ISYE6644 Week 5 Note

General Simulation Principles

1. Steps in Simulations

- Problem formulation
- Objectives and planning, what specific questions to answer
- Model building
- Data collection (what data, budget…)
- Coding, decide on language, write program, modeling paradigm
- Verification (is code okay, if not just go back to step 5)
- Model Validation (Is model okay? If not go back to model building and data collection)
- Experimental Design (What experiments need to be efficiently answer our questions)
- Run Experiments (often consumes a lot of time)
- Output Analysis. Statistical analysis, estimate relevant measures of performance (iterative with experimental design and production runs)
- Make report, Implement…

2. Some useful definitions relevant to general simulation models

- A system is a collection of entities that interact together to accomplish a goal
- A model is an abstract representation of a system
- System state: a set of variables that contains enough info to describe the system. A snapshot of the system
- Entities can be permanent or temporary (machine or customers) and can have various properties or attributes.
- A list (or queue) is an ordered list of associated entities.
- An event is a point in time at which the system state changes (and cannot be predicted with certainty beforehand)
- An activity is a duration of time of specified length (an unconditional wait). For example, exponential customer interarrival times.
- A conditional wait is a duration of time of unspecified length. For example we use arrival and service time to reverse engineer the waiting time.

3. Time-Advance Mechanism

- Simulation clock is a variable whose value represents simulated time (does not equal real time)
- Time advance mechanism is about how the clock moves (always move forward, tho not always true)

We consider Fixed Increment Time Advance and Next-event time advance.

- Fixed-Increment Time Advance: update the state of the system at fixed times, and this is used in continuous time models (computation power waste ?)

- Next-Event Time Advance

- Next-Event Time Advance: The clock is initialized at 0. All known future event times are determined and placed in the future events list, ordered by time. The clock advances to the most imminent event and then to the next most imminent event. At each event, the state of the system is updated and FEL (future event list) is updated as well.

- Updating the FEL: Anytime there is an event, the simulation may update the chronological order of the FEL's order by inserting new events/deleting events/Moving events/Do nothing.

- We need efficient list processing for the FEL (for example **inked lists**)
- Events may take place at the same time. Establish ground rules for how to deal with ties.

4. Two high level Modeling Approaches

- Event Scheduling, concentrate on the events
- Process Interaction, do the generic customer modeling in the P-I approach but do not need to deal with the event bookkeeping.
  Example: a customer is generated, eventually get served and then leaves. Create – Process – Dispose.

5. Simulation Languages:
- Fortran, SImio, Arena, Extend, AnyLogic…
- SimPyl (Python language)
- Cost and ease of learning, World view (what models are you using), features (graphics, user community, RV generator)