# IE400-Spring 2019-2020
# Study Set 1

**Q1)** The Southern Confederation of Kibbutzim is a group of three kibbutzim (farming communities). Overall planning for this group is done by an office and this office currently is planning agricultural production for the coming year. The agricultural output of each kibbutz is limited by both the amount of available irrigable land and water allocated for irrigation. These data are given in Table 1. The crops suited for this region include sugar beets, cotton and sorghum. These crops differ primarily in their return per acre and their consumption of water. In addition to that there is a maximum quota for the total acreage that can be devoted to each of these crops (Table 2). To ensure equity between the three kibbutzim, it has been agreed that every kibbutz will plant the same proportion of its available irrigable land. For example, if kibbutz 1 will plant 200 of its available 400 acres, then kibbutz 2 must plant 300 of its 600 acres while kibbutz 3 plants 150 acres of its 300 acres. Formulate an LP whose solution will maximize the total net return to the Southern Confederation of Kibbutzim as a whole.

| Kibbutz | Usable Land(Acres) | Water Allocation(Acre Feet) |
|---|---|---|
| 1 | 400 | 600 |
| 2 | 600 | 800 |
| 3 | 300 | 375 |

Table 1

| Crop | Maximum Quota(Acres) | Water Consumption(Acre Feet/Acre) | Net Return($/Acre) |
|---|---|---|---|
| Sugar Beets | 600 | 3 | 1000 |
| Cotton | 500 | 2 | 750 |
| Sorghum | 325 | 1 | 250 |

Table 2

**Q2)** Alexis Cornby makes her living buying and selling corn. On January 1, she has 50 tons of corn and $1000. On the first day of each month, Alexis can buy corn at the following prices per ton: January, $300; February, $350; March, $400; April, $500. On the last day of each month, Alexis can sell corn at the following prices per ton: January, $250; February, $400; March, $350; April, $550. Alexis stores her corn in a warehouse that can hold at most 100 tons of corn. She must be able to pay cash for all corn at the time of purchase. Use linear programming how Alexis can maximize her cash on hand at the end of April.

**Q3)** Willy Wonka's Candy Company produces three types of candy: Wonka Bars, Bottle Caps and Giant Sweet Tarts. In order to produce the different type of candies, Willy can run three different production processes as described below. Each process involves blending different types of sugars in the Magical Factories Mixer.

**Process 1:** Running Process 1 for one hour:

Costs: $5
Requires: Two barrels of sugar type A and three barrels of sugar type B
Output: Two Wonka Bars and one packet of Bottle Caps

**Process 2:** Running Process 2 for one hour:
Costs: $4
Requires: One barrel of sugar type A and three barrels of sugar type B
Output: Three packets of Bottle Caps

**Process 3:** Running Process 3 for one hour:
Costs: $1
Requires: Two barrels of sugar type B and three packets of Bottle Caps
Output: Two Wonka Bars and one packet of Giant Sweet tarts

Each week we can purchase:
200 barrels of sugar type A at $2 per barrel
300 barrels of sugar type B at $3 per barrel
Assume that they can sell everything that they can produce. Wonka Bars are sold at $9 per bar
Bottle Caps are sold at $10 per packet. Giant Sweet Tarts are sold at $24 per packet. Assume that 100 hours of mixing are available.

**a)** Formulate an LP whose solution will maximize Willy Wonka's profit. Hint: Use decision variable xi: number of hours process i runs, i=1, 2, 3.

**b)** Assume that instead of having 200 barrels of sugar type A and 300 barrels of sugar type B available that you can order a total of 500 Barrels. Show how to modify your LP formulation in part a to account for this revised problem.

**c)** Suppose that instead of selling the three candies separately, they can only be sold as part of a box consisting of one Wonka Bar, two packets of Bottle Caps and one pack of Giant Sweet Tarts. Each Wonka Box sells for $54. Modify your LP formulation in part a to model this new scenario. (You may need to add another decision variable.)

**Q4)** SilComputers makes quarterly decisions about their product mix with notebook computers and desktop computers. SilComputers would like to know how many of each product to produce in order to maximize profit for the quarter. There are a number of limits on what SilComputers can produce.

1. Each computer (either notebook or desktop) requires one memory unit and our supplier has allocated 10 such units to us. Each computer requires memory.
2. A notebook computer needs 1 chip set while a desktop computer needs 2 chip sets. We have a stock of 15 chip sets to use over the next quarter.
3. Each computer requires assembly time. Due to tight tolerances, a notebook computer takes more time to assemble: 4 minutes versus 3 minutes for a desktop. There are 25 minutes of assembly time available in the next quarter.

Given current market conditions, material cost, and our production system, each notebook computer produced generates $750 profit, and each desktop produces $1000 profit.

a. Formulate the problem as linear programming.
b. Sketch the feasible region.
c. Find extreme points.

**Q5)**

$$\begin{aligned} \textbf{max} \quad & z = 3x_1 + 2x_2 \\ & 2x_1 + x_2 \leq 4 \\ & -2x_1 + x_2 \leq 2 \\ & x_1 - x_2 \leq 1 \\ & x_1, x_2 \geq 0 \end{aligned}$$

Solve the problem graphically, specifying the variable values and $z^*$ at the optimum.