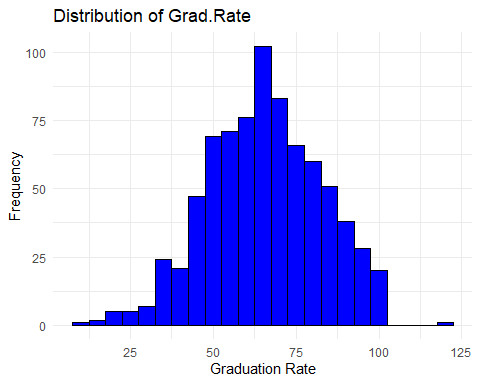
ASSIGNMENT 3

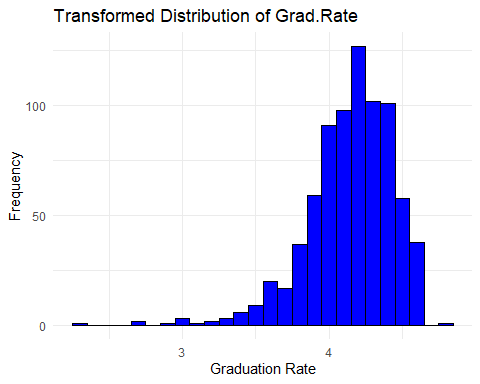
SivaRamaKrishna yarra

2023-10-31

#Problem1(a)  
# Read the data  
data <- read.csv("college.csv")  
  
#a) Analyze distribution of Grad.Rate  
# Load necessary libraries  
library(ggplot2)  
# Plot the distribution of Grad.Rate  
ggplot(data, aes(x=Grad.Rate)) + geom\_histogram(binwidth=5, fill="blue", color="black") +   
 labs(title="Distribution of Grad.Rate", x="Graduation Rate", y="Frequency") +   
 theme\_minimal()



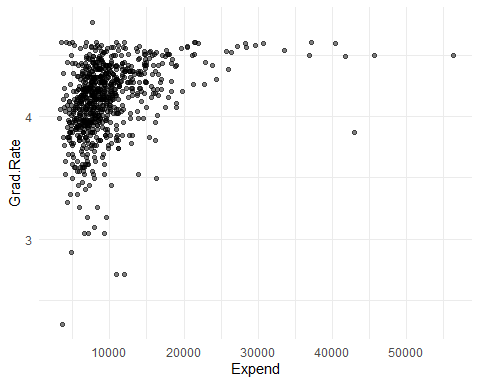
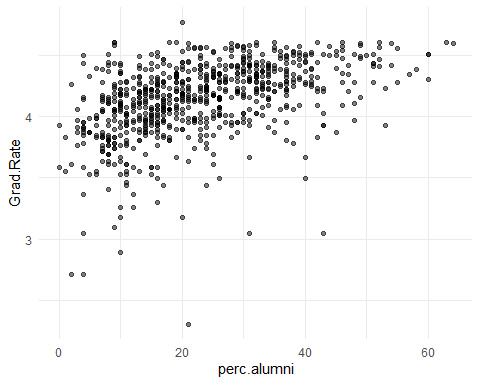
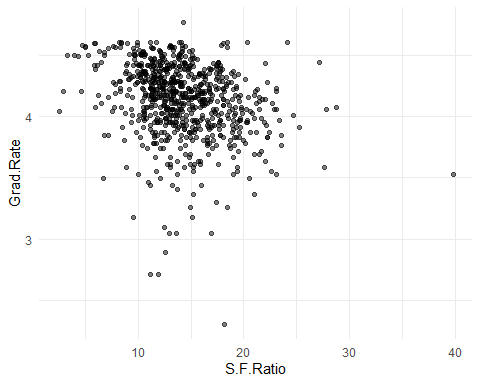
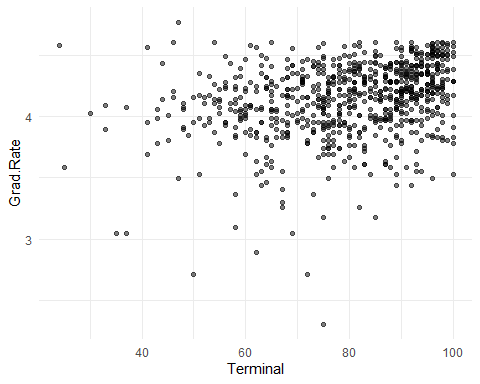
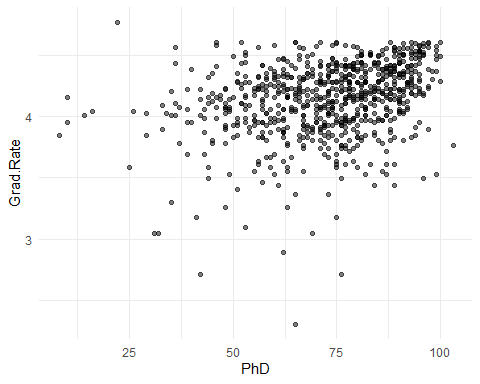
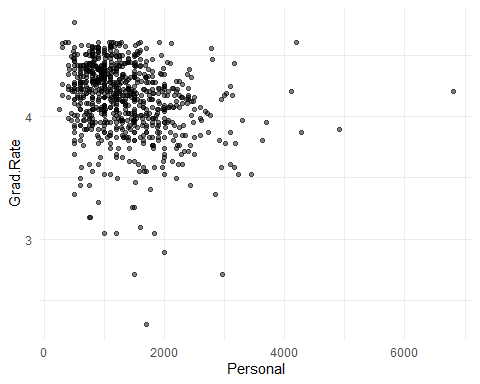
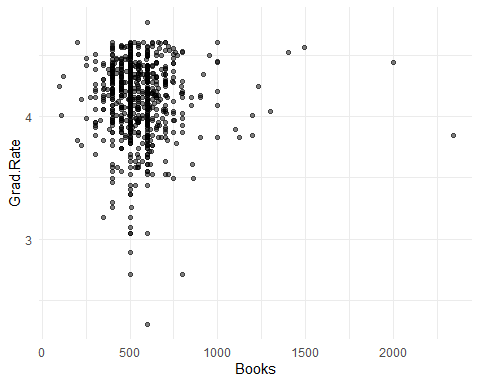
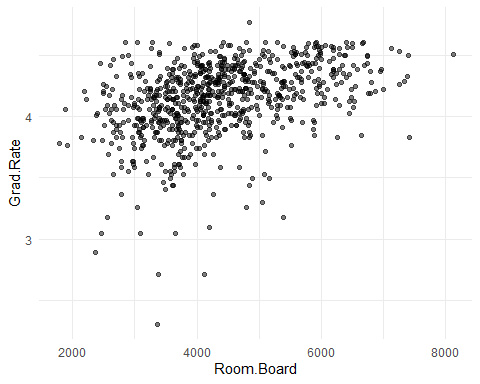
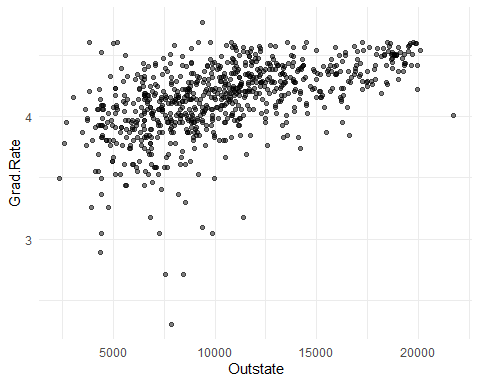
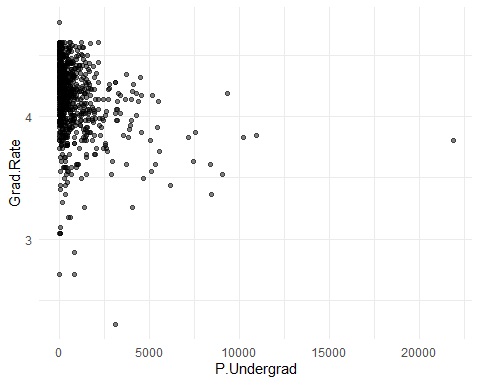
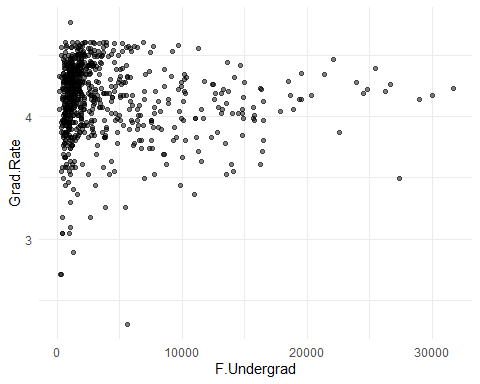
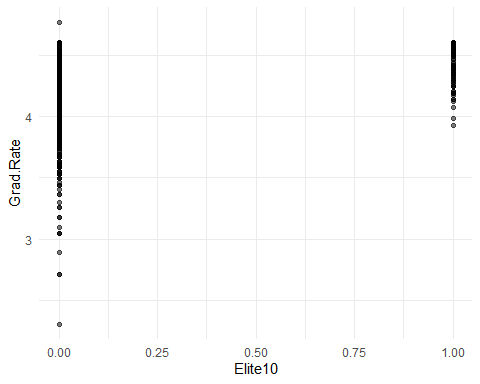
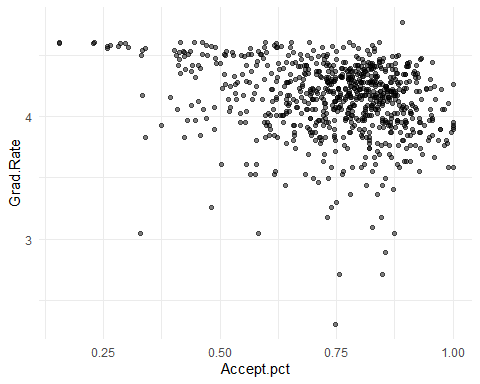
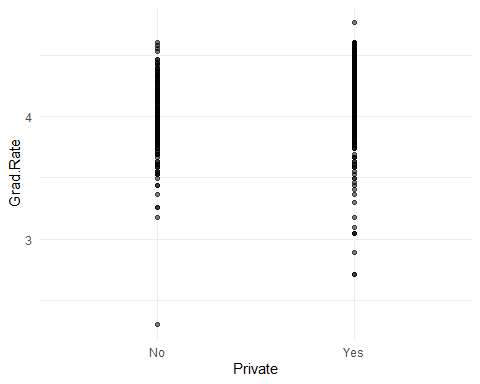
data$Grad.Rate<-log(data$Grad.Rate)  
  
ggplot(data, aes(x=Grad.Rate)) + geom\_histogram(binwidth=0.1, fill="blue", color="black") +   
 labs(title="Transformed Distribution of Grad.Rate", x="Graduation Rate", y="Frequency") +   
 theme\_minimal()



#Problem1(b)

#b) Scatterplots for Grad.Rate vs each independent variable  
# Creating scatterplots for each variable  
independent\_vars <- names(data)[2:(ncol(data)-1)] # Exclude 'school' and 'Grad.Rate'  
for (var in independent\_vars) {  
 print(ggplot(data, aes\_string(x=var, y="Grad.Rate")) + geom\_point(alpha=0.5) + theme\_minimal())  
}

## Warning: `aes\_string()` was deprecated in ggplot2 3.0.0.  
## ℹ Please use tidy evaluation idioms with `aes()`.  
## ℹ See also `vignette("ggplot2-in-packages")` for more information.  
## This warning is displayed once every 8 hours.  
## Call `lifecycle::last\_lifecycle\_warnings()` to see where this warning was  
## generated.

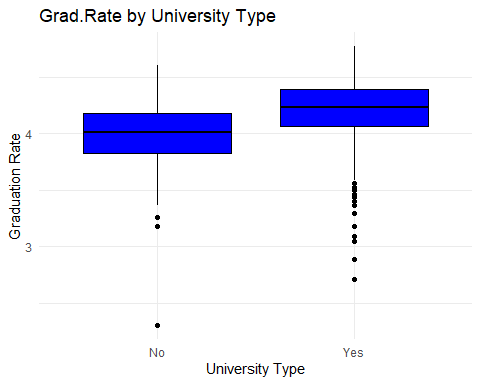


# Correlation analysis  
  
correlation\_matrix<-cor(data[,-c(1,2)])  
correlation\_matrix

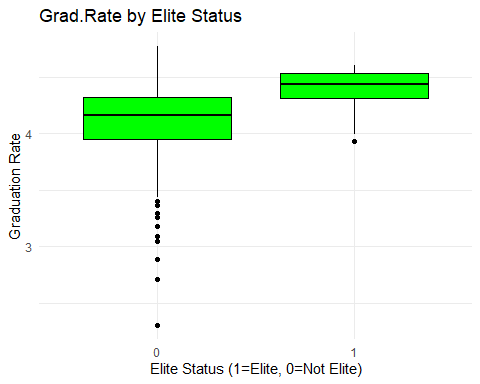
## Accept.pct Elite10 F.Undergrad P.Undergrad Outstate  
## Accept.pct 1.00000000 -0.46245330 -0.15565379 -0.09228664 -0.24095073  
## Elite10 -0.46245330 1.00000000 0.06083999 -0.11644570 0.39947675  
## F.Undergrad -0.15565379 0.06083999 1.00000000 0.57051219 -0.21574200  
## P.Undergrad -0.09228664 -0.11644570 0.57051219 1.00000000 -0.25351232  
## Outstate -0.24095073 0.39947675 -0.21574200 -0.25351232 1.00000000  
## Room.Board -0.31030204 0.29847208 -0.06889039 -0.06132551 0.65425640  
## Books -0.17407288 0.09217607 0.11554976 0.08119952 0.03885487  
## Personal 0.01997851 -0.07526924 0.31719954 0.31988162 -0.29908690  
## PhD -0.31833394 0.34106219 0.31833697 0.14911422 0.38298241  
## Terminal -0.30379999 0.32664984 0.30001894 0.14190357 0.40798320  
## S.F.Ratio 0.10998188 -0.29349738 0.27970335 0.23253051 -0.55482128  
## perc.alumni -0.13210402 0.30259090 -0.22946222 -0.28079236 0.56626242  
## Expend -0.40862232 0.55977784 0.01865162 -0.08356842 0.67277862  
## Grad.Rate -0.22948475 0.30150616 -0.06248495 -0.25004967 0.53324387  
## Room.Board Books Personal PhD Terminal  
## Accept.pct -0.31030204 -0.174072883 0.01997851 -0.31833394 -0.30379999  
## Elite10 0.29847208 0.092176073 -0.07526924 0.34106219 0.32664984  
## F.Undergrad -0.06889039 0.115549761 0.31719954 0.31833697 0.30001894  
## P.Undergrad -0.06132551 0.081199521 0.31988162 0.14911422 0.14190357  
## Outstate 0.65425640 0.038854868 -0.29908690 0.38298241 0.40798320  
## Room.Board 1.00000000 0.127962970 -0.19942818 0.32920228 0.37453955  
## Books 0.12796297 1.000000000 0.17929476 0.02690573 0.09995470  
## Personal -0.19942818 0.179294764 1.00000000 -0.01093579 -0.03061311  
## PhD 0.32920228 0.026905731 -0.01093579 1.00000000 0.84958703  
## Terminal 0.37453955 0.099954700 -0.03061311 0.84958703 1.00000000  
## S.F.Ratio -0.36262774 -0.031929274 0.13634483 -0.13053011 -0.16010395  
## perc.alumni 0.27236345 -0.040207736 -0.28596808 0.24900866 0.26713029  
## Expend 0.50173942 0.112409075 -0.09789189 0.43276168 0.43879922  
## Grad.Rate 0.39867414 -0.006404662 -0.25855499 0.29453029 0.28611348  
## S.F.Ratio perc.alumni Expend Grad.Rate  
## Accept.pct 0.10998188 -0.13210402 -0.40862232 -0.229484755  
## Elite10 -0.29349738 0.30259090 0.55977784 0.301506162  
## F.Undergrad 0.27970335 -0.22946222 0.01865162 -0.062484953  
## P.Undergrad 0.23253051 -0.28079236 -0.08356842 -0.250049668  
## Outstate -0.55482128 0.56626242 0.67277862 0.533243871  
## Room.Board -0.36262774 0.27236345 0.50173942 0.398674142  
## Books -0.03192927 -0.04020774 0.11240908 -0.006404662  
## Personal 0.13634483 -0.28596808 -0.09789189 -0.258554989  
## PhD -0.13053011 0.24900866 0.43276168 0.294530290  
## Terminal -0.16010395 0.26713029 0.43879922 0.286113484  
## S.F.Ratio 1.00000000 -0.40292917 -0.58383204 -0.274912522  
## perc.alumni -0.40292917 1.00000000 0.41771172 0.457131186  
## Expend -0.58383204 0.41771172 1.00000000 0.345480592  
## Grad.Rate -0.27491252 0.45713119 0.34548059 1.000000000

#Problem1(c)

#c) Boxplots for graduation rates by university type and elite status  
  
# Boxplot for Grad.Rate by Private/Public University  
ggplot(data, aes(x=Private, y=Grad.Rate)) +   
 geom\_boxplot(fill="blue", color="black") +   
 labs(title="Grad.Rate by University Type", x="University Type", y="Graduation Rate") +   
 theme\_minimal()



# Boxplot for Grad.Rate by Elite/Not Elite Status  
ggplot(data, aes(x=factor(Elite10), y=Grad.Rate)) +   
 geom\_boxplot(fill="green", color="black") +   
 labs(title="Grad.Rate by Elite Status", x="Elite Status (1=Elite, 0=Not Elite)", y="Graduation Rate") +   
 theme\_minimal()



#Problem1(d)

#d) Fit a full model  
full\_model <- lm(Grad.Rate ~ . - school, data=data)  
summary(full\_model)

##   
## Call:  
## lm(formula = Grad.Rate ~ . - school, data = data)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -1.65101 -0.09527 0.00743 0.12974 0.78402   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 3.793e+00 1.120e-01 33.883 < 2e-16 \*\*\*  
## PrivateYes 7.732e-02 3.148e-02 2.456 0.01426 \*   
## Accept.pct -2.152e-01 7.026e-02 -3.063 0.00227 \*\*   
## Elite10 5.042e-02 3.662e-02 1.377 0.16901   
## F.Undergrad 1.292e-05 2.612e-06 4.949 9.20e-07 \*\*\*  
## P.Undergrad -3.697e-05 7.138e-06 -5.179 2.86e-07 \*\*\*  
## Outstate 2.066e-05 4.180e-06 4.944 9.43e-07 \*\*\*  
## Room.Board 3.066e-05 1.087e-05 2.821 0.00491 \*\*   
## Books -4.489e-05 5.423e-05 -0.828 0.40804   
## Personal -3.050e-05 1.423e-05 -2.144 0.03236 \*   
## PhD 2.085e-03 1.028e-03 2.029 0.04281 \*   
## Terminal -5.456e-04 1.144e-03 -0.477 0.63348   
## S.F.Ratio 3.465e-04 2.959e-03 0.117 0.90681   
## perc.alumni 5.023e-03 8.846e-04 5.678 1.93e-08 \*\*\*  
## Expend -8.255e-06 2.775e-06 -2.975 0.00303 \*\*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.2361 on 762 degrees of freedom  
## Multiple R-squared: 0.3898, Adjusted R-squared: 0.3786   
## F-statistic: 34.77 on 14 and 762 DF, p-value: < 2.2e-16

#Problem1(e)

#e) Multi-collinearity and VIF statistics  
library(car)

## Loading required package: carData

vif\_values <- vif(full\_model)  
print(vif\_values)

## Private Accept.pct Elite10 F.Undergrad P.Undergrad Outstate   
## 2.739521 1.486633 1.687903 2.233117 1.643393 3.935059   
## Room.Board Books Personal PhD Terminal S.F.Ratio   
## 1.976762 1.115823 1.290983 3.917716 3.946581 1.909722   
## perc.alumni Expend   
## 1.672367 2.922643

#Problem1(f)

#f) Variable selection procedures  
# Backward Selection  
backward\_model <- step(full\_model, direction="backward")

## Start: AIC=-2228.14  
## Grad.Rate ~ (school + Private + Accept.pct + Elite10 + F.Undergrad +   
## P.Undergrad + Outstate + Room.Board + Books + Personal +   
## PhD + Terminal + S.F.Ratio + perc.alumni + Expend) - school  
##   
## Df Sum of Sq RSS AIC  
## - S.F.Ratio 1 0.00076 42.488 -2230.1  
## - Terminal 1 0.01269 42.500 -2229.9  
## - Books 1 0.03821 42.526 -2229.4  
## - Elite10 1 0.10568 42.593 -2228.2  
## <none> 42.488 -2228.1  
## - PhD 1 0.22953 42.717 -2225.9  
## - Personal 1 0.25627 42.744 -2225.5  
## - Private 1 0.33641 42.824 -2224.0  
## - Room.Board 1 0.44380 42.931 -2222.1  
## - Expend 1 0.49334 42.981 -2221.2  
## - Accept.pct 1 0.52308 43.011 -2220.6  
## - Outstate 1 1.36271 43.850 -2205.6  
## - F.Undergrad 1 1.36555 43.853 -2205.6  
## - P.Undergrad 1 1.49556 43.983 -2203.3  
## - perc.alumni 1 1.79786 44.285 -2197.9  
##   
## Step: AIC=-2230.12  
## Grad.Rate ~ Private + Accept.pct + Elite10 + F.Undergrad + P.Undergrad +   
## Outstate + Room.Board + Books + Personal + PhD + Terminal +   
## perc.alumni + Expend  
##   
## Df Sum of Sq RSS AIC  
## - Terminal 1 0.01283 42.501 -2231.9  
## - Books 1 0.03813 42.527 -2231.4  
## - Elite10 1 0.10560 42.594 -2230.2  
## <none> 42.488 -2230.1  
## - PhD 1 0.23150 42.720 -2227.9  
## - Personal 1 0.25962 42.748 -2227.4  
## - Private 1 0.33928 42.828 -2225.9  
## - Room.Board 1 0.44359 42.932 -2224.1  
## - Accept.pct 1 0.53070 43.019 -2222.5  
## - Expend 1 0.60488 43.093 -2221.1  
## - Outstate 1 1.36521 43.854 -2207.6  
## - F.Undergrad 1 1.39627 43.885 -2207.0  
## - P.Undergrad 1 1.49651 43.985 -2205.2  
## - perc.alumni 1 1.80214 44.291 -2199.8  
##   
## Step: AIC=-2231.89  
## Grad.Rate ~ Private + Accept.pct + Elite10 + F.Undergrad + P.Undergrad +   
## Outstate + Room.Board + Books + Personal + PhD + perc.alumni +   
## Expend  
##   
## Df Sum of Sq RSS AIC  
## - Books 1 0.04461 42.546 -2233.1  
## - Elite10 1 0.10636 42.608 -2231.9  
## <none> 42.501 -2231.9  
## - Personal 1 0.25582 42.757 -2229.2  
## - PhD 1 0.35827 42.859 -2227.4  
## - Private 1 0.35898 42.860 -2227.3  
## - Room.Board 1 0.43261 42.934 -2226.0  
## - Accept.pct 1 0.53614 43.037 -2224.2  
## - Expend 1 0.61044 43.112 -2222.8  
## - Outstate 1 1.35246 43.854 -2209.6  
## - F.Undergrad 1 1.38679 43.888 -2208.9  
## - P.Undergrad 1 1.50352 44.005 -2206.9  
## - perc.alumni 1 1.78933 44.291 -2201.8  
##   
## Step: AIC=-2233.07  
## Grad.Rate ~ Private + Accept.pct + Elite10 + F.Undergrad + P.Undergrad +   
## Outstate + Room.Board + Personal + PhD + perc.alumni + Expend  
##   
## Df Sum of Sq RSS AIC  
## - Elite10 1 0.10504 42.651 -2233.2  
## <none> 42.546 -2233.1  
## - Personal 1 0.30274 42.849 -2229.6  
## - Private 1 0.34894 42.895 -2228.7  
## - PhD 1 0.37773 42.924 -2228.2  
## - Room.Board 1 0.40928 42.955 -2227.6  
## - Accept.pct 1 0.50692 43.053 -2225.9  
## - Expend 1 0.62302 43.169 -2223.8  
## - F.Undergrad 1 1.35834 43.904 -2210.7  
## - Outstate 1 1.36108 43.907 -2210.6  
## - P.Undergrad 1 1.49937 44.045 -2208.2  
## - perc.alumni 1 1.80726 44.353 -2202.8  
##   
## Step: AIC=-2233.16  
## Grad.Rate ~ Private + Accept.pct + F.Undergrad + P.Undergrad +   
## Outstate + Room.Board + Personal + PhD + perc.alumni + Expend  
##   
## Df Sum of Sq RSS AIC  
## <none> 42.651 -2233.2  
## - Personal 1 0.29979 42.951 -2229.7  
## - Private 1 0.33284 42.984 -2229.1  
## - Room.Board 1 0.39919 43.050 -2227.9  
## - PhD 1 0.40176 43.053 -2227.9  
## - Expend 1 0.52456 43.175 -2225.7  
## - Accept.pct 1 0.71923 43.370 -2222.2  
## - Outstate 1 1.38174 44.033 -2210.4  
## - F.Undergrad 1 1.41008 44.061 -2209.9  
## - P.Undergrad 1 1.66949 44.320 -2205.3  
## - perc.alumni 1 1.88618 44.537 -2201.5

