RV College of Engineering®
Autonomous Institution Affiliated to Visvesvaraya Technological University, Belagavi
Approved by AICTE New Delhi

Academic Year 2023-2024 (Odd Semester)

USN:

Department of Artificial Intelligence and Machine Learning

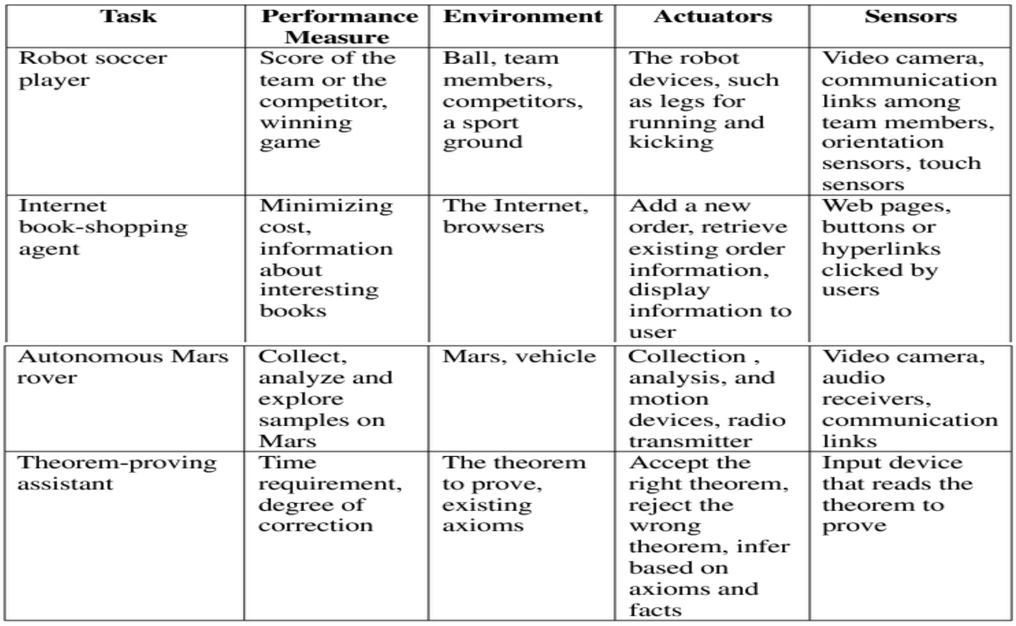
Course Code:21AI52 **Date: 08.01.2024**
Sem: V **Duration:** 90 Minutes

CIE-I
Artificial Intelligence and Machine Learning

Scheme and Solutions

<table>
<tr><th colspan="2">SL. No</th><th>Questions</th><th>M</th><th>BT</th><th>CO</th></tr>
<tr><td>1</td><td>(a)</td><td>
<table>
<tr><th></th><th>True/False</th><th>Support</th></tr>
<tr><td>An agent that senses only partial information about the state cannot be perfecty rational.</td><td>False</td><td>The vacuum cleaning is rational, despite having no information about the other square</td></tr>
<tr><td>There exists a task environment in which every agent is rational.</td><td>True</td><td>If every action results in the same result.</td></tr>
<tr><td>The input to an agent program is the same as the input to the agent function.</td><td>False</td><td>The agent program and function are different entities, the program contains history percepts and the function is only the current percept.</td></tr>
<tr><td>Suppose an agent selects its action uniformly at random from the set of possible actions. There exists a deterministic task environment in which this agent is rational.</td><td>True</td><td>Eventually one of the random selections will be the correct one.</td></tr>
<tr><td>Every agent is rational in an unobservable environment.</td><td>False</td><td>A GPS mapping system that doesn’t record its findings.</td></tr>
<tr><td>A perfectly rational poker-playing agent never loses.</td><td>False</td><td>There is always a chance that its opponent will be dealt with better cards.</td></tr>
</table>
6*1 = 6 Marks</td><td>06</td><td>L3</td><td>CO1</td></tr>
<tr><td></td><td>b)</td><td>For each possible precept sequence, a rational agent should select an action that is expected to maximize its performance measure, given the evidence provided by the percept sequence and whatever built-in knowledge the agent possesses.
a. Healthcare: Rational agents make medical diagnoses, plan treatment, and monitor patients' progress. They can analyze medical data, predict the progression of diseases, and optimize the treatment plan.
b. Transportation: Rational agents are used in transportation to plan routes, schedule vehicles, and optimize the use of resources. Self-driving cars, drones, and robots use rational agents to make decisions, plan their actions and optimize their behaviour to achieve their goals, such as safely transporting passengers or completing a task.
Definition – 02 Marks
Applications – 02 marks</td><td>04</td><td>L2</td><td>CO1</td></tr>
</table>

