

Technical Report

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Abstract

Introduction

The Portland Police Bureau (PPB) serves the greater Portland, Oregon metropolitan area. Within Portland, there are 95+ neighborhoods that differ from each other greatly in terms of income, race, and percentage of population below the poverty line. We predicted that income and race would have effects on the performance of the PPB, which we assessed through dispatch time. We looked to see if we could predict response time of the PPB using income and race of the neighborhoods, as well as variables provided by the PPB that ranked the priority of the call and classified the reason for calling, such as crime or traffic complaint.

The Data

Our data is a combination of two different datasets. Census data from 2010 was taken from the City of Portland website (<https://www.portlandoregon.gov/civic/56897>) and data about police response time from 2012 was taken from the Portland Police Bureau (<https://www.portlandoregon.gov/police/76454>.). Rather than using total response time, we are using the time spent in the queue, that is, the amount of time a caller waited in the police dispatch queue before an officer was dispatched to them. The total response time includes travel time once the officer was dispatched. As there is no record of how far the officer had to travel, there was no way to standardize the total response time, so we used the time spent in the queue as a more standardized response time.

The unit of observation in this combined dataset is a call to the Portland Police Bureau (PPB). The number of observations is 194,044. To predict the time in queue of the PPB we are looking at priority of the crime as rated by the PPB, racial makeup of the neighborhood (in percentage of white population), population density, and average income in the neighborhood.

Location data is majority of data that is missing in observations with missing data. This is addressed by PPB on the website. If “the incident occurred outside of the boundaries of the Portland neighborhoods or at a location that could not be assigned to a specific address in the system (e.g., Portland, near Washington Park, on the streetcar, etc.)” (PPB) there will be no data for location.

Population and economic data came from Portland Monthly: (<https://www.pdxmonthly.com/articles/2016/4/1/real-estate-2016-the-city>)

Exploratory Data Analysis

Time in Queue for PPB calls

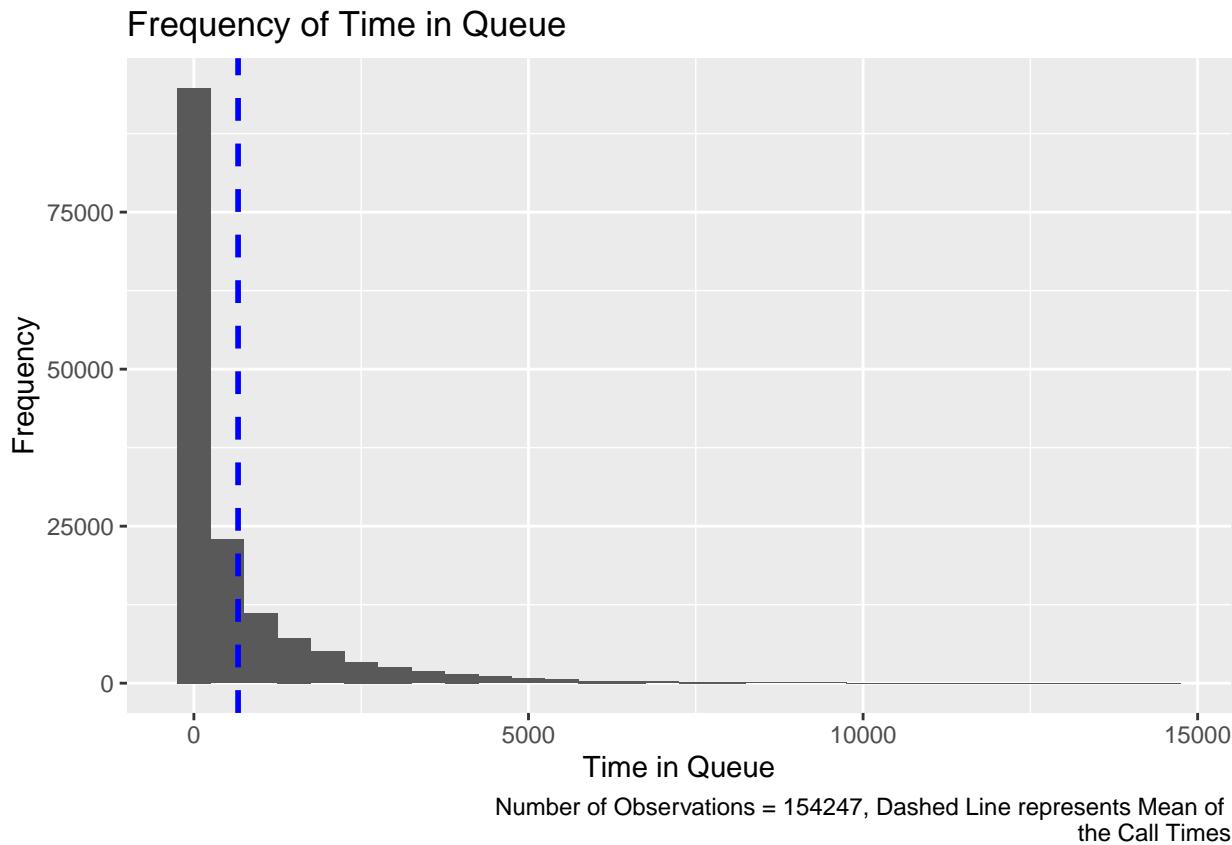
There were categorical variables in the data that coded the priority of the call and the category of the call. Priority was low, medium, or high, so we recoded the variable to be 0, 0.5, and 1, respectively. Category was recoded to be 1 for the “crime” category and 0 for all other categories, including Traffic, Disorder, and Assist. We assumed that crime calls may be given priority over other kinds of calls.

As a preliminary visualization of all of the data, a histogram was generated for time spent in the queue. This histogram is heavily skewed right, with a majority of the calls spending less time in the queue than the mean.

```

ggplot(data=calls, aes(x=TimeInQueue_sec)) +
  geom_histogram(binwidth=500) +
  labs(x = "Time in Queue", y="Frequency" , title="Frequency of Time in Queue",
       caption="Number of Observations = 154247, Dashed Line represents Mean of
       the Call Times") +
  geom_vline(aes(xintercept=mean(TimeInQueue_sec)),
             color="blue", linetype="dashed", size=1)

```



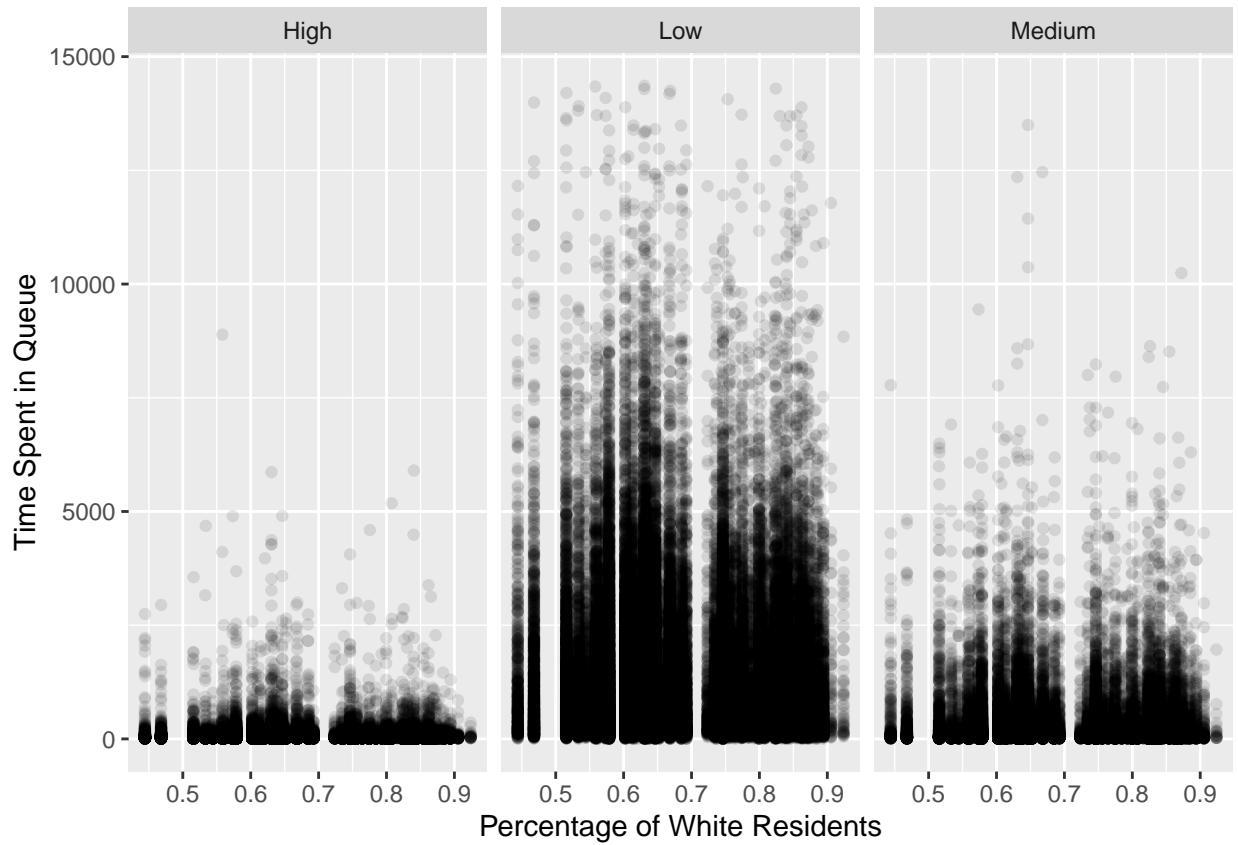
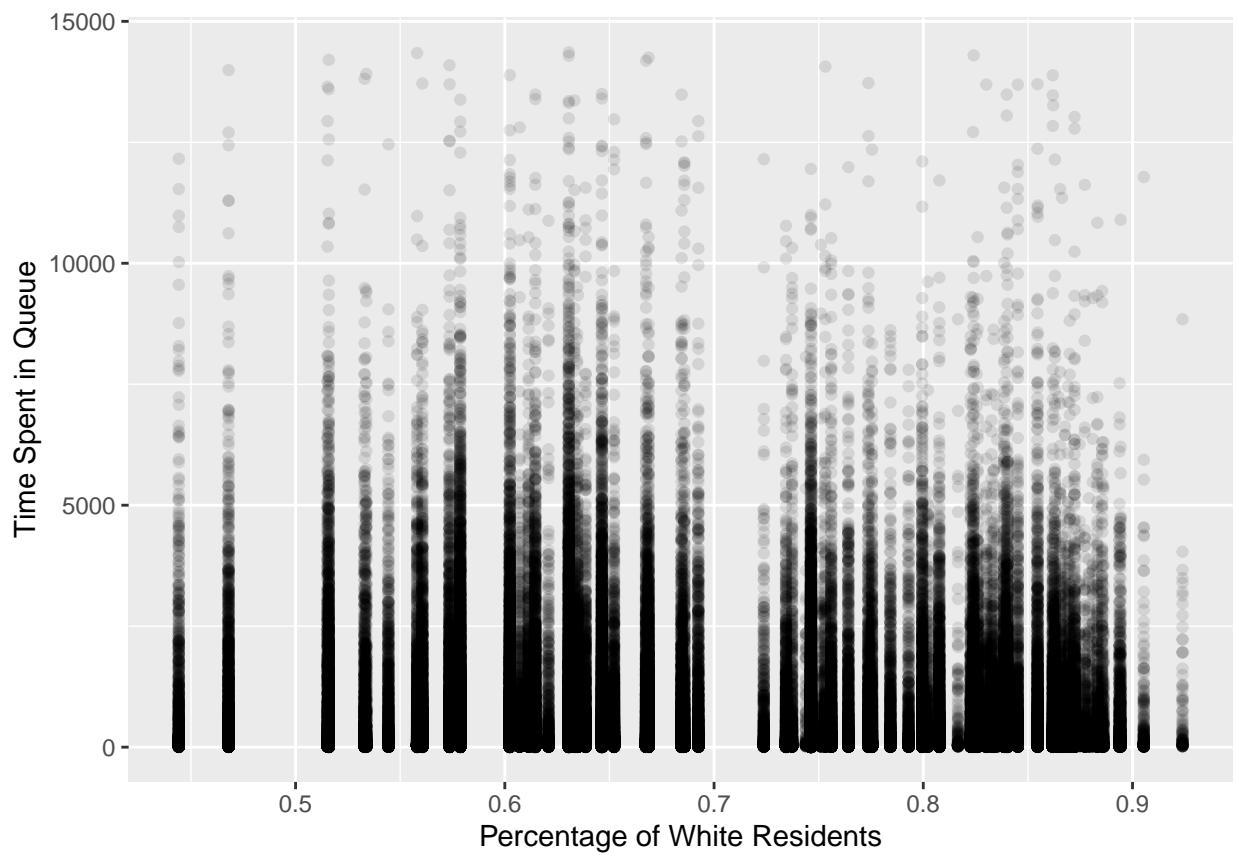
```
summary(calls$TimeInQueue_sec)
```

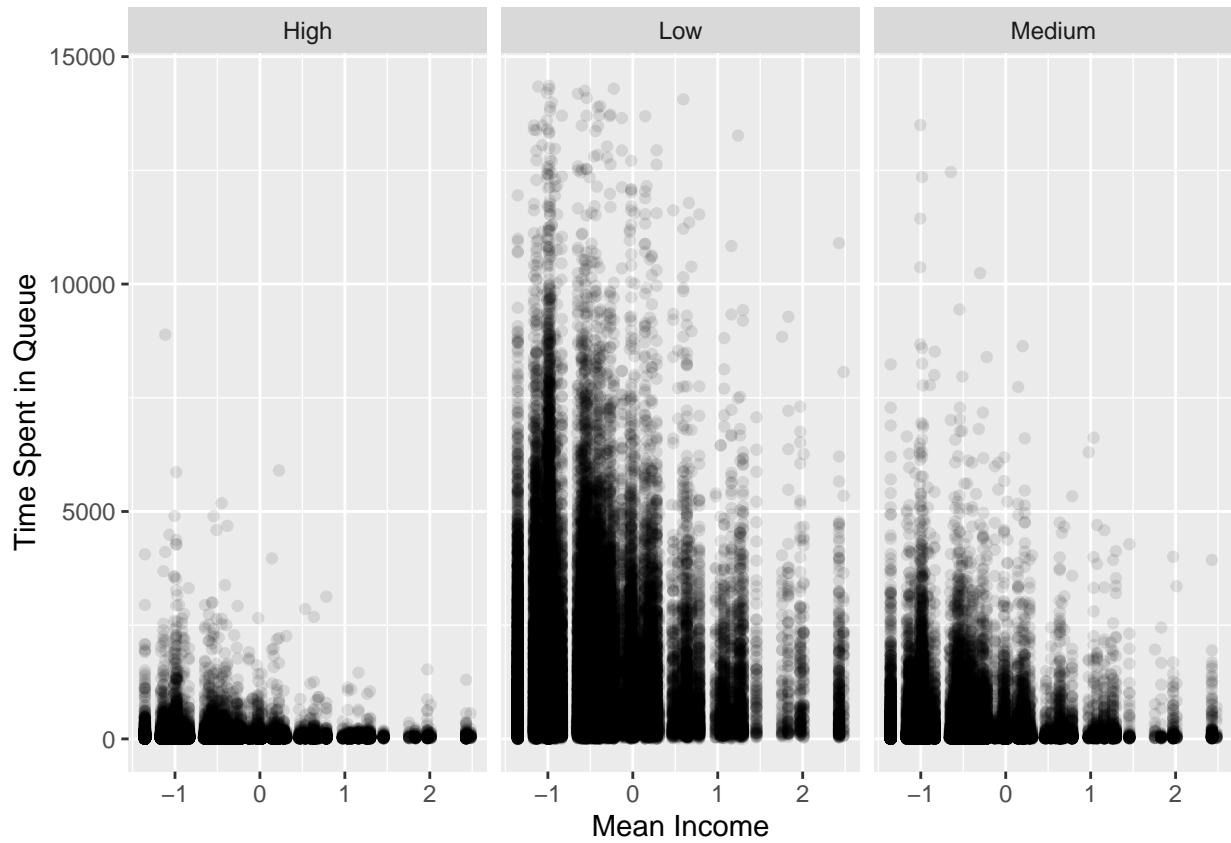
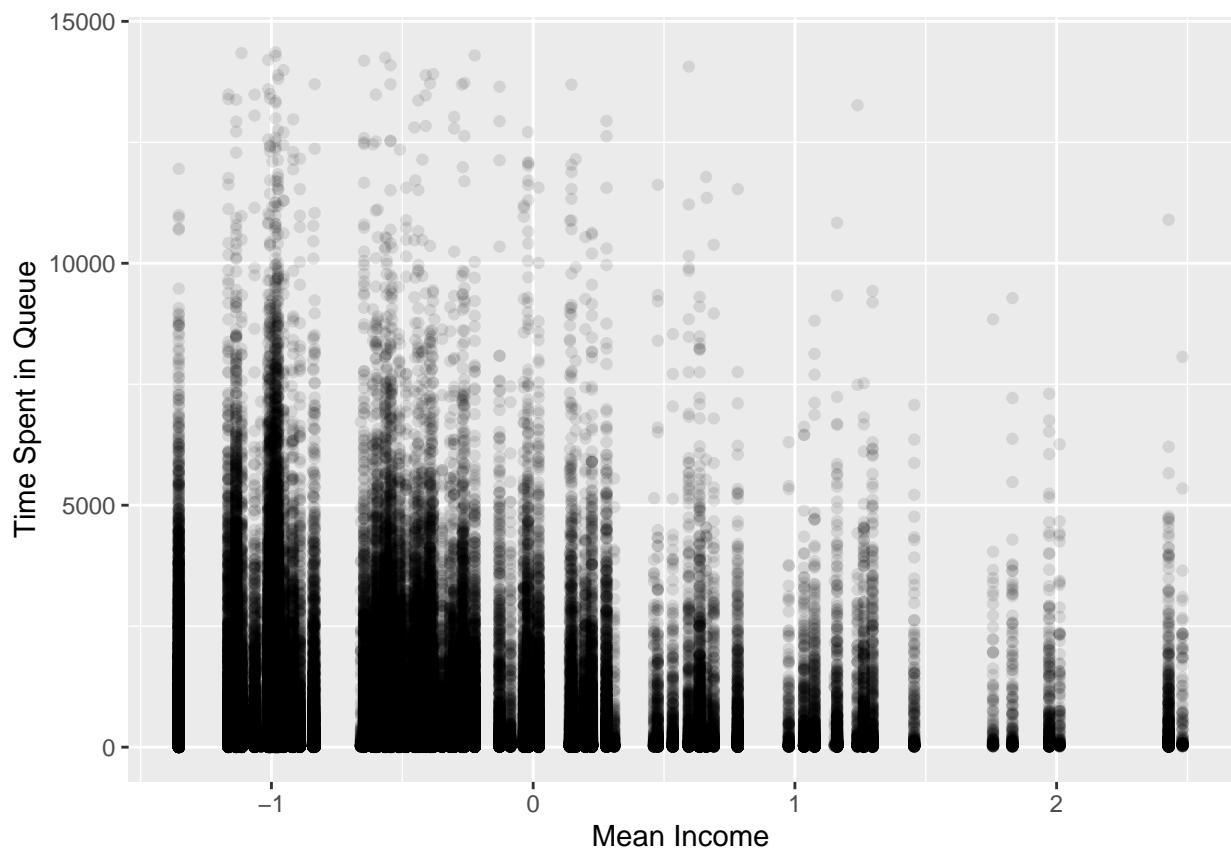
```

##      Min. 1st Qu. Median      Mean 3rd Qu.    Max.
##      0.0    37.0   114.0    660.5   686.0 14359.0

