NORTHWESTERN UNIVERSITY | SCHOOL OF PROFESSIONAL STUDIES

Fall 2019 Midterm Exam

MSDS 400: Math for Data Scientists

Points possible: 100

Description: The midterm exam will cover topics from sessions 1-4.

Resources: The exam is completely open book. You may use course textbooks, materials provided on Canvas, graphing calculators (such as TI 83 or 84); *but any more advanced calculators, Excel Solver, Web calculators, Web-graphic calculators, or simplex method calculators are not allowed. Programming languages other than Python are also not permitted*.

For questions that require calculations, all calculations should be shown, not just the final answer. This will allow for partial credit for those answers that might be set up correctly but have calculation errors. For questions that specifically require Python, the code and output should be included with your answer. For questions that require graphs, only use Python.

Restrictions: All answers are to be your work only. You are not to receive assistance from any other person.

To complete the exam:

1. Answer all questions on the exam thoroughly. Create a Microsoft Word document, including the question number, the question, your typed answer, and graphs if required. You may use Word's equation editor to complete your answers.

2. Once you have completed your exam, return to the exam item where you downloaded the exam PDF, click View/Complete Assignment, and submit your document.

1. Reebok is designing a new type of Crossfit shoe, the Nano XIX. The fixed cost for the production will be $24,000. The variable cost will be $18 per pair of shoes. The shoes will sell for $120 for each pair. Graph the cost and revenue functions and determine how many pairs of sneakers will have to be sold for the company to break even on this new line of shoes.

2. Arielle invests a total of $17,500 in three products. She invests one part in a mutual fund which has an annual return of 11%. She invests the second part in government bonds at 7% per year. The third part she puts in CDs at 5% per year. She invests twice as much in the mutual fund as in the CDs. In the first year Arielle's investments bring a total return of $1495. How much did she invest in each product?

3. Vandelay Industries has 252 sales reps, each to be assigned to one of four marketing teams. If the first team is to have three times as many members as the second team and the third team is to have twice as many members as the fourth team, how can the members be distributed among the teams?

4. Phil's Candy makes three types of artisanal chocolate bars: cherry, almond, and raisin. Matrix A gives the amount of ingredients in one batch. Matrix B gives the costs of ingredients from suppliers J and K. Calculate the cost of 100 batches of each candy using ingredients from supplier K.

$$A = \begin{bmatrix} \text{sugar} & \text{choc} & \text{milk} & \\ 6 & 8 & 1 & \text{cherry} \\ 6 & 4 & 1 & \text{almond} \\ 5 & 7 & 1 & \text{raisin} \end{bmatrix}$$

$$B = \begin{bmatrix} \text{J} & \text{K} & \\ 4 & 3 & \text{sugar} \\ 4 & 5 & \text{choc} \\ 2 & 2 & \text{milk} \end{bmatrix}$$

5. Welsh-Ryan Arena seats 15,000 people. Courtside seats cost $8, first level seats cost $6, and upper deck seats cost $4. The total revenue for a sellout is $76,000. If half the courtside seats, half the upper deck seats, and all the first level seats are sold, then the total revenue is $44,000. How many of each type of seat are there?

6. Due to new environmental restrictions, Hoch Industries must use a new process to reduce pollution. The old process emits 6 g of Sulphur and 3 g of lead per liter of chemical made. The new process emits 2 g of Sulphur and 4 g of lead per liter of chemical made. The company makes a profit of 25¢ per liter under the old process and 16¢ per liter under the new process. No more than 18,000 g of Sulphur and no more than 12,000 g of lead can be emitted daily. How many liters of chemicals should be made daily under each process to maximize profits? What is the maximum profit?

7. Northwestern is looking to hire teachers and TA's to fill its staffing needs for its summer program at minimum cost. The average monthly salary of a teacher is $2400 and the average monthly salary of a TA is $1100. The program can accommodate up to 45 staff members and needs at least 30 to run properly. They must have at least 10 TA's and may have up to 3 TA's for every 2 teachers. How many teachers and TA's the should the program hire to minimize costs. What is the minimum cost?

8. To be at his best as an athlete, Roger needs at least 10 units of vitamin A, 12 units of vitamin B, and 20 units of vitamin C per day. Pill #1 contains 4 units of A and 3 of B. Pill #2 contains 1 unit of A, 2 of B, and 4 of C. Pill #3 contains 10 units of A, 1 of B, and 5 of C. Pill #1 costs 6 cents, pill #2 costs 8 cents, and pill #3 costs 1 cent. How many of each pill must Roger take to minimize his cost, and what is that cost?

9. Better Buy stocks Blu-ray DVD players, surround sound systems, and Smart TVs. They have limited storage space and can stock a maximum of 210 of these three machines. They know from past experience that they should stock twice as many DVD players as stereo systems and at least 30 TVs. If each DVD player sells for $450, each surround sound system sells for $2000, and each TV sells for $750, how many of each should be stocked and sold for maximum revenues? What is the maximum revenue?

10. McDowell's is conducting a sweepstakes, and ships two boxes of game pieces to a particular franchise. Box A has 4% of its contents being winners, while 5% of the contents of box B are winners. Box A contains 27% of the total tickets. The contents of both boxes are mixed in a drawer and a ticket is chosen at random. Find the probability it came from box A if it is a winner.