MSDS 660 Week 2 Assignment

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Introduction

In this week's assignment we will be exploring a dataset which came from Zillow, a popular website used for finding housing, apartments, etc. It has data on price, number of rooms, tax information, and the year each house was built. Additionally, it contains some data which is not numeric and for this week's assignment, we will only pay attention to the numeric data. The purpose of this assignment is to perform a simple linear regression analysis. It will involve finding correlations between variables, removing outliers, removing null values, plotting, and creating models. Let's begin!

```
# first we will import packages, read in the data, create a dataframe, and
view some summary information

# load the data.table, ggolot2, and dplyr libraries and the zillow_price.csv
file
library('ggplot2')
library('Rmisc')

## Loading required package: lattice

## Loading required package: plyr

library('stargazer')

##
## Please cite as:

##  Hlavac, Marek (2022). stargazer: Well-Formatted Regression and Summary
Statistics Tables.

##  R package version 5.2.3. https://CRAN.R-project.org/package=stargazer

library('dplyr')

##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:plyr':
##
##     arrange, count, desc, failwith, id, mutate, rename, summarise,
##     summarize
```

```
## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union

library('purrr')

##
## Attaching package: 'purrr'

## The following object is masked from 'package:plyr':
##
##     compact

dt <- read.csv("C:\\Users\\jerem\\OneDrive\\Documents\\School\\_REGIS\\2022-
05_Summer\\MSDS660\\Week2\\zillow_price.csv")

# Convert the file to a data table
dt <- as.data.frame(dt)

head(dt)

##   parcelid airconditioningtypeid architecturalstyletypeid basementsqft
## 1 10711738                    1                       NA           NA
## 2 10711755                    1                       NA           NA
## 3 10711805                    1                       NA           NA
## 4 10711816                    1                       NA           NA
## 5 10711858                    1                       NA           NA
## 6 10711910                   NA                       NA           NA
##   bathroomcnt bedroomcnt buildingclasstypeid buildingqualitytypeid
## 1           3          4                  NA                     4
## 2           3          3                  NA                     4
## 3           2          3                  NA                     4
## 4           2          4                  NA                     4
## 5           2          4                  NA                     4
## 6           2          3                  NA                     4
##   calculatedbathnbr decktypeid finishedfloor1squarefeet
## 1                 3         NA                      NA
## 2                 3         NA                      NA
## 3                 2         NA                      NA
## 4                 2         NA                      NA
## 5                 2         NA                      NA
## 6                 2         NA                      NA
##   calculatedfinishedsquarefeet finishedsquarefeet12 finishedsquarefeet13
## 1                         2538                2538                   NA
## 2                         1589                1589                   NA
## 3                         2411                2411                   NA
## 4                         2232                2232                   NA
```

```
## 5                          1882                1882                    NA
## 6                          1477                1477                    NA
##   finishedsquarefeet15 finishedsquarefeet50 finishedsquarefeet6 fips
## 1                   NA                   NA                  NA 6037
## 2                   NA                   NA                  NA 6037
## 3                   NA                   NA                  NA 6037
## 4                   NA                   NA                  NA 6037
## 5                   NA                   NA                  NA 6037
## 6                   NA                   NA                  NA 6037
##   fireplacecnt fullbathcnt garagecarcnt garagetotalsqft hashottuborspa
## 1           NA           3           NA              NA
## 2           NA           3           NA              NA
## 3           NA           2           NA              NA
## 4           NA           2           NA              NA
## 5           NA           2           NA              NA
## 6           NA           2           NA              NA
##   heatingorsystemtypeid latitude  longitude lotsizesquarefeet poolcnt
## 1                     2 34220381 -118620802             11012       1
## 2                     2 34222040 -118622240             11010       1
## 3                     2 34220427 -118618549             11723       1
## 4                     2 34222390 -118618631              9002      NA
## 5                     2 34222544 -118617961              9002       1
## 6                     2 34221864 -118615739             11285       1
##   poolsizesum pooltypeid10 pooltypeid2 pooltypeid7
propertycountylandusecode
## 1          NA           NA          NA           1
0101
## 2          NA           NA          NA           1
0101
## 3          NA           NA          NA           1
0101
## 4          NA           NA          NA          NA
0100
## 5          NA           NA          NA           1
0101
## 6          NA           NA          NA           1
0101
##   propertylandusetypeid propertyzoningdesc rawcensustractandblock
regionidcity
## 1                   261             LARE11               60371132
12447
## 2                   261             LARE11               60371132
12447
## 3                   261              LARE9               60371132
12447
## 4                   261              LARE9               60371132
12447
## 5                   261              LARE9               60371132
12447
## 6                   261             LARE11               60371132
```

```
12447
##   regionidcounty regionidneighborhood regionidzip roomcnt storytypeid
## 1           3101                268588       96339       0          NA
## 2           3101                268588       96339       0          NA
## 3           3101                268588       96339       0          NA
## 4           3101                268588       96339       0          NA
## 5           3101                268588       96339       0          NA
## 6           3101                268588       96339       0          NA
##   threequarterbathnbr typeconstructiontypeid unitcnt yardbuildingsqft17
## 1                  NA                     NA       1                 NA
## 2                  NA                     NA       1                 NA
## 3                  NA                     NA       1                 NA
## 4                  NA                     NA       1                 NA
## 5                  NA                     NA       1                 NA
## 6                  NA                     NA       1                 NA
##   yardbuildingsqft26 yearbuilt numberofstories fireplaceflag
## 1                 NA      1978              NA
## 2                 NA      1959              NA
## 3                 NA      1973              NA
## 4                 NA      1973              NA
## 5                 NA      1973              NA
## 6                 NA      1960              NA
##   structuretaxvaluedollarcnt taxvaluedollarcnt assessmentyear
## 1                     245180            567112           2015
## 2                     254691            459844           2015
## 3                     235114            384787           2015
## 4                     262309            437176           2015
## 5                     232037            382055           2015
## 6                      57098             76860           2015
##   landtaxvaluedollarcnt taxdelinquencyflag taxdelinquencyyear
## 1                321932                                   NA
## 2                205153                                   NA
## 3                149673                                   NA
## 4                174867                                   NA
## 5                150018                                   NA
## 6                 19762                                   NA
##   censustractandblock     price logerror transactiondate
## 1       6.037113e+13 622343.10   0.0276      2016-08-02
## 2       6.037113e+13 594921.55  -0.0182      2016-08-02
## 3       6.037113e+13 420397.41  -0.1009      2016-05-03
## 4       6.037113e+13 479316.38  -0.0121      2016-04-05
## 5       6.037113e+13 420538.79  -0.0481      2016-07-15
## 6       6.037113e+13  96246.55   0.2897      2016-08-30

# how many observations and columns are there?
# number of observations = number of rows = 90275
nrow(dt)

## [1] 90275
```

```
# number of columns = 60
ncol(dt)

## [1] 60

# use str and summary to see how many missing values we have,
# and what the data looks like
str(dt)

## 'data.frame':    90275 obs. of  60 variables:
##  $ parcelid                    : int  10711738 10711755 10711805 10711816
10711858 10711910 10712086 10712162 10712163 10712195 ...
##  $ airconditioningtypeid       : int  1 1 1 1 1 NA 1 1 1 1 ...
##  $ architecturalstyletypeid    : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ basementsqft                : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ bathroomcnt                 : num  3 3 2 2 2 2 2 3 3 3 ...
##  $ bedroomcnt                  : int  4 3 3 4 4 3 4 3 4 3 ...
##  $ buildingclasstypeid         : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ buildingqualitytypeid       : int  4 4 4 4 4 4 4 4 4 4 ...
##  $ calculatedbathnbr           : num  3 3 2 2 2 2 2 3 3 3 ...
##  $ decktypeid                  : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ finishedfloor1squarefeet    : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ calculatedfinishedsquarefeet: int  2538 1589 2411 2232 1882 1477 1850
3193 2421 1678 ...
##  $ finishedsquarefeet12        : int  2538 1589 2411 2232 1882 1477 1850
3193 2421 1678 ...
##  $ finishedsquarefeet13        : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ finishedsquarefeet15        : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ finishedsquarefeet50        : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ finishedsquarefeet6         : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ fips                        : int  6037 6037 6037 6037 6037 6037 6037
6037 6037 6037 ...
