Universidad del Valle de Guatemala
Data Science 1 - Sección 10
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Laboratorio 1

Resumen del dataset

El siguiente dataset contiene 79 variables que describen las propiedades de casas en Ames, Iowa. Algunas de estas propiedades son: año de construcción, cantidad de baños, cantidad de cocinas, calidad general, condición general, tamaños de diferentes partes de la casa, entre otros. Todas ellas definen el precio de la casa. Una exploración rápida muestra lo siguiente:

```
> summary(data_training)
       Id          MSSubClass      MSZoning         LotFrontage       LotArea          Street             Alley          
 Min.   :   1.0   Min.   : 20.0   Length:1460        Min.   : 21.00   Min.   :  1300   Length:1460        Length:1460       
 1st Qu.: 365.8   1st Qu.: 20.0   Class :character   1st Qu.: 59.00   1st Qu.:  7554   Class :character   Class :character  
 Median : 730.5   Median : 50.0   Mode  :character   Median : 69.00   Median :  9478   Mode  :character   Mode  :character  
 Mean   : 730.5   Mean   : 56.9                      Mean   : 70.05   Mean   : 10517                                        
 3rd Qu.:1095.2   3rd Qu.: 70.0                      3rd Qu.: 80.00   3rd Qu.: 11602                                        
 Max.   :1460.0   Max.   :190.0                      Max.   :313.00   Max.   :215245                                        
                                                     NA's   :259                                                            
   LotShape         LandContour         Utilities          LotConfig          LandSlope          Neighborhood      
 Length:1460        Length:1460        Length:1460        Length:1460        Length:1460        Length:1460        
 Class :character   Class :character   Class :character   Class :character   Class :character   Class :character   
 Mode  :character   Mode  :character   Mode  :character   Mode  :character   Mode  :character   Mode  :character   
                                                                                                                   
                                                                                                                   
                                                                                                                   
                                                                                                                   
  Condition1         Condition2          BldgType          HouseStyle          OverallQual      OverallCond      YearBuilt   
 Length:1460        Length:1460        Length:1460        Length:1460        Min.   : 1.000   Min.   :1.000   Min.   :1872  
 Class :character   Class :character   Class :character   Class :character   1st Qu.: 5.000   1st Qu.:5.000   1st Qu.:1954  
 Mode  :character   Mode  :character   Mode  :character   Mode  :character   Median : 6.000   Median :5.000   Median :1973  
                                                                             Mean   : 6.099   Mean   :5.575   Mean   :1971  
                                                                             3rd Qu.: 7.000   3rd Qu.:6.000   3rd Qu.:2000  
                                                                             Max.   :10.000   Max.   :9.000   Max.   :2010  
                                                                                                                            
  YearRemodAdd     RoofStyle           RoofMatl          Exterior1st        Exterior2nd        MasVnrType       
 Min.   :1950   Length:1460        Length:1460        Length:1460        Length:1460        Length:1460        
 1st Qu.:1967   Class :character   Class :character   Class :character   Class :character   Class :character   
 Median :1994   Mode  :character   Mode  :character   Mode  :character   Mode  :character   Mode  :character   
 Mean   :1985                                                                                                   
 3rd Qu.:2004                                                                                                   
 Max.   :2010                                                                                                   
                                                                                                                
   MasVnrArea      ExterQual          ExterCond          Foundation         BsmtQual           BsmtCond        
 Min.   :   0.0   Length:1460        Length:1460        Length:1460        Length:1460        Length:1460        
 1st Qu.:   0.0   Class :character   Class :character   Class :character   Class :character   Class :character   
 Median :   0.0   Mode  :character   Mode  :character   Mode  :character   Mode  :character   Mode  :character   
 Mean   : 103.7                                                                                                 
 3rd Qu.: 166.0                                                                                                 
 Max.   :1600.0                                                                                                 
 NA's   :8                                                                                                      
 BsmtExposure       BsmtFinType1         BsmtFinSF1     BsmtFinType2         BsmtFinSF2       BsmtUnfSF     
 Length:1460        Length:1460        Min.   :   0.0   Length:1460        Min.   :   0.00   Min.   :   0.0  
 Class :character   Class :character   1st Qu.:   0.0   Class :character   1st Qu.:   0.00   1st Qu.: 223.0  
 Mode  :character   Mode  :character   Median : 383.5   Mode  :character   Median :   0.00   Median : 477.5  
                                       Mean   : 443.6                      Mean   :  46.55   Mean   : 567.2  
                                       3rd Qu.: 712.2                      3rd Qu.:   0.00   3rd Qu.: 808.0  
                                       Max.   :5644.0                      Max.   :1474.00   Max.   :2336.0  
```

Descripción de variables

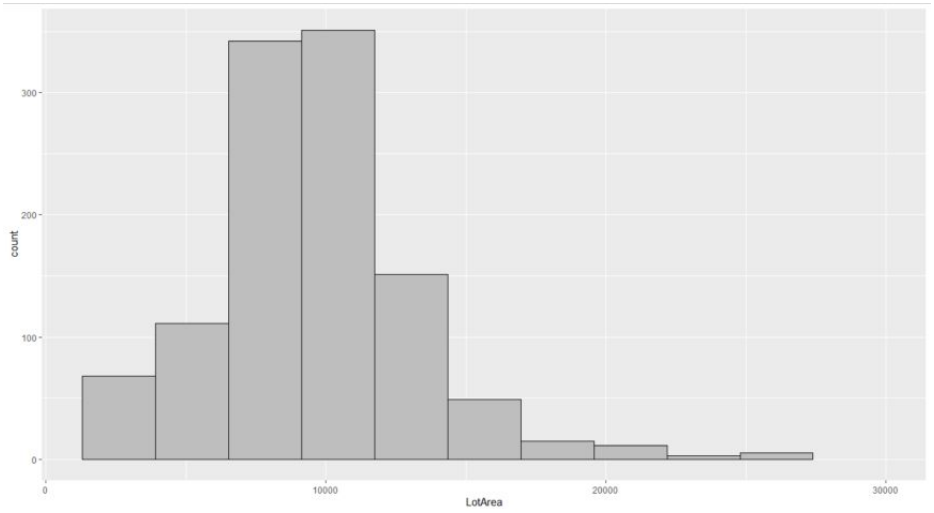
Cuantitativas		Cualitativas	
Discretas	Continuas	Ordinales	Nominales
BsmtFullBath BsmtHalfBath FullBath HalfBath Bedroom Kitchen TotRmsAbvGrd Fireplaces GarageCars EnclosedPorch 3SsnPorch ScreenPorch PoolArea	LotFrontage LotArea MasVnrArea BsmtFinSF1 BsmtFinSF2 BsmtUnfSF TotalBsmtSF 1stFlrSF 2ndFlrSF LowQualFinSF GrLivArea GarageArea WoodDeckSF OpenPorchSF MiscVal SalePrice	MSSubClass YearBuilt YearRemodAdd OverallQual OverallCond GarageYrBlt MoSold YrSold	MSZoning Street Alley LotShape LandContour Utilities LotConfig LandSlope Neighborhood Condition1 Condition2 BldgType HouseStyle RoofStyle RoofMatl Exterior1st Exterior2nd MasVnrType ExterQual ExterCond Foundation BsmtQual BsmtCond BsmtExposure BsmtFinType1 BsmtFinType2 Heating HeatingQC CentralAir Electrical KitchenQual Functional FireplaceQu GarageType GarageFinish GarageQual GarageCond PavedDrive PoolQC Fence MiscFeature SaleType SaleCondition

Gráficos exploratorios variables numéricas

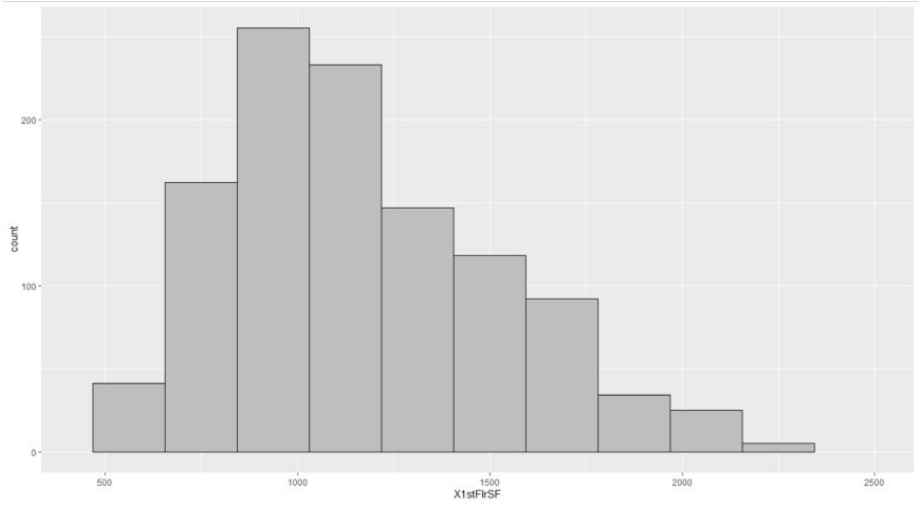
Después de generar cierta cantidad de gráficas para los datos numéricos, se pudo observar que la mayoría contiene datos atípicos. Entonces, con fines ilustrativos, no se tomaron en cuenta estos datos al limitar el rango de las gráficas. A continuación se muestran algunos ejemplos:

1. Histogramas

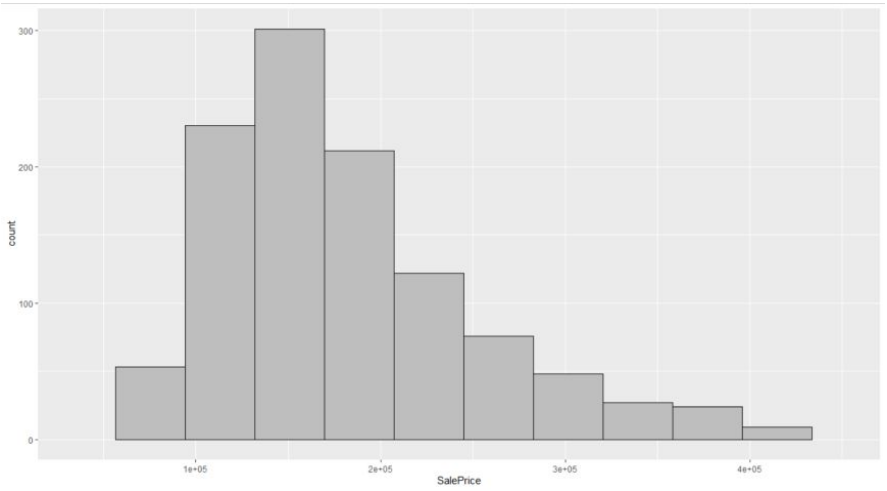
   Variable: LotArea



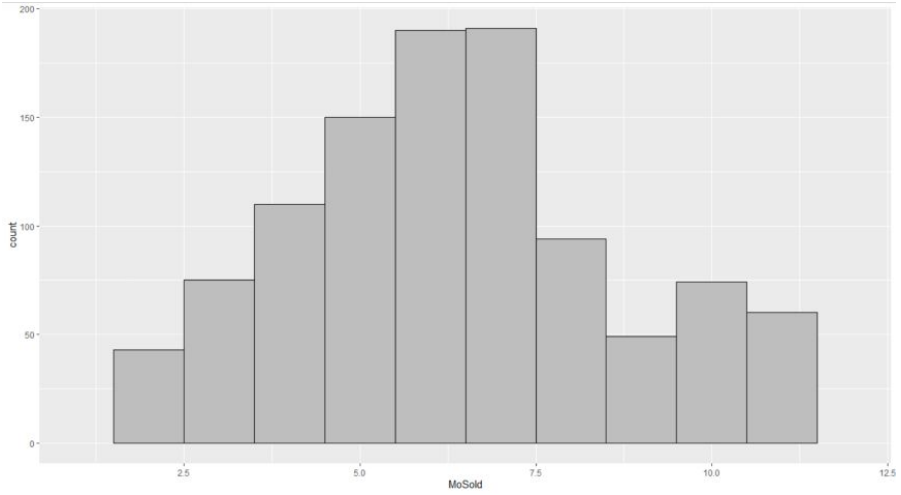
   Variable: X1stFlrSF



Variable: SalePrice

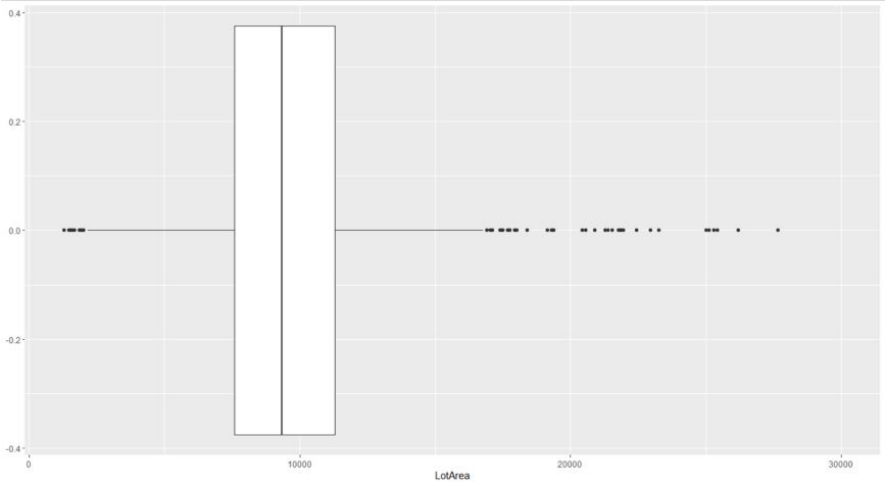


Variable: MoSold

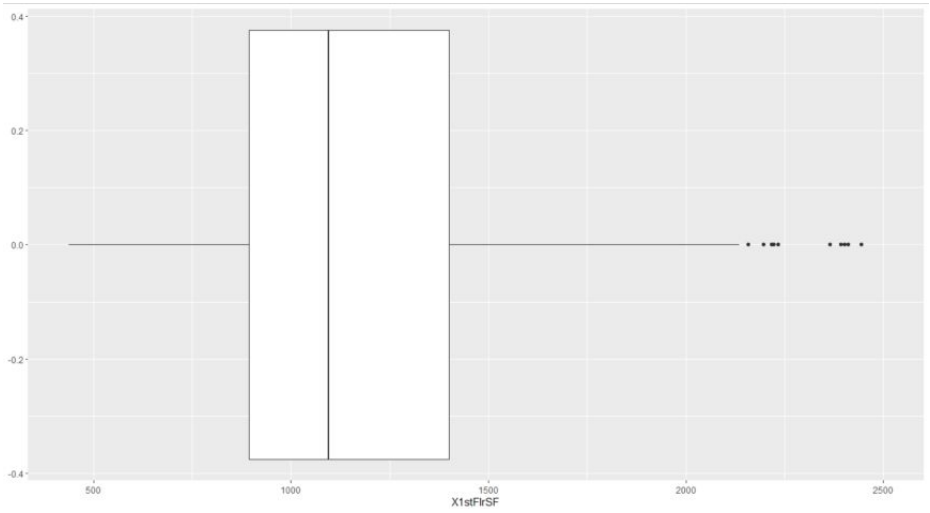


2. Diagrama de caja y bigotes

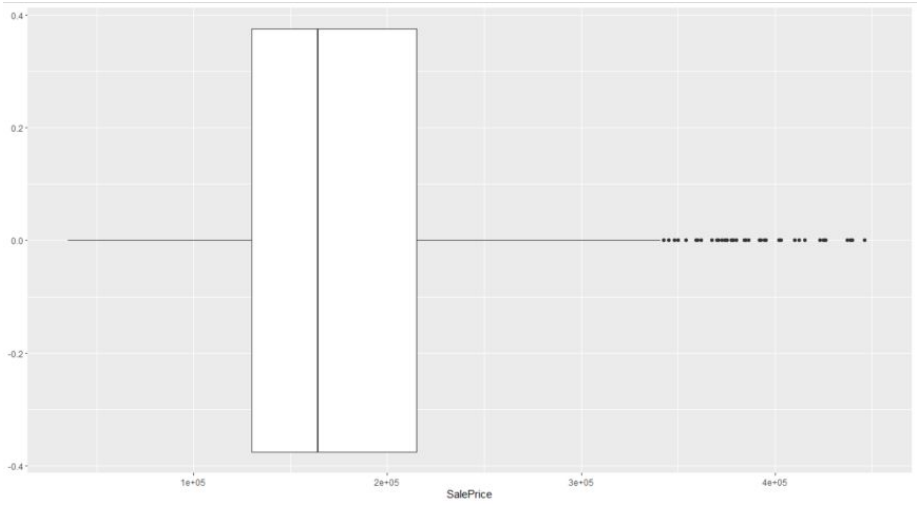
Variable: LotArea



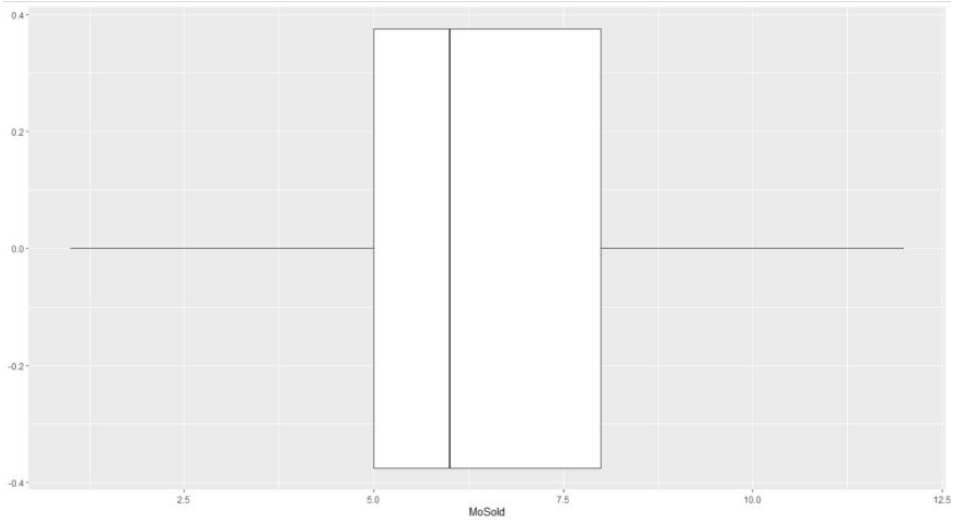
Variable: X1stFlrSF



Variable: SalePrice

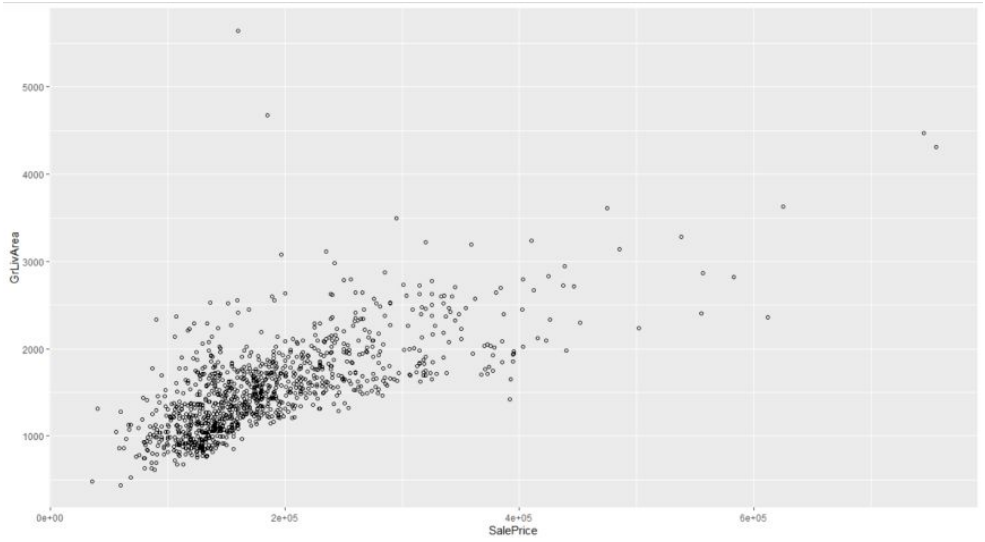


Variable: MoSold

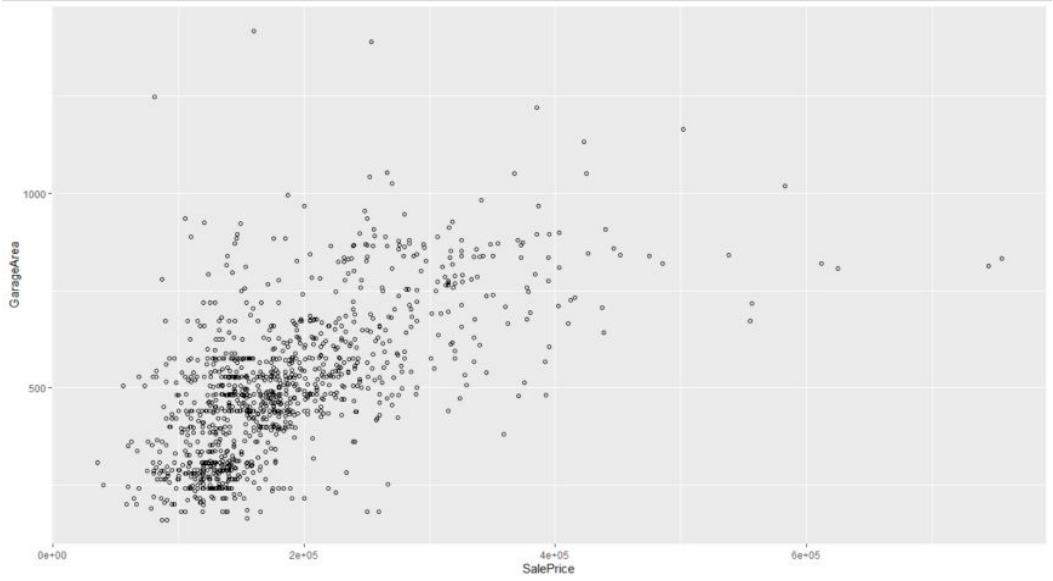


3. Gráfico de dispersión

Variables: GrLivArea vs SalePrice

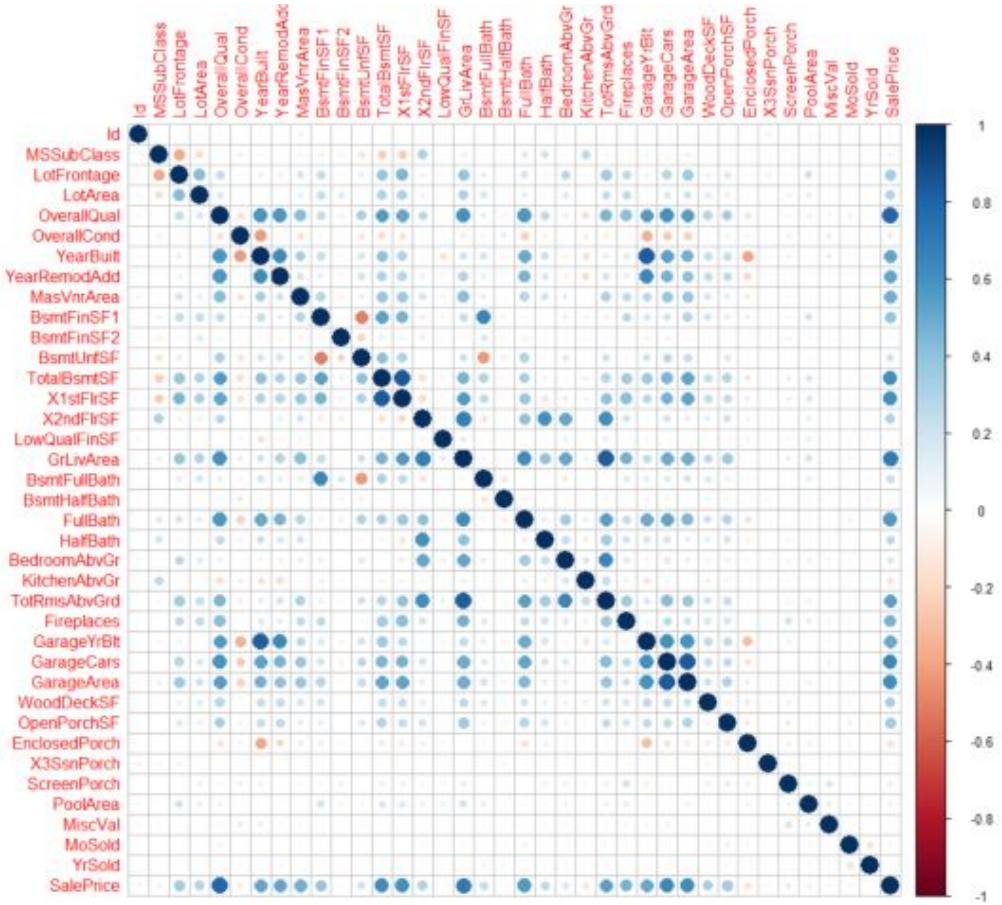


Variables: GarageArea vs SalePrice



4. Correlación entre variables

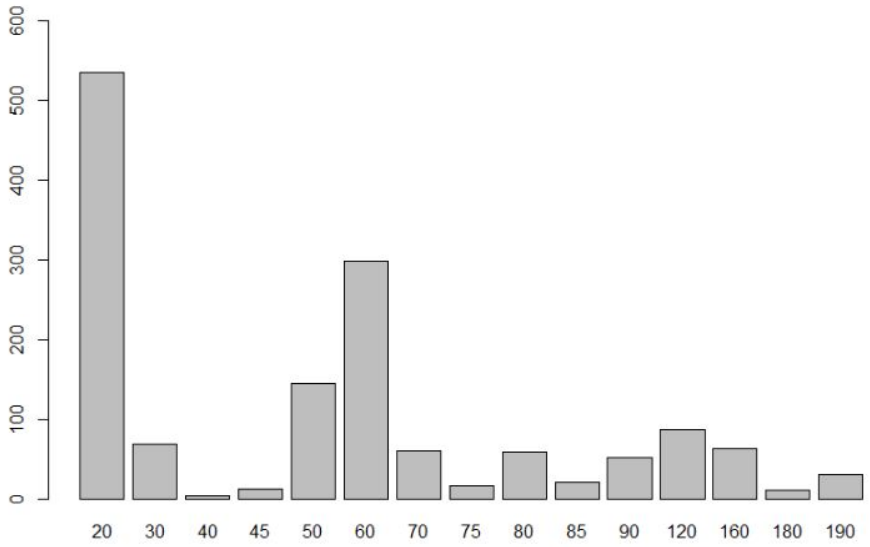
Al hacer un gráfico de correlación, se observan puntos atípicos que hacen referencia a que ciertos pares no tienen correlación. Por ejemplo, de las variables X3SsnPorch hasta YrSold, se encuentra poca o nula relación. Por otro lado, no se debería considerar el id de la casa, ya que no hay relación con alguna otra variable.



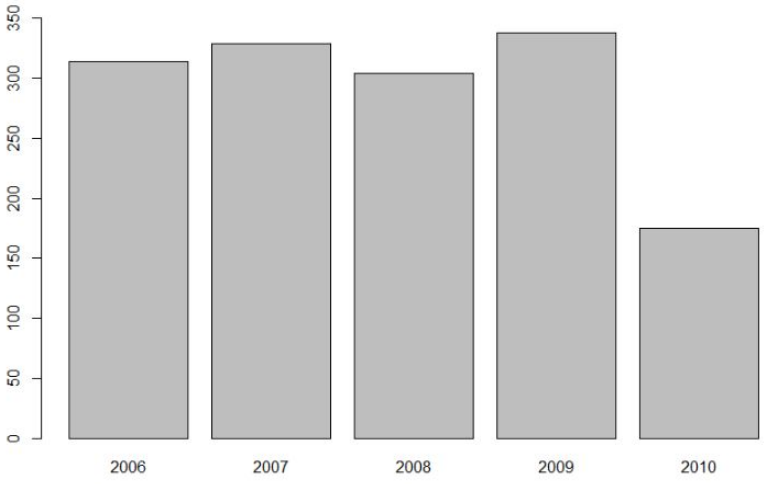
Gráficos exploratorios variables categóricas

