BAN 502 Course Project

Winslow Goins

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library(tidyverse)  
library(tidymodels)  
library(mice)   
library(VIM)   
library(naniar)   
library(skimr)   
library(GGally)  
library(lmtest)  
library(MASS)  
library(car)  
library(ggcorrplot)  
library(glmnet)  
library(lubridate)  
library(splines)  
library(gridExtra)  
library(e1071)  
library(ROCR)  
library(ggcorrplot)  
library(lmtest)  
library(caret)  
library(rpart)  
library(rpart.plot)  
library(rattle)  
library(RColorBrewer)  
library(gridExtra)  
library(vip)  
library(ranger)  
library(skimr)  
library(e1071)  
library(xgboost)  
library(usemodels)  
library(nnet)  
library(stacks)  
library(leaps)   
library(splines)

ames\_student<- read\_csv("ames\_student.csv")

summary(ames\_student)

## MS\_SubClass MS\_Zoning Lot\_Frontage Lot\_Area   
## Length:2053 Length:2053 Min. : 0.00 Min. : 1300   
## Class :character Class :character 1st Qu.: 43.00 1st Qu.: 7500   
## Mode :character Mode :character Median : 62.00 Median : 9548   
## Mean : 57.38 Mean : 10258   
## 3rd Qu.: 78.00 3rd Qu.: 11600   
## Max. :313.00 Max. :215245   
## Street Alley Lot\_Shape Land\_Contour   
## Length:2053 Length:2053 Length:2053 Length:2053   
## Class :character Class :character Class :character Class :character   
## Mode :character Mode :character Mode :character Mode :character   
##   
##   
##   
## Utilities Lot\_Config Land\_Slope Neighborhood   
## Length:2053 Length:2053 Length:2053 Length:2053   
## Class :character Class :character Class :character Class :character   
## Mode :character Mode :character Mode :character Mode :character   
##   
##   
##   
## Condition\_1 Condition\_2 Bldg\_Type House\_Style   
## Length:2053 Length:2053 Length:2053 Length:2053   
## Class :character Class :character Class :character Class :character   
## Mode :character Mode :character Mode :character Mode :character   
##   
##   
##   
## Overall\_Qual Overall\_Cond Year\_Built Year\_Remod\_Add  
## Length:2053 Length:2053 Min. :1875 Min. :1950   
## Class :character Class :character 1st Qu.:1953 1st Qu.:1965   
## Mode :character Mode :character Median :1972 Median :1993   
## Mean :1971 Mean :1984   
## 3rd Qu.:2000 3rd Qu.:2004   
## Max. :2010 Max. :2010   
## Roof\_Style Roof\_Matl Exterior\_1st Exterior\_2nd   
## Length:2053 Length:2053 Length:2053 Length:2053   
## Class :character Class :character Class :character Class :character   
## Mode :character Mode :character Mode :character Mode :character   
##   
##   
##   
## Mas\_Vnr\_Type Mas\_Vnr\_Area Exter\_Qual Exter\_Cond   
## Length:2053 Min. : 0.0 Length:2053 Length:2053   
## Class :character 1st Qu.: 0.0 Class :character Class :character   
## Mode :character Median : 0.0 Mode :character Mode :character   
## Mean : 103.8   
## 3rd Qu.: 164.0   
## Max. :1600.0   
## Foundation Bsmt\_Qual Bsmt\_Cond Bsmt\_Exposure   
## Length:2053 Length:2053 Length:2053 Length:2053   
## Class :character Class :character Class :character Class :character   
## Mode :character Mode :character Mode :character Mode :character   
##   
##   
##   
## BsmtFin\_Type\_1 BsmtFin\_SF\_1 BsmtFin\_Type\_2 BsmtFin\_SF\_2   
## Length:2053 Min. :1.00 Length:2053 Min. : 0.00   
## Class :character 1st Qu.:3.00 Class :character 1st Qu.: 0.00   
## Mode :character Median :3.00 Mode :character Median : 0.00   
## Mean :4.21 Mean : 52.57   
## 3rd Qu.:7.00 3rd Qu.: 0.00   
## Max. :7.00 Max. :1526.00   
## Bsmt\_Unf\_SF Total\_Bsmt\_SF Heating Heating\_QC   
## Min. : 0.0 Min. : 0 Length:2053 Length:2053   
## 1st Qu.: 226.0 1st Qu.: 793 Class :character Class :character   
## Median : 460.0 Median : 988 Mode :character Mode :character   
## Mean : 561.2 Mean :1055   
## 3rd Qu.: 801.0 3rd Qu.:1304   
## Max. :2336.0 Max. :5095   
## Central\_Air Electrical First\_Flr\_SF Second\_Flr\_SF   
## Length:2053 Length:2053 Min. : 432 Min. : 0.0   
## Class :character Class :character 1st Qu.: 882 1st Qu.: 0.0   
## Mode :character Mode :character Median :1088 Median : 0.0   
## Mean :1168 Mean : 326.1   
## 3rd Qu.:1402 3rd Qu.: 701.0   
## Max. :5095 Max. :1862.0   
## Low\_Qual\_Fin\_SF Gr\_Liv\_Area Bsmt\_Full\_Bath Bsmt\_Half\_Bath   
## Min. : 0.000 Min. : 480 Min. :0.0000 Min. :0.00000   
## 1st Qu.: 0.000 1st Qu.:1137 1st Qu.:0.0000 1st Qu.:0.00000   
## Median : 0.000 Median :1447 Median :0.0000 Median :0.00000   
## Mean : 4.973 Mean :1499 Mean :0.4301 Mean :0.05796   
## 3rd Qu.: 0.000 3rd Qu.:1737 3rd Qu.:1.0000 3rd Qu.:0.00000   
## Max. :1064.000 Max. :5095 Max. :3.0000 Max. :2.00000   
## Full\_Bath Half\_Bath Bedroom\_AbvGr Kitchen\_AbvGr   
## Min. :0.000 Min. :0.0000 Min. :0.000 Min. :1.000   
## 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 :1.564 Mean :0.3751 Mean :2.855 Mean :1.047   
## 3rd Qu.:2.000 3rd Qu.:1.0000 3rd Qu.:3.000 3rd Qu.:1.000   
## Max. :4.000 Max. :2.0000 Max. :6.000 Max. :3.000   
## Kitchen\_Qual TotRms\_AbvGrd Functional Fireplaces   
## Length:2053 Min. : 3.000 Length:2053 Min. :0.000   
## Class :character 1st Qu.: 5.000 Class :character 1st Qu.:0.000   
## Mode :character Median : 6.000 Mode :character Median :1.000   
## Mean : 6.442 Mean :0.603   
## 3rd Qu.: 7.000 3rd Qu.:1.000   
## Max. :15.000 Max. :4.000   
## Fireplace\_Qu Garage\_Type Garage\_Finish Garage\_Cars   
## Length:2053 Length:2053 Length:2053 Min. :0.000   
## Class :character Class :character Class :character 1st Qu.:1.000   
## Mode :character Mode :character Mode :character Median :2.000   
## Mean :1.774   
## 3rd Qu.:2.000   
## Max. :5.000   
## Garage\_Area Garage\_Qual Garage\_Cond Paved\_Drive   
## Min. : 0 Length:2053 Length:2053 Length:2053   
## 1st Qu.: 320 Class :character Class :character Class :character   
## Median : 478 Mode :character Mode :character Mode :character   
## Mean : 472   
## 3rd Qu.: 576   
## Max. :1488   
## Wood\_Deck\_SF Open\_Porch\_SF Enclosed\_Porch Three\_season\_porch  
## Min. : 0.00 Min. : 0.00 Min. : 0.00 Min. : 0.000   
## 1st Qu.: 0.00 1st Qu.: 0.00 1st Qu.: 0.00 1st Qu.: 0.000   
## Median : 0.00 Median : 27.00 Median : 0.00 Median : 0.000   
## Mean : 93.52 Mean : 48.17 Mean : 23.02 Mean : 2.799   
## 3rd Qu.: 168.00 3rd Qu.: 72.00 3rd Qu.: 0.00 3rd Qu.: 0.000   
## Max. :1424.00 Max. :742.00 Max. :584.00 Max. :407.000   
## Screen\_Porch Pool\_Area Pool\_QC Fence   
## Min. : 0.00 Min. : 0.000 Length:2053 Length:2053   
## 1st Qu.: 0.00 1st Qu.: 0.000 Class :character Class :character   
## Median : 0.00 Median : 0.000 Mode :character Mode :character   
## Mean : 16.68 Mean : 1.339   
## 3rd Qu.: 0.00 3rd Qu.: 0.000   
## Max. :576.00 Max. :800.000   
## Misc\_Feature Misc\_Val Mo\_Sold Year\_Sold   
## Length:2053 Min. : 0.00 Min. : 1.000 Min. :2006   
## Class :character 1st Qu.: 0.00 1st Qu.: 4.000 1st Qu.:2007   
## Mode :character Median : 0.00 Median : 6.000 Median :2008   
## Mean : 60.12 Mean : 6.189 Mean :2008   
## 3rd Qu.: 0.00 3rd Qu.: 8.000 3rd Qu.:2009   
## Max. :17000.00 Max. :12.000 Max. :2010   
## Sale\_Type Sale\_Condition Longitude Latitude   
## Length:2053 Length:2053 Min. :-93.69 Min. :41.99   
## Class :character Class :character 1st Qu.:-93.66 1st Qu.:42.02   
## Mode :character Mode :character Median :-93.64 Median :42.03   
## Mean :-93.64 Mean :42.03   
## 3rd Qu.:-93.62 3rd Qu.:42.05   
## Max. :-93.58 Max. :42.06   
## Above\_Median   
## Length:2053   
## Class :character   
## Mode :character   
##   
##   
##

