Assignment 6.1

library(C50)

data(churn)

head(churnTrain)

head(churnTest)

#churnTrain = churnTrain[1:500,]

#churnTest = churnTest[1:500,]

# logistic regression model:

fit <- glm(churn~.,data = churnTrain,family = binomial(link='logit'))

summary(fit)

library(MASS)

step\_fit <- stepAIC(fit,method='backward')

summary(step\_fit)

confint(step\_fit)

#ANOVA on base model

anova(fit,test = 'Chisq')

#ANOVA from reduced model after applying the Step AIC

anova(step\_fit,test = 'Chisq')

#plot the fitted model

plot(fit$fitted.values)

library(C50)

> data(churn)

> head(churnTrain)

state account\_length area\_code international\_plan voice\_mail\_plan number\_vmail\_messages

1 KS 128 area\_code\_415 no yes 25

2 OH 107 area\_code\_415 no yes 26

3 NJ 137 area\_code\_415 no no 0

4 OH 84 area\_code\_408 yes no 0

5 OK 75 area\_code\_415 yes no 0

6 AL 118 area\_code\_510 yes no 0

total\_day\_minutes total\_day\_calls total\_day\_charge total\_eve\_minutes total\_eve\_calls

1 265.1 110 45.07 197.4 99

2 161.6 123 27.47 195.5 103

3 243.4 114 41.38 121.2 110

4 299.4 71 50.90 61.9 88

5 166.7 113 28.34 148.3 122

6 223.4 98 37.98 220.6 101

total\_eve\_charge total\_night\_minutes total\_night\_calls total\_night\_charge total\_intl\_minutes

1 16.78 244.7 91 11.01 10.0

2 16.62 254.4 103 11.45 13.7

3 10.30 162.6 104 7.32 12.2

4 5.26 196.9 89 8.86 6.6

5 12.61 186.9 121 8.41 10.1

6 18.75 203.9 118 9.18 6.3

total\_intl\_calls total\_intl\_charge number\_customer\_service\_calls churn

1 3 2.70 1 no

2 3 3.70 1 no

3 5 3.29 0 no

4 7 1.78 2 no

5 3 2.73 3 no

6 6 1.70 0 no

> head(churnTest)

state account\_length area\_code international\_plan voice\_mail\_plan number\_vmail\_messages

1 HI 101 area\_code\_510 no no 0

2 MT 137 area\_code\_510 no no 0

3 OH 103 area\_code\_408 no yes 29

4 NM 99 area\_code\_415 no no 0

5 SC 108 area\_code\_415 no no 0

6 IA 117 area\_code\_415 no no 0

total\_day\_minutes total\_day\_calls total\_day\_charge total\_eve\_minutes total\_eve\_calls

1 70.9 123 12.05 211.9 73

2 223.6 86 38.01 244.8 139

3 294.7 95 50.10 237.3 105

4 216.8 123 36.86 126.4 88

5 197.4 78 33.56 124.0 101

6 226.5 85 38.51 141.6 68

total\_eve\_charge total\_night\_minutes total\_night\_calls total\_night\_charge total\_intl\_minutes

1 18.01 236.0 73 10.62 10.6

2 20.81 94.2 81 4.24 9.5

3 20.17 300.3 127 13.51 13.7

4 10.74 220.6 82 9.93 15.7

5 10.54 204.5 107 9.20 7.7

6 12.04 223.0 90 10.04 6.9

total\_intl\_calls total\_intl\_charge number\_customer\_service\_calls churn

1 3 2.86 3 no

2 7 2.57 0 no

3 6 3.70 1 no

4 2 4.24 1 no

5 4 2.08 2 no

6 5 1.86 1 no

> fit <- glm(churn~.,data = churnTrain,family = binomial(link='logit'))

> summary(fit)

Call:

glm(formula = churn ~ ., family = binomial(link = "logit"), data = churnTrain)

Deviance Residuals:

Min 1Q Median 3Q Max

-3.0431 0.1661 0.3123 0.4995 1.9487

Coefficients:

Estimate Std. Error z value Pr(>|z|)

