Kaggle House Prices

Javier Guzmán Figueira Domínguez

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Inspección de los datos

```
updatePartitions <- function() {
    train.size <- nrow(train)
    full.set.size <- nrow(full.set)

    train <<- full.set[c(1:train.size), ]
    test <<- full.set[c((train.size + 1):full.set.size), ]
}
```

Las dimensiones del conjunto de entrenamiento son las siguientes:

```
dim(train)
```

```
## [1] 1460   81
```

```
dim(test)
```

```
## [1] 1459   80
```

```
dim(full.set)
```

```
## [1] 2919   81
```

A continuacin, procedemos a examinar las variables del dataset:

```
str(full.set)
```

```
## 'data.frame':    2919 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 ...
```

Y observamos el inicio:

```r
head(full.set)
```

```
##   Id MSSubClass MSZoning LotFrontage LotArea Street Alley LotShape
## 1  1         60       RL          65    8450   Pave  <NA>      Reg
## 2  2         20       RL          80    9600   Pave  <NA>      Reg
## 3  3         60       RL          68   11250   Pave  <NA>      IR1
## 4  4         70       RL          60    9550   Pave  <NA>      IR1
## 5  5         60       RL          84   14260   Pave  <NA>      IR1
## 6  6         50       RL          85   14115   Pave  <NA>      IR1
##   LandContour Utilities LotConfig LandSlope Neighborhood Condition1
## 1         Lvl    AllPub    Inside       Gtl      CollgCr       Norm
## 2         Lvl    AllPub       FR2       Gtl      Veenker      Feedr
## 3         Lvl    AllPub    Inside       Gtl      CollgCr       Norm
## 4         Lvl    AllPub    Corner       Gtl      Crawfor       Norm
## 5         Lvl    AllPub       FR2       Gtl      NoRidge       Norm
## 6         Lvl    AllPub    Inside       Gtl      Mitchel       Norm
##   Condition2 BldgType HouseStyle OverallQual OverallCond YearBuilt
## 1       Norm     1Fam     2Story           7           5      2003
## 2       Norm     1Fam     1Story           6           8      1976
## 3       Norm     1Fam     2Story           7           5      2001
## 4       Norm     1Fam     2Story           7           5      1915
## 5       Norm     1Fam     2Story           8           5      2000
## 6       Norm     1Fam     1.5Fin           5           5      1993
##   YearRemodAdd RoofStyle RoofMatl Exterior1st Exterior2nd MasVnrType
## 1         2003     Gable  CompShg     VinylSd     VinylSd    BrkFace
## 2         1976     Gable  CompShg     MetalSd     MetalSd       None
## 3         2002     Gable  CompShg     VinylSd     VinylSd    BrkFace
## 4         1970     Gable  CompShg     Wd Sdng     Wd Shng       None
## 5         2000     Gable  CompShg     VinylSd     VinylSd    BrkFace
## 6         1995     Gable  CompShg     VinylSd     VinylSd       None
##   MasVnrArea ExterQual ExterCond Foundation BsmtQual BsmtCond BsmtExposure
## 1        196        Gd        TA      PConc       Gd       TA           No
## 2          0        TA        TA     CBlock       Gd       TA           Gd
## 3        162        Gd        TA      PConc       Gd       TA           Mn
## 4          0        TA        TA     BrkTil       TA       Gd           No
## 5        350        Gd        TA      PConc       Gd       TA           Av
## 6          0        TA        TA       Wood       Gd       TA           No
##   BsmtFinType1 BsmtFinSF1 BsmtFinType2 BsmtFinSF2 BsmtUnfSF TotalBsmtSF
## 1          GLQ        706          Unf          0       150         856
## 2          ALQ        978          Unf          0       284        1262
## 3          GLQ        486          Unf          0       434         920
## 4          ALQ        216          Unf          0       540         756
## 5          GLQ        655          Unf          0       490        1145
## 6          GLQ        732          Unf          0        64         796
##   Heating HeatingQC CentralAir Electrical X1stFlrSF X2ndFlrSF LowQualFinSF
## 1    GasA        Ex          Y      SBrkr       856       854            0
## 2    GasA        Ex          Y      SBrkr      1262         0            0
## 3    GasA        Ex          Y      SBrkr       920       866            0
## 4    GasA        Gd          Y      SBrkr       961       756            0
## 5    GasA        Ex          Y      SBrkr      1145      1053            0
## 6    GasA        Ex          Y      SBrkr       796       566            0
##   GrLivArea BsmtFullBath BsmtHalfBath FullBath HalfBath BedroomAbvGr
## 1      1710            1            0        2        1            3
## 2      1262            0            1        2        0            3
## 3      1786            1            0        2        1            3
## 4      1717            1            0        1        0            3
## 5      2198            1            0        2        1            4
## 6      1362            1            0        1        1            1
##   KitchenAbvGr KitchenQual TotRmsAbvGrd Functional Fireplaces FireplaceQu
## 1            1          Gd            8        Typ          0        <NA>
## 2            1          TA            6        Typ          1          TA
## 3            1          Gd            6        Typ          1          TA
## 4            1          Gd            7        Typ          1          Gd
## 5            1          Gd            9        Typ          1          TA
## 6            1          TA            5        Typ          0        <NA>
##   GarageType GarageYrBlt GarageFinish GarageCars GarageArea GarageQual
## 1     Attchd        2003          RFn          2        548         TA
## 2     Attchd        1976          RFn          2        460         TA
## 3     Attchd        2001          RFn          2        608         TA
## 4     Detchd        1998          Unf          3        642         TA
## 5     Attchd        2000          RFn          3        836         TA
## 6     Attchd        1993          Unf          2        480         TA
##   GarageCond PavedDrive WoodDeckSF OpenPorchSF EnclosedPorch X3SsnPorch
## 1         TA          Y          0          61             0          0
## 2         TA          Y        298           0             0          0
## 3         TA          Y          0          42             0          0
## 4         TA          Y          0          35           272          0
## 5         TA          Y        192          84             0          0
## 6         TA          Y         40          30             0        320
##   ScreenPorch PoolArea PoolQC Fence MiscFeature MiscVal MoSold YrSold
## 1           0        0   <NA>  <NA>        <NA>       0      2   2008
## 2           0        0   <NA>  <NA>        <NA>       0      5   2007
## 3           0        0   <NA>  <NA>        <NA>       0      9   2008
## 4           0        0   <NA>  <NA>        <NA>       0      2   2006
## 5           0        0   <NA>  <NA>        <NA>       0     12   2008
## 6           0        0   <NA> MnPrv        Shed     700     10   2009
##   SaleType SaleCondition SalePrice
## 1       WD        Normal    208500
## 2       WD        Normal    181500
## 3       WD        Normal    223500
## 4       WD       Abnorml    140000
## 5       WD        Normal    250000
## 6       WD        Normal    143000
```

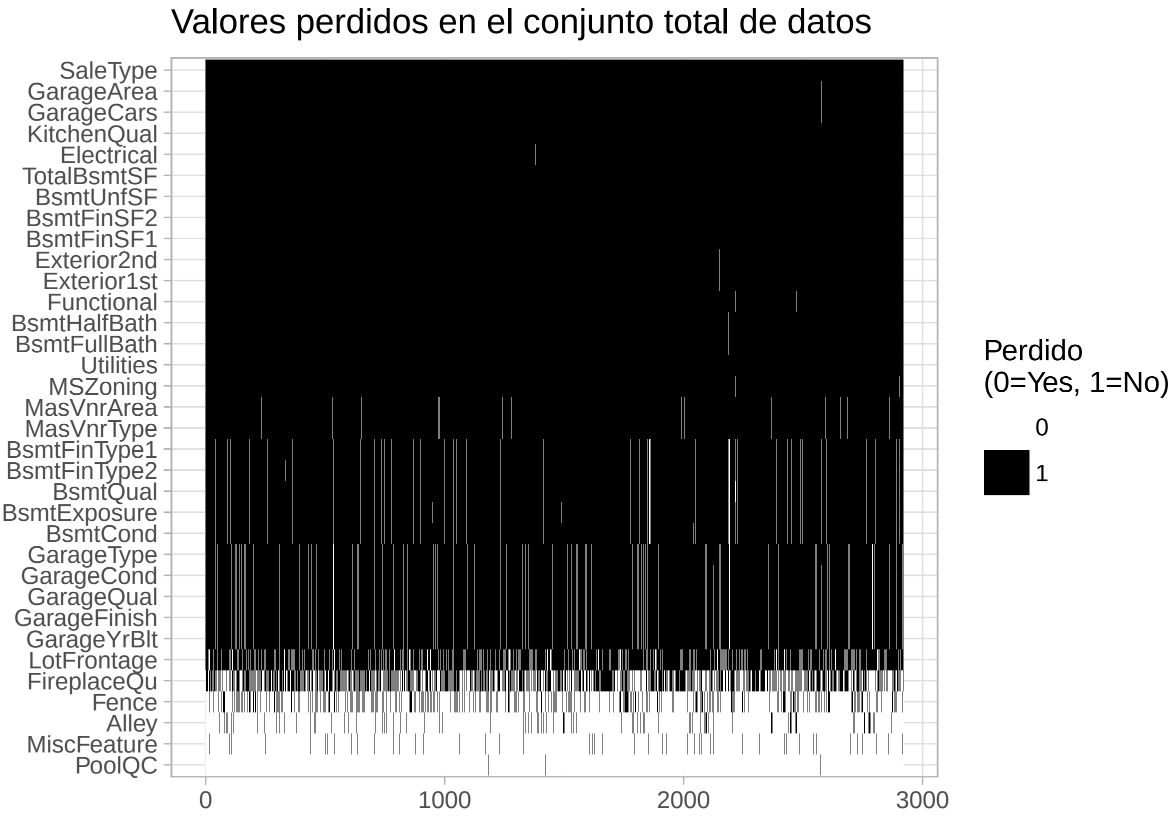
- Análisis de valores perdidos

```r
getLostValuesStats <- function() {
    lost.count <- colSums(sapply(select(full.set, -SalePrice),
        is.na))
    lost.count <- subset(lost.count, lost.count > 0)
    lost.percentage <- (lost.count/nrow(full.set)) * 100
    return(data.frame(lost.count, lost.percentage))
}

getLostValuesStats()
```

```
##              lost.count lost.percentage
## MSZoning              4      0.13703323
## LotFrontage         486     16.64953751
## Alley              2721     93.21685509
## Utilities             2      0.06851662
## Exterior1st           1      0.03425831
## Exterior2nd           1      0.03425831
## MasVnrType           24      0.82219938
## MasVnrArea           23      0.78794108
## BsmtQual             81      2.77492292
## BsmtCond             82      2.80918123
## BsmtExposure         82      2.80918123
## BsmtFinType1         79      2.70640630
## BsmtFinSF1            1      0.03425831
## BsmtFinType2         80      2.74066461
## BsmtFinSF2            1      0.03425831
## BsmtUnfSF             1      0.03425831
## TotalBsmtSF           1      0.03425831
## Electrical            1      0.03425831
## BsmtFullBath          2      0.06851662
## BsmtHalfBath          2      0.06851662
## KitchenQual           1      0.03425831
## Functional            2      0.06851662
## FireplaceQu        1420     48.64679685
## GarageType          157      5.37855430
## GarageYrBlt         159      5.44707091
## GarageFinish        159      5.44707091
## GarageCars            1      0.03425831
## GarageArea            1      0.03425831
## GarageQual          159      5.44707091
## GarageCond          159      5.44707091
## PoolQC             2909     99.65741692
## Fence              2348     80.43850634
## MiscFeature        2814     96.40287770
## SaleType              1      0.03425831
```

