Data Analysis - Ames House Prices

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The Dataset

```
library(faraway)
library(dplyr)
```

```
##
## Attaching package: 'dplyr'
```

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

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

```
library(psych)
```

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

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

```
library(corrplot)
```

```
## corrplot 0.92 loaded
```

```
library(ggplot2)
```

```
##
## Attaching package: 'ggplot2'
```

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

```
library(ggcorrplot)
library(lares)
library(reshape2)

housing_data = read.csv("dataset\\AmesHousing.csv")

summary(housing_data)
```

```
##      Order             PID             MS.SubClass      MS.Zoning
##  Min.   :   1.0   Min.   :5.263e+08   Min.   : 20.00   Length:2930
##  1st Qu.: 733.2   1st Qu.:5.285e+08   1st Qu.: 20.00   Class :character
##  Median :1465.5   Median :5.355e+08   Median : 50.00   Mode  :character
##  Mean   :1465.5   Mean   :7.145e+08   Mean   : 57.39
##  3rd Qu.:2197.8   3rd Qu.:9.072e+08   3rd Qu.: 70.00
##  Max.   :2930.0   Max.   :1.007e+09   Max.   :190.00
##
##   Lot.Frontage       Lot.Area         Street             Alley
##  Min.   : 21.00   Min.   :  1300   Length:2930        Length:2930
##  1st Qu.: 58.00   1st Qu.:  7440   Class :character   Class :character
##  Median : 68.00   Median :  9436   Mode  :character   Mode  :character
##  Mean   : 69.22   Mean   : 10148
##  3rd Qu.: 80.00   3rd Qu.: 11555
##  Max.   :313.00   Max.   :215245
##  NA's   :490
##   Lot.Shape         Land.Contour        Utilities          Lot.Config
##  Length:2930        Length:2930        Length:2930        Length:2930
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
##
##
##   Land.Slope        Neighborhood       Condition.1        Condition.2
##  Length:2930        Length:2930        Length:2930        Length:2930
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
##
##
##   Bldg.Type         House.Style         Overall.Qual     Overall.Cond
##  Length:2930        Length:2930        Min.   : 1.000   Min.   :1.000
##  Class :character   Class :character   1st Qu.: 5.000   1st Qu.:5.000
##  Mode  :character   Mode  :character   Median : 6.000   Median :5.000
##                                        Mean   : 6.095   Mean   :5.563
##                                        3rd Qu.: 7.000   3rd Qu.:6.000
##                                        Max.   :10.000   Max.   :9.000
##
##    Year.Built   Year.Remod.Add  Roof.Style         Roof.Matl
##  Min.   :1872   Min.   :1950   Length:2930        Length:2930
##  1st Qu.:1954   1st Qu.:1965   Class :character   Class :character
##  Median :1973   Median :1993   Mode  :character   Mode  :character
##  Mean   :1971   Mean   :1984
##  3rd Qu.:2001   3rd Qu.:2004
##  Max.   :2010   Max.   :2010
##
##  Exterior.1st       Exterior.2nd       Mas.Vnr.Type        Mas.Vnr.Area
##  Length:2930        Length:2930        Length:2930        Min.   :   0.0
##  Class :character   Class :character   Class :character   1st Qu.:   0.0
##  Mode  :character   Mode  :character   Mode  :character   Median :   0.0
```

```
##                                                    Mean   : 101.9
##                                                    3rd Qu.: 164.0
##                                                    Max.   :1600.0
##                                                    NA's   :23
##   Exter.Qual         Exter.Cond         Foundation         Bsmt.Qual
##  Length:2930        Length:2930        Length:2930        Length:2930
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
##
##
##   Bsmt.Cond         Bsmt.Exposure      BsmtFin.Type.1      BsmtFin.SF.1
##  Length:2930        Length:2930        Length:2930        Min.   :   0.0
##  Class :character   Class :character   Class :character   1st Qu.:   0.0
##  Mode  :character   Mode  :character   Mode  :character   Median : 370.0
##                                                           Mean   : 442.6
##                                                           3rd Qu.: 734.0
##                                                           Max.   :5644.0
##                                                           NA's   :1
##  BsmtFin.Type.2      BsmtFin.SF.2      Bsmt.Unf.SF     Total.Bsmt.SF
##  Length:2930        Min.   :   0.00   Min.   :   0.0   Min.   :   0
##  Class :character   1st Qu.:   0.00   1st Qu.: 219.0   1st Qu.: 793
##  Mode  :character   Median :   0.00   Median : 466.0   Median : 990
##                     Mean   :  49.72   Mean   : 559.3   Mean   :1052
##                     3rd Qu.:   0.00   3rd Qu.: 802.0   3rd Qu.:1302
##                     Max.   :1526.00   Max.   :2336.0   Max.   :6110
##                     NA's   :1         NA's   :1        NA's   :1
##    Heating           Heating.QC        Central.Air         Electrical
##  Length:2930        Length:2930        Length:2930        Length:2930
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
##
##
##   X1st.Flr.SF      X2nd.Flr.SF     Low.Qual.Fin.SF     Gr.Liv.Area
##  Min.   : 334.0   Min.   :   0.0   Min.   :   0.000   Min.   : 334
##  1st Qu.: 876.2   1st Qu.:   0.0   1st Qu.:   0.000   1st Qu.:1126
##  Median :1084.0   Median :   0.0   Median :   0.000   Median :1442
##  Mean   :1159.6   Mean   : 335.5   Mean   :   4.677   Mean   :1500
##  3rd Qu.:1384.0   3rd Qu.: 703.8   3rd Qu.:   0.000   3rd Qu.:1743
##  Max.   :5095.0   Max.   :2065.0   Max.   :1064.000   Max.   :5642
##
##  Bsmt.Full.Bath   Bsmt.Half.Bath      Full.Bath       Half.Bath
##  Min.   :0.0000   Min.   :0.00000   Min.   :0.000   Min.   :0.0000
##  1st Qu.:0.0000   1st Qu.:0.00000   1st Qu.:1.000   1st Qu.:0.0000
##  Median :0.0000   Median :0.00000   Median :2.000   Median :0.0000
##  Mean   :0.4314   Mean   :0.06113   Mean   :1.567   Mean   :0.3795
##  3rd Qu.:1.0000   3rd Qu.:0.00000   3rd Qu.:2.000   3rd Qu.:1.0000
##  Max.   :3.0000   Max.   :2.00000   Max.   :4.000   Max.   :2.0000
##  NA's   :2        NA's   :2
```

```
##  Bedroom.AbvGr   Kitchen.AbvGr   Kitchen.Qual       TotRms.AbvGrd
##  Min.   :0.000   Min.   :0.000   Length:2930        Min.   : 2.000
##  1st Qu.:2.000   1st Qu.:1.000   Class :character   1st Qu.: 5.000
##  Median :3.000   Median :1.000   Mode  :character   Median : 6.000
##  Mean   :2.854   Mean   :1.044                      Mean   : 6.443
##  3rd Qu.:3.000   3rd Qu.:1.000                      3rd Qu.: 7.000
##  Max.   :8.000   Max.   :3.000                      Max.   :15.000
##
##   Functional          Fireplaces     Fireplace.Qu       Garage.Type
##  Length:2930        Min.   :0.0000   Length:2930        Length:2930
##  Class :character   1st Qu.:0.0000   Class :character   Class :character
##  Mode  :character   Median :1.0000   Mode  :character   Mode  :character
##                     Mean   :0.5993
##                     3rd Qu.:1.0000
##                     Max.   :4.0000
##
##  Garage.Yr.Blt  Garage.Finish       Garage.Cars     Garage.Area
##  Min.   :1895   Length:2930        Min.   :0.000   Min.   :   0.0
##  1st Qu.:1960   Class :character   1st Qu.:1.000   1st Qu.: 320.0
##  Median :1979   Mode  :character   Median :2.000   Median : 480.0
##  Mean   :1978                      Mean   :1.767   Mean   : 472.8
##  3rd Qu.:2002                      3rd Qu.:2.000   3rd Qu.: 576.0
##  Max.   :2207                      Max.   :5.000   Max.   :1488.0
##  NA's   :159                       NA's   :1       NA's   :1
##  Garage.Qual        Garage.Cond        Paved.Drive         Wood.Deck.SF
##  Length:2930        Length:2930        Length:2930        Min.   :   0.00
##  Class :character   Class :character   Class :character   1st Qu.:   0.00
##  Mode  :character   Mode  :character   Mode  :character   Median :   0.00
##                                                           Mean   :  93.75
##                                                           3rd Qu.: 168.00
##                                                           Max.   :1424.00
##
##  Open.Porch.SF    Enclosed.Porch     X3Ssn.Porch       Screen.Porch
##  Min.   :  0.00   Min.   :   0.00   Min.   :  0.000   Min.   :  0
##  1st Qu.:  0.00   1st Qu.:   0.00   1st Qu.:  0.000   1st Qu.:  0
##  Median : 27.00   Median :   0.00   Median :  0.000   Median :  0
##  Mean   : 47.53   Mean   :  23.01   Mean   :  2.592   Mean   : 16
##  3rd Qu.: 70.00   3rd Qu.:   0.00   3rd Qu.:  0.000   3rd Qu.:  0
##  Max.   :742.00   Max.   :1012.00   Max.   :508.000   Max.   :576
##
##    Pool.Area         Pool.QC            Fence           Misc.Feature
##  Min.   :  0.000   Length:2930        Length:2930        Length:2930
##  1st Qu.:  0.000   Class :character   Class :character   Class :character
##  Median :  0.000   Mode  :character   Mode  :character   Mode  :character
##  Mean   :  2.243
##  3rd Qu.:  0.000
##  Max.   :800.000
##
##     Misc.Val           Mo.Sold          Yr.Sold      Sale.Type
##  Min.   :    0.00   Min.   : 1.000   Min.   :2006   Length:2930
##  1st Qu.:    0.00   1st Qu.: 4.000   1st Qu.:2007   Class :character
##  Median :    0.00   Median : 6.000   Median :2008   Mode  :character
```

```
##  Mean   :   50.63   Mean   : 6.216   Mean   :2008
##  3rd Qu.:    0.00   3rd Qu.: 8.000   3rd Qu.:2009
##  Max.   :17000.00   Max.   :12.000   Max.   :2010
##
##  Sale.Condition       SalePrice
##  Length:2930        Min.   : 12789
##  Class :character   1st Qu.:129500
##  Mode  :character   Median :160000
##                     Mean   :180796
##                     3rd Qu.:213500
##                     Max.   :755000
##
```

```
nrow(housing_data)
```

```
## [1] 2930
```

```
ncol(housing_data)
```

```
## [1] 82
```

```
# Using small chunk of dataset for quick testing :)

#housing_data = housing_data[1:100,]
#str(housing_data)

# Coercing categorical predictors into factor variables

housing_data$MS.Zoning = as.factor(housing_data$MS.Zoning)
housing_data$Street = as.factor(housing_data$Street)
housing_data$Lot.Shape = as.factor(housing_data$Lot.Shape)
housing_data$Land.Contour = as.factor(housing_data$Land.Contour)
housing_data$Utilities = as.factor(housing_data$Utilities)
housing_data$Lot.Config = as.factor(housing_data$Lot.Config)
housing_data$Land.Slope = as.factor(housing_data$Land.Slope)
housing_data$Bldg.Type = as.factor(housing_data$Bldg.Type)
housing_data$House.Style = as.factor(housing_data$House.Style)
housing_data$Roof.Style = as.factor(housing_data$Roof.Style)
housing_data$Foundation = as.factor(housing_data$Foundation)

str(housing_data)
```

```
## 'data.frame':    2930 obs. of  82 variables:
##  $ Order          : int  1 2 3 4 5 6 7 8 9 10 ...
##  $ PID            : int  526301100 526350040 526351010 526353030 527105010 527105030 52712715
0 527145080 527146030 527162130 ...
##  $ MS.SubClass    : int  20 20 20 20 60 60 120 120 120 60 ...
##  $ MS.Zoning      : Factor w/ 7 levels "A (agr)","C (all)",..: 6 5 6 6 6 6 6 6 6 6 ...
##  $ Lot.Frontage   : int  141 80 81 93 74 78 41 43 39 60 ...
##  $ Lot.Area       : int  31770 11622 14267 11160 13830 9978 4920 5005 5389 7500 ...
##  $ Street         : Factor w/ 2 levels "Grvl","Pave": 2 2 2 2 2 2 2 2 2 2 ...
##  $ Alley          : chr  NA NA NA NA ...
##  $ Lot.Shape      : Factor w/ 4 levels "IR1","IR2","IR3",..: 1 4 1 4 1 1 4 1 1 4 ...
##  $ Land.Contour   : Factor w/ 4 levels "Bnk","HLS","Low",..: 4 4 4 4 4 4 4 2 4 4 ...
##  $ Utilities      : Factor w/ 3 levels "AllPub","NoSeWa",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ Lot.Config     : Factor w/ 5 levels "Corner","CulDSac",..: 1 5 1 1 5 5 5 5 5 5 ...
##  $ Land.Slope     : Factor w/ 3 levels "Gtl","Mod","Sev": 1 1 1 1 1 1 1 1 1 1 ...
##  $ Neighborhood   : chr  "NAmes" "NAmes" "NAmes" "NAmes" ...
##  $ Condition.1    : chr  "Norm" "Feedr" "Norm" "Norm" ...
##  $ Condition.2    : chr  "Norm" "Norm" "Norm" "Norm" ...
##  $ Bldg.Type      : Factor w/ 5 levels "1Fam","2fmCon",..: 1 1 1 1 1 1 5 5 5 1 ...
##  $ House.Style    : Factor w/ 8 levels "1.5Fin","1.5Unf",..: 3 3 3 3 6 6 3 3 3 6 ...
##  $ Overall.Qual   : int  6 5 6 7 5 6 8 8 8 7 ...
##  $ Overall.Cond   : int  5 6 6 5 5 6 5 5 5 5 ...
##  $ Year.Built     : int  1960 1961 1958 1968 1997 1998 2001 1992 1995 1999 ...
##  $ Year.Remod.Add : int  1960 1961 1958 1968 1998 1998 2001 1992 1996 1999 ...
##  $ Roof.Style     : Factor w/ 6 levels "Flat","Gable",..: 4 2 4 4 2 2 2 2 2 2 ...
##  $ Roof.Matl      : chr  "CompShg" "CompShg" "CompShg" "CompShg" ...
##  $ Exterior.1st   : chr  "BrkFace" "VinylSd" "Wd Sdng" "BrkFace" ...
##  $ Exterior.2nd   : chr  "Plywood" "VinylSd" "Wd Sdng" "BrkFace" ...
##  $ Mas.Vnr.Type   : chr  "Stone" "None" "BrkFace" "None" ...
##  $ Mas.Vnr.Area   : int  112 0 108 0 0 20 0 0 0 0 ...
##  $ Exter.Qual     : chr  "TA" "TA" "TA" "Gd" ...
##  $ Exter.Cond     : chr  "TA" "TA" "TA" "TA" ...
##  $ Foundation     : Factor w/ 6 levels "BrkTil","CBlock",..: 2 2 2 2 3 3 3 3 3 3 ...
##  $ Bsmt.Qual      : chr  "TA" "TA" "TA" "TA" ...
##  $ Bsmt.Cond      : chr  "Gd" "TA" "TA" "TA" ...
##  $ Bsmt.Exposure  : chr  "Gd" "No" "No" "No" ...
##  $ BsmtFin.Type.1 : chr  "BLQ" "Rec" "ALQ" "ALQ" ...
##  $ BsmtFin.SF.1   : int  639 468 923 1065 791 602 616 263 1180 0 ...
##  $ BsmtFin.Type.2 : chr  "Unf" "LwQ" "Unf" "Unf" ...
##  $ BsmtFin.SF.2   : int  0 144 0 0 0 0 0 0 0 0 ...
##  $ Bsmt.Unf.SF    : int  441 270 406 1045 137 324 722 1017 415 994 ...
##  $ Total.Bsmt.SF  : int  1080 882 1329 2110 928 926 1338 1280 1595 994 ...
##  $ Heating        : chr  "GasA" "GasA" "GasA" "GasA" ...
##  $ Heating.QC     : chr  "Fa" "TA" "TA" "Ex" ...
##  $ Central.Air    : chr  "Y" "Y" "Y" "Y" ...
##  $ Electrical     : chr  "SBrkr" "SBrkr" "SBrkr" "SBrkr" ...
##  $ X1st.Flr.SF    : int  1656 896 1329 2110 928 926 1338 1280 1616 1028 ...
##  $ X2nd.Flr.SF    : int  0 0 0 0 701 678 0 0 0 776 ...
##  $ Low.Qual.Fin.SF: int  0 0 0 0 0 0 0 0 0 0 ...
##  $ Gr.Liv.Area    : int  1656 896 1329 2110 1629 1604 1338 1280 1616 1804 ...
##  $ Bsmt.Full.Bath : int  1 0 0 1 0 0 1 0 1 0 ...
##  $ Bsmt.Half.Bath : int  0 0 0 0 0 0 0 0 0 0 ...
```

```
##  $ Full.Bath      : int  1 1 1 2 2 2 2 2 2 ...
##  $ Half.Bath      : int  0 0 1 1 1 1 0 0 0 1 ...
##  $ Bedroom.AbvGr  : int  3 2 3 3 3 3 2 2 2 3 ...
##  $ Kitchen.AbvGr  : int  1 1 1 1 1 1 1 1 1 1 ...
##  $ Kitchen.Qual   : chr  "TA" "TA" "Gd" "Ex" ...
##  $ TotRms.AbvGrd  : int  7 5 6 8 6 7 6 5 5 7 ...
##  $ Functional     : chr  "Typ" "Typ" "Typ" "Typ" ...
##  $ Fireplaces     : int  2 0 0 2 1 1 0 0 1 1 ...
##  $ Fireplace.Qu   : chr  "Gd" NA NA "TA" ...
##  $ Garage.Type    : chr  "Attchd" "Attchd" "Attchd" "Attchd" ...
##  $ Garage.Yr.Blt  : int  1960 1961 1958 1968 1997 1998 2001 1992 1995 1999 ...
##  $ Garage.Finish  : chr  "Fin" "Unf" "Unf" "Fin" ...
##  $ Garage.Cars    : int  2 1 1 2 2 2 2 2 2 ...
##  $ Garage.Area    : int  528 730 312 522 482 470 582 506 608 442 ...
##  $ Garage.Qual    : chr  "TA" "TA" "TA" "TA" ...
##  $ Garage.Cond    : chr  "TA" "TA" "TA" "TA" ...
##  $ Paved.Drive    : chr  "P" "Y" "Y" "Y" ...
##  $ Wood.Deck.SF   : int  210 140 393 0 212 360 0 0 237 140 ...
##  $ Open.Porch.SF  : int  62 0 36 0 34 36 0 82 152 60 ...
##  $ Enclosed.Porch : int  0 0 0 0 0 0 170 0 0 0 ...
##  $ X3Ssn.Porch    : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ Screen.Porch   : int  0 120 0 0 0 0 0 144 0 0 ...
##  $ Pool.Area      : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ Pool.QC        : chr  NA NA NA NA ...
##  $ Fence          : chr  NA "MnPrv" NA NA ...
##  $ Misc.Feature   : chr  NA NA "Gar2" NA ...
##  $ Misc.Val       : int  0 0 12500 0 0 0 0 0 0 0 ...
##  $ Mo.Sold        : int  5 6 6 4 3 6 4 1 3 6 ...
##  $ Yr.Sold        : int  2010 2010 2010 2010 2010 2010 2010 2010 2010 2010 ...
##  $ Sale.Type      : chr  "WD " "WD " "WD " "WD " ...
##  $ Sale.Condition : chr  "Normal" "Normal" "Normal" "Normal" ...
##  $ SalePrice      : int  215000 105000 172000 244000 189900 195500 213500 191500 236500 18900
0 ...
```