1. Gráficos de barra

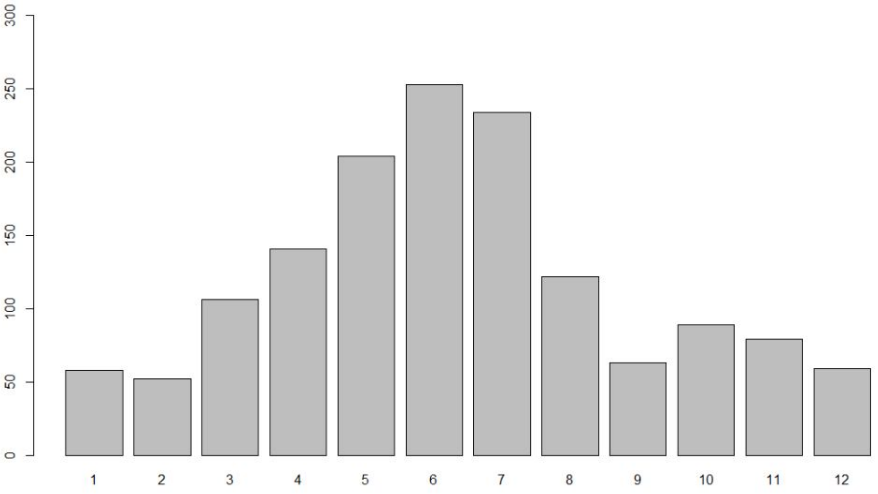
   Variable: MSSubClass



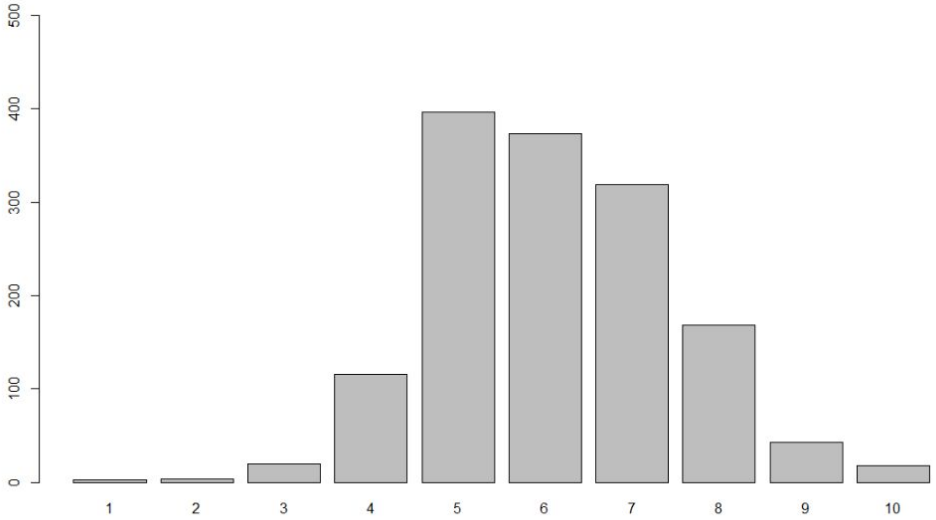
Variable: YrSold



Variable: MoSold

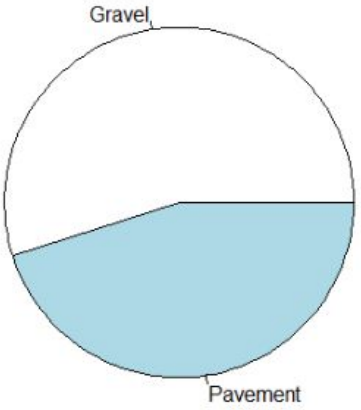


Variable: OverallQual

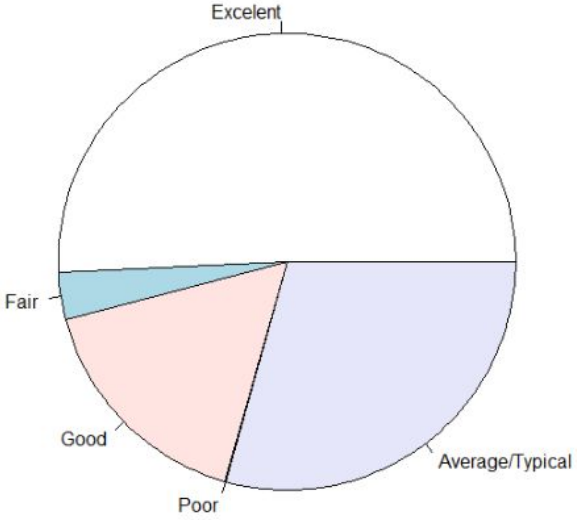


2. Gráficos de área (Pie)

Variable: Alley

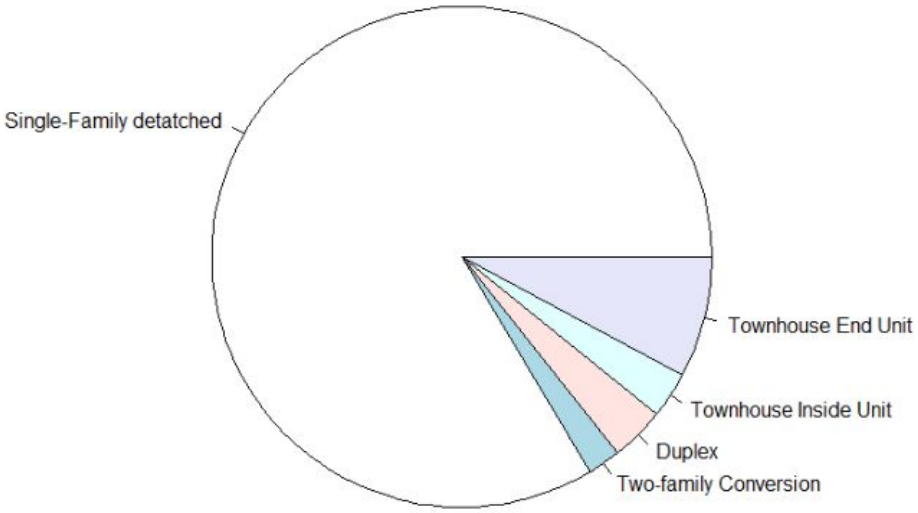


Variable: HeatingQC



Variable: BsmtQual

Variable: BldgType



3. Tablas de frecuencia

Variable: Utilities

AllPub	NoSeWa
1459	1

Variable: LotConfig

Corner	CulDSac	FR2	FR3	Inside
263	94	47	4	1052

Variable: Heating

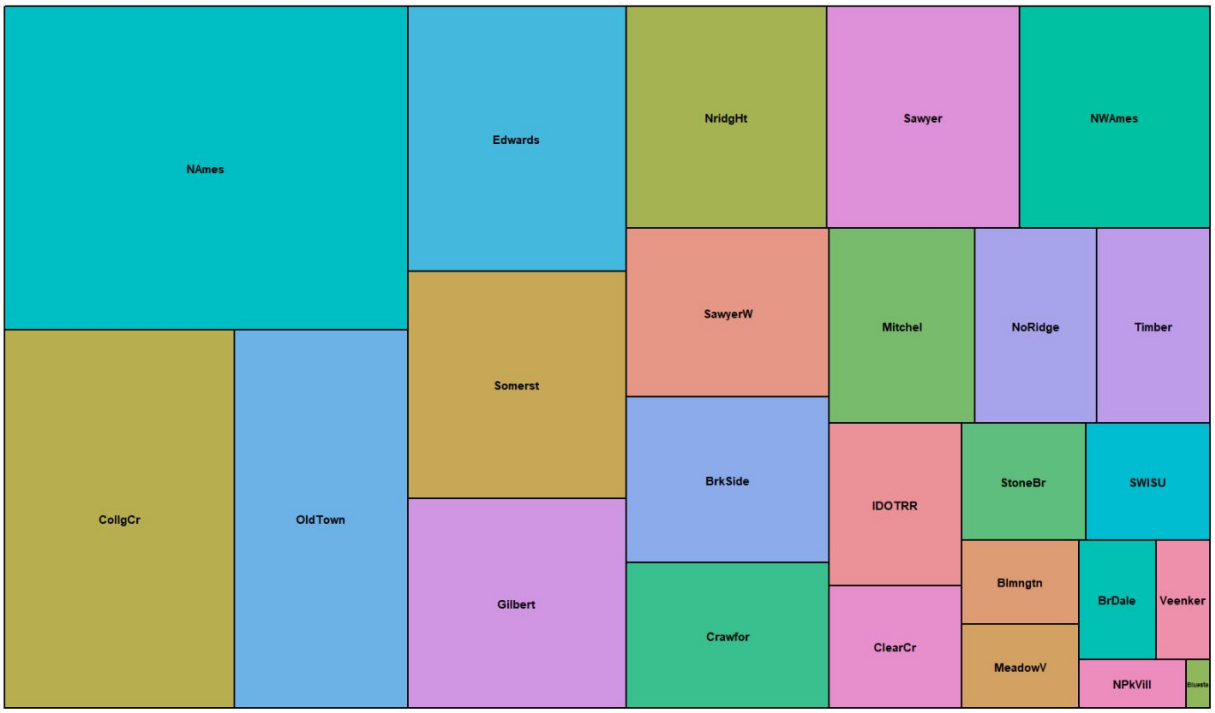
Floor	GasA	GasW	Grav	OthW	Wall
1	1428	18	7	2	4

Variable: GarageType

2Types	Attchd	Basment	BuiltIn	CarPort	Detchd
6	870	19	88	9	387

4. Tablas de proporción

Variable: Neighborhood



Análisis de componentes principales

Primero, se analiza si es posible utilizar la técnica de análisis factorial para formar las combinaciones lineales de las variables. Se tomaron únicamente las variables más importantes. Esto se hace mediante la función “paf” y se analiza su KMO. Como el KMO es elevado (0.78), podemos decir que sí es posible utilizar esta técnica. Además, se verificó que sí vale la pena aplicar los componentes principales con el test de Bartlett. Mientras más alto sea este resultado, es mejor; en este caso se obtuvo un valor de 6359.1.

```
> pafDatos$KMO
[1] 0.78787

> pafDatos$Bartlett
[1] 6359.1
```

El resumen de estos resultados y la operación de paf se muestran a continuación.

```
> summary(pafDatos)
$KMO
[1] 0.78787

$MSA
                MSA
GrLivArea   0.78861
LotArea     0.85188
GarageArea  0.87015
X1stFlrSF   0.78185
YearBuilt   0.68832
YrSold      0.49347
MoSold      0.52889
OpenPorchSF 0.89640
GarageYrBlt 0.68234
LotFrontage 0.83913
TotalBsmtSF 0.77816
SalePrice   0.84857

$Bartlett
[1] 6359.1

$Communalities
            Initial Communalities Final Extraction
GrLivArea                0.599465         0.7187200
LotArea                  0.230485         0.2232588
GarageArea               0.566791         0.5507416
X1stFlrSF                0.751295         0.8279618
YearBuilt                0.724289         0.7212135
YrSold                   0.026933         0.0064661
MoSold                   0.034857         0.0149144
OpenPorchSF              0.182229         0.1809828
GarageYrBlt              0.748883         0.9405085
LotFrontage              0.333962         0.3228366
TotalBsmtSF              0.741503         0.8199540
SalePrice                0.705067         0.7461420

$Factor.Loadings
                 [,1]       [,2]       [,3]
GrLivArea   -0.696149 -0.2916674  0.3860404
LotArea     -0.341071 -0.3251006  0.0351951
GarageArea  -0.730491  0.1072384  0.0749916
X1stFlrSF   -0.793743 -0.3331773 -0.2948325
YearBuilt   -0.615781  0.5785312 -0.0856093
YrSold       0.014425  0.0070248 -0.0787953
MoSold      -0.045067 -0.0119556  0.1128733
OpenPorchSF -0.392418  0.0142645  0.1636685
GarageYrBlt -0.651410  0.7184490  0.0019896
LotFrontage -0.458674 -0.3345494  0.0230482
TotalBsmtSF -0.798741 -0.2034778 -0.3749180
SalePrice   -0.840079 -0.0156998  0.2004054

$RMS
[1] 0.034568
```