```

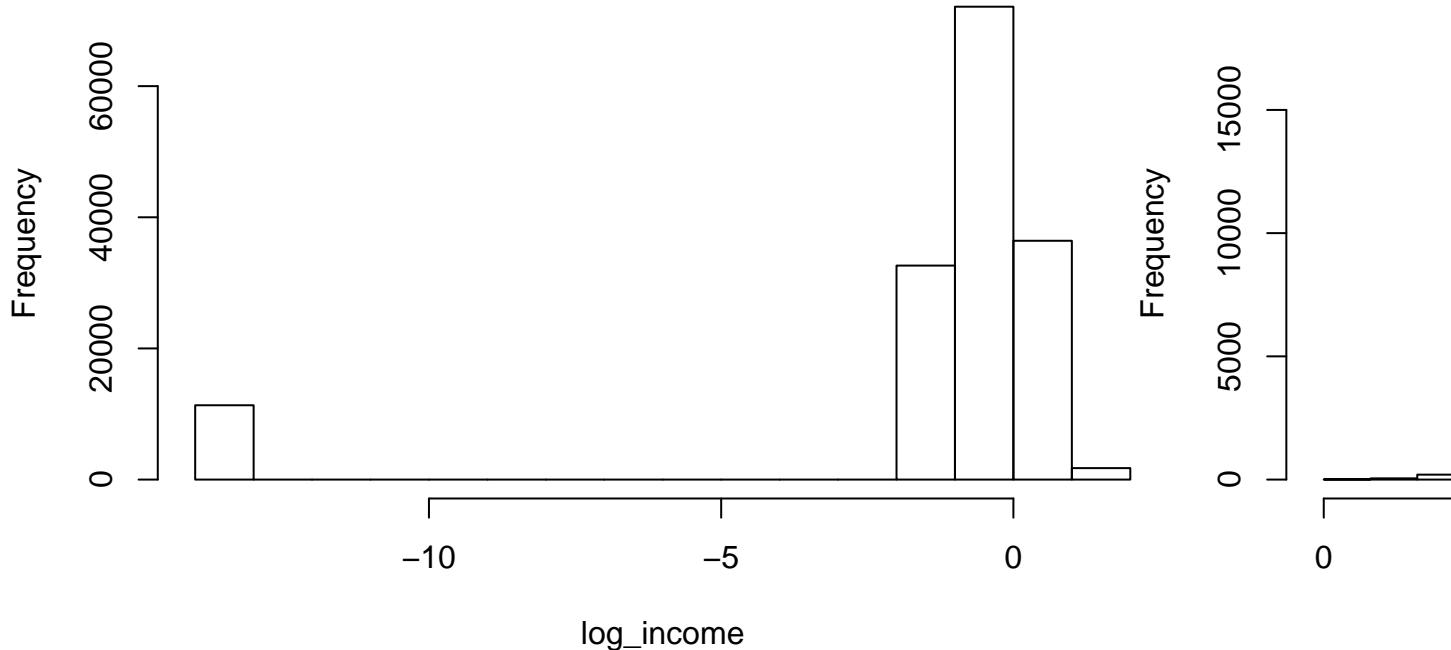
Plotting bivariate correlations was our first step in exploring the data. For each, the entire dataset was plotted without priority first and then also plotted with the data faceted by priority. Faceting by priority allowed us to see how important priority was to response time as well as see that generally, those with lower income spent longer times in the queue when controlling for the priority of the call.





We ran principal component analysis in an attempt for dimension reduction.

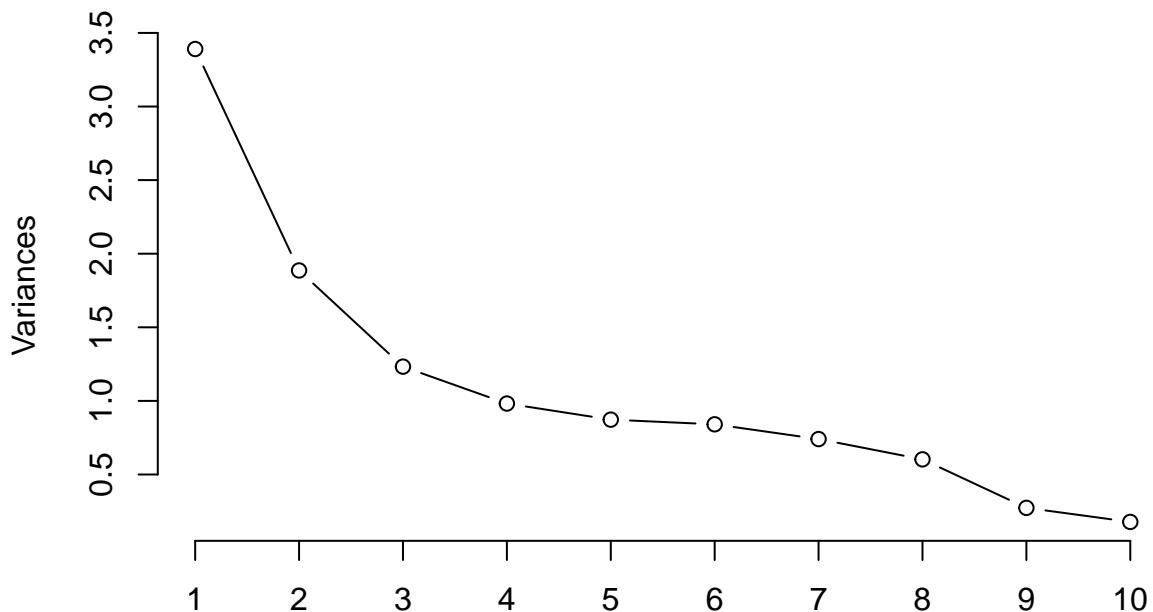
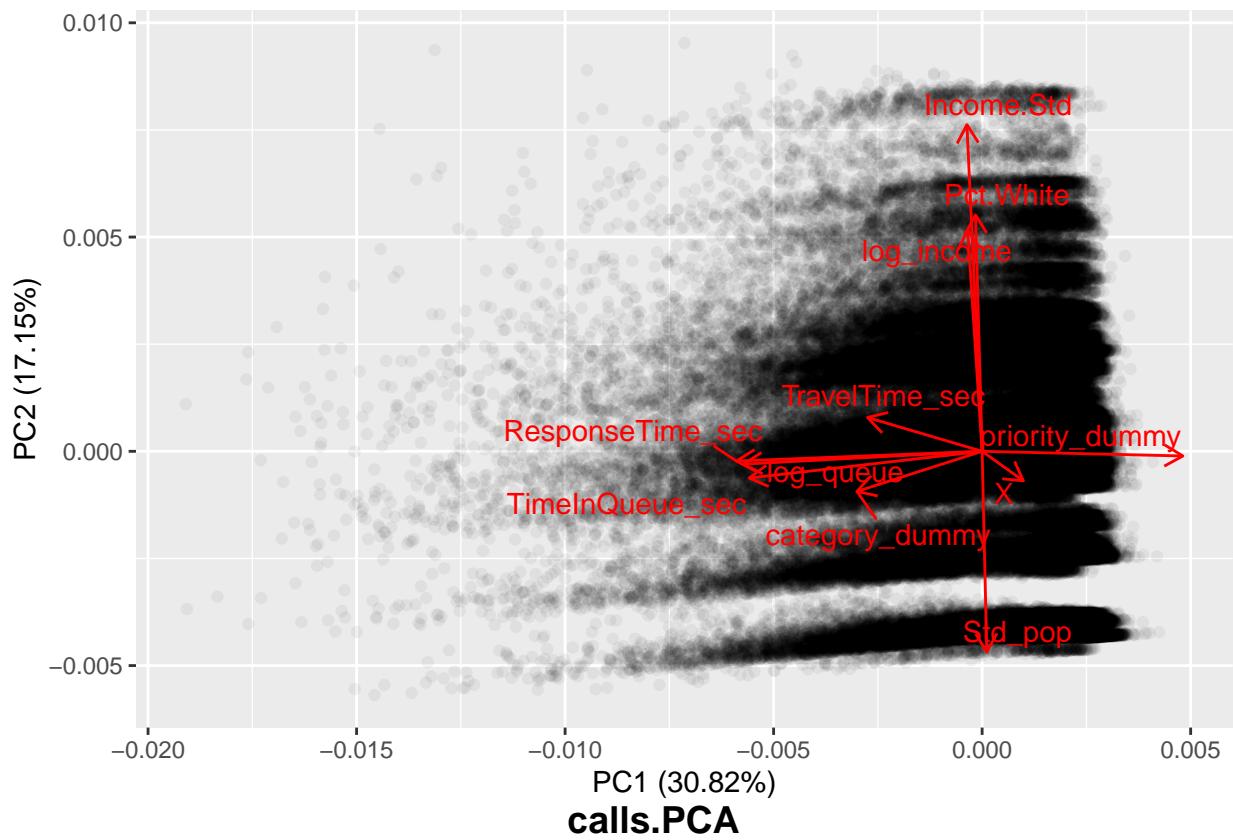
Histogram of log_income



```
## Importance of components:
##          PC1      PC2      PC3      PC4      PC5      PC6
## Standard deviation 1.8414 1.3734 1.1103 0.99096 0.93418 0.91700
## Proportion of Variance 0.3082 0.1715 0.1121 0.08927 0.07934 0.07644
## Cumulative Proportion 0.3082 0.4797 0.5918 0.68106 0.76040 0.83684
##          PC7      PC8      PC9      PC10     PC11
## Standard deviation 0.86061 0.77646 0.52282 0.42174 5.743e-15
## Proportion of Variance 0.06733 0.05481 0.02485 0.01617 0.000e+00
## Cumulative Proportion 0.90417 0.95898 0.98383 1.00000 1.000e+00

## List of 5
## $ sdev    : num [1:11] 1.841 1.373 1.11 0.991 0.934 ...
## $ rotation: num [1:11, 1:11] 0.0837 -0.4986 -0.4727 -0.2326 -0.0135 ...
##   ..- attr(*, "dimnames")=List of 2
##     ...$ : chr [1:11] "X" "ResponseTime_sec" "TimeInQueue_sec" "TravelTime_sec" ...
##     ...$ : chr [1:11] "PC1" "PC2" "PC3" "PC4" ...
## $ center   : Named num [1:11] 7.71e+04 1.10e+03 6.61e+02 4.44e+02 6.93e-01 ...
##   ..- attr(*, "names")= chr [1:11] "X" "ResponseTime_sec" "TimeInQueue_sec" "TravelTime_sec" ...
## $ scale    : Named num [1:11] 4.45e+04 1.46e+03 1.26e+03 5.73e+02 1.14e-01 ...
##   ..- attr(*, "names")= chr [1:11] "X" "ResponseTime_sec" "TimeInQueue_sec" "TravelTime_sec" ...
## $ x        : num [1:154234, 1:11] 1.253 1.265 -0.496 1.77 1.64 ...
##   ..- attr(*, "dimnames")=List of 2
##     ...$ : chr [1:154234] "1" "2" "3" "4" ...
##     ...$ : chr [1:11] "PC1" "PC2" "PC3" "PC4" ...
## - attr(*, "class")= chr "prcomp"
```

