

CS4237: Systems Modeling and Simulation

AY2006/07 – Semester 1

1. **Introduction** (Bank & Carson chapters 1 and 2)
 - Ways to Study a System
 - What is Simulation?
 - Modeling and Simulation
 - Simulation Model
 - Discrete-Event Simulation
 - Example: Simulation of Queuing Systems
 - Summary
2. **Principles of Modeling and Simulation** (Bank & Carson chapter 3.1)
 - Concepts in Discrete-Event Simulation
 - How do we Advance Simulated Time?
 - fixed-increment time advance
 - next-event time advance
 - How to Model Events in Simulated Time?
 - Modeling World Views
 - event-scheduling approach
 - process interaction approach
 - Summary
3. **Components & Organization of Discrete-Event Simulation** (Bank & Carson chapter 4.4)
 - Components and Organization
 - Example of a Single Server Queue
 - Problem Statement
 - Variables, Functions and Subroutines
 - Overall Structure in Java
 - Java Simulator Program
 - Summary
4. **Simulation Algorithms & Software** (Bank & Carson chapter 3.2, 4.1, 4.7)
 - Serial DES Algorithms
 - Parallel & Distributed Simulation
 - Classification of Simulation Software
 - Selection of Simulation Software
 - Composable Simulation
 - Summary
5. **Statistical Models in Simulation** (Bank & Carson chapter 5)
 - Purpose
 - Review of Terminology and Concepts
 - Common (parametric) Distributions
 - discrete distributions
 - continuous distributions
 - Poisson distribution

- Empirical distributions
 - Summary
6. **Random Number Generation** (Bank & Carson chapter 7)
- Purpose
 - Properties of Random Numbers
 - Techniques for Generating Random Numbers
 - Linear congruential method
 - Combined linear congruential generators
 - Random-number streams
 - Tests for Random Numbers
 - Frequency tests
 - Autocorrelation test
 - Summary
7. **Random Variate Generation** (Bank & Carson chapter 8)
- Purpose and Overview
 - Techniques
 - Inverse transform
 - Acceptance rejection
 - Special
 - Summary
8. **Input Data Modeling** (Bank & Carson chapter 9.1 to 9.6)
- Purpose and overview
 - Four steps
 - Collecting raw data
 - Identifying the distribution
 - Estimating the parameters
 - Testing for goodness-of-fit
 - Modeling in the Absence of Data
 - Some Rules of Thumb
 - Summary
9. **Simulation Model Verification & Validation** (Bank & Carson chapter 10)
- Purpose and overview
 - Verification
 - Calibration and Validation
 - Face Validity
 - Validation of Model Assumptions
 - Validating Input-Output Transformations
 - Summary
10. **Output Analysis** (Bank & Carson chapter 11)
- Introduction
 - Purpose and problems
 - Statistical analysis
 - Types of simulation

- Terminating simulation
 - Analysis of transient simulations
- Non-terminating simulation
 - Ways of gathering independent observations
 - Analysis of steady-state simulations
- Summary

11. **Comparison and Evaluation of Alternative System Designs** (Bank & Carson 12.1, 12.2, 12.4)

- Purpose
- Two-system comparisons:
 - Independent sampling
 - Correlated sampling (common random numbers)
- Multiple system comparisons:
 - Bonferroni approach: confidence-interval estimation, selecting the best and screening
- Optimization via simulation – robust heuristics and control sampling variability
- Summary

12. **Experimental Designs Overview**

- Purpose
- Terminology
- Types of Experimental Designs
 - Simple Design
 - Full Factorial Design
 - Fractional Factorial Design
- Multiple Measures of Performance and Multiple Decision Variables
- Further Reading

13. **Case Study – Comparison of Load Balancing Strategies on Cluster-based Web Servers**

