Simulation

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Outline

- Plan:
  - Introduce basics of simulation modeling
  - Define terminology and methods used
  - Introduce simulation paradigms
    - Monte Carlo simulation
    - Time-driven simulation
    - Event-driven simulation
  - Technical issues for simulations
    - Random number generation
    - Statistical inference

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Monte Carlo Simulation

- Estimating an answer to some difficult problem using numerical approximation, based on random numbers
- Examples: numerical integration, primality testing, WSN coverage, poker hands
- Suited to stochastic problems in which probabilistic answers are acceptable
- Might be one-sided answers (e.g., prime)
- Can bound probability to some epsilon
- There is (usually) no notion of time at all

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Time-Driven Simulation

- Time advances in fixed size steps
- Time step = smallest unit in model
- Check each entity to see if state changes
- Well-suited to continuous systems
  - e.g., river flow, factory floor automation
- Granularity issue:
  - Too small: slow execution for model
  - Too large: miss important state changes

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Event-Driven Simulation (1 of 2)

- Discrete-event simulation (DES)
- System is modeled as a set of entities that affect each other via events (messages)
- Each entity can have a set of states
- Events happen at specific points in time (continuous or discrete), and trigger state changes in the system
- Very general technique, well-suited to modeling discrete systems (e.g, queues)

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Event-Driven Simulation (2 of 2)

- Typical implementation involves an event list, ordered by time
- Process events in (non-decreasing) timestamp order, with seed event at t=0
- Each event can trigger 0 or more events
  - Zero: “dead end” event
  - One: “sustaining” event
  - More than one: “triggering” event
- Simulation ends when event list is null, or desired time duration has elapsed

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Summary

- Simulation methods offer a range of general-purpose approaches for performance eval
- Simulation modeler must determine the appropriate aspects of system to model
- "The hardest part about simulation is deciding what not to model." - M. Lavigne
- Many technical issues: RNG, validation, statistical inference, efficiency
- We will look at some examples soon