

HOMEWORK 1

Due: 17.00 on November 1st, 2022

Submit your answer report and the file of the model you used, to the relevant ODTUClass assignment.

Question 1. The Wotton Company produces t-shirts and sweatshirts. Each product is produced from two main resources which are wool and cotton. The resource requirements for each product and the total resource availabilities are as follows:

	Resource requirement / unit product		Profit Earned / unit product (\$)
	Wool (lb)	Cotton (lb)	
T-shirt	3	5	12
Sweatshirt	6	4	16
Total availability	900	1200	

Linear programming model formulation for this problem in order to maximize profit is as follows.

Decision Variables:

x = Number of t-shirts to be produced

y = Number of sweatshirts to be produced

Maximize $12x + 16y$

subject to

$$\begin{array}{lll}
 3x + 6y \leq 900 & (1) & \text{\#wool constraint} \\
 5x + 4y \leq 1200 & (2) & \text{\#cotton constraint} \\
 x \geq 0, y \geq 0 & (3) & \text{\#cardinality constraints}
 \end{array}$$

- Solve the model graphically.
- What would be the effect on the optimal solution if the profit for a sweatshirt is increased by 1 and changed to 17\$?
- What would be the effect on the optimal solution of the problem in part (a) if the profit for a t-shirt is increased by more than 8 units and changed to 20\$ or more?
- What would be the effect on the optimal solution of the problem in part (a) if 300 additional pounds of wool can be obtained?

Question 2. The Wondertaste Bakery produces three main special berry products: cheesecake, muffin, and cake. Each product has to be produced more than the production requirement and is produced by one of the four preparation procedures which are fully handmade, machine 1, machine 2, and machine 3. Production costs and processing times of each product type with respect to process types are given as following:

	Production costs (\$) / unit product				Production requirement / product type
	Handmade	Machine 1	Machine 2	Machine 3	
Cheesecake	5	5	3	4	3000
Muffin	3	4	4	3	5000
Cake	8	6	5	4	2000

	Processing times (hours) / unit product			
	Handmade	Machine 1	Machine 2	Machine 3
Cheesecake	0.90	0.25	0.20	0.20
Muffin	0.50	0.30	0.20	0.25
Cake	1.2	0.60	0.60	0.50
Time availability of processes	1500	1200	1500	2000

- a) How many products should be produced from each type in order to minimize total cost? Note that this problem is infeasible to solve by hand so you will need to use a linear programming software (i.e. Excel OpenSolver, or optimization packages in Python, etc.).

Note: Answer parts b,c,d,e, and f separately.

- b) For what values of the cost of producing cheesecake in machine 2, the current basis remains optimal (same variables are selected to be in the basis)? What happens to the optimal solution and optimal objective function value when the cost of producing cheesecake in machine 2 is increased by 1 unit?
- c) For what values of the cost of producing cake in machine 2, the current basis remains optimal? What happens to the optimal solution and optimal objective function value when the cost of producing cake in machine 2 is increased by 1 unit, decreased by 2 units?
- d) For what values of production requirement of Muffin, current basis remains optimal? What happens to the optimal solution and optimal objective function value when production requirement of Muffin is increased by 1 unit? What is the shadow price for this constraint?
- e) For what values of the time availability of the Machine 3, current basis remains optimal? What happens to the optimal solution and optimal objective function value when the time

availability of the Machine 3 is increased by 1 unit? What is the shadow price for this constraint?

- f) Assume that one customer demands a handmade cheesecake for a special event. What happens to the optimal solution and optimal objective function value if the model is forced to produce at least one handmade cheesecake? For what values of the cost of producing a handmade cheesecake, the current basis remains optimal? For what values of the cost of producing a handmade cheesecake, handmade cheesecake takes positive value?