كلية الحاسبات والذكاء الإصطناعي

SC311
Modeling and Simulation

Lecture 01

Dr. Ahmed Hagag

Faculty of Computers and Artificial Intelligence
Benha University

Spring 2023

Introduce Myself

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Basic Course Information

- Course code: **SC311**
- Course name: **Modeling and Simulation**
- Level: **3rd Year / B.Sc.**
- Instructor: **Dr. Ahmed Hagag**

What do you expect to get from this course?

Assessment

Assignments	Attendance	Final Exam
10	5	50
الواجبات	الحضور	الامتحان النهائي

Lab Exam	Oral & Project	Midterm
10	10	15
اختبار العملي	الشفوي مع المشروع	منتصف الفصل

Project (1/2)

Activity	Notes
Project	Self-Study

- **7~10** students per group (Send me at: **ahagag@fci.bu.edu.eg**)
- **Due date: 1-3-2023**
- Follow up the groups in the lectures.
- Final discussion at the end of the semester.
  - Documentation.
  - Discussion.

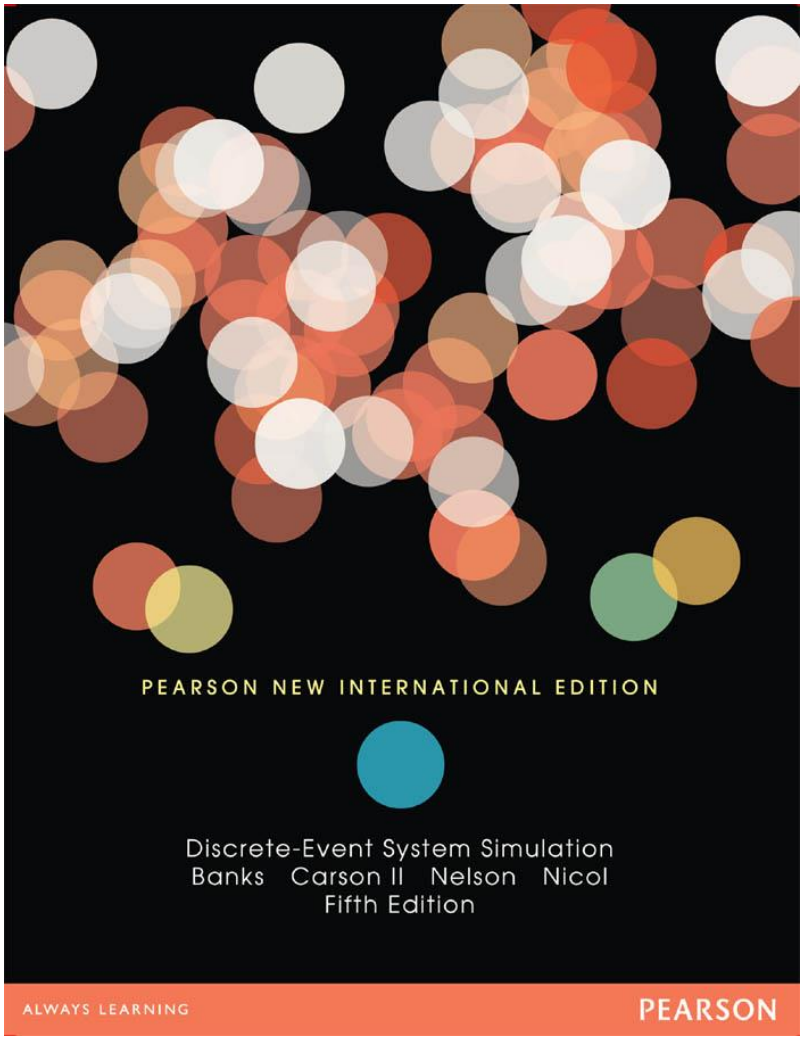
Project (2/2)

Simulation Software

You can find documents and tutorials at this website

https://www.anylogic.com/

Lectures References (1/4)

