

# AI Algorithms (Search, Decision Trees, Neural Networks)

## 1. Introduction to AI Algorithms

AI algorithms are the core mechanisms that allow artificial intelligence systems to think, learn, and make decisions. An algorithm is a step-by-step procedure used to solve a problem or perform a task. In Artificial Intelligence, algorithms help machines search for optimal solutions, learn patterns from data, make predictions and decisions, and adapt to new information. Among the most important AI algorithms are Search Algorithms, Decision Trees, and Neural Networks.

## 2. Search Algorithms in AI

Search algorithms are used to explore possible solutions and find the best or optimal answer to a problem. They are widely used in game playing, pathfinding, robotics, and problem-solving systems.

### 2.1 What is Search in AI?

Search involves navigating through a state space to reach a goal state from an initial state. Examples include shortest path finding, puzzle solving, and game playing.

### 2.2 Uninformed (Blind) Search

Breadth-First Search explores all nodes level by level and is complete but uses high memory. Depth-First Search explores deep paths first, uses less memory, but may get stuck in infinite paths.

### 2.3 Informed (Heuristic) Search

Informed search uses heuristics to guide the search efficiently. The A\* algorithm combines cost and heuristic values and guarantees optimal solutions when admissible heuristics are used.

### 2.4 Applications of Search Algorithms

Search algorithms are used in navigation systems, robotics path planning, game AI, and scheduling problems.

## 3. Decision Trees

Decision Trees are supervised machine learning algorithms used for classification and regression tasks. They represent decisions using a tree-like structure.

### 3.1 Structure of Decision Trees

A decision tree consists of a root node, internal nodes, branches, and leaf nodes that represent final predictions.

### 3.2 How Decision Trees Work

Data is split based on features to improve purity using criteria such as Information Gain, Gini Index, and Entropy.

### 3.3 Advantages and Limitations

Decision Trees are easy to interpret and require minimal preprocessing but are prone to overfitting and less effective for complex problems.

### 3.4 Applications of Decision Trees

Applications include medical diagnosis, credit approval systems, customer classification, and risk assessment.

## 4. Neural Networks

Neural Networks are inspired by the human brain and form the foundation of deep learning. They are used to solve complex and non-linear problems.

### 4.1 Structure of Neural Networks

A neural network consists of input layers, hidden layers, output layers, weights, biases, and activation functions.

### 4.2 Learning Process

The learning process includes feeding input data, predicting output, calculating error, adjusting weights using backpropagation, and repeating until accuracy improves.

### 4.3 Types of Neural Networks

Types include Artificial Neural Networks, Convolutional Neural Networks, Recurrent Neural Networks, and Deep Neural Networks.

### 4.4 Applications of Neural Networks

Neural networks are used in image recognition, speech recognition, natural language processing, self-driving cars, and medical image analysis.

## 6. Conclusion

AI algorithms form the backbone of intelligent systems. Search algorithms efficiently find solutions, decision trees provide interpretable decisions, and neural networks handle complex real-world problems.

Algorithm	Purpose	Strength
Search Algorithms	Problem-solving	Optimal path finding
Decision Trees	Classification	Interpretability
Neural Networks	Pattern recognition	High accuracy