**ECE 358 – Lab 1 Report**

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**Question 1.** *Write a short piece of C code to generate 1000 exponential random variable with l=75. What is the mean and variance of the 1000 random variables you generated? Do they agree with the expected value and the variance of an exponential random variable with l=75? (if not, check your code, since this would really impact the remainder of your experiment).*

**#include <stdio.h>**

**#include <stdlib.h>**

**#include <math.h>**

**float calcErrPercent(float theoretical, float actual){**

**return fabs((theoretical)-actual)/theoretical\*100;**

**}**

**int main(){**

**double lambda = 75;**

**srand(time(0));**

**double sum = 0;**

**double nums[1000];**

**for (int i = 0; i < 1000; i++) {**

**nums[i] = -log(1.0 - ((double)rand())/RAND\_MAX) / lambda;;**

**sum += nums[i];**

**}**

**double avg = sum / 1000;**

**double stdev = 0;**

**for (int i = 0; i < 1000; i++) {**

**stdev += pow(nums[i] - avg, 2);**

**}**

**double variance = sqrt(stdev / (1000-1));**

**printf("Expected mean: %f\n", (1/lambda));**

**printf("Measured mean: %f\n", avg);**

**printf("Error for mean: %0.2f%%\n", calcErrPercent(1/lambda, avg));**

**printf("Measured variance %f\n", variance);**

**printf("Error for variance: %0.2f%%\n", calcErrPercent(1/lambda, variance));**

**}**

Which produces the output:

Expected mean: 0.013333

Measured mean: 0.013270

Error for mean: 0.48%

Measured variance 0.013440

Error for variance: 0.80%

The theoretical expected mean and variance for set of randomly generated numbers with a Poisson distribution correspond to in the provided equation. As we can see from the results, it is clear that the resulting set of randomly generated numbers agree with the expected mean and variance, with an error of 0.48% and 0.80% respectively.

**Question 2.** *Build your simulator for this queue and explain in words what you have done. Show your code in the report. In particular, define your variables. Should there be a need, draw diagrams to show your program structure. Explain how you compute the performance metrics.*

Explain here.

**Question 3.** *The packet length will follow an exponential distribution with an average of L = 2000 bits. Assume that C = 1Mbps. Use your simulator to obtain the following graphs. Provide comments on all your figures.*

1. *E[N], the average number of packets in the queue as a function of r (for 0.25 < r < 0.95, step size 0.1). Explain how you do that.*

As provided in the lab manual, , where L=2000 bits and C= 1Mbps = 10E6bps. Plugging in values yields 0.002. To find the lower bound of setting and solving for yields 125. For the upper bound of setting and solving for yields 475. To find the step size, setting and solving for yields . Using the above results, we constructed a for loop that iterates the parameter from 125 to 475 with a step size of 5, and extracted the simulation output for each value of

To compute the average number of packets in the queue, we created a counter variable to track the number of packets. At each observer event, the counter is incremented by the number of elements in the queue. At the end of the simulation, the average number of packets is computed by dividing the counter by the total number of observer events.

