MIDDLE EAST TECHNICAL UNIVERSITY

Spring 2020-2021
CENG 222 - Statistical Methods for Computer Engineering
hw4

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Contents

1 Solution

To conduct the Monte Carlo Study, first we need to determine the size of the Monte Carlo simulation. Since we were asked to use normal approximation to determine the size of your Monte Carlo simulation we can use below formula(knowing that p=0.62 ϵ was wanted to be 0.008 and wanted confidence level was 0.98 because of the confidence level $Z_{a/2}$ is approximately 2.3263):

$$N \geq p * (1-p)(\frac{Z_{a/2}}{\epsilon})^2$$

$$N \geq 0.62 * (1-0.62)(\frac{2.3263}{0.008})^2$$

$$N \geq 19921.7164088$$

Because of that we will choose the size as 19922.

Since This is binomial we can use N=250 (50 trials per day for 5 days) bernoulli trials to estiamate how many plastic chunks will be produced for every simulation.

```
i=0;
for deneme=1:littleN; % this loop counts the accepted trials
U = rand;
if p >= U
i=i+1;
end
end;
accepted=i;
```

Note: littleN is 250 you can check it in the code below inside the appendix section.

In here we re just checking 250 trials and counting the accepted ones. After This point we will use Rejection method(algorithm 5.4 from the textbook) to estimate the results.

According to this method we would need to choose 2 numbers from uniform distribution. One of them will be used for x-axis(after multiplying it by the x-axis length(8) and adding the starting point of the x-axis to it which is 0) and other for the y-axis(which will be then multiplied by the highest point of y-axis(according to given functions) so to simulate y coordinate) of the point we will chose. By doing this we will be creating a rectangle where we choose our points. And until the point we choose is inside the limits of the functions(under the pdf curve.) we will try again so that we will only accept the valid points. The code of this rejection method is below(the whole code is in the appendices section)

```
weight=0;    % total weight for this week
for product=1:accepted;
X=0;
Y=0.22;      % started like that to make sure while loop starts
NORMAL=0;

while (Y>NORMAL);
U=rand;
X=8*U;
Y=0.22*rand;

if X <=2
NORMAL=0.07*X;
elseif X<=5
NORMAL=-0.02*((X-4)^2)+0.22;
elseif X<=7
NORMAL=0.08*(5-X)+0.2;
else
NORMAL=-0.04*X+0.32;
end
end;

weight=weight+X;
end;
```

Note: If the point(x,y) is inside the pdf curve(under the curve) it means that that for that X value it was between the bounds of accepted probability. That is why we are rejecting until we found a point like this.

1.1 A)

According to my results, probability that the total weight of the plastics produced by the factory in a week of five workdays exceeds 640 tons is **0.125941**.

1.2 B) Total weight

According to my results, estimated total weight of the plastics produced in five days was **598.829854** tons.

1.3 C) Standard Deviation

The Standard deviation of our study is **35.916883**. Since the confidence level was %98 and ϵ was 0.008 our results are accurate within %98 of the time with error margin of 0.008. We know that std(X)=$\sigma/\sqrt{N}$. Because of that we can say that its accuracy will increase with the decrease of its std(X) and since increasing N will decrease std(X) increasing N will also increase accuracy

2 Appendix

```
N=19922; % size of the Monte Carlo study with alpha 0.02 and er
p=0.62;  % given probability of the simulation

TotalWeight=zeros(N,1); % total weight of the chunks for every

littleN=250;

for k=1:N;
i=0;
for deneme=1:littleN; % this loop counts the accepted trials
U = rand;
if p >= U
i=i+1;
end
end;
accepted=i;
```

```
weight=0;    % total weight for this week
for product=1:accepted;
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NORMAL=0;

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elseif X<=7
NORMAL=0.08*(5-X)+0.2;
else
NORMAL=-0.04*X+0.32;
end
end;

weight=weight+X;
end;
TotalWeight(k) = weight;
```

```
end;

p_est = mean(TotalWeight>640);
expectedWeight = mean(TotalWeight);
stdWeight = std(TotalWeight);
fprintf('Estimated probability = %f\n', p_est);
fprintf('Expected weight = %f\n', expectedWeight);
fprintf('Standard deviation = %f\n', stdWeight);
```