lab2

```
## 1.1
ameslist <- read.table("https://msudataanalytics.github.io/SSC442/Labs/data/ames.csv",
                       header = TRUE,
                       sep = ",")
names(ameslist)
```

```
##  [1] "Id"            "MSSubClass"    "MSZoning"      "LotFrontage"
##  [5] "LotArea"       "Street"        "Alley"         "LotShape"
##  [9] "LandContour"   "Utilities"     "LotConfig"     "LandSlope"
## [13] "Neighborhood"  "Condition1"    "Condition2"    "BldgType"
## [17] "HouseStyle"    "OverallQual"   "OverallCond"   "YearBuilt"
## [21] "YearRemodAdd"  "RoofStyle"     "RoofMatl"      "Exterior1st"
## [25] "Exterior2nd"   "MasVnrType"    "MasVnrArea"    "ExterQual"
## [29] "ExterCond"     "Foundation"    "BsmtQual"      "BsmtCond"
## [33] "BsmtExposure"  "BsmtFinType1"  "BsmtFinSF1"    "BsmtFinType2"
## [37] "BsmtFinSF2"    "BsmtUnfSF"     "TotalBsmtSF"   "Heating"
## [41] "HeatingQC"     "CentralAir"    "Electrical"    "X1stFlrSF"
## [45] "X2ndFlrSF"     "LowQualFinSF"  "GrLivArea"     "BsmtFullBath"
## [49] "BsmtHalfBath"  "FullBath"      "HalfBath"      "BedroomAbvGr"
## [53] "KitchenAbvGr"  "KitchenQual"   "TotRmsAbvGrd"  "Functional"
## [57] "Fireplaces"    "FireplaceQu"   "GarageType"    "GarageYrBlt"
## [61] "GarageFinish"  "GarageCars"    "GarageArea"    "GarageQual"
## [65] "GarageCond"    "PavedDrive"    "WoodDeckSF"    "OpenPorchSF"
## [69] "EnclosedPorch" "X3SsnPorch"    "ScreenPorch"   "PoolArea"
## [73] "PoolQC"        "Fence"         "MiscFeature"   "MiscVal"
## [77] "MoSold"        "YrSold"        "SaleType"      "SaleCondition"
## [81] "SalePrice"
```

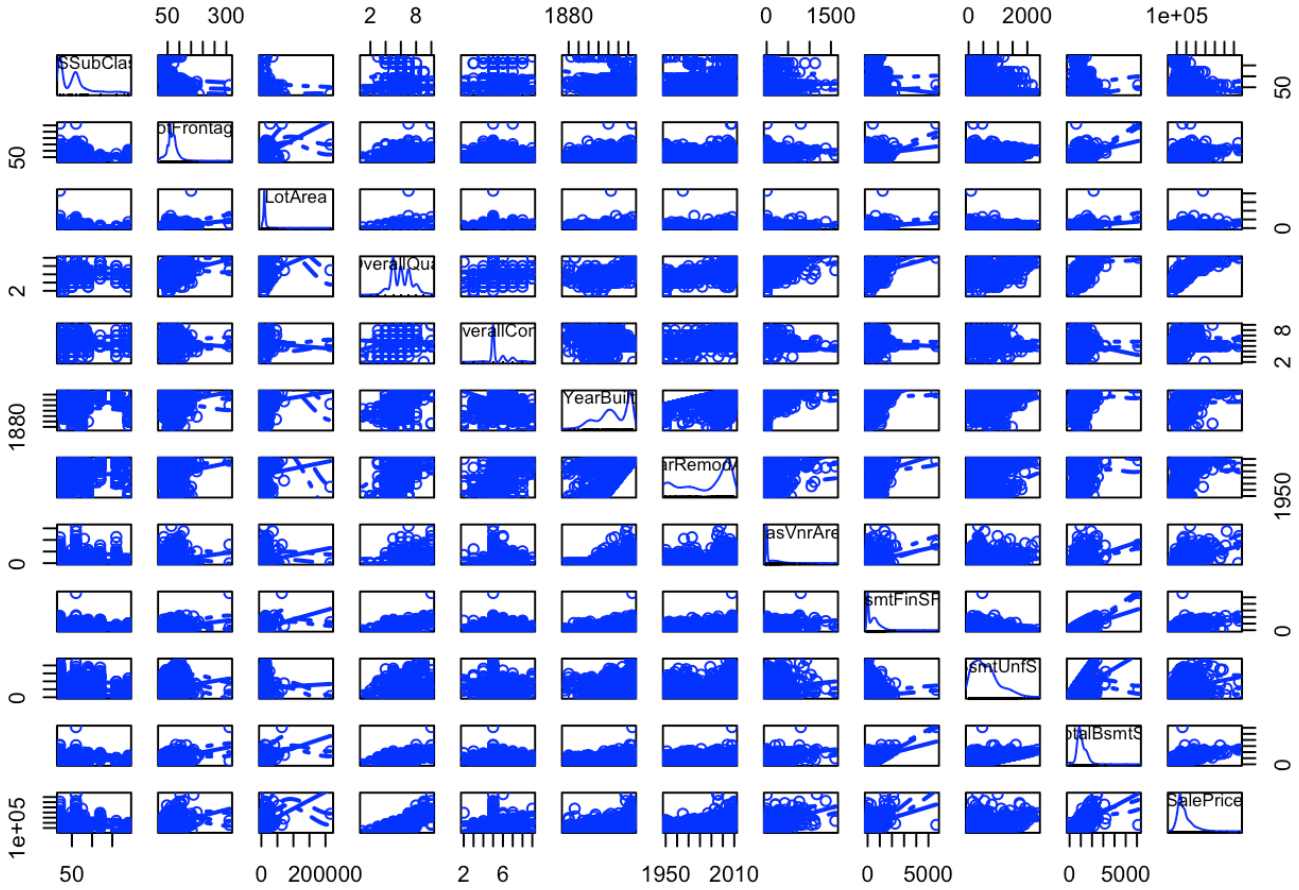
```
Ames <- vector()
Ames1 <- names(ameslist)
for(n in Ames1){
  amesl <- ameslist[n]
  if (is.numeric(amesl[1,n]) == TRUE){
    Ames <- c(Ames, amesl)
  }
}

write.table(Ames, file = "Ames.txt", sep = "\t",
            row.names = FALSE)

## 1.2
library(car)
```

```
## Loading required package: carData
```

```
ameslist_plot <- ameslist[c(2,4:5,18:21,27,35,38:39,81)]
scatterplotMatrix(ameslist_plot)
```




```
## From the plot, we see SalePrice seems highly correlated with OverallQual, YearB
uilt, YearRemodAdd, MaxVnrArea

## 1.3
Ames_matrix <- matrix(unlist(Ames),1460,45)
```

```
## Warning in matrix(unlist(Ames), 1460, 45): 数据长度[55480]不是矩阵列数[45]
## 的整倍数
```

```
cor_value <- cor(Ames_matrix)
cor_value
```

```
##                [,1]         [,2] [,3]         [,4]        [,5]
##  [1,]  1.0000000000  0.011156478   NA -0.033225519 -0.02836475
```

```
##  [2,]  0.0111564782  1.000000000   NA -0.139781082  0.03262771
##  [3,]            NA           NA    1           NA          NA
##  [4,] -0.0332255186 -0.139781082   NA  1.000000000  0.10580574
##  [5,] -0.0283647539  0.032627708   NA  0.105805742  1.00000000
##  [6,]  0.0126089248 -0.059315817   NA -0.005636270 -0.09193234
##  [7,] -0.0127127154  0.027850137   NA  0.014227652  0.57232277
##  [8,] -0.0219976419  0.040581045   NA  0.013788427  0.55068392
##  [9,]            NA           NA   NA           NA          NA
## [10,] -0.0050240490 -0.069835749   NA  0.214103131  0.23966597
## [11,] -0.0059676720 -0.065648579   NA  0.111169745 -0.05911869
## [12,] -0.0079397034 -0.140759481   NA -0.002618360  0.30815893
## [13,] -0.0154145661 -0.238518409   NA  0.260833135  0.53780850
## [14,]  0.0104960410 -0.251758352   NA  0.299474579  0.47622383
## [15,]  0.0055898489  0.307885721   NA  0.050985948  0.29549288
## [16,] -0.0442299581  0.046473756   NA  0.004778970 -0.03042928
## [17,]  0.0082727577  0.074853180   NA  0.263116167  0.59300743
## [18,]  0.0022885556  0.003491026   NA  0.158154531  0.11109779
## [19,] -0.0201547452 -0.002332535   NA  0.048045571 -0.04015016
## [20,]  0.0055874529  0.131608222   NA  0.126030627  0.55059971
## [21,]  0.0067838113  0.177354389   NA  0.014259469  0.27345810
## [22,]  0.0377185542 -0.023438028   NA  0.119689908  0.10167636
## [23,]  0.0029512364  0.281721040   NA -0.017783871 -0.18388223
## [24,]  0.0272387244  0.040380065   NA  0.190014778  0.42745234
## [25,] -0.0197716324 -0.045569340   NA  0.271364010  0.39676504
## [26,]            NA           NA   NA           NA          NA
## [27,]  0.0165696771 -0.040109793   NA  0.154870740  0.60067072
## [28,]  0.0176337785 -0.098671543   NA  0.180402755  0.56202176
## [29,] -0.0296431972 -0.012579358   NA  0.171697687  0.23892339
## [30,] -0.0004769113 -0.006100121   NA  0.084773809  0.30881882
## [31,]  0.0028892179 -0.012036622   NA -0.018339734 -0.11393686
## [32,] -0.0466347889 -0.043824549   NA  0.020422830  0.03037057
## [33,]  0.0013302086 -0.026030177   NA  0.043160378  0.06488636
## [34,]  0.0570439048  0.008282708   NA  0.077672392  0.06516584
## [35,] -0.0062424048 -0.007683291   NA  0.038067692 -0.03140621
## [36,]  0.0211721766 -0.013584643   NA  0.001204988  0.07081517
## [37,]  0.0007117940 -0.021407038   NA -0.014261407 -0.02734671
## [38,] -0.0219167194 -0.084284135   NA  0.263843354  0.79098160
## [39,]  1.0000000000  0.011156478   NA -0.033225519 -0.02836475
## [40,]  0.0111564782  1.000000000   NA -0.139781082  0.03262771
## [41,]            NA           NA   NA           NA          NA
## [42,] -0.0332255186 -0.139781082   NA  1.000000000  0.10580574
## [43,] -0.0283647539  0.032627708   NA  0.105805742  1.00000000
## [44,]  0.0126089248 -0.059315817   NA -0.005636270 -0.09193234
## [45,] -0.0127127154  0.027850137   NA  0.014227652  0.57232277
##                [,6]         [,7]         [,8] [,9]        [,10]
##  [1,]  0.012608925 -0.012712715 -0.021997642   NA -0.005024049
##  [2,] -0.059315817  0.027850137  0.040581045   NA -0.069835749
##  [3,]           NA           NA           NA   NA          NA
##  [4,] -0.005636270  0.014227652  0.013788427   NA  0.214103131
##  [5,] -0.091932343  0.572322769  0.550683924   NA  0.239665966
```

