Quantitative Decision Modeling

Fall 2017

**Midterm Exam (Type A)**

Time: 11/20/2017 (Monday)

**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_**

Please show all work and submit your Excel files on Sakai in order to receive partial credit.

Good luck!

**Question 1:**

Best Buy sells HP desktops and designates a receiving area enough to hold 12 HP desktops. Distributors deliver HP desktops to fill the designated receiving area (according to an order-up-to inventory policy) every 36 hours. Received unfinished desktops then wait in the receiving area for assembly. The processing time at Assembly follows a uniform distribution with a minimum of 1 hours and a maximum of 4 hours. The assembled desktops are then packaged to finished desktops. The processing time of packaging follows an exponential distribution with a mean of 30 minutes. Finished desktops are stored in a large storage space to wait for purchase. Assume that HP desktops are purchased every 3 hours, on average according to an exponential distribution, when there are desktops available. Initially all storages are empty. The process flow map for Best Buy is given below. Suppose we want to run 50 simulations. Each simulation will be run for 600 hours. Let time units represent *hours.*

Process Flow Map for Best Buy

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Entrance |  | Buffer |  | WS |  | WS |  | Buffer |  | Exit |
| Desktops Arrival |  | Unfinished Desktops |  | Assembly |  | Package |  | Finished Desktops |  | Purchase Requests |

a. (12 points) Specify your SimQuick model by filling in the following tables (use screen shots, bullets, whatever is easy for you).

**Entrances:**



**Buffers:**

|  |
| --- |
|  |

**Work Stations:**

|  |
| --- |
|  |

|  |
| --- |
| **Exits:** |
|  |

b. (3 points) Based on your SimQuick results, what fraction of customer demand is being satisfied in these simulations?

c. (6 points) According to these simulations, what’s the cycle time of process, i.e., how much time, on average, are the desktops spending in the process between the time of arrival and the time of purchase? (Show all work in order to receive partial credit.)

d. (3 points) What’s the utilization rate of Assembly?

e. (3 points) Compared to the original process, if desktops are purchased every 4 hours, on average according to an exponential distribution, then the cycle time of process will

(select one): Decrease / Increase / Remain unchanged

f. (3 points) Compared to the original process, if distributors deliver HP desktops to fill the designated receiving area every 48 hours, then the service level will

(select one): Decrease / Increase / Remain unchanged

**Question 2:**

Consider the following process of visiting Alcatraz Island (“The Rock”) in the San Francisco Bay during the peak demand hours of 9am-1pm (5 hours \* 60 minutes). Alcatraz Cruises offers ferry transportation services. Each ferry carries exactly 40 travelers every time and depart every 30 minutes starting from 9am. Upon arrival at the island, 30% of travelers will enter a line to rent audio guides for the tour and then enter the ticket line to buy entrance tickets. The rest of travelers will directly enter the ticket line to buy entrance tickets. We assume there is unlimited space for all waiting lines. There are one audio rental window and two ticket windows. The amount of time for each traveler to rent an audio guide can be approximated by a normal distribution with a mean of 2 minutes and a standard deviation of 1 minute. In addition, the amount of time for each traveler to buy a ticket can be approximated by a normal distribution with a mean of 1 minutes and a standard deviation of 0.5 minute. After buying the tickets, all travelers will start their island tours. The National Park Services wants to study waiting times for the travelers.

a. (9 points) Using the elements of SimQuick, draw below a process flow map that models this process. Using words and arrows (e.g., Ferry (Entrance) > DP) will be sufficient.

b. (10 points) Suppose we want to run 50 simulations and we assume there are no customers in the lines at the beginning of the simulations. Upload your Excel file to show your final settings.

**Entrances:**

|  |
| --- |
|  |

**Buffers:**

|  |
| --- |
|  |
|  |

**Work Stations:**

|  |
| --- |
|  |
|  |

**Decision Points:**

|  |
| --- |
|  |

**Exits:**

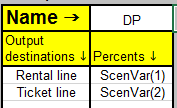
|  |
| --- |
|  |



c. (3 points) On average, how long does a traveler need to wait in line to buy a ticket?

d. We want to conduct sensitivity analysis to test the impact of the percentage of travelers who rent audio guides (consider four scenarios 20%, 25%, 30%, and 35%) on the waiting time in line to rent audio guides.

Set up the decision point using ScenVar(∙) and specify Scenarios below (4 points):



|  |  |  |  |
| --- | --- | --- | --- |
| **Scenarios** |  | Scenario Variable | |
|  |  | 1 | 2 |
| Scenarios | 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |

Explain the relationship between the waiting time in line to rent audio guides and the percentage of travelers who rent audio guides (4 points).

**Question 3 (you have made it this far without any tears – good job!):**

The Internal Revenue Service (IRS) estimates that during each of the next 4 months it will need the numbers of supercomputers indicated in row 9 of the spreadsheet shown below. To meet these requirements the IRS rents supercomputers for a period of 1, 2, or 3 months. The rental costs are shown in rows 4-6. The IRS has no supercomputers at the beginning of month 1. The IRS must decide how many computers to rent for each amount of time, starting at the beginning of each month, so as to satisfy the requirements at minimum total cost. For example, cell C17 will contain the number of computers to rent starting at the beginning of month 2 for 3 months (that is, till the end of month 4). Since the original requirements are estimates, the IRS wants to solve this problem for several different levels of requirements. In this case, in each month, the requirement being considered is 10% higher (see cell B11) than the original requirement. These “adjusted requirements” are calculated by Excel in row 21.

a. (20 points) Suppose the decision variables are B15:E17. Specify the Excel file below. Make sure to record *all the necessary formulas*.

|  |
| --- |
|  |

b. (8 points) Specify Solver:

Set Objective: \_\_\_\_\_\_\_\_\_

To: ○ Max ○ Min ○ Value of: \_\_\_\_\_\_\_\_\_

By Changing Variable Cells: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Subject to the Constraints:

|  |
| --- |
|  |

□ Make Unconstrained Variables Non-Negative

Select a Solving Method: Simplex LP

c. (4.5 points) Based on your Solver results,

How many supercomputers the IRS should rent for 2 months in Month 1? \_\_\_\_\_\_\_\_

How many supercomputers the IRS should rent for 3 months in Month 2? \_\_\_\_\_\_\_\_\_

How many supercomputers the IRS should rent for 1 month in Month 3? \_\_\_\_\_\_\_\_\_

d. (7.5 points) Sensitivity analysis:

* The optimal total rental cost would \_\_\_\_\_\_\_\_\_ (increase / decrease / remain unchanged) if percent increase in requirement is changed to 20%.
* The optimal total rental cost would \_\_\_\_\_\_\_\_\_ (increase / decrease / remain unchanged) if rental cost per computer for one month is $800.
* The optimal total rental cost would \_\_\_\_\_\_\_\_\_ (increase / decrease / remain unchanged) if original requirement for Month 2 is 1200.