(Intercept) 9.686e+00 9.798e-01 9.885 < 2e-16 \*\*\*

stateAL -3.385e-01 7.629e-01 -0.444 0.657272

stateAR -9.106e-01 7.519e-01 -1.211 0.225884

stateAZ -8.973e-02 8.452e-01 -0.106 0.915453

stateCA -1.816e+00 7.822e-01 -2.322 0.020238 \*

stateCO -6.445e-01 7.631e-01 -0.845 0.398339

stateCT -1.021e+00 7.252e-01 -1.408 0.159167

stateDC -6.880e-01 8.081e-01 -0.851 0.394577

stateDE -7.460e-01 7.490e-01 -0.996 0.319234

stateFL -5.916e-01 7.610e-01 -0.777 0.436956

stateGA -6.601e-01 7.778e-01 -0.849 0.396075

stateHI 2.300e-01 8.963e-01 0.257 0.797469

stateIA -2.083e-01 9.024e-01 -0.231 0.817410

stateID -8.705e-01 7.474e-01 -1.165 0.244100

stateIL 2.382e-01 8.340e-01 0.286 0.775165

stateIN -4.410e-01 7.526e-01 -0.586 0.557924

stateKS -1.062e+00 7.296e-01 -1.455 0.145659

stateKY -7.889e-01 7.658e-01 -1.030 0.302931

stateLA -5.546e-01 8.352e-01 -0.664 0.506716

stateMA -1.161e+00 7.430e-01 -1.562 0.118261

stateMD -1.144e+00 7.168e-01 -1.596 0.110430

stateME -1.327e+00 7.281e-01 -1.823 0.068321 .

stateMI -1.390e+00 7.137e-01 -1.948 0.051400 .

stateMN -1.160e+00 7.149e-01 -1.622 0.104709

stateMO -5.979e-01 7.741e-01 -0.772 0.439914

stateMS -1.355e+00 7.278e-01 -1.862 0.062601 .

stateMT -1.865e+00 7.166e-01 -2.603 0.009245 \*\*

stateNC -5.765e-01 7.545e-01 -0.764 0.444822

stateND -1.274e-01 7.969e-01 -0.160 0.872995

stateNE -2.952e-01 8.055e-01 -0.367 0.713984

stateNH -1.160e+00 7.689e-01 -1.509 0.131367

stateNJ -1.572e+00 7.098e-01 -2.215 0.026757 \*

stateNM -4.590e-01 7.867e-01 -0.583 0.559596

stateNV -1.251e+00 7.245e-01 -1.727 0.084198 .

stateNY -1.161e+00 7.191e-01 -1.614 0.106496

stateOH -6.726e-01 7.464e-01 -0.901 0.367508

stateOK -8.660e-01 7.557e-01 -1.146 0.251811

stateOR -7.684e-01 7.354e-01 -1.045 0.296126

statePA -1.141e+00 7.791e-01 -1.464 0.143121

stateRI 1.099e-01 8.198e-01 0.134 0.893337

stateSC -1.747e+00 7.371e-01 -2.370 0.017782 \*

stateSD -8.227e-01 7.607e-01 -1.081 0.279510

stateTN -2.604e-01 8.207e-01 -0.317 0.751071

stateTX -1.637e+00 7.079e-01 -2.313 0.020745 \*

stateUT -1.047e+00 7.435e-01 -1.408 0.159056

stateVA 4.425e-01 8.220e-01 0.538 0.590344

stateVT -8.390e-02 7.799e-01 -0.108 0.914330

stateWA -1.400e+00 7.237e-01 -1.934 0.053081 .

