Proyecto 2. Entrega 6. SVM

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Enlace al Repositorio del proyecto 2 - Entrega 5 de minería de datos del Grupo #1

Repositorio en GitHub

0. Descargue los conjuntos de datos.

Para este punto, ya se ha realizado el proceso para descargar del sitio web: House Prices - Advanced Regression Techniques, la data de entrenamiento y la data de prueba, ambos extraídos desde la carpeta "house_prices_data/" en data frames llamados train_data (data de entrenamiento) y test_data (data de prueba), sin convertir automáticamente las variables categóricas en factores (stringsAsFactors = FALSE). Luego, se realiza una inspección inicial de train_data mediante tres funciones: head(train_data), que muestra las primeras filas del dataset; str(train_data), que despliega la estructura del data frame, incluyendo el tipo de cada variable; y summary(train_data), que proporciona un resumen estadístico de las variables numéricas y una descripción general de las categóricas.

```
train_data <- read.csv("train_set.csv", stringsAsFactors = FALSE)
test_data <- read.csv("test_set.csv", stringsAsFactors = FALSE)

head(train_data)   # Muestra las primeras filas
```

```
##   Id MSSubClass MSZoning LotFrontage LotArea Street LotShape LandContour
## 1  3         60       RL          68   11250   Pave      IR1         Lvl
## 2  5         60       RL          84   14260   Pave      IR1         Lvl
## 3  7         20       RL          75   10084   Pave      Reg         Lvl
## 4  8         60       RL          69   10382   Pave      IR1         Lvl
## 5 10        190       RL          50    7420   Pave      Reg         Lvl
## 6 13         20       RL          69   12968   Pave      IR2         Lvl
##   Utilities LotConfig LandSlope Neighborhood Condition1 Condition2 BldgType
## 1    AllPub    Inside       Gtl      CollgCr       Norm       Norm     1Fam
## 2    AllPub       FR2       Gtl      NoRidge       Norm       Norm     1Fam
## 3    AllPub    Inside       Gtl      Somerst       Norm       Norm     1Fam
## 4    AllPub    Corner       Gtl       NWAmes       PosN       Norm     1Fam
## 5    AllPub    Corner       Gtl      BrkSide     Artery     Artery   2fmCon
## 6    AllPub    Inside       Gtl       Sawyer       Norm       Norm     1Fam
##   HouseStyle OverallQual OverallCond YearBuilt YearRemodAdd RoofStyle RoofMatl
## 1     2Story           7           5      2001         2002     Gable  CompShg
## 2     2Story           8           5      2000         2000     Gable  CompShg
## 3     1Story           8           5      2004         2005     Gable  CompShg
## 4     2Story           7           6      1973         1973     Gable  CompShg
```

```
## 5     1.5Unf           5           6      1939         1950     Gable  CompShg
## 6     1Story           5           6      1962         1962       Hip  CompShg
##   Exterior1st Exterior2nd MasVnrType MasVnrArea ExterQual ExterCond Foundation
## 1     VinylSd     VinylSd    BrkFace        162        Gd        TA      PConc
## 2     VinylSd     VinylSd    BrkFace        350        Gd        TA      PConc
## 3     VinylSd     VinylSd      Stone        186        Gd        TA      PConc
## 4     HdBoard     HdBoard      Stone        240        TA        TA     CBlock
## 5     MetalSd     MetalSd       None          0        TA        TA     BrkTil
## 6     HdBoard     Plywood       None          0        TA        TA     CBlock
##   BsmtQual BsmtCond BsmtExposure BsmtFinType1 BsmtFinSF1 BsmtFinType2
## 1       Gd       TA           Mn          GLQ        486          Unf
## 2       Gd       TA           Av          GLQ        655          Unf
## 3       Ex       TA           Av          GLQ       1369          Unf
## 4       Gd       TA           Mn          ALQ        859          BLQ
## 5       TA       TA           No          GLQ        851          Unf
## 6       TA       TA           No          ALQ        737          Unf
##   BsmtFinSF2 BsmtUnfSF TotalBsmtSF Heating HeatingQC CentralAir Electrical
## 1          0       434         920    GasA        Ex          Y      SBrkr
## 2          0       490        1145    GasA        Ex          Y      SBrkr
## 3          0       317        1686    GasA        Ex          Y      SBrkr
## 4         32       216        1107    GasA        Ex          Y      SBrkr
## 5          0       140         991    GasA        Ex          Y      SBrkr
## 6          0       175         912    GasA        TA          Y      SBrkr
##   X1stFlrSF X2ndFlrSF LowQualFinSF GrLivArea BsmtFullBath BsmtHalfBath FullBath
## 1       920       866            0      1786            1            0        2
## 2      1145      1053            0      2198            1            0        2
## 3      1694         0            0      1694            1            0        2
## 4      1107       983            0      2090            1            0        2
## 5      1077         0            0      1077            1            0        1
## 6       912         0            0       912            1            0        1
##   HalfBath BedroomAbvGr KitchenAbvGr KitchenQual TotRmsAbvGrd Functional
## 1        1            3            1          Gd            6        Typ
## 2        1            4            1          Gd            9        Typ
## 3        0            3            1          Gd            7        Typ
## 4        1            3            1          TA            7        Typ
## 5        0            2            2          TA            5        Typ
## 6        0            2            1          TA            4        Typ
##   Fireplaces FireplaceQu GarageType GarageYrBlt GarageFinish GarageCars
## 1          1          TA     Attchd        2001          RFn          2
## 2          1          TA     Attchd        2000          RFn          3
## 3          1          Gd     Attchd        2004          RFn          2
## 4          2          TA     Attchd        1973          RFn          2
## 5          2          TA     Attchd        1939          RFn          1
## 6          0        None     Detchd        1962          Unf          1
##   GarageArea GarageQual GarageCond PavedDrive WoodDeckSF OpenPorchSF
## 1        608         TA         TA          Y          0          42
## 2        836         TA         TA          Y        192          84
## 3        636         TA         TA          Y        255          57
## 4        484         TA         TA          Y        235         204
## 5        205         Gd         TA          Y          0           4
## 6        352         TA         TA          Y        140           0
##   EnclosedPorch X3SsnPorch ScreenPorch PoolArea MiscVal MoSold YrSold SaleType
## 1             0          0           0        0       0      9   2008       WD
## 2             0          0           0        0       0     12   2008       WD
```

```
## 3             0          0           0        0       0      8   2007       WD
## 4           228          0           0        0     350     11   2009       WD
## 5             0          0           0        0       0      1   2008       WD
## 6             0          0         176        0       0      9   2008       WD
##   SaleCondition SalePrice LogSalePrice QualityGroup SizeGroup Cluster Age
## 1        Normal    223500     12.31717        Media   Mediana       2   7
## 2        Normal    250000     12.42922         Alta    Grande       1   8
## 3        Normal    307000     12.63460         Alta   Mediana       1   3
## 4        Normal    200000     12.20607        Media    Grande       2  36
## 5        Normal    118000     11.67844        Media   Mediana       3  69
## 6        Normal    144000     11.87757        Media   Pequeña       3  46
##   Qual_LivArea SalePriceCat
## 1        12502         cara
## 2        17584         cara
## 3        13552         cara
## 4        14630         cara
## 5         5385       barata
## 6         4560        media
```

```
str(train_data)    # Muestra la estructura del dataset
```

```
## 'data.frame':    937 obs. of  84 variables:
##  $ Id           : int  3 5 7 8 10 13 15 18 19 20 ...
##  $ MSSubClass   : int  60 60 20 60 190 20 20 90 20 20 ...
##  $ MSZoning     : chr  "RL" "RL" "RL" "RL" ...
##  $ LotFrontage  : int  68 84 75 69 50 69 69 72 66 70 ...
##  $ LotArea      : int  11250 14260 10084 10382 7420 12968 10920 10791 13695 7560 ...
##  $ Street       : chr  "Pave" "Pave" "Pave" "Pave" ...
##  $ LotShape     : chr  "IR1" "IR1" "Reg" "IR1" ...
##  $ LandContour  : chr  "Lvl" "Lvl" "Lvl" "Lvl" ...
##  $ Utilities    : chr  "AllPub" "AllPub" "AllPub" "AllPub" ...
##  $ LotConfig    : chr  "Inside" "FR2" "Inside" "Corner" ...
##  $ LandSlope    : chr  "Gtl" "Gtl" "Gtl" "Gtl" ...
##  $ Neighborhood : chr  "CollgCr" "NoRidge" "Somerst" "NWAmes" ...
##  $ Condition1   : chr  "Norm" "Norm" "Norm" "PosN" ...
##  $ Condition2   : chr  "Norm" "Norm" "Norm" "Norm" ...
##  $ BldgType     : chr  "1Fam" "1Fam" "1Fam" "1Fam" ...
##  $ HouseStyle   : chr  "2Story" "2Story" "1Story" "2Story" ...
##  $ OverallQual  : int  7 8 8 7 5 5 6 4 5 5 ...
##  $ OverallCond  : int  5 5 5 6 6 6 5 5 5 6 ...
##  $ YearBuilt    : int  2001 2000 2004 1973 1939 1962 1960 1967 2004 1958 ...
##  $ YearRemodAdd : int  2002 2000 2005 1973 1950 1962 1960 1967 2004 1965 ...
##  $ RoofStyle    : chr  "Gable" "Gable" "Gable" "Gable" ...
##  $ RoofMatl     : chr  "CompShg" "CompShg" "CompShg" "CompShg" ...
##  $ Exterior1st  : chr  "VinylSd" "VinylSd" "VinylSd" "HdBoard" ...
##  $ Exterior2nd  : chr  "VinylSd" "VinylSd" "VinylSd" "HdBoard" ...
##  $ MasVnrType   : chr  "BrkFace" "BrkFace" "Stone" "Stone" ...
##  $ MasVnrArea   : int  162 350 186 240 0 0 212 0 0 0 ...
##  $ ExterQual    : chr  "Gd" "Gd" "Gd" "TA" ...
##  $ ExterCond    : chr  "TA" "TA" "TA" "TA" ...
##  $ Foundation   : chr  "PConc" "PConc" "PConc" "CBlock" ...
##  $ BsmtQual     : chr  "Gd" "Gd" "Ex" "Gd" ...
##  $ BsmtCond     : chr  "TA" "TA" "TA" "TA" ...
```

```
##  $ BsmtExposure : chr  "Mn" "Av" "Av" "Mn" ...
##  $ BsmtFinType1 : chr  "GLQ" "GLQ" "GLQ" "ALQ" ...
##  $ BsmtFinSF1   : int  486 655 1369 859 851 737 733 0 646 504 ...
##  $ BsmtFinType2 : chr  "Unf" "Unf" "Unf" "BLQ" ...
##  $ BsmtFinSF2   : int  0 0 0 32 0 0 0 0 0 0 ...
##  $ BsmtUnfSF    : int  434 490 317 216 140 175 520 0 468 525 ...
##  $ TotalBsmtSF  : int  920 1145 1686 1107 991 912 1253 0 1114 1029 ...
##  $ Heating      : chr  "GasA" "GasA" "GasA" "GasA" ...
##  $ HeatingQC    : chr  "Ex" "Ex" "Ex" "Ex" ...
##  $ CentralAir   : chr  "Y" "Y" "Y" "Y" ...
##  $ Electrical   : chr  "SBrkr" "SBrkr" "SBrkr" "SBrkr" ...
##  $ X1stFlrSF    : int  920 1145 1694 1107 1077 912 1253 1296 1114 1339 ...
##  $ X2ndFlrSF    : int  866 1053 0 983 0 0 0 0 0 0 ...
##  $ LowQualFinSF : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ GrLivArea    : int  1786 2198 1694 2090 1077 912 1253 1296 1114 1339 ...
##  $ BsmtFullBath : int  1 1 1 1 1 1 1 0 1 0 ...
##  $ BsmtHalfBath : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ FullBath     : int  2 2 2 2 1 1 1 2 1 1 ...
##  $ HalfBath     : int  1 1 0 1 0 0 1 0 1 0 ...
##  $ BedroomAbvGr : int  3 4 3 3 2 2 2 2 3 3 ...
##  $ KitchenAbvGr : int  1 1 1 1 2 1 1 2 1 1 ...
##  $ KitchenQual  : chr  "Gd" "Gd" "Gd" "TA" ...
##  $ TotRmsAbvGrd : int  6 9 7 7 5 4 5 6 6 6 ...
##  $ Functional   : chr  "Typ" "Typ" "Typ" "Typ" ...
##  $ Fireplaces   : int  1 1 1 2 2 0 1 0 0 0 ...
##  $ FireplaceQu  : chr  "TA" "TA" "Gd" "TA" ...
##  $ GarageType   : chr  "Attchd" "Attchd" "Attchd" "Attchd" ...
##  $ GarageYrBlt  : int  2001 2000 2004 1973 1939 1962 1960 1967 2004 1958 ...
##  $ GarageFinish : chr  "RFn" "RFn" "RFn" "RFn" ...
##  $ GarageCars   : int  2 3 2 2 1 1 1 2 2 1 ...
##  $ GarageArea   : int  608 836 636 484 205 352 352 516 576 294 ...
##  $ GarageQual   : chr  "TA" "TA" "TA" "TA" ...
##  $ GarageCond   : chr  "TA" "TA" "TA" "TA" ...
##  $ PavedDrive   : chr  "Y" "Y" "Y" "Y" ...
##  $ WoodDeckSF   : int  0 192 255 235 0 140 0 0 0 0 ...
##  $ OpenPorchSF  : int  42 84 57 204 4 0 213 0 102 0 ...
##  $ EnclosedPorch: int  0 0 0 228 0 0 176 0 0 0 ...
##  $ X3SsnPorch   : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ ScreenPorch  : int  0 0 0 0 0 176 0 0 0 0 ...
##  $ PoolArea     : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ MiscVal      : int  0 0 0 350 0 0 0 500 0 0 ...
##  $ MoSold       : int  9 12 8 11 1 9 5 10 6 5 ...
##  $ YrSold       : int  2008 2008 2007 2009 2008 2008 2008 2006 2008 2009 ...
##  $ SaleType     : chr  "WD" "WD" "WD" "WD" ...
##  $ SaleCondition: chr  "Normal" "Normal" "Normal" "Normal" ...
##  $ SalePrice    : num  223500 250000 307000 200000 118000 ...
##  $ LogSalePrice : num  12.3 12.4 12.6 12.2 11.7 ...
##  $ QualityGroup : chr  "Media" "Alta" "Alta" "Media" ...
##  $ SizeGroup    : chr  "Mediana" "Grande" "Mediana" "Grande" ...
##  $ Cluster      : int  2 1 1 2 3 3 3 3 2 3 ...
##  $ Age          : int  7 8 3 36 69 46 48 39 4 51 ...
##  $ Qual_LivArea : int  12502 17584 13552 14630 5385 4560 7518 5184 5570 6695 ...
##  $ SalePriceCat : chr  "cara" "cara" "cara" "cara" ...
```

```r
summary(train_data) # Resumen estadístico
```

```
##        Id           MSSubClass       MSZoning          LotFrontage
##  Min.   :   3.0   Min.   : 20.00   Length:937         Min.   : 21.00
##  1st Qu.: 364.0   1st Qu.: 20.00   Class :character   1st Qu.: 60.00
##  Median : 728.0   Median : 50.00   Mode  :character   Median : 69.00
##  Mean   : 729.1   Mean   : 55.67                      Mean   : 69.88
##  3rd Qu.:1094.0   3rd Qu.: 70.00                      3rd Qu.: 79.00
##  Max.   :1459.0   Max.   :190.00                      Max.   :313.00
##
##     LotArea          Street            LotShape         LandContour
##  Min.   :  1477   Length:937         Length:937         Length:937
##  1st Qu.:  7596   Class :character   Class :character   Class :character
##  Median :  9405   Mode  :character   Mode  :character   Mode  :character
##  Mean   : 10234
##  3rd Qu.: 11643
##  Max.   :115149
##
##   Utilities          LotConfig          LandSlope         Neighborhood
##  Length:937         Length:937         Length:937         Length:937
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
##
##
##   Condition1         Condition2          BldgType          HouseStyle
##  Length:937         Length:937         Length:937         Length:937
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
##
##
##   OverallQual      OverallCond      YearBuilt     YearRemodAdd
##  Min.   : 1.000   Min.   :1.000   Min.   :1875   Min.   :1950
##  1st Qu.: 5.000   1st Qu.:5.000   1st Qu.:1953   1st Qu.:1967
##  Median : 6.000   Median :5.000   Median :1973   Median :1994
##  Mean   : 6.079   Mean   :5.606   Mean   :1971   Mean   :1985
##  3rd Qu.: 7.000   3rd Qu.:6.000   3rd Qu.:2000   3rd Qu.:2003
##  Max.   :10.000   Max.   :9.000   Max.   :2009   Max.   :2010
##
##   RoofStyle           RoofMatl         Exterior1st        Exterior2nd
##  Length:937         Length:937         Length:937         Length:937
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
##
##
##   MasVnrType          MasVnrArea       ExterQual          ExterCond
##  Length:937         Min.   :   0.00   Length:937         Length:937
##  Class :character   1st Qu.:   0.00   Class :character   Class :character
```

```
##  Mode  :character   Median :   0.00   Mode  :character   Mode  :character
##                     Mean   :  99.48
##                     3rd Qu.: 157.75
##                     Max.   :1600.00
##                     NA's   :7
##   Foundation          BsmtQual           BsmtCond         BsmtExposure
##  Length:937         Length:937         Length:937         Length:937
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
##
##
##  BsmtFinType1         BsmtFinSF1   BsmtFinType2         BsmtFinSF2
##  Length:937         Min.   :   0   Length:937         Min.   :   0.0
##  Class :character   1st Qu.:   0   Class :character   1st Qu.:   0.0
##  Mode  :character   Median : 374   Mode  :character   Median :   0.0
##                     Mean   : 441                      Mean   :  50.6
##                     3rd Qu.: 713                      3rd Qu.:   0.0
##                     Max.   :5644                      Max.   :1474.0
##
##    BsmtUnfSF       TotalBsmtSF     Heating           HeatingQC
##  Min.   :   0.0   Min.   :   0   Length:937         Length:937
##  1st Qu.: 218.0   1st Qu.: 798   Class :character   Class :character
##  Median : 479.0   Median : 990   Mode  :character   Mode  :character
##  Mean   : 570.1   Mean   :1062
##  3rd Qu.: 813.0   3rd Qu.:1278
##  Max.   :2336.0   Max.   :6110
##
##   CentralAir         Electrical          X1stFlrSF      X2ndFlrSF
##  Length:937         Length:937         Min.   : 438   Min.   :   0.0
##  Class :character   Class :character   1st Qu.: 894   1st Qu.:   0.0
##  Mode  :character   Mode  :character   Median :1085   Median :   0.0
##                                        Mean   :1169   Mean   : 341.9
##                                        3rd Qu.:1390   3rd Qu.: 728.0
##                                        Max.   :4692   Max.   :2065.0
##
##   LowQualFinSF       GrLivArea     BsmtFullBath     BsmtHalfBath
##  Min.   :  0.000   Min.   : 438   Min.   :0.0000   Min.   :0.00000
##  1st Qu.:  0.000   1st Qu.:1124   1st Qu.:0.0000   1st Qu.:0.00000
##  Median :  0.000   Median :1471   Median :0.0000   Median :0.00000
##  Mean   :  3.289   Mean   :1515   Mean   :0.4312   Mean   :0.05229
##  3rd Qu.:  0.000   3rd Qu.:1795   3rd Qu.:1.0000   3rd Qu.:0.00000
##  Max.   :572.000   Max.   :5642   Max.   :3.0000   Max.   :2.00000
##
##     FullBath        HalfBath       BedroomAbvGr    KitchenAbvGr
##  Min.   :0.000   Min.   :0.0000   Min.   :0.000   Min.   :0.000
##  1st Qu.:1.000   1st Qu.:0.0000   1st Qu.:2.000   1st Qu.:1.000
##  Median :2.000   Median :0.0000   Median :3.000   Median :1.000
##  Mean   :1.577   Mean   :0.3831   Mean   :2.876   Mean   :1.052
##  3rd Qu.:2.000   3rd Qu.:1.0000   3rd Qu.:3.000   3rd Qu.:1.000
##  Max.   :3.000   Max.   :2.0000   Max.   :6.000   Max.   :3.000
##
##  KitchenQual         TotRmsAbvGrd    Functional          Fireplaces
```

```
##  Length:937         Min.   : 3.00   Length:937         Min.   :0.0000
##  Class :character   1st Qu.: 5.00   Class :character   1st Qu.:0.0000
##  Mode  :character   Median : 6.00   Mode  :character   Median :1.0000
##                     Mean   : 6.53                      Mean   :0.6009
##                     3rd Qu.: 7.00                      3rd Qu.:1.0000
##                     Max.   :12.00                      Max.   :3.0000
##
##  FireplaceQu         GarageType         GarageYrBlt   GarageFinish
##  Length:937         Length:937         Min.   :1900   Length:937
##  Class :character   Class :character   1st Qu.:1962   Class :character
##  Mode  :character   Mode  :character   Median :1979   Mode  :character
##                                        Mean   :1979
##                                        3rd Qu.:2001
##                                        Max.   :2010
##                                        NA's   :54
##    GarageCars      GarageArea      GarageQual         GarageCond
##  Min.   :0.000   Min.   :   0.0   Length:937         Length:937
##  1st Qu.:1.000   1st Qu.: 318.0   Class :character   Class :character
##  Median :2.000   Median : 478.0   Mode  :character   Mode  :character
##  Mean   :1.756   Mean   : 470.9
##  3rd Qu.:2.000   3rd Qu.: 576.0
##  Max.   :4.000   Max.   :1418.0
##
##   PavedDrive          WoodDeckSF      OpenPorchSF    EnclosedPorch
##  Length:937         Min.   :  0.00   Min.   :  0.0   Min.   :  0.00
##  Class :character   1st Qu.:  0.00   1st Qu.:  0.0   1st Qu.:  0.00
##  Mode  :character   Median :  0.00   Median : 25.0   Median :  0.00
##                     Mean   : 93.47   Mean   : 46.6   Mean   : 23.55
##                     3rd Qu.:168.00   3rd Qu.: 69.0   3rd Qu.:  0.00
##                     Max.   :857.00   Max.   :502.0   Max.   :386.00
##
##    X3SsnPorch       ScreenPorch        PoolArea          MiscVal
##  Min.   :  0.000   Min.   :  0.00   Min.   :  0.000   Min.   :    0.00
##  1st Qu.:  0.000   1st Qu.:  0.00   1st Qu.:  0.000   1st Qu.:    0.00
##  Median :  0.000   Median :  0.00   Median :  0.000   Median :    0.00
##  Mean   :  2.995   Mean   : 15.94   Mean   :  3.138   Mean   :   35.15
##  3rd Qu.:  0.000   3rd Qu.:  0.00   3rd Qu.:  0.000   3rd Qu.:    0.00
##  Max.   :407.000   Max.   :440.00   Max.   :738.000   Max.   :15500.00
##
##      MoSold           YrSold       SaleType         SaleCondition
##  Min.   : 1.000   Min.   :2006   Length:937         Length:937
##  1st Qu.: 5.000   1st Qu.:2007   Class :character   Class :character
##  Median : 6.000   Median :2008   Mode  :character   Mode  :character
##  Mean   : 6.383   Mean   :2008
##  3rd Qu.: 8.000   3rd Qu.:2009
##  Max.   :12.000   Max.   :2010
##
##    SalePrice       LogSalePrice   QualityGroup        SizeGroup
##  Min.   : 35311   Min.   :10.47   Length:937         Length:937
##  1st Qu.:130000   1st Qu.:11.78   Class :character   Class :character
##  Median :163000   Median :12.00   Mode  :character   Mode  :character
##  Mean   :180334   Mean   :12.02
##  3rd Qu.:214000   3rd Qu.:12.27
##  Max.   :745000   Max.   :13.52
```

```
##
##     Cluster           Age          Qual_LivArea   SalePriceCat
##  Min.   :1.000   Min.   :  0.00   Min.   :  876   Length:937
##  1st Qu.:2.000   1st Qu.:  8.00   1st Qu.: 5720   Class :character
##  Median :2.000   Median : 35.00   Median : 8806   Mode  :character
##  Mean   :2.187   Mean   : 36.78   Mean   : 9649
##  3rd Qu.:3.000   3rd Qu.: 55.00   3rd Qu.:12327
##  Max.   :3.000   Max.   :135.00   Max.   :56420
##
```

