Final project

Due April 30, 2021

```
library(tidyverse)
```

```
## -- Attaching packages --------------------------------------------------------- tidyverse 1.3.0 --

## v ggplot2 3.3.2     v purrr   0.3.4
## v tibble  3.0.3     v dplyr   1.0.2
## v tidyr   1.1.1     v stringr 1.4.0
## v readr   1.3.1     v forcats 0.5.0

## -- Conflicts ------------------------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
library(data.table)
```

```
##
## Attaching package: 'data.table'

## The following objects are masked from 'package:dplyr':
##
##     between, first, last

## The following object is masked from 'package:purrr':
##
##     transpose
```

```
library(mlr)
```

```
## Loading required package: ParamHelpers

## 'mlr' is in maintenance mode since July 2019. Future development
## efforts will go into its successor 'mlr3' (<https://mlr3.mlr-org.com>).
```

```
library(dplyr)
library(randomForest)
```

```
## Warning: package 'randomForest' was built under R version 4.0.5

## randomForest 4.6-14
```

```
## Type rfNews() to see new features/changes/bug fixes.

##
## Attaching package: 'randomForest'

## The following object is masked from 'package:dplyr':
##
##     combine

## The following object is masked from 'package:ggplot2':
##
##     margin
```

```
library(rpart)

data <- read.csv("NIS2012-200k.csv", header = TRUE, stringsAsFactors = TRUE)

data.dt <- data.frame(data)
```

The final project requires that you build a predictive model based on real data – your own or the provided National Impatient data– and a paper-style short report (2-3 of pages long) describing the problem, the approach(es) taken, and the results. Below is a *guideline* structure for the report. You should use the section breakdown into intro, methods, results, conclusions/discussion but don't have to necessarily include every element listed below within those sections. And you may want to include elements not listed below. Use your judgement.

Introduction

The National Impatient Sample (NIS) data, collected by the Healthcare Cost and Utilization Project (HCUP), is the largest publicly available dataset that contains information on inpatient healthcare in hospitals throughout the United States. The NIS is used by policymakers and health officials to make national estimates of healthcare utilization, and observe key features of inpatient care. The NIS was first started in 1998 by the Healthcare Cost and Utilization Project, and contains information such as patient demographics, classification of diseases, total hospital bill, length of stay, and many other features that characterize hospital care. The goal of this assignment will be to build a model to predict impatient mortality an determine what factors contribute a increased risk of death during hospitalization.

The data that will be used in this assignment consists of a random subset of 200,000 patients from the 2012 National Impatient Sample. The data was taken from the Healthcare Cost and Ultilization Project (HCUP), which is the largest collection of hospital care data in the United States. The data was taken from discharge records from all hospitals that are participating with the HCUP, and use state guidelines to help identify the hospitals that qualify for the data collection process. 47 states and the District of Columbia participate in the NIS, and data is available for hospitals in those states. The outcome of interest is the inpatient mortality, of whether the patient died during the period of hospitalization. Features such as patient demographic, severity of disease, risk of mortality, and comorbidities were incorpated to determine if a patient was likely to die during hospitalization. This can be used to identify features that increase the risk of patient mortality in hospitals and seek to prevent such deaths in the future.

1. Describe the problem explaining in particular why prediction is of primary interest (inference could also be of interest but there has to be a good reason for wanting to predict a particular outcome)
2. Describe the data (e.g. data source, data collection, outcome of interest, available features, sample size, missing data, etc.)

Methods

First the relevant features to the outcome of interest was sorted out from the 175 original features that were present.

Then then data was then reevaluated and factors were added when necessary.

1. Describe any data pre-processing steps (e.g. cleaning, recoding, variable transformation, dealing with missing data, selection of features to be included in your models, etc)

Out of the 175 possible features that were present in the original dataset, only 44 variables were selected to be included in analysis and model building. These 44 include data regarding patient demographics (age, race, gender), comorbidities (such as alcohol abuse and COPD), and the risks of patient mortality. Each variable was examined and was made into factor variables as was appropriate. A majority of the features were converted into dummy variables, however some remained as strings and integers. In examining the missing data, there was less than 1% of the total sample size that was missing from the target variable, whether the patient died. Because the sample was small compared to the dataset, the missing values of the target variable were removed before the analysis.

2. Briefly describe the Machine learning methods you will be using and why they are appropriate for your data (e.g. given the sample size and dimensionality of your training data, are you more concerned about bias or variance?) You should try and compare at least 3 distinct appropriate methods.
3. Describe how you are splitting the data into testing and training and any resampling strategy used for comparing methods, tuning parameters, and/or model/feature selection.

Logistic Regression

I will be comparing 3 different methods to build a predictive model for patient mortality. The first will be logistic regression model. The logistic regression model is one of the most commonly used and basic binary classifiers. Because the desired goal is to determine if a patient died during their hospitalization, the outcome is a binary outcome. Given the extremely large sample size of the data with around 200,000 observations, both the training and testing sets will be large enough to ensure an accurate prediction model.

Forward selection was used to determine the features that will be included in the logistic regression model. According to the forward selection process, only the **APRDRG_Risk_Mortality**, a factor variable that characterizes the risk of patient mortality, was determined to be significant in the data. However, the race variable was also included to determine the effect of patient demographics on mortality. There will only be a couple of features included in the actual logistic prediction model, therefore the model will be a simpler one indicating that the model will have a higher bias. However, the large sample size of the data and the use of cross validation will be used to determine the accuracy of the results.

```
library('pROC')
```

```
## Type 'citation("pROC")' for a citation.

##
## Attaching package: 'pROC'

## The following objects are masked from 'package:stats':
##
##     cov, smooth, var
```

```
data_glm <- glm(DIED~APRDRG_Risk_Mortality + RACE, family = 'binomial',data = forward_log_data[log_trai

pred_glm <- factor(predict(data_glm,newdata = forward_log_data[log_test, ],type = 'response') >0.5)


predict_prob_train <- predict(data_glm, newdata = forward_log_data[log_train, ])
predict_prob_test <- predict(data_glm,newdata = forward_log_data[log_test, ])

roc_glm_train <- roc(forward_log_data[log_train,]$DIED,predict_prob_train, ci = TRUE, of = 'auc')
```

```
## Setting levels: control = Alive, case = Died
```

```
## Setting direction: controls < cases
```

```
roc_glm_test <- roc(forward_log_data[log_test, ]$DIED,predict_prob_test, ci = TRUE, of = 'auc')
```

```
## Setting levels: control = Alive, case = Died
## Setting direction: controls < cases
```

Balanced Random Forests

The data itself is very unbalanced, with 184,598 patients that were successfully discharged compared to the 3,412 that died in the hospital. This could lead to an optimistically low misclassification error. Therefore, balanced random forests will be used to help rebalance the two binary outcomes.

```
library(randomForest)


data_rf <- randomForest(DIED~.,data = refine_data[log_train, ],
                        mtry = sqrt(44),
                        ntree = 500,
                        strata = refine_data$DIED,
                        sampsize = c(2274,2274))

data_rf
```

```
##
## Call:
##  randomForest(formula = DIED ~ ., data = refine_data[log_train,      ], mtry = sqrt(44), ntree = 500
##                Type of random forest: classification
##                      Number of trees: 500
## No. of variables tried at each split: 7
##
##         OOB estimate of  error rate: 1.69%
## Confusion matrix:
##        Alive Died  class.error
## Alive 123035   30 0.0002437736
## Died    2088  186 0.9182058047
```

```
rf_roc_train <- roc(refine_data[log_train, ]$DIED, data_rf$votes[,1])
```

```
## Setting levels: control = Alive, case = Died
```

```
## Setting direction: controls > cases
```

```
auc(rf_roc_train)
```

```
## Area under the curve: 0.9355
```

```
rf_predict_test <- predict(data_rf,
                           newdata = refine_data[log_test, ],
                           type = 'prob')

rf_roc_test <- roc(refine_data[log_test, ]$DIED,rf_predict_test[,1])
```

```
## Setting levels: control = Alive, case = Died
## Setting direction: controls > cases
```

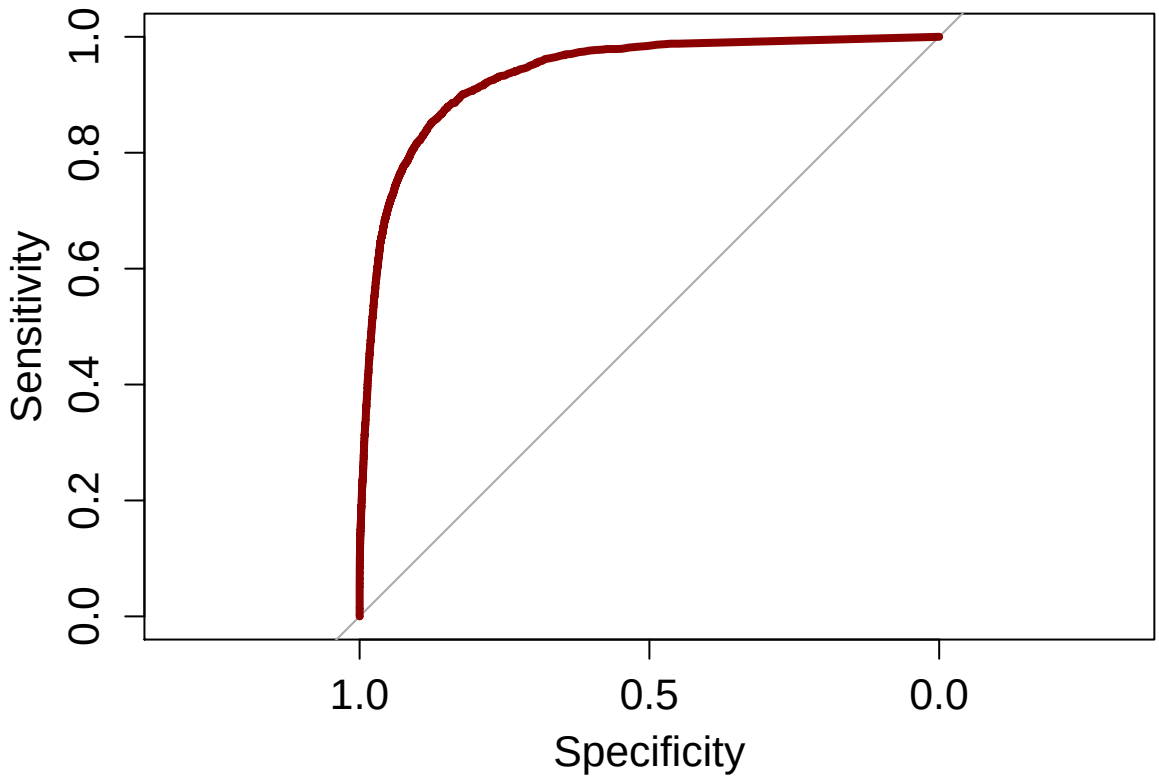
```
auc(rf_roc_test)
```

```
## Area under the curve: 0.9304
```

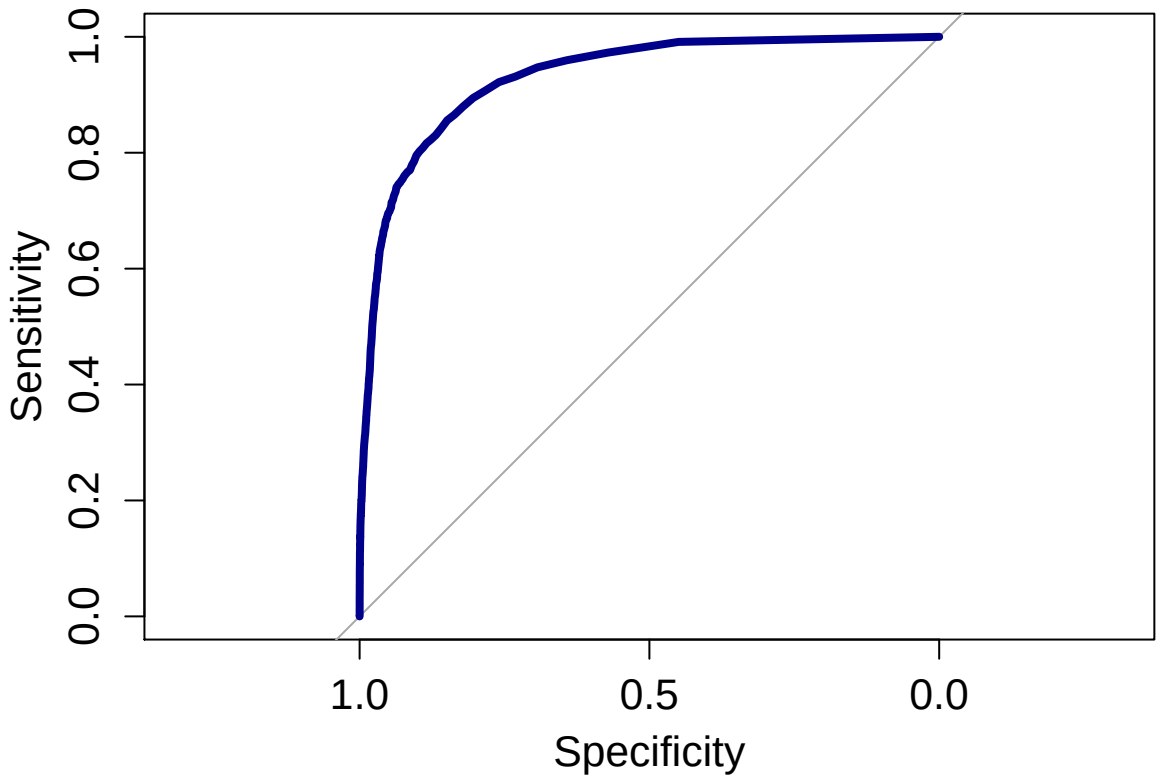
```
ci(rf_roc_test)
```

```
## 95% CI: 0.9233-0.9374 (DeLong)
```