2 a) 06 L3 CO2

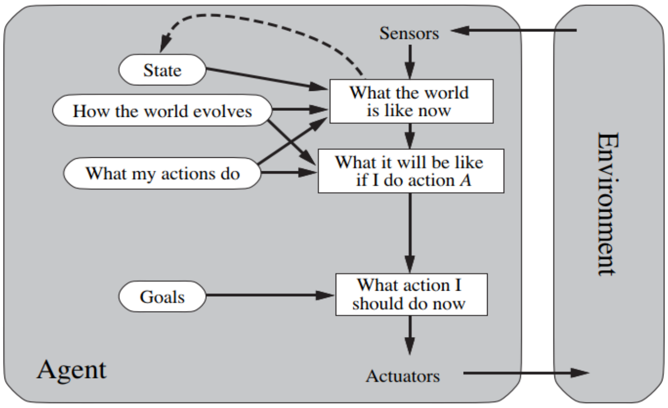


Task	Performance Measure	Environment	Actuators	Sensors
Robot soccer player	Score of the team or the competitor, winning game	Ball, team members, competitors, a sport ground	The robot devices, such as legs for running and kicking	Video camera, communication links among team members, orientation sensors, touch sensors
Internet book-shopping agent	Minimizing cost, information about interesting books	The Internet, browsers	Add a new order, retrieve existing order information, display information to user	Web pages, buttons or hyperlinks clicked by users
Autonomous Mars rover	Collect, analyze and explore samples on Mars	Mars, vehicle	Collection , analysis, and motion devices, radio transmitter	Video camera, audio receivers, communication links
Theorem-proving assistant	Time requirement, degree of correction	The theorem to prove, existing axioms	Accept the right theorem, reject the wrong theorem, infer based on axioms and facts	Input device that reads the theorem to prove

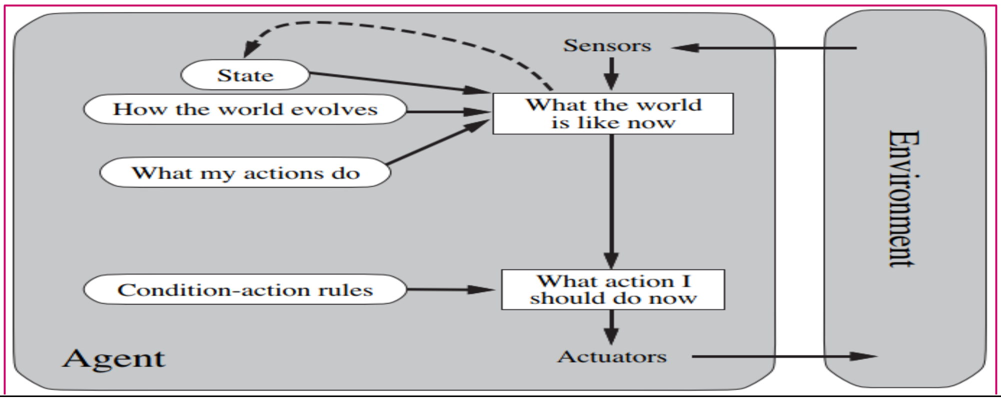
Each Carries – **1.5 Marks**

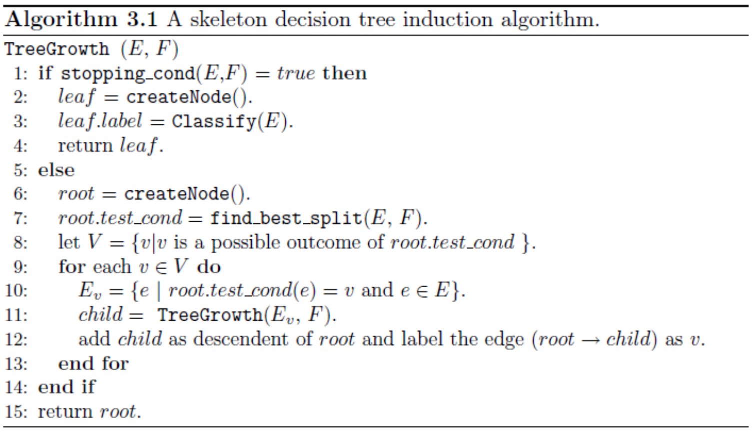
b) 04 L2 CO1

Utility based agents: Explanation and diagram – **02 Marks**



Model-based reflex agent
Explanation and diagram – **02 Marks**



3			10	L4	CO3

Algorithm 3.1 A skeleton decision tree induction algorithm.

```
TreeGrowth (E, F)
if stopping_cond(E,F) = true then
    leaf = createNode().
    leaf.label = Classify(E).
    return leaf.
else
    root = createNode().
    root.test_cond = find_best_split(E, F).
    let V = {v|v is a possible outcome of root.test_cond }.
    for each v ∈ V do
        E_v = {e | root.test_cond(e) = v and e ∈ E}.
        child = TreeGrowth(E_v, F).
        add child as descendent of root and label the edge (root → child) as v.
    end for
end if
return root.
```

