

UNIT – I : INTRODUCTION TO AI AND PRODUCTION SYSTEMS

PART – A (2 Marks)

1. Define — Artificial Intelligence [N – 08]

The exciting new effort to make computers think machines with minds in the full and literal sense. A field of study that seeks to explain and emulate intelligent behaviors in terms of computational processes. The study of the computations that make it possible to perceive, reason and act.

2. List down the characteristics of intelligent agent. [M – 11]

- Rationality
- Adaptability
- Autonomous

3. Define — Agent [M – 11]

An agent is anything that can be viewed as perceiving its environment through sensors and acting upon the environment through effectors.

4. Define — Rational Agent [N – 11]

A rational agent is one that does the right thing. Here right thing is one that will cause agent to be more successful. That leaves us with the problem of deciding how and when to evaluate the agent's success.

5. Define — Omniscient Agent [N-9]

An omniscient agent knows the actual outcome of its action and can act accordingly; but omniscience is impossible in reality.

6. What are the factors that a rational agent should depend on at any given time?

1. The performance measure that defines degree of success.
2. Ever thing that the agent has perceived so far.
3. When the agent knows about the environment.
4. The action that the agent can perform.

7. Define — Ideal Rational Agent

[A-9]

For each possible percept sequence, an ideal rational agent should do whatever action is expected to maximize its performance measure on the basis of the evidence provided by the percept sequence & whatever built-in knowledge that the agent has.

8. Define — Agent Program

[M-11]

Agent program is a function that implements the agents mapping from percept to actions.

9. List the various type of agent program.

[A-13]

- Simple reflex agent program.
- Agent that keep track of the world.
- Goal based agent program.
- Utility based agent program.

10. State the various properties of environment.

[M-9]

Accessible Vs Inaccessible:

If an agent's sensing apparatus give it access to the complete state of the environment then we can say the environment is accessible to the agent.

Deterministic Vs Non deterministic:

If the next state of the environment is completely determined by the current state and the actions selected by the agent, then the environment is deterministic.

Episodic Vs Non episodic:

In this, agent's experience is divided into episodes. Each episodes consists of agents perceiving and then acting. The quality of the action depends on the episode itself because subsequent episode do not depend on what action occur in previous experience.

Discrete Vs Continuous:

If there is a limited no. of distinct clearly defined percepts & action we say that the environment is discrete.

11. What are the phases involved in designing a problem solving agent?

[M-9]

The three phases are:

- Problem formulation.
- Search solution.
- Execution.

12. List the basic elements that are to be include in problem definition.

[M-11]

- Initial state.
- Operator.
- Successor function.
- State space.
- Path.
- Goal test.
- Path cost.

13. Mention the criteria for the evaluation of search strategy.

[N-9]

There are 4 criteria:

- Completeness.
- Time complexity.
- Space complexity.
- Optimality.

14. List the various search strategies.

[M-9]

- BFS
- Uniform cost search
- DFS
- Depth limited search
- Iterative deepening search
- Bidirectional search

15. List out the various informed search strategy.

[N-9]

- Best first search –greedy search
- A* search
- Memory bounded search-Iterative deepening A*search
- Simplified memory bounded A*search
- Iterative improvement search –hill climbing
- Simulated annealing
- Heuristic search

16. Define — Iterative Deepening Search

[M-11]

Iterative deepening is a strategy that sidesteps the issue of choosing the best depth limit by trying all possible depth limits: first depth 0, then depth 1, then depth 2 & so on.

17. Define — Constraint Satisfaction Problem

[M-13]

A constraint satisfaction problem is a special kind of problem satisfies some additional structural properties beyond the basic requirements for problem in general. In a CSP; the states are defined by the values of a set of variables and the goal test specifies a set of constraint that the value must obey.

18. What are the drawbacks of DFS?

[N-9]

The drawback of DFS is that it can get stuck going down the wrong path. Many problems have very deep or even infinite search tree. So DFS will never be able to recover from an unlucky choice at one of the nodes near the top of the tree. So DFS should be avoided for search trees with large or infinite maximum depths.

