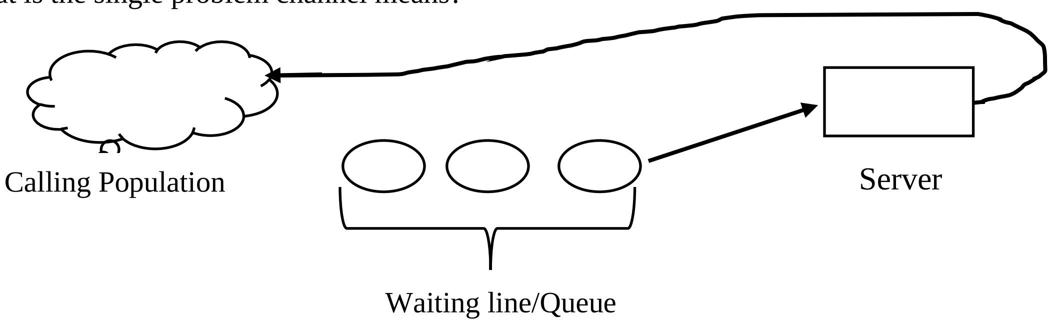
CSC 510 TEST Guide

What is the single problem channel means?



Three components of single channel queuing system are

- calling population,
- waiting line and
- server

The **calling population** process are the order of customers that are waiting to be process

Waiting process is the line in which others are waiting in the server

Server process is only request giving by the customer on the order and after it is done processing it is again sent back to the calling population to be process.

Calculation:

Calculate arrival time distribution and assign random number

Time B/W arrivals	Probability	Cumulative Probability	Random Digit Assignment
1	0.25	0.25	0.25
2	0.40	0.65	26-65
3	0.20	0.85	66-85
4	0.15	1.00	86-100

Calculate service time distribution and assign random number

For Server1

Service Time	Probability	Cumulative Probability	Random Digit Assignment
2	0.30	0.30	0-30
3	0.28	0.58	31-58
4	0.25	0.83	59-83
5	0.17	1.00	84-100

For Server2

Service Time	Probability	Cumulative Probability	Random Digit Assignment
3	0.35	0.35	0-35
4	0.25	0.60	36-60
5	0.20	0.80	61-80
6	0.20	1.00	81-100

Inter-Arrival Time Determination

Customer	Random Digit	IAT(Inter-Arrival Time)
1	-	-
2	26	2
3	98	4
4	90	4

5	29	2
6	42	2

Simulator for six customers table

Customer	IAT	Arrival Time	SERVER1			SERVER2			Caller delay	Time in System (ST+CD)
			Time service Begins	Service time	Time service End	Time service Begins	Service time	Time service Ends		
1	-	0	0	5	5	-	-	-	0	5
2	2	2	-	-	-	2	3	5	0	3
3	4	6	6	3	9	-	-	-	0	3
4	4	10	10	5	15	-	-	-	0	5
5	2	12	-	-	-	12	6	18	0	6
6	2	14	15	3	18	-	-	-	1	4

2. **Random numbers** are samples drawn from a uniformly distributed random variable between some satisfied intervals, they have equal probability of occurrence.

Properties of Random Numbers

1. Uniformity:
2. Independent:
3. Maximum Density:
4. Maximum Cycle:

1. Uniformity:

- The random numbers generated should be uniform. That means a sequence of random numbers should be equally probable everywhere.
- If we divide all the set of random numbers into several numbers of class interval then number of samples in each class should be same.
- If 'N' number of random numbers are divided into 'K' class interval, then expected number of samples in each class should be equal to ei = N / K.

2. Independent:

- Each random number should be independent samples drawn from a continuous uniform distribution between 0 and 1.
- The probability density function is given by: f(x) = 1, 0 <= x <= 1 = 0, otherwise

3. Maximum Density:

- The large samples of random number should be generated in a given range.

4. Maximum Cycle:

- It states that the repetition of numbers should be allowed only after a large interval of time.

Using Chi-square test for the uniformity at 90% for the given random numbers. Degree of freedom for 6 = 10.645, 7 = 11.017, 8 = 13.362, 9 = 14.684, l0 = 15.987.