		Pseudo code – **05 Marks** Illustrating with the given features and constructing the tree – **05 marks**			
4		For the given data, calculate (a) Entropy (b) Information Gain for the Outlook Feature **Entropy can be calucated for one attribute (Play Volleyball)** $Entropy(S) = -\frac{9}{14}log_2\left(\frac{9}{14}\right) - -\frac{5}{14}log_2\left(\frac{5}{14}\right) = 0.94$ **- 02 Marks** **Information Gain – Outlook Feature** $Entropy(S_{Sunny}) = -\frac{2}{5}log_2\left(\frac{2}{5}\right) - -\frac{3}{5}log_2\left(\frac{3}{5}\right) = 0.97$ **- 02 Marks** $Entropy(S_{Overcast}) = -\frac{4}{4}log_2\left(\frac{4}{4}\right) - -\frac{0}{4}log_2\left(\frac{0}{4}\right) = 0$ **- 02 Marks** $Entropy(S_{Rain}) = -\frac{3}{5}log_2\left(\frac{3}{5}\right) - -\frac{2}{5}log_2\left(\frac{2}{5}\right) = 0.97$ **- 02 Marks** Information Gain(Outlook) = 0.94 - [(5/14) * 0.97 + (4/14) * 0 + (5/14) * 0.97] ≈ 0.246 - **02 marks**	10	L3	CO5
5	a)	**Using Validation Set - 1.5 marks** – Divide training data into two parts: – Training set: – use for model building – Validation set: – use for estimating generalization error – Note: validation set is not the same as test set – Drawback: – Less data available for training **Incorporating Model Complexity - 1.5 marks** – Rationale: Occam's Razor	05	L3	CO2

- Given two models of similar generalization errors, one should prefer the simpler model over the more complex model
- A complex model has a greater chance of being fitted accidentally
- Therefore, one should include model complexity when evaluating a model

  Gen. Error(Model) = Train. Error(Model, Train. Data) +
  x Complexity(Model)

where α is a hyper-parameter that strikes a balance between minimizing training error and reducing model complexity. A higher value of α gives more emphasis to the model complexity in the estimation of generalization performance

Pessimistic Error Estimate of decision tree *T* with k leaf nodes - **1.0 Marks**

$$err_{gen}(T) = err(T) + \Omega \times \frac{k}{N_{train}}$$

- err(T): error rate on all training records
- Ω: trade-off hyper-parameter (similar to)
  - ◆ Relative cost of adding a leaf node
- k: number of leaf nodes
- N_{train}: total number of training records

Minimum Description Length - **1.0 Marks**

- Cost(Model,Data) = Cost(Data|Model) + x Cost(Model)
  - Cost is the number of bits needed for encoding.
  - Search for the least costly model.
- Cost(Data|Model) encodes the misclassification errors.
- Cost(Model) uses node encoding (number of children) plus splitting condition encoding

	b)	Explain the concept of k-fold cross-validation? Provide an example to illustrate its application in Machine Learning?	05	L3	CO5

- **K-fold cross-validation** is a resampling technique used in machine learning to assess the performance and generalization ability of a model.
- The main idea is to divide the dataset into k subsets (or folds), train the model k times, each time using k-1 folds for training and the remaining one fold for validation.
- This process is repeated k times, with each of the k folds used exactly once as the validation data.
- The k results from the folds can then be averaged to produce a single estimation of model performance.
- The total test error rate, errtest, is then computed as

$$err_{test} = \frac{\sum_{i=1}^{k} err_{sum}(i)}{N}.$$

		k-fold cross validation – **03 Marks** Example – **02 Marks**			

Course Outcome	
CO1	Explain and apply AI and ML algorithms to address various requirements of real-world problems.
CO2	Design and develop AI and ML solutions to benefit society, science, and industry.
CO3	Use modern tools to create AI and ML solutions.
CO4	Demonstrate effective communication through team presentations and reports to analyze the impact of AI and ML solutions on society and nature.
CO5	Conduct performance evaluation, modeling, and validation of AI and ML solutions benefiting lifelong learning.

M-Marks, BT-Blooms Taxonomy Levels, CO-Course Outcomes

Marks Distribution	**Particulars**	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**L1**	**L2**	**L3**	**L4**	**L5**	**L6**
	Max Marks	14	11	10	--	15		08	32	10	--	--