An Overview of Computer Simulations

Lawrence M. Leemis and Stephen K. Park, Discrete-Event Simulation: A First Course, Prentice Hall, 2006

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Lecture Outline

- Syllabus and class organization
- In-class reading and discussion
- Concept of model and simulation
- Discrete-event simulation

Syllabus and Class Organization

- Finding the information
  - https://blackboard.vsu.edu/
  - https://huichen-cs.github.io/course/CSCI570/
- Syllabus

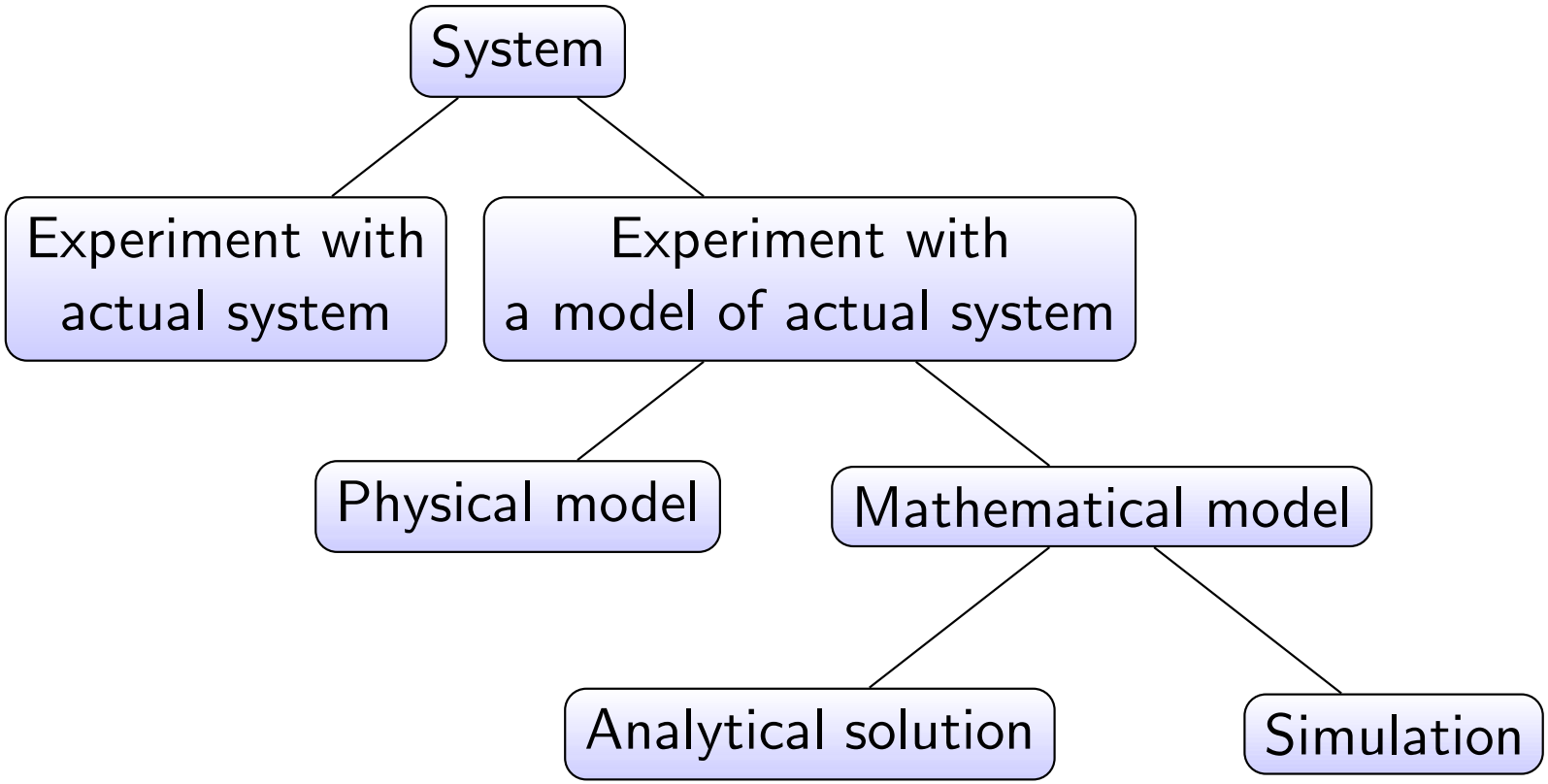
Which is the Fastest Check-Out Lane at the Grocery Store?

- (15 minutes) Read:
  Which Is The Fastest Check-Out Lane At The Grocery Store?
  https://goo.gl/4aIe8J

Discussion Questions

- How to answer the question asked in the article?
- How is it relevant to computer science?
- Can you write a program to answer the question?
- Can you ask similar questions about a computer system or a network?

How to Study a System?



Model and Simulation

- Model: Construct a conceptual framework that describes a system
- Simulate: Experiment using computer implementation of a model
- Analyze: Draw conclusion and aid decision making

Why Simulate?