Principal Component Analysis for 911 Queue Time

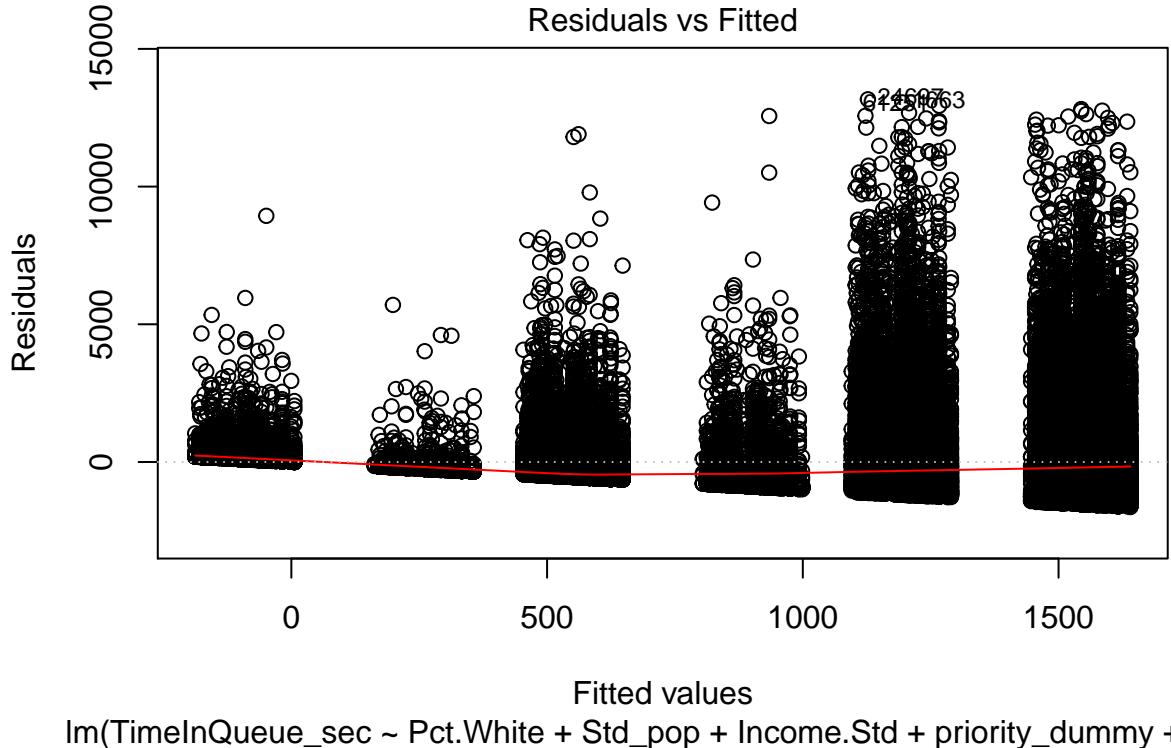


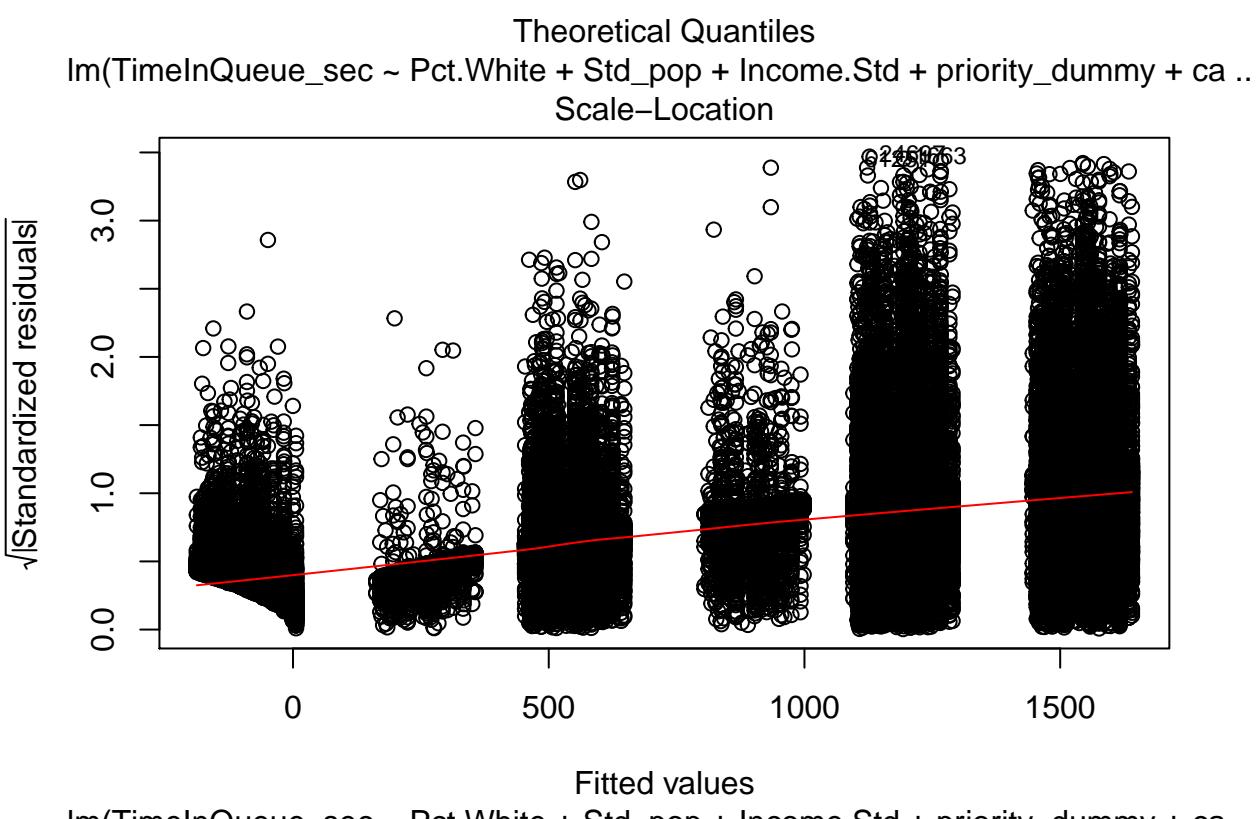
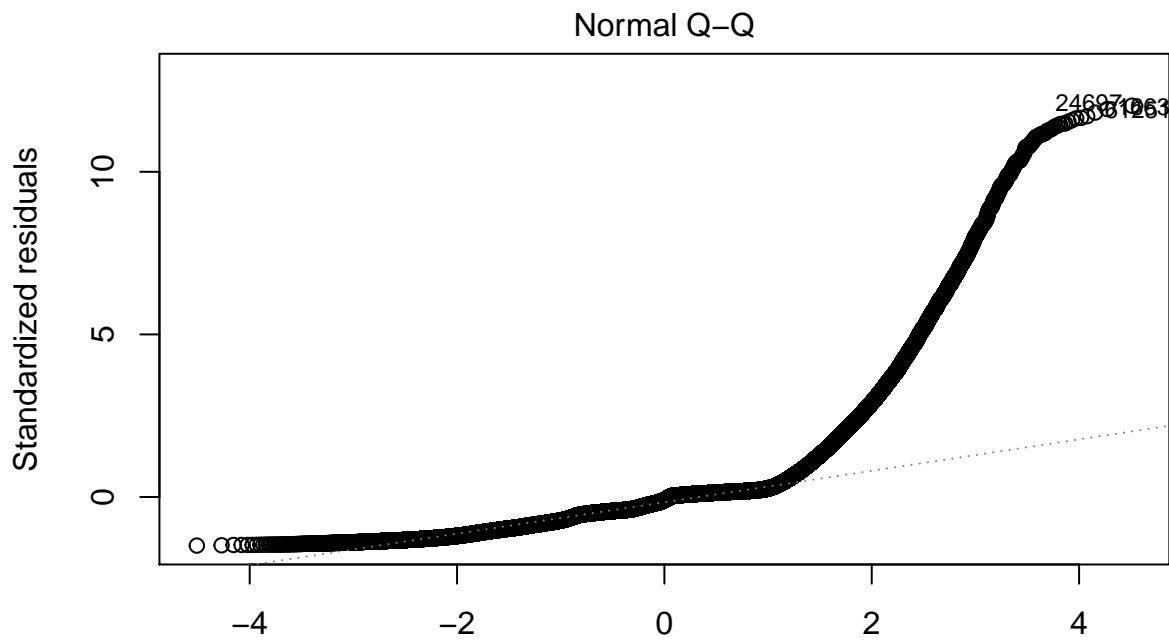
Modeling

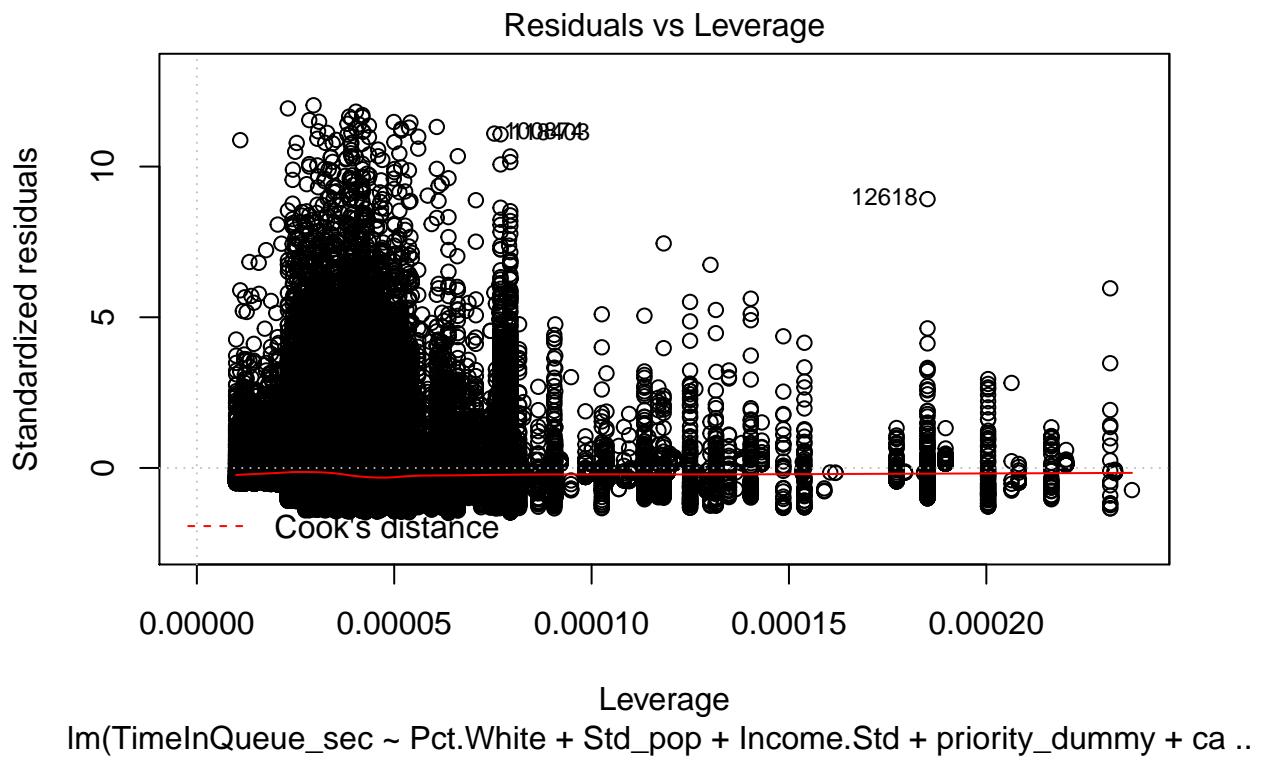
We tried a basic non-crossvalidated linear model just to see how the skew of the variables would impact the diagnostic graphs. Upon seeing the non-random residuals and highly non-linear QQ plot, we applied

log transformations to some of the variables. The linear model using the transformed variables still had problems in the diagnostic graphs, but they were improved from the non-transformed model. When we built a cross-validated linear model, we decided to use these transformed variables.

```
##  
## Call:  
## lm(formula = TimeInQueue_sec ~ Pct.White + Std.pop + Income.Std +  
##     priority_dummy + category_dummy, data = calls_dummy)  
##  
## Residuals:  
##      Min       1Q   Median       3Q      Max  
## -1634.4  -533.5 -105.2  180.0 13168.7  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 1502.924    22.279   67.460 < 2e-16 ***  
## Pct.White    -451.016    28.606  -15.766 < 2e-16 ***  
## Std.pop        8.719     1.980    4.403 1.07e-05 ***  
## Income.Std     14.816     5.383    2.753  0.00591 **  
## priority_dummy -1283.701    6.965 -184.320 < 2e-16 ***  
## category_dummy  350.753    6.740   52.038 < 2e-16 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 1094 on 154228 degrees of freedom  
## Multiple R-squared:  0.2438, Adjusted R-squared:  0.2437  
## F-statistic:  9942 on 5 and 154228 DF, p-value: < 2.2e-16
```

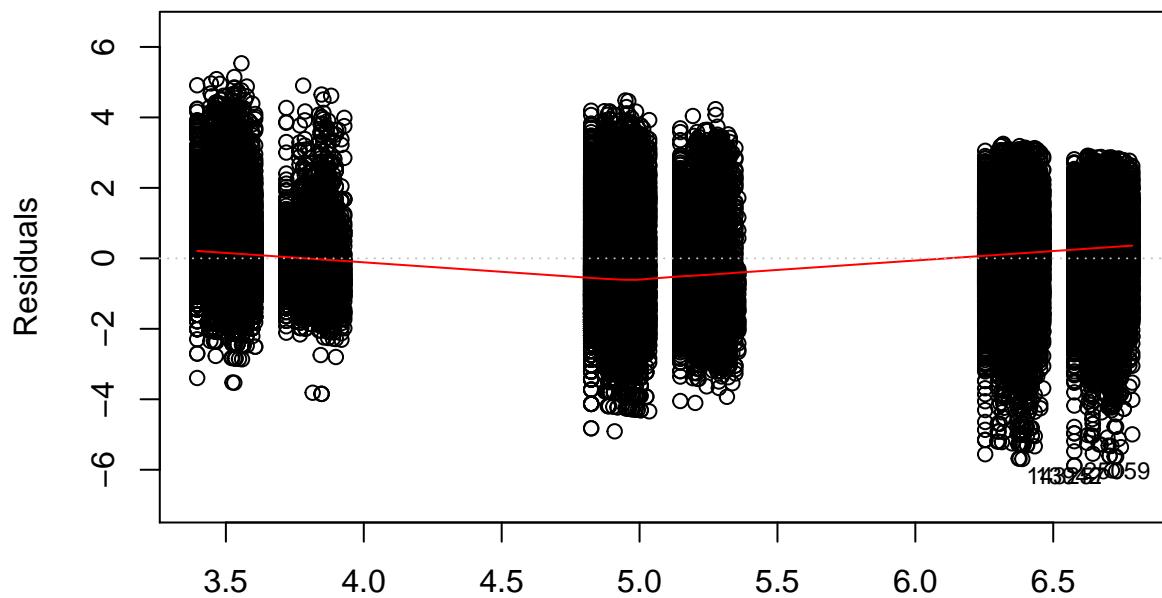






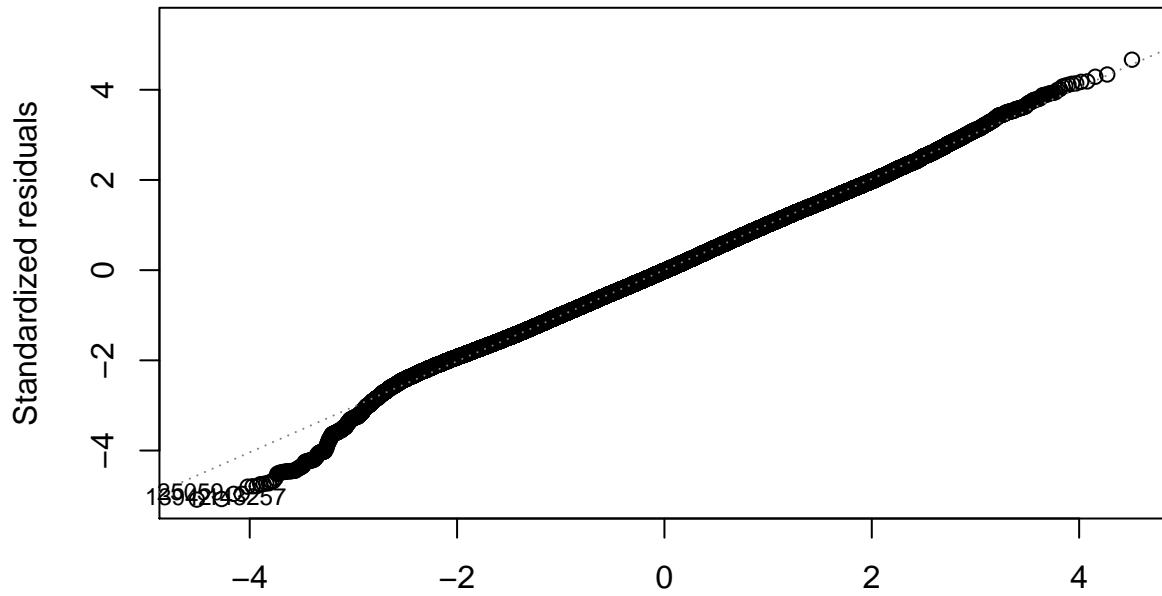
```
##
## Call:
## lm(formula = log_queue ~ Pct.White + log_income + priority_dummy +
##     category_dummy, data = calls_dummy)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -6.0349 -0.8047 -0.0168  0.8127  5.5361
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 6.6455115  0.0195351 340.183 < 2e-16 ***
## Pct.White    -0.3977650  0.0265922 -14.958 < 2e-16 ***
## log_income    0.0068571  0.0008448   8.117 4.81e-16 ***
## priority_dummy -2.8572870  0.0075449 -378.705 < 2e-16 ***
## category_dummy  0.3231592  0.0072980   44.280 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.186 on 154229 degrees of freedom
## Multiple R-squared:  0.5378, Adjusted R-squared:  0.5378
## F-statistic: 4.486e+04 on 4 and 154229 DF,  p-value: < 2.2e-16
```