First few examples:

```
housing_data$SalePrice[1:10]
```

```
##  [1] 215000 105000 172000 244000 189900 195500 213500 191500 236500 189000
```

```
housing_data$Lot.Area[1:10]
```

```
##  [1] 31770 11622 14267 11160 13830  9978  4920  5005  5389  7500
```

```
housing_data$Utilities[1:10]
```

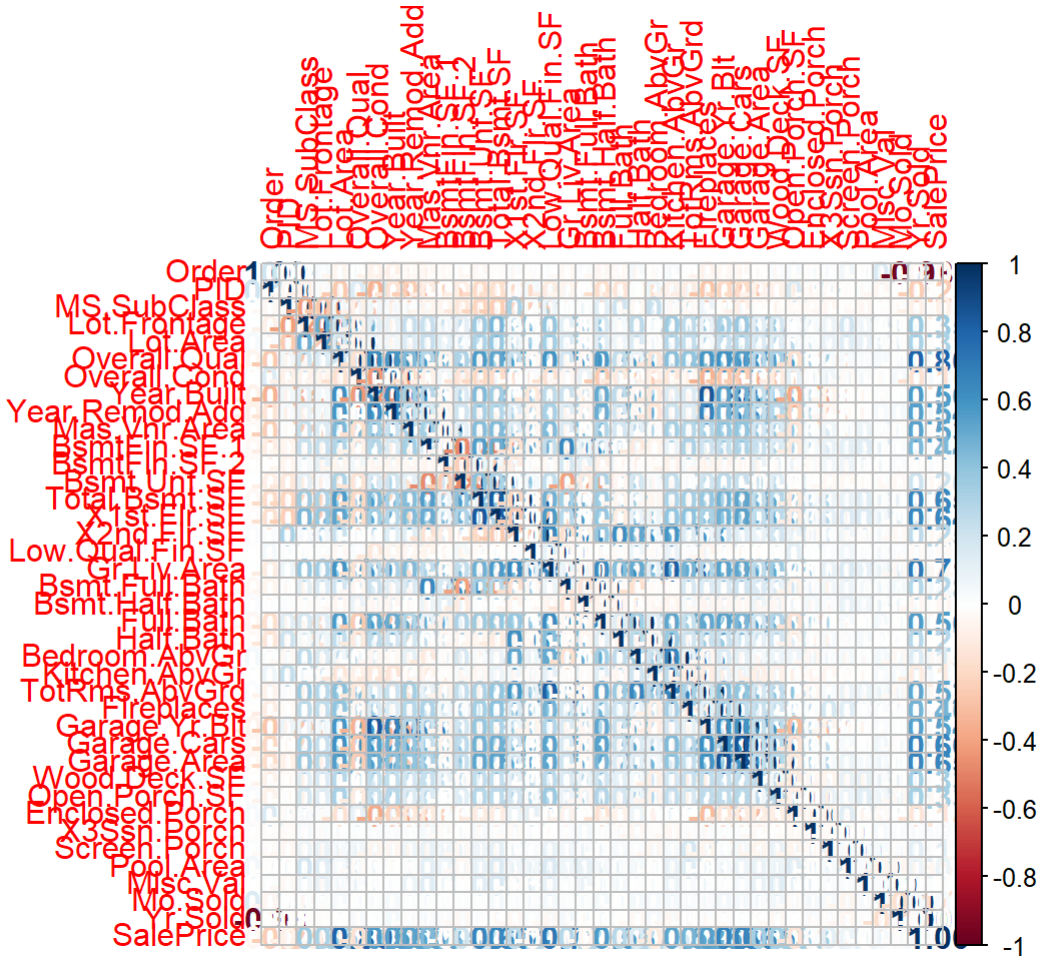
```
##  [1] AllPub AllPub AllPub AllPub AllPub AllPub AllPub AllPub AllPub AllPub
## Levels: AllPub NoSeWa NoSewr
```

