FIT3152 Data analytics. Tutorial 07: Decision Trees

Objectives:

- Understand entropy and information gain in relation to decision tree algorithms
- Create decision trees using R
- Using decision trees for profiling
- Using decision trees for classifying unseen instances
- Evaluation of decision tree models – confusion matrices

Reference: An Introduction to Statistical Learning with applications in R (Springer Texts in Statistics), James, Witten, Hastie and Tibshirani, Chapter 8 (available on-line from Monash Library)

Pre-tutorial Activity

The "diamonds" data set comes packaged with ggplot2 and contains data about the price of diamonds as well as information on size and the 4 Cs affecting diamond price: carat (size), cut, colour and clarity.

1. Create a class variable named "price_level" as a factor and with two values "High" and "Low" based on the median price of diamonds.

2. Split the data into 70% training and 30% testing data sets. Fit a decision tree model to predict the price_level of diamonds and check accuracy using a confusion matrix.

3. Next, fit a decision tree model to predict price_level using the 4 C variables (carat (size), cut, colour and clarity) only and compare accuracy with the previous model.

Tutorial Activities

1 Work through the examples in the lecture slides. For the examples using R you will need to download and install the 'tree' package using the following code.

```
install.packages("tree")
library(tree)
```

2 Calculation of entropy and information gain

Table 1 below includes data for 10 different types of aliens. The data is to be used to determine which aliens are friendly and which are not.

a. What is the entropy of the IsFriendly class?
b. Which decision attribute should you choose as the root of the decision tree – you can work this out without doing any calculations. Explain why you chose that attribute.
c. What is the information gain of the attribute you chose in b.?
d. Using the attribute you chose in b. as the root node, and using examples 1 to 10, build a decision tree for classifying aliens as friendly or not.
e. Using your decision tree, what are the predictions for aliens 11, 12, 13 in table 2?

Table 1: Training Set

ID	colour	size	teeth	IsFriendly
1	red	medium	yes	no
2	blue	big	no	yes
3	green	medium	no	no
4	green	small	yes	no
5	blue	big	yes	yes
6	blue	small	yes	yes
7	red	small	no	yes
8	red	medium	no	yes
9	blue	medium	yes	yes
10	green	small	no	no

Table 2: Test Set

ID	colour	size	teeth	IsFriendly
11	red	big	yes	?
12	green	big	yes	?
13	blue	small	no	?

3 The built-in data set mtcars describes the fuel consumption and 10 other variables for 32 cars produced during 1973 – 1974. Fuel consumption is determined as miles per gallon (mpg). Create a decision tree to classify cars as either high consumption (greater than the median), or low consumption. To do this, follow the steps below.

a. Convert the mpg variables in to a class using the script below and create new data set: carsclass.

```
data(mtcars)
attach(mtcars)
attach(mtcars)
summary(mpg)
cons = ifelse(mpg >= 19.20, "yes", "no")
carsclass = cbind(cons, mtcars)
head(carsclass)
```

b. Partition your new data set into 70% training and 30% test.

c. Fit the 'tree' model to your data. Make sure you don't include mpg as an attribute. You may need to first create a synthetically larger training data set using resampling with replacement as was done for the playtennis example.

d. Examine your decision tree using summary and plot functions. What are the important attributes for determining fuel economy?

e. Using the test data set, calculate the accuracy of your model. How well does it predict fuel economy?

4 The Zoo data set (zoo.data.csv) contains data relating to seven classes of animals.

Using all the data, construct a decision tree to predict class "type" based on the other attributes. Note that you will need to specify that "type" is a factor. Which attributes are most influential in determining the class of an animal. What classes have less than 100% accuracy?

Now split your data into a training set 70% and test set 30% and refit the model. What is the overall accuracy of the model when measured on the test set?

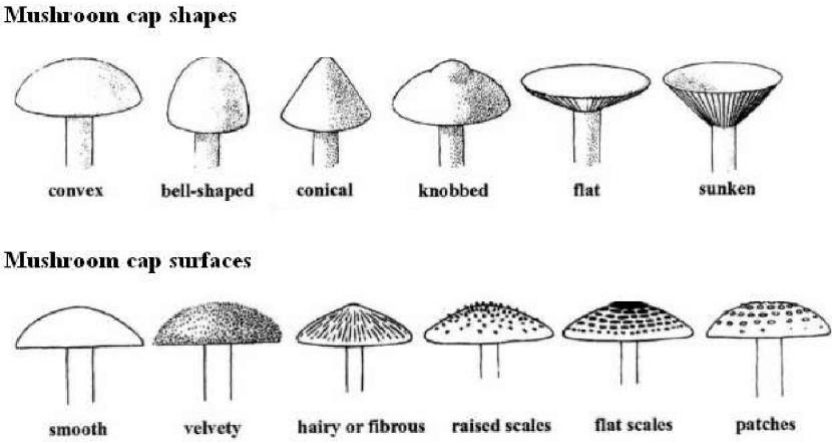
5 The Mushroom data set (mushroom.data.csv) contains 22 pieces of information about 8000+ species of mushrooms. This data set was obtained from the UCI Machine Learning Repository. Further information about the data can be obtained from: https://archive.ics.uci.edu/ml/datasets/Mushroom

Using the data, construct a decision tree to predict whether an unclassified mushroom is of "class" poisonous or edible based on the other attributes:

1. cap-shape: bell=b,conical=c,convex=x,flat=f, knobbed=k,sunken=s
2. cap-surface: fibrous=f,grooves=g,scaly=y,smooth=s
3. cap-color: brown=n,buff=b,cinnamon=c,gray=g,green=r, pink=p, purple=u, red=e, white=w, yellow=y
4. bruises?: bruises=t,no=f
5. odor: almond=a,anise=l,creosote=c,fishy=y,foul=f, musty=m,none=n,pungent=p,spicy=s

…

You should create a training and test data set and report the accuracy of your model. Which attributes are most important in distinguishing between poisonous and edible mushrooms?



6 Using data from the Kaggle competition: Titanic: Machine Learning from Disaster (ref https://www.kaggle.com/c/titanic/data) develop a decision tree model to predict whether a passenger would have or have not survived. The data has been portioned into a training and a test set: (Kaggle.Titanic.train.csv, Kaggle.Titanic.test.csv) The main details of the attributes, from the Kaggle site, are:

```
VARIABLE DESCRIPTIONS:
survival        Survival
                (0 = No; 1 = Yes)
pclass          Passenger Class
                (1 = 1st; 2 = 2nd; 3 = 3rd)
name            Name
sex             Sex
age             Age
sibsp           Number of Siblings/Spouses Aboard
parch           Number of Parents/Children Aboard
ticket          Ticket Number
fare            Passenger Fare
cabin           Cabin
embarked        Port of Embarkation
                (C = Cherbourg; Q = Queenstown; S = Southampton)
```

How accurate is your model? Based on your model, what are the most important predictors for survival?