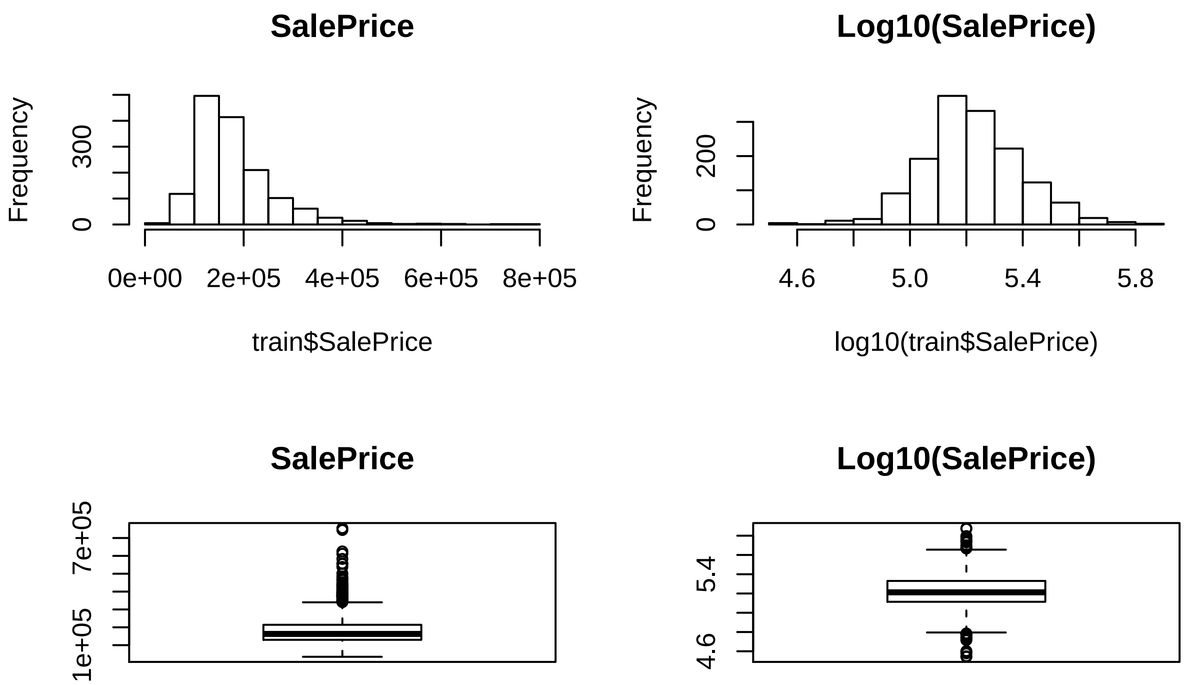
```
lost.values.count <- full.set[, colSums(is.na(select(full.set,
    -SalePrice))) > 0]

is.lost.value <- as.data.frame(ifelse(is.na(lost.values.count),
    0, 1))
is.lost.value <- is.lost.value[, order(colSums(is.lost.value))]

is.lost.value.grid <- expand.grid(list(x = 1:nrow(is.lost.value),
    y = colnames(is.lost.value)))
is.lost.value.grid$m <- as.vector(as.matrix(is.lost.value))
is.lost.value.grid <- data.frame(x = unlist(is.lost.value.grid$x),
    y = unlist(is.lost.value.grid$y), m = unlist(is.lost.value.grid$m))
```

```r
ggplot2::ggplot(is.lost.value.grid) + ggplot2::geom_tile(ggplot2::aes(x = x,
    y = y, fill = factor(m))) + ggplot2::scale_fill_manual(values = c("white",
    "black"), name = "Perdido\n(0=Yes, 1=No)") + ggplot2::theme_light() +
    ggplot2::ylab("") + ggplot2::xlab("") + ggplot2::ggtitle("Valores perdidos en el conjunto total de d
```



- Análisis de la distribución de la variable clase

```r
par(mfrow = c(2, 2))

hist(train$SalePrice, main = "SalePrice")
hist(log10(train$SalePrice), main = "Log10(SalePrice)")

boxplot(train$SalePrice, main = "SalePrice")
boxplot(log10(train$SalePrice), main = "Log10(SalePrice)")
```



```
par(mfrow = c(1, 1))
```

- Distribución de los valores perdidos en función de la variable Log(SalePrice)

“‘{r} # TODO: DELETE ¿? lost.values.features <- rownames(getLostValuesStats()) factor.features <- names(train)[which(sapply(train, is.factor))] lost.values.features.factor <- dplyr::intersect(factor.features, lost.values.features)

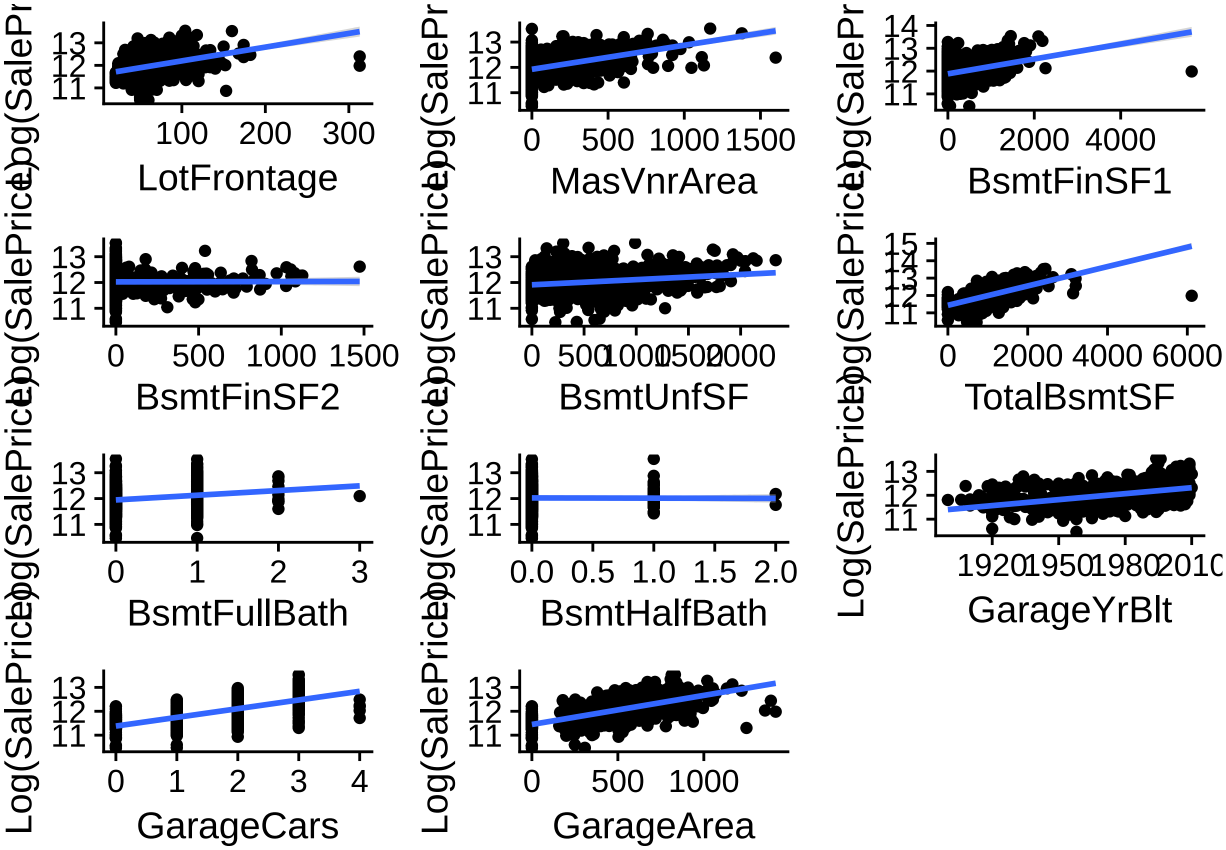
plots <- lapply(lost.values.features.factor, function(feature) { categories <- train[, feature] ggplot(data = train, aes(x = feature, y = log(SalePrice), fill = categories)) + geom_boxplot() })

cowplot::plot_grid(plotlist = plots, ncol = 3) “‘

- Examinamos la distribución de las variables continuas con respecto a Log(SalePrice)

```
lost.values.features <- rownames(getLostValuesStats())
numeric.features <- names(train)[which(sapply(train, is.numeric))]
lost.values.features.numeric <- dplyr::intersect(numeric.features,
    lost.values.features)

plots <- lapply(lost.values.features.numeric, function(feature) {
    ggplot(data = train, aes(x = train[, feature], y = log(train$SalePrice))) +
        geom_point() + geom_smooth(method = "lm") + xlab(label = feature) +
        ylab(label = "Log(SalePrice)")
})

cowplot::plot_grid(plotlist = plots, ncol = 3)
```

```
## Warning: Removed 259 rows containing non-finite values (stat_smooth).
## Warning: Removed 259 rows containing missing values (geom_point).

## Warning: Removed 8 rows containing non-finite values (stat_smooth).

## Warning: Removed 8 rows containing missing values (geom_point).

## Warning: Removed 81 rows containing non-finite values (stat_smooth).

## Warning: Removed 81 rows containing missing values (geom_point).
```



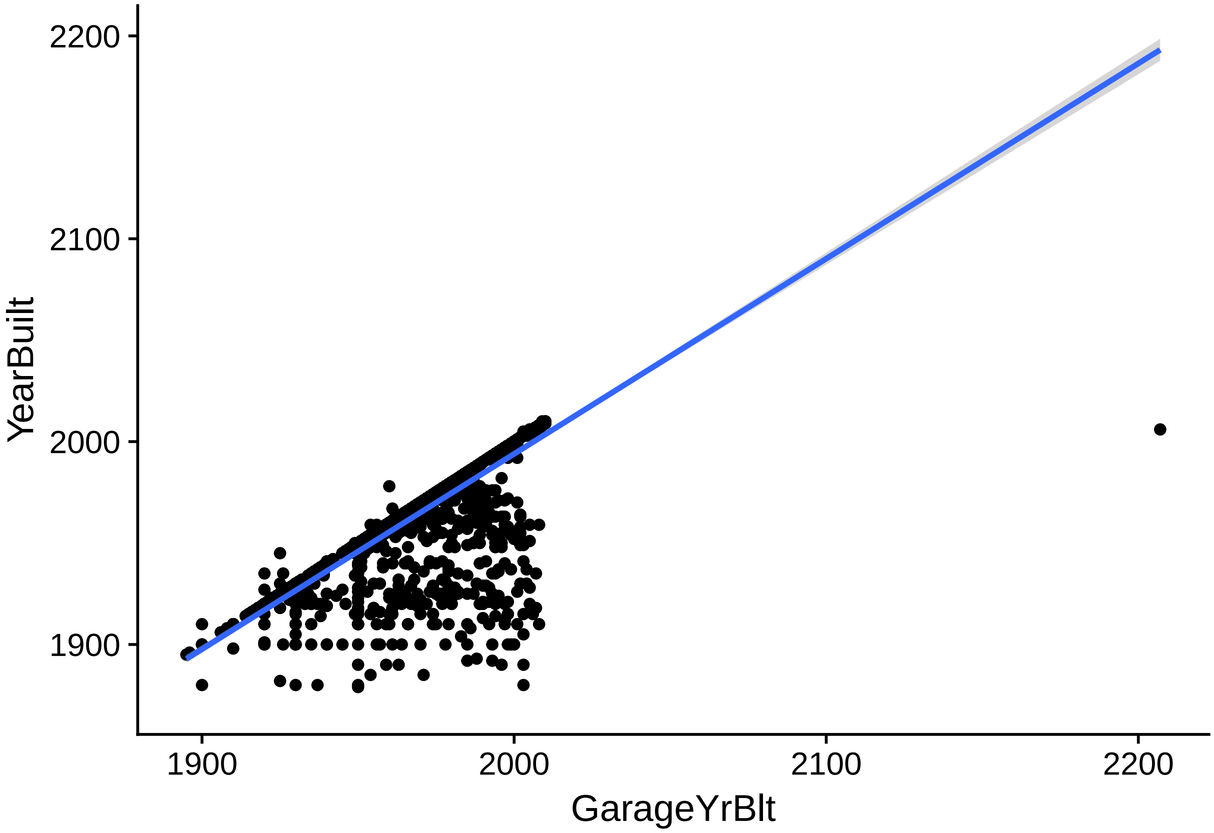
Tratamiento de los valores perdidos

- GarageYrBlt

Se aprecia que es una propidad que, lógicamente, está muy relacionada con YearBuilt (año de construcción). En general, se puede decir que GarageYrBlt tiende a ser igual a YearBuilt. Por consiguiente, en los valores perdidos de GarageYrBlt, se procede a asígnar el correspondiente valor de YearBuilt.

```
ggplot(data = full.set, aes(x = GarageYrBlt, y = YearBuilt)) +
    geom_point() + geom_smooth(method = "lm")
```

```
## Warning: Removed 159 rows containing non-finite values (stat_smooth).

## Warning: Removed 159 rows containing missing values (geom_point).
```



```
full.set$GarageYrBlt[full.set$GarageYrBlt == 2207] <- 2007
full.set$GarageYrBlt[is.na(full.set$GarageYrBlt)] <- full.set$YearBuilt[is.na(full.set$GarageYrBlt)]

updatePartitions()
```

- LotFrontage

Por lógica, se puede decir que el área de la propiedad con la longitud de la fachada. Para confirmarlo, comprobamos la correlación entre ellas:

```
cor(full.set$LotFrontage, full.set$LotArea, use = "complete.obs")
```

```
## [1] 0.4898956
```