# Forward Selection  
null\_model <- lm(Grad.Rate ~ 1, data=data)  
forward\_model <- step(null\_model, scope=list(lower=null\_model, upper=full\_model), direction="forward")

## Start: AIC=-1872.31  
## Grad.Rate ~ 1  
##   
## Df Sum of Sq RSS AIC  
## + Outstate 1 19.7992 49.831 -2130.3  
## + perc.alumni 1 14.5505 55.079 -2052.5  
## + Room.Board 1 11.0671 58.563 -2004.8  
## + Expend 1 8.3108 61.319 -1969.1  
## + Private 1 6.7672 62.863 -1949.8  
## + Elite10 1 6.3298 63.300 -1944.4  
## + PhD 1 6.0403 63.590 -1940.8  
## + Terminal 1 5.7000 63.930 -1936.7  
## + S.F.Ratio 1 5.2624 64.368 -1931.4  
## + Personal 1 4.6548 64.975 -1924.1  
## + P.Undergrad 1 4.3536 65.276 -1920.5  
## + Accept.pct 1 3.6669 65.963 -1912.3  
## + F.Undergrad 1 0.2719 69.358 -1873.3  
## <none> 69.630 -1872.3  
## + Books 1 0.0029 69.627 -1870.3  
##   
## Step: AIC=-2130.27  
## Grad.Rate ~ Outstate  
##   
## Df Sum of Sq RSS AIC  
## + perc.alumni 1 2.46802 47.363 -2167.7  
## + P.Undergrad 1 0.98181 48.849 -2143.7  
## + Accept.pct 1 0.75406 49.077 -2140.1  
## + Personal 1 0.75053 49.080 -2140.1  
## + PhD 1 0.66547 49.165 -2138.7  
## + Elite10 1 0.64873 49.182 -2138.4  
## + Terminal 1 0.39264 49.438 -2134.4  
## + Room.Board 1 0.30187 49.529 -2133.0  
## + F.Undergrad 1 0.20173 49.629 -2131.4  
## <none> 49.831 -2130.3  
## + Books 1 0.05130 49.779 -2129.1  
## + S.F.Ratio 1 0.04412 49.787 -2129.0  
## + Private 1 0.02916 49.802 -2128.7  
## + Expend 1 0.02242 49.808 -2128.6  
##   
## Step: AIC=-2167.74  
## Grad.Rate ~ Outstate + perc.alumni  
##   
## Df Sum of Sq RSS AIC  
## + Accept.pct 1 0.76895 46.594 -2178.5  
## + Room.Board 1 0.65088 46.712 -2176.5  
## + PhD 1 0.56267 46.800 -2175.0  
## + P.Undergrad 1 0.53489 46.828 -2174.6  
## + F.Undergrad 1 0.44159 46.921 -2173.0  
## + Elite10 1 0.42245 46.940 -2172.7  
## + Personal 1 0.41023 46.952 -2172.5  
## + Terminal 1 0.30456 47.058 -2170.8  
## + S.F.Ratio 1 0.17380 47.189 -2168.6  
## <none> 47.363 -2167.7  
## + Expend 1 0.05994 47.303 -2166.7  
## + Books 1 0.01170 47.351 -2165.9  
## + Private 1 0.00395 47.359 -2165.8  
##   
## Step: AIC=-2178.46  
## Grad.Rate ~ Outstate + perc.alumni + Accept.pct  
##   
## Df Sum of Sq RSS AIC  
## + P.Undergrad 1 0.78875 45.805 -2189.7  
## + Personal 1 0.47712 46.117 -2184.4  
## + Room.Board 1 0.40579 46.188 -2183.2  
## + Expend 1 0.33908 46.255 -2182.1  
## + PhD 1 0.29847 46.295 -2181.4  
## + F.Undergrad 1 0.23346 46.360 -2180.4  
## + S.F.Ratio 1 0.15344 46.440 -2179.0  
## + Terminal 1 0.12805 46.466 -2178.6  
## <none> 46.594 -2178.5  
## + Elite10 1 0.09922 46.495 -2178.1  
## + Books 1 0.06809 46.526 -2177.6  
## + Private 1 0.03330 46.560 -2177.0  
##   
## Step: AIC=-2189.72  
## Grad.Rate ~ Outstate + perc.alumni + Accept.pct + P.Undergrad  
##   
## Df Sum of Sq RSS AIC  
## + F.Undergrad 1 1.22083 44.584 -2208.7  
## + PhD 1 0.64320 45.162 -2198.7  
## + Room.Board 1 0.51487 45.290 -2196.5  
## + Terminal 1 0.37589 45.429 -2194.1  
## + Expend 1 0.25996 45.545 -2192.2  
## + Personal 1 0.24233 45.563 -2191.8  
## + S.F.Ratio 1 0.22478 45.580 -2191.6  
## <none> 45.805 -2189.7  
## + Elite10 1 0.06171 45.743 -2188.8  
## + Books 1 0.04467 45.760 -2188.5  
## + Private 1 0.01709 45.788 -2188.0  
##   
## Step: AIC=-2208.71  
## Grad.Rate ~ Outstate + perc.alumni + Accept.pct + P.Undergrad +   
## F.Undergrad  
##   
## Df Sum of Sq RSS AIC  
## + Room.Board 1 0.53677 44.047 -2216.1  
## + Expend 1 0.47715 44.107 -2215.1  
## + Personal 1 0.44653 44.138 -2214.5  
## + Private 1 0.23306 44.351 -2210.8  
## + PhD 1 0.19653 44.388 -2210.2  
## <none> 44.584 -2208.7  
## + S.F.Ratio 1 0.09239 44.492 -2208.3  
## + Books 1 0.08016 44.504 -2208.1  
## + Terminal 1 0.06417 44.520 -2207.8  
## + Elite10 1 0.00468 44.580 -2206.8  
##   
## Step: AIC=-2216.12  
## Grad.Rate ~ Outstate + perc.alumni + Accept.pct + P.Undergrad +   
## F.Undergrad + Room.Board  
##   
## Df Sum of Sq RSS AIC  
## + Expend 1 0.52950 43.518 -2223.5  
## + Personal 1 0.38784 43.660 -2221.0  
## + Private 1 0.17487 43.873 -2217.2  
## + PhD 1 0.16029 43.887 -2217.0  
## + Books 1 0.12290 43.925 -2216.3  
## <none> 44.047 -2216.1  
## + S.F.Ratio 1 0.10797 43.939 -2216.0  
## + Terminal 1 0.02887 44.019 -2214.6  
## + Elite10 1 0.00569 44.042 -2214.2  
##   
## Step: AIC=-2223.52  
## Grad.Rate ~ Outstate + perc.alumni + Accept.pct + P.Undergrad +   
## F.Undergrad + Room.Board + Expend  
##   
## Df Sum of Sq RSS AIC  
## + Personal 1 0.295342 43.223 -2226.8  
## + PhD 1 0.242133 43.276 -2225.9  
## + Private 1 0.163862 43.354 -2224.4  
## <none> 43.518 -2223.5  
## + Elite10 1 0.107978 43.410 -2223.4  
## + Books 1 0.098685 43.419 -2223.3  
## + Terminal 1 0.063646 43.454 -2222.7  
## + S.F.Ratio 1 0.000864 43.517 -2221.5  
##   
## Step: AIC=-2226.81  
## Grad.Rate ~ Outstate + perc.alumni + Accept.pct + P.Undergrad +   
## F.Undergrad + Room.Board + Expend + Personal  
##   
## Df Sum of Sq RSS AIC  
## + PhD 1 0.238862 42.984 -2229.1  
## + Private 1 0.169940 43.053 -2227.9  
## <none> 43.223 -2226.8  
## + Elite10 1 0.110612 43.112 -2226.8  
## + Terminal 1 0.059691 43.163 -2225.9  
## + Books 1 0.050175 43.172 -2225.7  
## + S.F.Ratio 1 0.000101 43.222 -2224.8  
##   
## Step: AIC=-2229.12  
## Grad.Rate ~ Outstate + perc.alumni + Accept.pct + P.Undergrad +   
## F.Undergrad + Room.Board + Expend + Personal + PhD  
##   
## Df Sum of Sq RSS AIC  
## + Private 1 0.33284 42.651 -2233.2  
## <none> 42.984 -2229.1  
## + Elite10 1 0.08893 42.895 -2228.7  
## + Terminal 1 0.04108 42.943 -2227.9  
## + Books 1 0.03370 42.950 -2227.7  
## + S.F.Ratio 1 0.00344 42.980 -2227.2  
##   
## Step: AIC=-2233.16  
## Grad.Rate ~ Outstate + perc.alumni + Accept.pct + P.Undergrad +   
## F.Undergrad + Room.Board + Expend + Personal + PhD + Private  
##   
## Df Sum of Sq RSS AIC  
## <none> 42.651 -2233.2  
## + Elite10 1 0.105038 42.546 -2233.1  
## + Books 1 0.043282 42.608 -2231.9  
## + Terminal 1 0.020120 42.631 -2231.5  
## + S.F.Ratio 1 0.000759 42.650 -2231.2

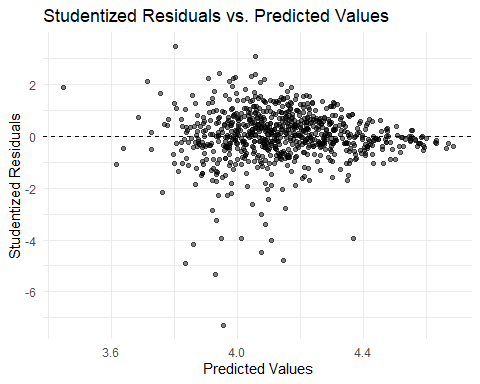
#Problem1(g)

#g) Fit a final regression model M1  
#final Model based on the backward selection as observed in the output  
M1 <- lm(Grad.Rate ~ Private + Accept.pct + Elite10 + F.Undergrad + P.Undergrad +   
 Outstate + Room.Board + Personal + PhD + perc.alumni + Expend, data=data)  
summary(M1)

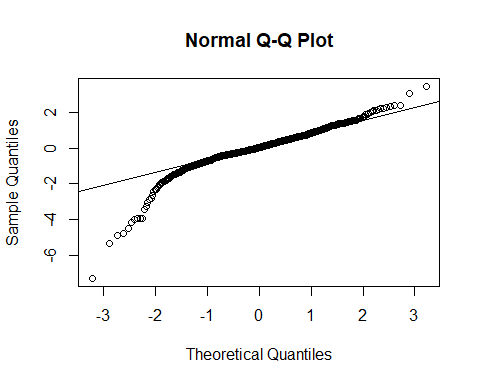
##   
## Call:  
## lm(formula = Grad.Rate ~ Private + Accept.pct + Elite10 + F.Undergrad +   
## P.Undergrad + Outstate + Room.Board + Personal + PhD + perc.alumni +   
## Expend, data = data)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -1.65407 -0.09599 0.00627 0.13276 0.80185   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 3.764e+00 8.441e-02 44.591 < 2e-16 \*\*\*  
## PrivateYes 7.728e-02 3.085e-02 2.505 0.012457 \*   
## Accept.pct -2.094e-01 6.936e-02 -3.019 0.002620 \*\*   
## Elite10 5.026e-02 3.657e-02 1.374 0.169757   
## F.Undergrad 1.274e-05 2.578e-06 4.942 9.50e-07 \*\*\*  
## P.Undergrad -3.700e-05 7.126e-06 -5.192 2.67e-07 \*\*\*  
## Outstate 2.051e-05 4.146e-06 4.947 9.27e-07 \*\*\*  
## Room.Board 2.913e-05 1.074e-05 2.713 0.006822 \*\*   
## Personal -3.255e-05 1.395e-05 -2.333 0.019901 \*   
## PhD 1.764e-03 6.769e-04 2.606 0.009336 \*\*   
## perc.alumni 5.004e-03 8.778e-04 5.700 1.71e-08 \*\*\*  
## Expend -8.500e-06 2.540e-06 -3.347 0.000857 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.2358 on 765 degrees of freedom  
## Multiple R-squared: 0.389, Adjusted R-squared: 0.3802   
## F-statistic: 44.27 on 11 and 765 DF, p-value: < 2.2e-16

#Problem1(h)

#h) Scatter plot of studentized residuals against predicted values  
# Compute studentized residuals  
studentized\_residuals <- rstudent(M1)  
  
# Scatter plot  
ggplot(data, aes(x=predict(M1), y=studentized\_residuals)) +  
 geom\_point(alpha=0.5) +   
 geom\_hline(yintercept = 0, linetype = "dashed") +  
 labs(title="Studentized Residuals vs. Predicted Values", x="Predicted Values", y="Studentized Residuals") +   
 theme\_minimal()

 #Problem1(i)

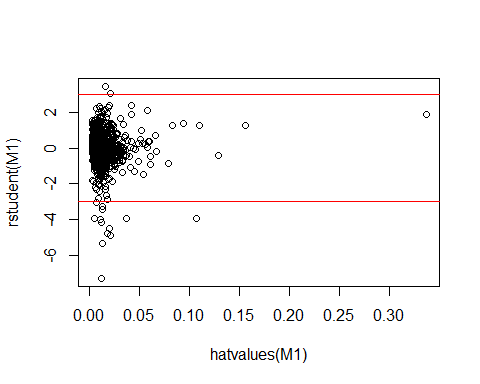
#i) Normal probability plot of residuals  
qqnorm(studentized\_residuals)  
qqline(studentized\_residuals)

 #Problem1(j)

#j) Outliers or Influential Points  
# Cook's distance to detect influential observations  
cook\_d <- cooks.distance(M1)  
  
a<-influence.measures(M1)  
summary(a)

