UNIT I INTRODUCTION TO ARTIFICIAL INTELLIGENCE

PART A

1 Define Artificial Intelligence (AI).

The study of how to make computers do things at which at the moment, people are better.

- Systems that think like humans
- Systems that act like humans
- Systems that think rationally
- Systems that act rationally

2. What is meant by Turing test?

To conduct this test we need two people and one machine. One person will be an interrogator (i.e.) questioner, will be asking questions to one person and one machine. Three of them will be in a separate room.

Interrogator knows them just as A and B. so it has to identify which is the person and machine.The goal of the machine is to make Interrogator believe that it is the person's answer. If machine succeeds by fooling Interrogator, the machine acts like a human. Programming a computer to pass Turing test is very difficult.

3. Define Rational Agent.

It is the agent which acts to achieve the best outcome (or) when there is uncertainty, the best expected outcome.

4. Define Agent.

An Agent is anything that can be viewed as perceiving (i.e.) understanding its environment through sensors and acting upon that environment through actuators.

5. Define an Omniscient agent.

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 Architecture.

The action program will run on some sort of computing device which is called as Architecture

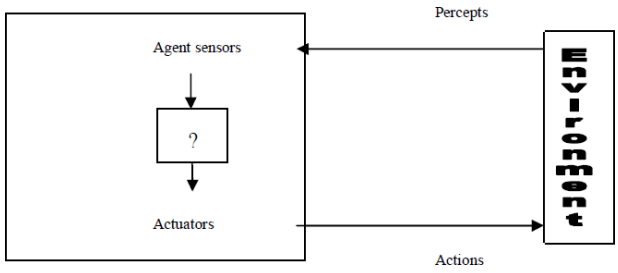
8. List the various type of agent program

1. Simple reflex agent
2. Model based Agent
3. Goal based agent program.
4. Utility based agent program
5. Learning Agent

9. Give the structure of agent in anenvironment?

Agent interacts with environment through sensors and actuators.

An Agent is anything that can be viewed as perceiving (i.e.) understanding its environment through sensors and acting upon that environment through actuators.



10. Define Percept Sequence.

An agent's choice of action at any given instant can depend on the entire percept sequence observed to elate.

11. Define Agent Function.

It is a mathematical description which deals with the agent's behavior that maps the given percept sequence into an action.

12. Define Agent Program.

Agent function for an agent will be implemented by agent program.

13. Define performance measures.

Performance measure embodies the criterion for success of an agent's behavior.

14. What is autonomy?

A rational agent should be autonomous. It should learn what it can do to compensate for partial (or) in correct prior knowledge.

15. What is important for task environment?

PEAS → P- Performance measure
E - Environment
A- Actuators
S – Sensors

Example

Interactive English tutor performance measure maximize student's score on test.

Environment

Set of students testing Agency

Actuators

Display exercises suggestions, corrections.

Sensors

Keyboard entry

16. List the properties of environments.

o Fully Observable Vs Partially Observable
o Deterministic Vs Stochastic
o Episodic Vs Sequential
o Static Vs Dynamic
o Discrete Vs Continuous
o Single Agent Vs Multiagent

17. What is the structure of intelligent Agent?

Intelligent Agent = Architecture + Agent Program

18. List the steps involved in simple problem solving technique.

i. Goal formulation
ii. Problem formulation

iii. Search
iv. Solution
v. Execution phase

19. What are the different types of problem?

1.Single state problem
2. multiple state problems
3. Contingency problem,
4.Exploration problem.

20. What are the components of a problem?

There are four components. They are
i. initial state
ii. Successor function
iii. Goal test
iv. Path cost

21. Define State Space.

The set of all possible states reachable from the initial state by any sequence of action is called state space.

22. Define Path.

A path in the state space is a sequence of state connected by sequence of actions.

23. Define Path Cost.

A function that assigns a numeric cost to each path, which is the sum of the cost of the each action along the path.

