Basics of Simulation

1/16/2009

Opening Discussion

- Have you thought of any questions about this class?
- Let's look at the schedule and discuss it briefly.

Categorizing Systems

- Static vs. Dynamic
- Deterministic vs. Stochastic
- Continuous vs. Discrete

Discrete-Event Simulation

- Our text focuses on discrete event simulations.
- These are used for dynamic models.
- The can be deterministic or stochastic.
- Obviously they are discrete so the state changes instantaneously at particular times.
- An event is an instantaneous occurrence that might change the state.

Time in a DES

- The time of the system jumps forward from one event to the next.
  - Start at 0 and find all known events.
  - Jump to first event and update time. Possibly find new events. Possibly update the general state of the system.
  - Jump to next event and continue until simulation is done.

Components of a DES

- Your book lists a number of different components that are common to any DES.
  - System state
  - Simulation clock
  - Event list
  - Statistic counters

More Components

  - Initialization routine
  - Timing routine
  - Event routine
  - Library routines
  - Report generator
  - Main program
- Your book ignores the possibility that events might be removed without processing.

A Single-Server Queuing System

- Simple system with arrival intervals of A_i and service times of S_i. One goal might be to learn the estimated wait time for any given customer.
- If we define the expected value to be the average we get the following:

$$\hat{d}(n) = \bar{D}(n) = \frac{\sum_{i=1}^{n} D_i}{n}$$

Expected Line Length

- We might want a different value q(n) for the average line length after n customers.
- Define Q(t) to be the number of people in line at time t, T_i to be the amount of time with i people in line, and T(n) the total time to service n customers.

$$\hat{q}(n) = \frac{\sum_{i=0}^{\infty} i T_i}{T(n)} = \frac{\int_0^{T(n)} Q(t)\,dt}{T(n)}$$

Expected Utilization

- Define u(n) to be utilization over n customers. Let B(t) be 0 or 1 depending on whether the resource is being used at time t.

$$\hat{u}(n) = \frac{\int_{0}^{T} (n) B(t) dt}{T(n)}$$

- Integrals can be calculated as sums of areas of rectangles.

Code for this Simulation

- Your book contains code for doing this simulation. Let's go look at it.
- It is written in old style C and does lots of things that I consider bad form (like using global variables).
- This code is not object-oriented but could be improved significantly if it were.

Event Graphs

- There is a formal method of looking at event based systems that will help us see how the system is organized and how it can be simplified.
- Events are drawn as labeled circles. Arrows indicate when an event can schedule another event. Thick arrows can take time. Thin arrows are automatic. A squiggly incoming arrow is an event scheduled at initialization.

Minute Essay

- What are your thoughts about today's lecture?
- If you have looked through the text, what do you think about it?