

Министерство науки и высшего образования Российской Федерации Федеральное государственное бюджетное образовательное учреждение высшего образования

«Московский государственный технический университет имени Н. Э. Баумана

(национальный исследовательский университет)» (МГТУ им. Н. Э. Баумана)

ФАКУЛЬТЕТ «Информатика и системы управления»	
КАФЕДРА «Программное обеспечение ЭВМ и информационные технологии»	

Отчёт по лабораторной работе №7 по курсу «Моделирование»

Тема	Моделирование работы информационного центра (GPSS)
Студе	ент Калашков П. А.
Групг	иа ИУ7-76Б
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Оцени	ка (баллы)
Препо	одаватели Рудаков И. В.

Целью данной работы является разработка программы на языке моделирования GPSS для моделирования процесса обработки 300 запросов клиентов информационным центром и определения вероятности отказа клиенту в обслуживании. Информационный центр работает следующим образом:

- 1. Клиенты приходят через интервал времени, равный 10 ± 2 мин.
- 2. Если все три имеющихся оператора заняты, клиенту отказывают в обслуживании. Операторы имеют разную производительность и могут обеспечивать обслуживание среднего запроса пользователя за 20 ± 5 мин., 40 ± 10 мин. и 40 ± 20 мин. соответственно. Клиенты стремятся занять свободного оператора с максимальной производительностью.
- 3. Полученные запросы сдаются в приемный накопитель, из которого они выбираются для обработки. На первый компьютер выбираются запросы от первого и второго операторов, на второй компьютер от третьего оператора. Время обработки на первом и втором компьютерах равны соответственно 15 мин. и 30 мин.

В процессе взаимодействия клиентов и информационного центра предусмотреть: режим нормального обслуживания, когда клиент выбирает одного из свободных операторов с максимальной производительностью, и режим отказа.

Моделирование функционирования системы

При моделировании функционирования системы эндогенными переменными являются:

- ullet время обслуживания клиента i-ым оператором, где $i=\overline{1,3};$
- ullet время обработки запроса на j-ом компьютере, где $j=\overline{1,2}.$

Экзогенными переменными являются:

- число обслуженных клиентов n_0 ;
- число клиентов, получивших отказ, n_1 .

Уравнение модели имеет следующий вид:

$$P_{\text{отказа}} = \frac{n_1}{n_0 + n_1} \tag{1}$$

Схемы модели

На рисунке 1 показана структурная схема модели.

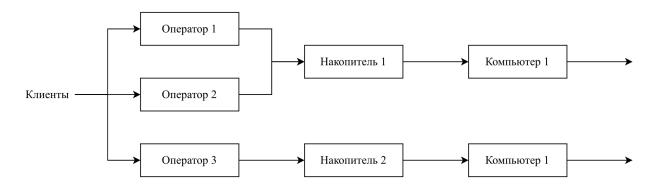


Рисунок 1 – Структурная схема модели информационного центра

На рисунке 2 представлена схема модели в терминах СМО.

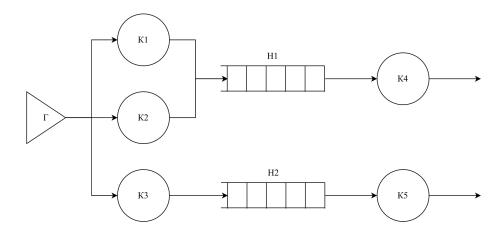


Рисунок 2 – Схема модели в терминах СМО

Результаты работы

Детали реализации

В листингах 1-2 приведена реализация программы моделирования информационного центра на языке GPSS.

Листинг 1 – Реализация программмы на языке GPSS

```
1 client medium FVARIABLE 10
2 delta_client FVARIABLE 2
3 operator 1 medium FVARIABLE 20
4 | operator_1_delta FVARIABLE 5
5 operator_2_medium FVARIABLE 40
6 operator 2 delta FVARIABLE 10
7 operator 3 medium FVARIABLE 40
8 operator 3 delta FVARIABLE 20
9
10 computer 1 medium FVARIABLE 8
11 computer 1 delta FVARIABLE 7
12 computer 2 medium FVARIABLE 16
13 computer 2 delta FVARIABLE 14
15 GENERATE (v$client medium), (v$delta client)
16
17 TEST E f$operator 1,0, test operator 2
18 SPLIT 1, processed
19 SEIZE operator 1
20 | \mathsf{ADVANCE} \ (v\$\mathsf{operator}\_1\_\mathsf{medium}) \ , (v\$\mathsf{operator}\_1\_\mathsf{delta})
21 RELEASE operator 1
22 TRANSFER , to queue of computer 1
23
24 test operator 2 TEST E f$operator 2,0,test operator 3
25 SPLIT 1, processed
26 SEIZE operator 2
27 ADVANCE (v$operator 2 medium), (v$operator 2 delta)
28 RELEASE operator 2
29 TRANSFER , to queue of computer 1
30
31 test operator 3 TEST E f$operator 3,0, denied
32 SPLIT 1, processed
33 SEIZE operator 3
34 ADVANCE (v$operator 3 medium), (v$operator 3 delta)
35 RELEASE operator 3
36 TRANSFER , to queue of computer 2
```

