School of Computer Science
Faculty of Science
National University of Engineering

Test 3

Topics: linear programming; the Simplex method algorithm; sensitivity analysis
Subject: Computational Mathematics **Period: 2021-1**

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1. Jackson Hole Manufacturing is a small manufacturer of plastic products used in the auto-motive and computer industries. One of its major contracts is with a large computer company and involves the production of plastic printer cases for the computer company's portable printers. The printer cases are produced on two injection molding machines. The M-100 machine has a production capacity of 25 printer cases per hour, and the M-200 machine has a production capacity of 40 cases per hour. Both machines use the same chemical material to produce the printer cases; the M-100 uses 40 pounds of the raw material per hour and the M-200 uses 50 pounds per hour. The computer company asked Jackson Hole to produce as many of the cases during the upcoming week as possible; it will pay $18 for each case Jackson Hole can deliver. However, next week is a regularly scheduled vacation period for most of Jackson Hole's production employees; during this time, annual maintenance is performed for all equipment in the plant. Because of the downtime for maintenance, the M-100 will be available for no more than 15 hours, and the M-200 will be available for no more than 10 hours. However, because of the high set-up cost involved with both machines, management requires that, if production is scheduled

on either machine, the machine must be operated for at least 5 hours. The supplier of the chemical material used in the production process informed Jackson Hole that a maximum of 1000 pounds of the chemical material will be available for next week's production; the cost for this raw material is \$6 per pound. In addition to the raw material cost, Jackson Hole estimates that the hourly costs of operating the M-100 and the M-200 are \$50 and \$75, respectively.

(a) (4 pts.) Formulate a linear programming model that can be used to maximize the contribution to profit.

(b) (4 pts.) Conduct the Simplex method in Python, implement the instructions of the algorithm we have seen in class. Find the optimal solution and the optimal value.

(c) (2 pt.) Compare the last item above with the result of calling a function of some library that solves LPP's.

2. Cranberries can be harvested using either a "wet" method or a "dry" method. Dry-harvested cranberries can be sold at a premium, while wet-harvested cranberries are used mainly for cranberry juice and bring in less revenue. Fresh Made Cranberry Cooperative must decide how much of its cranberry crop should be harvested wet and how much should be dry harvested. Fresh Made has 5000 barrels of cranberries that can be harvested using either the wet or dry method. Dry cranberries are sold for \$32.50 per barrel and wet cranberries are sold for \$17.50 per barrel. Once harvested, cranberries must be processed through several operations before they can be sold. Both wet and dry cranberries must go through dechaffing and cleaning operations. The dechaffing and the cleaning operations can each be run 24 hours per day for the 6-week season (for a total of 1008 hours). Each barrel of dry cranberries requires 0.18 hours in the dechaffing operation and 0.32 hours in the cleaning operation. Wet cranberries require 0.04 hours in the dechaffing operation and 0.10 hours in the cleaning operation. Wet cranberries must also go through a drying process. The drying process

can also be operated 24 hours per day for the 6-week season, and each barrel of wet cranberries must be dried for 0.22 hours.

(a) (3 pts.) Develop a linear program that Fresh Made can use to determine the optimal amount of cranberries to dry harvest and wet harvest.

(b) (2 pts.) Solve the linear program in part (a). How many barrels should be dry harvested? How many barrels should be wet harvested? Conduct the Simplex method in Python, implement the instructions of the algorithm we have seen in class.

(c) (1 pt.) Compare the last two item above with the result of calling a function of some library that solves LPP's.

(d) (2 pts.) Suppose that Fresh Made can increase its dechaffing capacity by using an outside firm for this operation. Fresh Made will still use its own dechaffing operation as much as possible, but it can purchase additional capacity from this outside firm for \$500 per hour. Should Fresh Made purchase additional dechaffing capacity? Why or why not?

(e) (2 pts.) Interpret the shadow price for the constraint corresponding to the cleaning operation. How would you explain the meaning of this shadow price to management?

June 23, 2021