LAB REPORT

SIMULATION & MODELING

International College

BSc. CSIT
5th Semester

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...for a complete human being

Texas International college

S.N	Lab	Sign
1.	Bank Simulation: Poisson process with 10-min inter-arrival and 5-min service time. Find: Probability of no wait, Expected number of customers, Expected time in the bank using C program.	
2.	Stadium Queue: Calculate total time to seat after ticket purchase with 1.5 min walk. Determine if arrival 2 min before the game allows seating by kickoff using C program.	
3.	Compute PI: Use Monte Carlo method to calculate π in C program.	
4.	Poisson Distribution: Generate Poisson distribution for λ = 12 cars/hr for x = 0 to 15. Using C program.	
5.	Weather Forecast: Markov Chain method to predict next day's weather with given probabilities. Using C program.	
6.	Health Monitoring: Find probability of being sick two days later using given transition probabilities. Using C program.	
7.	Stock Market Simulation: Markov Chain method to predict stock market behavior over two days. Using C program.	
8.	Random Number Generation: Generate first 7 random integers using given parameters (m=100, a=19, c=0, X0=63). Using C program.	
9.	Mixed Congruential Method: Generate 10 five-digit random integers and corresponding random variables. Using C program.	
10.	Multiplicative Congruential Method: Generate 10 three-digit random integers and corresponding random variables. Using C program.	
11.	Autocorrelation Function: Implement autocorrelation function in C.	
12.	Gap Test Function: Implement gap test function in C.	
13.	KS Test: Implement Kolmogorov-Smirnov test in C.	
14.	Chi-Square Test: Implement chi-square test function in C.	
15.	Implementation of GPSS Simulation.	

OUTPUTS

Lab-1

```
Probability that a customer will not have to wait at the counter is 0.500000.
Expected number of customers in the bank is 1.000000.
Expected time to be spent in the bank is 10.000000 minutes.
bipinsaud@bipin Simulation & Modeling %
```

Lab-2

```
Average time to get the ticket plus the time to reach the correct seat is 2.000000 minutes.
Hence, the sports fan can expect to be seated for the kick-off.%
bipinsaud@bipin Simulation & Modeling %
```

Lab-3

```
Approximated value of PI using Monte Carlo method: 3.1403600000
bipinsaud@bipin Simulation & Modeling %
```

Lab-4

```
P(X = 0) = 0.000006
P(X = 1) = 0.000074
P(X = 2) = 0.000442
P(X = 3) = 0.001770
P(X = 4) = 0.005309
P(X = 5) = 0.012741
P(X = 6) = 0.025481
P(X = 7) = 0.043682
P(X = 8) = 0.065523
P(X = 9) = 0.087364
P(X = 10) = 0.104837
P(X = 11) = 0.114368
P(X = 12) = 0.114368
P(X = 13) = 0.105570
P(X = 14) = 0.090489
P(X = 15) = 0.072391
bipinsaud@bipin Simulation & Modeling %
```

Lab-5

```
Transition matrix P * P:
0.280000 0.720000
0.240000 0.760000
Probability that it will not rain the day after tomorrow if it is not raining today: 0.760000
bipinsaud@bipin Simulation & Modeling %
```

Lab-6

```
Transition matrix P * P:
0.850000 0.150000
0.600000 0.400000
Probability that the person will be sick the day after tomorrow if they are sick today: 0.40
bipinsaud@bipin Simulation & Modeling %
```

Lab-7

```
Transition matrix P * P:
0.400000 0.600000
0.360000 0.640000
Probability that the market will be down the day after tomorrow if it is down today: 0.640000
bipinsaud@bipin Simulation & Modeling %
```

Lab-8

```
The first 7 random numbers are:
63
97
43
17
23
37
3
bipinsaud@bipin Simulation & Modeling %
```

Lab-9

```
Random Integer    Random Variable
00014             0.00014
00044             0.00044
00134             0.00134
00404             0.00404
01214             0.01214
03644             0.03644
10934             0.10934
32804             0.32804
98414             0.98414
95244             0.95244
bipinsaud@bipin Simulation & Modeling %
```

Lab-10

```
Random Integer   Random Variable
015              0.015
045              0.045
135              0.135
405              0.405
215              0.215
645              0.645
935              0.935
805              0.805
415              0.415
245              0.245
bipinsaud@bipin Simulation & Modeling %
```

