Second Semester Examination
Academic Session 2018/2019

June 2019

EPE401 – Artificial Intelligence in Manufacturing
[Kecerdikan Rekaan dalam Pembuatan]

Duration : 2 hours
Masa : 2 jam

Please check that this examination paper consists of EIGHT [8] printed pages including formula before you begin the examination.

[Sila pastikan bahawa kertas soalan ini mengandungi LAPAN [8] mukasurat bercetak sebelum anda memulakan peperiksaan.]

INSTRUCTIONS : Answer **ALL FOUR [4]** questions.
*[**ARAHAN** : Jawab **SEMUA EMPAT [4]** soalan.]*

In the event of any discrepancies, the English version shall be used.

[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.]

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1. [a] Explain TWO (2) differences between "Classification" and "Clustering".

Jelaskan DUA (2) perbezaan antara "Pengelasan" dan "Pengklusteran".

(20 marks/*markah)*

[b] List FIVE (5) metrics used to evaluate the accuracy of classification.

Senaraikan LIMA(5) metrik yang digunakan untuk menilai ketepatan pengelasan.

(20 marks/*markah)*

[c] Consider the dataset in Table 1.
Pertimbangkan dataset di Jadual 1.

Table 1
Jadual 1

x	0.5	3.0	4.5	4.6	4.9	5.2	5.3	5.5	7.0	9.5
y	-	-	+	+	+	-	-	+	-	-

Classify the data point $x = 5.0$ by
Kelaskan titik data $x = 5.0$ dengan

(i) 1-Nearest Neighbour (1-NN).
1-Jiran Terdekat (1-NN).

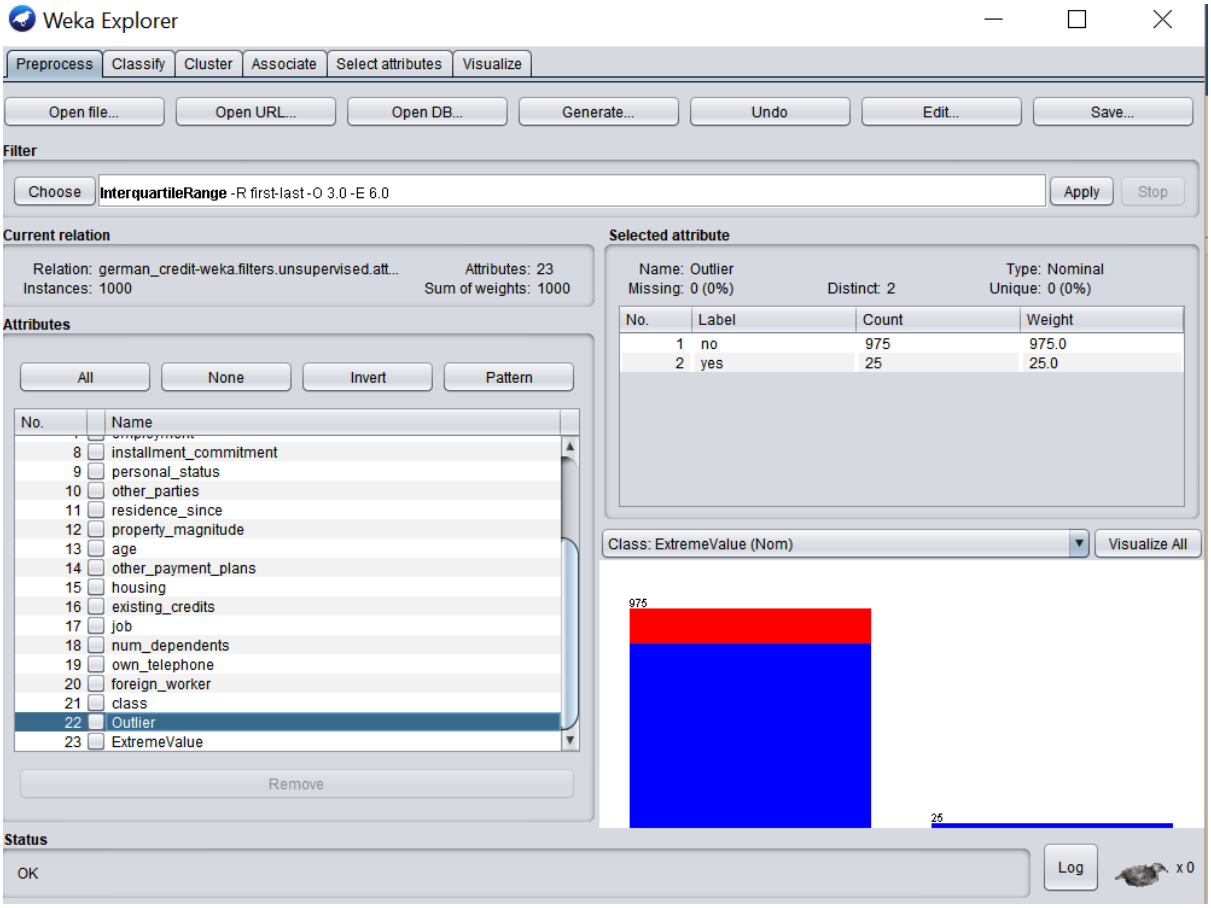
(ii) 3- Nearest Neighbour (3-NN)
3-Jiran Terdekat (3-NN).