ames = ames\_student %>% mutate(MS\_SubClass = as\_factor(MS\_SubClass)) %>%  
 mutate(MS\_Zoning = as\_factor(MS\_Zoning)) %>%  
 mutate(Street = as\_factor(Street)) %>%  
 mutate(Alley = as\_factor(Alley)) %>%  
 mutate(Lot\_Shape = as\_factor(Lot\_Shape)) %>%  
 mutate(Land\_Contour = as\_factor(Land\_Contour)) %>%  
 mutate(Utilities = as\_factor(Utilities)) %>%  
 mutate(Lot\_Config = as\_factor(Lot\_Config)) %>%  
 mutate(Land\_Slope = as\_factor(Land\_Slope)) %>%  
 mutate(Neighborhood = as\_factor(Neighborhood)) %>%  
 mutate(Condition\_1 = as\_factor(Condition\_1)) %>%  
 mutate(Condition\_2 = as\_factor(Condition\_2)) %>%  
 mutate(Bldg\_Type = as\_factor(Bldg\_Type)) %>%  
 mutate(House\_Style = as\_factor(House\_Style)) %>%  
 mutate(Overall\_Qual = as\_factor(Overall\_Qual)) %>%  
 mutate(Exter\_Cond = as\_factor(Exter\_Cond)) %>%  
 mutate(Year\_Built = as\_factor(Year\_Built)) %>%  
 mutate(Year\_Remod\_Add = as\_factor(Year\_Remod\_Add)) %>%  
 mutate(Roof\_Style = as\_factor(Roof\_Style)) %>%  
 mutate(Roof\_Matl = as\_factor(Roof\_Matl)) %>%  
 mutate(Exterior\_1st = as\_factor(Exterior\_1st)) %>%  
 mutate(Exterior\_2nd = as\_factor(Exterior\_2nd)) %>%  
 mutate(Mas\_Vnr\_Type = as\_factor(Mas\_Vnr\_Type)) %>%  
 mutate(Exter\_Qual = as\_factor(Exter\_Qual)) %>%  
 mutate(Exter\_Cond = as\_factor(Exter\_Cond)) %>%  
 mutate(Foundation = as\_factor(Foundation)) %>%  
 mutate(Bsmt\_Qual = as\_factor(Bsmt\_Qual)) %>%  
 mutate(Bsmt\_Cond = as\_factor(Bsmt\_Cond)) %>%  
 mutate(Bsmt\_Exposure = as\_factor(Bsmt\_Exposure)) %>%  
 mutate(BsmtFin\_Type\_1 = as\_factor(BsmtFin\_Type\_1)) %>%  
 mutate(MS\_SubClass = as\_factor(MS\_SubClass)) %>%  
 mutate(BsmtFin\_Type\_2 = as\_factor(BsmtFin\_Type\_2)) %>%  
 mutate(Heating = as\_factor(Heating)) %>%  
 mutate(Heating\_QC = as\_factor(Heating\_QC)) %>%  
 mutate(Central\_Air = as\_factor(Central\_Air)) %>%  
 mutate(Electrical = as\_factor(Electrical)) %>%  
 mutate(Bsmt\_Full\_Bath = as\_factor(Bsmt\_Full\_Bath)) %>%  
 mutate(Bsmt\_Half\_Bath = as\_factor(Bsmt\_Half\_Bath)) %>%  
 mutate(Full\_Bath = as\_factor(Full\_Bath)) %>%  
 mutate(Half\_Bath = as\_factor(Half\_Bath)) %>%  
 mutate(Bedroom\_AbvGr = as\_factor(Bedroom\_AbvGr)) %>%  
 mutate(Kitchen\_AbvGr = as\_factor(Kitchen\_AbvGr)) %>%  
 mutate(Kitchen\_Qual = as\_factor(Kitchen\_Qual)) %>%  
 mutate(Functional = as\_factor(Functional)) %>%  
 mutate(Fireplaces = as\_factor(Fireplaces)) %>%  
 mutate(Fireplace\_Qu = as\_factor(Fireplace\_Qu)) %>%  
 mutate(Garage\_Type = as\_factor(Garage\_Type)) %>%  
 mutate(Garage\_Finish = as\_factor(Garage\_Finish)) %>%  
 mutate(Garage\_Cars = as\_factor(Garage\_Cars)) %>%  
 mutate(Garage\_Qual = as\_factor(Garage\_Qual)) %>%  
 mutate(Garage\_Cond = as\_factor(Garage\_Cond)) %>%  
 mutate(Paved\_Drive = as\_factor(Paved\_Drive)) %>%  
 mutate(Pool\_QC = as\_factor(Pool\_QC)) %>%  
 mutate(Fence = as\_factor(Fence)) %>%  
 mutate(Misc\_Feature = as\_factor(Misc\_Feature)) %>%  
 mutate(Mo\_Sold = as\_factor(Mo\_Sold)) %>%  
 mutate(Year\_Sold = as\_factor(Year\_Sold)) %>%  
 mutate(Sale\_Type = as\_factor(Sale\_Type)) %>%  
 mutate(Sale\_Condition = as\_factor(Sale\_Condition)) %>%  
 mutate(Above\_Median = as\_factor(Above\_Median)) %>%  
 mutate(Overall\_Cond = as\_factor(Overall\_Cond))

summary(ames)