1. Matriz de correlación

   Se obtuvo la siguiente matriz de correlación. La variable más importante es SalePrice, por lo que se analizó con qué variables tenía algún tipo de relación fuerte. Las variables que afectan fuertemente al SalePrice son GrLivArea, GarageArea, X1stFlrSF y TotalBsmtSF.

```
> cor(data_training_numeric_clean_no_factors,use = "pairwise.complete.obs")
             GrLivArea    LotArea GarageArea  X1stFlrSF  YearBuilt      YrSold     MoSold OpenPorchSF GarageYrBlt LotFrontage TotalBsmtSF SalePrice
GrLivArea    1.000000  0.3071635   0.487550 0.56137226  0.2049673 -0.02443609  0.0530708    0.353534   0.2437338   0.396306   0.4646447 0.705154
LotArea      0.307164  1.0000000   0.211362 0.32967869  0.0292054 -0.00690389  0.0089985    0.099170   0.0137308   0.421184   0.3025539 0.299962
GarageArea   0.487550  0.2113624   1.000000 0.52118299  0.4712859 -0.01620605  0.0375966    0.302558   0.5926352   0.356851   0.5220512 0.619330
X1stFlrSF    0.561372  0.3296787   0.521183 1.00000000  0.3088748  0.00042049  0.0277310    0.244846   0.2790531   0.451085   0.8359994 0.607969
YearBuilt    0.204967  0.0292054   0.471286 0.30887484  1.0000000 -0.00458549  0.0137844    0.235432   0.8235195   0.109726   0.4091336 0.525394
YrSold      -0.024436 -0.0069039  -0.016206 0.00042049 -0.0045855  1.00000000 -0.1505766   -0.053035   0.0095961   0.013267  -0.0033775 -0.011869
MoSold       0.053071  0.0089985   0.037597 0.02773104  0.0137844 -0.15057661  1.0000000    0.089767   0.0092329   0.018815  -0.0014981 0.051568
OpenPorchSF  0.353534  0.0991700   0.302558 0.24484556  0.2354321 -0.05303516  0.0897669    1.000000   0.2571410   0.161815   0.2912859 0.343354
GarageYrBlt  0.243734  0.0137308   0.592635 0.27905312  0.8235195  0.00959605  0.0092329    0.257141   1.0000000   0.069878   0.3528768 0.504753
LotFrontage  0.396306  0.4211841   0.356851 0.45108503  0.1097256  0.01326707  0.0188145    0.161815   0.0698781   1.000000   0.3876195 0.344270
TotalBsmtSF  0.464645  0.3025539   0.522051 0.83599935  0.4091336 -0.00337749 -0.0014981    0.291286   0.3528768   0.387620   1.0000000 0.615612
SalePrice    0.705154  0.2999622   0.619330 0.60796911  0.5253936 -0.01186882  0.0515681    0.343354   0.5047530   0.344270   0.6156122 1.000000
```

2. Componentes principales

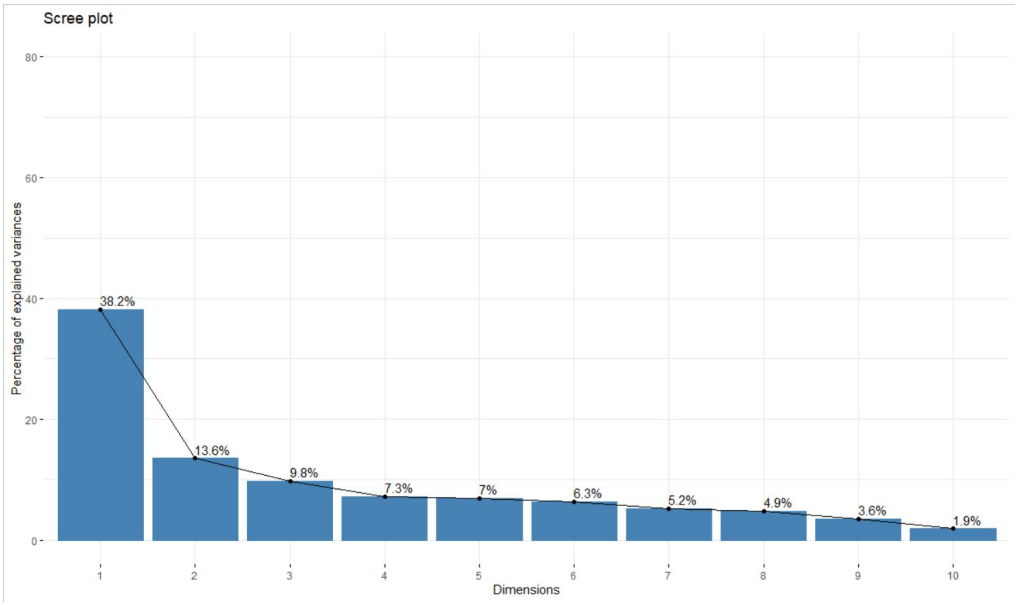
   Los componentes principales que se obtuvieron fueron los siguientes. Sin embargo, esta información es difícil de interpretar solamente con los datos normalizados. Entonces, se obtuvo la importancia de cada componente principal, en términos de desviación estándar, proporción de varianza y proporción acumulativa. En base a la

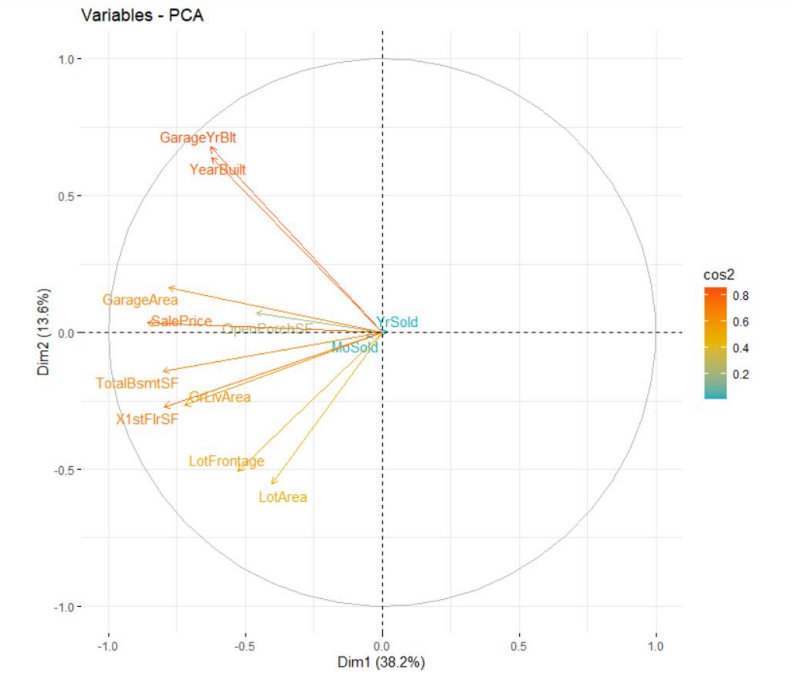
importancia, se escogerían 4 componentes principales para explicar la mayor variabilidad.

```
> compPrinc
Standard deviations (1, .., p=12):
 [1] 2.14136 1.27545 1.08630 0.93388 0.91407 0.87105 0.79046 0.76309 0.65408 0.47840 0.37539 0.36963

Rotation (n x k) = (12 x 12):
                PC1        PC2        PC3        PC4        PC5        PC6        PC7        PC8        PC9        PC10       PC11       PC12
GrLivArea  -0.3368438 -0.2078160  0.0796308 -0.224097  0.1963431 -0.061198  0.6163135 -0.0374082  0.2148634 -0.48340398  0.287131 -0.030995
LotArea    -0.1881431 -0.4351502 -0.0495588  0.197872 -0.2048309  0.577611 -0.0883759 -0.5724141 -0.1348264 -0.06219286  0.004549 -0.022633
GarageArea -0.3645633  0.1268373 -0.0091185  0.040150 -0.0483596  0.069136  0.1884028  0.2838851 -0.8032795  0.10546175  0.132365 -0.228485
X1stFlrSF  -0.3721418 -0.2129309 -0.0628764  0.087953 -0.0098939 -0.460929 -0.2331255 -0.0607296 -0.0275092 -0.28891000 -0.601424 -0.296574
YearBuilt  -0.2914365  0.5005208 -0.0572864  0.162516 -0.1529395  0.155696 -0.1473556 -0.0570147  0.3957420 -0.00028082  0.249870 -0.585840
YrSold      0.0089293  0.0029695 -0.6611096 -0.629589 -0.4037966 -0.027676 -0.0137926 -0.0423107 -0.0177666  0.00182535  0.013950 -0.012316
MoSold     -0.0267071 -0.0089316  0.6831613 -0.288296 -0.6571492 -0.122753 -0.0308135 -0.0264248 -0.0012904 -0.00871842  0.021706  0.016521
OpenPorchSF -0.2154958  0.0565545  0.2590386 -0.599776  0.5037519  0.289625 -0.4228325 -0.0186084 -0.0347424  0.02699606 -0.061429 -0.032245
GarageYrBlt -0.2933819  0.5303384 -0.0529761  0.106318 -0.1250622  0.208039  0.0014556  0.0048883 -0.0113012 -0.35893423 -0.266385  0.599741
LotFrontage -0.2458951 -0.3975163 -0.0595223  0.094401 -0.1662359  0.301936 -0.1467549  0.7295183  0.2910753  0.05253143 -0.017198  0.093530
TotalBsmtSF -0.3744552 -0.1106210 -0.0801524  0.112029  0.0153291 -0.429217 -0.4029546 -0.1407805 -0.0173403  0.10743792  0.567423  0.357917
SalePrice   -0.4010260  0.0265776  0.0153141 -0.053616  0.0386528 -0.052482  0.3700704 -0.1689332  0.2152941  0.72382113 -0.279648  0.130965
```

```
> summary(compPrinc)
Importance of components:
                          PC1   PC2    PC3    PC4    PC5    PC6    PC7    PC8    PC9    PC10   PC11   PC12
Standard deviation     2.141 1.275 1.0863 0.9339 0.9141 0.8710 0.7905 0.7631 0.6541 0.4784 0.3754 0.3696
Proportion of Variance 0.382 0.136 0.0983 0.0727 0.0696 0.0632 0.0521 0.0485 0.0357 0.0191 0.0117 0.0114
Cumulative Proportion  0.382 0.518 0.6160 0.6887 0.7583 0.8216 0.8736 0.9222 0.9578 0.9769 0.9886 1.0000
```