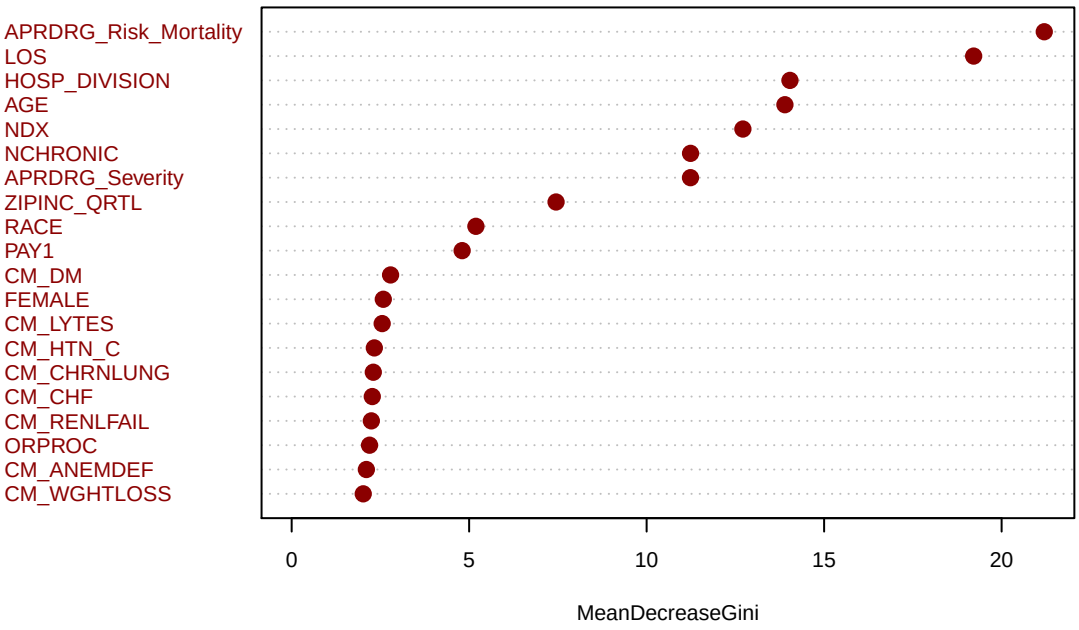
```
plot(rf_roc_train, lwd = 4, col = 'red4',cex.axis = 1.3, cex.lab = 1.3)
```




```
plot(rf_roc_test,lwd = 4, col = 'blue4', cex.axis = 1.3, cex.lab = 1.3)
```




```
varImpPlot(data_rf, cex = 0.7, pt.cex = 1.2, n.var = 20, main = "", pch = 16, col = 'red4')
```




```
library('pROC')
data_glm <- glm(DIED~APRDRG_Risk_Mortality + RACE, family = 'binomial',data = forward_log_data[log_train

pred_glm <- factor(predict(data_glm,newdata = forward_log_data[log_test, ],type = 'response') >0.5)


predict_prob_train <- predict(data_glm, newdata = forward_log_data[log_train, ])
predict_prob_test <- predict(data_glm,newdata = forward_log_data[log_test, ])

roc_glm_train <- roc(forward_log_data[log_train,]$DIED,predict_prob_train, ci = TRUE, of = 'auc')
```

```
## Setting levels: control = Alive, case = Died
```

```
## Setting direction: controls < cases
```

```
roc_glm_test <- roc(forward_log_data[log_test, ]$DIED,predict_prob_test, ci = TRUE, of = 'auc')
```

```
## Setting levels: control = Alive, case = Died
## Setting direction: controls < cases
```

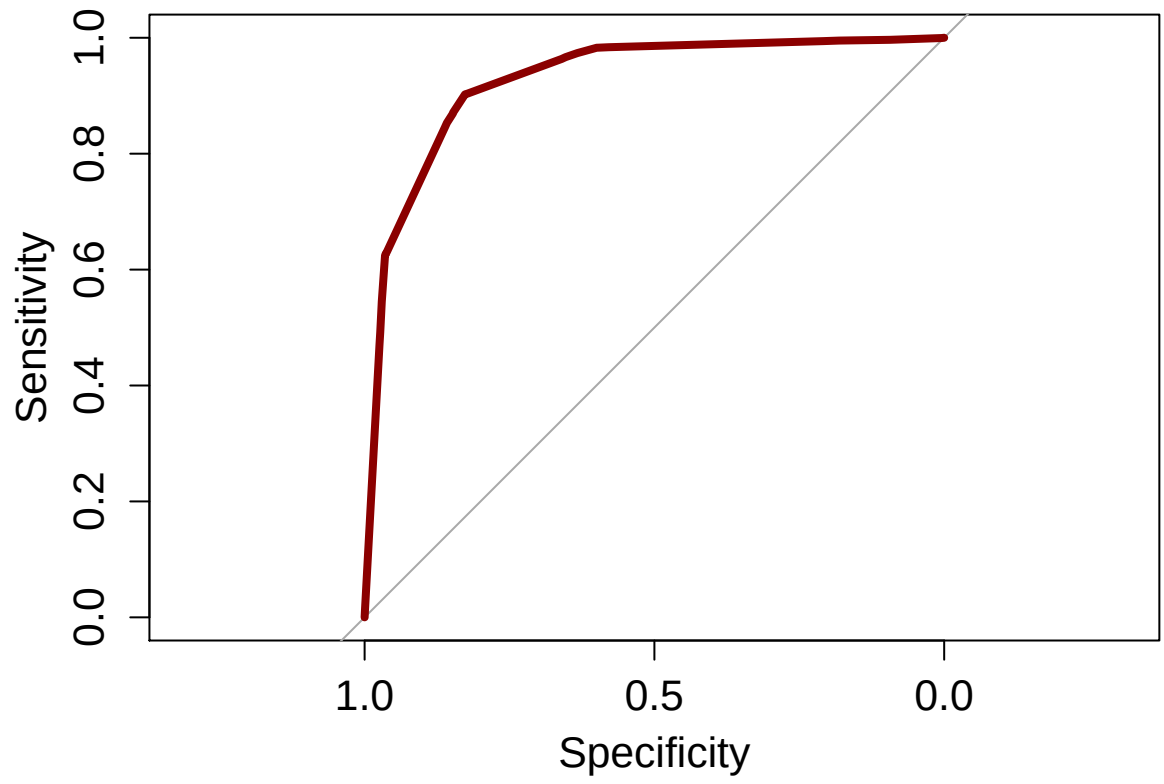
```
auc(roc_glm_train)
```

```
## Area under the curve: 0.9265
```

```
ci(roc_glm_train)
```

```
## 95% CI: 0.9216-0.9313 (DeLong)
```

```
plot(roc_glm_train, lwd = 4, col = 'red4',cex.axis = 1.3, cex.lab = 1.3)
```