19. What is called as bidirectional search?

[M-11]

The idea behind bidirectional search is to simultaneously search both forward from the initial state & backward from the goal & stop when the two searches meet in the middle.

20. Define — Depth Limited Search

[N-9]

Depth limited avoids the pitfalls of DFS by imposing a cut off of the maximum depth of a path. This cutoff can be implemented by special depth limited search algorithm or by using the general search algorithm with operators that keep track of the depth.

21. Write the procedure of IDA* search.

[M-13]

Iterative improvement algorithms keep only a single state in memory, but can get stuck on local maxima. In this algorithm each iteration is a DFS just as in regular iterative deepening. The depth first search is modified to use an f-cost limit rather than a depth limit. Thus each iteration expands all nodes inside the contour for the current f-cost.

22. What is the advantage of memory bounded search techniques?

[N-9]

We can reduce space requirements of A* with memory bounded alg such as IDA* & SMA*.

23. What do you mean by local maxima with respect to search techniques?

[M-11]

A local maxima is a peak that is higher than each of its neighboring state but lower than the global maximum.

PART – B (16 Marks)

1. Explain in detail the various agent programs. (16) [N/D- 12]
2. Explain in detail the toy problem. 2(16) [N/D - 12]
3. Describe the real world problem. (16) [N/D - 11]
4. Describe the state space in which iterative deepening search performs much worse than depth first search. (8) [M/J – 12]
5. Discuss the Problem and its Components. Explain in detail how a problem solving agent works. (16) [N/D – 11]
6. Explain in detail Iterative deepening depth first search. (8) [M/J – 12]
7. Prove the breadth first search is a special case of uninformed search strategies. (16) [M/J - 12]
8. Explain in detail the constraint satisfaction procedure to solve the crypt arithmetic problem.

$$\begin{array}{r} \text{CROSS} \\ + \quad \text{ROADS} \\ \hline \text{DANGER} \end{array}$$

(16) [N/D – 11]

1. Define — Knowledge Base System

[N-9]

Knowledge base is the central component of knowledge base agent and it is described as a set of representations of facts about the world.

2. Define — Sentence

[M-10]

Each individual representation of facts is called a sentence. The sentences are expressed in a language called as knowledge representation language.

3. Define — Inference Procedure

[N-11]

An inference procedure reports whether or not a sentence is entailed by knowledge base provided a knowledge base and a sentence. An inference procedure 'i' can be described by the sentences that it can derive. If i can derive from knowledge base, we can write. Alpha is derived from KB or i derives alpha from KB

4. What are the three levels in describing knowledge based agent?

[M-9]

- Logical level
- Implementation level
- Knowledge level or epistemological level

5. Define — Syntax

[N-9]

Syntax is the arrangement of words. Syntax of knowledge describes the possible configurations that can constitute sentences. Syntax of the language describes how to make sentences.

6. Define— Semantics

[M-9]

The semantics of the language defines the truth of each sentence with respect to each possible world. With this semantics, when a particular configuration exists within an agent, the agent believes the corresponding sentence.

7. Define— Logic

[M-11]

Logic is one which consist of

- i. A formal system for describing states of affairs, consisting of
 - a) Syntax
 - b) Semantics.
- ii. Proof Theory – a set of rules for deducing the entailment of a set sentences.

8. Define— Complete Inference Procedure. [N-11]

An inference procedure is complete if it can derive all true conditions from a set of premises.

9. Define— Interpretation [M-13]

Interpretation specifies exactly which objects, relations and functions are referred to by the constant predicate, and function symbols.

10. What is modus ponens rule in propositional logic? [M-9]

The standard patterns of inference that can be applied to derive chains of conclusions that lead to the desired goal is said to be Modus Ponens's rule.

11. Define— Term [N-9]

A term is a logical expression that refers to an object. Constant symbols are therefore terms.

