CS-350 Assignment A2

Yong Zhou

TOTAL POINTS

65 / 75

QUESTION 1

Building Confidence Intervals. 25 pts

1.1 What is the standard deviation of the sample used to compute this confidence interval was? **5 / 5**

✓ **- 0 pts** Correct

1.2 What is the probability that the true mean of the number of active connections on the web server is larger than 16? **5 / 5**

✓ **- 0 pts** Correct

1.3 Using the 36 observations, compute the 99th percentile confidence interval for the number of active connections on the web server. **5 / 5**

✓ **- 0 pts** Correct

1.4 If you double the number of observations, what would you expect the error in the 90th percentile confidence interval to be? What assumption did you have to make to give that answer? **5 / 5**

✓ **- 0 pts** Correct

1.5 How many additional observations do you need to make in order to make the error in the 90th percentile confidence be less than ± 5%? What assumption did you have to make to give that answer? **5 / 5**

✓ **- 0 pts** Correct

QUESTION 2

Single Queue Analysis. 25 pts

2.1 Write down the formula for the distribution of the total number of pending requests to the web server. What is the probability that the web server will be idle? **5 / 5**

✓ **- 0 pts** Correct

2.2 How many pending web requests do you expect to find in the system on average? What is the average response time for requests to the web server? **0 / 5**

✓ **- 5 pts** Incorrect

2.3 How much faster should the processor be in order to cut the response time by a third? **5 / 5**

✓ **- 0 pts** Correct

2.4 How much faster would the web server be if the HTTP server is re-engineered in a way that makes the time to process a request be highly predictable – almost a constant equal to 400 milliseconds? **5 / 5**

✓ **- 0 pts** Correct

2.5 Based on your answers above, provide justification for the following sentence: “Blindly going for faster hardware to improve performance may be what most practitioner do, but it should not be what an informed computer scientist (and especially one who took CS-350 at BU should do.” **5 / 5**

✓ **- 0 pts** **Correct**

QUESTION 3

Finite Queue Analysis. 25 pts

3.1 Assuming an infinite buffer, how many packets do you expect to find in the buffer (i.e., being played out or waiting to be played out)? What is the mean delay between receipt of a packet and the beginning of its playout? **5 / 5**

✓ **- 0 pts** **Correct**

3.2 Assuming an infinite buffer and assuming that a streaming media object consists of 10,000 packets, how many "blips" and how many "plops" do you expect to hear for that object? **5 / 5**

✓ **- 0 pts** **Correct**

3.3 Assuming N=4 packets, how many packets do you expect to find in the buffer? What is the mean delay between receipt of a packet and the beginning of its playout? **0 / 5**

✓ **- 5 pts** **Incorrect**

3.4 Assuming N=4 packets and that a streaming media object consists of 10,000 packets, how many "blips" and how many "plops" do you expect to hear for that object? **5 / 5**

✓ **- 0 pts** **Correct**

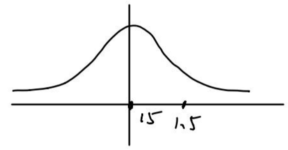
3.5 Based on your answers above, explain the following sentence: “Figuring out the right size for the buffer of a streaming media application is a tradeoff between tolerance for delay and tolerance for degraded audio quality.” In particular, give an example of a streaming media application for which an infinite (or very large) buffer would be preferable to a finite (or small) buffer, and give an example of the opposite. **5 / 5**

✓ **- 0 pts** **Correct**

gradescope

Q1.

90% confidence interval, interval [15 ± 1.5]
36 observations. of web server.



①

$E = Z_{\alpha/2} \frac{S}{\sqrt{N}}$

sample size = 36.

$E = 1.5$

$\bar{x} = 15$

$\alpha = 1 - 90\% = 0.1$

$1 - \alpha/2 = 0.95$

$Z(\alpha/2) = 1.65$

$1.5 = 1.65 \frac{S}{\sqrt{36}}$

$S \Rightarrow 5.455$

② probability of true mean of number of active larger than 16 ?

$Z = \frac{\bar{X} - \mu}{\frac{\sigma}{\sqrt{N}}}$

$P(X > 16) = 1 - P(Z < \frac{16 - 15}{5.455/\sqrt{36}})$

$= 1 - P(Z < 1.10)$

$= 1 - 0.8643$

≈ 0.1357

Thus. The probability of true mean of # of active larger than 16 is 0.1357

③ use 36 obrervations, find 99% confidence interval.

$N = 36$

$\bar{X} = 15$

$S = 5.455$

$\alpha = 1 - 99\% = 0.01$

$Z(1 - \frac{\alpha}{2}) = Z(0.995)$

$= 2.58.$

$E = Z(\alpha/2) \frac{\sigma}{\sqrt{N}}$

$= 2.58 \cdot \frac{5.455}{\sqrt{36}} \approx 2.346$

$CI = 15 \pm 2.346 = (12.654, 17.346)$

④. obversation = N.2 = 72. what the error of 80% for C.I? what assumption did you have to make?

