Modelling & Simulation

Models to support decision-making

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Models to support decision-making

- Modelling and simulation constitute an invaluable methodology to support decision-making in different dimensions, useful for *what-if* analysis

- More specifically, the models used in simulation to support decision-making are the following:
  - Normative (optimisation)
  - Descriptive
  - Predictive
  - Prescriptive
  - Speculative (scenarization)

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- Normative models
  - Usually used to describe the ideal system, generally resorting to optimisation methods to analytically determine the optimum values for the system parameters that most likely will yield optimum performance, under given conditions
  - *Examples*:
    - Determine the optimum resistance of a bridge's structure to support the maximum flow of vehicles
    - Determine the operation policy in a supermarket that is likely to yield the maximum income in terms of sold items

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- Descriptive models
  - Usually used to describe the current operation policy of a system in order to reproduce its current performance
  - *Examples*:
    - Describe a traffic junction performance in terms of throughput, waiting time, and queue size given the recurrent demand on each of the junction's approaches
    - Describe the performance of a supermarket in terms of number of clients served given a number of cashiers and queue regimes used

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- Predictive modes
  - Usually used to determine how the system will look like or operate in a future instant, possibly given the expected transformations to the environment in which the system operates
  - *Examples*:
    - Given an expected increase in demand during Christmas, how will a supermarket operate under its current operation policy (*i.e.* number of cashiers)?
    - Given a road traffic network, what will be the traffic flow in the next 30 minutes, 1 hour, and 2 hours from now?

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- Prescriptive models
  - Usually used to describe the necessary transformations to the systems in order to meet some performance criteria. Other models, such as the normative, may serve as target references.
  - *Examples*:
    - How many cashiers should be implemented at a supermarket in order to increase income up to a certain threshold, in terms of items sold?
    - What topological transformations should be implemented on a road network to alleviate congestion on given road segments?

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- Speculative models
  - Also known as *scenarization*, these models are usually used to test with new operation policies and configurations of the system to observe their outcome in terms of performance. They are also used to perform the so-called *what-if* analysis
  - *Examples*:
    - What if a new railway is build to directly connect Porto to Lisbon at high speed, without stopping at any station in between?
    - What if students are given an extra hour to conclude their exams?