Residuals vs Fitted



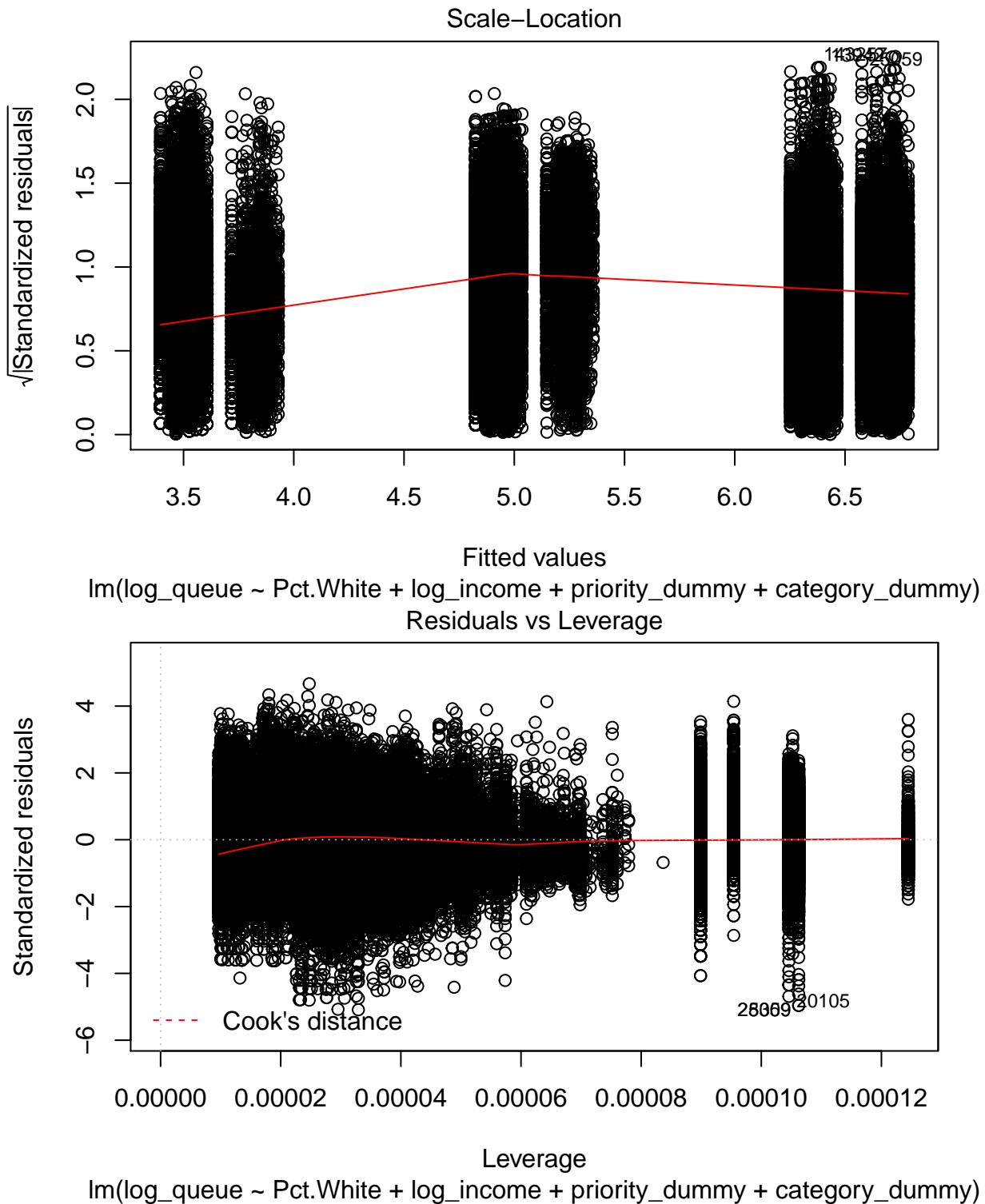
Fitted values

lm(log_queue ~ Pct.White + log_income + priority_dummy + category_dummy)
Normal Q-Q



Theoretical Quantiles

lm(log_queue ~ Pct.White + log_income + priority_dummy + category_dummy)



We tested six different models: three regression-based models and three algorithmic models. Using 10-fold cross-validation, we fit multiple linear regression, ridge regression, lasso, bagged trees, random forest, and boosted forest models. The caretEnsemble package tested the parameters for all of these models and chose the best performing model of each type. Since many of our variables were skewed, even after transformation, we anticipated the algorithmic approach to be more appropriate. However, since we wanted to engage in inference regarding time in the queue, linear-based models would provide more interpretable information.

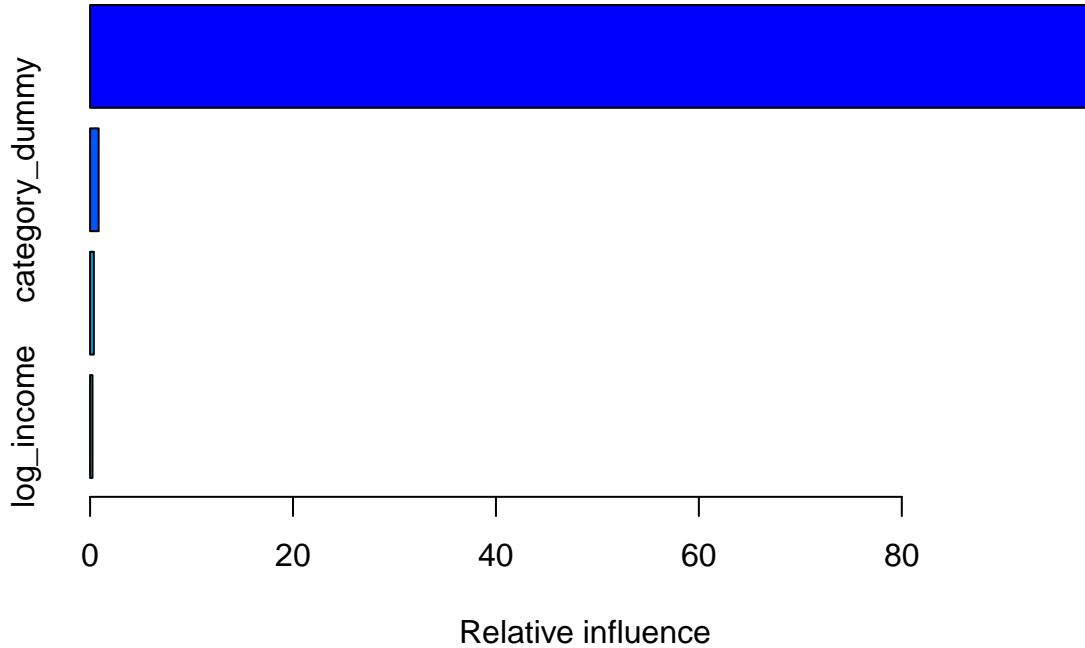


Figure 1: Summary of the Model with Least Mean Squared Error

```
##      LM GLMNET RANGER TREEBAG  GBM
## 1 1.19    1.19    1.15    1.16 1.15
```

Our dataset was large enough that we could tune the models through 10-fold CV on training set and then test the models into a test set. The test MSEs for the best model of each type is shown below.

```
##      LM GLMNET RANGER TREEBAG  GBM
## 1 1.42    1.42    1.33    1.35 1.33
```

The boosted random forest model has the lowest test MSE. We used variable importance to infer how much each variable was impacting the time in the queue. Unsurprisingly, priority and category were overwhelmingly the most important.

```
##             var rel.inf
## priority_dummy priority_dummy  98.553
## category_dummy category_dummy   0.843
## Pct.White          Pct.White   0.367
## log_income         log_income   0.236
```

We tried a boosted random forest model without priority and then without priority and category to compare the race and income variables. Interestingly, when we removed priority, income switched places with race as the more important of the two variables, indicating that priority may have been capturing some of the importance of income in the original model.

```
## Iter  TrainDeviance  ValidDeviance StepSize Improve
## 1     2.9807        -nan       0.1000  0.0613
## 2     2.9308        -nan       0.1000  0.0494
## 3     2.8903        -nan       0.1000  0.0400
## 4     2.8580        -nan       0.1000  0.0327
## 5     2.8315        -nan       0.1000  0.0265
## 6     2.8099        -nan       0.1000  0.0213
## 7     2.7928        -nan       0.1000  0.0173
## 8     2.7788        -nan       0.1000  0.0140
```

```

##      9    2.7673      -nan    0.1000   0.0114
##     10    2.7580      -nan    0.1000   0.0092
##     20    2.7236      -nan    0.1000   0.0011
##     40    2.7147      -nan    0.1000   0.0002
##     60    2.7124      -nan    0.1000  -0.0000
##     80    2.7114      -nan    0.1000   0.0000
##    100    2.7108      -nan    0.1000   0.0000
##    120    2.7103      -nan    0.1000   0.0000
##    140    2.7098      -nan    0.1000  -0.0000
##    150    2.7096      -nan    0.1000  -0.0000
##
## Iter TrainDeviance ValidDeviance StepSize Improve
##    1    2.9783      -nan    0.1000   0.0615
##    2    2.9282      -nan    0.1000   0.0499
##    3    2.8881      -nan    0.1000   0.0403
##    4    2.8549      -nan    0.1000   0.0329
##    5    2.8281      -nan    0.1000   0.0264
##    6    2.8068      -nan    0.1000   0.0216
##    7    2.7892      -nan    0.1000   0.0175
##    8    2.7746      -nan    0.1000   0.0142
##    9    2.7632      -nan    0.1000   0.0114
##   10    2.7540      -nan    0.1000   0.0094
##   20    2.7182      -nan    0.1000   0.0012
##   40    2.7110      -nan    0.1000   0.0001
##   60    2.7088      -nan    0.1000   0.0000
##   80    2.7076      -nan    0.1000   0.0000
##  100    2.7067      -nan    0.1000  -0.0000
##  120    2.7061      -nan    0.1000  -0.0000
##  140    2.7056      -nan    0.1000  -0.0000
##  150    2.7054      -nan    0.1000  -0.0001
##
## Iter TrainDeviance ValidDeviance StepSize Improve
##    1    2.9780      -nan    0.1000   0.0618
##    2    2.9269      -nan    0.1000   0.0502
##    3    2.8858      -nan    0.1000   0.0405
##    4    2.8533      -nan    0.1000   0.0328
##    5    2.8260      -nan    0.1000   0.0263
##    6    2.8049      -nan    0.1000   0.0214
##    7    2.7871      -nan    0.1000   0.0173
##    8    2.7730      -nan    0.1000   0.0141
##    9    2.7619      -nan    0.1000   0.0113
##   10    2.7524      -nan    0.1000   0.0093
##   20    2.7166      -nan    0.1000   0.0013
##   40    2.7092      -nan    0.1000   0.0002
##   60    2.7072      -nan    0.1000  -0.0001
##   80    2.7059      -nan    0.1000  -0.0000
##  100    2.7048      -nan    0.1000   0.0000
##  120    2.7040      -nan    0.1000  -0.0000
##  140    2.7035      -nan    0.1000  -0.0001
##  150    2.7033      -nan    0.1000  -0.0001
##
## Iter TrainDeviance ValidDeviance StepSize Improve
##    1    2.9792      -nan    0.1000   0.0610
##    2    2.9298      -nan    0.1000   0.0498

```

```

##      3    2.8892      -nan    0.1000   0.0402
##      4    2.8564      -nan    0.1000   0.0323
##      5    2.8305      -nan    0.1000   0.0262
##      6    2.8097      -nan    0.1000   0.0213
##      7    2.7922      -nan    0.1000   0.0173
##      8    2.7783      -nan    0.1000   0.0140
##      9    2.7671      -nan    0.1000   0.0114
##     10    2.7580      -nan    0.1000   0.0092
##    20    2.7233      -nan    0.1000   0.0011
##    40    2.7141      -nan    0.1000   0.0002
##   60    2.7118      -nan    0.1000   0.0000
##   80    2.7107      -nan    0.1000   0.0000
##  100    2.7100      -nan    0.1000  -0.0000
##  120    2.7094      -nan    0.1000   0.0000
##  140    2.7089      -nan    0.1000  -0.0000
##  150    2.7087      -nan    0.1000  -0.0000
##
## Iter  TrainDeviance  ValidDeviance StepSize Improve
##   1    2.9777      -nan    0.1000   0.0615
##   2    2.9282      -nan    0.1000   0.0502
##   3    2.8869      -nan    0.1000   0.0404
##   4    2.8550      -nan    0.1000   0.0327
##   5    2.8281      -nan    0.1000   0.0267
##   6    2.8065      -nan    0.1000   0.0216
##   7    2.7888      -nan    0.1000   0.0175
##   8    2.7746      -nan    0.1000   0.0143
##   9    2.7629      -nan    0.1000   0.0114
##  10    2.7534      -nan    0.1000   0.0093
##  20    2.7174      -nan    0.1000   0.0011
##  40    2.7102      -nan    0.1000   0.0001
##  60    2.7078      -nan    0.1000   0.0001
##  80    2.7064      -nan    0.1000  -0.0000
## 100    2.7052      -nan    0.1000  -0.0000
## 120    2.7044      -nan    0.1000   0.0000
## 140    2.7039      -nan    0.1000  -0.0000
## 150    2.7036      -nan    0.1000   0.0000
##
## Iter  TrainDeviance  ValidDeviance StepSize Improve
##   1    2.9766      -nan    0.1000   0.0621
##   2    2.9265      -nan    0.1000   0.0501
##   3    2.8859      -nan    0.1000   0.0407
##   4    2.8524      -nan    0.1000   0.0327
##   5    2.8253      -nan    0.1000   0.0264
##   6    2.8042      -nan    0.1000   0.0213
##   7    2.7869      -nan    0.1000   0.0175
##   8    2.7729      -nan    0.1000   0.0141
##   9    2.7611      -nan    0.1000   0.0116
##  10    2.7521      -nan    0.1000   0.0093
##  20    2.7155      -nan    0.1000   0.0012
##  40    2.7080      -nan    0.1000   0.0001
##  60    2.7057      -nan    0.1000  -0.0000
##  80    2.7040      -nan    0.1000  -0.0000
## 100    2.7032      -nan    0.1000  -0.0000
## 120    2.7023      -nan    0.1000   0.0000

```

```

##    140      2.7017      -nan     0.1000   -0.0001
##    150      2.7014      -nan     0.1000   -0.0001
##
## Iter  TrainDeviance  ValidDeviance StepSize Improve
##    1      2.9818      -nan     0.1000   0.0616
##    2      2.9325      -nan     0.1000   0.0500
##    3      2.8927      -nan     0.1000   0.0407
##    4      2.8594      -nan     0.1000   0.0330
##    5      2.8327      -nan     0.1000   0.0268
##    6      2.8118      -nan     0.1000   0.0217
##    7      2.7939      -nan     0.1000   0.0177
##    8      2.7795      -nan     0.1000   0.0141
##    9      2.7680      -nan     0.1000   0.0116
##   10      2.7584      -nan     0.1000   0.0093
##   20      2.7234      -nan     0.1000   0.0011
##   40      2.7137      -nan     0.1000   0.0001
##   60      2.7112      -nan     0.1000   0.0000
##   80      2.7102      -nan     0.1000   0.0000
##  100      2.7095      -nan     0.1000   -0.0000
##  120      2.7090      -nan     0.1000   -0.0000
##  140      2.7085      -nan     0.1000   -0.0000
##  150      2.7084      -nan     0.1000   0.0000
##
## Iter  TrainDeviance  ValidDeviance StepSize Improve
##    1      2.9804      -nan     0.1000   0.0621
##    2      2.9293      -nan     0.1000   0.0503
##    3      2.8884      -nan     0.1000   0.0409
##    4      2.8548      -nan     0.1000   0.0329
##    5      2.8282      -nan     0.1000   0.0266
##    6      2.8063      -nan     0.1000   0.0216
##    7      2.7887      -nan     0.1000   0.0176
##    8      2.7743      -nan     0.1000   0.0143
##    9      2.7625      -nan     0.1000   0.0116
##   10      2.7529      -nan     0.1000   0.0093
##   20      2.7172      -nan     0.1000   0.0012
##   40      2.7097      -nan     0.1000   0.0002
##   60      2.7075      -nan     0.1000   -0.0000
##   80      2.7062      -nan     0.1000   0.0000
##  100      2.7053      -nan     0.1000   -0.0000
##  120      2.7047      -nan     0.1000   -0.0001
##  140      2.7042      -nan     0.1000   -0.0000
##  150      2.7039      -nan     0.1000   -0.0000
##
## Iter  TrainDeviance  ValidDeviance StepSize Improve
##    1      2.9805      -nan     0.1000   0.0628
##    2      2.9298      -nan     0.1000   0.0509
##    3      2.8884      -nan     0.1000   0.0413
##    4      2.8550      -nan     0.1000   0.0334
##    5      2.8286      -nan     0.1000   0.0270
##    6      2.8064      -nan     0.1000   0.0219
##    7      2.7888      -nan     0.1000   0.0177
##    8      2.7739      -nan     0.1000   0.0146
##    9      2.7622      -nan     0.1000   0.0118
##   10      2.7525      -nan     0.1000   0.0096