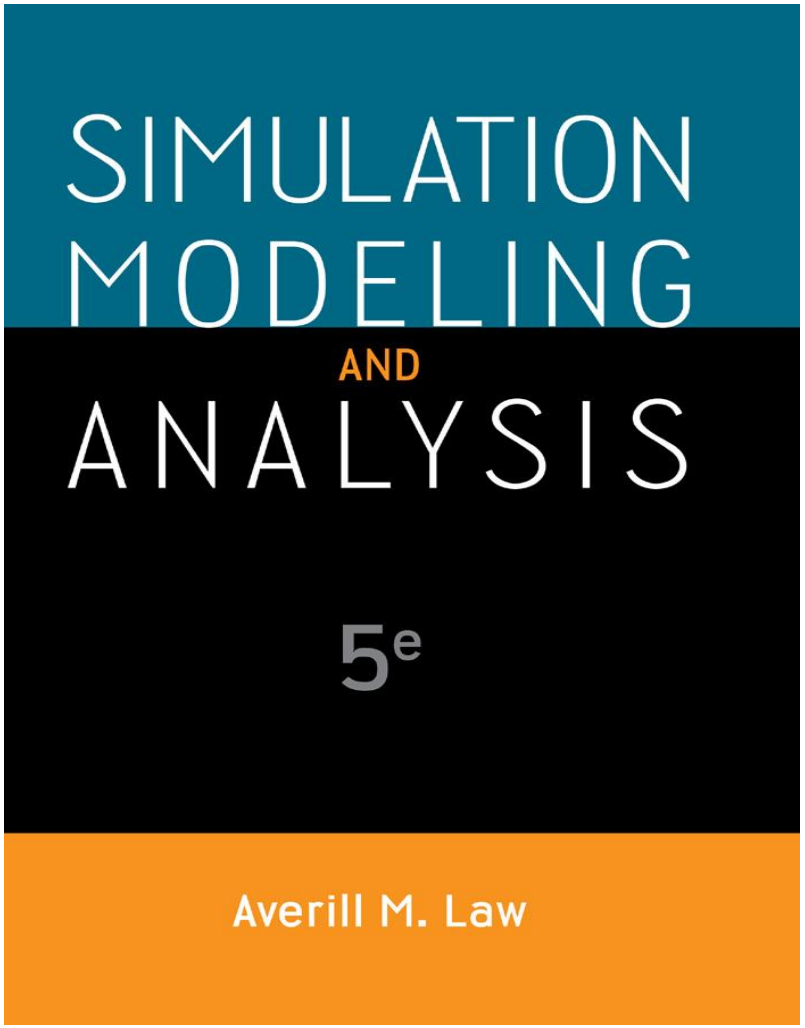


Discrete-Event System Simulation

Banks Carson II Nelson Nicol

Fifth Edition

Lectures References (2/4)

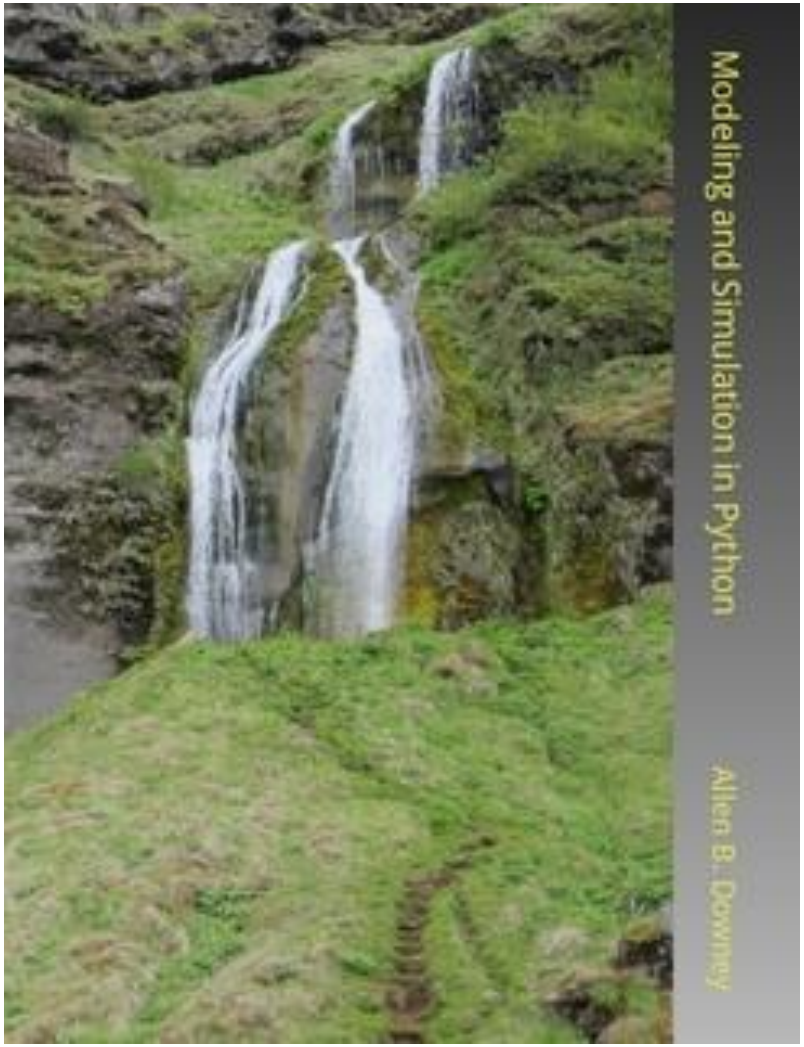


Simulation Modeling and Analysis

Averill M. Law

Fifth Edition

Lectures References (3/4)