##  $ fireplacecnt                : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ fullbathcnt                 : int  3 3 2 2 2 2 2 3 3 3 ...
##  $ garagecarcnt                : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ garagetotalsqft             : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ hashottuborspa              : chr  "" "" "" "" ...
##  $ heatingorsystemtypeid       : int  2 2 2 2 2 2 2 2 2 2 ...
##  $ latitude                    : int  34220381 34222040 34220427 34222390
34222544 34221864 34226039 34226833 34226843 34223689 ...
##  $ longitude                   : int  -118620802 -118622240 -118618549 -
118618631 -118617961 -118615739 -118618527 -118612917 -118612422 -118612746
...
##  $ lotsizesquarefeet           : num  11012 11010 11723 9002 9002 ...
##  $ poolcnt                     : int  1 1 1 NA 1 1 1 1 1 NA ...
##  $ poolsizesum                 : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ pooltypeid10                : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ pooltypeid2                 : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ pooltypeid7                 : int  1 1 1 NA 1 1 1 1 1 NA ...
##  $ propertycountylandusecode   : chr  "0101" "0101" "0101" "0100" ...
```

```
##  $ propertylandusetypeid       : int  261 261 261 261 261 261 261 261 261
261 ...
##  $ propertyzoningdesc          : chr  "LARE11" "LARE11" "LARE9" "LARE9"
...
##  $ rawcensustractandblock      : num  60371132 60371132 60371132 60371132
60371132 ...
##  $ regionidcity                : int  12447 12447 12447 12447 12447 12447
12447 12447 12447 12447 ...
##  $ regionidcounty              : int  3101 3101 3101 3101 3101 3101 3101
3101 3101 3101 ...
##  $ regionidneighborhood        : int  268588 268588 268588 268588 268588
268588 268588 268588 268588 268588 ...
##  $ regionidzip                 : int  96339 96339 96339 96339 96339 96339
96339 96339 96339 96339 ...
##  $ roomcnt                     : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ storytypeid                 : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ threequarterbathnbr         : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ typeconstructiontypeid      : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ unitcnt                     : int  1 1 1 1 1 1 1 1 1 1 ...
##  $ yardbuildingsqft17          : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ yardbuildingsqft26          : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ yearbuilt                   : int  1978 1959 1973 1973 1973 1960 1974
1964 1962 1961 ...
##  $ numberofstories             : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ fireplaceflag               : chr  "" "" "" "" ...
##  $ structuretaxvaluedollarcnt  : num  245180 254691 235114 262309 232037
...
##  $ taxvaluedollarcnt           : num  567112 459844 384787 437176 382055
...
##  $ assessmentyear              : int  2015 2015 2015 2015 2015 2015 2015
2015 2015 2015 ...
##  $ landtaxvaluedollarcnt       : num  321932 205153 149673 174867 150018
...
##  $ taxdelinquencyflag          : chr  "" "" "" "" ...
##  $ taxdelinquencyyear          : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ censustractandblock         : num  6.04e+13 6.04e+13 6.04e+13 6.04e+13
6.04e+13 ...
##  $ price                       : num  622343 594922 420397 479316 420539
...
##  $ logerror                    : num  0.0276 -0.0182 -0.1009 -0.0121 -
0.0481 ...
##  $ transactiondate             : chr  "2016-08-02" "2016-08-02" "2016-05-
03" "2016-04-05" ...

summary(dt)

##     parcelid         airconditioningtypeid architecturalstyletypeid
##  Min.   : 10711738   Min.   : 1.00         Min.   : 2.00
##  1st Qu.: 11559500   1st Qu.: 1.00         1st Qu.: 7.00
##  Median : 12547337   Median : 1.00         Median : 7.00
```

```
##  Mean   : 12984656   Mean   : 1.82         Mean   : 7.23
##  3rd Qu.: 14227552   3rd Qu.: 1.00         3rd Qu.: 7.00
##  Max.   :162960842   Max.   :13.00         Max.   :21.00
##                      NA's   :61494         NA's   :90014
##   basementsqft     bathroomcnt       bedroomcnt     buildingclasstypeid
##  Min.   : 100.0   Min.   : 0.000   Min.   : 0.000   Min.   :4
##  1st Qu.: 407.5   1st Qu.: 2.000   1st Qu.: 2.000   1st Qu.:4
##  Median : 616.0   Median : 2.000   Median : 3.000   Median :4
##  Mean   : 713.6   Mean   : 2.279   Mean   : 3.032   Mean   :4
##  3rd Qu.: 872.0   3rd Qu.: 3.000   3rd Qu.: 4.000   3rd Qu.:4
##  Max.   :1555.0   Max.   :20.000   Max.   :16.000   Max.   :4
##  NA's   :90232                                      NA's   :90259
##  buildingqualitytypeid calculatedbathnbr   decktypeid
##  Min.   : 1.00         Min.   : 1.000    Min.   :66
##  1st Qu.: 4.00         1st Qu.: 2.000    1st Qu.:66
##  Median : 7.00         Median : 2.000    Median :66
##  Mean   : 5.57         Mean   : 2.309    Mean   :66
##  3rd Qu.: 7.00         3rd Qu.: 3.000    3rd Qu.:66
##  Max.   :12.00         Max.   :20.000    Max.   :66
##  NA's   :32911         NA's   :1182      NA's   :89617
##  finishedfloor1squarefeet calculatedfinishedsquarefeet
finishedsquarefeet12
##  Min.   :  44             Min.   :    2               Min.   :    2
##  1st Qu.: 938             1st Qu.: 1184               1st Qu.: 1172
##  Median :1244             Median : 1540               Median : 1518
##  Mean   :1348             Mean   : 1773               Mean   : 1745
##  3rd Qu.:1614             3rd Qu.: 2095               3rd Qu.: 2056
##  Max.   :7625             Max.   :22741               Max.   :20013
##  NA's   :83419            NA's   :661                 NA's   :4679
##  finishedsquarefeet13 finishedsquarefeet15 finishedsquarefeet50
##  Min.   :1056         Min.   :  560        Min.   :  44
##  1st Qu.:1392         1st Qu.: 1648        1st Qu.: 938
##  Median :1440         Median : 2104        Median :1248
##  Mean   :1405         Mean   : 2380        Mean   :1356
##  3rd Qu.:1440         3rd Qu.: 2862        3rd Qu.:1619
##  Max.   :1584         Max.   :22741        Max.   :8352
##  NA's   :90242        NA's   :86711        NA's   :83419
##  finishedsquarefeet6      fips       fireplacecnt    fullbathcnt
##  Min.   : 257        Min.   :6037   Min.   :1.00    Min.   : 1.000
##  1st Qu.:1112        1st Qu.:6037   1st Qu.:1.00    1st Qu.: 2.000
##  Median :2028        Median :6037   Median :1.00    Median : 2.000
##  Mean   :2303        Mean   :6049   Mean   :1.19    Mean   : 2.241
##  3rd Qu.:3431        3rd Qu.:6059   3rd Qu.:1.00    3rd Qu.: 3.000
##  Max.   :7224        Max.   :6111   Max.   :5.00    Max.   :20.000
##  NA's   :89854                      NA's   :80668   NA's   :1182
##   garagecarcnt   garagetotalsqft  hashottuborspa     heatingorsystemtypeid
##  Min.   : 0.00   Min.   :   0.0   Length:90275       Min.   : 1.00
##  1st Qu.: 2.00   1st Qu.:   0.0   Class :character   1st Qu.: 2.00
##  Median : 2.00   Median : 433.0   Mode  :character   Median : 2.00
##  Mean   : 1.81   Mean   : 345.5                      Mean   : 3.93
```

```
##  3rd Qu.: 2.00   3rd Qu.: 484.0                      3rd Qu.: 7.00
##  Max.   :24.00   Max.   :7339.0                      Max.   :24.00
##  NA's   :60338   NA's   :60338                       NA's   :34195
##     latitude          longitude          lotsizesquarefeet    poolcnt
##  Min.   :33339295   Min.   :-119447865   Min.   :    167   Min.   :1
##  1st Qu.:33811538   1st Qu.:-118411692   1st Qu.:   5703   1st Qu.:1
##  Median :34021500   Median :-118173431   Median :   7200   Median :1
##  Mean   :34005411   Mean   :-118198868   Mean   :  29110   Mean   :1
##  3rd Qu.:34172742   3rd Qu.:-117921588   3rd Qu.:  11686   3rd Qu.:1
##  Max.   :34816009   Max.   :-117554924   Max.   :6971010   Max.   :1
##                                          NA's   :10150     NA's   :72374
##   poolsizesum      pooltypeid10    pooltypeid2     pooltypeid7
##  Min.   :  28.0   Min.   :1       Min.   :1       Min.   :1
##  1st Qu.: 420.0   1st Qu.:1       1st Qu.:1       1st Qu.:1
##  Median : 500.0   Median :1       Median :1       Median :1
##  Mean   : 519.8   Mean   :1       Mean   :1       Mean   :1
##  3rd Qu.: 600.0   3rd Qu.:1       3rd Qu.:1       3rd Qu.:1
##  Max.   :1750.0   Max.   :1       Max.   :1       Max.   :1
##  NA's   :89306    NA's   :89114   NA's   :89071   NA's   :73578
##  propertycountylandusecode propertylandusetypeid propertyzoningdesc
##  Length:90275              Min.   : 31.0         Length:90275
##  Class :character          1st Qu.:261.0         Class :character
##  Mode  :character          Median :261.0         Mode  :character
##                            Mean   :261.8
##                            3rd Qu.:266.0
##                            Max.   :275.0
##
##  rawcensustractandblock  regionidcity    regionidcounty
regionidneighborhood
##  Min.   :60371011       Min.   :  3491   Min.   :1286   Min.   :  6952
##  1st Qu.:60373203       1st Qu.: 12447   1st Qu.:1286   1st Qu.: 46736
##  Median :60376200       Median : 25218   Median :3101   Median :118887
##  Mean   :60491795       Mean   : 33761   Mean   :2525   Mean   :190647
##  3rd Qu.:60590423       3rd Qu.: 45457   3rd Qu.:3101   3rd Qu.:274800
##  Max.   :61110091       Max.   :396556   Max.   :3101   Max.   :764167
##                         NA's   :1803                    NA's   :54263
##   regionidzip        roomcnt        storytypeid    threequarterbathnbr
##  Min.   : 95982   Min.   : 0.000   Min.   :7       Min.   :1.00
##  1st Qu.: 96193   1st Qu.: 0.000   1st Qu.:7       1st Qu.:1.00
##  Median : 96393   Median : 0.000   Median :7       Median :1.00
##  Mean   : 96586   Mean   : 1.479   Mean   :7       Mean   :1.01
##  3rd Qu.: 96987   3rd Qu.: 0.000   3rd Qu.:7       3rd Qu.:1.00
##  Max.   :399675   Max.   :18.000   Max.   :7       Max.   :4.00
##  NA's   :35                        NA's   :90232   NA's   :78266
##  typeconstructiontypeid    unitcnt       yardbuildingsqft17
yardbuildingsqft26
##  Min.   : 4.00          Min.   :  1.00   Min.   :  25.0     Min.   :  18.0
##  1st Qu.: 6.00          1st Qu.:  1.00   1st Qu.: 180.0     1st Qu.: 100.0
##  Median : 6.00          Median :  1.00   Median : 259.5     Median : 159.0
##  Mean   : 6.01          Mean   :  1.11   Mean   : 310.1     Mean   : 311.7
```