## Potentially influential observations of  
## lm(formula = Grad.Rate ~ Private + Accept.pct + Elite10 + F.Undergrad + P.Undergrad + Outstate + Room.Board + Personal + PhD + perc.alumni + Expend, data = data) :  
##   
## dfb.1\_ dfb.PrvY dfb.Acc. dfb.El10 dfb.F.Un dfb.P.Un dfb.Otst dfb.Rm.B  
## 5 0.01 -0.28 0.02 0.05 0.14 -0.03 0.24 0.04   
## 17 -0.02 0.01 0.03 -0.01 0.01 0.00 -0.01 0.01   
## 21 0.01 0.02 -0.04 0.05 0.01 0.00 0.02 0.04   
## 24 0.02 -0.02 -0.01 -0.01 -0.03 -0.04 0.00 -0.01   
## 38 0.01 0.01 0.00 -0.03 0.00 0.00 0.00 -0.03   
## 48 -0.17 0.13 0.07 0.08 -0.01 -0.01 -0.27 0.14   
## 67 -0.04 -0.29 -0.01 -0.08 0.02 -0.03 0.17 0.19   
## 70 0.06 -0.81 0.08 0.11 -1.15\_\* 0.36 0.66 -0.09   
## 96 0.12 -0.06 0.09 0.04 0.08 -0.01 0.00 0.14   
## 99 -0.05 0.08 -0.10 -0.01 0.00 -0.04 -0.02 -0.19   
## 101 -0.06 0.03 0.02 0.01 -0.01 0.00 0.00 -0.07   
## 107 0.03 -0.01 -0.04 -0.06 0.01 -0.01 0.03 0.00   
## 114 -0.30 -0.31 0.33 0.10 -0.03 0.04 0.36 0.21   
## 145 0.03 0.00 -0.03 0.01 -0.01 -0.01 -0.01 0.00   
## 198 -0.18 0.19 0.04 0.03 0.13 0.02 -0.08 0.18   
## 199 -0.04 -0.07 -0.03 -0.02 -0.01 0.06 -0.02 0.00   
## 202 0.04 -0.01 -0.06 0.03 -0.16 0.44 0.08 -0.16   
## 216 -0.02 -0.11 -0.03 -0.04 -0.03 0.00 0.08 -0.03   
## 224 -0.01 0.00 0.01 -0.01 0.05 -0.10 -0.02 0.04   
## 239 0.18 0.16 -0.13 0.25 0.03 0.02 -0.11 -0.07   
## 251 0.01 0.00 -0.02 -0.01 0.00 -0.01 -0.01 0.00   
## 254 0.00 0.00 0.00 -0.01 0.00 0.00 0.00 0.00   
## 265 -0.64 -0.15 0.60 0.16 -0.03 0.09 -0.05 0.23   
## 266 0.04 0.04 0.05 0.06 0.01 0.02 0.02 0.02   
## 275 0.00 0.00 0.00 0.00 -0.02 0.00 0.00 0.00   
## 276 -0.21 -0.08 0.18 0.03 -0.05 0.00 -0.03 0.07   
## 282 -0.18 0.13 0.19 0.08 0.10 0.03 0.16 -0.17   
## 285 -0.02 -0.02 0.05 -0.07 -0.06 0.04 -0.18 0.01   
## 318 -0.01 0.09 -0.16 -0.01 -0.02 -0.11 0.05 0.07   
## 355 0.01 0.00 -0.01 0.00 0.00 0.00 0.00 -0.01   
## 358 -0.09 -0.10 0.07 0.00 0.00 0.01 0.04 0.05   
## 367 0.00 0.01 0.01 0.00 0.04 0.00 0.01 -0.01   
## 369 -0.01 0.00 0.01 0.01 0.00 -0.01 0.00 0.01   
## 378 0.19 -0.19 0.07 0.08 -0.11 0.14 -0.03 -0.05   
## 379 -0.15 -0.02 0.05 -0.04 -0.06 0.03 0.02 -0.17   
## 385 -0.06 -0.07 -0.05 0.03 0.06 0.11 -0.05 0.13   
## 395 -0.16 0.10 -0.06 -0.03 -0.06 -0.03 -0.05 0.00   
## 419 0.05 -0.05 -0.02 -0.02 0.02 -0.21 0.00 -0.07   
## 427 -0.05 0.02 -0.05 -0.04 -0.02 -0.02 0.00 -0.11   
## 431 0.00 0.00 0.00 0.01 0.00 0.00 0.00 0.00   
## 446 -0.04 -0.03 0.06 0.05 -0.21 0.09 -0.05 0.02   
## 452 0.06 -0.18 -0.04 0.00 0.03 0.02 0.23 0.01   
## 457 0.02 0.00 -0.02 -0.05 0.01 0.00 -0.03 0.02   
## 460 -0.01 0.00 0.02 0.00 0.00 0.00 0.00 0.00   
## 462 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00   
## 498 -0.18 0.04 0.05 -0.05 -0.04 -0.06 0.00 0.03   
## 507 0.12 0.01 -0.01 0.00 0.02 -0.01 0.06 -0.05   
## 543 0.00 0.01 -0.01 0.00 0.00 0.00 -0.01 0.01   
## 582 0.00 -0.02 0.00 0.01 -0.04 0.01 0.01 0.00   
## 586 -0.24 0.48 0.04 -0.09 0.27 -0.38 -0.34 0.13   
## 591 0.01 0.00 -0.01 -0.02 0.00 0.00 0.01 0.00   
## 606 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00   
## 610 -0.01 0.00 0.01 0.00 -0.01 0.00 -0.02 0.00   
## 620 0.00 0.00 0.00 -0.01 -0.01 0.00 0.00 0.00   
## 624 -0.02 0.02 0.02 0.05 0.07 -0.03 -0.01 0.01   
## 638 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00   
## 641 -0.04 0.06 0.02 0.06 -0.37 1.29\_\* 0.03 -0.16   
## 645 -0.01 -0.02 0.00 0.00 -0.03 0.03 0.01 0.01   
## 677 0.01 0.02 -0.01 0.01 -0.03 0.18 0.00 -0.03   
## 686 -0.01 0.05 -0.01 -0.01 0.09 0.00 -0.01 -0.01   
## 688 0.01 0.00 0.00 0.00 0.00 0.00 0.01 0.00   
## 692 0.03 0.00 -0.03 -0.01 0.02 -0.08 0.00 0.00   
## 701 0.00 0.00 0.00 0.00 0.01 0.00 0.00 0.00   
## 713 -0.03 0.17 -0.06 -0.01 0.06 0.05 0.07 -0.16   
## 715 -0.02 -0.07 -0.03 -0.03 -0.02 0.03 0.02 0.03   
## 721 0.03 0.04 -0.01 -0.01 -0.02 0.00 -0.15 -0.07   
## 729 -0.08 -0.01 0.13 0.01 -0.03 0.04 -0.10 -0.02   
## 732 0.22 0.15 -0.24 -0.03 0.00 -0.05 -0.03 -0.11   
## 736 0.03 -0.02 0.04 -0.02 0.03 -0.01 -0.03 0.08   
## 763 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00   
## 766 0.01 0.10 0.00 0.01 0.00 -0.03 -0.03 -0.06   
## 776 0.01 0.00 -0.02 -0.01 0.00 -0.01 -0.02 0.00   
## dfb.Prsn dfb.PhD dfb.prc. dfb.Expn dffit cov.r cook.d hat   
## 5 0.02 -0.27 0.38 -0.23 -0.61\_\* 0.67\_\* 0.03 0.01   
## 17 -0.01 0.01 -0.02 0.01 -0.05 1.05\_\* 0.00 0.03   
## 21 0.02 0.02 0.01 -0.16 -0.17 1.16\_\* 0.00 0.13\_\*  
## 24 0.01 0.00 0.01 0.02 -0.08 1.05\_\* 0.00 0.04   
## 38 0.00 0.01 0.00 0.02 -0.05 1.05\_\* 0.00 0.03   
## 48 0.04 0.24 0.03 -0.02 -0.36 1.04 0.01 0.05\_\*  
## 67 -0.10 -0.14 0.11 -0.03 -0.47\_\* 0.78\_\* 0.02 0.01   
## 70 0.20 -0.04 -0.41 -0.08 -1.37\_\* 0.89\_\* 0.15 0.11\_\*  
## 96 -0.14 -0.37 0.02 0.05 0.45\_\* 0.90\_\* 0.02 0.02   
## 99 0.10 0.32 0.01 -0.06 -0.43\_\* 0.80\_\* 0.02 0.01   
## 101 0.03 0.14 0.03 -0.04 -0.17 1.06\_\* 0.00 0.05\_\*  
## 107 0.00 -0.02 -0.05 0.01 -0.09 1.05\_\* 0.00 0.04   
## 114 0.10 -0.16 -0.17 -0.08 -0.65\_\* 0.76\_\* 0.03 0.02   
## 145 -0.04 0.00 -0.05 0.06 0.12 1.05\_\* 0.00 0.04   
## 198 0.15 -0.05 0.11 -0.04 -0.38\_\* 0.87\_\* 0.01 0.01   
## 199 -0.06 0.10 0.17 -0.02 -0.30 0.80\_\* 0.01 0.01   
## 202 0.10 0.01 0.08 -0.05 0.52\_\* 1.01 0.02 0.06\_\*  
## 216 0.15 -0.04 0.11 0.03 -0.26 0.89\_\* 0.01 0.01   
## 224 -0.04 -0.01 0.00 0.01 -0.13 1.08\_\* 0.00 0.06\_\*  
## 239 -0.12 0.03 -0.04 -0.12 0.40\_\* 1.00 0.01 0.04   
## 251 0.01 -0.01 0.01 0.03 0.05 1.07\_\* 0.00 0.05\_\*  
## 254 0.00 0.00 0.00 0.00 -0.01 1.05\_\* 0.00 0.03   
## 265 -0.09 0.32 0.21 -0.08 -0.78\_\* 0.83\_\* 0.05 0.04   
## 266 0.01 -0.13 -0.10 -0.01 0.24 0.95\_\* 0.00 0.01   
## 275 0.00 0.01 0.00 0.00 -0.02 1.05\_\* 0.00 0.04   
## 276 0.05 0.10 0.06 0.04 -0.26 0.94\_\* 0.01 0.01   
## 282 0.01 0.07 -0.02 -0.08 -0.39\_\* 0.91\_\* 0.01 0.02   
## 285 -0.06 -0.05 -0.03 0.52 0.55\_\* 1.17\_\* 0.03 0.16\_\*  
## 318 0.42 0.02 -0.05 -0.18 0.50\_\* 0.97 0.02 0.04   
## 355 0.01 0.00 -0.01 0.03 0.05 1.05\_\* 0.00 0.03   
## 358 -0.01 0.00 0.07 0.00 -0.18 0.95\_\* 0.00 0.01   
## 367 -0.03 0.00 -0.01 0.00 0.06 1.07\_\* 0.00 0.05\_\*  
## 369 0.05 -0.02 0.01 0.00 0.06 1.08\_\* 0.00 0.06\_\*  
## 378 -0.27 -0.13 -0.04 0.05 0.45\_\* 0.86\_\* 0.02 0.02   
## 379 0.06 0.26 0.01 0.09 -0.39\_\* 0.86\_\* 0.01 0.01   
## 385 -0.42 0.24 0.26 -0.27 -0.72\_\* 0.72\_\* 0.04 0.02   
## 395 -0.03 0.48 -0.40 0.04 -0.65\_\* 0.73\_\* 0.03 0.02   
## 419 0.01 0.03 -0.01 0.03 -0.25 1.09\_\* 0.01 0.08\_\*  
## 427 0.09 0.17 -0.06 0.07 -0.28 0.91\_\* 0.01 0.01   
## 431 0.01 0.00 0.00 0.00 0.01 1.08\_\* 0.00 0.06\_\*  
## 446 -0.02 0.06 -0.01 0.03 -0.24 1.07\_\* 0.00 0.06\_\*  
## 452 0.11 -0.25 0.05 -0.05 -0.35 0.93\_\* 0.01 0.02   
## 457 -0.03 -0.01 0.03 0.02 -0.08 1.05\_\* 0.00 0.03   
## 460 -0.01 0.01 -0.01 -0.01 -0.03 1.05\_\* 0.00 0.03   
## 462 0.00 0.00 0.00 0.00 0.01 1.06\_\* 0.00 0.04   
## 498 0.42 0.04 0.01 0.08 0.45\_\* 1.11\_\* 0.02 0.11\_\*  
## 507 -0.10 -0.12 -0.13 0.04 0.23 0.94\_\* 0.00 0.01   
## 543 0.01 0.00 0.00 0.00 0.02 1.05\_\* 0.00 0.03   
## 582 0.00 0.00 -0.01 0.00 -0.05 1.09\_\* 0.00 0.07\_\*  
## 586 -0.06 0.23 -0.20 0.30 -0.81\_\* 0.46\_\* 0.05 0.01   
## 591 0.00 0.00 -0.01 0.00 -0.03 1.05\_\* 0.00 0.03   
## 606 0.00 0.00 0.00 0.00 0.00 1.05\_\* 0.00 0.03   
## 610 0.00 0.00 -0.01 0.07 0.08 1.06\_\* 0.00 0.04   
## 620 0.00 0.00 0.00 0.00 -0.01 1.06\_\* 0.00 0.05   
## 624 0.00 -0.01 -0.01 -0.02 0.09 1.08\_\* 0.00 0.06\_\*  
## 638 0.00 0.00 0.00 0.00 -0.01 1.06\_\* 0.00 0.04   
## 641 -0.04 -0.08 0.27 0.10 1.34\_\* 1.45\_\* 0.15 0.34\_\*  
## 645 0.06 -0.01 0.01 -0.01 0.08 1.05\_\* 0.00 0.04   
## 677 -0.02 0.00 -0.01 0.02 0.19 1.08\_\* 0.00 0.07\_\*  
## 686 0.02 0.00 0.00 -0.01 0.11 1.07\_\* 0.00 0.05\_\*  
## 688 0.00 -0.01 0.00 0.00 0.02 1.05\_\* 0.00 0.03   
## 692 -0.02 -0.01 0.00 -0.01 -0.10 1.05\_\* 0.00 0.04   
## 701 0.00 0.00 0.00 0.00 0.01 1.05\_\* 0.00 0.03   
## 713 0.11 0.06 0.01 -0.02 -0.29 0.95\_\* 0.01 0.02   
## 715 -0.04 0.04 0.09 -0.02 -0.20 0.94\_\* 0.00 0.01   
## 721 -0.03 0.01 -0.01 0.33 0.37 1.08\_\* 0.01 0.08\_\*  
## 729 -0.02 -0.05 -0.06 0.41 0.45\_\* 1.09\_\* 0.02 0.09\_\*  
## 732 0.07 0.00 -0.12 -0.04 0.35 0.95\_\* 0.01 0.02   
## 736 -0.04 -0.17 -0.03 0.12 0.23 1.06\_\* 0.00 0.05\_\*  
## 763 -0.01 0.00 0.00 0.00 -0.01 1.05\_\* 0.00 0.03   
## 766 0.01 0.07 -0.12 0.01 0.19 0.95\_\* 0.00 0.01   
## 776 0.02 -0.01 0.01 0.07 0.10 1.08\_\* 0.00 0.06\_\*

plot(rstudent(M1)~hatvalues(M1))  
abline(a=3, b=0, col= 'red')  
abline(a=-3, b=0,col='red')



# Flag observations with Cook's distance > 4/n  
influential\_points <- as.numeric(names(cook\_d)[(cook\_d > 4/length(cook\_d))])  
print(influential\_points)

## [1] 5 48 67 70 96 99 114 143 153 170 198 199 202 216 239 265 276 282 285  
## [20] 304 318 320 378 379 385 395 419 427 452 498 586 588 592 604 629 641 713 721  
## [39] 729 732 777

# For outliers, you can inspect large studentized residuals  
outliers <- which(abs(studentized\_residuals) > 2) # Adjust the threshold as necessary  
print(outliers)

## 5 67 70 96 99 114 170 198 199 202 216 265 266 273 276 282 304 318 320 358   
## 5 67 70 96 99 114 170 198 199 202 216 265 266 273 276 282 304 318 320 358   
## 378 379 385 395 427 440 452 507 586 590 713 715 732 766 777   
## 378 379 385 395 427 440 452 507 586 590 713 715 732 766 777

#Problem1(k)

#k) adjusted r2 value  
r\_squared <- summary(M1)$r.squared  
print(r\_squared)

## [1] 0.3889722

#Problem2

# Load the necessary library  
library(tidyverse)

## ── Attaching core tidyverse packages ──────────────────────── tidyverse 2.0.0 ──  
## ✔ dplyr 1.1.3 ✔ readr 2.1.4  
## ✔ forcats 1.0.0 ✔ stringr 1.5.0  
## ✔ lubridate 1.9.3 ✔ tibble 3.2.1  
## ✔ purrr 1.0.2 ✔ tidyr 1.3.0  
## ── Conflicts ────────────────────────────────────────── tidyverse\_conflicts() ──  
## ✖ dplyr::filter() masks stats::filter()  
## ✖ dplyr::lag() masks stats::lag()  
## ✖ dplyr::recode() masks car::recode()  
## ✖ purrr::some() masks car::some()  
## ℹ Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become errors

# Load the data  
college\_data <- read.csv("college.csv")  
  
#problem2(A)  
# Fit the model with interaction terms  
model\_a <- lm(Grad.Rate ~ (Elite10 + Accept.pct + Outstate + perc.alumni + Expend)^2, data = college\_data)  
summary(model\_a)

##   
## Call:  
## lm(formula = Grad.Rate ~ (Elite10 + Accept.pct + Outstate + perc.alumni +   
## Expend)^2, data = college\_data)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -53.384 -7.793 0.274 7.560 57.038   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 4.698e+01 9.094e+00 5.166 3.05e-07 \*\*\*  
## Elite10 3.524e+01 1.057e+01 3.333 0.000901 \*\*\*  
## Accept.pct -1.573e+01 9.930e+00 -1.584 0.113673   
## Outstate 3.799e-03 1.355e-03 2.804 0.005183 \*\*   
## perc.alumni 5.232e-01 3.704e-01 1.413 0.158180   
## Expend -1.436e-03 9.098e-04 -1.579 0.114866   
## Elite10:Accept.pct -2.876e+01 1.229e+01 -2.340 0.019526 \*   
## Elite10:Outstate -2.267e-03 6.272e-04 -3.614 0.000321 \*\*\*  
## Elite10:perc.alumni -1.428e-01 1.716e-01 -0.832 0.405469   
## Elite10:Expend 1.821e-03 4.763e-04 3.824 0.000142 \*\*\*  
## Accept.pct:Outstate -1.083e-03 1.461e-03 -0.741 0.458660   
## Accept.pct:perc.alumni -1.732e-01 3.892e-01 -0.445 0.656448   
## Accept.pct:Expend 1.480e-03 9.472e-04 1.563 0.118541   
## Outstate:perc.alumni -5.319e-06 1.432e-05 -0.371 0.710419   
## Outstate:Expend -6.064e-08 3.942e-08 -1.538 0.124350   
## perc.alumni:Expend 2.098e-06 1.536e-05 0.137 0.891420   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 13.12 on 761 degrees of freedom  
## Multiple R-squared: 0.4281, Adjusted R-squared: 0.4169   
## F-statistic: 37.98 on 15 and 761 DF, p-value: < 2.2e-16

X.var=model.matrix(model\_a)[,-1]  
library(leaps)  
#backward selection  
bward=step(model\_a,direction="backward",trace=TRUE)

## Start: AIC=4015.73  
## Grad.Rate ~ (Elite10 + Accept.pct + Outstate + perc.alumni +   
## Expend)^2  
##   
## Df Sum of Sq RSS AIC  
## - perc.alumni:Expend 1 3.21 130945 4013.7  
## - Outstate:perc.alumni 1 23.74 130965 4013.9  
## - Accept.pct:perc.alumni 1 34.07 130975 4013.9  
## - Accept.pct:Outstate 1 94.59 131036 4014.3  
## - Elite10:perc.alumni 1 119.21 131061 4014.4  
## <none> 130941 4015.7  
## - Outstate:Expend 1 407.26 131349 4016.1  
## - Accept.pct:Expend 1 420.18 131362 4016.2  
## - Elite10:Accept.pct 1 942.40 131884 4019.3  
## - Elite10:Outstate 1 2247.56 133189 4027.0  
## - Elite10:Expend 1 2515.78 133457 4028.5  
##   
## Step: AIC=4013.75  
## Grad.Rate ~ Elite10 + Accept.pct + Outstate + perc.alumni + Expend +   
## Elite10:Accept.pct + Elite10:Outstate + Elite10:perc.alumni +   
## Elite10:Expend + Accept.pct:Outstate + Accept.pct:perc.alumni +   
## Accept.pct:Expend + Outstate:perc.alumni + Outstate:Expend  
##   
## Df Sum of Sq RSS AIC  
## - Outstate:perc.alumni 1 21.97 130967 4011.9  
## - Accept.pct:perc.alumni 1 42.75 130987 4012.0  
## - Accept.pct:Outstate 1 91.88 131036 4012.3  
## - Elite10:perc.alumni 1 120.08 131065 4012.5  
## <none> 130945 4013.7  
## - Accept.pct:Expend 1 421.83 131366 4014.2  
## - Outstate:Expend 1 470.21 131415 4014.5  
## - Elite10:Accept.pct 1 946.63 131891 4017.3  
## - Elite10:Outstate 1 2373.48 133318 4025.7  
## - Elite10:Expend 1 2522.64 133467 4026.6  
##   
## Step: AIC=4011.88  
## Grad.Rate ~ Elite10 + Accept.pct + Outstate + perc.alumni + Expend +   
## Elite10:Accept.pct + Elite10:Outstate + Elite10:perc.alumni +   
## Elite10:Expend + Accept.pct:Outstate + Accept.pct:perc.alumni +   
## Accept.pct:Expend + Outstate:Expend  
##   
## Df Sum of Sq RSS AIC  
## - Accept.pct:perc.alumni 1 31.76 130998 4010.1  
## - Accept.pct:Outstate 1 101.00 131068 4010.5  
## - Elite10:perc.alumni 1 163.91 131130 4010.9  
## <none> 130967 4011.9  
## - Accept.pct:Expend 1 428.17 131395 4012.4  
## - Outstate:Expend 1 648.13 131615 4013.7  
## - Elite10:Accept.pct 1 953.00 131920 4015.5  
## - Elite10:Outstate 1 2395.41 133362 4024.0  
## - Elite10:Expend 1 2798.12 133765 4026.3  
##   
## Step: AIC=4010.07  
## Grad.Rate ~ Elite10 + Accept.pct + Outstate + perc.alumni + Expend +   
## Elite10:Accept.pct + Elite10:Outstate + Elite10:perc.alumni +   
## Elite10:Expend + Accept.pct:Outstate + Accept.pct:Expend +   
## Outstate:Expend  
##   
## Df Sum of Sq RSS AIC  
## - Elite10:perc.alumni 1 132.44 131131 4008.9  
## - Accept.pct:Outstate 1 195.21 131194 4009.2  
## <none> 130998 4010.1  
## - Accept.pct:Expend 1 415.46 131414 4010.5  
## - Outstate:Expend 1 644.20 131642 4011.9  
## - Elite10:Accept.pct 1 1032.09 132030 4014.2  
## - Elite10:Outstate 1 2516.26 133515 4022.9  
## - Elite10:Expend 1 2773.09 133771 4024.3  
##   
## Step: AIC=4008.85  
## Grad.Rate ~ Elite10 + Accept.pct + Outstate + perc.alumni + Expend +   
## Elite10:Accept.pct + Elite10:Outstate + Elite10:Expend +   
## Accept.pct:Outstate + Accept.pct:Expend + Outstate:Expend  
##   
## Df Sum of Sq RSS AIC  
## - Accept.pct:Outstate 1 174.0 131305 4007.9  
## <none> 131131 4008.9  
## - Accept.pct:Expend 1 445.5 131576 4009.5  
## - Outstate:Expend 1 610.8 131741 4010.5  
## - Elite10:Accept.pct 1 1020.0 132151 4012.9  
## - Elite10:Expend 1 2824.5 133955 4023.4  
## - Elite10:Outstate 1 3345.2 134476 4026.4  
## - perc.alumni 1 8938.9 140070 4058.1  
##   
## Step: AIC=4007.88  
## Grad.Rate ~ Elite10 + Accept.pct + Outstate + perc.alumni + Expend +   
## Elite10:Accept.pct + Elite10:Outstate + Elite10:Expend +   
## Accept.pct:Expend + Outstate:Expend  
##   
## Df Sum of Sq RSS AIC  
## - Accept.pct:Expend 1 271.7 131576 4007.5  
## <none> 131305 4007.9  
## - Outstate:Expend 1 473.2 131778 4008.7  
## - Elite10:Accept.pct 1 1224.0 132529 4013.1  
## - Elite10:Expend 1 2861.6 134166 4022.6  
## - Elite10:Outstate 1 3438.3 134743 4026.0  
## - perc.alumni 1 8986.1 140291 4057.3  
##   
## Step: AIC=4007.49  
## Grad.Rate ~ Elite10 + Accept.pct + Outstate + perc.alumni + Expend +   
## Elite10:Accept.pct + Elite10:Outstate + Elite10:Expend +   
## Outstate:Expend  
##   
## Df Sum of Sq RSS AIC  
## <none> 131576 4007.5  
## - Outstate:Expend 1 589.5 132166 4009.0  
## - Elite10:Accept.pct 1 970.5 132547 4011.2  
## - Elite10:Expend 1 2892.9 134469 4022.4  
## - Elite10:Outstate 1 3228.4 134805 4024.3  
## - perc.alumni 1 8861.3 140438 4056.1

#forward selection  
step(model\_a,direction="forward",trace=TRUE)

## Start: AIC=4015.73  
## Grad.Rate ~ (Elite10 + Accept.pct + Outstate + perc.alumni +   
## Expend)^2

##   
## Call:  
## lm(formula = Grad.Rate ~ (Elite10 + Accept.pct + Outstate + perc.alumni +   
## Expend)^2, data = college\_data)  
##   
## Coefficients:  
## (Intercept) Elite10 Accept.pct   
## 4.698e+01 3.524e+01 -1.573e+01   
## Outstate perc.alumni Expend   
## 3.799e-03 5.232e-01 -1.436e-03   
## Elite10:Accept.pct Elite10:Outstate Elite10:perc.alumni   
## -2.876e+01 -2.267e-03 -1.428e-01   
## Elite10:Expend Accept.pct:Outstate Accept.pct:perc.alumni   
## 1.821e-03 -1.083e-03 -1.732e-01   
## Accept.pct:Expend Outstate:perc.alumni Outstate:Expend   
## 1.480e-03 -5.319e-06 -6.064e-08   
## perc.alumni:Expend   
## 2.098e-06

model1 <- lm(Grad.Rate ~ Elite10 + Accept.pct + Outstate + perc.alumni + Expend + Elite10:Accept.pct + Elite10:Outstate + Elite10:perc.alumni + Elite10 : Expend,data=college\_data)  
# Summary of the model  
summary(model1)

##   
## Call:  
## lm(formula = Grad.Rate ~ Elite10 + Accept.pct + Outstate + perc.alumni +   
## Expend + Elite10:Accept.pct + Elite10:Outstate + Elite10:perc.alumni +   
## Elite10:Expend, data = college\_data)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -53.787 -7.785 -0.400 7.769 57.177   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 5.316e+01 3.592e+00 14.801 < 2e-16 \*\*\*  
## Elite10 3.763e+01 1.000e+01 3.762 0.000181 \*\*\*  
## Accept.pct -1.519e+01 4.129e+00 -3.678 0.000251 \*\*\*  
## Outstate 2.296e-03 1.991e-04 11.532 < 2e-16 \*\*\*  
## perc.alumni 3.505e-01 5.030e-02 6.968 6.95e-12 \*\*\*  
## Expend -9.536e-04 2.073e-04 -4.601 4.93e-06 \*\*\*  
## Elite10:Accept.pct -2.274e+01 9.822e+00 -2.315 0.020881 \*   
## Elite10:Outstate -2.054e-03 5.390e-04 -3.811 0.000150 \*\*\*  
## Elite10:perc.alumni -1.227e-01 1.347e-01 -0.911 0.362485   
## Elite10:Expend 1.050e-03 2.889e-04 3.635 0.000297 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 13.12 on 767 degrees of freedom  
## Multiple R-squared: 0.4234, Adjusted R-squared: 0.4167   
## F-statistic: 62.58 on 9 and 767 DF, p-value: < 2.2e-16

#problem2(B)

#fit the model after removing the unsignificant terms  
model2 <- lm(Grad.Rate ~ Elite10 + Accept.pct + Outstate + perc.alumni + Expend + Elite10:Accept.pct + Elite10:Outstate + Elite10:Expend,data=college\_data)  
summary(model2)

##   
## Call:  
## lm(formula = Grad.Rate ~ Elite10 + Accept.pct + Outstate + perc.alumni +   
## Expend + Elite10:Accept.pct + Elite10:Outstate + Elite10:Expend,   
## data = college\_data)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -53.724 -7.744 -0.468 7.727 57.150   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 5.314e+01 3.591e+00 14.797 < 2e-16 \*\*\*  
## Elite10 3.585e+01 9.808e+00 3.655 0.000275 \*\*\*  
## Accept.pct -1.505e+01 4.126e+00 -3.647 0.000283 \*\*\*  
## Outstate 2.322e-03 1.970e-04 11.786 < 2e-16 \*\*\*  
## perc.alumni 3.334e-01 4.666e-02 7.145 2.09e-12 \*\*\*  
## Expend -9.506e-04 2.072e-04 -4.587 5.24e-06 \*\*\*  
## Elite10:Accept.pct -2.164e+01 9.747e+00 -2.220 0.026705 \*   
## Elite10:Outstate -2.253e-03 4.926e-04 -4.575 5.56e-06 \*\*\*  
## Elite10:Expend 1.057e-03 2.888e-04 3.661 0.000268 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 13.12 on 768 degrees of freedom  
## Multiple R-squared: 0.4228, Adjusted R-squared: 0.4168   
## F-statistic: 70.32 on 8 and 768 DF, p-value: < 2.2e-16

#Problem2(c)

fitmodel <- lm(Elite10 ~ Grad.Rate + Accept.pct + Outstate + perc.alumni + Expend, data = college\_data)  
summary(fitmodel)