## MS\_SubClass MS\_Zoning   
## One\_Story\_1946\_and\_Newer\_All\_Styles :772 Residential\_Low\_Density :1600   
## Two\_Story\_1946\_and\_Newer :383 Residential\_High\_Density : 20   
## One\_and\_Half\_Story\_Finished\_All\_Ages:204 Floating\_Village\_Residential: 87   
## One\_Story\_PUD\_1946\_and\_Newer :129 Residential\_Medium\_Density : 326   
## One\_Story\_1945\_and\_Older : 98 C\_all : 17   
## Two\_Story\_1945\_and\_Older : 95 A\_agr : 2   
## (Other) :372 I\_all : 1   
## Lot\_Frontage Lot\_Area Street Alley   
## Min. : 0.00 Min. : 1300 Pave:2046 No\_Alley\_Access:1914   
## 1st Qu.: 43.00 1st Qu.: 7500 Grvl: 7 Paved : 45   
## Median : 62.00 Median : 9548 Gravel : 94   
## Mean : 57.38 Mean : 10258   
## 3rd Qu.: 78.00 3rd Qu.: 11600   
## Max. :313.00 Max. :215245   
##   
## Lot\_Shape Land\_Contour Utilities Lot\_Config   
## Slightly\_Irregular : 714 Lvl:1833 AllPub:2052 Corner : 359   
## Regular :1275 HLS: 94 NoSewr: 1 Inside :1495   
## Moderately\_Irregular: 53 Bnk: 81 CulDSac: 135   
## Irregular : 11 Low: 45 FR2 : 56   
## FR3 : 8   
##   
##   
## Land\_Slope Neighborhood Condition\_1 Condition\_2 Bldg\_Type   
## Gtl:1951 North\_Ames : 327 Norm :1771 Norm :2027 OneFam :1706   
## Mod: 89 College\_Creek: 183 Feedr : 113 Feedr : 12 TwnhsE : 157   
## Sev: 13 Old\_Town : 181 Artery : 67 PosA : 4 Twnhs : 67   
## Edwards : 129 RRAn : 35 Artery : 4 Duplex : 76   
## Somerset : 119 PosN : 24 PosN : 3 TwoFmCon: 47   
## Gilbert : 109 RRAe : 19 RRNn : 1   
## (Other) :1005 (Other): 24 (Other): 2   
## House\_Style Overall\_Qual Overall\_Cond   
## One\_Story :1052 Average :587 Average :1143   
## Two\_Story : 590 Above\_Average:518 Above\_Average: 376   
## One\_and\_Half\_Fin: 225 Good :411 Good : 286   
## SLvl : 90 Very\_Good :237 Very\_Good : 98   
## SFoyer : 56 Below\_Average:169 Below\_Average: 73   
## Two\_and\_Half\_Unf: 19 Excellent : 70 Fair : 35   
## (Other) : 21 (Other) : 61 (Other) : 42   
## Year\_Built Year\_Remod\_Add Roof\_Style Roof\_Matl Exterior\_1st  
## 2005 : 104 1950 : 256 Hip : 404 CompShg:2023 VinylSd:705   
## 2006 : 93 2006 : 147 Gable :1607 WdShake: 8 MetalSd:319   
## 2007 : 76 2007 : 116 Mansard: 9 Tar&Grv: 17 Wd Sdng:313   
## 2003 : 62 2005 : 94 Gambrel: 14 WdShngl: 3 HdBoard:303   
## 2004 : 60 2004 : 80 Shed : 5 Roll : 1 Plywood:151   
## 1977 : 40 2003 : 70 Flat : 14 Metal : 1 CemntBd: 90   
## (Other):1618 (Other):1290 (Other):172   
## Exterior\_2nd Mas\_Vnr\_Type Mas\_Vnr\_Area Exter\_Qual   
## VinylSd:699 Stone : 166 Min. : 0.0 Typical :1272   
## MetalSd:317 None :1231 1st Qu.: 0.0 Good : 682   
## Wd Sdng:302 BrkFace: 638 Median : 0.0 Excellent: 78   
## HdBoard:277 BrkCmn : 17 Mean : 103.8 Fair : 21   
## Plywood:190 CBlock : 1 3rd Qu.: 164.0   
## CmentBd: 90 Max. :1600.0   
## (Other):178   
## Exter\_Cond Foundation Bsmt\_Qual Bsmt\_Cond   
## Typical :1787 CBlock:880 Typical :911 Good : 80   
## Good : 213 PConc :911 Good :849 Typical :1833   
## Fair : 43 Wood : 4 Excellent :178 Poor : 4   
## Excellent: 9 BrkTil:216 No\_Basement: 57 No\_Basement: 57   
## Poor : 1 Slab : 36 Fair : 57 Fair : 76   
## Stone : 6 Poor : 1 Excellent : 3   
##   
## Bsmt\_Exposure BsmtFin\_Type\_1 BsmtFin\_SF\_1 BsmtFin\_Type\_2  
## Gd : 199 BLQ :196 Min. :1.00 Unf :1740   
## No :1331 Rec :216 1st Qu.:3.00 LwQ : 64   
## Av : 284 ALQ :298 Median :3.00 BLQ : 47   
## Mn : 179 GLQ :578 Mean :4.21 Rec : 79   
## No\_Basement: 60 Unf :602 3rd Qu.:7.00 GLQ : 23   
## LwQ :106 Max. :7.00 No\_Basement: 58   
## No\_Basement: 57 ALQ : 42   
## BsmtFin\_SF\_2 Bsmt\_Unf\_SF Total\_Bsmt\_SF Heating   
## Min. : 0.00 Min. : 0.0 Min. : 0 GasA :2019   
## 1st Qu.: 0.00 1st Qu.: 226.0 1st Qu.: 793 GasW : 21   
## Median : 0.00 Median : 460.0 Median : 988 Grav : 6   
## Mean : 52.57 Mean : 561.2 Mean :1055 Wall : 5   
## 3rd Qu.: 0.00 3rd Qu.: 801.0 3rd Qu.:1304 Floor: 1   
## Max. :1526.00 Max. :2336.0 Max. :5095 OthW : 1   
##   
## Heating\_QC Central\_Air Electrical First\_Flr\_SF Second\_Flr\_SF   
## Fair : 61 Y:1916 SBrkr :1887 Min. : 432 Min. : 0.0   
## Typical : 618 N: 137 FuseA : 126 1st Qu.: 882 1st Qu.: 0.0   
## Excellent:1040 FuseF : 33 Median :1088 Median : 0.0   
## Good : 333 FuseP : 6 Mean :1168 Mean : 326.1   
## Poor : 1 Unknown: 1 3rd Qu.:1402 3rd Qu.: 701.0   
## Max. :5095 Max. :1862.0   
##   
## Low\_Qual\_Fin\_SF Gr\_Liv\_Area Bsmt\_Full\_Bath Bsmt\_Half\_Bath Full\_Bath  
## Min. : 0.000 Min. : 480 0:1201 0:1936 0: 10   
## 1st Qu.: 0.000 1st Qu.:1137 1: 823 1: 115 1: 920   
## Median : 0.000 Median :1447 2: 27 2: 2 2:1080   
## Mean : 4.973 Mean :1499 3: 2 3: 41   
## 3rd Qu.: 0.000 3rd Qu.:1737 4: 2   
## Max. :1064.000 Max. :5095   
##   
## Half\_Bath Bedroom\_AbvGr Kitchen\_AbvGr Kitchen\_Qual TotRms\_AbvGrd   
## 0:1300 0: 7 1:1959 Typical :1070 Min. : 3.000   
## 1: 736 1: 73 2: 92 Good : 790 1st Qu.: 5.000   
## 2: 17 2: 527 3: 2 Excellent: 142 Median : 6.000   
## 3:1105 Fair : 50 Mean : 6.442   
## 4: 297 Poor : 1 3rd Qu.: 7.000   
## 5: 32 Max. :15.000   
## 6: 12   
## Functional Fireplaces Fireplace\_Qu Garage\_Type   
## Typ :1896 0:993 Good :538 Attchd :1204   
## Min2 : 54 1:891 No\_Fireplace:993 BuiltIn : 127   
## Min1 : 51 2:161 Typical :409 Basment : 29   
## Mod : 27 3: 7 Poor : 36 Detchd : 549   
## Maj1 : 15 4: 1 Excellent : 21 No\_Garage : 108   
## Maj2 : 6 Fair : 56 CarPort : 15   
## (Other): 4 More\_Than\_Two\_Types: 21   
## Garage\_Finish Garage\_Cars Garage\_Area Garage\_Qual Garage\_Cond   
## Fin :509 0: 108 Min. : 0 Typical :1839 Typical :1872   
## Unf :872 1: 539 1st Qu.: 320 No\_Garage: 109 No\_Garage: 109   
## RFn :563 2:1131 Median : 478 Fair : 85 Fair : 53   
## No\_Garage:109 3: 261 Mean : 472 Good : 16 Excellent: 1   
## 4: 13 3rd Qu.: 576 Excellent: 2 Poor : 8   
## 5: 1 Max. :1488 Poor : 2 Good : 10   
##   
## Paved\_Drive Wood\_Deck\_SF Open\_Porch\_SF Enclosed\_Porch   
## Partial\_Pavement: 42 Min. : 0.00 Min. : 0.00 Min. : 0.00   
## Paved :1848 1st Qu.: 0.00 1st Qu.: 0.00 1st Qu.: 0.00   
## Dirt\_Gravel : 163 Median : 0.00 Median : 27.00 Median : 0.00   
## Mean : 93.52 Mean : 48.17 Mean : 23.02   
## 3rd Qu.: 168.00 3rd Qu.: 72.00 3rd Qu.: 0.00   
## Max. :1424.00 Max. :742.00 Max. :584.00   
##   
## Three\_season\_porch Screen\_Porch Pool\_Area Pool\_QC   
## Min. : 0.000 Min. : 0.00 Min. : 0.000 No\_Pool :2047   
## 1st Qu.: 0.000 1st Qu.: 0.00 1st Qu.: 0.000 Excellent: 2   
## Median : 0.000 Median : 0.00 Median : 0.000 Typical : 2   
## Mean : 2.799 Mean : 16.68 Mean : 1.339 Fair : 1   
## 3rd Qu.: 0.000 3rd Qu.: 0.00 3rd Qu.: 0.000 Good : 1   
## Max. :407.000 Max. :576.00 Max. :800.000   
##   
## Fence Misc\_Feature Misc\_Val Mo\_Sold   
## No\_Fence :1661 None:1978 Min. : 0.00 6 :352   
## Minimum\_Privacy : 225 Gar2: 5 1st Qu.: 0.00 7 :320   
## Good\_Privacy : 81 Shed: 66 Median : 0.00 5 :275   
## Good\_Wood : 77 Othr: 3 Mean : 60.12 4 :187   
## Minimum\_Wood\_Wire: 9 Elev: 1 3rd Qu.: 0.00 8 :169   
## Max. :17000.00 3 :164   
## (Other):586   
## Year\_Sold Sale\_Type Sale\_Condition Longitude Latitude   
## 2006:442 WD :1789 Normal :1712 Min. :-93.69 Min. :41.99   
## 2007:499 New : 163 Partial: 169 1st Qu.:-93.66 1st Qu.:42.02   
## 2008:445 COD : 54 Family : 30 Median :-93.64 Median :42.03   
## 2009:456 ConLD : 16 Abnorml: 121 Mean :-93.64 Mean :42.03   
## 2010:211 ConLI : 8 Alloca : 16 3rd Qu.:-93.62 3rd Qu.:42.05   
## CWD : 8 AdjLand: 5 Max. :-93.58 Max. :42.06   
## (Other): 15   
## Above\_Median  
## Yes:1043   
## No :1010   
##   
##   
##   
##   
##

skim(ames)

Data summary

|  |  |
| --- | --- |
| Name | ames |
| Number of rows | 2053 |
| Number of columns | 81 |
| \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |  |
| Column type frequency: |  |
| factor | 59 |
| numeric | 22 |
| \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |  |
| Group variables | None |