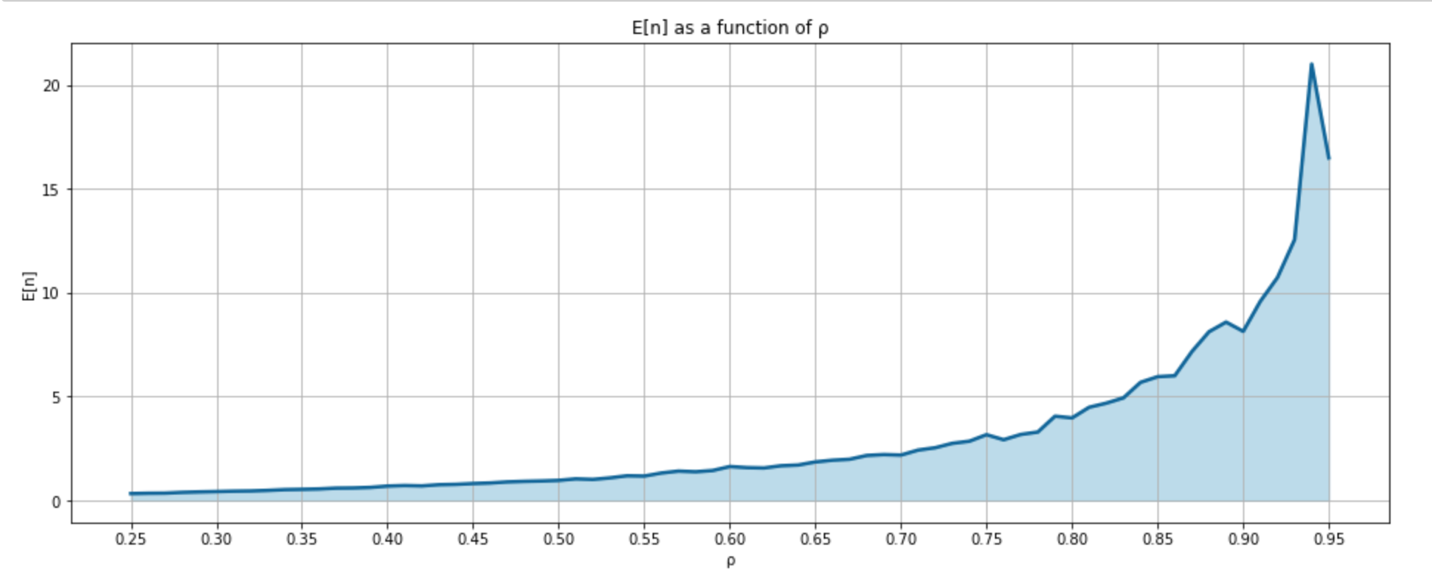


Figure 1. Average number of elements in queue as a function of ρ

1. *Pidle, the proportion of time the system is idle as a function of r, (for 0.25 < r < 0.95, step size 0.1). Explain how you do that.*

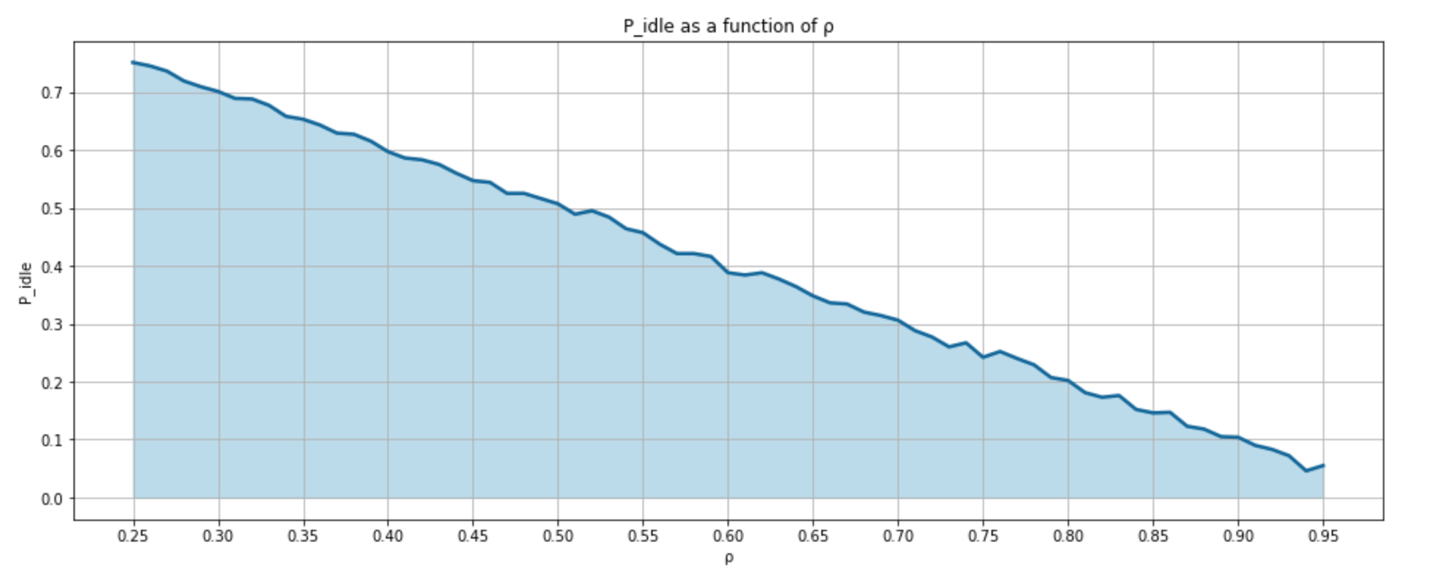


Figure 2. Idle time fraction as a function of ρ

**Question 4.** *For the same parameters, simulate for ρ=1.2. What do you observe? Explain.*

Pidle = 0

E[n] = 4810.117

**Question 5.** *Build a simulator for an M/M/1/K queue, and briefly explain your design.*

**Question 6.** *Let L=2000 bits and C=1 Mbps. Use your simulator to obtain the following graphs:*

1. *E[N] as a function of ρ (for 0.5 < ρ < 1.5, step size 0.1), for K = 10, 25, 50 packets. Show one curve for each value of K on the same graph.*