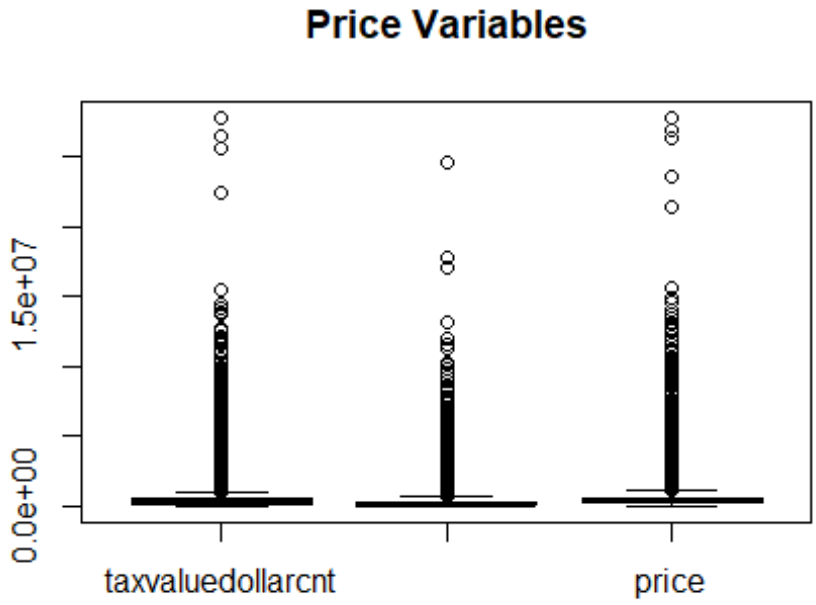
```
##  3rd Qu.: 6.00          3rd Qu.:  1.00   3rd Qu.: 384.0     3rd Qu.: 361.0
##  Max.   :13.00          Max.   :143.00   Max.   :2678.0     Max.   :1366.0
##  NA's   :89976          NA's   :31922    NA's   :87629      NA's   :90180
##    yearbuilt    numberofstories fireplaceflag
structuretaxvaluedollarcnt
##  Min.   :1885   Min.   :1.00    Length:90275       Min.   :    100
##  1st Qu.:1953   1st Qu.:1.00    Class :character   1st Qu.:  81245
##  Median :1970   Median :1.00    Mode  :character   Median : 132000
##  Mean   :1969   Mean   :1.44                       Mean   : 180093
##  3rd Qu.:1987   3rd Qu.:2.00                       3rd Qu.: 210534
##  Max.   :2015   Max.   :4.00                       Max.   :9948100
##  NA's   :756    NA's   :69705                      NA's   :380
##  taxvaluedollarcnt  assessmentyear landtaxvaluedollarcnt
taxdelinquencyflag
##  Min.   :      22   Min.   :2015   Min.   :      22      Length:90275
##  1st Qu.:  199023   1st Qu.:2015   1st Qu.:   82228      Class :character
##  Median :  342872   Median :2015   Median :  192970      Mode  :character
##  Mean   :  457673   Mean   :2015   Mean   :  278335
##  3rd Qu.:  540589   3rd Qu.:2015   3rd Qu.:  345420
##  Max.   :27750000   Max.   :2015   Max.   :24500000
##  NA's   :1                         NA's   :1
##  taxdelinquencyyear censustractandblock     price             logerror
##  Min.   : 6.0       Min.   :6.037e+13   Min.   :    4231   Min.   :-
4.60500
##  1st Qu.:13.0       1st Qu.:6.037e+13   1st Qu.:  247658   1st Qu.:-
0.02530
##  Median :14.0       Median :6.038e+13   Median :  391616   Median :
0.00600
##  Mean   :13.4       Mean   :6.049e+13   Mean   :  515860   Mean   :
0.01146
##  3rd Qu.:15.0       3rd Qu.:6.059e+13   3rd Qu.:  594922   3rd Qu.:
0.03920
##  Max.   :99.0       Max.   :6.111e+13   Max.   :27753111   Max.   :
4.73700
##  NA's   :88492      NA's   :605         NA's   :6
##  transactiondate
##  Length:90275
##  Class :character
##  Mode  :character
##
##
##
##
```

