MTH404 R Project

Mustafif Khan

Loading Required Packages

Before the dataset can be analyzed, the following packages must be imported:

```
library(tidyverse)
```

```
## -- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
## v dplyr     1.1.2     v readr     2.1.4
## v forcats   1.0.0     v stringr   1.5.0
## v ggplot2   3.4.2     v tibble    3.2.1
## v lubridate 1.9.2     v tidyr     1.3.0
## v purrr     1.0.1
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
## i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become errors
```

```
library(corrplot)
```

```
## corrplot 0.92 loaded
```

```
library(ggplot2)
library(lubridate)
library(gridExtra)
```

```
##
## Attaching package: 'gridExtra'
##
## The following object is masked from 'package:dplyr':
##
##     combine
```

```
library(caTools)
library(dplyr)
```

Reading the Training and Test Data

From the kaggle competition, we are provided the CSV data for training and testing, and the dataset is imported like the following:

```
train_data <- read.csv("train.csv")
test_data <- read.csv("test.csv")
head(train_data)
```

```
##   Id MSSubClass MSZoning LotFrontage LotArea Street Alley LotShape LandContour
## 1  1         60       RL          65    8450   Pave  <NA>      Reg         Lvl
```

```
## 2  2          20       RL          80    9600   Pave  <NA>      Reg          Lvl
## 3  3          60       RL          68   11250   Pave  <NA>      IR1          Lvl
## 4  4          70       RL          60    9550   Pave  <NA>      IR1          Lvl
## 5  5          60       RL          84   14260   Pave  <NA>      IR1          Lvl
## 6  6          50       RL          85   14115   Pave  <NA>      IR1          Lvl
##   Utilities LotConfig LandSlope Neighborhood Condition1 Condition2 BldgType
## 1    AllPub    Inside       Gtl      CollgCr       Norm       Norm     1Fam
## 2    AllPub       FR2       Gtl      Veenker      Feedr       Norm     1Fam
## 3    AllPub    Inside       Gtl      CollgCr       Norm       Norm     1Fam
## 4    AllPub    Corner       Gtl      Crawfor       Norm       Norm     1Fam
## 5    AllPub       FR2       Gtl      NoRidge       Norm       Norm     1Fam
## 6    AllPub    Inside       Gtl      Mitchel       Norm       Norm     1Fam
##   HouseStyle OverallQual OverallCond YearBuilt YearRemodAdd RoofStyle RoofMatl
## 1     2Story           7           5      2003         2003     Gable  CompShg
## 2     1Story           6           8      1976         1976     Gable  CompShg
## 3     2Story           7           5      2001         2002     Gable  CompShg
## 4     2Story           7           5      1915         1970     Gable  CompShg
## 5     2Story           8           5      2000         2000     Gable  CompShg
## 6     1.5Fin           5           5      1993         1995     Gable  CompShg
##   Exterior1st Exterior2nd MasVnrType MasVnrArea ExterQual ExterCond Foundation
## 1     VinylSd     VinylSd    BrkFace        196        Gd        TA      PConc
## 2     MetalSd     MetalSd       None          0        TA        TA     CBlock
## 3     VinylSd     VinylSd    BrkFace        162        Gd        TA      PConc
## 4     Wd Sdng     Wd Shng       None          0        TA        TA     BrkTil
## 5     VinylSd     VinylSd    BrkFace        350        Gd        TA      PConc
## 6     VinylSd     VinylSd       None          0        TA        TA       Wood
##   BsmtQual BsmtCond BsmtExposure BsmtFinType1 BsmtFinSF1 BsmtFinType2
## 1       Gd       TA           No          GLQ        706          Unf
## 2       Gd       TA           Gd          ALQ        978          Unf
## 3       Gd       TA           Mn          GLQ        486          Unf
## 4       TA       Gd           No          ALQ        216          Unf
## 5       Gd       TA           Av          GLQ        655          Unf
## 6       Gd       TA           No          GLQ        732          Unf
##   BsmtFinSF2 BsmtUnfSF TotalBsmtSF Heating HeatingQC CentralAir Electrical
## 1          0       150         856    GasA        Ex          Y      SBrkr
## 2          0       284        1262    GasA        Ex          Y      SBrkr
## 3          0       434         920    GasA        Ex          Y      SBrkr
## 4          0       540         756    GasA        Gd          Y      SBrkr
## 5          0       490        1145    GasA        Ex          Y      SBrkr
## 6          0        64         796    GasA        Ex          Y      SBrkr
##   X1stFlrSF X2ndFlrSF LowQualFinSF GrLivArea BsmtFullBath BsmtHalfBath FullBath
## 1       856       854            0      1710            1            0        2
## 2      1262         0            0      1262            0            1        2
## 3       920       866            0      1786            1            0        2
## 4       961       756            0      1717            1            0        1
## 5      1145      1053            0      2198            1            0        2
## 6       796       566            0      1362            1            0        1
##   HalfBath BedroomAbvGr KitchenAbvGr KitchenQual TotRmsAbvGrd Functional
## 1        1            3            1          Gd            8        Typ
## 2        0            3            1          TA            6        Typ
## 3        1            3            1          Gd            6        Typ
## 4        0            3            1          Gd            7        Typ
## 5        1            4            1          Gd            9        Typ
## 6        1            1            1          TA            5        Typ
```

```
##   Fireplaces FireplaceQu GarageType GarageYrBlt GarageFinish GarageCars
## 1          0        <NA>     Attchd        2003          RFn          2
## 2          1          TA     Attchd        1976          RFn          2
## 3          1          TA     Attchd        2001          RFn          2
## 4          1          Gd     Detchd        1998          Unf          3
## 5          1          TA     Attchd        2000          RFn          3
## 6          0        <NA>     Attchd        1993          Unf          2
##   GarageArea GarageQual GarageCond PavedDrive WoodDeckSF OpenPorchSF
## 1        548         TA         TA          Y          0          61
## 2        460         TA         TA          Y        298           0
## 3        608         TA         TA          Y          0          42
## 4        642         TA         TA          Y          0          35
## 5        836         TA         TA          Y        192          84
## 6        480         TA         TA          Y         40          30
##   EnclosedPorch X3SsnPorch ScreenPorch PoolArea PoolQC Fence MiscFeature
## 1             0          0           0        0   <NA>  <NA>        <NA>
## 2             0          0           0        0   <NA>  <NA>        <NA>
## 3             0          0           0        0   <NA>  <NA>        <NA>
## 4           272          0           0        0   <NA>  <NA>        <NA>
## 5             0          0           0        0   <NA>  <NA>        <NA>
## 6             0        320           0        0   <NA> MnPrv        Shed
##   MiscVal MoSold YrSold SaleType SaleCondition SalePrice
## 1       0      2   2008       WD        Normal    208500
## 2       0      5   2007       WD        Normal    181500
## 3       0      9   2008       WD        Normal    223500
## 4       0      2   2006       WD       Abnorml    140000
## 5       0     12   2008       WD        Normal    250000
## 6     700     10   2009       WD        Normal    143000
```

```
head(test_data)
```

```
##     Id MSSubClass MSZoning LotFrontage LotArea Street Alley LotShape
## 1 1461         20       RH          80   11622   Pave  <NA>      Reg
## 2 1462         20       RL          81   14267   Pave  <NA>      IR1
## 3 1463         60       RL          74   13830   Pave  <NA>      IR1
## 4 1464         60       RL          78    9978   Pave  <NA>      IR1
## 5 1465        120       RL          43    5005   Pave  <NA>      IR1
## 6 1466         60       RL          75   10000   Pave  <NA>      IR1
##   LandContour Utilities LotConfig LandSlope Neighborhood Condition1 Condition2
## 1         Lvl    AllPub    Inside       Gtl        NAmes      Feedr       Norm
## 2         Lvl    AllPub    Corner       Gtl        NAmes       Norm       Norm
## 3         Lvl    AllPub    Inside       Gtl      Gilbert       Norm       Norm
## 4         Lvl    AllPub    Inside       Gtl      Gilbert       Norm       Norm
## 5         HLS    AllPub    Inside       Gtl      StoneBr       Norm       Norm
## 6         Lvl    AllPub    Corner       Gtl      Gilbert       Norm       Norm
##   BldgType HouseStyle OverallQual OverallCond YearBuilt YearRemodAdd RoofStyle
## 1     1Fam     1Story           5           6      1961         1961     Gable
## 2     1Fam     1Story           6           6      1958         1958       Hip
## 3     1Fam     2Story           5           5      1997         1998     Gable
## 4     1Fam     2Story           6           6      1998         1998     Gable
## 5   TwnhsE     1Story           8           5      1992         1992     Gable
## 6     1Fam     2Story           6           5      1993         1994     Gable
##   RoofMatl Exterior1st Exterior2nd MasVnrType MasVnrArea ExterQual ExterCond
## 1  CompShg     VinylSd     VinylSd       None          0        TA        TA
## 2  CompShg     Wd Sdng     Wd Sdng    BrkFace        108        TA        TA
```

```
## 3  CompShg     VinylSd     VinylSd       None          0        TA        TA
## 4  CompShg     VinylSd     VinylSd    BrkFace         20        TA        TA
## 5  CompShg     HdBoard     HdBoard       None          0        Gd        TA
## 6  CompShg     HdBoard     HdBoard       None          0        TA        TA
##   Foundation BsmtQual BsmtCond BsmtExposure BsmtFinType1 BsmtFinSF1
## 1      CBlock       TA       TA           No          Rec        468
## 2      CBlock       TA       TA           No          ALQ        923
## 3       PConc       Gd       TA           No          GLQ        791
## 4       PConc       TA       TA           No          GLQ        602
## 5       PConc       Gd       TA           No          ALQ        263
## 6       PConc       Gd       TA           No          Unf          0
##   BsmtFinType2 BsmtFinSF2 BsmtUnfSF TotalBsmtSF Heating HeatingQC CentralAir
## 1          LwQ        144       270         882    GasA        TA          Y
## 2          Unf          0       406        1329    GasA        TA          Y
## 3          Unf          0       137         928    GasA        Gd          Y
## 4          Unf          0       324         926    GasA        Ex          Y
## 5          Unf          0      1017        1280    GasA        Ex          Y
## 6          Unf          0       763         763    GasA        Gd          Y
##   Electrical X1stFlrSF X2ndFlrSF LowQualFinSF GrLivArea BsmtFullBath
## 1      SBrkr       896         0            0       896            0
## 2      SBrkr      1329         0            0      1329            0
## 3      SBrkr       928       701            0      1629            0
## 4      SBrkr       926       678            0      1604            0
## 5      SBrkr      1280         0            0      1280            0
## 6      SBrkr       763       892            0      1655            0
##   BsmtHalfBath FullBath HalfBath BedroomAbvGr KitchenAbvGr KitchenQual
## 1            0        1        0            2            1          TA
## 2            0        1        1            3            1          Gd
## 3            0        2        1            3            1          TA
## 4            0        2        1            3            1          Gd
## 5            0        2        0            2            1          Gd
## 6            0        2        1            3            1          TA
##   TotRmsAbvGrd Functional Fireplaces FireplaceQu GarageType GarageYrBlt
## 1            5        Typ          0       <NA>     Attchd        1961
## 2            6        Typ          0       <NA>     Attchd        1958
## 3            6        Typ          1         TA     Attchd        1997
## 4            7        Typ          1         Gd     Attchd        1998
## 5            5        Typ          0       <NA>     Attchd        1992
## 6            7        Typ          1         TA     Attchd        1993
##   GarageFinish GarageCars GarageArea GarageQual GarageCond PavedDrive
## 1          Unf          1        730         TA         TA          Y
## 2          Unf          1        312         TA         TA          Y
## 3          Fin          2        482         TA         TA          Y
## 4          Fin          2        470         TA         TA          Y
## 5          RFn          2        506         TA         TA          Y
## 6          Fin          2        440         TA         TA          Y
##   WoodDeckSF OpenPorchSF EnclosedPorch X3SsnPorch ScreenPorch PoolArea PoolQC
## 1        140           0             0          0         120        0   <NA>
## 2        393          36             0          0           0        0   <NA>
## 3        212          34             0          0           0        0   <NA>
## 4        360          36             0          0           0        0   <NA>
## 5          0          82             0          0         144        0   <NA>
## 6        157          84             0          0           0        0   <NA>
##   Fence MiscFeature MiscVal MoSold YrSold SaleType SaleCondition
```

```
## 1 MnPrv        <NA>       0      6   2010       WD        Normal
## 2  <NA>        Gar2   12500      6   2010       WD        Normal
## 3 MnPrv        <NA>       0      3   2010       WD        Normal
## 4  <NA>        <NA>       0      6   2010       WD        Normal
## 5  <NA>        <NA>       0      1   2010       WD        Normal
## 6  <NA>        <NA>       0      4   2010       WD        Normal
```

