# Introduction to Artificial Intelligence Cheatsheet

What AI can do:
- AI can learn from data and make decisions based on patterns.
- AI can automate tasks that are difficult or time-consuming for humans.
- AI can optimize processes and systems to improve efficiency and effectiveness.
- AI can assist humans in making decisions by providing insights and recommendations.
- AI can interact with humans in natural language through chatbots and virtual assistants.

Goals of AI:
- Develop intelligent systems that can perform tasks that would normally require human intelligence.
- Create machines that can learn from experience and improve their performance over time.
- Build systems that can reason, understand, and perceive the world like humans do.
- Develop AI systems that can communicate with humans in natural language.
- Create machines that can be creative and innovate.

Methods of AI:
- Machine Learning: Algorithms that can learn from data and improve their performance over time.
- Natural Language Processing: Techniques for processing and understanding human language.
- Computer Vision: Techniques for interpreting and analyzing visual data.
- Robotics: Techniques for designing and controlling robots to perform tasks.
- Expert Systems: Rule-based systems that can make decisions based on knowledge and rules.

AI Techniques:
- Neural Networks: Algorithms inspired by the structure and function of the human brain.
- Decision Trees: Algorithms that use a tree-like model of decisions and their possible consequences.
- Genetic Algorithms: Algorithms that use principles of natural selection and genetics to optimize solutions.
- Support Vector Machines: Algorithms that use mathematical models to classify data into categories.
- Reinforcement Learning: Algorithms that learn from feedback to improve their performance over time.

Applications of AI in Business:
- Customer Service: Chatbots and virtual assistants can handle customer inquiries and support.
- Sales and Marketing: AI can analyze customer data to identify trends and personalize marketing campaigns.
- Operations and Supply Chain: AI can optimize processes and inventory management to reduce costs and improve efficiency.
- Finance and Accounting: AI can assist with fraud detection and financial analysis.
- Human Resources: AI can assist with recruitment, employee engagement, and talent management.

Programming with and without AI:
- Traditional programming involves writing code to tell a computer what to do.
- AI programming involves training models on data to make predictions or decisions.
- Both traditional programming and AI programming can be used together to create intelligent systems.

What is Intelligence:
- Intelligence is the ability to learn, reason, and solve problems.
- Intelligence involves the ability to adapt to new situations and environments.
- Intelligence can take many forms, including linguistic, logical-mathematical, spatial, musical, and emotional intelligence.

Difference between Human and Machine Intelligence:
- Human intelligence is flexible and adaptable, while machine intelligence is limited to the tasks it has been programmed or trained to perform.
- Human intelligence involves creativity, emotion, and intuition, while machine intelligence is based on algorithms and data.
- Human intelligence is self-aware, while machine intelligence is not.

Distributed AI and its Applications:
- Distributed AI involves multiple intelligent agents working together to solve a problem or perform a task.
- Applications of distributed AI include swarm robotics, distributed decision-making, and multi-agent systems.
- Distributed AI can improve efficiency and scalability in complex systems.

Predicate Logic:
- Predicate logic is a formal system for representing relationships between objects and concepts.
- Predicate logic uses symbols and rules to represent statements about objects and their properties.

- Predicate logic can be used for automated reasoning and natural language processing.

Knowledge Representation and its Types:
- Knowledge representation involves organizing and structuring information for use in intelligent systems.
- Types of knowledge representation include frames, semantic networks, ontologies, and logic-based representations.
- Knowledge representation enables intelligent systems to reason and make decisions based on knowledge and context.

AI Search Algorithms Cheatsheet

Depth First Search:
- A search algorithm that explores a graph or tree by traversing as far as possible along each branch before backtracking.
- Uses a stack to keep track of the nodes to be visited.
- Can get stuck in infinite loops if there are cycles in the graph.

Breadth First Search:
- A search algorithm that explores a graph or tree by visiting all the neighbors of a node before moving on to the next level.
- Uses a queue to keep track of the nodes to be visited.
- Guarantees finding the shortest path.

Bidirectional Search:
- A search algorithm that explores a graph or tree from both the start and goal nodes simultaneously.
- Can significantly reduce the number of nodes that need to be explored.
- Requires a way to check if a node has been visited from both directions.

Uniform Cost Search:
- A search algorithm that expands the node with the lowest cost so far.
- Uses a priority queue to keep track of the nodes to be visited.
- Can be used when the cost of each edge or node is known.

Iterative Deepening DFS:
- A search algorithm that performs a series of depth-first searches with increasing depth limits.
- Can find a solution with the least cost.
- Avoids the infinite loops of DFS by increasing the depth limit.