12. Define— Atomic Sentences [N-11]

An atomic sentence is formed from a predicate symbol followed by a parenthesized list of terms

13. What is the use of unification? [M-9]

The use of unification to identify appropriate substitutions for variables eliminates the instantiation step in first-order proofs, making the process much more efficient.

14. What is meant by memorization? [N-9]

Backward chaining suffers from redundant inferences and infinite loops; these can be alleviated by memoization.

15. What factor determines the selection of forward or backward reasoning approach for an Artificial Intelligence problem? [M-11]

Forward chaining is the form of data-driven reasoning. It can be used with an agent to derive conclusion from incoming percepts, often without a specific query in mind.

Backward chaining is a form of goal-directed reasoning. It is useful for answering specific questions such as "what shall I do now?" & "where are my keys?".

16. What are the limitations in using propositional logic to represent the knowledge base? [N-13]

Propositional logic doesn't scale to environments of unbounded size because it lacks the expressive power of deal concisely with time, space,& universal patterns of relationships among objects.

17. What is the need of resolution?

[M-11]

The generalized resolution inference rule provides a complete proof system for first order logic, using knowledge bases in conjunctive normal form.

PART – B (16 Marks)

1. Explain in detail the steps involved in the knowledge engineering process.
(16) [A/M - 2011]
2. Describe the use of first-order-logic to represent the knowledge. (16) [M/J – 2012]
3. Discuss the resolution for first order logic and inference rule. (16) [A/M – 2012]
4. Describe the syntactic elements of first-order logic. (8) [N/D – 2012]
5. Describe the Syntax and Semantics of a first order logic with an example.
(16) [N/D - 2011]
6. State the following facts and represent them in a predicate form.
F1. There are 500 employees in ABC Company
F2. Employees earning more than Rs.5000 pay tax.
F3. John is a manager in ABC Company
F4. Manager earns Rs.10, 000
Convert the facts in predicate form to clauses and then prove by resolution:
John pays tax. (16) [N/D – 2012]
6. Consider the following facts.
Team India
Team Australia
Final match between India and Australia
India scored 350 runs Australia score 350 runs India lost 5 wickets Australia lost 7 wickets
The team which scored the maximum runs wins
If the scores are same then the team which lost minimum wickets wins the match.
Represent the facts in predicate, convert to clause form and prove by resolution
"India wins the match". (16) [N/D - 2011]
8. Explain in detail the resolution for first order logic and inference rule. (16) [A/M - 2011]

1. What is meant by planning?

[N-9]

The task of coming up with a sequence of actions that will achieve a goal is called planning.

2. What are the functions of planning systems?

[M-11]

Planning systems are problem-solving algorithms that operate on explicit propositional (or first-order) representations of states and actions. These representations make possible the derivation of effective heuristics and the development of powerful and flexible algorithms for solving problems.

3. Write notes on STRIPS and ADL languages.

[N-11]

The STRIPS language describes actions in terms of their preconditions and effects and describes the initial and goal states as conjunctions of positive literals. The ADL language relaxes some of these constraints, allowing disjunction, negation, and quantifiers.

4. What is the need of POP algorithms?

[M-13]

Partial-order planning (POP) algorithms explore the space of plans without committing to a totally ordered sequence of actions. They work back from the goal, adding actions to the plan to achieve each subgoal. They are particularly effective on problems amenable to a divide-and-conquer approach

5. Write notes on planning graph.

[N-13]

A planning graph can be constructed incrementally, starting from the initial state. Each layer contains a superset of all the literals or actions that could occur at that time step and encodes mutual exclusion, or mutex, relations among literals or actions that cannot occur. Planning graphs yield useful heuristics for state-space and partial-order planners and can be used directly in the GRAPHPLAN algorithm

6. What is the need of GRAPHPLAN algorithm?

[M-13]

The GRAPHPLAN algorithm processes the planning graph, using a backward search to extract a plan. It allows for some partial ordering among actions.

7. What is the function of SATPLAN algorithm?

[N-9]

The SATPLAN algorithm translates a planning problem into propositional axioms and applies a satisfiability algorithm to find a model that corresponds to a valid plan. Several different propositional representations have been developed, with varying degrees of compactness and efficiency.

