Simulations and Simulators

Computer Simulation

- Computer simulation is often used as a tool to investigate the behavior of systems for which simple closed form analytic solutions are not available, possible or convenient.

- There are many different types of computer simulation;
  the common feature they all share is the attempt to generate a sample of representative scenarios for a model in which a complete enumeration of all possible states of the model would be prohibitive or impossible.

Discrete Events Simulation

- The simulator maintains a (temporally) sorted queue of **events**.
  The queue is read and, depending on the specific processed event, the system state is accordingly updated.
  It is not important to execute the simulation in real time.

- A special type of discrete simulation is known as **agent-based simulation**.
  In this case, the individual entities in the model (such as molecules, cells, cars, people…) are represented directly (rather than by their density or concentration) and *possess an individual internal state* and a set of rules to determine how the individual state must evolve from one time-step to the next.

Continuous Dynamic Simulation

- It performs the numerical solution of systems of differential equations (either partial or ordinary).
  Repeatedly, the simulator solves all the equations, and uses the outcomes to change the state and output of the simulation.
  Applications include flight simulators, chemical process modeling, simulations of electrical circuits, etc.

Stochastic Simulation

- Aka Monte Carlo method
- Typically used for discrete systems where events occur probabilistically, and which cannot be described directly with differential equations.
- Phenomena in this category include genetic drift, biochemical or gene regulatory networks with small numbers of molecules.

Simulator Architecture