PERFORMANCE EVALUATION

HOMEWORK 2
RANDOM WAYPOINT SIMULATION

Jean-Yves Le Boudec
Ehsan Mohammadpour

Due date: March 18, 2019, 23:55PM

Important: (1) In some problems we ask you to give the assumptions, comments or explanations. All these questions are accounted for grading. (2) write your answers in LaTeX. (3) Submit a single zip file which includes the pdf file for your answers and your Matlab files. Don't clutter the pdf document with Matlab code as this makes it difficult to read.

1 STATISTICS WARMUP

PROBLEM 1. *Write a program in Matlab that generates a sample of n iid standard normal variables, and display the corresponding histogram. Repeat the operation 9 times, for $n = 10, 20, 40, 80...$ and display the results on a 3×3 panel.*

PROBLEM 2. *Plots and Distributions*

1. *Plot the densities of the following distributions: Normal($0, 0.5$), Normal($0, 2$), Student(2), Student(20), Exponential(0.25), Exponential(4), Beta($10, 90$), Beta($20, 80$).*
2. *Write a program which generates a sample of $n = 1500$ RVs having a distribution in one of the above. Do it for all the distributions given above. Display the corresponding standard normal QQ-plots.*
3. *How do you interpret an S-shape in a normal QQ-plot ? A U-shape ? Justify.*

2 SIMULATE RANDOM WAYPOINT AND LOOK AT WHAT YOU HAVE DONE

PROBLEM 3. *Simulate the random waypoint model defined in the chapter "Simulation" (Example 6.5). Use the following parameters.*

- *Number of users: $N = 100$,*
- *The area is a rectangle of dimensions $l \times L$ with $l = L = 1000$m,*
- *Let S be one of the two group members' sciper number. $v_{\min} = (0.5 + 0.02 * S\%21)$m/s, $v_{\max} = (3 + 0.2 * S\%11)$m/s, where % is the modulo operator.*
- *The simulation terminates at (simulated) time $T_s = 86400\ s = 1\ day$.*

Write a simulation program in Matlab that

1. *computes and displays the mean, the minimum and the maximum number of waypoints reached by the different mobiles for only one simulation run*
2. *displays the trajectory and waypoints of one user; of 8 users.*

How much real time did your program take for 1 day of simulated time?

3 DIFFERENT VIEWPOINTS

EVENT AVERAGE (PALM) VIEWPOINT

a) Display the histogram of speeds sampled at transition epochs T_n, based on the samples for one mobile and for all mobiles.
b) Show a histogram of mobile positions based on the samples for one user and for all users. To this end, discretize the area into square bins; display a grey shade diagram where the intensity of the grey is proportional to the frequency.

You have obtained the view experienced by an observer who comes at an arbitrary transition time T_n.

TIME AVERAGE VIEWPOINT

a) Now sample the position and speed of mobiles every 10 seconds. Display the histogram of speeds sampled every 10 seconds (based on the samples for one mobile and for all mobiles).
b) Similarly, display a histogram of mobile positions sampled every 10 seconds (based on the samples for one mobile and for all mobiles).
c) You have obtained the view experienced by an observer who comes at an arbitrary point in time. Comment on what you see and compare the obtained results with those from the Event Average Viewpoint.

4 CONFIDENCE INTERVALS

4.1 CONFIDENCE INTERVALS FOR MEDIANS AND MEANS

For each of the N mobiles compute the average of the speed values sampled at transition epochs Tn (event average speed for each user). This gives you a data sequence $X_1, X_2, \ldots, X_N$. Similarly, for each of the N mobiles compute the average of the instant speed values sampled at arbitrary instants of time (time average speed for each user). This gives you another data sequence $Y_1, Y_2, \ldots, Y_N$.

a) First, take $N = 100$. For the sequences X and Y , compute and display on the same plot: median, confidence interval for the median at level 0.95, mean and confidence interval for the mean at level 0.95. ***Write explicitly and verify all the assumptions you use for the above computations.***
b) Compare the time average speed sequence with the event average speed sequence in terms of their mean/median values and the corresponding confidence intervals. How do you interpret the mean value of the event average speed sequence?
c) Do the same for $N = 30$.
d) Compare the results obtained for $N = 100$ against the corresponding results obtained for $N = 30$, and give the conclusion on how the number of samples affect the confidence intervals.

4.2 PREDICTION INTERVALS FOR SAMPLES

For each of the N mobiles compute the average of the instant speed values sampled at arbitrary instants of time (time average speed for each user). This gives you a data sequence $Y_1, Y_2, \ldots, Y_N$. First take $N = 100$. For this sequence compute and display on the same plot:

a) prediction interval for a sample at level 0.95, computed assuming the data are normal and using the estimates of the mean and variance, and
b) prediction interval for a sample at level 0.95, computed using order statistic.

Do another plot for $N = 60$, and one for $N = 30$.

Write explicitly and verify all the assumptions you used for the above computations.

c) Compare the results obtained in (a) against the corresponding results obtained in (b): are they similar or very different and why?
d) Compare the results obtained for $N = 100$ against the results obtained for $N = 60$ and $N = 30$: how does the value of N affect the prediction intervals in (a) and how in (b)? Explain.