

SIT718 Real world Analytics

Assessment Task 3 2022 T2

Total Marks = 100, Weighting - 30%

Your final submission should consists of:

1. "name-report.pdf: A pdf file (created in any word processor) containing the solutions of the questions, appropriate graphs, tables and references. The file should be labelled with your name. **This file should consists of up to 8 pages, 9 pages with title page).**
2. "name-code.R": Two codes combined in one R file, labelled with yourname.R, with codes for the lp models for Question 2 and Question 3.

Your assignment **will not be assessed** if we cannot reproduce your results with your R codes.

Reference style: Harvard

1. A cheese factory is making a new cheese from mixing two products A and B, each made of three different types of milk - sheep, cow and goat milk. The compositions of A and B and prices (\$/kg) are given as follows,

	Amount (litres) per 1000 kg of A and B			
	Sheep	Cow	Goat	Cost (\$/kg)
A	30	60	40	5
B	80	40	70	8

The recipes for the production of the new cheese require that there must be at least 45 litres Cow milk and at least 50 litres of Goat milk per 1000 kg of the cheese respectively, but no more than 60 litres of Sheep milk per 1000 kg of cheese.

The factory needs to produce at least 60 kg of cheese per week.

- a) Explain why a linear programming model would be suitable for this case study.

[5 marks]

- b) Formulate a Linear Programming (LP) model for the factory that minimises the total cost of producing the cheese while satisfying all constraints.

[10 marks]

- c) Use the graphical method to find the optimal solution. Show the feasible region and the optimal solution on the graph. Annotate all lines on your graph. What is the minimal cost for the product?

[10 marks]

Note: you can use graphical solvers available online but make sure that your graph is clear, all variables involved are clearly represented and annotated, and each line is clearly marked and related to the corresponding equation.

- d) Is there a range for the cost (\$) of A that can be changed without affecting the optimum point obtained above?

[5 marks]

Hint:

This question does not require conversion of litres into kilograms.

2. A food factory makes three types of cereals, A, B and C, from a mix of several ingredients: Oates, Apricots, Coconuts and Hazelnuts. The cereals are packaged in 1 kg boxes. The following table provides details of the sales price per box of cereals and the production cost per ton (1000 kg) of cereals respectively.

	Sales price per box(\$)	Production cost per ton
Cereal A	2.50	4.00
Cereal B	2.00	2.80
Cereal C	3.50	3.00.

The following table provides the purchase price per ton of ingredients and the maximum availability of the ingredients in tons respectively.

Ingredients	Purchase price (\$) per ton	Maximum availability in tons
Oates	100	10
Apricots	120	5
Coconuts	80	2
Hazelnuts	200	2

The minimum daily demand (in boxes) for each cereal and the proportion of the Oates, Apricots, Coconut and Hazelnuts in each cereal is detailed in the following table,

	Minimum demand (boxes)	Proportion of			
		Oates	Apricots	Coconuts	Hazelnuts
Cereal A	1000	0.8	0.1	0.05	0.05
Cereal B	700	0.65	0.2	0.05	0.1
Cereal C	750	0.5	0.1	0.1	0.3

- a) Let $x_{ij} \geq 0$ be a decision variable that denotes the number of kg of ingredient i , where i could be Oates, Apricots, Coconuts, Hazelnuts, used to produce Cereal j , here j is one of A,B,C, (in boxes). Formulate an LP model to determine the optimal production mix of cereals and the associated amounts of ingredients that maximises the profit, while satisfying the constraints.

[20 Marks]

- b) Solve the model in R/R Studio. Find the optimal profit and optimal values of the decision variables.

[20 Marks]

3. Two mining companies, Red and Blue, bid for the right to drill a field. The possible bids are \$ 15 Million, \$ 25 Million, \$ 35 Million, \$ 45 Million and \$ 50 Million. The winner is the company with the higher bid.

The two companies decide that in the case of a tie (equal bids), **Red** is the winner and will get the field.

Company Red has ordered a geological survey and, based on the report from the survey, concludes that getting the field for more than \$ 45 Million is as bad as not getting it (assume loss), except in case of a tie (assume win).

(a) State reasons why/how this game can be described as a two-players-zero-sum game
[5 Marks]

(b) Considering all possible combinations of bids, formulate the payoff matrix for the game.
[5 Marks]

(c) Explain what is a saddle point. Verify: does the game have a saddle point?
[5 Marks]

(d) Construct a linear programming model for Company Blue in this game.
[5 Marks]

(e) Produce an appropriate code to solve the linear programming model in part (d).
[5 Marks]

(f) Solve the game for Blue using the linear programming model and the code you constructed in parts (d) and (e). Interpret your solution.
[5 Marks]