library(tidyverse)

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

## v ggplot2 3.3.3 v purrr 0.3.4  
## v tibble 3.0.5 v dplyr 1.0.3  
## v tidyr 1.1.2 v stringr 1.4.0  
## v readr 1.4.0 v forcats 0.5.0

## -- Conflicts ------------------------------------------ tidyverse\_conflicts() --  
## x dplyr::filter() masks stats::filter()  
## x dplyr::lag() masks stats::lag()

library(tidymodels)

## -- Attaching packages -------------------------------------- tidymodels 0.1.2 --

## v broom 0.7.3 v recipes 0.1.15  
## v dials 0.0.9 v rsample 0.0.8   
## v infer 0.5.4 v tune 0.1.2   
## v modeldata 0.1.0 v workflows 0.2.1   
## v parsnip 0.1.5 v yardstick 0.0.7

## -- Conflicts ----------------------------------------- tidymodels\_conflicts() --  
## x scales::discard() masks purrr::discard()  
## x dplyr::filter() masks stats::filter()  
## x recipes::fixed() masks stringr::fixed()  
## x dplyr::lag() masks stats::lag()  
## x yardstick::spec() masks readr::spec()  
## x recipes::step() masks stats::step()

library(caret)

## Loading required package: lattice

##   
## Attaching package: 'caret'

## The following objects are masked from 'package:yardstick':  
##   
## precision, recall, sensitivity, specificity

## The following object is masked from 'package:purrr':  
##   
## lift

library(rpart)

##   
## Attaching package: 'rpart'

## The following object is masked from 'package:dials':  
##   
## prune

library(rpart.plot)  
library(rattle)

## Loading required package: bitops

## Rattle: A free graphical interface for data science with R.  
## Version 5.4.0 Copyright (c) 2006-2020 Togaware Pty Ltd.  
## Type 'rattle()' to shake, rattle, and roll your data.

library(RColorBrewer)

parole = read\_csv("parole.csv")

##   
## -- Column specification --------------------------------------------------------  
## cols(  
## male = col\_double(),  
## race = col\_double(),  
## age = col\_double(),  
## state = col\_double(),  
## time.served = col\_double(),  
## max.sentence = col\_double(),  
## multiple.offenses = col\_double(),  
## crime = col\_double(),  
## violator = col\_double()  
## )

str(parole)

## tibble [675 x 9] (S3: spec\_tbl\_df/tbl\_df/tbl/data.frame)  
## $ male : num [1:675] 1 0 1 1 1 1 1 0 0 1 ...  
## $ race : num [1:675] 1 1 2 1 2 2 1 1 1 2 ...  
## $ age : num [1:675] 33.2 39.7 29.5 22.4 21.6 46.7 31 24.6 32.6 29.1 ...  
## $ state : num [1:675] 1 1 1 1 1 1 1 1 1 1 ...  
## $ time.served : num [1:675] 5.5 5.4 5.6 5.7 5.4 6 6 4.8 4.5 4.7 ...  
## $ max.sentence : num [1:675] 18 12 12 18 12 18 18 12 13 12 ...  
## $ multiple.offenses: num [1:675] 0 0 0 0 0 0 0 0 0 0 ...  
## $ crime : num [1:675] 4 3 3 1 1 4 3 1 3 2 ...  
## $ violator : num [1:675] 0 0 0 0 0 0 0 0 0 0 ...  
## - attr(\*, "spec")=  
## .. cols(  
## .. male = col\_double(),  
## .. race = col\_double(),  
## .. age = col\_double(),  
## .. state = col\_double(),  
## .. time.served = col\_double(),  
## .. max.sentence = col\_double(),  
## .. multiple.offenses = col\_double(),  
## .. crime = col\_double(),  
## .. violator = col\_double()  
## .. )

summary(parole)

## male race age state   
## Min. :0.0000 Min. :1.000 Min. :18.40 Min. :1.000   
## 1st Qu.:1.0000 1st Qu.:1.000 1st Qu.:25.35 1st Qu.:2.000   
## Median :1.0000 Median :1.000 Median :33.70 Median :3.000   
## Mean :0.8074 Mean :1.424 Mean :34.51 Mean :2.887   
## 3rd Qu.:1.0000 3rd Qu.:2.000 3rd Qu.:42.55 3rd Qu.:4.000   
## Max. :1.0000 Max. :2.000 Max. :67.00 Max. :4.000   
## time.served max.sentence multiple.offenses crime   
## Min. :0.000 Min. : 1.00 Min. :0.0000 Min. :1.000   
## 1st Qu.:3.250 1st Qu.:12.00 1st Qu.:0.0000 1st Qu.:1.000   
## Median :4.400 Median :12.00 Median :1.0000 Median :2.000   
## Mean :4.198 Mean :13.06 Mean :0.5363 Mean :2.059   
## 3rd Qu.:5.200 3rd Qu.:15.00 3rd Qu.:1.0000 3rd Qu.:3.000   
## Max. :6.000 Max. :18.00 Max. :1.0000 Max. :4.000   
## violator   
## Min. :0.0000   
## 1st Qu.:0.0000   
## Median :0.0000   
## Mean :0.1156   
## 3rd Qu.:0.0000   
## Max. :1.0000

