1.1. Conceptual Model

Entity: Patients

- Patients are main individual element of the simulation. Their behavior is tracked. Patients move around the system.

Attributes: Waiting time in queue, arrival time, departure time, healing time and ID.

- Each patient should have an ID, since we must measure how long patient is treated. Additionally, each patient has waiting time in queue, arrival time, departure time and healing time in the system.

Events: Start, arrival, departure, healing

- There is a start event which generates first interarrival time whenever system is empty or not.
- When patient arrives, new interarrival must be generated. Also, if one of nurses is available, departure time must be generated.
- When patient departures, condition must be determined, healing time must be generated. Additionally, if queue is not empty, new departure time must be generated. If condition is critic, simulation must check bed availability and if there is at least one empty bed, it must be occupied.
- When patient heals, if he or she is in hospital, bed must be unoccupied.

Activities: Interarrival duration, service duration, healing duration. These activities affect how long user stay in system. Each of them all but certain to be greater than zero.

- Interarrival duration is determined by generate_interarrival()
- Service duration is determined by generate_nurse_service()
- Healing duration is determined three random function and one variable. Number of beds and generate_home_probability() functions determine where patient is treated. If number of empty beds is 0 or patient's status is not critic, patient will be treated in home. If patient is treated in home, generate_home_healing_time() will generate time for patient, otherwise generate_hospital_healing_time() will generate.

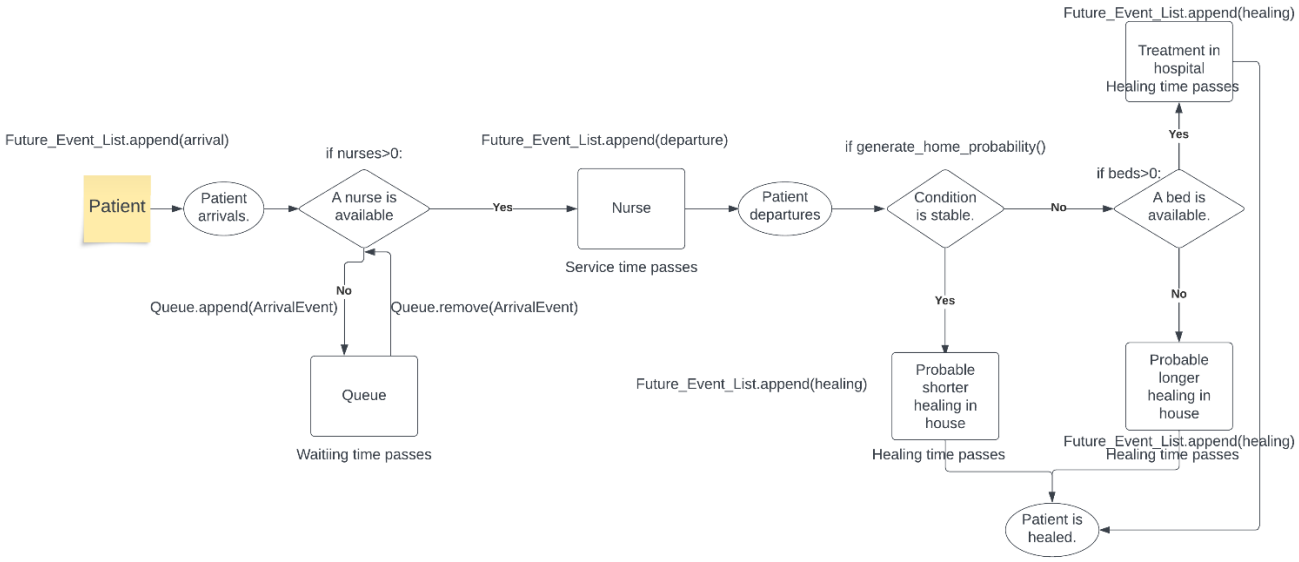
Delay: Waiting duration in queue. If a nurse is available, patient will not delay and will not wait in queue. Delay depends on number of nurses, service rate and arrival rate.

System state of interest: Queue length, number of available beds, number of available nurses, active sick people, patients in hospital.

- Queue length affects nurses' affect utilization and new departure time.
- Number of available beds may determine where patient is treated.
- Number of available nurses may cause new arrival to wait.
- Active sick people are people in server.

- Patients in hospital are people who affect treatment time of other patients. Who treated in home, do not affect the others when they healed.

DİAGRAM



PSUEDOCODE

Define Event():

Event.user

Event.type

Event.endTime

#In empty system:

Current_time=0

Nurses=2

Arrivals=0

Beds=5

Queue=[]

Future_Event_List=[]

Current_Event=None

Define GenerateInterarrival(): “math.log(1-randInt)*-1”

Define GenerateNurseServiceTime(): “(math.log(1-randInt)*-1)/0.666666667”

Define GenerateHospitalHealingTime(): “(math.log(1-randInt)*-1)/0.1875”

```
Define GenerateHomeHealingTime():
    if input c: “((math.log(1-randInt)*-1)/0.1875)*((randInt2/2)+1.25)”
    if input s: ”(math.log(1-randInt)*-1)/0.16”
Define Generate Home Probability():”randInt<=0.25”
Define Arrival():
    New Event event (Arrivals+1, “arrival”, GenerateInterarrival()+Current_time)
    Future_Event_List.append(event)
    If Nurses=0:
        Queue.append(event)
    Else:
        Nurses-=1
        New Event event (Arrivals, “departure”, GenerateNurseServiceTime
        ()+Current_time)
        Future_Event_List.append(event)
Define Departure():
    If GenerateHomeProbability():
        New Event event (CurrentEvent.id, “healing”, GenerateHomeHealingTime
            (s)+Current_time)
        Future_Event_List.append(event)
    Elif Beds=0:
        New Event event (CurrentEvent.id, “healing”, GenerateHomeHealingTime
            (c)+Current_time)
    Else:
        New Event event (CurrentEvent.id, “healing”, GenerateHospitalHealingTime
            ()+Current_time)
    Future_Event_List.append(event)
    If Queue is empty:
        Nurses+=1
    Else:
        New Event event (Queue.pop(0), “departure”, GenerateNurseServiceTime
        ()+Current_time)
```

Future_Event_List.append(event)

Define TreatedatHospital():

Beds+=1

Define AdvanceTime():

Next_event=event with minimum time in Future_Event_List

Current_time=Next_event.time

Define ExecuteTime():

Current_event=Future_Event_List.pop(0)

Call function of Current_event.type

Define Main():

New Event event (total_Arrivals, “arrival”, GenerateInterarrival()+current_time)

