Vicky Mohammad
mohammav@uoguelph.ca

Assignment 3

1. **(3 marks) You are to explain three types of machine learning. Give an example for each type of learning.**
    a. **Supervised learning.**
        i. In supervised learning, the algorithm analyzes a set of training data where it produces inferred function that is used for mapping new examples. An optimal scenario will allow for the algorithm to determine correctly which class labels for unseen instance. The learning algorithm generalize from the training data to unseen situations in a reasonable way. In supervised learning the agent observes some example input-output pairs and learns a function that maps from input and output. For example, the inputs are percepts and the output are provided by a teacher who says “brake!” or “Turn left.” Example 2 is that, the inputs are camera images and the outputs again come from a teacher who says, “that’s a bus.” The theory of braking is a function from states and braking actions to stopping distance in feet. In this case the output value is available directly from the agent’s percepts after the fact that the environment is the teacher.
    b. **Unsupervised learning.**
        i. In unsupervised learning the agent learns pattern in the input even though no explicit feedback is supplied. The most common unsupervised learning is clustering: detecting potential useful clusters of input examples. For example, a taxi agent might gradually develop a concept of “good traffic days” without ever being given labeled examples of each a teacher.
    c. **Reinforcement learning.**
        i. In reinforcement learning the agent learns from a series of reinforcements rewards or punishments. For example, the lack of a tip at the end of the journey gives the taxy agent an indication that it did something wrong. The two points for a win at the end of a chess game tells the agent it did something right. It is up to the agent to decide which of the actions prior to the reinforcement were most responsible for it.
2. **(12 marks) Decision Tree: A, B, C, D attributes.**
    a. **Calculate information gain of attributes for S (original data).**
    b. **Choose the root decision tree.**
    c. **Calculate the information gain attributes for subsets of S.**
    d. **Use the case 9 to 11 to test your decision tree and write out the result of the test.**

#2) Entropy Before $= E\left(\frac{3}{8}\right) = -\left(\frac{3}{8}\log_2\left(\frac{3}{8}\right) + \frac{5}{8}\log_2\left(\frac{5}{8}\right)\right)$

$$\text{Remainder}(A) = P(0)\cdot E\left(\frac{3}{5}\right) + P(1)\cdot E\left(\frac{1}{3}\right)$$
$$= \frac{5}{8}\cdot\left(-\left(\frac{3}{5}\log_2\frac{3}{5} + \frac{2}{5}\log_2\frac{2}{5}\right)\right)$$
$$+ \frac{3}{8}\left(-\left(\frac{2}{3}\log_2\frac{2}{3} + \frac{1}{3}\log_2\frac{1}{3}\right)\right)$$
$$= 0.9512$$

$\text{Remainder}(B) = 0.9512$

$\text{Remainder}(C) = 0.9512$

$\therefore$ Since, the value of remainder B and C are the same
thus Remainder (B) = Remainder (C)

$$\text{Remainder}(D) = P(0)\cdot E\left(\frac{2}{4}\right) + P(1)\cdot E\left(\frac{1}{4}\right)$$
$$= \frac{4}{8}\cdot(1) + \frac{4}{8}\cdot\left(-\left(\frac{3}{4}\log_2\frac{3}{4} + \frac{1}{4}\log_2\frac{1}{4}\right)\right)$$
$$= 0.9056$$

$\text{Gain}(A,B,C) = 0.954434 - 0.9512$
$= 0.003234$

$\text{Gain}(D) = 0.954434 - 0.9056391$
$= 0.048079$

$\therefore$ we choose D as the root node

We then split the root $D = 0$

Entropy Before $= E(\frac{3}{4}) = 1$

Remainder $(A) = P(0) \cdot E(\frac{1}{3}) + P(1) \cdot E(1)$

$= \frac{3}{4} \cdot \left(-\left(\frac{1}{3}\log_2\frac{1}{3} + \frac{2}{3}\log_2\frac{2}{3}\right)\right)$

$= 0.688722$

Remainder $(B) = P(0) \cdot E(1) + P(1) \cdot E(1)$

$= 0$

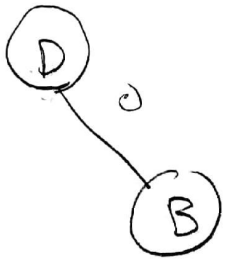
Since we get, there is no way we can get the remainder, hence there is no need to find the remainder of C

Gain$(A) = 1 - 0.688722 = 0.3113$

Gain$(B = 1 - 0 = 0$

∴ we choose B as the next nodal

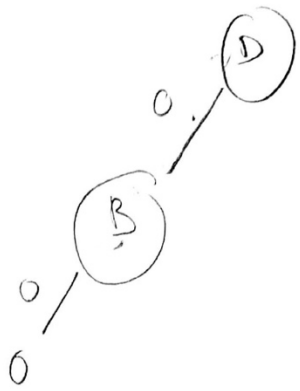
the tree now looks like:



Entropy Before = $E(D) = 0$

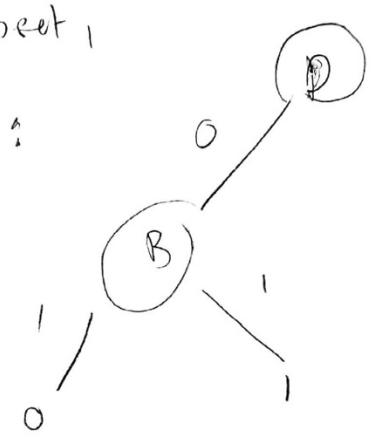
leaf node, so tree is 0

thus the tree would be



the leaf node cannot,

thus:



Entropy before $= E\left(\frac{1}{4}\right)$

$= -\left(\frac{1}{4}\log_2\frac{1}{4} + \frac{3}{4}\log_2\frac{3}{4}\right)$

$= 0.811278$

$\text{Remainder}(A) = P(0) \cdot E(0) + P(1) \cdot E\left(\frac{1}{3}\right)$

$= \frac{2}{4} \cdot \left(-\left(\frac{1}{2}\log_2\frac{1}{2} + \frac{1}{2}\log_2\frac{1}{2}\right)\right) = 0.5$

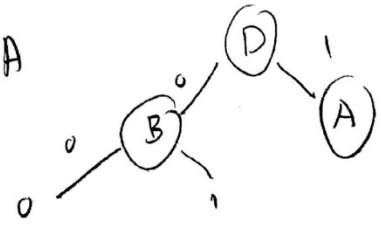
$\text{Remainder}(c) = (0) \cdot E\left(\frac{1}{3}\right) + P(1) \cdot E(0)$

$= \frac{3}{4}\left(-\left(\frac{1}{3}\log_2\frac{1}{3} + \frac{2}{3}\log_2\frac{2}{3}\right)\right) = 0.68872$

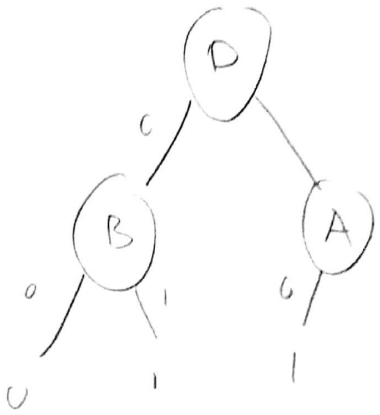
$\text{Gain}(A) = 0.811278 - 0.5 = 0.311278$

$\text{Gain}(c) = 0.811278 - 0.68872 = 0.122558$

∴ we choose A



Entropy before = $E(1) = 0$

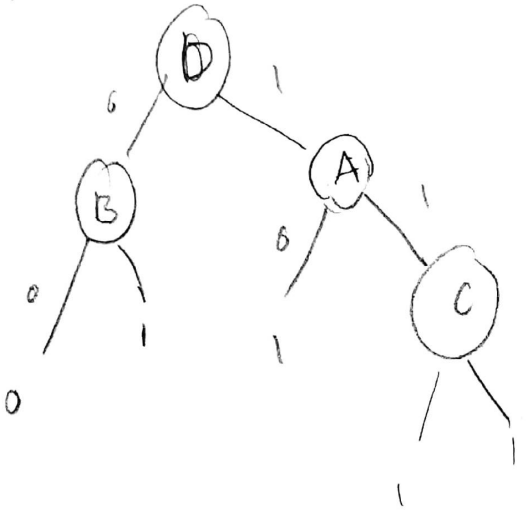


Entropy before = $E(\frac{1}{2}) = 1$

So only attribute left is C

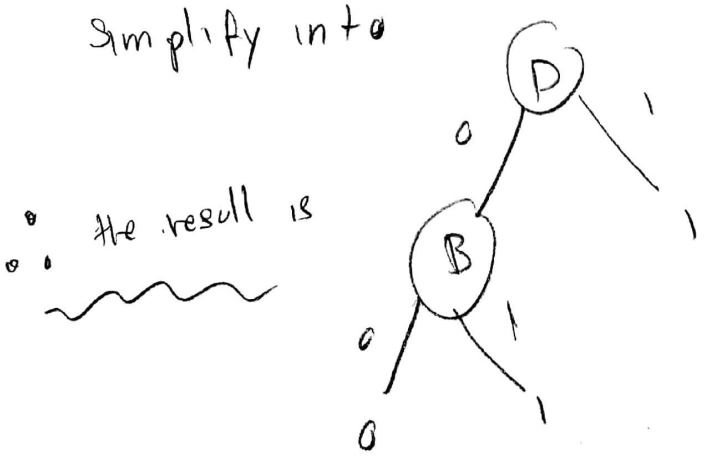
Thus we choose C

result:



We can

simplify into



∴ the result is