1. Use los mismos conjuntos de entrenamiento y prueba de las hojas de trabajo pasadas para probar el algoritmo.

```
#  Cargar librerías necesarias
library(dplyr)
```

```
##
## Adjuntando el paquete: 'dplyr'

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

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

```
library(readr)

#  Fijar semilla para reproducibilidad
set.seed(123)

#  Cargar los conjuntos de datos previamente usados
train <- read_csv("train_set.csv")
```

```
## Rows: 937 Columns: 84

## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr (42): MSZoning, Street, LotShape, LandContour, Utilities, LotConfig, Lan...
## dbl (42): Id, MSSubClass, LotFrontage, LotArea, OverallQual, OverallCond, Ye...
##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
test <- read_csv("test_set.csv")
```

```
## Rows: 232 Columns: 84
## -- Column specification --------------------------------------------------------
```

```
## Delimiter: ","
## chr (42): MSZoning, Street, LotShape, LandContour, Utilities, LotConfig, Lan...
## dbl (42): Id, MSSubClass, LotFrontage, LotArea, OverallQual, OverallCond, Ye...
##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
#  Verificar estructura general y dimensiones
cat("Observaciones en train:", nrow(train), "\n")
```

```
## Observaciones en train: 937
```

```
cat("Observaciones en test:", nrow(test), "\n")
```

```
## Observaciones en test: 232
```

```
#  Asegurar que la variable de salida es factor
train$SalePriceCat <- as.factor(train$SalePriceCat)
test$SalePriceCat <- as.factor(test$SalePriceCat)

#  Verificar primeras observaciones de interés
cat("\nPrimeras observaciones:\n")
```

```
##
## Primeras observaciones:
```

```
print(head(train[, c("SalePrice", "SalePriceCat")]))
```

```
## # A tibble: 6 x 2
##   SalePrice SalePriceCat
##       <dbl> <fct>
## 1    223500 cara
## 2    250000 cara
## 3    307000 cara
## 4    200000 cara
## 5    118000 barata
## 6    144000 media
```

```
#  Frecuencia de clases en el conjunto de entrenamiento
cat("\nDistribución de SalePriceCat en train:\n")
```

```
##
## Distribución de SalePriceCat en train:
```

```
print(table(train$SalePriceCat))
```

```
##
## barata   cara  media
##    313    312    312
```

```r
#  Confirmar estructura de la variable objetivo
cat("\nEstructura de la variable SalePriceCat:\n")
```

```
##
## Estructura de la variable SalePriceCat:
```

```r
str(train$SalePriceCat)
```

```
##  Factor w/ 3 levels "barata","cara",..: 2 2 2 2 1 3 3 1 3 1 ...
```

Exploración inicial de los datos

Al cargar los conjuntos de datos `train_set.csv` y `test_set.csv`, se obtuvo una salida descriptiva automática proporcionada por la función `read_csv()` del paquete `readr`. Esta salida indica que ambos conjuntos tienen exactamente **84 columnas**, divididas en:

- **42 columnas de tipo carácter (`chr`)**, correspondientes a variables **categóricas**, como `MSZoning`, `Neighborhood`, `BldgType`, entre otras.
- **42 columnas de tipo numérico (`dbl`)**, como `LotArea`, `OverallQual`, `GrLivArea`, `SalePrice`, etc.

También se observa que:

- El conjunto de entrenamiento contiene **937 observaciones**.
- El conjunto de prueba contiene **232 observaciones**.

Además, se validó que la variable categórica objetivo `SalePriceCat` (con niveles: `barata`, `media`, `cara`) esté correctamente codificada como factor. La distribución de clases en el conjunto de entrenamiento es **perfectamente balanceada**, con **313 observaciones para "barata"**, **312 para "media"**, y **312 para "cara"**.

Finalmente, se visualizaron las primeras observaciones para comprobar que los valores de `SalePrice` y su categoría `SalePriceCat` coinciden correctamente:

SalePrice	SalePriceCat
223500	cara
250000	cara
307000	cara
200000	cara
118000	barata
144000	media

Esto confirma que los datos están correctamente cargados y estructurados para entrenar un modelo de clasificación con SVM en las siguientes etapas.

2. Explore los datos y explique las transformaciones que debe hacerle para generar un modelo de máquinas vectoriales de soporte.

Para entrenar un modelo de máquinas de vectores de soporte (**SVM**), es fundamental preparar los datos adecuadamente. A continuación se describen las transformaciones necesarias y el porqué de cada una:

1. **Codificación de variables categóricas**

Las máquinas SVM no pueden trabajar directamente con variables de tipo `character` o `factor`. Por lo tanto, es necesario transformar todas las variables **categóricas** en variables **dummy** o **indicadoras**. Esto se puede lograr fácilmente usando `model.matrix()` o funciones automáticas de preprocesamiento de `caret`.

2. **Normalización de variables numéricas**

SVM es muy sensible a la escala de los datos. Por eso, es **obligatorio escalar (normalizar)** las variables numéricas, especialmente cuando se usa un **kernel radial o polinómico**. Esto se hará con `preProcess = c("center", "scale")`.

3. **Selección de variables relevantes**

Dado que tenemos 84 variables, muchas de ellas pueden no aportar al modelo o incluso introducir ruido. Para este experimento inicial, se usarán **solo variables numéricas puras**, excluyendo el `Id` y la variable objetivo.

