Artificial Intelligence

Short Notes based on ***Exit Exam***

Zemzem labs

1. Introduction to AI

AI Definition

AI is the study of **intelligent agents** that can perceive, reason, learn, and act.

Branches of AI

- Machine Learning
- Natural Language Processing
- Robotics
- Computer Vision
- Expert Systems
- Planning & Reasoning

Types of AI

- **Weak AI / Narrow AI** — specific tasks (e.g., Siri, ChatGPT)
- **Strong AI** — human-like intelligence (not achieved)
- **Superintelligence** — beyond human

2. Intelligent Agents

Agent

An entity that perceives environment and takes actions.

Agent Components

- Sensors
- Actuators
- Agent function / program

PEAS (Performance measure, Environment, Actuators, Sensors)

Used to define agent tasks.

Agent Types

- Simple Reflex Agents
- Model-Based Reflex Agents

- Goal-Based Agents
- Utility-Based Agents
- Learning Agents

3. Problem Solving & Search

Types of Search

1. **Uninformed (Blind) Search**
    - Breadth-First Search (BFS)
        - Complete, optimal in unweighted graphs
    - Depth-First Search (DFS)
        - Uses stack, not always optimal
    - Uniform Cost Search
    - Depth-Limited Search
    - Iterative Deepening Search (IDS)
2. **Informed (Heuristic) Search**
    - A* Search → optimal if heuristic is **admissible**
    - Greedy Best-First Search
    - Hill Climbing
    - Beam Search

Heuristics

- Estimates cost to goal
- Must be **admissible** (never overestimates)

4. Knowledge Representation

KR Methods

- **Propositional Logic**
- **First-Order Predicate Logic (FOPL)**
- **Semantic Networks**
- **Frames**
- **Scripts**

Inference

- Forward Chaining
- Backward Chaining

- Resolution

Unification

Matching predicates with variables.

5. Expert Systems

Components

- Knowledge Base
- Inference Engine
- Working Memory
- User Interface

Knowledge Types

- Declarative
- Procedural
- Meta-knowledge

Rule-Based Systems

Uses IF–THEN rules.

6. Machine Learning (ML)

ML Types

1. **Supervised Learning**
   - Classification
   - Regression
   - Algorithms:
     - Decision Trees
     - SVM
     - Naive Bayes
     - k-NN
     - Linear/Logistic Regression
2. **Unsupervised Learning**
   - Clustering (k-means, hierarchical)
   - Dimensionality reduction (PCA)

3. **Reinforcement Learning**
    - Agent learns via reward/punishment
    - Q-Learning, Markov Decision Processes

7. Neural Networks & Deep Learning

Artificial Neural Network (ANN)

Made of:

- Input layer
- Hidden layers
- Output layer

Activation Functions

- Sigmoid
- ReLU
- Tanh
- Softmax

Deep Learning

- Convolutional Neural Networks (CNNs) → images
- Recurrent Neural Networks (RNNs) → sequences
    - LSTM, GRU

Loss Functions

- MSE
- Cross-Entropy

Optimization

- Gradient Descent
- Adam
- Momentum

8. Natural Language Processing (NLP)

Tasks

- Tokenization
- Stemming / Lemmatization
- Part-of-speech tagging
- Named Entity Recognition
- Text classification
- Machine translation

Models

- Bag-of-Words
- TF-IDF
- RNNs
- Transformers (BERT, GPT)

9. Robotics

Key Components

- Sensors (camera, lidar)
- Actuators (motors)
- Perception
- Planning
- Motion control

Path Planning

- A*, Dijkstra
- Potential field method

10. Fuzzy Logic

Used for reasoning with **uncertainty**.

Key Concepts

- Membership functions
- Fuzzy sets
- Fuzzy rules (IF-THEN)
- Defuzzification

Used in washing machines, control systems.

11. Game Playing

Algorithms

- Minimax
- Alpha–Beta Pruning
- Game tree
- Utility functions

Used in Chess, Tic-Tac-Toe, Go.

12. Probability & Bayesian Networks

Bayesian Network

Graphical model representing probabilistic relationships.

Key Concepts

- Conditional probability
- Bayes theorem
- Joint distribution

Used in medical diagnosis, spam detection.

⭐ Ultra-Condensed Exam Summary

- AI = intelligent agents that act rationally
- BFS/DFS = uninformed search
- A* = best heuristic search, optimal with admissible heuristic
- Knowledge representation: propositional, predicate logic
- Expert system = KB + inference engine
- ML types: supervised, unsupervised, reinforcement
- ANN uses layers + activation functions
- CNNs for images, RNNs for sequences
- NLP = text processing + transformers
- Fuzzy logic for uncertainty
- Minimax for game playing
- Bayesian networks for probabilistic reasoning