8. Write notes on HTN planning.**[M-9]**

Hierarchical task network (HTN) planning allows the agent to take advice from the domain designer in the form of decomposition rules. This makes it feasible to create the very large plans required by many real-world applications.

9. Write the importance of resources.**[N-9]**

Many actions consume resources, such as money, gas, or raw materials. It is convenient to treat these resources as numeric measures in a pool rather than try to reason about, say, each individual coin and bill in the world. Actions can generate and consume resources, and it is usually cheap and effective to check partial plans for satisfaction of resource constraints before attempting further refinements.

10. Compare the conditional planning and conformant planning.**[M-13]**

Incomplete information can be dealt with by planning to use sensing actions to obtain the information needed. Conditional plans allow the agent to sense the world during execution to decide what branch of the plan to follow. In some cases, sensorless or conformant planning can be used to construct a plan that works without the need for perception. Both sensorless and conditional plans can be constructed by search in the space of belief states.

11. What is the use of execution monitoring?**[N-9]**

Incorrect information results in unsatisfied preconditions for actions and plans. Execution monitoring detects violations of the preconditions for successful completion of the plan.

12. Define— Re-planning Agent**[M-9]**

A replanning agent uses execution monitoring and splices in repairs as needed.

13. Define— Continuous Planning Agent**[M-13]**

A continuous planning agent creates new goals as it goes and reacts in real time.

14. Differentiate multi agent planning from multibody planning?**[N-9]**

Multi agent planning is necessary when there are other agents in the environment with which to cooperate, compete, or coordinate. Multibody planning constructs joint plans, using an efficient decomposition of joint action descriptions, but must be augmented with some form of coordination if two cooperative agents are to agree on which joint plan to execute.

15. Define— Partial Order Planning**[M-11]**

Any planning algorithm that can place two actions in to a plan without specifying which comes first.

16. What are the differences and similarities between problem solving and planning? [M-9]

Problem solving and planning involves finding sequences of action that lead to desirable states. But planning is also capable of working back from an explicit goal description to minimize irrelevant actions, possess autonomy and can take advantage of problem decomposition.

17. What are quantifiers? [N-9]

There is need to express properties of entire collections of objects, instead of enumerating the objects by name.

FOL contains two standard quantifiers called

- a) Universal (\forall) and
- b) Existential (\exists)

18. What is propositional logic? [M-11]

It is a way of representing knowledge. In logic and mathematics, a propositional calculus or logic is a formal system in which formulae representing propositions can be formed by combining atomic propositions using logical connectives.

Sentences considered in propositional logic are not arbitrary sentences but are the ones that are either true or false, but not both. This kind of sentences is called propositions.

Example

Some facts in propositional logic:

- It is raining. - RAINING
- It is sunny - SUNNY
- It is windy - WINDY

If it is raining ,then it is not sunny - RAINING \rightarrow \neg SUNNY

PART – B : (16 Marks)

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|--|------|------------|
| 1. Explain in detail about Planning with State-Space Search. | (16) | [N/D– 11] |
| 2. Explain partial order planning with example. | (16) | [N/D – 11] |
| 3. Explain GRAPHPLAN algorithm in detail. | (16) | [N/D – 12] |
| 4. Illustrate the use of first-order-logic to represent the knowledge. | (16) | [N/D – 11] |
| 5. Explain in detail about Multi-agent planning. | (16) | [M/J – 12] |
| 6. Explain the forward chaining and backward chaining algorithm with an example. | (16) | [N/D – 11] |
| 7. Describe the general process of knowledge engineering | (8) | [M/J – 12] |
| 8. Discuss the syntax and semantics of first order logic | (8) | [M/J – 12] |
| 9. Explain the concept of Hierarchical Task Network Planning in detail. | (16) | [N/D –12] |

1. Write short notes on uncertainty issues.

[N-9]

Uncertainty arises because of both laziness and ignorance. It is inescapable in complex, dynamic, or inaccessible worlds.