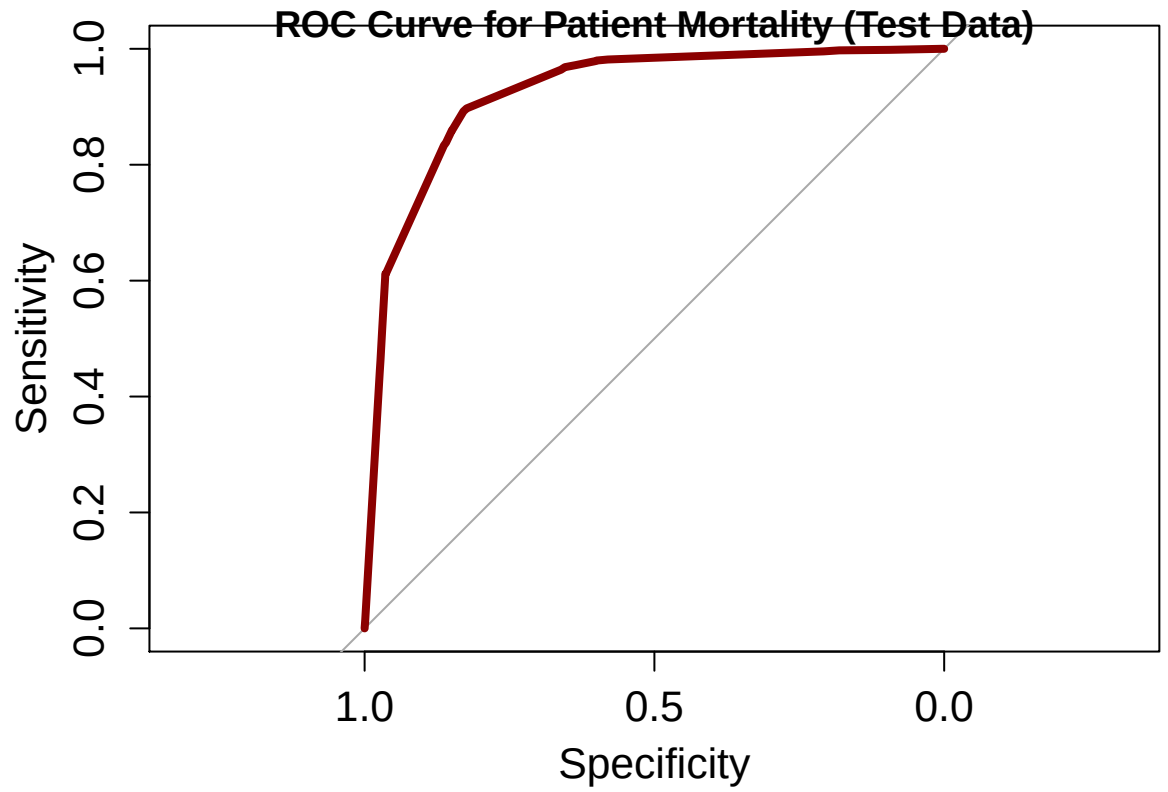

```
auc(roc_glm_test)
```

```
## Area under the curve: 0.9237
```

```
ci(roc_glm_test)
```

```
## 95% CI: 0.917-0.9305 (DeLong)
```

```
#have the auc of the test data
plot(roc_glm_test,lwd = 4, col = 'red4', cex.axis = 1.3, cex.lab = 1.3)
title(main = "ROC Curve for Patient Mortality (Test Data)")
```




```
#random forest
split_desc <- makeResampleDesc(method = "Holdout",stratify = TRUE)

set.seed(101)
split <- makeResampleInstance(split_desc,data_tsk,split = 0.7)

rf_train <- split$train.inds[[1]];rf_test <- split$test.inds[[1]]

rpart(DIED ~., data = refine_data[rf_train, ], method = "class",control = list(minsplit = 15,minbucket =
```

```
## n= 125339
##
## node), split, n, loss, yval, (yprob)
##       * denotes terminal node
##
##        1) root 125339 2274 Alive (0.981857203 0.018142797)
##          2) APRDRG_Risk_Mortality=Not specified,Minor Likelihood,Moderate Likelihood,Major Likelihood
##            4) APRDRG_Risk_Mortality=Minor Likelihood,Moderate Likelihood 102008  230 Alive (0.997745
##              8) APRDRG_Risk_Mortality=Minor Likelihood 73569   44 Alive (0.999401922 0.000598078) *
##              9) APRDRG_Risk_Mortality=Moderate Likelihood 28439  186 Alive (0.993459686 0.006540314)
##               18) LOS>=2.5 27952  160 Alive (0.994275902 0.005724098)
##                 36) NDX>=3.5 27469  142 Alive (0.994830536 0.005169464)
##                   72) LOS>=3.5 24068   96 Alive (0.996011301 0.003988699) *
##                   73) LOS< 3.5 3401   46 Alive (0.986474566 0.013525434)
##                    146) AGE< 80.5 2483   21 Alive (0.991542489 0.008457511) *
##                    147) AGE>=80.5 918   25 Alive (0.972766885 0.027233115)
```

```
##                     294) NCHRONIC>=2.5 868   18 Alive (0.979262673 0.020737327)
##                       588) PAY1=Medicare,Medicaid,Private,Self-Pay 857   16 Alive (0.981330222 0.018
##                        1176) CM_LIVER=0 852   15 Alive (0.982394366 0.017605634)
##                          2352) APRDRG_Severity=Minor Loss of Function,Moderate Loss of Function 756
##                          2353) APRDRG_Severity=Major Loss of Function 96    5 Alive (0.947916667 0.0
##                            4706) AGE< 91.5 81    2 Alive (0.975308642 0.024691358) *
##                            4707) AGE>=91.5 15    3 Alive (0.800000000 0.200000000)
##                              9414) HOSP_DIVISION=2,4,5,8,9 10    0 Alive (1.000000000 0.000000000) *
##                              9415) HOSP_DIVISION=1,3,6 5    2 Died (0.400000000 0.600000000) *
##                        1177) CM_LIVER=1 5    1 Alive (0.800000000 0.200000000) *
##                       589) PAY1=Other 11    2 Alive (0.818181818 0.181818182) *
##                     295) NCHRONIC< 2.5 50    7 Alive (0.860000000 0.140000000)
##                       590) HOSP_DIVISION=2,5,6,7,9 41    2 Alive (0.951219512 0.048780488) *
##                       591) HOSP_DIVISION=3,4,8 9    4 Died (0.444444444 0.555555556) *
##                  37) NDX< 3.5 483   18 Alive (0.962732919 0.037267081) *
##                19) LOS< 2.5 487   26 Alive (0.946611910 0.053388090)
##                  38) NEOMAT=0,1 470   22 Alive (0.953191489 0.046808511)
##                    76) APRDRG_Severity=Minor Loss of Function,Moderate Loss of Function 390   13 Alive
##                     152) AGE< 91 365   10 Alive (0.972602740 0.027397260)
##                       304) HOSP_DIVISION=1,3,4,6,8,9 205    2 Alive (0.990243902 0.009756098) *
##                       305) HOSP_DIVISION=2,5,7 160    8 Alive (0.950000000 0.050000000)
##                         610) NDX< 13.5 143    5 Alive (0.965034965 0.034965035)
##                          1220) ZIPINC_QRTL=,1,2 91    1 Alive (0.989010989 0.010989011) *
##                          1221) ZIPINC_QRTL=3,4 52    4 Alive (0.923076923 0.076923077)
##                            2442) AGE< 64.5 24    0 Alive (1.000000000 0.000000000) *
##                            2443) AGE>=64.5 28    4 Alive (0.857142857 0.142857143)
##                              4886) AGE>=67 23    1 Alive (0.956521739 0.043478261) *
##                              4887) AGE< 67 5    2 Died (0.400000000 0.600000000) *
##                         611) NDX>=13.5 17    3 Alive (0.823529412 0.176470588) *
##                     153) AGE>=91 25    3 Alive (0.880000000 0.120000000) *
##                    77) APRDRG_Severity=Major Loss of Function,Extreme Loss of Function 80    9 Alive
##                  39) NEOMAT=2 17    4 Alive (0.764705882 0.235294118) *
##               5) APRDRG_Risk_Mortality=Not specified,Major Likelihood 17597  619 Alive (0.964823549 0.03
##                10) LOS>=2.5 17364  553 Alive (0.968152499 0.031847501)
##                  20) LOS>=3.5 16370  456 Alive (0.972144166 0.027855834)
##                    40) APRDRG_Severity=Not specified,Minor Loss of Function,Moderate Loss of Function,Ma
##                      80) AGE< 89.5 12662  265 Alive (0.979071237 0.020928763)
##                       160) ORPROC>=0.5 2479   26 Alive (0.989511900 0.010488100) *
##                       161) ORPROC< 0.5 10183  239 Alive (0.976529510 0.023470490)
##                         322) NEOMAT=0,1 10146  234 Alive (0.976936724 0.023063276)
##                           644) CM_METS=0 9424  200 Alive (0.978777589 0.021222411)
##                            1288) AGE< 50.5 1156    7 Alive (0.993944637 0.006055363) *
##                            1289) AGE>=50.5 8268  193 Alive (0.976656991 0.023343009)
##                              2578) PAY1=Medicare,Medicaid,Self-Pay,No Charge 7328  154 Alive (0.9789847
##                                5156) APRDRG_Severity=Not specified,Minor Loss of Function,Moderate Loss
##                                5157) APRDRG_Severity=Major Loss of Function 6121  145 Alive (0.9763110
##                                 10314) HOSP_DIVISION=1,3,5,7,8,9 4423   87 Alive (0.980330093 0.0196699
##                                   20628) AGE< 87.5 4063   73 Alive (0.982032981 0.017967019) *
##                                   20629) AGE>=87.5 360   14 Alive (0.961111111 0.038888889)
##                                     41258) HOSP_DIVISION=1,3,7,8,9 294    8 Alive (0.972789116 0.027210
##                                     41259) HOSP_DIVISION=5 66    6 Alive (0.909090909 0.090909091)
##                                       82518) AGE>=88.5 24    0 Alive (1.000000000 0.000000000) *
##                                       82519) AGE< 88.5 42    6 Alive (0.857142857 0.142857143)
##                                        165038) NCHRONIC< 7.5 22    1 Alive (0.954545455 0.045454545) *
```

```
##                                   165039) NCHRONIC>=7.5 20    5 Alive (0.750000000 0.250000000)
##                                     330078) NCHRONIC>=9.5 13    1 Alive (0.923076923 0.076923077) *
##                                     330079) NCHRONIC< 9.5 7    3 Died (0.428571429 0.571428571) *
##                                 10315) HOSP_DIVISION=2,4,6 1698   58 Alive (0.965842167 0.034157833)
##                                   20630) RACE=Black,Hispanic,Asian,Native American 297    3 Alive (0.98
##                                   20631) RACE=White,Other 1401   55 Alive (0.960742327 0.039257673)
##                                     41262) LOS>=86.5 804   23 Alive (0.971393035 0.028606965)
##                                       82524) NDX< 17.5 493    7 Alive (0.985801217 0.014198783) *
##                                       82525) NDX>=17.5 311   16 Alive (0.948553055 0.051446945)
##                                         165050) HOSP_DIVISION=4,6 204    6 Alive (0.970588235 0.02941176
##                                         165051) HOSP_DIVISION=2 107   10 Alive (0.906542056 0.093457944)
##                                           330102) ZIPINC_QRTL=,2,3,4 86    5 Alive (0.941860465 0.058139
##                                           330103) ZIPINC_QRTL=1 21    5 Alive (0.761904762 0.238095238)
##                                             660206) CM_COAG=1 6    0 Alive (1.000000000 0.000000000) *
##                                             660207) CM_COAG=0 15    5 Alive (0.666666667 0.333333333)
##                                               1320414) LOS>=116.5 8    1 Alive (0.875000000 0.125000000) *
##                                               1320415) LOS< 116.5 7    3 Died (0.428571429 0.571428571) *
##                                     41263) LOS< 86.5 597   32 Alive (0.946398660 0.053601340) *
##                                   2579) PAY1=Private,Other 940   39 Alive (0.958510638 0.041489362) *
##                                 645) CM_METS=1 722   34 Alive (0.952908587 0.047091413) *
##                               323) NEOMAT=2 37    5 Alive (0.864864865 0.135135135) *
##                             81) AGE>=89.5 1579   75 Alive (0.952501583 0.047498417)
##                              162) PAY1=Medicare,Medicaid,Private 1561   71 Alive (0.954516336 0.045483664) *
##                              163) PAY1=Self-Pay,Other 18    4 Alive (0.777777778 0.222222222)
##                                326) ZIPINC_QRTL=,1,3 13    1 Alive (0.923076923 0.076923077) *
##                                327) ZIPINC_QRTL=2,4 5    2 Died (0.400000000 0.600000000) *
##                           41) APRDRG_Severity=Extreme Loss of Function 2129  116 Alive (0.945514326 0.05448567
##                             82) CM_METS=0 2019  101 Alive (0.949975235 0.050024765)
##                              164) AGE< 80.5 1639   68 Alive (0.958511287 0.041488713)
##                                328) NDX>=5.5 1625   65 Alive (0.960000000 0.040000000)
##                                  656) CM_LYMPH=0 1577   60 Alive (0.961953075 0.038046925)
##                                   1312) HOSP_DIVISION=1,4,6 288    4 Alive (0.986111111 0.013888889) *
##                                   1313) HOSP_DIVISION=2,3,5,7,8,9 1289   56 Alive (0.956555469 0.043444531)
##                                     2626) FEMALE=1,C 569   16 Alive (0.971880492 0.028119508) *
##                                     2627) FEMALE=0 720   40 Alive (0.944444444 0.055555556)
##                                       5254) CM_TUMOR=0 699   36 Alive (0.948497854 0.051502146)
##                                         10508) LOS>=63 479   19 Alive (0.960334029 0.039665971)
##                                           21016) ORPROC>=0.5 136    1 Alive (0.992647059 0.007352941) *
##                                           21017) ORPROC< 0.5 343   18 Alive (0.947521866 0.052478134)
##                                             42034) CM_ALCOHOL=0 294   13 Alive (0.955782313 0.044217687) *
##                                             42035) CM_ALCOHOL=1 49    5 Alive (0.897959184 0.102040816)
##                                               84070) LOS< 127.5 31    0 Alive (1.000000000 0.000000000) *
##                                               84071) LOS>=127.5 18    5 Alive (0.722222222 0.277777778)
##                                                 168142) CM_LIVER=0 13    2 Alive (0.846153846 0.153846154) *
##                                                 168143) CM_LIVER=1 5    2 Died (0.400000000 0.600000000) *
##                                         10509) LOS< 63 220   17 Alive (0.922727273 0.077272727)
##                                           21018) CM_PULMCIRC=0 202   13 Alive (0.935643564 0.064356436)
##                                             42036) NDX< 23.5 169    8 Alive (0.952662722 0.047337278) *
##                                             42037) NDX>=23.5 33    5 Alive (0.848484848 0.151515152)
##                                               84074) NDX>=26 12    0 Alive (1.000000000 0.000000000) *
##                                               84075) NDX< 26 21    5 Alive (0.761904762 0.238095238)
##                                                 168150) HOSP_DIVISION=3,7,8,9 16    2 Alive (0.875000000 0.12500
##                                                 168151) HOSP_DIVISION=2,5 5    2 Died (0.400000000 0.600000000) *
##                                           21019) CM_PULMCIRC=1 18    4 Alive (0.777777778 0.222222222) *
```

```
##                           5255) CM_TUMOR=1 21    4 Alive (0.809523810 0.190476190) *
##                         657) CM_LYMPH=1 48    5 Alive (0.895833333 0.104166667) *
##                       329) NDX< 5.5 14    3 Alive (0.785714286 0.214285714) *
##                     165) AGE>=80.5 380   33 Alive (0.913157895 0.086842105)
##                       330) LOS>=82 217   13 Alive (0.940092166 0.059907834)
##                         660) AGE>=86.5 107    3 Alive (0.971962617 0.028037383) *
##                         661) AGE< 86.5 110   10 Alive (0.909090909 0.090909091)
##                          1322) AGE< 84.5 74    3 Alive (0.959459459 0.040540541) *
##                          1323) AGE>=84.5 36    7 Alive (0.805555556 0.194444444)
##                            2646) RACE=White,Other 31    4 Alive (0.870967742 0.129032258) *
##                            2647) RACE=Black,Hispanic 5    2 Died (0.400000000 0.600000000) *
##                       331) LOS< 82 163   20 Alive (0.877300613 0.122699387)
##                         662) LOS< 67 115    9 Alive (0.921739130 0.078260870) *
##                         663) LOS>=67 48   11 Alive (0.770833333 0.229166667)
##                          1326) ZIPINC_QRTL=1,3,4 32    4 Alive (0.875000000 0.125000000) *
##                          1327) ZIPINC_QRTL=2 16    7 Alive (0.562500000 0.437500000)
##                            2654) FEMALE=1 11    3 Alive (0.727272727 0.272727273) *
##                            2655) FEMALE=0 5    1 Died (0.200000000 0.800000000) *
##                     83) CM_METS=1 110   15 Alive (0.863636364 0.136363636)
##                     166) NCHRONIC>=3.5 101   11 Alive (0.891089109 0.108910891)
##                       332) CM_CHRNLUNG=0 67    3 Alive (0.955223881 0.044776119) *
##                       333) CM_CHRNLUNG=1 34    8 Alive (0.764705882 0.235294118)
##                         666) CM_LYTES=0 16    1 Alive (0.937500000 0.062500000) *
##                         667) CM_LYTES=1 18    7 Alive (0.611111111 0.388888889)
##                          1334) ZIPINC_QRTL=1 6    0 Alive (1.000000000 0.000000000) *
##                          1335) ZIPINC_QRTL=2,3,4 12    5 Died (0.416666667 0.583333333) *
##                     167) NCHRONIC< 3.5 9    4 Alive (0.555555556 0.444444444) *
##                 21) LOS< 3.5 994   97 Alive (0.902414487 0.097585513)
##                   42) APRDRG_Severity=Not specified,Minor Loss of Function,Moderate Loss of Function,Ma
##                     84) AGE< 91 863   64 Alive (0.925840093 0.074159907)
##                     168) PAY1=Medicare,Medicaid,No Charge 677   41 Alive (0.939438700 0.060561300)
##                       336) NCHRONIC>=2.5 644   34 Alive (0.947204969 0.052795031)
##                         672) HOSP_DIVISION=1,2,3,5,6,8,9 562   24 Alive (0.957295374 0.042704626) *
##                         673) HOSP_DIVISION=4,7 82   10 Alive (0.878048780 0.121951220)
##                          1346) RACE=Black,Hispanic,Asian,Other 21    0 Alive (1.000000000 0.000000000)
##                          1347) RACE=White 61   10 Alive (0.836065574 0.163934426)
##                            2694) ZIPINC_QRTL=,2,4 27    2 Alive (0.925925926 0.074074074) *
##                            2695) ZIPINC_QRTL=1,3 34    8 Alive (0.764705882 0.235294118)
##                              5390) APRDRG_Severity=Minor Loss of Function,Moderate Loss of Function 1
##                              5391) APRDRG_Severity=Major Loss of Function 23    7 Alive (0.695652174 0
##                               10782) CM_HTN_C=0 8    1 Alive (0.875000000 0.125000000) *
##                               10783) CM_HTN_C=1 15    6 Alive (0.600000000 0.400000000)
##                                 21566) AGE>=72 8    2 Alive (0.750000000 0.250000000) *
##                                 21567) AGE< 72 7    3 Died (0.428571429 0.571428571) *
##                       337) NCHRONIC< 2.5 33    7 Alive (0.787878788 0.212121212) *
##                     169) PAY1=Private,Self-Pay,Other 186   23 Alive (0.876344086 0.123655914)
##                       338) AGE< 82.5 170   16 Alive (0.905882353 0.094117647) *
##                       339) AGE>=82.5 16    7 Alive (0.562500000 0.437500000)
##                         678) AGE>=85.5 9    1 Alive (0.888888889 0.111111111) *
##                         679) AGE< 85.5 7    1 Died (0.142857143 0.857142857) *
##                     85) AGE>=91 79   17 Alive (0.784810127 0.215189873)
##                     170) CM_CHRNLUNG=0 65   10 Alive (0.846153846 0.153846154)
##                       340) RACE=White,Hispanic,Asian,Other 60    7 Alive (0.883333333 0.116666667) *
##                       341) RACE=Black,Native American 5    2 Died (0.400000000 0.600000000) *
```

```
##                   171) CM_CHRNLUNG=1 14    7 Alive (0.500000000 0.500000000) *
##                43) APRDRG_Severity=Extreme Loss of Function 52   16 Alive (0.692307692 0.307692308)
##                  86) AGE< 66.5 32    4 Alive (0.875000000 0.125000000) *
##                  87) AGE>=66.5 20    8 Died (0.400000000 0.600000000)
##                   174) ZIPINC_QRTL=2,4 10    4 Alive (0.600000000 0.400000000) *
##                   175) ZIPINC_QRTL=,1,3 10    2 Died (0.200000000 0.800000000) *
##             11) LOS< 2.5 233   66 Alive (0.716738197 0.283261803)
##               22) AGE< 76.5 156   27 Alive (0.826923077 0.173076923)
##                 44) APRDRG_Severity=Not specified,Moderate Loss of Function,Major Loss of Function 14
##                   88) AGE< 1.5 31    0 Alive (1.000000000 0.000000000) *
##                   89) AGE>=1.5 111   20 Alive (0.819819820 0.180180180)
##                   178) NDX>=11.5 53    3 Alive (0.943396226 0.056603774)
##                     356) ZIPINC_QRTL=,1,2,4 37    0 Alive (1.000000000 0.000000000) *
##                     357) ZIPINC_QRTL=3 16    3 Alive (0.812500000 0.187500000)
##                       714) CM_CHRNLUNG=0 11    0 Alive (1.000000000 0.000000000) *
##                       715) CM_CHRNLUNG=1 5    2 Died (0.400000000 0.600000000) *
##                   179) NDX< 11.5 58   17 Alive (0.706896552 0.293103448)
##                     358) AGE< 73.5 53   13 Alive (0.754716981 0.245283019)
##                       716) HOSP_DIVISION=5,8,9 24    2 Alive (0.916666667 0.083333333) *
##                       717) HOSP_DIVISION=2,3,4,6,7 29   11 Alive (0.620689655 0.379310345)
##                        1434) ZIPINC_QRTL=,1 6    0 Alive (1.000000000 0.000000000) *
##                        1435) ZIPINC_QRTL=2,3,4 23   11 Alive (0.521739130 0.478260870)
##                          2870) RACE=White 16    5 Alive (0.687500000 0.312500000)
##                            5740) AGE< 47 7    0 Alive (1.000000000 0.000000000) *
##                            5741) AGE>=47 9    4 Died (0.444444444 0.555555556) *
##                          2871) RACE=Black,Hispanic,Other 7    1 Died (0.142857143 0.857142857) *
##                     359) AGE>=73.5 5    1 Died (0.200000000 0.800000000) *
##                 45) APRDRG_Severity=Minor Loss of Function,Extreme Loss of Function 14    7 Alive (0
##               23) AGE>=76.5 77   38 Died (0.493506494 0.506493506)
##                 46) HOSP_DIVISION=3,4,8 18    4 Alive (0.777777778 0.222222222) *
##                 47) HOSP_DIVISION=1,2,5,6,7,9 59   24 Died (0.406779661 0.593220339)
##                   94) NDX>=7.5 50   24 Died (0.480000000 0.520000000)
##                   188) AGE< 87.5 30   11 Alive (0.633333333 0.366666667)
##                     376) HOSP_DIVISION=1,5,6,7 21    5 Alive (0.761904762 0.238095238) *
##                     377) HOSP_DIVISION=2,9 9    3 Died (0.333333333 0.666666667) *
##                   189) AGE>=87.5 20    5 Died (0.250000000 0.750000000) *
##                 95) NDX< 7.5 9    0 Died (0.000000000 1.000000000) *
##           3) APRDRG_Risk_Mortality=Extreme Likelihood 5734 1425 Alive (0.751482386 0.248517614)
##             6) LOS>=3.5 5276 1094 Alive (0.792645944 0.207354056)
##              12) APRDRG_Severity=Minor Loss of Function,Moderate Loss of Function,Major Loss of Functi
##                24) HOSP_DIVISION=3,5,8 461   32 Alive (0.930585683 0.069414317)
##                  48) CM_METS=0 433   26 Alive (0.939953811 0.060046189)
##                    96) CM_CHF=0 348   14 Alive (0.959770115 0.040229885) *
##                    97) CM_CHF=1 85   12 Alive (0.858823529 0.141176471)
##                   194) CM_HTN_C=1 60    5 Alive (0.916666667 0.083333333) *
##                   195) CM_HTN_C=0 25    7 Alive (0.720000000 0.280000000)
##                     390) AGE>=73.5 20    4 Alive (0.800000000 0.200000000) *
##                     391) AGE< 73.5 5    2 Died (0.400000000 0.600000000) *
##                  49) CM_METS=1 28    6 Alive (0.785714286 0.214285714) *
##                25) HOSP_DIVISION=1,2,4,6,7,9 675   92 Alive (0.863703704 0.136296296)
##                  50) LOS>=90.5 359   36 Alive (0.899721448 0.100278552)
##                  100) RACE=Black,Hispanic,Asian,Native American 74    2 Alive (0.972972973 0.0270270
##                  101) RACE=White,Other 285   34 Alive (0.880701754 0.119298246)
##                    202) PAY1=Medicaid,Private,Other 62    2 Alive (0.967741935 0.032258065) *
```