```
##  [6,]  1.000000000 -0.375983196  0.073741498   NA -0.046230856
##  [7,] -0.375983196  1.000000000  0.592854976   NA  0.249503197
##  [8,]  0.073741498  0.592854976  1.000000000   NA  0.128450547
##  [9,]           NA           NA           NA    1           NA
## [10,] -0.046230856  0.249503197  0.128450547   NA  1.000000000
## [11,]  0.040229170 -0.049106831 -0.067758514   NA -0.050117400
## [12,] -0.136840570  0.149040392  0.181133087   NA -0.495251469
## [13,] -0.171097515  0.391452002  0.291065583   NA  0.522396052
## [14,] -0.144202784  0.281985859  0.240379268   NA  0.445862656
## [15,]  0.028942116  0.010307660  0.140023779   NA -0.137078986
## [16,]  0.025494320 -0.183784344 -0.062419100   NA -0.064502597
## [17,] -0.079685865  0.199009714  0.287388520   NA  0.208171130
## [18,] -0.054941515  0.187598550  0.119469879   NA  0.649211754
## [19,]  0.117820915 -0.038161806 -0.012337032   NA  0.067418478
## [20,] -0.194149489  0.468270787  0.439046484   NA  0.058543137
## [21,] -0.060769327  0.242655910  0.183330612   NA  0.004262424
## [22,]  0.012980060 -0.070651217 -0.040580928   NA -0.107354677
## [23,] -0.087000855 -0.174800246 -0.149597521   NA -0.081006851
## [24,] -0.057583166  0.095589128  0.191739816   NA  0.044315624
## [25,] -0.023819978  0.147716399  0.112581318   NA  0.260010920
## [26,]           NA           NA           NA   NA           NA
## [27,] -0.185757511  0.537850092  0.420622155   NA  0.224053522
## [28,] -0.151521371  0.478953820  0.371599809   NA  0.296970385
## [29,] -0.003333699  0.224880142  0.205725920   NA  0.204306145
## [30,] -0.032588814  0.188685840  0.226297633   NA  0.111760613
## [31,]  0.070356184 -0.387267783 -0.193919147   NA -0.102303306
## [32,]  0.025503660  0.031354513  0.045285810   NA  0.026450506
## [33,]  0.054810529 -0.050364435 -0.038740011   NA  0.062020623
## [34,] -0.001984942  0.004949728  0.005829372   NA  0.140491286
## [35,]  0.068776806 -0.034383139 -0.010286249   NA  0.003571473
## [36,] -0.003510839  0.012398471  0.021490002   NA -0.015726948
## [37,]  0.043949746 -0.013617680  0.035743247   NA  0.014358922
## [38,] -0.077855894  0.522897333  0.507100967   NA  0.386419806
## [39,]  0.012608925 -0.012712715 -0.021997642   NA -0.005024049
## [40,] -0.059315817  0.027850137  0.040581045   NA -0.069835749
## [41,]           NA           NA           NA   NA           NA
## [42,] -0.005636270  0.014227652  0.013788427   NA  0.214103131
## [43,] -0.091932343  0.572322769  0.550683924   NA  0.239665966
## [44,]  1.000000000 -0.375983196  0.073741498   NA -0.046230856
## [45,] -0.375983196  1.000000000  0.592854976   NA  0.249503197
##              [,11]        [,12]         [,13]        [,14]        [,15]
##  [1,] -0.005967672 -0.007939703 -0.0154145661  0.010496041  0.005589849
##  [2,] -0.065648579 -0.140759481 -0.2385184093 -0.251758352  0.307885721
##  [3,]           NA           NA           NA           NA           NA
##  [4,]  0.111169745 -0.002618360  0.2608331345  0.299474579  0.050985948
##  [5,] -0.059118693  0.308158927  0.5378084986  0.476223829  0.295492879
##  [6,]  0.040229170 -0.136840570 -0.1710975146 -0.144202784  0.028942116
##  [7,] -0.049106831  0.149040392  0.3914520021  0.281985859  0.010307660
##  [8,] -0.067758514  0.181133087  0.2910655826  0.240379268  0.140023779
##  [9,]           NA           NA           NA           NA           NA
```

```
## [10,] -0.050117400 -0.495251469  0.5223960520  0.445862656 -0.137078986
## [11,]  1.000000000 -0.209294492  0.1048095376  0.097117448 -0.099260316
## [12,] -0.209294492  1.000000000  0.4153596052  0.317987438  0.004469092
## [13,]  0.104809538  0.415359605  1.0000000000  0.819529975 -0.174511950
## [14,]  0.097117448  0.317987438  0.8195299750  1.000000000 -0.202646181
## [15,] -0.099260316  0.004469092 -0.1745119501 -0.202646181  1.000000000
## [16,]  0.014806998  0.028166688 -0.0332453873 -0.014240673  0.063352950
## [17,] -0.009639892  0.240257268  0.4548682025  0.566023969  0.687501064
## [18,]  0.158678061 -0.422900477  0.3073505537  0.244671104 -0.169493952
## [19,]  0.070948134 -0.095804288 -0.0003145818  0.001955654 -0.023854784
## [20,] -0.076443862  0.288886055  0.3237224136  0.380637495  0.421377983
## [21,] -0.032147837 -0.041117530 -0.0488037386 -0.119915909  0.609707300
## [22,] -0.015728114  0.166643317  0.0504499555  0.127400749  0.502900613
## [23,] -0.040751236  0.030085868 -0.0689006426  0.068100588  0.059305753
## [24,] -0.035226548  0.250647061  0.2855725637  0.409515979  0.616422635
## [25,]  0.046920709  0.051574882  0.3395193239  0.410531085  0.194560892
## [26,]           NA           NA            NA           NA           NA
## [27,] -0.038263513  0.214175190  0.4345848343  0.439316808  0.183925583
## [28,] -0.018226592  0.183302698  0.4866654638  0.489781654  0.138346959
## [29,]  0.067898326 -0.005316424  0.2320186091  0.235458623  0.092165418
## [30,]  0.003092562  0.129005415  0.2472637463  0.211671225  0.208026063
## [31,]  0.036543339 -0.002537855 -0.0954777367 -0.065291701  0.061988691
## [32,] -0.029993398  0.020764006  0.0373837273  0.056104374 -0.024357648
## [33,]  0.088871251 -0.012579273  0.0844889859  0.088758073  0.040606448
## [34,]  0.041709055 -0.035092241  0.1260531321  0.131524976  0.081486878
## [35,]  0.004939781 -0.023836645 -0.0184789224 -0.021095719  0.016196875
## [36,] -0.015210738  0.034888443  0.0131961786  0.031371560  0.035164427
## [37,]  0.031705637 -0.041258195 -0.0149686480 -0.013603771 -0.028699914
## [38,] -0.011378121  0.214479106  0.6135805516  0.605852185  0.319333803
## [39,] -0.005967672 -0.007939703 -0.0154145661  0.010496041  0.005589849
## [40,] -0.065648579 -0.140759481 -0.2385184093 -0.251758352  0.307885721
## [41,]           NA           NA            NA           NA           NA
## [42,]  0.111169745 -0.002618360  0.2608331345  0.299474579  0.050985948
## [43,] -0.059118693  0.308158927  0.5378084986  0.476223829  0.295492879
## [44,]  0.040229170 -0.136840570 -0.1710975146 -0.144202784  0.028942116
## [45,] -0.049106831  0.149040392  0.3914520021  0.281985859  0.010307660
##               [,16]        [,17]         [,18]         [,19]         [,20]
##  [1,] -0.0442299581  0.008272758  0.0022885556 -0.0201547452  0.0055874529
##  [2,]  0.0464737559  0.074853180  0.0034910258 -0.0023325346  0.1316082224
##  [3,]            NA           NA            NA           NA           NA
##  [4,]  0.0047789699  0.263116167  0.1581545311  0.0480455709  0.1260306265
##  [5,] -0.0304292840  0.593007430  0.1110977861 -0.0401501577  0.5505997094
##  [6,]  0.0254943199 -0.079685865 -0.0549415154  0.1178209151 -0.1941494887
##  [7,] -0.1837843444  0.199009714  0.1875985500 -0.0381618057  0.4682707872
##  [8,] -0.0624191001  0.287388520  0.1194698791 -0.0123370321  0.4390464839
##  [9,]            NA           NA            NA           NA           NA
## [10,] -0.0645025969  0.208171130  0.6492117536  0.0674184779  0.0585431369
## [11,]  0.0148069979 -0.009639892  0.1586780608  0.0709481337 -0.0764438620
## [12,]  0.0281666881  0.240257268 -0.4229004774 -0.0958042882  0.2888860555
## [13,] -0.0332453873  0.454868203  0.3073505537 -0.0003145818  0.3237224136
```

```
## [14,] -0.0142406727  0.566023969  0.2446711042  0.0019556536  0.3806374950
## [15,]  0.0633529501  0.687501064 -0.1694939517 -0.0238547839  0.4213779829
## [16,]  1.0000000000  0.134682813 -0.0471434219 -0.0058415048 -0.0007095096
## [17,]  0.1346828130  1.000000000  0.0348360495 -0.0189184832  0.6300116463
## [18,] -0.0471434219  0.034836050  1.0000000000 -0.1478709605 -0.0645120486
## [19,] -0.0058415048 -0.018918483 -0.1478709605  1.0000000000 -0.0545358120
## [20,] -0.0007095096  0.630011646 -0.0645120486 -0.0545358120  1.0000000000
## [21,] -0.0270800493  0.415771636 -0.0309049591 -0.0123399001  0.1363805887
## [22,]  0.1056065685  0.521269511 -0.1506728092  0.0465188484  0.3632519830
## [23,]  0.0075217443  0.100063165 -0.0415025464 -0.0379443502  0.1331152142
## [24,]  0.1311847760  0.825489374 -0.0532752361 -0.0238363413  0.5547842535
## [25,] -0.0212721434  0.461679134  0.1379277084  0.0289755866  0.2436705031
## [26,]            NA           NA            NA            NA            NA
## [27,] -0.0944795202  0.467247419  0.1318812244 -0.0208910590  0.4696720433
## [28,] -0.0676014132  0.468997477  0.1791894804 -0.0245355796  0.4056562085
## [29,] -0.0254436480  0.247432821  0.1753151901  0.0401612233  0.1877032138
## [30,]  0.0182510391  0.330223962  0.0673414614 -0.0253237579  0.2599774255
## [31,]  0.0610812378  0.009113210 -0.0499106491 -0.0085553339 -0.1150929635
## [32,] -0.0042956104  0.020643190 -0.0001060915  0.0351136309  0.0353530166
## [33,]  0.0267994130  0.101510396  0.0231477258  0.0321214072 -0.0081060933
## [34,]  0.0621573723  0.170205336  0.0676155562  0.0200246298  0.0496038256
## [35,] -0.0037928708 -0.002415640 -0.0230470249 -0.0073665245 -0.0142898450
## [36,] -0.0221739606  0.050239681 -0.0253608943  0.0328727052  0.0558721290
## [37,] -0.0289208798 -0.036525820  0.0670491377 -0.0465238818 -0.0196688407
## [38,] -0.0256061300  0.708624478  0.2271222331 -0.0168441543  0.5606637627
## [39,] -0.0442299581  0.008272758  0.0022885556 -0.0201547452  0.0055874529
## [40,]  0.0464737559  0.074853180  0.0034910258 -0.0023325346  0.1316082224
## [41,]            NA           NA            NA            NA            NA
## [42,]  0.0047789699  0.263116167  0.1581545311  0.0480455709  0.1260306265
## [43,] -0.0304292840  0.593007430  0.1110977861 -0.0401501577  0.5505997094
## [44,]  0.0254943199 -0.079685865 -0.0549415154  0.1178209151 -0.1941494887
## [45,] -0.1837843444  0.199009714  0.1875985500 -0.0381618057  0.4682707872
##              [,21]        [,22]        [,23]        [,24]        [,25]
##  [1,]  0.006783811  0.037718554  0.002951236  0.027238724 -0.019771632
##  [2,]  0.177354389 -0.023438028  0.281721040  0.040380065 -0.045569340
##  [3,]           NA           NA           NA           NA           NA
##  [4,]  0.014259469  0.119689908 -0.017783871  0.190014778  0.271364010
##  [5,]  0.273458099  0.101676356 -0.183882235  0.427452343  0.396765038
##  [6,] -0.060769327  0.012980060 -0.087000855 -0.057583166 -0.023819978
##  [7,]  0.242655910 -0.070651217 -0.174800246  0.095589128  0.147716399
##  [8,]  0.183330612 -0.040580928 -0.149597521  0.191739816  0.112581318
##  [9,]           NA           NA           NA           NA           NA
## [10,]  0.004262424 -0.107354677 -0.081006851  0.044315624  0.260010920
## [11,] -0.032147837 -0.015728114 -0.040751236 -0.035226548  0.046920709
## [12,] -0.041117530  0.166643317  0.030085868  0.250647061  0.051574882
## [13,] -0.048803739  0.050449956 -0.068900643  0.285572564  0.339519324
## [14,] -0.119915909  0.127400749  0.068100588  0.409515979  0.410531085
## [15,]  0.609707300  0.502900613  0.059305753  0.616422635  0.194560892
## [16,] -0.027080049  0.105606569  0.007521744  0.131184776 -0.021272143
## [17,]  0.415771636  0.521269511  0.100063165  0.825489374  0.461679134
```

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## [18,] -0.030904959 -0.150672809 -0.041502546 -0.053275236  0.137927708