We will now convert all the character columns to factors as shown below:

```
train_data <- as.data.frame(unclass(train_data), stringsAsFactors = TRUE)
test_data <- as.data.frame(unclass(test_data), stringsAsFactors = TRUE)
```

With the data converted, we can check if we are missing values in our training data:

```
# get the missing training values
missing_training_values <- sapply(train_data, function(x) sum(is.na(x)))
# create a data frame with column names and missing values
mtv_df <- data.frame(column = names(missing_training_values),
                     missing_values = missing_training_values)
mtv_df
```

```
##                      column missing_values
## Id                       Id              0
## MSSubClass       MSSubClass              0
## MSZoning           MSZoning              0
## LotFrontage     LotFrontage            259
## LotArea             LotArea              0
## Street               Street              0
## Alley                 Alley           1369
## LotShape           LotShape              0
## LandContour     LandContour              0
## Utilities         Utilities              0
## LotConfig         LotConfig              0
## LandSlope         LandSlope              0
## Neighborhood   Neighborhood              0
## Condition1       Condition1              0
## Condition2       Condition2              0
## BldgType           BldgType              0
## HouseStyle       HouseStyle              0
## OverallQual     OverallQual              0
## OverallCond     OverallCond              0
## YearBuilt         YearBuilt              0
## YearRemodAdd   YearRemodAdd              0
## RoofStyle         RoofStyle              0
## RoofMatl           RoofMatl              0
## Exterior1st     Exterior1st              0
## Exterior2nd     Exterior2nd              0
## MasVnrType       MasVnrType              8
## MasVnrArea       MasVnrArea              8
## ExterQual         ExterQual              0
## ExterCond         ExterCond              0
## Foundation       Foundation              0
## BsmtQual           BsmtQual             37
## BsmtCond           BsmtCond             37
## BsmtExposure   BsmtExposure             38
## BsmtFinType1   BsmtFinType1             37
```

```
## BsmtFinSF1       BsmtFinSF1             0
## BsmtFinType2   BsmtFinType2            38
## BsmtFinSF2       BsmtFinSF2             0
## BsmtUnfSF         BsmtUnfSF             0
## TotalBsmtSF     TotalBsmtSF             0
## Heating             Heating             0
## HeatingQC         HeatingQC             0
## CentralAir       CentralAir             0
## Electrical       Electrical             1
## X1stFlrSF         X1stFlrSF             0
## X2ndFlrSF         X2ndFlrSF             0
## LowQualFinSF   LowQualFinSF             0
## GrLivArea         GrLivArea             0
## BsmtFullBath   BsmtFullBath             0
## BsmtHalfBath   BsmtHalfBath             0
## FullBath           FullBath             0
## HalfBath           HalfBath             0
## BedroomAbvGr   BedroomAbvGr             0
## KitchenAbvGr   KitchenAbvGr             0
## KitchenQual     KitchenQual             0
## TotRmsAbvGrd   TotRmsAbvGrd             0
## Functional       Functional             0
## Fireplaces       Fireplaces             0
## FireplaceQu     FireplaceQu           690
## GarageType       GarageType            81
## GarageYrBlt     GarageYrBlt            81
## GarageFinish   GarageFinish            81
## GarageCars       GarageCars             0
## GarageArea       GarageArea             0
## GarageQual       GarageQual            81
## GarageCond       GarageCond            81
## PavedDrive       PavedDrive             0
## WoodDeckSF       WoodDeckSF             0
## OpenPorchSF     OpenPorchSF             0
## EnclosedPorch EnclosedPorch             0
## X3SsnPorch       X3SsnPorch             0
## ScreenPorch     ScreenPorch             0
## PoolArea           PoolArea             0
## PoolQC               PoolQC          1453
## Fence                 Fence          1179
## MiscFeature     MiscFeature          1406
## MiscVal             MiscVal             0
## MoSold               MoSold             0
## YrSold               YrSold             0
## SaleType           SaleType             0
## SaleCondition SaleCondition             0
## SalePrice         SalePrice             0
```

As you can notice there are data in this dataset that contains large amounts of missing values, such as columns like `PoolQC`, `Fence`, etc. We will be removing the columns with missing values like the following:

```
data.train <- subset(train_data, select = -c(Id, LotFrontage, Alley, MasVnrType, MasVnrArea, BsmtQual, B
head(data.train)
```

```
##   MSSubClass MSZoning LotArea Street LotShape LandContour Utilities LotConfig
```

```
## 1         60       RL    8450   Pave      Reg         Lvl    AllPub    Inside
## 2         20       RL    9600   Pave      Reg         Lvl    AllPub       FR2
## 3         60       RL   11250   Pave      IR1         Lvl    AllPub    Inside
## 4         70       RL    9550   Pave      IR1         Lvl    AllPub    Corner
## 5         60       RL   14260   Pave      IR1         Lvl    AllPub       FR2
## 6         50       RL   14115   Pave      IR1         Lvl    AllPub    Inside
##   LandSlope Neighborhood Condition1 Condition2 BldgType HouseStyle OverallQual
## 1       Gtl      CollgCr       Norm       Norm     1Fam     2Story           7
## 2       Gtl      Veenker      Feedr       Norm     1Fam     1Story           6
## 3       Gtl      CollgCr       Norm       Norm     1Fam     2Story           7
## 4       Gtl      Crawfor       Norm       Norm     1Fam     2Story           7
## 5       Gtl      NoRidge       Norm       Norm     1Fam     2Story           8
## 6       Gtl      Mitchel       Norm       Norm     1Fam     1.5Fin           5
##   OverallCond YearBuilt YearRemodAdd RoofStyle RoofMatl Exterior1st Exterior2nd
## 1           5      2003         2003     Gable  CompShg     VinylSd     VinylSd
## 2           8      1976         1976     Gable  CompShg     MetalSd     MetalSd
## 3           5      2001         2002     Gable  CompShg     VinylSd     VinylSd
## 4           5      1915         1970     Gable  CompShg     Wd Sdng     Wd Shng
## 5           5      2000         2000     Gable  CompShg     VinylSd     VinylSd
## 6           5      1993         1995     Gable  CompShg     VinylSd     VinylSd
##   ExterQual ExterCond Foundation BsmtFinSF1 BsmtFinSF2 BsmtUnfSF TotalBsmtSF
## 1        Gd        TA      PConc        706          0       150         856
## 2        TA        TA     CBlock        978          0       284        1262
## 3        Gd        TA      PConc        486          0       434         920
## 4        TA        TA     BrkTil        216          0       540         756
## 5        Gd        TA      PConc        655          0       490        1145
## 6        TA        TA       Wood        732          0        64         796
##   Heating HeatingQC CentralAir X1stFlrSF X2ndFlrSF LowQualFinSF GrLivArea
## 1    GasA        Ex          Y       856       854            0      1710
## 2    GasA        Ex          Y      1262         0            0      1262
## 3    GasA        Ex          Y       920       866            0      1786
## 4    GasA        Gd          Y       961       756            0      1717
## 5    GasA        Ex          Y      1145      1053            0      2198
## 6    GasA        Ex          Y       796       566            0      1362
##   BsmtFullBath BsmtHalfBath FullBath HalfBath BedroomAbvGr KitchenAbvGr
## 1            1            0        2        1            3            1
## 2            0            1        2        0            3            1
## 3            1            0        2        1            3            1
## 4            1            0        1        0            3            1
## 5            1            0        2        1            4            1
## 6            1            0        1        1            1            1
##   KitchenQual TotRmsAbvGrd Functional Fireplaces GarageCars GarageArea
## 1          Gd            8        Typ          0          2        548
## 2          TA            6        Typ          1          2        460
## 3          Gd            6        Typ          1          2        608
## 4          Gd            7        Typ          1          3        642
## 5          Gd            9        Typ          1          3        836
## 6          TA            5        Typ          0          2        480
##   PavedDrive WoodDeckSF OpenPorchSF EnclosedPorch X3SsnPorch ScreenPorch
## 1          Y          0          61             0          0           0
## 2          Y        298           0             0          0           0
## 3          Y          0          42             0          0           0
## 4          Y          0          35           272          0           0
## 5          Y        192          84             0          0           0
```

```
## 6          Y         40          30             0        320           0
##   PoolArea MiscVal MoSold YrSold SaleType SaleCondition SalePrice
## 1        0       0      2   2008       WD        Normal    208500
## 2        0       0      5   2007       WD        Normal    181500
## 3        0       0      9   2008       WD        Normal    223500
## 4        0       0      2   2006       WD       Abnorml    140000
## 5        0       0     12   2008       WD        Normal    250000
## 6        0     700     10   2009       WD        Normal    143000
```

Now it would be good to also remove these columns from our testing data as well:

```
data.test <- subset(test_data, select = -c(Id, LotFrontage, Alley, MasVnrType, MasVnrArea, BsmtQual, Bs
head(data.test)
```

```
##   MSSubClass MSZoning LotArea Street LotShape LandContour Utilities LotConfig
## 1         20       RH   11622   Pave      Reg         Lvl    AllPub    Inside
## 2         20       RL   14267   Pave      IR1         Lvl    AllPub    Corner
## 3         60       RL   13830   Pave      IR1         Lvl    AllPub    Inside
## 4         60       RL    9978   Pave      IR1         Lvl    AllPub    Inside
## 5        120       RL    5005   Pave      IR1         HLS    AllPub    Inside
## 6         60       RL   10000   Pave      IR1         Lvl    AllPub    Corner
##   LandSlope Neighborhood Condition1 Condition2 BldgType HouseStyle OverallQual
## 1       Gtl        NAmes      Feedr       Norm     1Fam     1Story           5
## 2       Gtl        NAmes       Norm       Norm     1Fam     1Story           6
## 3       Gtl      Gilbert       Norm       Norm     1Fam     2Story           5
## 4       Gtl      Gilbert       Norm       Norm     1Fam     2Story           6
## 5       Gtl      StoneBr       Norm       Norm   TwnhsE     1Story           8
## 6       Gtl      Gilbert       Norm       Norm     1Fam     2Story           6
##   OverallCond YearBuilt YearRemodAdd RoofStyle RoofMatl Exterior1st Exterior2nd
## 1           6      1961         1961     Gable  CompShg     VinylSd     VinylSd
## 2           6      1958         1958       Hip  CompShg     Wd Sdng     Wd Sdng
## 3           5      1997         1998     Gable  CompShg     VinylSd     VinylSd
## 4           6      1998         1998     Gable  CompShg     VinylSd     VinylSd
## 5           5      1992         1992     Gable  CompShg     HdBoard     HdBoard
## 6           5      1993         1994     Gable  CompShg     HdBoard     HdBoard
##   ExterQual ExterCond Foundation BsmtFinSF1 BsmtFinSF2 BsmtUnfSF TotalBsmtSF
## 1        TA        TA     CBlock        468        144       270         882
## 2        TA        TA     CBlock        923          0       406        1329
## 3        TA        TA      PConc        791          0       137         928
## 4        TA        TA      PConc        602          0       324         926
## 5        Gd        TA      PConc        263          0      1017        1280
## 6        TA        TA      PConc          0          0       763         763
##   Heating HeatingQC CentralAir X1stFlrSF X2ndFlrSF LowQualFinSF GrLivArea
## 1    GasA        TA          Y       896         0            0       896
## 2    GasA        TA          Y      1329         0            0      1329
## 3    GasA        Gd          Y       928       701            0      1629
## 4    GasA        Ex          Y       926       678            0      1604
## 5    GasA        Ex          Y      1280         0            0      1280
## 6    GasA        Gd          Y       763       892            0      1655
##   BsmtFullBath BsmtHalfBath FullBath HalfBath BedroomAbvGr KitchenAbvGr
## 1            0            0        1        0            2            1
## 2            0            0        1        1            3            1
## 3            0            0        2        1            3            1
## 4            0            0        2        1            3            1
## 5            0            0        2        0            2            1
```

```
## 6            0            0       2       1           3           1
##   KitchenQual TotRmsAbvGrd Functional Fireplaces GarageCars GarageArea
## 1          TA            5        Typ          0          1        730
## 2          Gd            6        Typ          0          1        312
## 3          TA            6        Typ          1          2        482
## 4          Gd            7        Typ          1          2        470
## 5          Gd            5        Typ          0          2        506
## 6          TA            7        Typ          1          2        440
##   PavedDrive WoodDeckSF OpenPorchSF EnclosedPorch X3SsnPorch ScreenPorch
## 1          Y        140           0             0          0         120
## 2          Y        393          36             0          0           0
## 3          Y        212          34             0          0           0
## 4          Y        360          36             0          0           0
## 5          Y          0          82             0          0         144
## 6          Y        157          84             0          0           0
##   PoolArea MiscVal MoSold YrSold SaleType SaleCondition
## 1        0       0      6   2010       WD        Normal
## 2        0   12500      6   2010       WD        Normal
## 3        0       0      3   2010       WD        Normal
## 4        0       0      6   2010       WD        Normal
## 5        0       0      1   2010       WD        Normal
## 6        0       0      4   2010       WD        Normal
```

