**UNIVERSITY OF NOVI SAD**
**TECHNICAL FACULTY**
**"MIHAJLO PUPIN"**
**ZRENJANIN**

# ITROCONFERENCE 7.0

## INFORMATION TECHNOLOGY AND EDUCATION DEVELOPMENT

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**PROCEEDINGS**

**ZRENJANIN, June 2016**

UNIVERSITY OF NOVI SAD
TECHNICAL FACULTY ”MIHAJLO PUPIN”
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VII INTERNATIONAL CONFERENCE ON

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PROCEEDINGS OF PAPERS

VII MEĐUNARODNA KONFERENCIJA

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*With this publication, the CD with all papers from the International Conference on Information Technology and Development of Education, ITRO 2016 is also published.*

# INTRODUCTION

This Proceedings of papers consists from full papers from the International conference "Information technology and development of education" - ITRO 2016, that was held at the Technical Faculty "Mihajlo Pupin" in Zrenjanin on June 10$^{th}$ 2016.

**The International conference on Information technology and development of education** has had a goal to contribute to the development of education in Serbia and the Region, as well as, to gather experts from natural and technical sciences' teaching fields.

The expected scientific-skilled analysis of the accomplishment in the field of the contemporary information and communication technologies, as well as analysis of state, needs and tendencies in education all around the world and in our country has been realized.

The authors and the participants of the Conference have dealt with the following thematic areas:

- Theoretical and methodological questions of contemporary pedagogy
- Personalization and learning styles
- Social networks and their influence on education
- Children security and safety on the Internet
- Curriculum of contemporary teaching
- Methodical questions of natural and technical sciences subject teaching
- Lifelong learning and teachers' professional training
- E-learning
- Education management
- Development and influence of IT on teaching
- Information communication infrastructure in teaching process

All submitted papers have been reviewed by at least two independent members of the Science Committee.

There were total of 163 authors that took part at the Conference from 15 countries, 4 continents: 96 from the Republic of Serbia and 67 from foreign countries such as: Macedonia, Bulgaria, Slovakia, Russia, Montenegro, Albania, Hungary, Italy, India, Rumania, Bosnia and Herzegovina, USA, Egypt and Nigeria. They were presented 82 scientific papers; 42 from Serbia and 40 from the above mentioned countries.

The papers presented at the Conference and published in Proceedings can be useful for teachers while learning and teaching in the fields of informatics, technics and other teaching subjects and activities. Contribution to the science and teaching development in this Region and wider has been achieved in this way.

***The Organizing Committee of the Conference***

# *CONTENTS*

## *INVITED LECTURES*



## *SCIENTIFIC PAPERS*

# *GAMES AND SIMULATIONS IN EDUCATION*

# Simulation of M/M/n/m Queuing System

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**Abstract - Simulation is the imitation of the operations of a system or process from the real world, which takes place over time. Simulation involves generating artificial history of the system and observation of the same, for making important conclusions about the operational characteristics of the presented system. In this paper we analyze the queuing system with finite capacity M / M / n / m. Additionally, we give demonstration of simulation of the market as example of M / M / n / m queuing system.**

## I. INTRODUCTION

The simulation model represents a set of assumptions concerning the operations of the system. These assumptions are expressed in mathematical, logical, and symbolic relationships between the entities, or objects of interest at the system. Once developed and validated, the model can be used for answering at "what if?" questions about the real-world system. Potential changes to the system can first be simulated, in order to predict their impact on system performance. Simulation can also be used to study systems in the design stage, before such systems are built. Therefore, simulation modeling can be used as an analysis tool for predicting the effect of changes to existing systems and as a design tool to predict the performance of new systems under a variety of different circumstances. Simulation models have their advantages and disadvantages that make it impossible to receive a clear answer at the question when to use simulation. Technically correct response is that the simulation should be used when the advantages of its use outweigh the disadvantages. Practically speaking, the simulation analysis should be selected when one or both of the following conditions are satisfied: the necessary assumptions required for suitable analytical model are not efficiently fulfilled from real system or appropriately formulated model can't be solved analytically. [1]