stateWI -2.836e-01 7.798e-01 -0.364 0.716109

stateWV -5.732e-01 7.329e-01 -0.782 0.434139

stateWY -2.952e-01 7.541e-01 -0.391 0.695449

account\_length -9.646e-04 1.434e-03 -0.673 0.501212

area\_codearea\_code\_415 7.876e-02 1.418e-01 0.555 0.578569

area\_codearea\_code\_510 1.016e-01 1.632e-01 0.622 0.533622

international\_planyes -2.192e+00 1.534e-01 -14.294 < 2e-16 \*\*\*

voice\_mail\_planyes 2.131e+00 5.944e-01 3.585 0.000337 \*\*\*

number\_vmail\_messages -3.832e-02 1.865e-02 -2.055 0.039866 \*

total\_day\_minutes 3.823e-01 3.380e+00 0.113 0.909942

total\_day\_calls -4.045e-03 2.862e-03 -1.414 0.157477

total\_day\_charge -2.326e+00 1.988e+01 -0.117 0.906870

total\_eve\_minutes -8.927e-01 1.700e+00 -0.525 0.599510

total\_eve\_calls -1.018e-03 2.890e-03 -0.352 0.724642

total\_eve\_charge 1.041e+01 2.000e+01 0.521 0.602695

total\_night\_minutes 2.228e-01 9.044e-01 0.246 0.805401

total\_night\_calls -1.810e-04 2.928e-03 -0.062 0.950718

total\_night\_charge -5.039e+00 2.010e+01 -0.251 0.802042

total\_intl\_minutes 4.149e+00 5.494e+00 0.755 0.450194

total\_intl\_calls 9.055e-02 2.575e-02 3.516 0.000438 \*\*\*

total\_intl\_charge -1.567e+01 2.035e+01 -0.770 0.441115

number\_customer\_service\_calls -5.366e-01 4.100e-02 -13.089 < 2e-16 \*\*\*

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

Null deviance: 2758.3 on 3332 degrees of freedom

Residual deviance: 2070.8 on 3263 degrees of freedom

AIC: 2210.8

Number of Fisher Scoring iterations: 6

> library(MASS)

> step\_fit <- stepAIC(fit,method='backward')