Analysis of the Train Data

Before we create a model to analyze our training data, we will need to look at the structure of our different columns using the `str()` function and get a summary of our training data.

```
str(train_data)
```

```
## 'data.frame':    1460 obs. of  81 variables:
##  $ Id           : int  1 2 3 4 5 6 7 8 9 10 ...
##  $ MSSubClass   : int  60 20 60 70 60 50 20 60 50 190 ...
##  $ MSZoning     : Factor w/ 5 levels "C (all)","FV",..: 4 4 4 4 4 4 4 4 5 4 ...
##  $ LotFrontage  : int  65 80 68 60 84 85 75 NA 51 50 ...
##  $ LotArea      : int  8450 9600 11250 9550 14260 14115 10084 10382 6120 7420 ...
##  $ Street       : Factor w/ 2 levels "Grvl","Pave": 2 2 2 2 2 2 2 2 2 2 ...
##  $ Alley        : Factor w/ 2 levels "Grvl","Pave": NA NA NA NA NA NA NA NA NA NA ...
##  $ LotShape     : Factor w/ 4 levels "IR1","IR2","IR3",..: 4 4 1 1 1 1 4 1 4 4 ...
##  $ LandContour  : Factor w/ 4 levels "Bnk","HLS","Low",..: 4 4 4 4 4 4 4 4 4 4 ...
##  $ Utilities    : Factor w/ 2 levels "AllPub","NoSeWa": 1 1 1 1 1 1 1 1 1 1 ...
##  $ LotConfig    : Factor w/ 5 levels "Corner","CulDSac",..: 5 3 5 1 3 5 5 1 5 1 ...
##  $ LandSlope    : Factor w/ 3 levels "Gtl","Mod","Sev": 1 1 1 1 1 1 1 1 1 1 ...
##  $ Neighborhood : Factor w/ 25 levels "Blmngtn","Blueste",..: 6 25 6 7 14 12 21 17 18 4 ...
##  $ Condition1   : Factor w/ 9 levels "Artery","Feedr",..: 3 2 3 3 3 3 3 5 1 1 ...
##  $ Condition2   : Factor w/ 8 levels "Artery","Feedr",..: 3 3 3 3 3 3 3 3 3 1 ...
##  $ BldgType     : Factor w/ 5 levels "1Fam","2fmCon",..: 1 1 1 1 1 1 1 1 1 2 ...
##  $ HouseStyle   : Factor w/ 8 levels "1.5Fin","1.5Unf",..: 6 3 6 6 6 1 3 6 1 2 ...
##  $ OverallQual  : int  7 6 7 7 8 5 8 7 7 5 ...
##  $ OverallCond  : int  5 8 5 5 5 5 5 6 5 6 ...
##  $ YearBuilt    : int  2003 1976 2001 1915 2000 1993 2004 1973 1931 1939 ...
##  $ YearRemodAdd : int  2003 1976 2002 1970 2000 1995 2005 1973 1950 1950 ...
##  $ RoofStyle    : Factor w/ 6 levels "Flat","Gable",..: 2 2 2 2 2 2 2 2 2 2 ...
##  $ RoofMatl     : Factor w/ 8 levels "ClyTile","CompShg",..: 2 2 2 2 2 2 2 2 2 2 ...
```

```
##  $ Exterior1st  : Factor w/ 15 levels "AsbShng","AsphShn",..: 13 9 13 14 13 13 13 7 4 9 ...
##  $ Exterior2nd  : Factor w/ 16 levels "AsbShng","AsphShn",..: 14 9 14 16 14 14 14 7 16 9 ...
##  $ MasVnrType   : Factor w/ 4 levels "BrkCmn","BrkFace",..: 2 3 2 3 2 3 4 4 3 3 ...
##  $ MasVnrArea   : int  196 0 162 0 350 0 186 240 0 0 ...
##  $ ExterQual    : Factor w/ 4 levels "Ex","Fa","Gd",..: 3 4 3 4 3 4 3 4 4 4 ...
##  $ ExterCond    : Factor w/ 5 levels "Ex","Fa","Gd",..: 5 5 5 5 5 5 5 5 5 5 ...
##  $ Foundation   : Factor w/ 6 levels "BrkTil","CBlock",..: 3 2 3 1 3 6 3 2 1 1 ...
##  $ BsmtQual     : Factor w/ 4 levels "Ex","Fa","Gd",..: 3 3 3 4 3 3 1 3 4 4 ...
##  $ BsmtCond     : Factor w/ 4 levels "Fa","Gd","Po",..: 4 4 4 2 4 4 4 4 4 4 ...
##  $ BsmtExposure : Factor w/ 4 levels "Av","Gd","Mn",..: 4 2 3 4 1 4 1 3 4 4 ...
##  $ BsmtFinType1 : Factor w/ 6 levels "ALQ","BLQ","GLQ",..: 3 1 3 1 3 3 3 1 6 3 ...
##  $ BsmtFinSF1   : int  706 978 486 216 655 732 1369 859 0 851 ...
##  $ BsmtFinType2 : Factor w/ 6 levels "ALQ","BLQ","GLQ",..: 6 6 6 6 6 6 6 2 6 6 ...
##  $ BsmtFinSF2   : int  0 0 0 0 0 0 0 32 0 0 ...
##  $ BsmtUnfSF    : int  150 284 434 540 490 64 317 216 952 140 ...
##  $ TotalBsmtSF  : int  856 1262 920 756 1145 796 1686 1107 952 991 ...
##  $ Heating      : Factor w/ 6 levels "Floor","GasA",..: 2 2 2 2 2 2 2 2 2 2 ...
##  $ HeatingQC    : Factor w/ 5 levels "Ex","Fa","Gd",..: 1 1 1 3 1 1 1 1 3 1 ...
##  $ CentralAir   : Factor w/ 2 levels "N","Y": 2 2 2 2 2 2 2 2 2 2 ...
##  $ Electrical   : Factor w/ 5 levels "FuseA","FuseF",..: 5 5 5 5 5 5 5 5 2 5 ...
##  $ X1stFlrSF    : int  856 1262 920 961 1145 796 1694 1107 1022 1077 ...
##  $ X2ndFlrSF    : int  854 0 866 756 1053 566 0 983 752 0 ...
##  $ LowQualFinSF : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ GrLivArea    : int  1710 1262 1786 1717 2198 1362 1694 2090 1774 1077 ...
##  $ BsmtFullBath : int  1 0 1 1 1 1 1 1 0 1 ...
##  $ BsmtHalfBath : int  0 1 0 0 0 0 0 0 0 0 ...
##  $ FullBath     : int  2 2 2 1 2 1 2 2 2 1 ...
##  $ HalfBath     : int  1 0 1 0 1 1 0 1 0 0 ...
##  $ BedroomAbvGr : int  3 3 3 3 4 1 3 3 2 2 ...
##  $ KitchenAbvGr : int  1 1 1 1 1 1 1 1 2 2 ...
##  $ KitchenQual  : Factor w/ 4 levels "Ex","Fa","Gd",..: 3 4 3 3 3 4 3 4 4 4 ...
##  $ TotRmsAbvGrd : int  8 6 6 7 9 5 7 7 8 5 ...
##  $ Functional   : Factor w/ 7 levels "Maj1","Maj2",..: 7 7 7 7 7 7 7 7 3 7 ...
##  $ Fireplaces   : int  0 1 1 1 1 0 1 2 2 2 ...
##  $ FireplaceQu  : Factor w/ 5 levels "Ex","Fa","Gd",..: NA 5 5 3 5 NA 3 5 5 5 ...
##  $ GarageType   : Factor w/ 6 levels "2Types","Attchd",..: 2 2 2 6 2 2 2 2 6 2 ...
##  $ GarageYrBlt  : int  2003 1976 2001 1998 2000 1993 2004 1973 1931 1939 ...
##  $ GarageFinish : Factor w/ 3 levels "Fin","RFn","Unf": 2 2 2 3 2 3 2 2 3 2 ...
##  $ GarageCars   : int  2 2 2 3 3 2 2 2 2 1 ...
##  $ GarageArea   : int  548 460 608 642 836 480 636 484 468 205 ...
##  $ GarageQual   : Factor w/ 5 levels "Ex","Fa","Gd",..: 5 5 5 5 5 5 5 5 2 3 ...
##  $ GarageCond   : Factor w/ 5 levels "Ex","Fa","Gd",..: 5 5 5 5 5 5 5 5 5 5 ...
##  $ PavedDrive   : Factor w/ 3 levels "N","P","Y": 3 3 3 3 3 3 3 3 3 3 ...
##  $ WoodDeckSF   : int  0 298 0 0 192 40 255 235 90 0 ...
##  $ OpenPorchSF  : int  61 0 42 35 84 30 57 204 0 4 ...
##  $ EnclosedPorch: int  0 0 0 272 0 0 0 228 205 0 ...
##  $ X3SsnPorch   : int  0 0 0 0 0 320 0 0 0 0 ...
##  $ ScreenPorch  : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ PoolArea     : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ PoolQC       : Factor w/ 3 levels "Ex","Fa","Gd": NA NA NA NA NA NA NA NA NA NA ...
##  $ Fence        : Factor w/ 4 levels "GdPrv","GdWo",..: NA NA NA NA NA 3 NA NA NA NA ...
##  $ MiscFeature  : Factor w/ 4 levels "Gar2","Othr",..: NA NA NA NA NA 3 NA 3 NA NA ...
##  $ MiscVal      : int  0 0 0 0 0 700 0 350 0 0 ...
##  $ MoSold       : int  2 5 9 2 12 10 8 11 4 1 ...
```

```
##  $ YrSold       : int  2008 2007 2008 2006 2008 2009 2007 2009 2008 2008 ...
##  $ SaleType     : Factor w/ 9 levels "COD","Con","ConLD",..: 9 9 9 9 9 9 9 9 9 9 ...
##  $ SaleCondition: Factor w/ 6 levels "Abnorml","AdjLand",..: 5 5 5 1 5 5 5 5 1 5 ...
##  $ SalePrice    : int  208500 181500 223500 140000 250000 143000 307000 200000 129900 118000 ...
```

```
summary(train_data)
```

```
##        Id           MSSubClass       MSZoning     LotFrontage
##  Min.   :   1.0   Min.   : 20.0   C (all):  10   Min.   : 21.00
##  1st Qu.: 365.8   1st Qu.: 20.0   FV     :  65   1st Qu.: 59.00
##  Median : 730.5   Median : 50.0   RH     :  16   Median : 69.00
##  Mean   : 730.5   Mean   : 56.9   RL     :1151   Mean   : 70.05
##  3rd Qu.:1095.2   3rd Qu.: 70.0   RM     : 218   3rd Qu.: 80.00
##  Max.   :1460.0   Max.   :190.0                   Max.   :313.00
##                                                  NA's   :259
##     LotArea        Street      Alley      LotShape  LandContour  Utilities
##  Min.   :  1300   Grvl:   6   Grvl:  50   IR1:484   Bnk:  63    AllPub:1459
##  1st Qu.:  7554   Pave:1454   Pave:  41   IR2: 41   HLS:  50    NoSeWa:   1
##  Median :  9478               NA's:1369   IR3: 10   Low:  36
##  Mean   : 10517                           Reg:925   Lvl:1311
##  3rd Qu.: 11602
##  Max.   :215245
##
##    LotConfig    LandSlope   Neighborhood   Condition1     Condition2
##  Corner : 263   Gtl:1382   NAmes  :225   Norm   :1260   Norm   :1445
##  CulDSac:  94   Mod:  65   CollgCr:150   Feedr  :  81   Feedr  :   6
##  FR2    :  47   Sev:  13   OldTown:113   Artery :  48   Artery :   2
##  FR3    :   4              Edwards:100   RRAn   :  26   PosN   :   2
##  Inside :1052              Somerst: 86   PosN   :  19   RRNn   :   2
##                            Gilbert: 79   RRAe   :  11   PosA   :   1
##                            (Other):707   (Other):  15   (Other):   2
##    BldgType      HouseStyle   OverallQual      OverallCond      YearBuilt
##  1Fam  :1220   1Story :726   Min.   : 1.000   Min.   :1.000   Min.   :1872
##  2fmCon:  31   2Story :445   1st Qu.: 5.000   1st Qu.:5.000   1st Qu.:1954
##  Duplex:  52   1.5Fin :154   Median : 6.000   Median :5.000   Median :1973
##  Twnhs :  43   SLvl   : 65   Mean   : 6.099   Mean   :5.575   Mean   :1971
##  TwnhsE: 114   SFoyer : 37   3rd Qu.: 7.000   3rd Qu.:6.000   3rd Qu.:2000
##                1.5Unf : 14   Max.   :10.000   Max.   :9.000   Max.   :2010
##                (Other): 19
##   YearRemodAdd    RoofStyle       RoofMatl     Exterior1st   Exterior2nd
##  Min.   :1950   Flat   :  13   CompShg:1434   VinylSd:515   VinylSd:504
##  1st Qu.:1967   Gable  :1141   Tar&Grv:  11   HdBoard:222   MetalSd:214
##  Median :1994   Gambrel:  11   WdShngl:   6   MetalSd:220   HdBoard:207
##  Mean   :1985   Hip    : 286   WdShake:   5   Wd Sdng:206   Wd Sdng:197
##  3rd Qu.:2004   Mansard:   7   ClyTile:   1   Plywood:108   Plywood:142
##  Max.   :2010   Shed   :   2   Membran:   1   CemntBd: 61   CmentBd: 60
##                                (Other):   2   (Other):128   (Other):136
##    MasVnrType    MasVnrArea     ExterQual ExterCond  Foundation  BsmtQual
##  BrkCmn : 15   Min.   :   0.0   Ex: 52    Ex:   3   BrkTil:146   Ex  :121
##  BrkFace:445   1st Qu.:   0.0   Fa: 14    Fa:  28   CBlock:634   Fa  : 35
##  None   :864   Median :   0.0   Gd:488    Gd: 146   PConc :647   Gd  :618
##  Stone  :128   Mean   : 103.7   TA:906    Po:   1   Slab  : 24   TA  :649
##  NA's   :  8   3rd Qu.: 166.0             TA:1282   Stone :  6   NA's: 37
##                Max.   :1600.0                       Wood  :  3
##                NA's   :8
```