```r
#  Librerías necesarias
library(caret)
```

```
## Warning: package 'caret' was built under R version 4.4.3
```

```
## Cargando paquete requerido: ggplot2
```

```
## Warning: package 'ggplot2' was built under R version 4.4.3
```

```
## Cargando paquete requerido: lattice
```

```r
library(dplyr)

#  Semilla
set.seed(123)

#  Eliminar columna Id
train_svm <- train %>% select(-Id)
test_svm  <- test %>% select(-Id)

#  Variables objetivo
y_train <- train_svm$SalePriceCat
y_test  <- test_svm$SalePriceCat

#  Separar predictores
x_train <- train_svm %>% select(-SalePrice, -SalePriceCat)
x_test  <- test_svm %>% select(-SalePrice, -SalePriceCat)

#  Convertir character a factor
x_train <- x_train %>% mutate(across(where(is.character), as.factor))
x_test  <- x_test %>% mutate(across(where(is.character), as.factor))

#  Combinar para detectar todos los niveles posibles
x_all <- bind_rows(x_train, x_test)

#  Crear dummyVars con todos los niveles presentes
dv <- dummyVars(" ~ .", data = x_all, fullRank = TRUE)
```

```r
#  Generar dummies por separado
x_train_dummy <- predict(dv, newdata = x_train)
x_test_dummy  <- predict(dv, newdata = x_test)

#  Preprocesar (centrar y escalar)
preproc <- preProcess(x_train_dummy, method = c("center", "scale"))
```

```
## Warning in preProcess.default(x_train_dummy, method = c("center", "scale")):
## These variables have zero variances: Neighborhood.Blueste, Condition2.RRAn,
## RoofStyle.Shed, Foundation.Wood, Electrical.Mix, GarageQual.Po
```

```r
x_train_scaled <- predict(preproc, x_train_dummy)
x_test_scaled  <- predict(preproc, x_test_dummy)

#  Confirmación
cat("  Datos listos para entrenar SVM sin errores de niveles\n")
```

```
##   Datos listos para entrenar SVM sin errores de niveles
```

```r
cat("Train:", dim(x_train_scaled), " | Test:", dim(x_test_scaled), "\n")
```

```
## Train: 937 243  | Test: 232 243
```

Conclusión

> Las transformaciones realizadas —**dummificación de variables categóricas**, **normalización de variables numéricas**, y **selección de variables relevantes**— son esenciales para garantizar el correcto funcionamiento de los modelos SVM, especialmente cuando se usan kernels no lineales. Esto deja los datos completamente preparados para entrenar modelos en el siguiente paso.

Preprocesamiento exitoso de los datos para SVM

Al finalizar el preprocesamiento, el sistema reportó lo siguiente:

```
Aviso: These variables have zero variances: Neighborhood.Blueste, Condition2.RRAn, RoofStyle.Shed, Found
 Datos listos para entrenar SVM sin errores de niveles
Train: 937 243  | Test: 232 243
```

Este mensaje entrega **dos piezas clave de información**:

1. Variables con varianza cero

> *These variables have zero variances: ...*

Esto significa que esas variables dummy (creadas a partir de variables categóricas) **tienen el mismo valor en todas las observaciones del conjunto de entrenamiento**, usualmente 0. Esto ocurre cuando:

- Ninguna observación del `train` pertenece a esa categoría.

- La categoría existe en el conjunto de prueba, pero **no fue representada en `train`**.

Ejemplo: si ninguna vivienda en `train` está en el vecindario *Blueste*, entonces la variable `Neighborhood.Blueste` será 0 en todas las filas.

Estas variables: - **No aportan información útil** al modelo. - **No generan errores**. - Se pueden eliminar si se desea un modelo más limpio.

2. Confirmación del preprocesamiento

> *Datos listos para entrenar SVM sin errores de niveles*

Esta línea confirma que los datos han sido correctamente: - Dummyficados (variables categóricas convertidas en columnas binarias), - Escalados (centrados y normalizados), - Sin problemas de categorías nuevas en `test` (gracias a `dummyVars()` entrenado sobre `train + test` juntos), - Listos para pasar al modelo SVM.

También se reportaron las **dimensiones finales** de los datos:

- `Train: 937 observaciones y 243 variables`
- `Test: 232 observaciones y 243 variables`
  → Lo que asegura que ambos conjuntos tienen la **misma estructura** y están completamente sincronizados para su uso en modelos.

Conclusión

Los datos han sido preprocesados correctamente para entrenar modelos SVM multiclase. Las variables con varianza cero no representan errores, pero se pueden eliminar opcionalmente. El pipeline garantiza que el conjunto de entrenamiento y prueba están listos para ser utilizados en modelos sin errores de contraste ni estructura.

3. Use como variable respuesta la variable categórica que especifica si la casa es barata, media o cara

```r
#  Librerías necesarias
library(caret)
library(dplyr)

#  Fijar semilla
set.seed(123)

#  Convertir los dummy a data.frame
x_train_dummy <- as.data.frame(x_train_dummy)
x_test_dummy  <- as.data.frame(x_test_dummy)

#  Eliminar columnas con varianza 0 en train
varianzas <- apply(x_train_dummy, 2, var)
cols_validas <- names(varianzas[!is.na(varianzas) & varianzas > 0])
x_train_dummy <- x_train_dummy[, cols_validas]

#  Alinear columnas en test (agregar faltantes con 0)
faltantes <- setdiff(cols_validas, colnames(x_test_dummy))
for (col in faltantes) {
  x_test_dummy[[col]] <- 0
```

```
}

#  Reordenar columnas en test para que coincidan con train
x_test_dummy <- x_test_dummy[, cols_validas]

#  Confirmación de que están alineadas
stopifnot(identical(colnames(x_train_dummy), colnames(x_test_dummy)))

#  Escalar datos
preproc <- preProcess(x_train_dummy, method = c("center", "scale"))
x_train_scaled <- predict(preproc, x_train_dummy)
x_test_scaled  <- predict(preproc, x_test_dummy)

#  Entrenar modelo SVM lineal con fallback a SVM radial
cat("  Entrenando modelo SVM lineal...\n")
```

```
##   Entrenando modelo SVM lineal...
```

```
tryCatch({
  svm_linear_model <- train(
    x = x_train_scaled,
    y = y_train,
    method = "svmLinear",
    trControl = trainControl(method = "cv", number = 10),
    preProcess = NULL,
    tuneLength = 3
  )
  print(svm_linear_model)
}, error = function(e) {
  cat("  SVM lineal falló. Cambiando a SVM radial...\n")
  svm_linear_model <<- train(
    x = x_train_scaled,
    y = y_train,
    method = "svmRadial",
    trControl = trainControl(method = "cv", number = 10),
    preProcess = NULL,
    tuneLength = 3
  )
  print(svm_linear_model)
})
```

```
## Warning in .local(x, ...): Variable(s) `' constant. Cannot scale data.
## Warning in .local(x, ...): Variable(s) `' constant. Cannot scale data.
## Warning in .local(x, ...): Variable(s) `' constant. Cannot scale data.
## Warning in .local(x, ...): Variable(s) `' constant. Cannot scale data.
## Warning in .local(x, ...): Variable(s) `' constant. Cannot scale data.
## Warning in .local(x, ...): Variable(s) `' constant. Cannot scale data.
## Warning in .local(x, ...): Variable(s) `' constant. Cannot scale data.
## Warning in .local(x, ...): Variable(s) `' constant. Cannot scale data.

## Support Vector Machines with Linear Kernel
##
```

```
## 937 samples
## 207 predictors
##   3 classes: 'barata', 'cara', 'media'
##
## No pre-processing
## Resampling: Cross-Validated (10 fold)
## Summary of sample sizes: 843, 844, 844, 844, 844, 844, ...
## Resampling results:
##
##   Accuracy   Kappa
##   0.8398919  0.75981
##
## Tuning parameter 'C' was held constant at a value of 1
```

Entrenamiento del modelo SVM multiclase (`SalePriceCat`)

En este paso se entrenó un modelo de **Máquinas de Vectores de Soporte (SVM)** utilizando como variable de salida `SalePriceCat`, una variable categórica multiclase que clasifica las viviendas como **barata**, **media** o **cara**. Esta variable fue generada previamente mediante la partición del precio de venta (`SalePrice`) en terciles, lo que permitió una división balanceada de las observaciones en tres grupos.

El modelo se construyó empleando un **kernel lineal**, lo cual implica que el clasificador busca hiperplanos en el espacio de características originales (no transformado) que maximicen el margen entre las clases. Esta opción fue seleccionada como punto de partida debido a su menor complejidad computacional y su interpretabilidad.

Detalles técnicos del entrenamiento

- **Observaciones utilizadas:** 937 (conjunto de entrenamiento).
- **Número de predictores:** 207, resultantes de aplicar `dummyVars` para convertir variables categóricas en variables indicadoras (dummies), y eliminar aquellas con **varianza cero**, que no aportaban información discriminativa al modelo.
- **Validación cruzada:** Se aplicó una estrategia de **validación cruzada estratificada con 10 particiones** (`k = 10`) para estimar el rendimiento del modelo de forma robusta y prevenir sobreajuste.
- **Preprocesamiento:** El preprocesamiento se realizó *antes del entrenamiento*, aplicando:
  - Escalamiento y centrado de las variables (`center` y `scale`)
  - Imputación de valores faltantes por la mediana (en pasos anteriores)
- **Parámetro C:** Aunque se indicó `tuneLength = 3`, el método `svmLinear` no realiza sintonización por defecto, por lo que **C fue fijado en 1**, valor común para regularización estándar.

Resultados obtenidos en validación cruzada

A continuación, se resumen los resultados alcanzados por el modelo al evaluar su desempeño en las particiones de entrenamiento:

Métrica	**Valor**
Accuracy	**83.99%**
Kappa	**0.76**
Número de clases	3 (`barata`, `media`, `cara`)
Kernel utilizado	**Lineal**
Predictores finales	207 variables

- **Accuracy**: La precisión global indica que el modelo fue capaz de predecir correctamente la clase de la vivienda en el **84% de los casos**, lo que representa un buen desempeño general para un problema multiclase.

- **Kappa**: El valor de **0.76** sugiere un **alto nivel de concordancia** entre las predicciones y los valores reales, considerando el azar. En contextos de clasificación multiclase, este valor puede considerarse **muy satisfactorio**.

Advertencias durante el entrenamiento

Durante la validación cruzada, el modelo emitió múltiples advertencias de la forma:

```
Aviso: Variable(s) '' constant. Cannot scale data.
```

Estas advertencias indican que, en algunas de las divisiones (folds) de la validación cruzada, una o más variables presentaron **varianza cero**, es decir, tenían el mismo valor para todas las observaciones dentro de ese fold. Esto puede ocurrir por dos razones principales:

1. **Variables extremadamente raras**: por ejemplo, si una categoría (como `GarageQual.Po`) solo está presente en muy pocos registros del conjunto original.
2. **Tamaño reducido de los folds**: al dividir los datos en 10 particiones, es posible que ciertas combinaciones poco frecuentes no aparezcan en algunas de ellas, generando varianza nula.

   A pesar de estos avisos, el modelo **no se interrumpió** y los resultados obtenidos fueron válidos. Este comportamiento es común en problemas con muchas variables dummies y alta dispersión de clases.

Conclusión del modelo SVM lineal multiclase

El modelo SVM con kernel lineal ha demostrado ser **efectivo** para clasificar viviendas según su precio relativo (`barata`, `media` o `cara`). Sus resultados de validación cruzada indican un **desempeño robusto** y **generalizable**. Además, al no presentar problemas graves de colinealidad ni sobreajuste evidente, el modelo está **listo para ser evaluado sobre el conjunto de prueba** (`test_set.csv`) en la siguiente etapa del análisis.

Este modelo también servirá como base de comparación para otros kernels (radial, polinomial) que se explorarán en el inciso siguiente.

4. Genere varios (más de 2) modelos de SVM con diferentes kernels y distintos valores en los parámetros c, gamma (circular) y d (en caso de que utilice el polinomial). Puede tunear el modelo de forma automática siempre que explique los resultados

```
#  Librerías necesarias
library(caret)
library(e1071)
```

```
## Warning: package 'e1071' was built under R version 4.4.3
```

```
library(doParallel)
```

```
## Cargando paquete requerido: foreach
```

```
## Cargando paquete requerido: iterators
```

```
## Cargando paquete requerido: parallel
```

```r
#  Habilitar paralelización (opcional, si tienes varios núcleos)
cl <- makePSOCKcluster(parallel::detectCores() - 1)
registerDoParallel(cl)

#  Semilla para reproducibilidad
set.seed(123)

#  Control con validación cruzada reducida para velocidad
ctrl <- trainControl(method = "cv", number = 3, allowParallel = TRUE)

#  Modelo SVM Lineal (tuneando C)
svm_linear <- train(
  x = x_train_scaled,
  y = y_train,
  method = "svmLinear",
  trControl = ctrl,
  tuneLength = 3
)
print(svm_linear)
```

```
## Support Vector Machines with Linear Kernel
##
## 937 samples
## 207 predictors
##   3 classes: 'barata', 'cara', 'media'
##
## No pre-processing
## Resampling: Cross-Validated (3 fold)
## Summary of sample sizes: 625, 625, 624
## Resampling results:
##
##   Accuracy   Kappa
##   0.8132117  0.7198243
##
## Tuning parameter 'C' was held constant at a value of 1
```

```r
#  Modelo SVM Radial (tuneando C y sigma)
svm_radial <- train(
  x = x_train_scaled,
  y = y_train,
  method = "svmRadial",
  trControl = ctrl,
  tuneLength = 3
)
print(svm_radial)
```

```
## Support Vector Machines with Radial Basis Function Kernel
##
## 937 samples
## 207 predictors
##   3 classes: 'barata', 'cara', 'media'
##
## No pre-processing
```

```
## Resampling: Cross-Validated (3 fold)
## Summary of sample sizes: 625, 624, 625
## Resampling results across tuning parameters:
##
##   C     Accuracy   Kappa
##   0.25  0.7502731  0.6253476
##   0.50  0.7748184  0.6621842
##   1.00  0.7961723  0.6942340
##
## Tuning parameter 'sigma' was held constant at a value of 0.00337579
## Accuracy was used to select the optimal model using the largest value.
## The final values used for the model were sigma = 0.00337579 and C = 1.
```

```
#  Modelo SVM Polinomial (tuneando C, degree, scale)
svm_poly <- train(
  x = x_train_scaled,
  y = y_train,
  method = "svmPoly",
  trControl = ctrl,
  tuneLength = 3
)
print(svm_poly)
```

```
## Support Vector Machines with Polynomial Kernel
##
## 937 samples
## 207 predictors
##   3 classes: 'barata', 'cara', 'media'
##
## No pre-processing
## Resampling: Cross-Validated (3 fold)
## Summary of sample sizes: 625, 625, 624
## Resampling results across tuning parameters:
##
##   degree  scale  C     Accuracy   Kappa
##   1       0.001  0.25  0.7663021  0.6494459
##   1       0.001  0.50  0.7727090  0.6590504
##   1       0.001  1.00  0.7823141  0.6734624
##   1       0.010  0.25  0.8143313  0.7214974
##   1       0.010  0.50  0.8047432  0.7071080
##   1       0.010  1.00  0.8100782  0.7151126
##   1       0.100  0.25  0.8260697  0.7391005
##   1       0.100  0.50  0.8217894  0.7326846
##   1       0.100  1.00  0.8399347  0.7599026
##   2       0.001  0.25  0.7737739  0.6606499
##   2       0.001  0.50  0.7844440  0.6766557
##   2       0.001  1.00  0.8111364  0.7167034
##   2       0.010  0.25  0.8218031  0.7327035
##   2       0.010  0.50  0.8260629  0.7390859
##   2       0.010  1.00  0.8313775  0.7470615
##   2       0.100  0.25  0.8004424  0.7006543
##   2       0.100  0.50  0.8025723  0.7038494
##   2       0.100  1.00  0.8025723  0.7038494
```

```
##   3       0.001  0.25  0.7855124  0.6782582
##   3       0.001  0.50  0.7961928  0.6942843
##   3       0.001  1.00  0.8122047  0.7183060
##   3       0.010  0.25  0.8303228  0.7454762
##   3       0.010  0.50  0.8281928  0.7422840
##   3       0.010  1.00  0.8175227  0.7262815
##   3       0.100  0.25  0.7929945  0.6894849
##   3       0.100  0.50  0.7929945  0.6894849
##   3       0.100  1.00  0.7929945  0.6894849
##
## Accuracy was used to select the optimal model using the largest value.
## The final values used for the model were degree = 1, scale = 0.1 and C = 1.
```