Start: AIC=2210.8

churn ~ state + account\_length + area\_code + international\_plan +

voice\_mail\_plan + number\_vmail\_messages + total\_day\_minutes +

total\_day\_calls + total\_day\_charge + total\_eve\_minutes +

total\_eve\_calls + total\_eve\_charge + total\_night\_minutes +

total\_night\_calls + total\_night\_charge + total\_intl\_minutes +

total\_intl\_calls + total\_intl\_charge + number\_customer\_service\_calls

Df Deviance AIC

- state 50 2158.3 2198.3

- area\_code 2 2071.2 2207.2

- total\_night\_calls 1 2070.8 2208.8

- total\_day\_minutes 1 2070.8 2208.8

- total\_day\_charge 1 2070.8 2208.8

- total\_night\_minutes 1 2070.9 2208.9

- total\_night\_charge 1 2070.9 2208.9

- total\_eve\_calls 1 2070.9 2208.9

- total\_eve\_charge 1 2071.1 2209.1

- total\_eve\_minutes 1 2071.1 2209.1

- account\_length 1 2071.3 2209.3

- total\_intl\_minutes 1 2071.4 2209.4

- total\_intl\_charge 1 2071.4 2209.4

<none> 2070.8 2210.8

- total\_day\_calls 1 2072.8 2210.8

- number\_vmail\_messages 1 2075.1 2213.1

- total\_intl\_calls 1 2083.9 2221.9

- voice\_mail\_plan 1 2084.9 2222.9

- number\_customer\_service\_calls 1 2250.7 2388.7

- international\_plan 1 2272.4 2410.4

Step: AIC=2198.28

churn ~ account\_length + area\_code + international\_plan + voice\_mail\_plan +

number\_vmail\_messages + total\_day\_minutes + total\_day\_calls +

total\_day\_charge + total\_eve\_minutes + total\_eve\_calls +

total\_eve\_charge + total\_night\_minutes + total\_night\_calls +

total\_night\_charge + total\_intl\_minutes + total\_intl\_calls +

total\_intl\_charge + number\_customer\_service\_calls

Df Deviance AIC

- area\_code 2 2158.7 2194.7

- total\_day\_minutes 1 2158.3 2196.3

- total\_day\_charge 1 2158.3 2196.3

- total\_night\_minutes 1 2158.3 2196.3

- total\_night\_charge 1 2158.3 2196.3

- total\_night\_calls 1 2158.3 2196.3

- total\_eve\_calls 1 2158.4 2196.4

- total\_eve\_charge 1 2158.5 2196.5

- total\_eve\_minutes 1 2158.5 2196.5

- account\_length 1 2158.6 2196.6

- total\_intl\_minutes 1 2158.9 2196.9

- total\_intl\_charge 1 2158.9 2196.9

- total\_day\_calls 1 2159.6 2197.6

<none> 2158.3 2198.3

- number\_vmail\_messages 1 2162.3 2200.3

- voice\_mail\_plan 1 2171.8 2209.8

- total\_intl\_calls 1 2172.7 2210.7

- number\_customer\_service\_calls 1 2335.5 2373.5

- international\_plan 1 2347.8 2385.8

Step: AIC=2194.72

churn ~ account\_length + international\_plan + voice\_mail\_plan +

number\_vmail\_messages + total\_day\_minutes + total\_day\_calls +

total\_day\_charge + total\_eve\_minutes + total\_eve\_calls +

total\_eve\_charge + total\_night\_minutes + total\_night\_calls +

total\_night\_charge + total\_intl\_minutes + total\_intl\_calls +

total\_intl\_charge + number\_customer\_service\_calls

Df Deviance AIC

- total\_day\_minutes 1 2158.7 2192.7

- total\_day\_charge 1 2158.7 2192.7

- total\_night\_minutes 1 2158.7 2192.7

- total\_night\_charge 1 2158.8 2192.8

- total\_night\_calls 1 2158.8 2192.8

- total\_eve\_calls 1 2158.9 2192.9

- total\_eve\_charge 1 2159.0 2193.0

- total\_eve\_minutes 1 2159.0 2193.0

- account\_length 1 2159.1 2193.1

- total\_intl\_minutes 1 2159.4 2193.4

- total\_intl\_charge 1 2159.4 2193.4

- total\_day\_calls 1 2160.1 2194.1

<none> 2158.7 2194.7

- number\_vmail\_messages 1 2162.7 2196.7

- voice\_mail\_plan 1 2172.3 2206.3

- total\_intl\_calls 1 2173.3 2207.3

- number\_customer\_service\_calls 1 2335.7 2369.7

- international\_plan 1 2348.3 2382.3

Step: AIC=2192.73

churn ~ account\_length + international\_plan + voice\_mail\_plan +

number\_vmail\_messages + total\_day\_calls + total\_day\_charge +

total\_eve\_minutes + total\_eve\_calls + total\_eve\_charge +

total\_night\_minutes + total\_night\_calls + total\_night\_charge +

total\_intl\_minutes + total\_intl\_calls + total\_intl\_charge +

number\_customer\_service\_calls

