IE709, IEOR for Health Care
Assignment 2, February 14, 2018
Due February 23, 2018 on Moodle

Note: There are 2 questions on 1 pages. Detailed report (pdf format) and all programs should be uploaded on Moodle in a zip file. All graphs, figures etc must be included in the report and not uploaded separately. Work in teams of two or one. Clearly write the names and roll numbers of the team members in the report.

1. Write two programs (preferably in python, but other languages are also allowed) for deciding the service areas of EMS facilities within a city. You may make assumptions similar to Carter et al.
   (a) Given a rectangular region of length 'l' and width 'w', and coordinates of N EMS facilities $(x_1, y_1), \ldots, (x_N, y_N)$, we would like to draw a map of areas served by each facility assuming that each call is served by the facilitiy nearest to it. One simple way to approach this problem is to divide the map into tiny discrete pixels of size $\frac{l}{k} \times \frac{w}{k}$ for a reasonable value of k. Write a program that outputs the facility number for each pixel. Use this output to draw a map for a region with $l = 20, w = 12, k = 50, N = 4$ and locations $(6, 4), (8, 10), (18, 7), (12, 2)$. Assume rectilinear distances.
   (b) Based on the output of the first program and assuming a reasonable population density and speed of travel, write a program to find the average time to service a call for the whole region and the proportion of population served by each location.
   (c) In order to balance the load on the stations, we would like to modify slightly the map of service regions. Suggest a small modification in the map obtained in part (a) above for this purpose. Recompute the average time and proportions of population served. Draw the new map. You do not have to find the 'optimal' solution, a better solution is sufficient.

2. Consider the problem of scheduling appointments for a single practitioner. We would like to find an appropriate schedule for 30 patients over 6 hours and then evaluate its performance by means of discrete event simulation. We may assume that the time a patient sits with the practitioner is roughly gamma distributed with a mean of about 12 minutes, and the standard deviation 3 minutes. Suppose the doctor arrives at 9:00 AM.
   (a) Suppose two patients are called for appointment at 9:00 AM. Implement a routine to simulate the waiting time of the second patient to get service. Run the simulation for a sufficiently large number of runs and obtain a histogram of the waiting times. Plot the histogram and comment on its shape.
   (b) Implement the Bailey and Welch rule of calling two patients at 9:00 AM and then one patient every 12 minutes. Your simulation should run until all 30 patients are served. Run a sufficiently large number of simulations to find out the average sum of all waiting times of all patients and the average time the practitioner is idle.
   (c) Implement the Soriano's rule of calling two patients at 9:00 AM and then two patients every 24 minutes. Your simulation should run until all 30 patients are served. Run a sufficiently large number of simulations to find out the average sum of all waiting times of all patients and the average time the practitioner is idle.
   (d) Does any of the above two rules dominate the other (while considering patients' waiting time and practitioner's idle time)?
   (e) Suggest and implement a rule that dominates Bailey and Welch rule in your simulations.
   (f) For each of the above simulations, you must write different programs. Each of the programs must be uploaded on Moodle.

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