Collinearity and correlation analysis

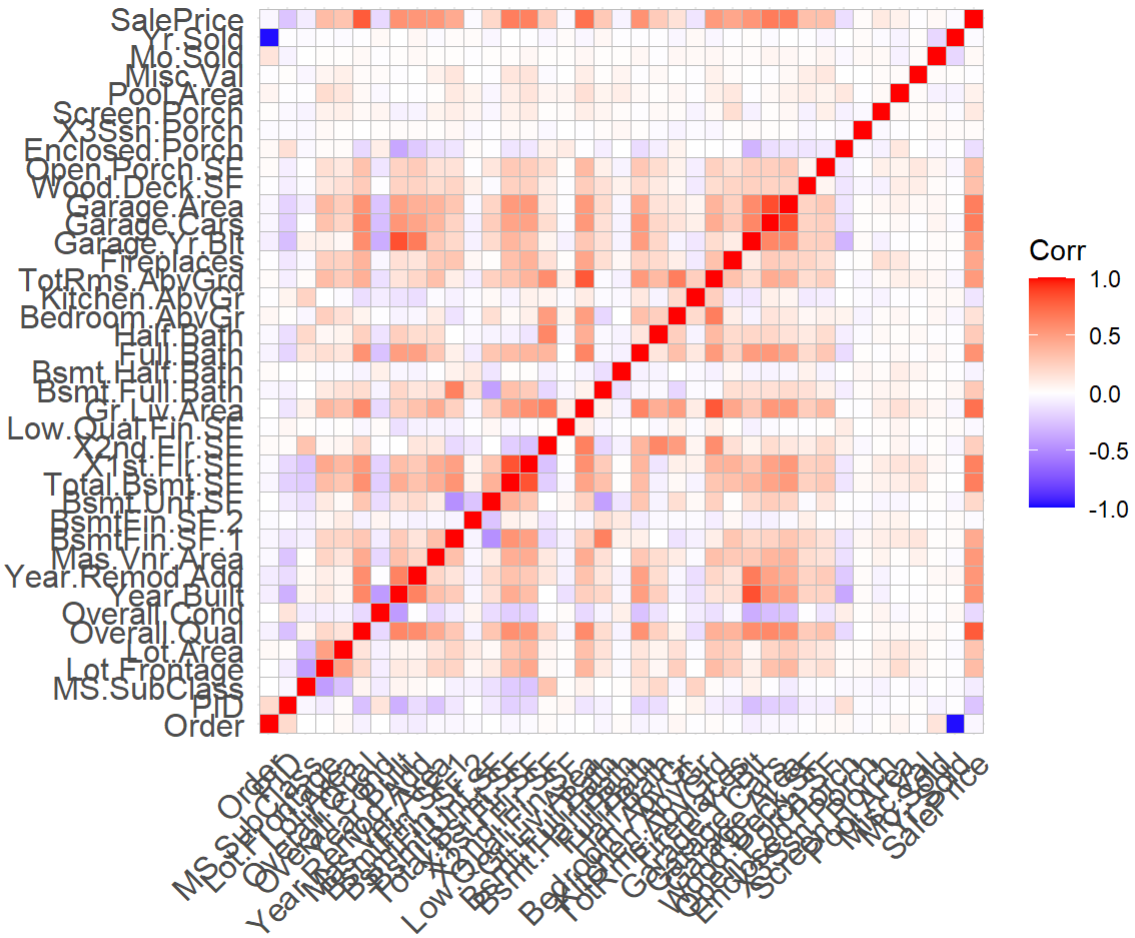
```
# Subsetting all the numeric elements of the dataset for collinearity and correlation analysis:

n_idxs = unlist(lapply(housing_data, is.numeric), use.names = FALSE)
numeric_housing_data = housing_data[, n_idxs]

str(numeric_housing_data)
```

```
## 'data.frame':    2930 obs. of  39 variables:
##  $ Order          : int  1 2 3 4 5 6 7 8 9 10 ...
##  $ PID            : int  526301100 526350040 526351010 526353030 527105010 527105030 52712715
0 527145080 527146030 527162130 ...
##  $ MS.SubClass    : int  20 20 20 20 60 60 120 120 120 60 ...
##  $ Lot.Frontage   : int  141 80 81 93 74 78 41 43 39 60 ...
##  $ Lot.Area       : int  31770 11622 14267 11160 13830 9978 4920 5005 5389 7500 ...
##  $ Overall.Qual   : int  6 5 6 7 5 6 8 8 8 7 ...
##  $ Overall.Cond   : int  5 6 6 5 5 6 5 5 5 5 ...
##  $ Year.Built     : int  1960 1961 1958 1968 1997 1998 2001 1992 1995 1999 ...
##  $ Year.Remod.Add : int  1960 1961 1958 1968 1998 1998 2001 1992 1996 1999 ...
##  $ Mas.Vnr.Area   : int  112 0 108 0 0 20 0 0 0 0 ...
##  $ BsmtFin.SF.1   : int  639 468 923 1065 791 602 616 263 1180 0 ...
##  $ BsmtFin.SF.2   : int  0 144 0 0 0 0 0 0 0 0 ...
##  $ Bsmt.Unf.SF    : int  441 270 406 1045 137 324 722 1017 415 994 ...
##  $ Total.Bsmt.SF  : int  1080 882 1329 2110 928 926 1338 1280 1595 994 ...
##  $ X1st.Flr.SF    : int  1656 896 1329 2110 928 926 1338 1280 1616 1028 ...
##  $ X2nd.Flr.SF    : int  0 0 0 0 701 678 0 0 0 776 ...
##  $ Low.Qual.Fin.SF: int  0 0 0 0 0 0 0 0 0 0 ...
##  $ Gr.Liv.Area    : int  1656 896 1329 2110 1629 1604 1338 1280 1616 1804 ...
##  $ Bsmt.Full.Bath : int  1 0 0 1 0 0 1 0 1 0 ...
##  $ Bsmt.Half.Bath : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ Full.Bath      : int  1 1 1 2 2 2 2 2 2 2 ...
##  $ Half.Bath      : int  0 0 1 1 1 1 0 0 0 1 ...
##  $ Bedroom.AbvGr  : int  3 2 3 3 3 3 2 2 2 3 ...
##  $ Kitchen.AbvGr  : int  1 1 1 1 1 1 1 1 1 1 ...
##  $ TotRms.AbvGrd  : int  7 5 6 8 6 7 6 5 5 7 ...
##  $ Fireplaces     : int  2 0 0 2 1 1 0 0 1 1 ...
##  $ Garage.Yr.Blt  : int  1960 1961 1958 1968 1997 1998 2001 1992 1995 1999 ...
##  $ Garage.Cars    : int  2 1 1 2 2 2 2 2 2 2 ...
##  $ Garage.Area    : int  528 730 312 522 482 470 582 506 608 442 ...
##  $ Wood.Deck.SF   : int  210 140 393 0 212 360 0 0 237 140 ...
##  $ Open.Porch.SF  : int  62 0 36 0 34 36 0 82 152 60 ...
##  $ Enclosed.Porch : int  0 0 0 0 0 0 170 0 0 0 ...
##  $ X3Ssn.Porch    : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ Screen.Porch   : int  0 120 0 0 0 0 0 144 0 0 ...
##  $ Pool.Area      : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ Misc.Val       : int  0 0 12500 0 0 0 0 0 0 0 ...
##  $ Mo.Sold        : int  5 6 6 4 3 6 4 1 3 6 ...
##  $ Yr.Sold        : int  2010 2010 2010 2010 2010 2010 2010 2010 2010 2010 ...
##  $ SalePrice      : int  215000 105000 172000 244000 189900 195500 213500 191500 236500 18900
0 ...
```

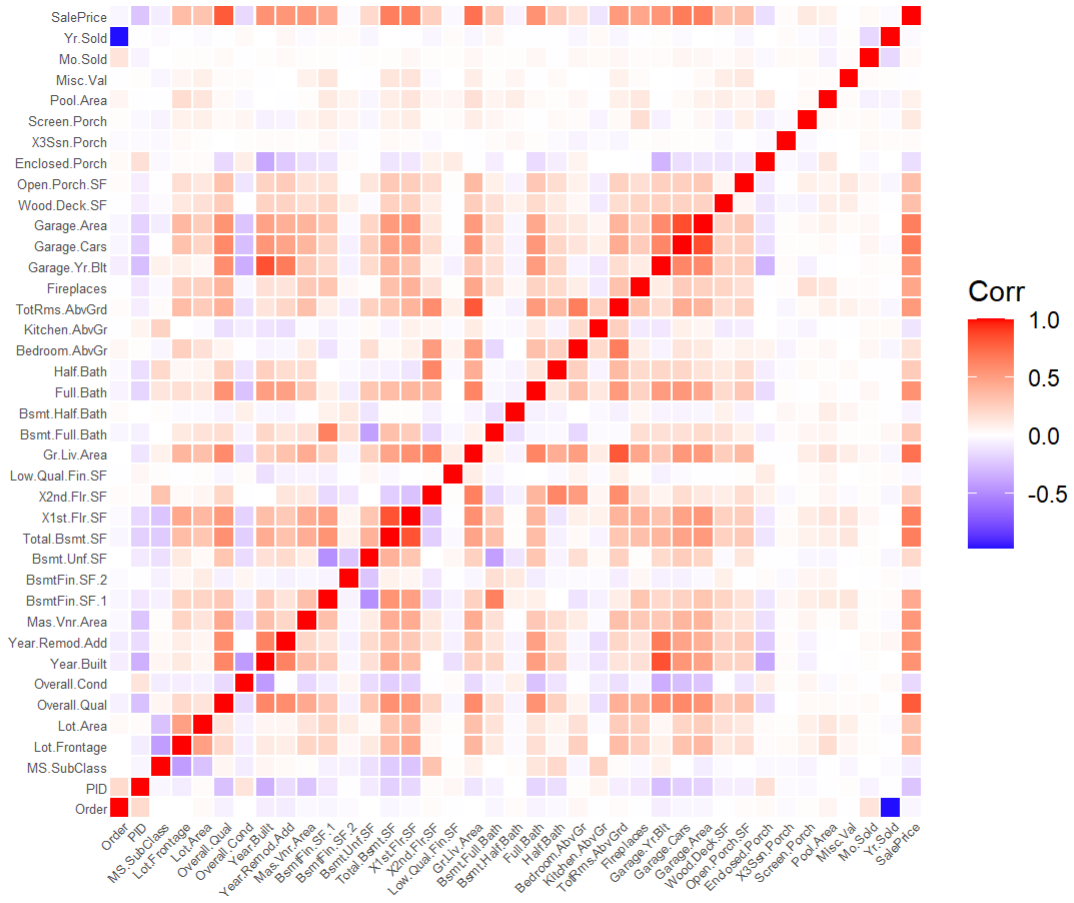
```
# MUST specify use = "complete.obs" argument to ignore NA's in dataset
corrs = round(cor(numeric_housing_data, use="complete.obs"), 2)
corrplot(corrs, method="number")
```




```
ggcorrplot(corrs, lab_size = 0.1)
```




```
#corrs

ggplot(melt(corrs), aes(Var1, Var2, fill=value)) +
  geom_tile(height=0.9, width=0.9) +
  scale_fill_gradient2(low="blue", mid="white", high="red") +
  theme_minimal() +
  coord_equal() +
  labs(x="",y="",fill="Corr") +
  theme(axis.text.x=element_text(size=5, angle=45, vjust=1, hjust=1,
                                 margin=margin(-3,0,0,0)),
        axis.text.y=element_text(size=5, margin=margin(0,-3,0,0)),
        panel.grid.major=element_blank())
```



