

# ARTIFICIAL INTELLIGENCE (CS60045)

## (Class Test – 4)

Nov 5, 2021

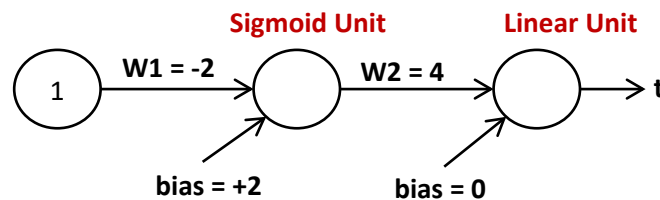
**Answer ALL questions**

Time 1 hour

40 marks

**All parts of a question must be answered in the same place**

1. [Neural Networks] Consider the given neural network with one input unit, one hidden unit using sigmoid activation and one output unit (linear). Consider one training instance for which input value is 1 and golden output value is 1. [ Hint: The sigmoid function is  $A(x) = 1/(1 + e^{-x})$  ]

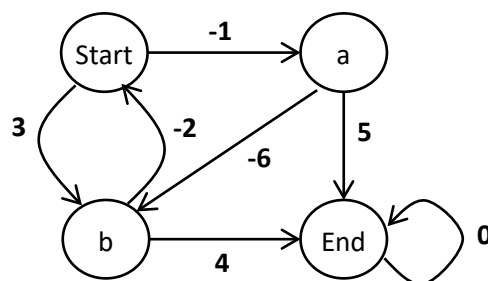


The error function is given by:  $E = (t - y)^2/2$

- What is the output of the hidden unit and output for this training case?
- What is the error for this training case?
- What is the derivative of the loss with respect to  $W2$  for this training case?
- What is the derivative of the loss with respect to  $W1$  for this training case?

[4+2+3+3 = 12 marks]

2. [Reinforcement Learning] Consider the reinforcement learning environment drawn below (let  $\gamma = 0.9$ ). The numbers on the edges indicate the immediate reward on taking that edge.



- Show the action in each state corresponding to the optimal policy.
- Compute the  $V^*$  value at each state.
- Assume we use a Q table for this task and initialize all of its entries to 2. A learner then follows the path  $\text{start} \rightarrow b \rightarrow \text{end}$ . Show the updated Q values on the graph above.
- Starting with the updated Q values from Part (c), again follow the path  $\text{start} \rightarrow b \rightarrow \text{end}$  and show that the Q values have changed

[4+4+2+2 = 12 marks]

3. [Decision Tree Learning] Consider the problem of diagnosing Covid19 in a patient, given the following binary-valued (i.e., true or false) attributes:

- Fever = patient has fever
- Cough = patient has cough
- Breathing = patient has difficulty breathing
- HumanContact = patient had recent contact with human infected with Covid19
- CovContact = patient had recent contact with an item having Covid19 virus

Consider the training set S given below. In each of the six training examples, true or false values for each of the five attributes are given, as well as the correct classification for each example.

Patient	Fever	Cough	Breathing	Human Contact	CovContact	Covid19
P1	T	T	F	F	F	F
P2	T	T	T	T	F	T
P3	F	F	T	F	T	F
P4	F	T	T	F	T	T
P5	T	T	F	F	T	T
P6	T	F	F	T	T	F

- Compute the information gain,  $\text{Gain}(S, A)$ , for each attribute A with respect to the training set S. Show your work clearly
- Which attribute would the ID3 algorithm discussed in class choose to use for the root of the tree?
- Find a decision tree that ID3 would return, using information gain as the splitting criterion. (If there is a tie for highest information gain, choose one of the highest-gain attributes at random.) Include your work that shows how you traced the steps of ID3. Verify that your resulting tree is consistent with the training data.

[6+2+8 = 16 marks]