Листинг 2 – Реализация программмы на языке GPSS

```
to_queue_of_computer_1 QUEUE computer_1_queue
2 SEIZE computer_1
 3 DEPART computer 1 queue
4 ADVANCE (v$computer 1 medium),(v$computer 1 delta)
 5 RELEASE computer 1
 6 TRANSFER , delete
8 to _queue_of_computer_2 QUEUE computer_2_queue
9 SEIZE computer 2
10 DEPART computer 2 queue
11 ADVANCE (v$computer 2 medium),(v$computer 2 delta)
12 RELEASE computer 2
13|\mathsf{TRANSFER}| , delete
14
15 processed TRANSFER , calculate result
16 calculate result SAVEVALUE PERCENT, (n$denied/(n$denied+n$processed))
17 TERMINATE 1
18 denied TERMINATE 1
19 delete TERMINATE 0
20
21
22 START 300
```

Примеры работы

На рисунках 3—4 представлен пример работы разработанной программы для описанного информационного центра с обработкой 300 заявок. Вычисленная вероятность отказа равна 0.227.

Sunday, December 24, 2023 18:19:09

START TIME 0.000	END TIME 2967.544		FACILITIES 5	STORAGES 0
NAME CALCULATE RESULT		VALUE 33.000		
CLIENT MEDIUM	100			
COMPUTER 1		17.000		
COMPUTER_1_DELTA		09.000		
COMPUTER_1_MEDIUM		08.000		
COMPUTER 1 QUEUE		16.000		
COMPUTER 2		19.000		
COMPUTER 2 DELTA		11.000		
COMPUTER 2 MEDIUM		10.000		
COMPUTER 2 QUEUE		18.000		
DELETE		36.000		
DELTA_CLIENT	100	01.000		
DENIED		35.000		
OPERATOR_1	100	12.000		
OPERATOR_1_DELTA	100	03.000		
OPERATOR_1_MEDIUM	100	02.000		
OPERATOR_2	100	14.000		
OPERATOR_2_DELTA		05.000		
OPERATOR_2_MEDIUM	100	04.000		
OPERATOR_3		15.000		
OPERATOR_3_DELTA	100	07.000		
OPERATOR_3_MEDIUM	1000	06.000		
PERCENT		13.000		
PROCESSED		32.000		
TEST_OPERATOR_2		8.000		
TEST_OPERATOR_3		14.000		
TO_QUEUE_OF_COMPUTER_				
TO_QUEUE_OF_COMPUTER_	.2	26.000		

