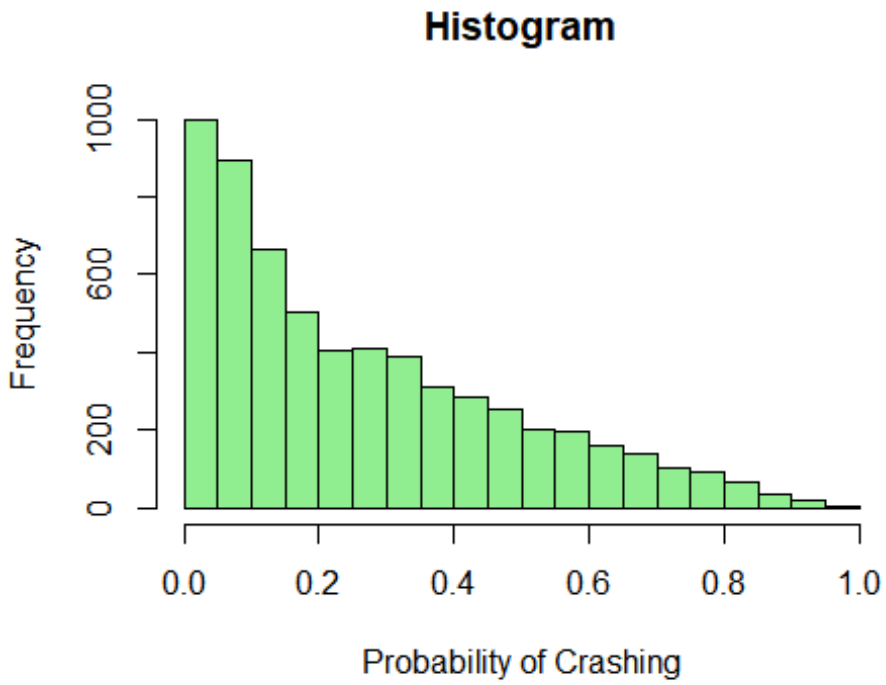
```
## - EDUCATION   4   5509.5 5569.5
## - HOME_VAL    1   5505.3 5571.3
## - MSTATUS     1   5505.9 5571.9
## - BLUEBOOK    1   5508.3 5574.3
## - INCOME      1   5509.0 5575.0
## - PARENT1     1   5517.0 5583.0
## - CLM_FREQ    1   5523.2 5589.2
## - KIDSDRIV    1   5525.5 5591.5
## - JOB         8   5543.0 5595.0
## - TIF         1   5535.0 5601.0
## - TRAVTIME    1   5540.0 5606.0
## - CAR_USE     1   5548.6 5614.6
## - CAR_TYPE    5   5558.5 5616.5
## - MVR_PTS     1   5554.7 5620.7
## - REVOKED     1   5566.2 5632.2
## - URBANICITY  1   5967.2 6033.2
##
## Step:  AIC=5559.05
## TARGET_FLAG ~ KIDSDRIV + PARENT1 + TRAVTIME + CAR_USE + TIF +
##     CLM_FREQ + REVOKED + MVR_PTS + CAR_AGE + INCOME + HOME_VAL +
##     BLUEBOOK + OLDCLAIM + MSTATUS + EDUCATION + JOB + CAR_TYPE +
##     URBANICITY
##
##              Df Deviance    AIC
## - CAR_AGE     1   5493.8 5557.8
## <none>            5493.1 5559.1
## - OLDCLAIM    1   5501.2 5565.2
## - EDUCATION   4   5510.0 5568.0
## - HOME_VAL    1   5506.0 5570.0
## - MSTATUS     1   5507.3 5571.3
## - BLUEBOOK    1   5509.1 5573.1
## - INCOME      1   5510.1 5574.1
## - PARENT1     1   5517.3 5581.3
## - CLM_FREQ    1   5523.8 5587.8
## - KIDSDRIV    1   5525.9 5589.9
## - JOB         8   5543.5 5593.5
## - TIF         1   5536.0 5600.0
## - TRAVTIME    1   5540.5 5604.5
## - CAR_USE     1   5549.5 5613.5
## - CAR_TYPE    5   5559.2 5615.2
## - MVR_PTS     1   5555.8 5619.8
## - REVOKED     1   5566.8 5630.8
## - URBANICITY  1   5967.4 6031.4
##
## Step:  AIC=5557.78
## TARGET_FLAG ~ KIDSDRIV + PARENT1 + TRAVTIME + CAR_USE + TIF +
##     CLM_FREQ + REVOKED + MVR_PTS + INCOME + HOME_VAL + BLUEBOOK +
##     OLDCLAIM + MSTATUS + EDUCATION + JOB + CAR_TYPE + URBANICITY
##
##              Df Deviance    AIC
```

```
## <none>             5493.8 5557.8
## - OLDCLAIM    1    5501.9 5563.9
## - HOME_VAL    1    5506.6 5568.6
## - MSTATUS     1    5508.1 5570.1
## - EDUCATION   4    5515.5 5571.5
## - BLUEBOOK    1    5509.8 5571.8
## - INCOME      1    5511.1 5573.1
## - PARENT1     1    5518.1 5580.1
## - CLM_FREQ    1    5524.3 5586.3
## - KIDSDRIV    1    5526.6 5588.6
## - JOB         8    5544.2 5592.2
## - TIF         1    5536.9 5598.9
## - TRAVTIME    1    5541.2 5603.2
## - CAR_USE     1    5550.2 5612.2
## - CAR_TYPE    5    5560.0 5614.0
## - MVR_PTS     1    5556.6 5618.6
## - REVOKED     1    5567.6 5629.6
## - URBANICITY  1    5968.5 6030.5

##
## Call:
## glm(formula = TARGET_FLAG ~ KIDSDRIV + PARENT1 + TRAVTIME + CAR_USE +
##     TIF + CLM_FREQ + REVOKED + MVR_PTS + INCOME + HOME_VAL +
##     BLUEBOOK + OLDCLAIM + MSTATUS + EDUCATION + JOB + CAR_TYPE +
##     URBANICITY, family = "binomial", data = no_na_df)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -2.5484  -0.7189  -0.3947   0.6354   3.1125
##
## Coefficients:
##                                Estimate Std. Error z value Pr(>|z|)
## (Intercept)                  -2.772e+00  3.182e-01  -8.711  < 2e-16 ***
## KIDSDRIV                      3.638e-01  6.317e-02   5.759 8.44e-09 ***
## PARENT1Yes                    5.343e-01  1.083e-01   4.933 8.09e-07 ***
## TRAVTIME                      1.496e-02  2.178e-03   6.870 6.41e-12 ***
## CAR_USEPrivate               -7.829e-01  1.051e-01  -7.447 9.56e-14 ***
## TIF                          -5.505e-02  8.538e-03  -6.448 1.13e-10 ***
## CLM_FREQ                      1.817e-01  3.267e-02   5.564 2.64e-08 ***
## REVOKEDYes                    9.110e-01  1.052e-01   8.664  < 2e-16 ***
## MVR_PTS                       1.242e-01  1.577e-02   7.876 3.38e-15 ***
## INCOME                       -5.254e-06  1.278e-06  -4.111 3.93e-05 ***
## HOME_VAL                     -1.429e-06  4.007e-07  -3.565 0.000364 ***
## BLUEBOOK                     -2.186e-05  5.513e-06  -3.966 7.31e-05 ***
## OLDCLAIM                     -1.268e-05  4.477e-06  -2.832 0.004632 **
## MSTATUSYes                   -3.512e-01  9.235e-02  -3.803 0.000143 ***
## EDUCATIONBachelors           -3.810e-01  1.252e-01  -3.042 0.002352 **
## EDUCATIONHigh School          6.275e-02  1.078e-01   0.582 0.560533
## EDUCATIONMasters             -2.379e-01  1.852e-01  -1.285 0.198896
## EDUCATIONPhD                 -1.422e-01  2.332e-01  -0.610 0.541953
```

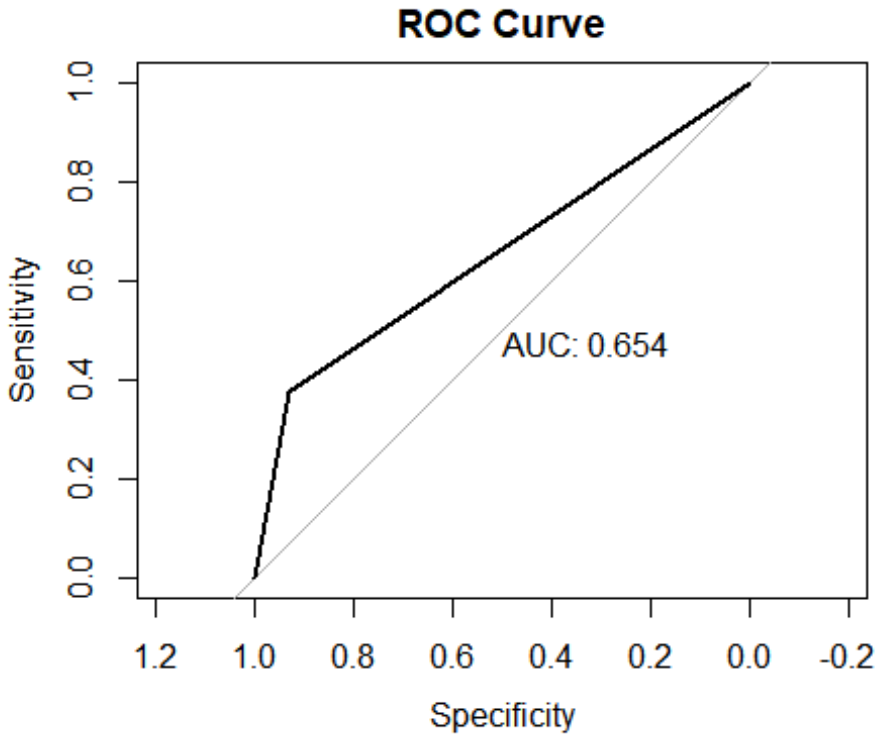
```
## JOBBlue Collar                  1.491e-01  2.148e-01   0.694 0.487641
## JOBClerical                     2.737e-01  2.260e-01   1.211 0.225827
## JOBDoctor                      -4.619e-01  3.114e-01  -1.483 0.137996
## JOBHome Maker                   2.027e-01  2.360e-01   0.859 0.390287
## JOBLawyer                       9.464e-02  1.936e-01   0.489 0.624947
## JOBManager                     -6.922e-01  1.995e-01  -3.470 0.000520 ***
## JOBProfessional                 4.181e-02  2.045e-01   0.204 0.838022
## JOBStudent                      3.952e-02  2.447e-01   0.161 0.871715
## CAR_TYPEPanel Truck             5.791e-01  1.766e-01   3.280 0.001038 **
## CAR_TYPEPickup                  4.670e-01  1.158e-01   4.031 5.55e-05 ***
## CAR_TYPESports Car              8.509e-01  1.236e-01   6.885 5.78e-12 ***
## CAR_TYPESUV                     6.545e-01  9.816e-02   6.668 2.60e-11 ***
## CAR_TYPEVan                     5.255e-01  1.409e-01   3.731 0.000191 ***
## URBANICITYHighly Urban/ Urban   2.326e+00  1.273e-01  18.269  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 7078.9  on 6134  degrees of freedom
## Residual deviance: 5493.8  on 6103  degrees of freedom
## AIC: 5557.8
##
## Number of Fisher Scoring iterations: 5
```

Confusion matrix and the curve…



```
##            Actual
## Predictions    0    1
##           0 1137  258
##           1   82  155

## Confusion Matrix and Statistics
##
##           Reference
## Prediction    0    1
##          0 1137  258
##          1   82  155
##
##                Accuracy : 0.7917
##                  95% CI : (0.7711, 0.8111)
##     No Information Rate : 0.7469
##     P-Value [Acc > NIR] : 1.272e-05
##
##                   Kappa : 0.3585
##
##  Mcnemar's Test P-Value : < 2.2e-16
##
##             Sensitivity : 0.37530
##             Specificity : 0.93273
##          Pos Pred Value : 0.65401
##          Neg Pred Value : 0.81505
##              Prevalence : 0.25306
##          Detection Rate : 0.09498
##    Detection Prevalence : 0.14522
##       Balanced Accuracy : 0.65402
##
##        'Positive' Class : 1
##
```



Select Models

We will use the Stepwise regression models for both questions, as the logistic stepwise model was the most accurate, had the highest sensitivity, and was the least complex. The stepwise linear model also had a higher adjusted R^2 value, and a smaller p-value. Thus, these should be our best bet in imputing the target values in the evaluation dataset.

