Upward Mobility - model validation

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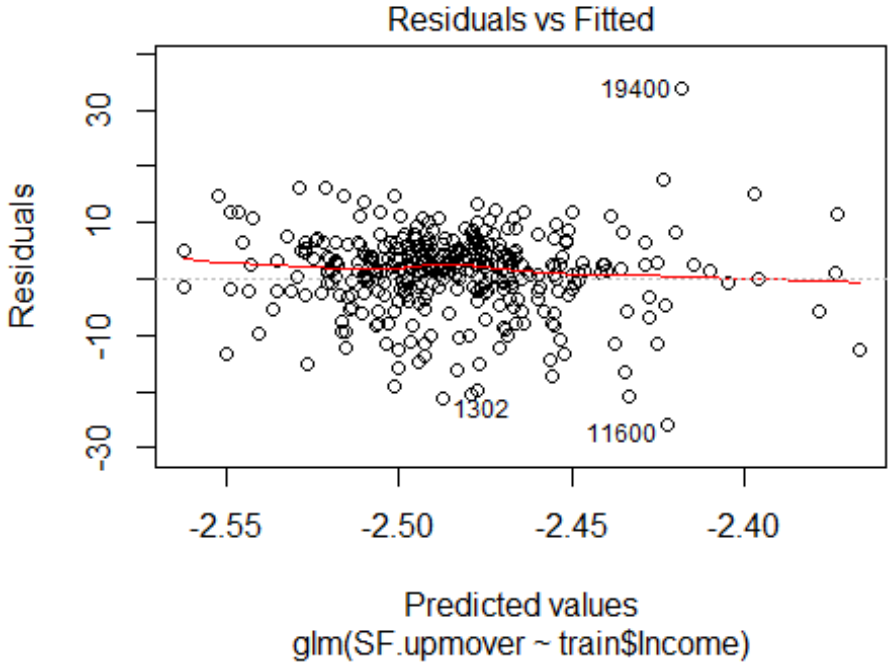
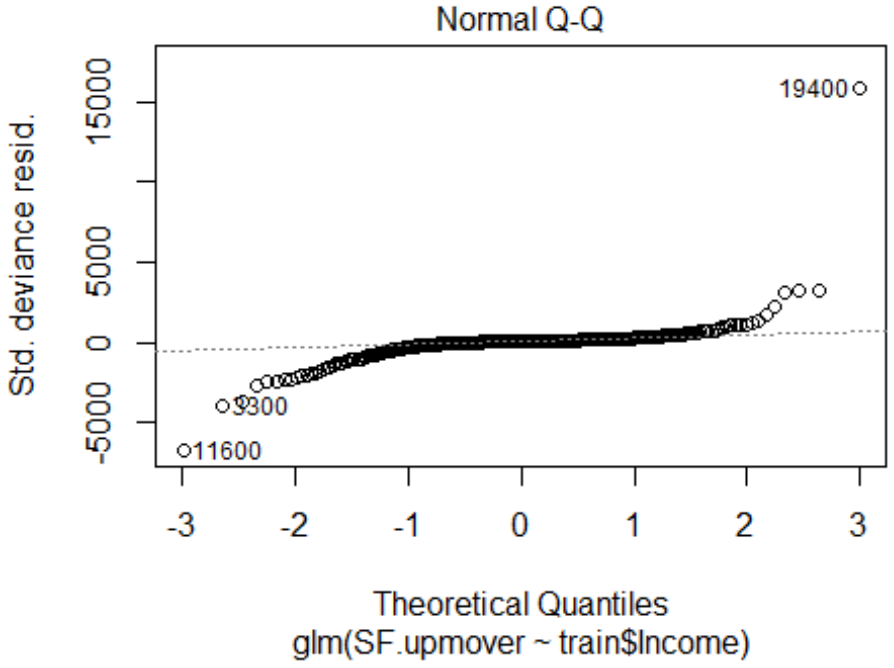
```
rm(list=ls()) # clear global environment
getwd() # double check wd

mobility =
read.csv('http://dept.stat.lsa.umich.edu/~bbh/s485/data/Mobility.csv',
row.names = 1)

#************ TRAIN DATA ************

#1.)

# 50% of the sample size - test sample

sample_size = floor(0.50 * nrow(mobility))

# set the seed to make the partition reproductible
set.seed(123)
train_ind = sample(seq_len(nrow(mobility)), size = sample_size)

train = mobility[train_ind, ]
test = mobility[-train_ind, ]

#nrow(train) #370 rows
#nrow(test) #371 rows

#nrow(train$N.child)
#nrow(test$N.child)

write.csv(test, file="testdata.csv", row.names=T) # creates file:
testdata.csv which is a separate file for the test data

#2.)
#model.frame(fitted_model)
# produces a data frame for the model without missing values

Income_traindata = model.frame(train$p.upmover~train$Income)
Gini_traindata = model.frame(train$p.upmover~train$Gini)
Seg_poverty_traindata = model.frame(train$p.upmover~train$Seg_poverty)
Seg_racial_traindata = model.frame(train$p.upmover~train$Seg_racial)
Seg_income_traindata = model.frame(train$p.upmover~train$Seg_income)
```

