stat6371\_kaggleProject

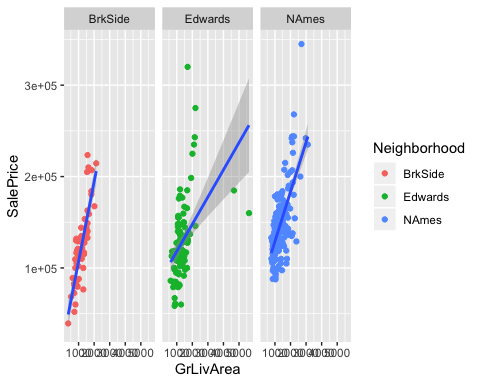
# install.packages("tidyverse")  
# install.packages("naniar")  
# install.packages("car")  
# install.packages("lmvar")  
# install.packages("gvlma")  
# install.packages("DAAG")  
# install.packages("lindia")  
# install.packages("pander")

## Load raw training set  
  
rawTrain\_df <- read.csv("data/train.csv")  
  
  
## Listing col names  
  
# names(rawTrain\_df)  
  
# summary(rawTrain\_df)  
  
  
## Describe data, identify categorical/factor variables  
  
# str(rawTrain\_df)

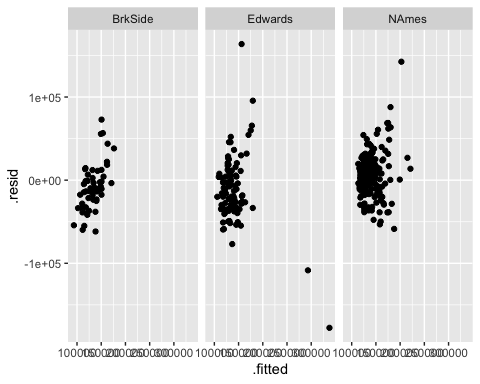
ANALYSIS 1: Assume that Century 21 Ames (a real estate company) in Ames Iowa has commissioned you to answer a very important question with respect to their business. Century 21 Ames only sells houses in the NAmes, Edwards and BrkSide neighborhoods and would like to simply get an estimate of how the SalePrice of the house is related to the square footage of the living area of the house (GrLIvArea) and if the SalesPrice (and its relationship to square footage) depends on which neighborhood the house is located in. Build and fit a model that will answer this question, keeping in mind that realtors prefer to talk about living area in increments of 100 sq. ft. Provide your client with the estimate (or estimates if it varies by neighborhood) as well as confidence intervals for any estimate(s) you provide. It turns out that Century 21’s leadership team has a member that has some statistical background. Therefore, make sure and provide evidence that the model assumptions are met and that any suspicious observations (outliers / influential observations) have been identified and addressed. Finally, of course, provide your client with a well written conclusion that quantifies the relationship between living area and sale price with respect to these three neighborhoods. Remember that the company is only concerned with the three neighborhoods they sell in.

## Split the raw dataframe with desired neighborhoods.  
  
aOne\_df <-   
 rawTrain\_df %>%   
 filter(  
 (Neighborhood == "NAmes" |   
 Neighborhood == "Edwards" |  
 Neighborhood == "BrkSide"  
 )  
 )  
  
## Number of Rows  
  
# nrow(a1\_df)  
  
## Find NA values in the Analysis 1 dataframe  
## Check to make sure there aren't NA values in our variables we want to use for prediction  
#   
# a1\_isNaCols <- colSums(is.na(a1\_df), na.rm = FALSE)%>% tibble::enframe(name = NULL)  
#   
# a1\_naCols <- a1\_df[ ,which(!a1\_isNaCols == 0)]  
#   
# a1\_countNaRows <- colSums(is.na(a1\_naCols), na.rm = FALSE)%>% tibble::enframe(name = NULL)  
#   
# a1\_naColCounts <- cbind(names(a1\_naCols),a1\_countNaRows)  
#   
# a1\_naColz <- a1\_naColCounts[order(-a1\_naColCounts$value),]

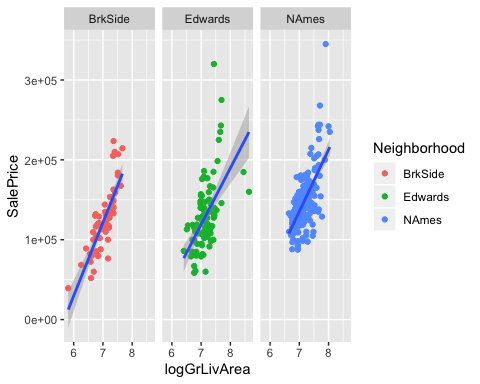
# colsOfInterest <- c("Neighborhood", "GrLivArea", "SalePrice")  
  
# aOne\_df <- a1\_df#[, colsOfInterest]  
  
aOne\_df %>%  
 ggplot() +  
 geom\_point(  
 aes(  
 x=GrLivArea,  
 y=SalePrice,  
 color=Neighborhood  
 )  
 ) +  
 geom\_smooth(  
 method = lm,  
 mapping =   
 aes(  
 x = aOne\_df$GrLivArea,  
 y = aOne\_df$SalePrice  
 ),  
 formula = y ~ x  
 ) +  
 facet\_wrap(  
 ~Neighborhood  
 )



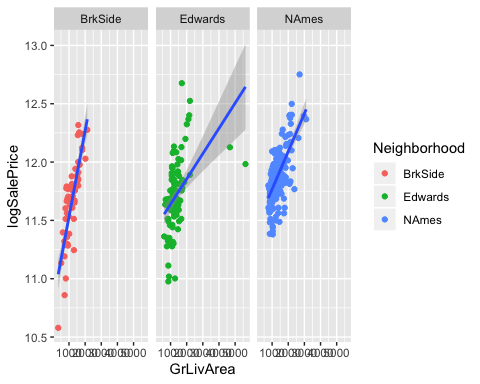
## Residual plot of untransformed data  
  
ggplot(  
 lm(  
 aOne\_df$SalePrice~aOne\_df$GrLivArea,  
 data=aOne\_df  
 )  
 ) +   
 geom\_point(  
 aes(  
 x=.fitted,   
 y=.resid  
 )  
 ) +   
 facet\_wrap(  
 ~aOne\_df$Neighborhood  
 )



## Add log transform column for x-var  
  
 aOne\_df <-   
 mutate(  
 aOne\_df,  
 logGrLivArea =  
 sapply(  
 aOne\_df$GrLivArea,   
 log  
 )  
 )  
  
## Plot log transformed x-variable  
  
aOne\_df %>%  
 ggplot() +  
 geom\_point(  
 aes(  
 x=logGrLivArea,  
 y=SalePrice,  
 color=Neighborhood  
 )  
 ) +  
 geom\_smooth(  
 method = lm,  
 mapping =   
 aes(  
 x = aOne\_df$logGrLivArea,  
 y = aOne\_df$SalePrice  
 ),  
 formula = y ~ x  
 ) +  
 facet\_wrap(  
 ~Neighborhood  
 )

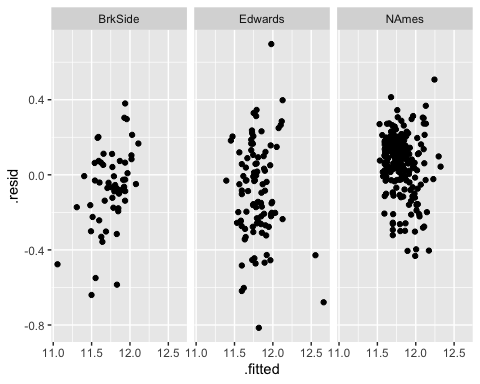


## Add log transform column for y-var  
  
aOne\_df <-   
 mutate(  
 aOne\_df,  
 logSalePrice =  
 sapply(  
 aOne\_df$SalePrice,   
 log  
 )  
 )  
  
## Plot log transformed y-var  
  
aOne\_df %>%  
 ggplot() +  
 geom\_point(  
 aes(  
 x=GrLivArea,  
 y=logSalePrice,  
 color=Neighborhood  
 )  
 ) +  
 geom\_smooth(  
 method = lm,  
 mapping =   
 aes(  
 x = aOne\_df$GrLivArea,  
 y = aOne\_df$logSalePrice  
 ),  
 formula = y ~ x  
 ) +  
 facet\_wrap(  
 ~Neighborhood  
 )



#  
#aOne\_df\_trns <-   
# mutate(  
# aOne\_df\_noLargePartials\_2,  
# salePriceSq = sapply(  
# aOne\_df\_noLargePartials\_2$logSalePrice,   
# function(x){  
# x\*\*3  
# }  
# )  
# )  
#  
#aOne\_df\_trns %>%  
# ggplot() +  
# geom\_point(  
# aes(  
# x=logGrLivArea,  
# y=salePriceSq  
# )  
# ) +  
# geom\_smooth(  
# method = lm,  
# mapping =   
# aes(  
# x = aOne\_df\_trns$logGrLivArea,  
# y = aOne\_df\_trns$salePriceSq  
# ),  
# formula = y ~ x  
# ) +  
# facet\_wrap(  
# ~Neighborhood  
# )  
#

## Residual plot of untransformed data  
  
ggplot(  
 lm(  
 aOne\_df$logSalePrice~aOne\_df$logGrLivArea,  
 data=aOne\_df  
 )  
 ) +   
 geom\_point(  
 aes(  
 x=.fitted,   
 y=.resid  
 )  
 ) +   
 facet\_wrap(  
 ~aOne\_df$Neighborhood  
 )



# write.csv(  
# aOne\_df,  
# file = "analysis1\_df"  
# )

# aOne\_unTrns\_lm <-   
# lm(  
# aOne\_df$SalePrice ~   
# aOne\_df$GrLivArea +   
# aOne\_df$Neighborhood +   
# (aOne\_df$GrLivArea \* aOne\_df$Neighborhood),  
# aOne\_df  
# )  
  
aOne\_TrnsXY\_lm <- lm(  
 aOne\_df$logSalePrice ~   
 aOne\_df$logGrLivArea +   
 aOne\_df$Neighborhood +   
 (aOne\_df$logGrLivArea \* aOne\_df$Neighborhood),  
 aOne\_df  
 )  
  
summary(aOne\_TrnsXY\_lm)

##   
## Call:  
## lm(formula = aOne\_df$logSalePrice ~ aOne\_df$logGrLivArea + aOne\_df$Neighborhood +   
## (aOne\_df$logGrLivArea \* aOne\_df$Neighborhood), data = aOne\_df)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.72080 -0.10353 0.02184 0.10586 0.80470   
##   
## Coefficients:  
## Estimate Std. Error  
## (Intercept) 5.91292 0.50459  
## aOne\_df$logGrLivArea 0.81965 0.07163  
## aOne\_df$NeighborhoodEdwards 2.09359 0.64589  
## aOne\_df$NeighborhoodNAmes 2.57981 0.59988  
## aOne\_df$logGrLivArea:aOne\_df$NeighborhoodEdwards -0.29998 0.09122  
## aOne\_df$logGrLivArea:aOne\_df$NeighborhoodNAmes -0.34662 0.08482  
## t value Pr(>|t|)   
## (Intercept) 11.718 < 2e-16 \*\*\*  
## aOne\_df$logGrLivArea 11.443 < 2e-16 \*\*\*  
## aOne\_df$NeighborhoodEdwards 3.241 0.0013 \*\*   
## aOne\_df$NeighborhoodNAmes 4.301 2.17e-05 \*\*\*  
## aOne\_df$logGrLivArea:aOne\_df$NeighborhoodEdwards -3.289 0.0011 \*\*   
## aOne\_df$logGrLivArea:aOne\_df$NeighborhoodNAmes -4.087 5.35e-05 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.1923 on 377 degrees of freedom  
## Multiple R-squared: 0.5121, Adjusted R-squared: 0.5056   
## F-statistic: 79.14 on 5 and 377 DF, p-value: < 2.2e-16

# summary(aOne\_unTrns\_lm)  
  
press(aOne\_TrnsXY\_lm)

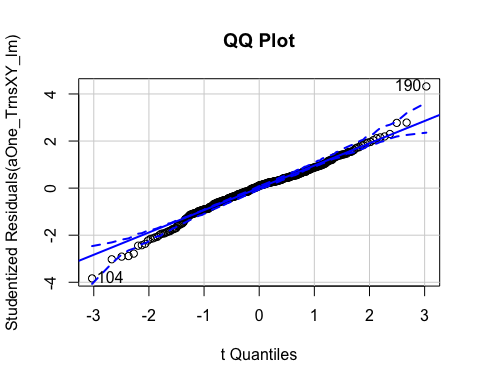
## [1] 14.60908

#{r} #aOne\_trns\_lm <- lm( # aOne\_df\_trns$salePriceSq ~ # aOne\_df\_trns$logGrLivArea + # aOne\_df\_trns$Neighborhood + # (aOne\_df\_trns$logGrLivArea \* aOne\_df\_trns$Neighborhood), # aOne\_df\_trns # ) # #summary(aOne\_trns\_lm) # #press(aOne\_trns\_lm) # #

# Assessing Outliers  
outlierTest(aOne\_TrnsXY\_lm) # Bonferonni p-value for most extreme obs

## rstudent unadjusted p-value Bonferroni p  
## 190 4.321333 1.9879e-05 0.0076135

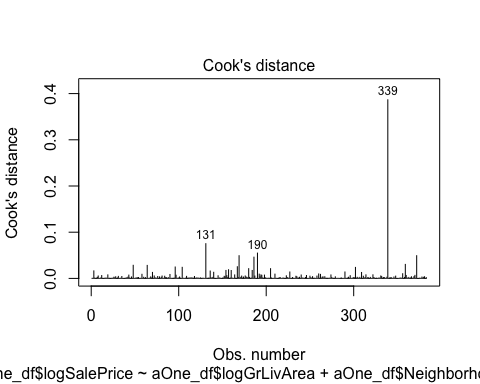
qqPlot(aOne\_TrnsXY\_lm, main="QQ Plot") #qq plot for studentized resid



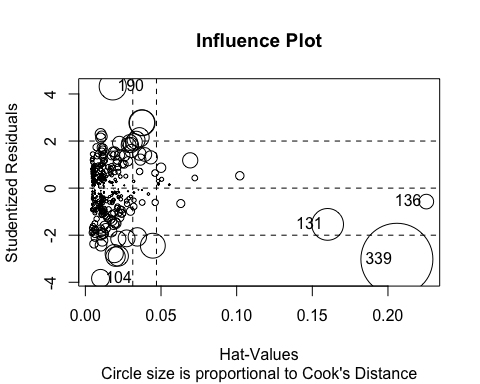
## [1] 104 190

#leveragePlots(aOne\_TrnsXY\_lm) # leverage plots

# Cook's D plot  
# identify D values > 4/(n-k-1)  
cutoff <-   
 4/((nrow(aOne\_df)-length(aOne\_TrnsXY\_lm$coefficients)-2))  
  
plot(  
 aOne\_TrnsXY\_lm,   
 which=4,   
 cook.levels=cutoff  
 )