```
##   TARGET_FLAG TARGET_AMT KIDSDRIV AGE HOMEKIDS YOJ PARENT1 TRAVTIME
CAR_USE
## 1          NA         NA        0  48        0  11      No       26
Private
## 2          NA         NA        1  40        1  11     Yes       21
Private
## 3          NA         NA        0  44        2  12     Yes       30
Commercial
## 4          NA         NA        0  35        2  NA     Yes       74
Private
## 5          NA         NA        0  59        0  12      No       45
Private
## 6          NA         NA        0  46        0  14      No        7
Commercial
##   TIF RED_CAR CLM_FREQ REVOKED MVR_PTS CAR_AGE INCOME HOME_VAL BLUEBOOK
## 1   1     yes        0      No       2      10  52881        0    21970
## 2   6      no        1      No       2       1  50815        0    18930
## 3  10      no        0      No       0      10  43486        0     5900
## 4   6      no        0     Yes       0       4  21204        0     9230
```

```
## 5   1     yes        2      No       4       1  87460        0    15420
## 6   1      no        1      No       2      12     NA   207519    25660
##   OLDCLAIM MSTATUS SEX   EDUCATION          JOB    CAR_TYPE
URBANICITY
## 1        0      No   M   Bachelors      Manager         Van Highly Urban/
Urban
## 2     3295      No   M High School      Manager     Minivan Highly Urban/
Urban
## 3        0      No   F High School  Blue Collar         SUV Highly Rural/
Rural
## 4        0      No   M High School     Clerical      Pickup Highly Rural/
Rural
## 5    44857      No   M High School      Manager     Minivan Highly Urban/
Urban
## 6     2119     Yes   M   Bachelors Professional Panel Truck Highly Urban/
Urban
```

Does the person crash the car?

The following shows if a person crash his or her car...

```
##    1    2    3    4    5    6    7    8    9   10   11   12   13   14   15
16
##    0    0    0    0    0    0    0    0    0    0    0    1    1    0    0
1
##   17   18   19   20   21   22   23   24   25   26   27   28   29   30   31
32
##    1    0    1    0    0    0    0    0    0    0    0    0    0    0    0
0
##   33   34   35   36   37   38   39   40   41   42   43   44   45   46   47
48
##    0    0    0    0    0    0    0    1    0    1    0    1    0    0    0
0
##   49   50   51   52   53   54   55   56   57   58   59   60   61   62   63
64
##    0    1    0    0    1    0    0    0    0    0    0    1    0    0    0
0
##   65   66   67   68   69   70   71   72   73   74   75   76   77   78   79
80
##    0    0    1    1    0    0    0    0    1    0    1    0    0    0    0
0
##   81   82   83   84   85   86   87   88   89   90   91   92   93   94   95
96
##    1    0    0    0    1    1    0    0    0    1    0    0    0    0    0
0
##   97   98   99  100  101  102  103  104  105  106  107  108  109  110  111
112
##    0    0    0    0    0    1    1    1    0    0    0    0    0    0    1
0
##  113  114  115  116  117  118  119  120  121  122  123  124  125  126  127
```

```
128
##    0    0    1    0    0    1    1    0    0    1    1    0    0    0    0
0
##  129  130  131  132  133  134  135  136  137  138  139  140  141  142  143
144
##    0    0    0    0    0    0    0    0    1    1    0    0    0    1    0
0
##  145  146  147  148  149  150  151  152  153  154  155  156  157  158  159
160
##    0    1    0    0    0    0    1    0    1    1    0    0    0    0    1
1
##  161  162  163  164  165  166  167  168  169  170  171  172  173  174  175
176
##    0    0    0    0    1    0    0    0    0    0    0    1    0    0    0
0
##  177  178  179  180  181  182  183  184  185  186  187  188  189  190  191
192
##    1    1    1    1    1    0    0    0    0    0    0    0    0    0    1
1
##  193  194  195  196  197  198  199  200  201  202  203  204  205  206  207
208
##    0    0    0    1    0    0    0    0    0    0    0    0    0    0    1
0
##  209  210  211  212  213  214  215  216  217  218  219  220  221  222  223
224
##    0    0    0    0    1    0    0    0    0    0    0    0    0    0    0
0
##  225  226  227  228  229  230  231  232  233  234  235  236  237  238  239
240
##    0    0    1    0    0    0    0    0    0    0    0    0    0    0    0
1
##  241  242  243  244  245  246  247  248  249  250  251  252  253  254  255
256
##    0    0    1    0    0    0    0    0    0    1    0    1    0    0    0
0
##  257  258  259  260  261  262  263  264  265  266  267  268  269  270  271
272
##    0    0    1    0    0    0    0    0    0    0    0    0    1    0    1
0
##  273  274  275  276  277  278  279  280  281  282  283  284  285  286  287
288
##    0    0    0    0    1    0    0    0    0    0    0    0    0    0    0
0
##  289  290  291  292  293  294  295  296  297  298  299  300  301  302  303
304
##    1    1    0    0    0    0    0    0    0    1    0    0    0    0    0
0
##  305  306  307  308  309  310  311  312  313  314  315  316  317  318  319
320
##    0    0    0    0    0    0    1    0    0    1    0    0    0    0    1
```

```
##  321  322  323  324  325  326  327  328  329  330  331  332  333  334  335
336
##    0    1    0    0    1    0    1    0    0    0    0    0    1    0    0
0
##  337  338  339  340  341  342  343  344  345  346  347  348  349  350  351
352
##    0    1    0    0    1    1    0    1    0    0    0    0    0    0    0
0
##  353  354  355  356  357  358  359  360  361  362  363  364  365  366  367
368
##    1    1    0    1    0    0    0    0    1    0    0    1    0    0    0
0
##  369  370  371  372  373  374  375  376  377  378  379  380  381  382  383
384
##    0    0    0    0    0    0    0    1    0    0    0    0    0    0    0
0
##  385  386  387  388  389  390  391  392  393  394  395  396  397  398  399
400
##    0    0    0    0    0    1    0    0    0    0    0    0    0    0    0
0
##  401  402  403  404  405  406  407  408  409  410  411  412  413  414  415
416
##    0    0    0    0    0    0    0    0    0    0    0    1    0    0    1
0
##  417  418  419  420  421  422  423  424  425  426  427  428  429  430  431
432
##    0    0    0    0    1    1    1    0    0    0    0    0    0    0    0
0
##  433  434  435  436  437  438  439  440  441  442  443  444  445  446  447
448
##    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0
##  449  450  451  452  453  454  455  456  457  458  459  460  461  462  463
464
##    1    1    0    0    0    0    0    1    0    1    0    0    0    0    0
0
##  465  466  467  468  469  470  471  472  473  474  475  476  477  478  479
480
##    0    0    1    1    0    0    0    1    0    0    0    0    1    1    0
0
##  481  482  483  484  485  486  487  488  489  490  491  492  493  494  495
496
##    0    0    0    0    1    1    0    0    0    1    1    0    0    0    0
1
##  497  498  499  500  501  502  503  504  505  506  507  508  509  510  511
512
##    0    0    0    0    0    0    1    0    1    0    0    0    0    0    0
0
##  513  514  515  516  517  518  519  520  521  522  523  524  525  526  527
```

```
528
##    0    0    0    0    1    0    0    0    0    0    0    0    0    0    0
0
##  529  530  531  532  533  534  535  536  537  538  539  540  541  542  543
544
##    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0
##  545  546  547  548  549  550  551  552  553  554  555  556  557  558  559
560
##    0    0    0    1    0    0    0    0    0    0    0    0    0    0    0
0
##  561  562  563  564  565  566  567  568  569  570  571  572  573  574  575
576
##    0    0    0    0    1    0    1    0    0    1    0    0    0    0    0
0
##  577  578  579  580  581  582  583  584  585  586  587  588  589  590  591
592
##    0    0    0    0    0    1    0    1    0    0    0    0    1    0    0
0
##  593  594  595  596  597  598  599  600  601  602  603  604  605  606  607
608