Df Deviance AIC

- total\_night\_minutes 1 2158.8 2190.8

- total\_night\_charge 1 2158.8 2190.8

- total\_night\_calls 1 2158.8 2190.8

- total\_eve\_calls 1 2158.9 2190.9

- total\_eve\_charge 1 2159.0 2191.0

- total\_eve\_minutes 1 2159.0 2191.0

- account\_length 1 2159.1 2191.1

- total\_intl\_minutes 1 2159.4 2191.4

- total\_intl\_charge 1 2159.4 2191.4

- total\_day\_calls 1 2160.1 2192.1

<none> 2158.7 2192.7

- number\_vmail\_messages 1 2162.7 2194.7

- voice\_mail\_plan 1 2172.3 2204.3

- total\_intl\_calls 1 2173.3 2205.3

- total\_day\_charge 1 2316.9 2348.9

- number\_customer\_service\_calls 1 2335.7 2367.7

- international\_plan 1 2348.3 2380.3

Step: AIC=2190.75

churn ~ account\_length + international\_plan + voice\_mail\_plan +

number\_vmail\_messages + total\_day\_calls + total\_day\_charge +

total\_eve\_minutes + total\_eve\_calls + total\_eve\_charge +

total\_night\_calls + total\_night\_charge + total\_intl\_minutes +

total\_intl\_calls + total\_intl\_charge + number\_customer\_service\_calls

Df Deviance AIC

- total\_night\_calls 1 2158.8 2188.8

- total\_eve\_calls 1 2158.9 2188.9

- total\_eve\_charge 1 2159.0 2189.0

- total\_eve\_minutes 1 2159.0 2189.0

- account\_length 1 2159.1 2189.1

- total\_intl\_minutes 1 2159.4 2189.4

- total\_intl\_charge 1 2159.4 2189.4

- total\_day\_calls 1 2160.1 2190.1

<none> 2158.8 2190.8

- number\_vmail\_messages 1 2162.8 2192.8

- total\_night\_charge 1 2169.9 2199.9

- voice\_mail\_plan 1 2172.3 2202.3

- total\_intl\_calls 1 2173.4 2203.4

- total\_day\_charge 1 2316.9 2346.9

- number\_customer\_service\_calls 1 2335.9 2365.9

- international\_plan 1 2348.3 2378.3

Step: AIC=2188.81

churn ~ account\_length + international\_plan + voice\_mail\_plan +

number\_vmail\_messages + total\_day\_calls + total\_day\_charge +

total\_eve\_minutes + total\_eve\_calls + total\_eve\_charge +

total\_night\_charge + total\_intl\_minutes + total\_intl\_calls +

total\_intl\_charge + number\_customer\_service\_calls

Df Deviance AIC

- total\_eve\_calls 1 2159.0 2187.0

- total\_eve\_charge 1 2159.1 2187.1

- total\_eve\_minutes 1 2159.1 2187.1

- account\_length 1 2159.2 2187.2

- total\_intl\_minutes 1 2159.5 2187.5

- total\_intl\_charge 1 2159.5 2187.5

- total\_day\_calls 1 2160.1 2188.1

<none> 2158.8 2188.8

- number\_vmail\_messages 1 2162.8 2190.8

- total\_night\_charge 1 2170.0 2198.0

- voice\_mail\_plan 1 2172.3 2200.3

- total\_intl\_calls 1 2173.4 2201.4

- total\_day\_charge 1 2317.3 2345.3

- number\_customer\_service\_calls 1 2335.9 2363.9

- international\_plan 1 2348.6 2376.6

Step: AIC=2186.96

churn ~ account\_length + international\_plan + voice\_mail\_plan +

number\_vmail\_messages + total\_day\_calls + total\_day\_charge +

total\_eve\_minutes + total\_eve\_charge + total\_night\_charge +

total\_intl\_minutes + total\_intl\_calls + total\_intl\_charge +

number\_customer\_service\_calls

Df Deviance AIC

- total\_eve\_charge 1 2159.2 2185.2

- total\_eve\_minutes 1 2159.2 2185.2

- account\_length 1 2159.3 2185.3

- total\_intl\_minutes 1 2159.6 2185.6

- total\_intl\_charge 1 2159.7 2185.7

- total\_day\_calls 1 2160.3 2186.3

<none> 2159.0 2187.0

- number\_vmail\_messages 1 2162.9 2188.9

- total\_night\_charge 1 2170.1 2196.1

- voice\_mail\_plan 1 2172.4 2198.4

- total\_intl\_calls 1 2173.5 2199.5

- total\_day\_charge 1 2317.7 2343.7

- number\_customer\_service\_calls 1 2336.0 2362.0

- international\_plan 1 2348.7 2374.7

Step: AIC=2185.2

churn ~ account\_length + international\_plan + voice\_mail\_plan +

number\_vmail\_messages + total\_day\_calls + total\_day\_charge +

total\_eve\_minutes + total\_night\_charge + total\_intl\_minutes +

total\_intl\_calls + total\_intl\_charge + number\_customer\_service\_calls

Df Deviance AIC

- account\_length 1 2159.6 2183.6

- total\_intl\_minutes 1 2159.9 2183.9

