Machine Learning Project

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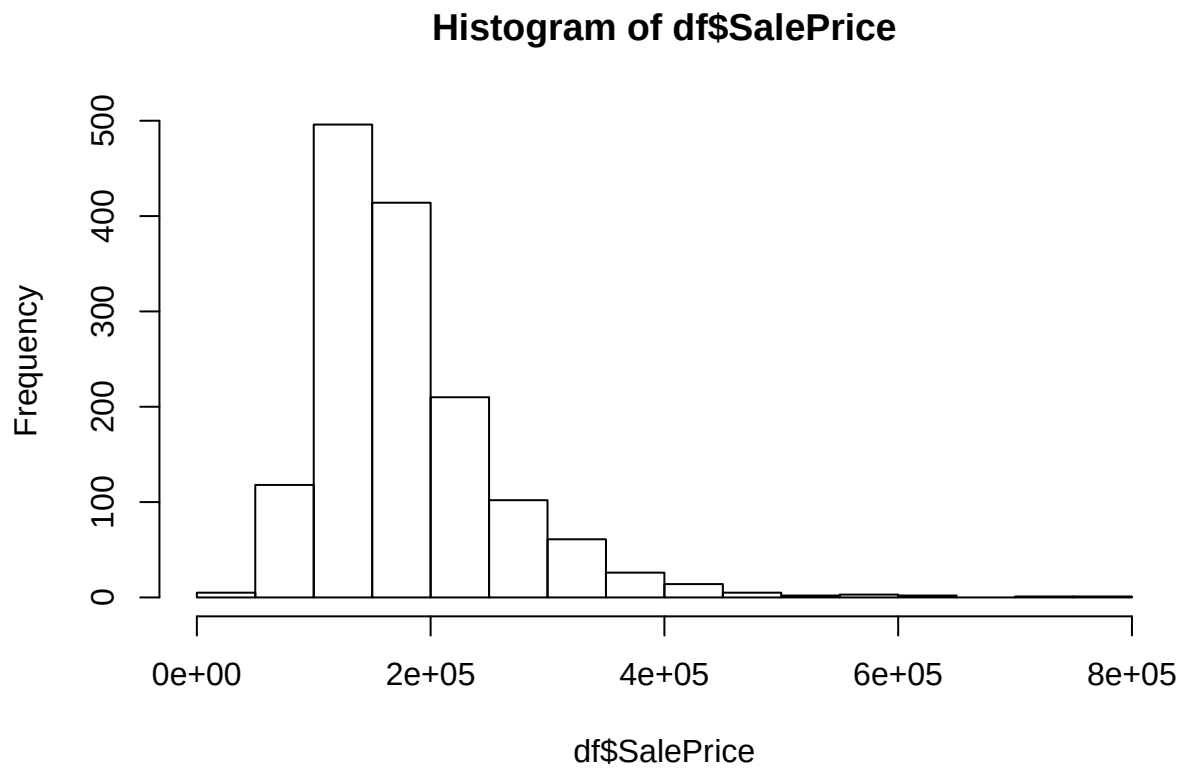
```
setwd("C:/Users/Michal/Documents/01- Master Degree/GitHub/ST443-Project-group9/Housing price data")
getwd()
```

```
## [1] "C:/Users/Michal/Documents/01- Master Degree/GitHub/ST443-Project-group9/Housing price data"
```

```
train = read.csv("train.csv", row.names = "Id", stringsAsFactors=FALSE)
testing_kaggle = read.csv("test.csv", row.names = "Id", stringsAsFactors=FALSE)
```

```
#combining train and test data for quicker data prep
testing_kaggle$SalePrice <- NA
train$isTrain <- 1
testing_kaggle$isTrain <- 0
df <- rbind(train,testing_kaggle)
```

```
hist(df$SalePrice)
```




```
colSums(sapply(df, is.na))
```

```
##    MSSubClass      MSZoning   LotFrontage       LotArea        Street
##             0             4           486             0             0
##         Alley      LotShape   LandContour     Utilities     LotConfig
```

```
##          2721             0             0             2             0
##     LandSlope  Neighborhood    Condition1    Condition2      BldgType
##             0             0             0             0             0
##    HouseStyle   OverallQual   OverallCond     YearBuilt  YearRemodAdd
##             0             0             0             0             0
##     RoofStyle      RoofMatl   Exterior1st   Exterior2nd    MasVnrType
##             0             0             1             1            24
##    MasVnrArea     ExterQual     ExterCond    Foundation      BsmtQual
##            23             0             0             0            81
##      BsmtCond  BsmtExposure  BsmtFinType1    BsmtFinSF1  BsmtFinType2
##            82            82            79             1            80
##    BsmtFinSF2     BsmtUnfSF   TotalBsmtSF       Heating     HeatingQC
##             1             1             1             0             0
##    CentralAir    Electrical     X1stFlrSF     X2ndFlrSF  LowQualFinSF
##             0             1             0             0             0
##     GrLivArea  BsmtFullBath  BsmtHalfBath      FullBath      HalfBath
##             0             2             2             0             0
##  BedroomAbvGr  KitchenAbvGr   KitchenQual  TotRmsAbvGrd    Functional
##             0             0             1             0             2
##    Fireplaces   FireplaceQu    GarageType   GarageYrBlt  GarageFinish
##             0          1420           157           159           159
##    GarageCars    GarageArea    GarageQual    GarageCond    PavedDrive
##             1             1           159           159             0
##    WoodDeckSF   OpenPorchSF EnclosedPorch    X3SsnPorch   ScreenPorch
##             0             0             0             0             0
##      PoolArea        PoolQC         Fence   MiscFeature       MiscVal
##             0          2909          2348          2814             0
##        MoSold        YrSold      SaleType SaleCondition     SalePrice
##             0             0             1             0          1459
##       isTrain
##             0
```