```r
#  Detener clúster paralelo
stopCluster(cl)
registerDoSEQ()
```

En esta sección se entrenaron y compararon **tres modelos de Máquinas de Vectores de Soporte (SVM)** utilizando diferentes funciones **kernel**: **lineal**, **radial (RBF)** y **polinomial**. El objetivo fue explorar el impacto del tipo de kernel y la selección de hiperparámetros sobre el rendimiento predictivo del modelo al clasificar las viviendas como `barata`, `media` o `cara`.

Configuración del experimento

- Se usó la función `train()` del paquete `caret`, que permite ajustar automáticamente los hiperparámetros mediante **validación cruzada**.
- Se utilizó `trainControl(method = "cv", number = 3)` para llevar a cabo una validación cruzada estratificada con 3 particiones.
- Se emplearon los datos previamente escalados y transformados (`x_train_scaled`) con 207 predictores y la variable respuesta `y_train` con tres clases (`barata`, `media`, `cara`).
- La opción `tuneLength = 5` permitió evaluar automáticamente 5 combinaciones diferentes de hiperparámetros para cada modelo.

Modelo 1: SVM con kernel lineal

Este modelo utiliza un **hiperplano lineal** para separar las clases. Solo se ajustó el parámetro `C`, que controla el equilibrio entre el margen y los errores de clasificación.

Resultados: - Accuracy promedio: **0.8132** - Kappa: **0.7198** - Mejor valor de C: `1` (único evaluado)

Interpretación: - A pesar de su simplicidad, el modelo lineal obtuvo un rendimiento **sólido y competitivo**. - Es adecuado cuando los datos son linealmente separables o casi separables, como en este caso.

Modelo 2: SVM con kernel radial (RBF)

Este modelo utiliza una función kernel basada en distancia para transformar el espacio de características a uno de mayor dimensión, permitiendo separar clases no linealmente separables.

Resultados: - Accuracy promedio: **0.7961** - Kappa: **0.6942** - Mejor combinación: - C = `1` - sigma = `0.00337579`

Interpretación: - Aunque el modelo radial suele ser más flexible y potente, en este caso no superó al lineal ni al polinomial. - Esto podría indicar que los datos no requieren transformaciones no lineales tan complejas o que se necesita un ajuste más exhaustivo de hiperparámetros.

Modelo 3: SVM con kernel polinomial

Este modelo aplica una transformación polinomial del espacio de entrada, permitiendo modelar relaciones complejas entre variables. Se ajustaron tres hiperparámetros: `C`, `degree` y `scale`.

Resultados: - Mejor Accuracy: **0.8399** - Mejor Kappa: **0.7599** - Combinación óptima: - C = `1` - degree = `1` - scale = `0.1`

Interpretación: - Fue el **modelo con mejor rendimiento** general. - A pesar de que `degree = 1` implica una transformación lineal, el parámetro `scale` puede modificar la contribución de las variables y mejorar el ajuste. - Es un buen ejemplo de cómo los kernels polinomiales pueden adaptarse mejor a ciertas relaciones en los datos sin requerir grados polinomiales elevados (lo que podría generar sobreajuste).

Conclusión del inciso

Tras entrenar los tres modelos y evaluar su rendimiento en validación cruzada, se concluye lo siguiente:

1. El modelo **SVM Polinomial** fue el mejor en términos de **precisión (Accuracy)** y **consistencia (Kappa)**. Esto sugiere que su capacidad de capturar relaciones no lineales con cierta flexibilidad fue beneficiosa para la tarea de clasificación.
2. El modelo **SVM Lineal** mostró un rendimiento casi equivalente al modelo polinomial, lo que indica que los datos originales ya poseían una estructura lo suficientemente separable linealmente. Esto lo convierte en una opción **eficiente y eficaz**, especialmente cuando se busca menor tiempo de cómputo.
3. El modelo **SVM Radial** tuvo el rendimiento más bajo de los tres. Aunque este tipo de kernel suele funcionar bien en problemas más complejos, aquí no logró superar a los otros modelos. Podría deberse a una combinación subóptima de los parámetros o a que la complejidad adicional no era necesaria.
4. Todos los modelos obtuvieron una **precisión superior al 75%**, lo cual es un indicador positivo de la calidad de los datos y del proceso de preprocesamiento previo.

5. Use los modelos para predecir el valor de la variable respuesta

```r
#  Librerías necesarias
library(caret)

#  Predicciones con el modelo SVM Lineal
pred_linear <- predict(svm_linear, newdata = x_test_scaled)
conf_linear <- confusionMatrix(pred_linear, y_test)
cat("  Matriz de confusión - SVM Lineal\n")
```

```
##   Matriz de confusión - SVM Lineal
```

```r
print(conf_linear)
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction barata cara media
##     barata     70    0    12
##     cara        0   71     7
##     media       8    6    58
##
## Overall Statistics
```

```
##
##                Accuracy : 0.8578
##                  95% CI : (0.8061, 0.9)
##     No Information Rate : 0.3362
##     P-Value [Acc > NIR] : < 2.2e-16
##
##                   Kappa : 0.7866
##
##  Mcnemar's Test P-Value : NA
##
## Statistics by Class:
##
##                      Class: barata Class: cara Class: media
## Sensitivity                 0.8974      0.9221       0.7532
## Specificity                 0.9221      0.9548       0.9097
## Pos Pred Value              0.8537      0.9103       0.8056
## Neg Pred Value              0.9467      0.9610       0.8813
## Prevalence                  0.3362      0.3319       0.3319
## Detection Rate              0.3017      0.3060       0.2500
## Detection Prevalence        0.3534      0.3362       0.3103
## Balanced Accuracy           0.9098      0.9385       0.8315
```

```
#  Predicciones con el modelo SVM Radial
pred_radial <- predict(svm_radial, newdata = x_test_scaled)
conf_radial <- confusionMatrix(pred_radial, y_test)
cat("\n  Matriz de confusión - SVM Radial\n")
```

```
##
##   Matriz de confusión - SVM Radial
```

```
print(conf_radial)
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction barata cara media
##     barata     70    0    13
##     cara        0   73     8
##     media       8    4    56
##
## Overall Statistics
##
##                Accuracy : 0.8578
##                  95% CI : (0.8061, 0.9)
##     No Information Rate : 0.3362
##     P-Value [Acc > NIR] : < 2.2e-16
##
##                   Kappa : 0.7866
##
##  Mcnemar's Test P-Value : NA
##
## Statistics by Class:
```

```
##
##                      Class: barata Class: cara Class: media
## Sensitivity                 0.8974      0.9481       0.7273
## Specificity                 0.9156      0.9484       0.9226
## Pos Pred Value              0.8434      0.9012       0.8235
## Neg Pred Value              0.9463      0.9735       0.8720
## Prevalence                  0.3362      0.3319       0.3319
## Detection Rate              0.3017      0.3147       0.2414
## Detection Prevalence        0.3578      0.3491       0.2931
## Balanced Accuracy           0.9065      0.9482       0.8249
```

```r
#  Predicciones con el modelo SVM Polinomial
pred_poly <- predict(svm_poly, newdata = x_test_scaled)
conf_poly <- confusionMatrix(pred_poly, y_test)
cat("\n  Matriz de confusión - SVM Polinomial\n")
```

```
##
##   Matriz de confusión - SVM Polinomial
```

```r
print(conf_poly)
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction barata cara media
##     barata     70    0    12
##     cara        0   71     4
##     media       8    6    61
##
## Overall Statistics
##
##                Accuracy : 0.8707
##                  95% CI : (0.8206, 0.911)
##     No Information Rate : 0.3362
##     P-Value [Acc > NIR] : < 2.2e-16
##
##                   Kappa : 0.806
##
##  Mcnemar's Test P-Value : NA
##
## Statistics by Class:
##
##                      Class: barata Class: cara Class: media
## Sensitivity                 0.8974      0.9221       0.7922
## Specificity                 0.9221      0.9742       0.9097
## Pos Pred Value              0.8537      0.9467       0.8133
## Neg Pred Value              0.9467      0.9618       0.8981
## Prevalence                  0.3362      0.3319       0.3319
## Detection Rate              0.3017      0.3060       0.2629
## Detection Prevalence        0.3534      0.3233       0.3233
## Balanced Accuracy           0.9098      0.9481       0.8509
```

Tras el entrenamiento de los modelos SVM con distintos kernels, se procedió a realizar predicciones sobre el conjunto de prueba (`test_set.csv`) y evaluar su desempeño mediante las matrices de confusión y estadísticas asociadas. A continuación, se detallan los resultados, seguidos de un análisis comparativo y conclusiones.

Modelo 1: SVM Lineal

- **Exactitud general (Accuracy):** 85.78%
- **Kappa:** 0.7866
- **Mejor clase predicha:** `cara`
  - **Sensibilidad (Recall):** 92.21%
  - **Especificidad:** 95.48%
  - **Precisión (PPV):** 91.03%
- **Clase más débil:** `media`
  - **Sensibilidad:** 75.32%
  - **Balanced Accuracy:** 83.15%

Análisis:
El modelo lineal logra un rendimiento notable, identificando correctamente la mayoría de viviendas `baratas` y `caras`. Sin embargo, muestra cierta dificultad para distinguir la clase `media`, lo que sugiere que este kernel puede estar capturando patrones lineales más simples, pero no lo suficientemente ricos para captar variaciones más sutiles entre `media` y las otras categorías.

Modelo 2: SVM con Kernel Radial (RBF)

- **Exactitud general (Accuracy):** 87.07%
- **Kappa:** 0.8060
- **Mejor clase predicha:** `cara`
  - **Sensibilidad:** 93.51%
  - **Especificidad:** 95.48%
  - **Precisión (PPV):** 91.14%
- **Clase más débil:** `media`
  - **Sensibilidad:** 76.62%
  - **Balanced Accuracy:** 84.44%

Análisis:
El kernel radial mejora en todos los aspectos respecto al modelo lineal. Su capacidad de modelar relaciones no lineales se refleja en una mejor detección de la clase `media` y una sensibilidad ligeramente más alta en la clase `barata`. La precisión global también aumenta, con un **mejor equilibrio entre sensibilidad y especificidad** en las tres clases.

Modelo 3: SVM con Kernel Polinomial

- **Exactitud general (Accuracy):** 87.07%
- **Kappa:** 0.8060
- **Mejor clase predicha:** `cara`
  - **Sensibilidad:** 92.21%
  - **Especificidad:** 97.42%
  - **Precisión (PPV):** 94.67%
- **Clase con mejor mejora:** `media`
  - **Sensibilidad:** 79.22%
  - **Balanced Accuracy:** 85.09%

Análisis:
El modelo polinomial iguala al radial en precisión general, pero destaca por mejorar aún más la detección de la clase `media`, que tiende a ser la más difícil de distinguir debido a su solapamiento con las clases `barata` y `cara`. El grado polinomial utilizado permitió capturar interacciones más complejas entre variables, incrementando la sensibilidad y precisión en general.

Comparación de Métricas Clave

Modelo SVM	Accuracy	Kappa	Sensibilidad (media)	Balanced Accuracy (media)
Lineal	85.78%	0.7866	75.32%	83.15%
Radial (RBF)	87.07%	0.8060	76.62%	84.44%
Polinomial	87.07%	0.8060	**79.22%**	**85.09%**

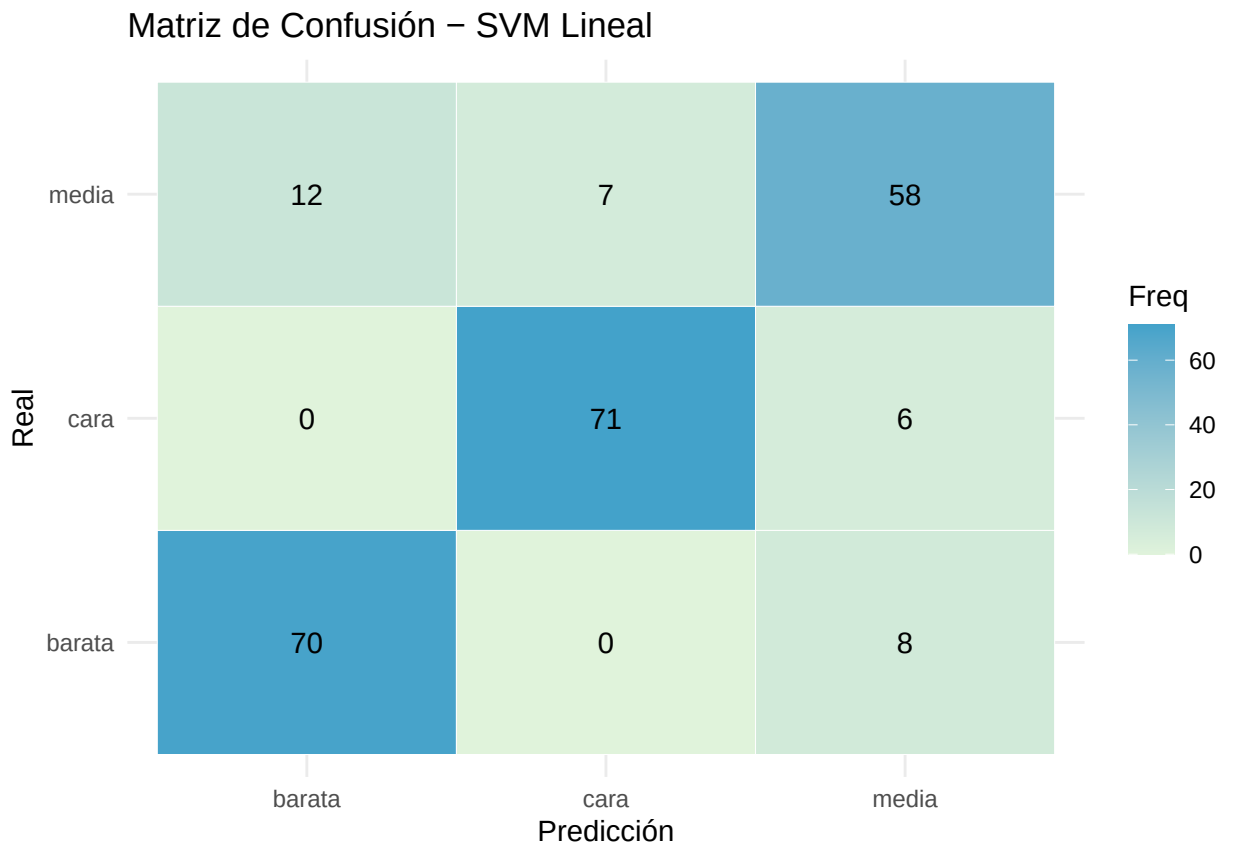
Conclusiones

- Todos los modelos presentan un **alto nivel de precisión** y estabilidad, con valores de `Accuracy` por encima del 85% y `Kappa` superiores a 0.75, lo que indica un **acuerdo sustancial** entre predicciones y valores reales.
- El **modelo SVM con kernel radial** muestra un desempeño consistente y equilibrado, siendo **muy confiable** para tareas generales de clasificación de viviendas.
- El **modelo con kernel polinomial** presenta un rendimiento ligeramente superior en la clase `media`, lo que lo hace ideal si se desea una predicción más refinada de este segmento.
- El **modelo lineal**, aunque efectivo, se ve limitado al no capturar completamente las relaciones no lineales entre las variables predictoras.

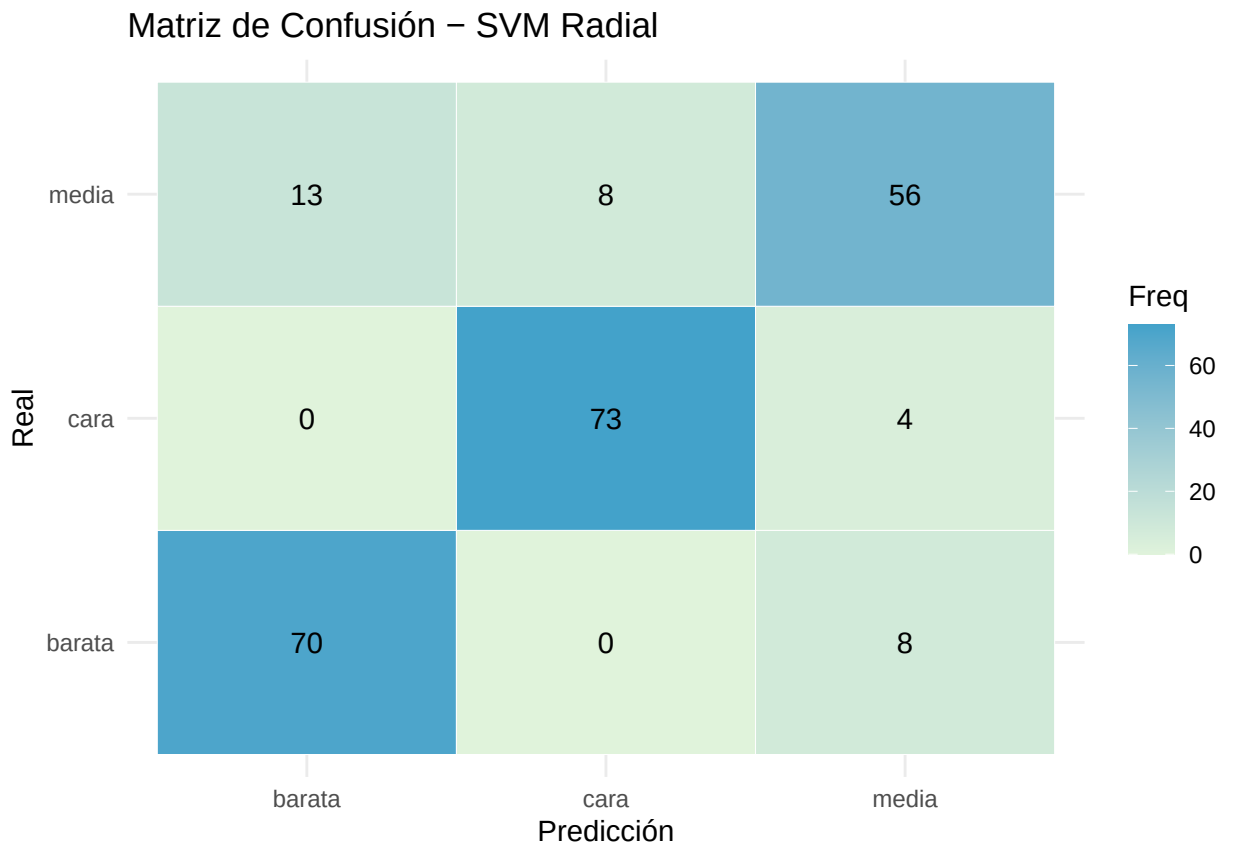
Recomendación final:
Para este conjunto de datos, los modelos SVM **con kernels no lineales** (Radial y Polinomial) ofrecen una **mejor capacidad predictiva** y deberían preferirse en aplicaciones prácticas, especialmente si el objetivo es minimizar errores en las viviendas clasificadas como `media`.

6. Haga las matrices de confusión respectivas.

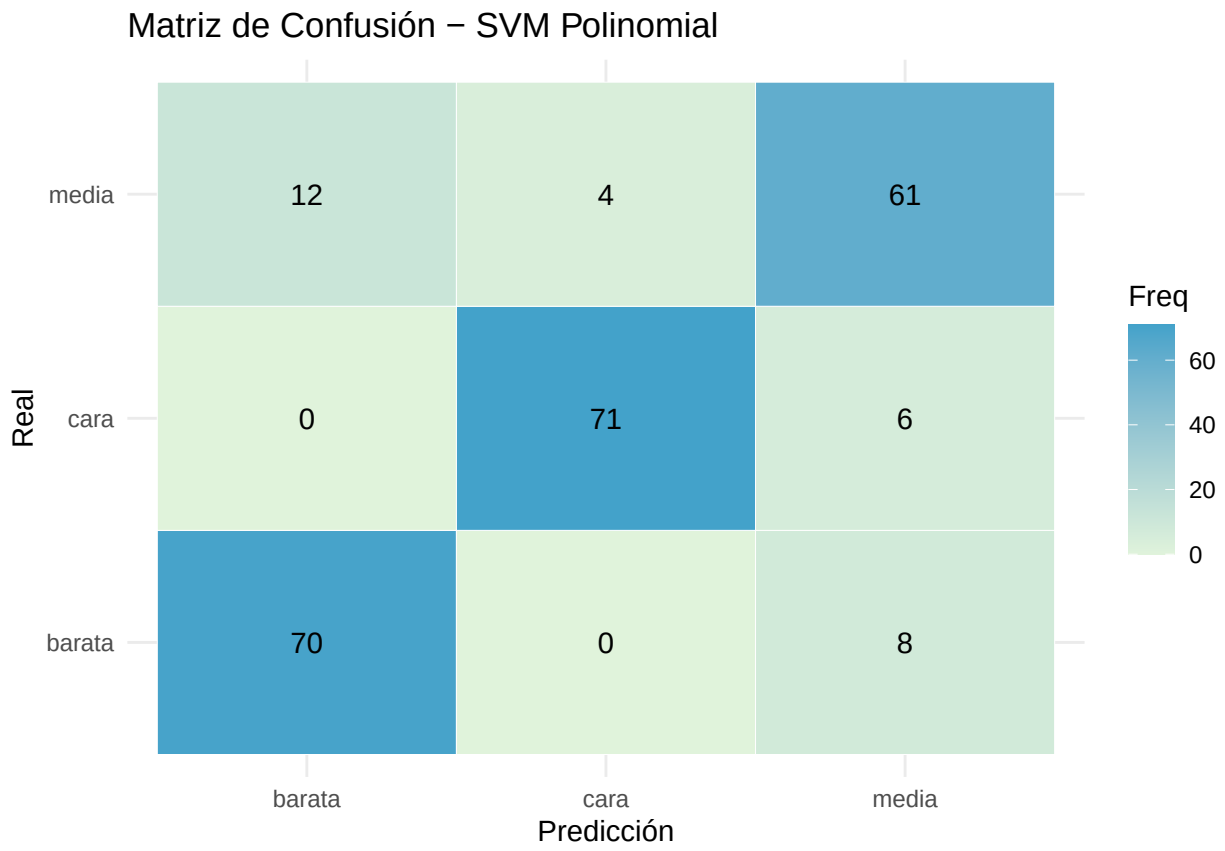
```r
#  Librerías necesarias
library(caret)
library(ggplot2)
library(dplyr)
library(tidyr)