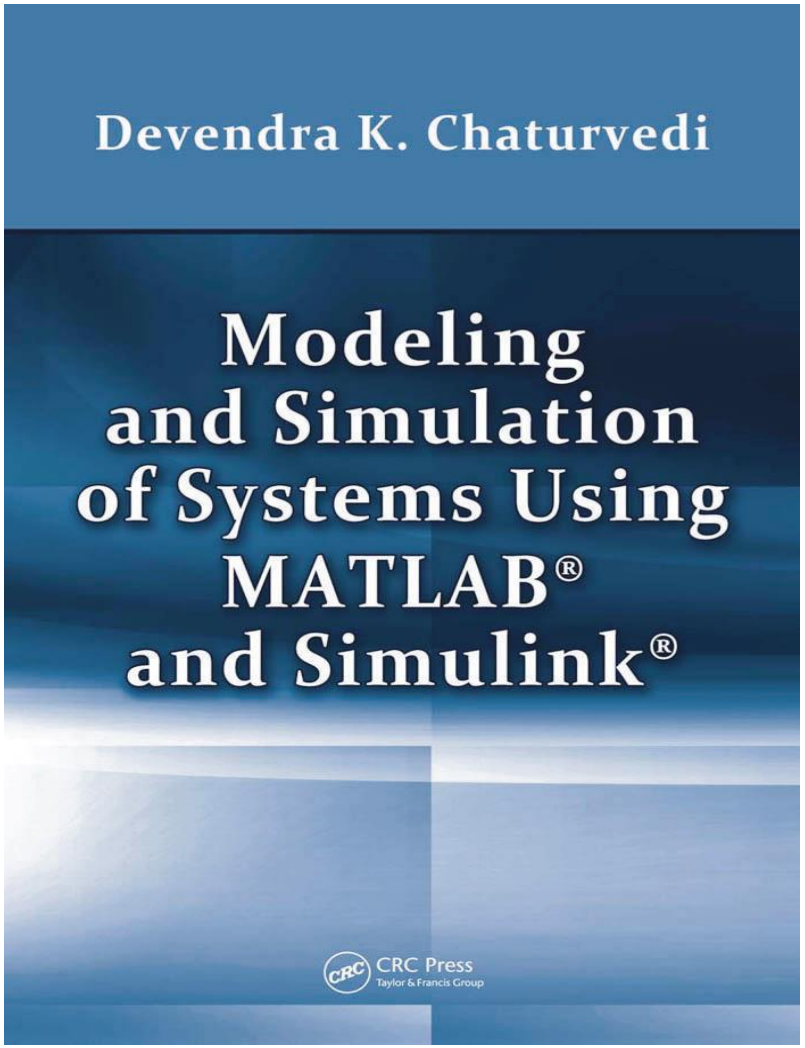


Modeling and Simulation in Python

Allen B. Downey

Version 1.0.2

Lectures References (4/4)



Modeling and Simulation of Systems Using MATLAB and Simulink

Devendra K. Chaturvedi

Course Objectives

This subject provides students with:

- The basic system concept and definitions of system.
- Techniques to model and to simulate various systems.
- The ability to analyze a system and to make use of the information to improve the performance.
- Some basics of Programming.

Course Syllabus

- Chapter 1: Introduction.
- Chapter 2: Probability as Using in Simulation.
- Chapter 3: Queueing Simulation.
- Chapter 4: Inventory Simulation.
- Chapter 5: Random-Number Generation.
- Chapter 6: Statistical Models in Simulation.
- Chapter 7: Input Modeling.

Chapter 1: Introduction (1/2)