**Variable type: factor**

| skim\_variable | n\_missing | complete\_rate | ordered | n\_unique | top\_counts |
| --- | --- | --- | --- | --- | --- |
| MS\_SubClass | 0 | 1 | FALSE | 16 | One: 772, Two: 383, One: 204, One: 129 |
| MS\_Zoning | 0 | 1 | FALSE | 7 | Res: 1600, Res: 326, Flo: 87, Res: 20 |
| Street | 0 | 1 | FALSE | 2 | Pav: 2046, Grv: 7 |
| Alley | 0 | 1 | FALSE | 3 | No\_: 1914, Gra: 94, Pav: 45 |
| Lot\_Shape | 0 | 1 | FALSE | 4 | Reg: 1275, Sli: 714, Mod: 53, Irr: 11 |
| Land\_Contour | 0 | 1 | FALSE | 4 | Lvl: 1833, HLS: 94, Bnk: 81, Low: 45 |
| Utilities | 0 | 1 | FALSE | 2 | All: 2052, NoS: 1 |
| Lot\_Config | 0 | 1 | FALSE | 5 | Ins: 1495, Cor: 359, Cul: 135, FR2: 56 |
| Land\_Slope | 0 | 1 | FALSE | 3 | Gtl: 1951, Mod: 89, Sev: 13 |
| Neighborhood | 0 | 1 | FALSE | 28 | Nor: 327, Col: 183, Old: 181, Edw: 129 |
| Condition\_1 | 0 | 1 | FALSE | 9 | Nor: 1771, Fee: 113, Art: 67, RRA: 35 |
| Condition\_2 | 0 | 1 | FALSE | 8 | Nor: 2027, Fee: 12, Pos: 4, Art: 4 |
| Bldg\_Type | 0 | 1 | FALSE | 5 | One: 1706, Twn: 157, Dup: 76, Twn: 67 |
| House\_Style | 0 | 1 | FALSE | 8 | One: 1052, Two: 590, One: 225, SLv: 90 |
| Overall\_Qual | 0 | 1 | FALSE | 10 | Ave: 587, Abo: 518, Goo: 411, Ver: 237 |
| Overall\_Cond | 0 | 1 | FALSE | 9 | Ave: 1143, Abo: 376, Goo: 286, Ver: 98 |
| Year\_Built | 0 | 1 | FALSE | 114 | 200: 104, 200: 93, 200: 76, 200: 62 |
| Year\_Remod\_Add | 0 | 1 | FALSE | 61 | 195: 256, 200: 147, 200: 116, 200: 94 |
| Roof\_Style | 0 | 1 | FALSE | 6 | Gab: 1607, Hip: 404, Gam: 14, Fla: 14 |
| Roof\_Matl | 0 | 1 | FALSE | 6 | Com: 2023, Tar: 17, WdS: 8, WdS: 3 |
| Exterior\_1st | 0 | 1 | FALSE | 16 | Vin: 705, Met: 319, Wd : 313, HdB: 303 |
| Exterior\_2nd | 0 | 1 | FALSE | 17 | Vin: 699, Met: 317, Wd : 302, HdB: 277 |
| Mas\_Vnr\_Type | 0 | 1 | FALSE | 5 | Non: 1231, Brk: 638, Sto: 166, Brk: 17 |
| Exter\_Qual | 0 | 1 | FALSE | 4 | Typ: 1272, Goo: 682, Exc: 78, Fai: 21 |
| Exter\_Cond | 0 | 1 | FALSE | 5 | Typ: 1787, Goo: 213, Fai: 43, Exc: 9 |
| Foundation | 0 | 1 | FALSE | 6 | PCo: 911, CBl: 880, Brk: 216, Sla: 36 |
| Bsmt\_Qual | 0 | 1 | FALSE | 6 | Typ: 911, Goo: 849, Exc: 178, No\_: 57 |
| Bsmt\_Cond | 0 | 1 | FALSE | 6 | Typ: 1833, Goo: 80, Fai: 76, No\_: 57 |
| Bsmt\_Exposure | 0 | 1 | FALSE | 5 | No: 1331, Av: 284, Gd: 199, Mn: 179 |
| BsmtFin\_Type\_1 | 0 | 1 | FALSE | 7 | Unf: 602, GLQ: 578, ALQ: 298, Rec: 216 |
| BsmtFin\_Type\_2 | 0 | 1 | FALSE | 7 | Unf: 1740, Rec: 79, LwQ: 64, No\_: 58 |
| Heating | 0 | 1 | FALSE | 6 | Gas: 2019, Gas: 21, Gra: 6, Wal: 5 |
| Heating\_QC | 0 | 1 | FALSE | 5 | Exc: 1040, Typ: 618, Goo: 333, Fai: 61 |
| Central\_Air | 0 | 1 | FALSE | 2 | Y: 1916, N: 137 |
| Electrical | 0 | 1 | FALSE | 5 | SBr: 1887, Fus: 126, Fus: 33, Fus: 6 |
| Bsmt\_Full\_Bath | 0 | 1 | FALSE | 4 | 0: 1201, 1: 823, 2: 27, 3: 2 |
| Bsmt\_Half\_Bath | 0 | 1 | FALSE | 3 | 0: 1936, 1: 115, 2: 2 |
| Full\_Bath | 0 | 1 | FALSE | 5 | 2: 1080, 1: 920, 3: 41, 0: 10 |
| Half\_Bath | 0 | 1 | FALSE | 3 | 0: 1300, 1: 736, 2: 17 |
| Bedroom\_AbvGr | 0 | 1 | FALSE | 7 | 3: 1105, 2: 527, 4: 297, 1: 73 |
| Kitchen\_AbvGr | 0 | 1 | FALSE | 3 | 1: 1959, 2: 92, 3: 2 |
| Kitchen\_Qual | 0 | 1 | FALSE | 5 | Typ: 1070, Goo: 790, Exc: 142, Fai: 50 |
| Functional | 0 | 1 | FALSE | 8 | Typ: 1896, Min: 54, Min: 51, Mod: 27 |
| Fireplaces | 0 | 1 | FALSE | 5 | 0: 993, 1: 891, 2: 161, 3: 7 |
| Fireplace\_Qu | 0 | 1 | FALSE | 6 | No\_: 993, Goo: 538, Typ: 409, Fai: 56 |
| Garage\_Type | 0 | 1 | FALSE | 7 | Att: 1204, Det: 549, Bui: 127, No\_: 108 |
| Garage\_Finish | 0 | 1 | FALSE | 4 | Unf: 872, RFn: 563, Fin: 509, No\_: 109 |
| Garage\_Cars | 0 | 1 | FALSE | 6 | 2: 1131, 1: 539, 3: 261, 0: 108 |
| Garage\_Qual | 0 | 1 | FALSE | 6 | Typ: 1839, No\_: 109, Fai: 85, Goo: 16 |
| Garage\_Cond | 0 | 1 | FALSE | 6 | Typ: 1872, No\_: 109, Fai: 53, Goo: 10 |
| Paved\_Drive | 0 | 1 | FALSE | 3 | Pav: 1848, Dir: 163, Par: 42 |
| Pool\_QC | 0 | 1 | FALSE | 5 | No\_: 2047, Exc: 2, Typ: 2, Fai: 1 |
| Fence | 0 | 1 | FALSE | 5 | No\_: 1661, Min: 225, Goo: 81, Goo: 77 |
| Misc\_Feature | 0 | 1 | FALSE | 5 | Non: 1978, She: 66, Gar: 5, Oth: 3 |
| Mo\_Sold | 0 | 1 | FALSE | 12 | 6: 352, 7: 320, 5: 275, 4: 187 |
| Year\_Sold | 0 | 1 | FALSE | 5 | 200: 499, 200: 456, 200: 445, 200: 442 |
| Sale\_Type | 0 | 1 | FALSE | 10 | WD: 1789, New: 163, COD: 54, Con: 16 |
| Sale\_Condition | 0 | 1 | FALSE | 6 | Nor: 1712, Par: 169, Abn: 121, Fam: 30 |
| Above\_Median | 0 | 1 | FALSE | 2 | Yes: 1043, No: 1010 |

**Variable type: numeric**

| skim\_variable | n\_missing | complete\_rate | mean | sd | p0 | p25 | p50 | p75 | p100 | hist |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Lot\_Frontage | 0 | 1 | 57.38 | 33.20 | 0.00 | 43.00 | 62.00 | 78.00 | 313.00 | ▇▇▁▁▁ |
| Lot\_Area | 0 | 1 | 10258.40 | 8427.38 | 1300.00 | 7500.00 | 9548.00 | 11600.00 | 215245.00 | ▇▁▁▁▁ |
| Mas\_Vnr\_Area | 0 | 1 | 103.75 | 183.59 | 0.00 | 0.00 | 0.00 | 164.00 | 1600.00 | ▇▁▁▁▁ |
| BsmtFin\_SF\_1 | 0 | 1 | 4.21 | 2.24 | 1.00 | 3.00 | 3.00 | 7.00 | 7.00 | ▅▆▁▁▇ |
| BsmtFin\_SF\_2 | 0 | 1 | 52.57 | 175.99 | 0.00 | 0.00 | 0.00 | 0.00 | 1526.00 | ▇▁▁▁▁ |
| Bsmt\_Unf\_SF | 0 | 1 | 561.19 | 441.72 | 0.00 | 226.00 | 460.00 | 801.00 | 2336.00 | ▇▅▂▁▁ |
| Total\_Bsmt\_SF | 0 | 1 | 1054.57 | 435.33 | 0.00 | 793.00 | 988.00 | 1304.00 | 5095.00 | ▇▇▁▁▁ |
| First\_Flr\_SF | 0 | 1 | 1167.52 | 391.79 | 432.00 | 882.00 | 1088.00 | 1402.00 | 5095.00 | ▇▃▁▁▁ |
| Second\_Flr\_SF | 0 | 1 | 326.07 | 422.44 | 0.00 | 0.00 | 0.00 | 701.00 | 1862.00 | ▇▂▂▁▁ |
| Low\_Qual\_Fin\_SF | 0 | 1 | 4.97 | 49.09 | 0.00 | 0.00 | 0.00 | 0.00 | 1064.00 | ▇▁▁▁▁ |
| Gr\_Liv\_Area | 0 | 1 | 1498.56 | 487.84 | 480.00 | 1137.00 | 1447.00 | 1737.00 | 5095.00 | ▇▇▁▁▁ |
| TotRms\_AbvGrd | 0 | 1 | 6.44 | 1.54 | 3.00 | 5.00 | 6.00 | 7.00 | 15.00 | ▅▇▃▁▁ |
| Garage\_Area | 0 | 1 | 471.96 | 213.43 | 0.00 | 320.00 | 478.00 | 576.00 | 1488.00 | ▃▇▂▁▁ |
| Wood\_Deck\_SF | 0 | 1 | 93.52 | 127.71 | 0.00 | 0.00 | 0.00 | 168.00 | 1424.00 | ▇▁▁▁▁ |
| Open\_Porch\_SF | 0 | 1 | 48.17 | 69.51 | 0.00 | 0.00 | 27.00 | 72.00 | 742.00 | ▇▁▁▁▁ |
| Enclosed\_Porch | 0 | 1 | 23.02 | 60.59 | 0.00 | 0.00 | 0.00 | 0.00 | 584.00 | ▇▁▁▁▁ |
| Three\_season\_porch | 0 | 1 | 2.80 | 25.65 | 0.00 | 0.00 | 0.00 | 0.00 | 407.00 | ▇▁▁▁▁ |
| Screen\_Porch | 0 | 1 | 16.68 | 57.94 | 0.00 | 0.00 | 0.00 | 0.00 | 576.00 | ▇▁▁▁▁ |
| Pool\_Area | 0 | 1 | 1.34 | 27.74 | 0.00 | 0.00 | 0.00 | 0.00 | 800.00 | ▇▁▁▁▁ |
| Misc\_Val | 0 | 1 | 60.12 | 662.76 | 0.00 | 0.00 | 0.00 | 0.00 | 17000.00 | ▇▁▁▁▁ |
| Longitude | 0 | 1 | -93.64 | 0.03 | -93.69 | -93.66 | -93.64 | -93.62 | -93.58 | ▅▅▇▇▁ |
| Latitude | 0 | 1 | 42.03 | 0.02 | 41.99 | 42.02 | 42.03 | 42.05 | 42.06 | ▂▂▇▇▇ |

## Data Clean, Data Split, Recip

amesclean = ames %>% dplyr::select(-Alley, -Street, -Utilities, -Heating, -Bsmt\_Half\_Bath, -Pool\_QC, -Mo\_Sold, -Year\_Sold, -Pool\_Area, -Longitude, -Latitude)

set.seed(12345)  
ames\_split = initial\_split(amesclean, prop = 0.65, strata = Above\_Median)  
train = training(ames\_split)  
test = testing(ames\_split)

amesABMV\_recipe = recipe(Above\_Median ~., train) #recipe 1  
  
amesABMV\_recipe2 = recipe(Above\_Median ~ MS\_SubClass + Lot\_Shape + Neighborhood + Bldg\_Type + House\_Style + Overall\_Qual + Overall\_Cond + Year\_Built + Year\_Remod\_Add + Foundation + Bsmt\_Qual + Bsmt\_Cond + Bsmt\_Full\_Bath + Full\_Bath + Half\_Bath + Kitchen\_Qual + Fireplaces + Garage\_Cars + Garage\_Type + Sale\_Type + Sale\_Condition + Lot\_Area + Total\_Bsmt\_SF + First\_Flr\_SF + Second\_Flr\_SF + Gr\_Liv\_Area+ TotRms\_AbvGrd + Garage\_Area, train) #recipe2  
  
amesABMV\_recipe3 = recipe(Above\_Median ~ Neighborhood + House\_Style + Overall\_Qual + Overall\_Cond + Full\_Bath + Half\_Bath + Kitchen\_Qual + Fireplaces + Garage\_Cars + Sale\_Type + Lot\_Area + Total\_Bsmt\_SF + Gr\_Liv\_Area+ Garage\_Area, train) #recipe3  
  
ctrl\_grid = control\_stack\_grid() #necessary for working with the stacks package  
ctrl\_res = control\_stack\_resamples() #necessary for working with the stacks package