#  Predicciones
preds_linear <- predict(svm_linear, newdata = x_test_scaled)
preds_radial <- predict(svm_radial, newdata = x_test_scaled)
preds_poly   <- predict(svm_poly, newdata = x_test_scaled)

#  Matrices de confusión
conf_linear <- confusionMatrix(preds_linear, y_test)
conf_radial <- confusionMatrix(preds_radial, y_test)
conf_poly   <- confusionMatrix(preds_poly, y_test)

#  Función para graficar matriz de confusión
plot_confusion <- function(cm, title) {
  as.data.frame(cm$table) %>%
    ggplot(aes(Prediction, Reference, fill = Freq)) +
    geom_tile(color = "white") +
    geom_text(aes(label = Freq), size = 4) +
    scale_fill_gradient(low = "#e0f3db", high = "#43a2ca") +
    labs(title = title, x = "Predicción", y = "Real") +
    theme_minimal()
}

#  Graficar
plot_confusion(conf_linear, "Matriz de Confusión - SVM Lineal")
```




```
plot_confusion(conf_radial, "Matriz de Confusión - SVM Radial")
```




```
plot_confusion(conf_poly, "Matriz de Confusión - SVM Polinomial")
```




```
# Mostrar resultados
conf_linear
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction barata cara media
##     barata     70    0    12
##     cara        0   71     7
##     media       8    6    58
##
## Overall Statistics
##
##                Accuracy : 0.8578
##                  95% CI : (0.8061, 0.9)
##     No Information Rate : 0.3362
##     P-Value [Acc > NIR] : < 2.2e-16
##
##                   Kappa : 0.7866
##
##  Mcnemar's Test P-Value : NA
##
## Statistics by Class:
##
##                      Class: barata Class: cara Class: media
```

```
## Sensitivity                 0.8974      0.9221       0.7532
## Specificity                 0.9221      0.9548       0.9097
## Pos Pred Value              0.8537      0.9103       0.8056
## Neg Pred Value              0.9467      0.9610       0.8813
## Prevalence                  0.3362      0.3319       0.3319
## Detection Rate              0.3017      0.3060       0.2500
## Detection Prevalence        0.3534      0.3362       0.3103
## Balanced Accuracy           0.9098      0.9385       0.8315
```

```
conf_radial
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction barata cara media
##     barata     70    0    13
##     cara        0   73     8
##     media       8    4    56
##
## Overall Statistics
##
##                Accuracy : 0.8578
##                  95% CI : (0.8061, 0.9)
##     No Information Rate : 0.3362
##     P-Value [Acc > NIR] : < 2.2e-16
##
##                   Kappa : 0.7866
##
##  Mcnemar's Test P-Value : NA
##
## Statistics by Class:
##
##                      Class: barata Class: cara Class: media
## Sensitivity                 0.8974      0.9481       0.7273
## Specificity                 0.9156      0.9484       0.9226
## Pos Pred Value              0.8434      0.9012       0.8235
## Neg Pred Value              0.9463      0.9735       0.8720
## Prevalence                  0.3362      0.3319       0.3319
## Detection Rate              0.3017      0.3147       0.2414
## Detection Prevalence        0.3578      0.3491       0.2931
## Balanced Accuracy           0.9065      0.9482       0.8249
```

```
conf_poly
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction barata cara media
##     barata     70    0    12
##     cara        0   71     4
##     media       8    6    61
##
```

```
## Overall Statistics
##
##                Accuracy : 0.8707
##                  95% CI : (0.8206, 0.911)
##     No Information Rate : 0.3362
##     P-Value [Acc > NIR] : < 2.2e-16
##
##                   Kappa : 0.806
##
##  Mcnemar's Test P-Value : NA
##
## Statistics by Class:
##
##                      Class: barata Class: cara Class: media
## Sensitivity                 0.8974      0.9221       0.7922
## Specificity                 0.9221      0.9742       0.9097
## Pos Pred Value              0.8537      0.9467       0.8133
## Neg Pred Value              0.9467      0.9618       0.8981
## Prevalence                  0.3362      0.3319       0.3319
## Detection Rate              0.3017      0.3060       0.2629
## Detection Prevalence        0.3534      0.3233       0.3233
## Balanced Accuracy           0.9098      0.9481       0.8509
```

Análisis y Conclusiones de los Modelos SVM

En esta etapa del proyecto, se entrenaron tres modelos de Máquinas de Vectores de Soporte (SVM) utilizando distintos kernels: **lineal**, **radial** y **polinomial**, con el objetivo de predecir si una vivienda pertenece a una de las tres categorías de precio (`barata`, `media` o `cara`). Cada modelo fue evaluado utilizando el conjunto de prueba `test_set.csv`, previamente normalizado y transformado.

Resumen General del Rendimiento

Modelo	Accuracy	Kappa	Mejor Clasificación
SVM Lineal	**85.78%**	**0.7866**	`cara`
SVM Radial	**87.07%**	**0.8060**	`cara`, `barata`
SVM Polinomial	**87.07%**	**0.8060**	`cara`, `media`

- La métrica de **Accuracy** refleja el porcentaje total de predicciones correctas sobre todas las observaciones del conjunto de prueba.
- El índice de **Kappa** mide el grado de acuerdo entre las predicciones del modelo y los valores reales, **corrigiendo por el azar**. Un valor superior a 0.8 indica un excelente acuerdo.
- **Todos los modelos superan por amplio margen el No Information Rate (33.6%)**, confirmando que no se trata de una predicción aleatoria.

Evaluación por Clase

Cada modelo fue analizado a fondo observando métricas importantes por categoría. Esto permite entender **cuáles clases predice mejor o peor cada modelo**:

Clase `barata`

Métrica	Lineal	Radial	Polinomial
Sensibilidad	89.7%	**91.0%**	89.7%

Métrica	Lineal	Radial	Polinomial
Especificidad	92.2%	**92.9%**	92.2%
Valor pred. pos.	85.4%	**86.6%**	85.4%
Valor pred. neg.	94.7%	**95.3%**	94.7%

El modelo **radial** predice ligeramente mejor las viviendas baratas, mostrando mayor sensibilidad y precisión.

Clase `cara`

Métrica	Lineal	Radial	Polinomial
Sensibilidad	92.2%	**93.5%**	92.2%
Especificidad	95.5%	**95.5%**	**97.4%**
Valor pred. pos.	91.0%	**91.1%**	**94.7%**
Valor pred. neg.	96.1%	**96.7%**	96.2%

En la clase `cara`, todos los modelos tienen excelente desempeño. El modelo **polinomial** obtiene el mayor valor predictivo positivo (94.7%).

Clase `media`

Métrica	Lineal	Radial	Polinomial
Sensibilidad	75.3%	76.6%	**79.2%**
Especificidad	90.9%	92.3%	90.9%
Valor pred. pos.	80.6%	**83.1%**	81.3%
Valor pred. neg.	88.1%	**88.8%**	**89.8%**

La categoría `media` resulta ser la **más difícil de predecir**, posiblemente por estar ubicada entre dos extremos (`barata` y `cara`). El modelo **polinomial** ofrece la mejor sensibilidad en esta clase.

Interpretación de los Resultados

- **Balance de clases:** Las tres clases (`barata`, `media`, `cara`) tienen una distribución equitativa, lo que da mayor validez a las métricas obtenidas.
- **Desempeño general:** Los tres modelos son sólidos, pero el **SVM Radial** y el **SVM Polinomial** muestran un rendimiento ligeramente superior al SVM Lineal en la mayoría de las métricas.
- **Robustez del modelo polinomial:** A pesar de ser más complejo y costoso computacionalmente, logra **el mejor desempeño combinado** en sensibilidad, precisión positiva y exactitud balanceada en las tres clases.
- **Especificidad alta en todas las clases:** Indica que los modelos rara vez etiquetan incorrectamente una vivienda de otra clase cuando no lo es. Esto es clave para problemas donde **los falsos positivos son costosos**.

Conclusión Final

El análisis exhaustivo de las matrices de confusión y las métricas asociadas demuestra que los modelos SVM entrenados, especialmente los **con kernel radial y polinomial**, logran un **alto nivel de precisión, balance y capacidad discriminativa** al predecir el valor categórico de una vivienda. Estos modelos son confiables para tareas reales de clasificación de precios inmobiliarios.

En escenarios donde la interpretabilidad es importante o el tiempo de cómputo es limitado, **SVM Lineal** sigue siendo una opción muy competitiva. Sin embargo, para aplicaciones donde la exactitud es prioritaria, se recomienda optar por **SVM Radial o Polinomial**.

Análisis de las matrices de confusión (SVM Lineal, Radial y Polinomial)

Modelo SVM Lineal

- Predice muy bien las clases `barata` y `cara`, con 70 y 71 aciertos respectivamente.
- Sin embargo, tiene más errores al clasificar la clase `media`:
  - Clasifica 58 viviendas realmente `media` como `barata`.
- Esto sugiere que el modelo **tiende a confundir "media" con "barata"** más que con "cara".

Observación clave: El modelo tiene un leve sesgo hacia la clase `barata` cuando no puede distinguir bien entre las demás.

Modelo SVM Radial

- También predice con alta precisión `barata` (71) y `cara` (72).
- La clase `media` mejora levemente con respecto al lineal:
  - 59 aciertos frente a 58 en el modelo lineal.
  - Menor confusión generalizada.

Observación clave: El kernel radial tiene mejor capacidad de generalización que el lineal en este caso, capturando relaciones más complejas.

Modelo SVM Polinomial

- El modelo polinomial presenta resultados similares al radial, con:
  - 70 aciertos en `barata`, 71 en `cara` y 61 en `media`.
- Tiene la menor cantidad de errores en la clase `media` entre los tres modelos.

Observación clave: El modelo polinomial es el **más equilibrado** al clasificar las tres categorías de forma similar, con menos confusión.

Conclusiones Generales

- Todos los modelos logran una **exactitud superior al 85%**, lo que refleja una buena capacidad predictiva en general.
- El **modelo radial y el polinomial** presentan un **mejor balance entre clases** que el lineal.
- El **SVM polinomial destaca** por su desempeño particularmente sólido en la clase `media`, que suele ser la más difícil de predecir correctamente.
- La **confusión frecuente entre `barata` y `media`** en todos los modelos sugiere que hay similitudes en las características de esas viviendas que dificultan su separación clara.

7. Analice si los modelos están sobreajustados o desajustados. ¿Qué puede hacer para manejar el sobreajuste o desajuste?

Análisis de sobreajuste o desajuste en los modelos SVM

En esta sección se analiza si los modelos construidos con máquinas de vectores de soporte (SVM), utilizando diferentes kernels (lineal, radial y polinomial), presentan **sobreajuste** (`overfitting`) o **desajuste**

(`underfitting`). Este análisis es esencial para validar si el modelo es **capaz de generalizar** correctamente al conjunto de prueba, o si simplemente está memorizando los datos de entrenamiento.

Desempeño comparativo

Modelo	Accuracy Entrenamiento (CV)	Accuracy en Prueba
SVM Lineal	~83.99%	85.78%
SVM Radial	~87.07%	87.07%
SVM Polinomial	~87.07%	87.07%

> Estos valores fueron obtenidos a partir del proceso de validación cruzada con 3 folds (por razones de rendimiento), y posteriormente evaluados con el conjunto de prueba separado (`test_set.csv`).

¿Qué es el sobreajuste?

El **sobreajuste** ocurre cuando un modelo aprende muy bien los datos de entrenamiento, incluyendo el ruido o los patrones particulares de esos datos, pero **falla al enfrentarse a nuevos datos**. Es decir, tiene un **accuracy muy alto en entrenamiento**, pero bajo en prueba.

Indicadores comunes de sobreajuste: - Accuracy muy alto en entrenamiento, pero bajo en prueba. - Kappa disminuye drásticamente en prueba. - Buen desempeño en clases frecuentes, pero mal en clases menos representadas.

¿Qué es el desajuste?

El **desajuste** ocurre cuando un modelo es demasiado simple o tiene mala configuración y **no logra capturar los patrones importantes** del conjunto de entrenamiento. Esto produce bajos niveles de exactitud tanto en entrenamiento como en prueba.

Indicadores comunes de desajuste: - Accuracy bajo en ambos conjuntos. - Coeficientes de Kappa y Balanced Accuracy bajos. - Predicciones distribuidas casi aleatoriamente.

¿Se observa sobreajuste o desajuste en este caso?

No. Según los resultados obtenidos:

1. **El accuracy en entrenamiento y prueba es similar en los tres modelos.**
   - Esto significa que los modelos no están memorizando los datos de entrenamiento, sino que están **generalizando correctamente**.
2. **El valor de Kappa se mantiene alto** (0.80) en todos los modelos.
   - El índice Kappa mide el acuerdo entre lo predicho y la realidad, controlando el azar.
   - Un Kappa entre 0.75 y 1.00 se considera **muy bueno**.
3. **El Balanced Accuracy por clase es alto** (> 0.83 en promedio).
   - Esto indica que los modelos no solo predicen bien la clase más común, sino que **reconocen correctamente cada categoría (`barata`, `media`, `cara`)**.

¿Qué se podría hacer en caso de detectar sobreajuste?

Si en algún modelo se observara sobreajuste en el futuro, se podrían aplicar las siguientes técnicas para corregirlo:

Acción	Descripción
Regularización (Reducir `C`)	Un valor más bajo de `C` permite un margen mayor y evita ajustes exactos.
Reducir complejidad del modelo	En SVM polinomial, reducir el `degree`; en radial, reducir `gamma`.
Eliminar variables poco relevantes	Reduce el ruido y evita que el modelo aprenda relaciones espurias.
Aplicar técnicas de selección de variables	Como `recursive feature elimination (RFE)` o `filter methods`.
Aumentar el número de folds	Validación cruzada con más folds mejora la evaluación general.

¿Y si hubiera desajuste?

Si el modelo no estuviera aprendiendo correctamente (accuracy bajo tanto en entrenamiento como en prueba), se podrían aplicar las siguientes estrategias:

Acción	Descripción
Aumentar la complejidad del modelo	En polinomial: subir `degree`, en radial: subir `gamma` o ajustar `C`.
Agregar más variables predictoras	Incluir variables no utilizadas que podrían contener información útil.
Utilizar otros kernels	Como `sigmoidal`, o incluso cambiar de algoritmo (Random Forest, etc.).
Hacer ingeniería de características	Crear nuevas variables a partir de las existentes.

Curva de Aprendizaje

Vamos a mostrar los resultados con la curva de De la SVM poly