Рисунок 3 – Результат работы программы, часть 1

1 GENERATE 300 0 0 0 0 0 0 1 1 1	LABEL	LOC	BLOCK TYPE	ENTR	Y COUNT	CURRE	NT COU	NT R	ETRY	
3 SPLIT		1	GENERATE		300		0		0	
A		2	TEST		300		0		0	
SADVANCE		3	SPLIT		118		0		0	
TEST_OPERATOR_2		4	SEIZE	:	118		0		0	
TEST_OPERATOR_2 8 TEST 182 0 0 0 10 SEIZE 59 0 0 0 11 ADVANCE 59 1 0 0 11 ADVANCE 59 1 0 0 12 RELEASE 58 0 0 0 13 TRANSFER 58 0 0 0 15 SPLIT 55 0 0 0 16 SEIZE 59 0 0 0 17 ADVANCE 59 1 0 0 18 SEIZE 59 0 0 0 19 TRANSFER 58 0 0 0 10 SEIZE 59 0 0 0 10 SEIZE 59 0 0 0 0 10 SEIZE 59 1 0 0 0 10 SEIZE 59 1 0 0 0 10 SEIZE 59 0 0 0 0 10 SEIZE 55 0 0 0 0 11 SEIZE 55 0 0 0 0 11 SEIZE 55 0 0 0 0 12 SEIZE 55 0 0 0 0 13 TRANSFER 54 0 0 0 14 SEIZE 55 1 0 0 0 15 SPLIT 55 0 0 0 0 16 SEIZE 55 0 0 0 0 17 ADVANCE 55 1 0 0 0 18 RELEASE 54 0 0 0 0 19 TRANSFER 54 0 0 0 19 TRANSFER 54 0 0 0 10 SEIZE 175 0 0 0 0 0 0 10 SEIZE 175 0 0 0 0 0 0 10 SEIZE 175 0 0 0 0 0 0 10 SEIZE 175 0 0 0 0 0 0 10 SEIZE 175 0 0 0 0 0 0 0 10 SEIZE 175 0 0 0 0 0 0 0 10 SEIZE 175 0 0 0 0 0 0 0 10 SEIZE 175 0 0 0 0 0 0 0 10 SEIZE 175 0 0 0 0 0 0 0 10 SEIZE 175 0 0 0 0 0 0 0 10 SEIZE 175 0 0 0 0 0 0 0 10 SEI		5	ADVANCE	:	118		1		0	
TEST_OPERATOR_2		6	RELEASE		117		0		0	
9 SPLIT 59 0 0 0 10 SEIZE 59 0 0 0 11 ADVANCE 59 1 0 0 12 RELEASE 58 0 0 0 13 TRANSFER 58 0 0 0 15 SPLIT 55 0 0 0 16 SEIZE 55 0 0 0 17 ADVANCE 59 1 1 0 16 SEIZE 55 0 0 0 17 ADVANCE 55 1 0 0 18 RELEASE 55 0 0 0 18 RELEASE 55 0 0 0 19 TRANSFER 55 0 0 0 19 TRANSFER 54 0 0 0 10 COPUEUE_OF_COMPUTER_1 20 QUEUE 175 0 0 0 21 SEIZE 175 0 0 0 22 DEPART 175 0 0 0 23 ADVANCE 175 0 0 0 24 RELEASE 175 0 0 0 25 TRANSFER 175 0 0 0 26 RELEASE 175 0 0 0 27 SEIZE 54 0 0 0 27 SEIZE 54 0 0 0 27 SEIZE 54 0 0 0 28 DEPART 54 0 0 0 29 ADVANCE 54 1 0 0 0 20 ADVANCE 54 1 0 0 0 20 ADVANCE 54 1 0 0 0 20 ADVANCE 54 1 0 0 0 0 20 ADVANCE 54 1 0 0 0 20 ADVANCE 54 1 0 0 0 0 0 20 ADVANCE 54 1 0 0 0 0 0 20 ADVANCE 54 1 0 0 0 0 0 20 ADVANCE 54 1 0 0 0 0 0 20 ADVANCE 54 1 0 0 0 0 0 0 20 ADVAN		7	TRANSFER		117		0		0	
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11 ADVANCE 59 1 0		9	SPLIT		59		0		0	
12 RELEASE 58 0 0 0 13 TRANSFER 58 0 0 0 TEST_OPERATOR_3 14 TEST 123 0 0 0 15 SPLIT 55 0 0 0 16 SEIZE 55 0 0 0 17 ADVAINCE 55 1 0 0 18 RELEASE 54 0 0 0 19 TRANSFER 54 0 0 0 19 TRANSFER 54 0 0 0 10 OUEUE_OF_COMPUTER_1 20 QUEUE 175 0 0 0 21 SEIZE 175 0 0 0 22 DEPART 175 0 0 0 24 RELEASE 175 0 0 0 24 RELEASE 175 0 0 0 25 TRANSFER 175 0 0 0 26 RELEASE 175 0 0 0 27 SEIZE 175 0 0 0 28 DEPART 175 0 0 0 29 ADVAINCE 175 0 0 0 20 TO_QUEUE_OF_COMPUTER_2 26 QUEUE 54 0 0 27 SEIZE 54 0 0 0 28 DEPART 54 0 0 0 29 ADVAINCE 54 1 0 0 20 ADVAINCE 54 1 0 0 21 TRANSFER 53 0 0 0 0 22 TEAMSFER 232 0 0 0 23 