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##                   203) PAY1=Medicare,Self-Pay 223   32 Alive (0.856502242 0.143497758)
##                     406) CM_METS=0 209   27 Alive (0.870813397 0.129186603)
##                       812) AGE< 74.5 77    5 Alive (0.935064935 0.064935065)
##                        1624) CM_RENLFAIL=0 56    1 Alive (0.982142857 0.017857143) *
##                        1625) CM_RENLFAIL=1 21    4 Alive (0.809523810 0.190476190)
##                          3250) CM_ANEMDEF=0 15    0 Alive (1.000000000 0.000000000) *
##                          3251) CM_ANEMDEF=1 6    2 Died (0.333333333 0.666666667) *
##                       813) AGE>=74.5 132   22 Alive (0.833333333 0.166666667)
##                        1626) NCHRONIC>=4.5 116   16 Alive (0.862068966 0.137931034)
##                          3252) LOS>=116.5 84    8 Alive (0.904761905 0.095238095) *
##                          3253) LOS< 116.5 32    8 Alive (0.750000000 0.250000000)
##                            6506) HOSP_DIVISION=1,6 8    0 Alive (1.000000000 0.000000000) *
##                            6507) HOSP_DIVISION=2,4,7,9 24    8 Alive (0.666666667 0.333333333)
##                             13014) ZIPINC_QRTL=3,4 13    2 Alive (0.846153846 0.153846154) *
##                             13015) ZIPINC_QRTL=1,2 11    5 Died (0.454545455 0.545454545) *
##                        1627) NCHRONIC< 4.5 16    6 Alive (0.625000000 0.375000000)
##                          3254) HOSP_DIVISION=7,9 7    1 Alive (0.857142857 0.142857143) *
##                          3255) HOSP_DIVISION=1,2,4 9    4 Died (0.444444444 0.555555556) *
##                     407) CM_METS=1 14    5 Alive (0.642857143 0.357142857) *
##                  51) LOS< 90.5 316   56 Alive (0.822784810 0.177215190)
##                   102) LOS< 63 133    9 Alive (0.932330827 0.067669173) *
##                   103) LOS>=63 183   47 Alive (0.743169399 0.256830601)
##                     206) NCHRONIC>=1.5 174   42 Alive (0.758620690 0.241379310)
##                       412) ORPROC>=0.5 23    2 Alive (0.913043478 0.086956522) *
##                       413) ORPROC< 0.5 151   40 Alive (0.735099338 0.264900662)
##                         826) CM_HTN_C=0 54    9 Alive (0.833333333 0.166666667)
##                          1652) HOSP_DIVISION=2,4,9 24    1 Alive (0.958333333 0.041666667) *
##                          1653) HOSP_DIVISION=1,6,7 30    8 Alive (0.733333333 0.266666667)
##                            3306) NDX>=14.5 12    1 Alive (0.916666667 0.083333333) *
##                            3307) NDX< 14.5 18    7 Alive (0.611111111 0.388888889)
##                              6614) AGE>=89 5    0 Alive (1.000000000 0.000000000) *
##                              6615) AGE< 89 13    6 Died (0.461538462 0.538461538) *
##                         827) CM_HTN_C=1 97   31 Alive (0.680412371 0.319587629)
##                          1654) HOSP_DIVISION=1,4,6,7,9 74   20 Alive (0.729729730 0.270270270)
##                            3308) NCHRONIC>=6.5 40    6 Alive (0.850000000 0.150000000) *
##                            3309) NCHRONIC< 6.5 34   14 Alive (0.588235294 0.411764706)
##                              6618) AGE< 86 25    8 Alive (0.680000000 0.320000000) *
##                              6619) AGE>=86 9    3 Died (0.333333333 0.666666667) *
##                          1655) HOSP_DIVISION=2 23   11 Alive (0.521739130 0.478260870)
##                            3310) PAY1=Private,Self-Pay,Other 6    1 Alive (0.833333333 0.166666667) *
##                            3311) PAY1=Medicare,Medicaid 17    7 Died (0.411764706 0.588235294)
##                              6622) AGE>=72.5 10    4 Alive (0.600000000 0.400000000) *
##                              6623) AGE< 72.5 7    1 Died (0.142857143 0.857142857) *
##                     207) NCHRONIC< 1.5 9    4 Died (0.444444444 0.555555556) *
##                13) APRDRG_Severity=Extreme Loss of Function 4140  970 Alive (0.765700483 0.234299517)
##                  26) HOSP_DIVISION=3,4,5,7,8 2429  502 Alive (0.793330589 0.206669411)
##                    52) NDX< 37.5 2413  492 Alive (0.796104434 0.203895566)
##                   104) AGE< 50.5 459   68 Alive (0.851851852 0.148148148)
##                     208) CM_METS=0 439   61 Alive (0.861047836 0.138952164)
##                       416) CM_LYTES=0 173   15 Alive (0.913294798 0.086705202) *
##                       417) CM_LYTES=1 266   46 Alive (0.827067669 0.172932331)
##                         834) CM_PERIVASC=0 251   39 Alive (0.844621514 0.155378486)
##                          1668) LOS< 91 137   14 Alive (0.897810219 0.102189781)
##                            3336) CM_LIVER=0 125   10 Alive (0.920000000 0.080000000)
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##                             6672) HOSP_DIVISION=3,4,8 58    0 Alive (1.000000000 0.000000000) *
##                             6673) HOSP_DIVISION=5,7 67   10 Alive (0.850746269 0.149253731)
##                              13346) NDX>=15.5 52    5 Alive (0.903846154 0.096153846) *
##                              13347) NDX< 15.5 15    5 Alive (0.666666667 0.333333333)
##                                26694) PAY1=Medicare,Private 8    1 Alive (0.875000000 0.125000000) *
##                                26695) PAY1=Medicaid,Self-Pay 7    3 Died (0.428571429 0.571428571) *
##                            3337) CM_LIVER=1 12    4 Alive (0.666666667 0.333333333) *
##                           1669) LOS>=91 114   25 Alive (0.780701754 0.219298246)
##                             3338) AGE>=23.5 90   15 Alive (0.833333333 0.166666667)
##                               6676) ZIPINC_QRTL=,3,4,A 44    3 Alive (0.931818182 0.068181818) *
##                               6677) ZIPINC_QRTL=1,2 46   12 Alive (0.739130435 0.260869565)
##                                13354) NCHRONIC>=2.5 41    8 Alive (0.804878049 0.195121951)
##                                  26708) AGE< 38 11    0 Alive (1.000000000 0.000000000) *
##                                  26709) AGE>=38 30    8 Alive (0.733333333 0.266666667)
##                                    53418) ORPROC< 0.5 23    4 Alive (0.826086957 0.173913043) *
##                                    53419) ORPROC>=0.5 7    3 Died (0.428571429 0.571428571) *
##                                13355) NCHRONIC< 2.5 5    1 Died (0.200000000 0.800000000) *
##                             3339) AGE< 23.5 24   10 Alive (0.583333333 0.416666667)
##                               6678) NCHRONIC< 7 18    5 Alive (0.722222222 0.277777778) *
##                               6679) NCHRONIC>=7 6    1 Died (0.166666667 0.833333333) *
##                           835) CM_PERIVASC=1 15    7 Alive (0.533333333 0.466666667)
##                            1670) LOS>=88.5 5    1 Alive (0.800000000 0.200000000) *
##                            1671) LOS< 88.5 10    4 Died (0.400000000 0.600000000) *
##                      209) CM_METS=1 20    7 Alive (0.650000000 0.350000000)
##                        418) NDX>=19 9    1 Alive (0.888888889 0.111111111) *
##                        419) NDX< 19 11    5 Died (0.454545455 0.545454545) *
##                    105) AGE>=50.5 1954  424 Alive (0.783009212 0.216990788)
##                      210) CM_LIVER=0 1827  384 Alive (0.789819376 0.210180624)
##                        420) ZIPINC_QRTL=3,4 728  132 Alive (0.818681319 0.181318681)
##                          840) NDX< 24.5 526   84 Alive (0.840304183 0.159695817)
##                           1680) LOS>=19.5 470   66 Alive (0.859574468 0.140425532)
##                             3360) RACE=White,Black,Hispanic 455   60 Alive (0.868131868 0.131868132)
##                               6720) CM_ANEMDEF=1 150   11 Alive (0.926666667 0.073333333)
##                                13440) AGE< 91 140    8 Alive (0.942857143 0.057142857)
##                                  26880) NCHRONIC>=6.5 106    3 Alive (0.971698113 0.028301887) *
##                                  26881) NCHRONIC< 6.5 34    5 Alive (0.852941176 0.147058824)
##                                    53762) ZIPINC_QRTL=3 17    0 Alive (1.000000000 0.000000000) *
##                                    53763) ZIPINC_QRTL=4 17    5 Alive (0.705882353 0.294117647)
##                                     107526) LOS< 94 12    1 Alive (0.916666667 0.083333333) *
##                                     107527) LOS>=94 5    1 Died (0.200000000 0.800000000) *
##                                13441) AGE>=91 10    3 Alive (0.700000000 0.300000000) *
##                               6721) CM_ANEMDEF=0 305   49 Alive (0.839344262 0.160655738)
##                                13442) NDX< 15.5 111   12 Alive (0.891891892 0.108108108) *
##                                13443) NDX>=15.5 194   37 Alive (0.809278351 0.190721649)
##                                  26886) NCHRONIC>=9.5 58    6 Alive (0.896551724 0.103448276) *
##                                  26887) NCHRONIC< 9.5 136   31 Alive (0.772058824 0.227941176)
##                                    53774) AGE< 80.5 87   15 Alive (0.827586207 0.172413793)
##                                     107548) AGE>=76.5 13    0 Alive (1.000000000 0.000000000) *
##                                     107549) AGE< 76.5 74   15 Alive (0.797297297 0.202702703)
##                                       215098) NDX>=18.5 33    4 Alive (0.878787879 0.121212121) *
##                                       215099) NDX< 18.5 41   11 Alive (0.731707317 0.268292683)
##                                         430198) AGE>=55.5 34    7 Alive (0.794117647 0.205882353)
##                                           860396) HOSP_DIVISION=3,7 15    1 Alive (0.933333333 0.06666
##                                           860397) HOSP_DIVISION=4,5,8 19    6 Alive (0.684210526 0.315
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##                                     1720794) LOS< 89.5 10    1 Alive (0.900000000 0.100000000) *
##                                     1720795) LOS>=89.5 9    4 Died (0.444444444 0.555555556) *
##                                   430199) AGE< 55.5 7    3 Died (0.428571429 0.571428571) *
##                                 53775) AGE>=80.5 49   16 Alive (0.673469388 0.326530612)
##                                 107550) LOS< 138.5 43   12 Alive (0.720930233 0.279069767)
##                                   215100) CM_COAG=1 8    0 Alive (1.000000000 0.000000000) *
##                                   215101) CM_COAG=0 35   12 Alive (0.657142857 0.342857143)
##                                     430202) AGE>=83.5 29    8 Alive (0.724137931 0.275862069)
##                                       860404) ZIPINC_QRTL=4 11    1 Alive (0.909090909 0.090909091)
##                                       860405) ZIPINC_QRTL=3 18    7 Alive (0.611111111 0.388888889)
##                                     1720810) CM_HTN_C=0 8    1 Alive (0.875000000 0.125000000) *
##                                     1720811) CM_HTN_C=1 10    4 Died (0.400000000 0.600000000) *
##                                   430203) AGE< 83.5 6    2 Died (0.333333333 0.666666667) *
##                                 107551) LOS>=138.5 6    2 Died (0.333333333 0.666666667) *
##                             3361) RACE=Asian,Other 15    6 Alive (0.600000000 0.400000000)
##                               6722) ORPROC>=0.5 6    0 Alive (1.000000000 0.000000000) *
##                               6723) ORPROC< 0.5 9    3 Died (0.333333333 0.666666667) *
##                           1681) LOS< 19.5 56   18 Alive (0.678571429 0.321428571)
##                             3362) AGE>=56.5 51   14 Alive (0.725490196 0.274509804)
##                               6724) NDX< 16.5 18    1 Alive (0.944444444 0.055555556) *
##                               6725) NDX>=16.5 33   13 Alive (0.606060606 0.393939394)
##                                 13450) CM_HYPOTHY=1 6    0 Alive (1.000000000 0.000000000) *
##                                 13451) CM_HYPOTHY=0 27   13 Alive (0.518518519 0.481481481)
##                                   26902) CM_RENLFAIL=0 21    8 Alive (0.619047619 0.380952381)
##                                     53804) CM_DM=1 5    0 Alive (1.000000000 0.000000000) *
##                                     53805) CM_DM=0 16    8 Alive (0.500000000 0.500000000)
##                                       107610) AGE< 72.5 5    1 Alive (0.800000000 0.200000000) *
##                                       107611) AGE>=72.5 11    4 Died (0.363636364 0.636363636) *
##                                   26903) CM_RENLFAIL=1 6    1 Died (0.166666667 0.833333333) *
##                             3363) AGE< 56.5 5    1 Died (0.200000000 0.800000000) *
##                         841) NDX>=24.5 202   48 Alive (0.762376238 0.237623762)
##                           1682) ORPROC>=0.5 67    8 Alive (0.880597015 0.119402985) *
##                           1683) ORPROC< 0.5 135   40 Alive (0.703703704 0.296296296)
##                             3366) ZIPINC_QRTL=4 67   13 Alive (0.805970149 0.194029851) *
##                             3367) ZIPINC_QRTL=3 68   27 Alive (0.602941176 0.397058824)
##                               6734) AGE>=65.5 50   17 Alive (0.660000000 0.340000000)
##                                 13468) AGE< 75.5 14    1 Alive (0.928571429 0.071428571) *
##                                 13469) AGE>=75.5 36   16 Alive (0.555555556 0.444444444)
##                                   26938) CM_ANEMDEF=1 25    9 Alive (0.640000000 0.360000000)
##                                     53876) HOSP_DIVISION=4,5 9    1 Alive (0.888888889 0.111111111) *
##                                     53877) HOSP_DIVISION=3,7,8 16    8 Alive (0.500000000 0.500000000)
##                                       107754) LOS< 105.5 10    3 Alive (0.700000000 0.300000000) *
##                                       107755) LOS>=105.5 6    1 Died (0.166666667 0.833333333) *
##                                   26939) CM_ANEMDEF=0 11    4 Died (0.363636364 0.636363636) *
##                               6735) AGE< 65.5 18    8 Died (0.444444444 0.555555556)
##                                 13470) FEMALE=0 10    3 Alive (0.700000000 0.300000000) *
##                                 13471) FEMALE=1 8    1 Died (0.125000000 0.875000000) *
##                       421) ZIPINC_QRTL=,1,2,A 1099  252 Alive (0.770700637 0.229299363)
##                         842) CM_COAG=0 916  193 Alive (0.789301310 0.210698690)
##                           1684) LOS< 67 303   47 Alive (0.844884488 0.155115512)
##                             3368) RACE=Black,Hispanic,Asian,Other 88    6 Alive (0.931818182 0.068181818)
##                             3369) RACE=White,Native American 215   41 Alive (0.809302326 0.190697674)
##                               6738) AGE>=84.5 39    2 Alive (0.948717949 0.051282051) *
##                               6739) AGE< 84.5 176   39 Alive (0.778409091 0.221590909)
```