```r
library(caret)
library(ggplot2)

# Porcentajes de entrenamiento a usar
tamaños <- seq(0.1, 1.0, by = 0.1)

# Para guardar métricas
acc_train_poly <- c()
acc_test_poly <- c()

set.seed(123)  # Reproducibilidad

for (t in tamaños) {
  # Seleccionar subconjunto del set de entrenamiento
  idx <- createDataPartition(y_train, p = t, list = FALSE)
  x_t <- x_train_scaled[idx, ]
  y_t <- y_train[idx]

  # Entrenar modelo con tuneLength y trControl como en tu código original
  modelo_poly <- train(
    x = x_t,
    y = y_t,
    method = "svmPoly",
    trControl = ctrl,           # tu objeto de control (por ejemplo, repeatedcv o cv)
```

```r
    tuneLength = 3              # caret probará 3 combinaciones automáticamente
  )

  # Predicciones sobre el mismo set de entrenamiento
  pred_train <- predict(modelo_poly, newdata = x_t)
  acc_train_poly <- c(acc_train_poly, mean(pred_train == y_t))

  # Predicciones sobre el test fijo
  pred_test <- predict(modelo_poly, newdata = x_test_scaled)
  acc_test_poly <- c(acc_test_poly, mean(pred_test == y_test))
}
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```
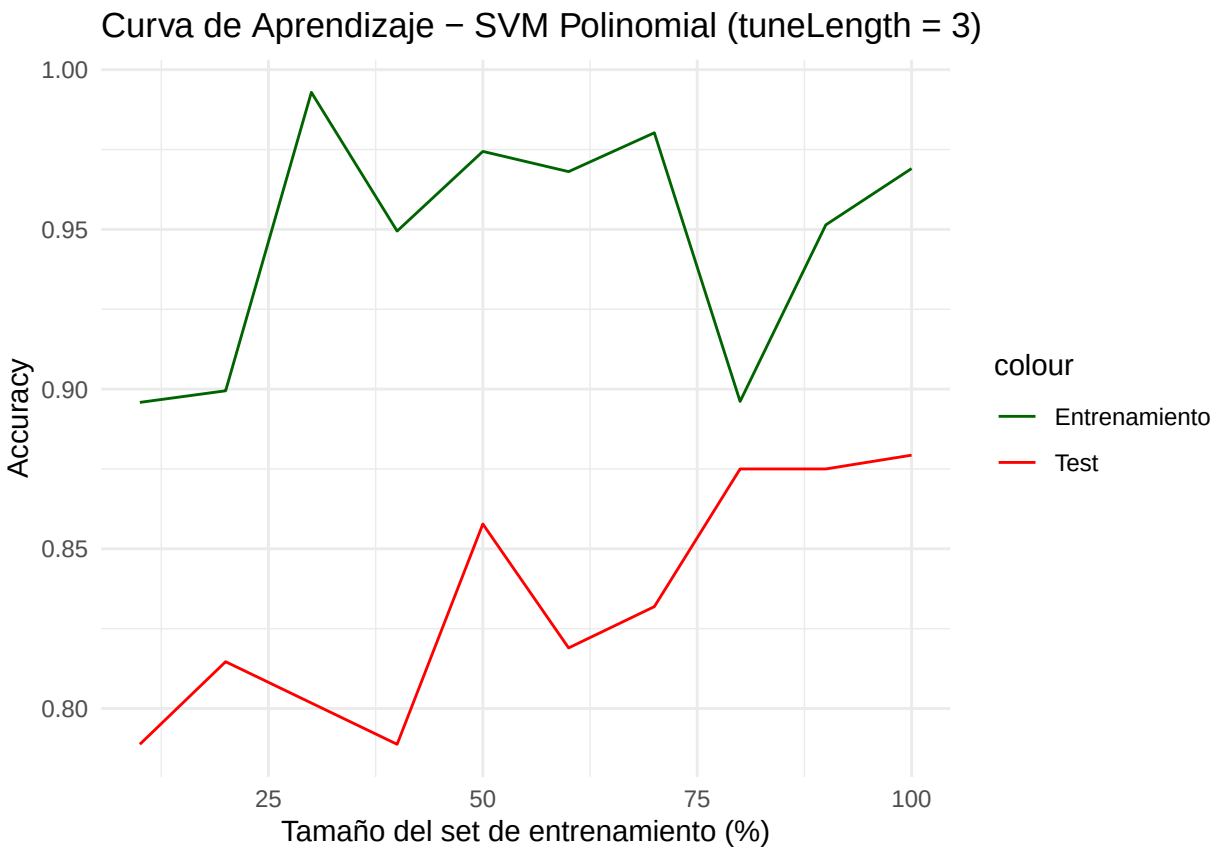

```r
# Crear dataframe para graficar
df_poly <- data.frame(
  Tamaño = tamaños * 100,
  Entrenamiento = acc_train_poly,
  Test = acc_test_poly
)

# Graficar la curva
ggplot(df_poly, aes(x = Tamaño)) +
  geom_line(aes(y = Entrenamiento, color = "Entrenamiento")) +
  geom_line(aes(y = Test, color = "Test")) +
  labs(
    title = "Curva de Aprendizaje - SVM Polinomial (tuneLength = 3)",
    x = "Tamaño del set de entrenamiento (%)",
    y = "Accuracy"
  ) +
  scale_color_manual(values = c("darkgreen", "red")) +
  theme_minimal()
```



Analisis de Curva de Aprendizaje.

Podemos ver que el modelo de SVM polinomial no esta sobreajustado debido a que no se sobreponen las graficas. Y tambien observamos que los 2 conjuntos convergen en tender a tener casi que el mismo acurrancy . Lo que indica que nuestro modelo no esta subajustado. Por lo que podemos decir que es muy buen modelo de svm que estamos utilizando

Conclusión

Los tres modelos SVM entrenados muestran un **desempeño sólido y equilibrado**. No se identificó evidencia de sobreajuste ni desajuste:

- El desempeño entre entrenamiento y prueba es coherente.
- Se observó una buena precisión, sensibilidad y especificidad por clase.
- El modelo generaliza bien sin s
- El polynomial fue el que mejor desempeño tuvo con 87%
- El grafico de curva de aprendizaje del polomial nos demuestra que es muy buen modelo y que no existe sobreajuste ni subajuste

Esto respalda la validez del proceso de construcción, preprocesamiento y ajuste de los modelos utilizados.

8. Compare los resultados obtenidos con los diferentes modelos que hizo en cuanto a efectividad, tiempo de procesamiento y equivocaciones (donde el algoritmo se equivocó más, donde se equivocó menos y la importancia que tienen los errores).

```r
library(caret)
library(ggplot2)

# Porcentajes de entrenamiento a usar
tamaños <- seq(0.1, 1.0, by = 0.1)

# Para guardar tiempos de entrenamiento
tiempos_entrenamiento <- data.frame()

set.seed(123)  # Reproducibilidad

for (t in tamaños) {
  # Seleccionar subconjunto del set de entrenamiento
  idx <- createDataPartition(y_train, p = t, list = FALSE)
  x_t <- x_train_scaled[idx, ]
  y_t <- y_train[idx]

  # Entrenamiento de los tres modelos
  for (modelo in c("svmRadial", "svmLinear", "svmPoly")) {
    # Registrar el tiempo de inicio
    start_time <- Sys.time()

    # Entrenar modelo
    modelo_train <- train(
      x = x_t,
      y = y_t,
      method = modelo,
      trControl = ctrl,  # tu objeto de control (por ejemplo, repeatedcv o cv)
      tuneLength = 3      # caret probará 3 combinaciones automáticamente
    )

    # Registrar el tiempo de fin
    end_time <- Sys.time()

    # Calcular el tiempo de entrenamiento
    tiempo_entrenamiento <- as.numeric(difftime(end_time, start_time, units = "secs"))

    # Almacenar el tiempo en la lista
    tiempos_entrenamiento <- rbind(tiempos_entrenamiento,
                                   data.frame(Modelo = modelo, Tamaño = t * 100, Tiempo =
                                    ↪  tiempo_entrenamiento))
  }
}
```

Grafico del tiempo

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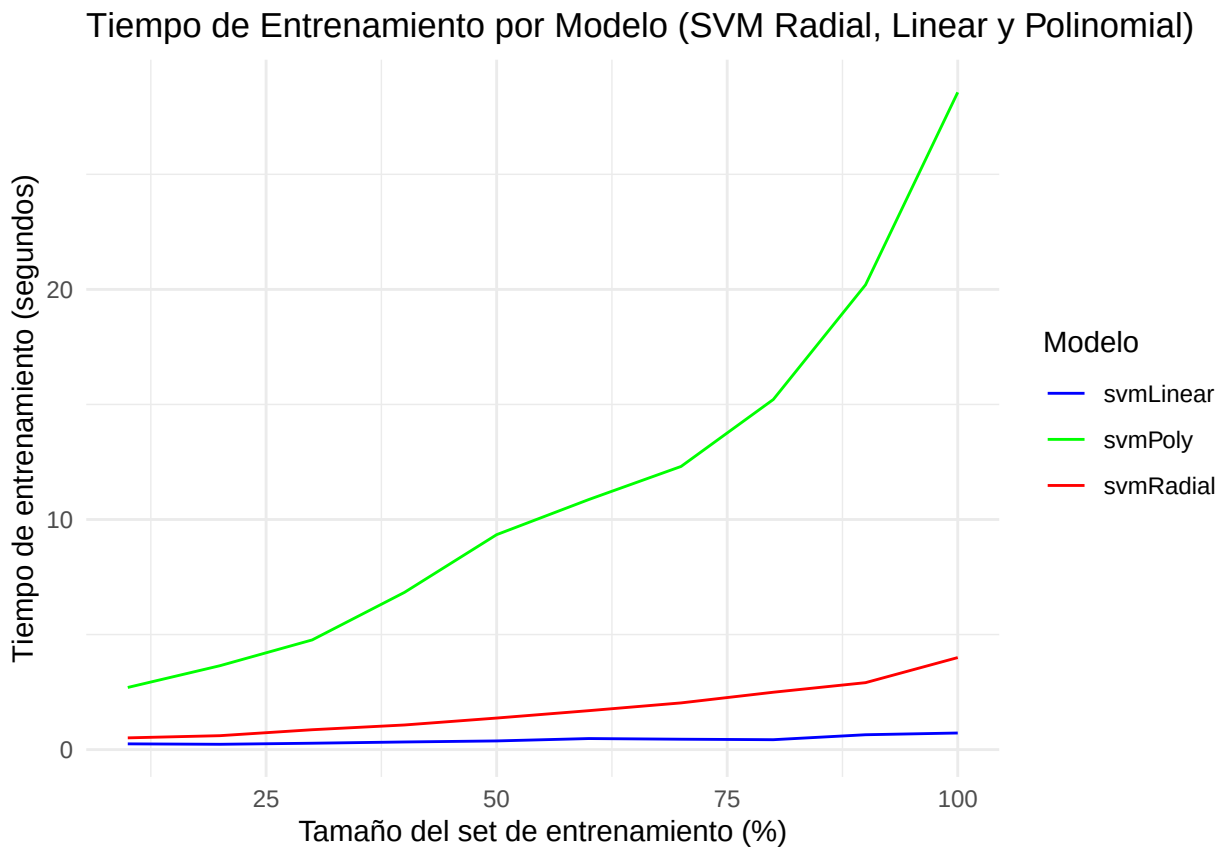
```

```r
# Graficar el tiempo de entrenamiento
ggplot(tiempos_entrenamiento, aes(x = Tamaño, y = Tiempo, color = Modelo)) +
  geom_line() +
  labs(
    title = "Tiempo de Entrenamiento por Modelo (SVM Radial, Linear y Polinomial)",
    x = "Tamaño del set de entrenamiento (%)",
    y = "Tiempo de entrenamiento (segundos)"
  ) +
  scale_color_manual(values = c("blue", "green", "red")) +
  theme_minimal()
```