##    0    0    1    1    1    0    0    1    1    0    0    0    0    0    1
0
##  609  610  611  612  613  614  615  616  617  618  619  620  621  622  623
624
##    0    0    0    0    0    0    0    0    0    0    0    1    0    0    0
0
##  625  626  627  628  629  630  631  632  633  634  635  636  637  638  639
640
##    0    1    1    0    0    1    0    0    0    0    0    0    0    1    0
0
##  641  642  643  644  645  646  647  648  649  650  651  652  653  654  655
656
##    0    0    0    0    0    0    0    0    0    0    0    0    1    0    0
0
##  657  658  659  660  661  662  663  664  665  666  667  668  669  670  671
672
##    0    0    0    0    0    1    0    0    0    0    0    0    0    0    0
1
##  673  674  675  676  677  678  679  680  681  682  683  684  685  686  687
688
##    1    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0
##  689  690  691  692  693  694  695  696  697  698  699  700  701  702  703
704
##    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0
##  705  706  707  708  709  710  711  712  713  714  715  716  717  718  719
720
##    0    0    0    1    0    0    0    0    0    0    0    0    0    0    0
```

```
##  721  722  723  724  725  726  727  728  729  730  731  732  733  734  735
736
##    1    0    0    0    0    0    0    0    0    0    1    0    0    0    0
0
##  737  738  739  740  741  742  743  744  745  746  747  748  749  750  751
752
##    0    0    0    0    1    0    1    0    0    0    1    0    0    0    0
0
##  753  754  755  756  757  758  759  760  761  762  763  764  765  766  767
768
##    1    1    0    0    0    0    0    0    0    1    0    0    1    1    0
0
##  769  770  771  772  773  774  775  776  777  778  779  780  781  782  783
784
##    0    0    0    1    0    1    0    0    0    0    0    0    0    1    0
0
##  785  786  787  788  789  790  791  792  793  794  795  796  797  798  799
800
##    0    0    0    0    0    0    0    0    0    0    0    0    0    1    1
0
##  801  802  803  804  805  806  807  808  809  810  811  812  813  814  815
816
##    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0
##  817  818  819  820  821  822  823  824  825  826  827  828  829  830  831
832
##    0    1    1    0    1    0    0    0    1    0    0    0    0    0    0
0
##  833  834  835  836  837  838  839  840  841  842  843  844  845  846  847
848
##    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0
##  849  850  851  852  853  854  855  856  857  858  859  860  861  862  863
864
##    1    1    1    0    0    0    0    0    0    0    1    0    0    1    0
0
##  865  866  867  868  869  870  871  872  873  874  875  876  877  878  879
880
##    0    0    1    0    0    1    0    1    0    1    0    0    0    0    0
0
##  881  882  883  884  885  886  887  888  889  890  891  892  893  894  895
896
##    0    0    0    0    1    0    1    0    0    0    0    0    0    0    0
0
##  897  898  899  900  901  902  903  904  905  906  907  908  909  910  911
912
##    0    0    0    0    0    0    1    0    0    0    1    0    0    0    1
0
##  913  914  915  916  917  918  919  920  921  922  923  924  925  926  927
```

```
928
##    0    0    0    0    1    1    0    0    0    0    0    0    0    0    0
0
##  929  930  931  932  933  934  935  936  937  938  939  940  941  942  943
944
##    1    0    0    1    0    0    0    0    0    0    0    0    1    0    0
0
##  945  946  947  948  949  950  951  952  953  954  955  956  957  958  959
960
##    1    0    0    0    0    1    0    0    0    1    0    0    0    0    0
0
##  961  962  963  964  965  966  967  968  969  970  971  972  973  974  975
976
##    0    0    0    0    0    1    0    0    0    0    1    0    0    0    0
0
##  977  978  979  980  981  982  983  984  985  986  987  988  989  990  991
992
##    0    0    0    0    0    0    1    1    1    1    0    0    0    1    0
0
##  993  994  995  996  997  998  999 1000 1001 1002 1003 1004 1005 1006 1007
1008
##    0    0    0    0    0    0    0    0    0    1    1    0    0    0    0
0
## 1009 1010 1011 1012 1013 1014 1015 1016 1017 1018 1019 1020 1021 1022 1023
1024
##    0    0    0    0    0    0    0    0    0    0    0    0    0    0    1
0
## 1025 1026 1027 1028 1029 1030 1031 1032 1033 1034 1035 1036 1037 1038 1039
1040
##    1    1    0    0    0    0    0    0    0    0    0    0    0    0    0
0
## 1041 1042 1043 1044 1045 1046 1047 1048 1049 1050 1051 1052 1053 1054 1055
1056
##    0    0    1    0    1    0    0    0    0    0    1    0    1    0    0
0
## 1057 1058 1059 1060 1061 1062 1063 1064 1065 1066 1067 1068 1069 1070 1071
1072
##    0    0    1    1    0    1    0    0    0    0    0    0    0    1    0
0
## 1073 1074 1075 1076 1077 1078 1079 1080 1081 1082 1083 1084 1085 1086 1087
1088
##    0    1    0    0    0    0    1    0    1    1    0    0    0    1    0
0
## 1089 1090 1091 1092 1093 1094 1095 1096 1097 1098 1099 1100 1101 1102 1103
1104
##    0    0    0    0    0    0    0    0    0    0    0    1    0    0    0
0
## 1105 1106 1107 1108 1109 1110 1111 1112 1113 1114 1115 1116 1117 1118 1119
1120
##    0    0    0    0    0    0    1    0    0    0    0    0    0    1    1
```

```
## 1121 1122 1123 1124 1125 1126 1127 1128 1129 1130 1131 1132 1133 1134 1135
1136
##    0    0    0    0    0    0    1    0    0    0    0    0    1    0    0
0
## 1137 1138 1139 1140 1141 1142 1143 1144 1145 1146 1147 1148 1149 1150 1151
1152
##    0    0    0    0    0    0    0    0    1    0    0    1    0    1    0
1
## 1153 1154 1155 1156 1157 1158 1159 1160 1161 1162 1163 1164 1165 1166 1167
1168
##    0    0    1    0    0    0    0    0    0    0    0    0    0    0    0
0
## 1169 1170 1171 1172 1173 1174 1175 1176 1177 1178 1179 1180 1181 1182 1183
1184
##    0    0    0    1    1    1    0    0    0    0    0    1    0    1    0
0
## 1185 1186 1187 1188 1189 1190 1191 1192 1193 1194 1195 1196 1197 1198 1199
1200
##    1    0    0    0    0    0    0    0    0    1    0    0    0    0    0
0
## 1201 1202 1203 1204 1205 1206 1207 1208 1209 1210 1211 1212 1213 1214 1215
1216
##    0    0    0    0    0    0    1    0    0    0    0    0    0    0    0
0
## 1217 1218 1219 1220 1221 1222 1223 1224 1225 1226 1227 1228 1229 1230 1231
1232
##    1    0    0    0    0    0    1    0    1    0    0    0    0    1    0
0
## 1233 1234 1235 1236 1237 1238 1239 1240 1241 1242 1243 1244 1245 1246 1247
1248
##    0    1    0    0    0    1    0    0    0    0    0    0    0    1    0
0
## 1249 1250 1251 1252 1253 1254 1255 1256 1257 1258 1259 1260 1261 1262 1263
1264
##    0    0    0    1    0    0    0    0    1    0    0    0    0    0    0
1
## 1265 1266 1267 1268 1269 1270 1271 1272 1273 1274 1275 1276 1277 1278 1279
1280
##    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0
## 1281 1282 1283 1284 1285 1286 1287 1288 1289 1290 1291 1292 1293 1294 1295
1296
##    1    0    0    0    0    0    1    0    0    0    1    0    0    0    0
0
## 1297 1298 1299 1300 1301 1302 1303 1304 1305 1306 1307 1308 1309 1310 1311
1312
##    0    0    1    0    0    0    0    0    0    0    0    0    0    1    1
0
## 1313 1314 1315 1316 1317 1318 1319 1320 1321 1322 1323 1324 1325 1326 1327
```

```
1328
##    1    0    0    0    0    0    0    1    0    0    1    0    0    0    0
0
## 1329 1330 1331 1332 1333 1334 1335 1336 1337 1338 1339 1340 1341 1342 1343
1344
##    0    0    0    0    0    0    0    0    0    0    0    0    0    1    0
0
## 1345 1346 1347 1348 1349 1350 1351 1352 1353 1354 1355 1356 1357 1358 1359
1360
##    1    0    0    0    0    0    0    1    0    0    0    0    0    0    0
0
## 1361 1362 1363 1364 1365 1366 1367 1368 1369 1370 1371 1372 1373 1374 1375
1376