Future_Event_List.append(event)

OUR RANDOM VALUES

S: 2

Triage Nurse Rate: 0.666666667

p_1: 0.25

K: 5

Healing in hospital rate: 0.1875

HAND SIMULATION

Time	Current Event	FEL	Queue Size	Nurse Availability	Available Beds	Sick People	People in Hospital
0	-	A(0.5078)	0	available,available	5	0	0
0.5078	A(0.5078)	A(1.1155),D1(1.5374)	0	busy,available	5	1	1
1.1155	A(1.1155)	D1(1.5374),A(3.1081),D2(6.6133)	0	busy,busy	5	2	2
1.5374	D1(1.5374)	A(3.1081),D2(6.6133),Hs(7.071)	0	available,busy	4	2	2
3.1081	A(3.1081)	D2(6.6133),Hs(7.071),A(3.2387),D1(5.5347)	0	busy,busy	4	3	3
3.2387	A(3.2387)	Hs(7.071),D2(6.6133),D1(5.5347),A(4.9829)	1	busy,busy	4	4	4
4.9829	A(4.9829)	D2(6.6133),D1(5.5347),Hs(7.071),A(5.5002)	2	busy,busy	4	5	5
5.5002	A(5.5002)	D1(5.5347),Hs(7.071),D2(6.6133),A(6.458)	3	busy,busy	4	6	6
5.5347	D1(5.5347)	Hs(7.071),D2(6.6133),A(6.458),Hs(7.2898),D1(6.1906)	2	busy,busy	3	6	6
6.1906	D1(6.1906)	D2(6.6133),A(6.458),Hs(7.2898),Hs(7.071),Hm(9.9838),D1(6.3245)	1	busy,busy	3	6	5
6.3245	D1(6.3245)	A(6.458),Hs(7.2898),Hs(7.071),Hm(9.9838),D2(6.6133),Hm(7.6779),D1(6.3671)	0	busy,busy	3	6	4
6.3671	D1(6.3671)	Hs(7.2898),Hs(7.071),Hm(9.9838),D2(6.6133),Hm(7.6779),A(6.458),Hs(13.9803)	0	available,busy	2	6	4
6.458	A(6.458)	Hs(7.071),Hm(9.9838),D2(6.6133),Hm(7.6779),Hs(7.2898),Hs(13.9803),A(9.2745),D1(7.0977)	0	busy,busy	2	7	5
6.6133	D2(6.6133)	Hm(9.9838),Hs(7.071),Hm(7.6779),Hs(7.2898),Hs(13.9803),A(9.2745),D1(7.0977),Hs(6.8555)	0	busy,available	1	7	5
6.8555	Hs(6.8555)	Hs(7.071),Hm(7.6779),Hs(7.2898),Hs(13.9803),A(9.2745),D1(7.0977),Hm(9.9838)	0	busy,available	2	6	4
7.071	Hs(7.071)	Hm(7.6779),Hs(7.2898),Hs(13.9803),A(9.2745),D1(7.0977),Hm(9.9838)	0	busy,available	3	5	3
7.0977	D1(7.0977)	Hs(7.2898),Hs(13.9803),A(9.2745),Hm(7.6779),Hm(9.9838),Hs(8.7918)	0	available,available	2	5	3
7.2898	Hs(7.2898)	Hs(13.9803),A(9.2745),Hm(7.6779),Hm(9.9838),Hs(8.7918)	0	available,available	3	4	2
7.6779	Hm(7.6779)	A(9.2745),Hs(13.9803),Hm(9.9838),Hs(8.7918)	0	available,available	3	3	2
8.7918	Hs(8.7918)	Hs(13.9803),Hm(9.9838),A(9.2745)	0	available,available	4	2	1

Nurse availability, queue size and future event list is important states for simulation. We picked closest from FEL and advanced time.

We can see that, all of beds are not occupied for the process. This is because, system started empty and only 7 arrivals came. If the simulation gets longer, it would be patient which can be send home due to lack of beds.