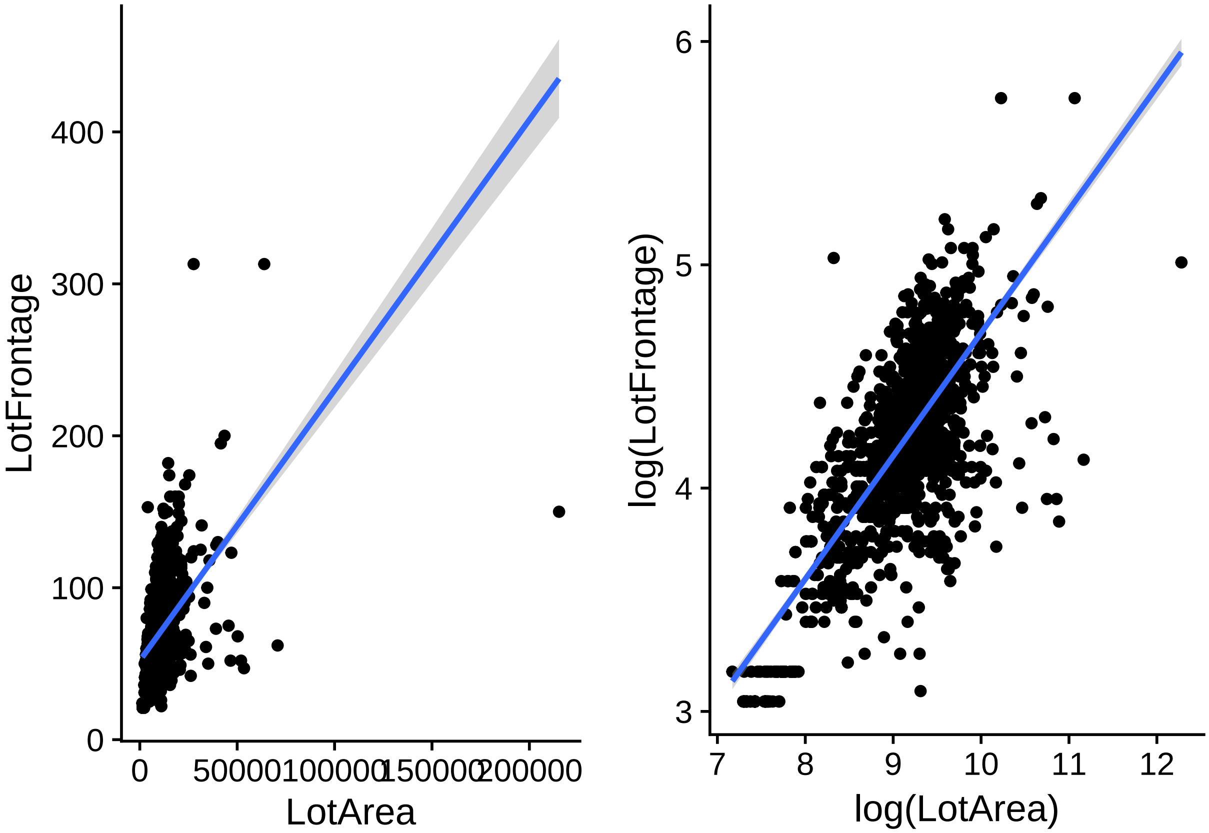
```
cor(log(full.set$LotFrontage), log(full.set$LotArea), use = "complete.obs")
```

```
## [1] 0.7662858
```

Y visualizamos su relación:

```
plotLotRelation <- ggplot(data = full.set, aes(x = LotArea, y = LotFrontage)) +
    geom_point() + geom_smooth(method = "lm")

plotLogLotRelation <- ggplot(data = full.set, aes(x = log(LotArea),
    y = log(LotFrontage))) + geom_point() + geom_smooth(method = "lm")

cowplot::plot_grid(plotLotRelation, plotLogLotRelation, ncol = 2)
```

```
## Warning: Removed 486 rows containing non-finite values (stat_smooth).
## Warning: Removed 486 rows containing missing values (geom_point).

## Warning: Removed 486 rows containing non-finite values (stat_smooth).

## Warning: Removed 486 rows containing missing values (geom_point).
```



Se puede confirmar que existe una alta correlación directa entre *LotFrontage* con *LotArea*. Dado, que estas dos propiedades están relacionadas, seguramente una de ellas sea desechada en el proceso de selección de variables. Idependientemente de ello, en este paso sustituiremos los valores de *LotFrontage*, por la mediana de los valores existentes.

```
full.set$LotFrontage[is.na(full.set$LotFrontage)] <- mean(full.set$LotFrontage[!is.na(full.set$LotFronta

updatePartitions()
```

```
cor(full.set$LotFrontage, full.set$LotArea, use = "complete.obs")
```

```
## [1] 0.364382
```

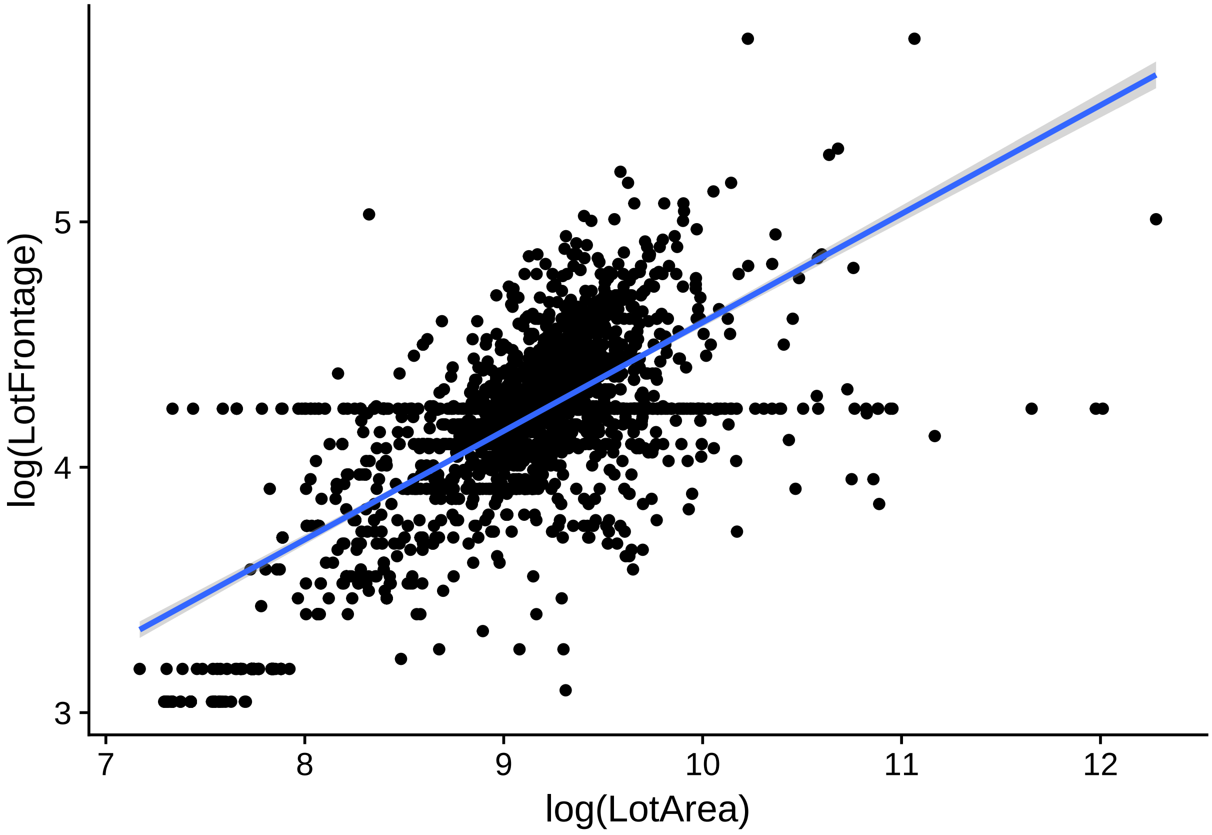
```
cor(log(full.set$LotFrontage), log(full.set$LotArea), use = "complete.obs")
```

```
## [1] 0.6894001
```

Observamos que la correlación continúa siendo similar después de tratar los valores perdidos en *LotFrontage*.

TODO: Quizás remplazar con la media no sea la mejor opción (cambia bastante la correlación). Si no se encuentra una solución mejor, quizás habría que cargarse directamente la variable.

```
ggplot(data = full.set, aes(x = log(LotArea), y = log(LotFrontage))) +
    geom_point() + geom_smooth(method = "lm")
```

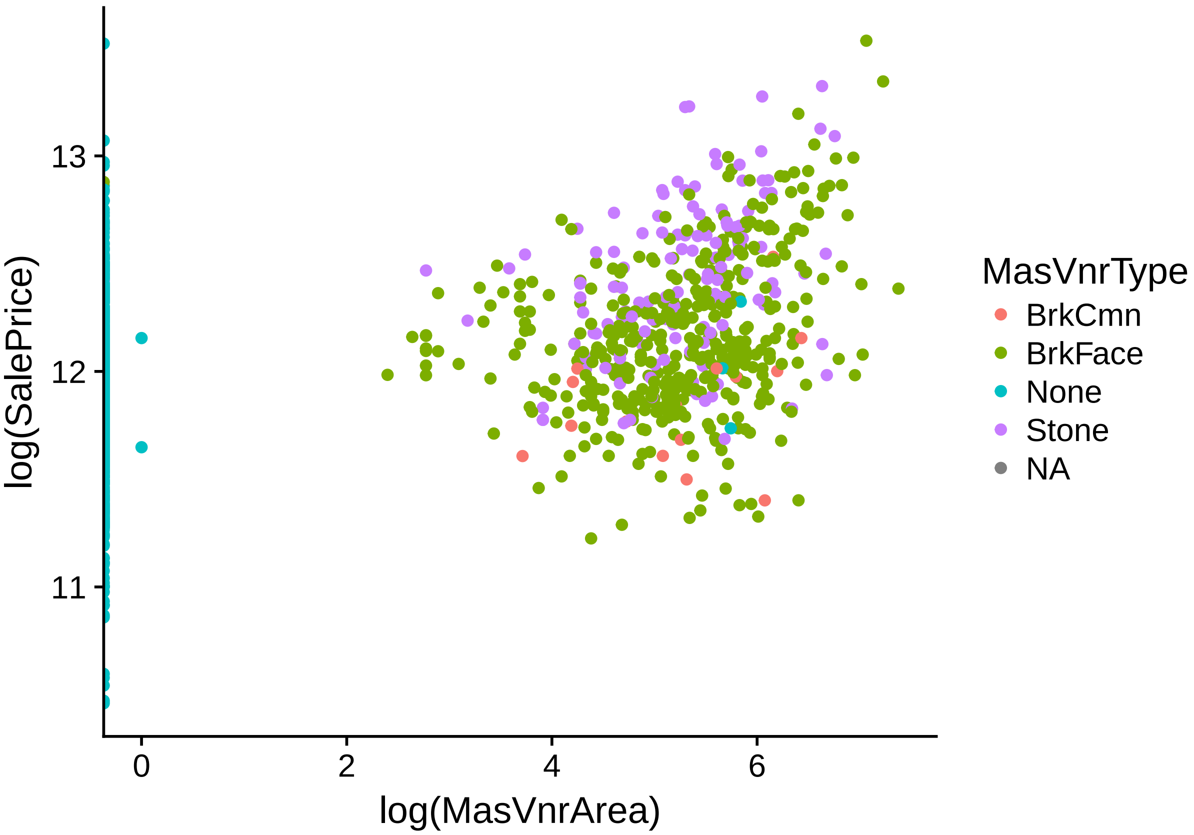


- MasVnrArea

Existe una gran cantidad de entradas con valor 0. Esto seguramente se deba a la carencia de “chapado”:

```
ggplot2::qplot(data = train, x = log(MasVnrArea), y = log(SalePrice),
    col = MasVnrType)
```

```
## Warning: Removed 8 rows containing missing values (geom_point).
```



También observamos que en ambas variables los valores perdidos (8) forman parte de los mismos ejemplos:

```
full.set$Id[is.na(full.set$MasVnrArea)]
```

```
##  [1]  235  530  651  937  974  978 1244 1279 1692 1707 1883 1993 2005 2042
## [15] 2312 2326 2341 2350 2369 2593 2658 2687 2863
```

```
full.set$Id[is.na(full.set$MasVnrType)]
```

```
##  [1]  235  530  651  937  974  978 1244 1279 1692 1707 1883 1993 2005 2042
## [15] 2312 2326 2341 2350 2369 2593 2611 2658 2687 2863
```