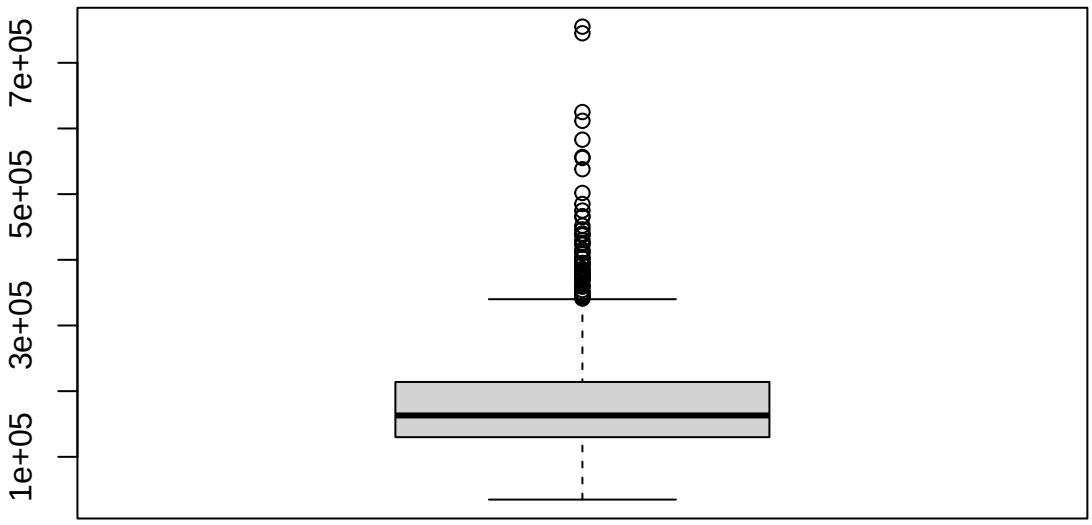
```
##  BsmtCond    BsmtExposure BsmtFinType1   BsmtFinSF1     BsmtFinType2
##  Fa  :  45   Av  :221     ALQ :220     Min.   :   0.0   ALQ :  19
##  Gd  :  65   Gd  :134     BLQ :148     1st Qu.:   0.0   BLQ :  33
##  Po  :   2   Mn  :114     GLQ :418     Median : 383.5   GLQ :  14
##  TA  :1311   No  :953     LwQ : 74     Mean   : 443.6   LwQ :  46
##  NA's:  37   NA's: 38     Rec :133     3rd Qu.: 712.2   Rec :  54
##                           Unf :430     Max.   :5644.0   Unf :1256
##                           NA's: 37                      NA's:  38
##    BsmtFinSF2        BsmtUnfSF       TotalBsmtSF      Heating     HeatingQC
##  Min.   :   0.00   Min.   :   0.0   Min.   :   0.0   Floor:   1   Ex:741
##  1st Qu.:   0.00   1st Qu.: 223.0   1st Qu.: 795.8   GasA :1428   Fa: 49
##  Median :   0.00   Median : 477.5   Median : 991.5   GasW :  18   Gd:241
##  Mean   :  46.55   Mean   : 567.2   Mean   :1057.4   Grav :   7   Po:  1
##  3rd Qu.:   0.00   3rd Qu.: 808.0   3rd Qu.:1298.2   OthW :   2   TA:428
##  Max.   :1474.00   Max.   :2336.0   Max.   :6110.0   Wall :   4
##
##  CentralAir Electrical     X1stFlrSF      X2ndFlrSF     LowQualFinSF
##  N:  95     FuseA:  94   Min.   : 334   Min.   :   0   Min.   :  0.000
##  Y:1365     FuseF:  27   1st Qu.: 882   1st Qu.:   0   1st Qu.:  0.000
##             FuseP:   3   Median :1087   Median :   0   Median :  0.000
##             Mix  :   1   Mean   :1163   Mean   : 347   Mean   :  5.845
##             SBrkr:1334   3rd Qu.:1391   3rd Qu.: 728   3rd Qu.:  0.000
##             NA's :   1   Max.   :4692   Max.   :2065   Max.   :572.000
##
##    GrLivArea     BsmtFullBath     BsmtHalfBath        FullBath
##  Min.   : 334   Min.   :0.0000   Min.   :0.00000   Min.   :0.000
##  1st Qu.:1130   1st Qu.:0.0000   1st Qu.:0.00000   1st Qu.:1.000
##  Median :1464   Median :0.0000   Median :0.00000   Median :2.000
##  Mean   :1515   Mean   :0.4253   Mean   :0.05753   Mean   :1.565
##  3rd Qu.:1777   3rd Qu.:1.0000   3rd Qu.:0.00000   3rd Qu.:2.000
##  Max.   :5642   Max.   :3.0000   Max.   :2.00000   Max.   :3.000
##
##     HalfBath       BedroomAbvGr    KitchenAbvGr   KitchenQual  TotRmsAbvGrd
##  Min.   :0.0000   Min.   :0.000   Min.   :0.000   Ex:100      Min.   : 2.000
##  1st Qu.:0.0000   1st Qu.:2.000   1st Qu.:1.000   Fa: 39      1st Qu.: 5.000
##  Median :0.0000   Median :3.000   Median :1.000   Gd:586      Median : 6.000
##  Mean   :0.3829   Mean   :2.866   Mean   :1.047   TA:735      Mean   : 6.518
##  3rd Qu.:1.0000   3rd Qu.:3.000   3rd Qu.:1.000               3rd Qu.: 7.000
##  Max.   :2.0000   Max.   :8.000   Max.   :3.000               Max.   :14.000
##
##  Functional    Fireplaces    FireplaceQu   GarageType   GarageYrBlt
##  Maj1:  14   Min.   :0.000   Ex  : 24    2Types :  6   Min.   :1900
##  Maj2:   5   1st Qu.:0.000   Fa  : 33    Attchd :870   1st Qu.:1961
##  Min1:  31   Median :1.000   Gd  :380    Basment: 19   Median :1980
##  Min2:  34   Mean   :0.613   Po  : 20    BuiltIn: 88   Mean   :1979
##  Mod :  15   3rd Qu.:1.000   TA  :313    CarPort:  9   3rd Qu.:2002
##  Sev :   1   Max.   :3.000   NA's:690    Detchd :387   Max.   :2010
##  Typ :1360                               NA's   : 81   NA's   :81
##  GarageFinish   GarageCars      GarageArea     GarageQual  GarageCond
##  Fin :352     Min.   :0.000   Min.   :   0.0   Ex  :   3   Ex  :   2
##  RFn :422     1st Qu.:1.000   1st Qu.: 334.5   Fa  :  48   Fa  :  35
##  Unf :605     Median :2.000   Median : 480.0   Gd  :  14   Gd  :   9
##  NA's: 81     Mean   :1.767   Mean   : 473.0   Po  :   3   Po  :   7
##               3rd Qu.:2.000   3rd Qu.: 576.0   TA  :1311   TA  :1326
```

```
##              Max.   :4.000   Max.   :1418.0   NA's:  81   NA's:  81
##
##  PavedDrive   WoodDeckSF      OpenPorchSF     EnclosedPorch      X3SsnPorch
##  N:  90     Min.   :  0.00   Min.   :  0.00   Min.   :  0.00   Min.   :  0.00
##  P:  30     1st Qu.:  0.00   1st Qu.:  0.00   1st Qu.:  0.00   1st Qu.:  0.00
##  Y:1340     Median :  0.00   Median : 25.00   Median :  0.00   Median :  0.00
##             Mean   : 94.24   Mean   : 46.66   Mean   : 21.95   Mean   :  3.41
##             3rd Qu.:168.00   3rd Qu.: 68.00   3rd Qu.:  0.00   3rd Qu.:  0.00
##             Max.   :857.00   Max.   :547.00   Max.   :552.00   Max.   :508.00
##
##   ScreenPorch        PoolArea        PoolQC       Fence      MiscFeature
##  Min.   :  0.00   Min.   :  0.000   Ex  :   2   GdPrv:  59   Gar2:   2
##  1st Qu.:  0.00   1st Qu.:  0.000   Fa  :   2   GdWo :  54   Othr:   2
##  Median :  0.00   Median :  0.000   Gd  :   3   MnPrv: 157   Shed:  49
##  Mean   : 15.06   Mean   :  2.759   NA's:1453   MnWw :  11   TenC:   1
##  3rd Qu.:  0.00   3rd Qu.:  0.000               NA's :1179   NA's:1406
##  Max.   :480.00   Max.   :738.000
##
##     MiscVal             MoSold           YrSold        SaleType
##  Min.   :    0.00   Min.   : 1.000   Min.   :2006   WD     :1267
##  1st Qu.:    0.00   1st Qu.: 5.000   1st Qu.:2007   New    : 122
##  Median :    0.00   Median : 6.000   Median :2008   COD    :  43
##  Mean   :   43.49   Mean   : 6.322   Mean   :2008   ConLD  :   9
##  3rd Qu.:    0.00   3rd Qu.: 8.000   3rd Qu.:2009   ConLI  :   5
##  Max.   :15500.00   Max.   :12.000   Max.   :2010   ConLw  :   5
##                                                     (Other):   9
##  SaleCondition    SalePrice
##  Abnorml: 101   Min.   : 34900
##  AdjLand:   4   1st Qu.:129975
##  Alloca :  12   Median :163000
##  Family :  20   Mean   :180921
##  Normal :1198   3rd Qu.:214000
##  Partial: 125   Max.   :755000
##
```