2.2. PROGRAM SIMULATION

Empty Simulation with 50 events

Time	Current Event	FEL	Queue Size	Nurse Availability	Available Beds	Sick People	People in Hospital
0	-	A(0.5078)	0	available,available	5	0	0
0.5078	A(0.5078)	A(1.1155),D1(1.5374)	0	busy,available	5	1	1
1.1155	A(1.1155)	D1(1.5374),A(3.1081),D2(6.6133)	0	busy,busy	5	2	2
1.5374	D1(1.5374)	A(3.1081),D2(6.6133),Hs(7.071)	0	available,busy	4	2	2
3.1081	A(3.1081)	D2(6.6133),Hs(7.071),A(3.2387),D1(5.5347)	0	busy,busy	4	3	3
3.2387	A(3.2387)	Hs(7.071),D2(6.6133),D1(5.5347),A(4.9829)	1	busy,busy	4	4	4
4.9829	A(4.9829)	D2(6.6133),D1(5.5347),Hs(7.071),A(5.5002)	2	busy,busy	4	5	5
5.5002	A(5.5002)	D1(5.5347),Hs(7.071),D2(6.6133),A(6.458)	3	busy,busy	4	6	6
5.5347	D1(5.5347)	Hs(7.071),D2(6.6133),A(6.458),Hs(7.2898),D1(6.1906)	2	busy,busy	3	6	6
6.1906	D1(6.1906)	D2(6.6133),A(6.458),Hs(7.2898),Hs(7.071),Hm(9.9838),D1(6.3245)	1	busy,busy	3	6	5
6.3245	D1(6.3245)	A(6.458),Hs(7.2898),Hs(7.071),Hm(9.9838),D2(6.6133),Hm(7.6779),D1(6.3671)	0	busy,busy	3	6	4
6.3671	D1(6.3671)	Hs(7.2898),Hs(7.071),Hm(9.9838),D2(6.6133),Hm(7.6779),A(6.458),Hs(13.9803)	0	available,busy	2	6	4
6.458	A(6.458)	Hs(7.071),Hm(9.9838),D2(6.6133),Hm(7.6779),Hs(7.2898),Hs(13.9803),A(9.2745),D1(7.0977)	0	busy,busy	2	7	5
6.6133	D2(6.6133)	Hm(9.9838),Hs(7.071),Hm(7.6779),Hs(7.2898),Hs(13.9803),A(9.2745),D1(7.0977),Hs(6.8555)	0	busy,available	1	7	5
6.8555	Hs(6.8555)	Hs(7.071),Hm(7.6779),Hs(7.2898),Hs(13.9803),A(9.2745),D1(7.0977),Hm(9.9838)	0	busy,available	2	6	4
7.071	Hs(7.071)	Hm(7.6779),Hs(7.2898),Hs(13.9803),A(9.2745),D1(7.0977),Hm(9.9838)	0	busy,available	3	5	3
7.0977	D1(7.0977)	Hs(7.2898),Hs(13.9803),A(9.2745),Hm(7.6779),Hm(9.9838),Hs(8.7918)	0	available,available	2	5	3
7.2898	Hs(7.2898)	Hs(13.9803),A(9.2745),Hm(7.6779),Hm(9.9838),Hs(8.7918)	0	available,available	3	4	2
7.6779	Hm(7.6779)	A(9.2745),Hs(13.9803),Hm(9.9838),Hs(8.7918)	0	available,available	3	3	2
8.7918	Hs(8.7918)	Hs(13.9803),Hm(9.9838),A(9.2745)	0	available,available	4	2	1
9.2745	A(9.2745)	Hm(9.9838),Hs(13.9803),A(9.4252),D1(10.3593)	0	busy,available	4	3	2
9.4252	A(9.4252)	Hs(13.9803),Hm(9.9838),D1(10.3593),A(10.9229),D2(11.2054)	0	busy,busy	4	4	3
9.9838	Hm(9.9838)	Hs(13.9803),D1(10.3593),A(10.9229),D2(11.2054)	0	busy,busy	4	3	3
10.3593	D1(10.3593)	Hs(13.9803),A(10.9229),D2(11.2054),Hs(29.7526)	0	available,busy	3	3	3
10.9229	A(10.9229)	Hs(13.9803),D2(11.2054),Hs(29.7526),A(11.2501),D1(16.97)	0	busy,busy	3	4	4
11.2054	D2(11.2054)	Hs(13.9803),Hs(29.7526),A(11.2501),D1(16.97),Hs(13.7996)	0	busy,available	2	4	4
11.2501	A(11.2501)	Hs(29.7526),Hs(13.9803),D1(16.97),Hs(13.7996),A(15.6399),D2(11.8965)	0	busy,busy	2	5	5
11.8965	D2(11.8965)	Hs(13.9803),D1(16.97),Hs(13.7996),A(15.6399),Hs(29.7526),Hs(13.4078)	0	busy,available	1	5	5
13.4078	Hs(13.4078)	D1(16.97),Hs(13.7996),A(15.6399),Hs(29.7526),Hs(13.9803)	0	busy,available	2	4	4
13.7996	Hs(13.7996)	D1(16.97),A(15.6399),Hs(29.7526),Hs(13.9803)	0	busy,available	3	3	3
13.9803	Hs(13.9803)	A(15.6399),Hs(29.7526),D1(16.97)	0	busy,available	4	2	2
15.6399	A(15.6399)	Hs(29.7526),D1(16.97),A(15.8617),D2(16.2051)	0	busy,busy	4	3	3
15.8617	A(15.8617)	D1(16.97),Hs(29.7526),D2(16.2051),A(16.3961)	1	busy,busy	4	4	4
16.2051	D2(16.2051)	Hs(29.7526),D1(16.97),A(16.3961),Hs(26.7597),D2(17.2568)	0	busy,busy	3	4	4
16.3961	A(16.3961)	D1(16.97),Hs(29.7526),Hs(26.7597),D2(17.2568),A(19.3893)	1	busy,busy	3	5	5
16.97	D1(16.97)	Hs(29.7526),Hs(26.7597),D2(17.2568),A(19.3893),Hs(31.8295),D1(18.1092)	0	busy,busy	2	5	5
17.2568	D2(17.2568)	Hs(26.7597),Hs(29.7526),A(19.3893),Hs(31.8295),D1(18.1092),Hs(26.6117)	0	busy,available	1	5	5
18.1092	D1(18.1092)	Hs(29.7526),A(19.3893),Hs(31.8295),Hs(26.7597),Hs(26.6117),Hs(30.117)	0	available,available	0	5	5
19.3893	A(19.3893)	Hs(29.7526),Hs(31.8295),Hs(26.7597),Hs(26.6117),Hs(30.117),A(19.4134),D1(19.6838)	0	busy,available	0	6	6
19.4134	A(19.4134)	Hs(31.8295),Hs(26.7597),Hs(26.6117),Hs(30.117),Hs(29.7526),D1(19.6838),A(20.0698),D2(19.5078)	0	busy,busy	0	7	7
19.5078	D2(19.5078)	Hs(26.7597),Hs(26.6117),Hs(30.117),Hs(29.7526),D1(19.6838),A(20.0698),Hs(31.8295),Hm(22.1187)	0	busy,available	0	7	6
19.6838	D1(19.6838)	Hs(26.6117),Hs(30.117),Hs(29.7526),Hs(26.7597),A(20.0698),Hs(31.8295),Hm(22.1187),Hm(20.1172)	0	available,available	0	7	5
20.0698	A(20.0698)	Hs(30.117),Hs(29.7526),Hs(26.7597),Hs(26.6117),Hs(31.8295),Hm(22.1187),Hm(20.1172),A(21.0293),D1(21.0405)	0	busy,available	0	8	6
20.1172	Hm(20.1172)	Hs(29.7526),Hs(26.7597),Hs(26.6117),Hs(31.8295),Hm(22.1187),Hs(30.117),A(21.0293),D1(21.0405)	0	busy,available	0	7	6
21.0293	A(21.0293)	Hs(26.7597),Hs(26.6117),Hs(31.8295),Hm(22.1187),Hs(30.117),Hs(29.7526),D1(21.0405),A(21.1438),D2(25.5094)	0	busy,busy	0	8	7
21.0405	D1(21.0405)	Hs(26.6117),Hs(31.8295),Hm(22.1187),Hs(30.117),Hs(29.7526),Hs(26.7597),A(21.1438),D2(25.5094),Hm(32.3726)	0	available,busy	0	8	6
21.1438	A(21.1438)	Hs(31.8295),Hm(22.1187),Hs(30.117),Hs(29.7526),Hs(26.7597),Hs(26.6117),D2(25.5094),Hm(32.3726),A(21.8266),D1(22	0	busy,busy	0	9	7
21.8266	A(21.8266)	Hm(22.1187),Hs(30.117),Hs(29.7526),Hs(26.7597),Hs(26.6117),D2(25.5094),Hm(32.3726),Hs(31.8295),D1(22.3116),A(22	1	busy,busy	0	10	8
22.1187	Hm(22.1187)	Hs(30.117),Hs(29.7526),Hs(26.7597),Hs(26.6117),D2(25.5094),Hm(32.3726),Hs(31.8295),D1(22.3116),A(22.1782)	1	busy,busy	0	9	8
22.1782	A(22.1782)	Hs(29.7526),Hs(26.7597),Hs(26.6117),D2(25.5094),Hm(32.3726),Hs(31.8295),D1(22.3116),Hs(30.117),A(23.3362)	2	busy,busy	0	10	9
22.3116	D1(22.3116)	Hs(26.7597),Hs(26.6117),D2(25.5094),Hm(32.3726),Hs(31.8295),Hs(29.7526),Hs(30.117),A(23.3362),Hm(24.7869),D1(23	1	busy,busy	0	10	8

