ORIE 5129: Data Science for e-Retail and the Sharing Economy
Homework Assignment 3
Due March 11, 12:00 pm

Please submit a single PDF document formatted to print and show all your work clearly. Feel free to scan and submit handwritten work. Do not spend too much time on word-processing your answers. **You will complete this assignment in groups of two or three.**

Question 1

A ridesharing company operates in a small city composed of three districts, downtown (DT), midtown (MT), and uptown (UT). There are 12 cars in the fleet. At the beginning of the day, we have 2 cars in DT, 8 cars in MT, and 2 cars in UT. Passengers arrive into the system with exponentially distributed interarrival times with mean 2 minutes. When a passenger arrives into the system, the origin and destination locations of the customer is determined according to the probabilities in the table below. For example, with probability 1/9, a customer arriving into the system needs to be picked up in MT and needs to be dropped off in DT. Note that there are passengers that need to be picked up and dropped off in the same district. If a passenger needs to be picked up at a certain district and there are no cars available at that district, then the passenger immediately *reverts to the competitor* and we lose business of the passenger.

drop pick	DT	MT	UT
DT	1/9	1/9	1/9
MT	1/9	1/9	1/9
UT	1/9	1/9	1/9

If a car picks up a passenger at a certain district, then it travels for a certain travel time and drops off the passenger at her destination, at which point, the car becomes available to pick up a passenger at the drop-off location. The cars do not move empty from one district to another. The table below gives the travel time between each pair of districts. For example, the travel time from MT to DT is 10 minutes, whereas the travel time from DT to DT is 17 minutes.

drop pick	DT	MT	UT
DT	17	10	24
MT	10	12	17
UT	24	17	10

We want to estimate the expected fraction of passengers that we lose to the competitor per day and the expected total amount of time per day that the cars spend idle waiting for a passenger (summed over all cars). You can take a day to be an 8-hour period.

a) Use two events: (1) A customer arrival (let us denote this event by (A,t) representing a customer arrival at time t). (2) Drop-off at a certain location after serving a passenger (let us denote this event by (C, i, t) representing a car arrival at location i at

time *t*). Precisely describe the state of the system and write precise pseudo code that describes how different events change the state of the system and what other events are scheduled in response. (Hint: When a passenger arrival occurs, you can sample the origin and destination of a passenger, at which point, you can check the availability of cars at the origin location of the passenger.)

b) Write a computer program that simulates the system for a day. Turn in your commented computer program. Make sure that your computer program computes the statistics of interest. (Hint: Note that the customers travel between each origin-destination pair with equal probability. To sample the origin (or destination) of a customer, you can use the Python routine random.randint(*a*, *b*).)

c) Run your computer program for multiple replications and report confidence intervals on the statistics of interest. Choose the number of replications so that the confidence intervals that you end up with are tight enough to be informative.

d) Briefly describe how your model would change if the passengers did not immediately revert to the competitor and waited at their origin district until a car became available there. You can answer this part in plain English.

All your team members should write and sign the following pledge: "*Academic integrity is expected of all students of Cornell University at all times, whether in the presence or absence of members of the faculty. Understanding this, I declare that all of the team members contributed equally to all stages of this homework assignment*."