**COMP 3710 Artificial Intelligence**

Winter 2018

Term test II

Student Name: Student Number:

1. (2 marks) There are two types of machine learning algorithms. Explain how they are different using the following table.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Name (not name of algorithm) | Supervised learning? | Use of training data set | Example algorithm |
| Type 1 | Clustering | No | No | k-Means |
| Type 2 | Classification | Yes | Yes | Backpropagation neural networks, k-nn, decision trees |

1. (3 marks) Compute the information gain for *Genre*. You do not have to compute the logarithms. Here are two related formulas.

Information Gain = 1 – ∑ (the weighted entropies)

Entropy = – p0 × (log2 p0) – p1 × (log2 p1)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Film** | ***Country*** | ***Big Star*** | ***Genre*** | **Success** |
| Film 1 | *USA* | *Yes* | *SF* | True |
| Film 2 | *USA* | *No* | *Comedy* | False |
| Film 3 | *USA* | *Yes* | *Comedy* | True |
| Film 4 | *Europe* | *No* | *Comedy* | True |
| Film 5 | *Europe* | *Yes* | *SF* | False |
| Film 6 | *Europe* | *Yes* | *Romance* | False |
| Film 7 | *Other* | *Yes* | *Comedy* | False |
| Film 8 | *Other* | *No* | *SF* | False |
| Film 9 | *Europe* | *Yes* | *Comedy* | True |
| Film 10 | *USA* | *Yes* | *Comedy* | True |

1 – (3/10 \* (-1/3 log\_2 1/3 – 2/3 log\_2 2/3) + 6/10 \* (- 4/6 log\_2 4/6 – 2/6 log\_2 2/6) + 1/10 \* (-1/1 log\_2 1/1))

1. (3 marks) Consider the inverted pendulum problem.

The input for *Theta* is fuzzified to ZE:0.7 and PS:0.3, and the input for *dTheta* is fuzzified to ZS:0.4 and ZE:0.6. Using the next fuzzy rules, find the output fuzzy sets with membership values that will be used for defuzzificatoin. (Note that the numbers after fuzzy sets are membership values.)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | *Theta* | | | | |
| *dTheta* |  | NM | NS | ZE | PS |
| NM |  |  | PM |  |
| NS |  |  | PS | ZE |
| ZE | PM | PS | ZE | NS |
| PS |  | ZE | NS |  |
| PM |  |  | NM |  |

ZE:0.7 and NS:0.4 -> PS:0.4

ZE:0.7 and ZE:0.6 -> ZE:0.6

PS:0.3 and NS:0.4 -> ZE:0.3 Therefore PS:04, ZE:0.6; NS:0.3

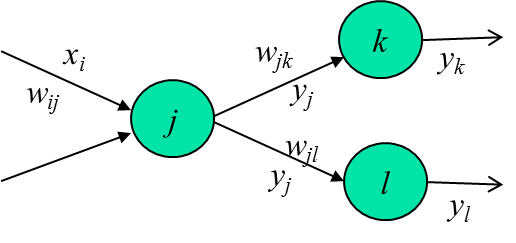
PS:0.3 and ZE:0.6 -> NS:0.3

1. (3 marks) Here is a training data set. Classify (3, 2) by using the 3-nearest neighbor algorithm.

|  |  |  |
| --- | --- | --- |
| *X* | *Y* | *Class* |
| 1 | 1 | *Blue* |
| 1 | 2 | *Blue* |
| 2 | 3 | *Green* |
| 4 | 1 | *Green* |
| 3 | 3 | *Red* |
| 4 | 3 | *Red* |

1. (6 marks) There are two output nodes in a backpropagation neural networks. The two output nodes are connected to two hidden nodes.

* Weights between the hidden layer and the output layer – Weight\_HO = [[0.2, 0.6], [0.8, 0.4]].
* The outputs from the hidden nodes – Output\_H = [1, 0].
* The outputs from the output nodes – Output\_O = [0.2, 0.5].
* The expected outputs – Expected = [1, 0].
* The learning rate is α = 0.1.
* The formulas are δ*k* = *yk* (1 – *yk*) *ek*; *wjk* = *wjk* + α *yj* δ*k*



1. (1 mark) Draw a diagram showing two layers, outputs, and weights, with the above values.
2. (1 mark) Compute the errors.

* Error[0] = 1 – 0.2 = 0.8
* Error[1] = 0 – 0.5 = -0.5

1. (2 marks) Compute the deltas for the output nodes.

* Delta\_O[0] = 0.2 \* (1 – 0.2) \* 0.8 = 0.128
* Delta\_O[1] = 0.5 \* (1 – 0.5) \* -0.5 = -0.125

1. (2 marks) Compute the new weights between the hidden layer and the output layer.

* Weight\_HO[0][0] = 0.2 + 0.1 \* 1 \* 0.128
* Weight\_HO[1][1] = 0.4 + 0.1 \* 0 \* -0.125