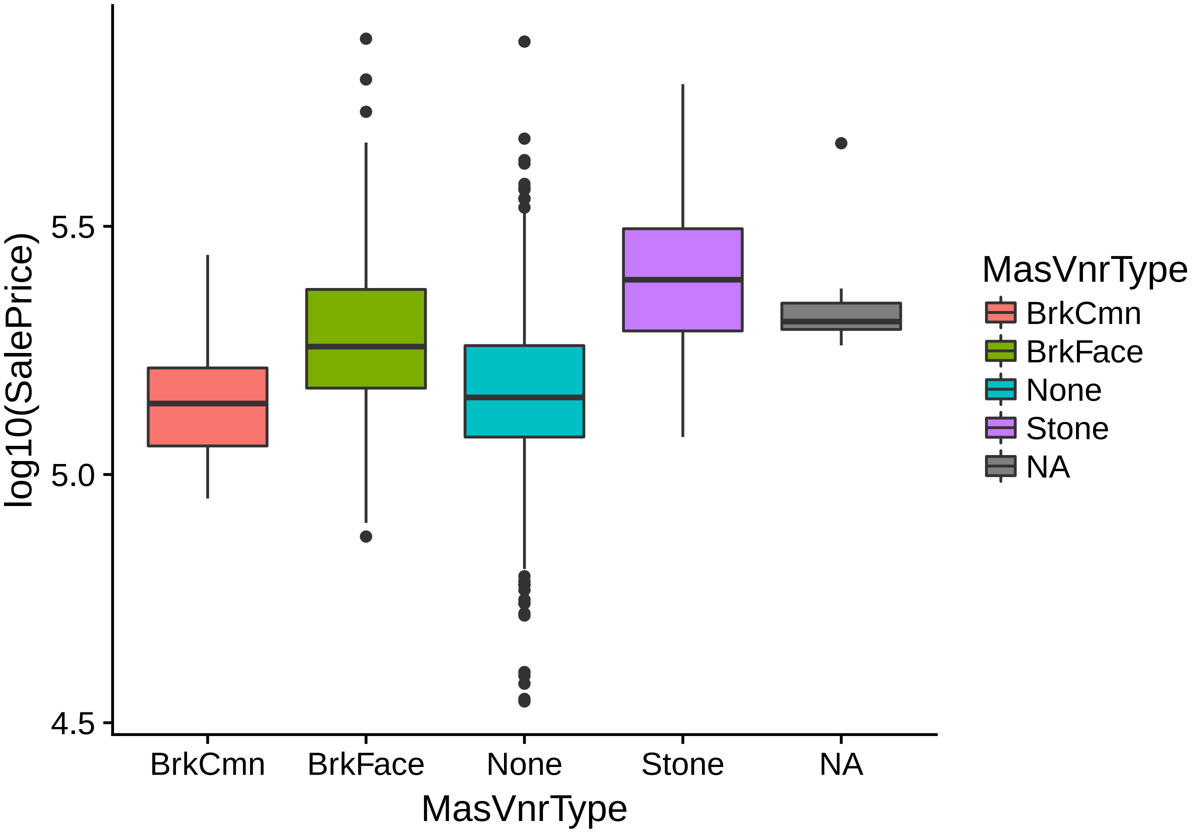
TODO: hay una entrada más en el conjunto de test

Por consiguiente, se elimina la caraterística *MasVnrArea*, ya que las entradas con valor 0, por ser del tipo "None", hacen que la información desprendida de la variable esté "deformada".

```
full.set <- dplyr::select(full.set, -MasVnrArea)

updatePartitions()
```

Ahora se deben tratar los valores perdidos de *MasVnrType*. Para ello, observamos *MasVnrType* en relación a *SalePrice* para entender su distribución.

```
qplot(data = train, x = MasVnrType, y = log10(SalePrice), geom = c("boxplot"),
    fill = MasVnrType)
```

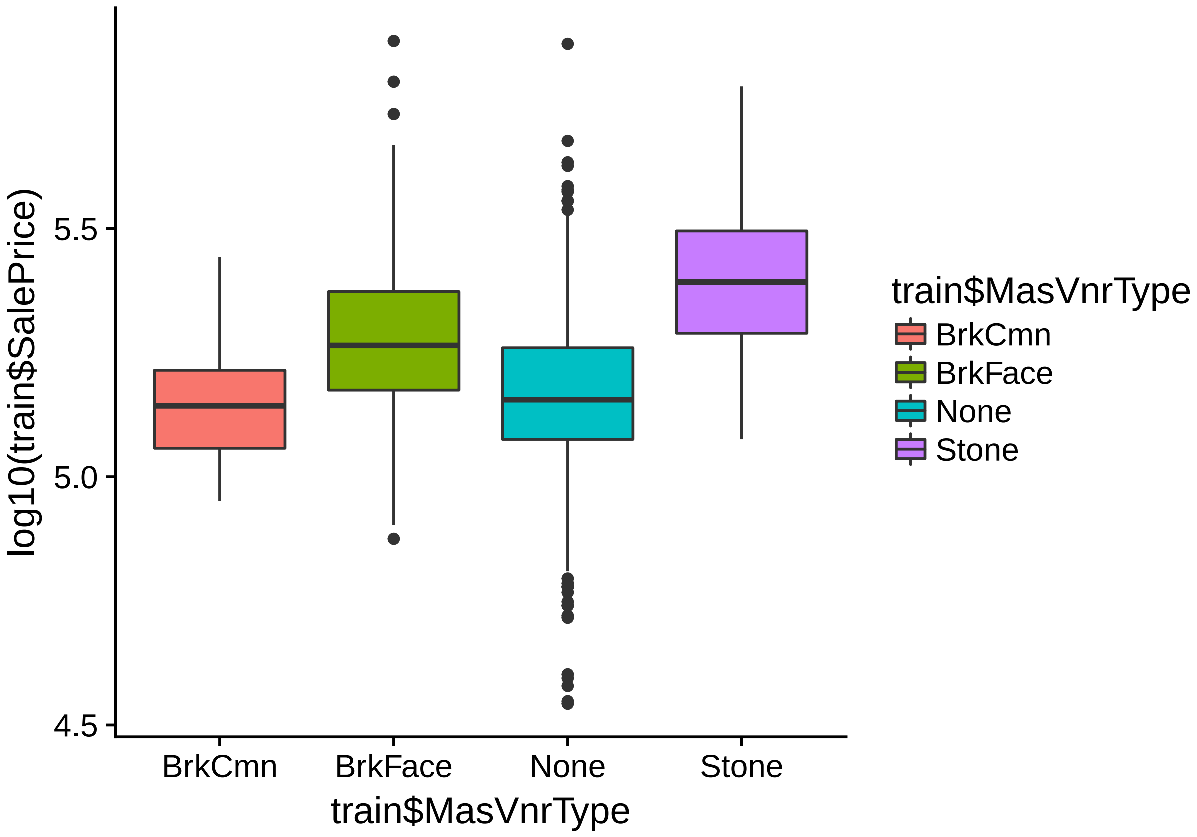


Asignamos a los valores perdidos el tipo “BrkFace”, por mayor proximidad de sus medias. Aunque también se les podría asignar el tipo “Stone”.

```r
full.set$MasVnrType[is.na(full.set$MasVnrType)] <- "BrkFace"

updatePartitions()
```

Finalmente, observamos la distribución resultante en las categorías de *MasVnrType* en relación a *SalePrice*.

```r
qplot(data = train, x = train$MasVnrType, y = log10(train$SalePrice),
    geom = c("boxplot"), fill = train$MasVnrType)
```



Variables categóricas

Las siguientes caraterísticas con valores perdidos se corresponden con aquellas que contienen entradas en las que hay una ausencia de la propiedad a la que representan. Por ejemplo, la propiedad *PoolQC* representa la calidad de la piscina, pero es obvio que en aquellas propiedades en las haya una ausencia de piscina, será inviable representar su calidad. Por consiguiente, se le asignarán el tipo "None" a aquellos valores ausentes (NA). Las caracteríasticas que contienen este tipo de valores perdidos son: *PoolQC*, *MiscFeature*, *Alley*, *Fence*, *FireplaceQu*, *GarageCond*, *GarageFinish*, *GarageQual*, *GarageType*, *BsmtCond*, *BsmtExposure*, *BsmtFinType1*, *BsmtFinType2* y *BsmtQual*.

```
categorical.features <- c("PoolQC", "MiscFeature", "Alley", "Fence",
    "FireplaceQu", "GarageCond", "GarageFinish", "GarageQual",
    "GarageType", "BsmtCond", "BsmtExposure", "BsmtFinType1",
    "BsmtFinType2", "BsmtQual")

for (feature in categorical.features) {
    if (is.factor(full.set[, feature])) {
        full.set[, feature] <- as.character(full.set[, feature])
        full.set[, feature][which(is.na(full.set[, feature]))] <- "None"
        full.set[, feature] <- factor(full.set[, feature])
    }
}

updatePartitions()
```

- Electrical

Esta característica presenta un valor perdido. Dada la mínima influencia que puede tener, se le asigna la categoría mayoritaria.

```
full.set$Electrical[is.na(full.set$Electrical)] <- as.character(sort(full.set$Electrical,
    decreasing = TRUE)[1])

updatePartitions()
```

Corrección de valores perdidos en el conjunto de test

En primer lugar, se examinan los valores perdidos que presenta el conjunto de test y se visualizan de la misma forma que se procedió con el conjunto de entrenamiento.

```
getLostValuesStats()
```

```
##              lost.count lost.percentage
## MSZoning              4      0.13703323
## Utilities             2      0.06851662
## Exterior1st           1      0.03425831
## Exterior2nd           1      0.03425831
## BsmtFinSF1            1      0.03425831
## BsmtFinSF2            1      0.03425831
## BsmtUnfSF             1      0.03425831
## TotalBsmtSF           1      0.03425831
## BsmtFullBath          2      0.06851662
## BsmtHalfBath          2      0.06851662
## KitchenQual           1      0.03425831
## Functional            2      0.06851662
## GarageCars            1      0.03425831
## GarageArea            1      0.03425831
## SaleType              1      0.03425831
```

TODO: ¿En las caraterísticas que presenten valores perdidos y ya se haya examinado previamente, se proceden a tratar de la misma forma para realizar un procedimiento consistente?

Así mismo, se procede a tratar las demás variables. Por una parte, se procesan las de tipo numérico, asignando la mediana a los valores faltantes.

```
lost.test.numeric.features <- c("BsmtFinSF1", "BsmtFinSF2", "BsmtUnfSF",
    "TotalBsmtSF", "BsmtFullBath", "BsmtHalfBath", "GarageCars",
    "GarageArea")

for (feature in lost.test.numeric.features) {
    full.set[, feature][is.na(full.set[, feature])] <- median(full.set[,
        feature][!is.na(full.set[, feature])])
}

updatePartitions()
```

En cuanto a las variables de tipo nominal, se les asigna la moda de sus valores.

```
lost.test.categorical.features <- c("Exterior1st", "Exterior2nd",
    "Functional", "KitchenQual", "MSZoning", "SaleType", "Utilities")

for (feature in lost.test.categorical.features) {
    full.set[, feature][is.na(full.set[, feature])] <- as.character(sort(full.set[,
        feature], decreasing = T)[1])
}

updatePartitions()
```

Antes de continuar, comprobamos que no hay valores perdidos en ninguno de los dos conjuntos.

```
getLostValuesStats()
```

```
## [1] lost.count      lost.percentage
## <0 rows> (or 0-length row.names)
```

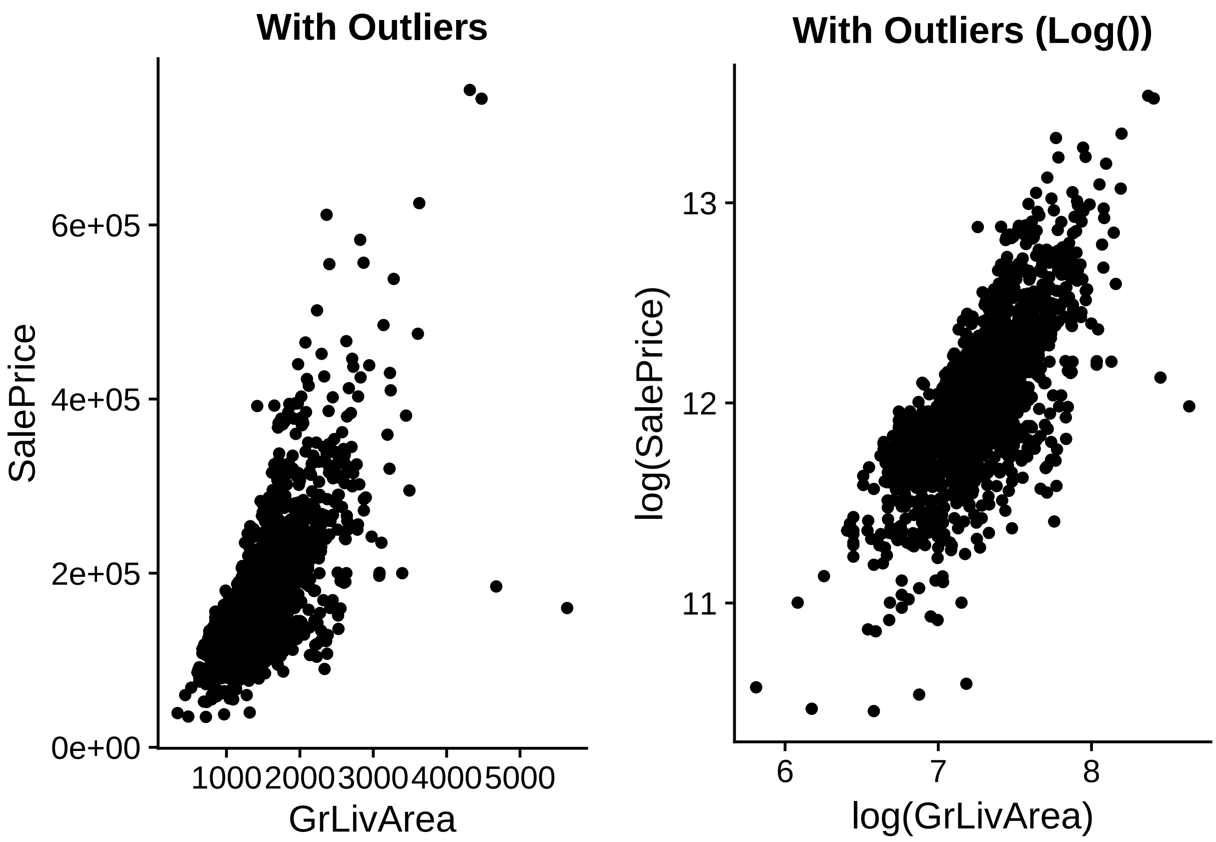
Transformación de datos

En primer lugar, se procede a eliminar la propiedad Id de los conjuntos de entrenamiento y test.

