Example stat 562

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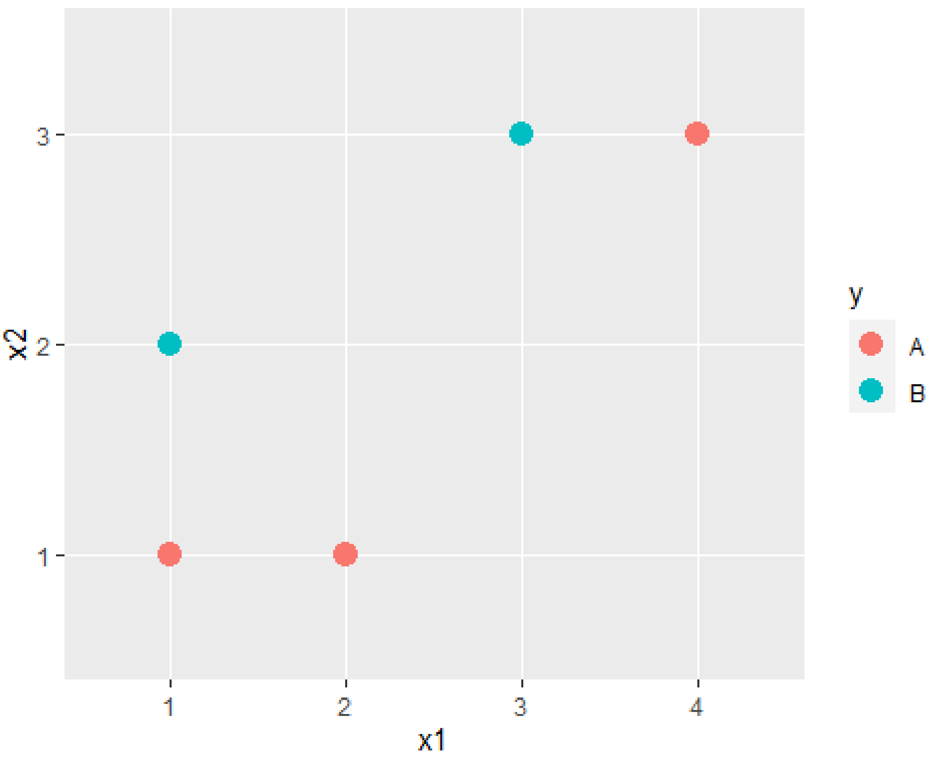
```
library(tidyverse)
```

```
## Warning: package 'tidyverse' was built under R version 4.3.1

## Warning: package 'ggplot2' was built under R version 4.3.1

## Warning: package 'lubridate' was built under R version 4.3.1

## ── Attaching core tidyverse packages ──────────────────────── tidyverse
2.0.0 ──
## ✓ dplyr     1.1.2     ✓ readr     2.1.4
## ✓ forcats   1.0.0     ✓ stringr   1.5.0
## ✓ ggplot2   3.4.2     ✓ tibble    3.2.1
## ✓ lubridate 1.9.2     ✓ tidyr     1.3.0
## ✓ purrr     1.0.1
## ── Conflicts ──────────────────────────────────────────
tidyverse_conflicts() ──
## ✕ dplyr::filter() masks stats::filter()
## ✕ dplyr::lag()    masks stats::lag()
## ℹ Use the conflicted package (<http://conflicted.r-lib.org/>) to force all
conflicts to become errors
```

```
y=c("A","B","A","B","A")
x1=c(1,1,4,3,2)
x2=c(1,2,3,3,1)
data=as.data.frame(cbind(y,x1,x2))
ggplot(data,aes(x=x1,y=x2,col=y))+geom_point(size=4)
```



#originally: # – Originally we are checking how much impurity does the data set have in the very starting. #– Since this is the very small data set so we are doing it manually, but it is not possible to do like this #– manually in a huge data set.

```
g=2/5*3/5*2
```