A* Search:
- A search algorithm that combines the benefits of both uniform cost search and heuristic search.
- Uses a heuristic function to estimate the cost from the current node to the goal.
- Uses a priority queue that prioritizes nodes with the lowest $f(n) = g(n) + h(n)$ value.

Greedy BFS:
- A search algorithm that expands the node that is closest to the goal.
- Uses a heuristic function that estimates the distance to the goal.
- Can be faster than A* if the heuristic function is admissible and consistent.

Hill Climbing:
- A local search algorithm that repeatedly makes small improvements to the current solution until no further improvements can be made.
- Can get stuck in local optima if there are no neighboring states with better values.

Local Beam:
- A variant of hill climbing that keeps multiple states in memory at once and selects the best ones to continue exploring.
- Can escape from local optima more easily than hill climbing.

Traveling Salesman Problem:
- A classic optimization problem that involves finding the shortest possible route that visits every city in a list.
- Can be solved using various search algorithms, such as brute force, dynamic programming, and genetic algorithms.

Problem Reduction and Game Playing:
- Problem reduction involves breaking down a complex problem into smaller, more manageable sub-problems.
- Game playing involves developing strategies for games that involve decision making.
- The Nim game can be solved using AND-OR and min-max strategies, and alpha-beta pruning can be used to optimize the search.

AND-OR Strategy:
- An algorithm that uses logical expressions to represent the possible moves in a game.
- Uses AND to represent a set of possible moves and OR to represent a choice of moves.
- Can be used to solve games that involve multiple levels of decision making.

Min-Max Strategy:
- A strategy that assumes the opponent will make the move that is worst for the player.
- Minimizes the maximum possible loss.

- Can be used to solve games with perfect information.

Alpha-Beta Pruning Technique:
- A technique for optimizing the min-max algorithm by avoiding the evaluation of nodes that are guaranteed to be suboptimal.
- Uses alpha to represent the best value found so far for the max node and beta to represent the best value found so far for the min node.

Planning Cheatsheet

Planning is the process of generating a sequence of actions to achieve a goal. Here's a cheatsheet for planning:

Introduction
- Planning involves reasoning about a domain and generating a plan that achieves a goal.
- Planning is used in a variety of domains such as robotics, manufacturing, and game playing.

Types of Planning Systems
- Operator-based planning: The planner generates a plan by applying operators (actions) to the initial state until the goal state is reached.
- Case-based planning: The planner reuses a previously generated plan that is similar to the current planning problem.
- Planning algorithms: The planner generates a plan by searching through a state-space of possible plans.

State-Space Planning
- State-space planning involves searching through a graph of states and actions to reach the goal state.
- Linear planning involves a sequence of actions that are executed one after the other.
- Non-linear planning involves actions that can be executed in parallel or in any order.

Block World Problem
- The Block World Problem is a classic planning problem where the goal is to move blocks from one location to another.
- The Block World Problem can be solved using logic-based planning systems such as STRIPS.

STRIPS-Style Operators
- STRIPS-style operators represent actions as preconditions and effects.
- Preconditions are conditions that must be true before an action can be executed.

- Effects are conditions that become true after an action is executed.

Goal Stack Method
- The Goal Stack Method is a linear planning algorithm that generates a plan by decomposing the goal into subgoals and then decomposing the subgoals into actions.
- The Goal Stack Method uses a stack data structure to keep track of the current goal and subgoals.

Means-End Analysis
- Means-End Analysis is a linear planning algorithm that generates a plan by identifying the differences between the current state and the goal state and then selecting actions to reduce these differences.

Non-linear Planning Strategies
- Goal set planning involves generating a set of goals and then selecting actions that achieve these goals.
- Partial-order planning involves generating a partial order of actions and then selecting actions to achieve the goals.
- Constraint posting method involves generating constraints on the possible sequences of actions and then selecting actions that satisfy these constraints.

Learning Plans
- Triangle table is a method of learning plans by observing successful plans and unsuccessful plans.
- Other methods of learning plans include decision trees and neural networks.

Uncertainty Measure Cheatsheet

Introduction to Uncertainty
- Uncertainty refers to situations where there is insufficient knowledge or data to make a definite prediction or decision.
- In artificial intelligence, uncertainty arises in situations where there is incomplete or noisy data, or where there are multiple possible outcomes.

Nondeterministic Uncertainty
- Nondeterministic uncertainty refers to situations where the outcome of an event is not fully determined by the inputs or conditions.
- Nondeterministic uncertainty can be modeled using probability theory.