```

```

##      20      2.7154      -nan     0.1000    0.0013
##      40      2.7078      -nan     0.1000    0.0002
##      60      2.7054      -nan     0.1000   -0.0000
##      80      2.7041      -nan     0.1000   -0.0000
##     100      2.7031      -nan     0.1000    0.0000
##     120      2.7025      -nan     0.1000   -0.0001
##     140      2.7017      -nan     0.1000   -0.0000
##     150      2.7015      -nan     0.1000   -0.0001
##
## Iter TrainDeviance ValidDeviance StepSize Improve
##   1    2.9809      -nan     0.1000    0.0610
##   2    2.9312      -nan     0.1000    0.0498
##   3    2.8912      -nan     0.1000    0.0402
##   4    2.8587      -nan     0.1000    0.0324
##   5    2.8323      -nan     0.1000    0.0263
##   6    2.8110      -nan     0.1000    0.0213
##   7    2.7939      -nan     0.1000    0.0172
##   8    2.7802      -nan     0.1000    0.0139
##   9    2.7687      -nan     0.1000    0.0114
##  10    2.7596      -nan     0.1000    0.0092
##  20    2.7252      -nan     0.1000    0.0011
##  40    2.7156      -nan     0.1000    0.0002
##  60    2.7132      -nan     0.1000    0.0000
##  80    2.7122      -nan     0.1000    0.0000
## 100    2.7115      -nan     0.1000   -0.0000
## 120    2.7110      -nan     0.1000   -0.0000
## 140    2.7106      -nan     0.1000   -0.0000
## 150    2.7104      -nan     0.1000   -0.0000
##
## Iter TrainDeviance ValidDeviance StepSize Improve
##   1    2.9792      -nan     0.1000    0.0617
##   2    2.9287      -nan     0.1000    0.0501
##   3    2.8881      -nan     0.1000    0.0405
##   4    2.8559      -nan     0.1000    0.0325
##   5    2.8291      -nan     0.1000    0.0265
##   6    2.8080      -nan     0.1000    0.0217
##   7    2.7908      -nan     0.1000    0.0176
##   8    2.7769      -nan     0.1000    0.0143
##   9    2.7652      -nan     0.1000    0.0115
##  10    2.7557      -nan     0.1000    0.0095
##  20    2.7194      -nan     0.1000    0.0012
##  40    2.7120      -nan     0.1000    0.0002
##  60    2.7098      -nan     0.1000    0.0000
##  80    2.7084      -nan     0.1000   -0.0000
## 100    2.7075      -nan     0.1000   -0.0000
## 120    2.7066      -nan     0.1000   -0.0000
## 140    2.7062      -nan     0.1000   -0.0000
## 150    2.7059      -nan     0.1000   -0.0001
##
## Iter TrainDeviance ValidDeviance StepSize Improve
##   1    2.9798      -nan     0.1000    0.0622
##   2    2.9293      -nan     0.1000    0.0502
##   3    2.8888      -nan     0.1000    0.0410
##   4    2.8559      -nan     0.1000    0.0332

```

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##      5    2.8288      -nan    0.1000   0.0267
##      6    2.8071      -nan    0.1000   0.0219
##      7    2.7889      -nan    0.1000   0.0176
##      8    2.7744      -nan    0.1000   0.0142
##      9    2.7628      -nan    0.1000   0.0114
##     10    2.7531      -nan    0.1000   0.0092
##     20    2.7172      -nan    0.1000   0.0013
##     40    2.7099      -nan    0.1000   0.0000
##     60    2.7076      -nan    0.1000   0.0000
##     80    2.7064      -nan    0.1000  -0.0000
##    100    2.7055      -nan    0.1000  -0.0001
##    120    2.7047      -nan    0.1000  -0.0000
##    140    2.7041      -nan    0.1000  -0.0000
##    150    2.7039      -nan    0.1000  -0.0001
##
## Iter  TrainDeviance  ValidDeviance StepSize Improve
##    1    2.9795      -nan    0.1000   0.0613
##    2    2.9302      -nan    0.1000   0.0497
##    3    2.8898      -nan    0.1000   0.0403
##    4    2.8576      -nan    0.1000   0.0327
##    5    2.8312      -nan    0.1000   0.0266
##    6    2.8097      -nan    0.1000   0.0213
##    7    2.7918      -nan    0.1000   0.0174
##    8    2.7776      -nan    0.1000   0.0141
##    9    2.7661      -nan    0.1000   0.0113
##   10    2.7566      -nan    0.1000   0.0091
##   20    2.7225      -nan    0.1000   0.0011
##   40    2.7135      -nan    0.1000   0.0002
##   60    2.7111      -nan    0.1000   0.0000
##   80    2.7101      -nan    0.1000   0.0000
##  100    2.7095      -nan    0.1000   0.0000
##  120    2.7090      -nan    0.1000  -0.0000
##  140    2.7085      -nan    0.1000  -0.0000
##  150    2.7083      -nan    0.1000  -0.0000
##
## Iter  TrainDeviance  ValidDeviance StepSize Improve
##    1    2.9795      -nan    0.1000   0.0625
##    2    2.9291      -nan    0.1000   0.0502
##    3    2.8877      -nan    0.1000   0.0410
##    4    2.8550      -nan    0.1000   0.0331
##    5    2.8282      -nan    0.1000   0.0267
##    6    2.8063      -nan    0.1000   0.0217
##    7    2.7881      -nan    0.1000   0.0176
##    8    2.7741      -nan    0.1000   0.0143
##    9    2.7625      -nan    0.1000   0.0116
##   10    2.7532      -nan    0.1000   0.0095
##   20    2.7170      -nan    0.1000   0.0013
##   40    2.7097      -nan    0.1000   0.0000
##   60    2.7076      -nan    0.1000   0.0000
##   80    2.7061      -nan    0.1000   0.0001
##  100    2.7052      -nan    0.1000  -0.0000
##  120    2.7046      -nan    0.1000  -0.0000
##  140    2.7038      -nan    0.1000   0.0001
##  150    2.7036      -nan    0.1000   0.0000

```

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##  

## Iter TrainDeviance ValidDeviance StepSize Improve  

## 1 2.9781 -nan 0.1000 0.0623  

## 2 2.9277 -nan 0.1000 0.0504  

## 3 2.8867 -nan 0.1000 0.0408  

## 4 2.8532 -nan 0.1000 0.0332  

## 5 2.8264 -nan 0.1000 0.0267  

## 6 2.8042 -nan 0.1000 0.0218  

## 7 2.7863 -nan 0.1000 0.0175  

## 8 2.7718 -nan 0.1000 0.0141  

## 9 2.7606 -nan 0.1000 0.0115  

## 10 2.7511 -nan 0.1000 0.0093  

## 20 2.7153 -nan 0.1000 0.0013  

## 40 2.7078 -nan 0.1000 -0.0000  

## 60 2.7055 -nan 0.1000 0.0000  

## 80 2.7041 -nan 0.1000 -0.0000  

## 100 2.7029 -nan 0.1000 -0.0000  

## 120 2.7023 -nan 0.1000 -0.0000  

## 140 2.7017 -nan 0.1000 -0.0000  

## 150 2.7015 -nan 0.1000 -0.0001  

##  

## Iter TrainDeviance ValidDeviance StepSize Improve  

## 1 2.9802 -nan 0.1000 0.0621  

## 2 2.9293 -nan 0.1000 0.0504  

## 3 2.8880 -nan 0.1000 0.0408  

## 4 2.8551 -nan 0.1000 0.0330  

## 5 2.8282 -nan 0.1000 0.0268  

## 6 2.8063 -nan 0.1000 0.0216  

## 7 2.7884 -nan 0.1000 0.0175  

## 8 2.7739 -nan 0.1000 0.0141  

## 9 2.7628 -nan 0.1000 0.0115  

## 10 2.7530 -nan 0.1000 0.0092  

## 20 2.7187 -nan 0.1000 0.0011  

## 40 2.7091 -nan 0.1000 0.0002  

## 60 2.7066 -nan 0.1000 0.0000  

## 80 2.7056 -nan 0.1000 0.0000  

## 100 2.7049 -nan 0.1000 0.0000  

## 120 2.7044 -nan 0.1000 0.0000  

## 140 2.7040 -nan 0.1000 0.0000  

## 150 2.7038 -nan 0.1000 -0.0000  

##  

## Iter TrainDeviance ValidDeviance StepSize Improve  

## 1 2.9783 -nan 0.1000 0.0630  

## 2 2.9273 -nan 0.1000 0.0510  

## 3 2.8856 -nan 0.1000 0.0415  

## 4 2.8521 -nan 0.1000 0.0337  

## 5 2.8250 -nan 0.1000 0.0271  

## 6 2.8032 -nan 0.1000 0.0222  

## 7 2.7861 -nan 0.1000 0.0179  

## 8 2.7710 -nan 0.1000 0.0147  

## 9 2.7593 -nan 0.1000 0.0119  

## 10 2.7495 -nan 0.1000 0.0096  

## 20 2.7124 -nan 0.1000 0.0012  

## 40 2.7050 -nan 0.1000 0.0001

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##      60      2.7028      -nan     0.1000    0.0000
##      80      2.7015      -nan     0.1000   -0.0000
##     100      2.7006      -nan     0.1000    0.0000
##     120      2.6999      -nan     0.1000   -0.0001
##     140      2.6994      -nan     0.1000    0.0000
##     150      2.6992      -nan     0.1000   -0.0000
##
## Iter  TrainDeviance  ValidDeviance StepSize Improve
##    1      2.9789      -nan     0.1000    0.0636
##    2      2.9271      -nan     0.1000    0.0513
##    3      2.8851      -nan     0.1000    0.0416
##    4      2.8513      -nan     0.1000    0.0339
##    5      2.8241      -nan     0.1000    0.0272
##    6      2.8022      -nan     0.1000    0.0221
##    7      2.7845      -nan     0.1000    0.0180
##    8      2.7698      -nan     0.1000    0.0146
##    9      2.7579      -nan     0.1000    0.0118
##   10      2.7481      -nan     0.1000    0.0096
##   20      2.7108      -nan     0.1000    0.0013
##   40      2.7033      -nan     0.1000    0.0001
##   60      2.7009      -nan     0.1000    0.0000
##   80      2.6993      -nan     0.1000   -0.0000
##  100      2.6982      -nan     0.1000   -0.0000
##  120      2.6975      -nan     0.1000   -0.0000
##  140      2.6970      -nan     0.1000   -0.0000
##  150      2.6968      -nan     0.1000   -0.0000
##
## Iter  TrainDeviance  ValidDeviance StepSize Improve
##    1      2.9801      -nan     0.1000    0.0614
##    2      2.9308      -nan     0.1000    0.0502
##    3      2.8900      -nan     0.1000    0.0407
##    4      2.8577      -nan     0.1000    0.0330
##    5      2.8317      -nan     0.1000    0.0269
##    6      2.8101      -nan     0.1000    0.0219
##    7      2.7923      -nan     0.1000    0.0177
##    8      2.7780      -nan     0.1000    0.0144
##    9      2.7665      -nan     0.1000    0.0117
##   10      2.7568      -nan     0.1000    0.0094
##   20      2.7217      -nan     0.1000    0.0012
##   40      2.7120      -nan     0.1000    0.0002
##   60      2.7095      -nan     0.1000    0.0000
##   80      2.7086      -nan     0.1000   -0.0000
##  100      2.7078      -nan     0.1000   -0.0000
##  120      2.7073      -nan     0.1000   -0.0000
##  140      2.7069      -nan     0.1000    0.0000
##  150      2.7067      -nan     0.1000    0.0000
##
## Iter  TrainDeviance  ValidDeviance StepSize Improve
##    1      2.9793      -nan     0.1000    0.0622
##    2      2.9280      -nan     0.1000    0.0502
##    3      2.8869      -nan     0.1000    0.0408
##    4      2.8529      -nan     0.1000    0.0330
##    5      2.8261      -nan     0.1000    0.0268
##    6      2.8040      -nan     0.1000    0.0215

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##      7    2.7865      -nan    0.1000   0.0175
##      8    2.7724      -nan    0.1000   0.0142
##      9    2.7606      -nan    0.1000   0.0115
##     10    2.7511      -nan    0.1000   0.0093
##    20    2.7154      -nan    0.1000   0.0012
##    40    2.7081      -nan    0.1000   0.0001
##   60    2.7062      -nan    0.1000  -0.0000
##   80    2.7049      -nan    0.1000   0.0000
##  100    2.7039      -nan    0.1000  -0.0000
##  120    2.7034      -nan    0.1000  -0.0000
##  140    2.7026      -nan    0.1000  -0.0000
##  150    2.7025      -nan    0.1000  -0.0000
##
## Iter  TrainDeviance  ValidDeviance StepSize Improve
##    1    2.9785      -nan    0.1000   0.0629
##    2    2.9275      -nan    0.1000   0.0508
##    3    2.8861      -nan    0.1000   0.0411
##    4    2.8531      -nan    0.1000   0.0335
##    5    2.8252      -nan    0.1000   0.0270
##    6    2.8030      -nan    0.1000   0.0217
##    7    2.7857      -nan    0.1000   0.0175
##    8    2.7712      -nan    0.1000   0.0143
##    9    2.7597      -nan    0.1000   0.0116
##   10    2.7503      -nan    0.1000   0.0094
##   20    2.7135      -nan    0.1000   0.0013
##   40    2.7059      -nan    0.1000   0.0002
##   60    2.7037      -nan    0.1000   0.0001
##   80    2.7024      -nan    0.1000  -0.0000
##  100    2.7015      -nan    0.1000  -0.0000
##  120    2.7007      -nan    0.1000  -0.0000
##  140    2.7002      -nan    0.1000  -0.0001
##  150    2.7000      -nan    0.1000  -0.0001
##
## Iter  TrainDeviance  ValidDeviance StepSize Improve
##    1    2.9799      -nan    0.1000   0.0615
##    2    2.9300      -nan    0.1000   0.0497
##    3    2.8897      -nan    0.1000   0.0402
##    4    2.8571      -nan    0.1000   0.0326
##    5    2.8311      -nan    0.1000   0.0264
##    6    2.8098      -nan    0.1000   0.0217
##    7    2.7926      -nan    0.1000   0.0174
##    8    2.7786      -nan    0.1000   0.0142
##    9    2.7673      -nan    0.1000   0.0116
##   10    2.7580      -nan    0.1000   0.0094
##   20    2.7227      -nan    0.1000   0.0011
##   40    2.7133      -nan    0.1000   0.0002
##   60    2.7109      -nan    0.1000   0.0000
##   80    2.7100      -nan    0.1000   0.0000
##  100    2.7093      -nan    0.1000   0.0000
##  120    2.7088      -nan    0.1000   0.0000
##  140    2.7084      -nan    0.1000  -0.0000
##  150    2.7082      -nan    0.1000  -0.0000
##
## Iter  TrainDeviance  ValidDeviance StepSize Improve

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##      1    2.9790      -nan    0.1000   0.0620
##      2    2.9289      -nan    0.1000   0.0504
##      3    2.8881      -nan    0.1000   0.0409
##      4    2.8546      -nan    0.1000   0.0329
##      5    2.8282      -nan    0.1000   0.0269
##      6    2.8067      -nan    0.1000   0.0218
##      7    2.7886      -nan    0.1000   0.0176
##      8    2.7736      -nan    0.1000   0.0143
##      9    2.7618      -nan    0.1000   0.0115
##     10    2.7522      -nan    0.1000   0.0093
##    20    2.7170      -nan    0.1000   0.0012
##    40    2.7097      -nan    0.1000   0.0001
##    60    2.7076      -nan    0.1000  -0.0001
##    80    2.7062      -nan    0.1000   0.0001
##   100    2.7051      -nan    0.1000   0.0001
##   120    2.7045      -nan    0.1000  -0.0000
##   140    2.7040      -nan    0.1000  -0.0000
##   150    2.7037      -nan    0.1000  -0.0001
##
## Iter TrainDeviance ValidDeviance StepSize Improve
##   1    2.9790      -nan    0.1000   0.0625
##   2    2.9268      -nan    0.1000   0.0504
##   3    2.8858      -nan    0.1000   0.0408
##   4    2.8530      -nan    0.1000   0.0330
##   5    2.8263      -nan    0.1000   0.0268
##   6    2.8042      -nan    0.1000   0.0216
##   7    2.7867      -nan    0.1000   0.0174
##   8    2.7726      -nan    0.1000   0.0142
##   9    2.7608      -nan    0.1000   0.0115
##  10    2.7514      -nan    0.1000   0.0093
##  20    2.7150      -nan    0.1000   0.0012
##  40    2.7074      -nan    0.1000   0.0001
##  60    2.7050      -nan    0.1000   0.0001
##  80    2.7039      -nan    0.1000  -0.0000
## 100    2.7029      -nan    0.1000  -0.0000
## 120    2.7022      -nan    0.1000   0.0000
## 140    2.7015      -nan    0.1000  -0.0000
## 150    2.7013      -nan    0.1000  -0.0000
##
## Iter TrainDeviance ValidDeviance StepSize Improve
##   1    2.9787      -nan    0.1000   0.0610
##   2    2.9290      -nan    0.1000   0.0493
##   3    2.8890      -nan    0.1000   0.0400
##   4    2.8565      -nan    0.1000   0.0323
##   5    2.8306      -nan    0.1000   0.0262
##   6    2.8092      -nan    0.1000   0.0213
##   7    2.7913      -nan    0.1000   0.0172
##   8    2.7776      -nan    0.1000   0.0139
##   9    2.7663      -nan    0.1000   0.0113
##  10    2.7570      -nan    0.1000   0.0092
##  20    2.7229      -nan    0.1000   0.0011
##  40    2.7132      -nan    0.1000   0.0002
##  60    2.7107      -nan    0.1000   0.0000
##  80    2.7098      -nan    0.1000   0.0000

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##   100    2.7091      -nan    0.1000    0.0000
##   120    2.7086      -nan    0.1000   -0.0000
##   140    2.7081      -nan    0.1000   -0.0000
##   150    2.7079      -nan    0.1000   -0.0000
##
## Iter TrainDeviance  ValidDeviance StepSize Improve
##   1     2.9785       -nan    0.1000    0.0620
##   2     2.9278       -nan    0.1000    0.0504
##   3     2.8869       -nan    0.1000    0.0405
##   4     2.8535       -nan    0.1000    0.0329
##   5     2.8275       -nan    0.1000    0.0266
##   6     2.8058       -nan    0.1000    0.0217
##   7     2.7879       -nan    0.1000    0.0177
##   8     2.7735       -nan    0.1000    0.0141
##   9     2.7623       -nan    0.1000    0.0115
##  10    2.7527       -nan    0.1000    0.0095
##  20    2.7167       -nan    0.1000    0.0012
##  40    2.7090       -nan    0.1000    0.0002
##  60    2.7067       -nan    0.1000    0.0001
##  80    2.7054       -nan    0.1000   -0.0000
## 100    2.7044       -nan    0.1000    0.0000
## 120    2.7036       -nan    0.1000    0.0000
## 140    2.7029       -nan    0.1000   -0.0000
## 150    2.7026       -nan    0.1000    0.0000
##
## Iter TrainDeviance  ValidDeviance StepSize Improve
##   1     2.9782       -nan    0.1000    0.0622
##   2     2.9282       -nan    0.1000    0.0508
##   3     2.8874       -nan    0.1000    0.0412
##   4     2.8537       -nan    0.1000    0.0331
##   5     2.8272       -nan    0.1000    0.0269
##   6     2.8047       -nan    0.1000    0.0219
##   7     2.7869       -nan    0.1000    0.0176
##   8     2.7723       -nan    0.1000    0.0143
##   9     2.7607       -nan    0.1000    0.0116
##  10    2.7512       -nan    0.1000    0.0094
##  20    2.7145       -nan    0.1000    0.0011
##  40    2.7071       -nan    0.1000    0.0001
##  60    2.7044       -nan    0.1000    0.0000
##  80    2.7031       -nan    0.1000    0.0000
## 100    2.7021       -nan    0.1000   -0.0001
## 120    2.7013       -nan    0.1000   -0.0001
## 140    2.7007       -nan    0.1000   -0.0001
## 150    2.7004       -nan    0.1000   -0.0000
##
## Iter TrainDeviance  ValidDeviance StepSize Improve
##   1     2.9798       -nan    0.1000    0.0612
##   2     2.9290       -nan    0.1000    0.0498
##   3     2.8885       -nan    0.1000    0.0402
##   4     2.8565       -nan    0.1000    0.0323
##   5     2.8304       -nan    0.1000    0.0264
##   6     2.8094       -nan    0.1000    0.0215
##   7     2.7920       -nan    0.1000    0.0173
##   8     2.7776       -nan    0.1000    0.0140

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```

##      9    2.7661      -nan    0.1000   0.0113
##     10    2.7567      -nan    0.1000   0.0091
##     20    2.7224      -nan    0.1000   0.0011
##     40    2.7130      -nan    0.1000   0.0002
##     60    2.7105      -nan    0.1000   0.0001
##     80    2.7096      -nan    0.1000   0.0000
##    100    2.7088      -nan    0.1000  -0.0000
##    120    2.7084      -nan    0.1000  -0.0000
##    140    2.7079      -nan    0.1000  -0.0000
##    150    2.7077      -nan    0.1000  -0.0000
##
## Iter  TrainDeviance  ValidDeviance StepSize Improve
##    1    2.9797      -nan    0.1000   0.0623
##    2    2.9294      -nan    0.1000   0.0503
##    3    2.8881      -nan    0.1000   0.0411
##    4    2.8549      -nan    0.1000   0.0332
##    5    2.8285      -nan    0.1000   0.0270
##    6    2.8064      -nan    0.1000   0.0218
##    7    2.7889      -nan    0.1000   0.0177
##    8    2.7742      -nan    0.1000   0.0144
##    9    2.7626      -nan    0.1000   0.0116
##   10    2.7530      -nan    0.1000   0.0095
##   20    2.7166      -nan    0.1000   0.0012
##   40    2.7093      -nan    0.1000   0.0000
##   60    2.7071      -nan    0.1000  -0.0000
##   80    2.7058      -nan    0.1000   0.0000
##  100    2.7049      -nan    0.1000  -0.0000
##  120    2.7043      -nan    0.1000   0.0000
##  140    2.7039      -nan    0.1000  -0.0000
##  150    2.7036      -nan    0.1000  -0.0000
##
## Iter  TrainDeviance  ValidDeviance StepSize Improve
##    1    2.9788      -nan    0.1000   0.0629
##    2    2.9283      -nan    0.1000   0.0509
##    3    2.8875      -nan    0.1000   0.0406
##    4    2.8540      -nan    0.1000   0.0334
##    5    2.8269      -nan    0.1000   0.0269
##    6    2.8051      -nan    0.1000   0.0218
##    7    2.7874      -nan    0.1000   0.0177
##    8    2.7732      -nan    0.1000   0.0144
##    9    2.7617      -nan    0.1000   0.0117
##   10    2.7524      -nan    0.1000   0.0097
##   20    2.7145      -nan    0.1000   0.0012
##   40    2.7076      -nan    0.1000   0.0001
##   60    2.7050      -nan    0.1000  -0.0000
##   80    2.7036      -nan    0.1000   0.0000
##  100    2.7026      -nan    0.1000  -0.0000
##  120    2.7020      -nan    0.1000  -0.0001
##  140    2.7015      -nan    0.1000  -0.0000
##  150    2.7013      -nan    0.1000  -0.0001
##
## Iter  TrainDeviance  ValidDeviance StepSize Improve
##    1    2.9790      -nan    0.1000   0.0628
##    2    2.9290      -nan    0.1000   0.0507