#0.48

#choosing 1st node split: #– Start spliting through x-axis # – Now here we are trying different place to split the data set and according to each place we are tying to #– to calculate the impurity, and we get minimum impurity in g1.3 this split (means x1 less then3.5 and greater then 3.5)

```
g1.1=1/2*1/2*2*(0.4)+1/3*2/3*2*(0.6) #0.4667
g1.2=1/3*2/3*2*(0.6)+1/2*1/2*2*(0.4) #0.4667
g1.3=1/2*1/2*2*(0.8)+0*0.2 #0.4
```

Now we will similarly split through y-axis

check the impurity in the each split and choose the one having the minimum impurity, and mimimum impurity

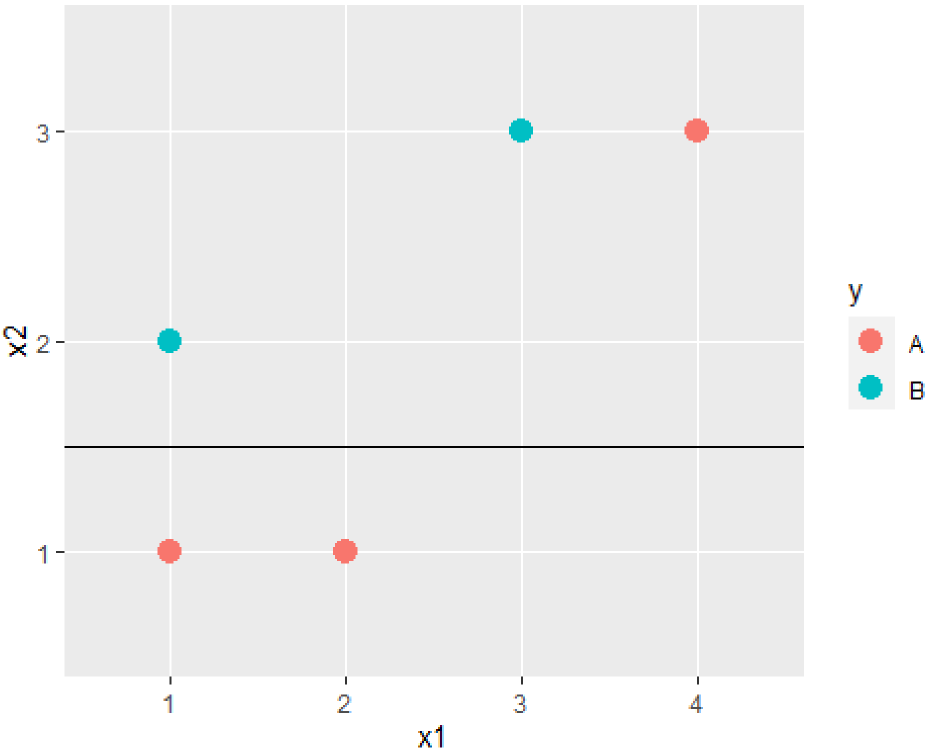
will be for the one having the pure node.

The minimum impurity is along g2.2 so we will split along that, means x2<1.5 or x2>1.5

```
g2.1=0*(0.4)+1/3*2/3*2*(0.6) #0.2667
g2.2=1/3*2/3*2*(0.6)+1/2*1/2*2*(0.4) #0.4667
```

#pick x2< 1.5 v.s x2 > 1.5 as 1st split

```
ggplot(data,aes(x=x1,y=x2,col=y))+geom_point(size=4)+geom_hline(yintercept=1.5)
```