- total\_intl\_charge 1 2159.9 2183.9

- total\_day\_calls 1 2160.5 2184.5

<none> 2159.2 2185.2

- number\_vmail\_messages 1 2163.1 2187.1

- total\_night\_charge 1 2170.4 2194.4

- voice\_mail\_plan 1 2172.6 2196.6

- total\_intl\_calls 1 2173.7 2197.7

- total\_eve\_minutes 1 2200.5 2224.5

- total\_day\_charge 1 2318.3 2342.3

- number\_customer\_service\_calls 1 2336.4 2360.4

- international\_plan 1 2348.8 2372.8

Step: AIC=2183.56

churn ~ international\_plan + voice\_mail\_plan + number\_vmail\_messages +

total\_day\_calls + total\_day\_charge + total\_eve\_minutes +

total\_night\_charge + total\_intl\_minutes + total\_intl\_calls +

total\_intl\_charge + number\_customer\_service\_calls

Df Deviance AIC

- total\_intl\_minutes 1 2160.2 2182.2

- total\_intl\_charge 1 2160.3 2182.3

- total\_day\_calls 1 2160.9 2182.9

<none> 2159.6 2183.6

- number\_vmail\_messages 1 2163.5 2185.5

- total\_night\_charge 1 2170.7 2192.7

- voice\_mail\_plan 1 2172.9 2194.9

- total\_intl\_calls 1 2174.0 2196.0

- total\_eve\_minutes 1 2200.7 2222.7

- total\_day\_charge 1 2318.8 2340.8

- number\_customer\_service\_calls 1 2337.1 2359.1

- international\_plan 1 2349.9 2371.9

Step: AIC=2182.24

churn ~ international\_plan + voice\_mail\_plan + number\_vmail\_messages +

total\_day\_calls + total\_day\_charge + total\_eve\_minutes +

total\_night\_charge + total\_intl\_calls + total\_intl\_charge +

number\_customer\_service\_calls

Df Deviance AIC

- total\_day\_calls 1 2161.6 2181.6

<none> 2160.2 2182.2

- number\_vmail\_messages 1 2164.1 2184.1

- total\_night\_charge 1 2171.4 2191.4

- voice\_mail\_plan 1 2173.5 2193.5

- total\_intl\_calls 1 2174.5 2194.5

- total\_intl\_charge 1 2179.2 2199.2

- total\_eve\_minutes 1 2201.3 2221.3

- total\_day\_charge 1 2319.8 2339.8

- number\_customer\_service\_calls 1 2337.7 2357.7

- international\_plan 1 2350.0 2370.0

Step: AIC=2181.62

churn ~ international\_plan + voice\_mail\_plan + number\_vmail\_messages +

total\_day\_charge + total\_eve\_minutes + total\_night\_charge +

total\_intl\_calls + total\_intl\_charge + number\_customer\_service\_calls

Df Deviance AIC

<none> 2161.6 2181.6

- number\_vmail\_messages 1 2165.5 2183.5

- total\_night\_charge 1 2172.9 2190.9

- voice\_mail\_plan 1 2175.0 2193.0

- total\_intl\_calls 1 2176.1 2194.1

- total\_intl\_charge 1 2180.7 2198.7

- total\_eve\_minutes 1 2202.3 2220.3

- total\_day\_charge 1 2321.6 2339.6

- number\_customer\_service\_calls 1 2338.5 2356.5

- international\_plan 1 2351.2 2369.2

> summary(step\_fit)

Call:

glm(formula = churn ~ international\_plan + voice\_mail\_plan +

number\_vmail\_messages + total\_day\_charge + total\_eve\_minutes +

total\_night\_charge + total\_intl\_calls + total\_intl\_charge +

number\_customer\_service\_calls, family = binomial(link = "logit"),

data = churnTrain)

Deviance Residuals:

Min 1Q Median 3Q Max

-3.2421 0.1969 0.3375 0.5133 2.1204

Coefficients:

Estimate Std. Error z value Pr(>|z|)

(Intercept) 8.067161 0.515870 15.638 < 2e-16 \*\*\*

international\_planyes -2.040338 0.145243 -14.048 < 2e-16 \*\*\*

voice\_mail\_planyes 2.003234 0.572352 3.500 0.000465 \*\*\*

number\_vmail\_messages -0.035262 0.017964 -1.963 0.049654 \*

total\_day\_charge -0.076589 0.006371 -12.022 < 2e-16 \*\*\*

total\_eve\_minutes -0.007182 0.001142 -6.290 3.17e-10 \*\*\*

total\_night\_charge -0.082547 0.024653 -3.348 0.000813 \*\*\*

total\_intl\_calls 0.092176 0.024988 3.689 0.000225 \*\*\*

total\_intl\_charge -0.326138 0.075453 -4.322 1.54e-05 \*\*\*

number\_customer\_service\_calls -0.512256 0.039141 -13.087 < 2e-16 \*\*\*

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

Null deviance: 2758.3 on 3332 degrees of freedom

Residual deviance: 2161.6 on 3323 degrees of freedom

AIC: 2181.6

Number of Fisher Scoring iterations: 6

> confint(step\_fit)

Waiting for profiling to be done...