## Model 1

Log Model 1

ames\_model =   
 logistic\_reg(mode = "classification") %>%   
 set\_engine("glm")   
  
ames\_recipe = amesABMV\_recipe2 %>%  
 step\_dummy(all\_nominal(), -all\_outcomes()) %>%  
 step\_zv(all\_predictors())   
   
  
  
logreg\_wf = workflow() %>%  
 add\_recipe(ames\_recipe) %>%   
 add\_model(ames\_model)  
  
ames\_fit = fit(logreg\_wf, train)

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

saveRDS(ames\_fit,"ameslog1.rds")

ames\_fit = readRDS("ameslog1.rds")

summary(ames\_fit$fit$fit$fit)

##   
## Call:  
## stats::glm(formula = ..y ~ ., family = stats::binomial, data = data)  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -8.49 0.00 0.00 0.00 8.49   
##   
## Coefficients: (4 not defined because of singularities)  
## Estimate Std. Error  
## (Intercept) -3.472e+14 8.689e+07  
## Lot\_Area -3.074e+10 5.931e+02  
## Total\_Bsmt\_SF -1.144e+12 1.220e+04  
## First\_Flr\_SF -6.531e+12 7.839e+04  
## Second\_Flr\_SF -6.617e+12 7.507e+04  
## Gr\_Liv\_Area 5.424e+12 7.777e+04  
## TotRms\_AbvGrd -1.063e+14 2.870e+06  
## Garage\_Area -6.805e+11 2.452e+04  
## MS\_SubClass\_Two\_Story\_1946\_and\_Newer -2.655e+15 2.411e+07  
## MS\_SubClass\_One\_Story\_PUD\_1946\_and\_Newer 1.231e+15 4.609e+07  
## MS\_SubClass\_One\_and\_Half\_Story\_Finished\_All\_Ages -1.981e+15 2.512e+07  
## MS\_SubClass\_Two\_Story\_PUD\_1946\_and\_Newer 3.782e+14 5.186e+07  
## MS\_SubClass\_Split\_or\_Multilevel -5.542e+14 3.982e+07  
## MS\_SubClass\_One\_Story\_1945\_and\_Older -1.029e+15 1.731e+07  
## MS\_SubClass\_Duplex\_All\_Styles\_and\_Ages 8.868e+14 1.672e+07  
## MS\_SubClass\_Split\_Foyer 1.512e+15 3.169e+07  
## MS\_SubClass\_Two\_Family\_conversion\_All\_Styles\_and\_Ages 3.308e+15 9.873e+07  
## MS\_SubClass\_Two\_Story\_1945\_and\_Older -3.015e+15 2.593e+07  
## MS\_SubClass\_One\_Story\_with\_Finished\_Attic\_All\_Ages -9.718e+13 3.615e+07  
## MS\_SubClass\_PUD\_Multilevel\_Split\_Level\_Foyer 3.677e+15 6.211e+07  
## MS\_SubClass\_One\_and\_Half\_Story\_Unfinished\_All\_Ages -1.585e+15 7.042e+07  
## MS\_SubClass\_Two\_and\_Half\_Story\_All\_Ages -2.318e+15 5.687e+07  
## MS\_SubClass\_One\_and\_Half\_Story\_PUD\_All\_Ages 5.923e+15 1.063e+08  
## Lot\_Shape\_Regular -1.612e+14 4.995e+06  
## Lot\_Shape\_Moderately\_Irregular -3.624e+14 1.388e+07  
## Lot\_Shape\_Irregular -2.425e+14 2.795e+07  
## Neighborhood\_Gilbert -7.721e+14 1.509e+07  
## Neighborhood\_Stone\_Brook -1.862e+15 1.925e+07  
## Neighborhood\_Northwest\_Ames -2.251e+14 1.402e+07  
## Neighborhood\_Somerset -2.157e+15 1.507e+07  
## Neighborhood\_Briardale -1.969e+15 2.884e+07  
## Neighborhood\_Northpark\_Villa 1.596e+15 3.030e+07  
## Neighborhood\_Northridge\_Heights -1.157e+15 1.683e+07  
## Neighborhood\_Bloomington\_Heights 4.638e+14 2.356e+07  
## Neighborhood\_Northridge 1.355e+15 2.021e+07  
## Neighborhood\_Sawyer\_West -7.426e+14 1.531e+07  
## Neighborhood\_Sawyer -3.916e+14 1.131e+07  
## Neighborhood\_Greens -2.215e+15 4.227e+07  
## Neighborhood\_Old\_Town 3.123e+14 1.279e+07  
## Neighborhood\_Brookside -8.481e+14 1.484e+07  
## Neighborhood\_Iowa\_DOT\_and\_Rail\_Road -2.070e+14 1.670e+07  
## Neighborhood\_Clear\_Creek -1.965e+15 2.035e+07  
## Neighborhood\_South\_and\_West\_of\_Iowa\_State\_University -1.130e+15 2.190e+07  
## Neighborhood\_Edwards 6.265e+14 1.140e+07  
## Neighborhood\_College\_Creek -1.338e+14 1.328e+07  
## Neighborhood\_Crawford -1.805e+15 1.476e+07  
## Neighborhood\_Mitchell -1.879e+14 1.507e+07  
## Neighborhood\_Timberland -1.612e+15 1.734e+07  
## Neighborhood\_Meadow\_Village -3.263e+14 2.677e+07  
## Neighborhood\_Veenker -4.700e+14 2.449e+07  
## Neighborhood\_Blueste 2.052e+15 5.844e+07  
## Neighborhood\_Landmark 3.714e+14 7.506e+07  
## Neighborhood\_Green\_Hills -5.715e+14 7.950e+07  
## Bldg\_Type\_TwnhsE -1.517e+15 4.562e+07  
## Bldg\_Type\_Twnhs -9.959e+14 4.745e+07  
## Bldg\_Type\_Duplex NA NA  
## Bldg\_Type\_TwoFmCon -3.551e+15 9.847e+07  
## House\_Style\_Two\_Story 2.622e+15 2.747e+07  
## House\_Style\_One\_and\_Half\_Fin 1.842e+15 2.564e+07  
## House\_Style\_SLvl -2.491e+14 3.858e+07  
## House\_Style\_SFoyer -1.722e+15 2.843e+07  
## House\_Style\_One\_and\_Half\_Unf 1.009e+15 6.530e+07  
## House\_Style\_Two\_and\_Half\_Unf 2.227e+15 5.097e+07  
## House\_Style\_Two\_and\_Half\_Fin 4.684e+15 1.126e+08  
## Overall\_Qual\_Average 7.658e+14 6.561e+06  
## Overall\_Qual\_Good -7.261e+13 7.522e+06  
## Overall\_Qual\_Very\_Good 2.674e+14 1.114e+07  
## Overall\_Qual\_Excellent 2.085e+15 1.830e+07  
## Overall\_Qual\_Below\_Average 2.492e+14 1.088e+07  
## Overall\_Qual\_Fair 8.811e+14 2.328e+07  
## Overall\_Qual\_Poor -2.445e+15 4.320e+07  
## Overall\_Qual\_Very\_Excellent 4.183e+15 2.593e+07  
## Overall\_Qual\_Very\_Poor -6.167e+14 5.703e+07  
## Overall\_Cond\_Above\_Average -5.505e+14 6.761e+06  
## Overall\_Cond\_Good -3.909e+14 8.414e+06  
## Overall\_Cond\_Poor 4.502e+15 4.357e+07  
## Overall\_Cond\_Very\_Good -3.661e+14 1.283e+07  
## Overall\_Cond\_Below\_Average -5.008e+14 1.354e+07  
## Overall\_Cond\_Excellent -8.890e+14 2.396e+07  
## Overall\_Cond\_Fair 1.805e+15 1.696e+07  
## Overall\_Cond\_Very\_Poor -3.481e+15 5.994e+07  
## Year\_Built\_X1879 3.081e+15 1.166e+08  
## Year\_Built\_X1880 6.217e+15 1.080e+08  
## Year\_Built\_X1882 -9.254e+14 1.373e+08  
## Year\_Built\_X1890 4.012e+15 9.419e+07  
## Year\_Built\_X1892 1.029e+14 1.431e+08  
## Year\_Built\_X1895 5.446e+15 1.078e+08  
## Year\_Built\_X1898 3.289e+15 1.146e+08  
## Year\_Built\_X1900 2.725e+15 8.223e+07  
## Year\_Built\_X1902 1.859e+15 1.176e+08  
## Year\_Built\_X1904 3.756e+15 1.064e+08  
## Year\_Built\_X1905 5.139e+15 9.712e+07  
## Year\_Built\_X1907 1.041e+16 1.226e+08  
## Year\_Built\_X1910 4.341e+15 8.088e+07  
## Year\_Built\_X1911 8.347e+15 1.073e+08  
## Year\_Built\_X1912 3.209e+15 1.366e+08  
## Year\_Built\_X1914 5.634e+15 9.057e+07  
## Year\_Built\_X1915 3.996e+15 8.132e+07  
## Year\_Built\_X1916 3.303e+15 9.381e+07  
## Year\_Built\_X1917 5.965e+15 9.368e+07  
## Year\_Built\_X1918 5.920e+15 8.782e+07  
## Year\_Built\_X1919 2.639e+15 8.596e+07  
## Year\_Built\_X1920 4.474e+15 8.023e+07  
## Year\_Built\_X1921 4.714e+15 8.486e+07  
## Year\_Built\_X1922 4.406e+15 8.614e+07  
## Year\_Built\_X1923 5.077e+15 8.156e+07  
## Year\_Built\_X1924 4.806e+15 8.288e+07  
## Year\_Built\_X1925 2.749e+15 8.076e+07  
## Year\_Built\_X1926 4.333e+15 8.383e+07  
## Year\_Built\_X1927 3.761e+15 8.555e+07  
## Year\_Built\_X1928 4.744e+15 8.764e+07  
## Year\_Built\_X1929 5.217e+15 8.522e+07  
## Year\_Built\_X1930 4.343e+15 8.262e+07  
## Year\_Built\_X1931 6.868e+15 9.324e+07  
## Year\_Built\_X1934 3.116e+15 8.501e+07  
## Year\_Built\_X1935 4.952e+15 8.328e+07  
## Year\_Built\_X1936 2.671e+15 8.794e+07  
## Year\_Built\_X1937 3.414e+15 8.525e+07  
## Year\_Built\_X1938 3.009e+15 8.699e+07  
## Year\_Built\_X1939 6.797e+15 9.001e+07  
## Year\_Built\_X1940 3.762e+15 8.162e+07  
## Year\_Built\_X1941 3.451e+15 8.295e+07  
## Year\_Built\_X1942 1.001e+15 1.164e+08  
## Year\_Built\_X1945 3.072e+15 8.483e+07  
## Year\_Built\_X1946 