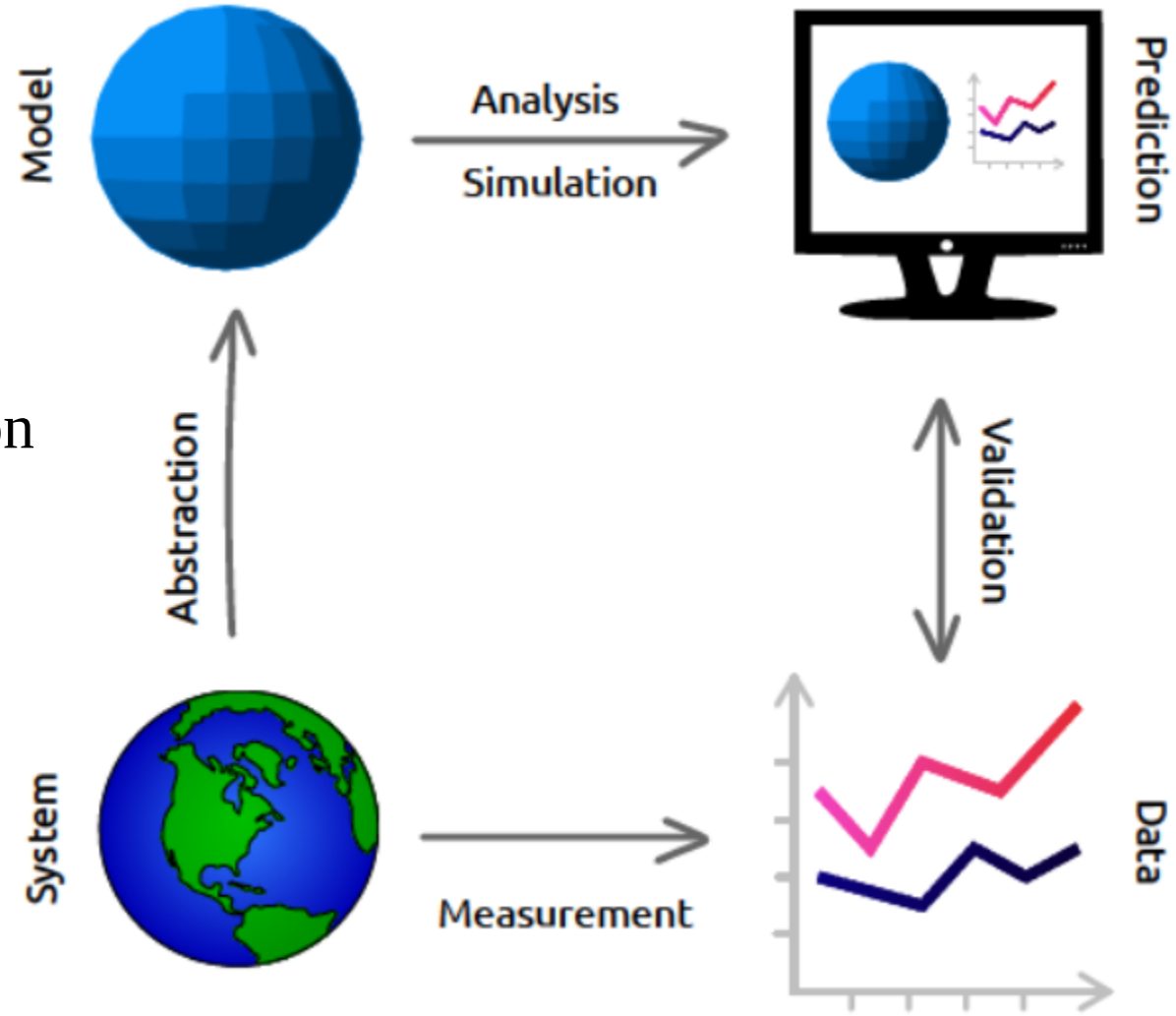
- General Introduction.
  - ✓ Important Definitions.
  - ✓ When Simulation is the Appropriate Tool.
  - ✓ When Simulation is Not Appropriate.
  - ✓ Advantages and Disadvantages of Simulation.
- Areas of Application.

Chapter 1: Introduction (2/2)

- Systems and System Environment.
- Components of a System.
- Classification of Systems.
- Steps in a Simulation Study.

General Introduction (1/10)

Modeling and simulation of physical systems



General Introduction (2/10)

Important Definitions (1/4):

- The **system** is something in the real world we are interested in. Often, it is something complicated, so we must decide which details can be simplified or abstracted away.

General Introduction (2/10)

Important Definitions (2/4):

- There result of abstraction is a **model** that includes the features we think are essential. A model can be represented in the form of diagrams and equations, which can be used for *mathematical analysis*. It can also be implemented in the form of a computer program, which can run **simulations**.
- A **simulation** is the imitation of the operation of a real-world process or system over time.

General Introduction (2/10)

Important Definitions (3/4):

- A **model** is a simplification of a real system.
- **Modeling** is the process of representing a system with a specific tool to study its behavior.
- A model can be:
  - **Analytic:** when a mathematical approach is feasible.
  - **Simulation:** model used for complex systems.
  - **Experimental:** when the real system already exists.

General Introduction (2/10)

Important Definitions (4/4):

- The result of analysis and simulation can be a **prediction** about what the system will do, an explanation of why it behaves the way it does, or a design intended to achieve a purpose.
- We can **validate** predictions and **test designs** by taking measurements from the real world and comparing the data we get with the results from analysis and simulation.

General Introduction (3/10)

Goal of Modeling and Simulation (1/2):

- A model can be used to investigate a wide verity of "what if" questions about real-world system.
  - Potential changes to the system can be simulated and predicate their impact on the system.
  - Find adequate parameters before implementation.

General Introduction (3/10)

Goal of Modeling and Simulation (2/2):

- So, simulation can be used as
  - Analysis tool for predicating the effect of changes.
  - Design tool to predicate the performance of new system.

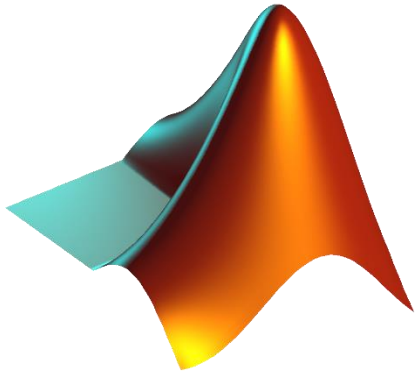
- It is better to do simulation before implementation.