# Influence Plot  
influencePlot(  
 aOne\_TrnsXY\_lm,   
 main="Influence Plot",   
 sub="Circle size is proportional to Cook's Distance"   
 )



## StudRes Hat CookD  
## 104 -3.8356341 0.01003581 0.02398505  
## 131 -1.5409476 0.16011659 0.07517290  
## 136 -0.5728569 0.22534912 0.01593916  
## 190 4.3213329 0.01808341 0.05475111  
## 339 -3.0229829 0.20590279 0.38657449

# aOne\_df[339,]

#mtcars[order(mpg),]  
  
edwrds <-   
 aOne\_df %>%   
 filter(Neighborhood == "Edwards")  
  
edwrds[order(-edwrds$GrLivArea),]

## Id MSSubClass MSZoning LotFrontage LotArea Street Alley LotShape  
## 88 1299 60 RL 313 63887 Pave <NA> IR3  
## 33 524 60 RL 130 40094 Pave <NA> IR1  
## 97 1424 80 RL NA 19690 Pave <NA> IR1  
## 60 922 90 RL 67 8777 Pave <NA> Reg  
## 9 176 20 RL 84 12615 Pave <NA> Reg  
## 79 1169 70 RL 120 13728 Pave <NA> Reg  
## 40 608 20 RL 78 7800 Pave <NA> Reg  
## 20 363 85 RL 64 7301 Pave <NA> Reg  
## 4 111 50 RL 75 9525 Pave <NA> Reg  
## 69 1046 20 RL NA 13680 Pave <NA> IR1  
## 17 293 50 RL 60 11409 Pave <NA> Reg  
## 6 146 160 RM 24 2522 Pave <NA> Reg  
## 11 194 160 RM 24 2522 Pave <NA> Reg  
## 74 1089 160 RM 24 2522 Pave <NA> Reg  
## 89 1305 160 RM 32 3363 Pave <NA> Reg  
## 50 725 20 RL 86 13286 Pave <NA> IR1  
## 30 446 20 RL 73 9855 Pave <NA> Reg  
## 38 564 50 RL 66 21780 Pave <NA> Reg  
## 66 1012 90 RL 75 9825 Pave <NA> Reg  
## 83 1255 60 RL 60 6931 Pave <NA> Reg  
## 94 1378 50 RL 60 10998 Pave Grvl Reg  
## 52 750 50 RL 50 8405 Pave <NA> Reg  
## 71 1054 20 RL 68 8562 Pave <NA> Reg  
## 44 652 70 RL 60 9084 Pave <NA> Reg  
## 15 240 50 RL 52 8741 Pave <NA> Reg  
## 45 660 20 RL 75 9937 Pave <NA> Reg  
## 49 724 50 RL 60 8172 Pave <NA> Reg  
## 78 1152 20 RL 134 17755 Pave <NA> Reg  
## 72 1073 50 RL 50 7585 Pave <NA> Reg  
## 29 442 90 RL 92 12108 Pave <NA> Reg  
## 61 943 90 RL 42 7711 Pave <NA> IR1  
## 73 1074 60 RL 75 7950 Pave <NA> IR1  
## 58 888 50 RL 59 16466 Pave <NA> IR1  
## 47 672 70 RH 54 6629 Pave <NA> Reg  
## 24 391 50 RL 50 8405 Pave Grvl Reg  
## 85 1274 80 RL 124 11512 Pave <NA> IR1  
## 8 166 190 RL 62 10106 Pave <NA> Reg  
## 35 536 190 RL 70 7000 Pave <NA> Reg  
## 98 1449 50 RL 70 11767 Pave <NA> Reg  
## 10 183 20 RL 60 9060 Pave <NA> Reg  
## 26 411 20 RL 68 9571 Pave <NA> Reg  
## 96 1385 50 RL 60 9060 Pave <NA> Reg  
## 100 1460 20 RL 75 9937 Pave <NA> Reg  
## 55 815 50 RL 45 8248 Pave Grvl Reg  
## 59 918 20 RL NA 17140 Pave <NA> Reg  
## 81 1186 50 RL 60 9738 Pave <NA> Reg  
## 53 772 20 RL 67 8877 Pave <NA> Reg  
## 32 503 20 RL 70 9170 Pave <NA> Reg  
## 14 212 20 RL 83 10420 Pave <NA> Reg  
## 51 739 90 RL 60 10800 Pave <NA> Reg  
## 56 840 50 RL 70 11767 Pave <NA> Reg  
## 28 440 50 RL 67 12354 Pave Grvl Reg  
## 22 387 50 RL 58 8410 Pave <NA> Reg  
## 46 664 85 RL 90 10012 Pave <NA> Reg  
## 64 986 190 RL 68 10880 Pave <NA> Reg  
## 1 40 90 RL 65 6040 Pave <NA> Reg  
## 48 698 20 RL 57 6420 Pave <NA> IR1  
## 25 396 20 RL 68 9571 Pave <NA> Reg  
## 27 419 50 RL 60 8160 Pave <NA> Reg  
## 67 1021 20 RL 60 7024 Pave <NA> Reg  
## 36 554 20 RL 67 8777 Pave <NA> Reg  
## 5 118 20 RL 74 8536 Pave <NA> Reg  
## 23 388 80 RL 72 7200 Pave <NA> Reg  
## 80 1180 20 RL 77 8335 Pave <NA> Reg  
## 12 201 20 RM 80 8546 Pave <NA> Reg  
## 54 773 80 RL 94 7819 Pave <NA> Reg  
## 16 270 20 RL NA 7917 Pave <NA> IR1  
## 19 353 50 RL 60 9084 Pave <NA> Reg  
## 7 156 50 RL 60 9600 Pave <NA> Reg  
## 43 648 20 RL 85 10452 Pave <NA> IR1  
## 57 881 20 RL 60 7024 Pave <NA> Reg  
## 31 473 180 RM 35 3675 Pave <NA> Reg  
## 87 1298 180 RM 35 3675 Pave <NA> Reg  
## 99 1453 180 RM 35 3675 Pave <NA> Reg  
## 37 563 30 RL 63 13907 Pave <NA> Reg  
## 62 955 90 RL 35 9400 Pave <NA> IR1  
## 2 98 20 RL 73 10921 Pave <NA> Reg  
## 75 1123 20 RL NA 8926 Pave <NA> IR1  
## 90 1315 20 RL 60 8190 Pave <NA> Reg  
## 91 1320 20 RL 75 10215 Pave <NA> Reg  
## 65 1001 20 RL 74 10206 Pave <NA> Reg  
## 70 1050 20 RL 60 11100 Pave <NA> Reg  
## 77 1145 190 RL 60 12180 Pave <NA> Reg  
## 21 376 30 RL NA 10020 Pave <NA> IR1  
## 63 979 20 RL 68 9450 Pave <NA> Reg  
## 13 211 30 RL 67 5604 Pave <NA> Reg  
## 41 621 30 RL 45 8248 Pave Grvl Reg  
## 84 1258 30 RL 56 4060 Pave <NA> Reg  
## 86 1295 20 RL 60 8172 Pave <NA> Reg  
## 95 1381 30 RL 45 8212 Pave Grvl Reg  
## 18 309 30 RL NA 12342 Pave <NA> IR1  
## 68 1036 20 RL NA 11500 Pave <NA> IR1  
## 3 99 30 RL 85 10625 Pave <NA> Reg  
## 39 583 90 RL 81 11841 Grvl <NA> Reg  
## 93 1333 20 RL 67 8877 Pave <NA> Reg  
## 42 639 30 RL 67 8777 Pave <NA> Reg  
## 92 1327 30 RH 70 4270 Pave <NA> Reg  
## 76 1124 20 RL 50 9405 Pave <NA> Reg  
## 82 1213 30 RL 50 9340 Pave <NA> Reg  
## 34 529 30 RL 58 9098 Pave <NA> IR1  
## LandContour Utilities LotConfig LandSlope Neighborhood Condition1  
## 88 Bnk AllPub Corner Gtl Edwards Feedr  
## 33 Bnk AllPub Inside Gtl Edwards PosN  
## 97 Lvl AllPub CulDSac Gtl Edwards Norm  
## 60 Lvl AllPub Inside Gtl Edwards Feedr  
## 9 Lvl AllPub Corner Gtl Edwards Norm  
## 79 Lvl AllPub Corner Gtl Edwards Norm  
## 40 Bnk AllPub Inside Mod Edwards Norm  
## 20 Lvl AllPub Corner Gtl Edwards Norm  
## 4 Lvl AllPub Inside Gtl Edwards Norm  
## 69 Lvl AllPub CulDSac Gtl Edwards Norm  
## 17 Lvl AllPub Inside Gtl Edwards Norm  
## 6 Lvl AllPub Inside Gtl Edwards Norm  
## 11 Lvl AllPub Inside Gtl Edwards Norm  
## 74 Lvl AllPub Inside Gtl Edwards Norm  
## 89 Lvl AllPub Inside Gtl Edwards Norm  
## 50 Lvl AllPub Inside Gtl Edwards Norm  
## 30 Lvl AllPub Corner Gtl Edwards Norm  
## 38 Lvl AllPub Inside Gtl Edwards Norm  
## 66 Lvl AllPub Inside Gtl Edwards Norm  
## 83 Lvl AllPub Inside Gtl Edwards Norm  
## 94 Lvl AllPub Inside Gtl Edwards Norm  
## 52 Lvl AllPub Inside Gtl Edwards Norm  
## 71 Lvl AllPub Inside Mod Edwards Norm  
## 44 Lvl AllPub Inside Gtl Edwards Artery  
## 15 Lvl AllPub Inside Gtl Edwards Norm  
## 45 Lvl AllPub Corner Gtl Edwards Norm  
## 49 Lvl AllPub Inside Gtl Edwards Norm  
## 78 Lvl AllPub Inside Gtl Edwards Norm  
## 72 Lvl AllPub Inside Gtl Edwards Artery  
## 29 Lvl AllPub Inside Gtl Edwards Norm  
## 61 Lvl AllPub Inside Gtl Edwards Norm  
## 73 Bnk AllPub Corner Gtl Edwards Norm  
## 58 Lvl AllPub Inside Gtl Edwards Norm  
## 47 Lvl AllPub Inside Gtl Edwards Artery  
## 24 Lvl AllPub Inside Gtl Edwards Norm  
## 85 Lvl AllPub Corner Gtl Edwards Norm  
## 8 Lvl AllPub Inside Gtl Edwards Norm  
## 35 Lvl AllPub Inside Gtl Edwards Norm  
## 98 Lvl AllPub Inside Gtl Edwards Norm  
## 10 Lvl AllPub Inside Gtl Edwards Artery  
## 26 Lvl AllPub Inside Gtl Edwards Norm  
## 96 Lvl AllPub Inside Gtl Edwards Norm  
## 100 Lvl AllPub Inside Gtl Edwards Norm  
## 55 Lvl AllPub Inside Gtl Edwards Norm  
## 59 Lvl AllPub Inside Gtl Edwards Norm  
## 81 Lvl AllPub Inside Gtl Edwards Norm  
## 53 Lvl AllPub Inside Gtl Edwards Norm  
## 32 Lvl AllPub Corner Gtl Edwards Feedr  
## 14 Lvl AllPub Corner Gtl Edwards Norm  
## 51 Lvl AllPub Inside Gtl Edwards Norm  
## 56 Lvl AllPub Inside Gtl Edwards Norm  
## 28 Lvl AllPub Corner Gtl Edwards Norm  
## 22 Lvl AllPub FR2 Gtl Edwards Feedr  
## 46 Lvl AllPub Inside Gtl Edwards Norm  
## 64 Lvl AllPub Inside Gtl Edwards Norm  
## 1 Lvl AllPub Inside Gtl Edwards Norm  
## 48 Lvl AllPub Inside Gtl Edwards Norm  
## 25 Lvl AllPub Inside Gtl Edwards Norm  
## 27 Lvl AllPub Inside Gtl Edwards Norm  
## 67 Lvl AllPub Inside Gtl Edwards Norm  
## 36 Lvl AllPub Inside Gtl Edwards Feedr  
## 5 Lvl AllPub Corner Gtl Edwards Norm  
## 23 Lvl AllPub Inside Gtl Edwards Norm  
## 80 Lvl AllPub Corner Gtl Edwards Norm  
## 12 Lvl AllPub Corner Gtl Edwards Norm  
## 54 Lvl AllPub Inside Gtl Edwards Norm  
## 16 Lvl AllPub Corner Gtl Edwards Norm  
## 19 Lvl AllPub Inside Gtl Edwards Artery  
## 7 Lvl AllPub Corner Gtl Edwards Artery  
## 43 Lvl AllPub Inside Gtl Edwards Norm  
## 57 Lvl AllPub Inside Gtl Edwards Norm  
## 31 Lvl AllPub Inside Gtl Edwards Norm  
## 87 Lvl AllPub Inside Gtl Edwards Norm  
## 99 Lvl AllPub Inside Gtl Edwards Norm  
## 37 Lvl AllPub Inside Gtl Edwards Norm  
## 62 Lvl AllPub CulDSac Gtl Edwards Norm  
## 2 HLS AllPub Inside Gtl Edwards Norm  
## 75 Lvl AllPub Corner Gtl Edwards Norm  
## 90 Lvl AllPub Inside Gtl Edwards Norm  
## 91 Bnk AllPub Inside Gtl Edwards Norm  
## 65 Lvl AllPub Corner Gtl Edwards Norm  
## 70 Low AllPub Inside Gtl Edwards Norm  
## 77 Lvl AllPub Inside Gtl Edwards Norm  
## 21 Low AllPub Inside Sev Edwards Norm  
## 63 Bnk AllPub Inside Mod Edwards Norm  
## 13 Lvl AllPub Inside Gtl Edwards Norm  
## 41 Lvl AllPub Inside Gtl Edwards Norm  
## 84 Lvl AllPub Corner Gtl Edwards Feedr  
## 86 Lvl AllPub Inside Gtl Edwards Norm  
## 95 Lvl AllPub Inside Gtl Edwards Norm  
## 18 Lvl AllPub Inside Gtl Edwards Norm  
## 68 Lvl AllPub CulDSac Gtl Edwards Norm  
## 3 Lvl AllPub Corner Gtl Edwards Norm  
## 39 Lvl AllPub Inside Gtl Edwards Norm  
## 93 Lvl AllPub Inside Mod Edwards Norm  
## 42 Lvl AllPub Inside Gtl Edwards Feedr  
## 92 Bnk AllPub Inside Mod Edwards Norm  
## 76 Lvl AllPub Inside Gtl Edwards Norm  
## 82 Lvl AllPub Inside Gtl Edwards Norm  
## 34 Lvl AllPub Inside Gtl Edwards Norm  
## Condition2 BldgType HouseStyle OverallQual OverallCond YearBuilt  
## 88 Norm 1Fam 2Story 10 5 2008  
## 33 PosN 1Fam 2Story 10 5 2007  
## 97 Norm 1Fam SLvl 6 7 1966  
## 60 Norm Duplex 1.5Fin 5 7 1900  
## 9 Norm 1Fam 1Story 6 7 1950  
## 79 Norm 1Fam 2Story 6 7 1935  
## 40 Norm 1Fam 2Story 5 8 1948  
## 20 Norm 1Fam SFoyer 7 5 2003  
## 4 Norm 1Fam 1.5Fin 6 4 1954  
## 69 Norm 1Fam 1Story 3 5 1955  
## 17 Norm 1Fam 1.5Fin 5 4 1949  
## 6 Norm Twnhs 2Story 6 5 2004  
## 11 Norm Twnhs 2Story 7 5 2004  
## 74 Norm Twnhs 2Story 7 5 2004  
## 89 Norm TwnhsE 2Story 7 5 2004  
## 50 Norm 1Fam 1Story 9 5 2007  
## 30 Norm 1Fam 1Story 6 5 1956  
## 38 Norm 1Fam 1.5Fin 6 7 1918  
## 66 Norm Duplex 1Story 5 5 1965  
## 83 Norm 1Fam 2Story 7 5 2003  
## 94 Norm 1Fam 1.5Fin 5 5 1941  
## 52 Norm 1Fam 1.5Fin 4 3 1945  
## 71 Norm 1Fam 1Story 5 6 1957  
## 44 Norm 1Fam 2Story 4 5 1940  
## 15 Norm 1Fam 1.5Fin 6 4 1945  
## 45 Norm 1Fam 1Story 5 7 1964  
## 49 Norm 1Fam 1.5Fin 4 6 1954  
## 78 Norm 1Fam 1Story 5 4 1959  
## 72 Norm 1Fam 1.5Fin 5 3 1948  
## 29 Norm Duplex 1Story 4 4 1955  
## 61 Norm Duplex 1Story 4 3 1977  
## 73 Norm 1Fam 2Story 6 6 1977  
## 58 Norm 1Fam 1.5Fin 5 7 1955  
## 47 Norm 1Fam 2Story 6 6 1925  
## 24 Norm 1Fam 1.5Fin 5 8 1900  
## 85 Norm 1Fam SLvl 6 7 1959  
## 8 Norm 2fmCon 1.5Fin 5 7 1940  
## 35 Norm 2fmCon 2Story 5 7 1910  
## 98 Norm 1Fam 2Story 4 7 1910  
## 10 Norm 1Fam 1Story 5 6 1957  
## 26 Norm 1Fam 1Story 5 3 1958  
## 96 Norm 1Fam 1.5Fin 6 5 1939  
## 100 Norm 1Fam 1Story 5 6 1965  
## 55 Norm 1Fam 1.5Fin 5 7 1918  
## 59 Norm 1Fam 1Story 4 6 1956  
## 81 Norm 1Fam 1.5Fin 5 7 1924  
## 53 Norm 1Fam 1Story 4 5 1951  
## 32 Norm 1Fam 1Story 5 7 1965  
## 14 Norm 1Fam 1Story 6 5 2009  
## 51 Norm Duplex 1Story 5 5 1987  
## 56 Norm 1Fam 1.5Fin 5 6 1946  
## 28 Norm 1Fam 1.5Fin 6 8 1920  
## 22 Norm 1Fam 1.5Fin 5 3 1910  
## 46 Norm 1Fam SFoyer 4 5 1972  
## 64 Norm 2fmCon 1Story 5 5 1950  
## 1 Norm Duplex 1Story 