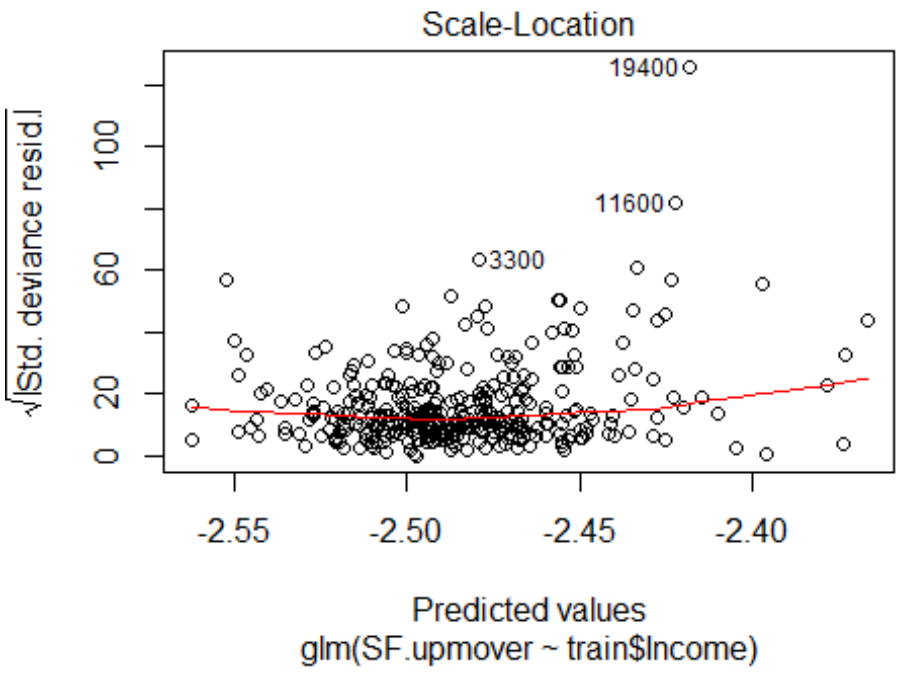
```r
#Likelihood Ratio Test
#choosing significance: 0.05

SF.upmover = with(train, N.child * prop.lowstart * cbind(S=train$p.upmover,
F=(1-train$p.upmover)))
SF.upmover = round(SF.upmover)

fit1 = glm(SF.upmover ~ 1, family = binomial('logit'), data = train)
fit2 = glm(SF.upmover ~ train$Income, family = binomial('logit'), data =
train)
fit3 = glm(SF.upmover ~ train$Income * train$Gini, family =
binomial('logit'), data = train)
fit4 = glm(SF.upmover ~ train$Income * train$Gini * train$Seg_poverty, family
= binomial('logit'), data = train)
fit5 = glm(SF.upmover ~ train$Income * train$Gini * train$Seg_poverty *
train$Seg_racial, family = binomial('logit'), data = train)
fit6 = glm(SF.upmover ~ train$Income * train$Gini * train$Seg_poverty *
train$Seg_racial * train$Seg_income, family = binomial('logit'), data =