Lab-11

```
Autocorrelation:
Lag 0: 11.00
Lag 1: 10.00
Lag 2: 8.67
Lag 3: 7.00
Lag 4: 5.00
bipinsaud@bipin Simulation & Modeling %
```


Lab-12

```
Enter the number of elements in the sequence: 5
Enter the sequence values: 10 3 17 9 21
Enter the target value: 1
Enter the maximum gap to count: 5
Enter the significance level alpha: 0.05
Enter the critical value D_alpha: 0.565

Calculations:
 x |   F(x)   |  S_N(x)  | |F(x) - S_N(x)|
---|----------|----------|---------------
 0   0.100000   0.000000        0.100000
 1   0.190000   0.000000        0.190000
 2   0.271000   0.000000        0.271000
 3   0.343900   0.000000        0.343900
 4   0.409510   0.000000        0.409510
 5   0.468559   0.000000        0.468559

Maximum Deviation D: 0.468559
D_cal < D_alpha, Null hypothesis is not rejected.
bipinsaud@bipin Simulation & Modeling %
```

Lab-13

```
Enter the sample size: 5
Enter the sample values:
Value 1: 0.54
Value 2: 0.73
Value 3: 0.38
Value 4: 0.11
Value 5: 0.98
Enter the significance level (e.g., 0.05): 0.05
|    i |     Ri |      i/n |  (i-1)/n |   D+ = i/n - Ri | D- = Ri - (i-1)/n |
|------|--------|----------|----------|-----------------|-------------------|
|    1 |   0.11 |     0.20 |     0.00 |            0.09 |              0.11 |
|    2 |   0.38 |     0.40 |     0.20 |            0.02 |              0.18 |
|    3 |   0.54 |     0.60 |     0.40 |            0.06 |              0.14 |
|    4 |   0.73 |     0.80 |     0.60 |            0.07 |              0.13 |
|    5 |   0.98 |     1.00 |     0.80 |            0.02 |              0.18 |
D+ = 0.090000, D- = 0.180000
D calculated: 0.180000
D critical (alpha = 0.050000): 0.608210
Do not reject the null hypothesis (H0)
bipinsaud@bipin Simulation & Modeling %
```

Lab-14


```
Enter the number of categories: 5
Enter the observed frequencies:
15 5 10 10 20
Enter the expected frequencies:
10 10 10 10 10
Enter the significance level alpha (e.g., 0.05): 0.05
Enter the critical value from the Chi-Square distribution table: 9.49

Calculations:
 Category | Observed | Expected | (Observed - Expected)^2 / Expected
----------|----------|----------|-----------------------------------
        1 |       15 |    10.00 |                              2.50
        2 |        5 |    10.00 |                              2.50
        3 |       10 |    10.00 |                              0.00
        4 |       10 |    10.00 |                              0.00
        5 |       20 |    10.00 |                             10.00

Chi-Square Statistic: 15.000000
Chi-Square statistic >= Critical value, Null hypothesis is rejected.
bipinsaud@bipin Simulation & Modeling %
```

LAB-15

GPSS MODEL

OBJECTIVE-1 :

Create a gpss model and program to simulate a barber shop for a day (9am to 4pm), where a costumer enters the shop every 10 ± 2 minute and a barber takes 13 ± 2 for a haircut.

PROGRAM:

```
GENERATE 10,2
QUEUE SEAT
SEIZE BARBER
DEPART SEAT
ADVANCE 13,2
RELEASE BARBER
TERMINATE
TIMER GENERATE 420
TERMINATE 1
```


OUTPUT:

GPSS World Simulation Report - Untitled Model 1.3.1

Friday, July 19, 2024 09:19:14

START TIME	END TIME	BLOCKS	FACILITIES	STORAGES
0.000	4200.000	9	1	0

NAME	VALUE
BARBER	10001.000
SEAT	10000.000
TIMER	8.000

LABEL	LOC	BLOCK TYPE	ENTRY COUNT	CURRENT COUNT	RETRY
	1	GENERATE	418	0	0
	2	QUEUE	418	94	0
	3	SEIZE	324	0	0
	4	DEPART	324	0	0
	5	ADVANCE	324	1	0
	6	RELEASE	323	0	0
	7	TERMINATE	323	0	0
TIMER	8	GENERATE	10	0	0
	9	TERMINATE	10	0	0