Methods

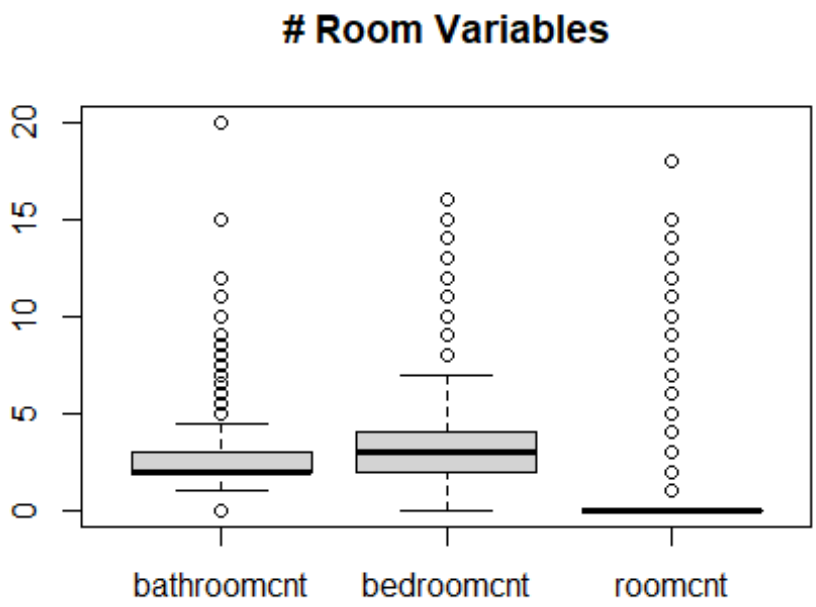
So, as we can see from the information above, there are many non-numeric columns in the dataset and there are many null/na values. For this week's assignment, it will make sense to remove these columns and these na values. For the simple linear regression, we will be creating boxplots of the data, finding which variables are most correlated to price, creating

a model and scatterplot of this variable+price, and plotting the model. From this, we hope to gain an understanding of the highest correlation to price in the Zillow dataset, and also if removing outliers changes our conclusion at all.

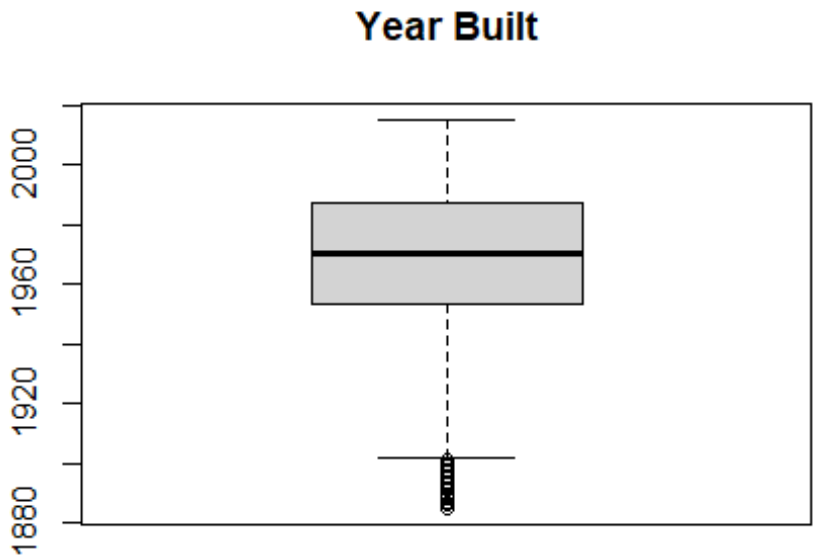
```
# first I'm going to just create some boxplots to satisfy my curiosity
small_nums <- c('bathroomcnt',
                'bedroomcnt',
                'roomcnt')

big_nums <- c('taxvaluedollarcnt',
              'landtaxvaluedollarcnt',
              'price')
dt_smallnums <- dt[ , small_nums]
dt_bignums <- dt[ , big_nums]
boxplot(dt_bignums)
title("Price Variables")
```



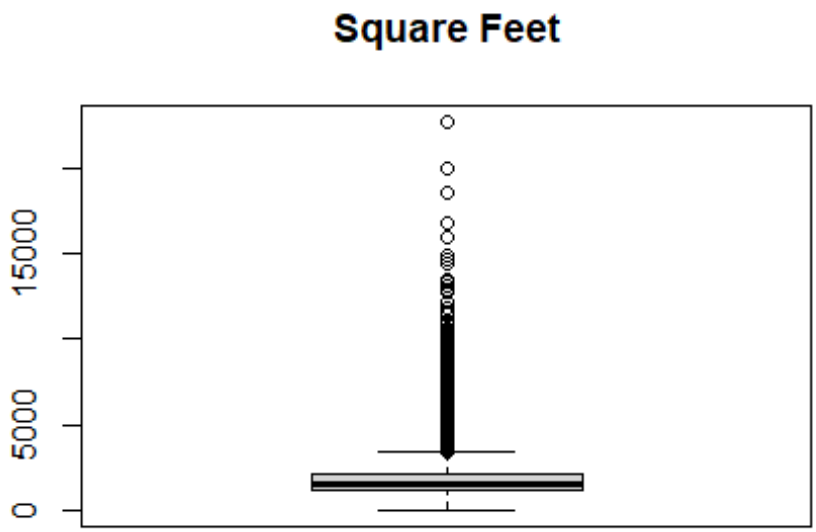

```
boxplot(dt_smallnums)
title("# Room Variables")
```




```
boxplot(dt$yearbuilt)
title("Year Built")
```



