Notes on Artificial Intelligence (AI)

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1. Introduction to Artificial Intelligence

Definition:
Artificial Intelligence (AI) is the simulation of human intelligence processes by machines, especially computer systems.

Key Goals of AI:

- Perception

- Reasoning

- Learning

- Natural interaction

- Problem-solving

Types of AI:

- **Narrow AI**: Specialized in one task (e.g., Siri, Alexa)

- **General AI**: Human-level intelligence across a wide range of tasks

- **Super AI**: Hypothetical AI surpassing human intelligence

Applications:

- Healthcare, Finance, Gaming, Autonomous Vehicles, Virtual Assistants, etc.

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2. Problem Solving and Search Algorithms

Problem Solving in AI:

Involves defining a **problem space**, **initial state**, **goal state**, and **actions** to reach the goal.

Search Algorithms:

Uninformed Search (Blind Search):

- **Breadth-First Search (BFS)**: Explores level by level

- **Depth-First Search (DFS)**: Explores as far as possible along one branch

- **Uniform Cost Search**: Explores based on path cost

Informed Search (Heuristic-based):

- **Greedy Best-First Search**: Uses heuristic to select the most promising node

- **A* Search**: Combines path cost and heuristic ($f(n) = g(n) + h(n)$)

Adversarial Search:

- **Minimax Algorithm**: For two-player games (e.g., chess)

- **Alpha-Beta Pruning**: Optimization for minimax

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3. Knowledge Representation and Reasoning (KR&R)

Knowledge Representation:

How to symbolically represent knowledge so a machine can reason with it.

Types of Representation:

- **Logical (Propositional & First-Order Logic)**

- **Semantic Networks**

- **Frames and Scripts**

- **Ontologies**

Reasoning:

Drawing conclusions from known facts.

Types of Reasoning:

- **Deductive Reasoning**: General to specific

- **Inductive Reasoning**: Specific to general

- **Abductive Reasoning**: Best explanation

- **Probabilistic Reasoning**: Using probability (e.g., Bayesian networks)

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4. Machine Learning Fundamentals

What is Machine Learning?

A subset of AI that enables systems to learn and improve from experience without being explicitly programmed.

Categories:

- **Supervised Learning**: Learn from labeled data (e.g., classification, regression)

- **Unsupervised Learning**: Find hidden patterns in unlabeled data (e.g., clustering)

- **Reinforcement Learning**: Learn by interacting with the environment (reward-based)

Common Algorithms:

- **Linear Regression**

- **Logistic Regression**

- **Decision Trees**

- **K-Nearest Neighbors (KNN)**

- **Naive Bayes**

- **Support Vector Machines (SVM)**

- **Neural Networks**

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5. Natural Language Processing (NLP)

Definition:

NLP enables computers to understand, interpret, and generate human language.

Key Tasks:

- **Tokenization**

- **Part-of-Speech Tagging**

- **Named Entity Recognition (NER)**

- **Sentiment Analysis**

- **Machine Translation**

- **Question Answering**

- **Text Summarization**

Techniques:

- **Rule-based Systems**

- **Statistical Methods**

- **Deep Learning (e.g., RNN, Transformers, BERT)**

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6. Computer Vision and Robotics

Computer Vision:

Enables machines to interpret visual data.

Key Tasks:

- **Image Classification**
- **Object Detection**
- **Image Segmentation**
- **Face Recognition**
- **Optical Character Recognition (OCR)**

Techniques:

- **Convolutional Neural Networks (CNNs)**
- **Image Preprocessing (e.g., filters, edge detection)**

Robotics:

Integrates AI to enable autonomous decision-making in physical systems.

Key Concepts:

- **Perception (using sensors)**
- **Motion Planning**
- **Control Systems**
- **Robot Localization and Mapping (SLAM)**

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7. Ethics and Future of AI

Ethical Issues:

- **Bias and Fairness**
- **Privacy Concerns**
- **Job Displacement**
- **Surveillance**
- **Autonomous Weapons**

Responsible AI:

- **Explainability**

- **Transparency**

- **Accountability**

- **Inclusiveness**

Future Trends:

- **Explainable AI (XAI)**

- **General AI development**

- **AI in creativity (e.g., art, music)**

- **Integration with IoT and Edge computing**

- **AI governance and regulations**

Summary Table:

Topic	Key Concepts
Introduction	Types of AI, Applications
Problem Solving	Search algorithms (BFS, DFS, A*), Game playing
KR & Reasoning	Logic, Ontologies, Reasoning types
Machine Learning	Supervised, Unsupervised, Algorithms
NLP	Parsing, Translation, Transformers
Computer Vision & Robotics	CNNs, Object Detection, Robot control
Ethics & Future	Fairness, Transparency, Regulation