$N = 72$

$S = 5.455$

$\alpha = 1 - 90\% = 0.1$

$Z(\alpha/2) = 1.65.$

$E = Z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{N}}$

$= 1.65 \cdot \frac{5.455}{\sqrt{72}}$

$= 1.061$

$C.I = (13.939, 16.061)$

⑤. How many additional observation need to make in order to make the error 90% confidence less than 5%. what assumption do you make?

$S = 5.455$

$E = 5\% \cdot 15 = 0.75$

$Z(\alpha/2) = (1 - \frac{\alpha}{2}) = 1.65$

$0.75 = Z_{\alpha/2} \frac{\sigma}{\sqrt{N}} = 1.65 \cdot \frac{5.455}{\sqrt{n}}$

$\Rightarrow n = (12.001)^2 \approx 144.$

$144 - 36 = 108.$ addition

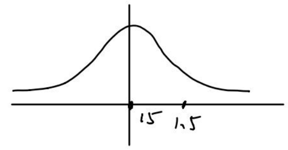
1.1 What is the standard deviation of the sample used to compute this confidence interval was? **5 / 5**

✓ **- 0 pts Correct**

gradescope

Q1.

90% confidence interval, interval [15 ± 1.5]
36 observations: of web server.



① $E = Z_{\alpha/2} \frac{S}{\sqrt{N}}$:

sample size = 36.
$E = 1.5$
$\bar{x} = 15$
$\alpha = 1 - 90\% = 0.1$

$1 - \alpha/2 = 0.95$
$Z(\alpha/2) = 1.65$

$1.5 = 1.65 \frac{S}{\sqrt{36}}$

$S \Rightarrow 5.455$

② probability of true mean of number of active larger than 16 ?

$Z = \frac{\bar{X} - \mu}{\frac{\sigma}{\sqrt{N}}}$

$P(X > 16) = 1 - P(Z < \frac{16-15}{5.455/\sqrt{36}})$
$= 1 - P(Z < 1.10)$
$= 1 - 0.8643$
≈ 0.1357

Thus. The probability of true mean of # of active larger than 16 is 0.1357

③ use 36 obvervations, find 99% confidence interval.

$N = 36$
$\bar{x} = 15$
$S = 5.455$
$\alpha = 1 - 99\% = 0.01$

$Z(1 - \frac{\alpha}{2}) = Z(0.995)$
$= 2.58$.

$E = Z(\alpha/2) \frac{\sigma}{\sqrt{N}}$
$= 2.58 \cdot \frac{5.455}{\sqrt{36}} \approx 2.346$

$CI = 15 \pm 2.346 = (12.654, 17.346)$

④. obversation = N·2 = 72. what the error of 80% for C.I? what assumption did you have to make?

$N = 72$
$S = 5.455$
$\alpha = 1 - 90\% = 0.1$
$Z(\alpha/2) = 1.65$.

$E = Z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{N}}$
$= 1.65 \cdot \frac{5.455}{\sqrt{72}}$
$= 1.061$

$C.I = (13.939, 16.061)$

⑤. How many additional observation need to make in order to make the error 90% confidence less than 5%. what assumption do you make?

$S = 5.455$
$E = 5\% \cdot 15 = 0.75$
$Z(\alpha/2) = (1 - \frac{\alpha}{2}) = 1.65$

$0.75 = Z_{\alpha/2} \frac{\sigma}{\sqrt{N}} = 1.65 \cdot \frac{5.455}{\sqrt{n}}$

$\Rightarrow n = (12.001)^2 \approx 144$. $144 - 36 = 108$. addition

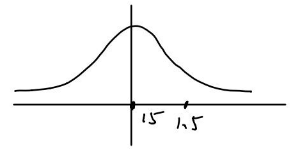
1.2 What is the probability that the true mean of the number of active connections on the web server is larger than 16? **5 / 5**

✓ **- 0 pts** **Correct**

gradescope

Q1.

90% confidence interval, interval [15 ± 1.5]
36 observations. of web server.



①
$E = Z_{\alpha/2} \frac{S}{\sqrt{N}}$

sample size = 36.
$E = 1.5$
$\bar{x} = 15$
$\alpha = 1 - 90\% = 0.1$

$1 - \alpha/2 = 0.95$
$Z(\alpha/2) = 1.65$

$1.5 = 1.65 \frac{S}{\sqrt{36}}$

$S \Rightarrow 5.455$

② probability of true mean of number of active larger than 16 ?

$Z = \frac{\bar{X} - \mu}{\frac{\sigma}{\sqrt{N}}}$

$P(X > 16) = 1 - P(Z < \frac{16 - 15}{5.455/\sqrt{36}})$
$= 1 - P(Z < 1.10)$
$= 1 - 0.8643$
≈ 0.1357

Thus. The probability of true mean of # of active larger than 16 is 0.1357

③ use 36 obvervations, find 99% confidence interval.