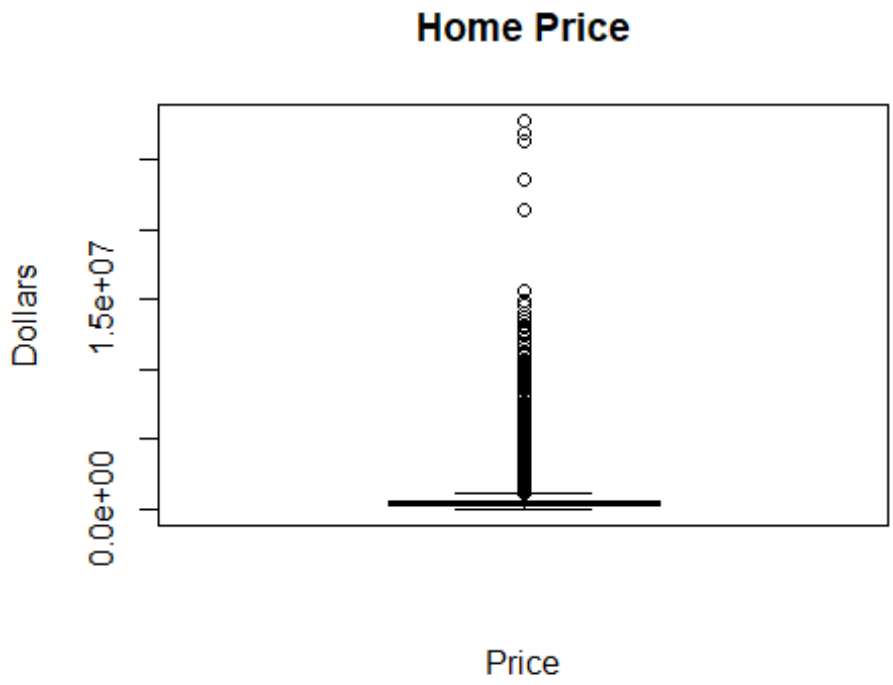
```
boxplot(dt$calculatedfinishedsquarefeet)
title("Square Feet")
```



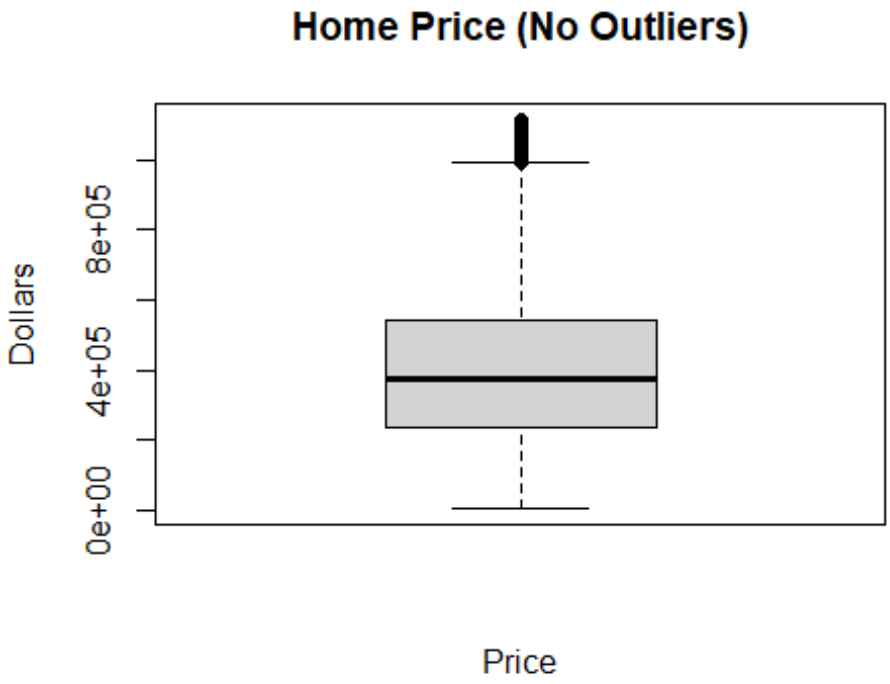

```
# columns that are numeric and don't have lots of missing values
# you can add others if you like
numeric_cols <- c('bathroomcnt',
                  'bedroomcnt',
                  'calculatedfinishedsquarefeet',
                  'roomcnt',
                  'yearbuilt',
                  'taxvaluedollarcnt',
                  'landtaxvaluedollarcnt',
                  'price')

# Simplify your dataset by only selecting the columns of your choosing dt[,
numeric_cols, with = FALSE]
dt_num <- dt[ , numeric_cols]

summary(dt_num)

##   bathroomcnt       bedroomcnt     calculatedfinishedsquarefeet
##  Min.   : 0.000   Min.   : 0.000   Min.   :    2
##  1st Qu.: 2.000   1st Qu.: 2.000   1st Qu.: 1184
##  Median : 2.000   Median : 3.000   Median : 1540
##  Mean   : 2.279   Mean   : 3.032   Mean   : 1773
##  3rd Qu.: 3.000   3rd Qu.: 4.000   3rd Qu.: 2095
##  Max.   :20.000   Max.   :16.000   Max.   :22741
```

```
##                                    NA's   :661
##     roomcnt         yearbuilt    taxvaluedollarcnt  landtaxvaluedollarcnt
##  Min.   : 0.000   Min.   :1885   Min.   :      22   Min.   :      22
##  1st Qu.: 0.000   1st Qu.:1953   1st Qu.:  199023   1st Qu.:   82228
##  Median : 0.000   Median :1970   Median :  342872   Median :  192970
##  Mean   : 1.479   Mean   :1969   Mean   :  457673   Mean   :  278335
##  3rd Qu.: 0.000   3rd Qu.:1987   3rd Qu.:  540589   3rd Qu.:  345420
##  Max.   :18.000   Max.   :2015   Max.   :27750000   Max.   :24500000
##                   NA's   :756    NA's   :1          NA's   :1
##      price
##  Min.   :    4231
##  1st Qu.:  247658
##  Median :  391616
##  Mean   :  515860
##  3rd Qu.:  594922
##  Max.   :27753111
##  NA's   :6
```

