BAYESIAN LEARNING

OVERVIEW

- Objective
- Bayesian Learning
- Bayesian Theorem
- Bayesian Inference
- Bayesian Networks
- Applications
- Case Study
- Conclusion

Famous Coin Flip Example

BAYESIAN LEARNING

Bayesian Learning is a statistical framework for modeling and predicting outcomes based on probability theory. It combines prior knowledge with observed data to make informed decisions and continuously update beliefs.

Key Elements: Bayesian Learning involves prior beliefs, likelihood, and posterior probabilities, allowing for principled handling of uncertainty.

WHY DO WE USE BAYESIAN LEARNING?

Decision-Making

Data-Analysis

Learning and Updating

$$P(\theta|y) = P(\theta) \times \frac{P(y|\theta)}{P(y)}$$
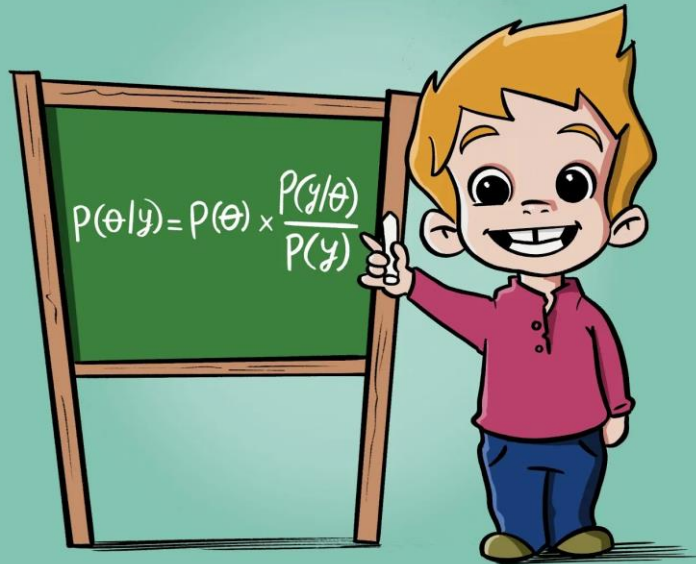
BAYES' THEOREM

Bayes' theorem, named after the 18th-century British statistician and theologian Thomas Bayes. It is a mathematical formula for determining <u>conditional probability</u>. It provides a way to update the probability for a hypothesis or event based on new evidence or data.

The theorem is expressed as follows:

$$P(A|B) = \frac{P(B|A) \cdot P(A)}{P(B)}$$

Where:
- $P(A|B)$ is the conditional probability of event A occurring given that event B has occurred.
- $P(B|A)$ is the conditional probability of event B occurring given that event A has occurred.
- $P(A)$ is the prior probability (the initial probability) of event A.
- $P(B)$ is the total probability of event B.

BAYESIAN INFERENCE

Bayesian inference is a statistical framework that involves updating beliefs, making predictions, and drawing conclusions based on probability theory and Bayes' theorem. It focuses on updating the probability distribution of a hypothesis, parameter, or model in the presence of new evidence.

ARE BAYESIAN LEARNING AND INFERENCE SAME?

BAYESIAN LEARNING

- Focuses on training and teaching machine learning models using Bayesian principles.

- The target is typically a machine learning model, algorithm, or computer program that learns from data

- Commonly applied in machine learning tasks like classification, regression, and recommendation systems.

BAYESIAN INFERENCE

- Focuses on making inferences, predictions, and decisions based on Bayesian principles.

- Targets are various scenarios, including parameter estimation, hypothesis testing, and decision-making, not limited to machine learning.

- Used in a wide range of fields, including statistics, scientific research, and decision analysis.

Focus→

Target→

Application →

BAYESIAN NETWORK

A Bayesian network, also known as a belief network or probabilistic graphical model, is a graphical representation of probabilistic relationships among a set of variables. It is a versatile tool for modeling uncertainty, making predictions, and reasoning under uncertainty.

Bayesian networks consist of **nodes** (representing variables) and **directed edges** (representing probabilistic dependencies) that form a **directed acyclic graph** (DAG). The structure encodes conditional independence relationships.