TRANSFER 232 0 0 0 24 TRANSFER 232 0 0 0 25 TRANSFER 232 0 0 0 26 CALCULATE_RESULT 33 SAVEVALUE 232 0 0 0 27 SEIZE 232 0 0 0 28 DEPART 232 0 0 0 29 ADVAINCE 24 1 0 0 20 ADVAINCE 25 1 1 0 0 0 20 ADVAINCE 25 1 1 0 0 0 20 ADVAINCE 25 1 1 0 0 0 20 ADVAINCE 25 0 0 0 0 21 TRANSFER 232 0 0 0 22 TRANSFER 232 0 0 0 23 TRANSFER 232 0 0 0 24 TRANSFER 232 0 0 0 25 TRANSFER 232 0 0 0 26 ADVAINCE 25 0 0 0 27 SEIZE 25 0 0 0 0 28 ADVAINCE 25 0 0 0 0 29 ADVAINCE 25 0 0 0 0 20 ADVAINCE 25 0 0 0 0 0 0 20 ADVAINCE 25 0 0 0 0 0 0 20 ADVAINCE 25 0 0 0 0 0 0 20 ADVAINCE 25 0 0 0 0 0 0 20 ADVAINCE 25 0 0 0 0 0 0 20 ADVAINCE 25 0 0 0 0 0 0 20 ADVAINCE 25 0 0 0 0 0 0 0 20 ADVAINCE 25 0 0 0 0 0 0 20 ADVA		10	SEIZE		59		0		0	
TEST_OPERATOR_3		11	ADVANCE		59		1		0	
TEST_OPERATOR_3		12	RELEASE		58		0		0	
15 SPLIT 55 0 0 0 16 SEIZE 55 0 0 0 17 ADVANCE 55 1 0 18 RELEASE 54 0 0 19 TRANSFER 54 0 0 10 TO_QUEUE_OF_COMPUTER_1 20 QUEUE 175 0 0 21 SEIZE 175 0 0 22 DEPART 175 0 0 23 ADVANCE 175 0 0 24 RELEASE 175 0 0 25 TRANSFER 175 0 0 26 PART 175 0 0 27 SEIZE 175 0 0 28 DEPART 175 0 0 29 ADVANCE 175 0 0 20 PART 175 0 0 21 SEIZE 54 0 0 22 DEPART 175 0 0 23 ADVANCE 175 0 0 24 RELEASE 175 0 0 25 TRANSFER 175 0 0 26 PART 175 0 0 0 27 SEIZE 54 0 0 0 27 SEIZE 54 0 0 0 28 DEPART 54 0 0 29 ADVANCE 54 1 0 20 PROCESSED 32 TRANSFER 232 0 0 21 TRANSFER 232 0 0 22 PROCESSED 34 TRANSFER 232 0 0 23 PROCESSED 35 TRANSFER 232 0 0 24 RERMINATE 228 0 0 25 PROCESSED 36 TRANSFER 232 0 0 26 PROCESSED 36 TRANSFER 232 0 0 27 PROCESSED 37 TRANSFER 232 0 0 28 DEPART 54 0 0 29 ADVANCE 54 1 0 0 20 PROCESSED 35 TRANSFER 232 0 0 20 PROCESSED 36 TRANSFER 232 0 0 21 PROCESSED 36 TRANSFER 232 0 0 22 PROCESSED 36 TRANSFER 232 0 0 23 PROCESSED 36 TRANSFER 232 0 0 24 PROCESSED 37 TRANSFER 232 0 0 25 PROCESSED 36 TRANSFER 232 0 0 26 PROCESSED 36 TRANSFER 232 0 0 27 PROCESSED 36 TRANSFER 232 0 0 28 PROCESSED 36 TRANSFER 232 0 0 29 PROCESSED 36 TRANSFER 232 0 0 20 PROCESSED 37 TRANSFER 232 0 0 0 0 20 PROCESSED 37 TRANSFER 232 0 0 0 0 20 PROCESSED 37 TRANSFER 232 0 0 0 0 20 PROCESSED 37 TRANSFER 232 0 0 0 0 20 PROCESSED 37 TRANSFER 232 0 0 0 0 20 PROCESSED 37 TRANS		13	TRANSFER		58		0		0	
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17 ADVANCE 55 1 0 0 19 18 RELEASE 54 0 0 0 19 19 TRANSFER 54 0 0 0 19 17 17 17 17 18 18 RELEASE 54 0 0 0 19 19 TRANSFER 54 0 0 0 19 17 17 18 18 18 18 18 18 18 18 18 18 18 18 18		15	SPLIT		55		0		0	
18		16	SEIZE		55		0		0	
19		17	ADVANCE		55		1		0	
TO_QUEUE_OF_COMPUTER_1		18	RELEASE		54		0		0	