(iii) 5- Nearest Neighbour (5-NN)
5-Jiran Terdekat (5-NN).

(30 marks/*markah)*

[d] The following shows the "InterquartileRange" filter (by default) option performed on WEKA.

Berikut menunjukkan pilihan tapis Julat Antara Kuartil (secara default) yang dilakukan dengan WEKA.



(i) Determine the number of data outliers detected.
Tentukan bilangan data tersisih yang dikesan.

(ii) State ONE (1) similarity or difference between outlier and extreme value.

Nyatakan SATU(1) persamaan atau perbezaan antara data tersisih dan nilai ekstrim.

(30 marks/*markah)*

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2. The economy order quantity (EOQ) is applied to determine the optimal order quantity in production, with formula given as below.

Kuantiti pesanan ekonomi (EOQ) digunakan untuk menentukan kuantiti pesanan optimum dalam pengeluaran, dengan formula diberi seperti berikut

$$\mathbf{Q} = \sqrt{\frac{\mathbf{2DS}}{\mathbf{H}}}$$

Q = Optimum number of units per order
Bilangan unit optimum setiap tempahan

D = Annual demand in units for the inventory item
Permintaan tahunan dalam unit bagi inventori berkenaan

S = Setup or ordering cost for each order
Kos penyediaan atau pemesanan untuk setiap pesanan

H = Holding or carrying cost per unit per year
Kos pemegangan seunit setiap tahun

[a] Devise a fuzzy logic system to generate result approximate to EOQ. Each variable should have THREE (3) fuzzy sets.

Reka satu sistem logik kabur untuk menjana hasil anggaran EOQ. Setiap pemboleh ubah perlu mempunyai TIGA (3) set kabur.

(50 marks/*markah*)

[b] Construct ONE (1) example of calculation of the fuzzy logic system based on Mamdani-style inference.

Binakan SATU (1) contoh pengiraan logik kabur berdasarkan inferens gaya Mamdani.

(20 marks/*markah*)

[c] Construct ONE (1) example of calculation of the fuzzy logic system based on Sugeno-style inference.

Cadangkan SATU (1) contoh pengiraan logik kabur berdasarkan inferens gaya Sugeno.

(20 marks/*markah*)

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[d] Briefly describe ONE(1) method to fine tuning your fuzzy logic system.

Huraikan secara ringkas SATU (1) kaedah untuk memperhalusi sistem logik kabur anda.

(10 marks/*markah***)**

3. The question will be based on the EOQ formula shown in Q2.
Soalan ini akan berdasarkan formula EOQ yang telah ditunjukkan dalam S2.

[a] Design and sketch a feedforward artificial neural network system consists of three layers of neurons to generate results approximate to EOQ.

Reka dan lakar satu sistem jaringan saraf tiruan jenis suap ke hadapan yang mengandungi tiga lapisan neuron untuk menjana keputusan-keputusan anggaran EOQ.

(20 marks/*markah***)**

[b] State all the parameters and their suitable values for your artificial neural network system.

Nyatakan semua parameter dan nilainya yang sesuai untuk sistem jaringan saraf tiruan anda.

(20 marks/*markah***)**

[c] Build TWO (2) test cases and compute ONE (1) epoch of training.
Bina DUA (2) kes ujian dan kira SATU (1) kitar lelaran latihan.

(40 marks/*markah***)**

[d] Suggest TWO (2) ways to improve the performances of the artificial neural network system.

Cadangkan DUA (2) cara untuk meningkatkan prestasi sistem jaringan saraf tiruan anda.