4 5 1955  
## 48 Norm 1Fam 1Story 5 7 1952  
## 25 Norm 1Fam 1Story 5 6 1956  
## 27 Norm 1Fam 1.5Fin 5 6 1940  
## 67 Norm 1Fam 1Story 4 5 2005  
## 36 Norm 1Fam 1Story 4 5 1949  
## 5 Norm 1Fam 1Story 5 5 2006  
## 23 Norm 1Fam SLvl 6 6 1976  
## 80 Norm 1Fam 1Story 5 5 1954  
## 12 Norm 1Fam 1Story 4 5 2003  
## 54 Norm 1Fam SLvl 6 5 1976  
## 16 Norm 1Fam 1Story 6 7 1976  
## 19 Norm 1Fam 1.5Fin 5 6 1941  
## 7 Norm 1Fam 1.5Fin 6 5 1924  
## 43 Norm 1Fam 1Story 6 5 1953  
## 57 Norm 1Fam 1Story 5 5 2005  
## 31 Norm TwnhsE SLvl 6 5 2005  
## 87 Norm TwnhsE SFoyer 6 5 2005  
## 99 Norm TwnhsE SLvl 5 5 2005  
## 37 Norm 1Fam 1Story 5 6 1940  
## 62 Norm Duplex SFoyer 6 5 1975  
## 2 Norm 1Fam 1Story 4 5 1965  
## 75 Norm 1Fam 1Story 4 3 1956  
## 90 Norm 1Fam 1Story 4 6 1954  
## 91 Norm 1Fam 1Story 4 5 1954  
## 65 Norm 1Fam 1Story 3 3 1952  
## 70 Norm 1Fam 1Story 4 7 1946  
## 77 Norm 2fmCon 1.5Fin 4 4 1941  
## 21 Norm 1Fam 1Story 1 1 1922  
## 63 Norm 1Fam 1Story 4 5 1954  
## 13 Norm 1Fam 1Story 5 6 1925  
## 41 Norm 1Fam 1Story 3 3 1914  
## 84 Norm 1Fam 1Story 5 8 1922  
## 86 Norm 1Fam 1Story 5 7 1955  
## 95 Norm 1Fam 1Story 3 3 1914  
## 18 Norm 1Fam 1Story 4 5 1940  
## 68 Norm 1Fam 1Story 4 3 1957  
## 3 Norm 1Fam 1Story 5 5 1920  
## 39 Norm Duplex SFoyer 6 5 1990  
## 93 Norm 1Fam 1Story 4 6 1938  
## 42 Norm 1Fam 1Story 5 7 1910  
## 92 Norm 1Fam 1Story 3 6 1931  
## 76 Norm 1Fam 1Story 5 9 1947  
## 82 Norm 1Fam 1Story 4 6 1941  
## 34 Norm 1Fam 1Story 4 7 1920  
## YearRemodAdd RoofStyle RoofMatl Exterior1st Exterior2nd MasVnrType  
## 88 2008 Hip ClyTile Stucco Stucco Stone  
## 33 2008 Hip CompShg CemntBd CmentBd Stone  
## 97 1966 Flat Tar&Grv Plywood Plywood None  
## 60 2003 Gable CompShg MetalSd MetalSd None  
## 9 2001 Gable CompShg WdShing Wd Shng None  
## 79 1986 Hip CompShg Stucco Stucco None  
## 40 2002 Gable CompShg MetalSd MetalSd None  
## 20 2003 Gable CompShg HdBoard HdBoard BrkFace  
## 4 1972 Gable CompShg Wd Sdng Wd Sdng None  
## 69 1955 Hip CompShg BrkFace Wd Sdng None  
## 17 2008 Gable CompShg Wd Sdng Wd Sdng None  
## 6 2006 Gable CompShg VinylSd VinylSd Stone  
## 11 2004 Gable CompShg VinylSd VinylSd Stone  
## 74 2004 Gable CompShg VinylSd VinylSd Stone  
## 89 2004 Gable CompShg VinylSd VinylSd Stone  
## 50 2008 Hip CompShg CemntBd CmentBd Stone  
## 30 1956 Hip CompShg Wd Sdng Wd Sdng None  
## 38 1950 Gable CompShg Wd Sdng Wd Sdng None  
## 66 1965 Hip CompShg AsphShn AsphShn None  
## 83 2004 Gable CompShg VinylSd VinylSd Stone  
## 94 1960 Gable CompShg Wd Sdng Wd Sdng None  
## 52 1950 Gable CompShg WdShing Wd Shng None  
## 71 2002 Hip CompShg HdBoard HdBoard Stone  
## 44 1950 Gable CompShg MetalSd MetalSd None  
## 15 1950 Gable CompShg VinylSd VinylSd None  
## 45 1999 Hip CompShg MetalSd MetalSd None  
## 49 1972 Gable CompShg MetalSd MetalSd None  
## 78 1959 Gable CompShg HdBoard Plywood BrkFace  
## 72 1950 Gable CompShg MetalSd MetalSd None  
## 29 1955 Gable CompShg VinylSd VinylSd BrkFace  
## 61 1977 Gable CompShg MetalSd MetalSd None  
## 73 1977 Hip CompShg HdBoard Plywood BrkFace  
## 58 1955 Gable CompShg MetalSd MetalSd None  
## 47 1950 Gambrel CompShg Wd Sdng Wd Sdng None  
## 24 1950 Gable CompShg MetalSd MetalSd None  
## 85 2006 Gable CompShg Plywood Plywood BrkFace  
## 8 1999 Gable CompShg Wd Sdng Wd Sdng None  
## 35 1991 Gable CompShg MetalSd MetalSd None  
## 98 2000 Gable CompShg MetalSd HdBoard None  
## 10 2006 Hip CompShg Wd Sdng Wd Sdng BrkFace  
## 26 1958 Gable CompShg BrkComm Brk Cmn None  
## 96 1950 Gable CompShg WdShing Wd Shng None  
## 100 1965 Gable CompShg HdBoard HdBoard None  
## 55 1950 Gable CompShg Stucco Stucco None  
## 59 1956 Gable CompShg VinylSd VinylSd None  
## 81 1950 Gable CompShg AsbShng AsbShng None  
## 53 1951 Gable CompShg Wd Sdng Wd Sdng None  
## 32 1965 Hip CompShg MetalSd MetalSd None  
## 14 2009 Gable CompShg VinylSd VinylSd None  
## 51 1988 Gable CompShg Plywood Plywood None  
## 56 1995 Gable CompShg MetalSd MetalSd None  
## 28 2000 Gable CompShg Wd Sdng Wd Sdng None  
## 22 1996 Gambrel CompShg Wd Sdng VinylSd None  
## 46 1972 Gable CompShg Plywood Plywood None  
## 64 1950 Gable CompShg MetalSd MetalSd None  
## 1 1955 Gable CompShg AsbShng Plywood None  
## 48 1952 Gable CompShg Wd Sdng Wd Sdng None  
## 25 1956 Gable CompShg Wd Sdng Wd Sdng None  
## 27 1950 Gable CompShg MetalSd MetalSd None  
## 67 2005 Gable CompShg VinylSd VinylSd None  
## 36 2003 Gable CompShg VinylSd VinylSd None  
## 5 2007 Gable CompShg VinylSd VinylSd None  
## 23 1976 Hip CompShg MetalSd MetalSd BrkFace  
## 80 1954 Gable CompShg Wd Sdng Wd Sdng None  
## 12 2004 Gable CompShg VinylSd VinylSd None  
## 54 1976 Gable CompShg Plywood Plywood None  
## 16 1976 Hip CompShg HdBoard HdBoard BrkFace  
## 19 1950 Gable CompShg VinylSd VinylSd None  
## 7 1950 Gable CompShg Wd Sdng Wd Sdng None  
## 43 1953 Hip CompShg Wd Sdng Wd Sdng Stone  
## 57 2006 Gable CompShg VinylSd VinylSd None  
## 31 2005 Gable CompShg VinylSd VinylSd BrkFace  
## 87 2006 Gable CompShg VinylSd VinylSd BrkFace  
## 99 2005 Gable CompShg VinylSd VinylSd BrkFace  
## 37 1969 Gable CompShg WdShing Wd Shng None  
## 62 1975 Flat Tar&Grv WdShing Plywood BrkFace  
## 2 1965 Hip CompShg HdBoard HdBoard BrkFace  
## 75 1956 Gable CompShg AsbShng AsbShng None  
## 90 1954 Hip CompShg Wd Sdng Wd Sdng None  
## 91 1954 Hip CompShg Wd Sdng Wd Sdng BrkFace  
## 65 1952 Flat Tar&Grv BrkComm Brk Cmn None  
## 70 2006 Gable CompShg MetalSd MetalSd None  
## 77 1950 Gable CompShg MetalSd MetalSd None  
## 21 1950 Gable CompShg Wd Sdng Wd Sdng None  
## 63 1954 Gable CompShg MetalSd MetalSd None  
## 13 1950 Gable CompShg Stucco Stucco None  
## 41 1950 Gable CompShg Stucco Stucco None  
## 84 1950 Gable CompShg Wd Sdng Wd Sdng None  
## 86 1990 Hip CompShg WdShing Plywood None  
## 95 1950 Gable CompShg Stucco Stucco None  
## 18 1950 Gable CompShg VinylSd VinylSd None  
## 68 1957 Gable CompShg Wd Sdng Wd Sdng None  
## 3 1950 Gable CompShg Wd Sdng Wd Sdng None  
## 39 1990 Gable CompShg HdBoard HdBoard BrkFace  
## 93 1958 Gable CompShg MetalSd MetalSd None  
## 42 1950 Gable CompShg MetalSd Wd Sdng None  
## 92 2006 Gable CompShg MetalSd MetalSd None  
## 76 2008 Hip CompShg VinylSd VinylSd None  
## 82 1950 Hip CompShg MetalSd MetalSd None  
## 34 2002 Gable CompShg Wd Sdng Wd Sdng None  
## MasVnrArea ExterQual ExterCond Foundation BsmtQual BsmtCond  
## 88 796 Ex TA PConc Ex TA  
## 33 762 Ex TA PConc Ex TA  
## 97 0 Gd Gd CBlock Gd TA  
## 60 0 TA TA CBlock TA TA  
## 9 0 TA TA CBlock TA Gd  
## 79 0 TA TA CBlock TA TA  
## 40 0 TA Gd CBlock TA Gd  
## 20 500 Gd TA Slab <NA> <NA>  
## 4 0 TA TA CBlock TA Fa  
## 69 0 TA TA Slab <NA> <NA>  
## 17 0 TA TA CBlock TA TA  
## 6 50 Gd TA PConc Gd TA  
## 11 50 Gd TA PConc Gd TA  
## 74 50 Gd TA PConc Gd TA  
## 89 117 Gd TA PConc Gd TA  
## 50 340 Ex TA PConc Ex TA  
## 30 0 TA TA CBlock TA TA  
## 38 0 TA TA BrkTil Gd TA  
## 66 0 TA TA CBlock <NA> <NA>  
## 83 92 Gd TA PConc Gd TA  
## 94 0 TA TA CBlock TA TA  
## 52 0 TA TA Slab <NA> <NA>  
## 71 145 TA TA CBlock TA TA  
## 44 0 TA TA CBlock TA TA  
## 15 0 TA TA CBlock TA Fa  
## 45 0 TA Gd PConc TA TA  
## 49 0 TA TA PConc TA TA  
## 78 132 TA TA CBlock TA TA  
## 72 0 TA TA CBlock Fa Fa  
## 29 270 TA TA CBlock TA TA  
## 61 0 TA TA PConc Gd TA  
## 73 140 TA TA CBlock TA TA  
## 58 0 TA Gd PConc TA TA  
## 47 0 TA Gd BrkTil TA TA  
## 24 0 TA TA BrkTil TA Gd  
## 85 84 TA TA CBlock TA TA  
## 8 0 TA Gd BrkTil TA TA  
## 35 0 TA TA CBlock Gd TA  
## 98 0 TA TA CBlock Fa TA  
## 10 98 TA TA PConc <NA> <NA>  
## 26 0 TA Fa CBlock TA Fa  
## 96 0 TA TA BrkTil TA TA  
## 100 0 Gd TA CBlock TA TA  
## 55 0 TA TA BrkTil TA TA  
## 59 0 TA TA CBlock TA TA  
## 81 0 TA Gd BrkTil TA TA  
## 53 0 TA TA CBlock Fa Fa  
## 32 0 TA TA CBlock TA TA  
## 14 0 TA TA PConc Gd TA  
## 51 0 TA TA CBlock Gd Gd  
## 56 0 TA TA CBlock TA TA  
## 28 0 TA TA BrkTil TA Fa  
## 22 0 TA Fa PConc TA TA  
## 46 0 TA TA CBlock Gd TA  
## 64 0 TA TA CBlock TA TA  
## 1 0 TA TA PConc <NA> <NA>  
## 48 0 TA TA PConc Ex Gd  
## 25 0 TA TA CBlock TA TA  
## 27 0 TA TA BrkTil TA TA  
## 67 0 TA TA PConc Gd TA  
## 36 0 TA TA CBlock <NA> <NA>  
## 5 0 TA TA PConc Gd TA  
## 23 255 TA TA CBlock TA TA  
## 80 0 TA TA Slab <NA> <NA>  
## 12 0 TA TA PConc Gd TA  
## 54 0 TA TA CBlock TA TA  
## 16 174 TA Gd CBlock TA Gd  
## 19 0 TA TA CBlock TA Fa  
## 7 0 TA TA BrkTil TA TA  
## 43 216 TA TA CBlock TA TA  
## 57 0 TA TA PConc Ex Gd  
## 31 80 TA TA PConc Gd TA  
## 87 82 TA TA PConc Gd TA  
## 99 80 TA TA PConc Gd TA  
## 37 0 TA TA CBlock TA TA  
## 62 250 TA TA CBlock Gd Gd  
## 2 48 TA TA CBlock TA TA  
## 75 0 TA TA CBlock TA TA  
## 90 0 TA TA CBlock TA TA  
## 91 132 TA TA PConc TA TA  
## 65 0 TA TA Slab <NA> <NA>  
## 70 0 TA TA CBlock <NA> <NA>  
## 77 0 TA Fa BrkTil Gd TA  
## 21 0 Fa Fa BrkTil Fa Po  
## 63 0 TA TA CBlock TA TA  
## 13 0 TA TA CBlock TA TA  
## 41 0 TA TA BrkTil TA TA  
## 84 0 TA TA PConc Fa TA  
## 86 0 TA TA CBlock TA TA  
## 95 0 TA Fa BrkTil TA Fa  
## 18 0 TA TA CBlock TA TA  
## 68 0 TA Gd Slab <NA> <NA>  
## 3 0 TA TA BrkTil TA TA  
## 39 104 TA Gd CBlock Gd TA  
## 93 0 TA TA CBlock TA TA  
## 42 0 TA TA CBlock Fa TA  
## 92 0 TA TA BrkTil TA TA  
## 76 0 TA Ex CBlock TA TA  
## 82 0 TA TA CBlock TA TA  
## 34 0 TA TA BrkTil TA TA  
## BsmtExposure BsmtFinType1 BsmtFinSF1 BsmtFinType2 BsmtFinSF2 BsmtUnfSF  
## 88 Gd GLQ 5644 Unf 0 466  
## 33 Gd GLQ 2260 Unf 0 878  
## 97 Av Unf 0 Unf 0 697  
## 60 No ALQ 1084 Unf 0 188  
## 9 Av ALQ 477 Unf 0 725  
## 79 No Rec 626 Unf 0 501  
## 40 No GLQ 603 Unf 0 293  
## 20 <NA> <NA> 0 <NA> 0 0  
## 4 No Rec 444 Unf 0 550  
## 69 <NA> <NA> 0 <NA> 0 0  
## 17 No LwQ 292 Unf 0 476  
## 6 No Unf 0 Unf 0 970  
## 11 No Unf 0 Unf 0 970  
## 74 No Unf 0 Unf 0 970  
## 89 No Unf 0 Unf 0 976  
## 50 No GLQ 1234 Unf 0 464  
## 30 No Unf 0 Unf 0 1436  
## 38 Mn Unf 0 Unf 0 1163  
## 66 <NA> <NA> 0 <NA> 0 0  
## 83 No Unf 0 Unf 0 746  
## 94 No LwQ 408 BLQ 420 156  
## 52 <NA> <NA> 0 <NA> 0 0  
## 71 Av Rec 383 Unf 0 833  
## 44 Mn Unf 0 Unf 0 755  
## 15 No LwQ 94 Unf 0 641  
## 45 No BLQ 637 Unf 0 849  
## 49 No Unf 0 Unf 0 941  
## 78 No BLQ 176 Unf 0 1290  
## 72 Mn Unf 0 Unf 0 810  
## 29 No ALQ 133 Unf 0 1307  
## 61 Gd GLQ 1440 Unf 0 0  
## 73 No BLQ 535 Unf 0 155  
## 58 No Unf 0 Unf 0 816  
## 47 No BLQ 551 Unf 0 121  
## 24 No Rec 241 BLQ 391 229  
## 85 Av ALQ 719 Unf 0 300  
## 8 No ALQ 351 Rec 181 112  
## 35 Gd GLQ 969 Unf 0 148  
## 98 No Unf 0 Unf 0 560  
## 10 <NA> <NA> 0 <NA> 0 0  
## 26 No Unf 0 Unf 0 1276  
## 96 Mn Rec 204 Unf 0 356  
## 100 No BLQ 830 LwQ 290 136  
## 55 No Unf 0 Unf 0 686  
## 59 No ALQ 1059 Unf 0 75  
## 81 No BLQ 392 Unf 0 392  
## 53 No LwQ 836 Unf 0 0  
## 32 No ALQ 698 GLQ 96 420  
## 14 Mn GLQ 36 Unf 0 1176  
## 51 Gd GLQ 1200 Unf 0 0  
## 56 No BLQ 352 Unf 0 416  
## 28 Mn Unf 0 Unf 0 684  
## 22 No Unf 0 Unf 0 658  
## 46 Av BLQ 920 Rec 180 38  
## 64 No ALQ 1040 Unf 0 124  
## 1 <NA> <NA> 0 <NA> 0 0  
## 48 Mn LwQ 210 ALQ 551 219  
## 25 Av BLQ 739 Unf 0 405  
## 27 No ALQ 312 Unf 0 444  
## 67 No GLQ 1024 Unf 0 108  
## 36 <NA> <NA> 0 <NA> 0 0  
## 5 No Unf 0 Unf 0 1125  
## 23 Av ALQ 631 Unf 0 410  
## 80 <NA> <NA> 0 <NA> 0 0  
## 12 No Unf 0 Unf 0 1121  
## 54 Av ALQ 422 BLQ 127 480  
## 16 No BLQ 751 Unf 0 392  
## 19 Mn LwQ 236 Rec 380 0  
## 7 No Unf 0 Unf 0 572  
## 43 Mn Rec 500 Unf 0 594  
## 57 No ALQ 980 Unf 0 110  
## 31 Gd GLQ 459 Unf 0 88  
## 87 Gd GLQ 547 Unf 0 0  
## 99 Gd GLQ 547 Unf 0 0  
## 37 No BLQ 290 Unf 0 706  
## 62 Gd GLQ 945 Unf 0 0  
## 2 No Rec 520 Unf 0 440  
## 75 No Unf 0 Unf 0 672  
## 90 No Rec 732 Unf 0 216  
## 91 No ALQ 492 Unf 0 372  
## 65 <NA> <NA> 0 <NA> 0 0  
## 70 <NA> <NA> 0 <NA> 0 0  
## 77 No BLQ 348 Unf 0 324  
## 21 Gd BLQ 350 Unf 0 333  
## 63 No LwQ 552 Unf 0 342  
## 13 No Rec 468 Unf 0 396  
## 41 No BLQ 41 Unf 0 823  
## 84 No Unf 0 Unf 0 864  
## 86 No Rec 167 Unf 0 697  
## 95 No Rec 203 Unf 0 661  
## 18 No BLQ 262 Unf 0 599  
## 68 <NA> <NA> 0 <NA> 0 0  
## 3 No ALQ 108 Unf 0 350  
## 39 Av GLQ 816 Unf 0 0  
## 93 Mn ALQ 690 Unf 0 126  
## 42 No Unf 0 Unf 0 796  
## 92 No Rec 544 Unf 0 0  
## 76 No Unf 0 Unf 0 698  
## 82 No Rec 344 Unf 0 328  
## 34 Mn ALQ 348 Unf 0 180  
## TotalBsmtSF Heating HeatingQC CentralAir Electrical X1stFlrSF  
## 88 6110 GasA Ex Y SBrkr 4692  
## 33 3138 GasA Ex Y SBrkr 3138  
## 97 697 GasA TA Y SBrkr 1575  
## 60 1272 GasA Gd Y SBrkr 1272  
## 9 1202 GasA TA Y SBrkr 2158  
## 79 1127 GasA Ex Y SBrkr 1236  
## 40 896 GasA Ex Y SBrkr 1112  
## 20 0 GasA Ex Y SBrkr 495  
## 4 994 GasA Gd Y SBrkr 1216  
## 69 0 GasA Ex Y FuseA 1733  
## 17 768 GasA Gd Y SBrkr 1148  
## 6 970 GasA Ex Y SBrkr 970  
## 11 970 GasA Ex Y SBrkr 970  
## 74 970 GasA Ex Y SBrkr 970  
## 89 976 GasA Ex Y SBrkr 976  
## 50 1698 GasA Ex Y SBrkr 1698  
## 30 1436 GasA Fa Y SBrkr 1689  
## 38 1163 GasA Ex Y SBrkr 1163  
## 66 0 GasA TA N SBrkr 1664  
## 83 746 GasA Ex Y SBrkr 760  
## 94 984 GasA Ex Y SBrkr 984  
## 52 0 Wall TA N FuseF 1088  
## 71 1216 GasA Ex Y FuseA 1526  
## 44 755 GasA TA Y SBrkr 755  
## 15 735 GasA TA Y FuseA 798  
## 45 1486 GasA Ex Y SBrkr 1486  
## 49 941 GasA Ex Y SBrkr 997  
## 78 1466 GasA TA Y SBrkr 1466  
## 72 810 GasA Fa Y FuseA 1002  
## 29 1440 GasA TA N FuseF 1440  
## 61 1440 GasA TA Y SBrkr 1440  
## 73 690 GasA TA Y SBrkr 698  
## 58 816 GasA TA Y SBrkr 872  
## 47 672 GasA TA N SBrkr 697  
## 24 861 GasA Ex Y SBrkr 961  
## 85 1019 GasA Gd Y SBrkr 1357  
## 8 644 GasA Gd Y SBrkr 808  
## 35 1117 GasA TA Y SBrkr 820  
## 98 560 GasA Gd N SBrkr 796  
## 10 0 GasA Ex Y SBrkr 1340  
## 26 1276 GasA TA Y FuseA 1276  
## 96 560 GasA TA Y SBrkr 698  
## 100 1256 GasA Gd Y SBrkr 1256  
## 55 686 GasW Gd Y SBrkr 686  
## 59 1134 GasA Ex Y FuseA 1229  
## 81 784 GasA Gd Y SBrkr 949  
## 53 836 GasA TA Y FuseF 1220  
## 32 1214 GasA Ex Y SBrkr 1214  
## 14 1212 GasA Ex Y SBrkr 1212  
## 51 1200 GasA TA Y SBrkr 1200  
## 56 768 GasA Ex Y SBrkr 768  
## 28 684 GasA Gd Y SBrkr 684  
## 22 658 GasA TA Y SBrkr 658  
## 46 1138 GasA TA Y SBrkr 1181  
## 64 1164 GasW TA N SBrkr 1164  
## 1 0 GasA TA N FuseP 1152  
## 48 980 GasA Fa Y FuseA 1148  
## 25 1144 GasA TA Y SBrkr 1144  
## 27 756 GasA Fa N FuseF 756  
## 67 1132 GasA Ex Y SBrkr 1132  
## 36 0 GasA Ex Y SBrkr 1126  
## 5 1125 GasA Gd Y SBrkr 1125  
## 23 1041 GasA Ex Y SBrkr 1125  
## 80 0 GasA Gd Y SBrkr 1124  
## 12 1121 GasA Ex Y SBrkr 1121  
## 54 1029 GasA TA Y SBrkr 1117  
## 16 1143 GasA TA Y SBrkr 1113  
## 19 616 GasA TA N SBrkr 616  
## 7 572 Grav Fa N FuseF 572  
## 43 1094 GasA Ex Y SBrkr 1094  
## 57 1090 GasA Gd Y SBrkr 1090  
## 31 547 GasA Ex Y SBrkr 1072  
## 87 547 GasA Gd Y SBrkr 1072  
## 99 547 GasA Gd Y SBrkr 1072  
## 37 996 GasA Ex Y SBrkr 996  
## 62 945 GasA TA Y SBrkr 980  
## 2 960 GasA TA Y FuseF 960  
## 75 672 GasA Ex Y FuseA 960  
## 90 948 GasA Ex Y SBrkr 948  
## 91 864 GasA Ex Y SBrkr 948  
## 65 0 GasW Fa N FuseF 944  
## 70 0 GasA Ex Y SBrkr 930  
## 77 672 Grav Fa N FuseA 672  
## 21 683 GasA Gd N FuseA 904  
## 63 894 GasA Ex Y SBrkr 894  
## 13 864 GasA TA N FuseA 864  
## 41 864 GasA TA N FuseF 864  
## 84 864 GasA Ex Y SBrkr 864  
## 86 864 GasA TA Y SBrkr 864  
## 95 864 GasA TA N FuseF 864  
## 18 861 GasA Ex Y SBrkr 861  
## 68 0 GasA Ex N SBrkr 845  
## 3 458 GasA Fa N SBrkr 835  
## 39 816 GasA TA Y SBrkr 816  
## 93 816 GasA Ex Y SBrkr 816  
## 42 796 GasA Gd Y FuseA 796  
## 92 544 GasA Ex Y SBrkr 774  
## 76 698 GasA Ex Y SBrkr 698  
## 82 672 GasA TA Y SBrkr 672  
## 34 528 GasA Ex Y SBrkr 605  
## X2ndFlrSF LowQualFinSF GrLivArea BsmtFullBath BsmtHalfBath FullBath  
## 88 950 0 5642 2 0 2  
## 33 1538 0 4676 1 0 3  
## 97 626 0 2201 0 0 2  
## 60 928 0 2200 2 0 2  
## 9 0 0 2158 1 0 2  
## 79 872 0 2108 0 0 2  
## 40 896 0 2008 1 0 3  
## 20 1427 0 1922 0 0 3  
## 4 639 0 1855 0 0 2  
## 69 0 0 1733 0 0 2  
## 17 568 0 1716 0 0 1  
## 6 739 0 1709 0 0 2  
## 11 739 0 1709 0 0 2  
## 74 739 0 1709 0 0 2  
## 89 732 0 1708 0 0 2  
## 50 0 0 1698 1 0 2  
## 30 0 0 1689 0 0 1  
## 38 511 0 1674 0 0 2  
## 66 0 0 1664 0 0 2  
## 83 896 0 1656 0 0 2  
## 94 620 0 1604 0 0 2  
## 52 441 0 1529 0 0 2  
## 71 0 0 1526 0 0 1  
## 44 755 0 1510 1 0 1  
## 15 689 0 1487 0 0 1  
## 45 0 0 1486 1 0 1  
## 49 473 0 1470 0 0 2  
## 78 0 0 1466 0 0 1  
## 72 454 0 1456 1 1 1  
## 29 0 0 1440 0 0 2  
## 61 0 0 1440 2 0 2  
## 73 728 0 1426 0 0 1  
## 58 521 0 1393 0 0 1  
## 47 672 0 1369 1 0 2  
## 24 406 0 1367 1 0 1  
## 85 0 0 1357 1 0 1  
## 8 547 0 1355 1 0 2  
## 35 527 0 1347 1 0 1  
## 98 550 0 1346 0 0 1  
## 10 0 0 1340 0 0 1  
## 26 0 0 1276 0 0 1  
## 96 560 0 1258 0 0 1  
## 100 0 0 1256 1 0 1  
## 55 564 0 1250 0 1 1  
## 59 0 0 1229 0 0 1  
## 81 272 0 1221 1 0 1  
## 53 0 0 1220 0 0 1  
## 32 0 0 1214 1 0 1  
## 14 0 0 1212 0 0 2  
## 51 0 0 1200 3 0 3  
## 56 432 0 1200 0 0 1  
## 28 512 0 1196 0 0 1  
## 22 526 0 1184 0 0 1  
## 46 0 0 1181 1 0 2  
## 64 0 0 1164 1 0 1  
## 1 0 0 1152 0 0 2  
## 48 0 0 1148 0 1 1  
## 25 0 0 1144 1 0 1  
## 27 378 0 1134 1 0 1  
## 67 0 0 1132 1 0 1  
## 36 0 0 1126 0 0 2  
## 5 0 0 1125 0 0 1  
## 23 0 0 1125 1 0 1  
## 80 0 0 1124 0 0 1  
## 12 0 0 1121 0 0 2  
## 54 0 0 1117 1 0 1  
## 16 0 0 1113 1 0 1  
## 19 495 0 1111 0 1 1  
## 7 524 0 1096 0 0 1  
## 43 0 0 1094 0 0 1  
## 57 0 0 1090 1 0 1  
## 31 0 0 1072 1 0 1  
## 87 0 0 1072 1 0 2  
## 99 0 0 1072 1 0 1  
## 37 0 0 996 1 0 1  
## 62 0 0 980 0 2 2  
## 2 0 0 960 1 0 1  
## 75 0 0 960 0 0 1  
## 90 0 0 948 1 0 1  
## 91 0 0 948 0 0 1  
## 65 0 0 944 0 0 1  
## 70 0 0 930 0 0 1  
## 77 252 0 924 1 0 1  
## 21 0 0 904 1 0 0  
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## 88 1 3 1 Ex 12 Typ  
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## 97 0 4 1 Gd 8 Typ  
## 60 2 4 2 TA 9 Typ  
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## 88 3 Gd Attchd 2008 Fin 2  
## 33 1 Gd BuiltIn 2007 Fin 3  
## 97 1 Gd Attchd 1966 Unf 2  
## 60 0 <NA> <NA> NA <NA> 0  
## 9 1 Gd Attchd 1950 Unf 2  
## 79 2 TA Basment 1935 Unf 2  
## 40 0 <NA> Attchd 1948 Unf 1  
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## 69 1 Gd Attchd 1955 Unf 2  
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## 88 1418 TA TA Y 214 292  
## 33 884 TA TA Y 208 406  
## 97 432 Gd Gd Y 586 236  
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## 9 576 TA TA Y 0 29  
## 79 540 TA TA Y 0 0  
## 40 230 TA TA Y 103 0  
## 20 672 TA TA Y 0 0  
## 4 325 TA TA Y 182 0  
## 69 452 TA TA Y 0 0  
## 17 281 TA TA Y 0 0  
## 6 380 TA TA Y 0 40  
## 11 380 TA TA Y 0 40  
## 74 380 TA TA Y 0 40  
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## 50 768 TA TA Y 327 64  
## 30 480 TA TA Y 0 0  
## 38 396 TA TA N 72 36  
## 66 0 <NA> <NA> Y 0 0  
## 83 397 TA TA Y 178 128  
## 94 660 TA TA Y 0 68  
## 52 240 TA TA N 92 0  
## 71 364 TA TA Y 116 78  
## 44 296 Fa Po P 120 0  
## 15 220 TA TA Y 0 140  
## 45 480 TA TA Y 0 0  
## 49 548 TA TA Y 0 0  
## 78 528 TA TA Y 0 140  
## 72 280 TA TA P 0 0  
## 29 0 <NA> <NA> Y 0 0  
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## 73 440 TA TA Y 252 0  
## 58 300 TA TA Y 121 0  
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## 24 384 TA TA Y 0 130  
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## 98 384 Fa TA Y 168 24  
## 10 252 TA TA Y 116 0  
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## 96 280 TA TA P 0 0  
## 100 276 TA TA Y 736 68  
## 55 280 TA TA P 207 0  
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## 32 461 Fa Fa Y 0 0  
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## 51 0 <NA> <NA> Y 120 0  
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## 19 200 TA Fa Y 48 0  
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## 37 0 <NA> <NA> Y 144 0  
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## 88 0 1 2008 New Partial 160000 8.637994  
## 33 0 10 2007 New Partial 184750 8.450198  
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## 60 0 9 2008 WD Normal 145900 7.696213  
## 9 0 6 2007 WD Normal 243000 7.676937  
## 79 0 7 2008 WD Normal 235000 7.653495  
## 40 0 8 2006 WD Normal 225000 7.604894  
## 20 0 7 2009 ConLD Normal 198500 7.561122  
## 4 0 10 2006 WD Normal 136900 7.525640  
## 69 0 6 2009 WD Normal 139600 7.457609  
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## 83 0 7 2008 WD Normal 165400 7.412160  
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## 61 0 8 2007 Oth Abnorml 150000 7.272398  
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## 58 0 4 2008 WD Normal 135500 7.239215  
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## 35 0 1 2008 WD Normal 107500 7.205635  
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## 10 0 6 2007 WD Normal 120000 7.200425  
## 26 0 6 2009 COD Abnorml 60000 7.151485  
## 96 0 10 2009 WD Normal 105000 7.137278  
## 100 0 6 2008 WD Normal 147500 7.135687  
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## 81 0 3 2006 WD Normal 104900 7.107425  
## 53 0 4 2006 COD Normal 102000 7.106606  
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## 81 11.56076  
## 53 11.53273  
## 32 11.84940  
## 14 12.13350  
## 51 12.09514  
## 56 11.77913  
## 28 11.60824  
## 22 11.30220  
## 46 11.83138  
## 64 11.73607  
## 1 11.31447  
## 48 11.72400  
## 25 11.76757  
## 27 11.74404  
## 67 12.07824  
## 36 11.58989  
## 5 11.95118  
## 23 11.73607  
## 80 11.44035  
## 12 11.84940  
## 54 11.58058  
## 16 11.90497  
## 19 11.46163  
## 7 11.27720  
## 43 11.95118  
## 57 11.96400  
## 31 11.90497  
## 87 11.84940  
## 99 11.88449  
## 37 11.58989  
## 62 11.75587  
## 2 11.45900  
## 75 11.62625  
## 90 11.68688  
## 91 11.61729  
## 65 11.31447  
## 70 11.34923  
## 77 11.28978  
## 21 11.01863  
## 63 11.60824  
## 13 11.49272  
## 41 11.11245  
## 84 11.51192  
## 86 11.65269  
## 95 10.97678  
## 18 11.32055  
## 68 11.33857  
## 3 11.32660  
## 39 11.68267  
## 93 11.51293  
## 42 11.35041  
## 92 11.27720  
## 76 11.67844  
## 82 11.63514  
## 34 11.36210

