Project details

I. Simulation parameters

The main goal of this project is to compare the theoretical predictions derived in the handout distributed in class, with numerical results obtained by simulation.

The capacity, N, of the parking lot is a large number, say, 1000. The initial number n_0 of vehicles in the parking lot at the beginning of the simulation could be 100, 200, 300, etc.

Vehicles are assumed to arrive and depart the parking lot at certain rates. To evaluate the analytical predictions, two sets of results are to be obtained.

The first set of results is designed to use constant arrival rate and departure rate, therefore called constant case. Suggested values for the constant case are $\lambda = 800$ and $\mu = 2$.

In the second set of results the car arrival and departure rates into/from parking lot should are periodic functions of time with a period of 24 hours. While many periodic functions could possibly be employed, and the students are encouraged to do so, the following generic functions can be used:

$$\lambda(t) = a + b \sin \theta(t) \tag{1}$$

and

$$\mu(t) = c + d \sin \theta(t). \tag{2}$$

where $a,\ b,\ c,\ d$ are constants. Assuming an average occupancy of 500 cars in a 24-hour period, it is suggested to set $a = 1300, b = 500, c = 3, d = 1$. Therefore, the arrival rate of vehicles used in this case could be

$$\lambda(t) = 1300 + 5 \sin \left(\frac{\pi * t}{12} \right)$$

and the departure-rate of vehicles could be

$$\mu(t) = 3 + 1 \sin \left(\frac{\pi * t}{12} \right).$$

It is easy to verify that in the general case, the choice of $\lambda(t)$ and $\mu(t)$ guarantee 24-hour periodicity.

It would also be of interest to simulate a scenario in which the parking lot occupancy will eventually stabilize after a sufficient long time. For this purpose, the following generic arrival and departure rates could be employed:

$$\lambda(t) = 800 + 400 * (1 + 2 \exp(-0.3t)) * \sin \left(\frac{\pi * t}{12} \right)$$

and

$$\mu(t) = 2 + (1 + \exp(-0.2t)) * \sin \left(\frac{\pi * t}{12} \right).$$