General Introduction (4/10)

Simulation Language

You can use:

- **MATLAB®**
- **Python**
- Java
- C/C++
- Others …



General Introduction (5/10)

Simulation Software

Some of important:

- AnyLogic
- Arena
- AutoMod
- ExtendSim
- Flexsim
- ProModel
- SIMUL8
- Others …

General Introduction (5/10)

Simulation Software

You can use:

- **AnyLogic**
- Arena
- AutoMod
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- SIMUL8
- Others …

https://www.anylogic.com/

Use in the project!

General Introduction (6/10)

When Simulation is the Appropriate Tool?

General Introduction (7/10)

When Simulation is the Appropriate Tool? (1/3)

- Simulation enable the study of internal interaction of a subsystem with complex system.
- Environmental changes can be simulated and find their effects.
- A simulation model help us to gain knowledge about improvement of system.
- Finding important input parameters with changing simulation inputs.

General Introduction (7/10)

When Simulation is the Appropriate Tool? (2/3)

- Simulation can be used with new design before implementation.
- Simulating different capabilities for a machine can help determine the requirement.
- Risky: Risk involved in experimentation is another factor. In some systems there is a risk of damaging the system, or a risk of life.

General Introduction (7/10)

When Simulation is the Appropriate Tool? (3/3)

- A plan can be visualized with animated simulation.
- The modern system is too complex that its internal interaction can be treated only by simulation.
- Too expensive: Experimenting with a real system is an extremely costly affair.
  - For example, the physical experimentation of a complex system like the satellite system is quite expensive and time-consuming.

General Introduction (8/10)

When Simulation is Not Appropriate ?

General Introduction (9/10)

When Simulation is Not Appropriate?

- When the problem can be solved by common sense.
- When the problem can be solved analytically.
- If it is easier to perform direct experiments.
- If cost exceed savings.
- If resource or time are not available.

General Introduction (9/10)

Advantages of Simulation (1/2)

- Hypotheses about how or why certain phenomena occur can be tested for feasibility.
- Time can be compressed or expanded to allow for a speed-up or slow-down of the phenomena.
- Insight can be obtained about the interaction of variables.
- Insight can be obtained about the importance of variables to the performance of the system.

General Introduction (9/10)

Advantages of Simulation (2/2)

- New hardware designs, physical layouts, transportation systems, and so on can be tested easily.
- A simulation study can help in understanding how the system operates.
- " *What if* " questions can be answered. This is useful in the design of new systems.

General Introduction (10/10)

Disadvantages of Simulation

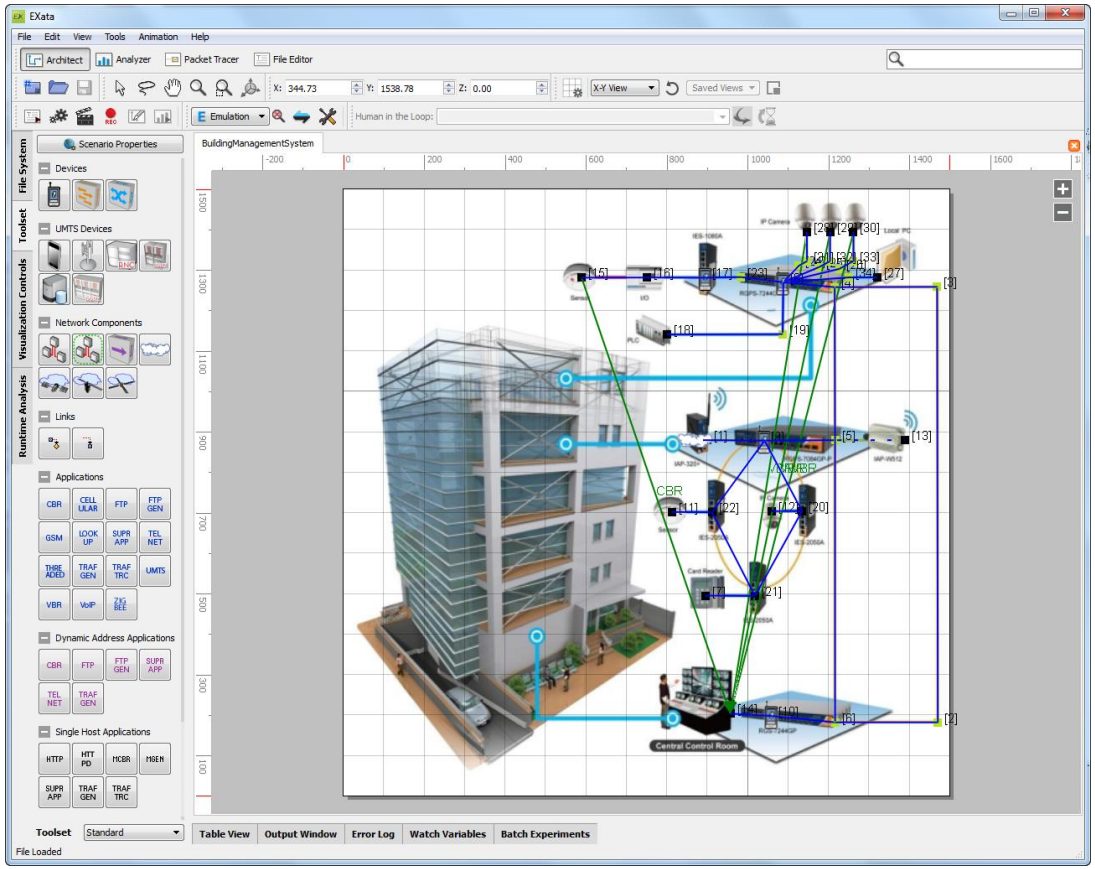
- Model building requires special training.
- Simulation results can be difficult to interpret.
- Simulation modeling and analysis can be time consuming and expensive.
- Simulation is used in some cases when an analytical solution is possible.

