Chapter 2: Introduction to Simulation Modeling

Refer to Text Book:

- "Operations Research: Applications and Algorithms" By Wayne L. Winston ,Ch. 21
- "Operations Research: An Introduction" By Hamdi Taha, Ch. 16

6. Advantages/Disadvantages

- **Advantages**

1. Simpler than mathematical model and straight forward.
2. Flexibility to model things as they are (even if messy and complicated) with less simplifying assumptions in modeling
3. Allows uncertainty, non-stationary modeling
4. Many advances in simulation software always fast and give more power to simulation
5. Good tool for “what if” analysis once the model is built.

6. Advantages/Disadvantages

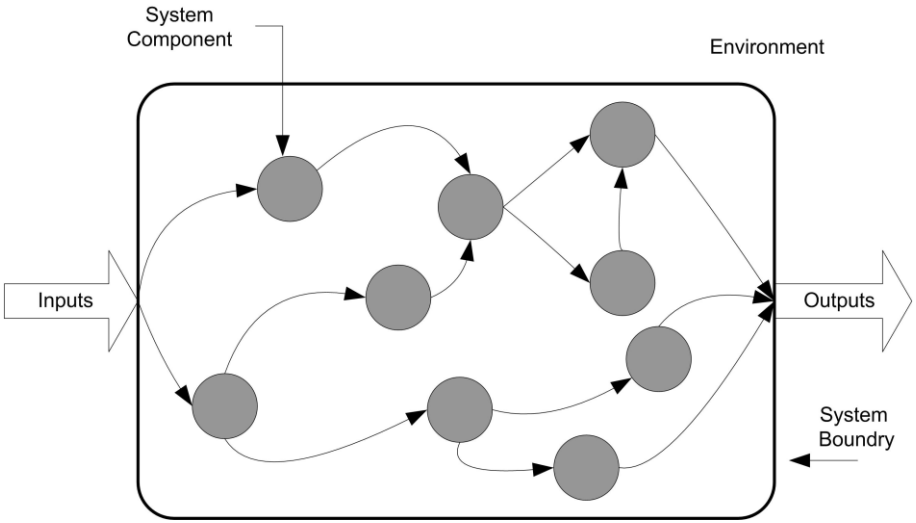
- **Disadvantages**

1. Don’t get exact answers, only approximations, estimates are needed
2. Statistical design is needed which is different from expert to expert because of the statistical design of experiment.
3. Analysis of simulation experiments takes time and expertise
4. Programming based, so it is different from progaramer to programmer and takes time for any modification or changes
5. It is not an optimizing technique

7. Simulation Bsics

- **Definition**

A ***system*** is a set of components/ elements that uses a specific inputs and work together towards a common goal/outputs.



System Contents:

1. System Inputs
2. System Components/Elements
3. System Outputs
4. System Environment/ Boundary

7. Simulation Basics

- **Examples of Systems**

1. Manufacturing system
2. Transportation system
3. Health-Care system
4. Service system (Bank)

Find System Contents:

1. System Inputs
2. System Components/Elements
3. System Outputs
4. System Environment/ Boundary

7. Simulation Basics

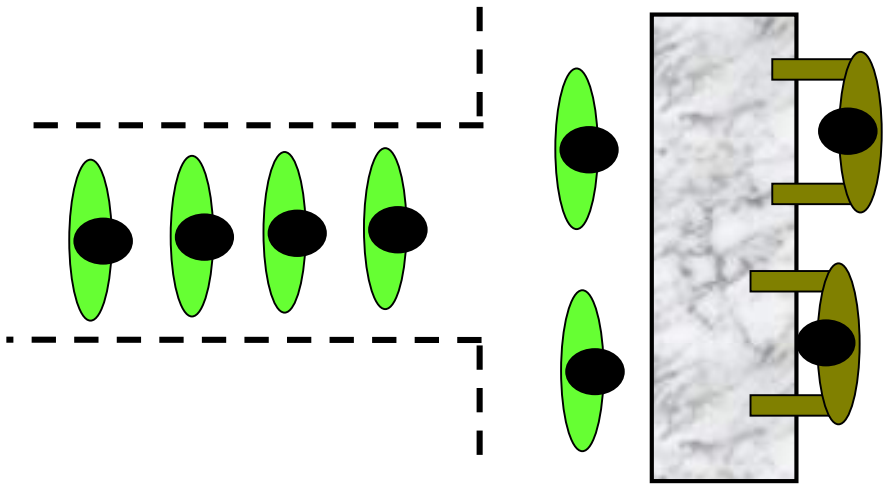
- **Definition**

The ***state*** of a system is the collection of variables necessary to describe the status of the system at any given time

Example

Consider a bank

- servers
- customers waiting in line
- customers being served



7. Simulation Basics

- **Definition :** The ***state*** of a system

Example

Consider a bank:

- State Change by customers arrival or departure
- State Variables:
  - Number of busy servers
  - Number of customers in the bank
  - Number of customers entered the bank
  - Number of customers departed the bank
  - Number of customers waiting for service

7. Simulation Basics

- **Definition :**

An ***entity*** in the system is the object of interest that cause the state variables of the system to change.

Example

Consider a bank:

- The entity of interest is the customers.

Consider an airport: The entity of interest

- Passengers.
- Luggage

7. Simulation Basics

- **Definition :**

The ***attribute*** of an entity is a specific characteristic for any entity in the system.

All entities have same attribute name but different values for different entities, for example:

- Time of arrival
- Time of departure
- Age of an arrival
- Color of the entity

7. Simulation Basics

- **Definition :**

The ***attribute*** of an entity is a specific characteristic for any entity in the system.

Example

Consider a bank:

Attributes of the customers such as

- The age of a customer
- The occupation of a customer.
- The balance of a customer.

