Modelling & Simulation

Test structure & exercises

M. EIC • Y2 / S1 • 2023-2024

Structure

- Two parts (90 min in total)
- Part I: Theory
  - 8 points
  - 30 minutes
  - Multiple choice questions
  - 3 wrong answers imply a penalty of 1 correct answer
  - No consultation allowed
- Part II: Practical
  - 12 points
  - 60 minutes
  - Questions about open-problems
  - Open-book test

Theory part

1. In simulation, modelling is the process of representing the essential parts of the system that are important for the analysis. This process is best described as:

    a) Constructivism
    b) Realism
    c) Analogy
    d) Abstraction

Theory part

1. Consider a given computer system architecture with considerable computational power. Which of the following would best represent a performance metric?

   a) Number of CPU cores
   b) RAM memory size
   c) Execution time of programs in multiprocessor mode
   d) Access to distributed storage

Theory part

1. Which of the following is likely to affect the performance of a given system:

    a) Workload
    b) Benchmark
    c) Threshold
    d) Metrics

Theory part

1. In the fight against the COVID-19 pandemic, *Rt* represents how quickly the virus is spreading, and its value is expected to be kept under 1.0. In this context, *Rt* can be best considered as:

   a) Threshold
   b) Indicator
   c) Workload
   d) Performance metric

Theory part

1. Analysing a supermarket performance through simulation, a manager tries various configurations with different numbers of cashiers. In this context, the number of cashiers is best described as:

   a) Controllable variable
   b) Uncontrollable variable
   c) Endogenous variable
   d) Output variable

Theory part

1. During Christmas, a bookstore decides to design a simulation model to describe how customers will choose among the various titles available. The model designer then defines a probability for each title to be chosen based on historical data from previous years' sales. These probabilities are best described as:
   a) Controllable variable
   b) Uncontrollable variable
   c) Endogenous variable
   d) Output variable

Theory part

1. The Transportation Department of the Oporto City Council has implemented a simulation model to optimise the traffic light plans (distribution of red and green times) in order to alleviate congestion. In this model, traffic light plans are best described as:
   a) Controllable variable
   b) Uncontrollable variable
   c) Endogenous variable
   d) Exogenous variable

Theory part

1. A bank has decided to optimise the performance of its various branches in the city of Oporto, running a simulation model on various scenarios differing in terms of number of tellers available in each branch, the specialisation of tellers (i.e. deposit-only, withdrawal-only, etc.), and the opening hours during the days of the week. Such scenarios are best described as:
   a) Operation policies
   b) Implementation policies
   c) Validation policies
   d) Calibration policies

Theory part

1. A Civil Engineering company has developed a simulation model to calculate the maximum in-service stress in a bridge or other similar reinforced-concrete structures. Such a model is best described as:

   a) Dynamic model
   b) Static model
   c) Behaviour model
   d) Optimal model

Theory part

1. Oporto's Airport is trying to improve its performance at check-in and drop-off counters, so they have decided to model the queues forming up by passengers at check-in areas. Such a model is best described as:

   a) Deterministic model
   b) Stochastic model
   c) Airport model
   d) Passenger model

Theory part

1. A model that simulates the chemical reaction when given reagents are combined over a period of time is best described as:

   a) Continuous model
   b) Discrete model
   c) Live model
   d) Real-time model

Theory part

1. From the list below, which option is NOT a proper metaphor for discrete simulation models:

    a) Events
    b) Processes
    c) Fluid dynamics
    d) Agents

Theory part

1. From the list below, which option is NOT a recognised advantage of using computer simulation analysis?

   a) Time compression
   b) Decision-making support
   c) Time expansion
   d) Test with the real system

Theory part

1. As for the purposes of the validation and the verification methods, they are meant, respectively, to:

   a) Certify the simulation model represents accurately the real system, and certify the simulation model implements correctly the logical model
   b) Certify the conceptual model represents accurately the simulation model, and certify the logical model implements correctly the simulation model
   c) Certify the abstracted real system represents accurately the conceptual model, and certify the logical model implements correctly the abstracted real system
   d) Certify the simulation model represents accurately the conceptual model, and certify the simulation model implements correctly the logical model

Theory part

1. In 1971, the American economist Thomas Schelling created an agent-based model that suggested inadvertent behaviour might also contribute to segregation. Which option below best identifies the type of environment used in Schelling's model?

   a) Aspatial
   b) Euclidean
   c) Cellular-automata
   d) Network

Practical part

For the problems that follow, answer the questions (NA when not applicable):

1. Considering simulation as a decision-support system, what models would be applicable (descriptive, normative, predictive, prescriptive, speculative)? More than 1 may apply.
2. What are the exogenous variables of the model (controllable and uncontrollable)?
3. What are the endogenous variables of the model?
4. What are the performance metrics of the model?
5. What performance indicators can be used and/or considered?
6. What operational policies could be considered?
7. Describe possible data collection methods, techniques and tools.
8. How could models be validated?
9. What different scenarios could be simulated?
10. What operational decisions could be supported by the simulation models?

Practical part

Problem 1

A supermarket manager plans to improve the performance of the various stores by applying new strategies to maximise the number of clients being attended at check-out when they are waiting to pay for their shoppings.

The supermarket stores currently operate with a given number of N cashiers serving the general public queueing up in one single queue per cashier.

Practical part

Problem 2

A wine producer plans to improve production by modernising the various vineyard farms of the company.

Currently, the vineyards operate manually without any sort of aids for irrigation or soil enhancement.

Practical part

Problem 3

In the fight against the COVID-19 pandemic, the government of a country plans to implement a vaccination work force aiming to vaccinate as much of the population as possible within a given period of time.

Currently, vaccination is only performed at health centres distributed in certain neighbourhoods.