$N = 36$
$\bar{x} = 15$
$S = 5.455$
$\alpha = 1 - 99\% = 0.01$

$Z(1 - \frac{\alpha}{2}) = Z(0.995)$
$= 2.58.$

$E = Z(\alpha/2) \frac{\sigma}{\sqrt{N}}$
$= 2.58 \cdot \frac{5.455}{\sqrt{36}} \approx 2.346$

$CI = 15 \pm 2.346 = (12.654, 17.346)$

④. obversation $= N \cdot 2 = 72$. what the error of 90% for C.I? what assumption did you have to make?

$N = 72$
$S = 5.455$
$\alpha = 1 - 90\% = 0.1$
$Z(\alpha/2) = 1.65.$

$E = Z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{N}}$
$= 1.65 \cdot \frac{5.455}{\sqrt{72}}$
$= 1.061$

$C.I = (13.939, 16.061)$

⑤. How many additional observation need to make in order to make the error 90% confidence less than 5%. what assumption do you make?

$S = 5.455$
$E = 5\% \cdot 15 = 0.75$
$Z(\alpha/2) = (1 - \frac{\alpha}{2}) = 1.65$

$0.75 = Z_{\alpha/2} \frac{\sigma}{\sqrt{N}} = 1.65 \cdot \frac{5.455}{\sqrt{n}}$

$\Rightarrow n = (12.001)^2 \approx 144.$

$144 - 36 = 108.$ addition

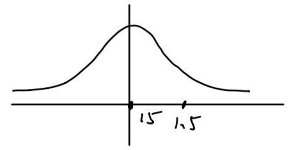
1.3 Using the 36 observations, compute the 99th percentile confidence interval for the number of active connections on the web server. **5 / 5**

✓ **- 0 pts Correct**

gradescope

Q1.

90% confidence interval, interval [15 ± 1.5]
36 observations of web server.



① $E = Z_{\alpha/2} \frac{S}{\sqrt{N}}$

sample size = 36.
$E = 1.5$
$\bar{x} = 15$
$\alpha = 1 - 90\% = 0.1$

$1 - \alpha/2 = 0.95$
$Z(\alpha/2) = 1.65$

$1.5 = 1.65 \frac{S}{\sqrt{36}}$

$S \Rightarrow 5.455$

② probability of true mean of number of active larger than 16?

$Z = \frac{\bar{X} - \mu}{\frac{\sigma}{\sqrt{N}}}$

$P(X > 16) = 1 - P(Z < \frac{16-15}{5.455/\sqrt{36}})$
$= 1 - P(Z < 1.10)$
$= 1 - 0.8643$
≈ 0.1357

Thus. The probability of true mean of # of active larger than 16 is 0.1357

③ use 36 obvervations, find 99% confidence interval.

$N = 36$
$\bar{X} = 15$
$S = 5.455$
$\alpha = 1 - 99\% = 0.01$

$Z(1 - \frac{\alpha}{2}) = Z(0.995)$
$= 2.58.$

$E = Z(\alpha/2) \frac{\sigma}{\sqrt{N}}$
$= 2.58 \cdot \frac{5.455}{\sqrt{36}} \approx 2.346$

$CI = 15 \pm 2.346 = (12.654, 17.346)$

④. obversation = N.2 = 72. what the error of 90% for C.I? what assumption did you have to make?

$N = 72$
$S = 5.455$
$\alpha = 1 - 90\% = 0.1$
$Z(\alpha/2) = 1.65.$

$E = Z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{N}}$
$= 1.65 \cdot \frac{5.455}{\sqrt{72}}$
$= 1.061$

$C.I = (13.939, 16.061)$

⑤. How many additional observation need to make in order to make the error 90% confidence less than 5%. what assumption do you make?

$S = 5.455$
$E = 5\% \cdot 15 = 0.75$
$Z(\alpha/2) = (1 - \frac{\alpha}{2}) = 1.65$

$0.75 = Z_{\alpha/2} \frac{\sigma}{\sqrt{N}} = 1.65 \cdot \frac{5.455}{\sqrt{n}}$

$\Rightarrow n = (12.001)^2 \approx 144.$

$144 - 36 = 108.$ addition

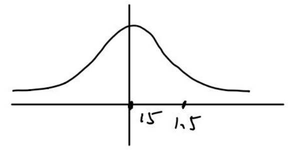
1.4 If you double the number of observations, what would you expect the error in the 90th percentile confidence interval to be? What assumption did you have to make to give that answer? **5 / 5**

✓ **- 0 pts** **Correct**

gradescope

Q1.

90% confidence interval, interval [15 ± 1.5]
36 observations. of web server.