Some of the advantages of simulation are presented below:

- Simulation permits to test every aspect of the proposed change or data, without these to be realized. This is important because if it's made a decision, make some changes, install some new system, all without being tested, it is possible to occur some problems later and the changes and corrections can be quite expensive.
- Avoid Reducing and increasing time. By reducing or increasing of time, the simulation allows acceleration or deceleration of time, the simulation is enable to accelerate and decelerate of the phenomenon, for analyze it more studiously.
- Often, the Managers want to know why a phenomenon appears in real systems. Simulation find answers at this question, so, execute the reconstruction of the scene are developed microscopic examinations of the system to determine why the phenomenon appear. This can't be achieved in real system because it can't be controlled and seen completely.
- One of the biggest advantages of using simulation software is that once it develops a valid simulation model, can be studied new operational procedures or methods without experimenting with real system. Modifications are included or entered into the model, and observe the impact of these changes on the computer instead of the real system.
- Modern factories and organizations are quite complex, so it's impossible to be known all interactions which exist at a given moment. The simulations are enabling better understand of the interactions between the variables that constitute such complex systems.

Except the advantages, of course, some disadvantages of simulation models exist:

- Model building requires special training. It is an art that is learned over time and through experience. Furthermore, if two models are constructed by different individuals, they might have similarities, but almost certainly will not be the same.

- Simulation results can be difficult to interpret.
- Simulation modeling and analysis can be time consuming and expensive.
- Simulation is used in some inappropriate cases when an analytical solution is possible, or even preferable.

Process simulation systems include the following steps:

1. Problem formulation ;
2. Data collection and analysis ;
3. Developing of the model ;
4. Verification and checking the validity of the model ;
5. Experimenting with the model and optimizing ;
6. Implementation of the results of the simulation.

To model a system, it is necessary to understand the concept of a system and the system boundary. A system is defined as a group of objects that are joined together in some regular interaction or interdependence towards the accomplishment of some purpose. A system is often affected by changes occurring outside the system. About this kind of changes we are saying that occur the system environment. In modeling systems, it is necessary to decide on the boundary between system and its environment. This decision may depend on the purpose of the study. In the case of the factory system, for example, the factors controlling the arrival of orders may be considered to be outside the influence of the factory and therefore part of the environment. However, if the effect of supply on demand is to be considered, there will be a relationship between factory output and arrival orders, and this relationship must be considered an activity of the system.

## II. Queueing Systems

Simulation is used often in the analysis of queueing system also known as congestive systems. These are systems which have need of system resources, and when resources are not available, those who are looking for, will wait to be available. Examples of these kinds of systems include clients who requires bank teller services, customers who pays on supermarket, in the computer system processes that are waiting on a central processing unit, etc.

Although, discrete simulation models are commonly used to analyze congestive systems, the uncomplicated or simplified analytical models of congestive systems can be helpful in explaining the more complex congestive systems. In addition to this, knowledge of congestive analytical models is often useful in the design and validation of simulation models and statistical analysis of the output of the simulation congestive systems.

Key elements of the queueing systems are the clients and the servers. The notion “client” can refer to people, machines, automobiles, patients, airplanes - everything what requires a specific service from a resource. The notion “server” can refer to a receptionist, a workman, a mechanic, medical staff, the processor (CPU) of a computer - any resource (people, machines, etc.) which achieve the required service.

The Kendall classification of queuing systems exists in several modifications. The most used classification uses 6 symbols:

$$A/B/s/q/c/p$$

These symbols represent the following characteristics of the system:

A - the distribution of the length of the intervals between two successive arrivals.

B - distribution of service time.

s - is the number of servers.

q - is the queuing discipline (FIFO, LIFO,…)

c - is the system capacity.

p - is the population size (number of possible customers).