Reglas de asociación

Para las reglas de asociación, se utilizó un nivel de confianza de 0.7 y un nivel de soporte de 0.2. El nivel bajo de soporte se debe a la gran cantidad de variables utilizadas. Además, solamente se tomaron en cuenta las variables que representaban una categoría definida. Se obtuvieron los siguientes resultados:

```
> reglas<-apriori(data_training_factors, parameter = list(support = 0.2,
+                                                         confidence = 0.70,
+                                                         target = "rules"))
Apriori

Parameter specification:
 confidence minval smax arem  aval originalSupport maxtime support minlen maxlen target  ext
        0.7    0.1    1 none FALSE            TRUE       5     0.2      1     10  rules TRUE

Algorithmic control:
 filter tree heap memopt load sort verbose
    0.1 TRUE TRUE  FALSE TRUE    2    TRUE

Absolute minimum support count: 275

set item appearances ...[0 item(s)] done [0.00s].
set transactions ...[31 item(s), 1378 transaction(s)] done [0.01s].
sorting and recoding items ... [9 item(s)] done [0.00s].
creating transaction tree ... done [0.00s].
checking subsets of size 1 2 3 4 5 6 done [0.01s].
writing ... [174 rule(s)] done [0.00s].
creating S4 object  ... done [0.00s].
```

```
> inspect(reglas)
     lhs                                                  rhs                      support confidence coverage lift     count
[1]  {}                                                => {RoofStyle=Gable}       0.77576 0.77576    1.00000  1.00000 1069
[2]  {}                                                => {SaleCondition=Normal}  0.82438 0.82438    1.00000  1.00000 1136
[3]  {}                                                => {LandContour=Lvl}       0.90203 0.90203    1.00000  1.00000 1243
[4]  {}                                                => {Electrical=SBrkr}      0.92308 0.92308    1.00000  1.00000 1272
[5]  {GarageType=Detchd}                               => {LotShape=Reg}          0.22134 0.78811    0.28084  1.26281  305
[6]  {GarageType=Detchd}                               => {RoofStyle=Gable}       0.23295 0.82946    0.28084  1.06922  321
[7]  {GarageType=Detchd}                               => {SaleCondition=Normal}  0.24528 0.87339    0.28084  1.05944  338
[8]  {GarageType=Detchd}                               => {LandContour=Lvl}       0.24673 0.87855    0.28084  0.97397  340
[9]  {GarageType=Detchd}                               => {Electrical=SBrkr}      0.23295 0.82946    0.28084  0.89858  321
[10] {LotShape=IR1}                                    => {GarageType=Attchd}     0.25109 0.74090    0.33890  1.17352  346
[11] {LotShape=IR1}                                    => {RoofStyle=Gable}       0.26052 0.76874    0.33890  0.99094  359
[12] {LotShape=IR1}                                    => {SaleCondition=Normal}  0.27939 0.82441    0.33890  1.00003  385
[13] {LotShape=IR1}                                    => {LandContour=Lvl}       0.29390 0.86724    0.33890  0.96143  405
[14] {LotShape=IR1}                                    => {Electrical=SBrkr}      0.32438 0.95717    0.33890  1.03694  447
[15] {LotShape=Reg}                                    => {RoofStyle=Gable}       0.48766 0.78140    0.62409  1.00726  672
[16] {LotShape=Reg}                                    => {SaleCondition=Normal}  0.51451 0.82442    0.62409  1.00004  709
[17] {LotShape=Reg}                                    => {LandContour=Lvl}       0.58345 0.93488    0.62409  1.03642  804
[18] {LotShape=Reg}                                    => {Electrical=SBrkr}      0.56241 0.90116    0.62409  0.97626  775
[19] {GarageType=Attchd}                               => {RoofStyle=Gable}       0.47750 0.75632    0.63135  0.97494  658
[20] {GarageType=Attchd}                               => {SaleCondition=Normal}  0.51669 0.81839    0.63135  0.99273  712
[21] {GarageType=Attchd}                               => {LandContour=Lvl}       0.57837 0.91609    0.63135  1.01559  797
[22] {GarageType=Attchd}                               => {Electrical=SBrkr}      0.60813 0.96322    0.63135  1.04349  838
[23] {RoofStyle=Gable}                                 => {SaleCondition=Normal}  0.64224 0.82788    0.77576  1.00424  885
[24] {SaleCondition=Normal}                            => {RoofStyle=Gable}       0.64224 0.77905    0.82438  1.00424  885
[25] {RoofStyle=Gable}                                 => {LandContour=Lvl}       0.70392 0.90739    0.77576  1.00594  970
[26] {LandContour=Lvl}                                 => {RoofStyle=Gable}       0.70392 0.78037    0.90203  1.00594  970
[27] {RoofStyle=Gable}                                 => {Electrical=SBrkr}      0.71408 0.92049    0.77576  0.99719  984
[28] {Electrical=SBrkr}                                => {RoofStyle=Gable}       0.71408 0.77358    0.92308  0.99719  984
[29] {SaleCondition=Normal}                            => {LandContour=Lvl}       0.74819 0.90757    0.82438  1.00614 1031
[30] {LandContour=Lvl}                                 => {SaleCondition=Normal}  0.74819 0.82944    0.90203  1.00614 1031
[31] {SaleCondition=Normal}                            => {Electrical=SBrkr}      0.75835 0.91989    0.82438  0.99655 1045
[32] {Electrical=SBrkr}                                => {SaleCondition=Normal}  0.75835 0.82154    0.92308  0.99655 1045
[33] {LandContour=Lvl}                                 => {Electrical=SBrkr}      0.83599 0.92679    0.90203  1.00402 1152
[34] {Electrical=SBrkr}                                => {LandContour=Lvl}       0.83599 0.90566    0.92308  1.00402 1152
[35] {LotShape=Reg,GarageType=Detchd}                  => {LandContour=Lvl}       0.20174 0.91148    0.22134  1.01047  278
[36] {LandContour=Lvl,GarageType=Detchd}               => {LotShape=Reg}          0.20174 0.81765    0.24673  1.31014  278
[37] {RoofStyle=Gable,GarageType=Detchd}               => {LandContour=Lvl}       0.20392 0.87539    0.23295  0.97046  281
[38] {LandContour=Lvl,GarageType=Detchd}               => {RoofStyle=Gable}       0.20392 0.82647    0.24673  1.06537  281
[39] {GarageType=Detchd,SaleCondition=Normal}          => {LandContour=Lvl}       0.21553 0.87870    0.24528  0.97413  297
[40] {LandContour=Lvl,GarageType=Detchd}               => {SaleCondition=Normal}  0.21553 0.87353    0.24673  1.05962  297
[41] {GarageType=Detchd,SaleCondition=Normal}          => {Electrical=SBrkr}      0.20319 0.82840    0.24528  0.89744  280
[42] {Electrical=SBrkr,GarageType=Detchd}              => {SaleCondition=Normal}  0.20319 0.87227    0.23295  1.05809  280
[43] {LandContour=Lvl,GarageType=Detchd}               => {Electrical=SBrkr}      0.20464 0.82941    0.24673  0.89853  282
[44] {Electrical=SBrkr,GarageType=Detchd}              => {LandContour=Lvl}       0.20464 0.87850    0.23295  0.97392  282
[45] {LotShape=IR1,GarageType=Attchd}                  => {SaleCondition=Normal}  0.20537 0.81792    0.25109  0.99216  283
[46] {LotShape=IR1,SaleCondition=Normal}               => {GarageType=Attchd}     0.20537 0.73506    0.27939  1.16428  283
[47] {LotShape=IR1,GarageType=Attchd}                  => {LandContour=Lvl}       0.22061 0.87861    0.25109  0.97404  304
[48] {LotShape=IR1,LandContour=Lvl}                    => {GarageType=Attchd}     0.22061 0.75062    0.29390  1.18891  304
[49] {LotShape=IR1,GarageType=Attchd}                  => {Electrical=SBrkr}      0.24456 0.97399    0.25109  1.05515  337
[50] {LotShape=IR1,Electrical=SBrkr}                   => {GarageType=Attchd}     0.24456 0.75391    0.32438  1.19413  337
[51] {LotShape=IR1,RoofStyle=Gable}                    => {SaleCondition=Normal}  0.21843 0.83844    0.26052  1.01705  301
[52] {LotShape=IR1,SaleCondition=Normal}               => {RoofStyle=Gable}       0.21843 0.78182    0.27939  1.00781  301
[53] {LotShape=IR1,RoofStyle=Gable}                    => {LandContour=Lvl}       0.22932 0.88022    0.26052  0.97582  316
[54] {LotShape=IR1,LandContour=Lvl}                    => {RoofStyle=Gable}       0.22932 0.78025    0.29390  1.00578  316
[55] {LotShape=IR1,RoofStyle=Gable}                    => {Electrical=SBrkr}      0.25109 0.96379    0.26052  1.04410  346
[56] {LotShape=IR1,Electrical=SBrkr}                   => {RoofStyle=Gable}       0.25109 0.77405    0.32438  0.99779  346
[57] {LotShape=IR1,SaleCondition=Normal}               => {LandContour=Lvl}       0.24456 0.87532    0.27939  0.97039  337
[58] {LotShape=IR1,LandContour=Lvl}                    => {SaleCondition=Normal}  0.24456 0.83210    0.29390  1.00936  337
[59] {LotShape=IR1,SaleCondition=Normal}               => {Electrical=SBrkr}      0.26705 0.95584    0.27939  1.03550  368
[60] {LotShape=IR1,Electrical=SBrkr}                   => {SaleCondition=Normal}  0.26705 0.82327    0.32438  0.99865  368
```

