JOHNS HOPKINS
CAREY BUSINESS SCHOOL

Simulation for Business Application
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Individual Homework Number 2

Due date: at the beginning of week 3 session

Reminder 1: Please submit your homework report in MS Word format named `First Name-LastName.docx`. Additionally, you need to submit one separate Excel file for each of questions 2, 3, and 4. Please name each Excel file `problem-number.xlsx`

Reminder 2: Only clearly typed solutions will be accepted & graded. Any hand-written homework submission will not be accepted/graded.

Late Submission Grading Rule: (0,1] hour delay: 10% deduction of homework grade, (1,2] hours delay: 20% deduction, (2,3] hours delay: 30% deduction, ... (you got the idea)

NOTE: Please make sure that your charts and your report are properly formatted. You will be graded for correctness of your answers along with format of your report and your charts. A tutorial video showing proper formatting of a chart is posted in Blackboard.

Part A: Simulation Application Questions

You need to set number of iterations to 20,000 for all @Risk simulation problems

1. Please read the **The Wink Hotel** problem statement available in the course website, under **week 3**. We will be solving this problem in class next week. It will help if you refresh your memory of binomial distribution. This distribution will be used for modeling customers show-up behavior. There is a good explanation of this distribution, with applications, in this website. Expectation in this problem:
   - Read the case
   - visit the above website and read through the examples. You may safely ignore the mathematical derivations.
   - Take a look at the provided template; we will solve this problem together in class; you do not need to submit anything for this problem.

2. This question is about *Zara Ruffled Cropped Top* problem. During the lecture, we assumed that Zara DC stores 100 units of inventory. Run your simulation model 11 times; each time with one of the inventory levels of 100, 101, ... 110. Then construct a Scatter plot showing average profit as a function of inventory levels you tested (100, 101, ..., 110). Report results of your model. What inventory level is better? **An open question:** Is there anything wrong with trying to find optimal solution in this manner?

3. Sum of the several normally distributed random numbers is normally distributed, where the mean of the sum is the sum of the individual means, and the variance of the sum is the sum of the individual variances. This is a very challenging result to prove mathematically, but it is very easy to demonstrate with simulation. In this question, you will use @Risk for that purpose. In four separate Excel cells, generate normally distributed numbers with parameters $\mu_1 = 12, \sigma_1 = 3, \mu_2 = 10, \sigma_2 = 30, \mu_3 = 121, \sigma_3 = 15, \mu_4 = -52, \sigma_4 = 11$ using function `=RiskNormal(`μ`, `σ`)`. Now, in another cell, calculate sum of the above numbers. Next, you need to signal @Risk to keep track of this particular cell as your output. Now, you are ready to simulate. Simulate for 20,000 iterations. Click on your output cell, go to `@Risk→Explore→Browse Results`. What is the mean, standard deviation, and 95th percentile of the output cell? Does the histogram (approximately) look like a normal distribution? You need to submit your histogram. You can get a copy of your histogram by going to `@Risk→Explore→Browse Results→` click on  (in lower right corner of the window) `→Copy Graph`, and then pasting it in your homework report.

Part B: Simulation Theory Question

4. **You cannot use @Risk for this problem.** Use Inversion Method[1] to generate 1000 normally distributed random variables with mean of 25 and standard deviation of 4. Produce a histogram of the 1000 generated normal random numbers. In order to generate a histogram go to `Insert→`  `→Histogram`[2]. Does your histogram look like a graph of normal probability distribution function? Please submit your excel file and include your (properly formatted) histogram.

   Hint: The automatic recalculation of random numbers is usually useful, but sometimes it can be annoying! There are situations when you want the random numbers to stay

[1] discussed in class

[2] Microsoft added Histogram to Excel as a default chart type in version 2016. If you are running an older version of Excel, you have several options for creating a good-looking histogram. This website discusses all your options in great detail: https://www.ablebits.com/office-addins-blog/2016/05/11/make-histogram-excel/

fixed- in other words you want to **freeze random numbers** at their current values. There are two possible ways for accomplishing this task.

Method 1:

You can stop Excel from updating the generated random numbers by setting formula updating on manual (`Formulas→Calculation Options→Manual`). Do not forget to set it back on `Automatic` once you are done with this question! This method is simpler but is not a 100% solution!!! Excel still will update your random numbers every time you save and open the file!

Method 2:

Step 1. Select the range that you want to freeze, such as A1:A23. In this problem, this is going to be the range of uniform random numbers you have generated using `=rand()` function.

Step 2. Press Ctrl+c to copy this range

Step 3. With the same range still selected, select the `Paste Values` option from the Paste drop down menu on the Home ribbon. This procedure pastes a copy of the range onto itself, except that the entries are now numbers, not formulas. Therefore, whenever the spreadsheet recalculates, these numbers do not change.

5. Please read `Milo the Math Genius` problem statement under **week 3**. We will solve this problem together.

6. Please read `Renting your friend's laptop` problem statement under **week 3**. We will solve this problem together.