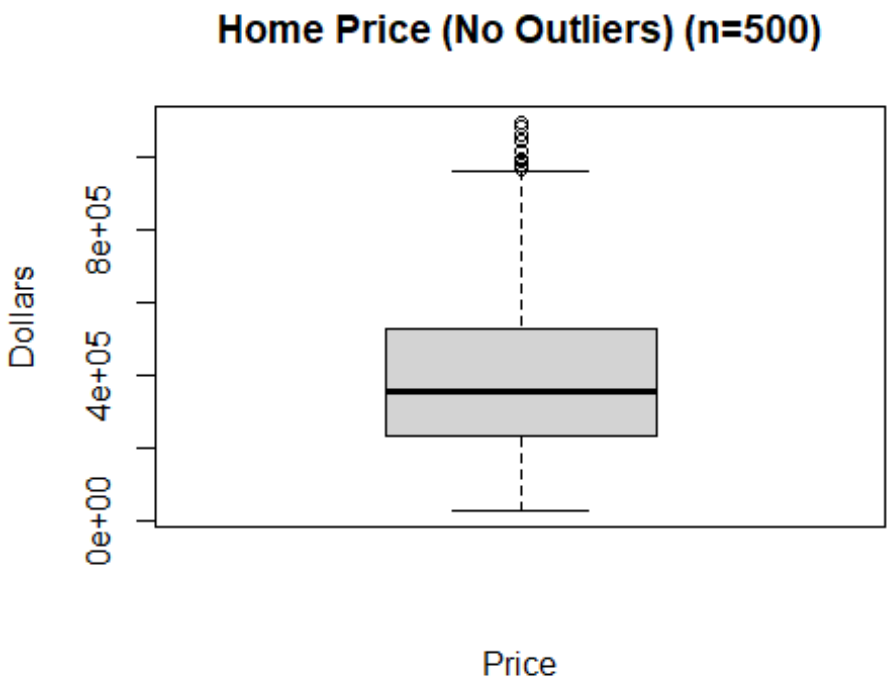
```r
# We want to try to correlate home price with another variable.
# Let's look to see if there are any outliers in the price column we need to remove
# Create a boxplot of the price data
price_data <- c('price')
dt_price <- dt[ , price_data]
boxplot(dt_price, xlab="Price", ylab="Dollars")
title("Home Price")
```



```r
# Wow there are expensive homes!

# Remove the outliers. dt[!which(dt$price %in% boxplot(dt$price)$out)]
dt_price_wo_outliers = dt_price[!dt_price %in% boxplot.stats(dt_price)$out]

# How many outliers did we drop? And lets plot a new box plot to see the
column
# 90275 - 84180 = 6095  entries were dropped!!! that's a lot
boxplot(dt_price_wo_outliers, xlab="Price", ylab="Dollars")
title("Home Price (No Outliers)")
```




```r
# In our case, we have too many observations.
# Use sample() to only sample a few hundred (maybe 500) points to plot.
# plot a few of the more interesting pairs together
sample_dt_price_wo_outliers = sample(dt_price_wo_outliers, 500)
boxplot(sample_dt_price_wo_outliers, xlab="Price", ylab="Dollars")
title("Home Price (No Outliers) (n=500)")
```




```
# create a new data.table by dropping any missing values
# look up 'complete.cases()'
# use dim() to see how many cases we dropped
dt_no_na <- dt_num[complete.cases(dt_num),]
#dt_no_na # this created waaaaaay too much output!
dim(dt_num)

## [1] 90275     8

dim(dt_no_na)

## [1] 89499     8

# get the pearson correlation between price and another variable using cor()
#...there are other types of correlations
# try ?cor to see options, and try another correlation
#?cor
cor(dt_no_na$yearbuilt, dt_no_na$price, method="pearson")

## [1] 0.1156169

cor.test(dt_no_na$yearbuilt, dt_no_na$price, method="pearson")

##
##  Pearson's product-moment correlation
##
## data:  dt_no_na$yearbuilt and dt_no_na$price
## t = 34.822, df = 89497, p-value < 2.2e-16
```

```
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.1091480 0.1220759
## sample estimates:
##       cor
## 0.1156169

cor.test(dt_no_na$bathroomcnt, dt_no_na$price, method="pearson")

##
##  Pearson's product-moment correlation
##
## data:  dt_no_na$bathroomcnt and dt_no_na$price
## t = 163.24, df = 89497, p-value < 2.2e-16
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.4739231 0.4840200
## sample estimates:
##       cor
## 0.4789874

cor.test(dt_no_na$bedroomcnt, dt_no_na$price, method="pearson")

##
##  Pearson's product-moment correlation
##
## data:  dt_no_na$bedroomcnt and dt_no_na$price
## t = 77.857, df = 89497, p-value < 2.2e-16
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.2457155 0.2579874
## sample estimates:
##       cor
## 0.2518616

cor.test(dt_no_na$calculatedfinishedsquarefeet, dt_no_na$price,
method="pearson")

##
##  Pearson's product-moment correlation
##
## data:  dt_no_na$calculatedfinishedsquarefeet and dt_no_na$price
## t = 218.27, df = 89497, p-value < 2.2e-16
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.5851119 0.5936631
## sample estimates:
##      cor
## 0.589404

cor.test(dt_no_na$roomcnt, dt_no_na$price, method="pearson")
```

```
##
##  Pearson's product-moment correlation
##
## data:  dt_no_na$roomcnt and dt_no_na$price
## t = -9.4569, df = 89497, p-value < 2.2e-16
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.03813935 -0.02504945
## sample estimates:
##         cor
## -0.03159575
```

```
cor.test(dt_no_na$taxvaluedollarcnt, dt_no_na$price, method="pearson")
```

```
##
##  Pearson's product-moment correlation
##
## data:  dt_no_na$taxvaluedollarcnt and dt_no_na$price
## t = 929.05, df = 89497, p-value < 2.2e-16
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.951249 0.952480
## sample estimates:
##       cor
## 0.9518683
```

```
cor.test(dt_no_na$landtaxvaluedollarcnt, dt_no_na$price, method="pearson")
```

```
##
##  Pearson's product-moment correlation
##
## data:  dt_no_na$landtaxvaluedollarcnt and dt_no_na$price
## t = 639.43, df = 89497, p-value < 2.2e-16
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.9045873 0.9069404
## sample estimates:
##       cor
## 0.9057708
```

```
#from these, it appears that taxvaluedollarcnt is the most correlated with
price


# use the lm() command to fit a linear model of price to the
# one variable you think is most correlated or predictive of price
# lm stands for 'linear model'
m1 <- lm(price ~ taxvaluedollarcnt, data = dt_no_na)
```

So the code above shows the correlation analysis and model creation of a simple linear regression. BUT this is with outliers still in the dataset. Now we will remove the outliers and perform the same analysis and then compare the models

```
# The method commented out below didn't work, but I wanted to keep it here
for posterity
#findOutliers <- function(dataframe){
#  dataframe %>%
#  select_if(is.numeric) %>%
#    map(~ boxplot.stats(.x)$out)
#}

#outliers <- findOutliers(dt_num)
#temp <- list()
#for (col in names(outliers)) {
#  outlier <- outliers[[col]]
#  if (length(outlier) > 0) {
#    temp[col] <- dt_num[-which(dt_num[[col]] %in% outlier),][col]
#  } else {
#    temp[col] <- dt_num[col]
#  }
#}

#boxplot(temp)
#removing the outliers makes all the row numbers different, hmm

#let's try something different
#find Q1, Q3, and interquartile range for values in column A
Q1 <- quantile(dt_no_na$price, .25)
Q3 <- quantile(dt_no_na$price, .75)
IQR <- IQR(dt_no_na$price)

#only keep rows in dataframe that have values within 1.5*IQR of Q1 and Q3
no_outliers <- subset(dt_no_na, dt_no_na$price> (Q1 - 1.5*IQR) &
dt_no_na$price< (Q3 + 1.5*IQR))

#view row and column count of new data frame before and after
dim(dt_no_na)

## [1] 89499     8

dim(no_outliers)

## [1] 83479     8

cor.test(no_outliers$yearbuilt, no_outliers$price, method="pearson")

##
##  Pearson's product-moment correlation
##
```

```
## data:  no_outliers$yearbuilt and no_outliers$price
## t = 57.754, df = 83477, p-value < 2.2e-16
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.1894829 0.2025288
## sample estimates:
##       cor
## 0.1960145
```

```
cor.test(no_outliers$bathroomcnt, no_outliers$price, method="pearson")
```

```
##
##  Pearson's product-moment correlation
##
## data:  no_outliers$bathroomcnt and no_outliers$price
## t = 121.26, df = 83477, p-value < 2.2e-16
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.3812035 0.3927389
## sample estimates:
##       cor
## 0.3869863
```

```
cor.test(no_outliers$bedroomcnt, no_outliers$price, method="pearson")
```

```
##
##  Pearson's product-moment correlation
##
## data:  no_outliers$bedroomcnt and no_outliers$price
## t = 70.642, df = 83477, p-value < 2.2e-16
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.231092 0.243894
## sample estimates:
##       cor
## 0.2375033
```

```
cor.test(no_outliers$calculatedfinishedsquarefeet, no_outliers$price,
method="pearson")
```

```
##
##  Pearson's product-moment correlation
##
## data:  no_outliers$calculatedfinishedsquarefeet and no_outliers$price
## t = 154.9, df = 83477, p-value < 2.2e-16
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.4672179 0.4777562
## sample estimates:
##      cor
## 0.472504
```

```
cor.test(no_outliers$roomcnt, no_outliers$price, method="pearson")

##
##  Pearson's product-moment correlation
##
## data:  no_outliers$roomcnt and no_outliers$price
## t = -1.0573, df = 83477, p-value = 0.2904
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.01044278  0.00312425
## sample estimates:
##          cor
## -0.003659433

cor.test(no_outliers$taxvaluedollarcnt, no_outliers$price, method="pearson")

##
##  Pearson's product-moment correlation
##
## data:  no_outliers$taxvaluedollarcnt and no_outliers$price
## t = 637.69, df = 83477, p-value < 2.2e-16
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.9097067 0.9120175
## sample estimates:
##       cor
## 0.9108692

cor.test(no_outliers$landtaxvaluedollarcnt, no_outliers$price,
method="pearson")

##
##  Pearson's product-moment correlation
##
## data:  no_outliers$landtaxvaluedollarcnt and no_outliers$price
## t = 414.23, df = 83477, p-value < 2.2e-16
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.8179640 0.8224044
## sample estimates:
##       cor
## 0.8201966

#from these, it appears that taxvaluedollarcnt is STILL the most correlated
with price
m2 <- lm(price ~ taxvaluedollarcnt, data = no_outliers)
```