21 SEIZE 175 0 0 0 22 DEPART 175 0 0 0 23 ADVANCE 175 0 0 0 24 RELEASE 175 0 0 0 25 TRANSFER 175 0 0 0 27 SEIZE 54 0 0 0 28 DEPART 54 0 0 28 DEPART 54 0 0 29 ADVANCE 54 1 0 0 29 ADVANCE 54 1 0 0 29 ADVANCE 54 1 0 0 30 RELEASE 53 0D 0 0 PROCESSED 32 TRANSFER 232 0 0 0 CALCULATE_RESULT 33 SAVEVALUE 232 0 0 0 DENIED 35 TERMINATE 232 0 0 0 FACILITY ENTRIES UTIL. AVE. TIME AVAIL. OWNER PEND INTER RETRY DELAY OPERATOR 1 118 0.806 20.277 1 527 0 0 0 0 DPRATOR 2 59 0.787 39.608 1 525 0 0 0 0 COMPUTER 1 175 0.489 8.286 1 0 0 0 0 QUEUE MAX CONT. ENTRY ENTRY(0) AVE.CONT. AVE.TIME AVE.(-0) RETRY COMPUTER 1 QUEUE 1 0 175 124 0.088 1.487 5.103 0 COMPUTER 2 QUEUE 1 0 175 124 0.088 1.487 5.103 0 COMPUTER 2 QUEUE 1 0 54 54 0.000 0.000 0.000 0		19	TRANSFER		54		0		0	
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TO_QUEUE_OF_COMPUTER_2		23	ADVANCE	:	175		0		0	
TO_QUEUE_OF_COMPUTER_2		24	RELEASE	:	175		0		0	
27 SEIZE 54 0 0 0 28 DEPART 54 0 0 29 ADVANCE 54 1 0 30 RELEASE 53 0D 0 31 TRANSFER 53 0 0 6 PROCESSED 32 TRANSFER 232 0 0 CALCULATE_RESULT 33 SAVEVALUE 232 0 0 DENIED 35 TERMINATE 232 0 0 DELETE 36 TERMINATE 228 0 FACILITY ENTRIES UTIL. AVE. TIME AVAIL. OWNER PEND INTER RETRY DELAY OPERATOR_1 118 0.806 20.277 1 527 0 0 0 0 OPERATOR_2 59 0.787 39.608 1 525 0 0 0 0 OPERATOR_3 55 0.719 38.809 1 531 0 0 0 0 OPERATOR_3 55 0.719 38.809 1 531 0 0 0 0 COMPUTER_1 175 0.489 8.286 1 0 0 0 0 0 COMPUTER_2 54 0.291 15.979 1 523 0 0 0 0 QUEUE MAX CONT. ENTRY ENTRY(0) AVE.CONT. AVE.TIME AVE.(-0) RETRY COMPUTER_2 QUEUE 1 0 175 124 0.088 1.487 5.103 0 COMPUTER_2 QUEUE 1 0 54 54 0.000 0.000 0.000 0		25	TRANSFER	:	175		0		0	
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30 RELEASE 53 0D 0 0 0 0 0 0 0 0		28	DEPART		54		0		0	
SAVEVALUE RETRY VALUE PROCESSED 31 TRANSFER 53 0 0 0 0 0 0 0 0 0		29	ADVANCE		54		1		0	
PROCESSED 32 TRANSFER 232 0 0 CALCULATE_RESULT 33 SAVEVALUE 232 0 0 DENIED 34 TERMINATE 232 0 0 DENIED 35 TERMINATE 68 0 0 DELETE 36 TERMINATE 228 0 FACILITY ENTRIES UTIL. AVE. TIME AVAIL. OWNER PEND INTER RETRY DELAY OPERATOR_1 118 0.806 20.277 1 527 0 0 0 0 0 OPERATOR_2 59 0.787 39.608 1 525 0 0 0 0 0 OPERATOR_3 55 0.719 38.809 1 531 0 0 0 0 0 COMPUTER_1 175 0.489 8.286 1 0 0 0 0 0 0 COMPUTER_2 54 0.291 15.979 1 523 0 0 0 0 0 QUEUE MAX CONT. ENTRY ENTRY(0) AVE.CONT. AVE.TIME AVE.(-0) RETRY COMPUTER_1_QUEUE 1 0 175 124 0.088 1.487 5.103 0 COMPUTER_2_QUEUE 1 0 54 54 0.000 0.000 0.000 0		30	RELEASE		53		ØD.		0	
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	SAVEVALUF		RETRY	VALUF						

Рисунок 4 – Результат работы программы, часть 2

Вывод

В ходе выполнения лабораторной работы была реализована программа на языке моделирования GPSS для моделирования процесса обработки 300 запросов клиентов информационным центром и определения вероятности отказа клиенту в обслуживании. Вероятность отказа равна 0.227.