20	43	43	42	14	10	33	17	6	11	12	7	3	31	8	41	55	44	19	49
15	16	4	1	35	22	9	46	37	57	56	28	53	29	48	59	5	40	27	51

Given that: $\propto = 0.9$, N=40

n = such that Ei >= 5

N/n >= 5 = 40/n >= 5

40/5 = 8

n = 8

Interval	O_i	$E_i = \frac{N}{n}$	$(O_i - E_i)^2$	$\frac{(O_i - E_i)^2}{E_i}$
1 – 10	9	5	4	3.2
11 – 20	8	5	3	1.8
21 – 30	5	5	0	0
31 – 40	4	5	-1	-0.2
41 - 50	8	5	3	1.8

51 – 60	6	5	1	0.2
	40			6.8

x_0^2 = 6.8

$x_0^2 \propto = 0.9,$ = 6.8

n - 1 = 8 – 1 = 7. Degree of Freedom of 7 = 11.017

x_0^2 = 11.017 > 6.8. Therefore, since the degree of freedom is greater than computed value. Null Hypothesis (H_0) is not rejected

3a. When is it an Appropriate Tool

i. Complex system: Informational, organization, and environmental changes can be simulated, and the effect of these alterations on the model's behavior can be observed.
ii. Learning from change: Changing simulation inputs and observing the resulting outputs can produce valuable insight into which variables are the most important and into how variables interact.
iii. Pedagogical value: Simulation can be used as a pedagogical device to reinforce analytic solution methodologies.
iv. Trial and Error: Simulation can be used to experiment with new designs or policies before implementation, so as to prepare for what might happen.
v. Verification and Mathematical Models: Simulation can be used to verify analytic solutions.

When is not an Appropriate Tool

i. Simulation should not be used when the problem can be solved by common sense.
ii. Simulation should not be used if the problem can be solved analytically.
iii. Simulation should not be used if it is easier to perform direct experiments.
iv. Don't use simulation if the costs exceed the savings
v. Simulation should not be performed if the resources or time are not available.
vi. Simulation takes data, sometimes lots of data. If no data is available, not even estimates, simulation is not advised.
vii. The ability to verify and validate the model.

3b. Question:
A sequence of random digits generated is as follows: 4, 2, 3, 5, 5, 6, 3, 7, 4, 2. Perform a Poker Test to determine the randomness of the sequence. Assume a single set of four digits is considered in the Poker Test.

Steps:

1. Divide the sequence into sets of four digits.
2. Identify the occurrence of different patterns (e.g., all different digits, one pair, two pairs, etc.).
3. Calculate the expected frequencies for each pattern.
4. Perform the Chi-Square test to compare the observed frequencies with the expected frequencies.

Given Sequence:
4, 2, 3, 5, 5, 6, 3, 7, 4, 2

Step 1: Divide the Sequence into Sets of Four Digits

Since the Poker Test typically considers a set of four digits, we divide the given sequence as follows:

- First set: 4, 2, 3, 5
- Second set: 5, 6, 3, 7
- Third set: 4, 2

Note: The third set is incomplete with only two digits, so we will exclude it from the Poker Test analysis.

Step 2: Identify the Patterns

For each set of four digits, identify the pattern:

First set (4, 2, 3, 5):

- All four digits are different. This is classified as a "No pair" pattern.

Second set (5, 6, 3, 7):

- All four digits are different. This is also classified as a "No pair" pattern.

Step 3: Calculate the Expected Frequencies for Each Pattern

The Poker Test typically classifies sets into the following patterns:

1. No pair (all four digits different)
2. One pair (two digits are the same, the other two are different)
3. Two pairs (two sets of pairs)
4. Three of a kind (three digits are the same, one different)
5. Four of a kind (all four digits are the same)

For a set of four digits, the probabilities of these patterns are:

- **No pair:** $\frac{5040}{10000} = 0.504$
- **One pair:** $\frac{4320}{10000} = 0.432$
- **Two pairs:** $\frac{270}{10000} = 0.027$
- **Three of a kind:** $\frac{360}{10000} = \ 0.036$
- **Four of a kind:** $\frac{10}{10000} = 0.001$

Step 4: Perform the Chi-Square Test

1. **Observed Frequencies (O):**
   - No pair: 2
   - One pair: 0
   - Two pairs: 0
   - Three of a kind: 0
   - Four of a kind: 0
2. **Expected Frequencies (E):**
   - For No pair: 2 * 0.504 = 1.0082
   - For One pair: 2 * 0.432 = 0.8642
   - For Two pairs: 2 * 0.027 = 0.0542
   - For Three of a kind: 2 * 0.036 = 0.0722
   - For Four of a kind: 2 * 0.001 = 0.0022
3. Chi-Square Statistic Calculation:
   $$x^2 = \sum_{i=1}^{n} \frac{(O-E)^2}{E}$$
   For No pair: $\frac{(2-1.008)^2}{1.008} = 0.982$
   For One pair: $\frac{(0-0.864)^2}{0.864} = 0.864$
   For Two pairs: $\frac{(0-0.054)^2}{0.054} = 0.054$
   For Four of a kind: $\frac{(0-0.072)^2}{0.072} = 0.072$
   For Three of a kind: $\frac{(0-0.002)^2}{0.002} = 0.002$
   $\text{Total Chi} - \text{Square value: } x^2 = 1.974$

The calculated Chi-Square value (1.974) is compared with a critical value from the Chi-Square distribution table (typically with df = 4−1 = 3).