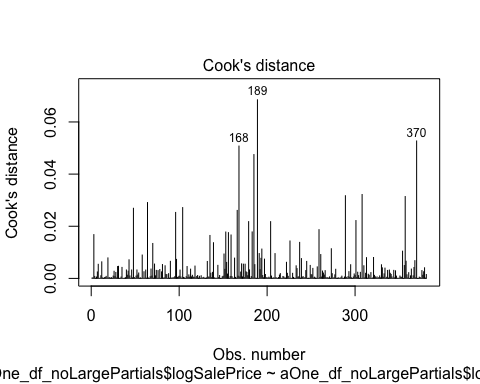
## Two properties with large GrLivArea, almost twice as large, but these homes are not complete.  
## Partial - Home was not completed when last assessed (associated with New Homes)  
  
## Check the rest of the df for partial houses.  
  
aOne\_df\_noLargePartials <-   
 aOne\_df %>%   
 filter(GrLivArea < 4500)  
  
summary(aOne\_df)

## Id MSSubClass MSZoning LotFrontage   
## Min. : 10.0 Min. : 20.00 C (all): 0 Min. : 24.00   
## 1st Qu.: 381.5 1st Qu.: 20.00 FV : 0 1st Qu.: 60.00   
## Median : 729.0 Median : 30.00 RH : 4 Median : 70.00   
## Mean : 744.0 Mean : 45.14 RL :341 Mean : 71.22   
## 3rd Qu.:1117.0 3rd Qu.: 60.00 RM : 38 3rd Qu.: 79.00   
## Max. :1460.0 Max. :190.00 Max. :313.00   
## NA's :54   
## LotArea Street Alley LotShape LandContour Utilities   
## Min. : 2522 Grvl: 1 Grvl: 7 IR1: 98 Bnk: 15 AllPub:383   
## 1st Qu.: 7634 Pave:382 Pave: 5 IR2: 1 HLS: 5 NoSeWa: 0   
## Median : 9098 NA's:371 IR3: 2 Low: 3   
## Mean : 9740 Reg:282 Lvl:360   
## 3rd Qu.:10646   
## Max. :63887   
##   
## LotConfig LandSlope Neighborhood Condition1 Condition2   
## Corner : 82 Gtl:368 NAmes :225 Norm :314 Norm :376   
## CulDSac: 11 Mod: 13 Edwards:100 Feedr : 28 Feedr : 4   
## FR2 : 11 Sev: 2 BrkSide: 58 Artery : 22 Artery : 1   
## FR3 : 1 Blmngtn: 0 PosN : 8 PosN : 1   
## Inside :278 Blueste: 0 RRAn : 7 RRNn : 1   
## BrDale : 0 PosA : 3 PosA : 0   
## (Other): 0 (Other): 1 (Other): 0   
## BldgType HouseStyle OverallQual OverallCond YearBuilt   
## 1Fam :342 1Story :232 Min. : 1.00 Min. :1.000 Min. :1900   
## 2fmCon: 7 1.5Fin : 62 1st Qu.: 5.00 1st Qu.:5.000 1st Qu.:1947   
## Duplex: 25 2Story : 42 Median : 5.00 Median :6.000 Median :1957   
## Twnhs : 3 SLvl : 27 Mean : 5.24 Mean :5.752 Mean :1955   
## TwnhsE: 6 SFoyer : 11 3rd Qu.: 6.00 3rd Qu.:7.000 3rd Qu.:1964   
## 1.5Unf : 8 Max. :10.00 Max. :9.000 Max. :2009   
## (Other): 1   
## YearRemodAdd RoofStyle RoofMatl Exterior1st Exterior2nd  
## Min. :1950 Flat : 7 CompShg:371 MetalSd:97 Wd Sdng:95   
## 1st Qu.:1954 Gable :288 Tar&Grv: 8 Wd Sdng:91 MetalSd:93   
## Median :1965 Gambrel: 5 ClyTile: 1 VinylSd:54 VinylSd:53   
## Mean :1972 Hip : 82 Roll : 1 HdBoard:52 HdBoard:51   
## 3rd Qu.:1994 Mansard: 1 WdShake: 1 BrkFace:24 Plywood:38   
## Max. :2009 Shed : 0 WdShngl: 1 Plywood:23 Wd Shng:14   
## (Other): 0 (Other):42 (Other):39   
## MasVnrType MasVnrArea ExterQual ExterCond Foundation   
## BrkCmn : 8 Min. : 0.00 Ex: 5 Ex: 1 BrkTil: 50   
## BrkFace:103 1st Qu.: 0.00 Fa: 4 Fa: 12 CBlock:269   
## None :253 Median : 0.00 Gd: 26 Gd: 44 PConc : 48   
## Stone : 19 Mean : 73.72 TA:348 Po: 1 Slab : 15   
## 3rd Qu.: 108.00 TA:325 Stone : 1   
## Max. :1115.00 Wood : 0   
##   
## BsmtQual BsmtCond BsmtExposure BsmtFinType1 BsmtFinSF1   
## Ex : 5 Fa : 17 Av : 26 ALQ :72 Min. : 0.0   
## Fa : 11 Gd : 13 Gd : 33 BLQ :74 1st Qu.: 0.0   
## Gd : 46 Po : 1 Mn : 30 GLQ :38 Median : 400.0   
## TA :297 TA :328 No :270 LwQ :26 Mean : 425.7   
## NA's: 24 NA's: 24 NA's: 24 Rec :68 3rd Qu.: 632.0   
## Unf :81 Max. :5644.0   
## NA's:24   
## BsmtFinType2 BsmtFinSF2 BsmtUnfSF TotalBsmtSF   
## ALQ : 5 Min. : 0.00 Min. : 0.0 Min. : 0.0   
## BLQ : 15 1st Qu.: 0.00 1st Qu.: 165.5 1st Qu.: 780.0   
## GLQ : 2 Median : 0.00 Median : 410.0 Median : 948.0   
## LwQ : 19 Mean : 64.06 Mean : 463.9 Mean : 953.7   
## Rec : 27 3rd Qu.: 0.00 3rd Qu.: 707.0 3rd Qu.:1127.0   
## Unf :291 Max. :1029.00 Max. :1800.0 Max. :6110.0   
## NA's: 24   
## Heating HeatingQC CentralAir Electrical X1stFlrSF   
## Floor: 1 Ex:115 N: 38 FuseA: 52 Min. : 334   
## GasA :368 Fa: 21 Y:345 FuseF: 15 1st Qu.: 895   
## GasW : 6 Gd: 81 FuseP: 1 Median :1053   
## Grav : 4 Po: 0 Mix : 0 Mean :1113   
## OthW : 0 TA:166 SBrkr:315 3rd Qu.:1236   
## Wall : 4 Max. :4692   
##   
## X2ndFlrSF LowQualFinSF GrLivArea BsmtFullBath   
## Min. : 0.0 Min. : 0.000 Min. : 334 Min. :0.0000   
## 1st Qu.: 0.0 1st Qu.: 0.000 1st Qu.:1003 1st Qu.:0.0000   
## Median : 0.0 Median : 0.000 Median :1200 Median :0.0000   
## Mean : 186.1 Mean : 2.977 Mean :1302 Mean :0.4334   
## 3rd Qu.: 398.0 3rd Qu.: 0.000 3rd Qu.:1496 3rd Qu.:1.0000   
## Max. :1538.0 Max. :392.000 Max. :5642 Max. :3.0000   
##   
## BsmtHalfBath FullBath HalfBath BedroomAbvGr   
## Min. :0.00000 Min. :0.000 Min. :0.0000 Min. :1.000   
## 1st Qu.:0.00000 1st Qu.:1.000 1st Qu.:0.0000 1st Qu.:2.000   
## Median :0.00000 Median :1.000 Median :0.0000 Median :3.000   
## Mean :0.08094 Mean :1.235 Mean :0.2298 Mean :2.869   
## 3rd Qu.:0.00000 3rd Qu.:1.000 3rd Qu.:0.0000 3rd Qu.:3.000   
## Max. :2.00000 Max. :3.000 Max. :2.0000 Max. :6.000   
##   
## KitchenAbvGr KitchenQual TotRmsAbvGrd Functional Fireplaces   
## Min. :0.000 Ex: 10 Min. : 2.000 Maj1: 8 Min. :0.0000   
## 1st Qu.:1.000 Fa: 20 1st Qu.: 5.000 Maj2: 2 1st Qu.:0.0000   
## Median :1.000 Gd: 63 Median : 6.000 Min1: 17 Median :0.0000   
## Mean :1.055 TA:290 Mean : 6.031 Min2: 8 Mean :0.4752   
## 3rd Qu.:1.000 3rd Qu.: 7.000 Mod : 7 3rd Qu.:1.0000   
## Max. :2.000 Max. :12.000 Sev : 1 Max. :3.0000   
## Typ :340   
## FireplaceQu GarageType GarageYrBlt GarageFinish GarageCars   
## Ex : 2 2Types : 1 Min. :1916 Fin : 43 Min. :0.000   
## Fa : 14 Attchd :179 1st Qu.:1954 RFn : 85 1st Qu.:1.000   
## Gd : 83 Basment: 11 Median :1960 Unf :217 Median :1.000   
## Po : 9 BuiltIn: 8 Mean :1963 NA's: 38 Mean :1.376   
## TA : 38 CarPort: 3 3rd Qu.:1970 3rd Qu.:2.000   
## NA's:237 Detchd :143 Max. :2009 Max. :4.000   
## NA's : 38 NA's :38   
## GarageArea GarageQual GarageCond PavedDrive WoodDeckSF   
## Min. : 0.0 Ex : 1 Ex : 1 N: 27 Min. : 0.00   
## 1st Qu.: 280.0 Fa : 11 Fa : 10 P: 11 1st Qu.: 0.00   
## Median : 380.0 Gd : 3 Gd : 4 Y:345 Median : 0.00   
## Mean : 382.0 Po : 0 Po : 2 Mean : 60.79   
## 3rd Qu.: 507.5 TA :330 TA :328 3rd Qu.: 98.00   
## Max. :1418.0 NA's: 38 NA's: 38 Max. :736.00   
##   
## OpenPorchSF EnclosedPorch X3SsnPorch ScreenPorch   
## Min. : 0.00 Min. : 0.00 Min. : 0.000 Min. : 0.00   
## 1st Qu.: 0.00 1st Qu.: 0.00 1st Qu.: 0.000 1st Qu.: 0.00   
## Median : 0.00 Median : 0.00 Median : 0.000 Median : 0.00   
## Mean : 30.03 Mean : 24.31 Mean : 3.052 Mean : 19.93   
## 3rd Qu.: 39.50 3rd Qu.: 0.00 3rd Qu.: 0.000 3rd Qu.: 0.00   
## Max. :406.00 Max. :552.00 Max. :407.000 Max. :385.00   
##   
## PoolArea PoolQC Fence MiscFeature MiscVal   
## Min. : 0.000 Ex : 1 GdPrv: 22 Gar2: 1 Min. : 0.00   
## 1st Qu.: 0.000 Fa : 0 GdWo : 30 Othr: 1 1st Qu.: 0.00   
## Median : 0.000 Gd : 2 MnPrv: 47 Shed: 20 Median : 0.00   
## Mean : 4.517 NA's:380 MnWw : 9 TenC: 0 Mean : 78.59   
## 3rd Qu.: 0.000 NA's :275 NA's:361 3rd Qu.: 0.00   
## Max. :738.000 Max. :15500.00   
##   
## MoSold YrSold SaleType SaleCondition  
## Min. : 1.000 Min. :2006 WD :350 Abnorml: 34   
## 1st Qu.: 5.000 1st Qu.:2007 COD : 19 AdjLand: 4   
## Median : 6.000 Median :2008 New : 4 Alloca : 2   
## Mean : 6.256 Mean :2008 ConLD : 3 Family : 5   
## 3rd Qu.: 7.000 3rd Qu.:2009 ConLI : 2 Normal :334   
## Max. :12.000 Max. :2010 ConLw : 2 Partial: 4   
## (Other): 3   
## SalePrice logGrLivArea logSalePrice   
## Min. : 39300 Min. :5.811 Min. :10.58   
## 1st Qu.:116000 1st Qu.:6.911 1st Qu.:11.66   
## Median :135500 Median :7.090 Median :11.82   
## Mean :138062 Mean :7.119 Mean :11.80   
## 3rd Qu.:155000 3rd Qu.:7.311 3rd Qu.:11.95   
## Max. :345000 Max. :8.638 Max. :12.75   
##

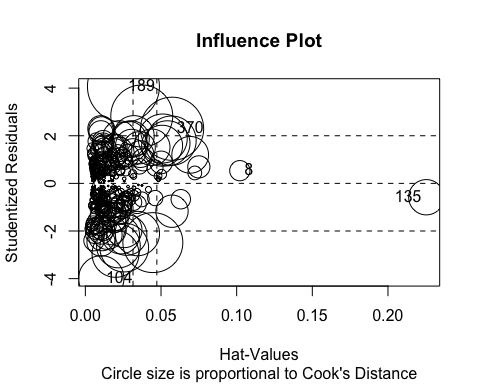