Areas of Application (1/2)

Give me some examples for systems can be simulated.

Areas of Application (2/2)

1. Networks

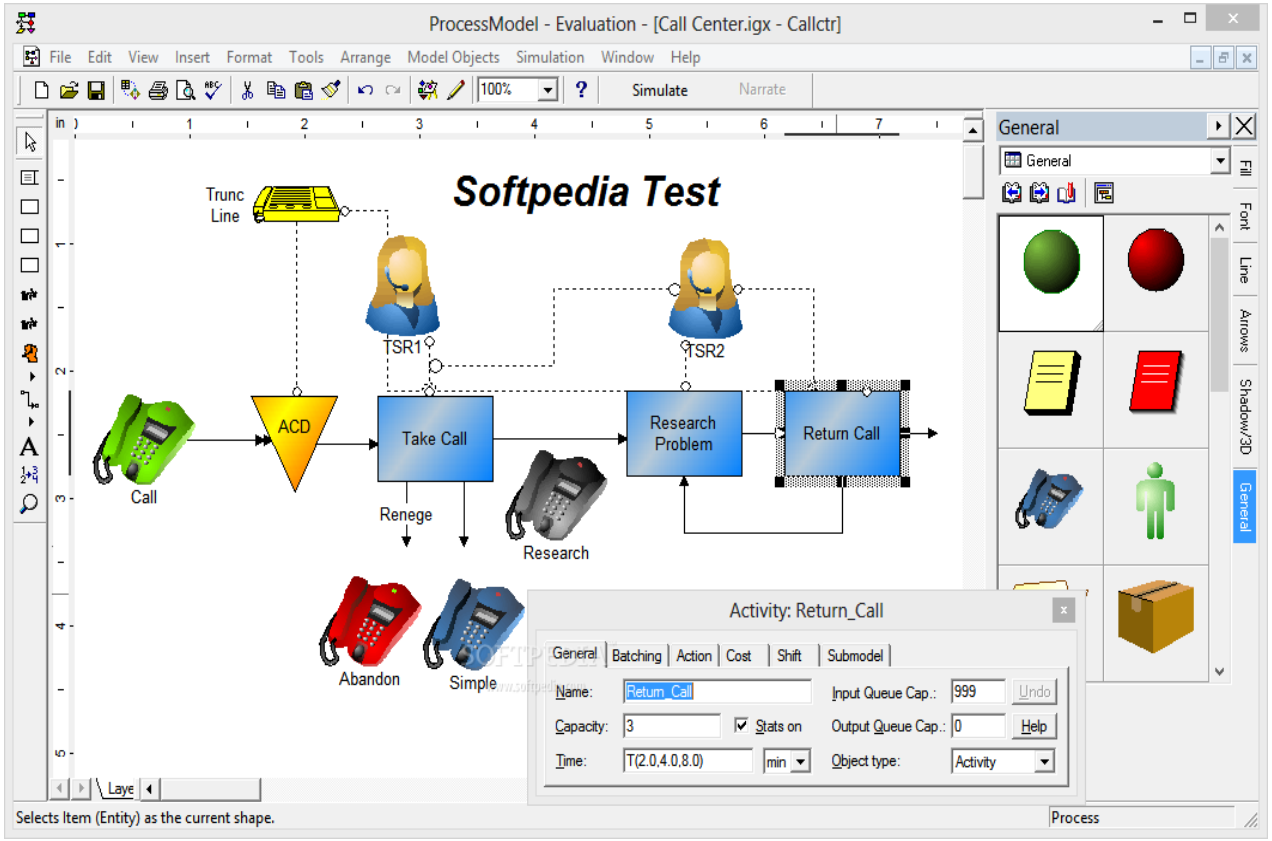


Areas of Application (2/2)