##    0    0    1    0    0    0    1    1    0    1    0    0    0    0    0
0
## 1377 1378 1379 1380 1381 1382 1383 1384 1385 1386 1387 1388 1389 1390 1391
1392
##    0    0    0    0    1    1    0    0    0    0    0    0    0    0    1
0
## 1393 1394 1395 1396 1397 1398 1399 1400 1401 1402 1403 1404 1405 1406 1407
1408
##    0    0    0    0    0    0    0    0    0    0    1    1    0    0    0
0
## 1409 1410 1411 1412 1413 1414 1415 1416 1417 1418 1419 1420 1421 1422 1423
1424
##    0    1    0    0    0    0    0    0    0    0    0    0    0    1    0
0
## 1425 1426 1427 1428 1429 1430 1431 1432 1433 1434 1435 1436 1437 1438 1439
1440
##    0    1    0    0    1    0    0    0    0    0    0    0    0    1    0
0
## 1441 1442 1443 1444 1445 1446 1447 1448 1449 1450 1451 1452 1453 1454 1455
1456
##    0    1    0    0    0    1    0    0    0    0    0    0    0    0    0
0
## 1457 1458 1459 1460 1461 1462 1463 1464 1465 1466 1467 1468 1469 1470 1471
1472
##    1    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0
## 1473 1474 1475 1476 1477 1478 1479 1480 1481 1482 1483 1484 1485 1486 1487
1488
##    0    0    0    0    1    0    0    0    0    0    0    0    0    0    0
0
## 1489 1490 1491 1492 1493 1494 1495 1496 1497 1498 1499 1500 1501 1502 1503
1504
##    1    0    0    1    0    0    1    0    0    0    0    0    0    0    0
1
## 1505 1506 1507 1508 1509 1510 1511 1512 1513 1514 1515 1516 1517 1518 1519
1520
##    0    0    1    0    0    0    0    0    0    0    0    0    0    0    0
```

```
## 1521 1522 1523 1524 1525 1526 1527 1528 1529 1530 1531 1532 1533 1534 1535
1536
##    0    0    0    0    0    0    0    0    0    1    0    0    0    0    0
0
## 1537 1538 1539 1540 1541 1542 1543 1544 1545 1546 1547 1548 1549 1550 1551
1552
##    0    0    1    1    0    0    0    0    1    0    0    0    0    0    0
0
## 1553 1554 1555 1556 1557 1558 1559 1560 1561 1562 1563 1564 1565 1566 1567
1568
##    0    1    0    0    0    0    0    0    0    0    0    0    1    0    0
0
## 1569 1570 1571 1572 1573 1574 1575 1576 1577 1578 1579 1580 1581 1582 1583
1584
##    0    0    1    0    0    0    0    0    0    0    0    0    0    0    0
0
## 1585 1586 1587 1588 1589 1590 1591 1592 1593 1594 1595 1596 1597 1598 1599
1600
##    0    0    0    0    0    0    0    1    0    0    0    0    0    0    0
0
## 1601 1602 1603 1604 1605 1606 1607 1608 1609 1610 1611 1612 1613 1614 1615
1616
##    1    0    0    1    0    1    0    0    0    1    0    0    0    1    0
1
## 1617 1618 1619 1620 1621 1622 1623 1624 1625 1626 1627 1628 1629 1630 1631
1632
##    0    1    0    0    1    0    1    0    0    0    0    0    0    1    0
1
## 1633 1634 1635 1636 1637 1638 1639 1640 1641 1642 1643 1644 1645 1646 1647
1648
##    0    0    0    0    1    0    0    0    0    0    0    0    0    0    0
0
## 1649 1650 1651 1652 1653 1654 1655 1656 1657 1658 1659 1660 1661 1662 1663
1664
##    0    1    0    0    0    0    1    0    0    0    0    0    0    1    1
1
## 1665 1666 1667 1668 1669 1670 1671 1672 1673 1674 1675 1676 1677 1678 1679
1680
##    1    0    0    0    1    0    1    0    1    0    0    0    0    0    0
0
## 1681 1682 1683 1684 1685 1686 1687 1688 1689 1690 1691 1692 1693 1694 1695
1696
##    0    1    1    0    0    0    0    0    0    0    0    0    0    0    0
1
## 1697 1698 1699 1700 1701 1702 1703 1704 1705 1706 1707 1708 1709 1710 1711
1712
##    0    1    1    0    0    0    0    0    0    0    1    0    1    0    0
0
## 1713 1714 1715 1716 1717 1718 1719 1720 1721 1722 1723 1724 1725 1726 1727
```

```
1728
##    0    0    0    0    0    0    0    0    0    0    0    0    1    0    0
0
## 1729 1730 1731 1732 1733 1734 1735 1736 1737 1738 1739 1740 1741 1742 1743
1744
##    1    0    0    0    0    0    0    0    0    0    0    0    1    0    0
0
## 1745 1746 1747 1748 1749 1750 1751 1752 1753 1754 1755 1756 1757 1758 1759
1760
##    0    0    0    0    0    0    0    0    0    1    0    0    0    0    0
0
## 1761 1762 1763 1764 1765 1766 1767 1768 1769 1770 1771 1772 1773 1774 1775
1776
##    1    0    0    0    0    1    0    0    0    0    0    0    0    1    0
0
## 1777 1778 1779 1780 1781 1782 1783 1784 1785 1786 1787 1788 1789 1790 1791
1792
##    1    0    1    0    0    0    0    0    0    0    0    0    1    0    0
0
## 1793 1794 1795 1796 1797 1798 1799 1800 1801 1802 1803 1804 1805 1806 1807
1808
##    0    0    0    0    0    0    0    0    0    0    0    0    0    0    1
1
## 1809 1810 1811 1812 1813 1814 1815 1816 1817 1818 1819 1820 1821 1822 1823
1824
##    0    0    0    0    1    0    0    0    0    0    0    0    0    0    0
0
## 1825 1826 1827 1828 1829 1830 1831 1832 1833 1834 1835 1836 1837 1838 1839
1840
##    0    1    0    0    0    0    0    0    0    0    0    0    0    1    0
1
## 1841 1842 1843 1844 1845 1846 1847 1848 1849 1850 1851 1852 1853 1854 1855
1856
##    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0
## 1857 1858 1859 1860 1861 1862 1863 1864 1865 1866 1867 1868 1869 1870 1871
1872
##    0    0    0    0    0    0    0    0    0    0    0    0    0    1    1
0
## 1873 1874 1875 1876 1877 1878 1879 1880 1881 1882 1883 1884 1885 1886 1887
1888
##    0    0    0    0    0    1    0    0    0    0    0    0    0    0    0
0
## 1889 1890 1891 1892 1893 1894 1895 1896 1897 1898 1899 1900 1901 1902 1903
1904
##    0    0    0    0    0    0    0    0    0    0    0    1    0    0    0
0
## 1905 1906 1907 1908 1909 1910 1911 1912 1913 1914 1915 1916 1917 1918 1919
1920
##    0    0    0    0    0    1    0    0    0    0    0    0    0    0    0
```

```
## 1921 1922 1923 1924 1925 1926 1927 1928 1929 1930 1931 1932 1933 1934 1935
1936
##    0    0    0    0    0    0    0    0    0    0    0    0    0    1    0
0
## 1937 1938 1939 1940 1941 1942 1943 1944 1945 1946 1947 1948 1949 1950 1951
1952
##    0    0    0    0    0    0    0    0    0    0    0    0    1    0    0
0
## 1953 1954 1955 1956 1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967
1968
##    1    0    0    0    0    0    0    0    1    0    0    0    0    0    0
0
## 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983
1984
##    0    0    0    0    0    1    0    0    0    0    0    0    0    0    0
0
## 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
2000
##    0    0    0    0    0    0    0    1    1    1    0    0    0    1    0
0
## 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
2016
##    1    0    1    0    1    0    1    0    0    0    0    0    1    0    0
0
## 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031
2032
##    0    1    1    0    0    0    0    0    0    0    0    0    0    1    0
0
## 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047
2048
##    0    0    1    0    0    0    1    0    0    0    0    0    0    0    0
1
## 2049 2050 2051 2052 2053 2054 2055 2056 2057 2058 2059 2060 2061 2062 2063
2064
##    0    0    0    0    0    0    1    0    0    0    0    0    0    0    0
0
## 2065 2066 2067 2068 2069 2070 2071 2072 2073 2074 2075 2076 2077 2078 2079
2080
##    0    0    0    1    0    0    0    0    1    0    0    0    1    0    0
1
## 2081 2082 2083 2084 2085 2086 2087 2088 2089 2090 2091 2092 2093 2094 2095
2096
##    0    0    0    0    0    0    0    0    0    1    0    0    0    0    0
1
## 2097 2098 2099 2100 2101 2102 2103 2104 2105 2106 2107 2108 2109 2110 2111
2112
##    0    0    1    1    1    0    1    0    0    0    1    0    0    0    1
0
## 2113 2114 2115 2116 2117 2118 2119 2120 2121 2122 2123 2124 2125 2126 2127
```

```
2128
##    0    0    0    0    0    0    1    0    0    0    1    0    0    0    0
0
## 2129 2130 2131 2132 2133 2134 2135 2136 2137 2138 2139 2140 2141
##    0    0    0    0    0    0    0    0    0    0    0    0    0
```

What's the pay off?