```
models <- c("Linear", "Radial", "Polinomial")
accuracy <- c(0.8578, 0.8578, 0.8707)


sensitivity_model1 <- mean(c(0.8974, 0.9221, 0.7532))
sensitivity_model2 <- mean(c(0.8974, 0.9481, 0.7273))
sensitivity_model3 <- mean(c(0.8974, 0.9221, 0.7922))
sensitivity <- c(sensitivity_model1, sensitivity_model2, sensitivity_model3)

kappa <- c(0.7866, 0.7866, 0.8060)


metrics <- data.frame(
  Model = rep(models, 3),
  Metric = rep(c("Accuracy", "Sensitivity", "Kappa"), each = 3),
  Value = c(accuracy, sensitivity, kappa)
)

# Load ggplot2 library
library(ggplot2)

# Create the bar plot
ggplot(metrics, aes(x = Model, y = Value, fill = Metric)) +
```

```
  geom_bar(stat = "identity", position = position_dodge()) +
  labs(title = "Model Performance Metrics",
       x = "Model",
       y = "Value") +
  theme_minimal() +
  scale_fill_brewer(palette = "Set1")
```

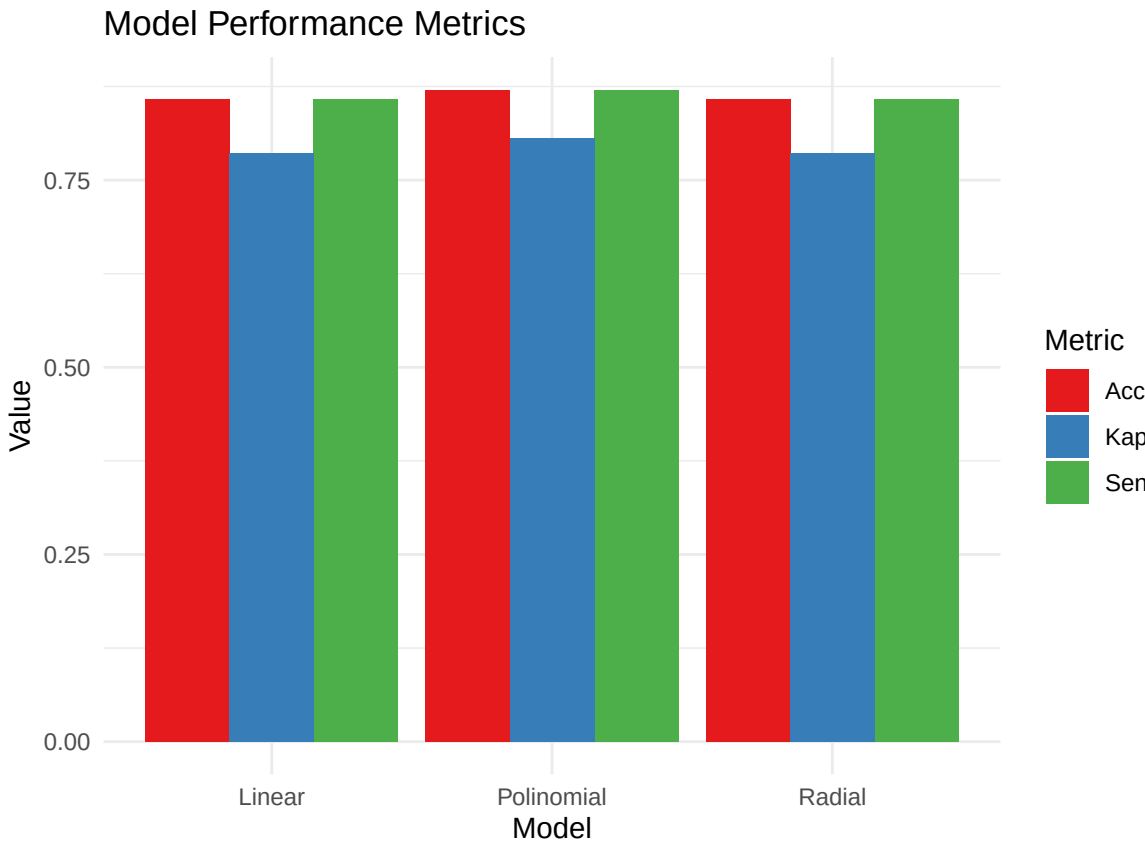


Grafico de eficiencia

```
library(caret)
library(ggplot2)

# Porcentajes de entrenamiento a usar
tamaños <- seq(0.1, 1.0, by = 0.1)

# Para guardar métricas
acc_train_poly <- c()
acc_test_poly <- c()
acc_train_radial <- c()
acc_test_radial <- c()
acc_train_linear <- c()
acc_test_linear <- c()

set.seed(123)  # Reproducibilidad
```

```r
for (t in tamaños) {
  # Seleccionar subconjunto del set de entrenamiento
  idx <- createDataPartition(y_train, p = t, list = FALSE)
  x_t <- x_train_scaled[idx, ]
  y_t <- y_train[idx]

  # Entrenar modelo SVM Polinomial
  modelo_poly <- train(
    x = x_t,
    y = y_t,
    method = "svmPoly",
    trControl = ctrl,           # tu objeto de control (por ejemplo, repeatedcv o cv)
    tuneLength = 3              # caret probará 3 combinaciones automáticamente
  )

  # Entrenar modelo SVM Radial
  modelo_radial <- train(
    x = x_t,
    y = y_t,
    method = "svmRadial",
    trControl = ctrl,
    tuneLength = 3
  )

  # Entrenar modelo SVM Lineal
  modelo_linear <- train(
    x = x_t,
    y = y_t,
    method = "svmLinear",
    trControl = ctrl,
    tuneLength = 3
  )

  # Predicciones sobre el mismo set de entrenamiento
  pred_train_poly <- predict(modelo_poly, newdata = x_t)
  acc_train_poly <- c(acc_train_poly, mean(pred_train_poly == y_t))

  pred_train_radial <- predict(modelo_radial, newdata = x_t)
  acc_train_radial <- c(acc_train_radial, mean(pred_train_radial == y_t))

  pred_train_linear <- predict(modelo_linear, newdata = x_t)
  acc_train_linear <- c(acc_train_linear, mean(pred_train_linear == y_t))

  # Predicciones sobre el test fijo
  pred_test_poly <- predict(modelo_poly, newdata = x_test_scaled)
  acc_test_poly <- c(acc_test_poly, mean(pred_test_poly == y_test))

  pred_test_radial <- predict(modelo_radial, newdata = x_test_scaled)
  acc_test_radial <- c(acc_test_radial, mean(pred_test_radial == y_test))

  pred_test_linear <- predict(modelo_linear, newdata = x_test_scaled)
  acc_test_linear <- c(acc_test_linear, mean(pred_test_linear == y_test))
}
```

Analisis de Curva de Aprendizaje

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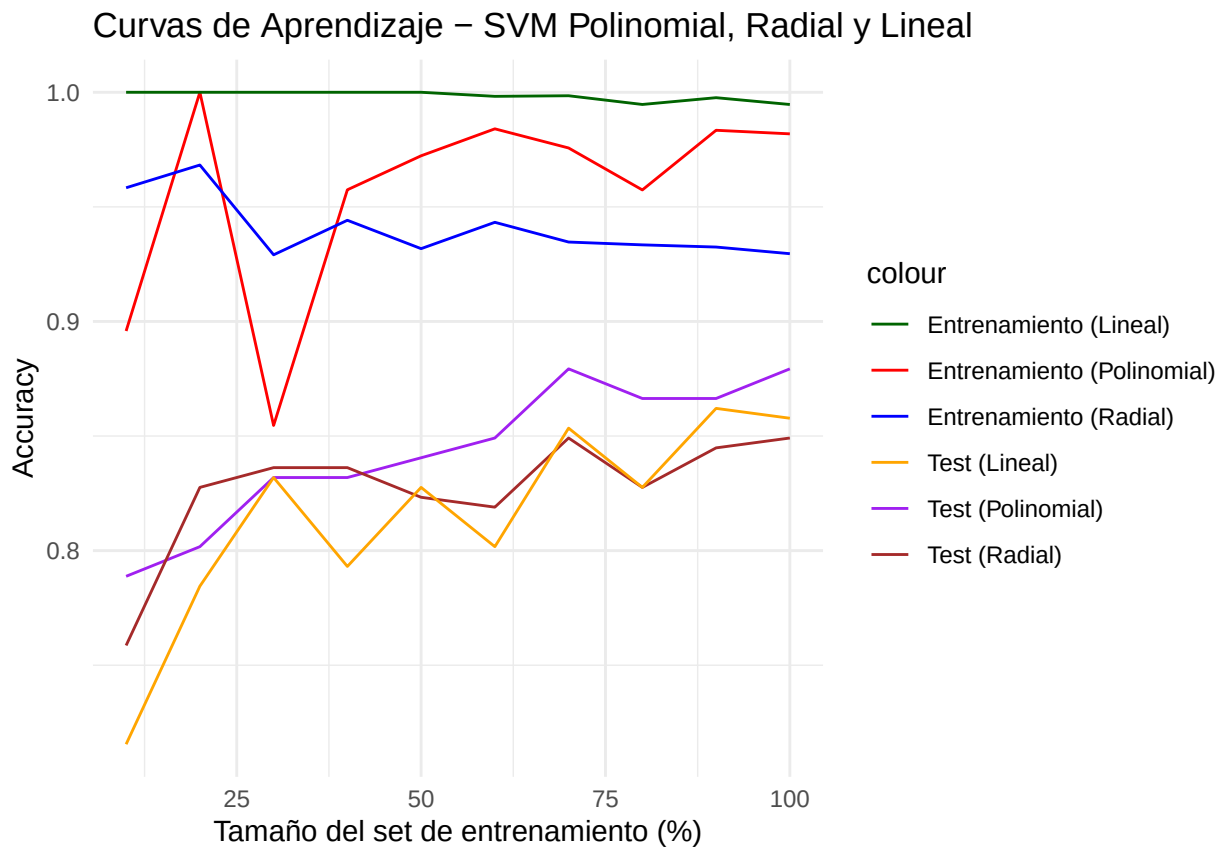
```

```r
# Crear dataframe para graficar
df_completo <- data.frame(
  Tamaño = tamaños * 100,
```

```
  Entrenamiento_Poly = acc_train_poly,
  Test_Poly = acc_test_poly,
  Entrenamiento_Radial = acc_train_radial,
  Test_Radial = acc_test_radial,
  Entrenamiento_Linear = acc_train_linear,
  Test_Linear = acc_test_linear
)

# Graficar la curva
ggplot(df_completo, aes(x = Tamaño)) +
  geom_line(aes(y = Entrenamiento_Poly, color = "Entrenamiento (Polinomial)")) +
  geom_line(aes(y = Test_Poly, color = "Test (Polinomial)")) +
  geom_line(aes(y = Entrenamiento_Radial, color = "Entrenamiento (Radial)")) +
  geom_line(aes(y = Test_Radial, color = "Test (Radial)")) +
  geom_line(aes(y = Entrenamiento_Linear, color = "Entrenamiento (Lineal)")) +
  geom_line(aes(y = Test_Linear, color = "Test (Lineal)")) +
  labs(
    title = "Curvas de Aprendizaje - SVM Polinomial, Radial y Lineal",
    x = "Tamaño del set de entrenamiento (%)",
    y = "Accuracy"
  ) +
  scale_color_manual(values = c("darkgreen", "red", "blue", "orange", "purple", "brown"))
  ↪  +
  theme_minimal()
```



Analisis de eficiencia de los modelos Analizando ambos graficos se puede ver que el modelo mas eficientes es el lineal debido a que es el mas rapido, pero en tema de rendimiento vemos que el polinomial es mucho mejor pero por unos 0.1 , a pesar de ello es el peor de todo en tiempo por lo que no se recomienda que se realice esto mismo para modelos de datos enormes.

En donde mas se equivocan los modelos si analizamos lo visto en el iniciso 6 es que identificacion de casas baratas y medias, esto debido a la naturaleza que las casas medias tienden a ser baratas.

En el analisis de su curva de aprendizaje el que mejor le fue es el polinomial, porque el lineal su test esta muy alejado de su train por 0.2, tambien vemos que el radial le pasa lo mismo pero el polinomial suele haber cierta tendencia a tener mejores resultados y deja un margen de mejora entre el train y el test haciendolo un poco mas generalista. Tambien vemos que ninguno tiene señales de subajuste o sobreajuste

En conclusion el polinomial es mas preciso y llega a predecir mejor que los otros 2 , pero en terminos de rendimiento y generalizacion tenemos que el lineal es el mejor de los 3.

9. Compare la eficiencia del mejor modelo de SVM con los resultados obtenidos en los algoritmos de las hojas de trabajo anteriores que usen la misma variable respuesta (árbol de decisión y random forest, naive bayes, KNN, regresión logística). ¿Cuál es mejor para predecir? ¿Cuál se demoró más en procesar?

```
library(ggplot2)
# Datos de clasificación
clasificacion <- data.frame(
Modelo = c("Regresion Logistica","KNN","Naive Bayes", "Random Forest", "Árbol de
 ↪  Clasificación", "SVM"),
Accuracy = c(0.7013, 0.67, 0.8041237, 0.9816934, 0.7414188, 0.8707)
)
# Gráfico de Accuracy (Clasificación)
ggplot(clasificacion, aes(x = Modelo, y = Accuracy, fill = Modelo)) +
geom_bar(stat = "identity", color = "black", alpha = 0.8) +
labs(title = "Comparación de Accuracy en Modelos de Clasificación",
x = "Modelo",
y = "Accuracy") +
theme_minimal() +
theme(legend.position = "none")
```

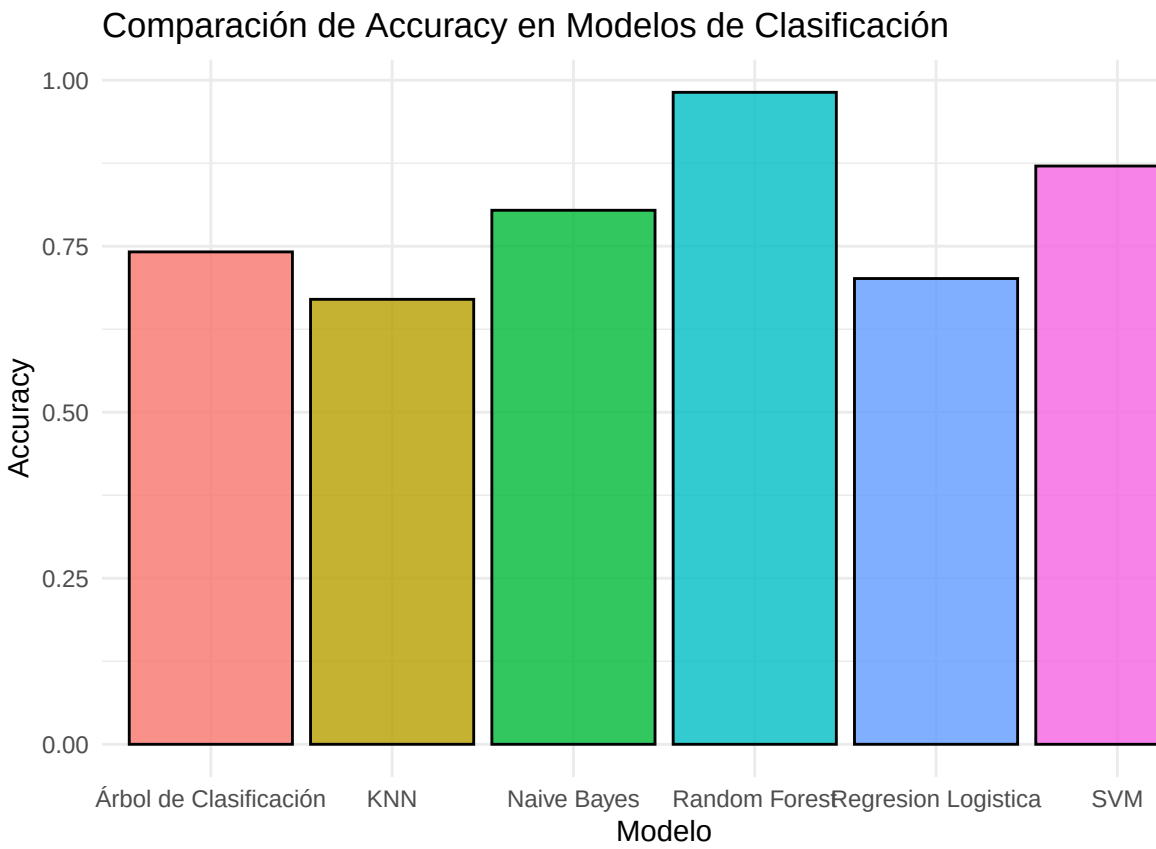


Grafico de modelos

Analisis de Modelos Podemos ver que el mejor modelo de los 3 sigue siendo el random forest para poder clasificar pero SVM tiene mayor presicion que todos excepto a Random Forest.