① $E = Z_{\alpha/2} \frac{S}{\sqrt{N}}$

sample size = 36.
$E = 1.5$
$\bar{x} = 15$
$\alpha = 1 - 90\% = 0.1$

$1 - \alpha/2 = 0.95$
$Z(\alpha/2) = 1.65$

$1.5 = 1.65 \frac{S}{\sqrt{36}}$

$S \Rightarrow 5.455$

② probability of true mean of number of active larger than 16 ?

$Z = \frac{\bar{X} - \mu}{\frac{\sigma}{\sqrt{N}}}$

$P(X > 16) = 1 - P(Z < \frac{16 - 15}{5.455/\sqrt{36}})$
$= 1 - P(Z < 1.10)$
$= 1 - 0.8643$
≈ 0.1357

Thus. The probability of true mean of # of active larger than 16 is 0.1357

③ use 36 obvervations, find 99% confidence interval.

$N = 36$
$\bar{X} = 15$
$S = 5.455$
$\alpha = 1 - 99\% = 0.01$

$Z(1 - \frac{\alpha}{2}) = Z(0.995)$
$= 2.58.$

$E = Z(\alpha/2) \frac{\sigma}{\sqrt{N}}$
$= 2.58 \cdot \frac{5.455}{\sqrt{36}} \approx 2.346$

$C.I = 15 \pm 2.346 = (12.654, 17.346)$

④. obversation $= N \cdot 2 = 72$. what the error of 90% for C.I? what assumption did you have to make?

$N = 72$
$S = 5.455$
$\alpha = 1 - 90\% = 0.1$
$Z(\alpha/2) = 1.65.$

$E = Z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{N}}$
$= 1.65 \cdot \frac{5.455}{\sqrt{72}}$
$= 1.061$

$C.I = (13.939, 16.061)$

⑤. How many additional observation need to make in order to make the error 90% confidence less than 5%. what assumption do you make?

$S = 5.455$
$E = 5\% \cdot 15 = 0.75$
$Z(\alpha/2) = (1 - \frac{\alpha}{2}) = 1.65$

$0.75 = Z_{\alpha/2} \frac{\sigma}{\sqrt{N}} = 1.65 \cdot \frac{5.455}{\sqrt{n}}$

$\Rightarrow n = (12.001)^2 \approx 144.$

$144 - 36 = 108.$ addition

1.5 How many additional observations do you need to make in order to make the error in the 90th percentile confidence be less than ± 5%? What assumption did you have to make to give that answer? **5 / 5**

✓ **- 0 pts** **Correct**

gradescope

Q2.) λ is rate of 120 request per min by possion. what is probability of request more than one second.

$T_q = \lambda = 120\,\text{min} \cdot \frac{1}{60s} = 2s$ $\qquad f(x=0, t>1) = \frac{(2 \cdot t)^0}{0!} \cdot e^{-2}$

$T_s = 400\,ms \qquad f(x) = \frac{(\lambda \cdot t)^x}{x!}$

$\Rightarrow 0.135$

① $P(S_j) = \sum_{i=0}^{\infty} \rho^i \cdot P(S_0)$

$\rho = \frac{\lambda}{\mu}$ when server idle $P(S_0) = 1 - \rho = 0.2$

② $q = \frac{\rho}{1-\rho} = \frac{0.8}{0.2} = 4.$

$\rho = \lambda \cdot T_s \Rightarrow T_s = \frac{\rho}{\lambda} = \frac{0.8}{2} = 0.4$

$w = q - \rho = 4 - 0.8 = 3.2$

$T_w = \frac{w}{\lambda} = \frac{3.2}{2s} = 1.6s$

③ $q = \lambda T_q \qquad \lambda = 2, \quad q = 4. \quad T_w = 1.6 \quad w = 3.2.$

$T_q = \frac{q}{\lambda} = \frac{\frac{\rho}{1-\rho}}{2} = \frac{\lambda T_s}{1 - \lambda T_s} = 0.2$

$T_q' = T_q \times (1 - \frac{1}{3})$

$T_q = \frac{\frac{\rho}{1-\rho}}{2} = \frac{\lambda T_s'}{1 - \lambda T_s'} \Rightarrow T_s' = 0.36s$

$f\% = \frac{T_s}{T_s'} = \frac{T_s}{3.6} = 1.11$

④ $M/D/1 : T_s$

$T_q = \frac{\rho}{2 \cdot \mu(1-\rho)} + T_s = \frac{\lambda T_s}{2 \cdot \frac{1}{T_s}(1 - \lambda T_s)} + T_s = \frac{2 \cdot 0.4}{2 \cdot \frac{1}{0.4} \cdot 0.2} + T_s$

$= 1.2$

$f\% = \frac{2}{1.2} = 1.67$

⑤ From ③ speed up response time and ④ the constant service time. we get. constant service time improve performance. instead.

2.1 Write down the formula for the distribution of the total number of pending requests to the web server. What is the probability that the web server will be idle? 5 / 5

✓ - 0 pts Correct

gradescope

Q2.) λ is rate of 120 request per min by possion. what is probability of request more than one second.

