Basics of Simulation

1/14/2009
Have you thought of any questions about this class?

Minute essays comments
- Starting Scala: Use my book and if you like it then consider the bigger one that costs money.
- Simulations from/for other classes.
- Three people have economic/finance interests.
Categorizing Systems

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

\[
\hat{q}(n) = \frac{\sum_{i=0}^{\infty} iT_i}{T(n)} = \frac{\int_0^{T(n)} Q(t) \, dt}{T(n)}
\]
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.
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.
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.
What are your thoughts about today's lecture?
If you have looked through the text, what do you think about it?