Joint and Conditional Probability
- Joint probability is the probability of two or more events occurring together.

- Conditional probability is the probability of an event given that another event has occurred.

Bayes' Theorem
- Bayes' Theorem is a mathematical formula that calculates the probability of a hypothesis given some evidence.
- Bayes' Theorem can be used to update the probability of a hypothesis as new evidence becomes available.
- Bayes' Theorem involves multiplying the prior probability of a hypothesis by the likelihood of the evidence given the hypothesis, and then dividing by the probability of the evidence.

Chain Evidences
- Chain evidences refer to situations where the probability of an event depends on a chain of other events.
- Chain evidences can be modeled using Bayesian networks.

Probabilities in Rules and Facts of Rule-Based System
- Rule-based systems use rules to infer conclusions from facts.
- Rules can include probabilities, which represent the likelihood of the conclusion given the facts.

Cumulative Probability
- Cumulative probability is the probability of one or more events occurring.
- OR-combination involves adding the probabilities of the events occurring.
- AND-combination involves multiplying the probabilities of the events occurring.

Negative Probabilities
- Negative probabilities are a mathematical concept that allows for probabilities that are less than zero.
- Negative probabilities can be used to model situations where the probability of an event is less than the probability of its complement.

Bayesian Belief Networks Cheatsheet

Definition
- Bayesian Belief Networks (BBNs) are a probabilistic graphical model used to represent uncertain knowledge.
- BBNs consist of nodes that represent variables and edges that represent probabilistic dependencies between variables.
- BBNs are used for probabilistic inference, where the probability of an event is calculated given some evidence.

Inference using Bayesian Belief Networks
- Inference in BBNs involves updating the probabilities of variables based on evidence.
- The process of inference involves using Bayes' Theorem and the BBN structure to calculate the posterior probability of a variable given some evidence.

Examples
- BBNs can be used in various applications such as medical diagnosis, fraud detection, and risk analysis.
- In medical diagnosis, BBNs can be used to infer the probability of a disease given some symptoms.
- In fraud detection, BBNs can be used to infer the probability of fraud given some transaction data.
- In risk analysis, BBNs can be used to infer the probability of a risk event given some risk factors.

Advantages and Disadvantages of BBN
- Advantages:
  - BBNs provide a graphical representation of uncertain knowledge, making it easier for humans to understand and interpret.
  - BBNs can handle missing or incomplete data and can update probabilities as new evidence becomes available.
- Disadvantages:
  - BBNs can be computationally expensive for large networks.
  - BBNs require domain knowledge to construct and can be sensitive to errors in the network structure.

Inductive Learning
- Inductive learning is a type of machine learning that involves inferring general rules from specific examples.
- Inductive learning algorithms can be used to learn the structure and probabilities of a BBN from data.

Fuzzy Sets and Fuzzy Logic
- Fuzzy sets are sets that allow for partial membership.
- Fuzzy logic is a type of logic that allows for uncertain or approximate reasoning.
- Fuzzy sets and fuzzy logic can be used in BBNs to handle uncertain or imprecise data.

Certainty Factor Theory - Dempster-Shafer Theory
- Certainty Factor Theory and Dempster-Shafer Theory are two other probabilistic models that can be used to handle uncertainty.

- Certainty Factor Theory assigns a degree of certainty to a rule or fact, ranging from 0 (completely uncertain) to 1 (completely certain).
- Dempster-Shafer Theory is a more general theory that can handle uncertain evidence that is not limited to binary outcomes.

Natural Language Processing (NLP) Cheatsheet

Overview of Linguistics
- Linguistics is the scientific study of language and its structure.
- Linguistics is important in NLP as it provides the foundation for understanding how language works and how it can be analyzed and processed.

Components of NLP
- NLP consists of several components, including:
  - Tokenization: breaking text into individual words or phrases.
  - Part-of-speech (POS) tagging: assigning grammatical categories to words.
  - Parsing: analyzing the grammatical structure of a sentence.
  - Named entity recognition (NER): identifying named entities such as people, organizations, and locations.
  - Sentiment analysis: determining the sentiment or opinion expressed in text.

Difficulties in NLU
- Natural Language Understanding (NLU) is the process of understanding the meaning of natural language text.
- NLU is difficult because natural language is ambiguous and can have multiple interpretations.

NLP Terminology
- Corpus: a collection of text used for analysis.
- Stop words: common words such as "the", "and", and "is" that are often removed from text during analysis.
- Stemming: reducing words to their root form (e.g. "jumping" to "jump") to simplify analysis.