7. Simulation Basics

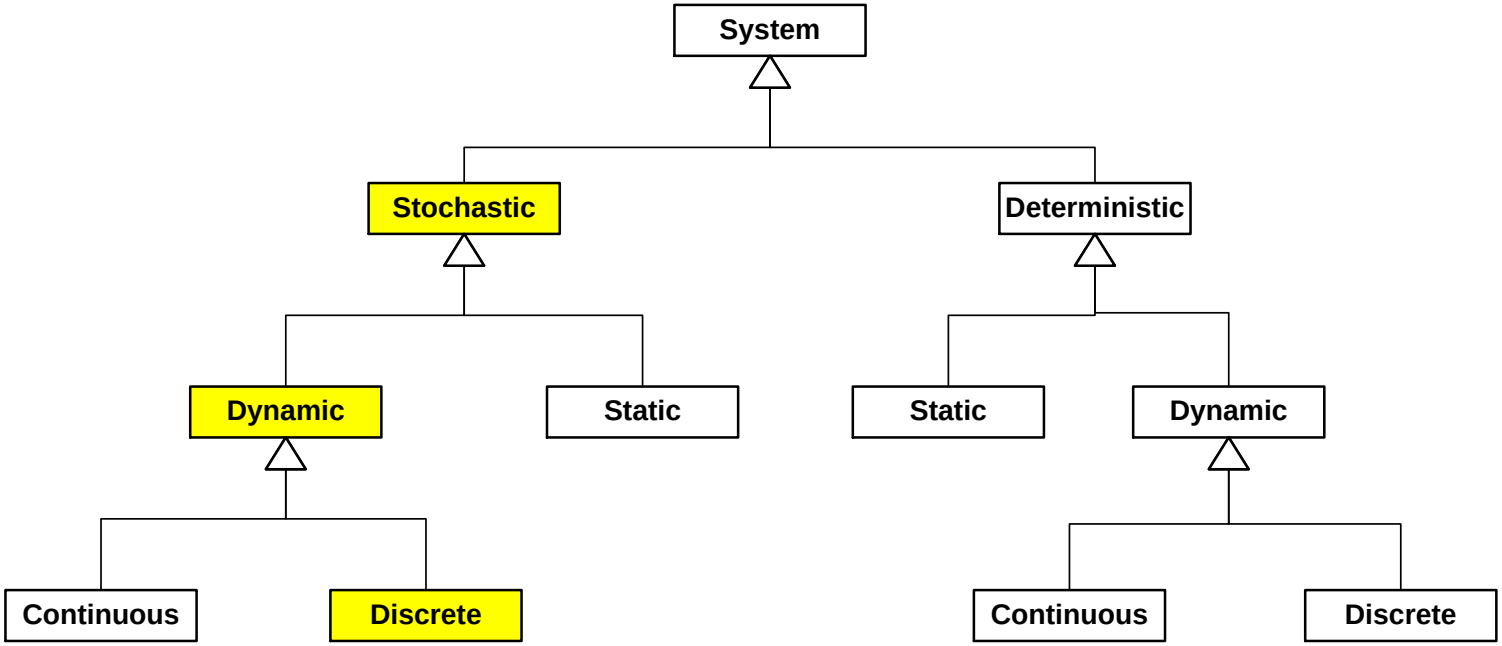
Cust. #	Time between arrivals (min)	Arrival time (min)	Service time (min)	Service start (min)	Cust. WIATE?	Wait Time (min)	Departure time (min)	Cashire Idle Time (min)	Mone Spent (SR)
1	0.24	0.24	0.33	0.24	0	0	0.58	0.24	30
2	0.69	0.93	2.10	0.93	0	0.00	3.03	0.36	20
3	0.82	1.76	9.51	3.03	1	1.27	12.54	0.00	30
4	7.63	9.39	4.27	12.54	1	3.15	16.81	0.00	20
5	3.19	12.58	4.22	16.81	1	4.23	21.03	0.00	20
6	1.67	14.26	1.42	21.03	1	6.77	22.45	0.00	20
7	5.03	19.29	0.49	22.45	1	3.16	22.94	0.00	30
8	3.23	22.52	1.53	22.94	1	0.42	24.47	0.00	10
9	5.42	27.94	2.25	27.94	0	0.00	30.19	3.48	20
10	10.01	37.96	1.61	37.96	0	0.00	39.56	7.77	30
11	0.10	38.05	0.39	39.56	1	1.51	39.95	0.00	20
12	0.89	38.94	3.84	39.95	1	1.01	43.80	0.00	50
13	7.58	46.52	7.44	46.52	0	0.00	53.96	2.72	30
14	6.00	52.52	0.24	53.96	1	1.44	54.20	0.00	30
15	10.75	63.27	9.36	63.27	0	0.00	72.62	9.07	10

7. Simulation Basics

Time		Change	No. in System
0	0.24	0	0
0.24	0.58	1	1
0.58	0.93	-1	0
0.93	1.76	1	1
1.76	3.03	1	2
3.03	9.39	-1	1
9.39	12.54	1	2
12.54	12.58	-1	1
12.58	14.26	1	2
14.26	16.81	1	3
16.81	19.29	-1	2
19.29	21.03	1	3
21.03	22.45	-1	2
22.45	22.52	-1	1
22.52	22.94	1	2
22.94	24.47	-1	1

Time		Change	No. in System
24.47	27.94	-1	0
27.94	30.19	1	1
30.19	37.96	-1	0
37.96	38.05	1	1
38.05	38.94	1	2
38.94	39.56	1	3
39.56	39.95	-1	2
39.95	43.80	-1	1
43.80	46.52	-1	0
46.52	52.52	1	1
52.52	53.96	1	2
53.96	54.20	-1	1
54.20	63.27	-1	0
63.27	72.62	1	1
72.62	0.00	-1	0