Taking a closer look at some of the most correlated predictors:

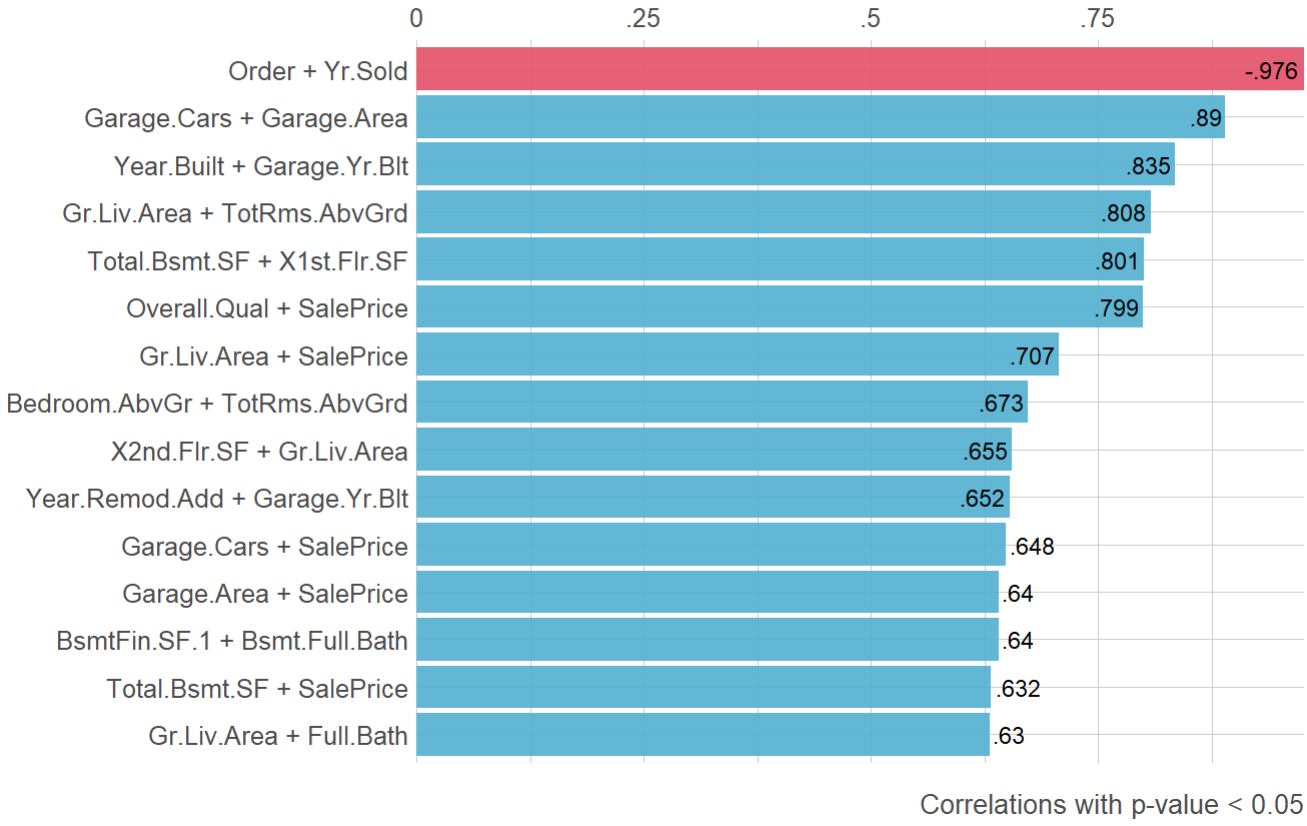
```
corr_cross(numeric_housing_data,
  max_pvalue = 0.05,
  top = 15
)
```

```
## Returning only the top 15. You may override with the 'top' argument
```

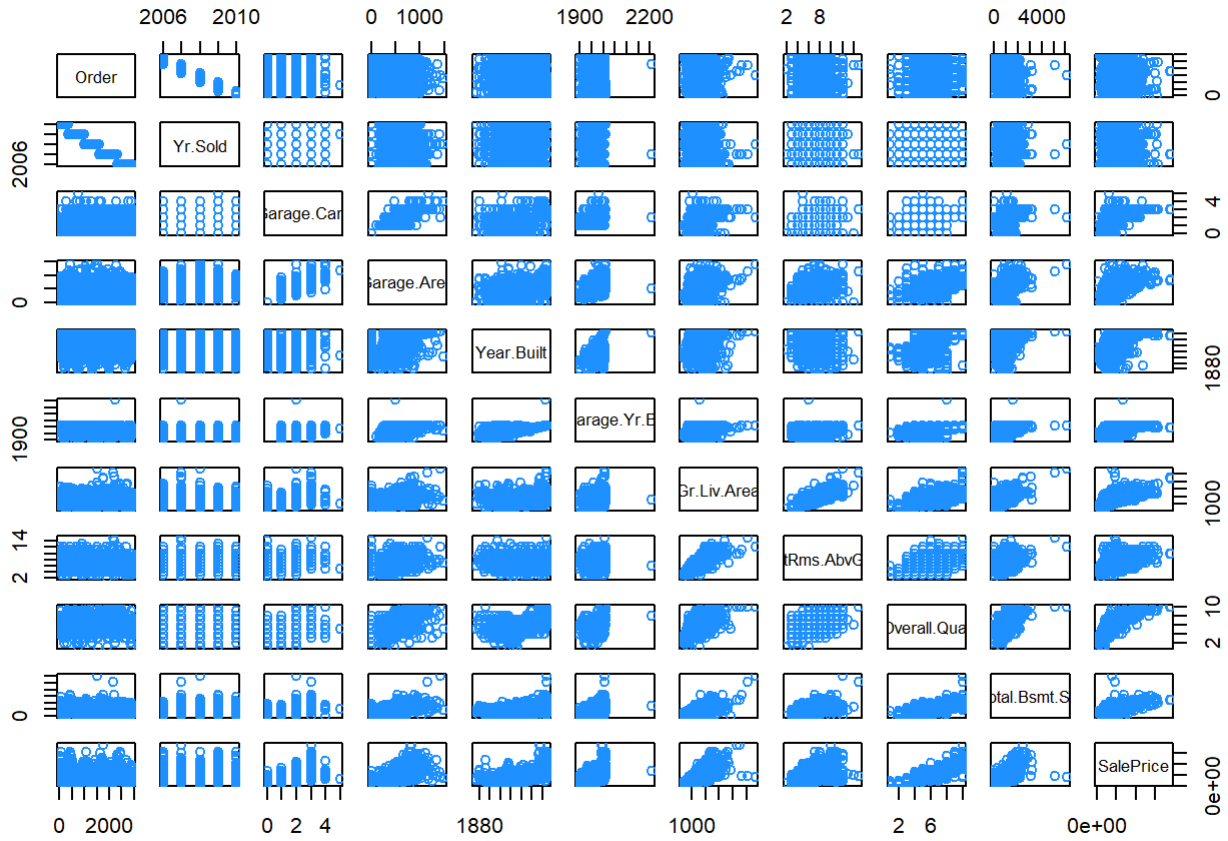
```
## Warning in .font_global(font, quiet = FALSE): Font 'Arial Narrow' is not
## installed, has other name, or can't be found
```

Ranked Cross-Correlations

15 most relevant




```
# A few of these further visualized in pairs:

corr_data = numeric_housing_data[, c("Order", "Yr.Sold", "Garage.Cars", "Garage.Area", "Year.Bui
lt", "Garage.Yr.Blt", "Gr.Liv.Area", "TotRms.AbvGrd", "Overall.Qual", "Total.Bsmt.SF", "SalePric
e")]

pairs(corr_data, col = "dodgerblue")
```



While some of these high correlation measures are to be expected, such as house year built along garage year built, we can also see some non-trivial patterns start to emerge from the more continuous numeric predictors.

