Test Questions Summary

# Week 1: What is intelligence?

## Intelligence can be characterized by the ability to:

* Reason & Problem-solved
* Learn & Adapt
* Perform complex tasks

## What is an intelligent system?

* Programming computers to solve tasks that would require:

### intelligence for people to solve (Minsky’s definition of AI)

* A truly intelligent system adapts itself to deal with changes

### in problems (automatic learning)

* Few machines can do that at present
* Intelligent systems display machine-level intelligence,

### reasoning, often learning, not necessarily self-adapting

## Intelligent Systems vs AI vs Machine Learning

### A plethora of terminologies:

* Intelligent Systems
* AI
* Intelligent agents
* ML
* Cognitive computing
* Computational intelligence, machine intelligence, soft computing, etc
* AI as system that thinks like a human
* AI as system that thinks rationally
* AI as system that acts like a human
* AI as system that acts rationally
* IA is a popular paragdigm of AI (Systems that act rationally)
* ML is a subfield of AI
* Cognitive computing refers to technology platforms that enable computers to mimic the way human mind works
* Computational intelligence and soft computing are a few other AI paradigms
* Machine intelligence was sometimes used as a terminology in place of AI

## Characteristics of intelligent systems

### Posses one or more of these:

* Capability to extract and store knowledge
* Human like reasoning process
* Learning from experience (or training)
* Dealing with imprecise expressions of facts
* Finding solutions through processes similiar to natural evolution
* has the ability to interact and deal with other agents (including humans)

### Recent trend:

* More sophisticated Interaction with the user though:
* natural language understanding
* speech recognition and synthesis
* image analysis

### Knowledge representation and reasoning:

* Logic based
* Rule based expert systems
* Constrant satisfactrion and optimisation problems

### Machine Learning:

* Deep learning
* Reinforcement learning
* Deep reinforcement learning

## Fuzzy logic:

* Fuzzy systems
* Rough set theory

## Soft computing/computational intelligence:

* Evolutionary computing
* Genetic algorithm/Different evolution
* Particle swarm optimisation/Ant colony optimisation
* Artificial neural networks

## Multi agent systems:

* Agent communication
* Automated negotiation
* NLP
* NL based conversational agents

## PEAS:

* P: Performance measures
* E: Environment
* A: Actions
* S: Sensing's percept

## Agent types:

1. Simple Reflex Agent

2. Model based reflex agent

3. Goal based agent

4. Utility based agent

5. Learning agent

## Summary Week 1:

* **Four main paradigms of AI (think vs act, rational vs human-like)**
* How you choose to view AI will define the appropriate technique
* **Main characteristics of intelligent systems**
* To develop a system with certain characteristics, some AI techniques will be introduced to you in this unit of study
* **Intelligent agents (IA)**
* Four basic agent types + four advanced agent types (by combining a basic agent type with the learning capability

# Week 2 – Problem Solving Agents:

## Q: What is a Problem Solving Agent?

A: A problem-solving agent is an artificial intelligence entity that operates by finding a sequence of actions that leads to the desired goal states from a given initial state. It uses problem-solving algorithms to find the best path.

## Q: Define Constraint Satisfaction Problem (CSP).

A: A Constraint Satisfaction Problem (CSP) is a mathematical problem defined by a set of objects whose state must satisfy several constraints or limitations. It is represented by three main components:

* a set of variables
* a set of domains for each variable
* a set of constraints.

## Q: Explain the Backtracking Search Algorithm used in CSPs.

A: The Backtracking algorithm is a **depth-first search** algorithm used to solve CSPs. It traverses the tree by exploring each branch before backtracking, which means it goes as far as possible before it tries the next option. The algorithm becomes more efficient when combined with techniques like forward checking and arc consistency.

## Q: What is Forward Checking?

A: Forward Checking is a **constraint propagation** algorithm that is often used alongside backtracking search. Whenever a variable **X** is assigned, the forward checking algorithm goes ahead to prune the domain of the unassigned variables that are connected to **X** by a constraint.

## Q: Explain Arc Consistency in the context of CSPs.

A: Arc Consistency is a property that ensures for every value in the domain of each variable, there exists a compatible value in the domain of each connected variable. Algorithms like AC-3 are often used to establish arc consistency in a CSP, thereby reducing the domain of variables and simplifying the problem.

## Q: Name and explain one Local Search Algorithm used in solving CSPs.

A: One common local search algorithm used in CSPs is the **Min-Conflicts** algorithm. The algorithm starts with a complete but inconsistent assignment and iteratively corrects it. In each step, it chooses a variable and assigns it a value that minimizes the number of conflicts with other variables.

# Summary Week 2:

* CSPs are a special kind of problem:

1. States defined by values of a fixed set of variables
2. Goal states defined by constraints on variable values

* Backtracking = depth first search with one variable assigned per node
* Variable ordering and value selection heuristics help significantly
* Forward checking prevents assignments that guarantee later failure
* Constraint propagation (e.g: arc consistency) does additional work to constrain values and detect inconsistencies

# Week 3 –Multiagent systems (MAS):

Q: What is a Multiagent System (MAS)?  
A: A Multiagent System (MAS) is a computerized system composed of multiple interacting intelligent agents within an environment. MAS can solve problems that are difficult or impossible for an individual agent to solve.