2.5 % 97.5 %

(Intercept) 7.070889530 9.0938386274

international\_planyes -2.326003857 -1.7562369114

voice\_mail\_planyes 0.907323062 3.1529598406

number\_vmail\_messages -0.070725900 -0.0002376739

total\_day\_charge -0.089209954 -0.0642271566

total\_eve\_minutes -0.009433875 -0.0049559927

total\_night\_charge -0.131007646 -0.0343300642

total\_intl\_calls 0.043965614 0.1419403277

total\_intl\_charge -0.474987860 -0.1790890316

number\_customer\_service\_calls -0.589558964 -0.4360233938

> #ANOVA on base model

> anova(fit,test = 'Chisq')

Analysis of Deviance Table

Model: binomial, link: logit

Response: churn

Terms added sequentially (first to last)

Df Deviance Resid. Df Resid. Dev Pr(>Chi)

NULL 3332 2758.3

state 50 83.184 3282 2675.1 0.0022252 \*\*

account\_length 1 1.221 3281 2673.9 0.2691078

area\_code 2 0.081 3279 2673.8 0.9602791

international\_plan 1 175.984 3278 2497.8 < 2.2e-16 \*\*\*

voice\_mail\_plan 1 43.206 3277 2454.6 4.928e-11 \*\*\*

number\_vmail\_messages 1 3.785 3276 2450.8 0.0517159 .

total\_day\_minutes 1 130.345 3275 2320.5 < 2.2e-16 \*\*\*

total\_day\_calls 1 1.314 3274 2319.2 0.2516785

total\_day\_charge 1 0.020 3273 2319.2 0.8879159

total\_eve\_minutes 1 31.752 3272 2287.4 1.752e-08 \*\*\*

total\_eve\_calls 1 0.177 3271 2287.2 0.6738425

total\_eve\_charge 1 0.610 3270 2286.6 0.4348650

total\_night\_minutes 1 8.859 3269 2277.8 0.0029160 \*\*

total\_night\_calls 1 0.023 3268 2277.7 0.8793045

total\_night\_charge 1 0.385 3267 2277.3 0.5348351

total\_intl\_minutes 1 12.482 3266 2264.9 0.0004108 \*\*\*

total\_intl\_calls 1 13.740 3265 2251.1 0.0002099 \*\*\*

total\_intl\_charge 1 0.472 3264 2250.7 0.4919867

number\_customer\_service\_calls 1 179.849 3263 2070.8 < 2.2e-16 \*\*\*

---

Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

> #ANOVA from reduced model after applying the Step AIC

> anova(step\_fit,test = 'Chisq')

Analysis of Deviance Table

Model: binomial, link: logit

Response: churn

Terms added sequentially (first to last)

Df Deviance Resid. Df Resid. Dev Pr(>Chi)

NULL 3332 2758.3

international\_plan 1 170.400 3331 2587.9 < 2.2e-16 \*\*\*

voice\_mail\_plan 1 41.868 3330 2546.0 9.765e-11 \*\*\*

number\_vmail\_messages 1 3.638 3329 2542.4 0.0564756 .

total\_day\_charge 1 135.452 3328 2406.9 < 2.2e-16 \*\*\*

total\_eve\_minutes 1 30.874 3327 2376.1 2.753e-08 \*\*\*

total\_night\_charge 1 8.500 3326 2367.6 0.0035509 \*\*

total\_intl\_calls 1 12.887 3325 2354.7 0.0003309 \*\*\*

total\_intl\_charge 1 16.210 3324 2338.5 5.668e-05 \*\*\*

number\_customer\_service\_calls 1 176.839 3323 2161.6 < 2.2e-16 \*\*\*

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

> #plot the fitted model

> plot(fit$fitted.values)