2. Define — Uncertainty

[M-9]

Uncertainty means that many of the simplifications that are possible with deductive inference are no longer valid.

3. What is full joint probability distribution?

[N-9]

The full joint probability distribution specifies the probability of each complete assignment of values to random variables. It is usually too large to create or use in its explicit form.

4. When will an agent behave irrationally?

[M-11]

The axioms of probability constrain the possible assignments of probabilities to propositions. An agent that violates the axioms will behave irrationally in some circumstances.

5. What is meant by absolute independence?

[M-13]

Absolute independence between subsets of random variables might allow the full joint distribution to be factored into smaller joint distributions. This could greatly reduce complexity, but seldom occurs in practice.

6. Define — Bayes Theorem

[N-9]

Bayes' rule allows unknown probabilities to be computed from known conditional probabilities, usually in the causal direction. Applying Bayes' rule with many pieces of evidence will in general run into the same scaling problems as does the full joint distribution.

7. Define— Conditional Independence

[M-13]

Conditional independence brought about by direct causal relationships in the domain might allow the full joint distribution to be factored into smaller, conditional distributions.

8. How does a naive bayes model work?

[N-11]

The naive Bayes model assumes the conditional independence of all effect variables, given a single cause variable, and grows linearly with the number of effects.

9. Define— Bayesian Networks.

[M-13]

A Bayesian network is a directed acyclic graph whose nodes correspond to random variables, each node has a conditional distribution for the node, given its parents. Bayesian networks provide a concise way to represent conditional independence relationships in the domain.

10. What is the use of Bayesian networks?

[N-13]

A Bayesian network specifies a full joint distribution; each joint entry is defined as the product of the corresponding entries in the local conditional distributions. A Bayesian network is often exponentially smaller than the full joint distribution.

11. Write notes on Hybrid Bayesian networks.

[N-9]

Many conditional distributions can be represented compactly by canonical families of distributions. Hybrid Bayesian networks, which include both discrete and continuous variables, use a variety of canonical distributions.

12. Write notes on variable elimination?

[M-13]

Inference in Bayesian networks means computing the probability distribution of a set of query variables, given a set of evidence variables. Exact inference algorithms, such as variable elimination, evaluate sums of products of conditional probabilities as efficiently as possible.

13. Define — Polytrees

[N-9]

In polytrees (singly connected networks), exact inference takes time linear in the size of the network. In the general case, the problem is intractable.

14. What is the use of stochastic approximation techniques?

[N-11]

Stochastic approximation techniques such as likelihood weighting and Markov chain Monte Carlo can give reasonable estimates of the true posterior probabilities in a network and can cope with much larger networks than can exact algorithms.

15. What are the applications of temporal probabilistic models?

[M-13]

The two applications of temporal probabilistic models are,

- Medical diagnosis
- Speech recognition.

16. Define — Dempster Shafer Theory**[M-13]**

The Dempster-Shafer theory uses interval-valued degrees of belief to represent an agent's knowledge of the probability of a proposition.

17. Write notes on Relational probability models.**[N-13]**

Probability theory can be combined with representational ideas from first-order logic to produce very powerful systems for reasoning under uncertainty. Relational probability models (RPMs) include representational restrictions that guarantee a well-defined probability distribution that can be expressed as an equivalent Bayesian network.

18. What is a decision tree?**[N-11]**

A decision tree takes as input an object or situation described by a set of attributes and returns a “decision” – the predicted output value for the input. A decision tree reaches its decision by performing a sequence of tests.

