Verification and Validation of Simulation Model

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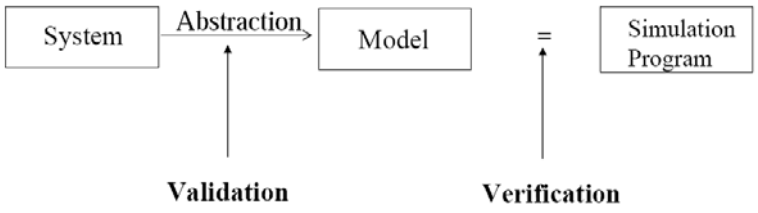

Verification

- Increase the level of confidence in the correctness of simulation program
- Approaches
  - use “trace” to debug simulation program–trace is obtained by printing state variables, statistical counters, etc., after each event
  - verify simulation output using analytic results

Fundamental Results

- Use fundamental results of queuing systems
- Examples
  - for any subsystem, mean arrival rate, mean number in system, and mean response time must be consistent with Little’s formula
  - for a closed network, relative utilization must be maintained, and utilization must not exceed the upper bound
  - for an interactive system model, mean response time must not be lower than the lower bound

Analytic Results

- Check results for cases where analytic results are known
- Examples
  - simulation model: open networks with exponential interarrival time distribution and uniform service time distribution
  - run simulation for the case of exponential service time distribution (analytic solution is available)
  - verify if the simulation output is consistent with known analytic results

Validation

- Model should be “good enough” (subjective)
- Seek expert opinion on system components that need to be carefully modeled, e.g., bottleneck
- Performance measures of interest may have impact on level of details required
  - mean response time
  - percentile of response time
- A model should be valid for the performance measures
- The most valid model may not be the most cost-effective model

Three Steps Approach to Validation

- 1. Build a model with high face validity
  - appears to be reasonable to people who are knowledgeable about the system being modeled
- 2. Validation of model assumptions
  - structural assumptions: entities, attributes, sets, etc.
  - data assumptions
    - collect reliable data
    - identify appropriate probability distribution
    - estimate parameters of the assumed distribution
    - validate the assumed distribution by a goodness-of-fit test

Three Steps Approach to Validation

- 3. Validation of input-output relationship
  - model should be able to predict system behavior under existing conditions
  - could be done using historical data collected for validation purpose