FACILITY	ENTRIES	UTIL.	AVE. TIME	AVAIL.	OWNER	PEND	INTER	RETRY	DELAY
BARBER	324	0.997	12.928	1	332	0	0	0	94

QUEUE	MAX	CONT.	ENTRY	ENTRY(0)	AVE.CONT.	AVE.TIME	AVE.(-0)	RETRY
SEAT	95	94	418	1	49.297	495.328	496.516	0

FEC XN	PRI	BDT	ASSEM	CURRENT	NEXT	PARAMETER	VALUE
429	0	4203.238	429	0	1		
332	0	4208.003	332	5	6		
430	0	4620.000	430	0	8		

OBJECTIVE-2 :

A machine tool in a manufacturing shop is turning out parts at the rate of every 5 minutes. When they are finished, the parts are sent to an inspector, who takes 4±3 minutes to examine each one and rejects 15% of the parts. Draw and explain a block diagram and write a GPSS program to simulate using the concept of facility.

PROGRAM:

```
GENERATE 5,0
QUEUE 1
SEIZE 1
DEPART 1
ADVANCE 4,3
RELEASE 1
TRANSFER 0.15 ACC REJ
ACC TERMINATE 1
REJ TERMINATE 1
```


OUTPUT:

```
                    GPSS World Simulation Report - Untitled Model 1.1.1


                         Friday, July 19, 2024 09:30:07

          START TIME        |  END TIME  BLOCKS  FACILITIES  STORAGES
               0.000             51.421     9         1          0


                NAME                      VALUE
           ACC                             8.000
           REJ                             9.000


 LABEL              LOC  BLOCK TYPE     ENTRY COUNT CURRENT COUNT RETRY
                    1    GENERATE            10             0       0
                    2    QUEUE               10             0       0
                    3    SEIZE               10             0       0
                    4    DEPART              10             0       0
                    5    ADVANCE             10             0       0
                    6    RELEASE             10             0       0
                    7    TRANSFER            10             0       0
ACC                 8    TERMINATE            7             0       0
REJ                 9    TERMINATE            3             0       0


FACILITY         ENTRIES  UTIL.   AVE. TIME AVAIL. OWNER PEND INTER RETRY DELAY
 1                   10    0.730       3.751  1        0    0     0     0      0


QUEUE              MAX CONT. ENTRY ENTRY(0) AVE.CONT. AVE.TIME   AVE.(-0) RETRY
 1                   1    0     10       6     0.093      0.477      1.194   0


FEC XN    PRI         BDT      ASSEM  CURRENT  NEXT  PARAMETER    VALUE
    11    0           55.000     11      0      1
```

OBJECTIVE-3:

A machine tool in a manufacturing shop is turning out parts at the rate of every 5 minutes. When they are finished, the parts are sent to an inspector, who takes 4±3 minutes to examine each one and rejects 20% of the parts. Draw and explain a block diagram for it and write a GPSS program to simulate using the concept of FACILITY.

PROGRAM:

```
GENERATE 5,0
QUEUE 1
SEIZE 1
DEPART 1
ADVANCE 4,3
RELEASE 1
TRANSFER 0.2 ACC REJ
ACC TERMINATE 1
```

OUTPUT:


```
                    GPSS World Simulation Report - Untitled Model 2.2.1


                         Friday, July 19, 2024 09:39:56

        START TIME           END TIME  BLOCKS  FACILITIES  STORAGES
             0.000             11.286     8        1          0


            NAME                         VALUE
          ACC                            8.000
          REJ                          UNSPECIFIED


 LABEL              LOC  BLOCK TYPE     ENTRY COUNT CURRENT COUNT RETRY
                    1    GENERATE             2             0       0
                    2    QUEUE                2             0       0
                    3    SEIZE                2             1       0
                    4    DEPART               1             0       0
                    5    ADVANCE              1             0       0
                    6    RELEASE              1             0       0
                    7    TRANSFER             1             0       0
ACC                 8    TERMINATE            1             0       0


FACILITY         ENTRIES  UTIL.   AVE. TIME AVAIL. OWNER PEND INTER RETRY DELAY
 1                     2    0.557       3.143  1        2     0     0     0       0


QUEUE              MAX CONT. ENTRY ENTRY(0) AVE.CONT. AVE.TIME   AVE.(-0) RETRY
 1                   1    1      2       1     0.114      0.643      1.286   0


CEC XN    PRI          M1      ASSEM  CURRENT  NEXT  PARAMETER    VALUE
     2    0          10.000      2      3       4


FEC XN    PRI          BDT     ASSEM  CURRENT  NEXT  PARAMETER    VALUE
     3    0          15.000      3      0       1
```

OBJECTIVE-4:

We are modeling a barber shop with the following qualities:

 The shop contains one barber and one barber's chair, open for eight hours in a day.