Basic Regression Models

```
#sapply(lapply(housing_data, unique), length)


# lm() complains when it runs into "NA" values in dataframe, so just replacing any with 0 for no
w...
housing_data[is.na(housing_data)] <- 0



full_additive = lm(SalePrice ~ ., data = housing_data)
summary(full_additive)
```

```
##
## Call:
## lm(formula = SalePrice ~ ., data = housing_data)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -295016   -9412     251    9049  145976
##
## Coefficients: (13 not defined because of singularities)
##                         Estimate Std. Error t value Pr(>|t|)
## (Intercept)            3.228e+06  7.730e+06   0.418 0.676257
## Order                 -2.673e+00  6.099e+00  -0.438 0.661254
## PID                    1.176e-05  7.583e-06   1.551 0.121065
## MS.SubClass           -6.378e+01  5.004e+01  -1.275 0.202593
## MS.ZoningC (all)       8.692e+03  3.045e+04   0.285 0.775285
## MS.ZoningFV            1.807e+04  2.999e+04   0.603 0.546821
## MS.ZoningI (all)       3.379e+04  3.575e+04   0.945 0.344658
## MS.ZoningRH            2.408e+04  3.052e+04   0.789 0.430275
## MS.ZoningRL            2.019e+04  2.974e+04   0.679 0.497142
## MS.ZoningRM            1.277e+04  2.985e+04   0.428 0.668852
## Lot.Frontage           1.466e+01  1.502e+01   0.976 0.329127
## Lot.Area               5.969e-01  7.965e-02   7.494 9.08e-14 ***
## StreetPave             1.996e+04  7.518e+03   2.655 0.007975 **
## AlleyGrvl              8.764e+02  2.554e+03   0.343 0.731549
## AlleyPave             -1.363e+03  3.133e+03  -0.435 0.663562
## Lot.ShapeIR2           3.758e+03  2.771e+03   1.356 0.175251
## Lot.ShapeIR3           1.693e+03  5.972e+03   0.284 0.776795
## Lot.ShapeReg           1.182e+03  1.072e+03   1.103 0.270234
## Land.ContourHLS        8.342e+03  3.251e+03   2.566 0.010353 *
## Land.ContourLow       -6.058e+03  4.224e+03  -1.434 0.151702
## Land.ContourLvl        4.399e+03  2.402e+03   1.832 0.067129 .
## UtilitiesNoSeWa       -2.173e+04  2.306e+04  -0.942 0.346256
## UtilitiesNoSewr       -2.251e+04  1.883e+04  -1.196 0.231928
## Lot.ConfigCulDSac      4.959e+03  2.144e+03   2.313 0.020793 *
## Lot.ConfigFR2         -4.919e+03  2.749e+03  -1.789 0.073695 .
## Lot.ConfigFR3         -3.087e+03  6.255e+03  -0.493 0.621734
## Lot.ConfigInside      -1.291e+02  1.152e+03  -0.112 0.910754
## Land.SlopeMod          5.484e+03  2.594e+03   2.114 0.034629 *
## Land.SlopeSev         -2.499e+04  7.871e+03  -3.175 0.001516 **
## NeighborhoodBlueste    4.836e+03  9.289e+03   0.521 0.602678
## NeighborhoodBrDale     6.709e+03  7.492e+03   0.896 0.370583
## NeighborhoodBrkSide   -5.597e+03  6.328e+03  -0.884 0.376533
## NeighborhoodClearCr   -1.398e+04  6.736e+03  -2.076 0.037991 *
## NeighborhoodCollgCr   -1.342e+04  5.647e+03  -2.377 0.017535 *
## NeighborhoodCrawfor    2.026e+03  6.242e+03   0.325 0.745470
## NeighborhoodEdwards   -2.080e+04  5.933e+03  -3.506 0.000463 ***
## NeighborhoodGilbert   -1.118e+04  5.200e+03  -2.149 0.031690 *
## NeighborhoodGreens     6.671e+03  9.662e+03   0.690 0.489963
## NeighborhoodGrnHill    1.030e+05  1.676e+04   6.148 9.01e-10 ***
## NeighborhoodIDOTRR    -1.168e+04  6.968e+03  -1.676 0.093791 .
## NeighborhoodLandmrk   -1.163e+04  2.303e+04  -0.505 0.613563
## NeighborhoodMeadowV   -3.595e+03  7.768e+03  -0.463 0.643511
```

```
## NeighborhoodMitchel   -1.888e+04  6.217e+03  -3.037 0.002416 **
## NeighborhoodNAmes     -1.454e+04  5.348e+03  -2.718 0.006609 **
## NeighborhoodNoRidge    2.443e+04  5.762e+03   4.239 2.32e-05 ***
## NeighborhoodNPkVill    1.375e+04  1.026e+04   1.340 0.180207
## NeighborhoodNridgHt    1.498e+04  5.130e+03   2.920 0.003530 **
## NeighborhoodNWAmes    -1.625e+04  5.441e+03  -2.987 0.002847 **
## NeighborhoodOldTown   -1.578e+04  6.344e+03  -2.487 0.012927 *
## NeighborhoodSawyer    -1.152e+04  5.733e+03  -2.009 0.044616 *
## NeighborhoodSawyerW   -1.257e+04  5.364e+03  -2.343 0.019184 *
## NeighborhoodSomerst    9.345e+03  5.951e+03   1.570 0.116458
## NeighborhoodStoneBr    3.510e+04  5.720e+03   6.135 9.78e-10 ***
## NeighborhoodSWISU     -1.619e+04  6.892e+03  -2.349 0.018906 *
## NeighborhoodTimber    -1.294e+04  6.297e+03  -2.055 0.039948 *
## NeighborhoodVeenker   -1.099e+04  6.923e+03  -1.588 0.112438
## Condition.1Feedr       4.457e+03  3.141e+03   1.419 0.155997
## Condition.1Norm        1.286e+04  2.603e+03   4.939 8.35e-07 ***
## Condition.1PosA        1.298e+04  5.973e+03   2.173 0.029855 *
## Condition.1PosN        1.800e+04  4.623e+03   3.894 0.000101 ***
## Condition.1RRAe        1.362e+03  5.358e+03   0.254 0.799333
## Condition.1RRAn        7.425e+03  4.362e+03   1.702 0.088858 .
## Condition.1RRNe        4.262e+03  9.664e+03   0.441 0.659215
## Condition.1RRNn       -1.808e+02  8.023e+03  -0.023 0.982019
## Condition.2Feedr      -7.740e+03  1.203e+04  -0.643 0.520122
## Condition.2Norm        7.247e+02  1.043e+04   0.069 0.944636
## Condition.2PosA        5.537e+04  1.589e+04   3.484 0.000503 ***
## Condition.2PosN       -1.208e+05  1.575e+04  -7.669 2.41e-14 ***
## Condition.2RRAe       -3.881e+04  3.084e+04  -1.258 0.208447
## Condition.2RRAn        1.344e+03  2.437e+04   0.055 0.956015
## Condition.2RRNn        7.838e+03  1.887e+04   0.415 0.677959
## Bldg.Type2fmCon       -2.918e+03  7.725e+03  -0.378 0.705650
## Bldg.TypeDuplex       -1.317e+04  4.783e+03  -2.753 0.005951 **
## Bldg.TypeTwnhs        -2.100e+04  6.058e+03  -3.466 0.000536 ***
## Bldg.TypeTwnhsE       -1.345e+04  5.402e+03  -2.489 0.012854 *
## House.Style1.5Unf      8.021e+03  5.650e+03   1.420 0.155816
## House.Style1Story      5.836e+03  2.691e+03   2.169 0.030176 *
## House.Style2.5Fin     -1.640e+04  9.571e+03  -1.713 0.086830 .
## House.Style2.5Unf     -2.362e+03  5.410e+03  -0.437 0.662432
## House.Style2Story     -1.814e+03  2.178e+03  -0.833 0.405042
## House.StyleSFoyer      6.158e+03  3.887e+03   1.584 0.113235
## House.StyleSLvl        4.571e+03  3.408e+03   1.341 0.179924
## Overall.Qual           6.323e+03  6.409e+02   9.867  < 2e-16 ***
## Overall.Cond           5.814e+03  5.514e+02  10.545  < 2e-16 ***
## Year.Built             3.164e+02  4.949e+01   6.394 1.90e-10 ***
## Year.Remod.Add         6.838e+01  3.527e+01   1.939 0.052623 .
## Roof.StyleGable        8.317e+03  1.010e+04   0.823 0.410417
## Roof.StyleGambrel      7.427e+03  1.129e+04   0.658 0.510840
## Roof.StyleHip          8.540e+03  1.018e+04   0.839 0.401779
## Roof.StyleMansard     -2.356e+03  1.252e+04  -0.188 0.850738
## Roof.StyleShed         2.805e+04  1.723e+04   1.628 0.103561
## Roof.MatlCompShg       6.716e+05  3.220e+04  20.855  < 2e-16 ***
## Roof.MatlMembran       7.318e+05  4.137e+04  17.690  < 2e-16 ***
## Roof.MatlMetal         7.141e+05  4.124e+04  17.315  < 2e-16 ***
```