$T_q = \lambda = 120\,min \cdot \frac{1}{60s} = 2\,s$ $\quad f(x=0, t>1) = \frac{(2 \cdot t)^0}{0!} \cdot e^{-2}$

$T_s = 400\,ms \quad f(x) = \frac{(\lambda \cdot t)^x}{x!}$

$\Rightarrow 0.135$

① $P(S_j) = \sum_{i=0}^{\infty} \rho^i \cdot P(S_0)$

$\rho = \frac{\lambda}{\mu}$ when server idle $P(S_0) = 1 - \rho = 0.2$

② $q = \frac{\rho}{1-\rho} = \frac{0.8}{0.2} = 4.$

$\rho = \lambda \cdot T_s \Rightarrow T_s = \frac{\rho}{\lambda} = \frac{0.8}{2} = 0.4$

$w = q - \rho = 4 - 0.8 = 3.2$

$T_w = \frac{w}{\lambda} = \frac{3.2}{2\,s} = 1.6s$

③ $q = \lambda T_q \quad \lambda = 2, \quad q = 4. \quad T_w = 1.6 \quad w = 3.2.$

$T_q = \frac{q}{\lambda} = \frac{\frac{\rho}{1-\rho}}{2} = \frac{\lambda T_s}{1 - \lambda T_s} = 0.2$

$T_q' = T_q \times (1 - \frac{1}{3})$

$T_q = \frac{\frac{\rho}{1-\rho}}{2} = \frac{\lambda T_s'}{1 - \lambda T_s'} \Rightarrow T_s' = 0.36s$

$f\% = \frac{T_s}{T_s'} = \frac{T_S}{3.6} = 1.11$

④ M/D/1 : T_s

$T_q = \frac{\rho}{2 \cdot \mu(1-\rho)} + T_s = \frac{\lambda T_s}{2 \cdot \frac{1}{T_s}(1 - \lambda T_s)} + T_s = \frac{2 \cdot 0.4}{2 \cdot \frac{1}{0.4} \cdot 0.2} + T_s$

$= 1.2$

$f\% = \frac{2}{1.2} = 1.67$

⑤ From ③ speed up response time and ④ the constant service time. we get. constant service time improve performance. instead.

2.2 How many pending web requests do you expect to find in the system on average? What is the average response time for requests to the web server? **0 / 5**

✓ **- 5 pts Incorrect**

gradescope

Q2.) λ is rate of 120 request per min by possion. what is probability of request more than one second.

$T_q = \lambda = 120\ min \cdot \frac{1}{60s} = 2s$

$T_s = 400\ ms$ $\quad f(x) = \frac{(\lambda \cdot t)^x}{x!}$

$f(x=0, t>1) = \frac{(2 \cdot t)^0}{0!} \cdot e^{-2}$

$\Rightarrow 0.135$

① $P(S_j) = \sum_{i=0}^{\infty} \rho^i \cdot P(S_0)$

$\rho = \frac{\lambda}{\mu}$ when server idle $P(S_0) = 1 - \rho = 0.2$

② $q = \frac{\rho}{1-\rho} = \frac{0.8}{0.2} = 4.$

$\rho = \lambda \cdot T_s \Rightarrow T_s = \frac{\rho}{\lambda} = \frac{0.8}{2} = 0.4$

$w = q - \rho = 4 - 0.8 = 3.2$

$T_w = \frac{w}{\lambda} = \frac{3.2}{2s} = 1.6s$

③ $q = \lambda T_q$ $\quad \lambda = 2,\ q = 4.\ T_w = 1.6\ w = 3.2.$

$T_q = \frac{q}{\lambda} = \frac{\frac{\rho}{1-\rho}}{2} = \frac{\lambda T_s}{1 - \lambda T_s} = 0.2$

$T_q' = T_q \times (1 - \frac{1}{3})$

$T_q = \frac{\frac{\rho}{1-\rho}}{2} = \frac{\lambda T_s'}{1 - \lambda T_s'} \Rightarrow T_s' = 0.36s$

$f\% = \frac{T_s}{T_s'} = \frac{T_s}{3.6} = 1.11$

④ M/D/1 : T_s

$T_q = \frac{\rho}{2 \cdot \mu(1-\rho)} + T_s = \frac{\lambda T_s}{2 \cdot \frac{1}{T_s}(1 - \lambda T_s)} + T_s = \frac{2 \cdot 0.4}{2 \cdot \frac{1}{0.4} \cdot 0.2} + T_s$

$= 1.2$

$f\% = \frac{2}{1.2} = 1.67$

⑤ From ③ speed up response time and ④ the constant service time. we get. constant service time improve performance. instead.

2.3 How much faster should the processor be in order to cut the response time by a third? **5 / 5**

✓ **- 0 pts** **Correct**

gradescope

Q2.) λ is rate of 120 request per min by possion. what is probability of request more than one second.