Visualizing the Data

To check the distribution of the target variable `SalePrice`, we will look at a boxplot and a histogram as shown below:

```
boxplot(data.train$SalePrice)
```




```r
hist(data.train$SalePrice)
```

Correlation with `SalePrice`

To analyze the data, we will need to create a model using the `lm()` function, where will be using `SalesPrice` to compare our other fields. Using the model, we can use `summary()` to find better information about our model, such as R^2.

```r
model <- lm(SalePrice ~., data=data.train)
summary(model)
```

```
##
## Call:
## lm(formula = SalePrice ~ ., data = data.train)
```

```
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -174481  -10672      87    9739  174481
##
## Coefficients: (3 not defined because of singularities)
##                         Estimate Std. Error t value Pr(>|t|)
## (Intercept)          -1.177e+06  1.062e+06  -1.108 0.267967
## MSSubClass           -9.706e+00  8.521e+01  -0.114 0.909331
## MSZoningFV            3.090e+04  1.218e+04   2.537 0.011307 *
## MSZoningRH            2.403e+04  1.226e+04   1.961 0.050124 .
## MSZoningRL            2.591e+04  1.044e+04   2.482 0.013187 *
## MSZoningRM            2.498e+04  9.768e+03   2.558 0.010652 *
## LotArea               7.020e-01  1.078e-01   6.511 1.07e-10 ***
## StreetPave            3.886e+04  1.225e+04   3.172 0.001552 **
## LotShapeIR2           4.488e+03  4.310e+03   1.041 0.298026
## LotShapeIR3           3.606e+03  8.782e+03   0.411 0.681391
## LotShapeReg           5.814e+02  1.660e+03   0.350 0.726120
## LandContourHLS        1.377e+04  5.274e+03   2.611 0.009138 **
## LandContourLow       -4.102e+03  6.505e+03  -0.631 0.528439
## LandContourLvl        7.264e+03  3.799e+03   1.912 0.056096 .
## UtilitiesNoSeWa      -2.945e+04  2.638e+04  -1.117 0.264409
## LotConfigCulDSac      7.684e+03  3.317e+03   2.316 0.020706 *
## LotConfigFR2         -5.783e+03  4.146e+03  -1.395 0.163346
## LotConfigFR3         -1.338e+04  1.305e+04  -1.026 0.305262
## LotConfigInside      -1.223e+03  1.800e+03  -0.680 0.496724
## LandSlopeMod          1.054e+04  4.025e+03   2.618 0.008960 **
## LandSlopeSev         -2.553e+04  1.106e+04  -2.308 0.021169 *
## NeighborhoodBlueste  -2.591e+03  1.931e+04  -0.134 0.893306
## NeighborhoodBrDale    8.307e+03  1.110e+04   0.748 0.454555
## NeighborhoodBrkSide  -1.848e+03  9.474e+03  -0.195 0.845418
## NeighborhoodClearCr  -1.285e+04  9.402e+03  -1.366 0.172110
## NeighborhoodCollgCr  -9.675e+03  7.320e+03  -1.322 0.186510
## NeighborhoodCrawfor   9.576e+03  8.653e+03   1.107 0.268642
## NeighborhoodEdwards  -1.675e+04  8.063e+03  -2.078 0.037942 *
## NeighborhoodGilbert  -1.372e+04  7.831e+03  -1.752 0.079967 .
## NeighborhoodIDOTRR   -7.378e+03  1.082e+04  -0.682 0.495261
## NeighborhoodMeadowV  -1.610e+03  1.138e+04  -0.141 0.887530
## NeighborhoodMitchel  -2.036e+04  8.262e+03  -2.464 0.013853 *
## NeighborhoodNAmes    -1.449e+04  7.887e+03  -1.837 0.066426 .
## NeighborhoodNoRidge   2.889e+04  8.381e+03   3.447 0.000585 ***
## NeighborhoodNPkVill   8.215e+03  1.430e+04   0.574 0.565891
## NeighborhoodNridgHt   2.457e+04  7.363e+03   3.337 0.000871 ***
## NeighborhoodNWAmes   -2.050e+04  8.129e+03  -2.522 0.011802 *
## NeighborhoodOldTown  -1.300e+04  9.654e+03  -1.346 0.178498
## NeighborhoodSawyer   -1.020e+04  8.214e+03  -1.241 0.214694
## NeighborhoodSawyerW  -6.161e+03  7.840e+03  -0.786 0.432106
## NeighborhoodSomerst   1.701e+02  8.956e+03   0.019 0.984850
## NeighborhoodStoneBr   3.894e+04  8.369e+03   4.652 3.63e-06 ***
## NeighborhoodSWISU    -9.499e+03  9.808e+03  -0.968 0.333002
## NeighborhoodTimber   -5.900e+03  8.352e+03  -0.706 0.480067
## NeighborhoodVeenker   3.057e+03  1.071e+04   0.285 0.775465
## Condition1Feedr       3.035e+03  5.088e+03   0.597 0.550888
## Condition1Norm        1.221e+04  4.194e+03   2.912 0.003652 **
```

```
## Condition1PosA        7.473e+03  1.028e+04   0.727 0.467294
## Condition1PosN        8.077e+03  7.598e+03   1.063 0.287986
## Condition1RRAe       -1.693e+04  9.355e+03  -1.810 0.070591 .
## Condition1RRAn        6.490e+03  6.998e+03   0.927 0.353893
## Condition1RRNe       -7.278e+03  1.834e+04  -0.397 0.691557
## Condition1RRNn        3.894e+03  1.308e+04   0.298 0.765911
## Condition2Feedr      -9.591e+03  2.300e+04  -0.417 0.676776
## Condition2Norm       -7.506e+03  1.958e+04  -0.383 0.701533
## Condition2PosA        1.981e+04  3.793e+04   0.522 0.601677
## Condition2PosN       -2.303e+05  2.756e+04  -8.355  < 2e-16 ***
## Condition2RRAe       -1.290e+05  4.672e+04  -2.762 0.005826 **
## Condition2RRAn       -1.203e+04  3.188e+04  -0.377 0.706040
## Condition2RRNn       -9.030e+03  2.705e+04  -0.334 0.738563
## BldgType2fmCon       -6.227e+03  1.285e+04  -0.485 0.627914
## BldgTypeDuplex       -1.012e+03  7.434e+03  -0.136 0.891695
## BldgTypeTwnhs        -2.535e+04  1.013e+04  -2.503 0.012452 *
## BldgTypeTwnhsE       -2.313e+04  9.172e+03  -2.522 0.011800 *
## HouseStyle1.5Unf      1.091e+04  7.882e+03   1.384 0.166513
## HouseStyle1Story      8.847e+03  4.321e+03   2.047 0.040846 *
## HouseStyle2.5Fin     -1.702e+04  1.227e+04  -1.387 0.165727
## HouseStyle2.5Unf     -1.154e+04  9.362e+03  -1.233 0.217944
## HouseStyle2Story     -6.393e+03  3.541e+03  -1.805 0.071281 .
## HouseStyleSFoyer      7.780e+03  6.178e+03   1.259 0.208155
## HouseStyleSLvl        7.395e+03  5.447e+03   1.358 0.174759
## OverallQual           7.995e+03  1.016e+03   7.866 7.75e-15 ***
## OverallCond           5.378e+03  8.690e+02   6.189 8.15e-10 ***
## YearBuilt             3.255e+02  7.342e+01   4.433 1.01e-05 ***
## YearRemodAdd          1.048e+02  5.520e+01   1.899 0.057764 .
## RoofStyleGable        1.166e+03  1.871e+04   0.062 0.950327
## RoofStyleGambrel      4.014e+03  2.047e+04   0.196 0.844550
## RoofStyleHip          2.794e+03  1.876e+04   0.149 0.881604
## RoofStyleMansard      1.701e+04  2.180e+04   0.780 0.435486
## RoofStyleShed         8.806e+04  3.544e+04   2.485 0.013079 *
## RoofMatlCompShg       6.490e+05  3.290e+04  19.726  < 2e-16 ***
## RoofMatlMembran       7.357e+05  4.761e+04  15.453  < 2e-16 ***
## RoofMatlMetal         6.956e+05  4.702e+04  14.793  < 2e-16 ***
## RoofMatlRoll          6.501e+05  4.149e+04  15.670  < 2e-16 ***
## RoofMatlTar&Grv       6.542e+05  3.782e+04  17.297  < 2e-16 ***
## RoofMatlWdShake       6.290e+05  3.662e+04  17.178  < 2e-16 ***
## RoofMatlWdShngl       7.264e+05  3.414e+04  21.279  < 2e-16 ***
## Exterior1stAsphShn   -1.052e+04  3.383e+04  -0.311 0.755948
## Exterior1stBrkComm   -1.114e+04  2.831e+04  -0.394 0.693978
## Exterior1stBrkFace    6.826e+03  1.251e+04   0.546 0.585378
## Exterior1stCBlock    -2.771e+04  2.751e+04  -1.007 0.314067
## Exterior1stCemntBd   -1.365e+04  1.916e+04  -0.712 0.476430
## Exterior1stHdBoard   -1.240e+04  1.257e+04  -0.986 0.324266
## Exterior1stImStucc   -6.737e+04  2.840e+04  -2.372 0.017821 *
## Exterior1stMetalSd   -1.769e+03  1.447e+04  -0.122 0.902709
## Exterior1stPlywood   -1.651e+04  1.245e+04  -1.327 0.184821
## Exterior1stStone     -1.357e+04  2.413e+04  -0.562 0.573885
## Exterior1stStucco    -3.662e+03  1.377e+04  -0.266 0.790369
## Exterior1stVinylSd   -1.633e+04  1.317e+04  -1.240 0.215151
## Exterior1stWd Sdng   -1.239e+04  1.204e+04  -1.029 0.303605
## Exterior1stWdShing   -4.981e+03  1.304e+04  -0.382 0.702524
```

```
## Exterior2ndAsphShn    6.790e+03  2.262e+04   0.300 0.764070
## Exterior2ndBrk Cmn    1.390e+04  2.059e+04   0.675 0.499800
## Exterior2ndBrkFace   -1.477e+03  1.318e+04  -0.112 0.910796
## Exterior2ndCBlock            NA         NA      NA       NA
## Exterior2ndCmentBd    1.242e+04  1.909e+04   0.651 0.515346
## Exterior2ndHdBoard    7.218e+03  1.233e+04   0.585 0.558422
## Exterior2ndImStucc    3.276e+04  1.430e+04   2.290 0.022173 *
## Exterior2ndMetalSd    2.064e+03  1.430e+04   0.144 0.885259
## Exterior2ndOther     -6.816e+03  2.812e+04  -0.242 0.808544
## Exterior2ndPlywood    8.246e+03  1.197e+04   0.689 0.491084
## Exterior2ndStone     -1.090e+04  1.719e+04  -0.634 0.525999
## Exterior2ndStucco     1.788e+03  1.355e+04   0.132 0.895032
## Exterior2ndVinylSd    1.576e+04  1.290e+04   1.222 0.221933
## Exterior2ndWd Sdng    9.923e+03  1.183e+04   0.839 0.401806
## Exterior2ndWd Shng    2.630e+03  1.236e+04   0.213 0.831584
## ExterQualFa          -8.529e+03  1.084e+04  -0.787 0.431681
## ExterQualGd          -3.090e+04  4.781e+03  -6.462 1.47e-10 ***
## ExterQualTA          -3.084e+04  5.350e+03  -5.765 1.03e-08 ***
## ExterCondFa          -2.928e+03  1.881e+04  -0.156 0.876302
## ExterCondGd          -8.101e+03  1.798e+04  -0.451 0.652382
## ExterCondPo           1.141e+04  3.272e+04   0.349 0.727454
## ExterCondTA          -5.396e+03  1.795e+04  -0.301 0.763722
## FoundationCBlock      1.815e+03  3.181e+03   0.571 0.568281
## FoundationPConc       4.844e+03  3.497e+03   1.385 0.166262
## FoundationSlab        8.598e+03  7.831e+03   1.098 0.272467
## FoundationStone       1.122e+03  1.086e+04   0.103 0.917690
## FoundationWood       -3.322e+04  1.509e+04  -2.202 0.027845 *
## BsmtFinSF1            3.705e+01  4.406e+00   8.410  < 2e-16 ***
## BsmtFinSF2            2.450e+01  5.784e+00   4.235 2.44e-05 ***
## BsmtUnfSF             1.494e+01  4.058e+00   3.682 0.000242 ***
## TotalBsmtSF                  NA         NA      NA       NA
## HeatingGasA          -6.917e+03  2.535e+04  -0.273 0.784959
## HeatingGasW          -1.549e+04  2.616e+04  -0.592 0.553999
## HeatingGrav          -1.447e+04  2.746e+04  -0.527 0.598290
## HeatingOthW          -4.535e+04  3.165e+04  -1.433 0.152168
## HeatingWall           8.977e+03  2.920e+04   0.307 0.758549
## HeatingQCFa          -1.475e+03  4.796e+03  -0.307 0.758543
## HeatingQCGd          -3.698e+03  2.135e+03  -1.732 0.083586 .
## HeatingQCPo           7.969e+03  2.742e+04   0.291 0.771402
## HeatingQCTA          -4.347e+03  2.116e+03  -2.055 0.040104 *
## CentralAirY          -3.391e+03  3.863e+03  -0.878 0.380291
## X1stFlrSF             5.514e+01  5.316e+00  10.371  < 2e-16 ***
## X2ndFlrSF             7.004e+01  5.237e+00  13.374  < 2e-16 ***
## LowQualFinSF          2.453e+01  1.857e+01   1.321 0.186673
## GrLivArea                    NA         NA      NA       NA
## BsmtFullBath          1.544e+03  1.964e+03   0.787 0.431715
## BsmtHalfBath          3.704e+02  3.108e+03   0.119 0.905148
## FullBath              2.525e+03  2.236e+03   1.129 0.258993
## HalfBath             -1.492e+02  2.131e+03  -0.070 0.944200
## BedroomAbvGr         -5.493e+03  1.378e+03  -3.987 7.06e-05 ***
## KitchenAbvGr         -1.589e+04  5.717e+03  -2.780 0.005517 **
## KitchenQualFa        -2.110e+04  6.340e+03  -3.329 0.000898 ***
## KitchenQualGd        -2.780e+04  3.480e+03  -7.987 3.06e-15 ***
## KitchenQualTA        -2.536e+04  3.984e+03  -6.366 2.70e-10 ***
```

```
## TotRmsAbvGrd          1.366e+03  9.726e+02   1.405 0.160408
## FunctionalMaj2        2.301e+02  1.359e+04   0.017 0.986491
## FunctionalMin1        4.184e+03  8.613e+03   0.486 0.627206
## FunctionalMin2        8.542e+03  8.555e+03   0.998 0.318234
## FunctionalMod        -7.163e+03  1.054e+04  -0.679 0.496974
## FunctionalSev        -6.026e+04  2.752e+04  -2.190 0.028719 *
## FunctionalTyp         1.963e+04  7.387e+03   2.657 0.007981 **
## Fireplaces            2.758e+03  1.369e+03   2.015 0.044125 *
## GarageCars            4.296e+03  2.216e+03   1.939 0.052730 .
## GarageArea            1.313e+01  7.612e+00   1.724 0.084874 .
## PavedDriveP          -3.247e+03  5.558e+03  -0.584 0.559139
## PavedDriveY          -2.036e+03  3.435e+03  -0.593 0.553525
## WoodDeckSF            1.361e+01  5.943e+00   2.290 0.022210 *
## OpenPorchSF           1.223e+01  1.180e+01   1.037 0.299976
## EnclosedPorch         5.377e+00  1.277e+01   0.421 0.673727
## X3SsnPorch            2.400e+01  2.308e+01   1.040 0.298539
## ScreenPorch           3.702e+01  1.257e+01   2.946 0.003275 **
## PoolArea              7.139e+01  1.828e+01   3.906 9.89e-05 ***
## MiscVal              -3.282e-01  1.466e+00  -0.224 0.822852
## MoSold               -6.294e+02  2.529e+02  -2.488 0.012966 *
## YrSold               -1.797e+02  5.234e+02  -0.343 0.731396
## SaleTypeCon           3.533e+04  1.835e+04   1.926 0.054373 .
## SaleTypeConLD         1.682e+04  9.993e+03   1.683 0.092642 .
## SaleTypeConLI         9.657e+03  1.188e+04   0.813 0.416551
## SaleTypeConLw        -2.273e+03  1.238e+04  -0.184 0.854415
## SaleTypeCWD           2.325e+04  1.332e+04   1.745 0.081277 .
## SaleTypeNew           3.472e+04  1.601e+04   2.169 0.030294 *
## SaleTypeOth           1.864e+04  1.498e+04   1.244 0.213637
## SaleTypeWD            5.420e+02  4.328e+03   0.125 0.900362
## SaleConditionAdjLand  8.245e+03  1.446e+04   0.570 0.568754
## SaleConditionAlloca   4.978e+03  8.751e+03   0.569 0.569512
## SaleConditionFamily  -1.417e+03  6.306e+03  -0.225 0.822241
## SaleConditionNormal   6.527e+03  2.970e+03   2.198 0.028155 *
## SaleConditionPartial -9.505e+03  1.543e+04  -0.616 0.537950
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 23960 on 1274 degrees of freedom
## Multiple R-squared:  0.9206, Adjusted R-squared:  0.909
## F-statistic: 79.79 on 185 and 1274 DF,  p-value: < 2.2e-16
```