Example : “HOW TO” manuals (for car repair)

PART – B (16 Marks)

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|--|------|------------|
| 1. Explain various axioms of probability. | (16) | [N/D– 11] |
| 2. Explain in detail about Bayes' Rule and Its Use. | (16) | [N/D – 11] |
| 3. Explain the Semantics of Bayesian Networks. | (16) | [N/D – 12] |
| 4. Explain how inference can be achieved in Bayesian Networks. | (16) | [N/D – 11] |
| 5. Explain in detail about Hidden Markov Models. | (16) | [M/J – 12] |
| 6. With an example explain the logics of non-monotonic reasoning | (8) | [M/J – 12] |
| 7. Explain how bayesian statistics provides reasoning under various kinds of uncertainty | (16) | [N/D –12] |
| 8. Explain the method of hidden markov models in speech recognition. | (16) | [N/D –12] |
| 9. Explain the method of handling approximate inference in Bayesian networks. | (16) | [N/D –12] |

1. What is the conceptual learning?

[N-11]

Learning takes many forms, depending on the nature of the performance element, the component to be improved, and the available feedback.

2. What are the types of learning?

[N-9]

- Supervised learning
- Un supervised learning

3. Define — Supervised Learning

[M-9]

If the available feedback, either from a teacher or from the environment, provides the correct value for the examples, the learning problem is called supervised learning.

4. Differentiate the classification from regression?

[M-11]

Learning a discrete-valued function is called classification learning a continuous function is called regression.

5. What is the use of ockham's razor?

[M-13]

Inductive learning involves finding a consistent hypothesis that agrees with the examples.

Ockham's razor suggests choosing the simplest consistent hypothesis. The difficulty of this task depends on the chosen representation.

6. What is the need of decision trees?

[M-11]

Decision trees can represent all Boolean functions. The information gain heuristic provides an efficient method for finding a simple, consistent decision tree.

7. How will you measure the performance of a learning algorithm?

[M-11]

The performance of a learning algorithm is measured by the learning curve, which shows the prediction accuracy on the test set as a function of the training set size.

8. What is the need of Computational learning theory?

[N-11]

Computational learning theory analyzes the sample complexity and computational complexity of inductive learning. There is a tradeoff between the expressiveness of the hypothesis language and the ease of learning.

9. What are the advantages of Bayesian learning methods?

[M-11]

Bayesian learning methods formulate learning as a form of probabilistic inference, using the observations to update a prior distribution over hypotheses. This approach provides a good way to implement Ockham's razor, but quickly becomes intractable for complex hypothesis spaces.

10. What are instance based models?

[M-13]

Instance-based models represent a distribution using the collection of training instances. Thus, the number of parameters grows with the training set. Nearest-neighbor methods look at the instances nearest to the point in question, whereas kernel methods form a distance-weighted combination of all the instances.

11. How does policy search work?

[N-11]

Policy search methods operate directly on a representation of the policy, attempting to improve it based on observed performance. The variance in the performance in a stochastic domain is a serious problem; for simulated domains this can be overcome by fixing the randomness in advance.

12. Define — Reinforcement Learning

[M-13]

The task of reinforcement learning is to use observed rewards to learn an optimal (or nearly optimal) policy for the environment.

13. Define — Passive Learning

[N-9]

The agent's policy is fixed and the task is to learn the utilities of states (or state-action pairs); this could also involve learning a model of the environment.

14. What is concept of learning with example?

[M-11]

Learning from example involves learning a function from example of its inputs and outputs. Consider for example an agent training to become a taxi driver. Every time the instructor shouts "brake" the agent can learn the condition action rule for when to brake.

15. Differentiate statistical learning from reinforcement learning?

[N-9]

Statistical learning involves learning functions and probability models from example, whereas reinforcement learning involves learning from success and failure of an agent in the absence of any prior examples.

PART – B (16 Marks)

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|--|------|------------|
| 1. Explain in detail about Learning Decision Trees. | (16) | [N/D – 12] |
| 2. Explain in detail about explanation based learning. | (16) | [N/D – 11] |
| 3. Explain in detail about how logical formulation of learning is carried out? | (16) | [M/J – 12] |
| 4. Write notes on Inductive Logic Programming with an example. | (16) | [N/D – 11] |
| 5. Explain briefly about learning with complete data under statistical learning methods. | (16) | [N/D – 12] |
| 6. Explain in detail about learning with hidden variables? | (16) | [M/J – 12] |
| 7. Briefly explain about instance based learning. | (16) | [N/D – 11] |