*A* and *B* can be used for following markings:

*M* – Poisson input flow i.e. arrivals (the length of the intervals between two successive arrivals follows an exponential distribution)

$E_m$ – is the Erlang distribution.

*D* – is the symbol for deterministic arrivals and constant service time?

*G* – is a general distribution.

*GI* – is a general distribution with independent random variable.

## III. *M/M/N/M* SYSTEMS

*M*/*M*/*n*/*m* system is queueing system where arrival distribution of client follows Poisson distribution (arrival rate$\lambda$), distribution of service time follows Exponential distribution. The system is composed of *n* servers (service rate$\mu$) and limited FIFO queue_(*m-n* places in the queue). If a new client comes when the system is full (we have *m* clients in the system), that client does not enter in the system, is leaving.

This system, for any values of $\lambda$ and $\mu$ for which $\rho = \frac{\lambda}{\mu} \neq 1$ may be observed in a stationary regime of work:

$$t \to \infty,\ p_k^{'}(t) = 0,$$
$$p_k(t) = p_k. \quad (1)$$

Effective arrival rate $\lambda_e$, the average number of clients per time that actually join the system is $\lambda_e = \lambda(1 - p_m)$ , where $1 - p_m$ represent the probability that the client, on arriving, will find empty place and he shall enter into the system. For all systems is valid $\lambda_e \leq \lambda$, for the systems with unlimited capacity its used $\lambda_e = \lambda$ and for the systems which rejects or refuses clients because is filled its used $\lambda_e < \lambda$.

For this system we apply following formulas:

The probability that there are no clients in the system:

$$p_0 = \left[ \sum_{k=0}^{n} \frac{\rho^k}{k!} + \frac{\rho^{n+1}}{n!} \frac{1 - \left(\frac{\rho}{n}\right)^{m-n}}{n - \rho} \right]^{-1}. \quad (2)$$

and when $\rho/n = 1$ : $p_0 = \left[ \sum_{k=0}^{n} \frac{\rho^k}{k!} + \frac{\rho^n}{n!}(m-n) \right]^{-1}$.

The probability that there are *k* clients in the system has *k:*

$$p_k = \begin{cases} \frac{\rho^k}{k!} p_0, 1 \leq k \leq n \\ \frac{\rho^k}{n^{k-n} n!} p_0, n < k < m \end{cases}. \quad (3)$$

The probability that the client will wait in the queue is:

$$P(k \geq n) = \sum_{k=n}^{m} p_k = p_n \frac{1 - \left(\frac{\rho}{n}\right)^{m-n+1}}{1 - \left(\frac{\rho}{n}\right)}. \quad (4)$$

The probability that client that comes into the system is not being served i.e. get cancellation:

$$p_m = \frac{\rho^m}{n^{m-n} n!} p_0. \quad (5)$$

The probability that the client will be served is:

$$p_{ops} = 1 - p_m. \quad (6)$$

Average number of clients in queue:

$$L_q = p_n \frac{\left(\frac{\rho}{n}\right)}{\left(1 - \frac{\rho}{n}\right)^2} \left[ 1 - (m-n+1)\left(\frac{\rho}{n}\right)^{m-n} + (m-n)\left(\frac{\rho}{n}\right)^{m-n+1} \right],$$

especially, for $\rho/n = 1$ than we have

$$L_q = p_n \frac{(m-n+1)(m-n)}{2}. \quad (7)$$

Average waiting time of clients, in the queue is:

$$W_q = \frac{L_q}{\lambda_e}. \quad (8)$$

Average waiting time of clients, in the queue is:

$$W = W_q + \frac{1}{\mu}. \quad (9)$$

Average number of clients in the system is:

$$L = \lambda_e W. \quad (10)$$

## IV. EXAMPLE OF SIMULATION OF STORE

Within the project are included: simulation of a store with one cash register, simulation of a store with two cash registers and simulation of a store with three cash registers. In this paper we will review only the case of simulation of a store with one cash register. In the segment or section of input parameters (Fig 1.) are entered the input data for the calculation of the basics features of the observed system. Arrival rate represent the number of clients who arrive in one hour. Average service time is the mean time needed to service a client (reciprocal value of the parameter $\mu$).

