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# Discrete Event Simulation

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# System: Discrete and Continuous

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- System:
  - a collection of entities that act and interact together toward the accomplishment of some logical end.
- Discrete system:
  - state variables change instantaneously at separated point in time, e.g., a bank, since state variables - number of customers, change only when a customer arrives or when a customer finishes being served and departs
- Continuous system:
  - state variable change continuously with respect to time, e.g., airplane moving through the air, since state variables - position and velocity change continuously with respect to time

# What is Discrete-Event Simulation (DES)

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- A discrete-event simulation
  - models a **system** whose **state** may change only at **discrete point in time**.
- System
  - is composed of objects called **entities** that have certain properties called **attributes**
- **State**
  - a collection of attributes or state variables that represent the entities of the system.
- **Event**
  - an instantaneous occurrence in time that may alter the state of the system
- An **event** initiates an **activity**, which is the length of time during which entities engage in some operations
- **Entities, attributes, events, activities** and the interrelationships between these components are defined in the model of the system



# What is Discrete-Event Simulation (DES)

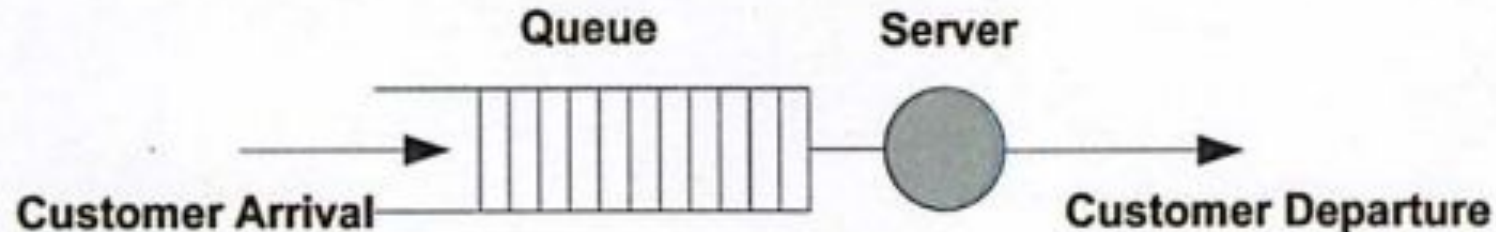
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- **Discrete-event simulation is stochastic, dynamic, and discrete**
- **Stochastic = Probabilistic**
  - Inter-arrival times and service times are random variables
  - Have cumulative distribution functions
- **Discrete = Instantaneous events are separated by intervals of time**
  - The state variables change instantaneously at separate points in time
    - The system can change at only a countable number of points in time.
  - These points in time are the ones at which an event occurs.
- **Dynamic = Changes over time**
  - Simulation clock
    - Keep track of the current value of simulated time as the simulation proceeds
  - A mechanism to advance simulated time from one value to another
    - Next-event time advance

# Example: A Single Server System

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- **Entities**: customers; server
- **Attributes of a customer**: service required
- **Attributes of server**: server's skill (its service rate)
- **Events**: arrival of a customer; departure of a customer
- **Activities**: serving a customer, waiting for a new customer





# Core Components

- Entities
- Entity Processors
  - Generator
  - Consumer
  - Server/Processor
  - Assembler, etc
- Queues
  - Storage/Waiting
- Conveyors
  - In-Transit state

# Primary Usage

- Scheduling
- Resource Allocation
- Capacity Planning
- Helps in identifying
  - Bottlenecks
  - Deadlocks
  - Latency



# Lets see an example

- Jaamsim
- <https://jaamsim.com/>
  - A free and open source discrete event simulation software
- Credits for Jaamsim content
  - Prof. B. Nelson [playlist](#)

# Notes

- You can implement a DES solution using NetLogo
- But its an **Overkill!**

