Grace Miguel

9/30/21

**Exam 1 Review**

**Introduction to M&S**

* Terminology and definitions
  + *Role of Time*
  + Static- outputs are aggregated to a single timeframe
  + Dynamic: outputs produce state trajectories over time
    - Discrete: *cannot* inspect intermediate state values
    - Continuous: ­*can* inspect intermediate state values
  + *Role of uncertainty*
    - Deterministic
    - Stochastic: includes at least 1 random variable such that results may vary
* Modeling complex systems
  + Experiment with a model of the system(a lot easier than real system)
    - Physical
    - Conceptual(graphical/ideas) systemigrams – not quantitative
    - Mathematical 🡪 analytical(equation) or simulation model(repetitive)

**Modeling Constructs**

* *Modeling Process*
  + Key steps: identify/formulate problem
  + Real-world data is source for validation
  + Choose appropriate model type and document for future understanding
  + Plan and execute a simulation experiment to collect data
  + Interpret and make recommendation
* *Model Behavior*
  + **Model state changes** are logical transitions between *states*(state trajectory)
    - **Process generators** sample random variables
    - **Transition functions** transform from current state to next

**Stochastic Models**

* *Samples and Uncertainty*
  + A sample is an observation of an event.
  + Sampling methods generate data from a population
  + S\_x is estimate of sample variance
* *Confidence intervals*
  + Central Limit Theorem(CLT) states the sample mean *of independent samples* approaches a normal distrubtion regardless of the population distribution
  + Use 1.96 for critical z score
  + Standard error of mean(SEM):
* Discrete Random variables
  + Random variables assign events to numbers
  + Binomial experiment: where n trials has the same chance of observing the event we are interested in(ex. Coin flip)
  + **PMF** assign probability *masses* to values
  + **CDF**: add up each event to get CDF, staircase graph. It assigns probabilities to random variable ranges
* Process Generators
  + Continuous/discrete
  + Inverse transform method : see slides
* Derived Random variables
* Monte Carlo Sampling

1. Identify **elementary state variables** and **random (state) variables** with probability distributions
2. Identify **derived state variables**  and their functional form
3. Determine **number of samples** are required or other convergence criteria
4. For each sample, **generate RVs** and compose and **record derived state variables**
5. Compute/visualize statistics- only last data point matters

* **Antithetic Variables**
  + **Antithetic variables**- leverage negative covariance in samples to improve estimates of expected value
  + **F**
  + Confidence intervals
  + Required sample size