3.759e+15 8.476e+07  
## Year\_Built\_X1947 3.509e+15 8.465e+07  
## Year\_Built\_X1948 2.632e+15 8.078e+07  
## Year\_Built\_X1949 4.817e+15 8.191e+07  
## Year\_Built\_X1950 5.626e+15 8.053e+07  
## Year\_Built\_X1951 3.691e+15 8.876e+07  
## Year\_Built\_X1952 3.242e+15 9.345e+07  
## Year\_Built\_X1953 2.080e+15 8.557e+07  
## Year\_Built\_X1954 4.022e+15 8.366e+07  
## Year\_Built\_X1955 5.480e+15 9.014e+07  
## Year\_Built\_X1956 3.385e+15 8.380e+07  
## Year\_Built\_X1957 4.163e+15 8.160e+07  
## Year\_Built\_X1958 3.817e+15 8.020e+07  
## Year\_Built\_X1959 2.610e+15 8.499e+07  
## Year\_Built\_X1960 4.074e+15 8.101e+07  
## Year\_Built\_X1961 3.131e+15 8.313e+07  
## Year\_Built\_X1962 3.812e+15 9.110e+07  
## Year\_Built\_X1963 3.613e+15 8.401e+07  
## Year\_Built\_X1964 3.137e+15 8.837e+07  
## Year\_Built\_X1965 3.143e+15 8.154e+07  
## Year\_Built\_X1966 3.992e+15 8.190e+07  
## Year\_Built\_X1967 4.500e+15 8.807e+07  
## Year\_Built\_X1968 4.041e+15 8.759e+07  
## Year\_Built\_X1969 1.672e+15 9.433e+07  
## Year\_Built\_X1970 5.651e+15 8.891e+07  
## Year\_Built\_X1971 5.632e+15 7.984e+07  
## Year\_Built\_X1972 2.588e+15 8.193e+07  
## Year\_Built\_X1973 -2.794e+14 9.924e+07  
## Year\_Built\_X1974 1.610e+15 8.524e+07  
## Year\_Built\_X1975 3.549e+15 8.431e+07  
## Year\_Built\_X1976 6.483e+15 8.894e+07  
## Year\_Built\_X1977 4.644e+15 8.019e+07  
## Year\_Built\_X1978 4.610e+15 8.280e+07  
## Year\_Built\_X1979 1.298e+15 8.957e+07  
## Year\_Built\_X1980 2.734e+15 8.613e+07  
## Year\_Built\_X1981 4.822e+15 8.956e+07  
## Year\_Built\_X1982 6.007e+15 1.049e+08  
## Year\_Built\_X1983 3.066e+15 9.853e+07  
## Year\_Built\_X1984 5.586e+15 8.995e+07  
## Year\_Built\_X1985 3.781e+15 9.440e+07  
## Year\_Built\_X1986 1.193e+15 1.073e+08  
## Year\_Built\_X1987 5.158e+15 9.201e+07  
## Year\_Built\_X1988 3.078e+15 8.543e+07  
## Year\_Built\_X1989 5.785e+15 1.080e+08  
## Year\_Built\_X1990 4.473e+15 8.264e+07  
## Year\_Built\_X1991 3.004e+15 9.199e+07  
## Year\_Built\_X1992 3.950e+15 8.037e+07  
## Year\_Built\_X1993 3.688e+15 7.969e+07  
## Year\_Built\_X1994 3.809e+15 7.801e+07  
## Year\_Built\_X1995 3.348e+15 7.851e+07  
## Year\_Built\_X1996 4.621e+15 7.817e+07  
## Year\_Built\_X1997 1.715e+15 7.856e+07  
## Year\_Built\_X1998 3.885e+15 7.814e+07  
## Year\_Built\_X1999 3.721e+15 7.784e+07  
## Year\_Built\_X2000 1.931e+15 7.801e+07  
## Year\_Built\_X2001 4.241e+15 7.883e+07  
## Year\_Built\_X2002 3.387e+15 7.871e+07  
## Year\_Built\_X2003 4.426e+15 7.726e+07  
## Year\_Built\_X2004 4.168e+15 7.674e+07  
## Year\_Built\_X2005 2.416e+15 7.601e+07  
## Year\_Built\_X2006 2.945e+15 7.583e+07  
## Year\_Built\_X2007 2.978e+15 7.511e+07  
## Year\_Built\_X2008 5.941e+15 7.183e+07  
## Year\_Built\_X2009 2.363e+15 6.214e+07  
## Year\_Built\_X2010 NA NA  
## Year\_Remod\_Add\_X1951 1.281e+14 5.384e+07  
## Year\_Remod\_Add\_X1952 -1.319e+15 5.644e+07  
## Year\_Remod\_Add\_X1953 3.092e+15 4.639e+07  
## Year\_Remod\_Add\_X1954 -7.716e+14 3.751e+07  
## Year\_Remod\_Add\_X1955 -2.275e+15 5.063e+07  
## Year\_Remod\_Add\_X1956 9.673e+14 3.865e+07  
## Year\_Remod\_Add\_X1957 -1.604e+15 3.490e+07  
## Year\_Remod\_Add\_X1958 -8.317e+14 2.617e+07  
## Year\_Remod\_Add\_X1959 3.833e+15 4.015e+07  
## Year\_Remod\_Add\_X1960 1.710e+15 2.815e+07  
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## Foundation\_Wood -3.864e+14 4.734e+07  
## Foundation\_BrkTil 2.442e+14 1.139e+07  
## Foundation\_Slab -6.151e+14 2.630e+07  
## Foundation\_Stone 2.200e+15 3.993e+07  
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## Bsmt\_Cond\_Typical 1.087e+15 1.068e+07  
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## Half\_Bath\_X2 -1.170e+15 2.594e+07  
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## Kitchen\_Qual\_Excellent -9.515e+14 1.309e+07  
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## Garage\_Cars\_X2 2.143e+14 1.865e+07  
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## Sale\_Type\_Con -1.092e+14 3.855e+07  
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## Sale\_Type\_Oth -2.124e+14 4.113e+07  
## Sale\_Type\_ConLI -2.557e+14 4.283e+07  
## Sale\_Type\_ConLw -6.186e+14 5.115e+07  
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## Sale\_Type\_VWD 1.385e+14 7.407e+07  
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## Sale\_Condition\_Family 1.555e+15 1.882e+07  
## Sale\_Condition\_Abnorml 1.610e+15 9.738e+06  
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## Bsmt\_Qual\_No\_Basement 21201279 <2e-16 \*\*\*  
## Bsmt\_Qual\_Fair 21569332 <2e-16 \*\*\*  
## Bsmt\_Qual\_Poor 12958556 <2e-16 \*\*\*  
## Bsmt\_Cond\_Typical 101841011 <2e-16 \*\*\*  
## Bsmt\_Cond\_Poor 80132653 <2e-16 \*\*\*  
## Bsmt\_Cond\_No\_Basement NA NA   
## Bsmt\_Cond\_Fair 37172263 <2e-16 \*\*\*  
## Bsmt\_Cond\_Excellent -22309946 <2e-16 \*\*\*  
## Bsmt\_Full\_Bath\_X1 11862752 <2e-16 \*\*\*  
## Bsmt\_Full\_Bath\_X2 71646252 <2e-16 \*\*\*  
## Bsmt\_Full\_Bath\_X3 -42218375 <2e-16 \*\*\*  
## Full\_Bath\_X1 12908859 <2e-16 \*\*\*  
## Full\_Bath\_X2 2805950 <2e-16 \*\*\*  
## Full\_Bath\_X3 -45787978 <2e-16 \*\*\*  
## Full\_Bath\_X4 2716238 <2e-16 \*\*\*  
## Half\_Bath\_X1 -5623056 <2e-16 \*\*\*  
## Half\_Bath\_X2 -45101640 <2e-16 \*\*\*  
## Kitchen\_Qual\_Good -47190712 <2e-16 \*\*\*  
## Kitchen\_Qual\_Excellent -72674588 <2e-16 \*\*\*  
## Kitchen\_Qual\_Fair 70587403 <2e-16 \*\*\*  
## Kitchen\_Qual\_Poor -59043221 <2e-16 \*\*\*  
## Fireplaces\_X1 -110606691 <2e-16 \*\*\*  
## Fireplaces\_X2 -156809677 <2e-16 \*\*\*  
## Fireplaces\_X3 -96365423 <2e-16 \*\*\*  
## Fireplaces\_X4 54228922 <2e-16 \*\*\*  
## Garage\_Cars\_X1 54212134 <2e-16 \*\*\*  
## Garage\_Cars\_X2 11488459 <2e-16 \*\*\*  
## Garage\_Cars\_X3 -4503963 <2e-16 \*\*\*  
## Garage\_Cars\_X4 -3104066 <2e-16 \*\*\*  
## Garage\_Cars\_X5 196897 <2e-16 \*\*\*  
## Garage\_Type\_BuiltIn 32924283 <2e-16 \*\*\*  
## Garage\_Type\_Basment -9482873 <2e-16 \*\*\*  
## Garage\_Type\_Detchd 143023206 <2e-16 \*\*\*  
## Garage\_Type\_No\_Garage NA NA   
## Garage\_Type\_CarPort -20352997 <2e-16 \*\*\*  
## Garage\_Type\_More\_Than\_Two\_Types 76167925 <2e-16 \*\*\*  
## Sale\_Type\_New -16298732 <2e-16 \*\*\*  
## Sale\_Type\_COD -20183675 <2e-16 \*\*\*  
## Sale\_Type\_Con -2831793 <2e-16 \*\*\*  
## Sale\_Type\_ConLD -11665206 <2e-16 \*\*\*  
## Sale\_Type\_Oth -5163877 <2e-16 \*\*\*  
## Sale\_Type\_ConLI -5970012 <2e-16 \*\*\*  
## Sale\_Type\_ConLw -12094766 <2e-16 \*\*\*  
## Sale\_Type\_CWD 629250 <2e-16 \*\*\*  
## Sale\_Type\_VWD 1869926 <2e-16 \*\*\*  
## Sale\_Condition\_Partial 58497346 <2e-16 \*\*\*  
## Sale\_Condition\_Family 82582792 <2e-16 \*\*\*  
## Sale\_Condition\_Abnorml 165316827 <2e-16 \*\*\*  
## Sale\_Condition\_Alloca 48239508 <2e-16 \*\*\*  
## Sale\_Condition\_AdjLand -41726687 <2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for binomial family taken to be 1)  
##   
## Null deviance: 1847.6 on 1332 degrees of freedom  
## Residual deviance: 2451.0 on 1031 degrees of freedom  
## AIC: 3055  
##   
## Number of Fisher Scoring iterations: 20