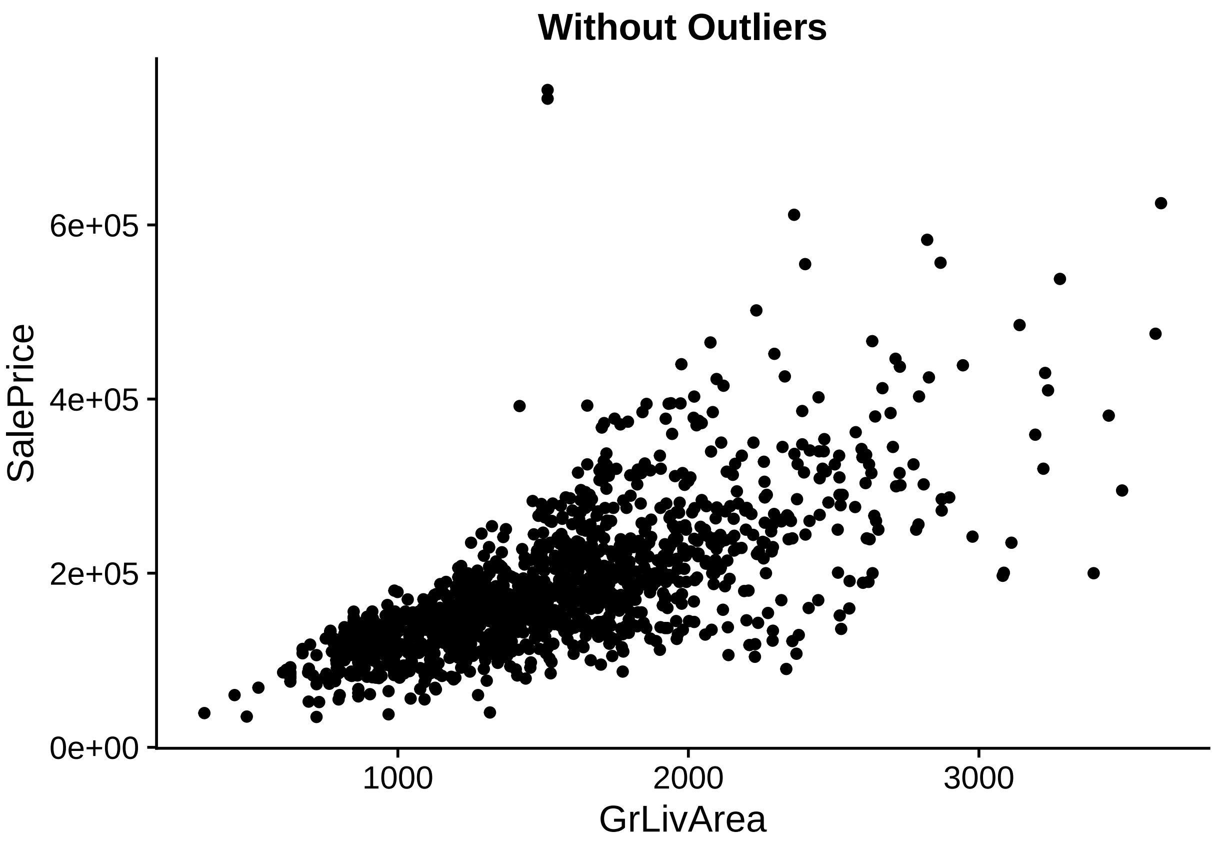
```
train.transformed <- dplyr::select(train, -Id)
test.transformed <- dplyr::select(test, -Id)
```

Tratamiento de outliers

```
plot.with.outliers <- ggplot(train.transformed, aes(y = SalePrice,
    x = GrLivArea)) + ggtitle("With Outliers") + geom_point()
plot.with.outliers.log <- ggplot(train.transformed, aes(y = log(SalePrice),
    x = log(GrLivArea))) + ggtitle("With Outliers (Log())") +
    geom_point()
cowplot::plot_grid(plot.with.outliers, plot.with.outliers.log,
    ncol = 2)
```



```
train.transformed[train.transformed$GrLivArea > 4000, ]$GrLivArea <- mean(train.transformed$GrLivArea) %
    as.numeric

ggplot(train.transformed, aes(y = SalePrice, x = GrLivArea)) +
    ggtitle("Without Outliers") + geom_point()
```



```
full.set.transformed <- data.frame(data.table::rbindlist(list(train.transformed,
    test.transformed), use.names = F, fill = F))
```

- Feature engeneriing

Creación de una nueva variable: Area total basement e

```
full.set.transformed <- dplyr::select(full.set.transformed, -LotFrontage)

full.set.transformed$TotalSF = full.set.transformed$TotalBsmtSF +
    full.set.transformed$X1stFlrSF + full.set.transformed$X2ndFlrSF

full.set.transformed$Age <- full.set.transformed$YrSold - full.set.transformed$YearRemodAdd

full.set.transformed$TotalProch <- full.set.transformed$EnclosedPorch +
    full.set.transformed$ScreenPorch + full.set.transformed$X3SsnPorch
```

Regularización de las variables continuas

Tal y como se ha mostrado, la variable *SalePrice* contiene una distribución asimétrica. Por consiguiente, para evitar el efecto que los valores extremos puedan causar, se procede a aplicar logaritmos a los valores de la distribución.

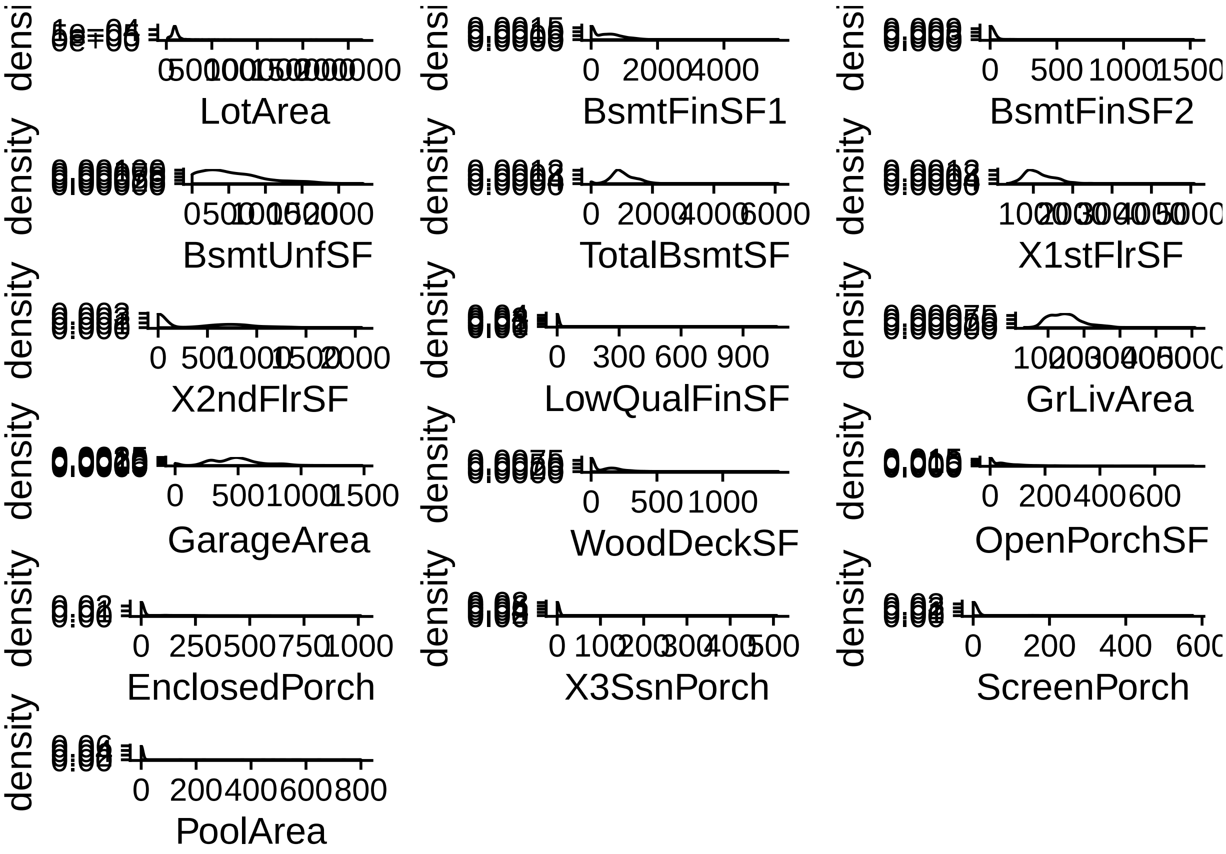
Así mismo, se procede a mostrar diagramas de densidad de cada una de las características que contengan datos númericos. De esta forma se podrá observa que transformaciones pueden ser convenientes de hacer a cada variable.

```r
full.set.transformed$SalePrice <- log(full.set.transformed$SalePrice)
```

```r
continuous.features <- c(
  "LotArea", ## Lot size in square feet
  "BsmtFinSF1", ## Type 1 finished square feet
  "BsmtFinSF2", ## Type 2 finished square feet
  "BsmtUnfSF", ## Unfinished square feet of basement area
  "TotalBsmtSF", ## Total square feet of basement area
  "X1stFlrSF", ## First Floor square feet
  "X2ndFlrSF", ## Second floor square feet
  "LowQualFinSF", ## Low quality finished square feet (all floors)
  "GrLivArea", ## Above grade (ground) living area square feet
  "GarageArea", ## Size of garage in square feet
  "WoodDeckSF", ## Wood deck area in square feet
  "OpenPorchSF", ## Open porch area in square feet
  "EnclosedPorch", ## Enclosed porch area in square feet
  "X3SsnPorch", ## Three season porch area in square feet
  "ScreenPorch", ## Screen porch area in square feet
  "PoolArea" ## Pool area in square feet
)

plots <- lapply(continuous.features, function(feature) {
    if (is.numeric(full.set.transformed[, feature])) {
        ggplot2::ggplot(data = full.set.transformed, aes(x = full.set.transformed[, feature])) +
                      geom_density() +
                      xlab(feature)
    }
})

cowplot::plot_grid(plotlist = plots, ncol = 3)
```