2. Military Applications

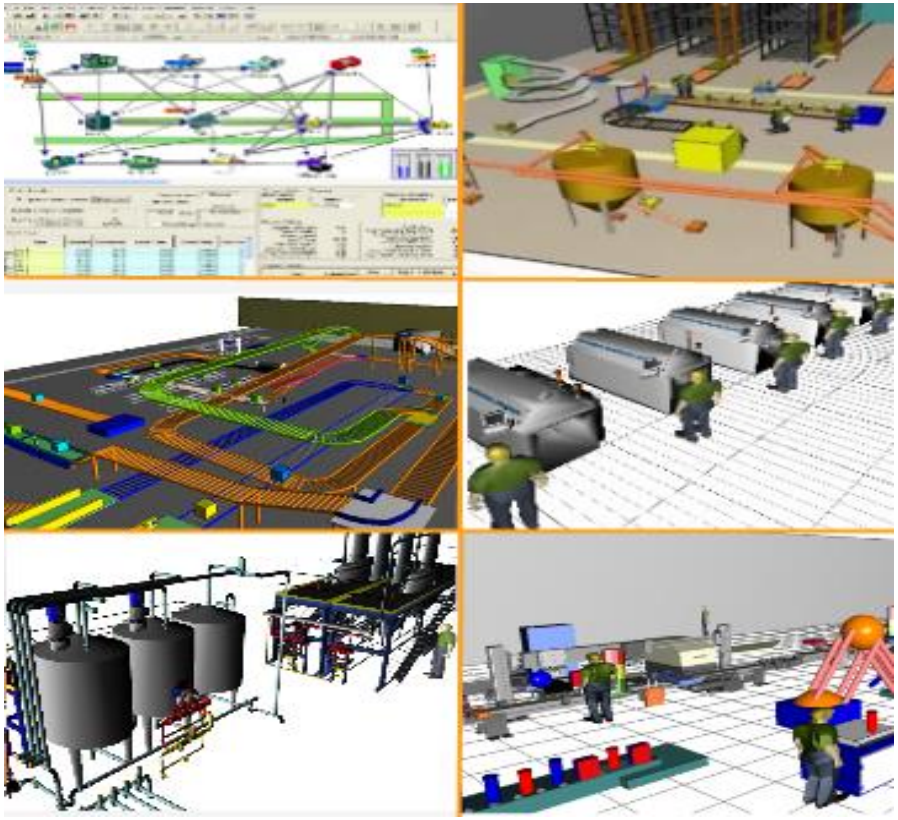
Areas of Application (2/2)

3. Call Centers



Areas of Application (2/2)

4. Manufacturing Applications



Areas of Application (2/2)

