# Probabilistic Reasoning

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# What is Probabilistic Reasoning ?

Probabilistic reasoning is a fundamental approach in artificial intelligence (AI) used to handle uncertainty in data and decision-making processes. Unlike deterministic systems, which assume that everything is known and precise, probabilistic systems accept that there is uncertainty and handle it effectively. This makes them more flexible and reliable

# Causes of uncertainty:

1. Information occurred from unreliable sources.
2. Experimental Errors
3. Equipment fault
4. Temperature variation
5. Climate change.

# Need for Probabilistic Reasoning in AI

**ROBOTICS**

Provides robots the capability to act in and interact with dynamic and uncertain environments.

**NATURAL LANGUAGE PROCESSING**

Gives computers an understanding of human language in all its ambiguity and sensitivity to context.

**MACHINE LEARNING**

Helps algorithms learn from possibly incomplete or noisy data

**DECISION MAKING SYSTEMS**

It empowers AI systems for well-informed decisions and judgments by considering the likelihood of alternative outcomes.

# Key Concepts in Probabilistic Reasoning

**01** Bayesian Networks

**02** Markov Models

**03** Bayes' Theorem

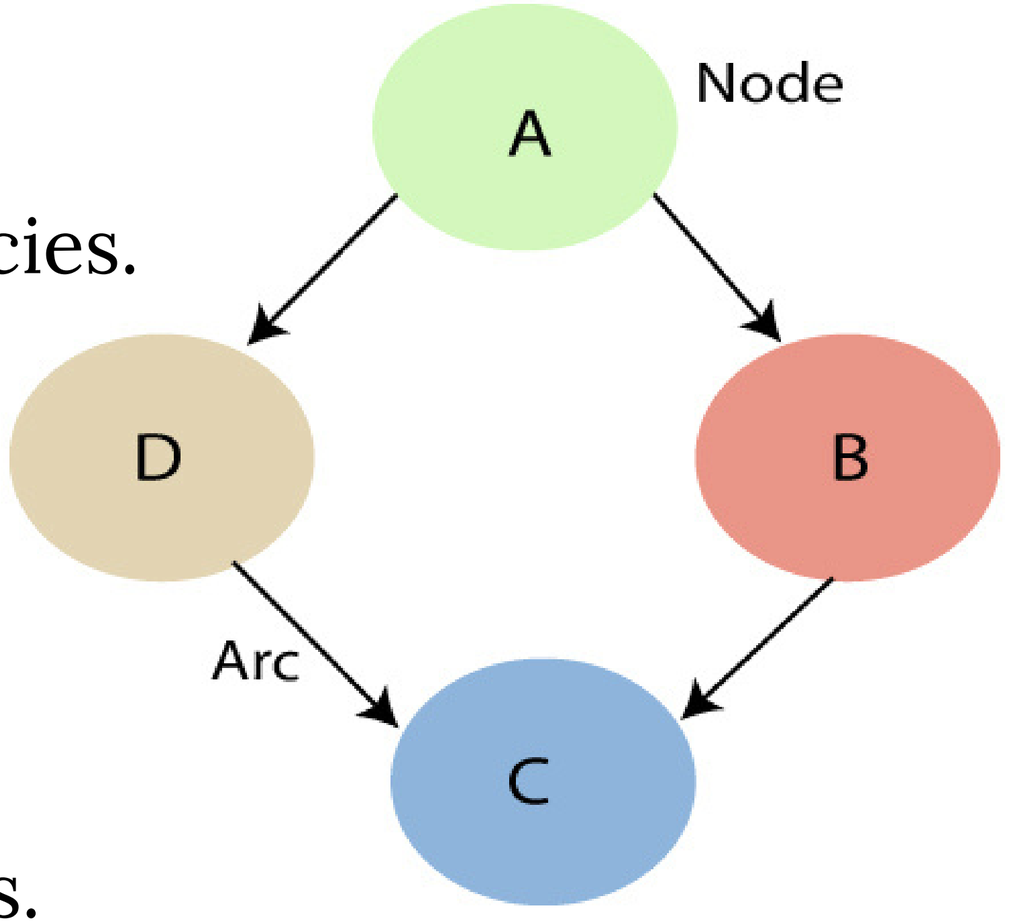
**04** Probabilistic Graphical Models

# 1. Bayesian Networks

- Structure:

Nodes represent variables.

Edges represent probabilistic dependencies.




- Inference:

Determining the probability of unknown variables.

- Example: Medical diagnosis networks.

# 2. Markov Models

Markov Models are used in AI to model systems where the future state depends only on the current state.

## A) MARKOV CHAINS:

**Definition**: Systems transitioning between states with probabilities dependent only on the current state.

**Applications**: Predictive text, financial markets, game AI.

## B) HIDDEN MARKOV MODELS (HMMS):

**Definition**: Systems where states are hidden and only observable through emissions.

**Applications**: Speech recognition, bioinformatics, part-of-speech tagging.

# 3. Bayes' Theorem

- Bayes' Theorem : $$P(H|E) = \frac{P(E|H) \cdot P(H)}{P(E)}$$
  - Posterior Probability: P (H|E)
  - Likelihood: P (E|H)
  - Prior Probability: P(H)
  - Marginal Likelihood: P(E)
- Application: Updating beliefs with new evidence.

# 4. Probabilistic Graphical Models

Probabilistic Graphical Models give a broader framework encompassing both Bayesian networks and Hidden Markov Models. In general, PGMs are an approach for representation and reasoning in a framework of uncertain information, given in graphical structure.

# Advantages of Probabilistic Reasoning

01

**Flexibility:** Probabilistic models can handle a wide range of uncertainties and are adaptable to various domains.

02

**Robustness:** These models are robust to noise and incomplete data, making them reliable in real-world applications.

03

**Interpretable:** Probabilistic models provide a clear framework for understanding and quantifying uncertainty, which can aid in transparency and explainability.

# Applications of Probabilistic Reasoning in AI

- Natural Language Processing (NLP):

-Speech recognition, machine translation.

- Robotics:

-Navigation and sensor data interpretation.

- Medical Diagnosis:

-Modeling relationships between symptoms and diseases.

- Computer Vision:

-Object recognition, image segmentation.

# Few more Applications

- Finance
- Game AI
- Autonomous Vehicles
- Fraud Detection
- Recommendation Systems

# Conclusion

- Probabilistic reasoning is crucial for managing uncertainty in AI.
- Enhances the performance and reliability of AI systems.
- Fundamental for advanced AI applications.

# Thank You