```

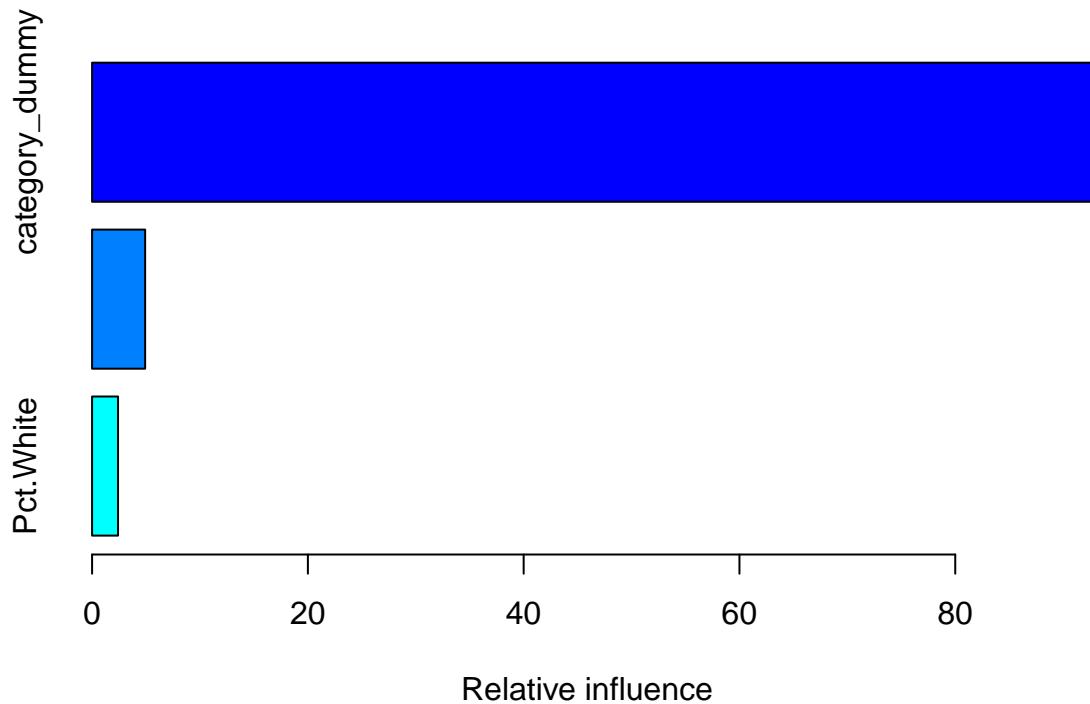


Figure 2: Summary of Boosted Random Forest Model without including priority as a predictor.

```

##      3      2.8877      -nan      0.1000      0.0410
##      4      2.8546      -nan      0.1000      0.0333
##      5      2.8275      -nan      0.1000      0.0272
##      6      2.8059      -nan      0.1000      0.0219
##      7      2.7880      -nan      0.1000      0.0178
##      8      2.7736      -nan      0.1000      0.0146
##      9      2.7612      -nan      0.1000      0.0118
##     10      2.7514      -nan      0.1000      0.0095
##     20      2.7152      -nan      0.1000      0.0013
##     40      2.7073      -nan      0.1000      0.0000
##     60      2.7049      -nan      0.1000      0.0000
##     80      2.7037      -nan      0.1000      -0.0000
##    100      2.7027      -nan      0.1000      0.0000
##    120      2.7019      -nan      0.1000      -0.0000
##    140      2.7015      -nan      0.1000      -0.0000
##    150      2.7012      -nan      0.1000      -0.0001

##          var rel.inf
## category_dummy category_dummy    92.68
## log_income      log_income      4.92
## Pct.White       Pct.White       2.40

## Iter   TrainDeviance  ValidDeviance StepSize Improve
##    1      3.0390        -nan      0.1000  0.0005
##    2      3.0386        -nan      0.1000  0.0003
##    3      3.0382        -nan      0.1000  0.0004
##    4      3.0379        -nan      0.1000  0.0003
##    5      3.0376        -nan      0.1000  0.0003
##    6      3.0374        -nan      0.1000  0.0003

```

```

##      7    3.0372      -nan    0.1000   0.0002
##      8    3.0369      -nan    0.1000   0.0002
##      9    3.0367      -nan    0.1000   0.0002
##     10    3.0366      -nan    0.1000   0.0001
##    20    3.0355      -nan    0.1000   0.0000
##    40    3.0340      -nan    0.1000  -0.0000
##   60    3.0332      -nan    0.1000  -0.0000
##   80    3.0325      -nan    0.1000   0.0000
## 100    3.0319      -nan    0.1000   0.0000
## 120    3.0315      -nan    0.1000  -0.0000
## 140    3.0310      -nan    0.1000   0.0000
## 150    3.0309      -nan    0.1000  -0.0000
##
## Iter TrainDeviance ValidDeviance StepSize Improve
##   1    3.0385      -nan    0.1000   0.0009
##   2    3.0378      -nan    0.1000   0.0007
##   3    3.0371      -nan    0.1000   0.0007
##   4    3.0365      -nan    0.1000   0.0005
##   5    3.0359      -nan    0.1000   0.0005
##   6    3.0355      -nan    0.1000   0.0002
##   7    3.0352      -nan    0.1000   0.0002
##   8    3.0349      -nan    0.1000   0.0002
##   9    3.0345      -nan    0.1000   0.0004
##  10    3.0343      -nan    0.1000   0.0001
##  20    3.0325      -nan    0.1000   0.0001
##  40    3.0301      -nan    0.1000   0.0000
##  60    3.0281      -nan    0.1000  -0.0000
##  80    3.0272      -nan    0.1000  -0.0000
## 100    3.0262      -nan    0.1000  -0.0001
## 120    3.0254      -nan    0.1000   0.0000
## 140    3.0247      -nan    0.1000  -0.0000
## 150    3.0245      -nan    0.1000   0.0000
##
## Iter TrainDeviance ValidDeviance StepSize Improve
##   1    3.0383      -nan    0.1000   0.0013
##   2    3.0373      -nan    0.1000   0.0010
##   3    3.0364      -nan    0.1000   0.0008
##   4    3.0356      -nan    0.1000   0.0006
##   5    3.0350      -nan    0.1000   0.0006
##   6    3.0345      -nan    0.1000   0.0004
##   7    3.0340      -nan    0.1000   0.0004
##   8    3.0336      -nan    0.1000   0.0003
##   9    3.0332      -nan    0.1000   0.0003
##  10    3.0328      -nan    0.1000   0.0003
##  20    3.0308      -nan    0.1000   0.0000
##  40    3.0281      -nan    0.1000   0.0000
##  60    3.0264      -nan    0.1000  -0.0000
##  80    3.0252      -nan    0.1000  -0.0001
## 100    3.0241      -nan    0.1000  -0.0001
## 120    3.0234      -nan    0.1000  -0.0000
## 140    3.0229      -nan    0.1000  -0.0000
## 150    3.0228      -nan    0.1000  -0.0001
##
## Iter TrainDeviance ValidDeviance StepSize Improve

```

```

##      1    3.0416      -nan    0.1000   0.0006
##      2    3.0411      -nan    0.1000   0.0004
##      3    3.0407      -nan    0.1000   0.0004
##      4    3.0405      -nan    0.1000   0.0003
##      5    3.0401      -nan    0.1000   0.0003
##      6    3.0398      -nan    0.1000   0.0003
##      7    3.0396      -nan    0.1000   0.0002
##      8    3.0394      -nan    0.1000   0.0002
##      9    3.0392      -nan    0.1000   0.0001
##     10    3.0390      -nan    0.1000   0.0001
##    20    3.0379      -nan    0.1000  -0.0000
##    40    3.0366      -nan    0.1000  -0.0000
##    60    3.0356      -nan    0.1000   0.0000
##   80    3.0350      -nan    0.1000   0.0000
## 100    3.0344      -nan    0.1000   0.0000
## 120    3.0339      -nan    0.1000  -0.0001
## 140    3.0336      -nan    0.1000  -0.0000
## 150    3.0334      -nan    0.1000  -0.0000
##
## Iter  TrainDeviance  ValidDeviance StepSize Improve
##    1    3.0412      -nan    0.1000   0.0009
##    2    3.0403      -nan    0.1000   0.0007
##    3    3.0397      -nan    0.1000   0.0006
##    4    3.0392      -nan    0.1000   0.0005
##    5    3.0388      -nan    0.1000   0.0004
##    6    3.0384      -nan    0.1000   0.0004
##    7    3.0380      -nan    0.1000   0.0004
##    8    3.0376      -nan    0.1000   0.0003
##    9    3.0374      -nan    0.1000   0.0002
##   10    3.0371      -nan    0.1000   0.0001
##   20    3.0352      -nan    0.1000   0.0001
##   40    3.0328      -nan    0.1000   0.0001
##   60    3.0314      -nan    0.1000  -0.0000
##   80    3.0298      -nan    0.1000  -0.0001
## 100    3.0288      -nan    0.1000  -0.0000
## 120    3.0280      -nan    0.1000   0.0000
## 140    3.0276      -nan    0.1000  -0.0001
## 150    3.0274      -nan    0.1000  -0.0000
##
## Iter  TrainDeviance  ValidDeviance StepSize Improve
##    1    3.0407      -nan    0.1000   0.0012
##    2    3.0397      -nan    0.1000   0.0010
##    3    3.0389      -nan    0.1000   0.0007
##    4    3.0382      -nan    0.1000   0.0006
##    5    3.0377      -nan    0.1000   0.0005
##    6    3.0373      -nan    0.1000   0.0004
##    7    3.0369      -nan    0.1000   0.0005
##    8    3.0366      -nan    0.1000   0.0002
##    9    3.0363      -nan    0.1000   0.0003
##   10    3.0357      -nan    0.1000   0.0003
##   20    3.0333      -nan    0.1000   0.0001
##   40    3.0306      -nan    0.1000   0.0000
##   60    3.0286      -nan    0.1000  -0.0000
##   80    3.0274      -nan    0.1000  -0.0000