```
##                             13478) HOSP_DIVISION=4 19    0 Alive (1.000000000 0.000000000) *
##                             13479) HOSP_DIVISION=3,5,7,8 157   39 Alive (0.751592357 0.248407643)
##                               26958) AGE< 81.5 135   29 Alive (0.785185185 0.214814815)
##                                 53916) NDX< 15.5 35    3 Alive (0.914285714 0.085714286) *
##                                 53917) NDX>=15.5 100   26 Alive (0.740000000 0.260000000)
##                                  107834) AGE>=75.5 23    2 Alive (0.913043478 0.086956522) *
##                                  107835) AGE< 75.5 77   24 Alive (0.688311688 0.311688312)
##                                    215670) AGE< 65.5 34    6 Alive (0.823529412 0.176470588) *
##                                    215671) AGE>=65.5 43   18 Alive (0.581395349 0.418604651)
##                                      431342) NCHRONIC>=7.5 32   10 Alive (0.687500000 0.312500000)
##                                        862684) LOS< 19.5 10    0 Alive (1.000000000 0.000000000) *
##                                        862685) LOS>=19.5 22   10 Alive (0.545454545 0.454545455)
##                                         1725370) CM_CHRNLUNG=1 10    2 Alive (0.800000000 0.2000000
##                                         1725371) CM_CHRNLUNG=0 12    4 Died (0.333333333 0.6666666
##                                      431343) NCHRONIC< 7.5 11    3 Died (0.272727273 0.727272727) *
##                               26959) AGE>=81.5 22   10 Alive (0.545454545 0.454545455)
##                                 53918) CM_LYTES=1 17    6 Alive (0.647058824 0.352941176)
##                                  107836) CM_HTN_C=1 12    3 Alive (0.750000000 0.250000000) *
##                                  107837) CM_HTN_C=0 5    2 Died (0.400000000 0.600000000) *
##                                 53919) CM_LYTES=0 5    1 Died (0.200000000 0.800000000) *
##                           1685) LOS>=67 613  146 Alive (0.761827080 0.238172920)
##                             3370) LOS>=69.5 559  113 Alive (0.797853309 0.202146691)
##                               6740) CM_NEURO=0 484   89 Alive (0.816115702 0.183884298)
##                                 13480) HOSP_DIVISION=3,4,8 196   24 Alive (0.877551020 0.122448980)
##                                   26960) AGE< 86.5 164   15 Alive (0.908536585 0.091463415)
##                                     53920) CM_VALVE=0 148   11 Alive (0.925675676 0.074324324) *
##                                     53921) CM_VALVE=1 16    4 Alive (0.750000000 0.250000000)
##                                      107842) NDX>=18 11    1 Alive (0.909090909 0.090909091) *
##                                      107843) NDX< 18 5    2 Died (0.400000000 0.600000000) *
##                                   26961) AGE>=86.5 32    9 Alive (0.718750000 0.281250000)
##                                     53922) CM_LYTES=0 13    1 Alive (0.923076923 0.076923077) *
##                                     53923) CM_LYTES=1 19    8 Alive (0.578947368 0.421052632)
##                                      107846) NCHRONIC>=7.5 10    2 Alive (0.800000000 0.200000000) *
##                                      107847) NCHRONIC< 7.5 9    3 Died (0.333333333 0.666666667) *
##                                 13481) HOSP_DIVISION=5,7 288   65 Alive (0.774305556 0.225694444)
##                                   26962) PAY1=Medicare,No Charge 220   41 Alive (0.813636364 0.18636363
##                                     53924) NCHRONIC>=11.5 29    1 Alive (0.965517241 0.034482759) *
##                                     53925) NCHRONIC< 11.5 191   40 Alive (0.790575916 0.209424084)
##                                      107850) CM_VALVE=0 181   35 Alive (0.806629834 0.193370166)
##                                        215700) CM_TUMOR=0 173   31 Alive (0.820809249 0.179190751)
##                                          431400) AGE>=83.5 44    3 Alive (0.931818182 0.068181818) *
##                                          431401) AGE< 83.5 129   28 Alive (0.782945736 0.217054264)
##                                            862802) NCHRONIC< 10.5 119   23 Alive (0.806722689 0.1932773
##                                             1725604) CM_HYPOTHY=1 13    0 Alive (1.000000000 0.0000000
##                                             1725605) CM_HYPOTHY=0 106   23 Alive (0.783018868 0.2169811
##                                               3451210) LOS>=149.5 12    0 Alive (1.000000000 0.0000000
##                                               3451211) LOS< 149.5 94   23 Alive (0.755319149 0.2446808
##                                                 6902422) LOS< 90.5 34    4 Alive (0.882352941 0.1176470
##                                                 6902423) LOS>=90.5 60   19 Alive (0.683333333 0.3166666
##                                                  13804846) LOS>=112.5 35    8 Alive (0.771428571 0.2285
##                                                    27609692) RACE=Black,Hispanic,Other 14    1 Alive (0
##                                                    27609693) RACE=White 21    7 Alive (0.666666667 0.333
##                                                      55219386) CM_RENLFAIL=0 13    2 Alive (0.846153846
##                                                      55219387) CM_RENLFAIL=1 8    3 Died (0.375000000 0
```

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##                                          13804847) LOS< 112.5 25   11 Alive (0.560000000 0.44000
##                                            27609694) CM_CHF=0 17    5 Alive (0.705882353 0.2941
##                                            27609695) CM_CHF=1 8    2 Died (0.250000000 0.750000
##                                       862803) NCHRONIC>=10.5 10    5 Alive (0.500000000 0.500000000
##                                  215701) CM_TUMOR=1 8    4 Alive (0.500000000 0.500000000) *
##                                 107851) CM_VALVE=1 10    5 Alive (0.500000000 0.500000000) *
##                               26963) PAY1=Medicaid,Private,Self-Pay,Other 68   24 Alive (0.64705882
##                                 53926) AGE< 75.5 61   19 Alive (0.688524590 0.311475410)
##                                  107852) AGE>=65.5 8    0 Alive (1.000000000 0.000000000) *
##                                  107853) AGE< 65.5 53   19 Alive (0.641509434 0.358490566)
##                                    215706) CM_PSYCH=1 6    0 Alive (1.000000000 0.000000000) *
##                                    215707) CM_PSYCH=0 47   19 Alive (0.595744681 0.404255319)
##                                      431414) ORPROC>=0.5 22    5 Alive (0.772727273 0.227272727) *
##                                      431415) ORPROC< 0.5 25   11 Died (0.440000000 0.560000000)
##                                        862830) RACE=Black 6    1 Alive (0.833333333 0.166666667) *
##                                        862831) RACE=White,Hispanic 19    6 Died (0.315789474 0.6842
##                                         1725662) CM_CHF=1 6    2 Alive (0.666666667 0.333333333) *
##                                         1725663) CM_CHF=0 13    2 Died (0.153846154 0.846153846) *
##                                   53927) AGE>=75.5 7    2 Died (0.285714286 0.714285714) *
##                              6741) CM_NEURO=1 75   24 Alive (0.680000000 0.320000000)
##                                13482) NCHRONIC>=6.5 66   18 Alive (0.727272727 0.272727273)
##                                  26964) CM_PARA=1 13    0 Alive (1.000000000 0.000000000) *
##                                  26965) CM_PARA=0 53   18 Alive (0.660377358 0.339622642)
##                                    53930) NDX< 16.5 9    0 Alive (1.000000000 0.000000000) *
##                                    53931) NDX>=16.5 44   18 Alive (0.590909091 0.409090909)
##                                     107862) CM_DM=0 36   12 Alive (0.666666667 0.333333333)
##                                       215724) NDX< 27.5 31    8 Alive (0.741935484 0.258064516)
##                                         431448) HOSP_DIVISION=3,4,5,8 26    5 Alive (0.807692308 0.192
##                                         431449) HOSP_DIVISION=7 5    2 Died (0.400000000 0.600000000) *
##                                       215725) NDX>=27.5 5    1 Died (0.200000000 0.800000000) *
##                                     107863) CM_DM=1 8    2 Died (0.250000000 0.750000000) *
##                                13483) NCHRONIC< 6.5 9    3 Died (0.333333333 0.666666667) *
##                             3371) LOS< 69.5 54   21 Died (0.388888889 0.611111111)
##                               6742) RACE=White 38   19 Alive (0.500000000 0.500000000)
##                                 13484) HOSP_DIVISION=3,5,7 28   11 Alive (0.607142857 0.392857143)
##                                   26968) NCHRONIC>=7.5 14    3 Alive (0.785714286 0.214285714) *
##                                   26969) NCHRONIC< 7.5 14    6 Died (0.428571429 0.571428571) *
##                                 13485) HOSP_DIVISION=4,8 10    2 Died (0.200000000 0.800000000) *
##                               6743) RACE=Black,Hispanic 16    2 Died (0.125000000 0.875000000) *
##                          843) CM_COAG=1 183   59 Alive (0.677595628 0.322404372)
##                           1686) NCHRONIC>=11.5 38    6 Alive (0.842105263 0.157894737) *
##                           1687) NCHRONIC< 11.5 145   53 Alive (0.634482759 0.365517241)
##                             3374) NCHRONIC< 10.5 125   40 Alive (0.680000000 0.320000000)
##                               6748) LOS< 19.5 14    1 Alive (0.928571429 0.071428571) *
##                               6749) LOS>=19.5 111   39 Alive (0.648648649 0.351351351)
##                                 13498) FEMALE=0 59   16 Alive (0.728813559 0.271186441)
##                                   26996) LOS>=70.5 32    4 Alive (0.875000000 0.125000000) *
##                                   26997) LOS< 70.5 27   12 Alive (0.555555556 0.444444444)
##                                     53994) CM_WGHTLOSS=0 21    7 Alive (0.666666667 0.333333333)
##                                      107988) RACE=White,Hispanic,Native American 14    2 Alive (0.85714
##                                      107989) RACE=Black,Other 7    2 Died (0.285714286 0.714285714) *
##                                     53995) CM_WGHTLOSS=1 6    1 Died (0.166666667 0.833333333) *
##                                 13499) FEMALE=1 52   23 Alive (0.557692308 0.442307692)
##                                   26998) LOS< 37 11    1 Alive (0.909090909 0.090909091) *
```

```
##                                26999) LOS>=37 41   19 Died (0.463414634 0.536585366)
##                                  53998) AGE>=69 27   11 Alive (0.592592593 0.407407407)
##                                   107996) CM_WGHTLOSS=1 7    1 Alive (0.857142857 0.142857143) *
##                                   107997) CM_WGHTLOSS=0 20   10 Alive (0.500000000 0.500000000)
##                                     215994) AGE< 73 5    1 Alive (0.800000000 0.200000000) *
##                                     215995) AGE>=73 15    6 Died (0.400000000 0.600000000)
##                                       431990) LOS>=111 6    2 Alive (0.666666667 0.333333333) *
##                                       431991) LOS< 111 9    2 Died (0.222222222 0.777777778) *
##                                  53999) AGE< 69 14    3 Died (0.214285714 0.785714286) *
##                             3375) NCHRONIC>=10.5 20    7 Died (0.350000000 0.650000000)
##                               6750) HOSP_DIVISION=5,7,8 13    6 Alive (0.538461538 0.461538462) *
##                               6751) HOSP_DIVISION=3,4 7    0 Died (0.000000000 1.000000000) *
##                        211) CM_LIVER=1 127   40 Alive (0.685039370 0.314960630)
##                          422) NCHRONIC>=10.5 44    7 Alive (0.840909091 0.159090909) *
##                          423) NCHRONIC< 10.5 83   33 Alive (0.602409639 0.397590361)
##                            846) AGE< 58 36    9 Alive (0.750000000 0.250000000)
##                             1692) NCHRONIC< 7.5 21    1 Alive (0.952380952 0.047619048) *
##                             1693) NCHRONIC>=7.5 15    7 Died (0.466666667 0.533333333)
##                               3386) CM_LYTES=0 5    1 Alive (0.800000000 0.200000000) *
##                               3387) CM_LYTES=1 10    3 Died (0.300000000 0.700000000) *
##                            847) AGE>=58 47   23 Died (0.489361702 0.510638298)
##                             1694) NCHRONIC>=8.5 18    5 Alive (0.722222222 0.277777778)
##                               3388) ZIPINC_QRTL=1,2,4 13    2 Alive (0.846153846 0.153846154) *
##                               3389) ZIPINC_QRTL=3 5    2 Died (0.400000000 0.600000000) *
##                             1695) NCHRONIC< 8.5 29   10 Died (0.344827586 0.655172414)
##                               3390) CM_WGHTLOSS=0 19    9 Died (0.473684211 0.526315789)
##                                 6780) LOS>=127.5 5    1 Alive (0.800000000 0.200000000) *
##                                 6781) LOS< 127.5 14    5 Died (0.357142857 0.642857143) *
##                               3391) CM_WGHTLOSS=1 10    1 Died (0.100000000 0.900000000) *
##                      53) NDX>=37.5 16    6 Died (0.375000000 0.625000000)
##                       106) CM_PERIVASC=1 7    2 Alive (0.714285714 0.285714286) *
##                       107) CM_PERIVASC=0 9    1 Died (0.111111111 0.888888889) *
##                    27) HOSP_DIVISION=1,2,6,9 1711  468 Alive (0.726475745 0.273524255)
##                      54) CM_HTN_C=1 960  224 Alive (0.766666667 0.233333333)
##                       108) AGE< 87.5 812  169 Alive (0.791871921 0.208128079)
##                         216) CM_METS=0 763  151 Alive (0.802096986 0.197903014)
##                           432) AGE< 80 571   99 Alive (0.826619965 0.173380035)
##                             864) AGE>=65.5 315   44 Alive (0.860317460 0.139682540)
##                              1728) CM_RENLFAIL=0 170   15 Alive (0.911764706 0.088235294) *
##                              1729) CM_RENLFAIL=1 145   29 Alive (0.800000000 0.200000000)
##                                3458) NCHRONIC>=6.5 130   22 Alive (0.830769231 0.169230769)
##                                  6916) CM_HYPOTHY=0 108   14 Alive (0.870370370 0.129629630)
##                                   13832) ZIPINC_QRTL=3 26    0 Alive (1.000000000 0.000000000) *
##                                   13833) ZIPINC_QRTL=1,2,4 82   14 Alive (0.829268293 0.170731707)
##                                     27666) CM_LYTES=0 35    2 Alive (0.942857143 0.057142857) *
##                                     27667) CM_LYTES=1 47   12 Alive (0.744680851 0.255319149)
##                                       55334) RACE=Black,Asian,Other 9    0 Alive (1.000000000 0.000000000)
##                                       55335) RACE=White,Hispanic 38   12 Alive (0.684210526 0.315789474)
##                                        110670) AGE>=74.5 15    3 Alive (0.800000000 0.200000000) *
##                                        110671) AGE< 74.5 23    9 Alive (0.608695652 0.391304348)
##                                          221342) LOS>=84.5 10    2 Alive (0.800000000 0.200000000) *
##                                          221343) LOS< 84.5 13    6 Died (0.461538462 0.538461538) *
##                                  6917) CM_HYPOTHY=1 22    8 Alive (0.636363636 0.363636364)
##                                   13834) CM_CHF=1 11    2 Alive (0.818181818 0.181818182) *
```

