Technische Universität Berlin
Institut für Mathematik

Dr. Axel Werner
Olaf Maurer

Mathematical Tools for Engineering and Management
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Homework assignment 3 (for presentation)

to be presented on December 15, 2010

Exercise 3

You are a consultant for a large food company. Your task is to design a new fruit juice, which covers the RDA (recommended daily allowance) within a tolerance of ±10%. Moreover, certain restrictions apply on the concentration of the different ingredients in order to ensure a good viscosity (e.g. limit the banana mark fraction), and to ensure a good taste (e.g. limit the lemon juice fraction). Your salary is related to the actual costs for purchasing the ingredients: The smaller the ingredient cost, the higher your salary — which of course you want to maximize. The costs for the different ingredients vary over the year.

Conc.	B1	B2	B6	C	E	Niacin	Min	Max
Apple	3	3	5	200	50	100	0.15	1
Banana	3	3	5	150	60	100	0.08	0.2
Lemon	10	10	15	1000	40	80	0.02	0.05
Pineapple	5	10	10	400	50	100	0.05	1
Orange	10	10	15	500	40	80	0.2	1
RDA	7	8	10	350	50	90	-	-

Figure 1: Concentrations

Costs	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Apple	5	5	5	5	5	4	3	3	3	3	4	5
Banana	6	6	6	6	6	6	6	6	6	6	6	6
Lemon	13	13	13	13	13	13	13	13	13	13	13	13
Pineapple	15	14	15	13	12	12	13	13	13	15	15	15
Orange	7	7	7	9	12	12	11	12	12	10	8	7

Figure 2: Costs

1. Design a fruit juice by providing concentrations for its ingredients such that your raw material costs are minimum, when considering an entire year.

2. Suppose you can store each ingredient for your fruit juice for up to one month. You may e.g. buy twice the amount of apples needed in May, and buy no apples in June. But after this month, your fruit goes bad and can't be used anymore. For budget reasons, in the end of the year, your storage must be empty. Suppose that, based on your current market projections, you want to produce exactly 100.000 bottles of juice each month. Determine an optimal buying policy: When should you buy what amount of fruit? Does this decision influence the optimal ingredients of your fruit juice?

3. As a large consumer of fruit, your supplier offers discounts based on the amount of food you buy. You pay the regular price for a single piece of fruit, but if you buy 100, 1000, 10000 pieces of fruit at once, you get a 10%, 20%, 40% discount. How does this influence your buying policy? Does this decision influence the optimal ingredients of your fruit juice? How good is your decision in terms of the optimality gap?

4. Prepare a 15min presentation to be held on December 15, 2010. In your presentation, you must convince the producer to trust your plans. This includes both a high-level overview of the optimization model and being prepared for any questions on the details of your solution. Due to time constraints, please get together in groups of **three** for this exercise.