Now after creating the models both with and without outliers included, we will view summaries and plots of each and then compare the results.

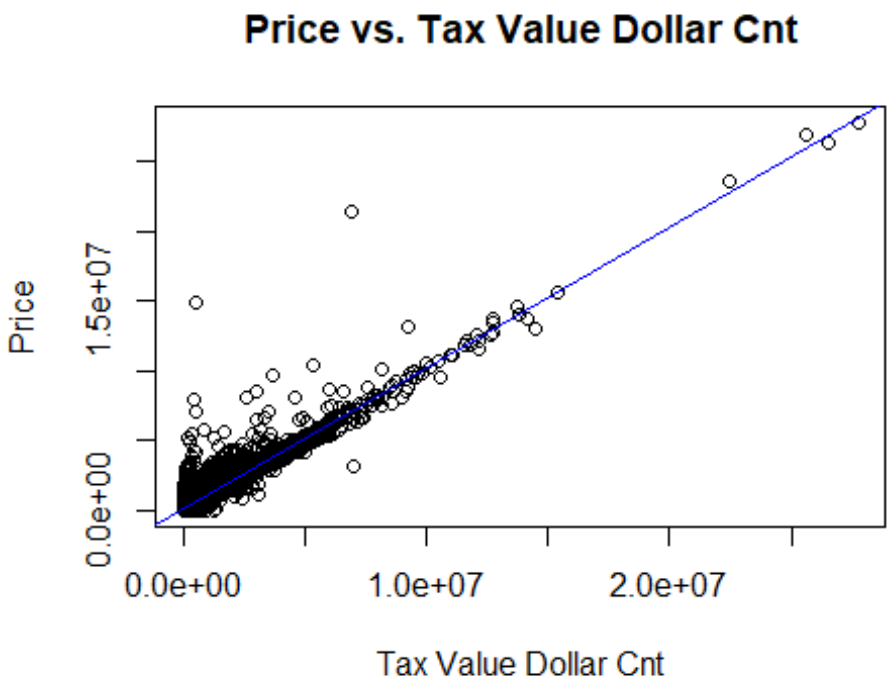
Results

As we can see from the results below, the analysis using outliers was slightly different than the analysis with outliers removed. Looking at just the scatterplots with the regression line overlaid, the scatterplot with outliers removed looks much more widespread and scattered at first glance, but this is only because it is more-or-less a "zoomed-in" view of the scatterplot with outliers included. Removing outliers seemed to enhance the scatterplot a bit.

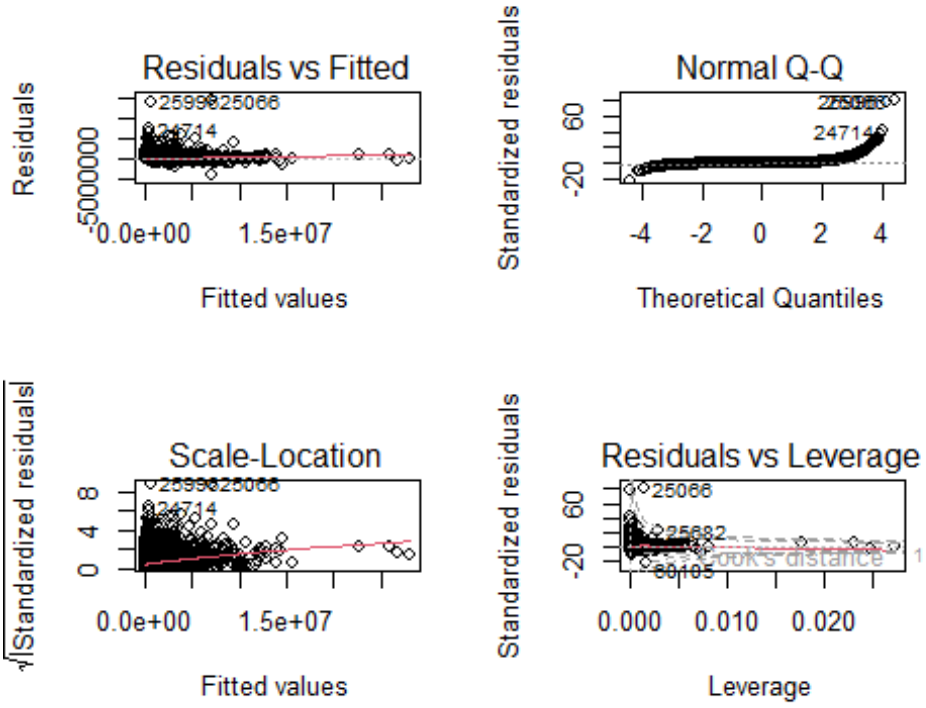
With regard to the model created for each of the two cases, we can see that the error has been reduced overall. The max residual was reduced from 14,391,401 to 971,142. The residual standard error was reduced from 179800 to 94970.