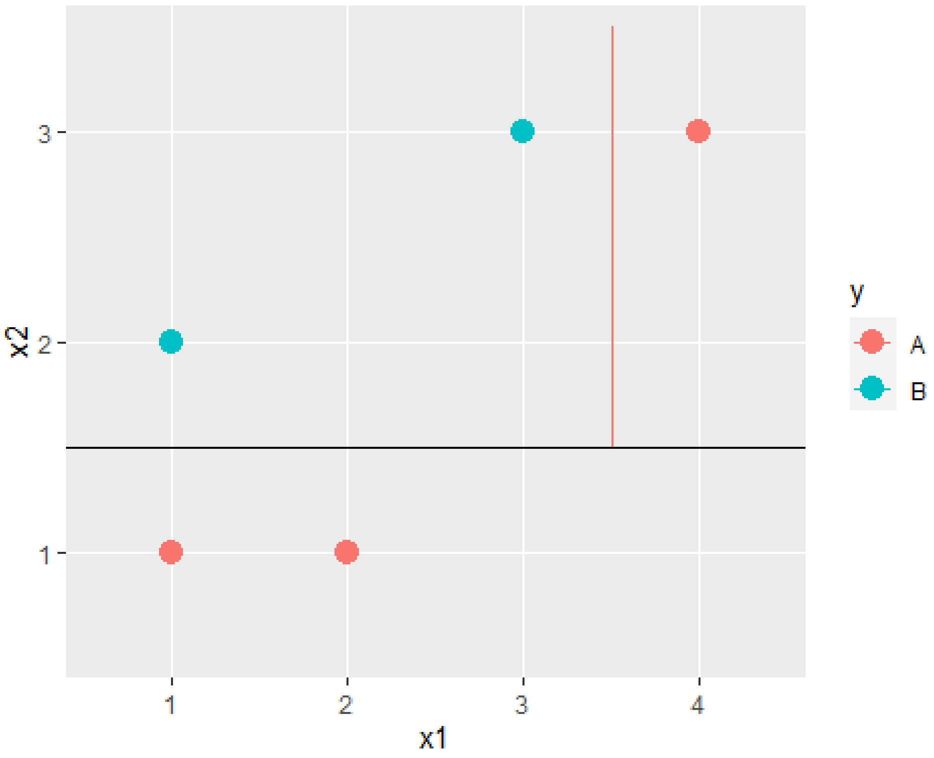


#choosing 2nd split

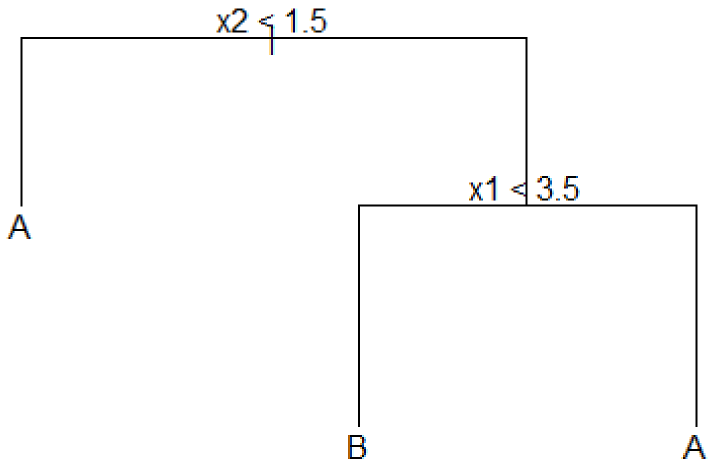
```
g1.1=0*1/3+1/2*1/2*2*2/3 #0.333
g1.3=0
g2.2=0*1/3+1/2*1/2*2*2/3 #0.333
```

#pick x1< 3.5 v.s x1 > 3.5 as 2nd split

```
ggplot(data,aes(x=x1,y=x2,col=y))+geom_point(size=4)+
  geom_hline(yintercept=1.5)+geom_segment(aes(x = 3.5, y = 1.5, xend = 3.5,
yend = 3.5))
```



```
library(tree)

## Warning: package 'tree' was built under R version 4.3.2

out=tree(as.factor(y)~.,data,control=tree.control(nobs=5,mincut = 0,
minsize=0, mindev = 0))
plot(out)
text(out)
```