The following shows the pay off for the person who has a crash car…

```
##        1        2        3        4        5        6        7        8
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##        9       10       11       12       13       14       15       16
##    0.000    0.000    0.000 5475.670       NA    0.000    0.000 5696.563
##       17       18       19       20       21       22       23       24
##       NA    0.000 4005.702    0.000    0.000    0.000    0.000    0.000
##       25       26       27       28       29       30       31       32
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##       33       34       35       36       37       38       39       40
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000 5773.914
##       41       42       43       44       45       46       47       48
##    0.000 5222.274    0.000 6895.830    0.000    0.000    0.000    0.000
##       49       50       51       52       53       54       55       56
##    0.000 4122.707    0.000    0.000 6354.033    0.000    0.000    0.000
##       57       58       59       60       61       62       63       64
##    0.000    0.000    0.000 3956.597    0.000    0.000    0.000    0.000
##       65       66       67       68       69       70       71       72
##    0.000    0.000 5079.031 7313.395    0.000    0.000    0.000    0.000
##       73       74       75       76       77       78       79       80
## 5291.526    0.000 5617.353    0.000    0.000    0.000    0.000    0.000
##       81       82       83       84       85       86       87       88
## 4258.968    0.000    0.000    0.000 5389.727 6707.825    0.000    0.000
##       89       90       91       92       93       94       95       96
##    0.000 6004.846    0.000    0.000    0.000    0.000    0.000    0.000
##       97       98       99      100      101      102      103      104
##    0.000    0.000    0.000    0.000    0.000 6769.367 6191.289 6218.239
##      105      106      107      108      109      110      111      112
##    0.000    0.000    0.000    0.000    0.000    0.000 5465.364    0.000
##      113      114      115      116      117      118      119      120
##    0.000    0.000 5368.212    0.000    0.000 5420.656 3319.370    0.000
##      121      122      123      124      125      126      127      128
##    0.000 5301.919 4497.096    0.000    0.000    0.000    0.000    0.000
##      129      130      131      132      133      134      135      136
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      137      138      139      140      141      142      143      144
## 6802.093 6829.302    0.000    0.000    0.000 5537.473    0.000    0.000
##      145      146      147      148      149      150      151      152
##    0.000 4494.962    0.000    0.000    0.000    0.000 6005.710    0.000
##      153      154      155      156      157      158      159      160
## 6369.258 3709.136    0.000    0.000    0.000    0.000 5348.406 5846.070
```

```
##      161      162      163      164      165      166      167      168
##    0.000    0.000    0.000    0.000 7559.370    0.000    0.000    0.000
##      169      170      171      172      173      174      175      176
##    0.000    0.000    0.000 7417.136    0.000    0.000    0.000    0.000
##      177      178      179      180      181      182      183      184
## 8473.842 5261.994 7898.267 4553.929 6200.101    0.000    0.000    0.000
##      185      186      187      188      189      190      191      192
##    0.000    0.000    0.000    0.000    0.000    0.000 4548.520 4814.371
##      193      194      195      196      197      198      199      200
##    0.000    0.000    0.000 4972.555    0.000    0.000    0.000    0.000
##      201      202      203      204      205      206      207      208
##    0.000    0.000    0.000    0.000    0.000    0.000 5968.634    0.000
##      209      210      211      212      213      214      215      216
##    0.000    0.000    0.000    0.000 5545.745    0.000    0.000    0.000
##      217      218      219      220      221      222      223      224
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      225      226      227      228      229      230      231      232
##    0.000    0.000 5783.903    0.000    0.000    0.000    0.000    0.000
##      233      234      235      236      237      238      239      240
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000 5629.963
##      241      242      243      244      245      246      247      248
##    0.000    0.000 6355.952    0.000    0.000    0.000    0.000    0.000
##      249      250      251      252      253      254      255      256
##    0.000 5206.449    0.000 5120.150    0.000    0.000    0.000    0.000
##      257      258      259      260      261      262      263      264
##    0.000    0.000 4650.007    0.000    0.000    0.000    0.000    0.000
##      265      266      267      268      269      270      271      272
##    0.000    0.000    0.000    0.000 6977.377    0.000 5488.436    0.000
##      273      274      275      276      277      278      279      280
##    0.000    0.000    0.000    0.000 6451.459    0.000    0.000    0.000
##      281      282      283      284      285      286      287      288
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      289      290      291      292      293      294      295      296
## 4036.865 5176.608    0.000    0.000    0.000    0.000    0.000    0.000
##      297      298      299      300      301      302      303      304
##    0.000 6578.373    0.000    0.000    0.000    0.000    0.000    0.000
##      305      306      307      308      309      310      311      312
##    0.000    0.000    0.000    0.000    0.000    0.000 7210.489    0.000
##      313      314      315      316      317      318      319      320
##    0.000 5813.319    0.000    0.000    0.000    0.000 5642.683    0.000
##      321      322      323      324      325      326      327      328
##    0.000 5232.695    0.000    0.000 5213.844    0.000 5652.385    0.000
##      329      330      331      332      333      334      335      336
##    0.000    0.000    0.000    0.000 5111.822    0.000    0.000    0.000
##      337      338      339      340      341      342      343      344
##    0.000 5345.916    0.000    0.000 4418.071 7482.650    0.000 5172.728
##      345      346      347      348      349      350      351      352
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      353      354      355      356      357      358      359      360
## 6432.744 5976.170    0.000 4121.160    0.000    0.000    0.000    0.000
```

```
##      361      362      363      364      365      366      367      368
## 5285.394    0.000    0.000 5054.093    0.000    0.000    0.000    0.000
##      369      370      371      372      373      374      375      376
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000 5335.288
##      377      378      379      380      381      382      383      384
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      385      386      387      388      389      390      391      392
##    0.000    0.000    0.000    0.000    0.000 4248.370    0.000    0.000
##      393      394      395      396      397      398      399      400
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      401      402      403      404      405      406      407      408
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      409      410      411      412      413      414      415      416
##    0.000    0.000    0.000 4733.234    0.000    0.000 4750.170    0.000
##      417      418      419      420      421      422      423      424
##    0.000    0.000    0.000    0.000 4957.193 6953.478 6649.642    0.000
##      425      426      427      428      429      430      431      432
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      433      434      435      436      437      438      439      440
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      441      442      443      444      445      446      447      448
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      449      450      451      452      453      454      455      456
## 5891.145 5936.302    0.000    0.000    0.000    0.000    0.000 6248.901
##      457      458      459      460      461      462      463      464
##    0.000 7460.280    0.000    0.000    0.000    0.000    0.000    0.000
##      465      466      467      468      469      470      471      472
##    0.000    0.000 6808.783 4239.256    0.000    0.000    0.000 5350.144
##      473      474      475      476      477      478      479      480
##    0.000    0.000    0.000    0.000 7031.717 4821.085    0.000    0.000
##      481      482      483      484      485      486      487      488
##    0.000    0.000    0.000    0.000 5054.732 5156.531    0.000    0.000
##      489      490      491      492      493      494      495      496
##    0.000 6490.070 5404.977    0.000    0.000    0.000    0.000 4636.621
##      497      498      499      500      501      502      503      504
##    0.000    0.000    0.000    0.000    0.000    0.000 4606.546    0.000
##      505      506      507      508      509      510      511      512
## 6904.102    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      513      514      515      516      517      518      519      520
##    0.000    0.000    0.000    0.000 7244.168    0.000    0.000    0.000
##      521      522      523      524      525      526      527      528
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      529      530      531      532      533      534      535      536
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      537      538      539      540      541      542      543      544
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      545      546      547      548      549      550      551      552
##    0.000    0.000    0.000 7315.510    0.000    0.000    0.000    0.000
##      553      554      555      556      557      558      559      560
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
```

```
##      561      562      563      564      565      566      567      568
##    0.000    0.000    0.000    0.000 4547.021    0.000 6108.173    0.000
##      569      570      571      572      573      574      575      576
##    0.000 4685.575    0.000    0.000    0.000    0.000    0.000    0.000
##      577      578      579      580      581      582      583      584
##    0.000    0.000    0.000    0.000    0.000 5819.177    0.000 4281.428
##      585      586      587      588      589      590      591      592
##    0.000    0.000    0.000    0.000 5695.009    0.000    0.000    0.000
##      593      594      595      596      597      598      599      600
##    0.000    0.000 4882.506 4492.539       NA    0.000    0.000 3608.387
##      601      602      603      604      605      606      607      608
## 5516.032    0.000    0.000    0.000    0.000    0.000 7217.174    0.000
##      609      610      611      612      613      614      615      616
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      617      618      619      620      621      622      623      624
