Assignment 3: Optimization and Excel Solver

Date Due: February 16, 2017   Instructor: Trani

Show all your work including code and results of your computation in the spreadsheet as screen captures.

Problem 1

Climate change is increasing the number of wild fires in the western states (see article: https://www.nature.com/collections/cdgjahjhic?gclid=EAIaIQobChMIo_6Fm4Xp9QIVtNSzCh3VwgoUEAAYAiAAEgKTJPD_BwE). Wild fires destroy infrastructure created by Civil Engineers.

A company that specializes in fighting wild fires in California uses two types of aircraft shown in Figure 1. The Bombardier CL 415 carries a maximum of 1,600 gallons of water in a single flight. The Air Tractor AT-802F carries 1,000 gallons per flight. The operation of the Bombardier CL-415 requires two crew members. The Air Tractor AT-802F is a single crew member plane. The company has 55 CL-415 and 50 AT-802F in the inventory to fight fires in the Spring 2022 season. The company has 135 crew members trained to operate either the CL415 or the AT 802F at its headquarters in Victorville (California). No more crews can be used in the fire fighting operation.
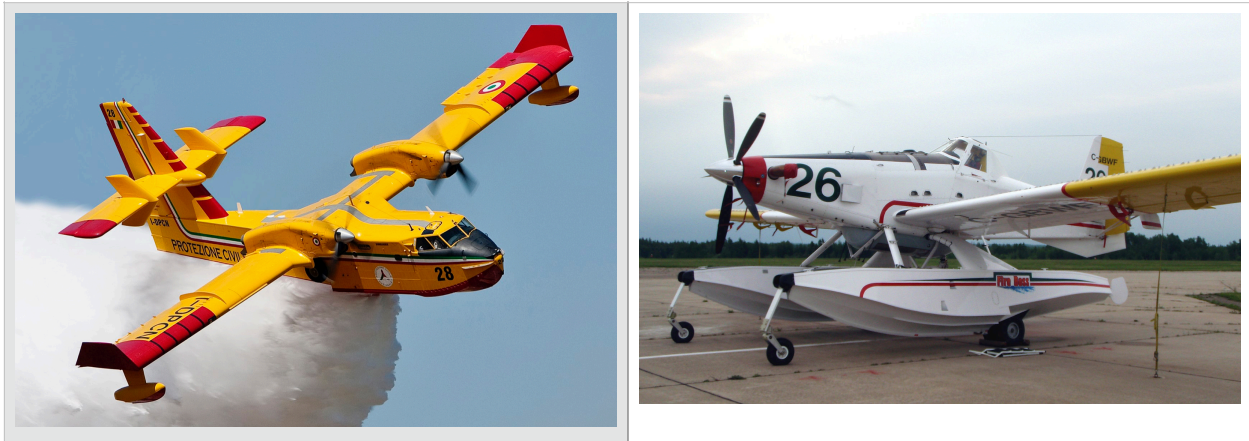

Figure 1. Types of Fire Fighting Aircraft. Bombardier CL-415 on the left (credit: Maarten Visser - Wikimedia commons) and the AT-802F Air Boss on the right (credit: Global Jet - Flickr: Fire Boss).

During a fire, the objective is to **maximize** the water load carried.

a) Formulate the problem as a linear programming problem. Clearly indicate the objective function and the functional constraints.

b) Solve the problem graphically. Clearly indicate corner points and plot two lines of constant Z value at two corner points.

c) Solve the problem using the Simplex Method. Make sure you show me every table in the procedure. For each table indicate the Basic Variables, Non-basic variables and value of the objective function (Z).

d) Solve the problem using Excel Solver. Verify the answer obtained in Part (c).

Problem 2

The company in Problem 1 has a maintenance facility at Victorville. Due to heavy maintenance required on the two types of aircraft used in fire fighting, the company estimates that a total of 85 aircraft can be made available to fight fires during the season with reliability.

a) Adding the new constraint, re-formulate the problem as a linear programming problem. Clearly indicate the objective function and the functional constraints.

b) Solve the problem using the Simplex Method. Make sure you show me every table in the procedure. For each table indicate the Basic Variables, Non-basic variables and value of the objective function (Z).

c) Solve the problem using Excel Solver.

Problem 3

Your company develops the following Linear Programming problem to minimize the cost of producing two types of concrete pipes commonly used in buildings. The objective function is the profit for the company (in dollars per production batch). The company would like to maximize the profit in solving this problem.

Objective $\text{Maximize } Z = 65X_1 + 60\,X_2$

Subject to

$$- 1.1\ x1\ + x2 <= 310$$

$$x1 + 6x2 <= 1300$$

$$3x1 + x2 <= 600$$

$$x_1,\ x_2 >= 0 \quad \text{(non-negativity conditions)}$$

For each task below, use screen captures of your setup using Excel Solver. Show the formulas of the cells to make out task simpler in grading.

a) Solve the problem using Excel Solver. State the exact solution found by Excel for the two decision variables. State the value of the objective function for the optimal solution found.

b) Solve the first two tables using the Simplex method. For each iteration, indicate the Basic Variables (in the table) and the current solution for Z.

Problem 4

A construction site requires a minimum of 45,000 cu. meters of sand and gravel mixture. The mixture must contain no less than 22,000 cu. meters of sand and no more than 26,000 cu. meters of gravel.

Materials may be obtained from three sites: 45% of sand and 55% gravel from site 1 at a delivery cost of $146 per cu. meter; 51% sand and 49% gravel from site 2 at a delivery cost of $148 per cu. meter; and 52% sand and 48% gravel from site 3 at a delivery cost of $147.00 per cu. meter.

Due to limited number of excavators at each site, site 1 can produce up to 22,000 cubic meters of material. Site 2 can produce up to 25,000 cu. meters, and site 3 up to 27,000 cu. meters of material.

a) Formulate the problem as a linear programming problem to minimize the cost to the company.

b) Solve the problem using Excel Solver. Find the amounts of material to be extracted from each site.

c) State the cost to produce the 45,000 cubic meters of material.