Steps in NLP
- Preprocessing: cleaning and formatting text data.
- Tokenization: breaking text into individual words or phrases.
- POS tagging: assigning grammatical categories to words.
- Parsing: analyzing the grammatical structure of a sentence.
- NER: identifying named entities such as people, organizations, and locations.
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Implementation Aspects of Syntactic Analysis
- Syntactic analysis is the process of analyzing the grammatical structure of a sentence.
- Context-Free Grammar (CFG) is a formal grammar used to describe the structure of a language.
- Top-Down parsing is a method of parsing that starts with the highest level of the grammar and works down to the individual words.

AI-based System to Predict Diseases Early
- AI-based systems can be used in healthcare to predict diseases early.
- These systems use machine learning algorithms to analyze patient data and identify patterns that may indicate the early onset of a disease.
- Early detection of diseases can lead to better outcomes for patients and lower healthcare costs.

Research Areas of AI
- Natural Language Processing (NLP)
- Robotics
- Computer Vision
- Machine Learning
- Knowledge Representation
- Reasoning and Problem Solving
- Planning and Scheduling
- Intelligent Agents

Task Classifications of AI
- Perception
- Learning
- Reasoning
- Planning
- Natural Language Processing (NLP)
- Robotics

AI Issues
- Ethics
- Privacy
- Bias
- Safety
- Job Displacement
- Regulation

Difference in Robot System and Other AI Programs

- Robot systems are physical machines that can interact with the environment, while other AI programs are purely software-based.
- Robot systems often require additional sensors and hardware components to interact with the environment.

Expert System Architecture
- Knowledge Base: stores information about a particular domain
- Inference Engine: applies rules and reasoning to the knowledge base
- User Interface: allows users to interact with the system
- Explanation Facility: provides explanations for the system's decisions

Evaluation of ES
- Knowledge Acquisition
- Knowledge Representation
- Inference Mechanism
- User Interface
- Explanation Facility

Characteristics of ES
- Knowledge-Intensive
- Domain-Specific
- Expertise-Driven
- Consistent
- Explains Its Reasoning
- Capable of Uncertainty Management

Capabilities of Expert System
- Diagnosis
- Design
- Planning and Scheduling
- Monitoring and Control
- Decision-Making

Components of ES
- Knowledge Base
- Inference Engine
- User Interface
- Explanation Facility

Limitations of ES
- Lack of Common Sense
- Limited Scope
- Difficulty Incorporating New Knowledge

- Difficulty Handling Uncertainty

Expert System Technology
- Rule-Based Systems
- Case-Based Reasoning
- Fuzzy Logic Systems
- Neural Networks

Development of Expert System
- Knowledge Acquisition
- Knowledge Representation
- Inference Mechanism Design
- User Interface Design
- Testing and Evaluation

Applications of ES
- Medical Diagnosis
- Financial Analysis
- Quality Control
- Customer Support
- Engineering Design

Benefits of ES
- Increased Efficiency
- Improved Decision-Making
- Reduced Costs
- Improved Quality of Service

What is Robotics
- Robotics is the branch of engineering and computer science that deals with the design, construction, and operation of robots.
- Robots are machines that can be programmed to perform a variety of tasks, often autonomously.
- Robotics combines knowledge and techniques from several fields, including mechanical engineering, electrical engineering, computer science, and artificial intelligence.

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Robot Locomotion
- Wheeled: robots that move using wheels
- Legged: robots that move using legs, often used in challenging environments
- Flying: robots that move through the air, such as drones
- Swimming: robots that move through water

Components of a Robot
- Actuators: components that produce motion, such as motors
- Sensors: components that detect changes in the environment
- Control system: manages the robot's behavior
- Power source: provides energy to the robot's components

Computer Vision
- Object Recognition: recognizing objects in images or videos
- Image Segmentation: dividing an image into segments based on shared characteristics
- Object Tracking: tracking objects as they move through a video
- Facial Recognition: recognizing faces in images or videos
- Image Classification: classifying images into categories

Tasks of Robotic Process Automation for Supply Chain Management
- Inventory Management
- Procurement
- Order Fulfillment
- Shipping and Logistics

Application Domain of Computer Vision
- Surveillance and Security
- Medical Imaging
- Robotics
- Autonomous Vehicles
- Augmented Reality

AI/ML in Social Problems Handling
- Predictive Policing: using AI/ML to predict and prevent crime
- Disaster Response: using AI/ML to assist in disaster response efforts
- Healthcare: using AI/ML to improve patient outcomes and reduce costs
- Education: using AI/ML to personalize learning experiences
- Social Services: using AI/ML to improve access to social services and support for vulnerable populations