summary(aOne\_df\_noLargePartials)

## Id MSSubClass MSZoning LotFrontage   
## Min. : 10.0 Min. : 20.00 C (all): 0 Min. : 24.0   
## 1st Qu.: 376.0 1st Qu.: 20.00 FV : 0 1st Qu.: 60.0   
## Median : 729.0 Median : 30.00 RH : 4 Median : 70.0   
## Mean : 743.1 Mean : 45.07 RL :339 Mean : 70.3   
## 3rd Qu.:1114.0 3rd Qu.: 60.00 RM : 38 3rd Qu.: 79.0   
## Max. :1460.0 Max. :190.00 Max. :313.0   
## NA's :54   
## LotArea Street Alley LotShape LandContour Utilities   
## Min. : 2522 Grvl: 1 Grvl: 7 IR1: 97 Bnk: 13 AllPub:381   
## 1st Qu.: 7590 Pave:380 Pave: 5 IR2: 1 HLS: 5 NoSeWa: 0   
## Median : 9084 NA's:369 IR3: 1 Low: 3   
## Mean : 9518 Reg:282 Lvl:360   
## 3rd Qu.:10628   
## Max. :31770   
##   
## LotConfig LandSlope Neighborhood Condition1 Condition2   
## Corner : 81 Gtl:366 NAmes :225 Norm :314 Norm :375   
## CulDSac: 11 Mod: 13 Edwards: 98 Feedr : 27 Feedr : 4   
## FR2 : 11 Sev: 2 BrkSide: 58 Artery : 22 Artery : 1   
## FR3 : 1 Blmngtn: 0 PosN : 7 RRNn : 1   
## Inside :277 Blueste: 0 RRAn : 7 PosA : 0   
## BrDale : 0 PosA : 3 PosN : 0   
## (Other): 0 (Other): 1 (Other): 0   
## BldgType HouseStyle OverallQual OverallCond YearBuilt   
## 1Fam :340 1Story :232 Min. :1.000 Min. :1.000 Min. :1900   
## 2fmCon: 7 1.5Fin : 62 1st Qu.:5.000 1st Qu.:5.000 1st Qu.:1947   
## Duplex: 25 2Story : 40 Median :5.000 Median :6.000 Median :1957   
## Twnhs : 3 SLvl : 27 Mean :5.215 Mean :5.756 Mean :1954   
## TwnhsE: 6 SFoyer : 11 3rd Qu.:6.000 3rd Qu.:7.000 3rd Qu.:1964   
## 1.5Unf : 8 Max. :9.000 Max. :9.000 Max. :2009   
## (Other): 1   
## YearRemodAdd RoofStyle RoofMatl Exterior1st Exterior2nd  
## Min. :1950 Flat : 7 CompShg:370 MetalSd:97 Wd Sdng:95   
## 1st Qu.:1954 Gable :288 Tar&Grv: 8 Wd Sdng:91 MetalSd:93   
## Median :1965 Gambrel: 5 Roll : 1 VinylSd:54 VinylSd:53   
## Mean :1972 Hip : 80 WdShake: 1 HdBoard:52 HdBoard:51   
## 3rd Qu.:1994 Mansard: 1 WdShngl: 1 BrkFace:24 Plywood:38   
## Max. :2009 Shed : 0 ClyTile: 0 Plywood:23 Wd Shng:14   
## (Other): 0 (Other):40 (Other):37   
## MasVnrType MasVnrArea ExterQual ExterCond Foundation   
## BrkCmn : 8 Min. : 0.00 Ex: 3 Ex: 1 BrkTil: 50   
## BrkFace:103 1st Qu.: 0.00 Fa: 4 Fa: 12 CBlock:269   
## None :253 Median : 0.00 Gd: 26 Gd: 44 PConc : 46   
## Stone : 17 Mean : 70.01 TA:348 Po: 1 Slab : 15   
## 3rd Qu.: 105.00 TA:323 Stone : 1   
## Max. :1115.00 Wood : 0   
##   
## BsmtQual BsmtCond BsmtExposure BsmtFinType1 BsmtFinSF1   
## Ex : 3 Fa : 17 Av : 26 ALQ :72 Min. : 0.0   
## Fa : 11 Gd : 13 Gd : 31 BLQ :74 1st Qu.: 0.0   
## Gd : 46 Po : 1 Mn : 30 GLQ :36 Median : 399.0   
## TA :297 TA :326 No :270 LwQ :26 Mean : 407.2   
## NA's: 24 NA's: 24 NA's: 24 Rec :68 3rd Qu.: 626.0   
## Unf :81 Max. :1880.0   
## NA's:24   
## BsmtFinType2 BsmtFinSF2 BsmtUnfSF TotalBsmtSF   
## ALQ : 5 Min. : 0.0 Min. : 0.0 Min. : 0.0   
## BLQ : 15 1st Qu.: 0.0 1st Qu.: 162.0 1st Qu.: 780.0   
## GLQ : 2 Median : 0.0 Median : 410.0 Median : 945.0   
## LwQ : 19 Mean : 64.4 Mean : 462.8 Mean : 934.4   
## Rec : 27 3rd Qu.: 0.0 3rd Qu.: 706.0 3rd Qu.:1125.0   
## Unf :289 Max. :1029.0 Max. :1800.0 Max. :2223.0   
## NA's: 24   
## Heating HeatingQC CentralAir Electrical X1stFlrSF   
## Floor: 1 Ex:113 N: 38 FuseA: 52 Min. : 334   
## GasA :366 Fa: 21 Y:343 FuseF: 15 1st Qu.: 894   
## GasW : 6 Gd: 81 FuseP: 1 Median :1053   
## Grav : 4 Po: 0 Mix : 0 Mean :1098   
## OthW : 0 TA:166 SBrkr:313 3rd Qu.:1235   
## Wall : 4 Max. :2223   
##   
## X2ndFlrSF LowQualFinSF GrLivArea BsmtFullBath   
## Min. : 0.0 Min. : 0.000 Min. : 334 Min. :0.0000   
## 1st Qu.: 0.0 1st Qu.: 0.000 1st Qu.:1002 1st Qu.:0.0000   
## Median : 0.0 Median : 0.000 Median :1200 Median :0.0000   
## Mean : 180.5 Mean : 2.992 Mean :1282 Mean :0.4278   
## 3rd Qu.: 384.0 3rd Qu.: 0.000 3rd Qu.:1486 3rd Qu.:1.0000   
## Max. :1427.0 Max. :392.000 Max. :3112 Max. :3.0000   
##   
## BsmtHalfBath FullBath HalfBath BedroomAbvGr   
## Min. :0.00000 Min. :0.000 Min. :0.0000 Min. :1.000   
## 1st Qu.:0.00000 1st Qu.:1.000 1st Qu.:0.0000 1st Qu.:2.000   
## Median :0.00000 Median :1.000 Median :0.0000 Median :3.000   
## Mean :0.08136 Mean :1.228 Mean :0.2257 Mean :2.869   
## 3rd Qu.:0.00000 3rd Qu.:1.000 3rd Qu.:0.0000 3rd Qu.:3.000   
## Max. :2.00000 Max. :3.000 Max. :2.0000 Max. :6.000   
##   
## KitchenAbvGr KitchenQual TotRmsAbvGrd Functional Fireplaces   
## Min. :0.000 Ex: 8 Min. : 2.000 Maj1: 8 Min. :0.0000   
## 1st Qu.:1.000 Fa: 20 1st Qu.: 5.000 Maj2: 2 1st Qu.:0.0000   
## Median :1.000 Gd: 63 Median : 6.000 Min1: 17 Median :0.0000   
## Mean :1.055 TA:290 Mean : 6.003 Min2: 8 Mean :0.4672   
## 3rd Qu.:1.000 3rd Qu.: 7.000 Mod : 7 3rd Qu.:1.0000   
## Max. :2.000 Max. :12.000 Sev : 1 Max. :3.0000   
## Typ :338   
## FireplaceQu GarageType GarageYrBlt GarageFinish GarageCars   
## Ex : 2 2Types : 1 Min. :1916 Fin : 41 Min. :0.00   
## Fa : 14 Attchd :178 1st Qu.:1954 RFn : 85 1st Qu.:1.00   
## Gd : 81 Basment: 11 Median :1960 Unf :217 Median :1.00   
## Po : 9 BuiltIn: 7 Mean :1963 NA's: 38 Mean :1.37   
## TA : 38 CarPort: 3 3rd Qu.:1970 3rd Qu.:2.00   
## NA's:237 Detchd :143 Max. :2009 Max. :4.00   
## NA's : 38 NA's :38   
## GarageArea GarageQual GarageCond PavedDrive WoodDeckSF   
## Min. : 0.0 Ex : 1 Ex : 1 N: 27 Min. : 0   
## 1st Qu.:280.0 Fa : 11 Fa : 10 P: 11 1st Qu.: 0   
## Median :380.0 Gd : 3 Gd : 4 Y:343 Median : 0   
## Mean :377.9 Po : 0 Po : 2 Mean : 60   
## 3rd Qu.:505.0 TA :328 TA :326 3rd Qu.: 92   
## Max. :968.0 NA's: 38 NA's: 38 Max. :736   
##   
## OpenPorchSF EnclosedPorch X3SsnPorch ScreenPorch   
## Min. : 0.00 Min. : 0.00 Min. : 0.000 Min. : 0.00   
## 1st Qu.: 0.00 1st Qu.: 0.00 1st Qu.: 0.000 1st Qu.: 0.00   
## Median : 0.00 Median : 0.00 Median : 0.000 Median : 0.00   
## Mean : 28.36 Mean : 24.44 Mean : 3.068 Mean : 20.03   
## 3rd Qu.: 38.00 3rd Qu.: 0.00 3rd Qu.: 0.000 3rd Qu.: 0.00   
## Max. :319.00 Max. :552.00 Max. :407.000 Max. :385.00   
##   
## PoolArea PoolQC Fence MiscFeature MiscVal   
## Min. : 0.000 Ex : 1 GdPrv: 22 Gar2: 1 Min. : 0   
## 1st Qu.: 0.000 Fa : 0 GdWo : 30 Othr: 1 1st Qu.: 0   
## Median : 0.000 Gd : 1 MnPrv: 47 Shed: 20 Median : 0   
## Mean : 3.281 NA's:379 MnWw : 9 TenC: 0 Mean : 79   
## 3rd Qu.: 0.000 NA's :273 NA's:359 3rd Qu.: 0   
## Max. :738.000 Max. :15500   
##   
## MoSold YrSold SaleType SaleCondition  
## Min. : 1.00 Min. :2006 WD :350 Abnorml: 34   
## 1st Qu.: 5.00 1st Qu.:2007 COD : 19 AdjLand: 4   
## Median : 6.00 Median :2008 ConLD : 3 Alloca : 2   
## Mean : 6.26 Mean :2008 ConLI : 2 Family : 5   
## 3rd Qu.: 7.00 3rd Qu.:2009 ConLw : 2 Normal :334   
## Max. :12.00 Max. :2010 New : 2 Partial: 2   
## (Other): 3   
## SalePrice logGrLivArea logSalePrice   
## Min. : 39300 Min. :5.811 Min. :10.58   
## 1st Qu.:116000 1st Qu.:6.910 1st Qu.:11.66   
## Median :135000 Median :7.090 Median :11.81   
## Mean :137882 Mean :7.112 Mean :11.80   
## 3rd Qu.:155000 3rd Qu.:7.304 3rd Qu.:11.95   
## Max. :345000 Max. :8.043 Max. :12.75   
##