 Customers arrive on average every 18 minutes, with the arrival time varying between 12 and 24 minutes.

 If the barber is busy, the customer will wait in a queue.

 Once the barber is free, the next customer will have a haircut.

 Each haircut takes between 12 and 18 minutes, with the average being 15 minutes.

 Once the haircut is done, the customer will leave the shop.

We want to answer these questions:

 How utilized is the barber through the day?

 How long does the queue get?

 On average, how long does a customer have to wait.

PROGRAM:

```
GENERATE 18,6
QUEUE 2
SEIZE 3
DEPART 2
ADVANCE 15,5
RELEASE 3
TERMINATE 0
GENERATE 480
TERMINATE 1
```

OUTPUT:

GPSS World Simulation Report - Untitled Model 3.2.1

Friday, July 19, 2024 09:50:24

START TIME	END TIME	BLOCKS	FACILITIES	STORAGES
0.000	480.000	9	1	0

LABEL	LOC	BLOCK TYPE	ENTRY COUNT	CURRENT COUNT	RETRY
	1	GENERATE	26	0	0
	2	QUEUE	26	0	0
	3	SEIZE	26	0	0
	4	DEPART	26	0	0
	5	ADVANCE	26	1	0
	6	RELEASE	25	0	0
	7	TERMINATE	25	0	0
	8	GENERATE	1	0	0
	9	TERMINATE	1	0	0

FACILITY	ENTRIES	UTIL.	AVE. TIME	AVAIL.	OWNER	PEND	INTER	RETRY	DELAY
3	26	0.811	14.978	1	27	0	0	0	0

QUEUE	MAX	CONT.	ENTRY	ENTRY(0)	AVE.CONT.	AVE.TIME	AVE.(-0)	RETRY
2	1	0	26	19	0.052	0.965	3.583	0

FEC XN	PRI	BDT	ASSEM	CURRENT	NEXT	PARAMETER	VALUE
27	0	481.491	27	5	6		
28	0	482.707	28	0	1		
29	0	960.000	29	0	8		

OBJECTIVE-5:

Consider that a machine tool in a manufacturing shop is turning out parts at the rate of one every 5 minutes. As they are finished, the parts go to an inspector, who takes 4±3 minutes to examine each one and rejects 10% of the parts. Now, develop a block diagram and write the code for simulating the above problem using GPSS, and also explain the function of each block used in the block diagram in detail.

PROGRAM:

```
GENERATE 5,0
QUEUE 1
SEIZE 1
DEPART 1
ADVANCE 4,3
RELEASE 1
TRANSFER 0.1 ACC REJ
ACC TERMINATE 1
REJ TERMINATE 1
```

OUTPUT:

GPSS World Simulation Report - Untitled Model 1.5.1

Tuesday, July 23, 2024 14:03:34

START TIME	END TIME	BLOCKS	FACILITIES	STORAGES
0.000	51.421	9	1	0

NAME	VALUE
ACC	8.000
REJ	9.000

LABEL	LOC	BLOCK TYPE	ENTRY COUNT	CURRENT COUNT	RETRY
	1	GENERATE	10	0	0
	2	QUEUE	10	0	0
	3	SEIZE	10	0	0
	4	DEPART	10	0	0
	5	ADVANCE	10	0	0
	6	RELEASE	10	0	0
	7	TRANSFER	10	0	0
ACC	8	TERMINATE	9	0	0
REJ	9	TERMINATE	1	0	0

FACILITY	ENTRIES	UTIL.	AVE. TIME	AVAIL.	OWNER	PEND	INTER	RETRY	DELAY
1	10	0.730	3.751	1	0	0	0	0	0

QUEUE	MAX	CONT.	ENTRY	ENTRY(0)	AVE.CONT.	AVE.TIME	AVE.(-0)	RETRY
1	1	0	10	6	0.093	0.477	1.194	0

FEC XN	PRI	BDT	ASSEM	CURRENT	NEXT	PARAMETER	VALUE
11	0	55.000	11	0	1		