

NATIONAL UNIVERSITY OF SINGAPORE

CE5310 HYDROINFORMATICS

(Semester I: AY2014/2015)

Time Allowed: 2.5 Hours

INSTRUCTIONS TO CANDIDATES

1. Please write your student number only. **Do not write your name.**
2. This assessment paper contains **FIVE** questions and comprises **FOUR** printed pages.
3. Answer **ALL** questions. Questions DO NOT carry equal marks.
4. Please start each question on a new page.
5. This is CLOSED BOOK assessment.

Question 1 Databases [TOTAL: 18 marks]

National University of Singapore has deployed sensors at various locations in its Kent Ridge Catchment to collect rainfall data. The following two tables are designed to manage the rainfall data.

Table: location

Column name	Data type	Comments
locationID	integer	Unique identifier of the location
locationName	var char	Name of that location
latitude	double	latitude of that location
longitude	double	longitude of that location

Table: rain

Column name	Data type	Comments
locationID	integer	a reference to the record in the location table
d	date	date of the data
t	time	time of the data
rainfall	double	rainfall data

Question 1.1

What are the advantages of using a database system to manage the data?

(3 marks)

Question 1.2

A new sensor is installed at a location in NUS to collect rainfall data. The ID of that location is 101, its name is NUS Central, and its coordinates are (1.296170, 103.773529). The rainfall data collected by this sensor at 9:05pm of 2014 Oct 11 is 1.8.

Write the two SQL statements to insert the above data about the new sensor and the rainfall data into the database tables.

(5 marks)

Question 1.3

Write the SQL query to find out the list of rainfall sensors in this geographical area: latitude in the range of [1.338666, 1.418637], longitude in the range of [103.693334, 103.813840].

Write the SQL query to find out the daily average rainfall observed by these sensors in the period of 2014 Nov 01 and 2014 Nov 30. The result should be sorted by date first and then by location.

(10 marks)

Question 2 GIS [TOTAL: 20 marks]**Question 2.1**

There is no universal definition of GIS. However, most GIS definitions list the functions or components of a GIS. Provide your own definition of GIS which mentions at least some of these functions.

(4 marks)

Question 2.2

Almost 2/3rds of Singapore's national territory consists of urban catchment areas in which the water is harvested and conveyed by drainage system to man-made lakes such as Pandan, Marina or Punggol-Serangoon Reservoirs. As such, management of water quality in these reservoirs had commenced at the catchment scale by managing sources of pollution, such as sewer leakage, runoff from industrial areas, fertilisers used in parks, runoff from hawker centres and car washes, etc. Based on these considerations, Water Quality Management Plans (WQMP) need to be developed to manage water quality within the catchments. GIS can be a helpful tool in the development of such WQMPs.

Give five examples of data layers that could be used in a GIS for a WQMP. For each layer give the data model used, the feature type (if relevant) and the relevant attribute(s). Give your answer in a table as follows:

No	Layer	Data Model	Feature Type	Attribute(s)
1				
2				
3				
4				
5				

(8 marks)

Question 2.3

The WQMP (see Question 2.2) should contain a map with 'hot spots' for potential pollution based on land use. There are four land use types considered, ranging from most polluted to least polluted: (1) industry, (2) commercial, (3) parks & fields, (4) residential. The closer one of these land use types to a main drainage canal, the higher the pollution potential. Describe in detail the spatial analysis required to identify hot spots.

(8 marks)

Question 3 Data Driven Learning [TOTAL: 14 marks]

Describe the principles of supervised, non-supervised and reinforcement learning. Discuss similarities and differences between the three approaches to data driven learning.

(14 marks)

Question 4 Artificial Neural Networks [TOTAL: 24 marks]**Question 4.1**

Sketch a neural network consisting of 3 inputs, one hidden layer which contains two neurons and single output neuron.

(8 marks)

Question 4.2

How many weights are included in this neural network that need to be learned?

(4 marks)

Question 4.3

Derive the equation for this neural network if all neurons in this network were:

- (i) linear
- (ii) sigmoids

(12 marks)

Question 5 Data Normalization [TOTAL: 24 marks]**Question 5.1**

Discuss and describe why is data normalization required in neural networks.

(6 marks)

Question 5.2

Describe the min-max data normalization algorithm.

(6 marks)

Question 5.3

Describe the z-score normalization algorithm.

(6 marks)

Question 5.4

Water depth observed on October 25 at 12:00 am in Sungei Ulu Pandan at the station located at Van Kleef Aquatic Science Centre is 1.24 m. Given that:

- smallest water depth ever observed at that location is 0.28 m,
- largest ever recorded water depth 3.45 m,
- mean water level 1.11 m, and
- standard deviation of observed water levels 0.34 m,

Normalise the observed water depth according to min-max and z-score normalization algorithm.

(6 marks)

END OF PAPER