##Classification Tree Example, Default data

```
library(tree)
library(ISLR2)
```

```
## Warning: package 'ISLR2' was built under R version 4.3.2
```

```
train=sample(1:10000,7000) # We take 7000 for training and 3000 for test
test=Default[-train,]
tree.d=tree(default~.,Default,split="gini",subset=train)
```

– default is only one column of the table which need to be predicted

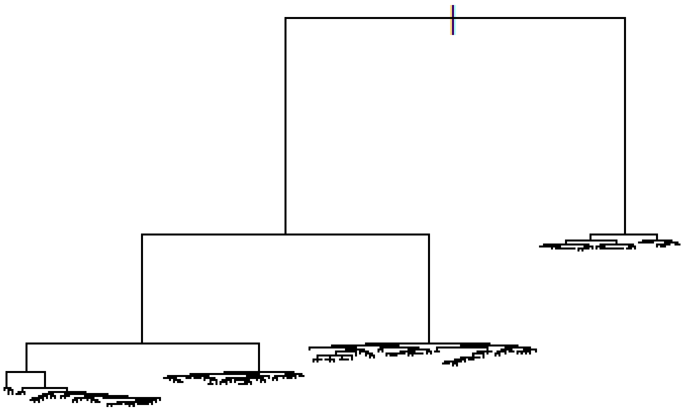
– the name of the data set is Default which is in the ISLR2 library

–code: default is the variable I need to predict and I want to predict it crossponidng to all prediction (~.)

– my data set name is Default and spliting criteria is gini and I will only make tree using tarining data set.

```
summary(tree.d)
```

```
##
## Classification tree:
## tree(formula = default ~ ., data = Default, subset = train, split =
"gini")
## Number of terminal nodes:  156
## Residual mean deviance:  0.0955 = 653.6 / 6844
## Misclassification error rate: 0.024 = 168 / 7000

plot(tree.d)
```



#predict class on test data

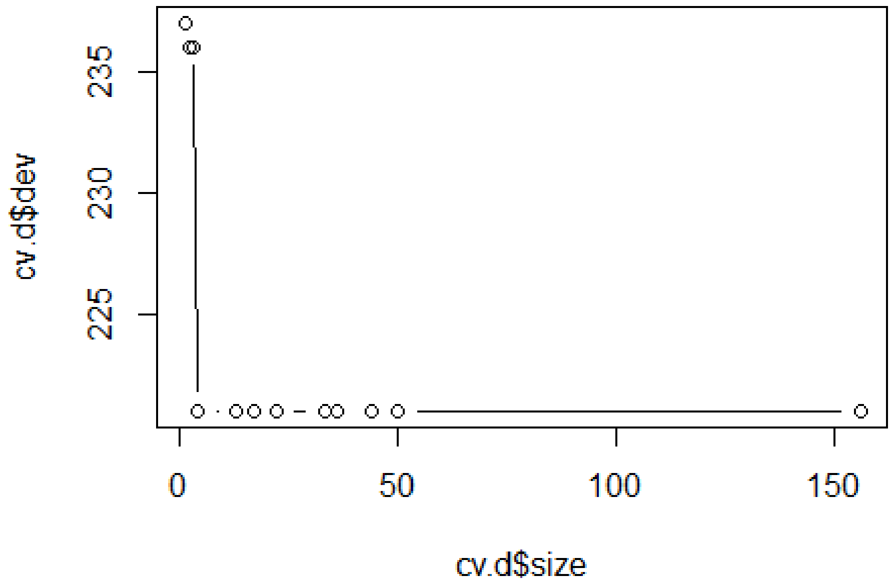
```
pred.d=predict(tree.d,test,type="class")
table(pred.d,test$default)

##
## pred.d   No  Yes
##    No  2854   43
##    Yes   50   53
```