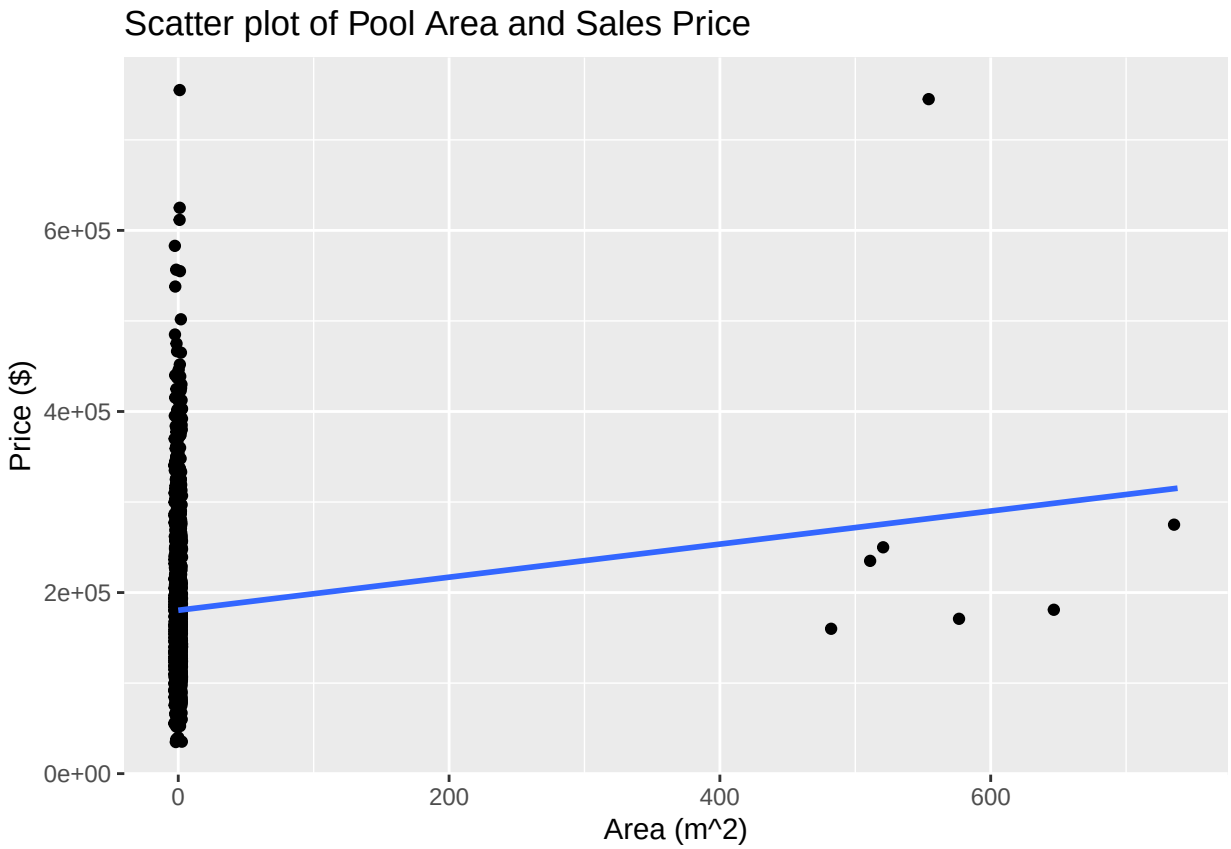
With the summary we can see that we have $R^2 = 0.9206$, and we can make some of the following interpretations when comparing `SalesPrice` with some of the most significant fields marked with `***`: Whenever the sales price increases by one dollar...

- `PoolArea`: the pool's area will increase by $71.39m^2$.
- `OverallQual`: the overall quality will increase by $7995.
- `OverallCond`: the overall condition will increase by $5378.
- `LotArea`: the lot's area will increase by $0.702m^2$.

