MATH 300 Project 1 - Petroleum Industry Management

Introduction

Your group provides consulting services to a petroleum company. The task is to advise them on how to meet the demands of their customers for motor oil, diesel oil, and gasoline. They have, at the moment, three plants. They have decided not to store any excess production for a variety of reasons, including added insurance costs, environmental factors, and deterioration of gasoline over time.

Objectives

From a barrel of crude oil, in one day, factory A can produce 20 gallons of motor oil, 10 gallons of diesel oil, and 5 gallons of gasoline. There is also waste in the form of paraffin, among other things. Similarly, factory B can produce 4 gallons, 14 gallons, and 5 gallons, respectively, while factory C can produce 4 gallons, 5 gallons, and 12 gallons, respectively of motor, diesel, and gasoline. Factory A has 3 gallons of paraffin to dispose of per barrel of crude, factory B 5 gallons, and factory C 2 gallons.

Suppose the current daily demand from distributors is 6000 gallons of motor oil, 7500 gallons of diesel oil, and 15,000 of gasoline.

Set up the system of equations which describes the above situation. Include units.

Next, decide how many barrels of crude oil each plant should get in order to meet the demand as a group. Remember that you can only provide each plant with an integer number of barrels.

Suppose the total demand for all products doubled. What would your solution now be? How does it compare to the original solution? Why, mathematically, should this have been expected?

Suppose that the company acquires another group of distributors and that the daily demand of this group is 4000 gallons of motor oil, 8000 gallons of diesel oil, and 4000 gallons of gasoline. How would you set up production of just this supply? Are there any options (more than one way)?

Next, calculate the needs of each factory (in barrels of crude, as usual) to meet the total demand of both groups of distributors. When you have done this, compare your answer to results already obtained. What mathematical conclusions can you draw?

Sensitivity and Robustness

In real life applications, constants are rarely ever exactly equal to their stated value; certain amounts of uncertainty are always present. This is part of the reason for the science of statistics. In the above model, the daily productions for the plants would be averages over a period of time. Your job here is to explore what effect small changes in the parameters have on the output.

To do this, pick *any* 3 coefficients, one at a time, and vary them one way and the other by 3%. For each case, note what effect this has on the solution, as a percentage change. Can you draw any overall conclusion?

The activity just described is sensitivity analysis. A model which does not change much for modest changes in its parameters is said to be robust.

A Plant Off-Line

Suppose factory C is shut down by the EPA temporarily for excessive emissions into the atmosphere. If your demand is as it was originally (6000, 7500, 15,000), what would you now say about the company's ability to meet it? What do you recommend they schedule for production now?

Other problems:

This situation has caused enough concern that the CEO is considering buying another plant, identical to the third, and use it permanently. Assuming that all 4 plants are on line, what production do you recommend to meet the current demand (10,000, 15,500, 19,000)? In general, what can you say about any increased flexibility that the 4^{th} plant might provide?

The company has just found a candle company that will buy its paraffin. Under the current conditions for demand, how much can be supplied to them per day?

The management is also considering selling the first plant due to aging equipment and high workman's compensation costs for the state it is located in. They would like to know what this would do to their production capability. Specifically, they would like an example of a demand they could *not* meet with only plants B and C, and also what effect having plant D has (recall it is identical to plant C). They would also like an example of a demand that they *could* meet with just plants B and C. Any general statements you could make here would be helpful.

Your conclusion should include a discussion of the nature of the terms *unique*, *no solution*, *overdetermined*, and *underdetermined* as they apply in the context of the oil plants. You may work in groups of 2 and each group need turn in one written report.

Due: Thursday, March 5^{th}.