Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER II
SESSION 2019/2020

COURSE NAME	:	INTELLIGENT CONTROL SYSTEM
COURSE CODE	:	BEH 41803
PROGRAMME CODE	:	BEJ
EXAMINATION DATE	:	JULY 2020
DURATION	:	3 HOUR
INSTRUCTION	:	ANSWERS ALL QUESTIONS **OPEN BOOK EXAMINATION**

THIS QUESTION PAPER CONSISTS OF **FOUR (4)** PAGES

Q1 A Neural Netwok (NN) model which is to be trained using backpropagation algorithm is shown in **Figure Q1**. All neurons in layers *i* and *k* have linear activation functions, and all neurons in layer *j* and layer have tangential activation functions given by:

$$O_j = f(net_j) = \frac{e^{Cnet_j} - e^{-Cnet_j}}{e^{Cnet_j} + e^{Cnet_j}}$$

(a) If C =1, T_k is target, n is learning rate, *net* is the sum of input neuron, and O is firing output of neuron, investigate model of weights adaptation for ΔW_{25}, ΔW_{45}, ΔW_{14}, ΔW_{12}, ΔW_{32}, ΔW_{34} and bias ΔB_2, ΔB_4 between layer if the MLPNN's cost function is given by E=0.5 $(T_k - O_k)^2$. [Note: Ignore the given values during derivation]

(25 marks)

(b) If n = 1, sample input and target value during training is given by [X_1=*1*, X_3=*1* and T_k=*1*], analyze all new weights adaptation value after single iteration process.

(15 marks)

Q2 By referring to Convolutional Neural Network (CNN) code in **Figure Q2:**

(a) Illustrate the model structure with details of layer labelling

(3 marks)

(b) Analyze image output shape and its total trainable parameters for each stack of the CNN layer.

(17 marks)

Q3 An engineer needs to design fuzzy position control system in which each antecedent and consequent must have only 3 fuzzy sets: Negative (*N*), Zero (*Z*) and Positive (*P*). The membership functions for the two antecedents and one consequent are given in **Figure Q3** and the model use Mamdani rule base and disjunctive aggregator.

(a) With reference to the under damped transient response, construct the most appropriate fuzzy control rules in matrix form to solve the positioning problem with minimum of overshoot if *error* = *input* - *output*. Give justification for each of the designed rules.

(5 marks)

(b) Based on the rules developed in **Q3(a)**, analyze model of output before Deffuzzification for E=-15.0 and ΔE = 1.0 case.

(12 marks)

(c) Based on answer from **Q3(b)**, examine the difference of crisp value ΔU when calculated using Bisector of Area (BOA) method and Center of Area (COA) method. For the COA, please use resolution of 1.

(20 marks)

(d) From the answer above, explain why the calculated COA's crisp is different with BOA output and what can be done to improve COA calculation.

(3 marks)

END OF QUESTIONS

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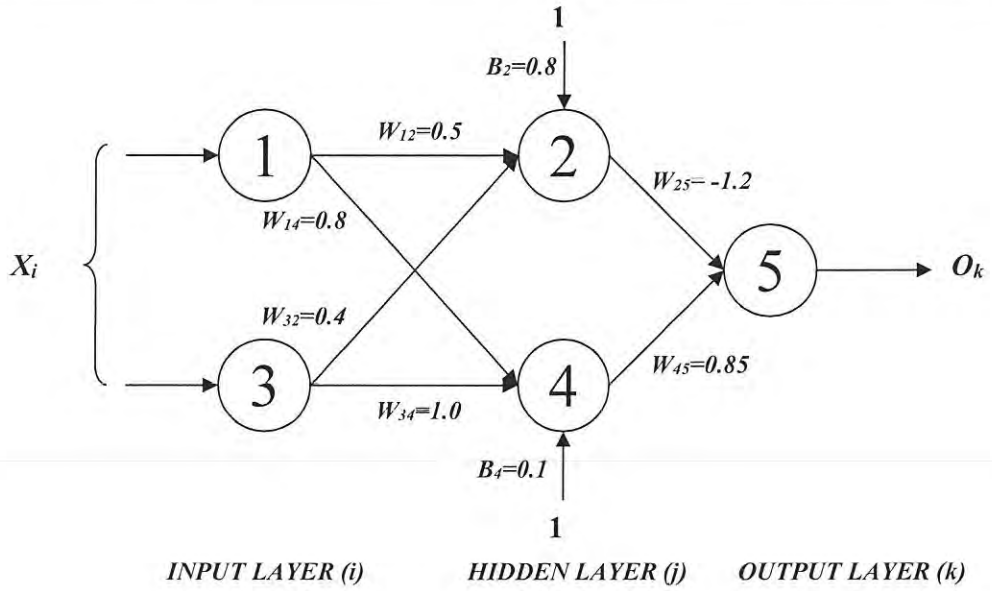