```
for(i in colnames(df[,sapply(df, is.character)])){

  df[,i][which(is.na(df[,i]))] <- "None"
}
```

```
colSums(sapply(df, is.na))
```

```
##    MSSubClass      MSZoning   LotFrontage       LotArea        Street
##             0             0           486             0             0
##         Alley      LotShape   LandContour     Utilities     LotConfig
##             0             0             0             0             0
##     LandSlope  Neighborhood    Condition1    Condition2      BldgType
##             0             0             0             0             0
##    HouseStyle   OverallQual   OverallCond     YearBuilt  YearRemodAdd
##             0             0             0             0             0
##     RoofStyle      RoofMatl   Exterior1st   Exterior2nd    MasVnrType
##             0             0             0             0             0
##    MasVnrArea     ExterQual     ExterCond    Foundation      BsmtQual
##            23             0             0             0             0
##      BsmtCond  BsmtExposure  BsmtFinType1    BsmtFinSF1  BsmtFinType2
##             0             0             0             1             0
##    BsmtFinSF2     BsmtUnfSF   TotalBsmtSF       Heating     HeatingQC
##             1             1             1             0             0
```

```
##    CentralAir    Electrical     X1stFlrSF     X2ndFlrSF  LowQualFinSF
##             0             0             0             0             0
##     GrLivArea  BsmtFullBath  BsmtHalfBath      FullBath      HalfBath
##             0             2             2             0             0
##  BedroomAbvGr  KitchenAbvGr   KitchenQual  TotRmsAbvGrd    Functional
##             0             0             0             0             0
##    Fireplaces   FireplaceQu    GarageType   GarageYrBlt  GarageFinish
##             0             0             0           159             0
##    GarageCars    GarageArea    GarageQual    GarageCond    PavedDrive
##             1             1             0             0             0
##    WoodDeckSF   OpenPorchSF EnclosedPorch    X3SsnPorch   ScreenPorch
##             0             0             0             0             0
##      PoolArea        PoolQC         Fence   MiscFeature       MiscVal
##             0             0             0             0             0
##        MoSold        YrSold      SaleType SaleCondition     SalePrice
##             0             0             0             0          1459
##       isTrain
##             0
```

```
df$LotFrontage[which(is.na(df$LotFrontage))] <- mean(df$LotFrontage,na.rm = T)
```

```
df$MasVnrArea[which(is.na(df$MasVnrArea))] <- mean(df$LotFrontage,na.rm = T)
```

```
x = c("BsmtFinSF1","BsmtFinSF2", "BsmtUnfSF", "TotalBsmtSF", "BsmtFullBath", "BsmtHalfBath", "GarageYrB

for(i in x){

  df[,i][which(is.na(df[,i]))] <- 0
}
```

```
colSums(sapply(df, is.na))
```

```