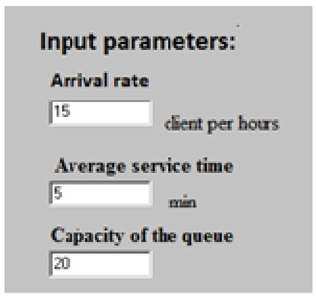


Figure 1 Input parameters

Maximum number of customers waiting in the queue with the number of cash registers (in this case only one) it gives the capacity of the store, respectively the maximum number of clients that can be in the store at given moment. If a client arrives at a moment when the store is full, then he would not enter in the store, i.e. get cancellation. When all these data will be entered, the simulation can begin by press the button "start". The clients are starting to come. If the cash register is free begins the payment, otherwise they stand in a queue and waiting. The visualization of store is given in Fig 2.

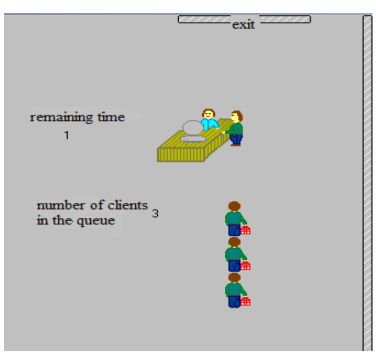


Figure 2 Visualization of the store

At that moment are beginning to generate and the output parameters Fig 3.

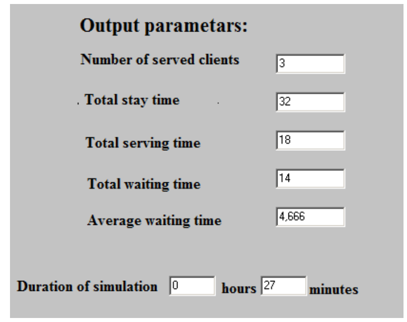


Figure 3 Output parameters

On this page we have few buttons in the upper right corner, Fig 4.

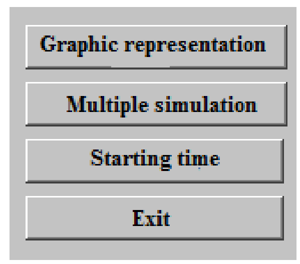


Figure 4 Menu

Each of these buttons has its function, to show you what it gets with selection the button "Graphic representation". In Fig 5. are provided tabular and graphic representation of obtained results, respectively the client's medium waiting time in queue and the medium staying time in the store. These results are updated every 10 minutes from the current simulation.

To answer the questions about the behavior and properties of the system, using the output of the simulation model, represent a rather difficult task. The output of the simulation model can easily to be misinterpreted so we get a wrong vision or idea about the system which is represented.

To illustrate this we would take a system with one server, or we will consider the store with one cash register. Let's suppose that customers come with arrival rate of 15 customers per hour and that the average serving time is 3 minutes, Fig 6.

The maximum number of clients is 20, which means that the length of the queue is 19. Also, we assume that the time between two successive arrivals of customers and the service time is exponentially distributed.

From the elementary queueing theory we can demonstrate that the average number of customers