Figure Q1

```
cnn_model = models.Sequential()
cnn_model.add(layers.Conv2D(32,(3,3), activation='relu', input_shape=(150,150,3)))
cnn_model.add(layers.MaxPooling2D((2,2)))
cnn_model.add(layers.Conv2D(64,(3,3),activation='relu'))
cnn_model.add(layers.MaxPooling2D((2,2)))
cnn_model.add(layers.Conv2D(128,(3,3),activation='relu'))
cnn_model.add(layers.MaxPooling2D((2,2)))
cnn_model.add(layers.Conv2D(128,(3,3),activation='relu'))
cnn_model.add(layers.MaxPooling2D((2,2)))
cnn_model.add(layers.Flatten())
cnn_model.add(layers.Dense(512, activation='relu'))
cnn_model.add(layers.Dense(1,activation='sigmoid'))
```

Figure Q2

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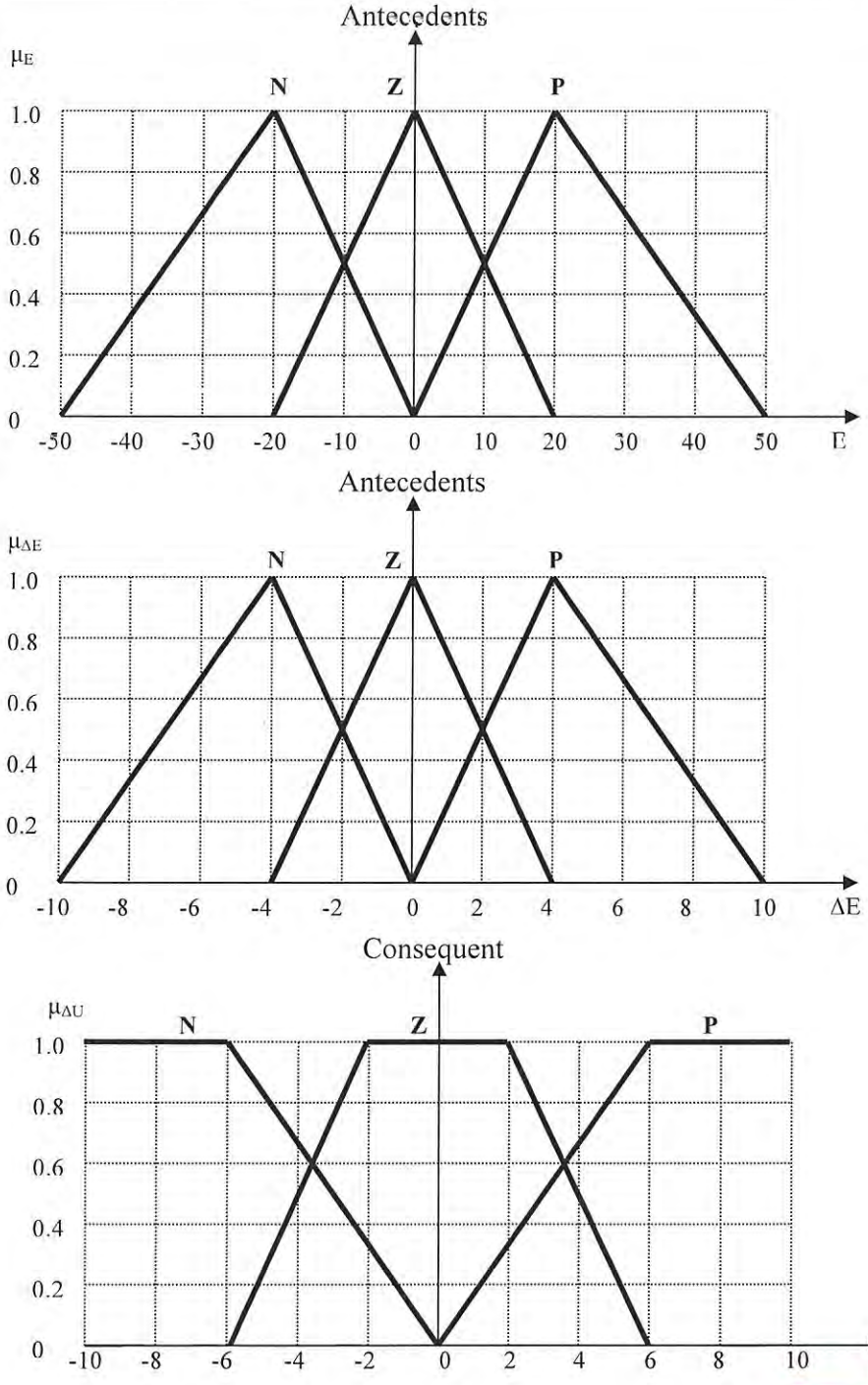

Figure Q3