##    0.000    0.000    0.000 7257.339    0.000    0.000    0.000    0.000
##      625      626      627      628      629      630      631      632
##    0.000 8393.521 6160.348    0.000    0.000 5325.100    0.000    0.000
##      633      634      635      636      637      638      639      640
##    0.000    0.000    0.000    0.000    0.000 6169.289    0.000    0.000
##      641      642      643      644      645      646      647      648
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      649      650      651      652      653      654      655      656
##    0.000    0.000    0.000    0.000 5215.720    0.000    0.000    0.000
##      657      658      659      660      661      662      663      664
##    0.000    0.000    0.000    0.000    0.000 3346.967    0.000    0.000
##      665      666      667      668      669      670      671      672
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000 4174.040
##      673      674      675      676      677      678      679      680
## 5705.315    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      681      682      683      684      685      686      687      688
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      689      690      691      692      693      694      695      696
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      697      698      699      700      701      702      703      704
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      705      706      707      708      709      710      711      712
##    0.000    0.000    0.000 5893.608    0.000    0.000    0.000    0.000
##      713      714      715      716      717      718      719      720
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      721      722      723      724      725      726      727      728
## 5262.107    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      729      730      731      732      733      734      735      736
##    0.000    0.000 3915.067    0.000    0.000    0.000    0.000    0.000
##      737      738      739      740      741      742      743      744
##    0.000    0.000    0.000    0.000 4859.104    0.000 4632.958    0.000
##      745      746      747      748      749      750      751      752
##    0.000    0.000 6333.132    0.000    0.000    0.000    0.000    0.000
##      753      754      755      756      757      758      759      760
## 4624.901       NA    0.000    0.000    0.000    0.000    0.000    0.000
```

```
##      761      762      763      764      765      766      767      768
##    0.000 5573.808    0.000    0.000 4879.736 5319.826    0.000    0.000
##      769      770      771      772      773      774      775      776
##    0.000    0.000    0.000 6227.692    0.000 6251.188    0.000    0.000
##      777      778      779      780      781      782      783      784
##    0.000    0.000    0.000    0.000    0.000 6695.185    0.000    0.000
##      785      786      787      788      789      790      791      792
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      793      794      795      796      797      798      799      800
##    0.000    0.000    0.000    0.000    0.000 4641.350 6332.597    0.000
##      801      802      803      804      805      806      807      808
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      809      810      811      812      813      814      815      816
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      817      818      819      820      821      822      823      824
##    0.000 6913.294 6594.283    0.000 4777.920    0.000    0.000    0.000
##      825      826      827      828      829      830      831      832
## 5693.148    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      833      834      835      836      837      838      839      840
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      841      842      843      844      845      846      847      848
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      849      850      851      852      853      854      855      856
## 6830.224 5524.305 6725.353    0.000    0.000    0.000    0.000    0.000
##      857      858      859      860      861      862      863      864
##    0.000    0.000 5213.194    0.000    0.000 5458.911    0.000    0.000
##      865      866      867      868      869      870      871      872
##    0.000    0.000 5947.022    0.000    0.000 5664.951    0.000 7598.274
##      873      874      875      876      877      878      879      880
##    0.000 5590.781    0.000    0.000    0.000    0.000    0.000    0.000
##      881      882      883      884      885      886      887      888
##    0.000    0.000    0.000    0.000 5295.700    0.000 6934.576    0.000
##      889      890      891      892      893      894      895      896
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      897      898      899      900      901      902      903      904
##    0.000    0.000    0.000    0.000    0.000    0.000 6346.439    0.000
##      905      906      907      908      909      910      911      912
##    0.000    0.000       NA    0.000    0.000    0.000 6837.345    0.000
##      913      914      915      916      917      918      919      920
##    0.000    0.000    0.000    0.000 7760.779 4775.519    0.000    0.000
##      921      922      923      924      925      926      927      928
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##      929      930      931      932      933      934      935      936
## 5034.844    0.000    0.000 4856.103    0.000    0.000    0.000    0.000
##      937      938      939      940      941      942      943      944
##    0.000    0.000    0.000    0.000 5310.618    0.000    0.000    0.000
##      945      946      947      948      949      950      951      952
## 5539.785    0.000    0.000    0.000    0.000 4447.436    0.000    0.000
##      953      954      955      956      957      958      959      960
##    0.000 4843.225    0.000    0.000    0.000    0.000    0.000    0.000
```

```
##      961      962      963      964      965      966      967      968
##    0.000    0.000    0.000    0.000    0.000 6875.781    0.000    0.000
##      969      970      971      972      973      974      975      976
##    0.000    0.000 5309.937    0.000    0.000    0.000    0.000    0.000
##      977      978      979      980      981      982      983      984
##    0.000    0.000    0.000    0.000    0.000    0.000 5422.135 4999.322
##      985      986      987      988      989      990      991      992
## 5537.809 5727.931    0.000    0.000    0.000 6546.481    0.000    0.000
##      993      994      995      996      997      998      999     1000
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1001     1002     1003     1004     1005     1006     1007     1008
##    0.000 7289.280 6292.301    0.000    0.000    0.000    0.000    0.000
##     1009     1010     1011     1012     1013     1014     1015     1016
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1017     1018     1019     1020     1021     1022     1023     1024
##    0.000    0.000    0.000    0.000    0.000    0.000 7913.074    0.000
##     1025     1026     1027     1028     1029     1030     1031     1032
## 6506.584 4640.733    0.000    0.000    0.000    0.000    0.000    0.000
##     1033     1034     1035     1036     1037     1038     1039     1040
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1041     1042     1043     1044     1045     1046     1047     1048
##    0.000    0.000 3426.357    0.000 4214.611    0.000    0.000    0.000
##     1049     1050     1051     1052     1053     1054     1055     1056
##    0.000    0.000 5227.218    0.000 4948.486    0.000    0.000    0.000
##     1057     1058     1059     1060     1061     1062     1063     1064
##    0.000    0.000 4746.100 5385.210    0.000 4351.973    0.000    0.000
##     1065     1066     1067     1068     1069     1070     1071     1072
##    0.000    0.000    0.000    0.000    0.000 4176.099    0.000    0.000
##     1073     1074     1075     1076     1077     1078     1079     1080
##    0.000 6880.506    0.000    0.000    0.000    0.000 5607.576    0.000
##     1081     1082     1083     1084     1085     1086     1087     1088
## 6984.803 6709.498    0.000    0.000    0.000 6868.757    0.000    0.000
##     1089     1090     1091     1092     1093     1094     1095     1096
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1097     1098     1099     1100     1101     1102     1103     1104
##    0.000    0.000    0.000 4205.585    0.000    0.000    0.000    0.000
##     1105     1106     1107     1108     1109     1110     1111     1112
##    0.000    0.000    0.000    0.000    0.000    0.000 5182.965    0.000
##     1113     1114     1115     1116     1117     1118     1119     1120
##    0.000    0.000    0.000    0.000    0.000 6709.209 6223.129    0.000
##     1121     1122     1123     1124     1125     1126     1127     1128
##    0.000    0.000    0.000    0.000    0.000    0.000 8912.265    0.000
##     1129     1130     1131     1132     1133     1134     1135     1136
##    0.000    0.000    0.000    0.000 5712.423    0.000    0.000    0.000
##     1137     1138     1139     1140     1141     1142     1143     1144
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1145     1146     1147     1148     1149     1150     1151     1152
## 5463.160    0.000    0.000 7196.456    0.000 6822.587    0.000 5751.812
##     1153     1154     1155     1156     1157     1158     1159     1160
##    0.000    0.000 6275.183    0.000    0.000    0.000    0.000    0.000
```

```
##     1161     1162     1163     1164     1165     1166     1167     1168
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1169     1170     1171     1172     1173     1174     1175     1176
##    0.000    0.000    0.000 7041.006 6108.312 6815.829    0.000    0.000
##     1177     1178     1179     1180     1181     1182     1183     1184
##    0.000    0.000    0.000 5580.595    0.000 3747.483    0.000    0.000
##     1185     1186     1187     1188     1189     1190     1191     1192
## 3846.994    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1193     1194     1195     1196     1197     1198     1199     1200
##    0.000 5409.701    0.000    0.000    0.000    0.000    0.000    0.000
##     1201     1202     1203     1204     1205     1206     1207     1208
##    0.000    0.000    0.000    0.000    0.000    0.000 3536.531    0.000
##     1209     1210     1211     1212     1213     1214     1215     1216
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1217     1218     1219     1220     1221     1222     1223     1224
## 6260.202    0.000    0.000    0.000    0.000    0.000 6330.222    0.000
##     1225     1226     1227     1228     1229     1230     1231     1232
## 4989.314    0.000    0.000    0.000    0.000 6936.248    0.000    0.000
##     1233     1234     1235     1236     1237     1238     1239     1240
##    0.000 5751.840    0.000    0.000    0.000 6438.584    0.000    0.000
##     1241     1242     1243     1244     1245     1246     1247     1248
##    0.000    0.000    0.000    0.000    0.000 7192.531    0.000    0.000
##     1249     1250     1251     1252     1253     1254     1255     1256
##    0.000    0.000    0.000 4215.831    0.000    0.000    0.000    0.000
##     1257     1258     1259     1260     1261     1262     1263     1264
##       NA    0.000    0.000    0.000    0.000    0.000    0.000       NA
##     1265     1266     1267     1268     1269     1270     1271     1272
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1273     1274     1275     1276     1277     1278     1279     1280