parole = parole %>% mutate(male = as\_factor(male)) %>%  
 mutate(male = fct\_recode(male, "No" = "0", "Yes" = "1")) %>%  
 mutate(race = as\_factor(race)) %>%  
 mutate(race = fct\_recode(race, "No" = "2", "Yes" = "1")) %>%  
 mutate(state = as\_factor(state)) %>%  
 mutate(state = fct\_recode(state, "No" = "2", "Yes" = "1")) %>%  
 mutate(crime = as\_factor(crime)) %>%  
 mutate(crime = fct\_recode(crime, "No" = "1", "Yes" = "2")) %>%  
 mutate(multiple.offenses = as\_factor(multiple.offenses)) %>%  
 mutate(multiple.offenses = fct\_recode(multiple.offenses, "No" = "0", "Yes" = "1")) %>%  
 mutate(violator = as\_factor(violator)) %>%  
 mutate(violator = fct\_recode(violator, "No" = "0", "Yes" = "1"))

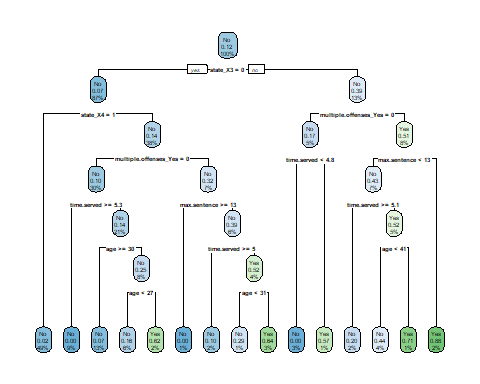
set.seed(12345)  
parole\_split = initial\_split(parole, prob = 0.70, strata = violator)  
train = training(parole\_split)  
test = testing(parole\_split)

parole\_recipe = recipe(violator~. , train) %>%  
 step\_dummy(all\_nominal(),-all\_outcomes())  
  
tree\_model = decision\_tree() %>%  
 set\_engine("rpart", model = TRUE) %>%  
 set\_mode("classification")  
  
parole\_wkflow =  
 workflow() %>%  
 add\_model(tree\_model) %>%  
 add\_recipe(parole\_recipe)  
  
parole\_fit = fit(parole\_wkflow, train)

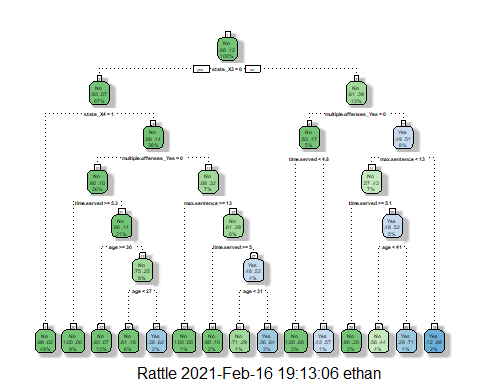
parole\_fit %>%  
 pull\_workflow\_fit() %>%  
 pluck("fit")