[61]	{LotShape=IR1,LandContour=Lvl}	=> {Electrical=SBrkr}	0.28302	0.96296	0.29390	1.04321	390
[62]	{LotShape=IR1,Electrical=SBrkr}	=> {LandContour=Lvl}	0.28302	0.87248	0.32438	0.96724	390
[63]	{LotShape=Reg,GarageType=Attchd}	=> {RoofStyle=Gable}	0.26633	0.74593	0.35704	0.96155	367
[64]	{LotShape=Reg,GarageType=Attchd}	=> {SaleCondition=Normal}	0.29245	0.81911	0.35704	0.99360	403
[65]	{LotShape=Reg,GarageType=Attchd}	=> {LandContour=Lvl}	0.34107	0.95528	0.35704	1.05904	470
[66]	{LotShape=Reg,GarageType=Attchd}	=> {Electrical=SBrkr}	0.34035	0.95325	0.35704	1.03269	469
[67]	{LotShape=Reg,RoofStyle=Gable}	=> {SaleCondition=Normal}	0.39913	0.81845	0.48766	0.99281	550
[68]	{LotShape=Reg,SaleCondition=Normal}	=> {RoofStyle=Gable}	0.39913	0.77574	0.51451	0.99997	550
[69]	{LotShape=Reg,RoofStyle=Gable}	=> {LandContour=Lvl}	0.45501	0.93304	0.48766	1.03437	627
[70]	{LotShape=Reg,LandContour=Lvl}	=> {RoofStyle=Gable}	0.45501	0.77985	0.58345	1.00527	627
[71]	{LotShape=Reg,RoofStyle=Gable}	=> {Electrical=SBrkr}	0.43614	0.89435	0.48766	0.96887	601
[72]	{LotShape=Reg,Electrical=SBrkr}	=> {RoofStyle=Gable}	0.43614	0.77548	0.56241	0.99964	601
[73]	{LotShape=Reg,SaleCondition=Normal}	=> {LandContour=Lvl}	0.48186	0.93653	0.51451	1.03825	664
[74]	{LotShape=Reg,LandContour=Lvl}	=> {SaleCondition=Normal}	0.48186	0.82587	0.58345	1.00180	664
[75]	{LotShape=Reg,SaleCondition=Normal}	=> {Electrical=SBrkr}	0.46154	0.89704	0.51451	0.97179	636
[76]	{LotShape=Reg,Electrical=SBrkr}	=> {SaleCondition=Normal}	0.46154	0.82065	0.56241	0.99547	636
[77]	{LotShape=Reg,LandContour=Lvl}	=> {Electrical=SBrkr}	0.52830	0.90547	0.58345	0.98093	728
[78]	{LotShape=Reg,Electrical=SBrkr}	=> {LandContour=Lvl}	0.52830	0.93935	0.56241	1.04138	728
[79]	{RoofStyle=Gable,GarageType=Attchd}	=> {SaleCondition=Normal}	0.39332	0.82371	0.47750	0.99918	542
[80]	{GarageType=Attchd,SaleCondition=Normal}	=> {RoofStyle=Gable}	0.39332	0.76124	0.51669	0.98128	542
[81]	{RoofStyle=Gable,GarageType=Attchd}	=> {LandContour=Lvl}	0.44194	0.92553	0.47750	1.02605	609
[82]	{LandContour=Lvl,GarageType=Attchd}	=> {RoofStyle=Gable}	0.44194	0.76412	0.57837	0.98499	609
[83]	{RoofStyle=Gable,GarageType=Attchd}	=> {Electrical=SBrkr}	0.45936	0.96201	0.47750	1.04217	633
[84]	{Electrical=SBrkr,GarageType=Attchd}	=> {RoofStyle=Gable}	0.45936	0.75537	0.60813	0.97371	633
[85]	{GarageType=Attchd,SaleCondition=Normal}	=> {LandContour=Lvl}	0.47605	0.92135	0.51669	1.02141	656
[86]	{LandContour=Lvl,GarageType=Attchd}	=> {SaleCondition=Normal}	0.47605	0.82309	0.57837	0.99843	656
[87]	{GarageType=Attchd,SaleCondition=Normal}	=> {Electrical=SBrkr}	0.49492	0.95787	0.51669	1.03769	682
[88]	{Electrical=SBrkr,GarageType=Attchd}	=> {SaleCondition=Normal}	0.49492	0.81384	0.60813	0.98721	682
[89]	{LandContour=Lvl,GarageType=Attchd}	=> {Electrical=SBrkr}	0.55878	0.96612	0.57837	1.04663	770
[90]	{Electrical=SBrkr,GarageType=Attchd}	=> {LandContour=Lvl}	0.55878	0.91885	0.60813	1.01865	770
[91]	{RoofStyle=Gable,SaleCondition=Normal}	=> {LandContour=Lvl}	0.58418	0.90960	0.64224	1.00840	805
[92]	{LandContour=Lvl,RoofStyle=Gable}	=> {SaleCondition=Normal}	0.58418	0.82990	0.70392	1.00669	805
[93]	{LandContour=Lvl,SaleCondition=Normal}	=> {RoofStyle=Gable}	0.58418	0.78080	0.74819	1.00649	805
[94]	{RoofStyle=Gable,SaleCondition=Normal}	=> {Electrical=SBrkr}	0.58999	0.91864	0.64224	0.99520	813
[95]	{RoofStyle=Gable,Electrical=SBrkr}	=> {SaleCondition=Normal}	0.58999	0.82622	0.71408	1.00223	813
[96]	{Electrical=SBrkr,SaleCondition=Normal}	=> {RoofStyle=Gable}	0.58999	0.77799	0.75835	1.00287	813
[97]	{LandContour=Lvl,RoofStyle=Gable}	=> {Electrical=SBrkr}	0.64949	0.92268	0.70392	0.99957	895
[98]	{RoofStyle=Gable,Electrical=SBrkr}	=> {LandContour=Lvl}	0.64949	0.90955	0.71408	1.00834	895
[99]	{LandContour=Lvl,Electrical=SBrkr}	=> {RoofStyle=Gable}	0.64949	0.77691	0.83599	1.00148	895
[100]	{LandContour=Lvl,SaleCondition=Normal}	=> {Electrical=SBrkr}	0.69231	0.92532	0.74819	1.00242	954
[101]	{Electrical=SBrkr,SaleCondition=Normal}	=> {LandContour=Lvl}	0.69231	0.91292	0.75835	1.01207	954
[102]	{LandContour=Lvl,Electrical=SBrkr}	=> {SaleCondition=Normal}	0.69231	0.82812	0.83599	1.00454	954
[103]	{LotShape=IR1,LandContour=Lvl,GarageType=Attchd}	=> {Electrical=SBrkr}	0.21480	0.97368	0.22061	1.05482	296
[104]	{LotShape=IR1,Electrical=SBrkr,GarageType=Attchd}	=> {LandContour=Lvl}	0.21480	0.87834	0.24456	0.97373	296
[105]	{LotShape=IR1,LandContour=Lvl,Electrical=SBrkr}	=> {GarageType=Attchd}	0.21480	0.75897	0.28302	1.20215	296
[106]	{LotShape=IR1,RoofStyle=Gable,SaleCondition=Normal}	=> {Electrical=SBrkr}	0.21045	0.96346	0.21843	1.04374	290
[107]	{LotShape=IR1,RoofStyle=Gable,Electrical=SBrkr}	=> {SaleCondition=Normal}	0.21045	0.83815	0.25109	1.01670	290
[108]	{LotShape=IR1,Electrical=SBrkr,SaleCondition=Normal}	=> {RoofStyle=Gable}	0.21045	0.78804	0.26705	1.01583	290
[109]	{LotShape=IR1,LandContour=Lvl,RoofStyle=Gable}	=> {Electrical=SBrkr}	0.22206	0.96835	0.22932	1.04905	306
[110]	{LotShape=IR1,RoofStyle=Gable,Electrical=SBrkr}	=> {LandContour=Lvl}	0.22206	0.88439	0.25109	0.98045	306
[111]	{LotShape=IR1,LandContour=Lvl,Electrical=SBrkr}	=> {RoofStyle=Gable}	0.22206	0.78462	0.28302	1.01141	306
[112]	{LotShape=IR1,LandContour=Lvl,SaleCondition=Normal}	=> {Electrical=SBrkr}	0.23585	0.96439	0.24456	1.04476	325
[113]	{LotShape=IR1,Electrical=SBrkr,SaleCondition=Normal}	=> {LandContour=Lvl}	0.23585	0.88315	0.26705	0.97907	325
[114]	{LotShape=IR1,LandContour=Lvl,Electrical=SBrkr}	=> {SaleCondition=Normal}	0.23585	0.83333	0.28302	1.01086	325
[115]	{LotShape=Reg,RoofStyle=Gable,GarageType=Attchd}	=> {SaleCondition=Normal}	0.21626	0.81199	0.26633	0.98497	298
[116]	{LotShape=Reg,GarageType=Attchd,SaleCondition=Normal}	=> {RoofStyle=Gable}	0.21626	0.73945	0.29245	0.95320	298
[117]	{LotShape=Reg,RoofStyle=Gable,GarageType=Attchd}	=> {LandContour=Lvl}	0.25399	0.95368	0.26633	1.05726	350
[118]	{LotShape=Reg,LandContour=Lvl,GarageType=Attchd}	=> {RoofStyle=Gable}	0.25399	0.74468	0.34107	0.95993	350
[119]	{LotShape=Reg,RoofStyle=Gable,GarageType=Attchd}	=> {Electrical=SBrkr}	0.25254	0.94823	0.26633	1.02725	348
[120]	{LotShape=Reg,Electrical=SBrkr,GarageType=Attchd}	=> {RoofStyle=Gable}	0.25254	0.74200	0.34035	0.95648	348
[121]	{LotShape=Reg,GarageType=Attchd,SaleCondition=Normal}	=> {LandContour=Lvl}	0.27866	0.95285	0.29245	1.05634	384
[122]	{LotShape=Reg,LandContour=Lvl,GarageType=Attchd}	=> {SaleCondition=Normal}	0.27866	0.81702	0.34107	0.99107	384