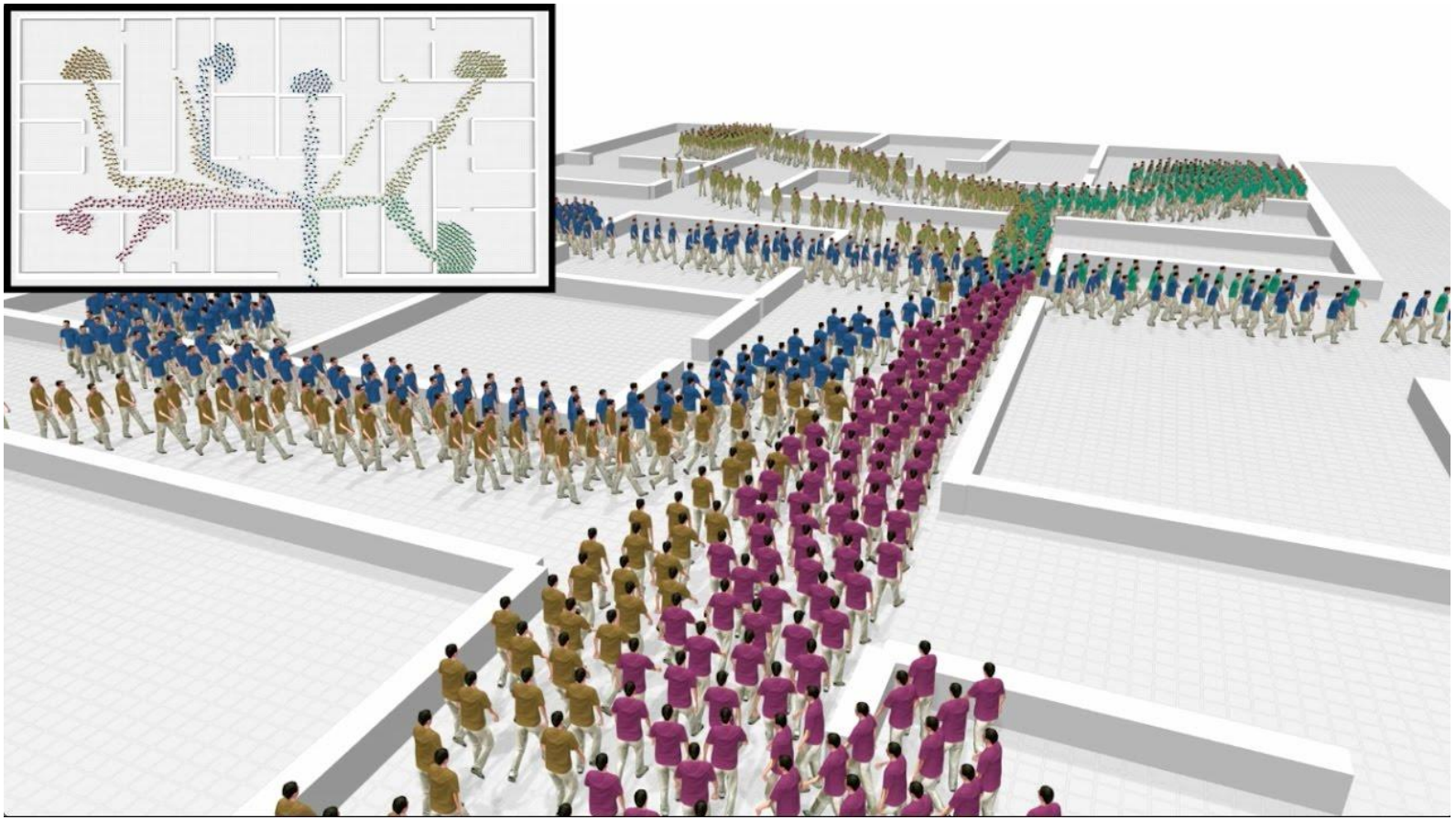
5. HealthCare

Areas of Application (2/2)

6. Road Traffic

Areas of Application (2/2)

7. Crowd Flow



Areas of Application (2/2)

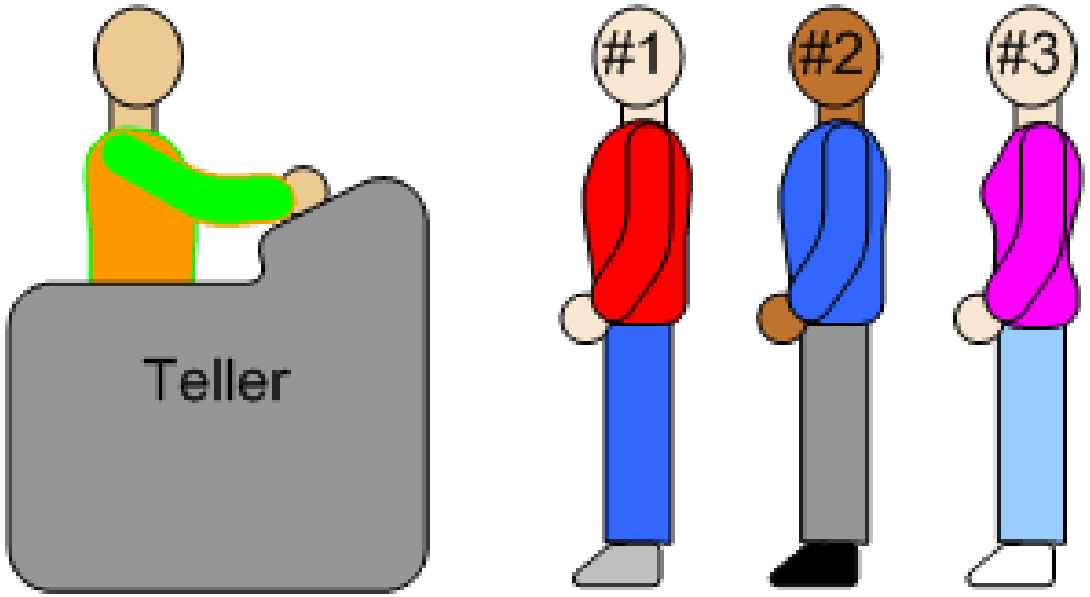
8. Airport

Areas of Application (2/2)

9. Car Garage

Areas of Application (2/2)

10. Banking



Areas of Application (2/2)

11. Trains Stations

Areas of Application (2/2)

12. Gas Station

Areas of Application (2/2)

12. Highway Junction

13. Automated Guided Vehicles

Video Lectures

All Lectures: https://www.youtube.com/playlist?list=PLxIvc-MGOs6geFJmdvDOIN5zE89-Hq8Ij

Lecture #1: https://www.youtube.com/watch?v=krdDck_2Mtw&list=PLxIvc-MGOs6geFJmdvDOIN5zE89-Hq8Ij&index=1

https://www.youtube.com/watch?v=R02LYmavJT0&list=PLxIvc-MGOs6geFJmdvDOIN5zE89-Hq8Ij&index=2

Thank You

Dr. Ahmed Hagag

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