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1281     1282     1283     1284     1285     1286     1287     1288
## 5428.112    0.000    0.000    0.000    0.000    0.000 4561.558    0.000
##     1289     1290     1291     1292     1293     1294     1295     1296
##    0.000    0.000 6678.837    0.000    0.000    0.000    0.000    0.000
##     1297     1298     1299     1300     1301     1302     1303     1304
##    0.000    0.000 6126.466    0.000    0.000    0.000    0.000    0.000
##     1305     1306     1307     1308     1309     1310     1311     1312
##    0.000    0.000    0.000    0.000    0.000 5076.144 4901.860    0.000
##     1313     1314     1315     1316     1317     1318     1319     1320
## 6085.861    0.000    0.000    0.000    0.000    0.000    0.000       NA
##     1321     1322     1323     1324     1325     1326     1327     1328
##    0.000    0.000 4236.719    0.000    0.000    0.000    0.000    0.000
##     1329     1330     1331     1332     1333     1334     1335     1336
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1337     1338     1339     1340     1341     1342     1343     1344
##    0.000    0.000    0.000    0.000    0.000 5490.831    0.000    0.000
##     1345     1346     1347     1348     1349     1350     1351     1352
##       NA    0.000    0.000    0.000    0.000    0.000    0.000 4719.092
##     1353     1354     1355     1356     1357     1358     1359     1360
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
```

```
##     1361     1362     1363     1364     1365     1366     1367     1368
##    0.000    0.000 6768.419    0.000    0.000    0.000 6637.771 3595.377
##     1369     1370     1371     1372     1373     1374     1375     1376
##    0.000 6348.059    0.000    0.000    0.000    0.000    0.000    0.000
##     1377     1378     1379     1380     1381     1382     1383     1384
##    0.000    0.000    0.000    0.000 8113.193 6031.657    0.000    0.000
##     1385     1386     1387     1388     1389     1390     1391     1392
##    0.000    0.000    0.000    0.000    0.000    0.000 5366.899    0.000
##     1393     1394     1395     1396     1397     1398     1399     1400
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1401     1402     1403     1404     1405     1406     1407     1408
##    0.000    0.000 6504.564 4461.362    0.000    0.000    0.000    0.000
##     1409     1410     1411     1412     1413     1414     1415     1416
##    0.000 5960.671    0.000    0.000    0.000    0.000    0.000    0.000
##     1417     1418     1419     1420     1421     1422     1423     1424
##    0.000    0.000    0.000    0.000    0.000 6396.493    0.000    0.000
##     1425     1426     1427     1428     1429     1430     1431     1432
##    0.000 6749.695    0.000    0.000 3614.795    0.000    0.000    0.000
##     1433     1434     1435     1436     1437     1438     1439     1440
##    0.000    0.000    0.000    0.000    0.000       NA    0.000    0.000
##     1441     1442     1443     1444     1445     1446     1447     1448
##    0.000 5575.614    0.000    0.000    0.000 4881.547    0.000    0.000
##     1449     1450     1451     1452     1453     1454     1455     1456
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1457     1458     1459     1460     1461     1462     1463     1464
## 5645.008    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1465     1466     1467     1468     1469     1470     1471     1472
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1473     1474     1475     1476     1477     1478     1479     1480
##    0.000    0.000    0.000    0.000 4335.014    0.000    0.000    0.000
##     1481     1482     1483     1484     1485     1486     1487     1488
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1489     1490     1491     1492     1493     1494     1495     1496
## 5904.515    0.000    0.000 4381.385    0.000    0.000 6229.020    0.000
##     1497     1498     1499     1500     1501     1502     1503     1504
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000 5267.192
##     1505     1506     1507     1508     1509     1510     1511     1512
##    0.000    0.000 5095.101    0.000    0.000    0.000    0.000    0.000
##     1513     1514     1515     1516     1517     1518     1519     1520
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1521     1522     1523     1524     1525     1526     1527     1528
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1529     1530     1531     1532     1533     1534     1535     1536
##    0.000 4973.152    0.000    0.000    0.000    0.000    0.000    0.000
##     1537     1538     1539     1540     1541     1542     1543     1544
##    0.000    0.000 5667.814 6760.523    0.000    0.000    0.000    0.000
##     1545     1546     1547     1548     1549     1550     1551     1552
## 5847.446    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1553     1554     1555     1556     1557     1558     1559     1560
##    0.000 5612.621    0.000    0.000    0.000    0.000    0.000    0.000
```

```
##     1561     1562     1563     1564     1565     1566     1567     1568
##    0.000    0.000    0.000    0.000 7166.470    0.000    0.000    0.000
##     1569     1570     1571     1572     1573     1574     1575     1576
##    0.000    0.000 5361.613    0.000    0.000    0.000    0.000    0.000
##     1577     1578     1579     1580     1581     1582     1583     1584
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1585     1586     1587     1588     1589     1590     1591     1592
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000 5996.193
##     1593     1594     1595     1596     1597     1598     1599     1600
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1601     1602     1603     1604     1605     1606     1607     1608
## 5559.496    0.000    0.000       NA    0.000 7158.428    0.000    0.000
##     1609     1610     1611     1612     1613     1614     1615     1616
##    0.000 4873.533    0.000    0.000    0.000 6861.509    0.000 5559.262
##     1617     1618     1619     1620     1621     1622     1623     1624
##    0.000 6030.426    0.000    0.000 5233.554    0.000 6012.400    0.000
##     1625     1626     1627     1628     1629     1630     1631     1632
##    0.000    0.000    0.000    0.000    0.000 6496.079    0.000 5244.937
##     1633     1634     1635     1636     1637     1638     1639     1640
##    0.000    0.000    0.000    0.000 6024.966    0.000    0.000    0.000
##     1641     1642     1643     1644     1645     1646     1647     1648
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1649     1650     1651     1652     1653     1654     1655     1656
##    0.000 4095.290    0.000    0.000    0.000    0.000 6675.684    0.000
##     1657     1658     1659     1660     1661     1662     1663     1664
##    0.000    0.000    0.000    0.000    0.000 8356.651 4343.948 6755.248
##     1665     1666     1667     1668     1669     1670     1671     1672
## 6530.786    0.000    0.000    0.000 5371.681    0.000 5399.944    0.000
##     1673     1674     1675     1676     1677     1678     1679     1680
## 5815.950    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1681     1682     1683     1684     1685     1686     1687     1688
##    0.000 4690.875 5638.786    0.000    0.000    0.000    0.000    0.000
##     1689     1690     1691     1692     1693     1694     1695     1696
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000 4865.409
##     1697     1698     1699     1700     1701     1702     1703     1704
##    0.000 5594.100 4691.226    0.000    0.000    0.000    0.000    0.000
##     1705     1706     1707     1708     1709     1710     1711     1712
##    0.000    0.000       NA    0.000 5597.763    0.000    0.000    0.000
##     1713     1714     1715     1716     1717     1718     1719     1720
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1721     1722     1723     1724     1725     1726     1727     1728
##    0.000    0.000    0.000    0.000 4925.682    0.000    0.000    0.000
##     1729     1730     1731     1732     1733     1734     1735     1736
## 6366.190    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1737     1738     1739     1740     1741     1742     1743     1744
##    0.000    0.000    0.000    0.000 5031.367    0.000    0.000    0.000
##     1745     1746     1747     1748     1749     1750     1751     1752
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1753     1754     1755     1756     1757     1758     1759     1760
##    0.000 4389.859    0.000    0.000    0.000    0.000    0.000    0.000
```

```
##     1761     1762     1763     1764     1765     1766     1767     1768
## 7176.761    0.000    0.000    0.000    0.000 4861.931    0.000    0.000
##     1769     1770     1771     1772     1773     1774     1775     1776
##    0.000    0.000    0.000    0.000    0.000 6824.111    0.000    0.000
##     1777     1778     1779     1780     1781     1782     1783     1784
## 4780.055    0.000 5018.836    0.000    0.000    0.000    0.000    0.000
##     1785     1786     1787     1788     1789     1790     1791     1792
##    0.000    0.000    0.000    0.000 4245.770    0.000    0.000    0.000
##     1793     1794     1795     1796     1797     1798     1799     1800
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1801     1802     1803     1804     1805     1806     1807     1808
##    0.000    0.000    0.000    0.000    0.000    0.000 5174.165 5898.036
##     1809     1810     1811     1812     1813     1814     1815     1816
##    0.000    0.000    0.000    0.000 5179.408    0.000    0.000    0.000
##     1817     1818     1819     1820     1821     1822     1823     1824
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1825     1826     1827     1828     1829     1830     1831     1832
##    0.000 4929.268    0.000    0.000    0.000    0.000    0.000    0.000
##     1833     1834     1835     1836     1837     1838     1839     1840
##    0.000    0.000    0.000    0.000    0.000       NA    0.000 5445.802
##     1841     1842     1843     1844     1845     1846     1847     1848
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1849     1850     1851     1852     1853     1854     1855     1856
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1857     1858     1859     1860     1861     1862     1863     1864
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1865     1866     1867     1868     1869     1870     1871     1872
##    0.000    0.000    0.000    0.000    0.000 4436.742 5887.182    0.000
##     1873     1874     1875     1876     1877     1878     1879     1880
##    0.000    0.000    0.000    0.000    0.000 6065.051    0.000    0.000
##     1881     1882     1883     1884     1885     1886     1887     1888
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1889     1890     1891     1892     1893     1894     1895     1896
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1897     1898     1899     1900     1901     1902     1903     1904
##    0.000    0.000    0.000 4204.661    0.000    0.000    0.000    0.000
##     1905     1906     1907     1908     1909     1910     1911     1912
##    0.000    0.000    0.000    0.000    0.000 6242.812    0.000    0.000
##     1913     1914     1915     1916     1917     1918     1919     1920
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1921     1922     1923     1924     1925     1926     1927     1928
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1929     1930     1931     1932     1933     1934     1935     1936