train)

anova(fit1, fit2, fit3, fit4, fit5, test = "LRT")
```

```
## Analysis of Deviance Table
##
## Model 1: SF.upmover ~ 1
## Model 2: SF.upmover ~ train$Income
## Model 3: SF.upmover ~ train$Income * train$Gini
## Model 4: SF.upmover ~ train$Income * train$Gini * train$Seg_poverty
## Model 5: SF.upmover ~ train$Income * train$Gini * train$Seg_poverty *
##     train$Seg_racial
##   Resid. Df Resid. Dev Df Deviance  Pr(>Chi)
## 1       362      18944
## 2       361      18734  1    209.9 < 2.2e-16 ***
## 3       359      17195  2   1539.9 < 2.2e-16 ***
## 4       355      13457  4   3737.8 < 2.2e-16 ***
## 5       347      10456  8   3000.6 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

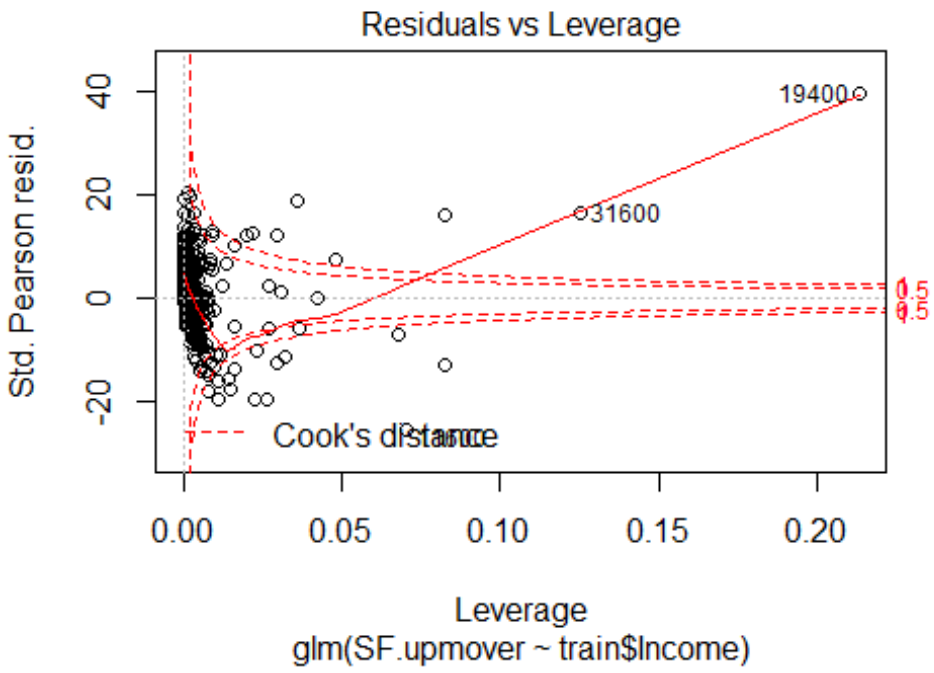
```r
#model with the best fit:
#fit 2: Income with Gini