#pruning

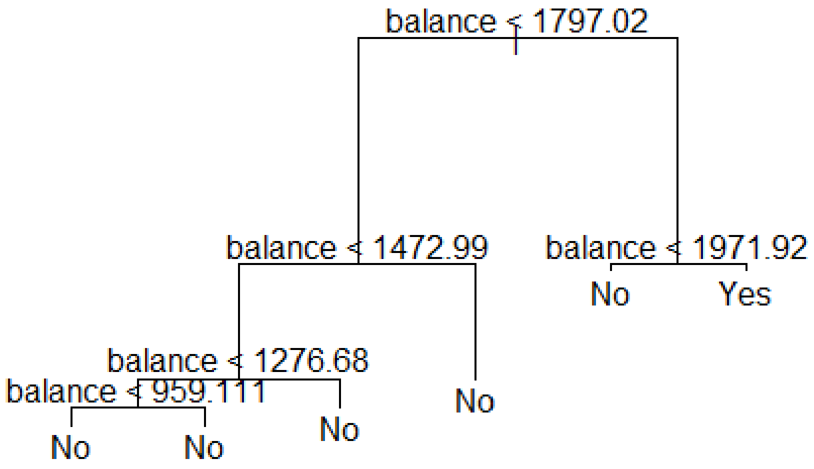
```
cv.d=cv.tree(tree.d)
```

#or if you want to use misclassification rate for the CV instead of the default deviance,

```
cv.d=cv.tree(tree.d,FUN = prune.misclass)
plot(cv.d$size, cv.d$dev, type="b")
```



```
prune.d=prune.tree(tree.d,best=6)
summary(prune.d)

##
## Classification tree:
## snip.tree(tree = tree.d, nodes = c(9L, 7L, 16L, 5L, 17L, 6L))
## Variables actually used in tree construction:
## [1] "balance"
## Number of terminal nodes:  6
## Residual mean deviance:  0.161 = 1126 / 6994
## Misclassification error rate: 0.02886 = 202 / 7000

plot(prune.d)
text(prune.d)
```



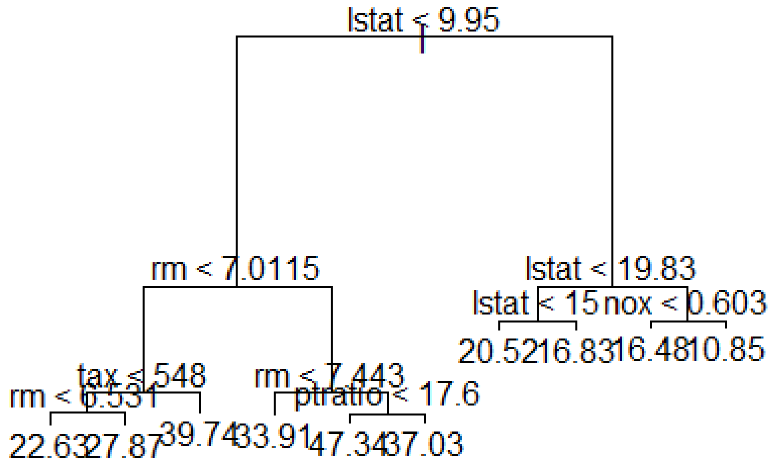
#predict class on test data

```
pred.d.prune=predict(prune.d,test,type="class")
table(pred.d.prune,test$default)

##
## pred.d.prune   No  Yes
##          No  2893   58
##          Yes   11   38
```

#Regression Tree Example: Boston House Price

```
library(ISLR2)
train=sample(1:506,350) # We take 350 for training and  for test
test=Boston[-train,]
tree.b=tree(medv~.,Boston,subset=train)
summary(tree.b)

##
## Regression tree:
## tree(formula = medv ~ ., data = Boston, subset = train)
## Variables actually used in tree construction:
## [1] "lstat"   "rm"      "tax"     "ptratio" "nox"
## Number of terminal nodes:  10
## Residual mean deviance:  13.28 = 4515 / 340
## Distribution of residuals:
##      Min.   1st Qu.    Median      Mean   3rd Qu.      Max.
## -16.04000  -2.04600   0.06297   0.00000   2.17300  16.09000
```