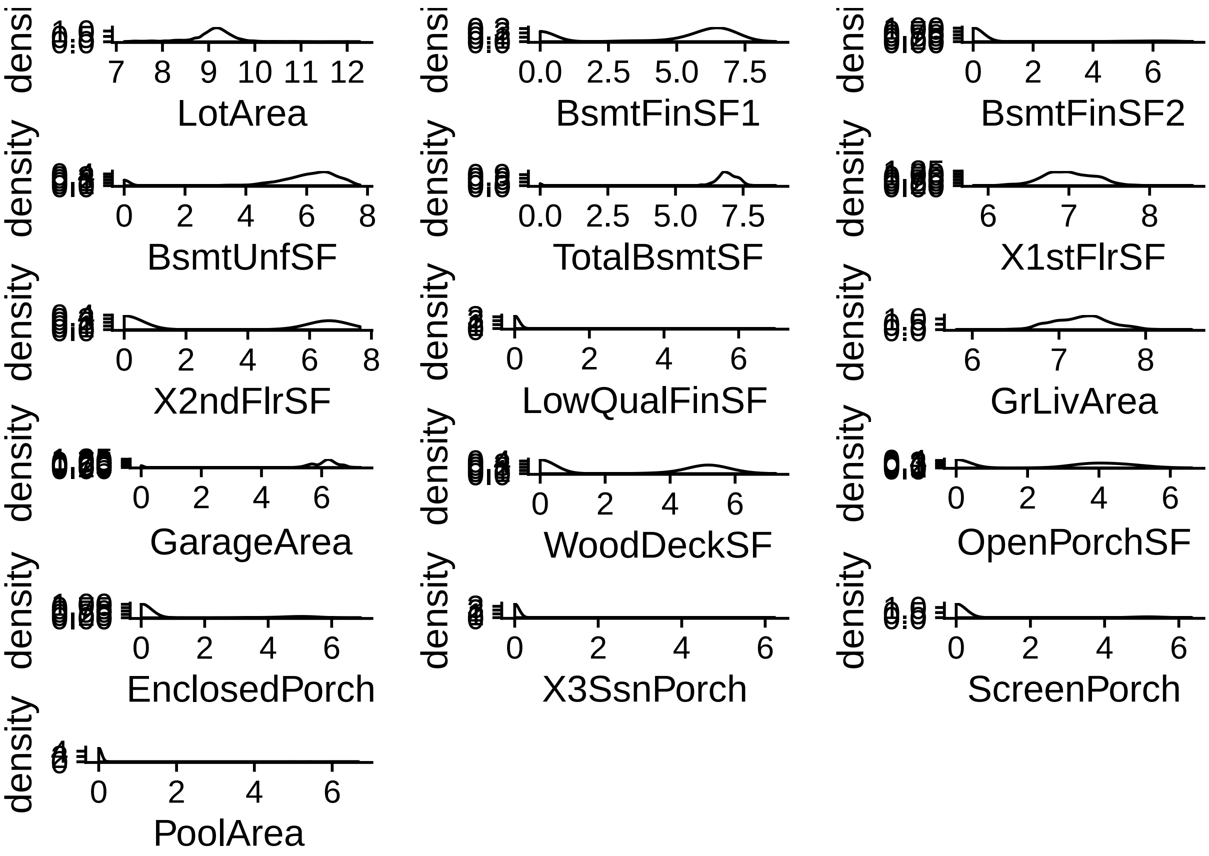


Let’s normalize the continuous values

```
full.set.transformed[, continuous.features] <- log(1 + full.set.transformed[,
    continuous.features])

plots <- lapply(continuous.features, function(feature) {
    if (is.numeric(full.set.transformed[, feature])) {
        ggplot2::ggplot(data = full.set.transformed, aes(x = full.set.transformed[,
            feature])) + geom_density() + xlab(feature)
    }
})

cowplot::plot_grid(plotlist = plots, ncol = 3)
```



Center & scale. . . .

```
set.seed(SEED)
full.set.preProcessed <- caret::preProcess(select(full.set.transformed,
    -SalePrice), method = c("center", "scale"))
full.set.transformed <- predict(full.set.preProcessed, full.set.transformed)
```

Cambiado las variable categóricas por numéricas # TODO: Buscar explicación

```
for (i in 1:ncol(full.set.transformed)) {
    if (is.factor(full.set.transformed[, i])) {
        levels(full.set.transformed[, i]) <- c(1:length(levels(full.set.transformed[,
            i])))
        full.set.transformed[, i] <- as.numeric(full.set.transformed[,
            i])
    }
}
```

- Spliting into train and test

```
train.processed <- full.set.transformed[1:nrow(train.transformed),
    ]
test.processed <- full.set.transformed[(nrow(train.transformed) +
    1):nrow(full.set.transformed), ]
test.processed <- dplyr::select(test.processed, -SalePrice)
```

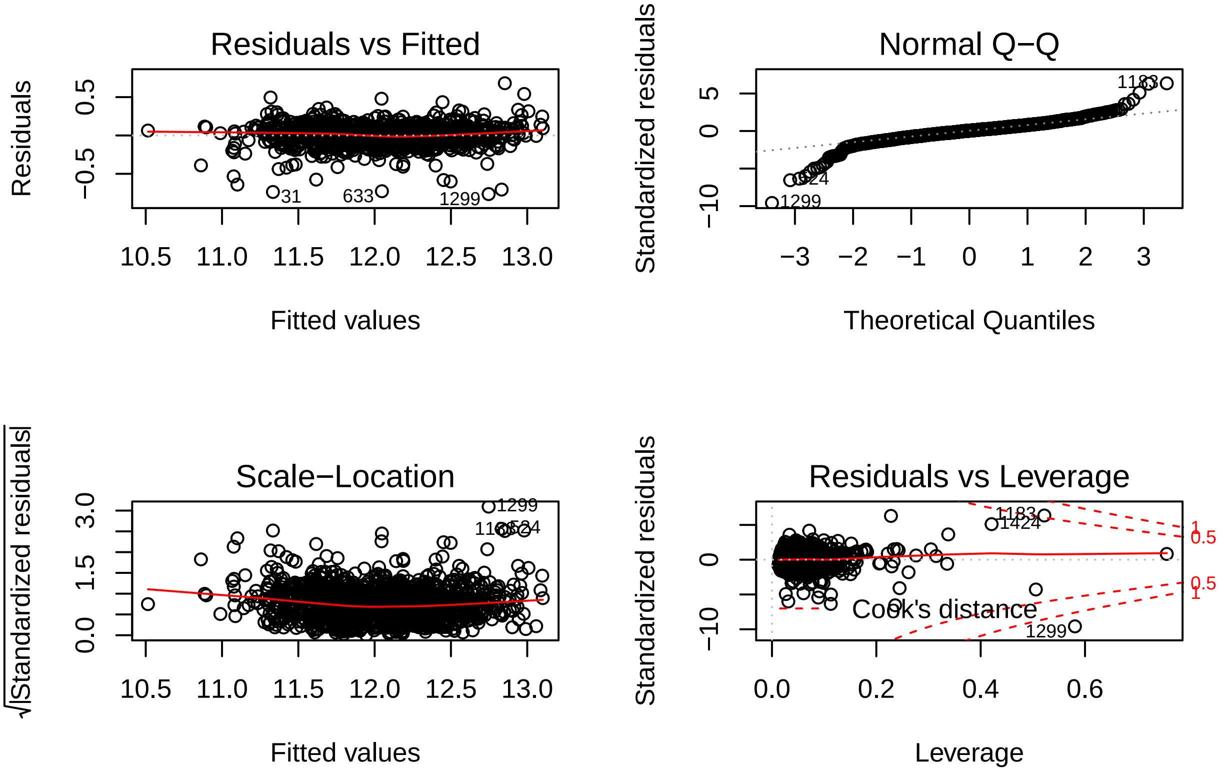
- lm

```
exploratory.lm = lm(SalePrice ~ ., data = train.processed)

par(mfrow = c(2, 2))
plot(exploratory.lm)
```

```
## Warning: not plotting observations with leverage one:
##   945

## Warning: not plotting observations with leverage one:
##   945
```



```
par(mfrow = c(1, 1))
```

```
importance <- caret::varImp(exploratory.lm)
importance.sort <- sort(importance$Overall, decreasing = TRUE,
    index.return = TRUE)

data.frame(Feature = rownames(importance)[importance.sort$ix],
    Overall = importance[importance.sort$ix, ])[1:15, ]
```

```
##          Feature   Overall
## 1      GrLivArea 12.731488
## 2    OverallQual 12.235935
## 3    OverallCond 11.489647
## 4        LotArea  8.350168
## 5  SaleCondition  6.885938
## 6     Functional  6.117128
## 7      YearBuilt  5.694831
## 8     GarageCars  5.470990
## 9         PoolQC  5.435886
## 10      PoolArea  4.572355
## 11  KitchenAbvGr  4.515456
## 12    BsmtFinSF1  4.364160
## 13   KitchenQual  3.949574
## 14    Fireplaces  3.809485
## 15     X2ndFlrSF  3.751977
```

Entrenamiento

- Entrenamiento "parcial"

```
train.processed.partition.index <- createDataPartition(train.processed$SalePrice,
    p = 0.7, list = FALSE)
train.processed.partition.train <- train.processed[train.processed.partition.index,
    ]
train.processed.partition.validation <- train.processed[-train.processed.partition.index,
    ]
```

```
## Warning in (function (x, y, offset = NULL, misc = NULL, distribution =
## "bernoulli", : variable 8: Utilities has no variation.

## Warning in (function (x, y, offset = NULL, misc = NULL, distribution =
## "bernoulli", : variable 8: Utilities has no variation.

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## "bernoulli", : variable 8: Utilities has no variation.

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## "bernoulli", : variable 8: Utilities has no variation.

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## "bernoulli", : variable 8: Utilities has no variation.

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## "bernoulli", : variable 8: Utilities has no variation.

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## "bernoulli", : variable 8: Utilities has no variation.

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## "bernoulli", : variable 8: Utilities has no variation.

## Warning in (function (x, y, offset = NULL, misc = NULL, distribution =
## "bernoulli", : variable 8: Utilities has no variation.

## Warning in (function (x, y, offset = NULL, misc = NULL, distribution =
## "bernoulli", : variable 8: Utilities has no variation.

## Warning in (function (x, y, offset = NULL, misc = NULL, distribution =
## "bernoulli", : variable 8: Utilities has no variation.
```

```
model.partial
```

```
## Stochastic Gradient Boosting
##
## 1024 samples
##   80 predictor
##
## No pre-processing
## Resampling: Cross-Validated (10 fold, repeated 1 times)
## Summary of sample sizes: 922, 923, 921, 920, 920, 922, ...
## Resampling results across tuning parameters:
##
##   interaction.depth  n.trees  RMSE       Rsquared   MAE
##   1                   50      0.1618867  0.8488163  0.11711994
##   1                  100      0.1395193  0.8774337  0.09966256
##   1                  150      0.1326389  0.8878549  0.09365680
##   2                   50      0.1420416  0.8751965  0.10080374
##   2                  100      0.1283956  0.8941579  0.09062408
##   2                  150      0.1248988  0.8995540  0.08734422
##   3                   50      0.1347026  0.8864781  0.09420402
##   3                  100      0.1244423  0.9006214  0.08627201
##   3                  150      0.1223390  0.9041350  0.08468674
##
## Tuning parameter 'shrinkage' was held constant at a value of 0.1
##
## Tuning parameter 'n.minobsinnode' was held constant at a value of 10
## RMSE was used to select the optimal model using the smallest value.
## The final values used for the model were n.trees = 150,
##  interaction.depth = 3, shrinkage = 0.1 and n.minobsinnode = 10.
```

- Validación del modelo

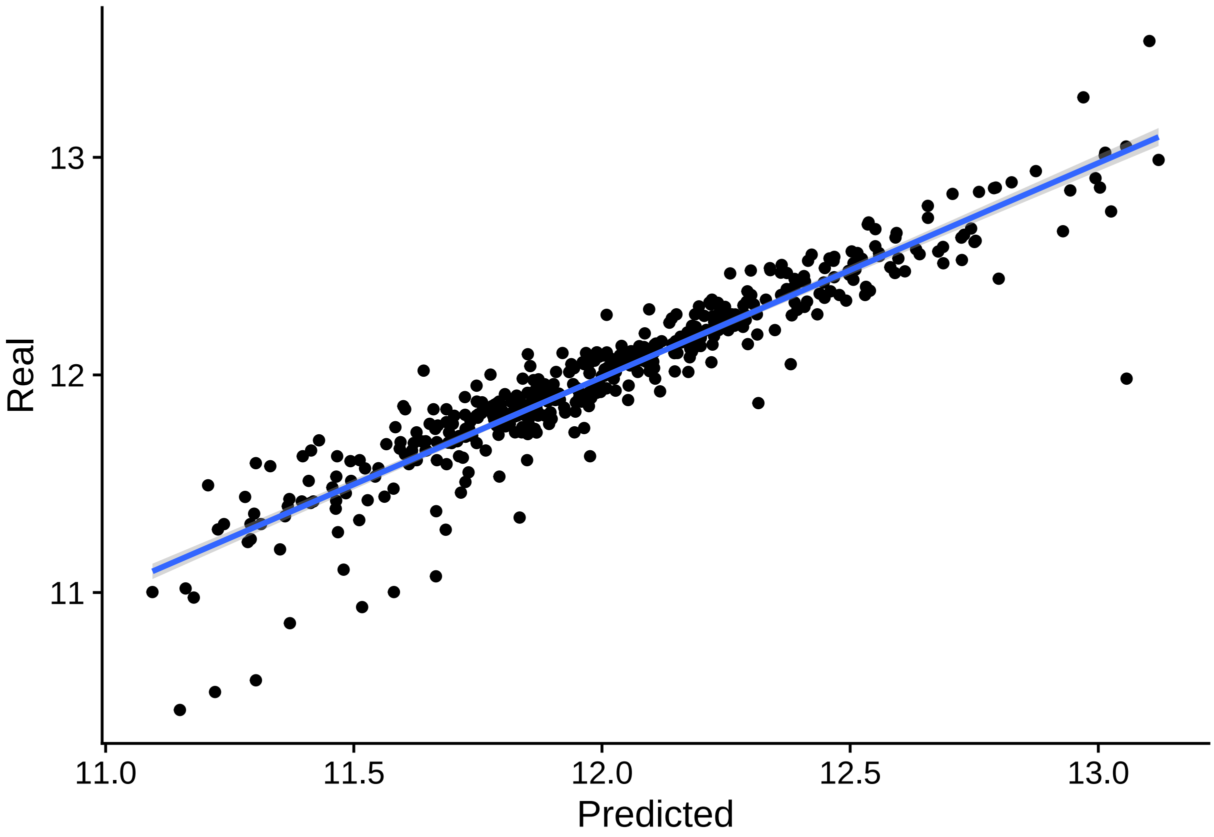
```
predictAndEvaluate <- function(model, validation.set) {
    validation.prediction <- stats::predict(model, dplyr::select(validation.set,
        -SalePrice))

    print(ggplot2::qplot(x = validation.prediction, y = validation.set$SalePrice,
        geom = c("point", "smooth"), method = "lm", xlab = "Predicted",
        ylab = "Real"))

    rmse(validation.set$SalePrice, validation.prediction)
}
```

```
predictAndEvaluate(model.partial, train.processed.partition.validation)
```

```
## Warning: Ignoring unknown parameters: method
```



```
## [1] 0.1467416
```