## n= 507   
##   
## node), split, n, loss, yval, (yprob)  
## \* denotes terminal node  
##   
## 1) root 507 59 No (0.88362919 0.11637081)   
## 2) state\_X3< 0.5 441 33 No (0.92517007 0.07482993)   
## 4) state\_X4>=0.5 250 6 No (0.97600000 0.02400000) \*  
## 5) state\_X4< 0.5 191 27 No (0.85863874 0.14136126)   
## 10) multiple.offenses\_Yes< 0.5 153 15 No (0.90196078 0.09803922)   
## 20) time.served>=5.25 45 0 No (1.00000000 0.00000000) \*  
## 21) time.served< 5.25 108 15 No (0.86111111 0.13888889)   
## 42) age>=30.35 68 5 No (0.92647059 0.07352941) \*  
## 43) age< 30.35 40 10 No (0.75000000 0.25000000)   
## 86) age< 26.7 32 5 No (0.84375000 0.15625000) \*  
## 87) age>=26.7 8 3 Yes (0.37500000 0.62500000) \*  
## 11) multiple.offenses\_Yes>=0.5 38 12 No (0.68421053 0.31578947)   
## 22) max.sentence>=12.5 7 0 No (1.00000000 0.00000000) \*  
## 23) max.sentence< 12.5 31 12 No (0.61290323 0.38709677)   
## 46) time.served>=5 10 1 No (0.90000000 0.10000000) \*  
## 47) time.served< 5 21 10 Yes (0.47619048 0.52380952)   
## 94) age< 31.05 7 2 No (0.71428571 0.28571429) \*  
## 95) age>=31.05 14 5 Yes (0.35714286 0.64285714) \*  
## 3) state\_X3>=0.5 66 26 No (0.60606061 0.39393939)   
## 6) multiple.offenses\_Yes< 0.5 23 4 No (0.82608696 0.17391304)   
## 12) time.served< 4.8 16 0 No (1.00000000 0.00000000) \*  
## 13) time.served>=4.8 7 3 Yes (0.42857143 0.57142857) \*  
## 7) multiple.offenses\_Yes>=0.5 43 21 Yes (0.48837209 0.51162791)   
## 14) max.sentence< 12.5 35 15 No (0.57142857 0.42857143)   
## 28) time.served>=5.05 10 2 No (0.80000000 0.20000000) \*  
## 29) time.served< 5.05 25 12 Yes (0.48000000 0.52000000)   
## 58) age< 40.8 18 8 No (0.55555556 0.44444444) \*  
## 59) age>=40.8 7 2 Yes (0.28571429 0.71428571) \*  
## 15) max.sentence>=12.5 8 1 Yes (0.12500000 0.87500000) \*

tree = parole\_fit %>%  
 pull\_workflow\_fit() %>%  
 pluck("fit")  
  
rpart.plot(tree)



fancyRpartPlot(tree)



parole\_fit$fit$fit$fit$cptable

## CP nsplit rel error xerror xstd  
## 1 0.03389831 0 1.0000000 1.000000 0.1223796  
## 2 0.02542373 3 0.8983051 1.101695 0.1275886  
## 3 0.01694915 5 0.8474576 1.084746 0.1267465  
## 4 0.01355932 6 0.8305085 1.084746 0.1267465  
## 5 0.01129944 11 0.7627119 1.186441 0.1316539  
## 6 0.01000000 14 0.7288136 1.152542 0.1300561

Start at the top of the tree and go to the right. Since he has multiple offenses again go to the right. Max sentence was less than 13 years so move to the left. Time served was less than 5.1 so move to the left and that gives you 2%.

0.01694915 would be optimal.

set.seed(123)  
folds = vfold\_cv(train, v = 5)

parole\_recipe = recipe(violator ~., train) %>%  
 step\_dummy(all\_nominal(),-all\_outcomes())  
  
tree\_model = decision\_tree(cost\_complexity = tune()) %>%  
 set\_engine("rpart", model = TRUE) %>%  
 set\_mode("classification")  
  
tree\_grid = grid\_regular(cost\_complexity(),  
 levels = 25)  
  
parole\_wkflow =   
 workflow() %>%  
 add\_model(tree\_model) %>%  
 add\_recipe(parole\_recipe)  
  
  
tree\_res =  
 parole\_wkflow %>%  
 tune\_grid(  
 resamples = folds,  
 grid = tree\_grid  
 )

##   
## Attaching package: 'rlang'

## The following objects are masked from 'package:purrr':  
##   
## %@%, as\_function, flatten, flatten\_chr, flatten\_dbl, flatten\_int,  
## flatten\_lgl, flatten\_raw, invoke, list\_along, modify, prepend,  
## splice