aOne\_noLargePartials\_TrnsXY\_lm <- lm(  
 aOne\_df\_noLargePartials$logSalePrice ~   
 aOne\_df\_noLargePartials$logGrLivArea +   
 aOne\_df\_noLargePartials$Neighborhood +   
 (aOne\_df\_noLargePartials$logGrLivArea \* aOne\_df\_noLargePartials$Neighborhood),  
 aOne\_df\_noLargePartials  
 )  
  
plot(  
 aOne\_noLargePartials\_TrnsXY\_lm,   
 which=4,   
 cook.levels=cutoff  
 )



# Influence Plot  
influencePlot(  
 aOne\_noLargePartials\_TrnsXY\_lm,   
 main="Influence Plot",   
 sub="Circle size is proportional to Cook's Distance"  
 )



## StudRes Hat CookD  
## 8 0.5335560 0.10208190 0.00540443  
## 104 -3.9905009 0.01052703 0.02715543  
## 135 -0.5822942 0.22534912 0.01646833  
## 189 4.0722418 0.02516380 0.06849805  
## 370 2.2935878 0.05731889 0.05271158

summary(aOne\_noLargePartials\_TrnsXY\_lm)

##   
## Call:  
## lm(formula = aOne\_df\_noLargePartials$logSalePrice ~ aOne\_df\_noLargePartials$logGrLivArea +   
## aOne\_df\_noLargePartials$Neighborhood + (aOne\_df\_noLargePartials$logGrLivArea \*   
## aOne\_df\_noLargePartials$Neighborhood), data = aOne\_df\_noLargePartials)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.73636 -0.10679 0.02187 0.10524 0.74523   
##   
## Coefficients:  
## Estimate  
## (Intercept) 5.91292  
## aOne\_df\_noLargePartials$logGrLivArea 0.81965  
## aOne\_df\_noLargePartials$NeighborhoodEdwards 1.01017  
## aOne\_df\_noLargePartials$NeighborhoodNAmes 2.57981  
## aOne\_df\_noLargePartials$logGrLivArea:aOne\_df\_noLargePartials$NeighborhoodEdwards -0.14631  
## aOne\_df\_noLargePartials$logGrLivArea:aOne\_df\_noLargePartials$NeighborhoodNAmes -0.34662  
## Std. Error  
## (Intercept) 0.49642  
## aOne\_df\_noLargePartials$logGrLivArea 0.07047  
## aOne\_df\_noLargePartials$NeighborhoodEdwards 0.69821  
## aOne\_df\_noLargePartials$NeighborhoodNAmes 0.59016  
## aOne\_df\_noLargePartials$logGrLivArea:aOne\_df\_noLargePartials$NeighborhoodEdwards 0.09868  
## aOne\_df\_noLargePartials$logGrLivArea:aOne\_df\_noLargePartials$NeighborhoodNAmes 0.08345  
## t value  
## (Intercept) 11.911  
## aOne\_df\_noLargePartials$logGrLivArea 11.631  
## aOne\_df\_noLargePartials$NeighborhoodEdwards 1.447  
## aOne\_df\_noLargePartials$NeighborhoodNAmes 4.371  
## aOne\_df\_noLargePartials$logGrLivArea:aOne\_df\_noLargePartials$NeighborhoodEdwards -1.483  
## aOne\_df\_noLargePartials$logGrLivArea:aOne\_df\_noLargePartials$NeighborhoodNAmes -4.154  
## Pr(>|t|)  
## (Intercept) < 2e-16  
## aOne\_df\_noLargePartials$logGrLivArea < 2e-16  
## aOne\_df\_noLargePartials$NeighborhoodEdwards 0.149  
## aOne\_df\_noLargePartials$NeighborhoodNAmes 1.60e-05  
## aOne\_df\_noLargePartials$logGrLivArea:aOne\_df\_noLargePartials$NeighborhoodEdwards 0.139  
## aOne\_df\_noLargePartials$logGrLivArea:aOne\_df\_noLargePartials$NeighborhoodNAmes 4.05e-05  
##   
## (Intercept) \*\*\*  
## aOne\_df\_noLargePartials$logGrLivArea \*\*\*  
## aOne\_df\_noLargePartials$NeighborhoodEdwards   
## aOne\_df\_noLargePartials$NeighborhoodNAmes \*\*\*  
## aOne\_df\_noLargePartials$logGrLivArea:aOne\_df\_noLargePartials$NeighborhoodEdwards   
## aOne\_df\_noLargePartials$logGrLivArea:aOne\_df\_noLargePartials$NeighborhoodNAmes \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.1892 on 375 degrees of freedom  
## Multiple R-squared: 0.5279, Adjusted R-squared: 0.5216   
## F-statistic: 83.87 on 5 and 375 DF, p-value: < 2.2e-16

press(aOne\_noLargePartials\_TrnsXY\_lm)

## [1] 13.94807

aOne\_df\_noLargePartials\_2 <-   
 mutate(  
 aOne\_df\_noLargePartials,  
 BlendNgbrhd =  
 sapply(  
 aOne\_df\_noLargePartials$Neighborhood,   
 function(x)  
 {  
 ifelse(  
 x == "NAmes",  
 "NAmes",  
 "NotNAmes"  
 )  
 }  
 )  
 )

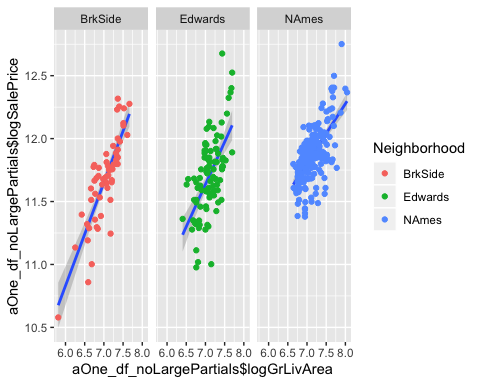
aOne\_noLargePartials\_2\_TrnsXY\_lm <- lm(  
 formula = aOne\_df\_noLargePartials\_2$logSalePrice ~   
 aOne\_df\_noLargePartials\_2$logGrLivArea +   
 aOne\_df\_noLargePartials\_2$BlendNgbrhd +   
 aOne\_df\_noLargePartials\_2$logGrLivArea:aOne\_df\_noLargePartials\_2$BlendNgbrhd,  
 data = aOne\_df\_noLargePartials\_2  
 )  
  
summary(aOne\_noLargePartials\_2\_TrnsXY\_lm)

##   
## Call:  
## lm(formula = aOne\_df\_noLargePartials\_2$logSalePrice ~ aOne\_df\_noLargePartials\_2$logGrLivArea +   
## aOne\_df\_noLargePartials\_2$BlendNgbrhd + aOne\_df\_noLargePartials\_2$logGrLivArea:aOne\_df\_noLargePartials\_2$BlendNgbrhd,   
## data = aOne\_df\_noLargePartials\_2)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.74852 -0.10760 0.02287 0.10890 0.71370   
##   
## Coefficients:  
## Estimate  
## (Intercept) 8.49273  
## aOne\_df\_noLargePartials\_2$logGrLivArea 0.47302  
## aOne\_df\_noLargePartials\_2$BlendNgbrhdNotNAmes -2.04222  
## aOne\_df\_noLargePartials\_2$logGrLivArea:aOne\_df\_noLargePartials\_2$BlendNgbrhdNotNAmes 0.26810  
## Std. Error  
## (Intercept) 0.31949  
## aOne\_df\_noLargePartials\_2$logGrLivArea 0.04474  
## aOne\_df\_noLargePartials\_2$BlendNgbrhdNotNAmes 0.47236  
## aOne\_df\_noLargePartials\_2$logGrLivArea:aOne\_df\_noLargePartials\_2$BlendNgbrhdNotNAmes 0.06643  
## t value  
## (Intercept) 26.582  
## aOne\_df\_noLargePartials\_2$logGrLivArea 10.573  
## aOne\_df\_noLargePartials\_2$BlendNgbrhdNotNAmes -4.323  
## aOne\_df\_noLargePartials\_2$logGrLivArea:aOne\_df\_noLargePartials\_2$BlendNgbrhdNotNAmes 4.035  
## Pr(>|t|)  
## (Intercept) < 2e-16  
## aOne\_df\_noLargePartials\_2$logGrLivArea < 2e-16  
## aOne\_df\_noLargePartials\_2$BlendNgbrhdNotNAmes 1.97e-05  
## aOne\_df\_noLargePartials\_2$logGrLivArea:aOne\_df\_noLargePartials\_2$BlendNgbrhdNotNAmes 6.60e-05  
##   
## (Intercept) \*\*\*  
## aOne\_df\_noLargePartials\_2$logGrLivArea \*\*\*  
## aOne\_df\_noLargePartials\_2$BlendNgbrhdNotNAmes \*\*\*  
## aOne\_df\_noLargePartials\_2$logGrLivArea:aOne\_df\_noLargePartials\_2$BlendNgbrhdNotNAmes \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.1894 on 377 degrees of freedom  
## Multiple R-squared: 0.5244, Adjusted R-squared: 0.5206   
## F-statistic: 138.6 on 3 and 377 DF, p-value: < 2.2e-16

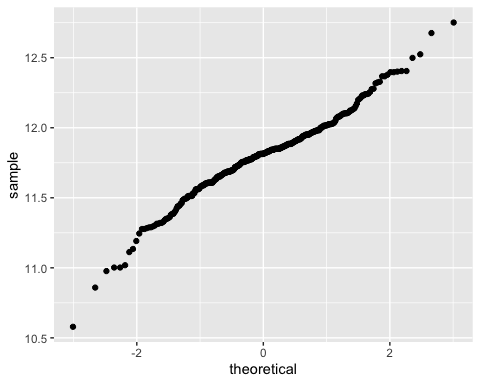
press(aOne\_noLargePartials\_2\_TrnsXY\_lm)

## [1] 13.85997

aOne\_df\_noLargePartials %>%  
 ggplot() +  
 geom\_smooth(  
 method = lm,  
 mapping =   
 aes(  
 x = aOne\_df\_noLargePartials$logGrLivArea,  
 y = aOne\_df\_noLargePartials$logSalePrice  
 )  
 ) +  
 geom\_point(  
 aes(  
 x=logGrLivArea,  
 y=logSalePrice,  
 color=Neighborhood  
 )  
 ) +  
 facet\_wrap(~Neighborhood)