Trying to improve model . . .

```
ensembleTrain <- function(train.set) {
    set.seed(SEED)

    trControl <- trainControl(method = "cv", number = 7, savePredictions = "final",
        index = createResample(train.set$OverallQual, 7), allowParallel = TRUE)

    garbage <- capture.output(modelList <- caretEnsemble::caretList(SalePrice ~
        ., data = train.set, trControl = trControl, metric = "RMSE",
        tuneList = list(gbm = caretModelSpec(method = "gbm",
            tuneGrid = expand.grid(n.trees = 700, interaction.depth = 5,
                shrinkage = 0.05, n.minobsinnode = 10)), xgbTree = caretModelSpec(method = "xgbTree",
            tuneGrid = expand.grid(nrounds = 2500, max_depth = 6,
                min_child_weight = 1.41, eta = 0.01, gamma = 0.0468,
                subsample = 0.769, colsample_bytree = 0.283)))))

    greedy_ensemble <- caretEnsemble(modelList, metric = "RMSE",
        trControl = trainControl(number = 25))

    return(greedy_ensemble)
}
```

```
## Warning in (function (x, y, offset = NULL, misc = NULL, distribution =
## "bernoulli", : variable 8: Utilities has no variation.
## Warning in (function (x, y, offset = NULL, misc = NULL, distribution =
## "bernoulli", : variable 8: Utilities has no variation.

## Warning in (function (x, y, offset = NULL, misc = NULL, distribution =
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## "bernoulli", : variable 8: Utilities has no variation.

## Warning in (function (x, y, offset = NULL, misc = NULL, distribution =
## "bernoulli", : variable 8: Utilities has no variation.

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## Warning in (function (x, y, offset = NULL, misc = NULL, distribution =
## "bernoulli", : variable 8: Utilities has no variation.

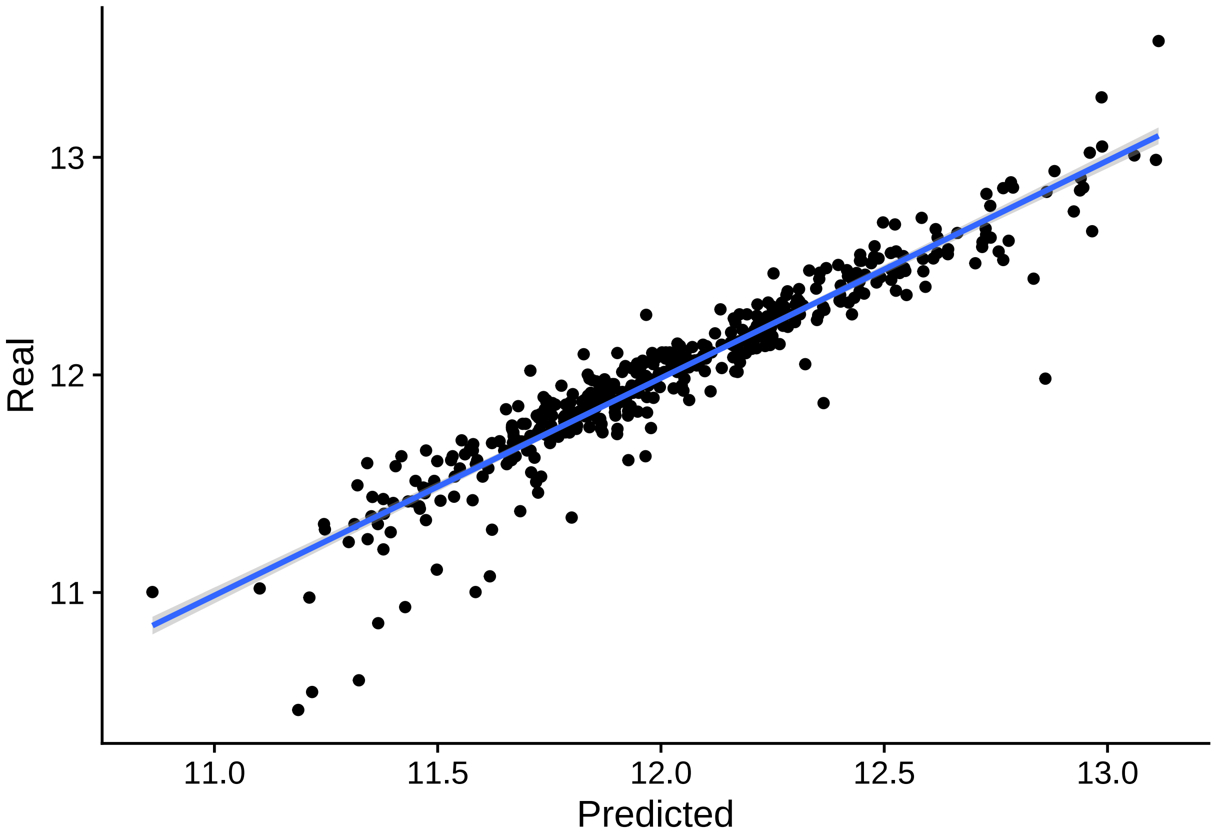
## Warning in (function (x, y, offset = NULL, misc = NULL, distribution =
## "bernoulli", : variable 8: Utilities has no variation.
```

```
model.ensemble
```

```
## A glm ensemble of 2 base models: gbm, xgbTree
##
## Ensemble results:
## Generalized Linear Model
##
## 2641 samples
##    2 predictor
##
## No pre-processing
## Resampling: Bootstrapped (25 reps)
## Summary of sample sizes: 2641, 2641, 2641, 2641, 2641, 2641, ...
## Resampling results:
##
##   RMSE      Rsquared   MAE
##   0.124079  0.9024444  0.086238
```

```
predictAndEvaluate(model.ensemble, train.processed.partition.validation)
```

```
## Warning: Ignoring unknown parameters: method
```



```
## [1] 0.1378206
```

Full train

```
## Warning in (function (x, y, offset = NULL, misc = NULL, distribution =
## "bernoulli", : variable 8: Utilities has no variation.
```

```
model.full
```

```
## A glm ensemble of 2 base models: gbm, xgbTree
##
## Ensemble results:
## Generalized Linear Model
##
## 3736 samples
##    2 predictor
##
## No pre-processing
## Resampling: Bootstrapped (25 reps)
## Summary of sample sizes: 3736, 3736, 3736, 3736, 3736, 3736, ...
## Resampling results:
##
##   RMSE       Rsquared   MAE
##   0.1254348  0.8993666  0.08295416
```