## [19,] -0.012339900  0.046518848 -0.037944350 -0.023836341  0.028975587
## [20,]  0.136380589  0.363251983  0.133115214  0.554784254  0.243670503
## [21,]  1.000000000  0.226651484 -0.068262549  0.343414858  0.203648508
## [22,]  0.226651484  1.000000000  0.198596758  0.676619936  0.107569681
## [23,] -0.068262549  0.198596758  1.000000000  0.256045409 -0.123936235
## [24,]  0.343414858  0.676619936  0.256045409  1.000000000  0.326114480
## [25,]  0.203648508  0.107569681 -0.123936235  0.326114480  1.000000000
## [26,]           NA           NA           NA           NA           NA
## [27,]  0.219178152  0.086106438 -0.050633892  0.362288571  0.300788766
## [28,]  0.163549364  0.065252530 -0.064433047  0.337822121  0.269141238
## [29,]  0.108080303  0.046853773 -0.090130273  0.165983884  0.200018796
## [30,]  0.199740148  0.093809572 -0.070090610  0.234191588  0.169405327
## [31,] -0.095316526  0.041570435  0.037312385  0.004151299 -0.024821869
## [32,] -0.004972488 -0.024477796 -0.024600359 -0.006683241  0.011257239
## [33,]  0.072425845  0.044299691 -0.051613366  0.059382600  0.184530270
## [34,]  0.022381498  0.070702584 -0.014525116  0.083757350  0.095073522
## [35,]  0.001290145  0.007766972  0.062340724  0.024762884  0.001408605
## [36,] -0.009049888  0.046543860  0.026588907  0.036907077  0.046357102
## [37,] -0.010268669 -0.036013893  0.031687207 -0.034516354 -0.024095565
## [38,]  0.284107676  0.168213154 -0.135907371  0.533723156  0.466928837
## [39,]  0.006783811  0.037718554  0.002951236  0.027238724 -0.019771632
## [40,]  0.177354389 -0.023438028  0.281721040  0.040380065 -0.045569340
## [41,]           NA           NA           NA           NA           NA
## [42,]  0.014259469  0.119689908 -0.017783871  0.190014778  0.271364010
## [43,]  0.273458099  0.101676356 -0.183882235  0.427452343  0.396765038
## [44,] -0.060769327  0.012980060 -0.087000855 -0.057583166 -0.023819978
## [45,]  0.242655910 -0.070651217 -0.174800246  0.095589128  0.147716399
##       [,26]       [,27]       [,28]        [,29]         [,30]
##  [1,]    NA  0.01656968  0.01763378 -0.029643197 -0.0004769113
##  [2,]    NA -0.04010979 -0.09867154 -0.012579358 -0.0061001212
##  [3,]    NA          NA          NA           NA            NA
##  [4,]    NA  0.15487074  0.18040276  0.171697687  0.0847738088
##  [5,]    NA  0.60067072  0.56202176  0.238923392  0.3088188234
##  [6,]    NA -0.18575751 -0.15152137 -0.003333699 -0.0325888135
##  [7,]    NA  0.53785009  0.47895382  0.224880142  0.1886858400
##  [8,]    NA  0.42062215  0.37159981  0.205725920  0.2262976327
##  [9,]    NA          NA          NA           NA            NA
## [10,]    NA  0.22405352  0.29697039  0.204306145  0.1117606134
## [11,]    NA -0.03826351 -0.01822659  0.067898326  0.0030925622
## [12,]    NA  0.21417519  0.18330270 -0.005316424  0.1290054146
## [13,]    NA  0.43458483  0.48666546  0.232018609  0.2472637463
## [14,]    NA  0.43931681  0.48978165  0.235458623  0.2116712255
## [15,]    NA  0.18392558  0.13834696  0.092165418  0.2080260632
## [16,]    NA -0.09447952 -0.06760141 -0.025443648  0.0182510391
## [17,]    NA  0.46724742  0.46899748  0.247432821  0.3302239617
## [18,]    NA  0.13188122  0.17918948  0.175315190  0.0673414614
## [19,]    NA -0.02089106 -0.02453558  0.040161223 -0.0253237579
## [20,]    NA  0.46967204  0.40565621  0.187703214  0.2599774255
## [21,]    NA  0.21917815  0.16354936  0.108080303  0.1997401475
```

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## [22,]    NA  0.08610644  0.06525253  0.046853773  0.0938095716
## [23,]    NA -0.05063389 -0.06443305 -0.090130273 -0.0700906099
## [24,]    NA  0.36228857  0.33782212  0.165983884  0.2341915878
## [25,]    NA  0.30078877  0.26914124  0.200018796  0.1694053271
## [26,]     1          NA          NA           NA           NA
## [27,]    NA  1.00000000  0.88247541  0.226342138  0.2135694456
## [28,]    NA  0.88247541  1.00000000  0.224666307  0.2414346721
## [29,]    NA  0.22634214  0.22466631  1.000000000  0.0586606086
## [30,]    NA  0.21356945  0.24143467  0.058660609  1.0000000000
## [31,]    NA -0.15143416 -0.12177672 -0.125988888 -0.0930793175
## [32,]    NA  0.03576529  0.03508670 -0.032770634 -0.0058424993
## [33,]    NA  0.05049379  0.05141176 -0.074181351  0.0743039439
## [34,]    NA  0.02093353  0.06104727  0.073378207  0.0607621115
## [35,]    NA -0.04308013 -0.02739991 -0.009551228 -0.0185837390
## [36,]    NA  0.04052173  0.02797380  0.021011044  0.0712548848
## [37,]    NA -0.03911690 -0.02737794  0.022270451 -0.0576193601
## [38,]    NA  0.64040920  0.62343144  0.324413445  0.3158562271
## [39,]    NA  0.01656968  0.01763378 -0.029643197 -0.0004769113
## [40,]    NA -0.04010979 -0.09867154 -0.012579358 -0.0061001212
## [41,]    NA          NA          NA           NA           NA
## [42,]    NA  0.15487074  0.18040276  0.171697687  0.0847738088
## [43,]    NA  0.60067072  0.56202176  0.238923392  0.3088188234
## [44,]    NA -0.18575751 -0.15152137 -0.003333699 -0.0325888135
## [45,]    NA  0.53785009  0.47895382  0.224880142  0.1886858400
##              [,31]         [,32]        [,33]        [,34]         [,35]
##  [1,]  0.002889218 -0.0466347889  0.001330209  0.057043905 -0.0062424048
##  [2,] -0.012036622 -0.0438245492 -0.026030177  0.008282708 -0.0076832913
##  [3,]           NA            NA           NA           NA            NA
##  [4,] -0.018339734  0.0204228296  0.043160378  0.077672392  0.0380676920
##  [5,] -0.113936859  0.0303705671  0.064886360  0.065165844 -0.0314062105
##  [6,]  0.070356184  0.0255036600  0.054810529 -0.001984942  0.0687768061
##  [7,] -0.387267783  0.0313545131 -0.050364435  0.004949728 -0.0343831387
##  [8,] -0.193919147  0.0452858098 -0.038740011  0.005829372 -0.0102862488
##  [9,]           NA            NA           NA           NA            NA
## [10,] -0.102303306  0.0264505062  0.062020623  0.140491286  0.0035714735
## [11,]  0.036543339 -0.0299933980  0.088871251  0.041709055  0.0049397812
## [12,] -0.002537855  0.0207640057 -0.012579273 -0.035092241 -0.0238366451
## [13,] -0.095477737  0.0373837273  0.084488986  0.126053132 -0.0184789224
## [14,] -0.065291701  0.0561043745  0.088758073  0.131524976 -0.0210957195
## [15,]  0.061988691 -0.0243576484  0.040606448  0.081486878  0.0161968746
## [16,]  0.061081238 -0.0042956104  0.026799413  0.062157372 -0.0037928708
## [17,]  0.009113210  0.0206431897  0.101510396  0.170205336 -0.0024156396
## [18,] -0.049910649 -0.0001060915  0.023147726  0.067615556 -0.0230470249
## [19,] -0.008555334  0.0351136309  0.032121407  0.020024630 -0.0073665245
## [20,] -0.115092963  0.0353530166 -0.008106093  0.049603826 -0.0142898450
## [21,] -0.095316526 -0.0049724884  0.072425845  0.022381498  0.0012901448
## [22,]  0.041570435 -0.0244777964  0.044299691  0.070702584  0.0077669720
## [23,]  0.037312385 -0.0246003587 -0.051613366 -0.014525116  0.0623407240
## [24,]  0.004151299 -0.0066832410  0.059382600  0.083757350  0.0247628842
## [25,] -0.024821869  0.0112572390  0.184530270  0.095073522  0.0014086054
```

```
## [26,]           NA           NA           NA           NA           NA
## [27,] -0.151434160  0.0357652851  0.050493792  0.020933531 -0.0430801281
## [28,] -0.121776720  0.0350867002  0.051411762  0.061047272 -0.0273999144
## [29,] -0.125988888 -0.0327706336 -0.074181351  0.073378207 -0.0095512282
## [30,] -0.093079318 -0.0058424993  0.074303944  0.060762111 -0.0185837390
## [31,]  1.000000000 -0.0373052828 -0.082864245  0.054202562  0.0183606001
## [32,] -0.037305283  1.0000000000 -0.031435847 -0.007991549  0.0003539653
## [33,] -0.082864245 -0.0314358470  1.000000000  0.051307395  0.0319457608
## [34,]  0.054202562 -0.0079915489  0.051307395  1.000000000  0.0296686509
## [35,]  0.018360600  0.0003539653  0.031945761  0.029668651  1.0000000000
## [36,] -0.028887266  0.0294737952  0.023216992 -0.033736640 -0.0064945502
## [37,] -0.009915937  0.0186449254  0.010694106 -0.059688932  0.0049062625
## [38,] -0.128577958  0.0445836653  0.111446571  0.092403549 -0.0211895796
## [39,]  0.002889218 -0.0466347889  0.001330209  0.057043905 -0.0062424048
## [40,] -0.012036622 -0.0438245492 -0.026030177  0.008282708 -0.0076832913
## [41,]           NA           NA           NA           NA           NA
## [42,] -0.018339734  0.0204228296  0.043160378  0.077672392  0.0380676920
## [43,] -0.113936859  0.0303705671  0.064886360  0.065165844 -0.0314062105
## [44,]  0.070356184  0.0255036600  0.054810529 -0.001984942  0.0687768061
## [45,] -0.387267783  0.0313545131 -0.050364435  0.004949728 -0.0343831387
##              [,36]        [,37]       [,38]         [,39]        [,40]
##  [1,]  0.021172177  0.000711794 -0.02191672  1.0000000000  0.011156478
##  [2,] -0.013584643 -0.021407038 -0.08428414  0.0111564782  1.000000000
##  [3,]           NA           NA          NA            NA           NA
##  [4,]  0.001204988 -0.014261407  0.26384335 -0.0332255186 -0.139781082
##  [5,]  0.070815172 -0.027346708  0.79098160 -0.0283647539  0.032627708
##  [6,] -0.003510839  0.043949746 -0.07785589  0.0126089248 -0.059315817
##  [7,]  0.012398471 -0.013617680  0.52289733 -0.0127127154  0.027850137
##  [8,]  0.021490002  0.035743247  0.50710097 -0.0219976419  0.040581045
##  [9,]           NA           NA          NA            NA           NA
## [10,] -0.015726948  0.014358922  0.38641981 -0.0050240490 -0.069835749
## [11,] -0.015210738  0.031705637 -0.01137812 -0.0059676720 -0.065648579
## [12,]  0.034888443 -0.041258195  0.21447911 -0.0079397034 -0.140759481
## [13,]  0.013196179 -0.014968648  0.61358055 -0.0154145661 -0.238518409
## [14,]  0.031371560 -0.013603771  0.60585218  0.0104960410 -0.251758352
## [15,]  0.035164427 -0.028699914  0.31933380  0.0055898489  0.307885721
## [16,] -0.022173961 -0.028920880 -0.02560613 -0.0442299581  0.046473756
## [17,]  0.050239681 -0.036525820  0.70862448  0.0082727577  0.074853180
## [18,] -0.025360894  0.067049138  0.22712223  0.0022885556  0.003491026
## [19,]  0.032872705 -0.046523882 -0.01684415 -0.0201547452 -0.002332535
## [20,]  0.055872129 -0.019668841  0.56066376  0.0055874529  0.131608222
## [21,] -0.009049888 -0.010268669  0.28410768  0.0067838113  0.177354389
## [22,]  0.046543860 -0.036013893  0.16821315  0.0377185542 -0.023438028
## [23,]  0.026588907  0.031687207 -0.13590737  0.0029512364  0.281721040
## [24,]  0.036907077 -0.034516354  0.53372316  0.0272387244  0.040380065
## [25,]  0.046357102 -0.024095565  0.46692884 -0.0197716324 -0.045569340
## [26,]           NA           NA          NA            NA           NA
## [27,]  0.040521730 -0.039116904  0.64040920  0.0165696771 -0.040109793
## [28,]  0.027973800 -0.027377940  0.62343144  0.0176337785 -0.098671543
## [29,]  0.021011044  0.022270451  0.32441344 -0.0296431972 -0.012579358
```

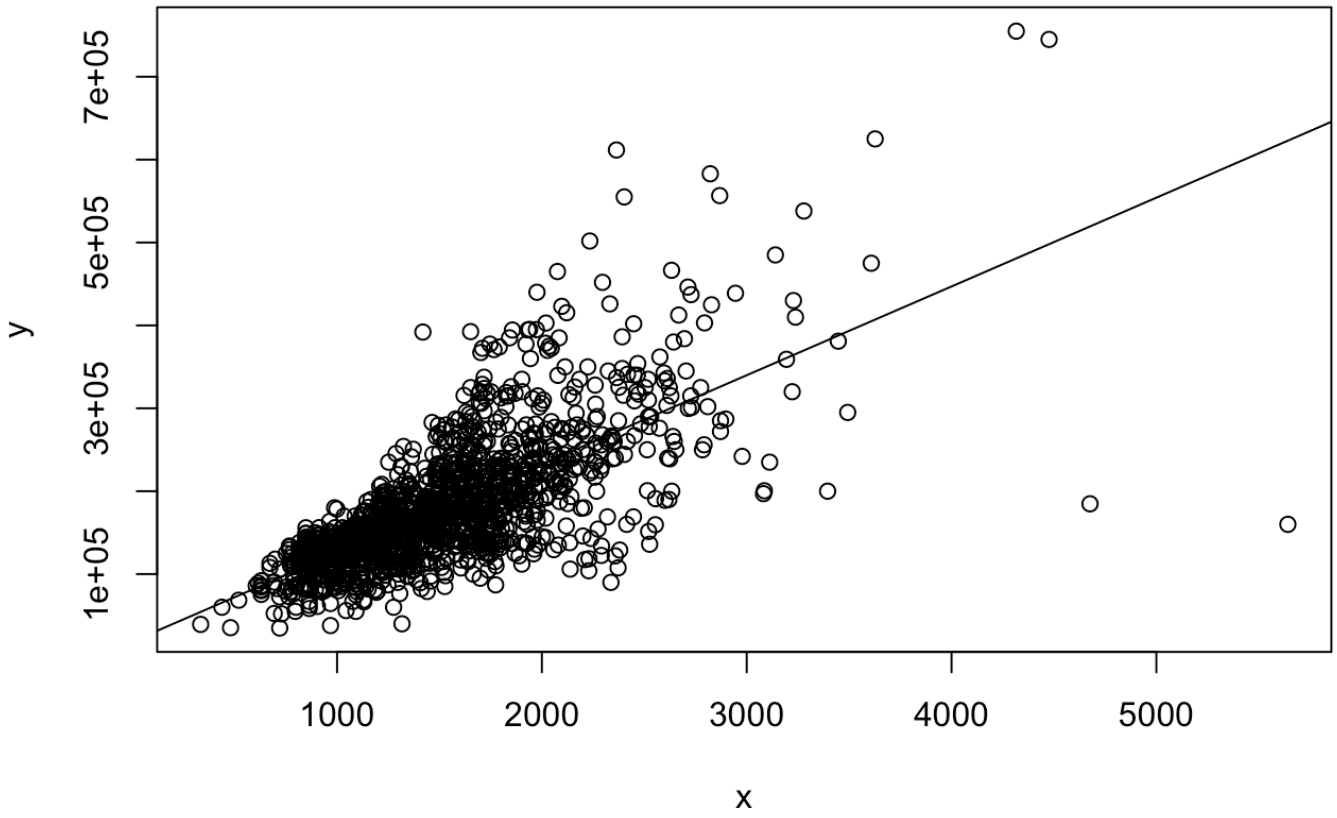
```
