COMP6925: Applied Operations Research
The University of the West Indies
Sept 2021

Assignment 1

Due Date: 8th October 2021 @ 11:59 PM (AoE)

Instructions:

- Create **.zip** folder with code and write-up to inzamam.rahaman@outlook.com. Your folder should be named using your UWI ID number
- Document code with comments
- Code should be submitted in `.jl` files named `ID-QUESTION.jl`. For example, if your student ID is 12345678 and the code relates to question 1b, then your code associated with that question should titled `12345678-1a.jl`
- No `.doc` or `.docx` files are to be submitted! Submit documents as PDF files - preferably typeset using LaTeX

1. Adamantium Ltd. wants to produce an alloy comprising 40 percent tin, 35 percent zinc, and 25 percent lead. To produce this alloy, they plan to combine proportions of five different alloys. This alloys differ in both cost and the percentages of zinc, tin, and lead they contain.

   The alloys, their properties, and their costs are as follows:

	Expenditures (million $)yr				
Property	1	2	3	4	5
% of zinc	60	25	45	20	50
% of tin	10	15	45	50	40
% of lead	30	60	10	30	10
Cost ($ per kg)	22	20	25	24	27

Table 1: Alloy Properties

Adamantium Ltd. wants to produce their alloy at the lowest possible cost.

   Answer the following:

   (a) Formulate the above as an optimization problem, stating any assumptions made. [5 marks]

   (b) Using Julia, solve your above optimization problem and display the results. [5 marks]

2. Super Fancy Realtors Ltd. owns 900 acres of underdeveloped land near a beautiful lake. They plan to construct vacation homes around the lake. The province places strict environmental guidelines to preserve the environment. They limit construction to three types of dwellings: single family, double family, and triple family. Moreover, they require that at least 60% of all dwellings constructed must be single family dwellings. They also require that single family homes occupy 2 acres of land, double family homes occupy 3 acres of land, and triple family homes occupy 4 acres of land to minimize the number of septic tanks that need to be built. The expected return for each type of dwelling is as follows: single family homes will net an expected return of $10,000, double family homes will net an expected return of $13,000, and triple family homes will net an expected return of $15,000.

   In addition to the dwellings, 1.5 acres of recreational space must be developed for every 200 families, and at least 15% of the land must be retained for the development of roads.

   The one-time water connection costs and the expected water usage also differ on a per unit basis between the different dwellings and recreational grounds as follows:

Feature	Single	Double	Triple	Recreational
Water connection cost	1000	1100	1500	900
Water usage (gal per day)	400	700	1100	500

Table 2: Water usage details

Regardless of the number of units built, the province will charge a minimum of $100,000 for the entire development. Moreover, they require that water usage stay below 250,000 gallons per day.

Given these constraints, Super Fancy Realtors Ltd. wants to devise the most profitable development plan.

(a) Formalize the above as an optimization problem. State any assumptions made. [15 marks]

(b) Write Julia code to solve the above problem. [10 marks]

(c) Suppose that Super Fancy Realtors Ltd. can purchase an additional 100 acres at a cost of $500,000. Should they purchase this 100 acres? Present an argument for why they should or should not. [10 marks]