Risk Analysis (AMI22Z)

Home Exercise 3.

**Instructions**: This a group exercise and you work with the same group that you have for home exercise 2. Odd number of groups (group number 1, 3, 5, …) should solve Problem 1 (below), and the even number of groups (group number 2, 4, 6, …) should solve Problem 2. Upload your solution of the allotted problem on Learn by October 28, 2021; 23:59 CET. Your solution should contain a report and the actual R codes that you used. Do not forget to set a random number generating seed in the beginning of your simulation so that your results are replicable. You will have to present your solution on Nov. 3. This home exercise is graded on a U-G (pass/fail) scale. Good luck!

**Problem 1**:

Suppose you are assigned to estimate optimal number of beds needed at a hospital. From the past data you know that on average 14.8 new patients seek for a bed every day at the hospital. Whenever a bed is empty the patient is admitted to the bed on “first come first serve” basis. Once a patient is admitted s/he stays at the hospital for 2.9 days. When a patient leaves a bed, it is made available for new intake in the next day, meaning that the minimum length of stay of patient is considered to be 1 day. Assume that

1. Patient inflow to the hospital is independent of each other, and over the days.
2. Individual patient’s length of stay is independently distributed as Geometric distribution (without 0; off course) with mean 2.9 days.
3. Daily patient inflow is distributed as Poisson with mean 14.8.
4. If a patient cannot be admitted to this hospital, then s/he will get admitted to another hospital; meaning that the patient is lost (in other word there is no waiting room).

Now, answer the following questions

1. Assume that currently your hospital has only **40** beds and one bed can serve only 1 patient at a time. Simulate the daily bed occupancy rate (occupied bed/Total bed; max. 1) at your hospital for a period of one year and display the time series.
2. What is the probability that a patient coming to this hospital will be sent to another hospital due to unavailability of beds? You may answer the last question by simulating the state of the system over a large number of days (e.g. 10000 days).
3. What is the required number of beds at the hospital so that the daily bed occupancy rate remains 85% or below with a probability of 0.95 (approximately)?

**Problem 2**:

Mr. “X” walks 1 km from his home to the nearest bus stop to catch a bus to his work. The walk takes 𝑁(8,1) minutes and refer to this random time as 𝑇1. He tries to arrive 5 minutes in advance to the scheduled departure of the bus. However, the bus does not perfectly comply with the schedule so the waiting time for Mr. X in minutes, 𝑇2, for the bus is 𝑈(0,5); given that there are no major disturbances due to snow or accidents of the bus service. Such disturbances happen 3 % of the times and the waiting time for the bus becomes 𝐸𝑥𝑝(𝜆=0.1) instead.

Under the normal situation, the duration (in min), 𝑇3, of the bus trip is 𝑁(31,𝜎=2). Under disturbances it is 31+𝐸𝑥𝑝(𝜆=0.1) minutes. The distance of the bus trip is 22.6 km. After getting down from the buss bus he has to walk another 0.4 km from the bus stop to the office. The time for this walk, 𝑇4, varies because of many reasons such as unlocking the main doors (when it closed), non-identical walking speed, exchange greetings with friends/colleagues on the road, etc. For the last part, consider two cases as follows. In the first case X walks independently of the preceding trip, in the second case he adjusts his walk (𝑇4) to the preceding trip such that a dependence is created.

(i) minutes

(ii) minutes

And now a couple of questions:

a) What is the expected travel time (approximately) for his arrival to the office? [Hint: Using Monte Carlo simulation compute ]

b) How much does the travel time vary?

c) Latest by which time does Mr X have to start from the home so that he arrives at his office before 08:00 with a probability of 0.99 (approximately)?

d) Comment on the distribution of the time for the trip to work?