CORK INSTITUTE OF TECHNOLOGY
INSTITIÚID TEICNEOLAÍOCHTA CHORCAÍ

Computing@CIT

DECISION ANALYTICS

Assignment 2: Linear Programming

DUE DATE

This assignment should be submitted to Canvas before 11:59pm on **Friday 13/12/2019**.

Please submit a single ZIP file with your student number and name in the filename. Your submission should contain:

- A detailed documentation of all code you developed, including the tests and evaluations you carried out
- All Python code you developed in a single .py file that can be executed and that generates the outputs you are referring to in your evaluation

You can achieve a total of 50 points as indicated in the tasks.

TASK 1 (supply chain optimisation, 30 points)

In this task you will optimise the cost of sourcing raw material from different suppliers, manufacturing products in different factories and delivering these products to customers. The input data for this task is contained in the Excel file "Assignment_DA_2_a_data.xlsx" and can be downloaded from Canvas. The file contains 8 sheets:

- Supplier stock
  A table indicating how many units of each raw material each of the suppliers has in stock.
- Raw material costs
  A table indicating how much each of the suppliers is charging per unit for each of the raw materials.
- Raw material shipping
  A table indicating the shipping costs per unit of raw material (the units for each material are the same) from each supplier to each factory

- Product requirements
  A table indicating the amount of raw material required to manufacture one unit of each of the products.
- Production capacity
  A table indicating how many units of each product each of the factories is able to manufacture.
- Production cost
  A table indicating the cost of manufacturing a unit of each product in each of the factories.
- Customer demand
  A table indicating the number of units of each product that have been ordered by the customers
- Shipping costs
  A table indicating the shipping costs per unit for delivering a product to the customer.

Factories can order suppliers from multiple suppliers and products can be delivered to customers from multiple factories.

The goal of this task is to develop and optimise a Liner Programming model that helps decide what raw material to order from which supplier, where to manufacture the products, and how to deliver the manufactured products to the customers so that the overall cost is minimised.

A. Load the input data from the file "Assignment_DA_2_a_data.xlsx" [1 point]. Note that not all fields are filled, for example Supplier C does not stock Material A.
B. Identify the decision variables of the problem for the Linear Programming model [3 points].
C. Identify the constraints of the problem for the Linear Programming model [5 points].
D. Identify the objective function for the Linear Programming model to minimise overall cost [3 points].
E. Implement and solve the Linear Programming model using the identified variables, constraints [5 points] and objective function [3 points].
F. Answer the question how much of each product each factory should order from each supplier [1 point] and how much this order will cost including shipping [1 point].
G. Answer the question how much of each product each factory should be manufacturing [1 point] and how much cost each factory is incurring for all products they manufacture [1 point].
H. Answer the question which products and how many each factory is delivering to each customer [1 point] and how much this will cost [1 point].
I. Answer the question how much cost a unit of each product (including the raw materials used for the manufacturing of the customer's specific product, the cost of manufacturing for the specific customer and all relevant shipping costs) incurs for each individual customer [4 points].

TASK 2 (airport taxiway optimisation, 20 points)

In this task you will optimise the taxi movements for arriving and departing aircraft moving between runways and terminals. The input data for this task is contained in the Excel file "Assignment_DA_2_b_data.xlsx" and can be downloaded from Canvas. The file contains 3 sheets:

- Flight schedule
  This table outlines the arrival and departure times for all flights of the day.
- Taxi distances
  This table outlines the taxi distances between the different runways and terminals of the airport.
- Terminal capacity
  This table shows the gate capacity of each terminal, i.e. how many planes can be present at the terminal at any given time.

The same runway cannot be occupied at the same time, neither for arrival nor for departure. For example, Flight B departing at 10:00 and flight L arriving at 10:00 cannot be assigned the same runway. Further to that, planes are occupying their allocated gate the whole timespan between arrival and departure during which the gate capacity of the terminal needs to be taken into consideration when allocating terminals. Planes have to taxi from the allocated arrival runway to the allocated terminal and then from the allocated terminal to the allocated departure runway. Arrival and departure runways can be different. The total taxi distance for each flight is the distance from the arrival runway to the allocated terminal and the way back from the terminal to the departure runway.

The goal of this task is to develop and optimise an Integer Liner Programming model for allocating an arrival runway, a departure runway and a terminal for each flight so that the overall taxi distance of all planes is minimised.

A. Load the input data from the file "Assignment_DA_2_b_data.xlsx" [1 point].
B. Identify the decision variables of the problem for the Linear Programming model [4 points].
C. Identify the constraints of the problem for the Linear Programming model [4 points].
D. Identify the objective function for the Linear Programming model to minimise overall taxi distance [1 points].
E. Implement and solve the Linear Programming model using the identified variables, constraints [4 points] and objective function [1 points].
F. Output the allocation of arrival runway [1 point], departure runway [1 point] and terminal [1 point] for each flight.
G. Answer the question how much total taxi distance was incurred by all flights together [1 point] and how many gates were occupied in each terminal at every time of the day [1 point].