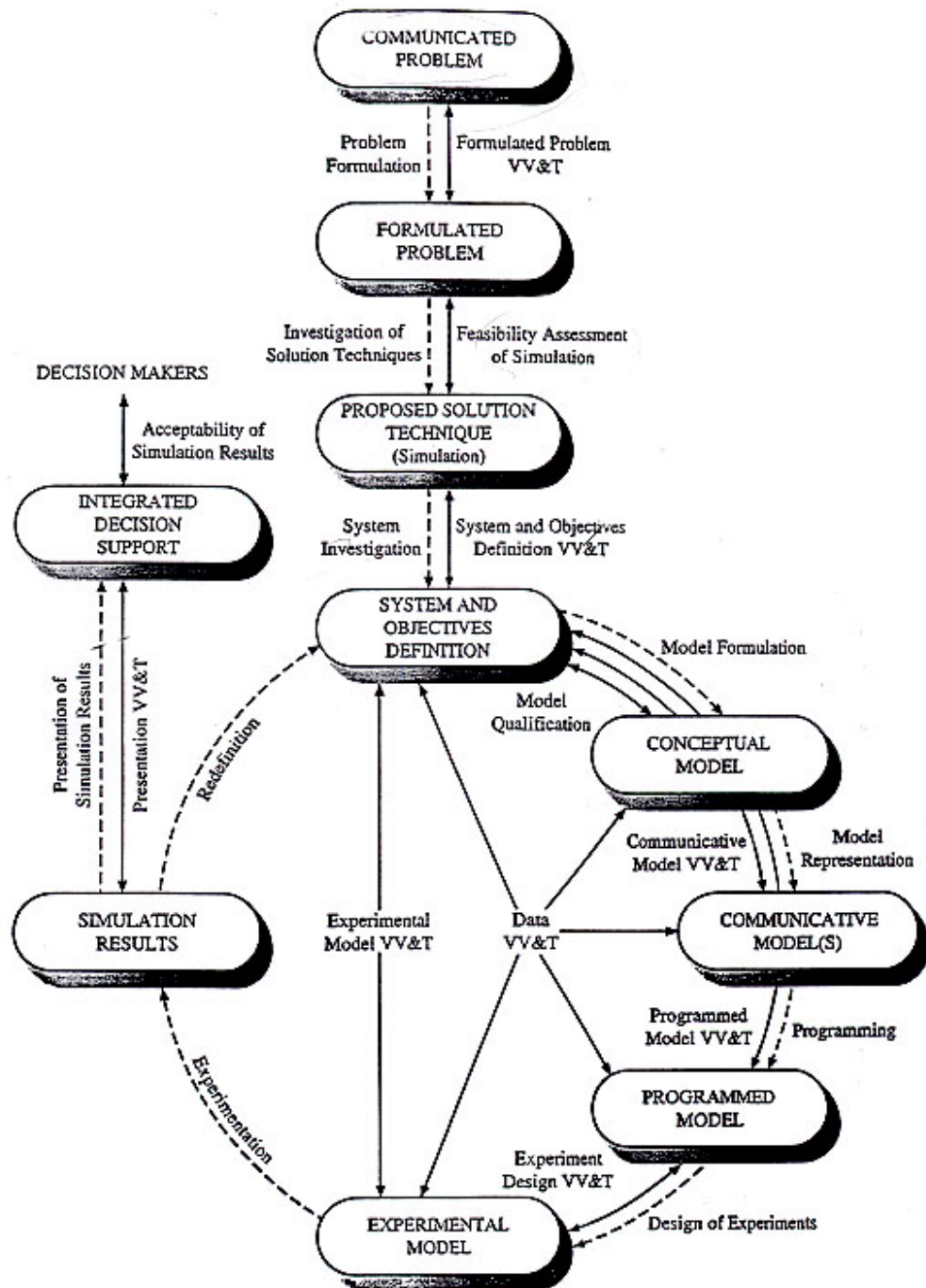
- Introduction
- System Modeling
- Simulation Implementation
- Workload Generation
- Simulation Model Validation
- Experiment Results and Analysis
- Summary

14. **Conclusions and Revision**

Readings

1. *A Comparative Study of Parallel and Sequential Priority Queue Algorithms*, R Rönngren, R. Ayani, **ACM Transactions on Modeling and Computer Simulation**, Volume 7, Issue 2, pp. 157 – 209, April 1997.
2. *Parallel Discrete Event Simulation*, R.J. Fujimoto, **Communications of the ACM**, pp. 31-53, October 1990.

3. *Composable Simulations*, S Kasputis, H.C. Ng, Proceedings of the Winter Simulation Conference, pp. 1577-1584, 2000.
4. *Zipf's Law and the Internet*, L.A. Adamic and B.A. Huberman, Glottometrics 3, pp. 143-150, 2002.
5. [*Comparison of Load Balancing Strategies on Cluster-based Web Servers*](#), Y.M. Teo and R. Ayani, Simulation, The Journal of the Society for Modelling and Simulation International, pp. 185-195, Vol. 77, No. 5-6, November-December 2001.
6. *Simulation of Computer Architectures: Simulators, Benchmarks, Methodologies, and Recommendations*, J.J. Yi and D.J. Lilja, IEEE Transactions on Computers, Vol. 55, No. 3, pp. 268-280, March 2006.
7. *Superscalar and Superpipelined Microprocessor Design and Simulation: A Senior Project*, V. Lee, et al., IEEE Transactions on Education, Vol. 40, No. 1, pp. 89-97, Feb 1997.



The Life Cycle of a Simulation Study