$T_q = \lambda = 120 \text{ min} \cdot \frac{1}{60s} = 2s$ $\qquad f(x=0, t>1) = \frac{(2 \cdot t)^0}{0!} \cdot e^{-2}$

$T_s = 400 \text{ ms} \qquad f(x) = \frac{(\lambda \cdot t)^x}{x!}$ $\qquad \Rightarrow 0.135$

① $P(S_j) = \sum_{i=0}^{\infty} \rho^i \cdot P(S_0)$

$\rho = \frac{\lambda}{\mu}$ when server idle $P(S_0) = 1 - \rho = 0.2$

② $q = \frac{\rho}{1-\rho} = \frac{0.8}{0.2} = 4.$

$\rho = \lambda \cdot T_s \Rightarrow T_s = \frac{\rho}{\lambda} = \frac{0.8}{2} = 0.4$

$w = q - \rho = 4 - 0.8 = 3.2$

$T_w = \frac{w}{\lambda} = \frac{3.2}{2s} = 1.6s$

③ $q = \lambda T_q$ $\qquad \lambda = 2, \quad q = 4. \quad T_w = 1.6 \quad w = 3.2.$

$T_q = \frac{q}{\lambda} = \frac{\frac{\rho}{1-\rho}}{2} = \frac{\lambda T_s}{1-\lambda T_s} = 0.2$

$T_q' = T_q \times (1 - \frac{1}{3})$

$T_q = \frac{\frac{\rho}{1-\rho}}{2} = \frac{\lambda T_s'}{1 - \lambda T_s'} \Rightarrow T_s' = 0.36s$

$f\% = \frac{T_s}{T_s'} = \frac{T_S}{3.6} = 1.11$

④ $M/D/1$: T_s

$T_q = \frac{\rho}{2 \cdot \mu(1-\rho)} + T_s = \frac{\lambda T_s}{2 \cdot \frac{1}{T_s}(1 - \lambda T_s)} + T_s = \frac{2 \cdot 0.4}{2 \cdot \frac{1}{0.4} \cdot 0.2} + T_s$

$= 1.2$

$f\% = \frac{2}{1.2} = 1.67$

⑤ From ③ speed up response time and ④ the constant service time. we get. constant service time improve performance. instead.

2.4 How much faster would the web server be if the HTTP server is re-engineered in a way that makes the time to process a request be highly predictable – almost a constant equal to 400 milliseconds? **5 / 5**

✓ **- 0 pts** **Correct**

gradescope

Q2.) λ is rate of 120 request per min by possion. what is probability of request more than one second.

$T_q = \lambda = 120\,min \cdot \frac{1}{60s} = 2\,s$ $\qquad f(x=0, t>1) = \frac{(2 \cdot t)^0}{0!} \cdot e^{-2}$

$T_s = 400\,ms$ $\qquad f(x) = \frac{(\lambda \cdot t)^x}{x!}$ $\qquad \Rightarrow 0.135$

① $P(S_j) = \sum_{i=0}^{\infty} \rho^i \cdot P(S_0)$

$\rho = \frac{\lambda}{\mu}$ when server idle $P(S_0) = 1 - \rho = 0.2$

② $q = \frac{\rho}{1-\rho} = \frac{0.8}{0.2} = 4.$

$\rho = \lambda \cdot T_s \Rightarrow T_s = \frac{\rho}{\lambda} = \frac{0.8}{2} = 0.4$

$w = q - \rho = 4 - 0.8 = 3.2$

$T_w = \frac{w}{\lambda} = \frac{3.2}{2\,s} = 1.6s$

③ $q = \lambda T_q$ $\qquad \lambda = 2, \quad q = 4. \quad T_w = 1.6 \quad w. = 3.2.$

$T_q = \frac{q}{\lambda} = \frac{\frac{\rho}{1-\rho}}{2} = \frac{\lambda T_s}{1 - \lambda T_s} = 0.2$

$T_q' = T_q \times (1 - \frac{1}{3})$

$T_q = \frac{\frac{\rho}{1-\rho}}{2} = \frac{\lambda T_s'}{1 - \lambda T_s'} \Rightarrow T_s' = 0.36s$

$f\% = \frac{T_s}{T_s'} = \frac{T_s}{3.6} = 1.11$

④ M/D/1 : T_s

$T_q = \frac{\rho}{2 \cdot \mu (1-\rho)} + T_s = \frac{\lambda T_s}{2 \cdot \frac{1}{T_s} (1 - \lambda T_s)} + T_s = \frac{2 \cdot 0.4}{2 \cdot \frac{1}{0.4} \cdot 0.2} + T_s$

$= 1.2$

$f\% = \frac{2}{1.2} = 1.67$

⑤ From ③ speed up response time and ④ the constant service time. we get. constant service time improve performance. instead.