##    MSSubClass      MSZoning   LotFrontage       LotArea        Street
##             0             0             0             0             0
##         Alley      LotShape   LandContour     Utilities     LotConfig
##             0             0             0             0             0
##     LandSlope  Neighborhood    Condition1    Condition2      BldgType
##             0             0             0             0             0
##    HouseStyle   OverallQual   OverallCond     YearBuilt  YearRemodAdd
##             0             0             0             0             0
##     RoofStyle      RoofMatl   Exterior1st   Exterior2nd    MasVnrType
##             0             0             0             0             0
##    MasVnrArea     ExterQual     ExterCond    Foundation      BsmtQual
##             0             0             0             0             0
##      BsmtCond  BsmtExposure  BsmtFinType1    BsmtFinSF1  BsmtFinType2
##             0             0             0             0             0
##    BsmtFinSF2     BsmtUnfSF   TotalBsmtSF       Heating     HeatingQC
##             0             0             0             0             0
##    CentralAir    Electrical     X1stFlrSF     X2ndFlrSF  LowQualFinSF
##             0             0             0             0             0
##     GrLivArea  BsmtFullBath  BsmtHalfBath      FullBath      HalfBath
##             0             0             0             0             0
##  BedroomAbvGr  KitchenAbvGr   KitchenQual  TotRmsAbvGrd    Functional
##             0             0             0             0             0
##    Fireplaces   FireplaceQu    GarageType   GarageYrBlt  GarageFinish
```

```
##            0            0            0            0            0
##   GarageCars   GarageArea   GarageQual   GarageCond   PavedDrive
##            0            0            0            0            0
##   WoodDeckSF  OpenPorchSF EnclosedPorch   X3SsnPorch  ScreenPorch
##            0            0            0            0            0
##     PoolArea       PoolQC        Fence  MiscFeature      MiscVal
##            0            0            0            0            0
##       MoSold       YrSold     SaleType SaleCondition    SalePrice
##            0            0            0            0         1459
##      isTrain
##            0
```

```
for(i in colnames(df[,sapply(df, is.character)])){
    df[,i] <- as.factor(df[,i])
}
```

```
# These are also categorical Variables
df$OverallCond <- as.factor(df$OverallCond)
df$OverallQual <- as.factor(df$OverallQual)
```

```
str(df)
```

```
## 'data.frame':    2919 obs. of  81 variables:
##  $ MSSubClass   : int  60 20 60 70 60 50 20 60 50 190 ...
##  $ MSZoning     : Factor w/ 6 levels "C (all)","FV",..: 5 5 5 5 5 5 5 5 6 5 ...
##  $ LotFrontage  : num  65 80 68 60 84 ...
##  $ 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/ 3 levels "Grvl","None",..: 2 2 2 2 2 2 2 2 2 2 ...
##  $ 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/ 3 levels "AllPub","None",..: 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  : Factor w/ 10 levels "1","2","3","4",..: 7 6 7 7 8 5 8 7 7 5 ...
##  $ OverallCond  : Factor w/ 9 levels "1","2","3","4",..: 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/ 16 levels "AsbShng","AsphShn",..: 14 9 14 15 14 14 14 7 4 9 ...
