Student Information

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Answer 1

a)

We are given that $\alpha = 0.02$ and $\epsilon = 0.03$, so we can determine the minimum size of the Monte Carlo simulation by this formula:

$$N \geq 0.25 \cdot (\frac{z_{\alpha/2}}{\epsilon})^2$$

N $\geq$ 1503.3

Since N should be greater than 1503.3, we choose 1504 as the minimum size.

The total weight of all the cargo unloaded at the port in a day exceeds 300000 tons with estimated probability **0.12**. The source code written in MATLAB is on the next page.

b)

We can estimate the total weight of all cargo unloaded at the port in a day by mean(TotalWeights) code in MATLAB, where the TotalWeights vector contains all the TotalWeight estimations.

The mean is **260257.15**, which is way less than 300000.

c)

We can estimate the standard deviation by std(TotalWeights) code in MATLAB, where the TotalWeights vector contains all the TotalWeight estimations.

The standard deviation is **33004.40**, which is considerably high, it is greater than 12% of the expected weight. Our estimations are not stable, they vary much; therefore the accuracy of our estimator is low.

Code Explanation

First, we have calculated the Monte Carlo study by Chebyshev's formula. The Poisson random variables are the number of bulk carriers, container ships, and oil tankers, and the gamma random variables are the weight of each of them. I have created 3 Poisson random variables X each for bulk carriers, container ships, and oil tankers with their parameter λ. For each bulk carrier, container, and oil tanker, I have created a gamma random variable with its parameters λ and α. The weights are stored in my 'weight' variable. After that, I summed weights in 'totalWeight' variable. I have repeated this N times and stored the totalWeights in the 'TotalWeights' vector. Then we calculated the probability, mean, and standard deviation, and printed the values.

```
alpha = 0.02;
epsilon = 0.03;
z = -norminv(alpha/2);
N = ceil(0.25 * (z / epsilon)^2); % 1504
TotalWeights = zeros(N, 1);

for k = 1 : N;
    totalWeight = 0;

    % bulk carriers ----------------------------------------------
    weight = 0;
    lambda = 50; U = rand; X = 0;

    F = exp(-lambda);
    while (U >= F);
        X = X + 1;
        F = F + exp(-lambda) * lambda^X / gamma(X + 1);
    end;

    alpha = 60; lambda = 0.1;

    for i = 1 : X;
        T = sum( -1/lambda * log(rand(alpha,1)));
        weight = weight + T;
    end;

    totalWeight = totalWeight + weight;

    % container ships ----------------------------------------------
    weight = 0;
    lambda = 40; U = rand; X = 0;

    F = exp(-lambda);
    while (U >= F);
```

```
        X = X + 1;
        F = F + exp(-lambda) * lambda^X / gamma(X + 1);
    end;

    alpha = 100; lambda = 0.05;

    for i = 1 : X;
        T = sum( -1/lambda * log(rand(alpha,1)));
        weight = weight + T;
    end;

    totalWeight = totalWeight + weight;

    % oil tankers ----------------------------------------------
    weight = 0;
    lambda = 25; U = rand; X = 0;

    F = exp(-lambda);
    while (U >= F);
        X = X + 1;
        F = F + exp(-lambda) * lambda^X / gamma(X + 1);
    end;

    alpha = 120; lambda = 0.02;

    for i = 1 : X;
        T = sum( -1/lambda * log(rand(alpha,1)));
        weight = weight + T;
    end;

    totalWeight = totalWeight + weight;

    TotalWeights(k) = totalWeight;
end;

p = mean(TotalWeights > 300000);
E = mean(TotalWeights);
s = std(TotalWeights);

fprintf('Estimated probability = %f\n', p)
fprintf('Expected weight = %f\n', E)
fprintf('Standard deviation = %f\n', s)
```

```
octave:4> source("simulation.m")
Estimated probability = 0.117686
Expected weight = 260257.152406
Standard deviation = 33004.403104
```