HOW BAYESIAN NETWORK WORKS?
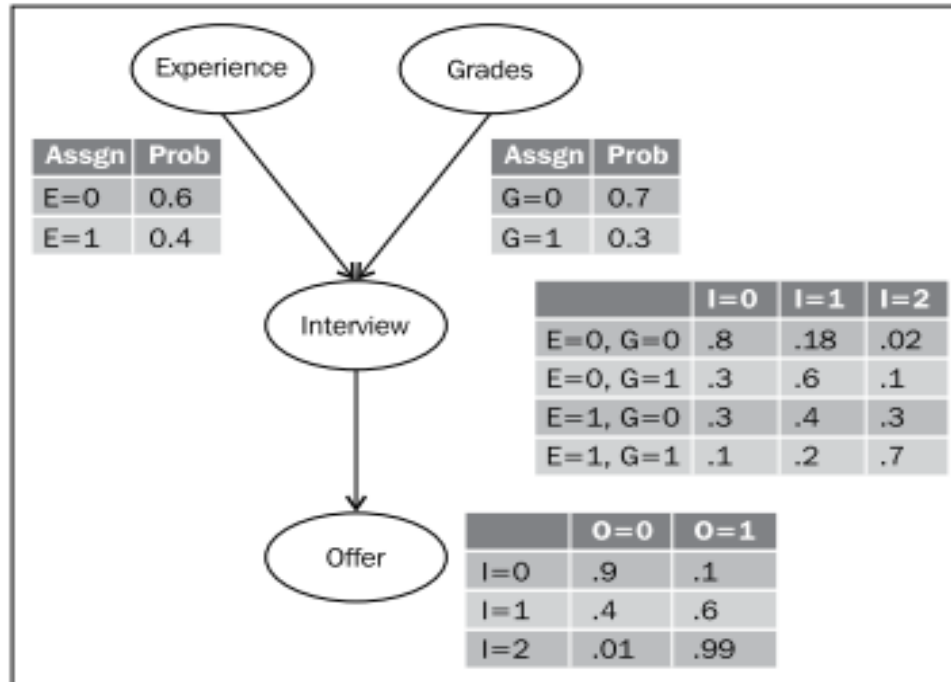
APPLICATION OF BAYESIAN LEARNING

Spam Detection:
Bayesian learning is applied in email filtering to classify emails as spam or not spam. It analyzes the content and characteristics of emails to make probabilistic decisions.

Natural Language Processing:
Bayesian learning aids in various NLP tasks, including part-of-speech tagging, text classification, and sentiment analysis, making it possible to understand and process human language.
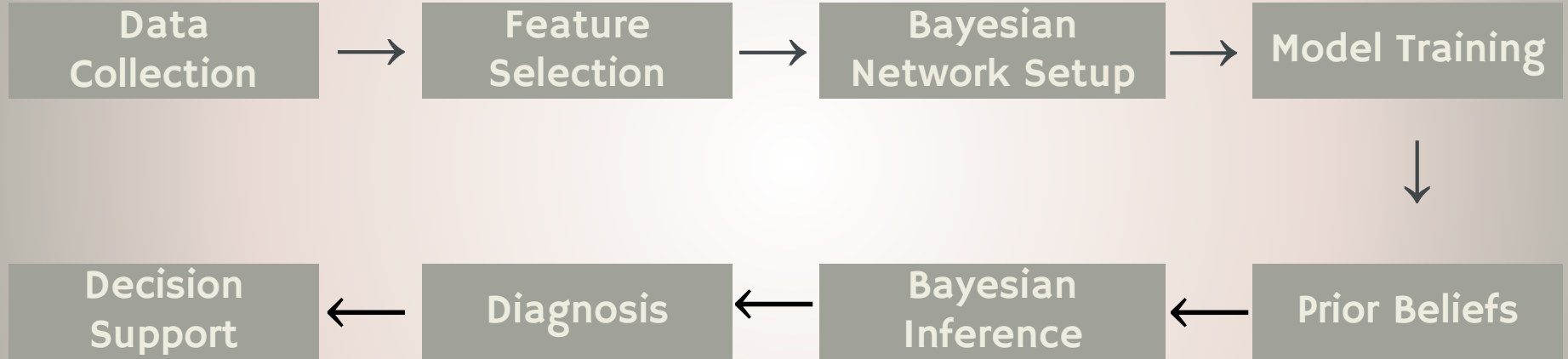
Image and Speech Recognition:
In image and speech recognition, Bayesian learning is used to model patterns and features in data, making it easier to recognize objects, speech, or handwriting.

Medical Diagnosis:
Bayesian learning is used to build diagnostic models that estimate the probability of a disease or condition based on patient symptoms and test results. This is valuable in healthcare for early diagnosis and treatment decisions.

Case Study

Medical Diagnosis

Data Collection	→ Feature Selection	→ Bayesian Network Setup	→ Model Training

↓

Decision Support	← Diagnosis	← Bayesian Inference	← Prior Beliefs

CONCLUSION

In conclusion, Bayesian learning is a fundamental concept that empowers us to harness the power of probability, navigate uncertainty, and make informed decisions. From revolutionizing medical diagnosis and enhancing machine learning to its diverse applications across various fields, Bayesian learning offers a transformative mindset for embracing the unknown. It encourages continuous learning and adaptation, ensuring that our models evolve with the availability of new data. By embracing Bayesian principles, we can unlock the potential of probabilistic thinking and transform the way we understand and address complex challenges.

THANKYOU

Q/A