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##                           13835) CM_CHF=0 11    5 Died (0.454545455 0.545454545) *
##                         3459) NCHRONIC< 6.5 15    7 Alive (0.533333333 0.466666667)
##                           6918) AGE< 73 7    2 Alive (0.714285714 0.285714286) *
##                           6919) AGE>=73 8    3 Died (0.375000000 0.625000000) *
##                       865) AGE< 65.5 256   55 Alive (0.785156250 0.214843750)
##                        1730) RACE=White,Asian,Other 179   29 Alive (0.837988827 0.162011173)
##                         3460) LOS< 152.5 167   24 Alive (0.856287425 0.143712575)
##                           6920) AGE>=53.5 109   11 Alive (0.899082569 0.100917431) *
##                           6921) AGE< 53.5 58   13 Alive (0.775862069 0.224137931)
##                            13842) AGE< 48.5 33    4 Alive (0.878787879 0.121212121) *
##                            13843) AGE>=48.5 25    9 Alive (0.640000000 0.360000000)
##                              27686) PAY1=Medicare,Medicaid,Self-Pay 17    3 Alive (0.823529412 0.1
##                              27687) PAY1=Private,Other 8    2 Died (0.250000000 0.750000000) *
##                         3461) LOS>=152.5 12    5 Alive (0.583333333 0.416666667) *
##                        1731) RACE=Black,Hispanic,Native American 77   26 Alive (0.662337662 0.33766
##                         3462) NDX< 21.5 47   11 Alive (0.765957447 0.234042553) *
##                         3463) NDX>=21.5 30   15 Alive (0.500000000 0.500000000)
##                           6926) CM_CHF=0 19    6 Alive (0.684210526 0.315789474) *
##                           6927) CM_CHF=1 11    2 Died (0.181818182 0.818181818) *
##                     433) AGE>=80 192   52 Alive (0.729166667 0.270833333)
##                       866) CM_CHF=0 111   22 Alive (0.801801802 0.198198198)
##                        1732) ORPROC>=0.5 32    2 Alive (0.937500000 0.062500000) *
##                        1733) ORPROC< 0.5 79   20 Alive (0.746835443 0.253164557)
##                         3466) NCHRONIC>=11.5 10    0 Alive (1.000000000 0.000000000) *
##                         3467) NCHRONIC< 11.5 69   20 Alive (0.710144928 0.289855072)
##                           6934) ZIPINC_QRTL=,1,2,3 50   12 Alive (0.760000000 0.240000000)
##                            13868) CM_LYTES=1 34    5 Alive (0.852941176 0.147058824) *
##                            13869) CM_LYTES=0 16    7 Alive (0.562500000 0.437500000)
##                              27738) NCHRONIC>=7.5 9    2 Alive (0.777777778 0.222222222) *
##                              27739) NCHRONIC< 7.5 7    2 Died (0.285714286 0.714285714) *
##                           6935) ZIPINC_QRTL=4 19    8 Alive (0.578947368 0.421052632)
##                            13870) HOSP_DIVISION=1,9 10    2 Alive (0.800000000 0.200000000) *
##                            13871) HOSP_DIVISION=2 9    3 Died (0.333333333 0.666666667) *
##                       867) CM_CHF=1 81   30 Alive (0.629629630 0.370370370)
##                        1734) CM_HYPOTHY=1 14    1 Alive (0.928571429 0.071428571) *
##                        1735) CM_HYPOTHY=0 67   29 Alive (0.567164179 0.432835821)
##                         3470) FEMALE=0 30    8 Alive (0.733333333 0.266666667) *
##                         3471) FEMALE=1 37   16 Died (0.432432432 0.567567568)
##                           6942) ZIPINC_QRTL=,1,3,4 28   13 Alive (0.535714286 0.464285714)
##                            13884) NCHRONIC>=12.5 5    0 Alive (1.000000000 0.000000000) *
##                            13885) NCHRONIC< 12.5 23   10 Died (0.434782609 0.565217391)
##                              27770) NDX< 15.5 7    1 Alive (0.857142857 0.142857143) *
##                              27771) NDX>=15.5 16    4 Died (0.250000000 0.750000000) *
##                           6943) ZIPINC_QRTL=2 9    1 Died (0.111111111 0.888888889) *
##                   217) CM_METS=1 49   18 Alive (0.632653061 0.367346939)
##                     434) CM_RENLFAIL=1 15    2 Alive (0.866666667 0.133333333) *
##                     435) CM_RENLFAIL=0 34   16 Alive (0.529411765 0.470588235)
##                       870) RACE=White,Hispanic,Asian,Native American 28   11 Alive (0.607142857 0.3
##                        1740) LOS< 73.5 13    3 Alive (0.769230769 0.230769231) *
##                        1741) LOS>=73.5 15    7 Died (0.466666667 0.533333333)
##                         3482) CM_CHRNLUNG=1 6    1 Alive (0.833333333 0.166666667) *
##                         3483) CM_CHRNLUNG=0 9    2 Died (0.222222222 0.777777778) *
##                       871) RACE=Black 6    1 Died (0.166666667 0.833333333) *
##                  109) AGE>=87.5 148   55 Alive (0.628378378 0.371621622)
```

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##                     218) CM_WGHTLOSS=0 121   40 Alive (0.669421488 0.330578512)
##                       436) NDX< 17.5 51   11 Alive (0.784313725 0.215686275)
##                         872) ZIPINC_QRTL=,1,2,4 38    5 Alive (0.868421053 0.131578947)
##                          1744) HOSP_DIVISION=1,9 15    0 Alive (1.000000000 0.000000000) *
##                          1745) HOSP_DIVISION=2,6 23    5 Alive (0.782608696 0.217391304)
##                            3490) LOS>=116.5 8    0 Alive (1.000000000 0.000000000) *
##                            3491) LOS< 116.5 15    5 Alive (0.666666667 0.333333333)
##                              6982) LOS< 61 6    0 Alive (1.000000000 0.000000000) *
##                              6983) LOS>=61 9    4 Died (0.444444444 0.555555556) *
##                         873) ZIPINC_QRTL=3 13    6 Alive (0.538461538 0.461538462) *
##                       437) NDX>=17.5 70   29 Alive (0.585714286 0.414285714)
##                         874) ORPROC< 0.5 61   22 Alive (0.639344262 0.360655738)
##                          1748) LOS>=99 29    7 Alive (0.758620690 0.241379310)
##                            3496) ZIPINC_QRTL=1,2,3 24    4 Alive (0.833333333 0.166666667) *
##                            3497) ZIPINC_QRTL=4 5    2 Died (0.400000000 0.600000000) *
##                          1749) LOS< 99 32   15 Alive (0.531250000 0.468750000)
##                            3498) LOS< 67 19    7 Alive (0.631578947 0.368421053)
##                              6996) LOS>=44.5 6    0 Alive (1.000000000 0.000000000) *
##                              6997) LOS< 44.5 13    6 Died (0.461538462 0.538461538) *
##                            3499) LOS>=67 13    5 Died (0.384615385 0.615384615) *
##                         875) ORPROC>=0.5 9    2 Died (0.222222222 0.777777778) *
##                     219) CM_WGHTLOSS=1 27   12 Died (0.444444444 0.555555556)
##                       438) HOSP_DIVISION=1,9 15    5 Alive (0.666666667 0.333333333)
##                         876) RACE=White 9    1 Alive (0.888888889 0.111111111) *
##                         877) RACE=Black,Hispanic,Asian,Other 6    2 Died (0.333333333 0.666666667) *
##                       439) HOSP_DIVISION=2,6 12    2 Died (0.166666667 0.833333333) *
##                   55) CM_HTN_C=0 751  244 Alive (0.675099867 0.324900133)
##                    110) AGE< 31.5 76   10 Alive (0.868421053 0.131578947) *
##                    111) AGE>=31.5 675  234 Alive (0.653333333 0.346666667)
##                      222) CM_LIVER=0 607  200 Alive (0.670510708 0.329489292)
##                        444) CM_METS=0 561  175 Alive (0.688057041 0.311942959)
##                          888) AGE< 56.5 126   28 Alive (0.777777778 0.222222222)
##                           1776) CM_DMCX=0 120   24 Alive (0.800000000 0.200000000)
##                             3552) NCHRONIC>=1.5 115   21 Alive (0.817391304 0.182608696) *
##                             3553) NCHRONIC< 1.5 5    2 Died (0.400000000 0.600000000) *
##                           1777) CM_DMCX=1 6    2 Died (0.333333333 0.666666667) *
##                          889) AGE>=56.5 435  147 Alive (0.662068966 0.337931034)
##                           1778) AGE>=76.5 241   67 Alive (0.721991701 0.278008299)
##                             3556) NCHRONIC>=4.5 196   48 Alive (0.755102041 0.244897959)
##                               7112) AGE< 89.5 149   29 Alive (0.805369128 0.194630872)
##                                14224) NCHRONIC< 9.5 107   14 Alive (0.869158879 0.130841121)
##                                  28448) HOSP_DIVISION=2,6,9 82    7 Alive (0.914634146 0.085365854) *
##                                  28449) HOSP_DIVISION=1 25    7 Alive (0.720000000 0.280000000)
##                                    56898) NCHRONIC>=7.5 7    0 Alive (1.000000000 0.000000000) *
##                                    56899) NCHRONIC< 7.5 18    7 Alive (0.611111111 0.388888889)
##                                     113798) CM_CHRNLUNG=0 13    3 Alive (0.769230769 0.230769231) *
##                                     113799) CM_CHRNLUNG=1 5    1 Died (0.200000000 0.800000000) *
##                                14225) NCHRONIC>=9.5 42   15 Alive (0.642857143 0.357142857)
##                                  28450) RACE=White,Asian,Other 35    9 Alive (0.742857143 0.257142857)
##                                  28451) RACE=Black,Hispanic 7    1 Died (0.142857143 0.857142857) *
##                               7113) AGE>=89.5 47   19 Alive (0.595744681 0.404255319)
##                                14226) HOSP_DIVISION=1,9 22    5 Alive (0.772727273 0.227272727)
##                                  28452) CM_HYPOTHY=0 17    1 Alive (0.941176471 0.058823529) *
##                                  28453) CM_HYPOTHY=1 5    1 Died (0.200000000 0.800000000) *
```