##    0.000    0.000    0.000    0.000    0.000 7316.304    0.000    0.000
##     1937     1938     1939     1940     1941     1942     1943     1944
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1945     1946     1947     1948     1949     1950     1951     1952
##    0.000    0.000    0.000    0.000 3300.204    0.000    0.000    0.000
##     1953     1954     1955     1956     1957     1958     1959     1960
## 4791.363    0.000    0.000    0.000    0.000    0.000    0.000    0.000
```

```
##     1961     1962     1963     1964     1965     1966     1967     1968
## 6600.605    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1969     1970     1971     1972     1973     1974     1975     1976
##    0.000    0.000    0.000    0.000    0.000 5401.739    0.000    0.000
##     1977     1978     1979     1980     1981     1982     1983     1984
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     1985     1986     1987     1988     1989     1990     1991     1992
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000 4550.490
##     1993     1994     1995     1996     1997     1998     1999     2000
## 6877.573 6313.547    0.000    0.000    0.000 6923.021    0.000    0.000
##     2001     2002     2003     2004     2005     2006     2007     2008
## 5930.305    0.000 5287.196    0.000 5844.087    0.000 8122.449    0.000
##     2009     2010     2011     2012     2013     2014     2015     2016
##    0.000    0.000    0.000    0.000 5019.293    0.000    0.000    0.000
##     2017     2018     2019     2020     2021     2022     2023     2024
##    0.000 4321.072 7004.309    0.000    0.000    0.000    0.000    0.000
##     2025     2026     2027     2028     2029     2030     2031     2032
##    0.000    0.000    0.000    0.000    0.000 4178.214    0.000    0.000
##     2033     2034     2035     2036     2037     2038     2039     2040
##    0.000    0.000 5710.700    0.000    0.000    0.000 5420.453    0.000
##     2041     2042     2043     2044     2045     2046     2047     2048
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000 5376.570
##     2049     2050     2051     2052     2053     2054     2055     2056
##    0.000    0.000    0.000    0.000    0.000    0.000 5637.280    0.000
##     2057     2058     2059     2060     2061     2062     2063     2064
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     2065     2066     2067     2068     2069     2070     2071     2072
##    0.000    0.000    0.000 4543.979    0.000    0.000    0.000    0.000
##     2073     2074     2075     2076     2077     2078     2079     2080
## 7807.939    0.000    0.000    0.000 6143.344    0.000    0.000 5672.914
##     2081     2082     2083     2084     2085     2086     2087     2088
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     2089     2090     2091     2092     2093     2094     2095     2096
##    0.000 4799.944    0.000    0.000    0.000    0.000    0.000 4751.927
##     2097     2098     2099     2100     2101     2102     2103     2104
##    0.000    0.000 8334.052 4442.980       NA    0.000 5388.466    0.000
##     2105     2106     2107     2108     2109     2110     2111     2112
##    0.000    0.000 4656.371    0.000    0.000    0.000 5244.470    0.000
##     2113     2114     2115     2116     2117     2118     2119     2120
##    0.000    0.000    0.000    0.000    0.000    0.000 4787.678    0.000
##     2121     2122     2123     2124     2125     2126     2127     2128
##    0.000    0.000 6373.741    0.000    0.000    0.000    0.000    0.000
##     2129     2130     2131     2132     2133     2134     2135     2136
##    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
##     2137     2138     2139     2140     2141
##    0.000    0.000    0.000    0.000    0.000
```

Appendix

```
library(corrplot)
library(tidyverse)
library(Hmisc)
library(PerformanceAnalytics)
library(mice)
library(gt)
library(caret)
library(bnstruct)
library(VIM)
library(corrr)
library(kableExtra)
library(rpart)
library(gtsummary)
library(reshape)
library(pROC)
library(randomForest)



#Import data
df1_data <-
read.csv("https://raw.githubusercontent.com/aaitelmouden/DATA621/master/Homew
ork4/data/insurance_training_data.csv")


df <- df1_data
glimpse(df)



# Get rid of INDEX, TARGET_FLAG, TARGET_AMT
df1 <- subset(df, select = -c(INDEX))

# Select money variables to clean before summary

df2 <- df1[, names(df1) %in% c("INCOME", "OLDCLAIM", "HOME_VAL", "BLUEBOOK")]

# Clean using string function

df2 <- apply(df2, 2, function(y) gsub("\\$","",y))
df2 <- apply(df2, 2, function(y) gsub(",","",y))
df2 <- apply(df2, 2, as.integer)
```

```
# Combine variables

df1 <- df1[, !names(df1) %in% c("INCOME", "OLDCLAIM", "HOME_VAL",
"BLUEBOOK")]
df1 <- cbind(df1, df2)

# Select characters variables to clean before summary

df2 <- df1[, names(df1) %in% c("MSTATUS", "SEX", "EDUCATION", "JOB",
"CAR_TYPE", "URBANICITY")]

# Clean using character function

df2 <- apply(df2, 2, function(y) gsub("z_","",y))

df1 <- df1[,!names(df1) %in% c("MSTATUS", "SEX", "EDUCATION", "JOB",
"CAR_TYPE", "URBANICITY")]
df1 <- cbind(df1, df2)

# Factor

df1$SEX <- factor(df1$SEX)
df1$PARENT1 <- factor(df1$PARENT1)
df1$CAR_USE <- factor(df1$CAR_USE)
df1$RED_CAR <- factor(df1$RED_CAR)
df1$REVOKED <- factor(df1$REVOKED)
df1$MSTATUS <- factor(df1$MSTATUS)
df1$EDUCATION <- factor(df1$EDUCATION)
df1$CAR_TYPE <- factor(df1$CAR_TYPE)
df1$MSTATUS <- factor(df1$MSTATUS)
df1$URBANICITY <- factor(df1$URBANICITY)
df1$JOB <- factor(df1$JOB)

# Summary table

table1 <- tbl_summary(df1,
          statistic = list(all_continuous() ~ "{mean} ({sd}) {median} {min}
{max}"), missing = "no")
table1

# Boxplot

ggplot(melt(df1), aes(x=factor(variable), y=value)) + facet_wrap(~variable,
scale="free") + geom_boxplot()

# Histogram
ggplot(melt(df1), aes(x=value)) + facet_wrap(~variable, scale="free") +
geom_histogram(bins=50)
```

```
# Outliers plot

ggplot(stack(df1), aes(x = ind, y = values, fill=ind)) +
  geom_boxplot(outlier.colour = "red",  outlier.alpha=.4) +
  coord_cartesian(ylim = c(0, 1000)) +
  theme_classic()+
  theme(axis.text.x=element_text(angle=45, hjust=1))

# Correlation between the numerical variables

df3 <- df1[,!names(df1) %in% c("PARENT1","RED_CAR",
"REVOKED","URBANICITY","INCOME","OLDCLAIM","HOME_VAL","BLUEBOOK","SEX","MSTAT
US","EDUCATION","JOB","CAR_USE","CAR_TYPE")]

a <- cor(df3, method="pearson", use="complete.obs")
a

corrplot(a)

# Imputing other NA variables by median before checking on minimum

df1[is.na(df1$HOME_VAL),]$HOME_VAL <-
median(df1[complete.cases(df1$HOME_VAL),]$HOME_VAL)
df1[is.na(df1$YOJ),]$YOJ <- median(df1[complete.cases(df1$YOJ),]$YOJ)
df1[is.na(df1$INCOME),]$INCOME <-
median(df1[complete.cases(df1$INCOME),]$INCOME)
df1[is.na(df1$AGE),]$AGE <- median(df1[complete.cases(df1$AGE),]$AGE)



# Looking at the minimum values in order to adjust for the BoxCox
Transformation

apply(df1,2,min)

# BoxCox Transformation

df4 <- df1 %>%
  filter(CAR_AGE >= 0) %>%
  mutate(CAR_AGE = CAR_AGE + 1, YOJ = YOJ + 1, INCOME = INCOME + 1) %>%
  select(TIF, BLUEBOOK, TRAVTIME, AGE, CAR_AGE, YOJ, INCOME)

apply(df4, 2, BoxCoxTrans)

# LM 1
```

```
df_lm <- df1 %>% select(-TARGET_FLAG) %>% filter(TARGET_AMT > 0)

# Linear regression

lm_model1 <- lm(TARGET_AMT~.,data = df_lm)

summary(lm_model1)


# Visualization

opar <- par(mfrow = c(2,2), oma = c(0, 0, 1.1, 0))
plot(lm_model1, las = 1)

# LM 2

lm_model2 <- step(lm_model1)
summary(lm_model2)


# LM 3

lm_model3 <- lm(TARGET_AMT ~ KIDSDRIV + AGE + HOMEKIDS + I(YOJ^1.6) + PARENT1
+ I(TRAVTIME^0.7) + CAR_USE + I(TIF^0.2) + RED_CAR + CLM_FREQ + REVOKED +
MVR_PTS + I(CAR_AGE^0.5) + I(INCOME^0.4) + HOME_VAL + I(BLUEBOOK^0.5) +
OLDCLAIM + MSTATUS + SEX + EDUCATION + JOB + CAR_TYPE + URBANICITY,
data=df_lm)
summary(lm_model3)

# Logistic Model

# Logistic M 1

df_rm <- df1 %>% select(-TARGET_AMT)


rm_model1 <- glm(TARGET_FLAG ~ ., family="binomial", df_rm)

summary(rm_model1)


# Logistic M 2

hist(rm_model1$fitted.values,main = " Histogram ",xlab = "Probability of
Crashing", col = 'light blue')

probabilities <- predict(rm_model1, df_rm, type = "response")
predicted1.classes <- ifelse(probabilities > 0.5, 1, 0)
```

```
df_rm$pred1.class <- predicted1.classes
table("Predictions" = df_rm$pred1.class, "Actual" = df_rm$TARGET_FLAG)


confusionMatrix(as.factor(predicted1.classes), as.factor(df_rm$TARGET_FLAG))

curve <- roc(response = df_rm$TARGET_FLAG,
    predictor = predicted1.classes,
    plot = TRUE,
    print.auc = TRUE,
    main = "ROC Curve")


df_rf <- subset(df_rm, select= -c(pred1.class))

trainIndex <- createDataPartition(df_rf$TARGET_FLAG, p = .8,
                                  list = FALSE,
                                  times = 1)
rf_train <- df_rf[ trainIndex,]
rf_test  <- df_rf[-trainIndex,]

rf <- randomForest(factor(TARGET_FLAG) ~ ., data = rf_train, na.action =
na.omit)
rf
varImpPlot(rf)

test_rf <- predict(rf, rf_test)
confusionMatrix(test_rf, factor(rf_test$TARGET_FLAG), positive = '1')


# Logistic M 3

no_na_df <- na.omit(rf_train)
rm_model1 <- glm(TARGET_FLAG ~ ., family="binomial", no_na_df)


model2 <- step(rm_model1)

summary(model2)


# Confusion matrix and the curve...


hist(model2$fitted.values,main = " Histogram ",xlab = "Probability of
Crashing", col = 'light green')
```

```
probabilities <- predict(model2, rf_test, type = "response")
predicted.classes <- ifelse(probabilities > 0.5, 1, 0)
rf_test$pred.class <- predicted.classes
table("Predictions" = rf_test$pred.class, "Actual" = rf_test$TARGET_FLAG)


confusionMatrix(as.factor(predicted.classes), as.factor(rf_test$TARGET_FLAG),
positive = '1')


curve <- roc(response = rf_test$TARGET_FLAG,
    predictor = predicted.classes,
    plot = TRUE,
    print.auc = TRUE,
    main = "ROC Curve")


# Select models

eval <-
read_csv('https://raw.githubusercontent.com/aaitelmouden/DATA621/master/Homew
ork4/data/insurance-evaluation-data.csv')

# Get rid of INDEX, TARGET_FLAG, TARGET_AMT
eval <- subset(eval, select = -c(INDEX))

# Select money variables to clean before summary

eval2 <- eval[, names(eval) %in% c("INCOME", "OLDCLAIM", "HOME_VAL",
"BLUEBOOK")]

# Clean using string function

eval2 <- apply(eval2, 2, function(y) gsub("\\$","",y))
eval2 <- apply(eval2, 2, function(y) gsub(",","",y))
eval2 <- apply(eval2, 2, as.integer)

# Combine variables

eval1 <- eval[, !names(eval) %in% c("INCOME", "OLDCLAIM", "HOME_VAL",
"BLUEBOOK")]
eval1 <- cbind(eval1, eval2)

# Select characters variables to clean before summary

eval2 <- eval1[, names(eval1) %in% c("MSTATUS", "SEX", "EDUCATION", "JOB",
"CAR_TYPE", "URBANICITY")]
```

```
# Clean using character function

eval2 <- apply(eval2, 2, function(y) gsub("z_","",y))

eval1 <- eval1[,!names(eval1) %in% c("MSTATUS", "SEX", "EDUCATION", "JOB",
"CAR_TYPE", "URBANICITY")]
eval1 <- cbind(eval1, eval2)
head(eval1)


### Does the person crash the car?


eval1[is.na(eval1$INCOME),]$INCOME <-
median(eval1[complete.cases(eval1$INCOME),]$INCOME)
eval1[is.na(eval1$HOME_VAL),]$HOME_VAL <- 0

probabilities <- predict(model2, eval1[, -1], type = "response")
preds <- ifelse(probabilities > 0.5, 1, 0)

preds[is.na(preds)] <-0
preds



### What's the pay off?


amt <- ifelse(preds == 1, predict(lm_model2, eval1[,-1], type = "response"),
0)
amt
```

References

- Regression Model Validation
- Binary Logistic Regression
- [What are pseudo R-squareds?] (https://stats.idre.ucla.edu/other/mult-pkg/faq/general/faq-what-are-pseudo-r-squareds/)