[123]	{LotShape=Reg,GarageType=Attchd,SaleCondition=Normal}	=> {Electrical=SBrkr}	0.27721	0.94789	0.29245	1.02688	382
[124]	{LotShape=Reg,Electrical=SBrkr,GarageType=Attchd}	=> {SaleCondition=Normal}	0.27721	0.81450	0.34035	0.98801	382
[125]	{LotShape=Reg,LandContour=Lvl,GarageType=Attchd}	=> {Electrical=SBrkr}	0.32729	0.95957	0.34107	1.03954	451
[126]	{LotShape=Reg,Electrical=SBrkr,GarageType=Attchd}	=> {LandContour=Lvl}	0.32729	0.96162	0.34035	1.06606	451
[127]	{LotShape=Reg,RoofStyle=Gable,SaleCondition=Normal}	=> {LandContour=Lvl}	0.37228	0.93273	0.39913	1.03403	513
[128]	{LotShape=Reg,LandContour=Lvl,RoofStyle=Gable}	=> {SaleCondition=Normal}	0.37228	0.81818	0.45501	0.99248	513
[129]	{LotShape=Reg,LandContour=Lvl,SaleCondition=Normal}	=> {RoofStyle=Gable}	0.37228	0.77259	0.48186	0.99591	513
[130]	{LotShape=Reg,RoofStyle=Gable,SaleCondition=Normal}	=> {Electrical=SBrkr}	0.35559	0.89091	0.39913	0.96515	490
[131]	{LotShape=Reg,RoofStyle=Gable,Electrical=SBrkr}	=> {SaleCondition=Normal}	0.35559	0.81531	0.43614	0.98899	490
[132]	{LotShape=Reg,Electrical=SBrkr,SaleCondition=Normal}	=> {RoofStyle=Gable}	0.35559	0.77044	0.46154	0.99314	490
[133]	{LotShape=Reg,LandContour=Lvl,RoofStyle=Gable}	=> {Electrical=SBrkr}	0.40784	0.89633	0.45501	0.97103	562
[134]	{LotShape=Reg,RoofStyle=Gable,Electrical=SBrkr}	=> {LandContour=Lvl}	0.40784	0.93511	0.43614	1.03667	562
[135]	{LotShape=Reg,LandContour=Lvl,Electrical=SBrkr}	=> {RoofStyle=Gable}	0.40784	0.77198	0.52830	0.99512	562
[136]	{LotShape=Reg,LandContour=Lvl,SaleCondition=Normal}	=> {Electrical=SBrkr}	0.43469	0.90211	0.48186	0.97728	599
[137]	{LotShape=Reg,Electrical=SBrkr,SaleCondition=Normal}	=> {LandContour=Lvl}	0.43469	0.94182	0.46154	1.04411	599
[138]	{LotShape=Reg,LandContour=Lvl,Electrical=SBrkr}	=> {SaleCondition=Normal}	0.43469	0.82280	0.52830	0.99808	599
[139]	{RoofStyle=Gable,GarageType=Attchd,SaleCondition=Normal}	=> {LandContour=Lvl}	0.36575	0.92989	0.39332	1.03088	504
[140]	{LandContour=Lvl,RoofStyle=Gable,GarageType=Attchd}	=> {SaleCondition=Normal}	0.36575	0.82759	0.44194	1.00389	504
[141]	{LandContour=Lvl,GarageType=Attchd,SaleCondition=Normal}	=> {RoofStyle=Gable}	0.36575	0.76829	0.47605	0.99037	504
[142]	{RoofStyle=Gable,GarageType=Attchd,SaleCondition=Normal}	=> {Electrical=SBrkr}	0.37663	0.95756	0.39332	1.03736	519
[143]	{RoofStyle=Gable,Electrical=SBrkr,GarageType=Attchd}	=> {SaleCondition=Normal}	0.37663	0.81991	0.45936	0.99457	519
[144]	{Electrical=SBrkr,GarageType=Attchd,SaleCondition=Normal}	=> {RoofStyle=Gable}	0.37663	0.76100	0.49492	0.98097	519
[145]	{LandContour=Lvl,RoofStyle=Gable,GarageType=Attchd}	=> {Electrical=SBrkr}	0.42598	0.96388	0.44194	1.04420	587
[146]	{RoofStyle=Gable,Electrical=SBrkr,GarageType=Attchd}	=> {LandContour=Lvl}	0.42598	0.92733	0.45936	1.02805	587
[147]	{LandContour=Lvl,Electrical=SBrkr,GarageType=Attchd}	=> {RoofStyle=Gable}	0.42598	0.76234	0.55878	0.98270	587
[148]	{LandContour=Lvl,GarageType=Attchd,SaleCondition=Normal}	=> {Electrical=SBrkr}	0.45791	0.96189	0.47605	1.04205	631
[149]	{Electrical=SBrkr,GarageType=Attchd,SaleCondition=Normal}	=> {LandContour=Lvl}	0.45791	0.92522	0.49492	1.02571	631
[150]	{LandContour=Lvl,Electrical=SBrkr,GarageType=Attchd}	=> {SaleCondition=Normal}	0.45791	0.81948	0.55878	0.99405	631
[151]	{LandContour=Lvl,RoofStyle=Gable,SaleCondition=Normal}	=> {Electrical=SBrkr}	0.53919	0.92298	0.58418	0.99990	743
[152]	{RoofStyle=Gable,Electrical=SBrkr,SaleCondition=Normal}	=> {LandContour=Lvl}	0.53919	0.91390	0.58999	1.01316	743
[153]	{LandContour=Lvl,RoofStyle=Gable,Electrical=SBrkr}	=> {SaleCondition=Normal}	0.53919	0.83017	0.64949	1.00702	743
[154]	{LandContour=Lvl,Electrical=SBrkr,SaleCondition=Normal}	=> {RoofStyle=Gable}	0.53919	0.77883	0.69231	1.00395	743
[155]	{LotShape=Reg,RoofStyle=Gable,GarageType=Attchd,SaleCondition=Normal}	=> {LandContour=Lvl}	0.20610	0.95302	0.21626	1.05653	284
[156]	{LotShape=Reg,LandContour=Lvl,RoofStyle=Gable,GarageType=Attchd}	=> {SaleCondition=Normal}	0.20610	0.81143	0.25399	0.98429	284
[157]	{LotShape=Reg,LandContour=Lvl,GarageType=Attchd,SaleCondition=Normal}	=> {RoofStyle=Gable}	0.20610	0.73958	0.27866	0.95336	284
[158]	{LotShape=Reg,RoofStyle=Gable,GarageType=Attchd,SaleCondition=Normal}	=> {Electrical=SBrkr}	0.20392	0.94295	0.21626	1.02153	281
[159]	{LotShape=Reg,RoofStyle=Gable,Electrical=SBrkr,GarageType=Attchd}	=> {SaleCondition=Normal}	0.20392	0.80747	0.25254	0.97949	281
[160]	{LotShape=Reg,Electrical=SBrkr,GarageType=Attchd,SaleCondition=Normal}	=> {RoofStyle=Gable}	0.20392	0.73560	0.27721	0.94823	281
[161]	{LotShape=Reg,LandContour=Lvl,RoofStyle=Gable,GarageType=Attchd}	=> {Electrical=SBrkr}	0.24165	0.95143	0.25399	1.03071	333
[162]	{LotShape=Reg,RoofStyle=Gable,Electrical=SBrkr,GarageType=Attchd}	=> {LandContour=Lvl}	0.24165	0.95690	0.25254	1.06082	333
[163]	{LotShape=Reg,LandContour=Lvl,Electrical=SBrkr,GarageType=Attchd}	=> {RoofStyle=Gable}	0.24165	0.73836	0.32729	0.95179	333
[164]	{LotShape=Reg,LandContour=Lvl,GarageType=Attchd,SaleCondition=Normal}	=> {Electrical=SBrkr}	0.26633	0.95573	0.27866	1.03537	367
[165]	{LotShape=Reg,Electrical=SBrkr,GarageType=Attchd,SaleCondition=Normal}	=> {LandContour=Lvl}	0.26633	0.96073	0.27721	1.06508	367
[166]	{LotShape=Reg,LandContour=Lvl,Electrical=SBrkr,GarageType=Attchd}	=> {SaleCondition=Normal}	0.26633	0.81375	0.32729	0.98710	367
[167]	{LotShape=Reg,LandContour=Lvl,RoofStyle=Gable,SaleCondition=Normal}	=> {Electrical=SBrkr}	0.33309	0.89474	0.37228	0.96930	459
[168]	{LotShape=Reg,RoofStyle=Gable,Electrical=SBrkr,SaleCondition=Normal}	=> {LandContour=Lvl}	0.33309	0.93673	0.35559	1.03847	459
[169]	{LotShape=Reg,LandContour=Lvl,RoofStyle=Gable,Electrical=SBrkr}	=> {SaleCondition=Normal}	0.33309	0.81673	0.40784	0.99071	459
[170]	{LotShape=Reg,LandContour=Lvl,Electrical=SBrkr,SaleCondition=Normal}	=> {RoofStyle=Gable}	0.33309	0.76628	0.43469	0.98777	459
[171]	{LandContour=Lvl,RoofStyle=Gable,GarageType=Attchd,SaleCondition=Normal}	=> {Electrical=SBrkr}	0.35123	0.96032	0.36575	1.04034	484
[172]	{RoofStyle=Gable,Electrical=SBrkr,GarageType=Attchd,SaleCondition=Normal}	=> {LandContour=Lvl}	0.35123	0.93256	0.37663	1.03385	484
[173]	{LandContour=Lvl,RoofStyle=Gable,Electrical=SBrkr,GarageType=Attchd}	=> {SaleCondition=Normal}	0.35123	0.82453	0.42598	1.00018	484
[174]	{LandContour=Lvl,Electrical=SBrkr,GarageType=Attchd,SaleCondition=Normal}	=> {RoofStyle=Gable}	0.35123	0.76704	0.45791	0.98875	484