#Generate Residual Plots
plot(fit2)
```


Residuals vs Fitted
Residuals
30
10
-10
-30
19400
1302
11600
-2.55
-2.50
-2.45
-2.40
Predicted values
glm(SF.upmover ~ train$Income)


Normal Q-Q
Std. deviance resid.
15000
5000
0
-5000
19400
9300
11600
-3
-2
-1
0
1
2
3
Theoretical Quantiles
glm(SF.upmover ~ train$Income)




```
#Modeling with natural spline bases
#install.packages("dplyr")
#install.packages("Rcpp")
#install.packages("DAAG")
dat0 = dplyr::filter(train)
#ns_mods = paste("SF.upmover ~ ns(train$Income, df=", 1:4, ")")

library(splines)
library(DAAG)

## Warning: package 'DAAG' was built under R version 3.4.4

## Loading required package: lattice
```




```
library(MASS)

##
## Attaching package: 'MASS'

## The following object is masked from 'package:DAAG':
##
##     hills

library(boot)

## Warning: package 'boot' was built under R version 3.4.2

##
## Attaching package: 'boot'

## The following object is masked from 'package:lattice':
##
##     melanoma

crossval = cv.glm(train, fit2)

anova(fit2, crossval, test = "LRT")

## Analysis of Deviance Table
##
## Model: binomial, link: logit
##
## Response: SF.upmover
```

```
##
## Terms added sequentially (first to last)
##
##
##              Df Deviance Resid. Df Resid. Dev  Pr(>Chi)
## NULL                            362      18944
## train$Income  1   209.88       361      18734 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#SF.upmover and train$Income
#SF.upmover
#train$Income #length = 370
length(train$Income)
```

```
## [1] 370
```

```
dim(SF.upmover) #dim = 370 2
```

```
## [1] 370   2
```

```
#SF.upmover[,'S']
#SF.upmover[,'F']

#using R spline() function
splineOutput = spline(x=SF.upmover[,'S'], y=train$Income)

#splineOutput$x #length = 792
#splineOutput$y # length = 792

#appending the above spline outputs to fit train data length
spline1 = splineOutput$x[2:371]
spline2 = splineOutput$y[2:371]

class(spline1)
```

```
## [1] "numeric"
```

```
class(SF.upmover[,'S'])
```

```
## [1] "numeric"
```

```
fitSx = glm(SF.upmover ~ 1, family = binomial('logit'), data = train)
fitSy = glm(SF.upmover ~ train$Income, family = binomial('logit'), data =
train)

anova(fitSx, fitSy, test = "LRT")
```

```
## Analysis of Deviance Table
##
## Model 1: SF.upmover ~ 1
## Model 2: SF.upmover ~ train$Income
```

```
##   Resid. Df Resid. Dev Df Deviance  Pr(>Chi)
## 1       362      18944
## 2       361      18734  1   209.88 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#************ TEST DATA ************

testdata = read.csv("testdata.csv", TRUE, ",")
#testdata

#hand selected: Commute and Local_gov_spending

Commute_testdata = model.frame(testdata$p.upmover~testdata$Commute)
Local_gov_spending_testdata =
model.frame(testdata$p.upmover~testdata$Local_gov_spending)

# LR-test
#choosing significance: 0.05

testdata = na.omit(testdata)
p.upmover2 = na.omit(testdata$p.upmover)
Commute = na.omit(testdata$Commute)
Local_gov_spending = na.omit(testdata$Local_gov_spending)


SF.upmover2 = with(testdata, N.child * prop.lowstart * cbind(S=p.upmover2,
F=(1-p.upmover2)))
SF.upmover2 = round(SF.upmover2)
dim(SF.upmover2)
```

```
## [1] 205   2
```

```
fit1b = glm(SF.upmover2 ~ 1, family = binomial('logit'), data = testdata)
fit2b = glm(SF.upmover2 ~ Commute, family = binomial('logit'), data =
testdata)
fit3b = glm(SF.upmover2 ~ Commute * Local_gov_spending, family =
binomial('logit'), data = testdata)

logit_mod = anova(fit1b, fit2b, fit3b, test = "LRT")
logit_mod
```

```
## Analysis of Deviance Table
##
## Model 1: SF.upmover2 ~ 1
## Model 2: SF.upmover2 ~ Commute
## Model 3: SF.upmover2 ~ Commute * Local_gov_spending
##   Resid. Df Resid. Dev Df Deviance  Pr(>Chi)
## 1       204      12908
## 2       203      11781  1  1127.58 < 2.2e-16 ***
```

```
## 3       201      10965  2   816.21 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

#each of the variables were significant
#look at coefficients
#newfit = update(logit_mod, data = testdata)
#coeffs = coef(summary(newfit))
#coeffs[, "Pr(>|z|)"] = p.adjust(coeffs[, "Pr(>|z|)"], "holm")
#coeffs
```