IFN501 - System Modeling and Simulation

Session 3: Introduction to Computer Simulation (Part 2)

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Outline

Acknowledgement

When not specifically defined, the contents of this presentation are adapted from [1].

Different Types of Simulation

- Continuous
- Monte Carlo
- Discrete Event
- Agent-based Modeling

Different Types of Simulation

Continuous Simulation

- Concerned with modeling a set of equations over time
- The set of equations represents a system
- System may consist of algebraic system, game theoretic models, statistical models, or differential equations
- The parameters may continuously changing
- Examples:
  - 4 WD suspension system
  - Competition between 2 populations
  - Population and/or urban growth

Different Types of Simulation

Monte Carlo Simulation

Definition

A scheme employing random numbers, which is used for solving certain stochastic or deterministic problems where the passage of time plays no role.

- Invented by John Von Neumann for his experiments in atomic bomb
- Based on random numbers – the name itself invokes the thoughts of gambling, gaming and chance
- The model is not influenced by time
- The use of random number generators gives Monte Carlo simulation characteristics not common to continuous simulation
- Example: paintball game between two groups

Different Types of Simulation

Discrete Event Computer Simulation

- Characterized by the passage of blocks of time during which nothing happens, punctuated by events which change the state of the system.
- Example: Customers at an ATM
  - Events: arrive, wait for service, receive service, depart
  - The duration of each event can be different e.g follows certain distribution pattern (See Tables 1 and 2)

Different Types of Simulation

Discrete Event Computer Simulation – Example

Table 1 : Time between customer arrivals

Time (min.)	Percentage (%)	Time (min.)	Percentage (%)
1	5	6	20
2	7	7	10
3	8	8	8
4	10	9	7
5	20	10	5

Table 2 : Service durations

Time (min.)	Percentage (%)	Time (min.)	Percentage (%)
1	10	4	25
2	25	5	10
3	30		

Different Types of Simulation

Discrete Event Computer Simulation – Example

- In [1] the example was coded and ran as a GPSS simulation for 1000 hours of simulated time
- Some results:
  - Maximum waiting line size is 5 customers
  - Average waiting time is 1.381 minutes
  - Utilization time is 76.3%
  - Average length of the waiting line is 0.251 customer
  - The machine was used 10898 times by 10898 customers
- The results can be used for evaluation and to determine if another machine is needed.

Different Types of Simulation

Agent-based Modeling

- Addresses the simultaneous interactions of multiple agents to simulate, recreate, study, and predict complex phenomenon.
- Common elements:
  - Multiple agents modeled and scaled with various levels of detail (granularity)
  - Decision-making heuristics and rules
  - Adaptive behaviors or learning
  - Interaction rules or topology
  - Environment for interaction often consisting of constrained resources

References I

[1] R. McHaney, Understanding Computer Simulation. Ventus Publishing, 2009.