##   
## Attaching package: 'vctrs'

## The following object is masked from 'package:dplyr':  
##   
## data\_frame

## The following object is masked from 'package:tibble':  
##   
## data\_frame

tree\_res

## # Tuning results  
## # 5-fold cross-validation   
## # A tibble: 5 x 4  
## splits id .metrics .notes   
## <list> <chr> <list> <list>   
## 1 <split [405/102]> Fold1 <tibble [50 x 5]> <tibble [0 x 1]>  
## 2 <split [405/102]> Fold2 <tibble [50 x 5]> <tibble [0 x 1]>  
## 3 <split [406/101]> Fold3 <tibble [50 x 5]> <tibble [0 x 1]>  
## 4 <split [406/101]> Fold4 <tibble [50 x 5]> <tibble [0 x 1]>  
## 5 <split [406/101]> Fold5 <tibble [50 x 5]> <tibble [0 x 1]>

best\_tree = tree\_res %>%  
 select\_best

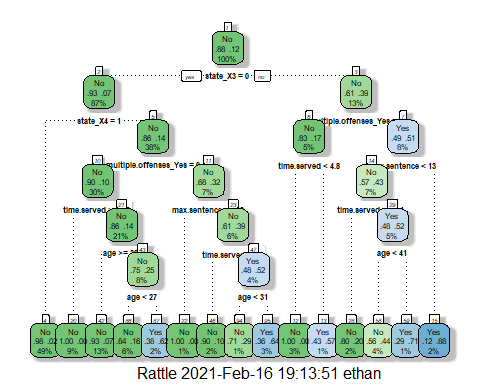
## Warning: No value of `metric` was given; metric 'roc\_auc' will be used.

best\_tree

## # A tibble: 1 x 2  
## cost\_complexity .config   
## <dbl> <chr>   
## 1 0.0000000001 Preprocessor1\_Model01

final\_wf =  
 parole\_wkflow %>%  
 finalize\_workflow(best\_tree)

final\_fit = fit(final\_wf, train)  
  
tree = final\_fit %>%  
 pull\_workflow\_fit() %>%  
 pluck("fit")  
  
fancyRpartPlot(tree, tweak = 1.5)



blood = read\_csv("blood.csv")

##   
## -- Column specification --------------------------------------------------------  
## cols(  
## Mnths\_Since\_Last = col\_double(),  
## TotalDonations = col\_double(),  
## Total\_Donated = col\_double(),  
## Mnths\_Since\_First = col\_double(),  
## DonatedMarch = col\_double()  
## )

blood = blood %>% mutate(DonatedMarch = as\_factor(DonatedMarch)) %>%  
 mutate(DonatedMarch = fct\_recode(DonatedMarch, "No" = "0", "Yes" = "1"))

set.seed(1234)  
blood\_split = initial\_split(blood, prob = 0.70, strata = DonatedMarch)  
train2 = training(blood\_split)  
test2 = testing(blood\_split)

set.seed(1234)  
folds2 = vfold\_cv(train2, v = 5)  
  
blood\_recipe = recipe( Mnths\_Since\_Last ~ DonatedMarch , train2)  
  
tree\_model2 = decision\_tree(cost\_complexity = tune()) %>%  
 set\_engine("rpart", model = TRUE) %>%  
 set\_mode("classification")  
  
tree\_grid2 = grid\_regular(cost\_complexity(),  
 levels = 25)  
  
blood\_wkflow =  
 workflow() %>%  
 add\_model(tree\_model2) %>%  
 add\_recipe(blood\_recipe)  
  
tree\_res2 =   
 blood\_wkflow %>%  
 tune\_grid(  
 resamples = folds2,  
 grid = tree\_grid2  
 )