##   
## Call:  
## lm(formula = Elite10 ~ Grad.Rate + Accept.pct + Outstate + perc.alumni +   
## Expend, data = college\_data)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.75664 -0.11744 -0.03826 0.04361 0.99371   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 1.572e-01 6.830e-02 2.301 0.02163 \*   
## Grad.Rate 1.737e-03 6.319e-04 2.749 0.00611 \*\*   
## Accept.pct -5.461e-01 6.440e-02 -8.481 < 2e-16 \*\*\*  
## Outstate -2.460e-06 3.354e-06 -0.733 0.46361   
## perc.alumni 1.644e-03 8.572e-04 1.918 0.05550 .   
## Expend 2.336e-05 2.338e-06 9.991 < 2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.2351 on 771 degrees of freedom  
## Multiple R-squared: 0.3926, Adjusted R-squared: 0.3887   
## F-statistic: 99.68 on 5 and 771 DF, p-value: < 2.2e-16

fittedmodel <- lm(Grad.Rate ~ Elite10 + Accept.pct + Outstate + perc.alumni + Expend +  
 Elite10:Accept.pct + Elite10:Outstate + Elite10:perc.alumni + Elite10:Expend,  
 data=college\_data)  
summary(fittedmodel)

##   
## Call:  
## lm(formula = Grad.Rate ~ Elite10 + Accept.pct + Outstate + perc.alumni +   
## Expend + Elite10:Accept.pct + Elite10:Outstate + Elite10:perc.alumni +   
## Elite10:Expend, data = college\_data)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -53.787 -7.785 -0.400 7.769 57.177   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 5.316e+01 3.592e+00 14.801 < 2e-16 \*\*\*  
## Elite10 3.763e+01 1.000e+01 3.762 0.000181 \*\*\*  
## Accept.pct -1.519e+01 4.129e+00 -3.678 0.000251 \*\*\*  
## Outstate 2.296e-03 1.991e-04 11.532 < 2e-16 \*\*\*  
## perc.alumni 3.505e-01 5.030e-02 6.968 6.95e-12 \*\*\*  
## Expend -9.536e-04 2.073e-04 -4.601 4.93e-06 \*\*\*  
## Elite10:Accept.pct -2.274e+01 9.822e+00 -2.315 0.020881 \*   
## Elite10:Outstate -2.054e-03 5.390e-04 -3.811 0.000150 \*\*\*  
## Elite10:perc.alumni -1.227e-01 1.347e-01 -0.911 0.362485   
## Elite10:Expend 1.050e-03 2.889e-04 3.635 0.000297 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 13.12 on 767 degrees of freedom  
## Multiple R-squared: 0.4234, Adjusted R-squared: 0.4167   
## F-statistic: 62.58 on 9 and 767 DF, p-value: < 2.2e-16

#problem2(d)

#5-fold cross validation  
# split samples (75% for training and 25% for testing)  
library(DAAG)

##   
## Attaching package: 'DAAG'

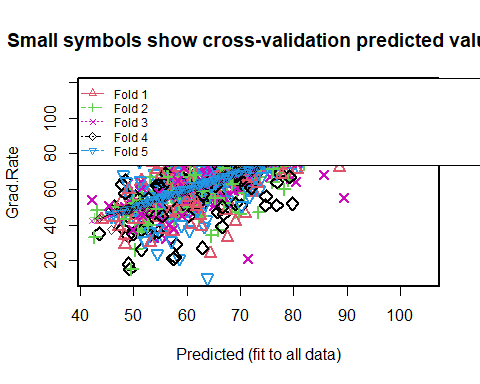
## The following object is masked from 'package:car':  
##   
## vif

select.myd <- sample(1:nrow(college\_data), 0.75\*nrow(college\_data))  
#Selecting 75% of the data for training purpose  
train.myd <- college\_data[select.myd,]  
#Selecting 25% (remaining) of the data for testing  
test.myd <- college\_data[-select.myd,]  
  
model1 <- lm(Grad.Rate ~ Elite10 + Accept.pct + Outstate + perc.alumni + Expend + Elite10:Accept.pct + Elite10:Outstate + Elite10:perc.alumni + Elite10 : Expend,data=train.myd)  
# Summary of the model  
summary(model1)

##   
## Call:  
## lm(formula = Grad.Rate ~ Elite10 + Accept.pct + Outstate + perc.alumni +   
## Expend + Elite10:Accept.pct + Elite10:Outstate + Elite10:perc.alumni +   
## Elite10:Expend, data = train.myd)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -54.393 -7.694 0.072 7.796 52.246   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 5.404e+01 4.296e+00 12.579 < 2e-16 \*\*\*  
## Elite10 3.884e+01 1.071e+01 3.628 0.000311 \*\*\*  
## Accept.pct -1.712e+01 4.936e+00 -3.468 0.000563 \*\*\*  
## Outstate 2.157e-03 2.430e-04 8.879 < 2e-16 \*\*\*  
## perc.alumni 4.783e-01 5.886e-02 8.126 2.74e-15 \*\*\*  
## Expend -1.073e-03 2.853e-04 -3.760 0.000187 \*\*\*  
## Elite10:Accept.pct -2.217e+01 1.053e+01 -2.106 0.035641 \*   
## Elite10:Outstate -2.158e-03 6.170e-04 -3.498 0.000505 \*\*\*  
## Elite10:perc.alumni -2.405e-01 1.530e-01 -1.572 0.116420   
## Elite10:Expend 1.278e-03 3.874e-04 3.299 0.001030 \*\*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 13.08 on 572 degrees of freedom  
## Multiple R-squared: 0.4461, Adjusted R-squared: 0.4374   
## F-statistic: 51.19 on 9 and 572 DF, p-value: < 2.2e-16

#5-fold cross validation  
cv.lm(data=college\_data, form.lm=model1, m= 5, plotit= T)

## Warning in cv.lm(data = college\_data, form.lm = model1, m = 5, plotit = T):   
##   
## As there is >1 explanatory variable, cross-validation  
## predicted values for a fold are not a linear function  
## of corresponding overall predicted values. Lines that  
## are shown for the different folds are approximate