logpred = predict(ames\_fit, train, type = "class")

## Warning in predict.lm(object, newdata, se.fit, scale = 1, type = if (type == :  
## prediction from a rank-deficient fit may be misleading

head(logpred)

## # A tibble: 6 x 1  
## .pred\_class  
## <fct>   
## 1 No   
## 2 No   
## 3 No   
## 4 No   
## 5 No   
## 6 No

confusionMatrix(logpred$.pred\_class,train$Above\_Median,positive="Yes")

## Confusion Matrix and Statistics  
##   
## Reference  
## Prediction Yes No  
## Yes 663 20  
## No 14 636  
##   
## Accuracy : 0.9745   
## 95% CI : (0.9645, 0.9823)  
## No Information Rate : 0.5079   
## P-Value [Acc > NIR] : <2e-16   
##   
## Kappa : 0.949   
##   
## Mcnemar's Test P-Value : 0.3912   
##   
## Sensitivity : 0.9793   
## Specificity : 0.9695   
## Pos Pred Value : 0.9707   
## Neg Pred Value : 0.9785   
## Prevalence : 0.5079   
## Detection Rate : 0.4974   
## Detection Prevalence : 0.5124   
## Balanced Accuracy : 0.9744   
##   
## 'Positive' Class : Yes   
##

logpred\_test = predict(ames\_fit, test, type = "class")

## Warning in predict.lm(object, newdata, se.fit, scale = 1, type = if (type == :  
## prediction from a rank-deficient fit may be misleading

head(logpred\_test)

## # A tibble: 6 x 1  
## .pred\_class  
## <fct>   
## 1 Yes   
## 2 Yes   
## 3 Yes   
## 4 Yes   
## 5 Yes   
## 6 No

confusionMatrix(logpred\_test$.pred\_class,test$Above\_Median,positive="Yes")

## Confusion Matrix and Statistics  
##   
## Reference  
## Prediction Yes No  
## Yes 326 51  
## No 40 303  
##   
## Accuracy : 0.8736   
## 95% CI : (0.8471, 0.897)  
## No Information Rate : 0.5083   
## P-Value [Acc > NIR] : <2e-16   
##   
## Kappa : 0.747   
##   
## Mcnemar's Test P-Value : 0.2945   
##   
## Sensitivity : 0.8907   
## Specificity : 0.8559   
## Pos Pred Value : 0.8647   
## Neg Pred Value : 0.8834   
## Prevalence : 0.5083   
## Detection Rate : 0.4528   
## Detection Prevalence : 0.5236   
## Balanced Accuracy : 0.8733   
##   
## 'Positive' Class : Yes   
##

The first Logimistic model should good accuracy with the training data and a good drop on the test data. The prediction rate is still okay, but its overfitted to the training data.

Log Model 2

ames\_modelA =   
 logistic\_reg(mode = "classification") %>%   
 set\_engine("glm")   
  
ames\_recipeA = amesABMV\_recipe3 %>%  
 step\_dummy(all\_nominal(), -all\_outcomes()) %>%  
 step\_zv(all\_predictors())  
  
logreg\_wfA = workflow() %>%  
 add\_recipe(ames\_recipeA) %>%   
 add\_model(ames\_modelA)  
  
ames\_fitA = fit(logreg\_wfA, train)

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

saveRDS(ames\_fitA,"ameslog2.rds")

ames\_fitA = readRDS("ameslog2.rds")

summary(ames\_fitA$fit$fit$fit)