```
## Roof.MatlRoll          6.706e+05  3.922e+04  17.096  < 2e-16 ***
## Roof.MatlTar&Grv       6.710e+05  3.333e+04  20.131  < 2e-16 ***
## Roof.MatlWdShake       6.707e+05  3.337e+04  20.098  < 2e-16 ***
## Roof.MatlWdShngl       7.238e+05  3.330e+04  21.735  < 2e-16 ***
## Exterior.1stAsphShn   -1.090e+04  2.381e+04  -0.458 0.647075
## Exterior.1stBrkComm    6.493e+03  1.354e+04   0.480 0.631551
## Exterior.1stBrkFace    1.720e+04  7.958e+03   2.161 0.030786 *
## Exterior.1stCBlock     7.862e+03  2.777e+04   0.283 0.777089
## Exterior.1stCemntBd   -7.406e+03  1.265e+04  -0.585 0.558400
## Exterior.1stHdBoard   -4.710e+03  7.779e+03  -0.606 0.544876
## Exterior.1stImStucc   -2.058e+04  2.393e+04  -0.860 0.389704
## Exterior.1stMetalSd    2.680e+03  8.739e+03   0.307 0.759087
## Exterior.1stPlywood   -2.518e+03  7.636e+03  -0.330 0.741641
## Exterior.1stPreCast    6.010e+04  2.333e+04   2.576 0.010034 *
## Exterior.1stStone     -1.443e+03  1.905e+04  -0.076 0.939620
## Exterior.1stStucco     1.898e+03  8.624e+03   0.220 0.825866
## Exterior.1stVinylSd   -8.576e+03  8.470e+03  -1.013 0.311363
## Exterior.1stWd Sdng   -1.302e+03  7.508e+03  -0.173 0.862323
## Exterior.1stWdShing   -3.765e+03  8.136e+03  -0.463 0.643556
## Exterior.2ndAsphShn    1.487e+04  1.801e+04   0.825 0.409231
## Exterior.2ndBrk Cmn   -4.801e+03  1.235e+04  -0.389 0.697424
## Exterior.2ndBrkFace   -5.086e+03  8.756e+03  -0.581 0.561393
## Exterior.2ndCBlock     9.937e+02  2.290e+04   0.043 0.965397
## Exterior.2ndCmentBd    7.801e+03  1.286e+04   0.607 0.543993
## Exterior.2ndHdBoard    2.884e+03  8.021e+03   0.360 0.719204
## Exterior.2ndImStucc    6.101e+03  9.725e+03   0.627 0.530439
## Exterior.2ndMetalSd   -2.666e+02  8.944e+03  -0.030 0.976227
## Exterior.2ndOther     -1.317e+04  2.360e+04  -0.558 0.576914
## Exterior.2ndPlywood    4.241e+02  7.728e+03   0.055 0.956236
## Exterior.2ndPreCast           NA         NA      NA       NA
## Exterior.2ndStone     -1.277e+04  1.318e+04  -0.969 0.332620
## Exterior.2ndStucco     1.858e+03  8.818e+03   0.211 0.833121
## Exterior.2ndVinylSd    1.011e+04  8.658e+03   1.168 0.242818
## Exterior.2ndWd Sdng    1.528e+03  7.774e+03   0.197 0.844161
## Exterior.2ndWd Shng    2.615e+03  8.146e+03   0.321 0.748239
## Mas.Vnr.TypeBrkCmn    -8.166e+03  6.563e+03  -1.244 0.213526
## Mas.Vnr.TypeBrkFace   -3.976e+03  4.839e+03  -0.822 0.411286
## Mas.Vnr.TypeCBlock    -8.850e+04  2.720e+04  -3.253 0.001156 **
## Mas.Vnr.TypeNone       6.980e+02  4.717e+03   0.148 0.882383
## Mas.Vnr.TypeStone      1.209e+03  4.921e+03   0.246 0.805892
## Mas.Vnr.Area           2.428e+01  3.816e+00   6.363 2.32e-10 ***
## Exter.QualFa          -1.813e+04  5.985e+03  -3.029 0.002473 **
## Exter.QualGd          -2.497e+04  3.103e+03  -8.046 1.28e-15 ***
## Exter.QualTA          -2.592e+04  3.486e+03  -7.435 1.41e-13 ***
## Exter.CondFa           6.646e+02  7.518e+03   0.088 0.929561
## Exter.CondGd           4.671e+03  6.760e+03   0.691 0.489630
## Exter.CondPo          -7.534e+03  1.685e+04  -0.447 0.654914
## Exter.CondTA           5.905e+03  6.716e+03   0.879 0.379413
## FoundationCBlock      -3.205e+02  1.975e+03  -0.162 0.871069
## FoundationPConc        1.428e+03  2.166e+03   0.659 0.509876
## FoundationSlab        -4.377e+03  6.011e+03  -0.728 0.466638
## FoundationStone        1.145e+04  7.214e+03   1.587 0.112691
```

```
## FoundationWood        -1.291e+04  1.028e+04  -1.255 0.209490
## Bsmt.Qual0             1.560e+04  3.275e+04   0.476 0.633914
## Bsmt.QualEx           -1.311e+04  4.190e+04  -0.313 0.754350
## Bsmt.QualFa           -2.628e+04  4.184e+04  -0.628 0.529909
## Bsmt.QualGd           -3.095e+04  4.182e+04  -0.740 0.459284
## Bsmt.QualPo           -1.970e+04  4.515e+04  -0.436 0.662584
## Bsmt.QualTA           -2.861e+04  4.181e+04  -0.684 0.493873
## Bsmt.Cond0                   NA         NA      NA       NA
## Bsmt.CondEx           -7.299e+03  1.308e+04  -0.558 0.576909
## Bsmt.CondFa            1.249e+03  2.489e+03   0.502 0.615908
## Bsmt.CondGd           -1.802e+02  2.133e+03  -0.085 0.932660
## Bsmt.CondPo            1.034e+04  1.172e+04   0.882 0.377712
## Bsmt.CondTA                  NA         NA      NA       NA
## Bsmt.Exposure0               NA         NA      NA       NA
## Bsmt.ExposureAv        1.119e+04  1.258e+04   0.890 0.373614
## Bsmt.ExposureGd        2.226e+04  1.268e+04   1.756 0.079213 .
## Bsmt.ExposureMn        4.488e+03  1.260e+04   0.356 0.721834
## Bsmt.ExposureNo        5.500e+03  1.254e+04   0.439 0.660932
## BsmtFin.Type.10              NA         NA      NA       NA
## BsmtFin.Type.1ALQ     -3.655e+03  1.872e+03  -1.952 0.051037 .
## BsmtFin.Type.1BLQ     -3.398e+03  2.001e+03  -1.698 0.089577 .
## BsmtFin.Type.1GLQ     -2.181e+02  1.771e+03  -0.123 0.902010
## BsmtFin.Type.1LwQ     -7.398e+03  2.326e+03  -3.181 0.001485 **
## BsmtFin.Type.1Rec     -5.917e+03  1.946e+03  -3.041 0.002379 **
## BsmtFin.Type.1Unf            NA         NA      NA       NA
## BsmtFin.SF.1           4.104e+01  3.070e+00  13.368  < 2e-16 ***
## BsmtFin.Type.20              NA         NA      NA       NA
## BsmtFin.Type.2ALQ      2.696e+04  2.226e+04   1.211 0.225867
## BsmtFin.Type.2BLQ      1.987e+04  2.220e+04   0.895 0.370793
## BsmtFin.Type.2GLQ      3.327e+04  2.253e+04   1.477 0.139865
## BsmtFin.Type.2LwQ      1.766e+04  2.220e+04   0.795 0.426419
## BsmtFin.Type.2Rec      1.943e+04  2.217e+04   0.877 0.380756
## BsmtFin.Type.2Unf      2.411e+04  2.214e+04   1.089 0.276272
## BsmtFin.SF.2           3.540e+01  5.324e+00   6.650 3.55e-11 ***
## Bsmt.Unf.SF            2.053e+01  2.797e+00   7.341 2.81e-13 ***
## Total.Bsmt.SF                NA         NA      NA       NA
## HeatingGasA            7.150e+03  2.267e+04   0.315 0.752435
## HeatingGasW            6.042e+03  2.314e+04   0.261 0.794051
## HeatingGrav           -5.938e+02  2.427e+04  -0.024 0.980487
## HeatingOthW           -2.146e+04  2.788e+04  -0.770 0.441457
## HeatingWall            2.038e+04  2.551e+04   0.799 0.424419
## Heating.QCFa          -3.524e+03  2.909e+03  -1.211 0.225834
## Heating.QCGd          -1.844e+03  1.327e+03  -1.390 0.164756
## Heating.QCPo          -1.810e+04  1.581e+04  -1.145 0.252429
## Heating.QCTA          -2.913e+03  1.304e+03  -2.234 0.025533 *
## Central.AirY          -3.405e+03  2.306e+03  -1.476 0.139972
## ElectricalFuseA       -9.556e+03  2.196e+04  -0.435 0.663406
## ElectricalFuseF       -9.853e+03  2.217e+04  -0.444 0.656725
## ElectricalFuseP       -1.108e+04  2.344e+04  -0.473 0.636389
## ElectricalMix          4.559e+03  3.626e+04   0.126 0.899964
## ElectricalSBrkr       -1.016e+04  2.188e+04  -0.464 0.642475
## X1st.Flr.SF            4.859e+01  3.232e+00  15.033  < 2e-16 ***
```