2.5 Based on your answers above, provide justification for the following sentence: "Blindly going for faster hardware to improve performance may be what most practitioner do, but it should not be what an informed computer scientist (and especially one who took CS-350 at BU should do." **5 / 5**

✓ **- 0 pts** **Correct**

gradescope

Q3. mp3 player hold up N packets. processing time is exp with mean of 25 msec. per packet.

① $T_s = 0.025$ s $\lambda = 36$ that is MM1.

$\rho = \lambda \cdot T_s = 0.9.$ $\lambda = 36$

$$q = \frac{\rho}{1-\rho} = \frac{0.9}{0.1} = 9.$$

$$w = q - \rho = \frac{\rho^2}{(1-\rho)} = 0.81$$

$$T_w = \frac{w}{\lambda} = \frac{81}{36} = 0.225\ s.$$

② There will not have blip.

$P(S_0) = 1 - \rho = 0.1$

$P(plop) = P(S_0) = 0.1 \times 10000 = 1000$

Thus, there is 1000 plops and no blips.

③ For M/M/1/K

$$P(reject) = P(S_K) = \frac{(1-\rho)\rho^K}{1-\rho^{K+1}} = 0.1 \cdot\cdot$$

$P(accept) = 1 - P(accept)$

$w = q - \rho = 8.1$

$\lambda' = \lambda \cdot P$

$T_w = \lambda' \cdot w = 26.91\ s$

Q3.4 the number of blips is: $10{,}000 \times 0.16 = 1600$ blips.

when a plop occurs, that means no arrivals

plop: $\Rightarrow \rho' = \lambda' T_s = 0.025 \cdot 30.24 = 0.756$

$P(plop) = 1 - \rho' = 0.244 \times 10000 = 2440$

Thus, we get 1600 blips and 2440 plops

5.) example: when we watch Youtobe, we want higher quality. therefore. I would like to wait for the buffer. otherwise. we could get to speed up but lower quality.

3.1 Assuming an infinite buffer, how many packets do you expect to find in the buffer (i.e., being played out or waiting to be played out)? What is the mean delay between receipt of a packet and the beginning of its playout? **5 / 5**

✓ **- 0 pts** **Correct**

gradescope

Q3. mp3 player hold up N packets. processing time is exp with mean of 25 msec. per packet.

① $T_s = 0.025$ s $\lambda = 36$ that is M/M/1.

$\rho = \lambda \cdot T_s = 0.9$. $\lambda = 36$

$q = \frac{\rho}{1-\rho} = \frac{0.9}{0.1} = 9$.

$w = q - \rho = \frac{\rho^2}{(1-\rho)} = 0.81$

$T_w = \frac{w}{\lambda} = \frac{81}{36} = 0.225$ s.

② There will not have blip.

$P(S_0) = 1 - \rho = 0.1$

$P(\text{plop}) = P(S_0) = 0.1 \times 10000 = 1000$

Thus, there is 1000 plops and no blips.

③ For M/M/1/K

$P(\text{reject}) = P(S_K) = \frac{(1-\rho)\rho^K}{1-\rho^{K+1}} = 0.1 \ldots$

$P(\text{accept}) = 1 - P(\text{accept})$

$w = q - \rho = 8.1$

$\lambda' = \lambda \cdot P$

$T_w = \lambda' \cdot w = 26.91$ s

Q3.4 the number of blips is: $10{,}000 \times 0.16 = 1600$ blips.

when a plop occurs, that means no arrivals

plop: $\Rightarrow \rho' = \lambda' T_s = 0.025 \cdot 30.24 = 0.756$

$P(\text{plop}) = 1 - \rho' = 0.244 \times 10000 = 2440$

Thus, we get 1600 blips and 2440 plops

5.) example: when we watch Youtobe, we want higher quality. therefore, I would like to wait for the buffer. otherwise. we could get to speed up but lower quality.

3.2 Assuming an infinite buffer and assuming that a streaming media object consists of 10,000 packets, how many "blips" and how many "plops" do you expect to hear for that object? **5 / 5**

✓ **- 0 pts** **Correct**

gradescope

Q3. mp3 player hold up N packets. processing time is exp with mean of 25 msec. per packet.

① $T_s = 0.025$ s $\quad \lambda = 36 \quad$ that is MM1.

$\rho = \lambda \cdot T_s = 0.9$. $\quad \lambda = 36$

$q = \frac{\rho}{1-\rho} = \frac{0.9}{0.1} = 9$.

$w = q - \rho = \frac{\rho^2}{(1-\rho)} = 0.81$

$T_w = \frac{w}{\lambda} = \frac{81}{36} = 0.225$ s.

② There will not have blip.

$P(S_0) = 1 - \rho = 0.1$

$P(plop) = P(S_0) = 0.1 \times 10000 = 1000$

Thus, there is 1000 plops and no blips.