## [30,]  0.071254885 -0.057619360  0.31585623 -0.0004769113 -0.006100121
## [31,] -0.028887266 -0.009915937 -0.12857796  0.0028892179 -0.012036622
## [32,]  0.029473795  0.018644925  0.04458367 -0.0466347889 -0.043824549
## [33,]  0.023216992  0.010694106  0.11144657  0.0013302086 -0.026030177
## [34,] -0.033736640 -0.059688932  0.09240355  0.0570439048  0.008282708
## [35,] -0.006494550  0.004906262 -0.02118958 -0.0062424048 -0.007683291
## [36,]  1.000000000 -0.145721413  0.04643225  0.0211721766 -0.013584643
## [37,] -0.145721413  1.000000000 -0.02892259  0.0007117940 -0.021407038
## [38,]  0.046432245 -0.028922585  1.00000000 -0.0219167194 -0.084284135
## [39,]  0.021172177  0.000711794 -0.02191672  1.0000000000  0.011156478
## [40,] -0.013584643 -0.021407038 -0.08428414  0.0111564782  1.000000000
## [41,]           NA           NA          NA            NA           NA
## [42,]  0.001204988 -0.014261407  0.26384335 -0.0332255186 -0.139781082
## [43,]  0.070815172 -0.027346708  0.79098160 -0.0283647539  0.032627708
## [44,] -0.003510839  0.043949746 -0.07785589  0.0126089248 -0.059315817
## [45,]  0.012398471 -0.013617680  0.52289733 -0.0127127154  0.027850137
##       [,41]        [,42]       [,43]        [,44]        [,45]
##  [1,]    NA -0.033225519 -0.02836475  0.012608925 -0.012712715
##  [2,]    NA -0.139781082  0.03262771 -0.059315817  0.027850137
##  [3,]    NA           NA          NA           NA           NA
##  [4,]    NA  1.000000000  0.10580574 -0.005636270  0.014227652
##  [5,]    NA  0.105805742  1.00000000 -0.091932343  0.572322769
##  [6,]    NA -0.005636270 -0.09193234  1.000000000 -0.375983196
##  [7,]    NA  0.014227652  0.57232277 -0.375983196  1.000000000
##  [8,]    NA  0.013788427  0.55068392  0.073741498  0.592854976
##  [9,]    NA           NA          NA           NA           NA
## [10,]    NA  0.214103131  0.23966597 -0.046230856  0.249503197
## [11,]    NA  0.111169745 -0.05911869  0.040229170 -0.049106831
## [12,]    NA -0.002618360  0.30815893 -0.136840570  0.149040392
## [13,]    NA  0.260833135  0.53780850 -0.171097515  0.391452002
## [14,]    NA  0.299474579  0.47622383 -0.144202784  0.281985859
## [15,]    NA  0.050985948  0.29549288  0.028942116  0.010307660
## [16,]    NA  0.004778970 -0.03042928  0.025494320 -0.183784344
## [17,]    NA  0.263116167  0.59300743 -0.079685865  0.199009714
## [18,]    NA  0.158154531  0.11109779 -0.054941515  0.187598550
## [19,]    NA  0.048045571 -0.04015016  0.117820915 -0.038161806
## [20,]    NA  0.126030627  0.55059971 -0.194149489  0.468270787
## [21,]    NA  0.014259469  0.27345810 -0.060769327  0.242655910
## [22,]    NA  0.119689908  0.10167636  0.012980060 -0.070651217
## [23,]    NA -0.017783871 -0.18388223 -0.087000855 -0.174800246
## [24,]    NA  0.190014778  0.42745234 -0.057583166  0.095589128
## [25,]    NA  0.271364010  0.39676504 -0.023819978  0.147716399
## [26,]    NA           NA          NA           NA           NA
## [27,]    NA  0.154870740  0.60067072 -0.185757511  0.537850092
## [28,]    NA  0.180402755  0.56202176 -0.151521371  0.478953820
## [29,]    NA  0.171697687  0.23892339 -0.003333699  0.224880142
## [30,]    NA  0.084773809  0.30881882 -0.032588814  0.188685840
## [31,]    NA -0.018339734 -0.11393686  0.070356184 -0.387267783
## [32,]    NA  0.020422830  0.03037057  0.025503660  0.031354513
## [33,]    NA  0.043160378  0.06488636  0.054810529 -0.050364435
```

```
## [34,]    NA  0.077672392  0.06516584 -0.001984942  0.004949728
## [35,]    NA  0.038067692 -0.03140621  0.068776806 -0.034383139
## [36,]    NA  0.001204988  0.07081517 -0.003510839  0.012398471
## [37,]    NA -0.014261407 -0.02734671  0.043949746 -0.013617680
## [38,]    NA  0.263843354  0.79098160 -0.077855894  0.522897333
## [39,]    NA -0.033225519 -0.02836475  0.012608925 -0.012712715
## [40,]    NA -0.139781082  0.03262771 -0.059315817  0.027850137
## [41,]     1           NA          NA           NA           NA
## [42,]    NA  1.000000000  0.10580574 -0.005636270  0.014227652
## [43,]    NA  0.105805742  1.00000000 -0.091932343  0.572322769
## [44,]    NA -0.005636270 -0.09193234  1.000000000 -0.375983196
## [45,]    NA  0.014227652  0.57232277 -0.375983196  1.000000000
```

```
cor_with_SalePrice <- cor_value[38,]
cor_with_SalePrice
```

```
##  [1] -0.02191672 -0.08428414          NA  0.26384335  0.79098160
##  [6] -0.07785589  0.52289733  0.50710097          NA  0.38641981
## [11] -0.01137812  0.21447911  0.61358055  0.60585218  0.31933380
## [16] -0.02560613  0.70862448  0.22712223 -0.01684415  0.56066376
## [21]  0.28410768  0.16821315 -0.13590737  0.53372316  0.46692884
## [26]          NA  0.64040920  0.62343144  0.32441344  0.31585623
## [31] -0.12857796  0.04458367  0.11144657  0.09240355 -0.02118958
## [36]  0.04643225 -0.02892259  1.00000000 -0.02191672 -0.08428414
## [41]          NA  0.26384335  0.79098160 -0.07785589  0.52289733
```

```
## Based on correlation coeffcient, LotArea is the most correlated with SalePrice,
GrLivArea comes the second

## 1.4
x <- ameslist$GrLivArea
y <- ameslist$SalePrice
z <- lm(y ~ x)
plot(x,y)
abline(z)
```




```
## scatterplot(x,y)
outliner <- which(ameslist$GrLivArea>4000)
outliner
```

```
## [1]  524  692 1183 1299
```

```
## 2.1
options(na.action='na.pass')
GarageTemp = model.matrix( ~ ameslist$GarageType - 1, data=ameslist$GarageType)
ameslist <- cbind(ameslist, GarageTemp)
ameslist$GarageOutside <- ifelse(ameslist$'ameslist$GarageTypeDetchd' == 1 | amesl
ist$'ameslist$GarageTypeCarPort' == 1, 1, 0)

x <- ameslist$GarageOutside
y <- ameslist$SalePrice
not_na_position <- which(!is.na(x))
x <- x[not_na_position]
y <- y[not_na_position]
lm.fit=lm(y ~ x)

## 2.2
names(Ames)
```

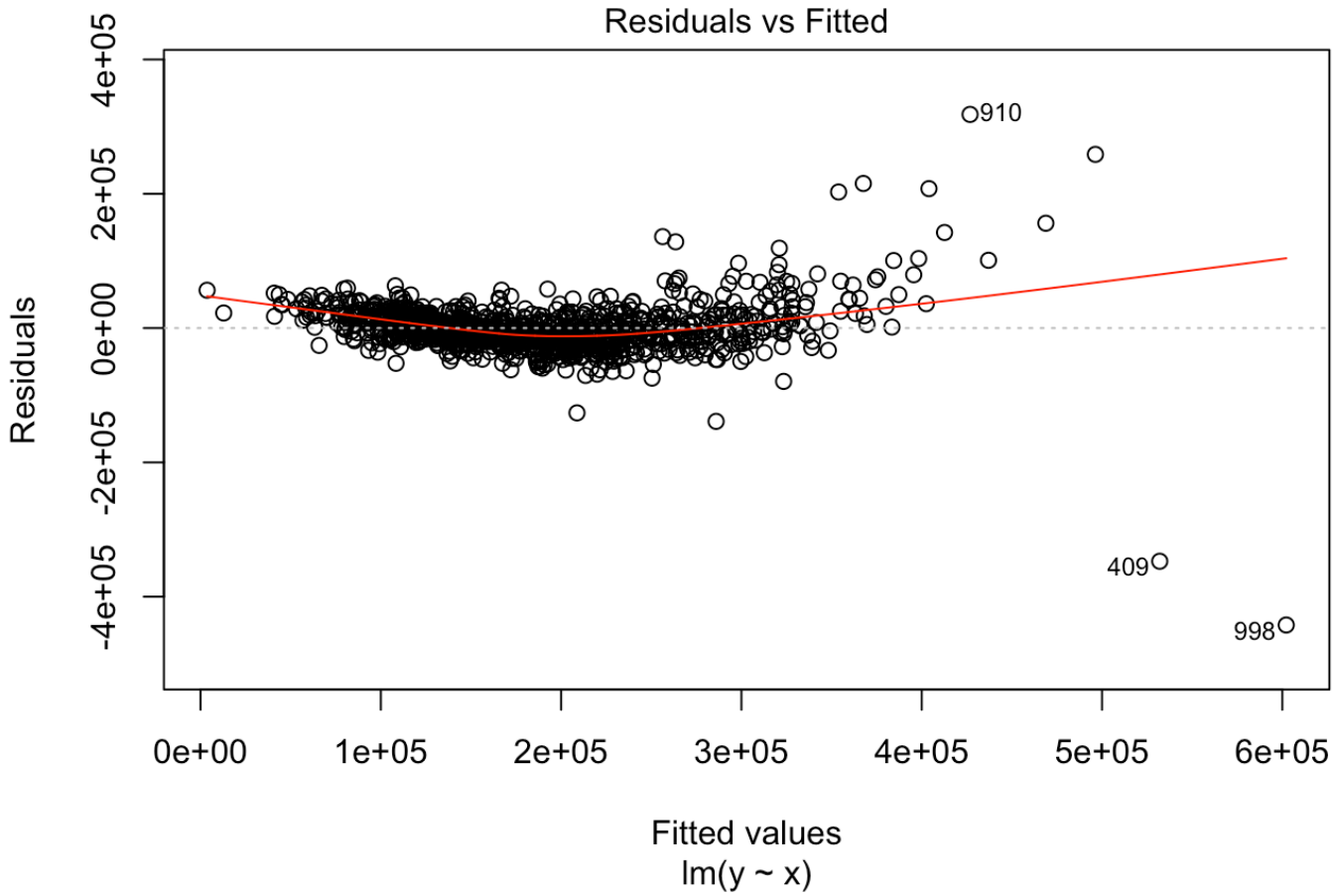
```
