Discrete-Event Simulation

An *event* e has:

- e.time – the time at which the event occurs
- e.action – the action to take at that time
- … parameters if required by the action

Basic operations on the *Pending Event Set*:

- schedule(e) – add e to the set
- e = getNext() – get the next event in time order

Discrete-Event Simulation Algorithm

```
// initialize
eventSet.schedule( x ); // for all initially known events x

// run the simulation
repeat {
    e = eventSet.getNext();
    // simulate event e at time e.time
    // this may involve scheduling events at future times
}
```

How does the model terminate? Several options!

Classic Example: A Bank

- Customers wait for service, get service and leave
- A queue of waiting customers
- Tellers wait, serve customers, and do paperwork

- Vary customer arrival distribution
- Vary number of tellers
- Measure average and maximum customer wait

Classic Example: A Bank

- Customer arrival event e
  schedule next arrival at e.time + $random_1$
  if queue empty and there is an idle teller t
    claim teller t
    schedule teller done at e.time + $random_2$
  else
    add this customer to queue

Classic Example: A Bank

- Teller done event e
  send custmer out the door
  schedule teller idle event at time e.t + $random_3$
- Teller idle event e
  if queue empty
    mark teller idle
  else
    dequeue customer
    schedule teller done at e.time + $random_2$

Example: An Epidemic Model

- People
  - in some place or in transit
  - some have jobs or are students
  - healthy, latent, contagous, bedridden, immune
- Places
  - are occupied by people
    healthy people get infected in places
  - some places are schools, workplaces or stores
    business hours, teaching hours

Example: An Epidemic Model

- Infection model:
  - infection changes state from healthy to latent
  - after latency time, to contageous
  - after contageous time, to bedridden or immune
  - after bedridden time, to immune or dead

    random elements to times and decisions

- Probability of infection:
  - place * duration * (contageous + bedridden)

Example: An Epidemic Model

Inputs to the simulation:

- Population
- Household size distribution
- Probability of employment
- Probability of being a student
- School size, stores per household distribution
- Student – teacher ratio (for schools)
- Customer – worker ratio (for stores)
- Workplace size distribution (non store/school)

Example: An Epidemic Model

Automatically computed during setup:

- Number of households
- Number of workers
- Number of students
- Number of schools
- Number of stores
- Number of teachers (all will work at schools)
- Number of store clerks (all will work at stores)
- Number of non school/store workplaces

Example: An Epidemic Model

Poorly Specified!

At this stage no code yet written

- Without trying to write code
  we are unlikely to find bugs in the spec!
- No input data format!
- How to describe randomness?