For a better visual we will be plotting graphs between the sale price and the significant fields mentioned.

```
# Plot between PoolArea and SalePrice
ggplot(data = data.train, aes(x = PoolArea, y = SalePrice)) +
  geom_jitter() +  geom_smooth(method = "lm", se = FALSE) +
  labs(title="Scatter plot of Pool Area and Sales Price", x="Area (m^2)",y="Price ($)")
```

```
## `geom_smooth()` using formula = 'y ~ x'
```

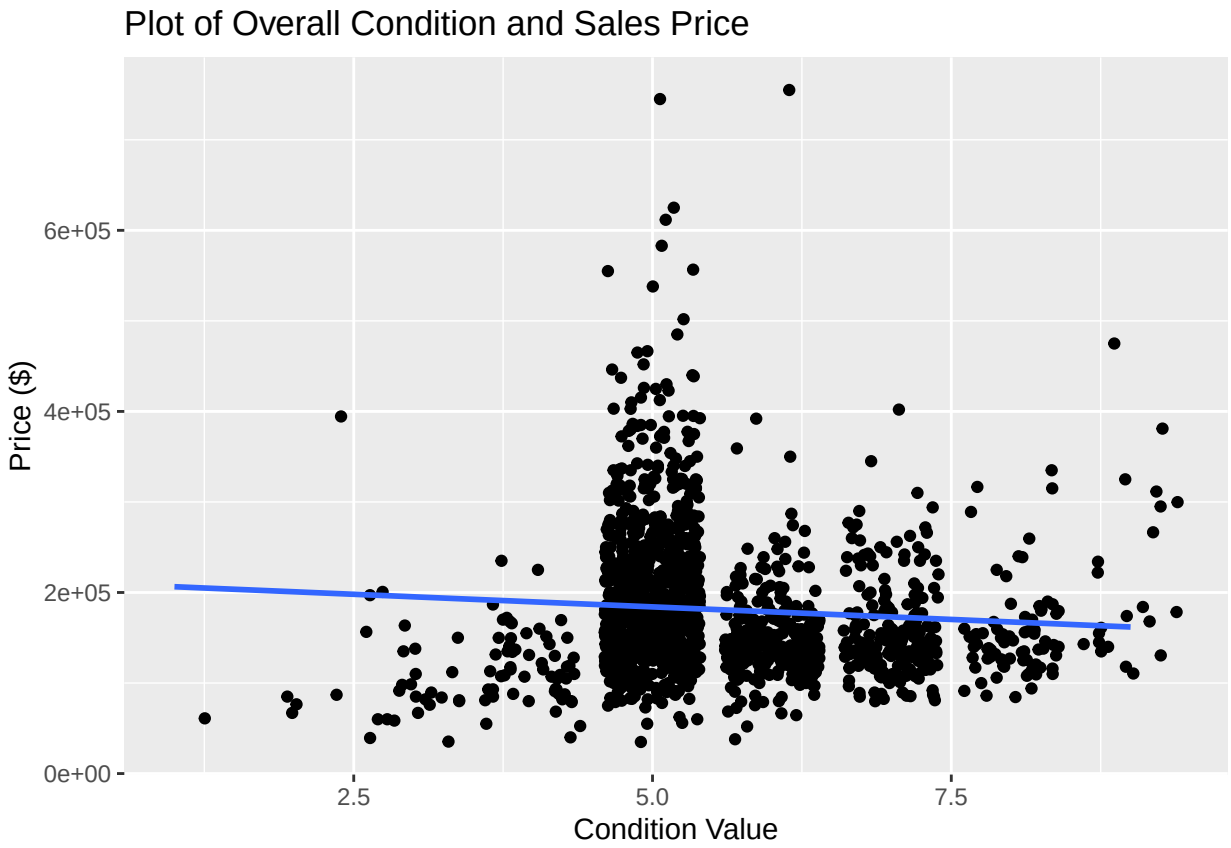



```
# Plot between Overall Quality and SalePrice
ggplot(data = data.train, aes(x = OverallQual, y = SalePrice)) +
  geom_jitter() +  geom_smooth(method = "lm", se = FALSE) +
  labs(title="Plot of Overall Quality and Sales Price", x="Quality Value",y="Price ($)")
```

```
## `geom_smooth()` using formula = 'y ~ x'
```

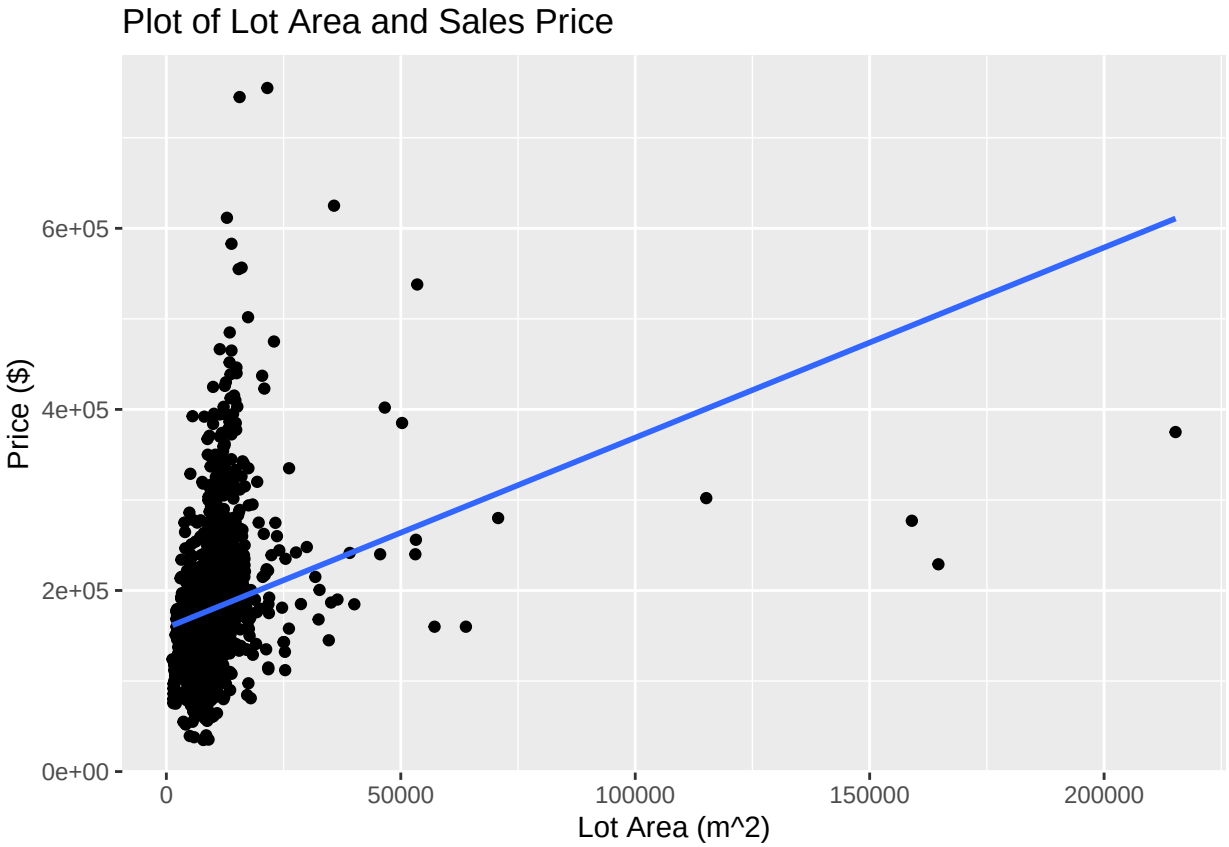

```
# Plot between Overall Condition and SalePrice
ggplot(data = data.train, aes(x = OverallCond, y = SalePrice)) +
  geom_jitter() +  geom_smooth(method = "lm", se = FALSE) +
  labs(title="Plot of Overall Condition and Sales Price", x="Condition Value",y="Price ($)")
```

```
## `geom_smooth()` using formula = 'y ~ x'
```




```
# plot between Lot Area and SalePrice
ggplot(data = data.train, aes(x = LotArea, y = SalePrice)) +
  geom_jitter() +  geom_smooth(method = "lm", se = FALSE) +
  labs(title="Plot of Lot Area and Sales Price", x="Lot Area (m^2)",y="Price ($)")
```

```
## `geom_smooth()` using formula = 'y ~ x'
```



While our plots show a great visualization between the correlation of the Price and the mentioned significant fields, it is still a small portion of the full plate of data we have. To gain a better insight to our complete palette, we need to look into a correlation plot of all the independent numerical variables and their association with our dependent variable sales price.