③ For M/M/1/K

$P(reject) = P(S_K) = \frac{(1-\rho)\rho^K}{1-\rho^{K+1}} = 0.1\cdots$

$P(accept) = 1 - P(accept)$

$w = q - \rho = 8.1$

$\lambda' = \lambda \cdot P$

$T_w = \lambda' \cdot w = 26.91$ s

Q3.4 the number of blips is: $10{,}000 \times 0.16 = 1600$ blips.

When a plop occurs, that means no arrivals

plop: $\Rightarrow \rho' = \lambda' T_s = 0.025 \cdot 30.24 = 0.756$

$P(plop) = 1 - \rho' = 0.244 \times 10000 = 2440$

Thus, we get 1600 blips and 2440 plops

5.) example: when we watch Youtube, we want higher quality. therefore. I would like to wait for the buffer. otherwise. we could get to speed up but lower quality.

3.3 Assuming N=4 packets, how many packets do you expect to find in the buffer? What is the mean delay between receipt of a packet and the beginning of its playout? **0 / 5**

✓ **- 5 pts** **Incorrect**

gradescope

Q3. mp3 player hold up N packets. processing time is exp with mean of 25 msec. per packet.

① $T_s = 0.025$ s $\quad \lambda = 36 \quad$ that is MM1.

$\rho = \lambda \cdot T_s = 0.9. \quad\quad x = 36$

$q = \frac{\rho}{1-\rho} = \frac{0.9}{0.1} = 9.$

$w = q - \rho = \frac{\rho^2}{(1-\rho)} = 0.81$

$T_w = \frac{w}{\lambda} = \frac{81}{36} = 0.225$ s.

② There will not have blip.

$P(S_0) = 1 - \rho = 0.1$

$P(plop) = P(S_0) = 0.1 \times 10000 = 1000$

Thus. there is 1000 plops and no blips.

③ For M/M/1/K

$P(reject) = P(S_K) = \frac{(1-\rho)\rho^K}{1-\rho^{K+1}} = 0.1..$

$P(accept) = 1 - P(accept)$

$W = q - \rho = 8.1$

$\lambda' = \lambda \cdot P$

$T_W = \lambda' \cdot W = 26.91$ s

Q3.4 the number of blips is: $10{,}000 \times 0.16 = 1600$ blips.

When a plop occurs, that means no arrivals

plop: $\Rightarrow \rho' = \lambda' T_s = 0.025 \cdot 30.24 = 0.756$

$P(plop) = 1 - \rho' = 0.244 \times 10000 = 2440$

Thus, we get 1600 blips and 2440 plops

5.) example: when we watch Youtube, we want higher quality. therefore. I would like to wait for the buffer. otherwise. we could get to speed up but lower quality.

3.4 Assuming N=4 packets and that a streaming media object consists of 10,000 packets, how many "blips" and how many "plops" do you expect to hear for that object? **5 / 5**

✓ **- 0 pts Correct**

gradescope

Q3. mp3 player hold up N packets. processing time is exp with mean of 25 msec. per packet.

① $T_s = 0.025$ s $\lambda = 36$ that is mm1.

$\rho = \lambda \cdot T_s = 0.9$. $\lambda = 36$

$q = \frac{\rho}{1-\rho} = \frac{0.9}{0.1} = 9$.

$w = q - \rho = \frac{\rho^2}{(1-\rho)} = 0.81$

$T_w = \frac{w}{\lambda} = \frac{81}{36} = 0.225$ s.

② There will not have blip.

$P(S_0) = 1 - \rho = 0.1$

$P(plop) = P(S_0) = 0.1 \times 10000 = 1000$

Thus, there is 1000 plops and no blips.

③ For M/M/1/K

$P(reject) = P(S_K) = \frac{(1-\rho)\rho^K}{1-\rho^{K+1}} = 0.1..$

$P(accept) = 1 - P(accept)$

$w = q - \rho = 8.1$

$\lambda' = \lambda \cdot P$

$T_W = \lambda' \cdot w = 26.91$ s

Q3.4 the number of blips is: $10{,}000 \times 0.16 = 1600$ blips.

When a plop occurs, that means no arrivals

plop: $\Rightarrow \rho' = \lambda' T_s = 0.025 \cdot 30.24 = 0.756$

$P(plop) = 1 - \rho' = 0.244 \times 10000 = 2440$

Thus, we get 1600 blips and 2440 plops

5.) example: when we watch Youtobe, we want higher quality. therefore. I would like to wait for the buffer. otherwise. we could get to speed up but lower quality.

3.5 Based on your answers above, explain the following sentence: “Figuring out the right size for the buffer of a streaming media application is a tradeoff between tolerance for delay and tolerance for degraded audio quality.” In particular, give an example of a streaming media application for which an infinite (or very large) buffer would be preferable to a finite (or small) buffer, and give an example of the opposite. **5 / 5**

✓ **- 0 pts** **Correct**

gradescope