(20 marks/*markah***)**

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4. A genetic algorithm program is used to solve an optimization problem. The chromosomes consist of ten genes denoted with alphabet 'a' till 'j'. They are structured as x = abcdefghij. Each gene represents a variable and can be holding any value between 1 and 9. The objective is to find variable values that can maximize the following function:

Satu program algoritma genetik digunakan untuk menyelesaikan satu masalah pengoptimasan. Kromosom tersebut mempunyai sepuluh gen yang diberi dengan huruf 'a' sehingga 'j'. Ia distrukturkan seperti berikut, x = abcdefghij. setiap gen menwakili satu nilai pemboleh ubah and boleh mewakili sebarang nilai di antara 1 dan 9. Objektif program ini adalah untuk mencari nilai-nilai pemboleh ubah yang boleh memaksimumkan fungsi berikut:

$$F(x) = ((a+b) - (c+d))/e + ((f+g) - (h+ i)))/j$$

The initial population consists of four individuals with the following chromosomes:

Populasi awal terdiri daripada empat individu dengan kromosom-kromosom berikut:

X1 =	4	5	3	4	6	3	5	4	2	3
X2 =	7	5	6	6	3	8	3	7	2	5
X3 =	2	8	5	3	7	7	7	6	6	6
X4 =	8	6	2	2	2	2	4	4	5	2

[a] Evaluate the fitness of each individual, and arrange them in order with the fittest first and the least fit last.

Nilai fit setiap individu, dan susunkan mereka dari paling fit ke paling kurang fit.

(20 marks/*markah***)**

[b] Perform and evaluate the effectiveness of the following crossover operations:

Laksana dan nilaikan keberkesanan operasi bersilang ganti seperti yang berikut:

(i) Cross the fittest two individuals using one-point crossover at the middle point.

Silang ganti dua individu yang paling fit dengan menggunakan cara silang ganti satu titik di tengah.

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(ii) Cross the second and third fittest individuals using a two-point crossover (points c and g).

Silang ganti individu kedua dan ketiga yang paling fit dengan menggunakan cara silang ganti dua titik (titik c dan g).

(iii) Cross the first and third fittest individuals (ranked 1st and 3rd) using a uniform crossover.

Silang ganti individu pertama dan ketiga yang paling fit dengan mengunakan cara silang ganti seragam.

(40 marks/*markah***)**

[c] Calculate the fitness of chromosome representing the optimal solution.

Kira nilai fit kromosom yang dapat mewakili penyelesaian optimum

(20 marks/*markah***)**

[d] Justify whether the initial population would be able to reach to the optimal solution without a mutation operator.

Berikan justifikasi sama ada populasi awal akan dapat sampai ke penyelesaian optimum tanpa operasi mutasi.

(20 marks/*markah***)**

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Formulas given for feedforward multilayer perceptron neural networks

Formula yang diberikan bagi rangkaian perceptron masuk depan berbilang neural

Activation functions

$$X = \sum_{i=1}^{n} x_i w_i - \emptyset$$

$$Y^{step} = \begin{cases} 1, if\ X \geq 0 \\ 0, if X < 0 \end{cases}$$

$$Y^{sign} = \begin{cases} +1, if\ X \geq 0 \\ -1, if X < 0 \end{cases}$$

$$Y^{sigmoid} = \frac{1}{1 + e^{-X}}$$

$$Y^{linear} = X$$

Error back propagation functions

$$e(p) = Y_d(p) - Y(p)$$
$$w_i(p+1) = w_i(p) + \alpha \times x_i(p) \times e(p)$$
$$\Delta w_{jk}(p) = \alpha \times \gamma_j(p) \times \delta_k(p)$$

Error gradient for neurons in the output layer

$$\delta_k(p) = y_{k(p)} \times [1 - y_k(p)] \times e_k(p)$$
$$e_k(p) = y_{d,k}(p) - y_k(p)$$
$$\Delta w_{jk}(p) = \alpha \times \gamma_j(p) \times \delta_k(p)$$
$$w_{jk}(p+1) = w_{jk}(p) + \Delta w_{jk}(p)$$

Error gradient for neurons in the hidden layer

$$\delta_j(p) = y_{j(p)} \times [1 - y_j(p)] \times \sum_{k=1}^{l} \delta_k(p) \times w_{jk}(p)$$

$$\Delta w_{ij}(p) = \alpha \times x_i(p) \times \delta_j(p)$$

$$w_{ij}(p+1) = w_{ij}(p) + \Delta w_{ij}(p)$$

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