Full simulation with 50 events

	A	B	C	D	E	F	G	H
1	Time	Current Event	FEL	Queue Size	Nurse Availability	Available Beds	Sick People	People in Hospital
2	0	-	D1(0.7617),D2(0.9116),Hs(3.6608),Hs(10.6269),Hs(19.5475),Hs(12.8248),Hs(5.5336),A(0.1306)	0	busy,busy	0	7	7
3	0.1306	A(0.1306)	D2(0.9116),Hs(3.6608),Hs(10.6269),Hs(19.5475),Hs(12.8248),Hs(5.5336),D1(0.7617),A(1.7484)	1	busy,busy	0	8	8
4	0.7617	D1(0.7617)	Hs(3.6608),Hs(10.6269),Hs(19.5475),Hs(12.8248),Hs(5.5336),D2(0.9116),A(1.7484),Hm(5.06),D1(2.0723)	0	busy,busy	0	8	7
5	0.9116	D2(0.9116)	Hs(10.6269),Hs(19.5475),Hs(12.8248),Hs(5.5336),Hs(3.6608),A(1.7484),Hm(5.06),D1(2.0723),Hm(3.9711)	0	busy,busy	0	8	6
6	1.7484	A(1.7484)	Hs(19.5475),Hs(12.8248),Hs(5.5336),Hs(3.6608),Hs(10.6269),Hm(5.06),D1(2.0723),Hm(3.9711),A(2.3553),D2(1.8823)	0	busy,busy	0	9	7
7	1.8823	D2(1.8823)	Hs(12.8248),Hs(5.5336),Hs(3.6608),Hs(10.6269),Hm(5.06),D1(2.0723),Hm(3.9711),A(2.3553),Hs(19.5475),Hm(3.2357)	0	busy,available	0	9	6
8	2.0723	D1(2.0723)	Hs(5.5336),Hs(3.6608),Hs(10.6269),Hm(5.06),Hs(12.8248),Hm(3.9711),A(2.3553),Hs(19.5475),Hm(3.2357),Hm(24.2189)	0	available,available	0	9	5
9	2.3553	A(2.3553)	Hs(3.6608),Hs(10.6269),Hm(5.06),Hs(12.8248),Hm(3.9711),Hs(5.5336),Hs(19.5475),Hm(3.2357),Hm(24.2189),A(3.7828),D1(6.58)	0	busy,available	0	10	6
10	3.2357	Hm(3.2357)	Hs(10.6269),Hm(5.06),Hs(12.8248),Hm(3.9711),Hs(5.5336),Hs(19.5475),Hs(3.6608),Hm(24.2189),A(3.7828),D1(6.58)	0	busy,available	0	9	6
11	3.6608	Hs(3.6608)	Hm(5.06),Hs(12.8248),Hm(3.9711),Hs(5.5336),Hs(19.5475),Hs(10.6269),Hm(24.2189),A(3.7828),D1(6.58)	0	busy,available	1	8	5
12	3.7828	A(3.7828)	Hs(12.8248),Hm(3.9711),Hs(5.5336),Hs(19.5475),Hs(10.6269),Hm(24.2189),Hm(5.06),D1(6.58),A(4.2092),D2(4.5885)	0	busy,busy	1	9	6
13	3.9711	Hm(3.9711)	Hs(12.8248),Hs(5.5336),Hs(19.5475),Hs(10.6269),Hm(24.2189),Hm(5.06),D1(6.58),A(4.2092),D2(4.5885)	0	busy,busy	1	8	6
14	4.2092	A(4.2092)	Hs(5.5336),Hs(19.5475),Hs(10.6269),Hm(24.2189),Hm(5.06),D1(6.58),Hs(12.8248),D2(4.5885),A(4.2546)	1	busy,busy	1	9	7
15	4.2546	A(4.2546)	Hs(19.5475),Hs(10.6269),Hm(24.2189),Hm(5.06),D1(6.58),Hs(12.8248),D2(4.5885),Hs(5.5336),A(5.7271)	2	busy,busy	1	10	8
16	4.5885	D2(4.5885)	Hs(10.6269),Hm(24.2189),Hm(5.06),D1(6.58),Hs(12.8248),Hs(19.5475),Hs(5.5336),A(5.7271),Hs(5.3921),D2(5.6732)	1	busy,busy	0	10	8
17	5.06	Hm(5.06)	Hm(24.2189),Hs(10.6269),D1(6.58),Hs(12.8248),Hs(19.5475),Hs(5.5336),A(5.7271),Hs(5.3921),D2(5.6732)	1	busy,busy	0	9	8
18	5.3921	Hs(5.3921)	Hs(10.6269),D1(6.58),Hs(12.8248),Hs(19.5475),Hs(5.5336),A(5.7271),Hm(24.2189),D2(5.6732)	1	busy,busy	1	8	7
19	5.5336	Hs(5.5336)	D1(6.58),Hs(12.8248),Hs(19.5475),Hs(10.6269),A(5.7271),Hm(24.2189),D2(5.6732)	1	busy,busy	2	7	6
20	5.6732	D2(5.6732)	Hs(12.8248),Hs(19.5475),Hs(10.6269),A(5.7271),Hm(24.2189),D1(6.58),Hs(12.0028),D2(8.3607)	0	busy,busy	1	7	6
21	5.7271	A(5.7271)	Hs(19.5475),Hs(10.6269),Hs(12.8248),Hm(24.2189),D1(6.58),Hs(12.0028),D2(8.3607),A(9.3633)	1	busy,busy	1	8	7
22	6.58	D1(6.58)	Hs(10.6269),Hs(12.8248),Hm(24.2189),Hs(19.5475),Hs(12.0028),D2(8.3607),A(9.3633),Hs(28.0807),D1(7.9856)	0	busy,busy	0	8	7
23	7.9856	D1(7.9856)	Hs(12.8248),Hm(24.2189),Hs(19.5475),Hs(12.0028),D2(8.3607),A(9.3633),Hs(28.0807),Hs(10.6269),Hm(41.3486)	0	available,busy	0	8	6
24	8.3607	D2(8.3607)	Hm(24.2189),Hs(19.5475),Hs(12.0028),Hs(12.8248),A(9.3633),Hs(28.0807),Hs(10.6269),Hm(41.3486),Hm(10.4001)	0	available,available	0	8	5
25	9.3633	A(9.3633)	Hs(19.5475),Hs(12.0028),Hs(12.8248),Hm(24.2189),Hs(28.0807),Hs(10.6269),Hm(41.3486),Hm(10.4001),A(9.7401),D1(10.1649)	0	busy,available	0	9	6
26	9.7401	A(9.7401)	Hs(12.0028),Hs(12.8248),Hm(24.2189),Hs(28.0807),Hs(10.6269),Hm(41.3486),Hm(10.4001),Hs(19.5475),D1(10.1649),A(12.5676),D2(12.7086)	0	busy,busy	0	10	7
27	10.165	D1(10.1649)	Hs(12.8248),Hm(24.2189),Hs(28.0807),Hs(10.6269),Hm(41.3486),Hm(10.4001),Hs(19.5475),Hs(12.0028),A(12.5676),D2(12.7086),Hm(35.6274)	0	available,busy	0	10	6
28	10.4	Hm(10.4001)	Hm(24.2189),Hs(28.0807),Hs(10.6269),Hm(41.3486),Hs(12.8248),Hs(19.5475),Hs(12.0028),A(12.5676),D2(12.7086),Hm(35.6274)	0	available,busy	0	9	6
29	10.627	Hs(10.6269)	Hs(28.0807),Hm(24.2189),Hm(41.3486),Hs(12.8248),Hs(19.5475),Hs(12.0028),A(12.5676),D2(12.7086),Hm(35.6274)	0	available,busy	1	8	5
