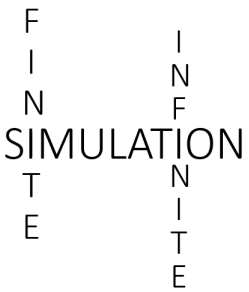
Infinite vs. Finite horizon simulations



Outline

Learning Objectives

By the end of this video, we hope that you will be able to:

- recognize which type of planning horizon is applicable to a simulation study
- analyze finite horizon simulations via the method of replications
- understand and plan an activity diagram

Infinite vs. Finite horizon simulations

Infinite vs. Finite horizon simulations

In real-life systems, we typically have to make decisions after some period of time. DES simulations can be categorised into two main categories:

Finite-horizon simulation

- A supermarket opens at 8.30 am and closes at 11pm. The closing time is an unambiguous end point for the simulation.
- From a factory, a delivery truck will only leave when it is fully loaded. Although the specific time at which this happens is random, the ending of the simulation is clearly defined.

Infinite horizon simulation

- Suppose that a convenience store is open 24 hours a day, and we are interested in simulating the operations. Our interest is probably in the long-term average number of customers arriving, amount spent by these customers and utilisation of the tellers.
- Suppose we simulate the operation of a telecommunication company. Again, since we are interested in the long-term utilisation of cell towers and satellites, we consider this an infinite-horizon simulation.

Replication

When we execute a simulation model on a computer, we shall have to specify a beginning and an ending. We refer to the generation of one such sequence of events as a **replication**

A Finite Simulation Workflow

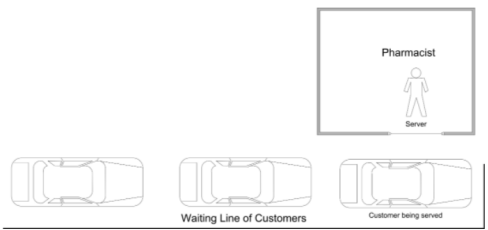
1. **Generate multiple replications**
2. **Compute a set of statistics or measures of performance for each replication**
3. **Take averages of these same statistics across replications**
4. **Compute confidence intervals**

Planning a DES

Planning a DES

Suppose we wish to model a drive-thru pharmacy. Such pharmacies are common in the United States, where personal cars are prevalent. They allow a customer to drive right up to a counter to receive their medication.

Let's suppose that the company currently has one pharmacist on duty at one teller window, and that the pharmacy is open from 9am to 5pm daily.



Suppose that management would like to set up a DES, and study the following aspects of the current operation:

- The time that customers wait in line.
- The typical number of cars waiting in line.
- What proportion of time the pharmacist is occupied.

Process Modelling

To model the process, we have to consider the entities "flowing" through the system.

What is the system? What are the entities?

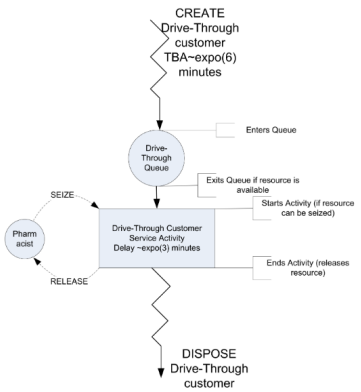
1. **An entity** is a something that flows through a system and uses the system resources.
2. **A resource** is something that is used by the entities and may affect the flow of the entities within the system.

What are the process flows?

Activity Diagram

Activity Diagram

An activity diagram is a pictorial representation of the process for an entity and its interactions with resources within the system.



An activity diagram contains the following labelled elements:

- **Queues** will be represented with circles.
- **Activities** will be shown as rectangles.
- **Resources** will be smaller circles.
- **Lines and arcs** will indicate flow of engagement of activities.
- **Dotted lines** are used to indicate the seize and release of resources.
- **Zigzag lines** indicate the arrival and departure of entities.

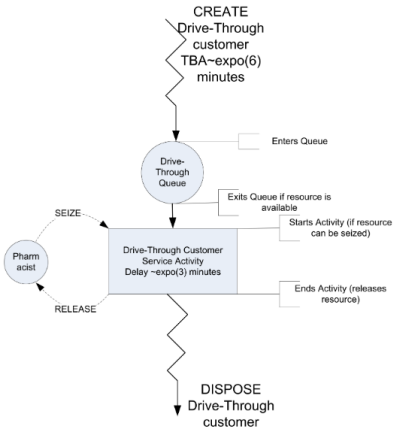
Activity Diagram (cont'd)

Activity Diagram Step-through

1. *(START)* Customer arrives
2. Check if the pharmacist is busy or idle
3. Once they arrive at the pharmacist
   - *Seize resource* use pharmacist
4. Once they complete using the resources or time required
   - *Release resource* leaves pharmacist
5. *(END)* The customer leaves

Using the output, we can compute

- The average time that customers wait in line.
- The time average number of cars in the queue.
- The proportion of time that the pharmacist is busy.



What's next

In Summary

To bring value, we have to use it to make decisions; to allow us to choose between alternatives. Here are some examples of what we can do:

1. Suppose we observe that some customers turn away if the queue is too long.
   - We could then build this into the model, and obtain an estimate of the number of customers lost, or the revenue lost as a result.
2. Suppose we realise that the pharmacist is overworked.
   - We wish to study how much better the situation would be if we had two tellers.
3. Suppose that we realise that the Poisson process is not realistic - the arrival rate differs by day of week and hour of the day.
   - We could build this into the model and identify busy periods for the pharmacist

References

Rossetti, M. (2015). *Simulation Modelling and Arena*. John Wiley Sons.