Algunas reglas interesantes son:

```
IF {LotShape=Reg} THEN {LandCountour=Lvl} con soporte=0.583 y confidence=0.935
IF {LotShape=Reg} THEN {Electrical=SBrkr} con soporte=0.562 y confidence=0.901
IF {GarageType=Attchd} THEN {LandCountour=Lvl} con soporte=0.578 y confidence=0.916
IF {LandCountour=Lvl} THEN {Electrical=SBrkr} con soporte=0.836 y confidence=0.927
IF {LandCountour=Lvl, Electrical=SBrkr, RoofStyle=Gable} THEN {SaleCondition=Normal} con
soporte=0.539 y confidence=0.83
```

Estas reglas, entre otras, tuvieron el mayor nivel de confianza y soporte. Es interesante notar que unas propiedades que parecen no tener relación, dependen una de la otra para suceder.

Discusión y conclusiones

El data set presentaba 79 variables que contenían información de casas con el propósito de predecir mejor el precio de venta. De estas 79 variables, la mayoría eran de tipo cualitativa. Algunos ejemplos de gráficos de estas variables cualitativas mostraban la proporción o cantidad de datos para esa variable. Por ejemplo, el mes de venta indica que los meses con mayor cantidad de casas vendidas fueron junio y julio. Para las variables cualitativas se utilizaron gráficos de barra, de pie, de proporción y tablas de frecuencia. Por otro lado, en las variables cuantitativas, se utilizaron histogramas, diagrama de caja y bigotes, gráfico de dispersión y gráfico de correlación. Un resultado interesante, por ejemplo, es que GrLivArea y SalePrice presentan una relación lineal. Es importante notar que existen diferentes gráficos para las variables cuantitativas y las cualitativas.

En el análisis de componentes principales, primero se debe analizar si es posible utilizar la técnica de análisis factorial para formar las combinaciones lineales. Para ello, se debe obtener el KMO y el test de Bartlett. En este caso ambos resultados fueron elevados, 0.78 y 6359.1 respectivamente, por lo que sí valía la pena aplicar los componentes principales. Al obtener la matriz de correlación, se notó que las variables que afectan fuertemente al SalePrice son GrLivArea, GarageArea, X1stFlrSF y TotalBsmtSF. Luego, al aplicar los componentes principales, los resultados en sí no son claros. Se tuvieron que normalizar estos datos y obtener la importancia de cada componente principal. Además, se realizaron dos gráficos para determinar la cantidad de componentes que puedan explicar la mayor variabilidad.

Por último, para las reglas de asociación se tomaron en cuenta las variables que representaban una categoría definida. Se utilizó un nivel de confianza de 0.7 y un nivel mínimo de soporte de 0.2. Aunque se obtuvieron bastantes reglas de asociación, las más interesantes fueron las que tuvieron el mayor nivel de confianza y soporte. Como se ha mencionado, al ver las reglas en general, se observó que aunque unas propiedades parecieran no tener relación, dependen una de la otra para suceder.

Se concluye finalmente que a partir de este análisis exploratorio, se deben limpiar los datos, dejar los más importantes, y eliminar correlaciones innecesarias. Existen varias columnas numéricas que contienen muchos NA representados como 0, por lo que hay que tenerlo en consideración al crear una relación numérica con esas columnas. También se debe eliminar la columna de Alley, ya que esta tiene como valor NA para casi todas las filas por lo que no es útil para el análisis.