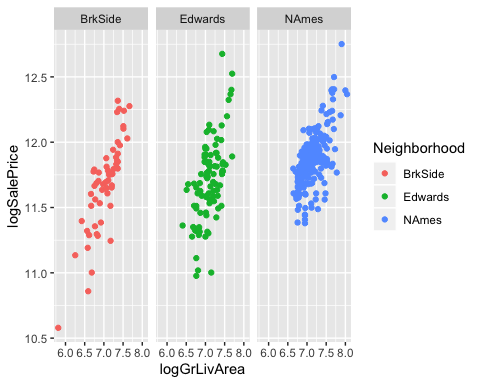


aOne\_df\_noLargePartials\_2 %>%   
 ggplot() +   
 geom\_qq(  
 aes(  
 sample = logSalePrice  
 )  
 )

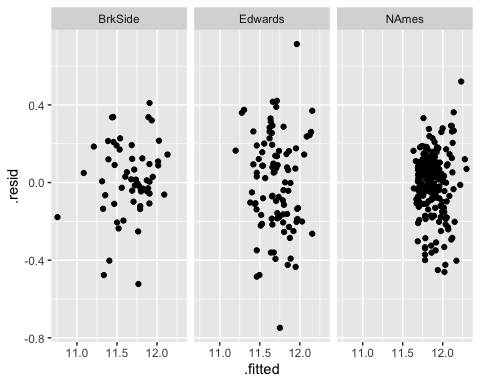


# aOne\_noLargePartials\_TrnsXY\_lm2 <- lm(  
# aOne\_df\_noLargePartials$logSalePrice ~   
# aOne\_df\_noLargePartials$logGrLivArea,  
# aOne\_df\_noLargePartials  
# )  
#   
#   
# summary(aOne\_noLargePartials\_TrnsXY\_lm2)

aOne\_df\_noLargePartials %>%  
 ggplot() +  
 geom\_point(  
 aes(  
 x=logGrLivArea,  
 y=logSalePrice,  
 color=Neighborhood  
 )  
 ) +  
 facet\_wrap(~Neighborhood)



ggplot(  
 aOne\_noLargePartials\_2\_TrnsXY\_lm  
 ) +   
 geom\_point(  
 aes(  
 x=.fitted,   
 y=.resid  
 )  
 ) +   
 facet\_wrap(  
 ~aOne\_df\_noLargePartials$Neighborhood  
 )



# ggplot(aOne\_df\_noLargePartials, aes(logSalePrice, logGrLivArea, shape=Neighborhood, # colour=Neighborhood, fill=Neighborhood)) +  
# geom\_smooth(method="lm") +  
# geom\_point(size=3) +  
# theme\_bw() +   
# xlab("Years") +  
# ylab("Concentrations (ppb)") +  
# ggtitle("Banizoumbou")  
#   
# ncvTest(  
# aOne\_noLargePartials\_TrnsXY\_lm  
# )  
#   
# aOne\_nLp\_Txy\_slp <-   
# spreadLevelPlot(  
# aOne\_noLargePartials\_TrnsXY\_lm  
# )  
#   
# aOne\_nLp\_Txy\_slp$PowerTransformation

# gvlma.lm(aOne\_noLargePartials\_TrnsXY\_lm, alphalevel = 0.05)  
#   
# plot.gvlma(  
# gvlma.lm(aOne\_noLargePartials\_TrnsXY\_lm, alphalevel = 0.05)  
# )

# cv.lm(df = aOne\_df\_noLargePartials, form.lm = formula(aOne\_df\_noLargePartials\_2$logSalePrice ~   
# aOne\_df\_noLargePartials\_2$logGrLivArea +   
# aOne\_df\_noLargePartials\_2$BlendNgbrhd +   
# (aOne\_df\_noLargePartials\_2$logGrLivArea \* aOne\_df\_noLargePartials\_2$BlendNgbrhd)), m=3, seed=2, # plotit=TRUE, printit=TRUE)

ANALYSIS 2: Build the most predictive model for sales prices of homes in all of Ames Iowa. This includes all neighborhoods. Your group is limited to only the techniques we have learned in 6371 (no random forests or other methods we have not yet covered). Specifically, you should produce 4 models: one from forward selection, one from backwards elimination, one from stepwise selection, and one that you build custom. The custom model could be one of the three preceding models or one that you build by adding or subtracting variables at your will. Generate an adjusted R2, CV Press and Kaggle Score for each of these models and clearly describe which model you feel is the best in terms of being able to predict future sale prices of homes in Ames, Iowa. In your paper, please include a table similar to the one below. The group with the lowest public Kaggle score will receive an extra 3 bonus points on the final exam!

## Analysis Question 1:

### Restatement of Problem

Century 21 Ames would like an estimate of how the SalePrice of the house is related to the square footage of the living area of the house and if the SalesPrice depends on which neighborhood the house is located in.

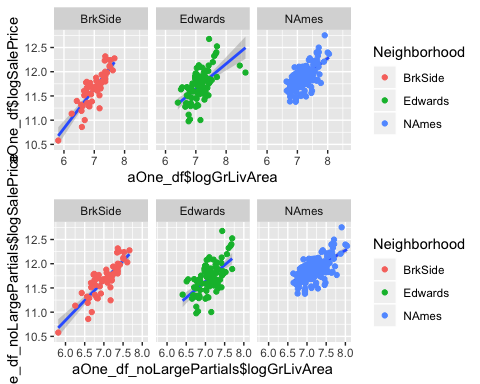
### Build and Fit the Model

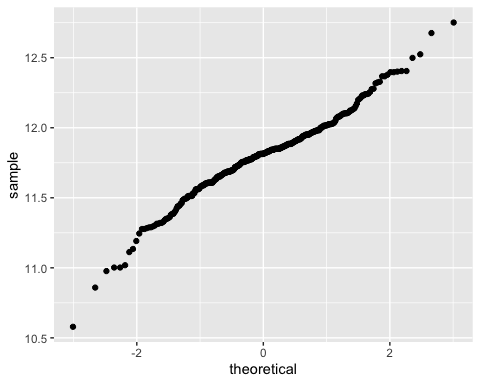
From initial models, it was found that from these 3 neighborhoods in Century 21 Ames district, the only neighborhood that was statistically significant was North Ames. The other two neighborhoods in the models were treated as one. See the appedix for supplementary code of initial models.

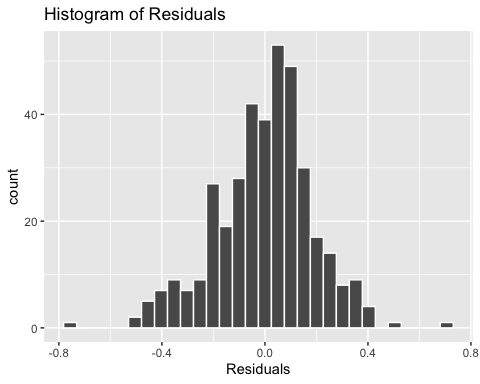
log(salePriceEstimate) = + log(GrLIvArea) + NAmes + (log(GrLIvArea)\* NAmes)

### Checking Assumptions

*Normality:* Judging from scatter plot, q-q plot, and histogram of residuals there is not strong enough evidence against normality.







*Linear Trend:*

The transformed data appears to have a linear trend, this assumption seems to be satisfied.

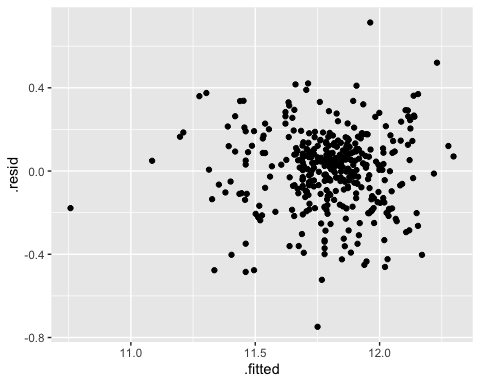
*Equal SD:*

This is assumption is satisfied, though it seems that smaller values of x have somewhat of a right skew for values of y in the NAmes neighborhood. We will proceed with this in mind, but this assumption seems like it is satified.

*Independence:*

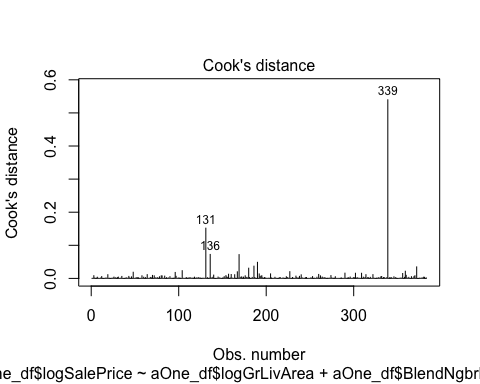
The data is assumed to be independent.

#### Residual Plots

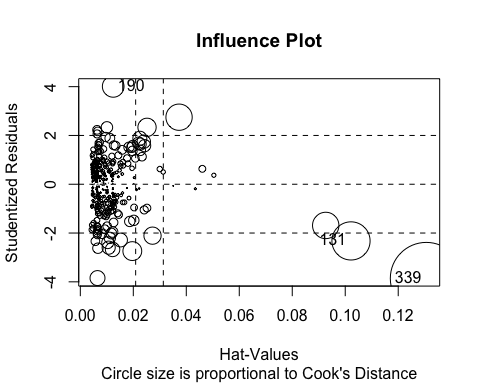


#### Influential point analysis (Cook’s D and Leverage)

plot(  
 aOne\_lm,   
 which=4,   
 cook.levels=cutoff  
 )

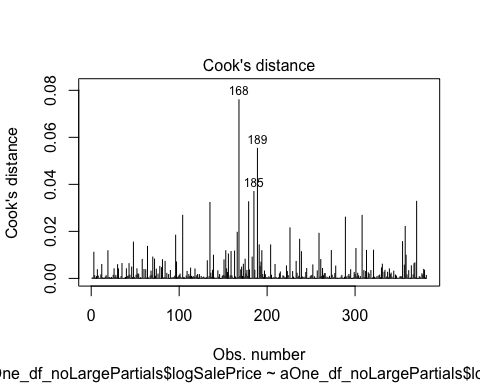


# Influence Plot  
influencePlot(  
 aOne\_lm,   
 main="Influence Plot",   
 sub="Circle size is proportional to Cook's Distance"  
 )

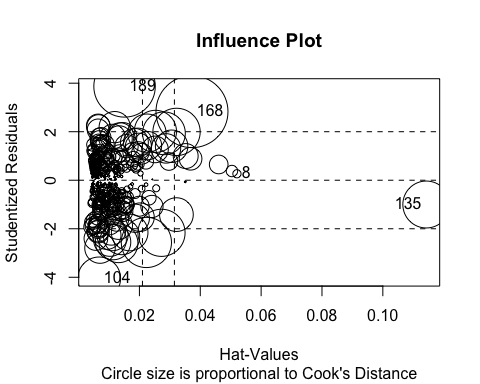


## StudRes Hat CookD  
## 131 -2.322948 0.10217513 0.15176235  
## 190 4.010642 0.01241146 0.04860308  
## 339 -3.859488 0.13060358 0.53963326

plot(  
 aOne\_lm\_noLargePartials,   
 which=4,   
 cook.levels=cutoff  
 )



# Influence Plot  
influencePlot(  
 aOne\_lm\_noLargePartials,   
 main="Influence Plot",   
 sub="Circle size is proportional to Cook's Distance"  
 )



## StudRes Hat CookD  
## 8 0.266763 0.052050021 0.0009792602  
## 104 -4.046479 0.006778209 0.0268413527  
## 135 -1.000419 0.114289929 0.0322863846  
## 168 2.827397 0.037273151 0.0759667333  
## 189 3.867570 0.015112686 0.0553328038

#### Comparing Competing Models

aOne\_lm\_summary <- summary(aOne\_lm)  
  
aOne\_lm\_noLargePartials\_summary <- summary(aOne\_lm\_noLargePartials)

##### Adj R2

aOne\_lm\_summary$adj.r.squared

## [1] 0.4931263

aOne\_lm\_noLargePartials\_summary$adj.r.squared

## [1] 0.5206446

##### Internal CV Press

press(aOne\_lm)

## [1] 14.89875

press(aOne\_lm\_noLargePartials)

## [1] 13.85997

##### Parameters

Estimates:

pander(aOne\_lm\_summary$coefficients)

Table continues below

|  |  |  |
| --- | --- | --- |
|  | Estimate | Std. Error |
| **(Intercept)** | 8.493 | 0.3285 |
| **aOne\_df$logGrLivArea** | 0.473 | 0.046 |
| **aOne\_df$BlendNgbrhdNotNAmes** | -1.26 | 0.456 |
| **aOne\_dfBlendNgbrhdNotNAmes** | 0.1565 | 0.06401 |

|  |  |  |
| --- | --- | --- |
|  | t value | Pr(>|t|) |
| **(Intercept)** | 25.85 | 1.119e-85 |
| **aOne\_df$logGrLivArea** | 10.28 | 4.856e-22 |
| **aOne\_df$BlendNgbrhdNotNAmes** | -2.763 | 0.006013 |
| **aOne\_dfBlendNgbrhdNotNAmes** | 2.445 | 0.01493 |

Interpretation:

xIncrse <- aOne\_lm\_summary$coefficients[2]  
  
yIncrse <- exp(exp(xIncrse))

Confidence Intervals:

pander(  
 confint(aOne\_lm)  
 )

|  |  |  |
| --- | --- | --- |
|  | 2.5 % | 97.5 % |
| **(Intercept)** | 7.847 | 9.139 |
| **aOne\_df$logGrLivArea** | 0.3826 | 0.5635 |
| **aOne\_df$BlendNgbrhdNotNAmes** | -2.156 | -0.3631 |
| **aOne\_dfBlendNgbrhdNotNAmes** | 0.03066 | 0.2824 |

pander(  
 confint(aOne\_lm\_noLargePartials)  
 )

Table continues below

|  |  |
| --- | --- |
|  | 2.5 % |
| **(Intercept)** | 7.865 |
| **aOne\_df\_noLargePartials$logGrLivArea** | 0.3851 |
| **aOne\_df\_noLargePartials$BlendNgbrhdNotNAmes** | -2.971 |
| **aOne\_df\_noLargePartialsBlendNgbrhdNotNAmes** | 0.1375 |

|  |  |
| --- | --- |
|  | 97.5 % |
| **(Intercept)** | 9.121 |
| **aOne\_df\_noLargePartials$logGrLivArea** | 0.561 |
| **aOne\_df\_noLargePartials$BlendNgbrhdNotNAmes** | -1.113 |
| **aOne\_df\_noLargePartialsBlendNgbrhdNotNAmes** | 0.3987 |

Conclusion A short summary of the analysis.

Analysis Question 2

Restatement of Problem

Model Selection Type of Selection Stepwise Forward Backward Custom

Checking Assumptions   
 Residual Plots  
 Influential point analysis (Cook’s D and Leverage)  
 Make sure to address each assumption  
  
 Comparing Competing Models  
 Adj R2   
 Internal CV Press   
 Kaggle Score   
  
 Conclusion: A short summary of the analysis.