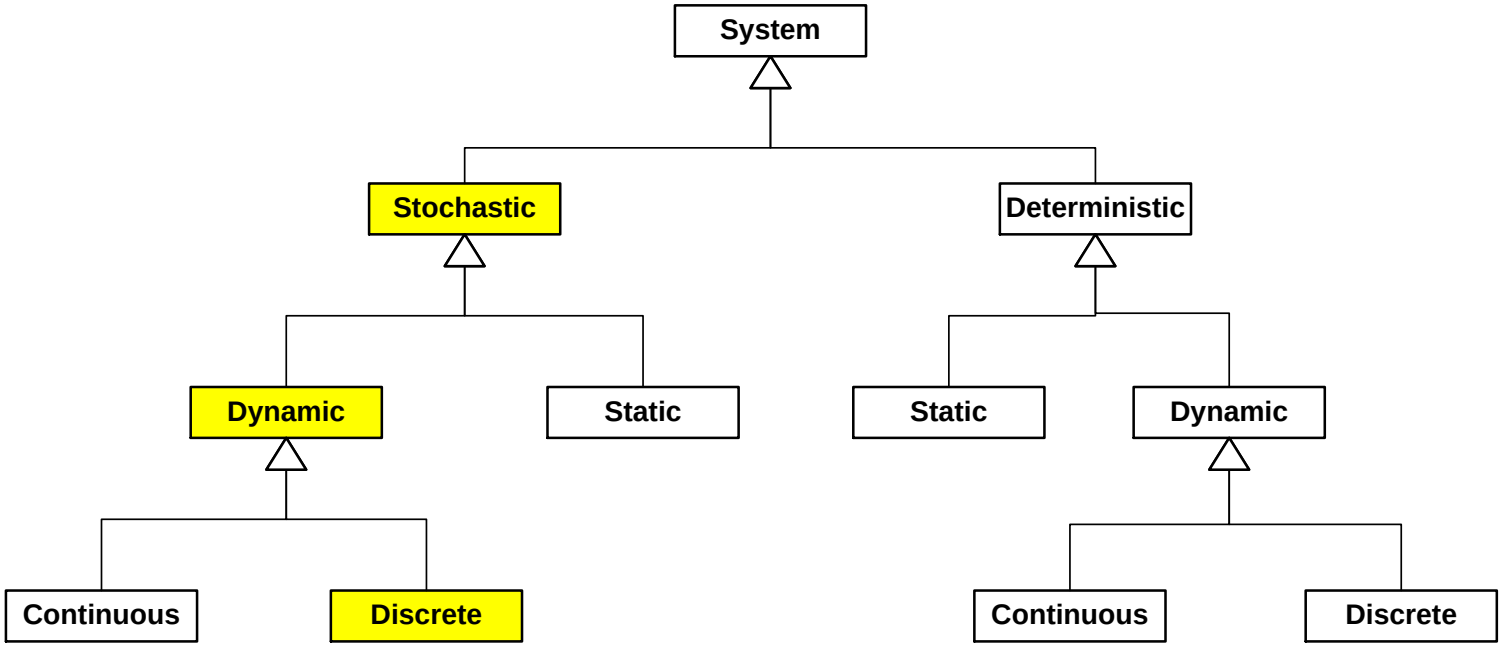
8. Types of Systems



Stochastics => there are some parameters or variables that has uncertainty or randomness

Deterministic => everything is exact

8. Types of Systems



Dynamic => some parameters change over time or periodically

Static => everything is exact and constant over time

8. Types of Systems

- **Discrete Systems**

A discrete system is one in which the state variables change only at a discrete set of points in time

- **Continuous System**

A continuous system is one in which state variables change continuously over time

8. Types of Systems

- Fast Food Counter (Discrete)

Measures changes with arrivals or departures

"Number of Customers waiting"

- Filling a Tank (Continuous)

Measures changes continuously over time

"amount of fuel in tank"