##   
## fold 1   
## Observations in test set: 155   
## 4 6 13 22 23 29  
## Predicted 72.44995 66.34431 65.150306 58.42528 68.718211 72.11213  
## cvpred 73.70815 66.79988 64.745485 57.71203 68.462072 71.82693  
## Grad.Rate 59.00000 55.00000 74.000000 70.00000 65.000000 58.00000  
## CV residual -14.70815 -11.79988 9.254515 12.28797 -3.462072 -13.82693  
## 34 38 39 42 55 60  
## Predicted 62.275851 82.557498 62.248758 64.65842 74.489477 75.225409  
## cvpred 61.831772 82.440629 62.456459 64.20865 75.329273 76.377575  
## Grad.Rate 65.000000 91.000000 72.000000 84.00000 72.000000 72.000000  
## CV residual 3.168228 8.559371 9.543541 19.79135 -3.329273 -4.377575  
## 61 62 64 72 76 79  
## Predicted 97.6995499 56.54135 64.39957 87.063824 70.61613 59.1790694  
## cvpred 96.9416256 56.21915 64.42137 86.881198 70.14865 58.5608877  
## Grad.Rate 96.0000000 67.00000 85.00000 89.000000 71.00000 59.0000000  
## CV residual -0.9416256 10.78085 20.57863 2.118802 0.85135 0.4391123  
## 84 90 91 94 99 102  
## Predicted 67.679798 57.898148 70.573859 63.533267 64.36575 67.2117843  
## cvpred 67.418222 57.678583 70.656367 63.270743 64.54497 67.1070616  
## Grad.Rate 64.000000 67.000000 62.000000 55.000000 24.00000 67.0000000  
## CV residual -3.418222 9.321417 -8.656367 -8.270743 -40.54497 -0.1070616  
## 103 106 120 125 133 134 142  
## Predicted 54.329761 62.57364 56.194246 68.53451 64.96032 69.851247 58.379490  
## cvpred 53.607152 61.93554 55.722608 68.17298 64.97919 69.163416 58.096405  
## Grad.Rate 49.000000 58.00000 46.000000 96.00000 78.00000 64.000000 59.000000  
## CV residual -4.607152 -3.93554 -9.722608 27.82702 13.02081 -5.163416 0.903595  
## 144 147 148 156 162 170  
## Predicted 68.071207 51.460854 63.518658 70.92818 49.445945 60.50343  
## cvpred 67.811301 51.405987 63.480213 70.05095 48.993223 60.53243  
## Grad.Rate 76.000000 42.000000 55.000000 46.00000 58.000000 87.00000  
## CV residual 8.188699 -9.405987 -8.480213 -24.05095 9.006777 26.46757  
## 176 181 184 185 189 195  
## Predicted 78.6019937 55.862415 61.085127 71.39044 68.260196 67.75772  
## cvpred 78.8882677 55.156642 60.741809 72.17391 67.570187 67.64331  
## Grad.Rate 78.0000000 50.000000 70.000000 59.00000 63.000000 53.00000  
## CV residual -0.8882677 -5.156642 9.258191 -13.17391 -4.570187 -14.64331  
## 206 210 220 228 235 244  
## Predicted 70.000044 66.840766 74.662315 72.843350 70.148680 72.881435  
## cvpred 70.361326 66.765521 75.551771 72.839542 69.891612 72.970541  
## Grad.Rate 80.000000 60.000000 72.000000 69.000000 76.000000 65.000000  
## CV residual 9.638674 -6.765521 -3.551771 -3.839542 6.108388 -7.970541  
## 245 262 263 273 277 284 286  
## Predicted 78.421078 64.123811 54.53168 62.89984 63.922379 69.22909 57.53911  
## cvpred 78.284609 63.964504 54.52257 62.45779 63.824803 69.12560 57.19087  
## Grad.Rate 69.000000 67.000000 44.00000 95.00000 66.000000 89.00000 36.00000  
## CV residual -9.284609 3.035496 -10.52257 32.54221 2.175197 19.87440 -21.19087  
## 298 301 309 312 313 328 334  
## Predicted 58.167863 53.62279 76.04530 65.718543 61.696916 66.00932 54.189722  
## cvpred 58.096011 53.43885 75.92771 65.810682 61.415463 66.52243 54.084924  
## Grad.Rate 52.000000 75.00000 85.00000 58.000000 56.000000 84.00000 51.000000  
## CV residual -6.096011 21.56115 9.07229 -7.810682 -5.415463 17.47757 -3.084924  
## 348 349 351 359 362 365 369  
## Predicted 65.86257 69.698790 64.634085 67.28963 59.91268 67.87394 55.419329  
## cvpred 64.56391 69.542422 64.726341 66.56123 59.34694 67.52382 55.119558  
## Grad.Rate 84.00000 77.000000 55.000000 48.00000 82.00000 89.00000 49.000000  
## CV residual 19.43609 7.457578 -9.726341 -18.56123 22.65306 21.47618 -6.119558  
## 375 378 386 390 394 402  
## Predicted 56.55313 48.37374 51.949957 56.207133 68.316731 54.769208  
## cvpred 55.73301 47.70143 51.260574 55.377052 67.974346 54.028051  
## Grad.Rate 61.00000 100.00000 60.000000 60.000000 64.000000 52.000000  
## CV residual 5.26699 52.29857 8.739426 4.622948 -3.974346 -2.028051  
## 405 406 408 410 412 427 432  
## Predicted 65.297862 58.32237 80.570107 67.91303 55.42481 67.50875 79.109917  
## cvpred 65.279986 58.35147 80.932082 69.22268 54.94078 67.01792 79.348174  
## Grad.Rate 61.000000 72.00000 71.000000 65.00000 44.00000 33.00000 83.000000  
## CV residual -4.279986 13.64853 -9.932082 -4.22268 -10.94078 -34.01792 3.651826  
## 435 443 444 449 451 456  
## Predicted 52.944089 65.222260 69.12979 58.47631 62.71397 58.726283  
## cvpred 52.429429 65.334713 69.70797 58.30015 62.77174 58.791069  
## Grad.Rate 50.000000 69.000000 42.00000 48.00000 39.00000 66.000000  
## CV residual -2.429429 3.665287 -27.70797 -10.30015 -23.77174 7.208931  
## 472 480 485 486 493 496  
## Predicted 69.6926611 64.234357 56.8133920 57.393077 72.181063 67.05500  
## cvpred 70.4798022 64.549993 56.4389842 57.037772 72.122011 67.23828  
## Grad.Rate 70.0000000 61.000000 57.0000000 58.000000 70.000000 83.00000  
## CV residual -0.4798022 -3.549993 0.5610158 0.962228 -2.122011 15.76172  
## 497 499 505 517 521 528 529  
## Predicted 71.576332 70.05449 67.89065 66.329027 60.75477 82.486261 86.695051  
## cvpred 71.456715 70.24715 67.72474 66.692744 60.10370 83.191813 86.617378  
## Grad.Rate 76.000000 98.00000 88.00000 66.000000 72.00000 81.000000 90.000000  
## CV residual 4.543285 27.75285 20.27526 -0.692744 11.89630 -2.191813 3.382622  
## 531 532 536 549 559 560 561  
## Predicted 48.616436 47.661819 54.26255 60.58222 51.28679 74.89076 54.82677  
## cvpred 48.164886 47.033148 54.02663 60.98743 50.05586 74.38444 54.45705  
## Grad.Rate 45.000000 53.000000 71.00000 40.00000 64.00000 97.00000 74.00000  
## CV residual -3.164886 5.966852 16.97337 -20.98743 13.94414 22.61556 19.54295  
## 570 573 578 581 583 584  
## Predicted 78.498350 57.649659 58.729678 57.09220 49.999354 60.562673  
## cvpred 79.509892 57.079255 58.322822 56.62935 49.598046 60.306978  
## Grad.Rate 76.000000 59.000000 53.000000 36.00000 43.000000 64.000000  
## CV residual -3.509892 1.920745 -5.322822 -20.62935 -6.598046 3.693022  
## 587 588 594 598 605 608  
## Predicted 50.938734 55.39146 87.048031 77.037406 47.114071 58.64779  
## cvpred 50.811328 55.12757 87.658642 78.274705 46.958275 57.77810  
## Grad.Rate 43.000000 84.00000 91.000000 74.000000 39.000000 46.00000  
## CV residual -7.811328 28.87243 3.341358 -4.274705 -7.958275 -11.77810  
## 620 625 634 635 638 641 645  
## Predicted 71.557081 48.25048 57.830952 55.22799 76.32935 62.51343 58.209962  
## cvpred 73.285126 48.61587 57.737472 55.41032 76.88912 62.47619 57.670386  
## Grad.Rate 66.000000 34.00000 63.000000 68.00000 87.00000 45.00000 48.000000  
## CV residual -7.285126 -14.61587 5.262528 12.58968 10.11088 -17.47619 -9.670386  
## 647 651 654 655 657 662  
## Predicted 50.520317 55.57918 59.897410 60.398306 56.905818 46.41161  
## cvpred 49.803599 54.86348 59.653245 59.726824 56.297163 46.40956  
## Grad.Rate 51.000000 37.00000 53.000000 55.000000 47.000000 44.00000  
## CV residual 1.196401 -17.86348 -6.653245 -4.726824 -9.297163 -2.40956  
## 664 667 673 674 685 686  
## Predicted 90.043351 73.17068 44.0702849 75.42764 48.39094 51.46595  
## cvpred 90.146171 73.70000 43.6870321 74.88645 47.81046 50.92205  
## Grad.Rate 93.000000 63.00000 43.0000000 92.00000 29.00000 65.00000  
## CV residual 2.853829 -10.70000 -0.6870321 17.11355 -18.81046 14.07795  
## 697 705 715 722 724 725  
## Predicted 57.032058 78.7328226 53.23568 66.78335 72.136538 82.022925  
## cvpred 56.482588 78.8482457 53.12755 66.09440 71.858336 82.197551  
## Grad.Rate 65.000000 79.0000000 30.00000 68.00000 67.000000 86.000000  
## CV residual 8.517412 0.1517543 -23.12755 1.90560 -4.858336 3.802449  
## 737 740 747 756 760 761 763  
## Predicted 62.66590 49.01905 58.695852 88.58218 65.701673 77.676874 61.777830  
## cvpred 62.46167 48.48644 58.290454 88.41681 65.730659 77.811013 61.880802  
## Grad.Rate 84.00000 60.00000 61.000000 72.00000 67.000000 68.000000 52.000000  
## CV residual 21.53833 11.51356 2.709546 -16.41681 1.269341 -9.811013 -9.880802  
## 769 777  
## Predicted 61.83348 60.70546  
## cvpred 61.67962 59.44384  
## Grad.Rate 50.00000 99.00000  
## CV residual -11.67962 39.55616  
##   
## Sum of squares = 29255.46 Mean square = 188.74 n = 155   
##   
## fold 2   
## Observations in test set: 156   
## 3 7 17 18 26 27 35  
## Predicted 69.50927 69.71023 103.246484 62.293767 43.193006 72.36454 65.42894  
## cvpred 69.56527 69.74598 104.260841 62.416737 43.518401 72.17002 65.49334  
## Grad.Rate 54.00000 63.00000 100.000000 59.000000 48.000000 88.00000 85.00000  
## CV residual -15.56527 -6.74598 -4.260841 -3.416737 4.481599 15.82998 19.50666  
## 43 51 54 56 57 58  
## Predicted 58.258719 61.91702 51.114353 68.46624 64.32576 50.237313  
## cvpred 58.438977 62.09159 51.436542 68.63535 64.32748 50.491997  
## Grad.Rate 52.000000 48.00000 58.000000 51.00000 75.00000 53.000000  
## CV residual -6.438977 -14.09159 6.563458 -17.63535 10.67252 2.508003  
## 68 74 83 86 88 95  
## Predicted 64.264420 69.027944 55.976325 59.584117 81.938885 66.109100  
## cvpred 64.417533 68.759374 56.028883 59.831546 82.738326 66.606576  
## Grad.Rate 58.000000 78.000000 49.000000 52.000000 74.000000 75.000000  
## CV residual -6.417533 9.240626 -7.028883 -7.831546 -8.738326 8.393424  
## 97 104 107 108 112 115  
## Predicted 77.423655 46.617623 75.346012 69.12095 66.199381 92.890989  
## cvpred 77.505009 46.914278 77.481017 69.46291 66.272168 93.542809  
## Grad.Rate 74.000000 50.000000 74.000000 47.00000 63.000000 87.000000  
## CV residual -3.505009 3.085722 -3.481017 -22.46291 -3.272168 -6.542809  
## 118 127 131 136 140 146  
## Predicted 76.260694 69.55983 67.967507 59.55241 78.418791 62.56872  
## cvpred 76.408147 69.45486 68.056268 59.67476 78.802215 62.59254  
## Grad.Rate 77.000000 100.00000 72.000000 76.00000 69.000000 45.00000  
## CV residual 0.591853 30.54514 3.943732 16.32524 -9.802215 -17.59254  
## 152 158 160 166 169 171  
## Predicted 76.05300 63.458343 91.872727 54.540518 54.8871638 53.16548  
## cvpred 76.07168 63.586493 92.243587 54.615435 54.9342423 53.84549  
## Grad.Rate 64.00000 72.000000 94.000000 46.000000 54.0000000 42.00000  
## CV residual -12.07168 8.413507 1.756413 -8.615435 -0.9342423 -11.84549  
## 191 192 194 196 203 204 205  
## Predicted 70.21898 85.59204 73.693307 55.27326 57.60857 55.522706 63.655762  
## cvpred 70.28739 85.57922 73.583251 55.65015 57.68898 55.782166 63.446127  
## Grad.Rate 82.00000 96.00000 67.000000 68.00000 68.00000 58.000000 62.000000  
## CV residual 11.71261 10.42078 -6.583251 12.34985 10.31102 2.217834 -1.446127  
## 207 217 219 225 227 229  
## Predicted 52.870423 65.418499 62.35123 64.36196 51.58601 70.859206  
## cvpred 52.875653 65.383733 62.31341 64.41989 51.79443 70.930506  
## Grad.Rate 46.000000 74.000000 46.00000 76.00000 36.00000 66.000000  
## CV residual -6.875653 8.616267 -16.31341 11.58011 -15.79443 -4.930506  
## 231 234 238 239 242 248 255  
## Predicted 74.290206 54.080737 82.884547 79.73261 69.52016 50.61396 65.13822  
## cvpred 75.008531 54.136274 84.724444 75.50513 69.41674 50.97245 65.71918  
## Grad.Rate 77.000000 57.000000 83.000000 100.00000 96.00000 38.00000 79.00000  
## CV residual 1.991469 2.863726 -1.724444 24.49487 26.58326 -12.97245 13.28082  
## 256 258 259 260 274 276  
## Predicted 73.767791 61.693701 75.039682 72.997893 52.33930 64.56636  
## cvpred 74.055034 62.022651 75.534657 73.334675 52.63211 64.48875  
## Grad.Rate 79.000000 60.000000 72.000000 72.000000 40.00000 34.00000  
## CV residual 4.944966 -2.022651 -3.534657 -1.334675 -12.63211 -30.48875  
## 282 287 288 290 293 296 308  
## Predicted 50.43736 66.75093 75.73780 56.29542 89.486984 60.442521 68.19390  
## cvpred 50.94712 66.80296 75.96802 56.44707 89.549058 60.768174 68.21682  
## Grad.Rate 26.00000 56.00000 80.00000 68.00000 88.000000 65.000000 94.00000  
## CV residual -24.94712 -10.80296 4.03198 11.55293 -1.549058 4.231826 25.78318  
## 315 318 319 324 329 332  
## Predicted 59.749191 65.04484 75.899457 53.698501 60.899003 76.771436  
## cvpred 59.894678 64.61534 75.782648 54.031046 61.204544 76.545541  
## Grad.Rate 61.000000 100.00000 81.000000 59.000000 53.000000 72.000000  
## CV residual 1.105322 35.38466 5.217352 4.968954 -8.204544 -4.545541  
## 336 339 340 342 350 366  
## Predicted 65.214451 69.926768 72.717526 64.650743 61.769966 60.21969  
## cvpred 65.606087 70.079544 72.900589 64.471285 62.199383 60.41713  
## Grad.Rate 59.000000 79.000000 70.000000 59.000000 68.000000 85.00000  
## CV residual -6.606087 8.920456 -2.900589 -5.471285 5.800617 24.58287  
## 383 385 388 392 400 413  
## Predicted 50.37443 49.62600 58.23428 62.33081 51.610748 60.497417  
## cvpred 50.66109 50.47842 58.48393 62.27178 51.904198 60.879357  
## Grad.Rate 37.00000 15.00000 83.00000 44.00000 58.000000 62.000000  
## CV residual -13.66109 -35.47842 24.51607 -18.27178 6.095802 1.120643  
## 414 419 423 424 429 430  
## Predicted 53.430902 69.88432 64.12015 67.4237685 90.180828 81.670591  
## cvpred 54.013258 69.94907 64.04163 67.3198334 90.482455 81.892138  
## Grad.Rate 52.000000 46.00000 58.00000 68.0000000 83.000000 79.000000  
## CV residual -2.013258 -23.94907 -6.04163 0.6801666 -7.482455 -2.892138  
## 431 436 440 446 448 462  
## Predicted 69.811629 49.413286 65.93271 67.553319 51.996370 59.09796  
## cvpred 70.214801 49.748181 65.91789 67.648193 52.171454 59.37964  
## Grad.Rate 67.000000 45.000000 37.00000 63.000000 44.000000 67.00000  
## CV residual -3.214801 -4.748181 -28.91789 -4.648193 -8.171454 7.62036  
## 463 464 471 478 490 503 509  
## Predicted 70.66042 70.530003 70.38305 61.20325 49.384755 73.750361 58.110754  
## cvpred 70.76918 70.382948 70.74342 61.34056 49.541755 74.058516 58.102021  
## Grad.Rate 58.00000 80.000000 84.00000 79.00000 58.000000 83.000000 56.000000  
## CV residual -12.76918 9.617052 13.25658 17.65944 8.458245 8.941484 -2.102021  
## 514 515 516 518 520 530 533  
## Predicted 65.41068 62.89387 78.041603 67.45441 69.455222 53.21768 57.62414  
## cvpred 65.39128 63.09938 79.950957 67.64843 69.677059 53.39433 57.89163  
## Grad.Rate 55.00000 52.00000 73.000000 89.00000 71.000000 67.00000 43.00000  
## CV residual -10.39128 -11.09938 -6.950957 21.35157 1.322941 13.60567 -14.89163  
## 534 540 545 548 550 552  
## Predicted 48.252799 55.390312 65.61955 85.1378425 71.300568 55.77996  
## cvpred 48.718869 55.696152 65.90834 85.3845643 71.331593 56.02933  
## Grad.Rate 43.000000 52.000000 78.00000 85.0000000 78.000000 72.00000  
## CV residual -5.718869 -3.696152 12.09166 -0.3845643 6.668407 15.97067  
## 555 569 577 585 592 599  
## Predicted 60.604269 56.847660 68.408415 59.99257 76.891299 66.92426  
## cvpred 60.629599 56.967808 68.963805 60.13234 72.154988 66.67641  
## Grad.Rate 67.000000 66.000000 67.000000 50.00000 81.000000 52.00000  
## CV residual 6.370401 9.032192 -1.963805 -10.13234 8.845012 -14.67641  
## 604 609 611 615 617 628  
## Predicted 42.72003 59.237297 50.166927 60.67206 61.26071 73.42741  
## cvpred 44.28114 59.400988 51.203362 61.11438 61.70206 73.47539  
## Grad.Rate 33.00000 57.000000 54.000000 75.00000 51.00000 47.00000  
## CV residual -11.28114 -2.400988 2.796638 13.88562 -10.70206 -26.47539  
## 630 633 636 643 646 677  
## Predicted 62.366249 58.502528 57.156144 58.82633 52.3996882 51.268372  
## cvpred 62.321986 58.668566 57.410743 59.27520 52.5170283 51.997485  
## Grad.Rate 59.000000 55.000000 56.000000 58.00000 52.0000000 47.000000  
## CV residual -3.321986 -3.668566 -1.410743 -1.27520 -0.5170283 -4.997485  
## 679 691 696 699 706 707 716  
## Predicted 50.89140 58.63373 51.218706 56.58729 61.478232 52.83752 66.35422  
## cvpred 51.02707 59.21562 51.715188 56.64742 61.546358 52.99296 66.33976  
## Grad.Rate 36.00000 47.00000 53.000000 67.00000 68.000000 40.00000 68.00000  
## CV residual -15.02707 -12.21562 1.284812 10.35258 6.453642 -12.99296 1.66024  
## 726 727 730 743 745 754  
## Predicted 93.348590 79.04332 49.996216 78.18340 57.509585 76.269388  
## cvpred 92.287031 79.05267 50.214741 78.14735 57.818942 77.564821  
## Grad.Rate 90.000000 65.00000 52.000000 60.00000 59.000000 71.000000  
## CV residual -2.287031 -14.05267 1.785259 -18.14735 1.181058 -6.564821  
## 755 759 762 774 775  
## Predicted 66.88778 68.425550 62.868682 67.72027 54.206293  
## cvpred 66.88255 68.549035 62.985271 67.87530 54.631324  
## Grad.Rate 72.00000 63.000000 59.000000 83.00000 49.000000  
## CV residual 5.11745 -5.549035 -3.985271 15.12470 -5.631324  
##   
## Sum of squares = 22614.14 Mean square = 144.96 n = 156   
##   
## fold 3   
## Observations in test set: 156   
## 8 11 12 16 24 30  
## Predicted 73.2611680 79.101781 84.700143 61.091417 55.370584 75.646553  
## cvpred 73.4860098 78.837266 84.741524 60.589636 54.219217 75.705965  
## Grad.Rate 73.0000000 73.000000 76.000000 69.000000 48.000000 71.000000  
## CV residual -0.4860098 -5.837266 -8.741524 8.410364 -6.219217 -4.705965  
## 32 44 48 49 66 69 70  
## Predicted 67.008278 58.342821 89.37980 71.21362 62.39144 64.69080 53.86350  
## cvpred 67.263362 57.954653 89.37412 70.75888 61.42539 64.39804 54.52151  
## Grad.Rate 71.000000 49.000000 55.00000 82.00000 49.00000 82.00000 33.00000  
## CV residual 3.736638 -8.954653 -34.37412 11.24112 -12.42539 17.60196 -21.52151  
## 71 73 81 89 96 98  
## Predicted 96.6136216 86.487447 70.72268 69.649794 60.82333 62.696030  
## cvpred 97.3256854 86.451087 70.85232 69.141388 60.39981 62.717182  
## Grad.Rate 97.0000000 93.000000 81.00000 79.000000 118.00000 64.000000  
## CV residual -0.3256854 6.548913 10.14768 9.858612 57.60019 1.282818  
## 101 109 113 117 121 122  
## Predicted 57.91984 67.66516 59.21588 68.464486 75.477204 69.83225  
## cvpred 57.43524 68.50383 58.39467 68.109171 75.301919 70.00082  
## Grad.Rate 47.00000 52.00000 48.00000 74.000000 67.000000 75.00000  
## CV residual -10.43524 -16.50383 -10.39467 5.890829 -8.301919 4.99918  
## 124 138 141 154 155 157 163  
## Predicted 91.161811 87.426504 89.32243 65.10801 49.01397 60.077979 83.359117  
## cvpred 91.516369 87.369034 89.31942 64.70393 48.36575 59.976188 83.673133  
## Grad.Rate 93.000000 95.000000 84.00000 51.00000 63.00000 54.000000 81.000000  
## CV residual 1.483631 7.630966 -5.31942 -13.70393 14.63425 -5.976188 -2.673133  
## 165 168 178 180 188 197 209  
## Predicted 83.755732 69.741443 47.811177 66.57057 66.18401 76.79534 59.66545  
## cvpred 83.942374 69.855918 47.561369 66.08461 65.74439 76.59607 58.65873  
## Grad.Rate 87.000000 60.000000 42.000000 54.00000 86.00000 94.00000 83.00000  
## CV residual 3.057626 -9.855918 -5.561369 -12.08461 20.25561 17.40393 24.34127  
## 215 226 237 249 257 261  
## Predicted 65.5435130 85.764668 63.075578 63.174663 85.629221 73.355431  
## cvpred 64.8872043 85.680985 62.465882 63.270666 85.596995 73.496618  
## Grad.Rate 65.0000000 83.000000 60.000000 73.000000 79.000000 72.000000  
## CV residual 0.1127957 -2.680985 -2.465882 9.729334 -6.596995 -1.496618  
## 264 275 283 289 291 295 300  
## Predicted 61.22916 63.586911 56.60129 60.568397 57.975997 72.90096 85.736794  
## cvpred 61.16247 63.333462 56.32154 60.095086 57.219515 72.78470 85.965263  
## Grad.Rate 47.00000 68.000000 75.00000 54.000000 61.000000 87.00000 92.000000  
## CV residual -14.16247 4.666538 18.67846 -6.095086 3.780485 14.21530 6.034737  
## 302 306 307 321 323 327  
## Predicted 73.72215 49.375166 87.65940 59.446232 68.187688 71.751752  
## cvpred 73.58786 48.808868 88.47465 58.704713 67.680029 71.426256  
## Grad.Rate 77.00000 51.000000 77.00000 63.000000 70.000000 80.000000  
## CV residual 3.41214 2.191132 -11.47465 4.295287 2.319971 8.573744  
## 335 338 345 347 355 356  
## Predicted 85.136075 64.4377284 65.50112 72.66201 94.2068512 45.479766  
## cvpred 85.484405 63.9211164 65.34429 73.38256 94.9614035 45.116831  
## Grad.Rate 77.000000 64.0000000 77.00000 90.00000 94.0000000 51.000000  
## CV residual -8.484405 0.0788836 11.65571 16.61744 -0.9614035 5.883169  
## 358 361 363 364 368 373 376  
## Predicted 56.04073 68.411845 69.45521 51.230625 60.18305 67.77732 65.19213  
## cvpred 55.28498 68.081242 68.92882 50.432906 59.96704 68.19808 64.49116  
## Grad.Rate 32.00000 78.000000 80.00000 59.000000 65.00000 58.00000 53.00000  
## CV residual -23.28498 9.918758 11.07118 8.567094 5.03296 -10.19808 -11.49116  
## 389 391 395 398 399 401  
## Predicted 66.98220 86.757507 71.46872 65.927185 74.083927 84.354185  
## cvpred 66.89085 87.765897 71.53788 65.569516 73.802139 84.246882  
## Grad.Rate 56.00000 84.000000 21.00000 72.000000 81.000000 83.000000  
## CV residual -10.89085 -3.765897 -50.53788 6.430484 7.197861 -1.246882  
## 404 411 434 447 453 459  
## Predicted 56.92119 55.819860 79.552035 79.50068 51.50644 75.465703  
## cvpred 55.90757 55.338455 79.416416 80.89649 50.93773 75.536443  
## Grad.Rate 71.00000 57.000000 75.000000 66.00000 61.00000 85.000000  
## CV residual 15.09243 1.661545 -4.416416 -14.89649 10.06227 9.463557  
## 460 461 467 468 469 470  
## Predicted 104.782612 80.84564 52.225117 76.328762 64.608279 85.71788  
## cvpred 104.982708 80.43331 51.567443 76.461128 65.035606 85.95014  
## Grad.Rate 99.000000 96.00000 47.000000 74.000000 68.000000 68.00000  
## CV residual -5.982708 15.56669 -4.567443 -2.461128 2.964394 -17.95014  
## 473 474 475 476 482 483  
## Predicted 76.3016763 70.6043581 80.37998 63.93835 68.74999 52.6594689  
## cvpred 76.1136347 70.3270726 80.96103 63.28503 68.63098 51.8998714  
## Grad.Rate 77.0000000 70.0000000 64.00000 81.00000 81.00000 51.0000000  
## CV residual 0.8863653 -0.3270726 -16.96103 17.71497 12.36902 -0.8998714  
## 488 492 504 519 522 524  
## Predicted 63.506745 67.586077 61.796869 64.526551466 56.493031 57.62621  
## cvpred 62.808844 67.076127 61.421868 64.000832948 56.099348 57.34537  
## Grad.Rate 70.000000 69.000000 53.000000 64.000000000 58.000000 47.00000  
## CV residual 7.191156 1.923873 -8.421868 -0.000832948 1.900652 -10.34537  
## 544 546 566 567 568 572  
## Predicted 50.850937 71.387082 61.875147 55.20413 62.077225 58.112808  
## cvpred 50.600419 71.606384 61.242746 54.62425 61.303079 57.478342  
## Grad.Rate 49.000000 64.000000 63.000000 42.00000 53.000000 65.000000  
## CV residual -1.600419 -7.606384 1.757254 -12.62425 -8.303079 7.521658  
## 574 580 593 596 602 607  
## Predicted 54.152710 72.26842 62.771388 65.75556 91.210931 71.712444  
## cvpred 53.505552 72.02974 62.441139 65.59660 91.722325 72.457278  
## Grad.Rate 46.000000 98.00000 65.000000 78.00000 88.000000 66.000000  
## CV residual -7.505552 25.97026 2.558861 12.40340 -3.722325 -6.457278  
## 610 612 613 614 619 622  
## Predicted 89.2138056 64.61339 65.53959 66.93323 70.166092 66.75765146  
## cvpred 89.7186056 64.13664 65.30686 66.62957 69.695232 65.96085324  
## Grad.Rate 90.0000000 71.00000 63.00000 93.00000 77.000000 66.00000000  
## CV residual 0.2813944 6.86336 -2.30686 26.37043 7.304768 0.03914676  
## 623 631 637 639 642 648 659  
## Predicted 42.22278 51.34810 68.831666 59.863391 49.340116 61.80828 56.69372  
## cvpred 42.31659 50.41112 68.941475 58.981871 48.978238 62.42601 55.78507  
## Grad.Rate 54.00000 64.00000 59.000000 53.000000 53.000000 53.00000 40.00000  
## CV residual 11.68341 13.58888 -9.941475 -5.981871 4.021762 -9.42601 -15.78507  
## 660 661 665 676 682 683 687  
## Predicted 58.07823 88.467926 56.991102 58.664018 63.11730 60.478305 48.341019  
## cvpred 57.86805 88.618983 56.853951 58.284348 62.40863 59.903573 47.314587  
## Grad.Rate 77.00000 97.000000 66.000000 63.000000 89.00000 62.000000 50.000000  
## CV residual 19.13195 8.381017 9.146049 4.715652 26.59137 2.096427 2.685413  
## 690 692 694 700 701 702  
## Predicted 78.566573 49.82664 87.186006 51.437555 59.41771 57.46559  
## cvpred 79.927141 49.45725 87.738981 50.377625 59.35468 56.69852  
## Grad.Rate 82.000000 37.00000 95.000000 46.000000 72.00000 38.00000  
## CV residual 2.072859 -12.45725 7.261019 -4.377625 12.64532 -18.69852  
## 703 708 711 712 714 720 732  
## Predicted 51.778179 66.44336 77.22735 59.10941 63.871131 72.74454 55.02572  
## cvpred 51.464847 66.14661 76.69380 58.70168 63.468655 72.18132 53.87578  
## Grad.Rate 45.000000 95.00000 96.00000 45.00000 73.000000 75.00000 90.00000  
## CV residual -6.464847 28.85339 19.30620 -13.70168 9.531345 2.81868 36.12422  
## 734 738 746 748 752 758  
## Predicted 92.552103 90.193491 54.641514 58.334845 72.17349 68.75157  
## cvpred 92.638654 90.836524 53.478923 57.674586 71.36397 68.12862  
## Grad.Rate 91.000000 92.000000 52.000000 65.000000 87.00000 80.00000  
## CV residual -1.638654 1.163476 -1.478923 7.325414 15.63603 11.87138  
## 764 767 768 771  
## Predicted 100.965025 54.690536 58.7344692 80.561487  
## cvpred 100.788555 54.172198 58.5409264 80.404434  
## Grad.Rate 99.000000 58.000000 59.0000000 75.000000  
## CV residual -1.788555 3.827802 0.4590736 -5.404434  
##   
## Sum of squares = 25065.53 Mean square = 160.68 n = 156   
##   
## fold 4   
## Observations in test set: 155   
## 2 5 9 21 36 37  
## Predicted 63.55849 49.31507 73.650252 45.94962 67.600370 87.995749  
## cvpred 63.45067 48.46732 73.577941 37.22906 67.415567 87.502307  
## Grad.Rate 56.00000 15.00000 80.000000 48.00000 71.000000 79.000000  
## CV residual -7.45067 -33.46732 6.422059 10.77094 3.584433 -8.502307  
## 41 46 50 63 67 75  
## Predicted 73.5415049 54.323373 57.598047 66.86371 49.04000 71.30501  
## cvpred 73.8390859 55.070194 56.853248 65.53211 49.54413 71.56269  
## Grad.Rate 73.0000000 46.000000 63.000000 46.00000 18.00000 83.00000  
## CV residual -0.8390859 -9.070194 6.146752 -19.53211 -31.54413 11.43731  
## 77 80 82 85 87 92  
## Predicted 65.72976 55.707309 69.102313 71.45990 88.631888 72.228639  
## cvpred 65.76487 55.870804 70.162433 71.65238 87.515257 72.369087  
## Grad.Rate 55.00000 61.000000 63.000000 83.00000 91.000000 67.000000  
## CV residual -10.76487 5.129196 -7.162433 11.34762 3.484743 -5.369087  
## 105 110 119 126 128 132 135  
## Predicted 52.705860 68.404578 60.60921 58.972638 72.54509 73.252567 60.34302  
## cvpred 53.054294 68.751479 60.67947 59.593268 72.39034 73.975709 60.54122  
## Grad.Rate 51.000000 73.000000 73.00000 51.000000 83.00000 77.000000 80.00000  
## CV residual -2.054294 4.248521 12.32053 -8.593268 10.60966 3.024291 19.45878  
## 139 149 150 153 172 173 179  
## Predicted 85.05667 60.31528 88.386308 52.41920 69.391178 75.236593 47.95527  
## cvpred 85.87302 60.66750 87.624016 48.70951 69.731803 75.477112 48.35750  
## Grad.Rate 93.00000 75.00000 91.000000 85.00000 77.000000 83.000000 38.00000  
## CV residual 7.12698 14.33250 3.375984 36.29049 7.268197 7.522888 -10.35750  
## 182 183 186 187 193 199 200  
## Predicted 51.06364 62.01635 73.564278 76.89270 46.504271 57.74422 56.65872  
## cvpred 51.45361 61.69815 73.804148 77.84539 47.049282 57.97672 57.30607  
## Grad.Rate 76.00000 82.00000 81.000000 64.00000 50.000000 22.00000 69.00000  
## CV residual 24.54639 20.30185 7.195852 -13.84539 2.950718 -35.97672 11.69393  
## 202 211 212 213 216 218  
## Predicted 59.356016 70.14091 55.249294 67.12288 58.02176 69.13804  
## cvpred 59.473049 71.28848 55.408619 68.35542 58.75481 70.00684  
## Grad.Rate 66.000000 51.00000 62.000000 54.00000 29.00000 52.00000  
## CV residual 6.526951 -20.28848 6.591381 -14.35542 -29.75481 -18.00684  
## 221 222 230 232 233 240  
## Predicted 59.934992 93.4350423 67.449713 61.63609 65.78836 72.443499  
## cvpred 60.207868 94.2801514 67.068519 61.26901 66.58277 72.852563  
## Grad.Rate 55.000000 95.0000000 72.000000 64.00000 47.00000 65.000000  
## CV residual -5.207868 0.7198486 4.931481 2.73099 -19.58277 -7.852563  
## 241 243 247 251 265 266  
## Predicted 84.166153 93.863705 59.645622 104.780974 57.42526 54.08037  
## cvpred 84.383767 92.409422 59.372779 104.383592 56.74191 55.01824  
## Grad.Rate 80.000000 91.000000 64.000000 100.000000 21.00000 84.00000  
## CV residual -4.383767 -1.409422 4.627221 -4.383592 -35.74191 28.98176  
## 267 268 270 272 280 292 299  
## Predicted 65.534063 61.78126 59.651215 66.383632 69.55714 63.088776 67.07353  
## cvpred 65.844038 62.04659 60.322024 66.930565 70.15791 63.409625 67.25237  
## Grad.Rate 75.000000 52.00000 54.000000 69.000000 98.00000 62.000000 84.00000  
## CV residual 9.155962 -10.04659 -6.322024 2.069435 27.84209 -1.409625 16.74763  
## 303 304 314 316 320 325  
## Predicted 65.82706 51.45496 72.950199 63.30629 52.05045 51.54401  
## cvpred 67.18997 51.65902 72.493129 63.82024 51.13645 51.70660  
## Grad.Rate 57.00000 26.00000 69.000000 53.00000 92.00000 37.00000  
## CV residual -10.18997 -25.65902 -3.493129 -10.82024 40.86355 -14.70660  
## 326 330 331 333 343 344  
## Predicted 48.881540 59.860949 74.697540 68.7629652 76.67755 71.447801  
## cvpred 49.457435 58.937618 75.141934 69.1263348 76.65790 71.601796  
## Grad.Rate 45.000000 65.000000 77.000000 70.0000000 96.00000 69.000000  
## CV residual -4.457435 6.062382 1.858066 0.8736652 19.34210 -2.601796  
## 346 352 353 360 374 377  
## Predicted 49.270349 76.80468 62.322500 66.27711 67.2516592 47.77998  
## cvpred 49.505706 76.99914 63.038955 66.46802 67.9982974 48.05637  
## Grad.Rate 50.000000 51.00000 61.000000 91.00000 67.0000000 63.00000  
## CV residual 0.494294 -25.99914 -2.038955 24.53198 -0.9982974 14.94363  
## 379 380 387 407 409 415 417  
## Predicted 62.87084 74.79743 76.49809 48.94843 69.68772 71.260020 68.282716  
## cvpred 63.96193 74.57774 76.90853 48.30775 70.60864 71.477327 68.041392  
## Grad.Rate 27.00000 56.00000 74.00000 34.00000 83.00000 76.000000 74.000000  
## CV residual -36.96193 -18.57774 -2.90853 -14.30775 12.39136 4.522673 5.958608  
## 420 422 425 426 433 438 445  
## Predicted 52.51852 50.649622 86.95489 70.383313 55.39793 72.64046 50.918559  
## cvpred 52.94614 51.009496 87.67388 70.891488 55.13710 73.03087 51.211254  
## Grad.Rate 41.00000 54.000000 92.00000 63.000000 64.00000 87.00000 48.000000  
## CV residual -11.94614 2.990504 4.32612 -7.891488 8.86290 13.96913 -3.211254  
## 450 455 457 458 465 466 484  
## Predicted 65.171019 62.763169 70.906372 43.56203 75.10339 54.316238 58.53072  
## cvpred 65.650649 63.116521 71.869567 43.81029 75.23843 55.204053 57.65128  
## Grad.Rate 68.000000 54.000000 62.000000 35.00000 86.00000 62.000000 77.00000  
## CV residual 2.349351 -9.116521 -9.869567 -8.81029 10.76157 6.795947 19.34872  
## 491 495 501 506 507 510 512  
## Predicted 55.53786 62.33438 67.386703 62.297937 60.13846 56.327129 70.14101  
## cvpred 55.80364 63.64591 67.259351 62.424992 60.21290 55.983323 69.97431  
## Grad.Rate 48.00000 85.00000 75.000000 55.000000 98.00000 61.000000 100.00000  
## CV residual -7.80364 21.35409 7.740649 -7.424992 37.78710 5.016677 30.02569  
## 513 523 526 537 539 541  
## Predicted 79.882061 74.96023 71.506897 50.438308 54.56049 69.110256  
## cvpred 80.779285 75.17159 72.118494 51.062563 55.40992 68.163492  
## Grad.Rate 83.000000 100.00000 70.000000 56.000000 36.00000 67.000000  
## CV residual 2.220715 24.82841 -2.118494 4.937437 -19.40992 -1.163492  
## 551 553 557 558 562 565 575  
## Predicted 59.081200 71.30493 68.05134 76.84433 80.400457 59.36088 82.145085  
## cvpred 58.141702 71.73846 67.94758 76.97544 82.190554 59.41420 82.378145  
## Grad.Rate 63.000000 88.00000 73.00000 79.00000 80.000000 49.00000 90.000000  
## CV residual 4.858298 16.26154 5.05242 2.02456 -2.190554 -10.41420 7.621855  
## 576 582 590 591 600 606 618  
## Predicted 71.989424 55.98730 66.57765 67.327363 48.47003 81.482656 60.34400  
## cvpred 69.778078 55.49867 67.40299 67.032029 47.56572 83.244208 60.55912  
## Grad.Rate 61.000000 69.00000 39.00000 70.000000 65.00000 78.000000 45.00000  
## CV residual -8.778078 13.50133 -28.40299 2.967971 17.43428 -5.244208 -15.55912  
## 621 624 632 640 644 650  
## Predicted 55.781679 66.82613 53.50654 74.73038 57.993108 65.047088  
## cvpred 55.512967 68.20714 53.83820 76.13748 57.785347 65.491998  
## Grad.Rate 63.000000 81.00000 35.00000 51.00000 49.000000 75.000000  
## CV residual 7.487033 12.79286 -18.83820 -25.13748 -8.785347 9.508002  
## 653 658 670 672 675 678  
## Predicted 54.694168 49.88208 79.0745772 65.391391 52.697402 69.45622684  
## cvpred 55.117785 50.00077 79.5705626 65.444048 53.217784 68.02415436  
## Grad.Rate 62.000000 35.00000 80.0000000 62.000000 48.000000 68.00000000  
## CV residual 6.882215 -15.00077 0.4294374 -3.444048 -5.217784 -0.02415436  
## 681 688 689 693 718 731  
## Predicted 55.36730 62.983780 70.136082 68.32537 48.410233 63.829808  
## cvpred 55.52961 62.501524 69.583925 67.95729 48.556475 64.373643  
## Grad.Rate 45.00000 57.000000 65.000000 79.00000 58.000000 63.000000  
## CV residual -10.52961 -5.501524 -4.583925 11.04271 9.443525 -1.373643  
## 735 739 741 742 750 751  
## Predicted 77.342814 62.05314 79.20311 52.869667 73.83057 66.56614  
## cvpred 76.506912 62.25444 79.99833 53.109014 74.21366 66.91166  
## Grad.Rate 69.000000 52.00000 67.00000 55.000000 80.00000 50.00000  
## CV residual -7.506912 -10.25444 -12.99833 1.890986 5.78634 -16.91166  
## 757  
## Predicted 79.74494  
## cvpred 79.60350  
## Grad.Rate 52.00000  
## CV residual -27.60350  
##   
## Sum of squares = 32345.81 Mean square = 208.68 n = 155   
##   
## fold 5   
## Observations in test set: 155   
## 1 10 14 15 19 20  
## Predicted 56.462558 60.883665 71.423483 64.077014 62.55709 54.28208  
## cvpred 57.138416 60.833314 71.271055 64.905538 63.01517 56.14127  
## Grad.Rate 60.000000 52.000000 68.000000 55.000000 46.00000 34.00000  
## CV residual 2.861584 -8.833314 -3.271055 -9.905538 -17.01517 -22.14127  
## 25 28 31 33 40 45 47  
## Predicted 60.352410 53.93556 67.887654 60.11598 60.76074 76.733909 60.849957  
## cvpred 60.681257 54.04255 67.768858 60.39073 60.68116 76.613655 60.833211  
## Grad.Rate 54.000000 69.00000 69.000000 48.00000 72.00000 69.000000 58.000000  
## CV residual -6.681257 14.95745 1.231142 -12.39073 11.31884 -7.613655 -2.833211  
## 52 53 59 65 78 93 100  
## Predicted 62.21230 53.06491 62.617895 79.765536 73.62233 56.16026 59.920762  
## cvpred 61.94557 53.52922 62.941359 79.144659 75.15303 56.96620 59.590963  
## Grad.Rate 56.00000 35.00000 58.000000 84.000000 60.00000 79.00000 66.000000  
## CV residual -5.94557 -18.52922 -4.941359 4.855341 -15.15303 22.03380 6.409037  
## 111 114 116 123 129 130  
## Predicted 55.247972 58.54989 83.381985 88.686835 63.56959 71.085282  
## cvpred 54.699798 59.65507 83.353757 88.295447 63.79167 71.499294  
## Grad.Rate 58.000000 21.00000 79.000000 91.000000 43.00000 75.000000  
## CV residual 3.300202 -38.65507 -4.353757 2.704553 -20.79167 3.500706  
## 137 143 145 151 159 161  
## Predicted 69.873024 60.48023 92.205596 67.188895 99.503261 65.313609  
## cvpred 69.628236 62.46523 90.806085 66.476045 99.336028 65.684265  
## Grad.Rate 72.000000 37.00000 99.000000 75.000000 98.000000 56.000000  
## CV residual 2.371764 -25.46523 8.193915 8.523955 -1.336028 -9.684265  
## 164 167 174 175 177 190  
## Predicted 73.256816 55.075007 62.498004 97.23171278 57.1077798 47.736315  
## cvpred 72.835592 55.846508 61.982442 97.09636463 57.6162382 47.162287  
## Grad.Rate 82.000000 61.000000 67.000000 97.00000000 58.0000000 44.000000  
## CV residual 9.164408 5.153492 5.017558 -0.09636463 0.3837618 -3.162287  
## 198 201 208 214 223 224  
## Predicted 54.53707 66.695953 50.610887 67.43027 79.057780 55.37410  
## cvpred 55.26603 66.922956 50.972088 64.86366 79.722417 56.38933  
## Grad.Rate 24.00000 57.000000 43.000000 82.00000 70.000000 34.00000  
## CV residual -31.26603 -9.922956 -7.972088 17.13634 -9.722417 -22.38933  
## 236 246 250 252 253 254  
## Predicted 63.23158 58.33569 80.849760 91.766960 60.490500 66.446023  
## cvpred 63.39765 59.88124 80.467082 91.593688 60.657133 64.962235  
## Grad.Rate 39.00000 70.00000 73.000000 100.000000 52.000000 63.000000  
## CV residual -24.39765 10.11876 -7.467082 8.406312 -8.657133 -1.962235  
## 269 271 278 279 281 285  
## Predicted 71.66458 86.250161 56.796874 74.1234945 61.785366 94.0041892  
## cvpred 71.25390 86.884434 56.664017 74.2917594 62.611506 90.2735601  
## Grad.Rate 56.00000 83.000000 65.000000 75.0000000 54.000000 90.0000000  
## CV residual -15.25390 -3.884434 8.335983 0.7082406 -8.611506 -0.2735601  
## 294 297 305 310 311 317  
## Predicted 70.22364 75.933600 53.428203 86.966788 63.691345 46.63875  
## cvpred 70.30690 75.297856 54.691368 86.593996 64.044942 46.93886  
## Grad.Rate 51.00000 79.000000 60.000000 91.000000 66.000000 45.00000  
## CV residual -19.30690 3.702144 5.308632 4.406004 1.955058 -1.93886  
## 322 337 341 354 357 367 370  
## Predicted 63.772052 63.657358 48.15027 68.62403 63.39865 58.09740 62.942453  
## cvpred 64.880647 64.274672 48.52104 68.78846 64.79566 57.90165 64.300764  
## Grad.Rate 62.000000 55.000000 68.00000 66.00000 52.00000 71.00000 71.000000  
## CV residual -2.880647 -9.274672 19.47896 -2.78846 -12.79566 13.09835 6.699236  
## 371 372 381 382 384 393 396  
## Predicted 58.36706 68.23538 67.46828 57.69638 52.09333 62.10798 73.818028  
## cvpred 58.79454 68.23361 67.96229 57.62814 54.02276 62.06145 73.688318  
## Grad.Rate 64.00000 75.00000 54.00000 74.00000 58.00000 78.00000 80.000000  
## CV residual 5.20546 6.76639 -13.96229 16.37186 3.97724 15.93855 6.311682  
## 397 403 416 418 421 428 437  
## Predicted 62.77343 71.497550 57.19556 51.06206 58.877940 59.423617 51.04154  
## cvpred 63.96406 71.457353 57.78654 51.70771 59.983025 59.795429 51.31886  
## Grad.Rate 88.00000 73.000000 42.00000 76.00000 56.000000 53.000000 48.00000  
## CV residual 24.03594 1.542647 -15.78654 24.29229 -3.983025 -6.795429 -3.31886  
## 439 441 442 452 454 477  
## Predicted 52.64141 65.431785 69.60560 52.22403 75.052863 71.92251262  
## cvpred 53.02327 66.725576 69.43438 52.40364 75.248778 71.98111336  
## Grad.Rate 65.00000 62.000000 83.00000 31.00000 73.000000 72.00000000  
## CV residual 11.97673 -4.725576 13.56562 -21.40364 -2.248778 0.01888664  
## 479 481 487 489 494 498 500  
## Predicted 65.922030 78.07395 64.91431 75.39357 67.2257371 55.98312 65.86731  
## cvpred 66.799746 78.40570 65.31812 76.12504 67.8647694 54.26590 66.25480  
## Grad.Rate 68.000000 90.00000 82.00000 97.00000 67.0000000 67.00000 78.00000  
## CV residual 1.200254 11.59430 16.68188 20.87496 -0.8647694 12.73410 11.74520  
## 502 508 511 525 527 535  
## Predicted 74.305114 71.30548 55.96194 76.558739 54.838175 64.108992  
## cvpred 74.478762 71.00671 56.51066 75.902636 54.778331 63.633522  
## Grad.Rate 84.000000 60.00000 41.00000 79.000000 48.000000 72.000000  
## CV residual 9.521238 -11.00671 -15.51066 3.097364 -6.778331 8.366478  
## 538 542 543 547 554 556  
## Predicted 53.971708 69.13824 60.957297 68.240580 45.8542549 67.834611  
## cvpred 53.995953 69.82408 62.602642 68.591076 45.7133593 67.491289  
## Grad.Rate 51.000000 89.00000 65.000000 66.000000 45.0000000 59.000000  
## CV residual -2.995953 19.17592 2.397358 -2.591076 -0.7133593 -8.491289  
## 563 564 571 579 586 589  
## Predicted 53.053983 49.124547 58.175784 57.76871 63.78698 63.144401  
## cvpred 53.356005 49.347883 60.095815 60.12425 64.99737 63.183771  
## Grad.Rate 56.000000 57.000000 53.000000 46.00000 10.00000 60.000000  
## CV residual 2.643995 7.652117 -7.095815 -14.12425 -54.99737 -3.183771  
## 595 597 601 603 616 626  
## Predicted 69.45230 71.29533 55.628548 59.046961 73.968677 67.299037  
## cvpred 69.14396 69.32760 56.167314 60.412765 74.162987 67.596576  
## Grad.Rate 96.00000 93.00000 64.000000 56.000000 67.000000 69.000000  
## CV residual 26.85604 23.67240 7.832686 -4.412765 -7.162987 1.403424  
## 627 629 649 652 656 663  
## Predicted 56.1234763 57.13561 65.318471 84.045210 50.41702 62.565887  
## cvpred 56.6603641 57.56149 66.044451 84.647061 50.37634 62.978437  
## Grad.Rate 57.0000000 31.00000 64.000000 83.000000 49.00000 54.000000  
## CV residual 0.3396359 -26.56149 -2.044451 -1.647061 -1.37634 -8.978437  
## 666 668 669 671 680 684  
## Predicted 65.294984 58.391459 79.23621 68.073990 54.43217 54.975119  
## cvpred 65.288325 58.547302 80.10572 68.367596 54.95609 55.382139  
## Grad.Rate 72.000000 63.000000 100.00000 66.000000 38.00000 53.000000  
## CV residual 6.711675 4.452698 19.89428 -2.367596 -16.95609 -2.382139  
## 695 698 704 709 710 713 717  
## Predicted 51.36211 53.18658 66.20277 80.509199 85.850569 52.00706 65.17567  
## cvpred 51.12950 52.97589 67.66032 78.114047 84.883982 52.61572 65.38184  
## Grad.Rate 65.00000 36.00000 78.00000 83.000000 90.000000 31.00000 73.00000  
## CV residual 13.87050 -16.97589 10.33968 4.885953 5.116018 -21.61572 7.61816  
## 719 721 723 728 729 733  
## Predicted 76.075214 90.5784604 63.4037089 58.537355 80.64808 61.91927  
## cvpred 75.104745 88.6536289 63.7951059 57.895149 75.94072 62.80440  
## Grad.Rate 72.000000 89.0000000 63.0000000 56.000000 90.00000 48.00000  
## CV residual -3.104745 0.3463711 -0.7951059 -1.895149 14.05928 -14.80440  
## 736 744 749 753 765 766 770  
## Predicted 48.65231 55.330725 64.53995 79.464673 72.835247 54.52586 76.666786  
## cvpred 47.11872 56.029932 64.72609 79.303151 72.706828 54.89927 76.297076  
## Grad.Rate 64.00000 55.000000 62.00000 85.000000 67.000000 91.00000 78.000000  
## CV residual 16.88128 -1.029932 -2.72609 5.696849 -5.706828 36.10073 1.702924  
## 772 773 776  
## Predicted 78.57824 58.93842 101.96310  
## cvpred 78.27618 60.23342 101.01505  
## Grad.Rate 82.00000 40.00000 99.00000  
## CV residual 3.72382 -20.23342 -2.01505  
##   
## Sum of squares = 25761.17 Mean square = 166.2 n = 155   
##   
## Overall (Sum over all 155 folds)   
## ms   
## 173.7994

