CENG 222

Statistical Methods for Computer Engineering

Spring '2018-2019

Homework 3

Student Information

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Answer a

I have conducted a Monte Carlo study using Matlab, after which I have used this study for estimating the probability that the total weight of all vehicles that pass over the bridge in the village in a day is more than 220 tons, for estimating expected weight and calculating the standard deviation of it.

To conduct such a study I have first used Normal approximation with $\alpha = 0.01$ and $\epsilon = 0.02$, namely (since no estimator for p has been given I have directly used the following):

$$\begin{aligned} N &\geq 0.25(\frac{z_{\alpha/2}}{\epsilon})^2 \\ &= 0.25(\frac{2.575}{0.02})^2 \\ &\approx 4144 \end{aligned}$$

I have created some variables for holding the values of distribution parameters and I have also created a vector named $TotalWeight$ for keeping the total weight of vehicles that use the bridge for each Monte Carlo run and initialized it to 0 for all N.

Next, to find number of vehicles for each type, I have generated samples ($NMotors$, $NCars$ and $NTrucks$) for all vehicles with their corresponding Poisson parameters using sampling from Poisson.

Then, to find weights of each vehicle according to its type, I have used the samples that correspond to numbers for each type of vehicles together with their corresponding Gamma parameters. With this way I was able to generate the sample weights for all vehicles ($WMotors$, $WCars$ and $WTrucks$) and after summing them up at the end I have calculated the total weight for 1 Monte Carlo run and filled the corresponding place in my $TotalWeight$ vector. I have repeated this study $N = 4144$ times and filled the $TotalWeight$ vector accordingly.

For the answer of *part a*; after construction of $TotalWeight$ vector with desired Monte Carlo runs, I have calculated the *mean* of the proportion of runs with the total weight more than 220 tons. With this way I have estimated the probability that the total weight of all the vehicles that pass over the bridge in a day is more than 220 tons; in other words, I have found our estimator for the desired probability.

I have simulated my solution in Octave Online a number of times and I was able to determine that my estimated probability is always in between 0.35 and 0.38 (But in general 0.36). I share a sample output (which I will refer in other parts of the answer) in below:

Estimated probability = 0.364865
Expected weight = 208441.367130
Standard deviation = 38401.600168

Answer b

For estimation of the total weight of all the vehicles that pass over the bridge in a day X, I have simply got the *mean* of $TotalWeight$ and found the Expected weight. Expected weight for a sample simulation can be seen from the sample output shared in part a.

Answer c

For estimation of $Std(X)$, I have simply got the *std* of $TotalWeight$ and found the Standard deviation of X. Standard deviation for a sample simulation can be seen from the sample output shared in part a.

Since initially we have created a Monte Carlo study with size N that attains our desired accuracy ($\alpha = 0.01$ and $\epsilon = 0.02$), We have guaranteed a Monte Carlo study of size N with an error not exceeding ϵ with high probability $(1-\alpha)$ and created an estimator X with that accuracy.