Prediction and submit

```
predictions <- predict(model.full, newdata = test.processed)
prediction.table <- data.frame(Id = test$Id, SalePrice = exp(predictions))
write.csv(prediction.table, "prediction2.csv", row.names = FALSE)
print(prediction.table)
```

```
##        Id SalePrice
## 1    1461 124914.33
## 2    1462 160429.39
## 3    1463 187314.30
## 4    1464 192898.89
## 5    1465 191940.32
## 6    1466 172585.90
## 7    1467 176692.80
## 8    1468 166006.14
## 9    1469 184336.50
## 10   1470 125953.84
## 11   1471 202806.51
## 12   1472  94415.75
## 13   1473  96435.21
## 14   1474 154802.96
## 15   1475 121953.41
## 16   1476 385099.21
## 17   1477 253862.98
## 18   1478 279610.94
## 19   1479 277078.68
## 20   1480 498420.60
## 21   1481 330111.65
## 22   1482 205616.64
## 23   1483 169264.38
## 24   1484 166438.35
## 25   1485 177996.55
## 26   1486 198711.00
## 27   1487 344933.22
## 28   1488 237314.85
## 29   1489 198668.37
## 30   1490 224564.20
## 31   1491 192786.90
## 32   1492  90923.68
## 33   1493 182705.37
## 34   1494 288399.79
## 35   1495 290413.84
## 36   1496 236113.51
## 37   1497 186531.09
## 38   1498 159750.28
## 39   1499 157779.22
## 40   1500 149246.44
## 41   1501 171309.94
## 42   1502 145842.55
## 43   1503 306952.14
## 44   1504 239776.50
## 45   1505 223635.37
## 46   1506 190062.33
## 47   1507 250554.53
## 48   1508 197265.21
## 49   1509 161131.22
## 50   1510 143301.05
## 51   1511 146567.75
## 52   1512 176738.30
## 53   1513 141040.04
## 54   1514 160558.03
## 55   1515 195783.25
## 56   1516 149161.09
## 57   1517 160522.74
## 58   1518 136488.85
## 59   1519 223054.20
## 60   1520 134337.31
## 61   1521 134209.69
## 62   1522 167505.69
## 63   1523 116452.48
## 64   1524 123035.10
## 65   1525 122844.22
## 66   1526 116638.55
## 67   1527 103221.10
## 68   1528 132685.97
## 69   1529 145278.18
## 70   1530 173410.86
## 71   1531 107500.43
## 72   1532  98373.79
## 73   1533 143541.74
## 74   1534 122864.62
## 75   1535 157210.23
## 76   1536 110223.85
## 77   1537  62547.06
## 78   1538 156521.22
## 79   1539 186836.98
## 80   1540  92076.03
## 81   1541 141332.37
## 82   1542 141468.95
## 83   1543 220158.05
## 84   1544  75291.24
## 85   1545 103716.19
## 86   1546 130107.51
## 87   1547 138904.97
## 88   1548 131923.44
## 89   1549 108983.04
## 90   1550 137687.41
## 91   1551 113785.06
## 92   1552 136225.30
## 93   1553 146560.50
## 94   1554 114145.19
## 95   1555 168673.47
## 96   1556  81729.55
## 97   1557 103513.29
## 98   1558  89176.67
## 99   1559  75706.03
## 100  1560 133001.35
## 101  1561 134313.21
## 102  1562 130958.37
## 103  1563 120809.29
## 104  1564 165370.91
## 105  1565 146532.41
## 106  1566 236333.30
## 107  1567  71886.81
## 108  1568 222569.28
## 109  1569 147112.85
## 110  1570 139192.84
## 111  1571 119589.79
## 112  1572 151400.59
## 113  1573 261011.18
## 114  1574 111323.07
## 115  1575 215853.38
## 116  1576 229906.94
## 117  1577 191117.90
## 118  1578 141787.96
## 119  1579 145861.92
## 120  1580 198677.56
## 121  1581 153433.30
## 122  1582 129317.84
## 123  1583 329296.38
## 124  1584 229978.75
## 125  1585 141818.42
## 126  1586  74650.37
## 127  1587  99112.03
## 128  1588 147776.47
## 129  1589  97246.66
## 130  1590 136549.12
## 131  1591  98701.34
## 132  1592 117817.64
## 133  1593 125250.24
## 134  1594 131876.26
## 135  1595 109393.72
## 136  1596 240895.88
## 137  1597 178633.46
## 138  1598 206149.49
## 139  1599 173513.50
## 140  1600 169380.83
## 141  1601  64821.51
## 142  1602 119168.90
## 143  1603  74295.24
## 144  1604 261857.82
## 145  1605 250154.17
## 146  1606 166035.48
## 147  1607 168258.31
## 148  1608 220755.91
## 149  1609 189996.40
## 150  1610 155190.24
## 151  1611 139124.98
## 152  1612 166035.30
## 153  1613 163568.31
## 154  1614 125307.05
## 155  1615  86046.40
## 156  1616  72025.67
## 157  1617  92627.89
## 158  1618 126577.70
## 159  1619 140846.02
## 160  1620 170260.39
## 161  1621 136724.21
## 162  1622 141435.10
## 163  1623 277013.10
## 164  1624 207706.76
## 165  1625 120997.96
## 166  1626 159790.82
## 167  1627 189882.55
## 168  1628 276851.30
## 169  1629 181084.45
## 170  1630 388393.97
## 171  1631 215348.13
## 172  1632 240653.65
## 173  1633 170620.19
## 174  1634 189957.18
## 175  1635 176704.35
## 176  1636 154929.64
## 177  1637 195264.09
## 178  1638 185510.49
## 179  1639 178973.68
## 180  1640 268696.61
## 181  1641 174231.78
## 182  1642 228089.47
## 183  1643 227446.32
## 184  1644 233023.49
## 185  1645 199773.70
## 186  1646 154012.30
## 187  1647 159316.65
## 188  1648 133775.96
## 189  1649 136117.04
## 190  1650 112173.96
## 191  1651 124042.71
## 192  1652  95332.00
## 193  1653  97177.60
## 194  1654 147281.48
## 195  1655 149644.54
## 196  1656 148953.31
## 197  1657 148162.90
## 198  1658 149346.95
## 199  1659 127991.17
## 200  1660 153015.85
## 201  1661 464993.06
## 202  1662 414185.86
## 203  1663 399911.65
## 204  1664 422013.81
## 205  1665 314316.69
## 206  1666 332474.97
## 207  1667 371781.93
## 208  1668 343731.66
## 209  1669 295233.96
## 210  1670 360244.62
## 211  1671 262028.05
## 212  1672 480650.66
## 213  1673 301259.18
## 214  1674 244032.15
## 215  1675 185431.51
## 216  1676 188739.55
## 217  1677 225235.79
## 218  1678 465125.75
## 219  1679 411126.44
## 220  1680 362318.34
## 221  1681 248771.48
## 222  1682 304548.36
## 223  1683 173345.30
## 224  1684 178063.76
## 225  1685 171152.20
## 226  1686 170415.66
## 227  1687 168280.76
## 228  1688 193115.13
## 229  1689 192491.26
## 230  1690 195121.66
## 231  1691 178323.88
## 232  1692 261146.49
## 233  1693 167532.79
## 234  1694 182211.72
## 235  1695 169598.64
## 236  1696 274728.90
## 237  1697 174168.69
## 238  1698 378107.76
## 239  1699 337810.00
## 240  1700 248028.28
## 241  1701 262910.03
## 242  1702 257564.54
## 243  1703 257737.11
## 244  1704 297548.35
## 245  1705 230238.86
## 246  1706 464040.08
## 247  1707 222155.56
## 248  1708 202076.06
## 249  1709 282804.73
## 250  1710 222709.67
## 251  1711 258760.18
## 252  1712 269526.82
## 253  1713 278873.13
## 254  1714 227395.70
## 255  1715 202892.44
## 256  1716 180453.45
## 257  1717 172525.27
## 258  1718 133255.86
## 259  1719 202901.69
## 260  1720 253611.08
## 261  1721 166589.00
## 262  1722 122315.23
## 263  1723 153687.36
## 264  1724 219291.90
## 265  1725 242806.46
## 266  1726 187733.86
## 267  1727 161241.80
## 268  1728 187576.30
## 269  1729 163526.90
## 270  1730 156444.63
## 271  1731 120677.76
## 272  1732 128019.93
## 273  1733 121436.54
## 274  1734 118575.48
## 275  1735 135555.72
## 276  1736 118735.41
## 277  1737 334077.02
## 278  1738 223830.32
## 279  1739 290208.33
## 280  1740 215043.05
## 281  1741 194467.86
## 282  1742 170394.62
## 283  1743 176212.40
## 284  1744 302815.77
## 285  1745 227879.20
## 286  1746 187822.15
## 287  1747 214275.12
## 288  1748 227035.90
## 289  1749 150038.95
## 290  1750 131533.32
## 291  1751 245060.33
## 292  1752 121480.16
## 293  1753 149592.21
## 294  1754 195179.96
## 295  1755 165709.87
## 296  1756 124885.43
## 297  1757 121780.40
## 298  1758 146458.74
## 299  1759 160414.59
## 300  1760 167307.57
## 301  1761 136618.45
## 302  1762 174925.48
## 303  1763 172794.75
## 304  1764 116582.28
## 305  1765 169010.16
## 306  1766 174819.67
## 307  1767 226665.53
## 308  1768 146228.47
## 309  1769 176245.71
## 310  1770 146035.59
## 311  1771 122657.29
## 312  1772 133122.21
## 313  1773 132071.67
## 314  1774 134851.17
## 315  1775 137584.82
## 316  1776 126868.58
## 317  1777 110286.11
## 318  1778 142819.27
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## 320  1780 176487.55
## 321  1781 130135.58
## 322  1782  88675.00
## 323  1783 140508.43
## 324  1784 100005.53
## 325  1785 116798.14
## 326  1786 129763.33
## 327  1787 170728.95
## 328  1788  51391.78
## 329  1789  92944.08
## 330  1790  79230.71
## 331  1791 185890.14
## 332  1792 157422.01
## 333  1793 133787.80
## 334  1794 147968.66
## 335  1795 129206.92
## 336  1796 118848.18
## 337  1797 107624.81
## 338  1798 124333.31
## 339  1799 104107.79
## 340  1800 129670.54
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## 342  1802 126572.89
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## 346  1806 117301.89
## 347  1807 124642.40
## 348  1808 115395.43
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## 350  1810 145841.01
## 351  1811  96965.62
## 352  1812  93965.23
## 353  1813 124953.90
## 354  1814  95247.81
## 355  1815  52402.91
## 356  1816  97666.52
## 357  1817 109483.44
## 358  1818 137108.33
## 359  1819 128335.87
## 360  1820  54333.24
## 361  1821 104634.74
## 362  1822 146759.23
## 363  1823  44766.17
## 364  1824 137288.04
## 365  1825 133875.46
## 366  1826 107192.26
## 367  1827 103474.07
## 368  1828 136621.87
## 369  1829 114936.00
## 370  1830 141684.97
## 371  1831 149003.12
## 372  1832  85188.26
## 373  1833 140081.10
## 374  1834 125382.90
## 375  1835 127779.04
## 376  1836 126418.25
## 377  1837  82987.82
## 378  1838 119560.43
## 379  1839  88146.97
## 380  1840 154877.91
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## 384  1844 131751.14
## 385  1845 135543.17
## 386  1846 154356.33
## 387  1847 162032.00
## 388  1848  55123.12
## 389  1849 108444.65
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## 391  1851 159366.41
## 392  1852 126769.43
## 393  1853 136695.78
## 394  1854 172426.55
## 395  1855 146419.86
## 396  1856 225436.42
## 397  1857 151965.75
## 398  1858 131691.90
## 399  1859 116591.18
## 400  1860 149080.01
## 401  1861 115939.01
## 402  1862 314173.38
## 403  1863 309491.25
## 404  1864 309441.33
## 405  1865 330208.14
## 406  1866 341062.84
## 407  1867 248688.33
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## 413  1873 242545.76
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## 416  1876 192839.96
## 417  1877 210079.33
## 418  1878 200088.91
## 419  1879 131956.94
## 420  1880 139466.36
## 421  1881 250363.76
## 422  1882 257582.32
## 423  1883 194905.60
## 424  1884 205447.91
## 425  1885 250539.72
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## 430  1890 126661.03
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## 432  1892 107107.52
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## 434  1894 127457.42
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## 449  1909 135244.35
## 450  1910 122665.73
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## 456  1916  62257.88
## 457  1917 261690.51
## 458  1918 139897.04
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## 462  1922 330449.64
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## 464  1924 233292.64
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## 466  1926 422880.15
## 467  1927 134075.57
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## 471  1931 145644.73
## 472  1932 140115.63
## 473  1933 178512.27
## 474  1934 182984.23
## 475  1935 172299.60
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## 477  1937 181721.32
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## 480  1940 190749.73
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## 482  1942 183315.03
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## 485  1945 388381.94
## 486  1946 149229.76
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## 488  1948 165219.14
## 489  1949 249276.17
## 490  1950 185188.21
## 491  1951 263750.15
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## 493  1953 165343.29
## 494  1954 182695.41
## 495  1955 130454.18
## 496  1956 297143.59
## 497  1957 151356.18
## 498  1958 313335.89
## 499  1959 141853.88
## 500  1960 117437.06
## 501  1961 118329.08
## 502  1962  95015.16
## 503  1963 100960.82
## 504  1964 107404.10
## 505  1965 149247.23
## 506  1966 144227.50
## 507  1967 282204.15
## 508  1968 448366.92
## 509  1969 395287.18
## 510  1970 436891.05
## 511  1971 446681.19
## 512  1972 386655.83
## 513  1973 267514.28
## 514  1974 317249.87
## 515  1975 431575.34
## 516  1976 271083.64
## 517  1977 356810.59
## 518  1978 365618.05
## 519  1979 342017.54
## 520  1980 194366.27
## 521  1981 360731.02
## 522  1982 220475.34
## 523  1983 201884.48
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## 525  1985 219920.14
## 526  1986 212223.93
## 527  1987 174860.65
## 528  1988 176304.78
## 529  1989 198311.09
## 530  1990 213172.69
## 531  1991 242337.83
## 532  1992 211314.54
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## 534  1994 241709.94
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## 536  1996 247642.91
## 537  1997 317609.86
## 538  1998 344673.36
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## 543  2003 270929.06
## 544  2004 267522.30
## 545  2005 224181.00
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## 561  2021 113468.44
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## 569  2029 165955.01
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## 572  2032 252215.78
## 573  2033 271671.85
## 574  2034 166549.28
## 575  2035 212691.97
## 576  2036 197194.34
## 577  2037 204720.11
## 578  2038 293078.94
## 579  2039 215765.33
## 580  2040 301600.14
## 581  2041 287292.65
## 582  2042 206722.97
## 583  2043 170774.68
## 584  2044 166322.46
## 585  2045 217527.75
## 586  2046 139212.52
## 587  2047 148090.04
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## 591  2051 104254.80
## 592  2052 127808.88
## 593  2053 146769.25
## 594  2054  83692.04
## 595  2055 154420.54
## 596  2056 144984.51
## 597  2057 118694.36
## 598  2058 225280.20
## 599  2059 132003.01
## 600  2060 173698.96
## 601  2061 180441.34
## 602  2062 129924.70
## 603  2063 114818.71
## 604  2064 140406.07
## 605  2065 116727.63
## 606  2066 161064.50
## 607  2067 110869.30
## 608  2068 137420.71
## 609  2069  82639.28
## 610  2070 115100.88
## 611  2071  94597.06
## 612  2072 127194.12
## 613  2073 136496.88
## 614  2074 186954.97
## 615  2075 144204.12
## 616  2076 119493.09
## 617  2077 153321.91
## 618  2078 130601.50
## 619  2079 132114.58
## 620  2080 116555.66
## 621  2081 127620.95
## 622  2082 119285.68
## 623  2083 146110.92
## 624  2084 111913.51
## 625  2085 121406.81
## 626  2086 105930.00
## 627  2087 121403.09
## 628  2088  94993.83
## 629  2089  76903.83
## 630  2090 130277.30
## 631  2091 119747.46
## 632  2092 125977.62
## 633  2093 114819.36
## 634  2094 113796.72
## 635  2095 148204.15
## 636  2096  78499.77
## 637  2097  94610.75
## 638  2098 148390.17
## 639  2099  52261.01
## 640  2100  80137.28
## 641  2101 119617.22
## 642  2102 129031.55
## 643  2103 102697.33
## 644  2104 141705.82
## 645  2105 123871.36
## 646  2106  63674.37
## 647  2107 225120.06
## 648  2108 112752.96
## 649  2109 111447.83
## 650  2110 138141.78
## 651  2111 145545.67
## 652  2112 140517.73
## 653  2113 124474.25
## 654  2114 113664.52
## 655  2115 166565.08
## 656  2116 121917.22
## 657  2117 150345.29
## 658  2118 123553.81
## 659  2119 107537.29
## 660  2120 115040.99
## 661  2121 100420.16
## 662  2122 105222.08
## 663  2123  87281.97
## 664  2124 161446.68
## 665  2125 131616.81
## 666  2126 148292.98
## 667  2127 152396.23
## 668  2128 122816.81
## 669  2129  98177.46
## 670  2130 141340.14
## 671  2131 133737.90
## 672  2132 117545.32
## 673  2133 126103.75
## 674  2134 116028.06
## 675  2135  93702.43
## 676  2136  71488.62
## 677  2137 109489.34
## 678  2138 135426.86
## 679  2139 154087.92
## 680  2140 141908.00
## 681  2141 140751.88
## 682  2142 128058.17
## 683  2143 146312.96
## 684  2144 115862.81
## 685  2145 138257.95
## 686  2146 159729.83
## 687  2147 144726.83
## 688  2148 134183.88
## 689  2149 146704.16
## 690  2150 229365.99
## 691  2151 116339.75
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