y\_pred <- predict.lm(model1, test.myd)  
y\_obs<-test.myd[,"Grad.Rate"]  
#Mean absolute percentage error(MAPE)  
mape\_m1<-mean(abs((y\_obs - y\_pred)/y\_obs))\*100  
mape\_m1

## [1] 17.34675

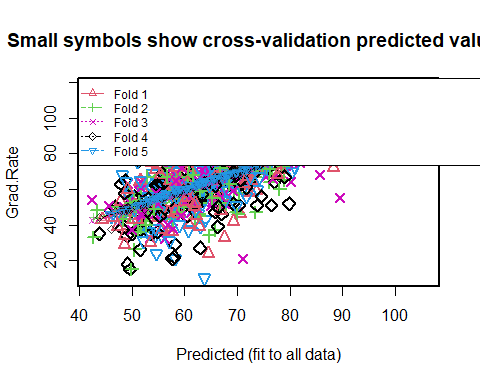
#Problem2(E)

#5-fold cross validation for model2  
model2 <- lm(Grad.Rate ~ Elite10 + Accept.pct + Outstate + perc.alumni + Expend + Elite10:Accept.pct + Elite10:Outstate + Elite10:Expend,data=train.myd)  
summary(model2)

##   
## Call:  
## lm(formula = Grad.Rate ~ Elite10 + Accept.pct + Outstate + perc.alumni +   
## Expend + Elite10:Accept.pct + Elite10:Outstate + Elite10:Expend,   
## data = train.myd)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -54.232 -7.646 -0.048 7.830 52.153   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 5.388e+01 4.301e+00 12.527 < 2e-16 \*\*\*  
## Elite10 3.621e+01 1.059e+01 3.419 0.000672 \*\*\*  
## Accept.pct -1.673e+01 4.936e+00 -3.389 0.000749 \*\*\*  
## Outstate 2.211e-03 2.408e-04 9.183 < 2e-16 \*\*\*  
## perc.alumni 4.427e-01 5.440e-02 8.138 2.51e-15 \*\*\*  
## Expend -1.062e-03 2.856e-04 -3.718 0.000221 \*\*\*  
## Elite10:Accept.pct -2.041e+01 1.048e+01 -1.948 0.051953 .   
## Elite10:Outstate -2.568e-03 5.601e-04 -4.584 5.60e-06 \*\*\*  
## Elite10:Expend 1.280e-03 3.879e-04 3.299 0.001030 \*\*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 13.1 on 573 degrees of freedom  
## Multiple R-squared: 0.4437, Adjusted R-squared: 0.4359   
## F-statistic: 57.13 on 8 and 573 DF, p-value: < 2.2e-16

cv.lm(data=college\_data, form.lm=model2, m= 5, plotit= T)

## Warning in cv.lm(data = college\_data, form.lm = model2, m = 5, plotit = T):   
##   
## As there is >1 explanatory variable, cross-validation  
## predicted values for a fold are not a linear function  
## of corresponding overall predicted values. Lines that  
## are shown for the different folds are approximate



