



An OO Programmed Approach to ARGESIM Comparison C6 'Emergency Department' with CSIM

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Simulator. CSIM (Mesquite Software) is a process-oriented, general-purpose simulation toolkit, which supports the development of process-oriented, discrete-event simulation models, by using the standard programming languages C and C++. Because of the nature of compiled C and C++ programs and CSIM's dynamic memory allocation, developed models are compact and efficient.

Model. We have described the model textually by writing the corresponding C++ code. In order to model patients we have defined the class *Patient* with a set of attributes (such as *patient id*, *type of treatment*), and a set of operations that define the flow and behavior of the patient during the treatment. Each patient in our simulation model is an object of the class *Patient*. The behavior of the patient is defined as a CSIM *process*. In a CSIM model a *process* represents an active entity.

We have used CSIM *facilities* to model units of the emergency department, which consists of the registration, casualty wards (CW), X-ray room, and plastering room. CSIM supports single-server and multi-server facilities. Multi-server facilities are used to model casualty wards CW1 and CW2, and X-ray room, whereas single-server facilities model the registration and plastering room. The waiting of patients until doctors begin to work at 08:00h, is modeled with a CSIM *event*. When at 08:00h this event occurs, patients may proceed with the treatment.

The replacement of a doctor in a CW is modeled by changing the working time of one of the two doctors in CW during the period the condition for doctor exchange holds. In CSIM we have changed the service time for one the two servers of the multi-server facility that models CW.

The default service discipline is First Come, First Served (FCFS). The priority of the patient is changed by using the CSIM statement,

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set_priority(new_priority).
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The objects of the CSIM class table are used to collect explicit statistics on treatment times. Statistics of CSIM facilities are collected automatically.

Task a - Average Treatment Times. Table 1 shows the mean, maximum, and standard deviation for each type of patient.

The result for all 250 patients is shown in the last row of the table.

Patient type	Treatment time [minutes]		
	mean	max.	s.d.
1	236	334	63
2	137	267	61
3	252	327	56
4	124	265	60
All	173	334	81
CW	queue length	doctor utilization	response T [min.]
1	57	0.92	96
2	31	0.84	83

Table 1. Simulation results for Task a.

Task b - Doctors' Exchange Strategy. This strategy increases the mean treatment time for all types of patients. The queue length, doctor utilization, and response time, are decreased for CW2, but the response time is increased for CW1 (see Table 2).

Patient type	Treatment time [minutes]		
	mean	max.	s.d.
1	253	378	81
2	146	307	70
3	266	381	73
4	138	303	73
All	185	381	94
CW	queue length	doctor utilization	response T [min.]
1	64	0.92	127
2	21	0.64	61

Table 2. Simulation results for Task b.

Task c - Priority Ranking. The strategy to increase the priority of the patient that enters for the second time one of units of the emergency department results with a decrease of the mean treatment time for patients of type 1 and type 3. But, the treatment time for patients of type 2 and type 4 is increased. However, the overall treatment time and standard deviation are decreased (see Table 3).

Patient type	Treatment time [minutes]		
	mean	max.	s.d.
1	165	334	76
2	167	329	76
3	179	323	75
4	157	326	75
All	163	334	76

Table 3. Simulation results for Task c.

Simulation is executed on Sun Blade 150 workstation (CPU 650MHz, memory 768MB). The CPU time used for one simulation run is 0.03 seconds. For each task we have executed 30 simulation runs.

C6 Classification: Object-Oriented Simulation Simulator: CSIM 18.3 for SPARC Solaris