##  [1] "Id"            "MSSubClass"    "LotFrontage"   "LotArea"
##  [5] "OverallQual"   "OverallCond"   "YearBuilt"     "YearRemodAdd"
##  [9] "MasVnrArea"    "BsmtFinSF1"    "BsmtFinSF2"    "BsmtUnfSF"
## [13] "TotalBsmtSF"   "X1stFlrSF"     "X2ndFlrSF"     "LowQualFinSF"
## [17] "GrLivArea"     "BsmtFullBath"  "BsmtHalfBath"  "FullBath"
## [21] "HalfBath"      "BedroomAbvGr"  "KitchenAbvGr"  "TotRmsAbvGrd"
## [25] "Fireplaces"    "GarageYrBlt"   "GarageCars"    "GarageArea"
## [29] "WoodDeckSF"    "OpenPorchSF"   "EnclosedPorch" "X3SsnPorch"
## [33] "ScreenPorch"   "PoolArea"      "MiscVal"       "MoSold"
## [37] "YrSold"        "SalePrice"
```

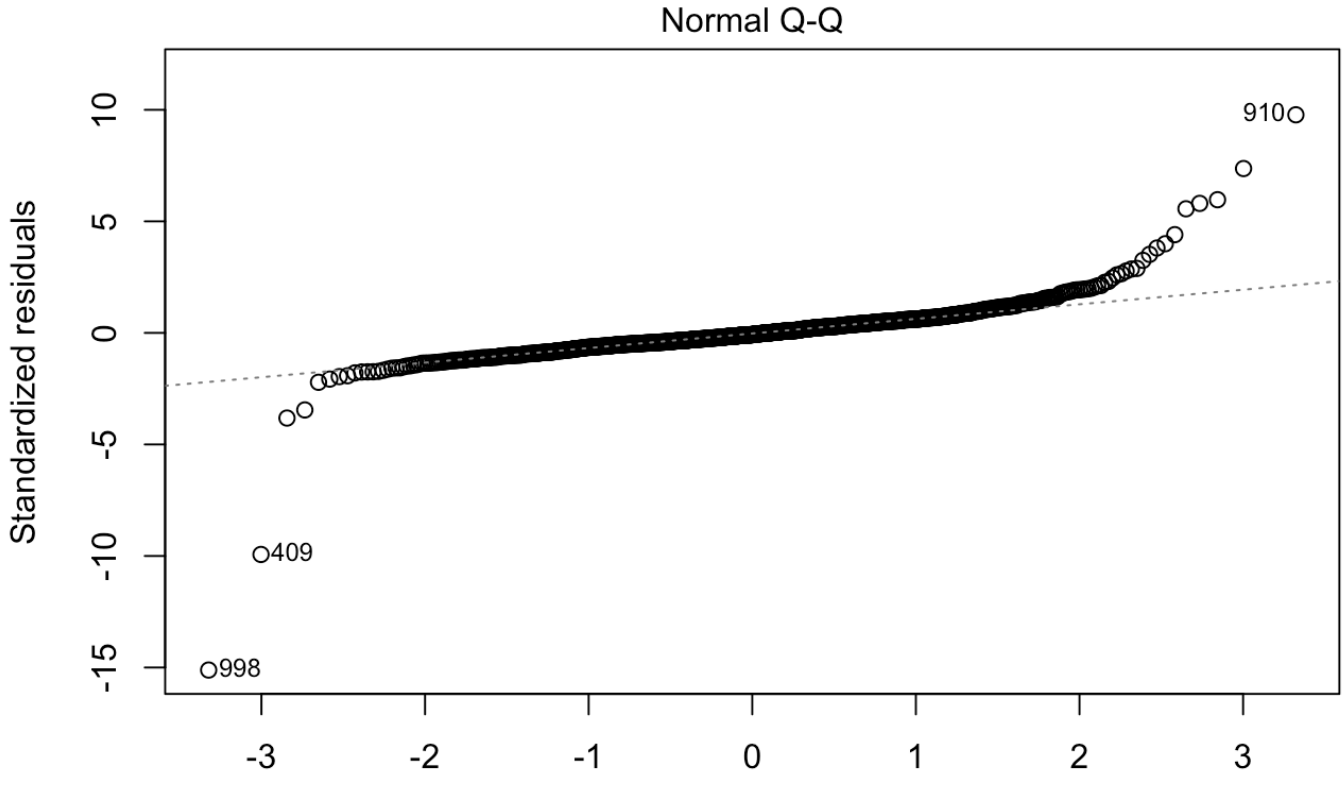
```
Ames_matrix <- na.exclude(Ames_matrix)
y <- Ames_matrix[,38]
x <- Ames_matrix[,c(1:37,39:45)]
lm.fit=lm(y ~ x)
summary(lm.fit)
```

```
##
## Call:
## lm(formula = y ~ x)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -442182  -16955   -2824   15125  318183
##
## Coefficients: (9 not defined because of singularities)
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -3.351e+05  1.701e+06  -0.197 0.843909
## x1          -1.205e+00  2.658e+00  -0.453 0.650332
## x2          -2.001e+02  3.451e+01  -5.797 8.84e-09 ***
## x3          -1.160e+02  6.126e+01  -1.894 0.058503 .
```

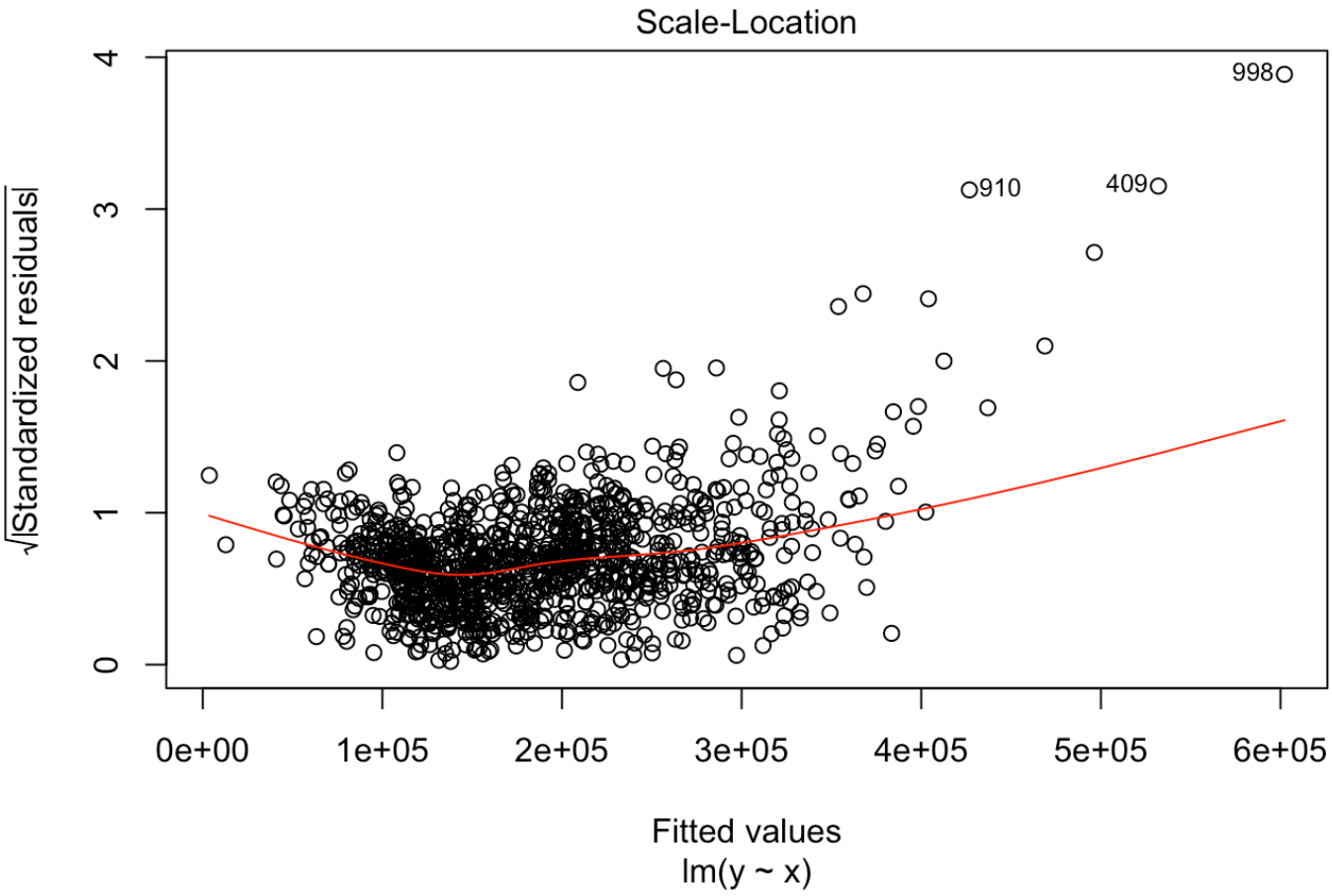
```
## x4           5.422e-01  1.575e-01   3.442 0.000599 ***
## x5           1.866e+04  1.482e+03  12.592  < 2e-16 ***
## x6           5.239e+03  1.368e+03   3.830 0.000135 ***
## x7           3.164e+02  8.766e+01   3.610 0.000321 ***
## x8           1.194e+02  8.668e+01   1.378 0.168607
## x9           3.141e+01  7.022e+00   4.473 8.54e-06 ***
## x10          1.736e+01  5.838e+00   2.973 0.003014 **
## x11          8.342e+00  8.766e+00   0.952 0.341532
## x12          5.005e+00  5.277e+00   0.948 0.343173
## x13                 NA         NA      NA       NA
## x14          4.597e+01  7.360e+00   6.246 6.02e-10 ***
## x15          4.663e+01  6.102e+00   7.641 4.72e-14 ***
## x16          3.341e+01  2.794e+01   1.196 0.232009
## x17                 NA         NA      NA       NA
## x18          9.043e+03  3.198e+03   2.828 0.004776 **
## x19          2.465e+03  5.073e+03   0.486 0.627135
## x20          5.433e+03  3.531e+03   1.539 0.124182
## x21         -1.098e+03  3.321e+03  -0.331 0.740945
## x22         -1.022e+04  2.155e+03  -4.742 2.40e-06 ***
## x23         -2.202e+04  6.710e+03  -3.282 0.001063 **
## x24          5.464e+03  1.487e+03   3.674 0.000251 ***
## x25          4.372e+03  2.189e+03   1.998 0.046020 *
## x26         -4.728e+01  9.106e+01  -0.519 0.603742
## x27          1.685e+04  3.491e+03   4.827 1.58e-06 ***
## x28          6.274e+00  1.213e+01   0.517 0.605002
## x29          2.144e+01  1.002e+01   2.139 0.032662 *
## x30         -2.252e+00  1.949e+01  -0.116 0.907998
## x31          7.295e+00  2.062e+01   0.354 0.723590
## x32          3.349e+01  3.758e+01   0.891 0.373163
## x33          5.805e+01  2.041e+01   2.844 0.004532 **
## x34         -6.052e+01  2.990e+01  -2.024 0.043204 *
## x35         -3.761e+00  6.960e+00  -0.540 0.589016
## x36         -2.217e+02  4.229e+02  -0.524 0.600188
## x37         -2.474e+02  8.458e+02  -0.293 0.769917
## x38                 NA         NA      NA       NA
## x39                 NA         NA      NA       NA
## x40                 NA         NA      NA       NA
## x41                 NA         NA      NA       NA
## x42                 NA         NA      NA       NA
## x43                 NA         NA      NA       NA
## x44                 NA         NA      NA       NA
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 36800 on 1085 degrees of freedom
## Multiple R-squared:  0.8096, Adjusted R-squared:  0.8034
## F-statistic: 131.8 on 35 and 1085 DF,  p-value: < 2.2e-16
```

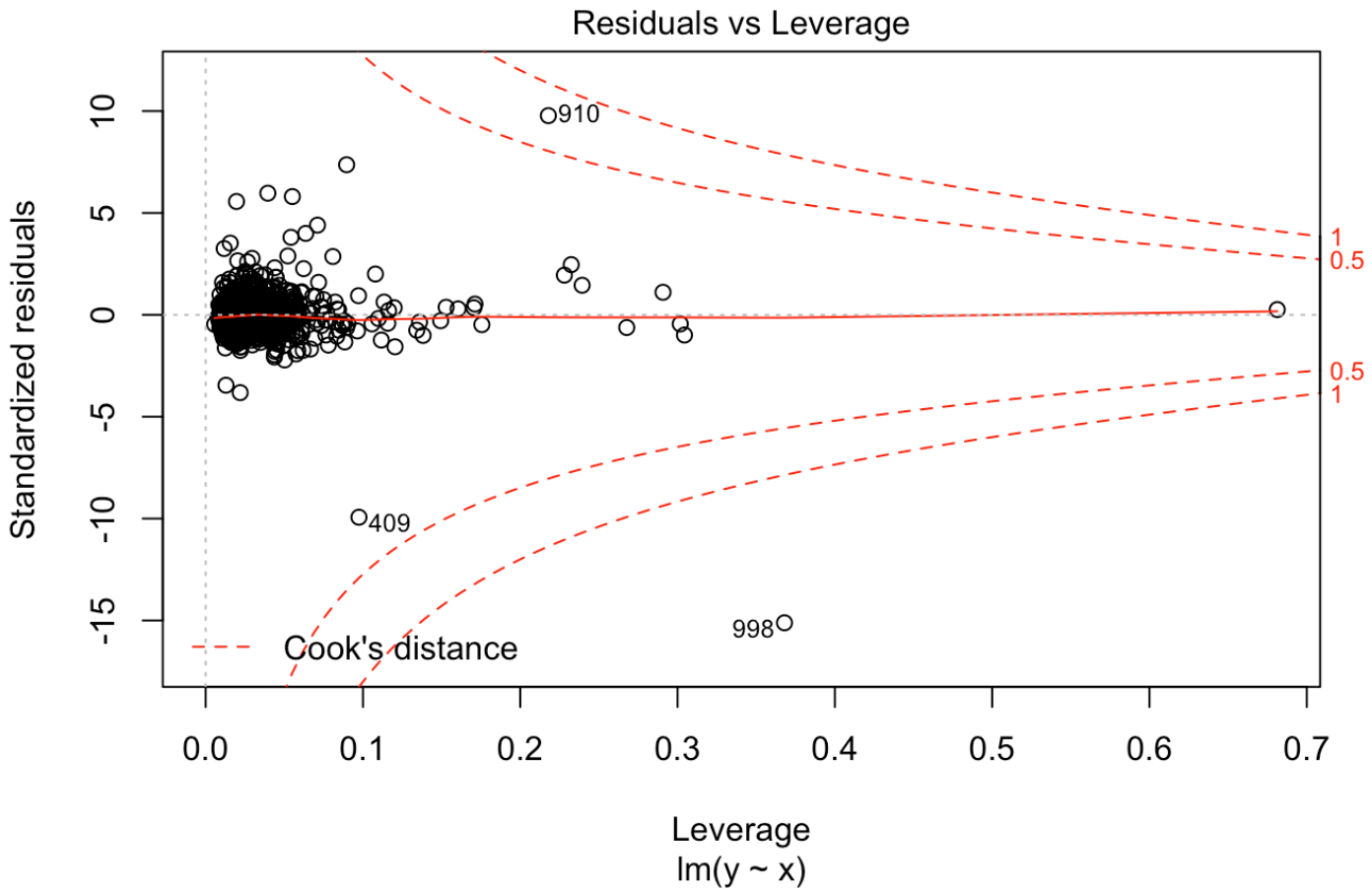
```
## Yes
## x2, x4, x5, x6, x9, x14, x15, x22, x24, x27
## MSSubClass, LotArea, OverallQual, OverallCond, MasVnrArea, X1stFlrSF, X2ndFlrSF
, BedroomAbvGr
## TotRmsAbvGrd, GarageCars

## 2.3
plot(lm.fit)
```


Residuals vs Fitted
Residuals
Fitted values
lm(y ~ x)
910
409
998
4e+05
2e+05
0e+00
-2e+05
-4e+05
0e+00
1e+05
2e+05
3e+05
4e+05
5e+05
6e+05


Normal Q-Q
Standardized residuals
910
409
998
10
5
0
-5
-10
-15
-3
-2
-1
0
1
2
3

Theoretical Quantiles
lm(y ~ x)






```
## There are three outliers points in the plot

## 2.4
y <- Ames_matrix[,38]
x1 <- Ames_matrix[,4]
x2 <- Ames_matrix[,17]
lm.fit=lm(y ~ x1 * x2)
summary(lm.fit)
```

```
##
## Call:
## lm(formula = y ~ x1 * x2)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -233473  -29836   -1886   23925  327091
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -3.918e+04  8.119e+03  -4.825 1.59e-06 ***
## x1           5.098e+00  5.496e-01   9.276  < 2e-16 ***
## x2           1.352e+02  4.803e+00  28.157  < 2e-16 ***
## x1:x2       -2.023e-03  2.452e-04  -8.251 4.39e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 56770 on 1117 degrees of freedom
## Multiple R-squared:  0.5334, Adjusted R-squared:  0.5321
## F-statistic: 425.6 on 3 and 1117 DF,  p-value: < 2.2e-16
```

```
## SalePrice ~ LotArea * GrLivArea, statistically Significant

## 2.5
## x^2
y <- Ames_matrix[,38]
x <- Ames_matrix[,c(1:37,39:45)]
trans_x <- x^2
x <- cbind(x, trans_x)
lm.fit=lm(y ~ x)
summary(lm.fit)
```

```
##
## Call:
## lm(formula = y ~ x)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -309034  -13037    -398   11802  176345
##
## Coefficients: (16 not defined because of singularities)
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  6.423e+08  2.273e+09   0.283 0.777554
## x1           1.945e+01  8.273e+00   2.351 0.018926 *
## x2           6.539e+01  9.273e+01   0.705 0.480858
## x3           7.266e+01  1.162e+02   0.625 0.532046
## x4           1.023e+00  2.782e-01   3.677 0.000248 ***
## x5          -4.747e+04  5.498e+03  -8.634  < 2e-16 ***
```

