CSC446/546 —Operations Research II: Simulations

Assignment 4

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Due date: 1 December 2015

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1. Please refer to Question 7 of Assignment 3 where you wrote a program to generate data for an exponential random variate ($\lambda = 1$). For the purpose of this question, let us consider this data (and histogram) you generated as if it were the data you collected in some real-life example (e.g., vehicle inter-arrival times). Now let us test whether this data really fits to an exponential distribution or not.

a. Use *q*-*q* plot to verify the distribution fitting of vehicle inter-arrival time to exponential distribution.

b. Estimate the mean and variance of the generated data.

c. Conduct a Chi-Square (for a significance level of $\alpha = 0.05$) test to verify whether the data conforms to exponential distribution or not.

d. What is the outcome if significance level is changed to $\alpha = 0.10$ and $\alpha = 0.01$ respectively?

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2. Records pertaining to the monthly number of job-related injuries at an underground coal mine were being studied by a federal agency. The values for the past 100 months were as shown in Table 1.

Injuries per Month	*Frequency of Occurrence*
0	35
1	40
2	13
3	6
4	4
5	1
6	1

Table 1: Monthly number of job related injuries

a. Apply the Chi-square test to these data to test the hypothesis that the underlying distribution is Poisson. Use the level of significance $\alpha = 0.05$.

b. Apply the Chi-square test to these to test the hypothesis that the distribution is Poisson with mean 1.0. Again let $\alpha = 0.05$.

c. What are the differences between parts (a) and (b), and when might each case arise?

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3. A simulation is to be conducted of a job shop that performs two operations: milling and planing, in that order. It would be possible to collect data about processing times for each operation, then generate random occurrences from each distribution. However, the shop manager says that the times might be related; large milling jobs take lots of planing. Data are collected for the next 25 orders, with the following results (Table 2) in minutes:

Order	*Milling Time (Minutes)*	*Planing Time (Minutes)*	*Order*	*Milling Time (Minutes)*	*Planing Time (Minutes)*
1	12.3	10.6	14	24.6	16.6
2	20.4	13.9	15	28.5	21.2
3	18.9	14.1	16	11.3	9.9
4	16.5	10.1	17	13.3	10.7
5	8.3	8.4	18	21.0	14.0
6	6.5	8.1	19	19.5	13.0
7	25.2	16.9	20	15.0	11.5
8	17.7	13.7	21	12.6	9.9
9	10.6	10.2	22	14.3	13.2
10	13.7	12.1	23	17.0	12.5
11	26.2	16.0	24	21.2	14.2
12	30.4	18.9	25	28.4	19.1
13	9.9	7.7			

Table 2: Milling and Planing Times

a. Plot milling time on the horizontal axis and planing time on the vertical axis. Do these data seem dependent?

b. Compute the sample correlation between milling time and planing time

c. Fit a bi-variate Normal distribution to these data (i.e., just write the method).

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4. The number of patrons staying at a small hotel on 20 successive nights was observed to be 20,14,21,19,14,18,21,25,27,26,22,18,13,18,18,18,25,23,20,21. Fit both an AR(1) and an EAR(1) model to this data. Decide which model provides a better fit by looking at the histogram of the data.

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5. Conduct a bank simulation (poisson arrivals and exponential service time distribution) for an utilization of $\rho = 0.7$ and for 5000 customer arrivals by running the single server Java code that you used before. Assume the average service time is 2 minutes. Run 10 replications of the same simulation (i.e., $\rho = 0.7$) by changing the initial seed and observe the total delay experienced by the customers.

a. What are the point estimator, confidence interval and prediction interval for this delay? Assume $\alpha = 0.05$

b. If real system's validation (measured) data reveals that the average delay experienced by customers is 5 minutes, is simulation data consistent with system behavior? Use $\alpha = 0.05$ and $\epsilon = 0.5$ minutes.

c. Repeat the above with 50000 customers. What differences did you observe between these experiments?