##   
## Call:  
## stats::glm(formula = ..y ~ ., family = stats::binomial, data = data)  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -2.8034 -0.1552 0.0000 0.1312 3.3549   
##   
## Coefficients:  
## Estimate Std. Error  
## (Intercept) 1.588e+01 2.806e+00  
## Lot\_Area -2.275e-05 3.829e-05  
## Total\_Bsmt\_SF -3.245e-03 6.699e-04  
## Gr\_Liv\_Area -2.661e-03 7.182e-04  
## Garage\_Area 7.115e-04 1.641e-03  
## Neighborhood\_Gilbert -2.968e+00 8.932e-01  
## Neighborhood\_Stone\_Brook -3.449e+01 2.863e+03  
## Neighborhood\_Northwest\_Ames -6.327e-01 5.670e-01  
## Neighborhood\_Somerset -2.481e+00 7.841e-01  
## Neighborhood\_Briardale 1.602e+01 4.435e+03  
## Neighborhood\_Northpark\_Villa 2.013e+01 5.265e+03  
## Neighborhood\_Northridge\_Heights -9.248e-01 1.279e+00  
## Neighborhood\_Bloomington\_Heights -1.083e+00 1.144e+00  
## Neighborhood\_Northridge -1.405e+01 2.728e+03  
## Neighborhood\_Sawyer\_West -1.624e+00 6.571e-01  
## Neighborhood\_Sawyer -8.444e-02 5.750e-01  
## Neighborhood\_Greens 1.366e+00 2.193e+00  
## Neighborhood\_Old\_Town 3.001e+00 8.457e-01  
## Neighborhood\_Brookside 2.257e-01 7.912e-01  
## Neighborhood\_Iowa\_DOT\_and\_Rail\_Road 1.910e-01 1.215e+00  
## Neighborhood\_Clear\_Creek -1.653e+00 9.295e-01  
## Neighborhood\_South\_and\_West\_of\_Iowa\_State\_University -7.023e-02 1.017e+00  
## Neighborhood\_Edwards 7.539e-01 6.656e-01  
## Neighborhood\_College\_Creek -2.016e+00 5.816e-01  
## Neighborhood\_Crawford -9.998e-01 6.885e-01  
## Neighborhood\_Mitchell -8.245e-01 6.690e-01  
## Neighborhood\_Timberland -2.052e+01 2.326e+03  
## Neighborhood\_Meadow\_Village 1.667e+01 3.709e+03  
## Neighborhood\_Veenker -1.591e-01 1.478e+00  
## Neighborhood\_Blueste 1.981e+01 1.236e+04  
## Neighborhood\_Landmark 1.781e+01 1.773e+04  
## Neighborhood\_Green\_Hills -2.649e+01 1.773e+04  
## House\_Style\_Two\_Story -5.277e-01 6.083e-01  
## House\_Style\_One\_and\_Half\_Fin -1.428e-01 6.503e-01  
## House\_Style\_SLvl -1.164e+00 5.608e-01  
## House\_Style\_SFoyer -1.212e+00 7.362e-01  
## House\_Style\_One\_and\_Half\_Unf 1.667e+01 4.312e+03  
## House\_Style\_Two\_and\_Half\_Unf -8.356e-01 1.250e+00  
## House\_Style\_Two\_and\_Half\_Fin -1.509e+00 4.013e+00  
## Overall\_Qual\_Average 8.846e-01 3.280e-01  
## Overall\_Qual\_Good -6.053e-01 4.071e-01  
## Overall\_Qual\_Very\_Good -3.688e+00 1.625e+00  
## Overall\_Qual\_Excellent 1.782e+00 1.574e+00  
## Overall\_Qual\_Below\_Average 1.440e+00 1.027e+00  
## Overall\_Qual\_Fair 1.445e+01 3.466e+03  
## Overall\_Qual\_Poor 6.737e+00 5.992e+03  
## Overall\_Qual\_Very\_Excellent -2.399e+01 4.299e+03  
## Overall\_Qual\_Very\_Poor 1.118e+01 1.232e+04  
## Overall\_Cond\_Above\_Average -6.952e-01 3.573e-01  
## Overall\_Cond\_Good -1.798e+00 5.077e-01  
## Overall\_Cond\_Poor 2.170e+01 1.997e+03  
## Overall\_Cond\_Very\_Good -2.230e+00 6.522e-01  
## Overall\_Cond\_Below\_Average -1.490e+00 8.854e-01  
## Overall\_Cond\_Excellent -1.371e+00 1.243e+00  
## Overall\_Cond\_Fair 4.104e+00 1.457e+00  
## Overall\_Cond\_Very\_Poor 1.376e+01 9.437e+03  
## Full\_Bath\_X1 -2.656e+00 1.730e+00  
## Full\_Bath\_X2 -3.373e+00 1.774e+00  
## Full\_Bath\_X3 -3.724e+01 2.818e+03  
## Full\_Bath\_X4 -1.269e+01 1.254e+04  
## Half\_Bath\_X1 -7.203e-01 3.677e-01  
## Half\_Bath\_X2 -9.943e-01 1.156e+00  
## Kitchen\_Qual\_Good -1.052e+00 3.471e-01  
## Kitchen\_Qual\_Excellent -2.103e+00 1.025e+00  
## Kitchen\_Qual\_Fair 9.551e-01 1.317e+00  
## Kitchen\_Qual\_Poor 9.965e+00 1.773e+04  
## Fireplaces\_X1 -1.894e+00 3.199e-01  
## Fireplaces\_X2 -2.965e+00 5.327e-01  
## Fireplaces\_X3 -2.131e+01 6.236e+03  
## Fireplaces\_X4 -1.274e+01 1.773e+04  
## Garage\_Cars\_X1 -1.517e+00 1.431e+00  
## Garage\_Cars\_X2 -3.213e+00 1.582e+00  
## Garage\_Cars\_X3 -3.020e+00 1.942e+00  
## Garage\_Cars\_X4 -6.234e+00 3.332e+00  
## Garage\_Cars\_X5 1.192e+01 1.773e+04  
## Sale\_Type\_New -1.006e-01 6.884e-01  
## Sale\_Type\_COD 2.027e+00 1.067e+00  
## Sale\_Type\_Con 1.720e-02 2.012e+00  
## Sale\_Type\_ConLD 1.713e+01 1.960e+03  
## Sale\_Type\_Oth 1.635e+01 6.427e+03  
## Sale\_Type\_ConLI 1.502e+01 3.018e+03  
## Sale\_Type\_ConLw -2.696e+00 3.449e+01  
## Sale\_Type\_CWD 9.864e-02 1.282e+00  
## Sale\_Type\_VWD 1.870e+01 1.773e+04  
## z value Pr(>|z|)   
## (Intercept) 5.659 1.52e-08 \*\*\*  
## Lot\_Area -0.594 0.552420   
## Total\_Bsmt\_SF -4.844 1.27e-06 \*\*\*  
## Gr\_Liv\_Area -3.704 0.000212 \*\*\*  
## Garage\_Area 0.434 0.664642   
## Neighborhood\_Gilbert -3.323 0.000890 \*\*\*  
## Neighborhood\_Stone\_Brook -0.012 0.990388   
## Neighborhood\_Northwest\_Ames -1.116 0.264459   
## Neighborhood\_Somerset -3.164 0.001555 \*\*   
## Neighborhood\_Briardale 0.004 0.997117   
## Neighborhood\_Northpark\_Villa 0.004 0.996950   
## Neighborhood\_Northridge\_Heights -0.723 0.469582   
## Neighborhood\_Bloomington\_Heights -0.947 0.343613   
## Neighborhood\_Northridge -0.005 0.995892   
## Neighborhood\_Sawyer\_West -2.472 0.013429 \*   
## Neighborhood\_Sawyer -0.147 0.883246   
## Neighborhood\_Greens 0.623 0.533467   
## Neighborhood\_Old\_Town 3.548 0.000388 \*\*\*  
## Neighborhood\_Brookside 0.285 0.775422   
## Neighborhood\_Iowa\_DOT\_and\_Rail\_Road 0.157 0.875109   
## Neighborhood\_Clear\_Creek -1.778 0.075328 .   
## Neighborhood\_South\_and\_West\_of\_Iowa\_State\_University -0.069 0.944925   
## Neighborhood\_Edwards 1.133 0.257314   
## Neighborhood\_College\_Creek -3.466 0.000528 \*\*\*  
## Neighborhood\_Crawford -1.452 0.146427   
## Neighborhood\_Mitchell -1.233 0.217755   
## Neighborhood\_Timberland -0.009 0.992962   
## Neighborhood\_Meadow\_Village 0.004 0.996414   
## Neighborhood\_Veenker -0.108 0.914278   
## Neighborhood\_Blueste 0.002 0.998721   
## Neighborhood\_Landmark 0.001 0.999198   
## Neighborhood\_Green\_Hills -0.001 0.998808   
## House\_Style\_Two\_Story -0.868 0.385648   
## House\_Style\_One\_and\_Half\_Fin -0.220 0.826144   
## House\_Style\_SLvl -2.076 0.037907 \*   
## House\_Style\_SFoyer -1.646 0.099678 .   
## House\_Style\_One\_and\_Half\_Unf 0.004 0.996916   
## House\_Style\_Two\_and\_Half\_Unf -0.668 0.503901   
## House\_Style\_Two\_and\_Half\_Fin -0.376 0.706866   
## Overall\_Qual\_Average 2.697 0.006995 \*\*   
## Overall\_Qual\_Good -1.487 0.137120   
## Overall\_Qual\_Very\_Good -2.269 0.023260 \*   
## Overall\_Qual\_Excellent 1.132 0.257734   
## Overall\_Qual\_Below\_Average 1.402 0.160935   
## Overall\_Qual\_Fair 0.004 0.996674   
## Overall\_Qual\_Poor 0.001 0.999103   
## Overall\_Qual\_Very\_Excellent -0.006 0.995547   
## Overall\_Qual\_Very\_Poor 0.001 0.999276   
## Overall\_Cond\_Above\_Average -1.946 0.051670 .   
## Overall\_Cond\_Good -3.541 0.000398 \*\*\*  
## Overall\_Cond\_Poor 0.011 0.991332   
## Overall\_Cond\_Very\_Good -3.420 0.000627 \*\*\*  
## Overall\_Cond\_Below\_Average -1.683 0.092386 .   
## Overall\_Cond\_Excellent -1.103 0.270089   
## Overall\_Cond\_Fair 2.817 0.004849 \*\*   
## Overall\_Cond\_Very\_Poor 0.001 0.998836   
## Full\_Bath\_X1 -1.536 0.124573   
## Full\_Bath\_X2 -1.901 0.057242 .   
## Full\_Bath\_X3 -0.013 0.989454   
## Full\_Bath\_X4 -0.001 0.999192   
## Half\_Bath\_X1 -1.959 0.050115 .   
## Half\_Bath\_X2 -0.860 0.389867   
## Kitchen\_Qual\_Good -3.031 0.002440 \*\*   
## Kitchen\_Qual\_Excellent -2.052 0.040193 \*   
## Kitchen\_Qual\_Fair 0.725 0.468330   
## Kitchen\_Qual\_Poor 0.001 0.999552   
## Fireplaces\_X1 -5.919 3.23e-09 \*\*\*  
## Fireplaces\_X2 -5.566 2.60e-08 \*\*\*  
## Fireplaces\_X3 -0.003 0.997273   
## Fireplaces\_X4 -0.001 0.999426   
## Garage\_Cars\_X1 -1.061 0.288862   
## Garage\_Cars\_X2 -2.031 0.042224 \*   
## Garage\_Cars\_X3 -1.555 0.119882   
## Garage\_Cars\_X4 -1.871 0.061318 .   
## Garage\_Cars\_X5 0.001 0.999464   
## Sale\_Type\_New -0.146 0.883787   
## Sale\_Type\_COD 1.900 0.057387 .   
## Sale\_Type\_Con 0.009 0.993180   
## Sale\_Type\_ConLD 0.009 0.993025   
## Sale\_Type\_Oth 0.003 0.997970   
## Sale\_Type\_ConLI 0.005 0.996028   
## Sale\_Type\_ConLw -0.078 0.937694   
## Sale\_Type\_CWD 0.077 0.938648   
## Sale\_Type\_VWD 0.001 0.999158   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for binomial family taken to be 1)  
##   
## Null deviance: 1847.60 on 1332 degrees of freedom  
## Residual deviance: 446.37 on 1249 degrees of freedom  
## AIC: 614.37  
##   
## Number of Fisher Scoring iterations: 19

logpredA = predict(ames\_fitA, train, type = "class")  
head(logpredA)

## # A tibble: 6 x 1  
## .pred\_class  
## <fct>   
## 1 No   
## 2 No   
## 3 No   
## 4 No   
## 5 No   
## 6 No

confusionMatrix(logpredA$.pred\_class,train$Above\_Median,positive="Yes")

## Confusion Matrix and Statistics  
##   
## Reference  
## Prediction Yes No  
## Yes 636 45  
## No 41 611  
##   
## Accuracy : 0.9355   
## 95% CI : (0.9209, 0.9481)  
## No Information Rate : 0.5079   
## P-Value [Acc > NIR] : <2e-16   
##   
## Kappa : 0.8709   
##   
## Mcnemar's Test P-Value : 0.7463   
##   
## Sensitivity : 0.9394   
## Specificity : 0.9314   
## Pos Pred Value : 0.9339   
## Neg Pred Value : 0.9371   
## Prevalence : 0.5079   
## Detection Rate : 0.4771   
## Detection Prevalence : 0.5109   
## Balanced Accuracy : 0.9354   
##   
## 'Positive' Class : Yes   
##

logpred\_testA = predict(ames\_fitA, test, type = "class")  
head(logpred\_testA)

## # A tibble: 6 x 1  
## .pred\_class  
## <fct>   
## 1 Yes   
## 2 Yes   
## 3 Yes   
## 4 No   
## 5 Yes   
## 6 No

confusionMatrix(logpred\_testA$.pred\_class,test$Above\_Median,positive="Yes")

## Confusion Matrix and Statistics  
##   
## Reference  
## Prediction Yes No  
## Yes 337 39  
## No 29 315  
##   
## Accuracy : 0.9056   
## 95% CI : (0.8818, 0.9259)  
## No Information Rate : 0.5083   
## P-Value [Acc > NIR] : <2e-16   
##   
## Kappa : 0.811   
##   
## Mcnemar's Test P-Value : 0.2751   
##   
## Sensitivity : 0.9208   
## Specificity : 0.8898   
## Pos Pred Value : 0.8963   
## Neg Pred Value : 0.9157   
## Prevalence : 0.5083   
## Detection Rate : 0.4681   
## Detection Prevalence : 0.5222   
## Balanced Accuracy : 0.9053   
##   
## 'Positive' Class : Yes   
##

The second Logimistic model has a decrease in accuracy but is more consistent with the test data. This is an improvement over the first model.