- Study a system
  - Prediction
    - Predict behavior before building
    - Predict for future expectations
  - Testing
    - System characterization

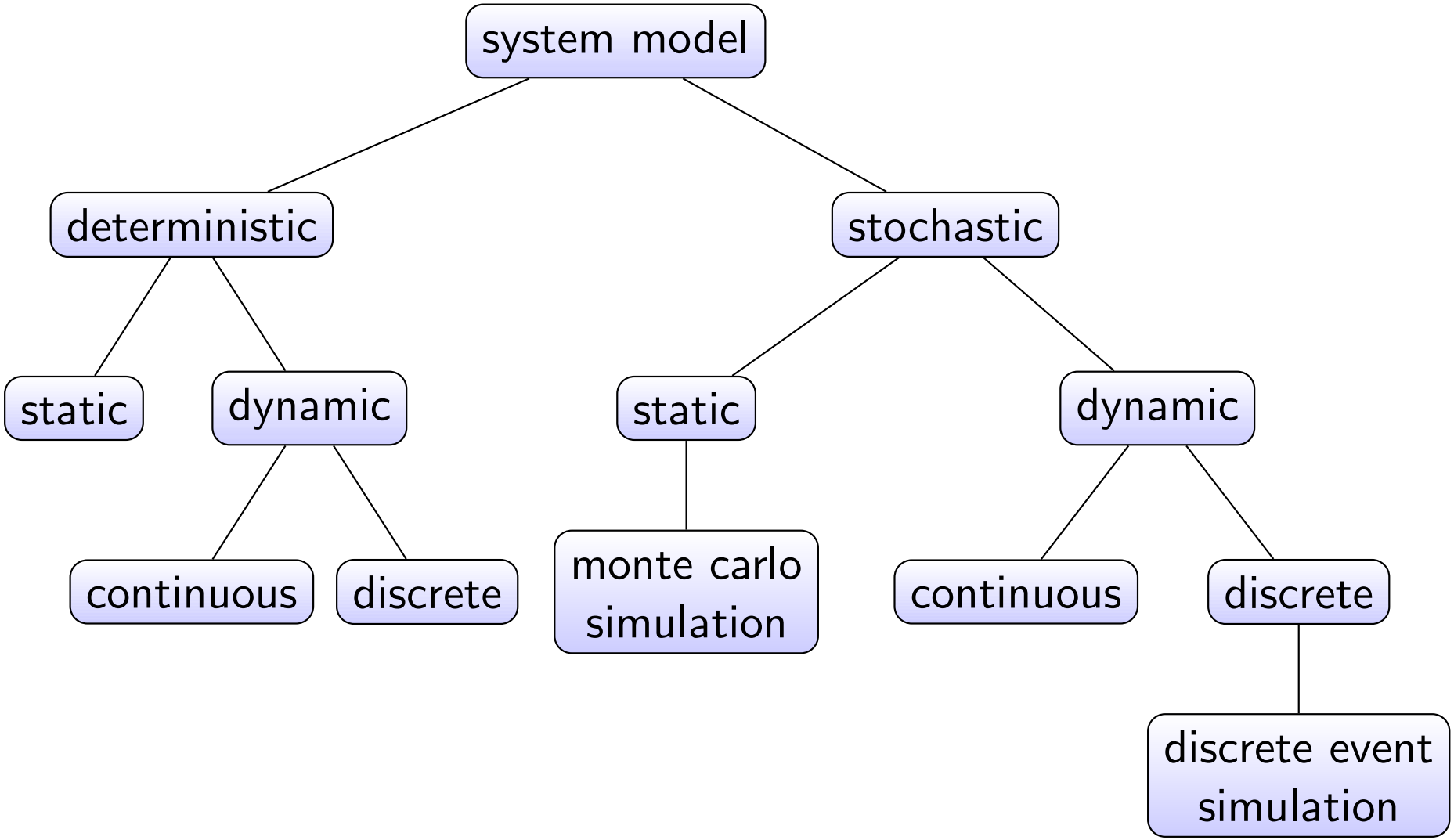
Characterization of Models

- Deterministic or stochastic?
  - Does the model contain stochastic (random) component?
- Static or dynamic?
  - Is time a significant variable?
- Contiguous or discrete?
  - Does system state evolve continuously or only at discrete point in time?
  - Continuous systems
    - Classical mechanics
  - Discrete systems
    - Queuing, inventory, machine shop model

Discrete-Event and Monte Carlo Simulations

- Discrete-Event Simulation
  - Stochastic
  - Discrete
  - Dynamic
- Monte Carlo Simulation
  - Stochastic
  - Static

Characterization of Models



Building DES Model

- Algorithm 1.1: How to develop a model?
  1. Determine goals and objectives
  2. Build a conceptual model
  3. Convert into a specification model
  4. Convert into a computational model
  5. Verify: do we build the model right (do we meet the specification)?
  6. Validate: do we build the right model (do we analyze the system to be analyzed)?
- An iterative process

Building DES Model: Three Levels

- Conceptual model
  - How comprehensive should the model be?
  - What are the state variables, which are dynamic, which are stochastic, which are important?
  - System diagrams
- Specification model
  - On "paper"
  - May involve equations, pseudo-code, algorithms, etc
  - How will the model receive input, what the output are
- Computational model
  - A computer program
  - General purpose or simulation programming language?

Building DES Model: Verification vs. Validation

- Verification
  - Did we build the model right?
    - Computational model should be consistent with specification
- Validation
  - Did we building the right model?
    - Computational model should be consistent with the system analyzed
    - Can an expert distinguish simulation output from system output?

Summary

- An overview of computer simulations
- Reading assignment
  - The machine shop model in the textbook (section 1.1.1 – section 1.1.3)