Lab 9 Report

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Introduction

The purpose of this exercise is to simulate a queue in the steady-state manner. In the mentioned state, at first the average delay corresponding to the customers could fluctuate and then converge to a more stable state in which the average delay would not face major changes. The fluctuating part of the average delays indicates the warm-up period. To be able to study the system more confident the data regarding the warm-up period has to be omitted.

End of Transient Period

There are many complex computational, visual and heuristic techniques to detect the warmup period. The heuristic method that is exploited in this lab, is based on dynamics of variance at different times.

As could be seen in the Figure 1, in transient period, high variances could be observed to the fluctuation of the average delays whereas after the period, the variances are low. By defining a range based on the variance and mean of the average delays, we could iterate over data and find the points at which the average delay is in the mentioned range. The result of the method could be seen in the Figure 1.

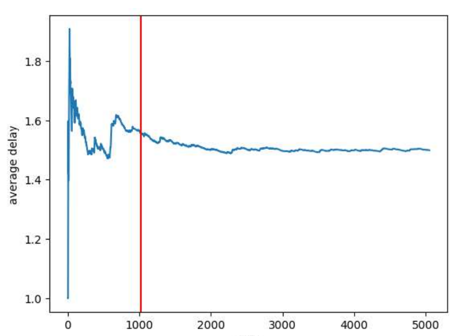

Figure 1 - transient ending point

Batch Means

After deleting the transient data, the remaining instances have to be divided into batches (at first 10 batches). The batching is done due to the fact that calculating confidence interval for the statistics of the average delay is not possible, since the instances are **not independent**. To have unbiased statistics, first, the mean of the batches are calculated and then the confidence interval of these means is computed. If the confidence interval is small enough, based on the accuracy which is defined, then it could be said that the statistics that we have are reliable and the simulation could be ended. Otherwise, we add more batches.

Hyper-exponential Random Generator

To be able to generate random numbers based on the hyper-exponential distributed with mean and variance equal to 1 and 100 respectively, we have to solve the following equation. μ_1 and μ_2 are the means of the two exponential distributions of which the hyper-exponential is built.

$$\begin{cases} 1 = \dfrac{P_1}{\mu_1} + \dfrac{P_2}{\mu_2} \\ 100 = P_1 \cdot \dfrac{2}{\mu_1^2} + P_2 \cdot \dfrac{2}{\mu_2^2} - \left(\dfrac{p_1}{\mu_1} + \dfrac{P_2}{\mu_2}\right)^2 \end{cases}$$

In the above equation both P values are equal to 0.5.

Simulator Input Parameters

Simulator takes as input the following parameters:

- Seed
- Utilization
- Service time distribution: can be HYP, EXP or DET
- Accuracy: For comparison of confidence interval

Simulator Outputs

Firstly the simulator calculate the point at which the transient ends. In addition, depending on the parameters passed as the input the statistics of

batches such as all the means, number of batches and the intervals could be extracted.

Added to these also plotting functions could be used to depict results. Consider Figure 2 and Figure 3.

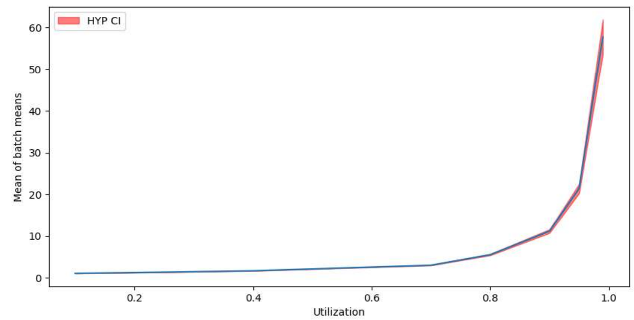

Figure 2 - 95% CI for HYP

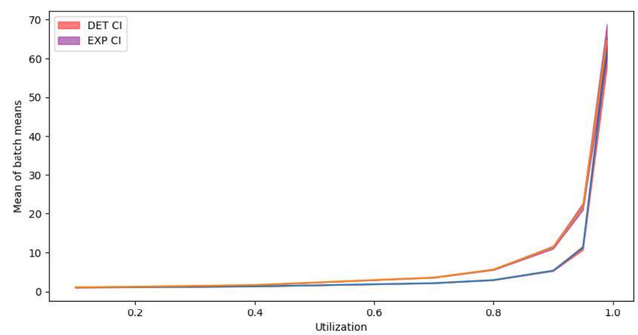

Figure 3 - 95% CI for DET and EXP