## Q: What are the different types of agents in a Multiagent System?

A: Agents in a Multiagent System can be homogeneous (all agents are identical) or heterogeneous (agents have different capabilities or roles). They can also be categorized based on their rationality, learning ability, and autonomy.

## Q: Explain the concepts of cooperation and competition in Multiagent Systems.

A: In MAS, agents may **cooperate** to achieve a common goal or compete against each other for resources. Cooperation often involves **communication** and **coordination**, while competition may involve conflict resolution strategies.

Q: What are auction mechanisms in Multiagent Systems?  
A: Auction mechanisms are algorithms for resource allocation among agents. Common types include English auctions, Dutch auctions, and Vickrey auctions. These mechanisms help in the efficient distribution of resources.

Q: Describe negotiation strategies commonly used in MAS.  
A: Negotiation strategies in MAS include tit-for-tat, game-theoretic approaches, and bargaining. The choice of strategy depends on the specific requirements of the task and the nature of the agents involved.

## Q: What is distributed problem solving in the context of MAS?

A: Distributed problem solving involves dividing a larger problem into smaller sub-problems that are solved by individual agents. The solutions are then aggregated to form the solution to the original problem.

## Q: Explain the concept of swarm intelligence in Multiagent Systems.

A: Swarm intelligence is the collective behavior of decentralized systems, often inspired by nature (e.g., ant colonies, bird flocking). It is used in MAS for tasks like optimization and pattern recognition.

# Agent interaction

## Q: What are Speech Acts?

A: Speech Acts are communicative actions agents perform while exchanging messages.  
**What**: They are categorized into assertives, directives, commissives, and declarations.  
**Why**: Understanding the type of speech act helps in interpreting the semantics of a message.

## ****Q: What is Plan-Based Semantics?****

A: Plan-Based Semantics is a framework for understanding the meaning of agent messages based on their intended effects on the receiver.  
What: It associates each communicative action with an expected "plan" or "goal."  
Why: It allows agents to reason about the intentions behind messages.

## ****Q: What is KQML?****

A: KQML is a language for agent communication that includes a set of performatives for querying and manipulating knowledge.  
**What**: It provides a standardized format for messages.  
**Why**: It enables interoperability among diverse agents.

## ****Q: What is KIF?****

A: KIF is a computer-oriented language for the interchange of knowledge among disparate programs.  
**What**: It allows for the expression of knowledge in a declarative form.  
**Why**: It helps in sharing knowledge bases across different agent architectures.

## ****Q: What is FIPA-ACL?****

A: FIPA-ACL is a standard language for agent communication.  
**What**: It includes a range of performatives for conveying intentions.  
**Why**: It is designed for interoperability among heterogeneous agents.

## ****Q: What are Interaction Protocols?****

A: Interaction Protocols define the rules and conventions for interactions among agents.  
**What**: These protocols specify the sequence of communicative actions allowed.  
**Why**: They ensure that interactions are meaningful and achieve their intended outcomes.

## ****Q: What is The Contract Net Protocol?****

A: It's a decentralized protocol used for task distribution among agents.  
**What**: It involves announcements, bidding, awarding, and expediting stages.  
**Why**: It allows for dynamic, flexible task allocation in a multiagent environment.

## ****Q: What are these stages in the context of The Contract Net Protocol?****

A: These stages represent the lifecycle of a task allocation process.  
**What**: Recognition is identifying a task, Announcements are calls for bids, Bidding involves making offers, and Award Expediting is the task execution phase.  
**Why**: These stages ensure a structured, effective approach to resource and task allocation.

Q: How are Interaction Protocols designed?  
A: Interaction Protocols are designed based on the objectives, constraints, and expected behaviors of the agents involved.  
**What**: This involves specifying the permissible actions, expected responses, and state transitions.  
**Why**: A well-designed protocol facilitates effective, reliable interactions among agents.

## ****Q: What are FIPA Interaction Protocols?****

A: These are standardized sets of interaction protocols.  
What: They include FIPA Request and FIPA Contract Net among others.  
Why: They provide a ready-to-use framework for developing multiagent systems.

## ****Q: What is the FIPA Request Interaction Protocol?****

A: It's a FIPA standard for one-to-one request interactions between agents.  
What: It defines how to make requests and how to respond to them.  
Why: It provides a standardized way to handle request-response interactions.

## ****Q: What is the FIPA Contract Net Interaction Protocol?****

A: It's a FIPA standard based on the Contract Net Protocol for task allocation.  
**What**: It standardizes the stages of announcement, bidding, and awarding.  
**Why**: It provides a consistent framework for task distribution in multiagent systems.

# Week 4 – Machine Learning:

## Basics and Fundamental

## Q: What is Machine Learning (ML)?

A: Machine learning is a subset of artificial intelligence that provides systems the ability to automatically learn and improve from experience without being explicitly programmed.