30	12.003	Hs(12.0028)	Hm(24.2189),Hm(41.3486),Hs(12.8248),Hs(19.5475),Hs(28.0807),A(12.5676),D2(12.7086),Hm(35.6274)	0	available,busy	2	7	4
31	12.568	A(12.5676)	Hm(41.3486),Hs(12.8248),Hs(19.5475),Hs(28.0807),Hm(24.2189),D2(12.7086),Hm(35.6274),A(15.3537),D1(13.7068)	0	busy,busy	2	8	5
32	12.709	D2(12.7086)	Hs(12.8248),Hs(19.5475),Hs(28.0807),Hm(24.2189),Hm(41.3486),Hm(35.6274),A(15.3537),D1(13.7068),Hs(22.0636)	0	busy,available	1	8	5
33	12.825	Hs(12.8248)	Hs(19.5475),Hs(28.0807),Hm(24.2189),Hm(41.3486),Hm(35.6274),A(15.3537),D1(13.7068),Hs(22.0636)	0	busy,available	2	7	4
34	13.707	D1(13.7068)	Hs(28.0807),Hm(24.2189),Hm(41.3486),Hm(35.6274),A(15.3537),Hs(19.5475),Hs(22.0636),Hs(25.7145)	0	available,available	1	7	4
35	15.354	A(15.3537)	Hm(24.2189),Hm(41.3486),Hm(35.6274),Hs(28.0807),Hs(19.5475),Hs(22.0636),Hs(25.7145),A(15.3778),D1(15.6482)	0	busy,available	1	8	5
36	15.378	A(15.3778)	Hm(41.3486),Hm(35.6274),Hs(28.0807),Hs(19.5475),Hs(22.0636),Hs(25.7145),Hm(24.2189),D1(15.6482),A(16.0342),D2(15.4723)	0	busy,busy	1	9	6
37	15.472	D2(15.4723)	Hm(35.6274),Hs(28.0807),Hs(19.5475),Hs(22.0636),Hs(25.7145),Hm(24.2189),D1(15.6482),A(16.0342),Hm(41.3486),Hs(16.9999)	0	busy,available	0	9	6
38	15.648	D1(15.6482)	Hs(28.0807),Hs(19.5475),Hs(22.0636),Hs(25.7145),Hm(24.2189),Hm(35.6274),A(16.0342),Hm(41.3486),Hs(16.9999),Hm(20.58)	0	available,available	0	9	5
39	16.034	A(16.0342)	Hs(19.5475),Hs(22.0636),Hs(25.7145),Hm(24.2189),Hm(35.6274),Hs(28.0807),Hm(41.3486),Hs(16.9999),Hm(20.58),A(16.0442),D1(17.4736)	0	busy,available	0	10	6
40	16.044	A(16.0442)	Hs(22.0636),Hs(25.7145),Hm(24.2189),Hm(35.6274),Hs(28.0807),Hm(41.3486),Hs(16.9999),Hm(20.58),Hs(19.5475),D1(17.4736),A(16.6914),D2(16.2159)	0	busy,busy	0	11	7
41	16.216	D2(16.2159)	Hs(25.7145),Hm(24.2189),Hm(35.6274),Hs(28.0807),Hm(41.3486),Hs(16.9999),Hm(20.58),Hs(19.5475),D1(17.4736),A(16.6914),Hs(22.0636),Hm(19.4271)	0	busy,available	0	11	6
42	16.691	A(16.6914)	Hm(24.2189),Hm(35.6274),Hs(28.0807),Hm(41.3486),Hs(16.9999),Hm(20.58),Hs(19.5475),D1(17.4736),Hs(25.7145),Hs(22.0636),Hm(19.4271),A(17.3683),D2(17.7155)	0	busy,busy	0	12	7
43	17	Hs(16.9999)	Hm(35.6274),Hs(28.0807),Hm(41.3486),Hm(24.2189),Hm(20.58),Hs(19.5475),D1(17.4736),Hs(25.7145),Hs(22.0636),Hm(19.4271),A(17.3683),D2(17.7155)	0	busy,busy	1	11	6
44	17.368	A(17.3683)	Hs(28.0807),Hm(41.3486),Hm(24.2189),Hm(20.58),Hs(19.5475),D1(17.4736),Hs(25.7145),Hs(22.0636),Hm(19.4271),Hm(35.6274),D2(17.7155),A(18.1468)	1	busy,busy	1	12	7
45	17.474	D1(17.4736)	Hm(41.3486),Hm(24.2189),Hm(20.58),Hs(19.5475),Hs(28.0807),Hs(25.7145),Hs(22.0636),Hm(19.4271),Hm(35.6274),D2(17.7155),A(18.1468),Hs(23.6498),D1(18.0202)	0	busy,busy	0	12	7
46	17.716	D2(17.7155)	Hm(24.2189),Hm(20.58),Hs(19.5475),Hs(28.0807),Hs(25.7145),Hs(22.0636),Hm(19.4271),Hm(35.6274),Hm(41.3486),A(18.1468),Hs(23.6498),D1(18.0202),Hm(18.3883)	0	busy,available	0	12	6
47	18.02	D1(18.0202)	Hm(20.58),Hs(19.5475),Hs(28.0807),Hs(25.7145),Hs(22.0636),Hm(19.4271),Hm(35.6274),Hm(41.3486),A(18.1468),Hs(23.6498),Hm(24.2189),Hm(18.3883),Hm(28.3649)	0	available,available	0	12	5
48	18.147	A(18.1468)	Hs(19.5475),Hs(28.0807),Hs(25.7145),Hs(22.0636),Hm(19.4271),Hm(35.6274),Hm(41.3486),Hm(20.58),Hs(23.6498),Hm(24.2189),Hm(18.3883),Hm(28.3649),A(18.2293),D1(18.2	0	busy,available	0	13	6
49	18.229	A(18.2293)	Hs(28.0807),Hs(25.7145),Hs(22.0636),Hm(19.4271),Hm(35.6274),Hm(41.3486),Hm(20.58),Hs(23.6498),Hm(24.2189),Hm(18.3883),Hm(28.3649),Hs(19.5475),D1(18.2629),A(20.0	0	busy,busy	0	14	7
50	18.263	D1(18.2629)	Hs(25.7145),Hs(22.0636),Hm(19.4271),Hm(35.6274),Hm(41.3486),Hm(20.58),Hs(23.6498),Hm(24.2189),Hm(18.3883),Hm(28.3649),Hs(19.5475),Hs(28.0807),A(20.0175),D2(19.2	0	available,busy	0	14	6
51	18.388	Hm(18.3883)	Hs(22.0636),Hm(19.4271),Hm(35.6274),Hm(41.3486),Hm(20.58),Hs(23.6498),Hm(24.2189),Hs(25.7145),Hm(28.3649),Hs(19.5475),Hs(28.0807),A(20.0175),D2(19.2402),Hm(25.8	0	available,busy	0	13	6
52	19.24	D2(19.2402)	Hm(19.4271),Hm(35.6274),Hm(41.3486),Hm(20.58),Hs(23.6498),Hm(24.2189),Hs(25.7145),Hm(28.3649),Hs(19.5475),Hs(28.0807),A(20.0175),Hs(22.0636),Hm(25.807),Hm(22.8	0	available,available	0	13	5

