Discrete Event Simulation Concepts

Discrete Event Simulation
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Concepts

- *system*: collection of entities interacting together to accomplish a goal
- *model*: an abstract representation of a system
  - structural / logical / mathematical relationships
  - describe system in terms of state, entities, attributes, processes, events, activities
- *system state*: collection of variables to describe a system at any time
- *entity*: object or component in the system
- *attributes*: properties of entities
- *list*: collection of entities ordered by first come first serve

Concepts

- *events*: instantaneous occurrence changing the state of a system
- *event notices*: record of events to occur
- *event lists*: list of event notices
  - ordered by time of occurrence
  - FEL: Future Events List
- *activity*: duration of time of specific length
  - e.g. interarrival / service times
  - duration may be deterministic, statistical, a function of system variables and / or entity attributes
- *delay*: activity: duration of time of unspecific length
  - waiting customer in a line
- *clock*: variable representing simulated time

Example: The Able – Baker Call Center Problem - Definition

In a computer technical support center where personnel take calls and provide service, the time between calls ranges between 1 to 4 minutes with distribution shown in Table x. There are two support people: Able and Baker. Able is more experienced and can provide faster service than Baker. The distribution of their service times are given. Able gets a call if both are idle. The problem is to determine how well the current arrangement is working. To estimate system performance, a simulation of the first 100 callers is made.

Example: The Able – Baker Call Center Problem - Components

- system state
  - $L_Q(t)$: no of caller waiting for service at time t
  - $L_A(t)$: Able is idle/busy at time t (0/1)
  - $L_B(t)$: Baker is idle/busy at time t (0/1)
- entities
  - callers and servers not needed to be represented explicitly
  - represent in terms of state variables

Example: The Able – Baker Call Center Problem - Components

- events
  - arrival of a call
  - service completion by Able
  - service completion by Baker
- activities
  - interarrival time of calls (as defined in table)
  - service time by Able (as defined in table)
  - service time by Baker (as defined in table)
- delays
  - a caller waits in queue until Able or Baker is free

Definition

- discrete event simulation
  - modeling over time of a system whose state changes occur at discrete points in time
  - produces sequence of snapshots of system evolving over time
  - includes:
    - system state at time t
    - FEL
    - values of cumulative statistics and counters

Event Scheduling

- mechanism for advancing simulation depends on FEL
- scheduling a future event: at start of activity
  - duration determined
  - end-activity event and its time determined
  - all placed on FEL
- sequence of actions a simulator / program performs to advance the clock and to build a new system snapshot: event-scheduling / time-advance algorithm

Event-Scheduling / Time-Advance Algorithm

step 1: remove event notice for imminent event from future events list (FEL)

step 2: advance CLOCK to imminent event time

step 3: execute imminent event: update system state, change entity attributes

step 4: generte future events (if necessary) and place the event notices on FEL, ranked by event time

step 5: update cummulative statisics and counters

Discrete Event Simulation

- world views: orientation to develop model
  - event-scheduling world view
  - process-interaction world view
  - activity-scanning world view

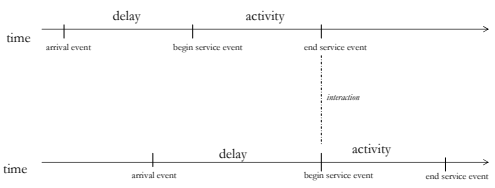
Event-Scheduling World View

- concentrate on
  - events
  - effect of events on system
- has variable time advance

Process-Interaction World View

- concentrate on processes
- proces: life cycle of one entity
- process: time sequenced list of events, activities and delays, including demands for resources, that define the life cycle of one entity as it moves thorugh the system
- define simulation model in terms of
  - entities / objects
  - their life cycle as they flow through system
    - demand resources
    - wait in queues
    - ...
- has variable time advance

Process-Interaction World View



Two interacting customer processes in a single-server queue

Activity-Scanning World View

- concentrate on
  - activities of a model
  - conditions that allow an activity to begin
- at each clock advance conditions for all activites checked
- if conditions true, activities started
- slow runtime
- mixed approach

A Simulation Example – Simulation of a Barber Shop

- assume data on interarrival rates and service times have been collected:
  - ta: interrarival time
  - ts: service time
- roll a die to get random numbers
- barber shop opens and starts serving customers at 8:00am
- only 1 barber, infinite waiting space
- assume no breaks
- do a hand-simulation of the barber shop and give a simulation table to show the progress of simulation
  - simulate for 10 customers
  - simulate for 4 hours

ta	probability	die
5	1/6	1
10	2/6	2, 3
20	3/6	4, 5, 6

ts	probability	die
30	1/6	1
20	1/6	2
15	4/6	3, 4, 5, 6

also look at:
- max / average queue length
- max / average waiting time for customers
- max / average idle time for barber