##   
## fold 1   
## Observations in test set: 155   
## 4 6 13 22 23 29  
## Predicted 73.53733 66.62707 65.135741 58.44602 68.694808 71.99951  
## cvpred 74.63982 67.07923 64.728448 57.72867 68.440691 71.71661  
## Grad.Rate 59.00000 55.00000 74.000000 70.00000 65.000000 58.00000  
## CV residual -15.63982 -12.07923 9.271552 12.27133 -3.440691 -13.71661  
## 34 38 39 42 55 60  
## Predicted 62.247906 81.955566 62.468753 64.47695 75.248050 75.547459  
## cvpred 61.804567 81.736809 62.673047 64.03209 75.973049 76.692163  
## Grad.Rate 65.000000 91.000000 72.000000 84.00000 72.000000 72.000000  
## CV residual 3.195433 9.263191 9.326953 19.96791 -3.973049 -4.692163  
## 61 62 64 72 76 79  
## Predicted 98.672594 56.60385 64.44932 88.148477 70.386785 59.2186009  
## cvpred 97.818433 56.28017 64.47317 87.781287 69.924367 58.5925653  
## Grad.Rate 96.000000 67.00000 85.00000 89.000000 71.000000 59.0000000  
## CV residual -1.818433 10.71983 20.52683 1.218713 1.075633 0.4074347  
## 84 90 91 94 99 102  
## Predicted 67.622355 57.954513 70.660943 63.427745 64.44354 67.12318022  
## cvpred 67.361635 57.735412 70.745081 63.167325 64.62288 67.02193532  
## Grad.Rate 64.000000 67.000000 62.000000 55.000000 24.00000 67.00000000  
## CV residual -3.361635 9.264588 -8.745081 -8.167325 -40.62288 -0.02193532  
## 103 106 120 125 133 134  
## Predicted 54.492869 62.585666 56.330559 68.51226 64.96815 69.721070  
## cvpred 53.763023 61.948765 55.856962 68.14774 64.98741 69.033429  
## Grad.Rate 49.000000 58.000000 46.000000 96.00000 78.00000 64.000000  
## CV residual -4.763023 -3.948765 -9.856962 27.85226 13.01259 -5.033429  
## 142 144 147 148 156 162  
## Predicted 58.5203764 67.879560 51.613951 63.679894 70.53844 49.41878  
## cvpred 58.2318956 67.623964 51.558854 63.637524 69.66622 48.96948  
## Grad.Rate 59.0000000 76.000000 42.000000 55.000000 46.00000 58.00000  
## CV residual 0.7681044 8.376036 -9.558854 -8.637524 -23.66622 9.03052  
## 170 176 181 184 185 189  
## Predicted 60.59622 78.3294696 55.867788 61.129076 71.47536 68.018008  
## cvpred 60.62679 78.6198603 55.159014 60.785061 72.25771 67.331792  
## Grad.Rate 87.00000 78.0000000 50.000000 70.000000 59.00000 63.000000  
## CV residual 26.37321 -0.6198603 -5.159014 9.214939 -13.25771 -4.331792  
## 195 206 210 220 228 235  
## Predicted 67.63062 70.235398 66.599323 74.969851 72.751933 70.152160  
## cvpred 67.51896 70.591292 66.527728 75.852117 72.750809 69.896224  
## Grad.Rate 53.00000 80.000000 60.000000 72.000000 69.000000 76.000000  
## CV residual -14.51896 9.408708 -6.527728 -3.852117 -3.750809 6.103776  
## 244 245 262 263 273 277 284  
## Predicted 72.783350 77.981060 64.089874 54.70726 62.87675 64.062605 69.17583  
## cvpred 72.875466 77.852431 63.932034 54.69613 62.43532 63.961464 69.07563  
## Grad.Rate 65.000000 69.000000 67.000000 44.00000 95.00000 66.000000 89.00000  
## CV residual -7.875466 -8.852431 3.067966 -10.69613 32.56468 2.038536 19.92437  
## 286 298 301 309 312 313 328  
## Predicted 57.59021 58.280399 53.70550 76.000098 65.830944 61.652728 66.30198  
## cvpred 57.24103 58.208665 53.51798 75.883952 65.922115 61.373775 66.80888  
## Grad.Rate 36.00000 52.000000 75.00000 85.000000 58.000000 56.000000 84.00000  
## CV residual -21.24103 -6.208665 21.48202 9.116048 -7.922115 -5.373775 17.19112  
## 334 348 349 351 359 362 365  
## Predicted 54.25275 65.58039 69.588250 64.756449 66.82939 59.64595 67.73916  
## cvpred 54.14950 64.27987 69.431651 64.847685 66.10608 59.08646 67.39164  
## Grad.Rate 51.00000 84.00000 77.000000 55.000000 48.00000 82.00000 89.00000  
## CV residual -3.14950 19.72013 7.568349 -9.847685 -18.10608 22.91354 21.60836  
## 369 375 378 386 390 394  
## Predicted 55.38822 56.475904 48.42661 51.855011 55.855983 68.193558  
## cvpred 55.09304 55.653172 47.75341 51.168284 55.031353 67.855266  
## Grad.Rate 49.00000 61.000000 100.00000 60.000000 60.000000 64.000000  
## CV residual -6.09304 5.346828 52.24659 8.831716 4.968647 -3.855266  
## 402 405 406 408 410 412  
## Predicted 54.545005 65.290130 58.33136 78.256076 67.514157 55.53547  
## cvpred 53.808019 65.273736 58.35628 78.673928 68.779044 55.04571  
## Grad.Rate 52.000000 61.000000 72.00000 71.000000 65.000000 44.00000  
## CV residual -1.808019 -4.273736 13.64372 -7.673928 -3.779044 -11.04571  
## 427 432 435 443 444 449  
## Predicted 67.43468 79.113173 52.895185 65.430424 69.25898 58.58673  
## cvpred 66.94710 79.353089 52.382824 65.538111 69.83813 58.40816  
## Grad.Rate 33.00000 83.000000 50.000000 69.000000 42.00000 48.00000  
## CV residual -33.94710 3.646911 -2.382824 3.461889 -27.83813 -10.40816  
## 451 456 472 480 485 486  
## Predicted 62.78187 58.926010 68.269596 64.542332 56.8803310 57.3888823  
## cvpred 62.83947 58.988746 68.932852 64.854816 56.4980172 57.0254175  
## Grad.Rate 39.00000 66.000000 70.000000 61.000000 57.0000000 58.0000000  
## CV residual -23.83947 7.011254 1.067148 -3.854816 0.5019828 0.9745825  
## 493 496 497 499 505 517 521  
## Predicted 71.975182 67.27667 71.463948 69.98058 67.76333 66.4440255 60.8118  
## cvpred 71.921554 67.45715 71.347649 70.17567 67.60114 66.8077567 60.1546  
## Grad.Rate 70.000000 83.00000 76.000000 98.00000 88.00000 66.0000000 72.0000  
## CV residual -1.921554 15.54285 4.652351 27.82433 20.39886 -0.8077567 11.8454  
## 528 529 531 532 536 549 559  
## Predicted 82.586104 87.168193 48.710424 47.714871 54.35488 60.87083 51.29423  
## cvpred 83.288214 86.947112 48.256779 47.085532 54.12164 61.27306 50.05313  
## Grad.Rate 81.000000 90.000000 45.000000 53.000000 71.00000 40.00000 64.00000  
## CV residual -2.288214 3.052888 -3.256779 5.914468 16.87836 -21.27306 13.94687  
## 560 561 570 573 578 581 583  
## Predicted 74.78093 54.82213 78.914523 57.634160 58.774998 57.10749 49.975127  
## cvpred 74.27392 54.44904 80.009543 57.062093 58.365298 56.64378 49.575625  
## Grad.Rate 97.00000 74.00000 76.000000 59.000000 53.000000 36.00000 43.000000  
## CV residual 22.72608 19.55096 -4.009543 1.937907 -5.365298 -20.64378 -6.575625  
## 584 587 588 594 598 605 608  
## Predicted 60.498998 51.052937 55.40009 86.82800 77.302119 47.205388 58.72174  
## cvpred 60.243046 50.923836 55.13615 87.43913 78.534911 47.050509 57.84227  
## Grad.Rate 64.000000 43.000000 84.00000 91.00000 74.000000 39.000000 46.00000  
## CV residual 3.756954 -7.923836 28.86385 3.56087 -4.534911 -8.050509 -11.84227  
## 620 625 634 635 638 641 645  
## Predicted 71.665727 48.44947 57.957015 55.32177 75.53269 62.21834 58.23623  
## cvpred 73.460883 48.80751 57.859485 55.50331 76.02400 62.18010 57.69394  
## Grad.Rate 66.000000 34.00000 63.000000 68.00000 87.00000 45.00000 48.00000  
## CV residual -7.460883 -14.80751 5.140515 12.49669 10.97600 -17.18010 -9.69394  
## 647 651 654 655 657 662  
## Predicted 50.585511 55.62170 59.942330 60.421556 56.931037 46.482354  
## cvpred 49.863715 54.89938 59.697348 59.746077 56.319365 46.478413  
## Grad.Rate 51.000000 37.00000 53.000000 55.000000 47.000000 44.000000  
## CV residual 1.136285 -17.89938 -6.697348 -4.746077 -9.319365 -2.478413  
## 664 667 673 674 685 686 697  
## Predicted 90.087283 71.32926 44.2408440 75.12294 48.53746 51.50193 57.016918  
## cvpred 90.179851 71.81707 43.8577022 74.58453 47.95326 50.95310 56.466442  
## Grad.Rate 93.000000 63.00000 43.0000000 92.00000 29.00000 65.00000 65.000000  
## CV residual 2.820149 -8.81707 -0.8577022 17.41547 -18.95326 14.04690 8.533558  
## 705 715 722 724 725 737 740  
## Predicted 78.5508532 53.40978 66.551856 71.92677 81.886021 62.77700 49.08140  
## cvpred 78.6690624 53.29996 65.867471 71.65453 82.065716 62.57194 48.54943  
## Grad.Rate 79.0000000 30.00000 68.000000 67.00000 86.000000 84.00000 60.00000  
## CV residual 0.3309376 -23.29996 2.132529 -4.65453 3.934284 21.42806 11.45057  
## 747 756 760 761 763 769 777  
## Predicted 58.82398 88.23348 65.705871 77.549218 61.90677 61.74641 60.43286  
## cvpred 58.41292 88.06988 65.737007 77.686828 62.01083 61.59484 59.17148  
## Grad.Rate 61.00000 72.00000 67.000000 68.000000 52.00000 50.00000 99.00000  
## CV residual 2.58708 -16.06988 1.262993 -9.686828 -10.01083 -11.59484 39.82852  
##   
## Sum of squares = 29290.98 Mean square = 188.97 n = 155   
##   
## fold 2   
## Observations in test set: 156   
## 3 7 17 18 26 27 35  
## Predicted 69.39855 69.748853 105.17393 62.421852 43.328087 72.2724 65.48651  
## cvpred 69.51032 69.767148 105.33833 62.482071 43.589083 72.1246 65.52342  
## Grad.Rate 54.00000 63.000000 100.00000 59.000000 48.000000 88.0000 85.00000  
## CV residual -15.51032 -6.767148 -5.33833 -3.482071 4.410917 15.8754 19.47658  
## 43 51 54 56 57 58 68  
## Predicted 58.430282 61.77782 51.190059 67.82363 64.26457 50.50042 64.213213  
## cvpred 58.526477 62.02333 51.475583 68.31228 64.29609 50.62664 64.393303  
## Grad.Rate 52.000000 48.00000 58.000000 51.00000 75.00000 53.00000 58.000000  
## CV residual -6.526477 -14.02333 6.524417 -17.31228 10.70391 2.37336 -6.393303  
## 74 83 86 88 95 97  
## Predicted 69.310433 56.001071 59.518308 81.292566 66.289229 77.247784  
## cvpred 68.902626 56.042218 59.800112 82.489939 66.698196 77.417052  
## Grad.Rate 78.000000 49.000000 52.000000 74.000000 75.000000 74.000000  
## CV residual 9.097374 -7.042218 -7.800112 -8.489939 8.301804 -3.417052  
## 104 107 108 112 115 118  
## Predicted 46.785222 79.043579 69.57767 66.113928 94.330180 76.2652123  
## cvpred 47.000612 79.553267 69.69352 66.229171 94.368216 76.4115374  
## Grad.Rate 50.000000 74.000000 47.00000 63.000000 87.000000 77.0000000  
## CV residual 2.999388 -5.553267 -22.69352 -3.229171 -7.368216 0.5884626  
## 127 131 136 140 146 152  
## Predicted 69.32154 67.973046 59.55763 78.249403 62.66376 76.04739  
## cvpred 69.33586 68.060618 59.67882 78.717889 62.64228 76.06988  
## Grad.Rate 100.00000 72.000000 76.00000 69.000000 45.00000 64.00000  
## CV residual 30.66414 3.939382 16.32118 -9.717889 -17.64228 -12.06988  
## 158 160 166 169 171 191 192  
## Predicted 63.730961 92.606731 54.301127 55.138844 53.40460 69.68797 84.59102  
## cvpred 63.725108 92.696475 54.497181 55.062903 53.96709 70.02132 85.10637  
## Grad.Rate 72.000000 94.000000 46.000000 54.000000 42.00000 82.00000 96.00000  
## CV residual 8.274892 1.303525 -8.497181 -1.062903 -11.96709 11.97868 10.89363  
## 194 196 203 204 205 207 217  
## Predicted 73.278881 55.28448 57.74715 55.542327 63.571497 53.033617 65.328727  
## cvpred 73.375814 55.65613 57.75983 55.793091 63.405216 52.959425 65.339682  
## Grad.Rate 67.000000 68.00000 68.00000 58.000000 62.000000 46.000000 74.000000  
## CV residual -6.375814 12.34387 10.24017 2.206909 -1.405216 -6.959425 8.660318  
## 219 225 227 229 231 234 238  
## Predicted 62.61627 64.2494 51.77509 70.750267 74.238556 54.182733 85.100917  
## cvpred 62.44783 64.3644 51.89076 70.876749 74.982475 54.188844 86.003466  
## Grad.Rate 46.00000 76.0000 36.00000 66.000000 77.000000 57.000000 83.000000  
## CV residual -16.44783 11.6356 -15.89076 -4.876749 2.017525 2.811156 -3.003466  
## 239 242 248 255 256 258 259  
## Predicted 79.52636 69.51584 50.73161 65.02369 73.675199 61.941456 74.702349  
## cvpred 75.33111 69.41470 51.03364 65.66240 74.009045 62.148318 75.365548  
## Grad.Rate 100.00000 96.00000 38.00000 79.00000 79.000000 60.000000 72.000000  
## CV residual 24.66889 26.58530 -13.03364 13.33760 4.990955 -2.148318 -3.365548  
## 260 274 276 282 287 288  
## Predicted 72.905799 52.49704 64.62583 50.43766 66.58421 75.622925  
## cvpred 73.289025 52.71311 64.51873 50.94707 66.71975 75.911096  
## Grad.Rate 72.000000 40.00000 34.00000 26.00000 56.00000 80.000000  
## CV residual -1.289025 -12.71311 -30.51873 -24.94707 -10.71975 4.088904  
## 290 293 296 308 315 318 319  
## Predicted 56.40726 89.31568 60.361634 68.1168 59.9798130 65.20070 75.774664  
## cvpred 56.50557 89.46254 60.728808 68.1791 60.0124931 64.69411 75.720449  
## Grad.Rate 68.00000 88.00000 65.000000 94.0000 61.0000000 100.00000 81.000000  
## CV residual 11.49443 -1.46254 4.271192 25.8209 0.9875069 35.30589 5.279551  
## 324 329 332 336 339 340 342  
## Predicted 53.716441 61.07872 76.695132 65.013666 69.926721 72.808448 64.64226  
## cvpred 54.040051 61.29656 76.507867 65.505733 70.079938 72.946976 64.46831  
## Grad.Rate 59.000000 53.00000 72.000000 59.000000 79.000000 70.000000 59.00000  
## CV residual 4.959949 -8.29656 -4.507867 -6.505733 8.920062 -2.946976 -5.46831  
## 350 366 383 385 388 392 400  
## Predicted 61.808990 60.22580 50.49097 49.90821 58.31053 61.98878 51.81388  
## cvpred 62.219874 60.42161 50.72127 50.62187 58.52181 62.10186 52.00860  
## Grad.Rate 68.000000 85.00000 37.00000 15.00000 83.00000 44.00000 58.00000  
## CV residual 5.780126 24.57839 -13.72127 -35.62187 24.47819 -18.10186 5.99140  
## 413 414 419 423 424 429  
## Predicted 60.454837 53.582603 70.04633 64.145940 67.2269896 89.994748  
## cvpred 60.858338 54.091055 70.03107 64.055967 67.2226166 90.387773  
## Grad.Rate 62.000000 52.000000 46.00000 58.000000 68.0000000 83.000000  
## CV residual 1.141662 -2.091055 -24.03107 -6.055967 0.7773834 -7.387773  
## 430 431 436 440 446 448  
## Predicted 81.032554 69.725715 49.577330 65.80540 67.583220 51.743911  
## cvpred 81.641422 70.279827 49.833149 65.85383 67.662901 52.045502  
## Grad.Rate 79.000000 67.000000 45.000000 37.00000 63.000000 44.000000  
## CV residual -2.641422 -3.279827 -4.833149 -28.85383 -4.662901 -8.045502  
## 462 463 464 471 478 490 503  
## Predicted 59.212489 70.44152 70.33858 70.21796 61.21827 49.431516 73.710954  
## cvpred 59.438744 70.65969 70.28708 70.66158 61.34988 49.567047 74.039047  
## Grad.Rate 67.000000 58.00000 80.00000 84.00000 79.00000 58.000000 83.000000  
## CV residual 7.561256 -12.65969 9.71292 13.33842 17.65012 8.432953 8.960953  
## 509 514 515 516 518 520 530  
## Predicted 58.00395 65.26605 62.83417 78.682407 67.62299 69.239621 52.94149  
## cvpred 58.04838 65.31873 63.06997 80.423757 67.73382 69.569653 53.25742  
## Grad.Rate 56.00000 55.00000 52.00000 73.000000 89.00000 71.000000 67.00000  
## CV residual -2.04838 -10.31873 -11.06997 -7.423757 21.26618 1.430347 13.74258  
## 533 534 540 545 548 550  
## Predicted 57.80838 48.378330 55.474035 65.47318 85.0878902 71.446856  
## cvpred 57.98598 48.783827 55.739224 65.83604 85.3589953 71.405127  
## Grad.Rate 43.00000 43.000000 52.000000 78.00000 85.0000000 78.000000  
## CV residual -14.98598 -5.783827 -3.739224 12.16396 -0.3589953 6.594873  
## 552 555 569 577 585 592  
## Predicted 56.00029 60.701885 56.922960 68.695917 59.90268 75.441091  
## cvpred 56.14161 60.679521 57.005924 69.108631 60.08859 71.314858  
## Grad.Rate 72.00000 67.000000 66.000000 67.000000 50.00000 81.000000  
## CV residual 15.85839 6.320479 8.994076 -2.108631 -10.08859 9.685142  
## 599 604 609 611 615 617  
## Predicted 66.71968 42.68515 59.422652 50.427414 60.79141 61.43009  
## cvpred 66.57364 44.26419 59.495414 51.335581 61.17511 61.78824  
## Grad.Rate 52.00000 33.00000 57.000000 54.000000 75.00000 51.00000  
## CV residual -14.57364 -11.26419 -2.495414 2.664419 13.82489 -10.78824  
## 628 630 633 636 643 646  
## Predicted 73.47754 62.185010 58.707731 57.101319 58.910755 52.5865679  
## cvpred 73.50044 62.231361 58.772128 57.384305 59.318312 52.6122366  
## Grad.Rate 47.00000 59.000000 55.000000 56.000000 58.000000 52.0000000  
## CV residual -26.50044 -3.231361 -3.772128 -1.384305 -1.318312 -0.6122366  
## 677 679 691 696 699 706 707  
## Predicted 51.420087 51.1928 58.90726 51.28855 56.60584 61.58123 52.64354  
## cvpred 52.074138 51.1807 59.35483 51.75171 56.65837 61.59939 52.89750  
## Grad.Rate 47.000000 36.0000 47.00000 53.00000 67.00000 68.00000 40.00000  
## CV residual -5.074138 -15.1807 -12.35483 1.24829 10.34163 6.40061 -12.89750  
## 716 726 727 730 743 745  
## Predicted 66.483617 94.482955 78.92521 49.700473 78.01401 57.613405  
## cvpred 66.405013 92.894649 78.99374 50.068473 78.06286 57.872859  
## Grad.Rate 68.000000 90.000000 65.00000 52.000000 60.00000 59.000000  
## CV residual 1.594987 -2.894649 -13.99374 1.931527 -18.06286 1.127141  
## 754 755 759 762 774 775  
## Predicted 76.202430 66.814787 68.52440 62.920820 67.62236 54.172857  
## cvpred 77.531095 66.847053 68.59919 63.012762 67.82757 54.616344  
## Grad.Rate 71.000000 72.000000 63.00000 59.000000 83.00000 49.000000  
## CV residual -6.531095 5.152947 -5.59919 -4.012762 15.17243 -5.616344  
##   
## Sum of squares = 22706.26 Mean square = 145.55 n = 156   
##   
## fold 3   
## Observations in test set: 156   
## 8 11 12 16 24 30  
## Predicted 73.1262150 79.125908 84.554249 61.098832 55.581515 75.436814  
## cvpred 73.2719054 78.852356 84.509903 60.596143 54.524261 75.383927  
## Grad.Rate 73.0000000 73.000000 76.000000 69.000000 48.000000 71.000000  
## CV residual -0.2719054 -5.852356 -8.509903 8.403857 -6.524261 -4.383927  
## 32 44 48 49 66 69 70  
## Predicted 66.865140 58.331635 89.49269 71.33348 62.53442 64.66187 53.34257  
## cvpred 67.043751 57.935044 89.51427 70.92263 61.62861 64.34781 53.76933  
## Grad.Rate 71.000000 49.000000 55.00000 82.00000 49.00000 82.00000 33.00000  
## CV residual 3.956249 -8.935044 -34.51427 11.07737 -12.62861 17.65219 -20.76933  
## 71 73 81 89 96 98  
## Predicted 96.0702591 86.452347 70.40545 69.658318 60.84969 62.41905  
## cvpred 96.8629838 86.381933 70.37990 69.140855 60.42977 62.30928  
## Grad.Rate 97.0000000 93.000000 81.00000 79.000000 118.00000 64.00000  
## CV residual 0.1370162 6.618067 10.62010 9.859145 57.57023 1.69072  
## 101 109 113 117 121 122  
## Predicted 58.25113 67.53765 59.25849 68.385479 75.401667 69.529248  
## cvpred 57.91326 68.30122 58.45155 67.986367 75.178393 69.552324  
## Grad.Rate 47.00000 52.00000 48.00000 74.000000 67.000000 75.000000  
## CV residual -10.91326 -16.30122 -10.45155 6.013633 -8.178393 5.447676  
## 124 138 141 154 155 157  
## Predicted 90.993265 89.134095 90.691421 64.92932 49.21973 60.024072  
## cvpred 91.252329 90.365033 91.726249 64.44136 48.66619 59.887964  
## Grad.Rate 93.000000 95.000000 84.000000 51.00000 63.00000 54.000000  
## CV residual 1.747671 4.634967 -7.726249 -13.44136 14.33381 -5.887964  
## 163 165 168 178 180 188 197  
## Predicted 83.157471 83.710326 69.39370 47.928796 66.59874 66.25369 76.77984  
## cvpred 83.357885 83.851646 69.33897 47.733421 66.11593 65.83421 76.55922  
## Grad.Rate 81.000000 87.000000 60.00000 42.000000 54.00000 86.00000 94.00000  
## CV residual -2.357885 3.148354 -9.33897 -5.733421 -12.11593 20.16579 17.44078  
## 209 215 226 237 249 257  
## Predicted 59.88957 65.628783104 85.852486 63.177265 62.76716 85.614567  
## cvpred 58.97871 65.003037596 85.786302 62.607377 62.68071 85.552113  
## Grad.Rate 83.00000 65.000000000 83.000000 60.000000 73.00000 79.000000  
## CV residual 24.02129 -0.003037596 -2.786302 -2.607377 10.31929 -6.552113  
## 261 264 275 283 289 291 295  
## Predicted 73.115580 61.19878 63.544433 56.53701 60.465654 58.063076 72.65199  
## cvpred 73.133045 61.10716 63.264519 56.23020 59.945652 57.343503 72.41366  
## Grad.Rate 72.000000 47.00000 68.000000 75.00000 54.000000 61.000000 87.00000  
## CV residual -1.133045 -14.10716 4.735481 18.76980 -5.945652 3.656497 14.58634  
## 300 302 306 307 321 323  
## Predicted 85.67951 73.950437 49.431512 87.25483 59.480275 68.176870  
## cvpred 85.86314 73.905137 48.891574 87.86418 58.756167 67.654881  
## Grad.Rate 92.00000 77.000000 51.000000 77.00000 63.000000 70.000000  
## CV residual 6.13686 3.094863 2.108426 -10.86418 4.243833 2.345119  
## 327 335 338 345 347 355  
## Predicted 71.739958 85.257276 64.47909821 65.50662 72.23003 93.3698263  
## cvpred 71.396769 85.919782 63.97327235 65.33977 72.74015 93.7743742  
## Grad.Rate 80.000000 77.000000 64.00000000 77.00000 90.00000 94.0000000  
## CV residual 8.603231 -8.919782 0.02672765 11.66023 17.25985 0.2256258  
## 356 358 361 363 364 368 373  
## Predicted 45.545844 56.12794 68.2656 69.51524 51.272768 60.087856 67.560422  
## cvpred 45.211464 55.41272 67.8631 69.00490 50.493184 59.822274 67.868716  
## Grad.Rate 51.000000 32.00000 78.0000 80.00000 59.000000 65.000000 58.000000  
## CV residual 5.788536 -23.41272 10.1369 10.99510 8.506816 5.177726 -9.868716  
## 376 389 391 395 398 399  
## Predicted 65.20944 66.83629 86.519811 71.10861 66.049125 73.917637  
## cvpred 64.50976 66.66667 87.396344 71.00270 65.735324 73.546734  
## Grad.Rate 53.00000 56.00000 84.000000 21.00000 72.000000 81.000000  
## CV residual -11.50976 -10.66667 -3.396344 -50.00270 6.264676 7.453266  
## 401 404 411 434 447 453  
## Predicted 84.239101 57.21831 55.759210 79.560492 76.74064 51.554921  
## cvpred 84.060079 56.33879 55.254517 79.409501 76.96288 51.003868  
## Grad.Rate 83.000000 71.00000 57.000000 75.000000 66.00000 61.000000  
## CV residual -1.060079 14.66121 