Individual Assignment 3: Simulation

If you have any questions regarding this assignment, please feel free to contact Andy Hu (a.hu@queensu.ca), the teaching assistant for this course. Feel free to cc me in your email.

Instructions for Standard Simulation Models

The @Risk simulation st ld consist of *three* sheets.

The first sheet is a values adsheet, showing your model as it normally appears on the screen. Note that the is printout reflect the outcome of a single recalculation of the spreadsheet, that is, a at means it doesn't tell you what the best answer is, the way the values printout does for an optimization model -- it's just a single possible realization of what might happen.

The next sheet is a formulas printout of your spreadsheet model, with each cell showing a formula rather than a value. Unlike optimization models, it is not necessary to put annotations on this sheet.

For simulations that contain large numbers of similar rows, it is OK to omit the repetitive rows from the values and formulas sheets by truncating the printout or using the "hide rows" command (select the rows to hide, right-click your selection, and then click Hide).

Both the values and formulas printout sheets should have row and column headings (A, B, C, ... along the top and 1, 2, 3, ... along the side).

The third sheet is the @RISK simulation output report for your model.

To the output report printout, you should add annotations indicating the answer to whatever problem was posed in the homework problem. These annotations may be done by hand or in Excel. An example annotation: "Scenario 5 has the highest average profit, and corresponds to a stocking level of 75. Therefore I would recommend stocking 75 calendars to achieve the highest expected profit."

Note that, due to the random nature simulation, it is possible for two people with correct solutions to get slightly differing answers for things like average profit or average cost. Generally, however, you should get the same choice for the optimal strategy unless there are two choices that are very close in average profit/cost.

For the problems below, submit a non-technical consulting report (approximately ½ a page for each problem) accompanied by a technical appendix to the portal dropbox. The report should highlight your findings (e.g. business implications) and be written in language that could be easily understood by an audience with little knowledge of quantitative models. The technical appendix of the first two questions should include the formulation of the model, as laid out in class (decisions, objective, constraints), and the screenshots of both the numerical values, as well as the formulae (accessed by pressing Ctrl + ~) for your model in Excel, and your actual Excel file. For the last problem, the technical appendix should include standard printouts of simulation models and your actual Excel file.

Please note that this assignment is due by 8:30 am, April 1st, 2023.

Problem 1 Computer Support (@Risk)

Company XYZ has 200 personal computers. Each working computer has a 5% probability, independent of all other computers, of encountering a hardware problem on any given day. Most hardware problems require 3/4 of an hour of attention from a computer support technician (CST). Each problem that occurs, however, has a 30% char l other problems) of developing into a more serious problem requiring an ext from a CST. You can assume that a CST always needs to spend an initial 3/4 hour oblem is minor or major.

Each CST can spend up t ing problems and costs the company $300 per day. Every CST hired must be paid t day, whether or not they have sufficient work to keep them busy. If the company doe STs to solve all the problems occurring on a given day, it hires an outside firm that r. However, computers being fixed by the outside firm can only be returned to the company by the end of the next day. For example, if the company sends two computers to the outside firm on day 1, these two computers will be fixed and returned to Company XYZ by the end of day 2, and can be operated on day 3.

Each computer not in use (e.g., either being fixed by a CST or the outside firm or on the way to be returned) results in a daily loss of $250 in profit for the company. Company XYZ's strategy is to fix the computers with minor issues with priority each day and send any remaining problematic computers to the outside firm. You can assume that the outside firm will continue fixing the computers so that the total number of hours needed to fix the computers is unaffected by who is performing the maintenance.

You are trying to decide whether to hire 1, 2, 3, or 4 CSTs.

Simulate a 100-day period with a sample size of 1000. You can assume that all 200 computers are working properly at the beginning of day 1.

Which option gives the lowest average cost per day? With this number, what is the average number of hours of support per day you must buy from the outside firm?

Problem 2. Coffee Shop (SIM@L8)

(Part 1) Your friend Alan manages a coffee shop and has gathered the following information. During the opening hours (8:00 am to 5:00 pm, Monday to Sunday), customers arrive at a rate of 10 per hour according to a Poisson distribution. On average, Alan can serve 12 customers per hour. His service times can be described by an exponential distribution. Alan is concerned about the number of customers waiting in line. He has asked your help in figuring out the following system characteristics:

(a) Average system utilization (i.e. percentage of time that Alan is busy).
(b) Average number of customers waiting in line.
(c) The average time a customer spends waiting in line.
(d) The average time a customer spends in the system.

(Part 2) Alan decides to hire his niece Catherine to work part-time this summer. Catherine will greet each customer, help the customer place an order and make payments, and relay the order information to Alan. Alan will focus solely on fulfilling the coffee order. Alan estimates that because of this streamlined operation, he can now serve 14 customers per hour, while Catherine can serve 18 customers per hour. Their service times are independent and each follows an exponential distribution. Once again, he has asked your help in figuring out the following system characteristics:

(a) Average utilization of Catherine.
(b) Average utilization of Alan.
(c) Average number of customers waiting in line (Hint: customers may need to wait at Catherine's station and/or at Alan's station).
(d) The average time [illegible] aiting in line

Build a SIMUL8 model [illegible] uestions. Set the "number of runs in trial" to 1,000. Please append printout(s) of you[illegible]luding Clock Property, any routing rules, and properties of building blocks and reso[illegible]Is) along with answers to the above questions.