Simulation Assignment
FEB22013(X)

January–February 2026

General instructions

- All parts of the assignment are made in the **same groups of 3 students**. If you are not registered in a group on Canvas, you are not allowed/able to submit the assignment.
- The deadlines for each part are:
  - Part 1: Saturday 17 January 23:59
  - Part 2: Saturday 31 January 23:59
  - Part 3: Saturday 14 February 23:59

  Late submissions automatically receive a grade zero.
- Only students whose name and student number are listed on the assignment are awarded a grade.
- Each group is expected to work **individually** without the usage of **generative AI**. Violations will be reported to the Examination Board and will be considered as fraud.

Hand-in instructions

- On Canvas, upload for each part of the assignment:
  1. A pdf file with the answers to the questions **(written in LaTeX)**.
     - Name your file as follows: *ass_part_{number}_group_{number}.pdf*
     - Note: only provide answers to the questions with a motivation. You do not need to add anything that is not asked for (so no full explanation of your entire model, etc.).
  2. The Plant Simulation file (.spp) containing your simulation model.
     - Name your file as follows: *ass_part_{number}_group_{number}.spp*
  3. Any other code/files you used for calculations. For example: excel files used to manipulate data; python scripts used to perform analyses on output data, etc.
     - Be as consistent as possible with the naming of the other files (e.g., for an excel file, use *ass_part_{number}_group_{number}.xlsx*)

Modeling a university service desk

Introduction

You are approached by the Prof. F. Iccient, the dean of the Faculty of Economics at the University of Ridderdam. This is a small university that consists of only two faculties: the Faculty of Economics and the Faculty of Business. Prof. Iccient has only recently been appointed as dean and has since been looking into the organization of operations at the university. He has the sense that it might be possible to organize things more efficiently. In particular, the dean believes that the current set-up of the support desks at the campus can be improved. He thinks this can be achieved by merging all support desks into one large support desk located at the main building. Being an avid user of simulation models in his own research, he contacts you as an OR expert with the question to look investigate, using simulation models, the potential benefits (or downsides) of this merged set-up.

Current set-up

The current set-up of support desks at the University of Ridderdam is as follows. There are three support desks:

- A general support desk at the main building (**general desk**)
- A support desk for the Faculty of Economics at the economics building (**economics desk**)
- A support desk for the Faculty of Business at the business building (**business desk**)

The general support desk handles the following general issues:

- University facilities (related to, e.g., classrooms, parking lots, etc.)
- IT (access to Canvas, university computers, etc.)
- Lost and found

Each of the faculty-specific support desks handles questions related to:

- Student affairs (related to, e.g., course/exam enrollment, study advisors, etc.)
- Employee affairs (related to, e.g., requesting schedule changes, complaints about students these days, etc.)

Each of the support desks is organized as follows:

- The desk is open from 09:00 to 17:00 every weekday.
  - Visitors in the queue at 17:00 are still helped, so the servers may end their day somewhat later than 17:00.
- There are two support people working (we will call these "servers").
- Each server helps with all types of questions.
- Visitors wait in line to be helped.
  - Employees have priority. They are always helped before students.
  - Besides that, the queueing principle is *first come, first served*.

Your task

As mentioned in the introduction, your task is to use simulation models to investigate the potential benefits or downsides of a merged support desk set-up. Your assignment is split into three parts:

- **Part 1** consists of determining a suitable way to model the **arrival process** at one of the support desks, and **validating** this by means of a simulation model of that support desk.
- **Part 2** consists of constructing a simulation model of a proposed **new system** in which all support desks are merged and moved to the main building. In this part, you will also define good **KPIs**, propose a reasonable **experimental setup** and investigate the usefulness of **variance reduction** methods.
- **Part 3** consists of the actual **analysis**: you will use the model developed in part 2 (and using the arrival process from part 1) to gain insights into the benefits and downsides of the newly proposed system. That is, you will **compare** it with the old system. Moreover, you will try to find the **best configuration** within the new system in terms of minimizing the average waiting time of visitors. Finally, you will **interpret and communicate** the results and reflect on the study's **limitations**.

Part 1: Determining the arrival process

In order to simulate the new merged set-up, we need to have an idea about the arrivals of *visitors* (i.e., students, employees and guests that have questions) at the support desks. More formally, we need to determine a way to model the *arrival process* of visitors at the support desks. Moreover, we need to model the distribution *service times* for each type of visitor.

Both the central support desk and the Business support desk have been collecting data on visitors' arrivals and service times for years. They already have a good way of modeling these. The details got lost in a drawer somewhere, but they promised to send you the necessary information in two weeks.

The Economics support desk is not as well-organized, however. They don't have any historical data besides data they collected in the past month (after a request by the dean). These data are made available to you as an Excel file on Canvas. For each visitor, they registered:

- Visitor type (student/employee)
- Time of arrival in the queue
- Time of start of service
- Time of end of service

Your task in part 1 of the assignment is to determine, based on these data, a good way to model the arrival process of each type of visitor at the Economics support desk. Below is a list of concrete questions to guide your analysis. You are asked to hand in a report with answers to these questions, including concise motivations.

Questions

1. Study the data. Determine how to model the arrival process. Make use of:
   a. A plot of arrivals over time
   b. Descriptive statistics
   c. Histogram(s)
   d. Contextual information
2. Determine the quality of your fitted arrival process using one or several Q-Q plots.
3. Determine the service process for each visitor type.
4. Assess the quality of the fitted service distributions using Q-Q plots.
5. Model the Economics faculty's service desk in Plant Simulation. Notes:
   - Use the information about the current set-up on page 2 of this document.
   - Use the arrival and service distributions estimated above.
   - Keep track of the following KPIs:
     a. Total number of visitors helped
     b. Total waiting time of visitors
     c. Average waiting time per visitor
     d. Average waiting time per visitor for each visitor type

   As an answer to this question, report the value of the average waiting time per visitor over a single run.

6. Using a table, describe what happens during the first 15 events of your discrete event simulation. Specifically, for each event, mention:

   a. An index numbering the event (1, 2, 3, etc.),

   b. At what time the event happens,

   c. A description of the event (typically, some object moving),

   d. What else happens in the model (e.g., what variables are updated, etc.),

   e. What new events are generated.

   An example is provided in Table 1. **Note that the first three events in your simulation might be different than the ones in the example!**
   Hint: in the EventController in Plant Simulation, you can open the Event Debugger to see the event list. You can click through events one by one in the EventController and see how the event list updates.

7. Validate the model using a Q-Q plot of the visitors' waiting times in your model versus those from the dataset. Comment on the quality of your model.

#	**Time**	**Description of event**	**What else happens in model**	**New events generated**
1	0.000	Initialization	All variables set to zero	Arrival of Visitor1 in Source
2	0.000	Arrival of Visitor1 in Source	Visitor and question type of Visitor1 determined	Move of Visitor1 to Buffer
3	0.000	Move of Visitor1 to Buffer		Move of Visitor1 to Processor Arrival of Visitor2 in Source
...	...	...	...	...

Table 1: Example event table