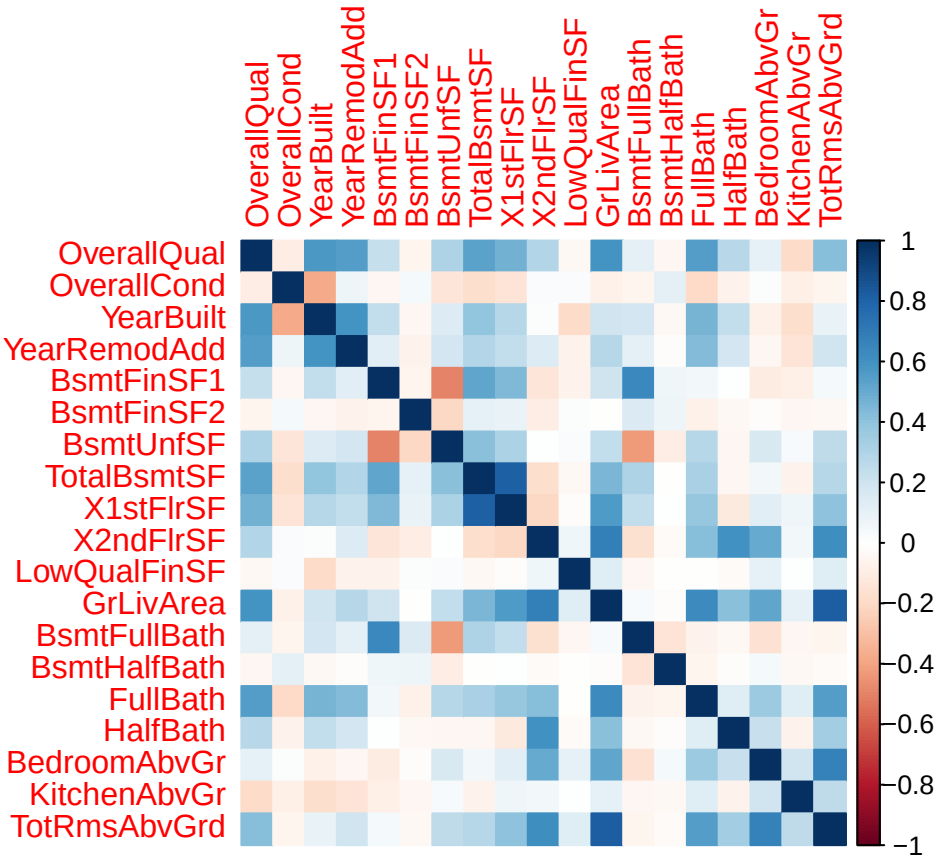
```
# get all the numerical variables
data.num <- data.train %>% dplyr::select(where(is.numeric))
# get the correlation data
data.cor <- data.frame(data.num[, 3:21])
correlation <- cor(data.cor)
# display the correlation
correlation
```

```
##               OverallQual OverallCond   YearBuilt YearRemodAdd   BsmtFinSF1
## OverallQual    1.00000000 -0.09193234  0.57232277   0.55068392  0.239665966
## OverallCond   -0.09193234  1.00000000 -0.37598320   0.07374150 -0.046230856
## YearBuilt      0.57232277 -0.37598320  1.00000000   0.59285498  0.249503197
## YearRemodAdd   0.55068392  0.07374150  0.59285498   1.00000000  0.128450547
## BsmtFinSF1     0.23966597 -0.04623086  0.24950320   0.12845055  1.000000000
## BsmtFinSF2    -0.05911869  0.04022917 -0.04910683  -0.06775851 -0.050117400
## BsmtUnfSF      0.30815893 -0.13684057  0.14904039   0.18113309 -0.495251469
## TotalBsmtSF    0.53780850 -0.17109751  0.39145200   0.29106558  0.522396052
## X1stFlrSF      0.47622383 -0.14420278  0.28198586   0.24037927  0.445862656
## X2ndFlrSF      0.29549288  0.02894212  0.01030766   0.14002378 -0.137078986
## LowQualFinSF -0.03042928  0.02549432 -0.18378434  -0.06241910 -0.064502597
## GrLivArea      0.59300743 -0.07968587  0.19900971   0.28738852  0.208171130
## BsmtFullBath   0.11109779 -0.05494152  0.18759855   0.11946988  0.649211754
## BsmtHalfBath -0.04015016  0.11782092 -0.03816181  -0.01233703  0.067418478
```

```
## FullBath      0.55059971 -0.19414949  0.46827079   0.43904648  0.058543137
## HalfBath      0.27345810 -0.06076933  0.24265591   0.18333061  0.004262424
## BedroomAbvGr  0.10167636  0.01298006 -0.07065122  -0.04058093 -0.107354677
## KitchenAbvGr -0.18388223 -0.08700086 -0.17480025  -0.14959752 -0.081006851
## TotRmsAbvGrd  0.42745234 -0.05758317  0.09558913   0.19173982  0.044315624
##                BsmtFinSF2    BsmtUnfSF   TotalBsmtSF    X1stFlrSF    X2ndFlrSF
## OverallQual  -0.059118693  0.308158927  0.5378084986  0.476223829  0.295492879
## OverallCond   0.040229170 -0.136840570 -0.1710975146 -0.144202784  0.028942116
## YearBuilt    -0.049106831  0.149040392  0.3914520021  0.281985859  0.010307660
## YearRemodAdd -0.067758514  0.181133087  0.2910655826  0.240379268  0.140023779
## BsmtFinSF1   -0.050117400 -0.495251469  0.5223960520  0.445862656 -0.137078986
## BsmtFinSF2    1.000000000 -0.209294492  0.1048095376  0.097117448 -0.099260316
## BsmtUnfSF    -0.209294492  1.000000000  0.4153596052  0.317987438  0.004469092
## TotalBsmtSF   0.104809538  0.415359605  1.0000000000  0.819529975 -0.174511950
## X1stFlrSF     0.097117448  0.317987438  0.8195299750  1.000000000 -0.202646181
## X2ndFlrSF    -0.099260316  0.004469092 -0.1745119501 -0.202646181  1.000000000
## LowQualFinSF  0.014806998  0.028166688 -0.0332453873 -0.014240673  0.063352950
## GrLivArea    -0.009639892  0.240257268  0.4548682025  0.566023969  0.687501064
## BsmtFullBath  0.158678061 -0.422900477  0.3073505537  0.244671104 -0.169493952
## BsmtHalfBath  0.070948134 -0.095804288 -0.0003145818  0.001955654 -0.023854784
## FullBath     -0.076443862  0.288886055  0.3237224136  0.380637495  0.421377983
## HalfBath     -0.032147837 -0.041117530 -0.0488037386 -0.119915909  0.609707300
## BedroomAbvGr -0.015728114  0.166643317  0.0504499555  0.127400749  0.502900613
## KitchenAbvGr -0.040751236  0.030085868 -0.0689006426  0.068100588  0.059305753
## TotRmsAbvGrd -0.035226548  0.250647061  0.2855725637  0.409515979  0.616422635
##                LowQualFinSF    GrLivArea BsmtFullBath  BsmtHalfBath
## OverallQual  -0.0304292840  0.593007430   0.11109779 -0.0401501577
## OverallCond   0.0254943199 -0.079685865  -0.05494152  0.1178209151
## YearBuilt    -0.1837843444  0.199009714   0.18759855 -0.0381618057
## YearRemodAdd -0.0624191001  0.287388520   0.11946988 -0.0123370321
## BsmtFinSF1   -0.0645025969  0.208171130   0.64921175  0.0674184779
## BsmtFinSF2    0.0148069979 -0.009639892   0.15867806  0.0709481337
## BsmtUnfSF     0.0281666881  0.240257268  -0.42290048 -0.0958042882
## TotalBsmtSF  -0.0332453873  0.454868203   0.30735055 -0.0003145818
## X1stFlrSF    -0.0142406727  0.566023969   0.24467110  0.0019556536
## X2ndFlrSF     0.0633529501  0.687501064  -0.16949395 -0.0238547839
## LowQualFinSF  1.0000000000  0.134682813  -0.04714342 -0.0058415048
## GrLivArea     0.1346828130  1.000000000   0.03483605 -0.0189184832
## BsmtFullBath -0.0471434219  0.034836050   1.00000000 -0.1478709605
## BsmtHalfBath -0.0058415048 -0.018918483  -0.14787096  1.0000000000
## FullBath     -0.0007095096  0.630011646  -0.06451205 -0.0545358120
## HalfBath     -0.0270800493  0.415771636  -0.03090496 -0.0123399001
## BedroomAbvGr  0.1056065685  0.521269511  -0.15067281  0.0465188484
## KitchenAbvGr  0.0075217443  0.100063165  -0.04150255 -0.0379443502
## TotRmsAbvGrd  0.1311847760  0.825489374  -0.05327524 -0.0238363413
##                  FullBath     HalfBath BedroomAbvGr KitchenAbvGr TotRmsAbvGrd
## OverallQual   0.5505997094  0.273458099   0.10167636 -0.183882235   0.42745234
## OverallCond  -0.1941494887 -0.060769327   0.01298006 -0.087000855  -0.05758317
## YearBuilt     0.4682707872  0.242655910  -0.07065122 -0.174800246   0.09558913
## YearRemodAdd  0.4390464839  0.183330612  -0.04058093 -0.149597521   0.19173982
## BsmtFinSF1    0.0585431369  0.004262424  -0.10735468 -0.081006851   0.04431562
## BsmtFinSF2   -0.0764438620 -0.032147837  -0.01572811 -0.040751236  -0.03522655
## BsmtUnfSF     0.2888860555 -0.041117530   0.16664332  0.030085868   0.25064706
## TotalBsmtSF   0.3237224136 -0.048803739   0.05044996 -0.068900643   0.28557256
```

```
## X1stFlrSF      0.3806374950 -0.119915909   0.12740075  0.068100588   0.40951598
## X2ndFlrSF      0.4213779829  0.609707300   0.50290061  0.059305753   0.61642264
## LowQualFinSF -0.0007095096 -0.027080049   0.10560657  0.007521744   0.13118478
## GrLivArea      0.6300116463  0.415771636   0.52126951  0.100063165   0.82548937
## BsmtFullBath -0.0645120486 -0.030904959  -0.15067281 -0.041502546  -0.05327524
## BsmtHalfBath -0.0545358120 -0.012339900   0.04651885 -0.037944350  -0.02383634
## FullBath       1.0000000000  0.136380589   0.36325198  0.133115214   0.55478425
## HalfBath       0.1363805887  1.000000000   0.22665148 -0.068262549   0.34341486
## BedroomAbvGr   0.3632519830  0.226651484   1.00000000  0.198596758   0.67661994
## KitchenAbvGr   0.1331152142 -0.068262549   0.19859676  1.000000000   0.25604541
## TotRmsAbvGrd   0.5547842535  0.343414858   0.67661994  0.256045409   1.00000000
```

```r
par(mfrow=c(1,1))
# plot the correlation
corrplot(correlation, method = "color")
```



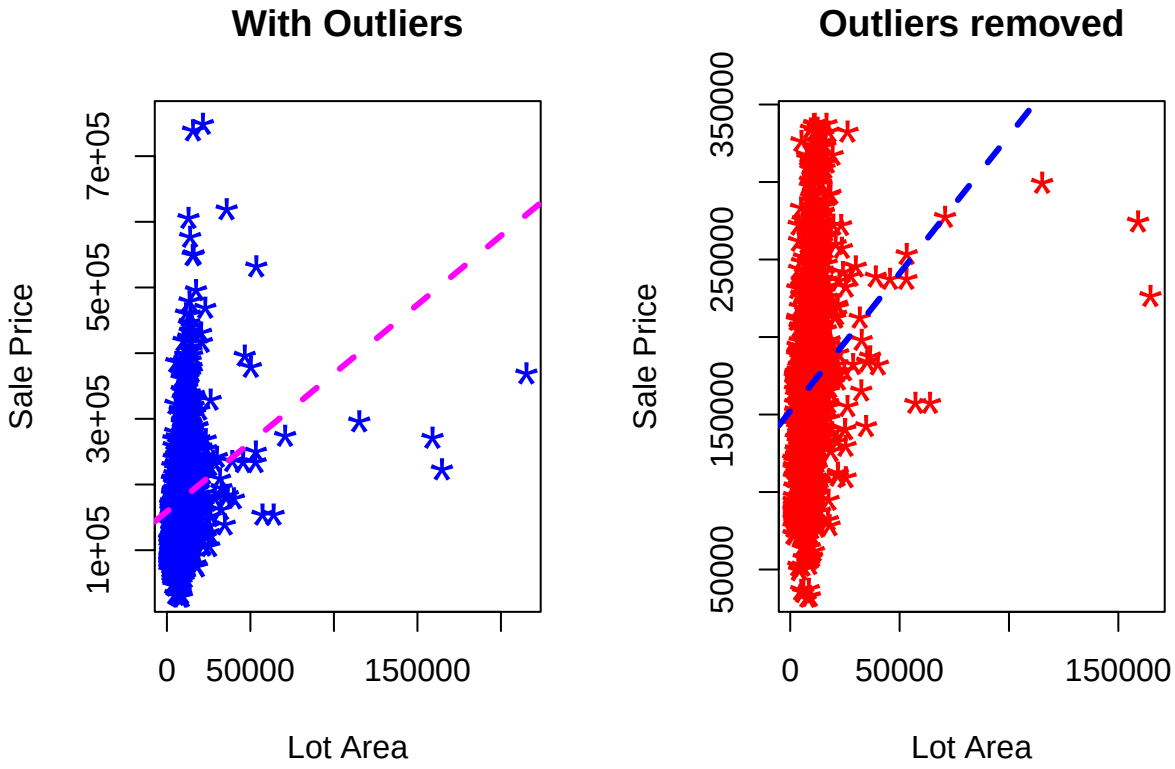
Outliers

Our data is quite accurate, but to see the effects outliers may have with `SalePrice`, we will try to plot the data with and without outliers to see the effect it has on us. First we need to extract outliers from the data and obtain the data without the outliers we'll find.

```r
outliers = boxplot(data.train$SalePrice, plot = FALSE)$out
outliers_data <- data.train[which(data.train$SalePrice %in% outliers),]
no_out_train <- data.train[-which(data.train$SalePrice %in% outliers),]
```

Now we can plot our data with outliers and without to see the effect it has on our data:

```r
par(mfrow=c(1,2))
# plot the data with the outliers
plot(data.train$LotArea, data.train$SalePrice, main = "With Outliers",
     xlab = "Lot Area", ylab = "Sale Price" , pch="*", col = "blue", cex = 2)
abline(lm(SalePrice ~ LotArea, data=data.train), col = "magenta", lwd = 3, lty = 2)
plot(no_out_train$LotArea, no_out_train$SalePrice, main="Outliers removed",
     xlab="Lot Area", ylab="Sale Price", pch="*", col="red", cex=2)
abline(lm(SalePrice ~ LotArea, data=no_out_train), col="blue", lwd=3, lty=2)
```



As you can see, we are able to concetrate the relationship between `SalePrice` and `LotArea` by removing the outliers and find that most of the values for `SalePrice` range from around $50000 – $350000.

Accuracy of the Model

We will determine the accuracy of the training data model by the following:

```r
# predicted values
pred <- model$fitted.values
tally_table <- data.frame(actual=data.train$SalePrice, predicted=pred)

mape <- mean(abs(tally_table$actual-tally_table$predicted)/tally_table$actual)
accuracy <- 1-mape
accuracy
```

```
## [1] 0.9151283
```

We can see that the accuracy of our training data model is 91.51%

Accuracy of the Model on Test Data