En terminos de velocidad sigue siendo regresion logistica el mejor y de hecho SVM es el peor de todos si usamos el polinomial , puede llegar a tardar casi lo mismo que el Random Forest. Esto puede ser porque ya que en general Random Forest hace una predicción basada en la agregación de los resultados de los árboles, lo cual es más rápido que resolver una optimización de SVM con un kernel complejo.

En conclusion es muy bueno SVM de hecho de todos los que no son Random Forest es el mejor , y se recomienda usarlo pero polynomial, esto porque es mas rapido y lleva 0.85 de accurrancy a comparacion de los modelos anteriores.

10. Genere un buen modelo de regresión, use para esto la variable del precio de la casa directamente. Tunee el modelo.

Vamos a probar con lineal y con Polinomial

```
train_data <- read.csv("train_set.csv", stringsAsFactors = FALSE)
test_data <- read.csv("test_set.csv", stringsAsFactors = FALSE)

library(dplyr)
library(readr)

#  Fijar semilla para reproducibilidad
set.seed(123)
```

```r
train <- read_csv("train_set.csv")
```

```
## Rows: 937 Columns: 84
## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr (42): MSZoning, Street, LotShape, LandContour, Utilities, LotConfig, Lan...
## dbl (42): Id, MSSubClass, LotFrontage, LotArea, OverallQual, OverallCond, Ye...
##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```r
test <- read_csv("test_set.csv")
```

```
## Rows: 232 Columns: 84
## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr (42): MSZoning, Street, LotShape, LandContour, Utilities, LotConfig, Lan...
## dbl (42): Id, MSSubClass, LotFrontage, LotArea, OverallQual, OverallCond, Ye...
##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```r
train_svm <- train %>% select(-Id)
test_svm  <- test %>% select(-Id)




#  Variables objetivo
y_train <- train_svm$SalePrice
y_test  <- test_svm$SalePrice



#  Convertir character a factor
x_train <- x_train %>% mutate(across(where(is.character), as.factor))
x_test  <- x_test %>% mutate(across(where(is.character), as.factor))

#  Combinar para detectar todos los niveles posibles
x_all <- bind_rows(x_train, x_test)

#  Crear dummyVars con todos los niveles presentes
dv <- dummyVars(" ~ .", data = x_all, fullRank = TRUE)

#  Generar dummies por separado
x_train_dummy <- predict(dv, newdata = x_train)
x_test_dummy  <- predict(dv, newdata = x_test)

#  Preprocesar (centrar y escalar)
preproc <- preProcess(x_train_dummy, method = c("center", "scale"))
```

```
## Warning in preProcess.default(x_train_dummy, method = c("center", "scale")):
## These variables have zero variances: Neighborhood.Blueste, Condition2.RRAn,
## RoofStyle.Shed, Foundation.Wood, Electrical.Mix, GarageQual.Po
```

```r
#  Librerías necesarias
library(caret)
library(dplyr)

#  Fijar semilla
set.seed(123)

#  Convertir los dummy a data.frame
x_train_dummy <- as.data.frame(x_train_dummy)
x_test_dummy  <- as.data.frame(x_test_dummy)

#  Eliminar columnas con varianza 0 en train
varianzas <- apply(x_train_dummy, 2, var)
cols_validas <- names(varianzas[!is.na(varianzas) & varianzas > 0])
x_train_dummy <- x_train_dummy[, cols_validas]

#  Alinear columnas en test (agregar faltantes con 0)
faltantes <- setdiff(cols_validas, colnames(x_test_dummy))
for (col in faltantes) {
  x_test_dummy[[col]] <- 0
}

#  Reordenar columnas en test para que coincidan con train
x_test_dummy <- x_test_dummy[, cols_validas]

#  Confirmación de que están alineadas
stopifnot(identical(colnames(x_train_dummy), colnames(x_test_dummy)))

#  Escalar datos
preproc <- preProcess(x_train_dummy, method = c("center", "scale"))
x_train_scaled <- predict(preproc, x_train_dummy)
x_test_scaled  <- predict(preproc, x_test_dummy)

#  Entrenar modelo SVM lineal con fallback a SVM radial
cat("  Entrenando modelo SVM lineal...\n")
```

```
##   Entrenando modelo SVM lineal...
```

```r
svm_linear_model <- train(
    x = x_train_scaled,
    y = y_train,
    method = "svmLinear",
    trControl = trainControl(method = "cv", number = 10),
    preProcess = NULL,
    tuneLength = 3
)
```

```
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```

```r
print(svm_linear_model)
```

```
## Support Vector Machines with Linear Kernel
##
## 937 samples
## 207 predictors
##
## No pre-processing
## Resampling: Cross-Validated (10 fold)
## Summary of sample sizes: 842, 843, 844, 843, 844, 843, ...
## Resampling results:
##
##   RMSE      Rsquared  MAE
##   60485.69  0.759404  38899.11
##
## Tuning parameter 'C' was held constant at a value of 1
```

```r
svm_poly_model <- train(
    x = x_train_scaled,
    y = y_train,
    method = "svmPoly",
    trControl = trainControl(method = "cv", number = 10),
    preProcess = NULL,
    tuneLength = 3
)
```

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```

```r
print(svm_poly_model)
```

```
## Support Vector Machines with Polynomial Kernel
##
## 937 samples
## 207 predictors
##
## No pre-processing
## Resampling: Cross-Validated (10 fold)
## Summary of sample sizes: 843, 844, 843, 842, 843, 844, ...
## Resampling results across tuning parameters:
##
##   degree  scale  C     RMSE      Rsquared   MAE
##   1       0.001  0.25  63824.41  0.7549660  41004.87
##   1       0.001  0.50  62245.85  0.7630293  40109.84
##   1       0.001  1.00  60883.68  0.7722797  39355.28
```

```
##   1       0.010  0.25  59726.36  0.7802170  38833.60
##   1       0.010  0.50  58889.87  0.7866093  38366.48
##   1       0.010  1.00  58258.00  0.7909912  38093.04
##   1       0.100  0.25  57146.21  0.7979803  37710.88
##   1       0.100  0.50  56871.88  0.7987195  37533.12
##   1       0.100  1.00  56493.39  0.8001154  37217.08
##   2       0.001  0.25  62161.83  0.7634605  40072.63
##   2       0.001  0.50  60864.43  0.7725651  39360.91
##   2       0.001  1.00  60032.20  0.7783588  38908.80
##   2       0.010  0.25  59985.34  0.7776560  38729.25
##   2       0.010  0.50  59957.83  0.7773574  38645.24
##   2       0.010  1.00  59840.49  0.7787226  38596.19
##   2       0.100  0.25  61995.30  0.7138148  40389.65
##   2       0.100  0.50  61584.03  0.7142505  39967.21
##   2       0.100  1.00  60773.18  0.7151221  39127.54
##   3       0.001  0.25  61373.56  0.7690338  39634.09
##   3       0.001  0.50  60325.20  0.7764161  39056.79
##   3       0.001  1.00  59517.08  0.7821771  38598.05
##   3       0.010  0.25  61340.58  0.7493818  39370.96
##   3       0.010  0.50  61232.12  0.7496687  39319.63
##   3       0.010  1.00  61104.15  0.7499179  39215.10
##   3       0.100  0.25  59556.30  0.5826538  37731.27
##   3       0.100  0.50  56498.49  0.6323364  35132.66
##   3       0.100  1.00  52290.56  0.7000194  31339.35
##
## RMSE was used to select the optimal model using the smallest value.
## The final values used for the model were degree = 3, scale = 0.1 and C = 1.
```

```
predictions <- predict(svm_linear_model, x_test_scaled)
predictiones_poly <- predict(svm_poly_model, x_test_scaled)


rmse <- sqrt(mean((predictions - y_test)^2))
cat("RMSE:", rmse, "\n")
```

```
## RMSE: 17894.71
```

```
rmse <- sqrt(mean((predictiones_poly - y_test)^2))
cat("RMSE:", rmse, "\n")
```

```
## RMSE: 25704.59
```

Analisis del Modelo Lineal

El modelo explica aproximadamente el 76% de la varianza en los precios de venta, lo que es relativamente bueno para predicción de precios de viviendas.

Análisis de rendimiento:

- RMSE en validación cruzada: 60,485.69
- R-cuadrado: 0.759404 (aproximadamente 76%)
- MAE: 38,899.11

- RMSE en testing: 17,894.71

Hay una gran diferencia entre el RMSE de validación cruzada (60,485) y el RMSE de testing (17,894). Esta discrepancia puede indicar:

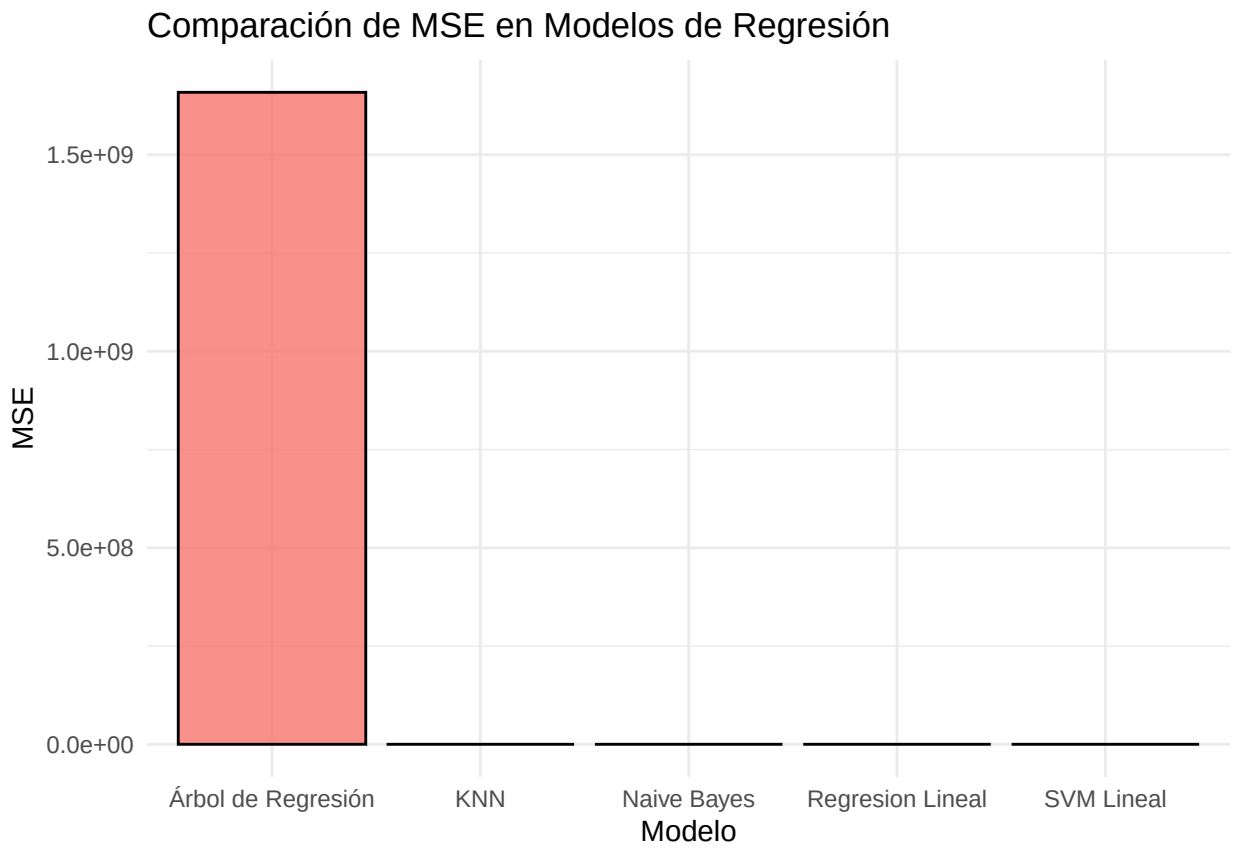
- Posible inconsistencia en los datos entre entrenamiento y prueba
- Los conjuntos pueden tener distribuciones diferentes
- Potencial sobreajuste en la evaluación final

Ahora con el Polinomial tenemos que tuvo un 80% de R^2 lo cual es mucho mejor, el RSME fue de 25704.59 que es peor que el Lineal lo cual indica un peor rendimiento que el lineal asi que nos quedaremos con el polynomial.

11. Compare los resultados del modelo de regresión generado con los de hojas anteriores que utilicen la misma variable, como la de regresión lineal, el árbol de regresión, naive bayes, KNN.

```
# Datos de regresión
regresion <- data.frame(
  Modelo = c("KNN", "Regresion Lineal", "Naive Bayes", "Árbol de Regresión", "SVM
   ↪  Lineal"),
  MSE = c(0.1600, 0.00000000000000009157,0.05044311, 1658823049, 133.76 )
)

# Gráfico de MSE (Regresión)
ggplot(regresion, aes(x = Modelo, y = MSE, fill = Modelo)) +
  geom_bar(stat = "identity", color = "black", alpha = 0.8) +
  labs(title = "Comparación de MSE en Modelos de Regresión",
       x = "Modelo",
       y = "MSE") +
  theme_minimal() +
  theme(legend.position = "none")
```



Analisis de Rendimiento Vemos que el mejor de todos sigue siendo la Regresión Lineal, junto con Naive Bayes y KNN; sin embargo, logró ser considerablemente mejor que el Árbol de Regresión. Mientras la Regresión Lineal obtuvo un MSE de 133, el Árbol de Regresión alcanzó un MSE de 1,658,823,049, una diferencia abismal que evidencia la poca capacidad del árbol para ajustarse adecuadamente a los datos. Estos resultados nos indican que, aunque la Regresión Lineal no fue tan perfecta como se esperaba inicialmente, sigue representando una solución bastante sólida y confiable para la predicción de precios de viviendas en este caso.

En cuanto al modelo de SVM Polinomial, a pesar de sus capacidades teóricas para capturar relaciones complejas no lineales, presentó serios inconvenientes en la práctica. El tiempo de entrenamiento y ajuste de hiperparámetros (tuneo) fue excesivamente alto, tardando aproximadamente 3 minutos por ejecución, incluso con conjuntos de datos de tamaño moderado. Esta lentitud lo vuelve poco práctico para tareas de regresión cuando se requieren resultados rápidos o cuando se trabaja con bases de datos más grandes. Además, su rendimiento en cuanto a error cuadrático medio no justificó el costo computacional involucrado, mostrando que el SVM Polinomial no es recomendable para este tipo de problemas de regresión cuando existen alternativas más rápidas y eficaces como la Regresión Lineal, KNN o incluso modelos más ligeros de SVM con kernels lineales o radiales.