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##                              14227) HOSP_DIVISION=2,6 25   11 Died (0.440000000 0.560000000)
##                                28454) NDX< 18.5 19    9 Alive (0.526315789 0.473684211)
##                                  56908) FEMALE=1 8    2 Alive (0.750000000 0.250000000) *
##                                  56909) FEMALE=0 11    4 Died (0.363636364 0.636363636) *
##                                28455) NDX>=18.5 6    1 Died (0.166666667 0.833333333) *
##                             3557) NCHRONIC< 4.5 45   19 Alive (0.577777778 0.422222222)
##                               7114) RACE=Hispanic,Other 7    0 Alive (1.000000000 0.000000000) *
##                               7115) RACE=White,Black,Asian 38   19 Alive (0.500000000 0.500000000)
##                                14230) ORPROC< 0.5 28   11 Alive (0.607142857 0.392857143)
##                                  28460) LOS>=96 10    2 Alive (0.800000000 0.200000000) *
##                                  28461) LOS< 96 18    9 Alive (0.500000000 0.500000000)
##                                    56922) AGE>=89 6    2 Alive (0.666666667 0.333333333) *
##                                    56923) AGE< 89 12    5 Died (0.416666667 0.583333333) *
##                                14231) ORPROC>=0.5 10    2 Died (0.200000000 0.800000000) *
##                           1779) AGE< 76.5 194   80 Alive (0.587628866 0.412371134)
##                             3558) AGE< 75.5 179   70 Alive (0.608938547 0.391061453)
##                               7116) LOS>=125.5 29    6 Alive (0.793103448 0.206896552) *
##                               7117) LOS< 125.5 150   64 Alive (0.573333333 0.426666667)
##                                14234) LOS< 111.5 135   53 Alive (0.607407407 0.392592593)
##                                  28468) AGE>=67.5 62   18 Alive (0.709677419 0.290322581)
##                                    56936) ZIPINC_QRTL=1,3,4 46   10 Alive (0.782608696 0.217391304)
##                                     113872) LOS>=73.5 19    1 Alive (0.947368421 0.052631579) *
##                                     113873) LOS< 73.5 27    9 Alive (0.666666667 0.333333333)
##                                       227746) CM_NEURO=1 5    0 Alive (1.000000000 0.000000000) *
##                                       227747) CM_NEURO=0 22    9 Alive (0.590909091 0.409090909)
##                                         455494) NDX< 18.5 16    5 Alive (0.687500000 0.312500000) *
##                                         455495) NDX>=18.5 6    2 Died (0.333333333 0.666666667) *
##                                    56937) ZIPINC_QRTL=,2 16    8 Alive (0.500000000 0.500000000)
##                                     113874) AGE< 71.5 5    1 Alive (0.800000000 0.200000000) *
##                                     113875) AGE>=71.5 11    4 Died (0.363636364 0.636363636) *
##                                  28469) AGE< 67.5 73   35 Alive (0.520547945 0.479452055)
##                                    56938) AGE< 65.5 61   26 Alive (0.573770492 0.426229508)
##                                     113876) ZIPINC_QRTL=,1,2 26    7 Alive (0.730769231 0.269230769)
##                                       227752) NDX< 16.5 7    0 Alive (1.000000000 0.000000000) *
##                                       227753) NDX>=16.5 19    7 Alive (0.631578947 0.368421053)
##                                         455506) PAY1=Medicare,Other 12    3 Alive (0.750000000 0.250000
##                                         455507) PAY1=Medicaid,Private 7    3 Died (0.428571429 0.571428
##                                     113877) ZIPINC_QRTL=3,4 35   16 Died (0.457142857 0.542857143)
##                                       227754) CM_LYTES=0 8    2 Alive (0.750000000 0.250000000) *
##                                       227755) CM_LYTES=1 27   10 Died (0.370370370 0.629629630)
##                                         455510) NDX< 24 22   10 Died (0.454545455 0.545454545)
##                                           911020) NCHRONIC>=5.5 15    6 Alive (0.600000000 0.400000000)
##                                             1822040) HOSP_DIVISION=6,9 9    2 Alive (0.777777778 0.2222
##                                             1822041) HOSP_DIVISION=1,2 6    2 Died (0.333333333 0.66666
##                                           911021) NCHRONIC< 5.5 7    1 Died (0.142857143 0.857142857) *
##                                         455511) NDX>=24 5    0 Died (0.000000000 1.000000000) *
##                                    56939) AGE>=65.5 12    3 Died (0.250000000 0.750000000) *
##                                14235) LOS>=111.5 15    4 Died (0.266666667 0.733333333) *
##                             3559) AGE>=75.5 15    5 Died (0.333333333 0.666666667)
##                               7118) ZIPINC_QRTL=2,3 7    2 Alive (0.714285714 0.285714286) *
##                               7119) ZIPINC_QRTL=1,4 8    0 Died (0.000000000 1.000000000) *
##                         445) CM_METS=1 46   21 Died (0.456521739 0.543478261)
##                           890) RACE=White,Black,Other 38   17 Alive (0.552631579 0.447368421)
##                            1780) LOS>=111 13    2 Alive (0.846153846 0.153846154) *
```