## x Fold1: preprocessor 1/1, model 1/25: Error: For a classification model, the out...

## x Fold1: preprocessor 1/1, model 2/25: Error: For a classification model, the out...

## x Fold1: preprocessor 1/1, model 3/25: Error: For a classification model, the out...

## x Fold1: preprocessor 1/1, model 4/25: Error: For a classification model, the out...

## x Fold1: preprocessor 1/1, model 5/25: Error: For a classification model, the out...

## x Fold1: preprocessor 1/1, model 6/25: Error: For a classification model, the out...

## x Fold1: preprocessor 1/1, model 7/25: Error: For a classification model, the out...

## x Fold1: preprocessor 1/1, model 8/25: Error: For a classification model, the out...

## x Fold1: preprocessor 1/1, model 9/25: Error: For a classification model, the out...

## x Fold1: preprocessor 1/1, model 10/25: Error: For a classification model, the ou...

## x Fold1: preprocessor 1/1, model 11/25: Error: For a classification model, the ou...

## x Fold1: preprocessor 1/1, model 12/25: Error: For a classification model, the ou...

## x Fold1: preprocessor 1/1, model 13/25: Error: For a classification model, the ou...

## x Fold1: preprocessor 1/1, model 14/25: Error: For a classification model, the ou...

## x Fold1: preprocessor 1/1, model 15/25: Error: For a classification model, the ou...

## x Fold1: preprocessor 1/1, model 16/25: Error: For a classification model, the ou...

## x Fold1: preprocessor 1/1, model 17/25: Error: For a classification model, the ou...

## x Fold1: preprocessor 1/1, model 18/25: Error: For a classification model, the ou...

## x Fold1: preprocessor 1/1, model 19/25: Error: For a classification model, the ou...

## x Fold1: preprocessor 1/1, model 20/25: Error: For a classification model, the ou...

## x Fold1: preprocessor 1/1, model 21/25: Error: For a classification model, the ou...

## x Fold1: preprocessor 1/1, model 22/25: Error: For a classification model, the ou...

## x Fold1: preprocessor 1/1, model 23/25: Error: For a classification model, the ou...

## x Fold1: preprocessor 1/1, model 24/25: Error: For a classification model, the ou...

## x Fold1: preprocessor 1/1, model 25/25: Error: For a classification model, the ou...

## x Fold2: preprocessor 1/1, model 1/25: Error: For a classification model, the out...

## x Fold2: preprocessor 1/1, model 2/25: Error: For a classification model, the out...

## x Fold2: preprocessor 1/1, model 3/25: Error: For a classification model, the out...

## x Fold2: preprocessor 1/1, model 4/25: Error: For a classification model, the out...

## x Fold2: preprocessor 1/1, model 5/25: Error: For a classification model, the out...

## x Fold2: preprocessor 1/1, model 6/25: Error: For a classification model, the out...

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## x Fold2: preprocessor 1/1, model 10/25: Error: For a classification model, the ou...

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## x Fold2: preprocessor 1/1, model 25/25: Error: For a classification model, the ou...

## x Fold3: preprocessor 1/1, model 1/25: Error: For a classification model, the out...

## x Fold3: preprocessor 1/1, model 2/25: Error: For a classification model, the out...

## x Fold3: preprocessor 1/1, model 3/25: Error: For a classification model, the out...

## x Fold3: preprocessor 1/1, model 4/25: Error: For a classification model, the out...

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## x Fold3: preprocessor 1/1, model 6/25: Error: For a classification model, the out...

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## x Fold3: preprocessor 1/1, model 9/25: Error: For a classification model, the out...

## x Fold3: preprocessor 1/1, model 10/25: Error: For a classification model, the ou...

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## x Fold3: preprocessor 1/1, model 25/25: Error: For a classification model, the ou...

## x Fold4: preprocessor 1/1, model 1/25: Error: For a classification model, the out...

## x Fold4: preprocessor 1/1, model 2/25: Error: For a classification model, the out...

## x Fold4: preprocessor 1/1, model 3/25: Error: For a classification model, the out...

## x Fold4: preprocessor 1/1, model 4/25: Error: For a classification model, the out...

## x Fold4: preprocessor 1/1, model 5/25: Error: For a classification model, the out...

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## x Fold4: preprocessor 1/1, model 11/25: Error: For a classification model, the ou...

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## x Fold5: preprocessor 1/1, model 1/25: Error: For a classification model, the out...

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## x Fold5: preprocessor 1/1, model 20/25: Error: For a classification model, the ou...

## x Fold5: preprocessor 1/1, model 21/25: Error: For a classification model, the ou...

## x Fold5: preprocessor 1/1, model 22/25: Error: For a classification model, the ou...

## x Fold5: preprocessor 1/1, model 23/25: Error: For a classification model, the ou...

## x Fold5: preprocessor 1/1, model 24/25: Error: For a classification model, the ou...

## x Fold5: preprocessor 1/1, model 25/25: Error: For a classification model, the ou...

## Warning: All models failed. See the `.notes` column.

tree\_res2

## Warning: This tuning result has notes. Example notes on model fitting include:  
## preprocessor 1/1, model 10/25: Error: For a classification model, the outcome should be a factor.  
## preprocessor 1/1, model 22/25: Error: For a classification model, the outcome should be a factor.  
## preprocessor 1/1, model 16/25: Error: For a classification model, the outcome should be a factor.

## # Tuning results  
## # 5-fold cross-validation   
## # A tibble: 5 x 4  
## splits id .metrics .notes   
## <list> <chr> <list> <list>   
## 1 <split [449/113]> Fold1 <NULL> <tibble [25 x 1]>  
## 2 <split [449/113]> Fold2 <NULL> <tibble [25 x 1]>  
## 3 <split [450/112]> Fold3 <NULL> <tibble [25 x 1]>  
## 4 <split [450/112]> Fold4 <NULL> <tibble [25 x 1]>  
## 5 <split [450/112]> Fold5 <NULL> <tibble [25 x 1]>