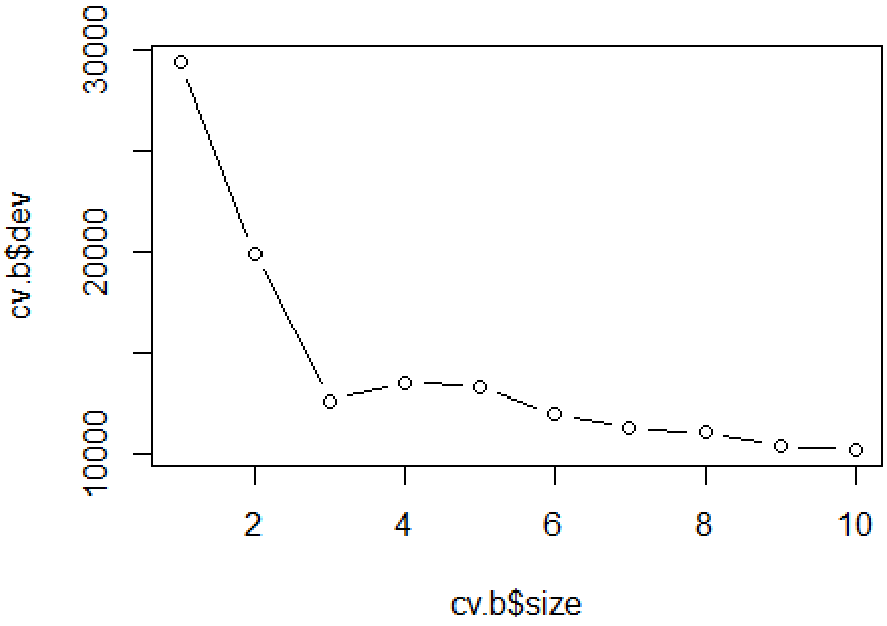
```
plot(tree.b)
text(tree.b,pretty = 0)
```



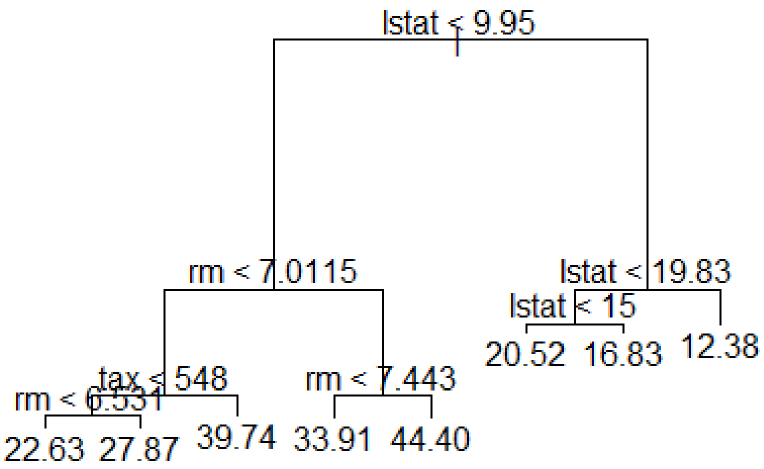
```
test.mse=mean((test$medv-predict(tree.b,test))^2)
test.mse

## [1] 17.33287
```

#pruning if needed

```
cv.b=cv.tree(tree.b)
plot(cv.b$size, cv.b$dev, type="b")
```



```r
prune.b=prune.tree(tree.b,best=8)
plot(prune.b)
text(prune.b)
```


lstat < 9.95
rm < 7.0115
lstat < 19.83
lstat < 15
tax < 548
rm < 7.443
rm < 6.531
20.52
16.83
12.38
22.63
27.87
39.74
33.91
44.40