Half Empty Simulation with 50 events

	A	B	C	D	E	F	G	H
1	Time	Current Event	FEL	Queue Size	Nurse Availability	Available Beds	Sick People	People in Hospital
2	0	-	D1(0.7617),Hs(3.2413),Hs(3.6608),A(1.9925)	0	busy,available	3	3	3
3	0.7617	D1(0.7617)	Hs(3.2413),Hs(3.6608),A(1.9925),Hs(13.5865)	0	available,available	2	3	3
4	1.9925	A(1.9925)	Hs(3.6608),Hs(3.2413),Hs(13.5865),A(3.0301),D1(2.1885)	0	busy,available	2	4	4
5	2.1885	D1(2.1885)	Hs(3.2413),Hs(13.5865),A(3.0301),Hs(3.6608),Hs(11.4909)	0	available,available	1	4	4
6	3.0301	A(3.0301)	Hs(13.5865),Hs(3.2413),Hs(3.6608),Hs(11.4909),A(3.5473),D1(4.4669)	0	busy,available	1	5	5
7	3.2413	Hs(3.2413)	Hs(13.5865),Hs(3.6608),Hs(11.4909),A(3.5473),D1(4.4669)	0	busy,available	2	4	4
8	3.5473	A(3.5473)	Hs(3.6608),Hs(11.4909),Hs(13.5865),D1(4.4669),A(4.4211),D2(4.041)	0	busy,busy	2	5	5
9	3.6608	Hs(3.6608)	Hs(11.4909),Hs(13.5865),D1(4.4669),A(4.4211),D2(4.041)	0	busy,busy	3	4	4
10	4.041	D2(4.041)	Hs(13.5865),D1(4.4669),A(4.4211),Hs(11.4909),Hs(4.7456)	0	busy,available	2	4	4
11	4.4211	A(4.4211)	D1(4.4669),Hs(13.5865),Hs(11.4909),Hs(4.7456),A(5.028),D2(4.555)	0	busy,busy	2	5	5
12	4.4669	D1(4.4669)	Hs(13.5865),Hs(11.4909),Hs(4.7456),A(5.028),D2(4.555),Hm(5.8203)	0	available,busy	2	5	4
13	4.555	D2(4.555)	Hs(11.4909),Hs(4.7456),A(5.028),Hs(13.5865),Hm(5.8203),Hm(26.7017)	0	available,available	2	5	3
14	4.7456	Hs(4.7456)	Hs(11.4909),A(5.028),Hs(13.5865),Hm(5.8203),Hm(26.7017)	0	available,available	3	4	2
15	5.028	A(5.028)	Hs(11.4909),Hs(13.5865),Hm(5.8203),Hm(26.7017),A(6.4555),D1(9.2527)	0	busy,available	3	5	3
16	5.8203	Hm(5.8203)	Hs(13.5865),Hs(11.4909),Hm(26.7017),A(6.4555),D1(9.2527)	0	busy,available	3	4	3
17	6.4555	A(6.4555)	Hs(11.4909),Hm(26.7017),Hs(13.5865),D1(9.2527),A(6.8819),D2(7.2612)	0	busy,busy	3	5	4
18	6.8819	A(6.8819)	Hm(26.7017),Hs(13.5865),D1(9.2527),Hs(11.4909),D2(7.2612),A(6.9273)	1	busy,busy	3	6	5
19	6.9273	A(6.9273)	Hs(13.5865),D1(9.2527),Hs(11.4909),D2(7.2612),Hm(26.7017),A(8.3998)	2	busy,busy	3	7	6
20	7.2612	D2(7.2612)	D1(9.2527),Hs(11.4909),Hs(13.5865),Hm(26.7017),A(8.3998),Hs(8.0647),D2(8.3459)	1	busy,busy	2	7	6
21	8.0647	Hs(8.0647)	Hs(11.4909),Hs(13.5865),Hm(26.7017),A(8.3998),D1(9.2527),D2(8.3459)	1	busy,busy	3	6	5
22	8.3459	D2(8.3459)	Hs(13.5865),Hm(26.7017),A(8.3998),D1(9.2527),Hs(11.4909),Hs(14.6755),D2(11.0334)	0	busy,busy	2	6	5
23	8.3998	A(8.3998)	Hm(26.7017),Hs(13.5865),D1(9.2527),Hs(11.4909),Hs(14.6755),D2(11.0334),A(12.036)	1	busy,busy	2	7	6
24	9.2527	D1(9.2527)	Hs(13.5865),Hm(26.7017),Hs(11.4909),Hs(14.6755),D2(11.0334),A(12.036),Hs(30.7534),D1(10.6583)	0	busy,busy	1	7	6
25	10.6583	D1(10.6583)	Hm(26.7017),Hs(11.4909),Hs(14.6755),D2(11.0334),A(12.036),Hs(30.7534),Hs(13.5865),Hs(34.0702)	0	available,busy	0	7	6
26	11.0334	D2(11.0334)	Hs(11.4909),Hs(14.6755),Hm(26.7017),A(12.036),Hs(30.7534),Hs(13.5865),Hs(34.0702),Hm(15.5923)	0	available,available	0	7	5
27	11.4909	Hs(11.4909)	Hs(14.6755),Hm(26.7017),A(12.036),Hs(30.7534),Hs(13.5865),Hs(34.0702),Hm(15.5923)	0	available,available	1	6	4
28	12.036	A(12.036)	Hm(26.7017),Hs(14.6755),Hs(30.7534),Hs(13.5865),Hs(34.0702),Hm(15.5923),A(12.2578),D1(12.6012)	0	busy,available	1	7	5
29	12.2578	A(12.2578)	Hs(14.6755),Hs(30.7534),Hs(13.5865),Hs(34.0702),Hm(15.5923),Hm(26.7017),D1(12.6012),A(12.7922),D2(16.499)	0	busy,busy	1	8	6
