Discrete event traffic simulation

Part 3

Simulation of a Call Center System
Completion date: lesson 9

In the Call Center of a telecom operator calls are received at an arrival rate of **80 calls/hour** (Poisson process), during the peak hour.

These calls have the following distribution:

- **30%** of the calls refer to requests that can be processed by a **general-purpose call center operator**. These calls have a minimum duration of **1 min** plus a duration following an **exponential distribution** with average equal to **2 min**. The maximum duration is **5 min**.
- **70%** of the calls require the contact with an **area-specific call center operator** (e.g., technical issues, billing). These calls are transferred accordingly. Until they are transferred to an area-specific call center operator, the duration of the calls follows a **Gaussian distribution** with an average of **1 min** and standard deviation of **20 seconds**. The minimum and maximum duration are respectively **30** and **120** seconds.

The **calls that find the system busy** are put in a **waiting queue with finite length**, until its limit is reached. Above that limit the calls are lost.

The **calls transferred and answered by an area-specific call center operator** have a minimum duration of **1 min** plus a duration following an exponential distribution with average equal to **2.5 min**. If the area-specific answering system is busy, the calls are put in an **infinite waiting queue**. The call answered by the general-purpose answering system is only considered processed when it is answered by an area-specific call center operator.

Whenever a call is in the waiting queue to be answered by a general-purpose call center operator, a **prediction of the average waiting time is made by the system** and communicated in audio format to the user, taking into account the current system load. This prediction must be exclusively based on the duration of previous calls processed by the system (i.e., it must not be estimated based on the duration of calls already declared, considering the corresponding distributions).

Model the system in these conditions and obtain the results specified in what follows.

a) General-purpose answering system:

- the **probability** that a **call is delayed** and **lost**;
- the **average delay of the calls** (for the calls that suffer delay) and the **distribution of the delays of the calls** (delays computed at the input of the system, until the call is answered);
- the **histogram of the prediction error for the waiting time in the input queue**, and the **average absolute and relative prediction errors** (the difference between the prediction of the waiting time and the actual waiting time observed must be considered).

b) Combined answering system – general-purpose plus area-specific:

- the average time between the arrival of a call to the general-purpose answering system and the call answering by the area-specific answering system.

Consider the following parameters for the system design:

- the **number of general-purpose** and **area-specific** call center operators;
- the **length of the waiting queue for the general-purpose** answering system.

Design the system in order to satisfy the following minimal performance goals:

- probability of a call being delayed at the input of the general-purpose answering system: 30%;
- probability of a call being lost at the input of the general-purpose answering system: 2%;
- average delay of the calls (for the calls that suffer delay at the input of the general-purpose answering system): 30 s;
- average total delay of the calls, since they arrive at the general-purpose answering system until they are answered by the area-specific answering system: 60 s.

Report

Deadline: 8th May 2019
Delivery: the report must be submitted in the Moodle.

Write a short final report on the third part of the work. The report must not exceed four A4 pages, including figures and tables. The font size shall be 11 points or higher, excluding listings which must be included in annex.

The report should be structured in the following sections:

1. General characterization of the simulation methodology

   Considering the discrete event simulation method applied in this work, specify the types and the structure of the events taken into account and the queues of events defined.

   By using a suitable representation, e.g., a diagram or a table, show in which circumstances a defined event originates other events.

2. Description of the simulation program

   Describe the simulation program using a short text supported by a high-level flow diagram, pseudo code, or other means you may find appropriate to specify the decisions taken and the tasks carried out.

3. Describe the algorithm used to predict the call waiting time

   Describe the methodology used to predict the call waiting time.

4. Simulation results

   First, present the parameters obtained for designing the system and the corresponding performance goals, as they were specified above.

   For the values found, present the following simulation results specified for the telecom operator call center system:

   - the distribution of the delays of the calls (delays computed at the input of the general-purpose answering system until the calls are answered by a general-purpose operator);
   - the histogram of the prediction error for the waiting time in the input queue, and the average absolute and relative prediction errors (the difference between the prediction of the waiting time and the actual waiting time observed must be considered).

5. Sensitivity analysis

   Consider as the test variable the **average total delay of the calls**, since they arrive at the general-purpose answering system until they are answered by the area-specific answering system.

Provide a graphical representation of the variation of this variable with the offered traffic at the input of the system (highlight the results obtained around the nominal arrival rate of 80 calls/hour).

Make an analysis of the estimator of the referred test variable when the arrival rate is **80 calls/hour**, considering a confidence interval of **90%**.