Multiple Objectives

CIS 418

An Example of Multiple Objective Optimization

Removing snow in Montreal.

Goal: minimize the expense and at the same time maximize contaminant removal (salt, sand). Different removal sites have different capacities.

Sector	Estimated Annual Snow Removal Requirements	Distance to disposal site # 1	2	3	4	5
1	133	3.4	2.4	4.6	7.4	9.3
2	152	2.4	2.1	8.3	9.1	8.8
3	154	1.4	2.9	3.7	9.4	8.6
4	133	2.6	3.6	4.5	8.2	8.9
5	127	1.5	3.1	12.1	7.9	8.8
6	129	4.2	4.9	6.5	7.7	6.1
7	111	4.8	6.2	9.9	6.2	5.7
8	110	5.4	6	5.2	7.6	4.9
9	130	3.1	4.1	6.6	7.5	7.2
10	135	3.2	6.5	7.1	6	8.3
		Disposal Site Capacity (1000s cubic feet)				
		350	250	500	400	200
		Contaminants removed at site				
		30%	40%	20%	70%	50%

*source – Ragsdale

Formulate the problem

- Objective:
  - Minimize cost (assume that it costs k$ per km travelled * ft^3 of snow) / Maximize the amount of contaminants removed
- Decisions:
  - From each sector go which sites are we removing the contaminant snow. 5X10=50 decision variables.
- Constraints:
  - Site capacity
  - You cannot remove snow that does not exist
  - Non-negative decision variables

Go to the excel file "Non-Linear Problem"->"Montreal Snow removal" and find the optimal solution.

Handling conflicting objectives

- Conflicting objectives:
  - Maximum amount of contaminants that can be removed
  - Minimum cost

- How can you use Optimization Parameter Analysis to create a plot showing minimum cost of removal for a given level of contaminants removal?

  - Set the constraint R.H as a parameter.

  - Run optimization report: objective as a function of the parameter
  - Plot the efficient frontier by using **“Chart”->”Multiple Optimizations”**

Selecting an operating point on the efficient frontier

- **Efficient Frontier – classic definition:** The efficient frontier is the set of optimal portfolios that offers the highest expected return for a defined level of risk or the lowest risk for a given level of expected return.

- **Efficient Frontier – in our case:** The set of optimal amount of contaminants removed for a defined level of cost (budget), or the set of optimal cost for a defined amount of contaminants removed.

- What point on the curve the city may want to choose to operate? Why?