30	12.6012	D1(12.6012)	Hs(30.7534),Hs(13.5865),Hs(34.0702),Hm(15.5923),Hm(26.7017),Hs(14.6755),A(12.7922),D2(16.499),Hs(16.3406)	0	available,busy	0	8	6
31	12.7922	A(12.7922)	Hs(13.5865),Hs(34.0702),Hm(15.5923),Hm(26.7017),Hs(14.6755),Hs(30.7534),D2(16.499),Hs(16.3406),A(15.7855),D1(14.	0	busy,busy	0	9	7
32	13.5865	Hs(13.5865)	Hs(34.0702),Hm(15.5923),Hm(26.7017),Hs(14.6755),Hs(30.7534),D2(16.499),Hs(16.3406),A(15.7855),D1(14.549)	0	busy,busy	1	8	6
33	14.549	D1(14.549)	Hm(15.5923),Hm(26.7017),Hs(14.6755),Hs(30.7534),D2(16.499),Hs(16.3406),A(15.7855),Hs(34.0702),Hs(18.5993)	0	available,busy	0	8	6
34	14.6755	Hs(14.6755)	Hm(26.7017),Hm(15.5923),Hs(30.7534),D2(16.499),Hs(16.3406),A(15.7855),Hs(34.0702),Hs(18.5993)	0	available,busy	1	7	5
35	15.5923	Hm(15.5923)	Hm(26.7017),Hs(30.7534),D2(16.499),Hs(16.3406),A(15.7855),Hs(34.0702),Hs(18.5993)	0	available,busy	1	6	5
36	15.7855	A(15.7855)	Hs(30.7534),D2(16.499),Hs(16.3406),Hm(26.7017),Hs(34.0702),Hs(18.5993),A(16.4427),D1(18.4165)	0	busy,busy	1	7	6
37	16.3406	Hs(16.3406)	D2(16.499),Hs(30.7534),Hm(26.7017),Hs(34.0702),Hs(18.5993),A(16.4427),D1(18.4165)	0	busy,busy	2	6	5
38	16.4427	A(16.4427)	Hs(30.7534),Hm(26.7017),Hs(34.0702),Hs(18.5993),D2(16.499),D1(18.4165),A(16.8928)	1	busy,busy	2	7	6
39	16.499	D2(16.499)	Hm(26.7017),Hs(34.0702),Hs(18.5993),Hs(30.7534),D1(18.4165),A(16.8928),Hs(16.6274),D2(16.7935)	0	busy,busy	1	7	6
40	16.6274	Hs(16.6274)	Hs(34.0702),Hs(18.5993),Hs(30.7534),D1(18.4165),A(16.8928),Hm(26.7017),D2(16.7935)	0	busy,busy	2	6	5
41	16.7935	D2(16.7935)	Hs(18.5993),Hs(30.7534),D1(18.4165),A(16.8928),Hm(26.7017),Hs(34.0702),Hs(17.1293)	0	busy,available	1	6	5
42	16.8928	A(16.8928)	Hs(30.7534),D1(18.4165),Hs(18.5993),Hm(26.7017),Hs(34.0702),Hs(17.1293),A(17.9461),D2(17.3224)	0	busy,busy	1	7	6
43	17.1293	Hs(17.1293)	D1(18.4165),Hs(18.5993),Hm(26.7017),Hs(34.0702),Hs(30.7534),A(17.9461),D2(17.3224)	0	busy,busy	2	6	5
44	17.3224	D2(17.3224)	Hs(18.5993),Hm(26.7017),Hs(34.0702),Hs(30.7534),A(17.9461),D1(18.4165),Hs(21.1713)	0	busy,available	1	6	5
45	17.9461	A(17.9461)	Hm(26.7017),Hs(34.0702),Hs(30.7534),Hs(18.5993),D1(18.4165),Hs(21.1713),A(18.0109),D2(17.9612)	0	busy,busy	1	7	6
46	17.9612	D2(17.9612)	Hs(34.0702),Hs(30.7534),Hs(18.5993),D1(18.4165),Hs(21.1713),A(18.0109),Hm(26.7017),Hs(21.4125)	0	busy,available	0	7	6
47	18.0109	A(18.0109)	Hs(30.7534),Hs(18.5993),D1(18.4165),Hs(21.1713),Hs(34.0702),Hm(26.7017),Hs(21.4125),A(18.1253),D2(22.491)	0	busy,busy	0	8	7
48	18.1253	A(18.1253)	Hs(18.5993),D1(18.4165),Hs(21.1713),Hs(34.0702),Hm(26.7017),Hs(21.4125),Hs(30.7534),D2(22.491),A(18.4949)	1	busy,busy	0	9	8
49	18.4165	D1(18.4165)	Hs(18.5993),Hs(21.1713),Hs(34.0702),Hm(26.7017),Hs(21.4125),Hs(30.7534),D2(22.491),A(18.4949),Hm(23.8224),D1(19.	0	busy,busy	0	9	7
50	18.4949	A(18.4949)	Hs(21.1713),Hs(34.0702),Hm(26.7017),Hs(21.4125),Hs(30.7534),D2(22.491),Hs(18.5993),Hm(23.8224),D1(19.5844),A(18.	1	busy,busy	0	10	8
51	18.5993	Hs(18.5993)	Hs(34.0702),Hm(26.7017),Hs(21.4125),Hs(30.7534),D2(22.491),Hs(21.1713),Hm(23.8224),D1(19.5844),A(18.8465)	1	busy,busy	1	9	7
52	18.8465	A(18.8465)	Hm(26.7017),Hs(21.4125),Hs(30.7534),D2(22.491),Hs(21.1713),Hm(23.8224),D1(19.5844),Hs(34.0702),A(20.0046)	2	busy,busy	1	10	8