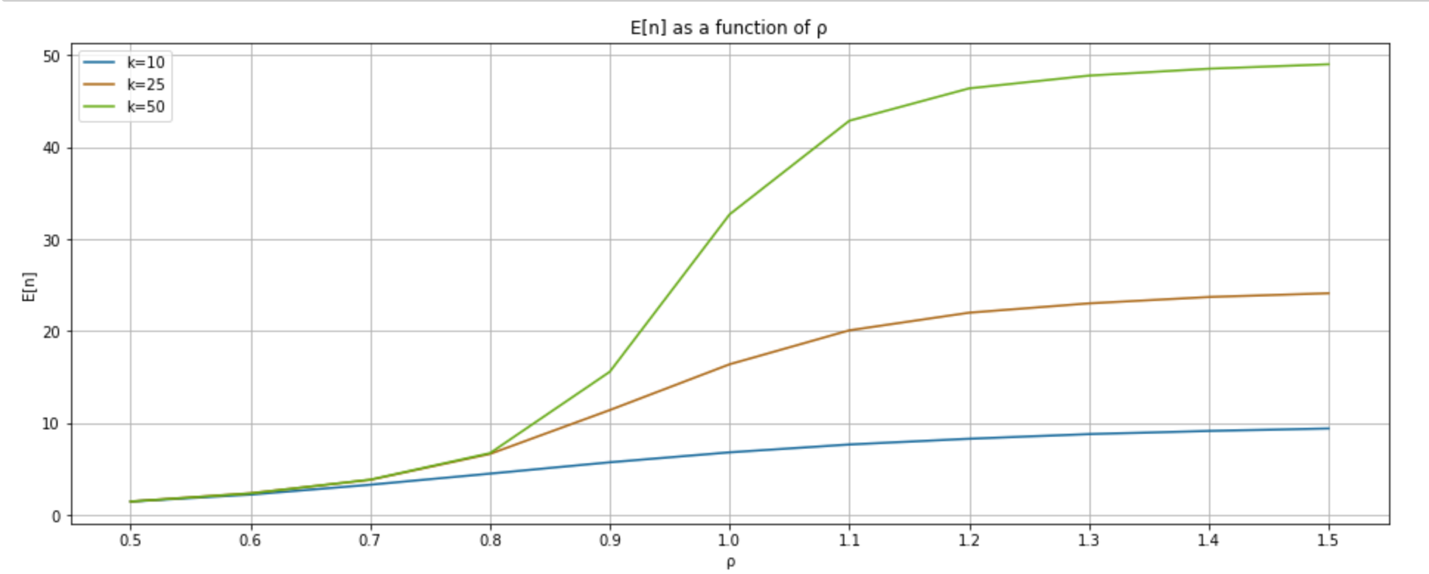


Figure 3. Average number of elements in queue as a function of ρ

1. *Ploss as a function of ρ (for 0.5 < ρ < 1.5) for K = 10, 25, 50 packets. Show one curve for each value of K on the same graph. Explain how you have obtained PLOSS. Use the following step sizes for ρ:* 
   1. For 0.4 < ρ ≤ 2 step size 0.1.
   2. For 2 < ρ ≤ 5 step size 0.2.
   3. For 5 < ρ < 10 step size 0.4.

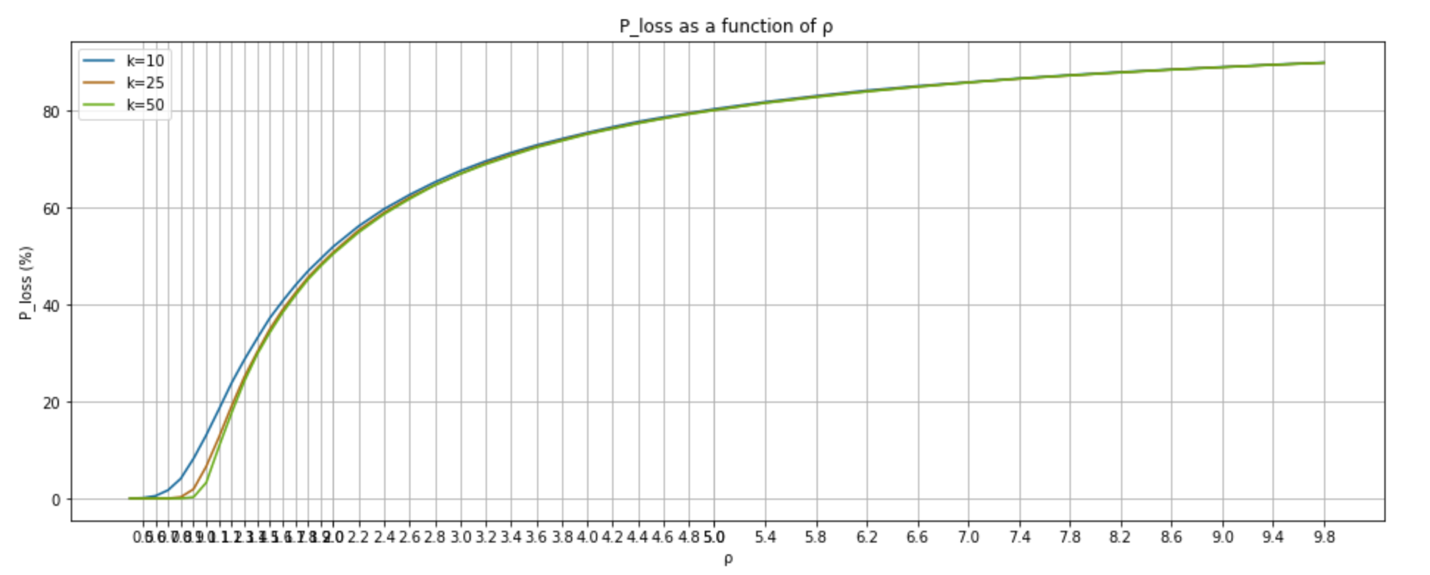


Figure 4. Packet loss as a function of ρ