```
## x6           1.968e+04  6.444e+03   3.054 0.002314 **
## x7           4.692e+03  6.894e+03   0.681 0.496321
## x8          -4.325e+04  1.572e+04  -2.751 0.006036 **
## x9          -1.206e+01  1.073e+01  -1.124 0.261416
## x10          5.942e+01  8.079e+00   7.356 3.83e-13 ***
## x11          1.633e+01  1.711e+01   0.954 0.340239
## x12          1.268e+01  9.201e+00   1.378 0.168430
## x13                 NA         NA      NA       NA
## x14          1.264e+02  1.795e+01   7.043 3.40e-12 ***
## x15          4.032e+01  1.192e+01   3.384 0.000741 ***
## x16          7.456e+00  9.595e+01   0.078 0.938075
## x17                 NA         NA      NA       NA
## x18          8.658e+02  7.114e+03   0.122 0.903154
## x19          1.382e+04  1.777e+04   0.778 0.436978
## x20         -2.817e+04  1.158e+04  -2.432 0.015177 *
## x21          2.373e+04  7.946e+03   2.986 0.002892 **
## x22          8.428e+03  6.219e+03   1.355 0.175644
## x23          2.292e+04  4.939e+04   0.464 0.642718
## x24         -1.345e+04  4.721e+03  -2.848 0.004481 **
## x25         -1.869e+03  3.670e+03  -0.509 0.610796
## x26         -2.525e+04  8.984e+03  -2.810 0.005040 **
## x27         -2.982e+04  9.494e+03  -3.140 0.001735 **
## x28         -1.108e+00  3.198e+01  -0.035 0.972365
## x29          1.216e+01  1.618e+01   0.752 0.452321
## x30          1.169e+02  3.139e+01   3.724 0.000207 ***
## x31          7.718e+01  3.983e+01   1.938 0.052925 .
## x32          1.319e+02  7.708e+01   1.712 0.087226 .
## x33          9.661e+00  4.499e+01   0.215 0.830019
## x34         -3.794e+02  3.093e+02  -1.226 0.220293
## x35         -4.751e+00  1.410e+01  -0.337 0.736274
## x36          1.482e+03  1.327e+03   1.117 0.264219
## x37         -5.777e+05  2.264e+06  -0.255 0.798615
## x38                 NA         NA      NA       NA
## x39                 NA         NA      NA       NA
## x40                 NA         NA      NA       NA
## x41                 NA         NA      NA       NA
## x42                 NA         NA      NA       NA
## x43                 NA         NA      NA       NA
## x44                 NA         NA      NA       NA
## x45         -1.307e-02  5.479e-03  -2.386 0.017229 *
## x46         -4.580e-01  4.818e-01  -0.951 0.342042
## x47         -2.067e-01  5.256e-01  -0.393 0.694200
## x48         -1.798e-06  1.435e-06  -1.252 0.210674
## x49          4.991e+03  4.312e+02  11.574  < 2e-16 ***
## x50         -9.899e+02  5.480e+02  -1.806 0.071176 .
## x51         -1.115e+00  1.771e+00  -0.630 0.528989
## x52          1.095e+01  3.975e+00   2.755 0.005978 **
## x53          3.548e-02  1.178e-02   3.013 0.002649 **
## x54         -9.608e-03  3.828e-03  -2.510 0.012231 *
## x55          2.103e-02  1.677e-02   1.254 0.210039
```

```
## x56          6.121e-03  4.045e-03   1.513 0.130517
## x57         -3.862e-03  3.958e-03  -0.976 0.329476
## x58         -1.220e-02  7.200e-03  -1.695 0.090401 .
## x59          4.541e-02  8.933e-03   5.083 4.40e-07 ***
## x60          1.190e-01  2.234e-01   0.533 0.594269
## x61         -1.150e-02  3.405e-03  -3.378 0.000758 ***
## x62         -2.295e+03  6.184e+03  -0.371 0.710695
## x63         -1.188e+04  1.651e+04  -0.720 0.471840
## x64          9.743e+03  3.439e+03   2.833 0.004697 **
## x65         -1.520e+04  6.757e+03  -2.249 0.024696 *
## x66         -2.529e+03  1.047e+03  -2.416 0.015852 *
## x67         -1.468e+04  1.578e+04  -0.930 0.352445
## x68          1.117e+03  3.215e+02   3.476 0.000530 ***
## x69          4.658e+03  1.982e+03   2.351 0.018915 *
## x70          6.450e+00  2.293e+00   2.813 0.005007 **
## x71          9.433e+03  2.225e+03   4.239 2.44e-05 ***
## x72          5.588e-03  2.406e-02   0.232 0.816365
## x73         -1.820e-02  3.645e-02  -0.499 0.617650
## x74         -5.088e-01  1.093e-01  -4.653 3.69e-06 ***
## x75         -2.909e-01  1.567e-01  -1.856 0.063716 .
## x76         -2.200e-01  2.153e-01  -1.022 0.307033
## x77          1.539e-01  1.686e-01   0.913 0.361573
## x78          7.129e-01  5.263e-01   1.355 0.175828
## x79         -1.000e-03  7.830e-03  -0.128 0.898364
## x80         -1.362e+02  9.804e+01  -1.389 0.165204
## x81          1.439e+02  5.637e+02   0.255 0.798536
## x82                 NA         NA      NA       NA
## x83                 NA         NA      NA       NA
## x84                 NA         NA      NA       NA
## x85                 NA         NA      NA       NA
## x86                 NA         NA      NA       NA
## x87                 NA         NA      NA       NA
## x88                 NA         NA      NA       NA
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 28350 on 1048 degrees of freedom
## Multiple R-squared:  0.8908, Adjusted R-squared:  0.8833
## F-statistic: 118.8 on 72 and 1048 DF,  p-value: < 2.2e-16
```

```
## sqrt(x)
y <- Ames_matrix[,38]
x <- Ames_matrix[,c(1:37,39:45)]
trans_x <- sqrt(x)
x <- cbind(x, trans_x)
lm.fit=lm(y ~ x)
summary(lm.fit)
```

```
##
```

```
## Call:
## lm(formula = y ~ x)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -343428  -14075    -397   12190  249513
##
## Coefficients: (17 not defined because of singularities)
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  1.775e+08  6.095e+07   2.912 0.003664 **
## x1          -2.519e+01  1.115e+01  -2.258 0.024130 *
## x2           6.808e+01  1.708e+02   0.399 0.690335
## x3          -5.122e+02  2.735e+02  -1.873 0.061354 .
## x4           3.430e-01  3.221e-01   1.065 0.287035
## x5           1.220e+05  1.129e+04  10.801  < 2e-16 ***
## x6          -1.376e+04  1.229e+04  -1.120 0.263107
## x7          -1.888e+04  1.503e+04  -1.256 0.209455
## x8           6.518e+04  3.410e+04   1.911 0.056220 .
## x9           7.659e+01  1.487e+01   5.152 3.09e-07 ***
## x10          1.508e+01  1.458e+01   1.034 0.301216
## x11          3.608e+01  2.554e+01   1.413 0.158014
## x12          1.244e+01  1.509e+01   0.825 0.409827
## x13                 NA         NA      NA       NA
## x14         -1.348e+02  3.518e+01  -3.831 0.000135 ***
## x15          3.530e+01  2.246e+01   1.571 0.116419
## x16          1.164e+01  1.220e+02   0.095 0.924012
## x17                 NA         NA      NA       NA
## x18         -5.122e+04  2.384e+04  -2.149 0.031871 *
## x19         -8.758e+04  6.596e+04  -1.328 0.184515
## x20          4.449e+04  1.373e+04   3.240 0.001233 **
## x21         -5.181e+04  2.478e+04  -2.091 0.036803 *
## x22         -1.083e+04  7.831e+03  -1.383 0.167059
## x23         -5.257e+04  1.456e+05  -0.361 0.718047
## x24          3.158e+04  9.667e+03   3.267 0.001122 **
## x25          2.165e+04  6.916e+03   3.130 0.001795 **
## x26          4.444e+04  1.963e+04   2.264 0.023770 *
## x27          1.332e+05  2.044e+04   6.515 1.13e-10 ***
## x28         -4.395e+01  5.997e+01  -0.733 0.463831
## x29          3.471e+00  2.650e+01   0.131 0.895816
## x30         -9.402e+01  4.237e+01  -2.219 0.026723 *
## x31         -3.859e+01  7.453e+01  -0.518 0.604757
## x32         -9.130e+01  1.348e+02  -0.677 0.498474
## x33          9.711e+01  8.572e+01   1.133 0.257484
## x34          3.070e+03  5.852e+02   5.247 1.87e-07 ***
## x35          1.331e+01  1.909e+01   0.697 0.485928
## x36         -3.860e+03  2.148e+03  -1.797 0.072616 .
## x37          1.335e+02  7.191e+02   0.186 0.852751
## x38                 NA         NA      NA       NA
## x39                 NA         NA      NA       NA
## x40                 NA         NA      NA       NA
```

```
## x41                 NA         NA      NA       NA
## x42                 NA         NA      NA       NA
## x43                 NA         NA      NA       NA
## x44                 NA         NA      NA       NA
## x45          1.156e+03  5.208e+02   2.220 0.026639 *
## x46         -1.136e+03  2.832e+03  -0.401 0.688364
## x47          9.103e+03  5.023e+03   1.812 0.070206 .
## x48          1.751e+02  1.214e+02   1.442 0.149593
## x49         -5.181e+05  5.475e+04  -9.464  < 2e-16 ***
## x50          1.024e+05  5.761e+04   1.777 0.075869 .
## x51          1.697e+06  1.326e+06   1.280 0.201003
## x52         -5.790e+06  3.032e+06  -1.909 0.056479 .
## x53         -1.447e+03  3.421e+02  -4.229 2.55e-05 ***
## x54          5.189e+02  2.951e+02   1.758 0.079019 .
## x55         -5.424e+02  5.519e+02  -0.983 0.325921
## x56         -1.951e+02  3.645e+02  -0.535 0.592508
## x57          8.608e+01  6.242e+02   0.138 0.890341
## x58          8.843e+03  2.418e+03   3.658 0.000267 ***
## x59         -1.641e+03  5.257e+02  -3.122 0.001847 **
## x60         -8.657e+02  2.375e+03  -0.365 0.715519
## x61          4.653e+03  2.229e+03   2.088 0.037080 *
## x62          5.401e+04  2.405e+04   2.246 0.024906 *
## x63          9.281e+04  6.659e+04   1.394 0.163721
## x64         -8.978e+04  3.294e+04  -2.725 0.006531 **
## x65          6.055e+04  2.538e+04   2.386 0.017230 *
## x66          1.350e+04  2.408e+04   0.561 0.575180
## x67          5.960e+04  3.558e+05   0.168 0.866998
## x68         -1.478e+05  5.005e+04  -2.953 0.003222 **
## x69         -2.038e+04  8.047e+03  -2.533 0.011461 *
## x70         -3.929e+06  1.737e+06  -2.261 0.023940 *
## x71         -3.311e+05  5.549e+04  -5.968 3.29e-09 ***
## x72          2.022e+03  2.849e+03   0.710 0.478013
## x73          3.683e+01  4.579e+02   0.080 0.935902
## x74          1.289e+03  5.989e+02   2.153 0.031541 *
## x75          8.919e+02  1.056e+03   0.845 0.398303
## x76          2.482e+03  2.217e+03   1.119 0.263240
## x77         -7.072e+02  1.269e+03  -0.557 0.577448
## x78         -7.314e+04  1.401e+04  -5.222 2.14e-07 ***
## x79         -6.332e+02  6.536e+02  -0.969 0.332869
## x80          1.714e+04  1.008e+04   1.701 0.089148 .
## x81                 NA         NA      NA       NA
## x82                 NA         NA      NA       NA
## x83                 NA         NA      NA       NA
## x84                 NA         NA      NA       NA
## x85                 NA         NA      NA       NA
## x86                 NA         NA      NA       NA
## x87                 NA         NA      NA       NA
## x88                 NA         NA      NA       NA
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##
## Residual standard error: 30770 on 1049 degrees of freedom
## Multiple R-squared:  0.8713, Adjusted R-squared:  0.8625
## F-statistic: 99.98 on 71 and 1049 DF,  p-value: < 2.2e-16
```

```
## ln(x)
## OverallQual as example
y <- Ames_matrix[,38]
x <- Ames_matrix[,5]
trans_x <- log(x)
x <- cbind(x, trans_x)
lm.fit=lm(y ~ x)
summary(lm.fit)
```

```
##
## Call:
## lm(formula = y ~ x)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -262887  -25783    -196   20217  332113
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   257084      30159   8.524   <2e-16 ***
## xx            125034       6228  20.076   <2e-16 ***
## xtrans_x     -471007      37551 -12.543   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 46890 on 1118 degrees of freedom
## Multiple R-squared:  0.6814, Adjusted R-squared:  0.6809
## F-statistic:  1196 on 2 and 1118 DF,  p-value: < 2.2e-16
```