

# Introduction to Pattern Recognition Homework 3 Report: Decision Trees and Random Forests

Andrés Ponce (彭思安)

0616110

May 20, 2020

## 1 Coding

- 1.1 Gini index or Entropy is often used for measuring the “best” splitting of the data. Please compute the entropy and Gini Index of the provided data by the formula below.**

$$Gini = 1 - \sum_j p_j^2$$

$$Entropy = - \sum_j p_j \log_2 p_j$$

The **Gini index** and **Entropy** are two criteria we sometimes use to measure the purity or quality of a split on data. The Gini index tells us how mixed the classes are, and we would like to choose the split that results in the lowest amount of mixing. The entropy is a measure of how much information we gain by making a split on a certain feature.

For the provided dataset, we have the Gini index and entropy as:

$$Gini = 0.4628099173553719 \quad Entropy = 0.9456603046006402$$

- 1.2 Implement the Decision Tree algorithm CART and train the model by the given arguments, and print the accuracy score on the test data.**

- 1.2.1 Using criterion='gini', show the accuracy score of the test data by max\_depth=3 and max\_depth = 10, respectively.**

On the testing data, we were able to achieve the following accuracy<sup>1</sup>:

clf_depth3	0.9812206572769953
clf_depth10	1.0

- 1.2.2 Using max\_depth=3, show the accuracy score of test data by criterion='gini' and criterion='entropy'.**

The results for use of gini and entropy on the testing data are as follows:

clf_gini	0.9370629370629371
clf_entropy	0.9370629370629371

---

<sup>1</sup>These tests used 'gini' as their purity function

## 2 Theory

- 2.1 Consider a dataset comprising 400 data points from Class  $C_1$  and 400 data points from class  $C_2$ . Suppose that a tree model A splits these into (300, 100) at the first leaf node and (100,300) at the second leaf node, where  $(n, m)$  denotes that  $n$  points are assigned to  $C_1$  and  $m$  points are assigned to  $C_2$ . Similarly, suppose that a second tree model B splits them into (200, 400) and (200, 0). Evaluate the misclassification rate for the two trees and hence show that they are equal.

The misclassification rate involves calculating

- 2.2 Similarly, evaluate the cross-entropy

$$Entropy = - \sum_{k=1}^K p_k \log_2 p_k$$

and the Gini index

$$Gini = 1 - \sum_{k=1}^K p_k^2$$

for the two trees and show that they are both lower for tree B than for tree A. Define  $p_k$  to be the proportion of data points in region  $R$  assigned to class  $k$ , where  $k = 1, \dots, K$ .

The calculations for entropy and the Gini index for the two trees are as follows

	Gini	Entropy
Tree A	0.25	0.81
Tree B	0.556	0.91