## Q: What are the types of machine learning?

A: The three main types **are supervised learning, unsupervised learning, and reinforcement learning**. There are also hybrid approaches like **semi-supervised learning** and **self-supervised learning**.

## Q: Explain overfitting and underfitting.

A: Overfitting is when the model learns the training data too well, including its noise and outliers, and performs poorly on unseen data. Underfitting is when the model fails to capture the underlying trend of the data, resulting in poor performance on both the training and new data.

## Q: When should one use ML?

A: One should use ML when tasks involve complex patterns that are difficult to solve with traditional algorithms, or when the task requires continuous improvement over time.

## Q: What is Supervised Learning?

A: Supervised Learning is a type of machine learning where the model is trained on labeled data. The model makes predictions or decisions based on input data and is corrected when its predictions are incorrect.

## Q: What is Unsupervised Learning?

A: Unsupervised Learning is a type of machine learning that involves modeling with datasets that don't have labeled responses. The system tries to learn the patterns and the structure from the data without any supervision.

## Q: What is Reinforcement Learning?

A: Reinforcement Learning is a type of machine learning where an agent learns how to behave in an environment by performing actions and receiving rewards or penalties.

## Q: What considerations are involved in designing a learning system?

A: Designing a learning system involves selecting the appropriate type of learning (supervised, unsupervised, or reinforcement), choosing the right algorithm, gathering and preparing the data, and evaluating the model's performance.

## Q: What should a practitioner know about ML?

A: A practitioner should be familiar with various types of learning algorithms, data preprocessing techniques, model evaluation metrics, and the practical applications of machine learning in different domains.

## Techniques and Algorithms

## Q: What is the k-NN algorithm?

A: k-Nearest Neighbors is a simple algorithm that stores all available cases and classifies new cases based on a similarity measure, such as Euclidean distance.

## Q: Explain Random Forests.

A: Random Forest is an ensemble learning method that constructs multiple decision trees during training and outputs the mode of the classes for classification or mean prediction for regression.

## Q: How does a Support Vector Machine work?

A: SVM works by finding a hyperplane that best separates the data into different classes. It maximizes the margin between the closest points (support vectors) of different classes.

## Evaluation Metrics

## Q: What is precision and recall?

A: Precision is the number of true positive results divided by the number of all positive results. Recall is the number of true positive results divided by the number of positive results that should have been returned. Both are used in classification problems.

Here are some metrics:

1. Accuracy
2. Precision and recall
3. Squared error
4. Likelihood
5. Posterior probability
6. Cost/Utility
7. Margin
8. Entropy
9. K-L divergence

## Advanced Topics

## Deep Learning

## Q: What is deep learning?

A: Deep learning is a type of machine learning that involves neural networks with three or more layers. These neural networks attempt to simulate the behavior of the human brain, allowing it to “learn” from large amounts of data.

## Q: How is Deep Learning different from traditional Machine Learning?

A: Traditional machine learning often requires manual feature engineering and data preprocessing, whereas deep learning models automatically learn relevant features from the data. Deep learning also scales better with data and is often better suited for complex tasks like image and speech recognition.

## Reinforcement Learning

## Q: What is Reinforcement Learning (RL)?

A: Reinforcement learning is a type of machine learning where an agent learns how to behave in an environment by taking actions and observing the rewards of those actions. It is particularly suited for problems where a decision needs to be made sequentially, and the reward may be delayed.

## Q: How is RL different from supervised and unsupervised learning?

A: In RL, the agent learns from a reward signal instead of labeled data (supervised) or inherent structure (unsupervised). The goal is to learn a policy that maximizes the cumulative reward over time, rather than to generalize from a dataset.

## Deep Learning vs Reinforcement Learning

## Q: Compare Deep Learning and Reinforcement Learning.

A: Deep learning focuses on learning representations from data, often through supervised or unsupervised methods. Reinforcement learning, on the other hand, focuses on learning optimal sequences of actions in interactive environments. Deep learning models can be a component of a reinforcement learning system, serving as function approximators for the policy or value functions.

## Q: Can Deep Learning and Reinforcement Learning be combined? Give examples if yes.

A: Yes, they can be combined in what's commonly known as Deep Reinforcement Learning. Examples include AlphaGo and OpenAI's DOTA 2 bots. In these cases, deep learning models are used to approximate the policy or value functions in a reinforcement learning setup.

## Q: How do Convolutional Neural Networks (CNNs) differ from Recurrent Neural Networks (RNNs)?

A: CNNs are primarily used for spatial data like images and are well-suited for tasks like image recognition. RNNs are used for sequential data like time series or natural language, capable of capturing temporal dependencies.

## Q: What are Generative Adversarial Networks (GANs) and how are they used?

A: GANs consist of two neural networks, the Generator and the Discriminator, that are trained together. The Generator tries to produce data that is indistinguishable from real data, while the Discriminator tries to distinguish between real and fake data. They are used in tasks like image generation, super-resolution, and data augmentation.

## Transfer Learning

## Q: Explain transfer learning.

A: Transfer learning is a technique where a model trained on one task is adapted for a second related task. For example, a neural network trained on general object recognition can be fine-tuned for a specialized task like identifying types of dogs.