1.745483 -4.409501 -10.96288 9.996132  
## 459 460 461 467 468 469  
## Predicted 75.164335 105.711189 80.71296 52.266441 76.152573 64.71013  
## cvpred 75.086047 106.668256 80.22727 51.639056 76.190592 65.16821  
## Grad.Rate 85.000000 99.000000 96.00000 47.000000 74.000000 68.00000  
## CV residual 9.913953 -7.668256 15.77273 -4.639056 -2.190592 2.83179  
## 470 473 474 475 476 482  
## Predicted 85.72974 77.948203 70.6601341 80.06979 63.97828 68.62902  
## cvpred 85.94357 78.781519 70.3982353 80.48979 63.33607 68.44661  
## Grad.Rate 68.00000 77.000000 70.0000000 64.00000 81.00000 81.00000  
## CV residual -17.94357 -1.781519 -0.3982353 -16.48979 17.66393 12.55339  
## 483 488 492 504 519 522  
## Predicted 52.720593 63.615614 67.567076 61.787760 64.6976776 56.486477  
## cvpred 52.002587 62.959481 67.039468 61.400278 64.2402489 56.086981  
## Grad.Rate 51.000000 70.000000 69.000000 53.000000 64.0000000 58.000000  
## CV residual -1.002587 7.040519 1.960532 -8.400278 -0.2402489 1.913019  
## 524 544 546 566 567 568  
## Predicted 57.70685 51.066247 71.505756 61.758064 55.26065 62.012105  
## cvpred 57.45481 50.906264 71.759917 61.076096 54.70920 61.215324  
## Grad.Rate 47.00000 49.000000 64.000000 63.000000 42.00000 53.000000  
## CV residual -10.45481 -1.906264 -7.759917 1.923904 -12.70920 -8.215324  
## 572 574 580 593 596 602 607  
## Predicted 58.094715 54.270601 72.09349 62.728157 65.71878 90.950140 69.998761  
## cvpred 57.454541 53.681768 71.76938 62.369772 65.53287 91.325581 69.795897  
## Grad.Rate 65.000000 46.000000 98.00000 65.000000 78.00000 88.000000 66.000000  
## CV residual 7.545459 -7.681768 26.23062 2.630228 12.46713 -3.325581 -3.795897  
## 610 612 613 614 619 622  
## Predicted 88.8905670 64.753002 65.498004 66.92096 70.136379 67.0931086  
## cvpred 89.1505994 64.331669 65.235767 66.60089 69.641512 66.4357438  
## Grad.Rate 90.0000000 71.000000 63.000000 93.00000 77.000000 66.0000000  
## CV residual 0.8494006 6.668331 -2.235767 26.39911 7.358488 -0.4357438  
## 623 631 637 639 642 648 659  
## Predicted 42.35282 51.56294 69.10442 60.004861 49.349134 61.263104 56.85481  
## cvpred 42.51188 50.72283 69.32211 59.184416 48.991593 61.626744 56.01885  
## Grad.Rate 54.00000 64.00000 59.00000 53.000000 53.000000 53.000000 40.00000  
## CV residual 11.48812 13.27717 -10.32211 -6.184416 4.008407 -8.626744 -16.01885  
## 660 661 665 676 682 683 687  
## Predicted 57.90410 89.338264 57.22229 58.672980 63.32461 60.512746 48.48900  
## cvpred 57.61295 90.264886 57.18465 58.294734 62.69888 59.950337 47.53566  
## Grad.Rate 77.00000 97.000000 66.00000 63.000000 89.00000 62.000000 50.00000  
## CV residual 19.38705 6.735114 8.81535 4.705266 26.30112 2.049663 2.46434  
## 690 692 694 700 701 702  
## Predicted 78.201661 49.97878 86.147812 51.707170 59.42409 57.65894  
## cvpred 79.380812 49.67617 86.288609 50.769543 59.36017 56.97769  
## Grad.Rate 82.000000 37.00000 95.000000 46.000000 72.00000 38.00000  
## CV residual 2.619188 -12.67617 8.711391 -4.769543 12.63983 -18.97769  
## 703 708 711 712 714 720 732  
## Predicted 51.818764 66.47862 77.33928 59.29546 63.903356 72.805747 55.16514  
## cvpred 51.525656 66.18664 76.84074 58.96820 63.509177 72.258709 54.08700  
## Grad.Rate 45.000000 95.00000 96.00000 45.00000 73.000000 75.000000 90.00000  
## CV residual -6.525656 28.81336 19.15926 -13.96820 9.490823 2.741291 35.91300  
## 734 738 746 748 752 758  
## Predicted 93.706414 89.870141 54.801417 58.222984 72.36299 68.85565  
## cvpred 94.650788 90.728834 53.717227 57.514385 71.62635 68.26753  
## Grad.Rate 91.000000 92.000000 52.000000 65.000000 87.00000 80.00000  
## CV residual -3.650788 1.271166 -1.717227 7.485615 15.37365 11.73247  
## 764 767 768 771  
## Predicted 103.109581 54.570319 58.5615375 81.846931  
## cvpred 104.414394 54.004336 58.2881254 82.572115  
## Grad.Rate 99.000000 58.000000 59.0000000 75.000000  
## CV residual -5.414394 3.995664 0.7118746 -7.572115  
##   
## Sum of squares = 24936.22 Mean square = 159.85 n = 156   
##   
## fold 4   
## Observations in test set: 155   
## 2 5 9 21 36 37  
## Predicted 63.735332 49.59265 73.786651 45.98725 67.360687 88.062387  
## cvpred 63.676661 48.82079 73.748403 37.29093 67.111057 87.571022  
## Grad.Rate 56.000000 15.00000 80.000000 48.00000 71.000000 79.000000  
## CV residual -7.676661 -33.82079 6.251597 10.70907 3.888943 -8.571022  
## 41 46 50 63 67 75  
## Predicted 73.4677836 54.254120 57.616350 66.99718 49.09366 71.27586  
## cvpred 73.7420373 54.982964 56.874735 65.69955 49.61709 71.52619  
## Grad.Rate 73.0000000 46.000000 63.000000 46.00000 18.00000 83.00000  
## CV residual -0.7420373 -8.982964 6.125265 -19.69955 -31.61709 11.47381  
## 77 80 82 85 87 92  
## Predicted 65.61709 55.870734 68.794220 71.45301 90.7291249 71.975437  
## cvpred 65.61692 56.077152 69.767715 71.64193 90.1844789 71.878471  
## Grad.Rate 55.00000 61.000000 63.000000 83.00000 91.0000000 67.000000  
## CV residual -10.61692 4.922848 -6.767715 11.35807 0.8155211 -4.878471  
## 105 110 119 126 128 132 135  
## Predicted 52.99116 68.280603 60.61981 58.906694 72.35490 73.133786 60.63052  
## cvpred 53.41488 68.592577 60.68980 59.507233 72.14561 73.823697 60.90562  
## Grad.Rate 51.00000 73.000000 73.00000 51.000000 83.00000 77.000000 80.00000  
## CV residual -2.41488 4.407423 12.31020 -8.507233 10.85439 3.176303 19.09438  
## 139 149 150 153 172 173 179  
## Predicted 85.132644 60.43779 88.280667 52.32663 69.463061 74.256051 48.08377  
## cvpred 85.561692 60.82208 87.477515 48.60296 69.824796 73.874678 48.52647  
## Grad.Rate 93.000000 75.00000 91.000000 85.00000 77.000000 83.000000 38.00000  
## CV residual 7.438308 14.17792 3.522485 36.39704 7.175204 9.125322 -10.52647  
## 182 183 186 187 193 199 200  
## Predicted 51.22664 61.90477 73.618020 77.02247 46.709692 57.95090 56.69676  
## cvpred 51.66137 61.56153 73.868834 78.00340 47.318417 58.23999 57.34736  
## Grad.Rate 76.00000 82.00000 81.000000 64.00000 50.000000 22.00000 69.00000  
## CV residual 24.33863 20.43847 7.131166 -14.00340 2.681583 -36.23999 11.65264  
## 202 211 212 213 216 218  
## Predicted 59.269920 70.33001 55.250274 66.14516 58.14006 69.21021  
## cvpred 59.361011 71.52697 55.406914 66.67537 58.90650 70.09927  
## Grad.Rate 66.000000 51.00000 62.000000 54.00000 29.00000 52.00000  
## CV residual 6.638989 -20.52697 6.593086 -12.67537 -29.90650 -18.09927  
## 221 222 230 232 233 240 241  
## Predicted 59.79900 91.831482 67.04059 61.539223 65.71203 72.405206 83.66022  
## cvpred 60.04192 91.731793 66.55513 61.147523 66.48439 72.804575 83.74126  
## Grad.Rate 55.00000 95.000000 72.00000 64.000000 47.00000 65.000000 80.00000  
## CV residual -5.04192 3.268207 5.44487 2.852477 -19.48439 -7.804575 -3.74126  
## 243 247 251 265 266 267  
## Predicted 93.457719 59.53459 105.835982 57.59557 54.33255 65.441000  
## cvpred 91.884862 59.23529 105.764051 56.94573 55.34146 65.729902  
## Grad.Rate 91.000000 64.00000 100.000000 21.00000 84.00000 75.000000  
## CV residual -0.884862 4.76471 -5.764051 -35.94573 28.65854 9.270098  
## 268 270 272 280 292 299 303  
## Predicted 61.598986 59.681463 66.209537 69.32656 62.865974 67.33850 65.75979  
## cvpred 61.819729 60.360378 66.714548 69.85629 63.130452 67.58122 67.10730  
## Grad.Rate 52.000000 54.000000 69.000000 98.00000 62.000000 84.00000 57.00000  
## CV residual -9.819729 -6.360378 2.285452 28.14371 -1.130452 16.41878 -10.10730  
## 304 314 316 320 325 326  
## Predicted 51.47078 73.122582 62.95395 51.96874 51.62328 48.877552  
## cvpred 51.68052 72.707868 63.37356 51.02946 51.81086 49.458786  
## Grad.Rate 26.00000 69.000000 53.00000 92.00000 37.00000 45.000000  
## CV residual -25.68052 -3.707868 -10.37356 40.97054 -14.81086 -4.458786  
## 330 331 333 343 344 346  
## Predicted 60.034502 74.520588 68.798566 76.61461 71.239538 49.3484228  
## cvpred 59.159383 74.919082 69.171832 76.57006 71.333891 49.6099463  
## Grad.Rate 65.000000 77.000000 70.000000 96.00000 69.000000 50.0000000  
## CV residual 5.840617 2.080918 0.828168 19.42994 -2.333891 0.3900537  
## 352 353 360 374 377 379 380  
## Predicted 76.44610 62.436132 66.43767 67.280375 47.86907 62.91401 74.52630  
## cvpred 76.53846 63.180445 66.66830 68.036349 48.17414 64.01491 74.23476  
## Grad.Rate 51.00000 61.000000 91.00000 67.000000 63.00000 27.00000 56.00000  
## CV residual -25.53846 -2.180445 24.33170 -1.036349 14.82586 -37.01491 -18.23476  
## 387 407 409 415 417 420 422  
## Predicted 76.522313 49.01114 69.51495 71.112786 68.31686 52.68649 50.475697  
## cvpred 76.935511 48.39032 70.38992 71.289678 68.08335 53.16199 50.797178  
## Grad.Rate 74.000000 34.00000 83.00000 76.000000 74.00000 41.00000 54.000000  
## CV residual -2.935511 -14.39032 12.61008 4.710322 5.91665 -12.16199 3.202822  
## 425 426 433 438 445 450  
## Predicted 85.740412 70.509054 55.482169 72.57778 51.109176 65.333544  
## cvpred 85.824143 71.052442 55.244703 72.95003 51.455669 65.856026  
## Grad.Rate 92.000000 63.000000 64.000000 87.00000 48.000000 68.000000  
## CV residual 6.175857 -8.052442 8.755297 14.04997 -3.455669 2.143974  
## 455 457 458 465 466 484 491  
## Predicted 62.821805 68.846240 43.781232 74.93544 54.446472 58.48260 55.802915  
## cvpred 63.192386 68.765305 44.095683 75.01792 55.372168 57.58569 56.139707  
## Grad.Rate 54.000000 62.000000 35.000000 86.00000 62.000000 77.00000 48.000000  
## CV residual -9.192386 -6.765305 -9.095683 10.98208 6.627832 19.41431 -8.139707  
## 495 501 506 507 510 512 513  
## Predicted 62.56141 67.148095 62.442421 60.37276 56.371734 70.27487 77.474114  
## cvpred 63.93278 66.959958 62.608706 60.50936 56.042977 70.13914 77.135144  
## Grad.Rate 85.00000 75.000000 55.000000 98.00000 61.000000 100.00000 83.000000  
## CV residual 21.06722 8.040042 -7.608706 37.49064 4.957023 29.86086 5.864856  
## 523 526 537 539 541 551  
## Predicted 74.61445 71.302185 50.484157 54.68249 68.9372662 58.944324  
## cvpred 74.72881 71.860122 51.125354 55.57141 67.9432018 57.963242  
## Grad.Rate 100.00000 70.000000 56.000000 36.00000 67.0000000 63.000000  
## CV residual 25.27119 -1.860122 4.874646 -19.57141 -0.9432018 5.036758  
## 553 557 558 562 565 575  
## Predicted 71.13723 68.078504 76.602190 79.6552536 59.35628 82.040225  
## cvpred 71.52905 67.981037 76.358161 80.7159532 59.40101 82.239516  
## Grad.Rate 88.00000 73.000000 79.000000 80.0000000 49.00000 90.000000  
## CV residual 16.47095 5.018963 2.641839 -0.7159532 -10.40101 7.760484  
## 576 582 590 591 600 606 618  
## Predicted 71.699771 55.72795 66.20412 69.257822 48.64736 79.371983 60.44573  
## cvpred 69.414713 55.17210 66.93299 69.476406 47.79438 79.957946 60.69344  
## Grad.Rate 61.000000 69.00000 39.00000 70.000000 65.00000 78.000000 45.00000  
## CV residual -8.414713 13.82790 -27.93299 0.523594 17.20562 -1.957946 -15.69344  
## 621 624 632 640 644 650 653  
## Predicted 55.651613 66.13818 53.60148 73.72117 57.976879 65.173789 54.86530  
## cvpred 55.348665 66.93399 53.96147 74.33002 57.771841 65.651236 55.33506  
## Grad.Rate 63.000000 81.00000 35.00000 51.00000 49.000000 75.000000 62.00000  
## CV residual 7.651335 14.06601 -18.96147 -23.33002 -8.771841 9.348764 6.66494  
## 658 670 672 675 678 681  
## Predicted 49.96637 77.649487 65.709615 52.881059 69.8577106 55.1893  
## cvpred 50.10569 77.488461 65.844013 53.448268 68.5277193 55.3051  
## Grad.Rate 35.00000 80.000000 62.000000 48.000000 68.0000000 45.0000  
## CV residual -15.10569 2.511539 -3.844013 -5.448268 -0.5277193 -10.3051  
## 688 689 693 718 731 735  
## Predicted 63.267878 70.452095 68.68186 48.564947 63.725995 77.135118  
## cvpred 62.858712 69.982257 68.40618 48.752491 64.243408 76.241399  
## Grad.Rate 57.000000 65.000000 79.00000 58.000000 63.000000 69.000000  
## CV residual -5.858712 -4.982257 10.59382 9.247509 -1.243408 -7.241399  
## 739 741 742 750 751 757  
## Predicted 62.05621 78.97940 52.987479 73.566543 66.32149 79.77176  
## cvpred 62.25175 79.71503 53.260048 73.880385 66.60218 79.62937  
## Grad.Rate 52.00000 67.00000 55.000000 80.000000 50.00000 52.00000  
## CV residual -10.25175 -12.71503 1.739952 6.119615 -16.60218 -27.62937  
##   
## Sum of squares = 32264.9 Mean square = 208.16 n = 155   
##   
## fold 5   
## Observations in test set: 155   
## 1 10 14 15 19 20  
## Predicted 56.552246 61.022498 71.326440 63.938673 62.60525 54.39764  
## cvpred 57.198646 60.925925 71.209054 64.818002 63.05321 56.22140  
## Grad.Rate 60.000000 52.000000 68.000000 55.000000 46.00000 34.00000  
## CV residual 2.801354 -8.925925 -3.209054 -9.818002 -17.05321 -22.22140  
## 25 28 31 33 40 45 47  
## Predicted 60.252320 53.91386 67.790591 60.30621 60.40038 76.825940 60.92207  
## cvpred 60.623352 54.02350 67.702792 60.51628 60.43774 76.684704 60.87745  
## Grad.Rate 54.000000 69.00000 69.000000 48.00000 72.00000 69.000000 58.00000  
## CV residual -6.623352 14.97650 1.297208 -12.51628 11.56226 -7.684704 -2.87745  
## 52 53 59 65 78 93 100  
## Predicted 62.015733 53.11017 62.65783 79.978077 73.73276 56.32270 59.853947  
## cvpred 61.812091 53.55811 62.97075 79.299625 75.24032 57.07486 59.544903  
## Grad.Rate 56.000000 35.00000 58.00000 84.000000 60.00000 79.00000 66.000000  
## CV residual -5.812091 -18.55811 -4.97075 4.700375 -15.24032 21.92514 6.455097  
## 111 114 116 123 129 130  
## Predicted 55.317791 58.21324 83.349995 88.667766 63.89073 70.93627  
## cvpred 54.743894 59.43346 83.343249 88.238816 64.00974 71.40352  
## Grad.Rate 58.000000 21.00000 79.000000 91.000000 43.00000 75.00000  
## CV residual 3.256106 -38.43346 -4.343249 2.761184 -21.00974 3.59648  
## 137 143 145 151 159 161  
## Predicted 69.743867 60.72368 90.05692 67.110555 100.115194 65.382670  
## cvpred 69.543299 62.63494 89.48338 66.423922 99.699032 65.732277  
## Grad.Rate 72.000000 37.00000 99.00000 75.000000 98.000000 56.000000  
## CV residual 2.456701 -25.63494 9.51662 8.576078 -1.699032 -9.732277  
## 164 167 174 175 177 190  
## Predicted 73.225345 55.139490 62.26041 97.4785017 57.0876788 48.00066  
## cvpred 72.819253 55.890687 61.82136 97.2450767 57.6047361 47.33644  
## Grad.Rate 82.000000 61.000000 67.00000 97.0000000 58.0000000 44.00000  
## CV residual 9.180747 5.109313 5.17864 -0.2450767 0.3952639 -3.33644  
## 198 201 208 214 223 224  
## Predicted 54.64277 67.05457 50.746378 67.50412 80.44399 55.46449  
## cvpred 55.33659 67.16604 51.056601 64.92416 80.73588 56.45266  
## Grad.Rate 24.00000 57.00000 43.000000 82.00000 70.00000 34.00000  
## CV residual -31.33659 -10.16604 -8.056601 17.07584 -10.73588 -22.45266  
## 236 246 250 252 253 254  
## Predicted 63.03170 58.43792 80.883819 92.568258 60.563306 67.035297  
## cvpred 63.26444 59.95542 80.497373 92.087772 60.704648 65.416321  
## Grad.Rate 39.00000 70.00000 73.000000 100.000000 52.000000 63.000000  
## CV residual -24.26444 10.04458 -7.497373 7.912228 -8.704648 -2.416321  
## 269 271 278 279 281 285  
## Predicted 71.72127 86.190642 56.741849 74.1831352 61.731976 94.0299410  
## cvpred 71.29779 86.873101 56.624415 74.3380247 62.573708 90.3307876  
## Grad.Rate 56.00000 83.000000 65.000000 75.0000000 54.000000 90.0000000  
## CV residual -15.29779 -3.873101 8.375585 0.6619753 -8.573708 -0.3307876  
## 294 297 305 310 311 317  
## Predicted 69.85305 75.908034 53.475282 86.831422 63.72005 46.728311  
## cvpred 70.06112 75.287201 54.723754 86.516879 64.06666 46.998536  
## Grad.Rate 51.00000 79.000000 60.000000 91.000000 66.00000 45.000000  
## CV residual -19.06112 3.712799 5.276246 4.483121 1.93334 -1.998536  
## 322 337 341 354 357 367 370  
## Predicted 63.672818 63.75236 48.18967 68.509834 63.31283 58.34531 62.875576  
## cvpred 64.817571 64.33753 48.54153 68.715662 64.74460 58.06741 64.263504  
## Grad.Rate 62.000000 55.00000 68.00000 66.000000 52.00000 71.00000 71.000000  
## CV residual -2.817571 -9.33753 19.45847 -2.715662 -12.74460 12.93259 6.736496  
## 371 372 381 382 384 393 396  
## Predicted 58.413169 68.240466 67.63828 57.45185 52.087745 62.02266 73.660954  
## cvpred 58.826116 68.238333 68.08181 57.45950 54.025055 62.00201 73.586082  
## Grad.Rate 64.000000 75.000000 54.00000 74.00000 58.000000 78.00000 80.000000  
## CV residual 5.173884 6.761667 -14.08181 16.54050 3.974945 15.99799 6.413918  
## 397 403 416 418 421 428 437  
## Predicted 62.65429 71.500606 57.04033 51.06833 58.981691 59.553507 51.057798  
## cvpred 63.88957 71.463048 57.68173 51.70966 60.054817 59.881135 51.325039  
## Grad.Rate 88.00000 73.000000 42.00000 76.00000 56.000000 53.000000 48.000000  
## CV residual 24.11043 1.536952 -15.68173 24.29034 -4.054817 -6.881135 -3.325039  
## 439 441 442 452 454 477  
## Predicted 52.75491 65.616734 69.68451 52.19695 75.423086 71.943828365  
## cvpred 53.09561 66.860022 69.48953 52.38174 75.509676 71.999850092  
## Grad.Rate 65.00000 62.000000 83.00000 31.00000 73.000000 72.000000000  
## CV residual 11.90439 -4.860022 13.51047 -21.38174 -2.509676 0.000149908  
## 479 481 487 489 494 498 500  
## Predicted 65.780772 78.20909 65.04135 75.33438 67.2944775 56.11470 65.94309  
## cvpred 66.708963 78.50697 65.40450 76.09168 67.9146238 54.35399 66.30447  
## Grad.Rate 68.000000 90.00000 82.00000 97.00000 67.0000000 67.00000 78.00000  
## CV residual 1.291037 11.49303 16.59550 20.90832 -0.9146238 12.64601 11.69553  
## 502 508 511 525 527 535  
## Predicted 74.170090 70.91444 56.16505 76.54185 55.080641 64.277232  
## cvpred 74.395394 70.74751 56.64697 75.89897 54.936841 63.749046  
## Grad.Rate 84.000000 60.00000 41.00000 79.00000 48.000000 72.000000  
## CV residual 9.604606 -10.74751 -15.64697 3.10103 -6.936841 8.250954  
## 538 542 543 547 554 556  
## Predicted 53.674356 68.76847 60.884023 68.128186 45.9742568 68.037665  
## cvpred 53.791963 69.58088 62.564974 68.519048 45.7872815 67.628594  
## Grad.Rate 51.000000 89.00000 65.000000 66.000000 45.0000000 59.000000  
## CV residual -2.791963 19.41912 2.435026 -2.519048 -0.7872815 -8.628594  
## 563 564 571 579 586 589  
## Predicted 53.067317 49.270463 58.265551 57.83807 63.72394 63.280554  
## cvpred 53.367104 49.449167 60.163645 60.18012 64.95662 63.276109  
## Grad.Rate 56.000000 57.000000 53.000000 46.00000 10.00000 60.000000  
## CV residual 2.632896 7.550833 -7.163645 -14.18012 -54.95662 -3.276109  
## 595 597 601 603 616 626  
## Predicted 69.23465 70.56049 55.785642 59.064877 74.110127 67.311485  
## cvpred 69.00292 68.92519 56.271304 60.428543 74.266582 67.605926  
## Grad.Rate 96.00000 93.00000 64.000000 56.000000 67.000000 69.000000  
## CV residual 26.99708 24.07481 7.728696 -4.428543 -7.266582 1.394074  
## 627 629 649 652 656 663  
## Predicted 56.1105217 56.99147 65.486124 83.883603 50.407886 62.72891  
## cvpred 56.6543391 57.46807 66.163407 84.693236 50.367232 63.08933  
## Grad.Rate 57.0000000 31.00000 64.000000 83.000000 49.000000 54.00000  
## CV residual 0.3456609 -26.46807 -2.163407 -1.693236 -1.367232 -9.08933  
## 666 668 669 671 680 684  
## Predicted 65.439112 58.656869 79.14222 68.311342 54.31654 54.851410  
## cvpred 65.386246 58.725246 80.05791 68.532836 54.87361 55.299535  
## Grad.Rate 72.000000 63.000000 100.00000 66.000000 38.00000 53.000000  
## CV residual 6.613754 4.274754 19.94209 -2.532836 -16.87361 -2.299535  
## 695 698 704 709 710 713 717  
## Predicted 51.50709 53.24895 66.19067 79.343080 85.714886 52.07197 64.995486  
## cvpred 51.23173 53.01070 67.65609 77.374539 84.753128 52.65586 65.262793  
## Grad.Rate 65.00000 36.00000 78.00000 83.000000 90.000000 31.00000 73.000000  
## CV residual 13.76827 -17.01070 10.34391 5.625461 5.246872 -21.65586 7.737207  
## 719 721 723 728 729 733  
## Predicted 75.599856 91.2290623 63.4251249 58.371342 80.25330 62.0125  
## cvpred 74.793395 89.1543154 63.8132309 57.781969 75.70549 62.8699  
## Grad.Rate 72.000000 89.0000000 63.0000000 56.000000 90.00000 48.0000  
## CV residual -2.793395 -0.1543154 -0.8132309 -1.781969 14.29451 -14.8699  
## 736 744 749 753 765 766 770  
## Predicted 48.92040 55.427335 64.59370 80.812117 72.512650 54.70565 76.715891  
## cvpred 47.29624 56.093214 64.76303 80.200675 72.495818 55.01759 76.334615  
## Grad.Rate 64.00000 55.000000 62.00000 85.000000 67.000000 91.00000 78.000000  
## CV residual 16.70376 -1.093214 -2.76303 4.799325 -5.495818 35.98241 1.665385  
## 772 773 776  
## Predicted 78.535127 58.96209 102.589197  
## cvpred 78.253523 60.25075 101.405454  
## Grad.Rate 82.000000 40.00000 99.000000  
## CV residual 3.746477 -20.25075 -2.405454  
##   
## Sum of squares = 25837.28 Mean square = 166.69 n = 155   
##   
## Overall (Sum over all 155 folds)   
## ms   
## 173.791

y\_pred <- predict.lm(model2, test.myd)  
y\_obs<-test.myd[,"Grad.Rate"]  
#Mean absolute percentage error(MAPE)  
mape\_m2<-mean(abs((y\_obs - y\_pred)/y\_obs))\*100  
mape\_m2

## [1] 17.30094