```
## X2nd.Flr.SF           6.178e+01  3.524e+00  17.531  < 2e-16 ***
## Low.Qual.Fin.SF       2.837e+01  1.069e+01   2.653 0.008019 **
## Gr.Liv.Area                  NA         NA      NA       NA
## Bsmt.Full.Bath        1.461e+03  1.231e+03   1.187 0.235245
## Bsmt.Half.Bath       -1.440e+03  1.869e+03  -0.770 0.441131
## Full.Bath             3.377e+03  1.375e+03   2.456 0.014114 *
## Half.Bath             1.940e+03  1.306e+03   1.486 0.137512
## Bedroom.AbvGr        -3.916e+03  8.578e+02  -4.566 5.20e-06 ***
## Kitchen.AbvGr        -1.218e+04  3.801e+03  -3.205 0.001366 **
## Kitchen.QualFa       -2.198e+04  3.965e+03  -5.543 3.26e-08 ***
## Kitchen.QualGd       -2.095e+04  2.306e+03  -9.084  < 2e-16 ***
## Kitchen.QualPo        1.324e+04  2.313e+04   0.573 0.567018
## Kitchen.QualTA       -2.197e+04  2.574e+03  -8.536  < 2e-16 ***
## TotRms.AbvGrd         1.000e+03  5.850e+02   1.710 0.087372 .
## FunctionalMaj2        8.741e+01  9.907e+03   0.009 0.992961
## FunctionalMin1        1.202e+04  6.169e+03   1.949 0.051417 .
## FunctionalMin2        1.123e+04  6.221e+03   1.805 0.071135 .
## FunctionalMod         3.945e+03  6.854e+03   0.576 0.564923
## FunctionalSal        -2.586e+03  2.201e+04  -0.117 0.906496
## FunctionalSev        -1.875e+04  1.733e+04  -1.081 0.279583
## FunctionalTyp         2.026e+04  5.557e+03   3.646 0.000272 ***
## Fireplaces            7.609e+03  1.621e+03   4.693 2.82e-06 ***
## Fireplace.QuEx       -2.916e+03  4.089e+03  -0.713 0.475818
## Fireplace.QuFa       -9.363e+03  3.306e+03  -2.832 0.004663 **
## Fireplace.QuGd       -6.002e+03  2.187e+03  -2.745 0.006095 **
## Fireplace.QuPo       -4.284e+03  3.774e+03  -1.135 0.256451
## Fireplace.QuTA       -6.887e+03  2.261e+03  -3.046 0.002340 **
## Garage.Type2Types    -2.294e+04  2.448e+04  -0.937 0.348885
## Garage.TypeAttchd    -1.273e+04  2.405e+04  -0.529 0.596582
## Garage.TypeBasment   -1.128e+04  2.421e+04  -0.466 0.641475
## Garage.TypeBuiltIn   -1.262e+04  2.408e+04  -0.524 0.600373
## Garage.TypeCarPort   -1.654e+04  2.469e+04  -0.670 0.503092
## Garage.TypeDetchd    -1.213e+04  2.401e+04  -0.505 0.613586
## Garage.Yr.Blt         3.398e+01  3.615e+01   0.940 0.347296
## Garage.Finish0               NA         NA      NA       NA
## Garage.FinishFin     -6.322e+04  7.406e+04  -0.854 0.393370
## Garage.FinishRFn     -6.584e+04  7.402e+04  -0.889 0.373836
## Garage.FinishUnf     -6.285e+04  7.401e+04  -0.849 0.395821
## Garage.Cars           3.975e+03  1.461e+03   2.721 0.006556 **
## Garage.Area           1.584e+01  5.018e+00   3.157 0.001612 **
## Garage.Qual0         -5.829e+02  3.306e+04  -0.018 0.985936
## Garage.QualEx         7.946e+04  1.883e+04   4.219 2.54e-05 ***
## Garage.QualFa        -2.253e+02  2.577e+03  -0.087 0.930346
## Garage.QualGd         1.179e+04  5.026e+03   2.346 0.019037 *
## Garage.QualPo        -1.154e+04  1.376e+04  -0.839 0.401426
## Garage.QualTA                NA         NA      NA       NA
## Garage.Cond0                 NA         NA      NA       NA
## Garage.CondEx        -6.025e+04  1.803e+04  -3.341 0.000846 ***
## Garage.CondFa        -7.891e+02  3.229e+03  -0.244 0.806963
## Garage.CondGd        -7.145e+03  6.215e+03  -1.150 0.250372
## Garage.CondPo         3.523e+02  7.691e+03   0.046 0.963465
## Garage.CondTA                NA         NA      NA       NA
```

```
## Paved.DriveP          -1.563e+03  3.384e+03  -0.462 0.644131
## Paved.DriveY           2.089e+02  2.128e+03   0.098 0.921797
## Wood.Deck.SF           9.003e+00  3.765e+00   2.391 0.016868 *
## Open.Porch.SF         -2.925e+00  7.130e+00  -0.410 0.681726
## Enclosed.Porch         5.217e+00  7.519e+00   0.694 0.487831
## X3Ssn.Porch           -4.472e-01  1.685e+01  -0.027 0.978830
## Screen.Porch           4.136e+01  7.841e+00   5.275 1.44e-07 ***
## Pool.Area              1.171e+00  5.567e+01   0.021 0.983213
## Pool.QCEx              8.812e+04  2.278e+04   3.869 0.000112 ***
## Pool.QCFa              2.590e+04  4.232e+04   0.612 0.540648
## Pool.QCGd              3.043e+04  4.115e+04   0.739 0.459734
## Pool.QCTA              8.025e+03  2.864e+04   0.280 0.779336
## FenceGdPrv            -2.030e+03  2.237e+03  -0.907 0.364227
## FenceGdWo              1.884e+03  2.225e+03   0.847 0.397283
## FenceMnPrv             2.036e+03  1.414e+03   1.441 0.149844
## FenceMnWw             -1.888e+03  6.451e+03  -0.293 0.769827
## Misc.FeatureElev      -5.336e+05  3.724e+04 -14.330  < 2e-16 ***
## Misc.FeatureGar2       2.432e+03  1.852e+04   0.131 0.895578
## Misc.FeatureOthr       2.070e+04  1.254e+04   1.651 0.098913 .
## Misc.FeatureShed       1.015e+03  2.769e+03   0.367 0.713938
## Misc.FeatureTenC      -5.636e+04  3.250e+04  -1.734 0.082981 .
## Misc.Val               3.640e-01  1.683e+00   0.216 0.828733
## Mo.Sold               -1.650e+02  1.579e+02  -1.045 0.296042
## Yr.Sold               -2.345e+03  3.845e+03  -0.610 0.541962
## Sale.TypeCon           2.844e+04  1.033e+04   2.752 0.005960 **
## Sale.TypeConLD         7.296e+03  5.341e+03   1.366 0.172066
## Sale.TypeConLI        -1.489e+02  7.851e+03  -0.019 0.984872
## Sale.TypeConLw         6.562e+03  8.407e+03   0.781 0.435096
## Sale.TypeCWD           1.015e+04  6.902e+03   1.471 0.141510
## Sale.TypeNew           1.357e+04  9.866e+03   1.375 0.169168
## Sale.TypeOth           5.243e+03  8.682e+03   0.604 0.545988
## Sale.TypeVWD          -6.458e+03  2.232e+04  -0.289 0.772310
## Sale.TypeWD            2.339e+03  2.664e+03   0.878 0.379971
## Sale.ConditionAdjLand  1.639e+04  7.289e+03   2.249 0.024597 *
## Sale.ConditionAlloca   1.267e+04  5.549e+03   2.283 0.022497 *
## Sale.ConditionFamily   1.965e+03  3.726e+03   0.527 0.598090
## Sale.ConditionNormal   8.054e+03  1.899e+03   4.240 2.31e-05 ***
## Sale.ConditionPartial  6.101e+03  9.515e+03   0.641 0.521422
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 21370 on 2655 degrees of freedom
## Multiple R-squared:  0.9351, Adjusted R-squared:  0.9284
## F-statistic: 139.6 on 274 and 2655 DF,  p-value: < 2.2e-16
```