Statistics for all conditions.

	E	HE	F
	long run marginal probabilities of being empty for triage 0.5088086028460719	long run marginal probabilities of being empty for triage 0.42343652180520047	long run marginal probabilities of being empty for triage 0.5998091777215138
	long run marginal probabilities of being empty for beds 0.6955421206533087	long run marginal probabilities of being empty for beds 0.834648888312313	long run marginal probabilities of being empty for beds 0.3983324670423866
	joint probability of both being empty 0.3565982737669464 7	joint probability of both being empty 0.3758559466228566	joint probability of both being empty 0.2076494237119928
	average number of people that are rejected due to bed unavailability 0.44	average number of people that are rejected due to bed unavailability 0.15	average number of people that are rejected due to bed unavailability 0.5238095238095238
	average utilization of each triage nurse 0.6696120520947858	average utilization of each triage nurse 0.7179292627415398	average utilization of each triage nurse 0.6179909455261134
	average number of occupied beds in the hospital 2.953469200346995	average number of occupied beds in the hospital 3.6097424206748494	average number of occupied beds in the hospital 4.534492041136982
	average number of patients that are treated at home 0.5172413793103449	average number of patients that are treated at home 0.32	average number of patients that are treated at home 0.6153846153846154
20	average time a sick person gets better 6.290734696198514	average time a sick person gets better 5.108395446541409	average time a sick person gets better 7.601359055050553
	long run marginal probabilities of being empty for triage 0.4592066771527562	long run marginal probabilities of being empty for triage 0.3741073325887 3946	long run marginal probabilities of being empty for triage 0.4058878092782915
	long run marginal probabilities of being empty for beds 0.8587983833897453	long run marginal probabilities of being empty for beds 0.7786228467815914	long run marginal probabilities of being empty for beds 0.7391844846755699
	joint probability of both being empty 0.3779097382804 51	joint probability of both being empty 0.2960075706829392	joint probability of both being empty 0.2860352937116587
	average number of people that are rejected due to bed unavailability 0.1793103448275862	average number of people that are rejected due to bed unavailability 0.20945945945945946	average number of people that are rejected due to bed unavailability 0.2569444444444444
	average utilization of each triage nurse 0.6653906328625429	average utilization of each triage nurse 0.7495094837819082	average utilization of each triage nurse 0.7297259722533926
	average number of occupied beds in the hospital 2.7688976122545	average number of occupied beds in the hospital 3.2429833923996667	average number of occupied beds in the hospital 3.3897324569457976
	average number of patients that are treated at home 0.4137931034827586	average number of patients that are treated at home 0.4207920792079208	average number of patients that are treated at home 0.465
200	average time a sick person gets better 7.959888820550919	average time a sick person gets better 7.959840247509972	average time a sick person gets better 8.205064893872485
	long run marginal probabilities of being empty for triage 0.2881775685007485	long run marginal probabilities of being empty for triage 0.300169023305467	long run marginal probabilities of being empty for triage 0.3037693668101956
	long run marginal probabilities of being empty for beds 0.7842302737884177	long run marginal probabilities of being empty for beds 0.7790139930606513	long run marginal probabilities of being empty for beds 0.7728163763344501
	joint probability of both being empty 0.2229356821504434	joint probability of both being empty 0.2365795919328926	joint probability of both being empty 0.2339331544089874
	average number of people that are rejected due to bed unavailability 0.2370860927152318	average number of people that are rejected due to bed unavailability 0.23733333333333334	average number of people that are rejected due to bed unavailability 0.2459677419354838 7
	average utilization of each triage nurse 0.795223734205087	average utilization of each triage nurse 0.7879935612447326	average utilization of each triage nurse 0.7860680389582236
	average number of occupied beds in the hospital 3.197737078037755	average number of occupied beds in the hospital 3.2835119002522184	average number of occupied beds in the hospital 3.308549955111237
	average number of patients that are treated at home 0.42686567164179107	average number of patients that are treated at home 0.4308457711442863	average number of patients that are treated at home 0.439
1000	average time a sick person gets better 10.845198646626327	average time a sick person gets better 10.598041438055509	average time a sick person gets better 10.660036861652605

Using the P(L(infinity) > c) formula for the M/M/c type of systems and subtracting that from 1 gives us the marginal probability of 0.35, which is lower than the cases n=20 and n=200 but higher than the case n=1000. However, when we tried to run the system with even higher n, like 10k or 100k, we saw that the probability converges to 0.35, so it is as expected.

Also, using the formula for server utilization (lambda/c*mu), we have calculated that the average utilization of a nurse should be 0.75, and this roughly agrees with simulation results. According to our simulation results, 0.4% of arriving patients are treated at home, which means 0.6 of them are treated at the hospital. Using that, we can calculate the total utilization (average number of occupied beds) with the arrival rate / treatment at hospital rate, and our calculations resulted in an average of 3.2 bed occupation, which agrees strongly with our simulation.

Multiplying the long-run marginal probabilities for being empty and beds resulted in a similar result to what our simulation found for their joint probability, so that agrees with our expectations as well.

The arrival rate of patients coming to the hospital is 1, and they are in critical condition with a 0.75 probability, and 20% of them are rejected, according to our simulation results, which means the rate of being treated at the hospital is 0.75*0.8, which is 0.6, close to what we found in our simulation.

Lastly, the summation of the rate of people rejected and the probability of being empty for triage result in a close number to 1, which is in our expectations.