##  $ Exterior2nd  : Factor w/ 17 levels "AsbShng","AsphShn",..: 15 9 15 17 15 15 15 7 17 9 ...
##  $ MasVnrType   : Factor w/ 4 levels "BrkCmn","BrkFace",..: 2 3 2 3 2 3 4 4 3 3 ...
##  $ MasVnrArea   : num  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/ 5 levels "Ex","Fa","Gd",..: 3 3 3 5 3 3 1 3 5 5 ...
##  $ BsmtCond     : Factor w/ 5 levels "Fa","Gd","None",..: 5 5 5 2 5 5 5 5 5 5 ...
##  $ BsmtExposure : Factor w/ 5 levels "Av","Gd","Mn",..: 4 2 3 4 1 4 1 3 4 4 ...
```

```
##  $ BsmtFinType1 : Factor w/ 7 levels "ALQ","BLQ","GLQ",..: 3 1 3 1 3 3 3 1 7 3 ...
##  $ BsmtFinSF1   : num  706 978 486 216 655 ...
##  $ BsmtFinType2 : Factor w/ 7 levels "ALQ","BLQ","GLQ",..: 7 7 7 7 7 7 7 2 7 7 ...
##  $ BsmtFinSF2   : num  0 0 0 0 0 0 0 32 0 0 ...
##  $ BsmtUnfSF    : num  150 284 434 540 490 64 317 216 952 140 ...
##  $ TotalBsmtSF  : num  856 1262 920 756 1145 ...
##  $ 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/ 6 levels "FuseA","FuseF",..: 6 6 6 6 6 6 6 6 2 6 ...
##  $ 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 : num  1 0 1 1 1 1 1 1 0 1 ...
##  $ BsmtHalfBath : num  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/ 5 levels "Ex","Fa","Gd",..: 3 5 3 3 3 5 3 5 5 5 ...
##  $ TotRmsAbvGrd : int  8 6 6 7 9 5 7 7 8 5 ...
##  $ Functional   : Factor w/ 8 levels "Maj1","Maj2",..: 8 8 8 8 8 8 8 8 3 8 ...
##  $ Fireplaces   : int  0 1 1 1 1 0 1 2 2 2 ...
##  $ FireplaceQu  : Factor w/ 6 levels "Ex","Fa","Gd",..: 4 6 6 3 6 4 3 6 6 6 ...
##  $ GarageType   : Factor w/ 7 levels "2Types","Attchd",..: 2 2 2 6 2 2 2 2 6 2 ...
##  $ GarageYrBlt  : num  2003 1976 2001 1998 2000 ...
##  $ GarageFinish : Factor w/ 4 levels "Fin","None","RFn",..: 3 3 3 4 3 4 3 3 4 3 ...
##  $ GarageCars   : num  2 2 2 3 3 2 2 2 2 1 ...
##  $ GarageArea   : num  548 460 608 642 836 480 636 484 468 205 ...
##  $ GarageQual   : Factor w/ 6 levels "Ex","Fa","Gd",..: 6 6 6 6 6 6 6 6 2 3 ...
##  $ GarageCond   : Factor w/ 6 levels "Ex","Fa","Gd",..: 6 6 6 6 6 6 6 6 6 6 ...
##  $ 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/ 4 levels "Ex","Fa","Gd",..: 4 4 4 4 4 4 4 4 4 4 ...
##  $ Fence        : Factor w/ 5 levels "GdPrv","GdWo",..: 5 5 5 5 5 3 5 5 5 5 ...
##  $ MiscFeature  : Factor w/ 5 levels "Gar2","None",..: 2 2 2 2 2 4 2 4 2 2 ...
##  $ 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/ 10 levels "COD","Con","ConLD",..: 10 10 10 10 10 10 10 10 10 10 ...
##  $ 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 ...
##  $ isTrain      : num  1 1 1 1 1 1 1 1 1 1 ...
```