IS5152 Data-driven Decision Making Technologies
SEMESTER II 2018-2019
Assignment 2
Due: Thursday, 18 April 2019, 6.30pm

- **This is a group assignment.**

- **For each group, please submit the softcopy of your answer only via email to** *disrudy@nus.edu.sg* **or** upload to Workbin/StudentSubmission.

- **The total marks for this assignment is 40 points (10 points for each question).**

1. (10 points) Consider the data below from 3 well-known convenience shops which include the following information:

   - Input x_1: the number of employees (normalized to 1),

   - Output y_1: the number of customers per employee,

   - Output y_2: the amount of daily sales per employee.

   The number of customers and the amount of daily sales per employee are given in the table below:

Shop	Employees (x_1)	Customers (y_1)	Sales (y_2)
A	1	4	30
B	1	3	50
C	1	6	20

   (a) (2 points) By plotting the efficient frontier for the 3 shops, identify the shop(s) that is/are not efficient.

   (b) (2 points) Pick an inefficient shop you identify in part (a). For this shop, state a linear program (**LP**) that represents an input oriented CCR model.

   (c) (3 points) Show that the LP you find in part (b) has an optimal objective function that is strictly less than 1.

   (d) (3 points) Show that it is possible to create a "composite" shop that is either

   - using less input and producing at least the same output, or

   - using the same input and producing more output

   than the inefficient shop.

2. (10 points) The XOR problem

x_1	x_2	target
-1	-1	1
-1	1	-1
1	-1	-1
1	1	1

can be solved by a neural network with one hidden unit if we allow direct connections between the input units and the output unit (see the figure below).
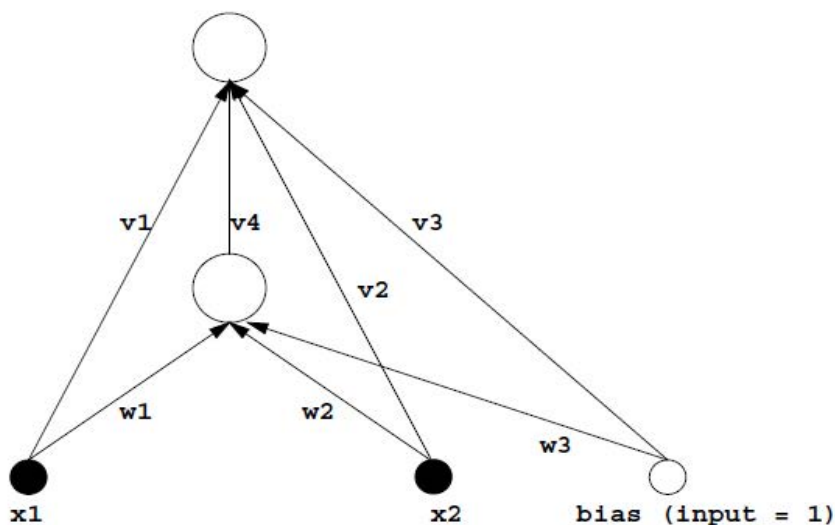
(a) (4 points) You are given the following weight values: $w_1 = 20, w_2 = 20, w_3 = -30, v_1 = -20, v_2 = -20, v_4 = 40$. Find the value(s) of v_3 such that all four samples in the problem are correctly classified. Assume that the hyperbolic activation function is used for both the hidden unit and the output unit.

(b) (6 points) Describe how the weights v_1 and w_1 will be updated using the error backpropagation method when an input (x_1, x_2) is presented to the network. Note: let the error be $E = \frac{1}{2}(d_1 - o_1)^2$.

3. (10 points) A firm produces two types of products: A and B. Production of either product requires an average of 3 hours. The plant has a normal production capacity of 135 hours per week. According to the marketing department, in each week 30 product A and 25 product B can be sold. Profits per unit of product A and product B are $5 and $6, respectively. Management has set the following goals, in order of decreasing importance:

- minimize underutilization of production capacity.

- avoid overtime operation of the plan beyond 15 hours per week.

- meet the demand for both products.

- maximize profit.

(a) (4 points) Formulate a preemptive goal programming model for this situation.

(b) (6 points) Solve the problem using the graphical method. State which goals (if any) are not achieved.

4. (10 points) A group of dentists is considering opening of a new private clinic. If the demand for dentists is high (that is, there is a favorable market for the clinic), the dentists could realize a net profit of $1,000,000. If the market is not favorable, they would lose $400,000. If they do not proceed at all, there will be no cost/profit. In the absence of any market data, the best the dentists can guess is that there is a 50-50 chance the clinic will be successful. The dentists may engage a market research firm to perform a study of the market, at a fee of $50,000. The market researchers claim their past experience shows that when the markets were favorable, their study correctly predicted success 70% of the time. Thirty percent of the time the study falsely predicted a failure. On the other hand, when the market condition was unfavorable, the study was correct 80% of the time in predicting a failure. The remaining 20% of the time, it incorrectly predicted a success.

(a) (2 points) State the Expected Value of Perfect Information.

(b) (6 points) State the Expected Value of Sample Information.

(c) (2 points) What is the best decision that the dentists should take?