



12 Pages

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1	Student Number	2304553
2	Title of Examination Paper	Artificial Intelligence
3	Module Code	ACCA7026
4	Date and Time of Examination	08/05/2024 09:00-11:00
5	Examination Venue	IQ 310
6	Seat Number	025
7	Number of Answer Books handed in	

List the numbers of the questions you have attempted	Office Use
2	17
3	15
4	31.5
Total	63.5

(Gweler yr ochr arall am y fersiwn Cymraeg)

79.38%

Question 2

2-1. A^* is an algorithm that aims at finding the shortest path using heuristic value, given cost of each edge and heuristic value of each node. The formula is $f(x) = g(x) + h(x)$, where $g(x)$ represents the cost and $h(x)$ represents the heuristic value.

Reasons for challenges are demonstrated as follows.

1. A^* can't do "expansion" as Monte Carlo Tree search, which means it can't increase branches (Tree nodes) to search for a solution. A^* can deal with complex problems with deterministic states like finding the shortest path between cities. Nodes, costs and heuristic values are given. So when facing complex state, it might face challenges.

2. To create and ~~obstruct~~ obstruct potentially winning lines, it needs a strategy of supervised learning or "simulation" in MCTS, which can randomly choose the next location of dropping coloured discs or choose based on probability of winning. However, A^* can't do above things.
 Need output in respect to A^*

3. To use A^* to solve problems, the problems should be deterministic which means all costs and all nodes are given and can't change, additional heuristic values should be given, too. Hence A^* is not capable of dealing with a problem with incomplete information and unpredictability of movements. A^* can't predict based on opponent's movements.

4. The game ~~deated~~ to solve. The nature of the game solved by A^* should be static rather than dynamic.

2.2 In MCTs, there are 4 steps including "selection", "expansion", "simulation" and "backpropagation".

The process is that, first select a tree node using Upper Confidence Bounds (UCBs), then expand the tree node, which means adding child nodes to the tree node. After that simulations will be done and parameters are calculated and stored. For example, as for playing Go using MCTs, $UCBs = \frac{w_i}{n_i} + C \sqrt{\frac{\ln N_i}{n_i}}$,

where w_i means the number of winning games for n_i means total number of playing games for of n node

C means exploration rate

N_i means the number of playing games of N , which is the parent node of n .

~~At above~~ After simulation for node n , w_i and n_i will be calculated and stored. The final step is "backpropagation" which means that it transmits its parameters to its parent node to refresh N_i .

1. "expansion" can do "branching" operation, which can deal with complex game state.

2. In UCBs, the parameter C can balance between exploitation and exploration, in line with that strategy. blocking the possible moves.

3. MCTs doesn't need full information because it can do "simulation" to record results and predict based on that.

4. MCTs can deal with dynamic games including Connect four, Go and so on based on its "expansion" and "simulation" operation.

Question 3

15

3.1. $UCB(s_i) = \bar{v}_i + c \sqrt{\frac{\ln N}{n_i}}$, where $\bar{v}_i$ is the average reward, c for exploration rate

6 $UCB(\bar{v}) = 0.8 + 1.5 \sqrt{\frac{\ln 80}{15}}$ (failed to borrow a calculator)

3.2 :

supervised learning	unsupervised learning	reinforcement learning
<u>prediction</u> <u>regression</u>	<u>clustering</u> <u>association</u>	<u>Goal based</u>

3.2.1. Supervised learning. The aim is to detect unauthorized transactions, which in line with prediction Transactions can be recorded and trained for models.

3.2.2 Unsupervised learning. The aim is to sort out those documents, which in line with clustering, no predefined labels are provided.

3.2.3 supervised learning. Preferences, purchase and browsing history and demographic information are provided as dataset for training model. It can be considered as prediction.

3.2.4 Reinforcement learning. The task is "goal based", the goal is to minimizing costs and meeting customer demand, no prediction or clustering is needed to be done.

Section B

Question 4

Question No.

Examiner Only

4.1 The number of stages are 7.

preprocessing the data : deal with ~~miss~~ missing data (if missing data is contained in remaining rows), drop non-necessary columns or rows if they're not useful or ~~not~~ not significant to this study, and so on.

Define the structure of proposed model.

~~Demonstrate~~ Design the number of layers, which model is used (CNN, RNN and so on) - number of neurons, activation function and so on.

Train the model with training set

Tune the hyperparameters with validation set
Tune hyperparameters including number of neurons, activation functions and so on.

Type

Evaluate the performance of model.

Evaluate

Fine-tuning the model

Train on the test set

4.2.1 The dimension is 500×8 .

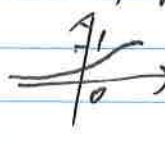
4.2.2 All of them are non-null so no missing values.

4.2.3 1. It is not significant to the dataset
2. The missing values are randomly distributed throughout the dataset

4.3 Because the task is to decide whether students are accepted or rejected. A Number 1 represents admitted, number 0 represents rejected so it can be considered as a binary classification problem.

The "student" class contains features, functions are not needed. Every student has a sequence number and values of 8 features including GRE score and so on. The types of each feature are needed to define, for example, GRE score should be integer and SOP should be float type. Features will be filled into a matrix to record for training.

4.4 The popular activation functions include Sigmoid, tanh, ReLU, Leaky ReLU, Softmax and so on.

 Sigmoid outputs value ranged from 0 to 1 which can be considered as probability.

3 Sigmoid will be added in the last output layer where will deal with the "admit" value. After the prediction of student admission admit, we will get a series of float type values because the introduction of activation function which can introduce non-linearity. The function is to compress data values from $(-\infty, +\infty)$ to $(0, 1)$. After that a threshold is given to classify them into 0 and 1, a typical threshold is 0.5.

4.5 Overfitting means the model can predict well on training data while fail to predict test data well. The reason is that the model tries its best to fit the training data to get a high accuracy.

Consequences include: 1. The model can only predict well on given dataset containing 500 students. When a new dataset is given to predict "admit", it will fail to get a high accuracy.

2. The model will be overestimated on new data performance of

		Prediction		
		Accepted	Rejected	
Actual	Accepted	150	15	TP = 150
	Rejected	30	5	FP = 30
				FN = 15
				TN = 5

4.6.2 Accuracy = $\frac{TP+TN}{TP+FP+FN+TN} = \frac{150+5}{150+30+15+5} = \frac{155}{200}$

precision = $\frac{TP}{TP+FP} = \frac{150}{150+30} = \frac{150}{180} \approx 83.3\%$

Recall = $\frac{TP}{TP+FN} = \frac{150}{150+15} = \frac{30}{33} \approx 90.9\%$

F1-score = $\frac{2 \text{ precision}}{\text{precision} + \text{Recall}} = \frac{2 \cdot \frac{150}{180}}{\frac{150}{180} + \frac{30}{33}} = X$

precision = 83.3% means that the model predicted 83.3% correctly in all predicted positive values.

Recall = 90.9% means that the model predicted 90.9% correctly in actual positive values.

F1-score is to consider both precision and Recall, its value is between precision and Recall,

so $X \in (83.3\%, 90.9\%)$