```

```

##   100    3.0267      -nan    0.1000   -0.0000
##   120    3.0260      -nan    0.1000    0.0000
##   140    3.0255      -nan    0.1000   -0.0000
##   150    3.0253      -nan    0.1000   -0.0000
##
## Iter TrainDeviance  ValidDeviance StepSize Improve
##   1     3.0410      -nan    0.1000   0.0004
##   2     3.0404      -nan    0.1000   0.0006
##   3     3.0399      -nan    0.1000   0.0005
##   4     3.0395      -nan    0.1000   0.0004
##   5     3.0392      -nan    0.1000   0.0003
##   6     3.0389      -nan    0.1000   0.0002
##   7     3.0386      -nan    0.1000   0.0003
##   8     3.0383      -nan    0.1000   0.0002
##   9     3.0381      -nan    0.1000   0.0002
##  10    3.0380      -nan    0.1000   0.0001
##  20    3.0367      -nan    0.1000   0.0000
##  40    3.0353      -nan    0.1000   0.0000
##  60    3.0345      -nan    0.1000  -0.0001
##  80    3.0338      -nan    0.1000  -0.0000
## 100    3.0331      -nan    0.1000   0.0000
## 120    3.0327      -nan    0.1000  -0.0000
## 140    3.0323      -nan    0.1000  -0.0000
## 150    3.0322      -nan    0.1000  -0.0000
##
## Iter TrainDeviance  ValidDeviance StepSize Improve
##   1     3.0405      -nan    0.1000   0.0010
##   2     3.0397      -nan    0.1000   0.0008
##   3     3.0390      -nan    0.1000   0.0007
##   4     3.0384      -nan    0.1000   0.0006
##   5     3.0379      -nan    0.1000   0.0005
##   6     3.0374      -nan    0.1000   0.0004
##   7     3.0371      -nan    0.1000   0.0003
##   8     3.0366      -nan    0.1000   0.0004
##   9     3.0363      -nan    0.1000   0.0002
##  10    3.0360      -nan    0.1000   0.0003
##  20    3.0339      -nan    0.1000   0.0001
##  40    3.0314      -nan    0.1000   0.0001
##  60    3.0298      -nan    0.1000   0.0001
##  80    3.0284      -nan    0.1000   0.0000
## 100    3.0274      -nan    0.1000  -0.0000
## 120    3.0266      -nan    0.1000   0.0000
## 140    3.0260      -nan    0.1000  -0.0000
## 150    3.0257      -nan    0.1000  -0.0000
##
## Iter TrainDeviance  ValidDeviance StepSize Improve
##   1     3.0401      -nan    0.1000   0.0013
##   2     3.0390      -nan    0.1000   0.0011
##   3     3.0382      -nan    0.1000   0.0009
##   4     3.0375      -nan    0.1000   0.0006
##   5     3.0370      -nan    0.1000   0.0006
##   6     3.0365      -nan    0.1000   0.0005
##   7     3.0360      -nan    0.1000   0.0004
##   8     3.0357      -nan    0.1000   0.0003

```

```

##      9    3.0352      -nan    0.1000   0.0003
##     10    3.0348      -nan    0.1000   0.0003
##     20    3.0321      -nan    0.1000   0.0002
##     40    3.0290      -nan    0.1000   0.0001
##     60    3.0271      -nan    0.1000  -0.0000
##     80    3.0258      -nan    0.1000   0.0000
##    100    3.0251      -nan    0.1000  -0.0000
##    120    3.0246      -nan    0.1000  -0.0001
##    140    3.0240      -nan    0.1000  -0.0001
##    150    3.0238      -nan    0.1000  -0.0001
##
## Iter TrainDeviance ValidDeviance StepSize Improve
##   1    3.0431      -nan    0.1000   0.0005
##   2    3.0426      -nan    0.1000   0.0004
##   3    3.0422      -nan    0.1000   0.0003
##   4    3.0419      -nan    0.1000   0.0003
##   5    3.0415      -nan    0.1000   0.0003
##   6    3.0412      -nan    0.1000   0.0002
##   7    3.0410      -nan    0.1000   0.0003
##   8    3.0407      -nan    0.1000   0.0002
##   9    3.0406      -nan    0.1000   0.0001
##  10    3.0404      -nan    0.1000   0.0001
##  20    3.0393      -nan    0.1000   0.0001
##  40    3.0379      -nan    0.1000   0.0000
##  60    3.0370      -nan    0.1000   0.0000
##  80    3.0363      -nan    0.1000  -0.0000
## 100    3.0358      -nan    0.1000  -0.0000
## 120    3.0353      -nan    0.1000  -0.0000
## 140    3.0348      -nan    0.1000  -0.0000
## 150    3.0347      -nan    0.1000  -0.0000
##
## Iter TrainDeviance ValidDeviance StepSize Improve
##   1    3.0426      -nan    0.1000   0.0010
##   2    3.0419      -nan    0.1000   0.0005
##   3    3.0413      -nan    0.1000   0.0006
##   4    3.0406      -nan    0.1000   0.0006
##   5    3.0400      -nan    0.1000   0.0005
##   6    3.0397      -nan    0.1000   0.0004
##   7    3.0392      -nan    0.1000   0.0004
##   8    3.0389      -nan    0.1000   0.0002
##   9    3.0385      -nan    0.1000   0.0002
##  10    3.0382      -nan    0.1000   0.0003
##  20    3.0361      -nan    0.1000   0.0001
##  40    3.0338      -nan    0.1000   0.0000
##  60    3.0324      -nan    0.1000  -0.0000
##  80    3.0313      -nan    0.1000  -0.0000
## 100    3.0303      -nan    0.1000  -0.0000
## 120    3.0293      -nan    0.1000  -0.0000
## 140    3.0288      -nan    0.1000  -0.0001
## 150    3.0286      -nan    0.1000  -0.0000
##
## Iter TrainDeviance ValidDeviance StepSize Improve
##   1    3.0421      -nan    0.1000   0.0013
##   2    3.0411      -nan    0.1000   0.0010

```

```

##      3    3.0403      -nan    0.1000   0.0008
##      4    3.0396      -nan    0.1000   0.0007
##      5    3.0390      -nan    0.1000   0.0005
##      6    3.0385      -nan    0.1000   0.0004
##      7    3.0381      -nan    0.1000   0.0003
##      8    3.0376      -nan    0.1000   0.0005
##      9    3.0373      -nan    0.1000   0.0002
##     10    3.0370      -nan    0.1000   0.0001
##    20    3.0343      -nan    0.1000   0.0000
##    40    3.0313      -nan    0.1000  -0.0001
##   60    3.0295      -nan    0.1000   0.0000
##   80    3.0283      -nan    0.1000   0.0000
##  100    3.0276      -nan    0.1000  -0.0000
##  120    3.0271      -nan    0.1000  -0.0000
##  140    3.0267      -nan    0.1000  -0.0001
##  150    3.0266      -nan    0.1000  -0.0001
##
## Iter TrainDeviance  ValidDeviance StepSize Improve
##   1    3.0403      -nan    0.1000   0.0006
##   2    3.0398      -nan    0.1000   0.0005
##   3    3.0395      -nan    0.1000   0.0001
##   4    3.0392      -nan    0.1000   0.0003
##   5    3.0389      -nan    0.1000   0.0004
##   6    3.0386      -nan    0.1000   0.0003
##   7    3.0383      -nan    0.1000   0.0003
##   8    3.0381      -nan    0.1000   0.0002
##   9    3.0378      -nan    0.1000   0.0002
##  10    3.0377      -nan    0.1000   0.0002
##  20    3.0364      -nan    0.1000   0.0000
##  40    3.0350      -nan    0.1000   0.0000
##  60    3.0340      -nan    0.1000   0.0000
##  80    3.0333      -nan    0.1000  -0.0000
## 100    3.0327      -nan    0.1000  -0.0000
## 120    3.0323      -nan    0.1000  -0.0000
## 140    3.0320      -nan    0.1000  -0.0001
## 150    3.0317      -nan    0.1000  -0.0000
##
## Iter TrainDeviance  ValidDeviance StepSize Improve
##   1    3.0399      -nan    0.1000   0.0009
##   2    3.0390      -nan    0.1000   0.0009
##   3    3.0384      -nan    0.1000   0.0006
##   4    3.0377      -nan    0.1000   0.0006
##   5    3.0371      -nan    0.1000   0.0005
##   6    3.0366      -nan    0.1000   0.0003
##   7    3.0362      -nan    0.1000   0.0003
##   8    3.0360      -nan    0.1000   0.0002
##   9    3.0357      -nan    0.1000   0.0002
##  10    3.0354      -nan    0.1000   0.0002
##  20    3.0334      -nan    0.1000   0.0002
##  40    3.0308      -nan    0.1000   0.0000
##  60    3.0290      -nan    0.1000   0.0000
##  80    3.0278      -nan    0.1000   0.0001
## 100    3.0268      -nan    0.1000  -0.0000
## 120    3.0262      -nan    0.1000  -0.0000

```

```

##    140      3.0256      -nan     0.1000    0.0001
##    150      3.0253      -nan     0.1000   -0.0000
##
## Iter  TrainDeviance  ValidDeviance StepSize Improve
##    1      3.0395      -nan     0.1000    0.0013
##    2      3.0385      -nan     0.1000    0.0011
##    3      3.0376      -nan     0.1000    0.0008
##    4      3.0369      -nan     0.1000    0.0007
##    5      3.0362      -nan     0.1000    0.0006
##    6      3.0358      -nan     0.1000    0.0003
##    7      3.0355      -nan     0.1000    0.0002
##    8      3.0352      -nan     0.1000    0.0001
##    9      3.0348      -nan     0.1000    0.0004
##   10      3.0345      -nan     0.1000    0.0003
##   20      3.0319      -nan     0.1000    0.0001
##   40      3.0290      -nan     0.1000    0.0000
##   60      3.0271      -nan     0.1000    0.0000
##   80      3.0260      -nan     0.1000    0.0000
##  100      3.0250      -nan     0.1000   -0.0001
##  120      3.0243      -nan     0.1000   -0.0000
##  140      3.0239      -nan     0.1000   -0.0001
##  150      3.0237      -nan     0.1000   -0.0000
##
## Iter  TrainDeviance  ValidDeviance StepSize Improve
##    1      3.0400      -nan     0.1000    0.0006
##    2      3.0394      -nan     0.1000    0.0004
##    3      3.0390      -nan     0.1000    0.0003
##    4      3.0387      -nan     0.1000    0.0003
##    5      3.0385      -nan     0.1000    0.0003
##    6      3.0382      -nan     0.1000    0.0002
##    7      3.0380      -nan     0.1000    0.0002
##    8      3.0378      -nan     0.1000    0.0001
##    9      3.0376      -nan     0.1000    0.0002
##   10      3.0374      -nan     0.1000    0.0001
##   20      3.0363      -nan     0.1000    0.0001
##   40      3.0349      -nan     0.1000    0.0000
##   60      3.0340      -nan     0.1000   -0.0000
##   80      3.0333      -nan     0.1000   -0.0000
##  100      3.0328      -nan     0.1000    0.0000
##  120      3.0323      -nan     0.1000   -0.0000
##  140      3.0318      -nan     0.1000   -0.0000
##  150      3.0316      -nan     0.1000   -0.0000
##
## Iter  TrainDeviance  ValidDeviance StepSize Improve
##    1      3.0396      -nan     0.1000    0.0010
##    2      3.0388      -nan     0.1000    0.0008
##    3      3.0383      -nan     0.1000    0.0005
##    4      3.0377      -nan     0.1000    0.0006
##    5      3.0372      -nan     0.1000    0.0005
##    6      3.0367      -nan     0.1000    0.0004
##    7      3.0363      -nan     0.1000    0.0004
##    8      3.0360      -nan     0.1000    0.0002
##    9      3.0358      -nan     0.1000    0.0002
##   10      3.0355      -nan     0.1000    0.0002

```

```

##      20      3.0332      -nan     0.1000    0.0002
##      40      3.0308      -nan     0.1000    0.0001
##      60      3.0293      -nan     0.1000    0.0000
##      80      3.0278      -nan     0.1000    0.0000
##     100      3.0269      -nan     0.1000   -0.0001
##     120      3.0260      -nan     0.1000    0.0000
##     140      3.0254      -nan     0.1000    0.0000
##     150      3.0252      -nan     0.1000   -0.0001
##
## Iter TrainDeviance ValidDeviance StepSize Improve
##   1      3.0391      -nan     0.1000    0.0013
##   2      3.0382      -nan     0.1000    0.0010
##   3      3.0374      -nan     0.1000    0.0008
##   4      3.0367      -nan     0.1000    0.0006
##   5      3.0362      -nan     0.1000    0.0004
##   6      3.0357      -nan     0.1000    0.0005
##   7      3.0353      -nan     0.1000    0.0005
##   8      3.0348      -nan     0.1000    0.0003
##   9      3.0344      -nan     0.1000    0.0003
##  10      3.0341      -nan     0.1000    0.0002
##  20      3.0317      -nan     0.1000    0.0002
##  40      3.0285      -nan     0.1000    0.0001
##  60      3.0267      -nan     0.1000   -0.0000
##  80      3.0255      -nan     0.1000   -0.0001
## 100      3.0247      -nan     0.1000   -0.0001
## 120      3.0240      -nan     0.1000    0.0000
## 140      3.0235      -nan     0.1000   -0.0001
## 150      3.0234      -nan     0.1000   -0.0001
##
## Iter TrainDeviance ValidDeviance StepSize Improve
##   1      3.0426      -nan     0.1000    0.0003
##   2      3.0420      -nan     0.1000    0.0006
##   3      3.0416      -nan     0.1000    0.0005
##   4      3.0412      -nan     0.1000    0.0004
##   5      3.0409      -nan     0.1000    0.0002
##   6      3.0406      -nan     0.1000    0.0003
##   7      3.0404      -nan     0.1000    0.0002
##   8      3.0402      -nan     0.1000    0.0002
##   9      3.0399      -nan     0.1000    0.0002
##  10      3.0398      -nan     0.1000    0.0001
##  20      3.0387      -nan     0.1000    0.0000
##  40      3.0374      -nan     0.1000    0.0000
##  60      3.0366      -nan     0.1000   -0.0000
##  80      3.0359      -nan     0.1000    0.0000
## 100      3.0353      -nan     0.1000    0.0000
## 120      3.0349      -nan     0.1000   -0.0000
## 140      3.0344      -nan     0.1000    0.0000
## 150      3.0343      -nan     0.1000    0.0000
##
## Iter TrainDeviance ValidDeviance StepSize Improve
##   1      3.0420      -nan     0.1000    0.0010
##   2      3.0412      -nan     0.1000    0.0008
##   3      3.0404      -nan     0.1000    0.0006
##   4      3.0399      -nan     0.1000    0.0006