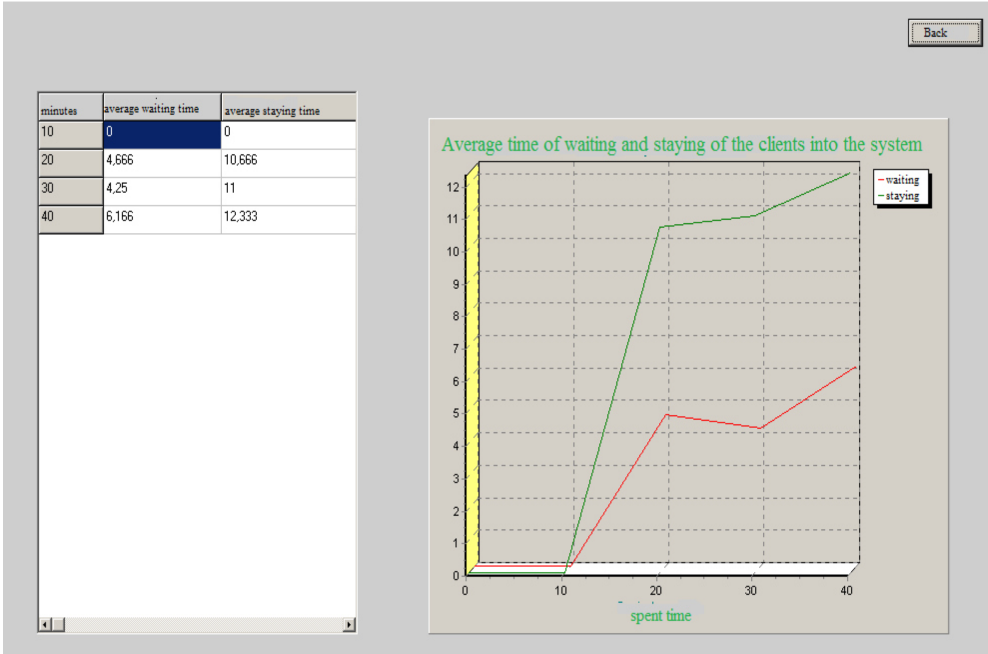


Figure 5 Graphic representation

who are waiting is $L_q$ = 2,182 and the expected waiting time, of the clients, waiting in line is $W_q$ =8,735 minutes. Using the simulation model, we determine the average number of customers waiting in queue and mean waiting time of the customers.

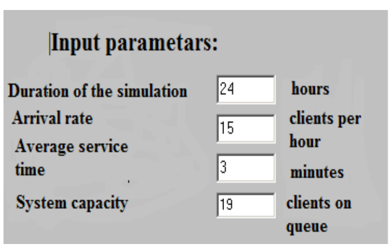


Figure 6 Input parameters

The results of 5 simulations with duration of 24 hours are shown in Fig 7.

| | Number of clients | Average number of customers waiting | Average waiting time |
|---|---|---|---|
| 1 | 306 | 2,494 | 11,725 |
| 2 | 291 | 1,522 | 7,439 |
| 3 | 318 | 1,377 | 6,283 |
| 4 | 307 | 1,359 | 6,107 |
| 5 | 312 | 1,126 | 5,403 |

Figure 7 Results for 5 simulations with duration of 24 hours

If we calculate the arithmetic mean from the results of the simulations, we will conclude that the average number of clients who are waiting is 1,575 and the average waiting time of the clients in the queue is 7,391 minutes.

These simulations show the difficulty in making decisions regarding the behavior of such a system. Each simulation is equivalent to observing the system 24 hours a day. In each simulation time of waiting, of approximately 300 customers, is registered and calculated arithmetic mean. Although, we have large samples, in the evaluation of the average waiting time of customers in the queue, in each simulation we make some mistake. If we accepted the result of the first simulation, we would have had an unsure estimation of the average waiting time of the customers. From here we may conclude that it is not enough to perform i.e. to make only one simulation, it is necessary to repeat its, to get a clearer image of the simulate system.

## REFERENCES

[1] Jarry Banks, John S Carson, Barry L. Nelson, David M. Nicol, “Discrete-Event System Simulation”.

[2] Stewart V. Hoover, Ronald F. Perry, “Simulation, a Problem-Solving Approach”, 1990.

[3] Jerry Banks, “Handbook of Simulation”, 1998.

[4] http://people.revoledu.com/kardi/tutorial/Queuing/MM1-Queuing-System.html