

## Unit-V (Simulation)

**Data Simulation:** Simulation is the process of taking large amount of data and using it to reflect (mirror) the real-world conditions to either predict or validate a model. The Requirement for simulation is Historical Data.

### **Features of Data Simulation:**

- ❖ Graphical User Interface
- ❖ Model Building
- ❖ Scalability

### **Benefits of Simulation:**

- ❖ The ability of behaviour (model behaviour) across various systems.
- ❖ Use Simulated data to produce a relatively reliable model.
- ❖ Visualization of Data Trends
- ❖ Comparing various scenarios to determine the ideal outcome.
- ❖ The Top Management of a company can design various strategies to increase production, sales, etc.

### **Advantages of Simulation**

- ❖ **Handles complex systems** – Can model systems that are difficult to solve mathematically.
- ❖ **Safe experimentation** – Tests can be done without risk to real systems.
- ❖ **Cost-effective** – Reduces the need for expensive real-world trials.
- ❖ **Time saving** – Long processes can be simulated quickly.
- ❖ **Better decision making** – Helps choose the best option by comparing results.

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**Monte Carlo Analysis (or Monte Carlo Simulation)** is a computational technique used to understand the impact of uncertainty and randomness in a system. Instead of solving a problem with fixed inputs, it runs many simulations using random values to estimate possible outcomes.

### **Steps:**

- ❖ **Define a problem** (e.g., predicting profit, risk, or probability)
- ❖ **Identify uncertain variables** (e.g., demand, cost, time)
- ❖ **Assign probability distributions** (normal, uniform, etc.)
- ❖ **Run simulations many times** (1000s or more)
- ❖ **Analyse results** (average, variance, probability of outcomes)

### **Applications:**

- ❖ **Finance:** Risk analysis, stock price simulation
- ❖ **Engineering:** Reliability testing
- ❖ **Project Management:** Time estimation

- ❖ **AI/ML:** Probabilistic models
- ❖ **Gaming:** Random behaviour simulation

**Advantages:**

- ❖ Handles complex problems
- ❖ Works with uncertainty
- ❖ Flexible and widely applicable

**Limitations:**

- ❖ Requires large computation
- ❖ Results depend on quality of random inputs