```

```

##      5    3.0394      -nan    0.1000   0.0005
##      6    3.0389      -nan    0.1000   0.0004
##      7    3.0385      -nan    0.1000   0.0003
##      8    3.0383      -nan    0.1000   0.0002
##      9    3.0379      -nan    0.1000   0.0003
##     10    3.0377      -nan    0.1000   0.0002
##    20    3.0359      -nan    0.1000  -0.0000
##    40    3.0334      -nan    0.1000   0.0001
##   60    3.0319      -nan    0.1000  -0.0000
##   80    3.0308      -nan    0.1000  -0.0000
## 100    3.0298      -nan    0.1000   0.0000
## 120    3.0290      -nan    0.1000  -0.0000
## 140    3.0283      -nan    0.1000  -0.0000
## 150    3.0279      -nan    0.1000  -0.0000
##
## Iter  TrainDeviance  ValidDeviance StepSize Improve
##    1    3.0418      -nan    0.1000   0.0013
##    2    3.0409      -nan    0.1000   0.0008
##    3    3.0401      -nan    0.1000   0.0008
##    4    3.0394      -nan    0.1000   0.0006
##    5    3.0387      -nan    0.1000   0.0007
##    6    3.0382      -nan    0.1000   0.0006
##    7    3.0376      -nan    0.1000   0.0004
##    8    3.0374      -nan    0.1000   0.0002
##    9    3.0370      -nan    0.1000   0.0003
##   10    3.0367      -nan    0.1000   0.0003
##   20    3.0346      -nan    0.1000   0.0001
##   40    3.0316      -nan    0.1000   0.0001
##   60    3.0299      -nan    0.1000   0.0000
##   80    3.0285      -nan    0.1000  -0.0000
## 100    3.0275      -nan    0.1000  -0.0000
## 120    3.0270      -nan    0.1000  -0.0000
## 140    3.0266      -nan    0.1000   0.0000
## 150    3.0264      -nan    0.1000  -0.0000
##
## Iter  TrainDeviance  ValidDeviance StepSize Improve
##    1    3.0398      -nan    0.1000   0.0005
##    2    3.0393      -nan    0.1000   0.0004
##    3    3.0389      -nan    0.1000   0.0003
##    4    3.0386      -nan    0.1000   0.0003
##    5    3.0383      -nan    0.1000   0.0003
##    6    3.0381      -nan    0.1000   0.0002
##    7    3.0378      -nan    0.1000   0.0002
##    8    3.0376      -nan    0.1000   0.0002
##    9    3.0374      -nan    0.1000   0.0002
##   10    3.0372      -nan    0.1000   0.0001
##   20    3.0361      -nan    0.1000   0.0001
##   40    3.0348      -nan    0.1000   0.0000
##   60    3.0339      -nan    0.1000   0.0000
##   80    3.0332      -nan    0.1000   0.0000
## 100    3.0327      -nan    0.1000  -0.0000
## 120    3.0321      -nan    0.1000  -0.0000
## 140    3.0317      -nan    0.1000  -0.0000
## 150    3.0314      -nan    0.1000  -0.0000

```

```

##  

## Iter TrainDeviance ValidDeviance StepSize Improve  

## 1 3.0396 -nan 0.1000 0.0009  

## 2 3.0387 -nan 0.1000 0.0008  

## 3 3.0380 -nan 0.1000 0.0006  

## 4 3.0375 -nan 0.1000 0.0006  

## 5 3.0370 -nan 0.1000 0.0005  

## 6 3.0367 -nan 0.1000 0.0004  

## 7 3.0363 -nan 0.1000 0.0004  

## 8 3.0360 -nan 0.1000 0.0002  

## 9 3.0356 -nan 0.1000 0.0004  

## 10 3.0353 -nan 0.1000 0.0002  

## 20 3.0333 -nan 0.1000 0.0001  

## 40 3.0308 -nan 0.1000 -0.0000  

## 60 3.0287 -nan 0.1000 0.0000  

## 80 3.0278 -nan 0.1000 -0.0000  

## 100 3.0269 -nan 0.1000 -0.0001  

## 120 3.0261 -nan 0.1000 -0.0001  

## 140 3.0254 -nan 0.1000 -0.0000  

## 150 3.0251 -nan 0.1000 -0.0001  

##  

## Iter TrainDeviance ValidDeviance StepSize Improve  

## 1 3.0391 -nan 0.1000 0.0013  

## 2 3.0382 -nan 0.1000 0.0009  

## 3 3.0373 -nan 0.1000 0.0008  

## 4 3.0366 -nan 0.1000 0.0007  

## 5 3.0360 -nan 0.1000 0.0006  

## 6 3.0355 -nan 0.1000 0.0005  

## 7 3.0349 -nan 0.1000 0.0003  

## 8 3.0345 -nan 0.1000 0.0003  

## 9 3.0343 -nan 0.1000 0.0001  

## 10 3.0340 -nan 0.1000 0.0002  

## 20 3.0316 -nan 0.1000 0.0000  

## 40 3.0286 -nan 0.1000 0.0001  

## 60 3.0266 -nan 0.1000 0.0000  

## 80 3.0256 -nan 0.1000 0.0000  

## 100 3.0248 -nan 0.1000 -0.0000  

## 120 3.0241 -nan 0.1000 -0.0001  

## 140 3.0236 -nan 0.1000 -0.0000  

## 150 3.0234 -nan 0.1000 -0.0001  

##  

## Iter TrainDeviance ValidDeviance StepSize Improve  

## 1 3.0411 -nan 0.1000 0.0005  

## 2 3.0406 -nan 0.1000 0.0004  

## 3 3.0403 -nan 0.1000 0.0003  

## 4 3.0400 -nan 0.1000 0.0002  

## 5 3.0397 -nan 0.1000 0.0003  

## 6 3.0394 -nan 0.1000 0.0003  

## 7 3.0392 -nan 0.1000 0.0002  

## 8 3.0390 -nan 0.1000 0.0002  

## 9 3.0388 -nan 0.1000 0.0001  

## 10 3.0386 -nan 0.1000 0.0001  

## 20 3.0375 -nan 0.1000 0.0001  

## 40 3.0364 -nan 0.1000 -0.0000

```

```

##      60      3.0355      -nan     0.1000    -0.0000
##      80      3.0348      -nan     0.1000     0.0000
##     100      3.0343      -nan     0.1000     0.0000
##     120      3.0338      -nan     0.1000    -0.0000
##     140      3.0334      -nan     0.1000    -0.0000
##     150      3.0332      -nan     0.1000     0.0000
##
## Iter   TrainDeviance  ValidDeviance StepSize Improve
##      1      3.0406      -nan     0.1000    0.0009
##      2      3.0399      -nan     0.1000    0.0007
##      3      3.0394      -nan     0.1000    0.0005
##      4      3.0389      -nan     0.1000    0.0005
##      5      3.0384      -nan     0.1000    0.0004
##      6      3.0379      -nan     0.1000    0.0005
##      7      3.0375      -nan     0.1000    0.0003
##      8      3.0371      -nan     0.1000    0.0003
##      9      3.0369      -nan     0.1000    0.0002
##     10      3.0367      -nan     0.1000    0.0001
##     20      3.0348      -nan     0.1000     0.0000
##     40      3.0325      -nan     0.1000    -0.0000
##     60      3.0306      -nan     0.1000    0.0001
##     80      3.0293      -nan     0.1000    -0.0000
##    100      3.0283      -nan     0.1000    -0.0000
##    120      3.0279      -nan     0.1000    -0.0000
##    140      3.0272      -nan     0.1000    -0.0000
##    150      3.0270      -nan     0.1000    -0.0001
##
## Iter   TrainDeviance  ValidDeviance StepSize Improve
##      1      3.0404      -nan     0.1000    0.0012
##      2      3.0395      -nan     0.1000    0.0010
##      3      3.0390      -nan     0.1000    0.0003
##      4      3.0381      -nan     0.1000    0.0007
##      5      3.0375      -nan     0.1000    0.0006
##      6      3.0370      -nan     0.1000    0.0005
##      7      3.0367      -nan     0.1000    0.0003
##      8      3.0362      -nan     0.1000    0.0004
##      9      3.0358      -nan     0.1000    0.0003
##     10      3.0355      -nan     0.1000    0.0003
##     20      3.0332      -nan     0.1000     0.0000
##     40      3.0302      -nan     0.1000    -0.0000
##     60      3.0283      -nan     0.1000    0.0001
##     80      3.0270      -nan     0.1000    -0.0000
##    100      3.0262      -nan     0.1000    -0.0000
##    120      3.0256      -nan     0.1000    -0.0001
##    140      3.0254      -nan     0.1000    -0.0001
##    150      3.0252      -nan     0.1000    -0.0001
##
## Iter   TrainDeviance  ValidDeviance StepSize Improve
##      1      3.0367      -nan     0.1000    0.0005
##      2      3.0362      -nan     0.1000    0.0004
##      3      3.0359      -nan     0.1000    0.0004
##      4      3.0355      -nan     0.1000    0.0003
##      5      3.0352      -nan     0.1000    0.0003
##      6      3.0350      -nan     0.1000    0.0002

```

```

##      7    3.0348      -nan    0.1000   0.0002
##      8    3.0346      -nan    0.1000   0.0002
##      9    3.0344      -nan    0.1000   0.0001
##     10    3.0343      -nan    0.1000   0.0002
##    20    3.0332      -nan    0.1000   0.0000
##    40    3.0319      -nan    0.1000   0.0000
##   60    3.0310      -nan    0.1000  -0.0000
##   80    3.0303      -nan    0.1000  -0.0000
##  100    3.0297      -nan    0.1000  -0.0000
##  120    3.0292      -nan    0.1000   0.0000
##  140    3.0288      -nan    0.1000  -0.0000
##  150    3.0286      -nan    0.1000  -0.0000
##
## Iter TrainDeviance ValidDeviance StepSize Improve
##   1    3.0365      -nan    0.1000   0.0008
##   2    3.0357      -nan    0.1000   0.0006
##   3    3.0349      -nan    0.1000   0.0007
##   4    3.0344      -nan    0.1000   0.0006
##   5    3.0339      -nan    0.1000   0.0004
##   6    3.0335      -nan    0.1000   0.0004
##   7    3.0331      -nan    0.1000   0.0003
##   8    3.0329      -nan    0.1000   0.0002
##   9    3.0325      -nan    0.1000   0.0003
##  10    3.0322      -nan    0.1000   0.0002
##  20    3.0305      -nan    0.1000   0.0000
##  40    3.0276      -nan    0.1000   0.0000
##  60    3.0261      -nan    0.1000  -0.0000
##  80    3.0248      -nan    0.1000   0.0000
## 100    3.0238      -nan    0.1000   0.0001
## 120    3.0229      -nan    0.1000  -0.0001
## 140    3.0222      -nan    0.1000  -0.0000
## 150    3.0220      -nan    0.1000  -0.0000
##
## Iter TrainDeviance ValidDeviance StepSize Improve
##   1    3.0361      -nan    0.1000   0.0012
##   2    3.0352      -nan    0.1000   0.0010
##   3    3.0344      -nan    0.1000   0.0006
##   4    3.0336      -nan    0.1000   0.0007
##   5    3.0329      -nan    0.1000   0.0004
##   6    3.0324      -nan    0.1000   0.0004
##   7    3.0321      -nan    0.1000   0.0003
##   8    3.0317      -nan    0.1000   0.0003
##   9    3.0314      -nan    0.1000   0.0002
##  10    3.0310      -nan    0.1000   0.0004
##  20    3.0285      -nan    0.1000   0.0001
##  40    3.0254      -nan    0.1000  -0.0000
##  60    3.0235      -nan    0.1000  -0.0000
##  80    3.0222      -nan    0.1000   0.0000
## 100    3.0211      -nan    0.1000  -0.0001
## 120    3.0206      -nan    0.1000  -0.0000
## 140    3.0201      -nan    0.1000  -0.0001
## 150    3.0200      -nan    0.1000  -0.0001
##
## Iter TrainDeviance ValidDeviance StepSize Improve

```

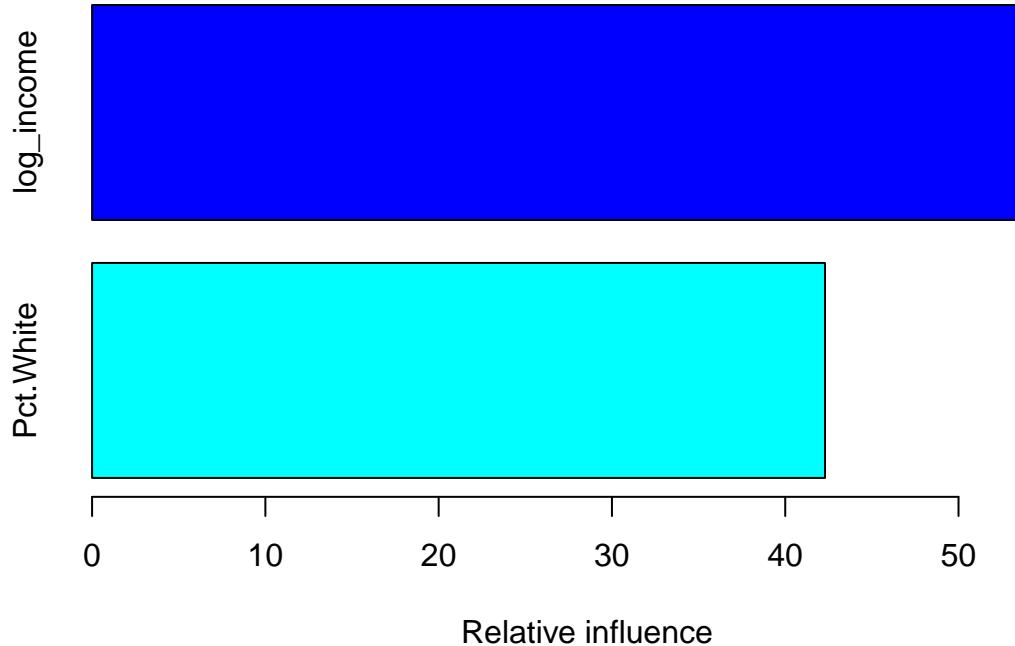


Figure 3: Summary of Boosted Random Forest Model without including priority and call type

```

##      1     3.0397      -nan    0.1000   0.0013
##      2     3.0389      -nan    0.1000   0.0009
##      3     3.0381      -nan    0.1000   0.0008
##      4     3.0372      -nan    0.1000   0.0007
##      5     3.0368      -nan    0.1000   0.0004
##      6     3.0363      -nan    0.1000   0.0005
##      7     3.0358      -nan    0.1000   0.0004
##      8     3.0353      -nan    0.1000   0.0003
##      9     3.0349      -nan    0.1000   0.0003
##     10     3.0346      -nan    0.1000   0.0004
##     20     3.0323      -nan    0.1000   0.0001
##     40     3.0295      -nan    0.1000   0.0001
##     60     3.0274      -nan    0.1000   0.0000
##     80     3.0263      -nan    0.1000   0.0000
##    100     3.0256      -nan    0.1000  -0.0001
##    120     3.0249      -nan    0.1000  -0.0001
##    140     3.0245      -nan    0.1000  -0.0000
##    150     3.0243      -nan    0.1000  -0.0001

##           var rel.inf
## log_income log_income     57.7
## Pct.White  Pct.White     42.3

```

Looking at our best linear regression and penalized regression models, we get more insights for inference. In the non-penalized model, all of the variables are significant at the 0.001 significance level. However, the coefficient for priority is much, much higher than the other coefficients. The penalized regression reduced the coefficients of all of the variables but did not make any of them zero, so we cannot fully discount any of the four variables.

```

## 
## Call:

```

```

## lm(formula = .outcome ~ ., data = dat)
##
## Residuals:
##   Min     1Q Median     3Q    Max
## -6.036 -0.804 -0.017  0.811  5.535
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  6.639560  0.020584 322.56 < 2e-16 ***
## Pct.White    -0.389505  0.028017 -13.90 < 2e-16 ***
## log_income    0.006940  0.000891    7.79 6.7e-15 ***
## category_dummy  0.325191  0.007685   42.32 < 2e-16 ***
## priority_dummy -2.855008  0.007944 -359.40 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.19 on 138805 degrees of freedom
## Multiple R-squared:  0.538, Adjusted R-squared:  0.538
## F-statistic: 4.04e+04 on 4 and 138805 DF, p-value: <2e-16
## 5 x 1 sparse Matrix of class "dgCMatrix"
##           1
## (Intercept) 6.60803
## Pct.White    -0.35320
## log_income    0.00587
## category_dummy  0.32004
## priority_dummy -2.84212

```

Discussion

Unfortunately we were limited by the amount of information contained in the data. More descriptive information, like the day and time of the call, would have been very helpful in determining the volume of calls at any given time, which likely has a strong relationship to time in the queue.

References

2010 Census Data for Portland Neighborhoods | The City of Portland, Oregon. (n.d.). Retrieved December 11, 2019, from The City Of Portland Oregon website: <https://www.portlandoregon.gov/civic/56897> DeNies, R. (2016, April 1). Portland Neighborhoods by the Numbers 2016: The City. Retrieved December 11, 2019, from Portland Monthly website: <https://www.pdxmonthly.com/articles/2016/4/1/real-estate-2016-the-city> Dispatched Calls | The City of Portland, Oregon. (n.d.). Retrieved December 11, 2019, from The City Of Portland Oregon website: <https://www.portlandoregon.gov/police/76454>

R Code