```
##                         1781) LOS< 111 25   10 Died (0.400000000 0.600000000)
##                           3562) LOS< 65 11    3 Alive (0.727272727 0.272727273) *
##                           3563) LOS>=65 14    2 Died (0.142857143 0.857142857) *
##                         891) RACE=Hispanic,Asian 8    0 Died (0.000000000 1.000000000) *
##                     223) CM_LIVER=1 68   34 Alive (0.500000000 0.500000000)
##                       446) HOSP_DIVISION=9 24    7 Alive (0.708333333 0.291666667) *
##                       447) HOSP_DIVISION=1,2,6 44   17 Died (0.386363636 0.613636364)
##                         894) AGE>=52.5 28   13 Alive (0.535714286 0.464285714)
##                          1788) RACE=White 21    7 Alive (0.666666667 0.333333333)
##                            3576) CM_CHF=0 13    2 Alive (0.846153846 0.153846154) *
##                            3577) CM_CHF=1 8    3 Died (0.375000000 0.625000000) *
##                          1789) RACE=Black,Hispanic,Asian 7    1 Died (0.142857143 0.857142857) *
##                         895) AGE< 52.5 16    2 Died (0.125000000 0.875000000) *
##               7) LOS< 3.5 458  127 Died (0.277292576 0.722707424)
##                14) APRDRG_Severity=Minor Loss of Function,Moderate Loss of Function,Major Loss of Functi
##                  28) HOSP_DIVISION=1,4,5 39   12 Alive (0.692307692 0.307692308)
##                    56) ZIPINC_QRTL=1,2,4 33    7 Alive (0.787878788 0.212121212)
##                     112) AGE< 77.5 18    1 Alive (0.944444444 0.055555556) *
##                     113) AGE>=77.5 15    6 Alive (0.600000000 0.400000000)
##                       226) AGE>=83.5 8    1 Alive (0.875000000 0.125000000) *
##                       227) AGE< 83.5 7    2 Died (0.285714286 0.714285714) *
##                    57) ZIPINC_QRTL=3 6    1 Died (0.166666667 0.833333333) *
##                  29) HOSP_DIVISION=2,3,6,7,8,9 110   42 Died (0.381818182 0.618181818)
##                    58) NDX< 17.5 97   42 Died (0.432989691 0.567010309)
##                     116) ZIPINC_QRTL=,4 19    5 Alive (0.736842105 0.263157895)
##                       232) PAY1=Medicare,Medicaid,Self-Pay 12    1 Alive (0.916666667 0.083333333) *
##                       233) PAY1=Private 7    3 Died (0.428571429 0.571428571) *
##                     117) ZIPINC_QRTL=1,2,3 78   28 Died (0.358974359 0.641025641)
##                       234) AGE< 69 33   16 Alive (0.515151515 0.484848485)
##                         468) AGE>=29 26   10 Alive (0.615384615 0.384615385)
##                           936) ZIPINC_QRTL=3 10    1 Alive (0.900000000 0.100000000) *
##                           937) ZIPINC_QRTL=1,2 16    7 Died (0.437500000 0.562500000)
##                            1874) NDX>=10.5 6    2 Alive (0.666666667 0.333333333) *
##                            1875) NDX< 10.5 10    3 Died (0.300000000 0.700000000) *
##                         469) AGE< 29 7    1 Died (0.142857143 0.857142857) *
##                       235) AGE>=69 45   11 Died (0.244444444 0.755555556)
##                         470) CM_ANEMDEF=1 5    2 Alive (0.600000000 0.400000000) *
##                         471) CM_ANEMDEF=0 40    8 Died (0.200000000 0.800000000) *
##                    59) NDX>=17.5 13    0 Died (0.000000000 1.000000000) *
##                15) APRDRG_Severity=Extreme Loss of Function 309   58 Died (0.187702265 0.812297735)
##                  30) NCHRONIC>=11.5 20   10 Alive (0.500000000 0.500000000)
##                    60) CM_LYTES=0 11    2 Alive (0.818181818 0.181818182) *
##                    61) CM_LYTES=1 9    1 Died (0.111111111 0.888888889) *
##                  31) NCHRONIC< 11.5 289   48 Died (0.166089965 0.833910035)
##                    62) NDX< 17.5 217   44 Died (0.202764977 0.797235023)
##                     124) CM_WGHTLOSS=1 11    5 Alive (0.545454545 0.454545455) *
##                     125) CM_WGHTLOSS=0 206   38 Died (0.184466019 0.815533981)
##                       250) LOS>=2.5 124   30 Died (0.241935484 0.758064516)
##                         500) AGE< 20 14    6 Alive (0.571428571 0.428571429) *
##                         501) AGE>=20 110   22 Died (0.200000000 0.800000000)
##                          1002) HOSP_DIVISION=1,3,5 40   13 Died (0.325000000 0.675000000)
##                            2004) AGE< 58.5 13    6 Alive (0.538461538 0.461538462) *
##                            2005) AGE>=58.5 27    6 Died (0.222222222 0.777777778)
##                              4010) AGE>=84 7    3 Alive (0.571428571 0.428571429) *
```

```
##                            4011) AGE< 84 20    2 Died (0.100000000 0.900000000) *
##                          1003) HOSP_DIVISION=2,4,6,7,8,9 70    9 Died (0.128571429 0.871428571)
##                            2006) PAY1=Medicare,Private 48    9 Died (0.187500000 0.812500000)
##                              4012) AGE< 83.5 34    9 Died (0.264705882 0.735294118)
##                                8024) NDX>=13.5 17    7 Died (0.411764706 0.588235294)
##                                 16048) AGE>=70 5    1 Alive (0.800000000 0.200000000) *
##                                 16049) AGE< 70 12    3 Died (0.250000000 0.750000000) *
##                                8025) NDX< 13.5 17    2 Died (0.117647059 0.882352941) *
##                              4013) AGE>=83.5 14    0 Died (0.000000000 1.000000000) *
##                            2007) PAY1=Medicaid,Self-Pay,Other 22    0 Died (0.000000000 1.000000000) *
##                       251) LOS< 2.5 82    8 Died (0.097560976 0.902439024) *
##                    63) NDX>=17.5 72    4 Died (0.055555556 0.944444444) *
```

4. If applicabble, describe any model/feature selection used.

5. If applicabble, describe any tuning parameters and how you will be tuning them.

6. Describe what performance metric(s) you will be using and why.

Results

1. Present key summaries (table and/or plots, but plots prefered when both available) of your data (e.g. class frequencies if a classification problem)

2. Report training, validation/cross-validation, and test errors. Present cross-validation plots for tuning parameters if available. Report variable importance (e.g. p-values, model coefficients, Random forest and boosting variable importance).

Conclusions/discussion

Discuss whether and why the prediction model(s) developed achieved sufficient high accuracy to be usefully deployed to predict new observations.

#Additional notes for those using the NIS data The data provided consists of a random subset of 200,000 patients from 2012 from the National Impatient Sample (NIS) data collected by the Healthcare Cost and Utilization Project (HCUP). You can find information on the HCUP database at https://www.hcup-us.ahrq.gov. You can choose to develop a model to predict death during hospitalization also known as impatient mortality (variable DIED in the dataset) or hospital length of stay (variable LOS in the dataset). For extra credit, you can also choose to predict both. The dataset has a relatively large number of variables. In the provided data dictionary I preselected variables (highlighted) which are both availabe (not all variables in the dictionary are available for 2012) which might be relevant for predicting impatient mortality and/or hospital length of stay. Based on their description and additional info from the HCUP site you should choose which variables among the preselected ones you will consider as features/predictors. You don't have to use them all. There maybe variables that are redundant (capture pretty much the same info others already capture), variables that are too complex (e.g. categorical with way too many levels), or that based on your judgment are unlikely to be important. Be aware that the data is real and has not been pre-processed in any way and you will have to do some data cleaning. For example, you should carefully check the variables you consider as possible predictors for correctness of type (e.g. many numeric variables will be read in as factor variables when you use `read.csv`), outliers, missing observations, nonsensical values, etc.