However, the R-squared value tells us that the model was actually not as well fit to the data without outliers, as it was with the outliers included. The R-squared value with outliers was 0.9061 while the R-squared value without outliers was 0.8297. This was also found when viewing the Pearson correlation with and without outliers, the same effect was found.

```
# view the model summary
summary(m1)

##
## Call:
## lm(formula = price ~ taxvaluedollarcnt, data = dt_no_na)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -3932089   -47320   -28139     2677 14391401
##
## Coefficients:
##                    Estimate Std. Error t value Pr(>|t|)
## (Intercept)       5.325e+04  7.800e+02   68.28   <2e-16 ***
## taxvaluedollarcnt 1.009e+00  1.086e-03  929.05   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 179800 on 89497 degrees of freedom
## Multiple R-squared:  0.9061, Adjusted R-squared:  0.9061
## F-statistic: 8.631e+05 on 1 and 89497 DF,  p-value: < 2.2e-16

# plot a scatter plot of the price and the variable you chose
plot(dt_no_na$taxvaluedollarcnt, dt_no_na$price, main = "Price vs. Tax Value
Dollar Cnt", xlab = "Tax Value Dollar Cnt", ylab="Price")

# add the regression line to the current plot using abline()
abline(m1, col = "blue")
```

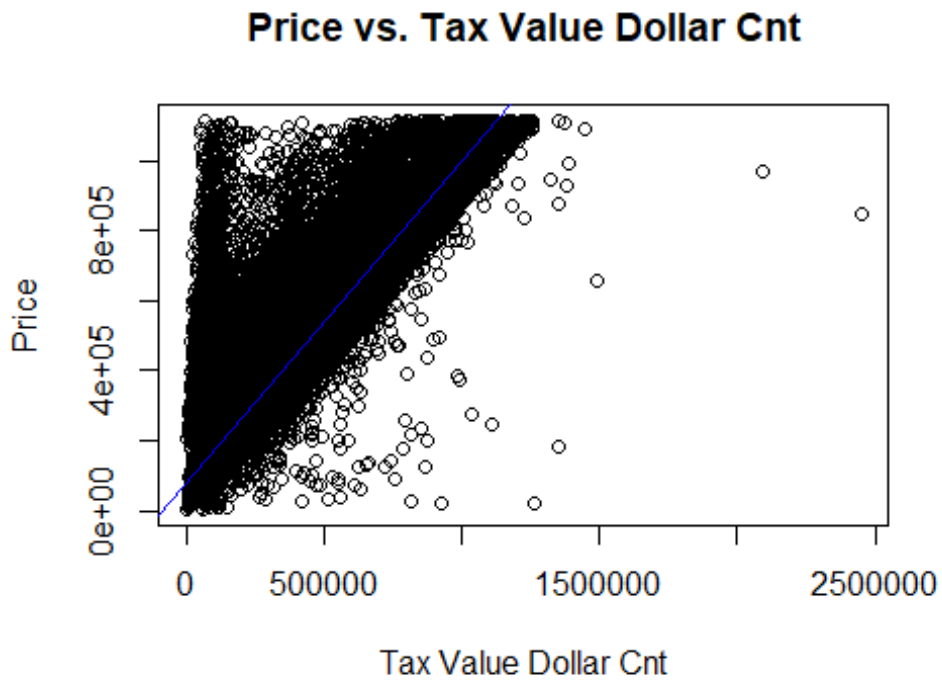



```
# R makes it very easy to plot the diagnostics of a fit
# here's a decent resources explaining the plots:
# http://data.library.virginia.edu/diagnostic-plots/
# plot the fit diagnostics here
par(mfrow=c(2,2)) # Change the panel layout to 2 x 2
plot(m1)
```

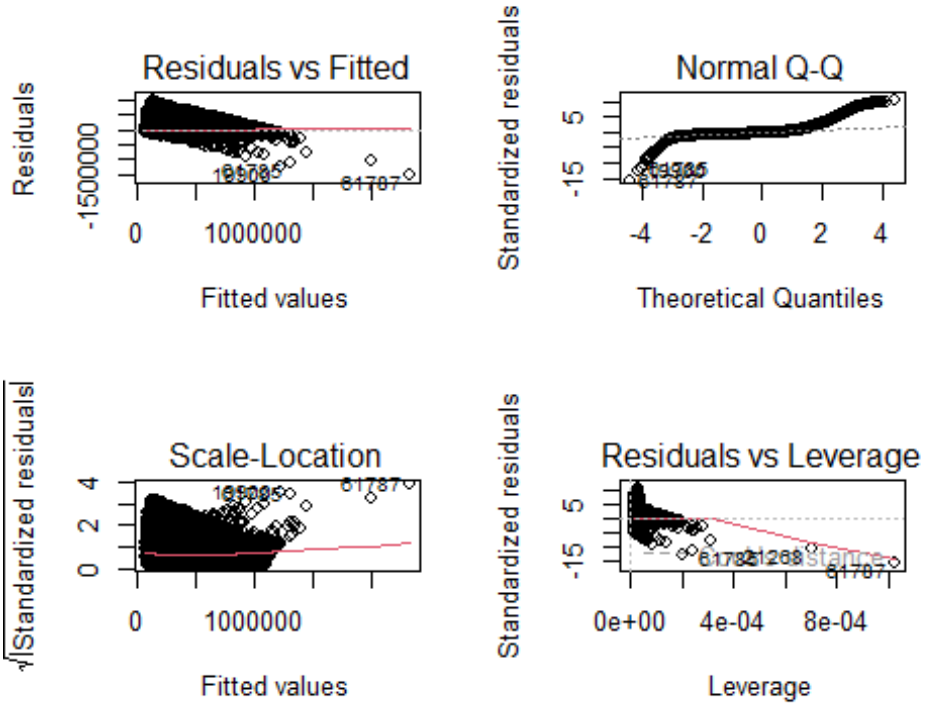



```
par(mfrow=c(1,1)) # Change back to 1 x 1

# view the model summary
summary(m2)

##
## Call:
## lm(formula = price ~ taxvaluedollarcnt, data = no_outliers)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1487009   -44399   -22876    13467   971142
##
## Coefficients:
##                     Estimate Std. Error t value Pr(>|t|)
## (Intercept)       7.481e+04  6.188e+02   120.9   <2e-16 ***
## taxvaluedollarcnt 9.218e-01  1.446e-03   637.7   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 94970 on 83477 degrees of freedom
## Multiple R-squared:  0.8297, Adjusted R-squared:  0.8297
## F-statistic: 4.066e+05 on 1 and 83477 DF,  p-value: < 2.2e-16

# plot a scatter plot of the price and the variable you chose
plot(no_outliers$taxvaluedollarcnt, no_outliers$price, main = "Price vs. Tax
Value Dollar Cnt", xlab = "Tax Value Dollar Cnt", ylab="Price")
```

```r
# add the regression line to the current plot using abline()
abline(m2, col = "blue")
```




```r
# R makes it very easy to plot the diagnostics of a fit
# here's a decent resources explaining the plots:
# http://data.library.virginia.edu/diagnostic-plots/
# plot the fit diagnostics here
par(mfrow=c(2,2)) # Change the panel layout to 2 x 2
plot(m2)
```




```
par(mfrow=c(1,1)) # Change back to 1 x 1
```

Conclusion

In conclusion, we found that when outliers were removed from the Price data from the Zillow dataset, the error was reduced overall but the simple linear regression model was also less correlated with the data, less accurately fit. This may be because the outliers helped to provide an indication of the general trend of the data and without them, the data was more scattered and thus it was more difficult to fit a model to the data. Overall, it was found that the Tax Value Dollar Count was the most correlated to home price, in both cases of outliers-included or outliers-removed.

In the future, we can improve this by finding other correlations between other variables in this dataset, or possibly by imputing null values instead of merely removing them. We can also include more columns or features from this dataset in our analysis and convert categorical data to numeric to give us more information to work with.

Thank you! Jeremy Beard