

Statistics 452: Statistical Learning and Prediction

Chapter 8, Part 4: Regression Trees Lab

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Boston Data

- ▶ Recall the Boston dataset in which the response is the median house price in \$1000 and there are 13 predictors.
- ▶ As on the midterm, I've replaced the variable `black` by `predAA`, an indicator that takes value 1 if the town is predominantly African American and 0 otherwise.

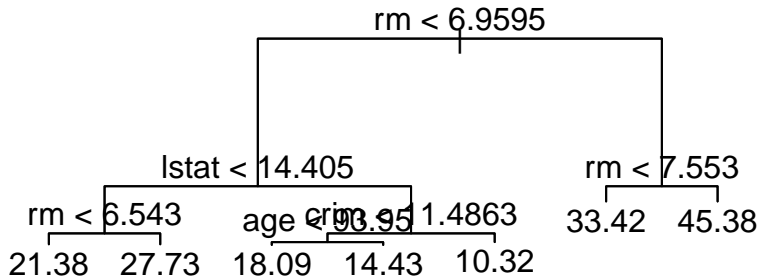
Training and Test Data

- ▶ Split the data in half for training and testing.

```
set.seed(1)
train <- sample(1:nrow(Boston),nrow(Boston)/2)
```

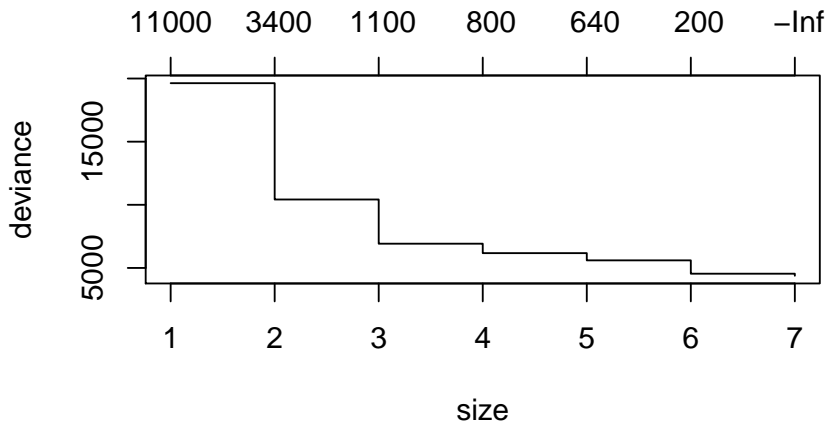
Regression Tree

```
library(tree)
tt <- tree(medv ~ ., data=Boston, subset=train)
plot(tt) # only rm, lstat, tax and dis used
text(tt)
```



Cross-Validation to Prune Tree

```
cvt <- cv.tree(tt)
plot(cvt) # No pruning required -- could use size 5
```



based on parsimony

Test Set Error

- Use the unpruned tree

```
yhat <- predict(tt,newdata=Boston[-train,])  
y <- Boston[-train,"medv"]  
mean((y-yhat)^2)
```

```
## [1] 35.28688
```

Bagging

```
library(randomForest)
set.seed(1) # for bootstrapping
btt <- randomForest(medv ~ ., data=Boston,subset=train,
                    mtry=13) # mtry=p for bagging
yhat <- predict(btt,newdata=Boston[-train,])
mean((y-yhat)^2)
```

```
## [1] 23.34321
```

Random Forest

```
set.seed(1) # for bootstrapping
rtt <- randomForest(medv ~ ., data=Boston, subset=train,
                    mtry=sqrt(13), importance=TRUE)
yhat <- predict(rtt, newdata=Boston[-train,])
mean((y-yhat)^2)
```

```
## [1] 18.56577
```

```
importance(rtt)
```

##	%IncMSE	IncNodePurity
## crim	16.224623	1208.50019
## zn	3.477727	187.46046
## indus	6.761188	742.21431
## chas	2.350918	103.29396
## nox	13.214861	1069.82251
## rm	28.589149	6477.77842
## age	12.211473	761.16192
## dis	9.809813	944.63009
## rad	4.004756	149.61208
## tax	9.687284	678.62951
## ptratio	10.277997	1319.36163
## lstat	25.566944	5435.75676
## predAA	8.224915	60.43943

Boosting

```
library(gbm)
bott <- gbm(medv ~ ., data=Boston[train,],
            distribution="gaussian",n.trees=1000) #M
yhat <- predict(bott,newdata=Boston[-train,],n.trees=1000)
mean((y-yhat)^2)
```

```
## [1] 18.95041
```

Boosting with Greater Interaction Depth

```
bott <- gbm(medv ~ ., data=Boston[train,], interaction.depth=4,  
           distribution="gaussian",n.trees=1000)  
yhat <- predict(bott,newdata=Boston[-train,],n.trees=1000)  
mean((y-yhat)^2)
```

```
## [1] 16.97259
```

Boosting with Less Shrinkage

```
bott <- gbm(medv ~ ., data=Boston[train,], interaction.depth=4,  
            shrinkage=0.001, # decrease from default 0.1  
            distribution="gaussian",n.trees=1000)  
yhat <- predict(bott,newdata=Boston[-train,],n.trees=1000)  
mean((y-yhat)^2)
```

```
## [1] 35.73102
```

Using the Test Set for Tuning

- ▶ Note: Using the test set to tune the boosting algorithm does not lead to valid test set estimates.
 - ▶ We are essentially fitting the test data.
- ▶ If we require a test set for tuning, it should not be the one we use to evaluate the tuned algorithm.
 - ▶ We should split the data into three parts: (i) training (can be the largest part), (ii) tuning test set, and (iii) test set.