24. Give example problems for Artificial Intelligence.

i. Toy problems
ii. Real world problems

25. Give example for real world and toy problems.

Real world problem examples:
i. Airline travel problem.
ii. Touring problem.
iii. Traveling salesman problem.
iv. VLSI Layout problem
v. Robot navigation
vi. Automatic Assembly
vii. Internet searching

Toy problem Examples:

1.Vacuum world problem.
2.8 – Queen problem
3.8 – Puzzle problem

UNIT II PROBLEM SOLVING METHODS

PART A

1. **Define search tree**.

The tree which is constructed for the search process over the state space is called search tree.

2. **Define search node.**

The root of the search tree that is the initial state of the problem is called search node.

3. **Define fringe.**

The collection of nodes that have been generated but not yet expanded, this collection is called fringe or frontier.

4. **List the performance measures of search strategies.**

i. Completeness
ii. Optimality
iii. Time complexity
iv. Space complexity

5. **Define branching factor(b).**

The number of nodes which is connected to each of the node in search tree is called Branching factor.

6. **Differentiate Blind Search and HeuristicSearch.**

Blind search	**Heuristic search**
i) No information about the path cost from the current state to goal state.	i) We have some information like minimum path caused to move
ii) Problem is solved with the information we which we know.	ii) Problem can be solved by the information which is already given.
iii) Example	**iii) Example**
a) Breadth first search	a) Best first search
b) Uniform cost search	b) Greedy search
c) Depth firs tSearch	c) A*search
d) Depth limitedsearch	
e) Iterative deepeningsearch	
f) Bi – DirectionalSearch	

7. Define Backtracking search.

The variant of depth first search called backtracking search. Only one successor is generated at a time rather than all successor, partially expanded node remembers which successor generate next is called Backtracking search.

8. Define Uniform cost search.

Uniform cost search expands the node 'n' with the lowest path cost instead of expanding the shallowest node.

9. Define Depth first search.

It expands the deepest node in the current fringe of the search tree.

10. Define depth limited search.

The problem of unbounded tress can be avoided by supplying depth limit L(i.e.) nodes at depth L are treated as if they have no successors. This is called Depth Limited search.

11.What is informed search?

One that uses problem – specific knowledge beyond the definition of the problem itself and it can find solutions more efficiently than an uninformed strategy.

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

There are 4 criteria: Completeness, time complexity, space complexity, optimality

13.List the various search strategies.

a. BFS
b. Uniform cost search
c. DFS
d. Depth limited search
e. Iterative deepening search
f. Bidirectional search

14.List the various informed search strategy.

1.Best first search –greedy search
2.A*search
3.Memory bounded search-Iterative deepening
A*search -simplified memory bounded
A*search -Iterative improvement search

15.What is Best First Search?

Best First Search is an instance of the general TREE SEARCH or GRAPH SEARCH algorithm in which a node is selected for expansion based on an evaluation function, f(n).

16.Define Evaluation function,f(n).

A node with the lowest evaluation is selected for expansion, because evaluation measures distance to the goal.

17.Define Heuristic function, h(n).

h (n) is defined as the estimated cost of the cheapest path from node n to a goal node.

18.Define Greedy Best FirstSearch.
It expands the node that is closest to the goal (i.e.) to reach solution in a quicker way. It is done by using the heuristic function: f(n) = h(n).

19.Define A*search.
A* search evaluates nodes by combining g(n), the cost to reach the node and h(n), the cost to get from the node to the goal.

f(n) = g(n) + h(n)

20.Define Admissible heuristic h(n).
In A* search, if it is optimal then, h(n) is an admissible heuristic which means h(n) never overestimates the cost to reach the goal.

21.What are the 2 types of memory bounded heuristic algorithms?
i. Recursive Best First Search(RBFS)
ii. Memory bounded A*(MA*)

22.Differentiate BFS &DFS.

- BFS means breath wise search.
- Space complexity is more.
- Do not give optimal solution
- Queuing fn is same as that of queue operator

- DFS means depth wise search.
- Space complexity is less
- Gives optimal solution
- Queuing fn is somewhat different from queue operator.

23.What is RBFS?
It keeps track of the f-value of the best alternative path available from any ancestor of the current node. RBFS remembers the f-value of the best leaf in the forgotten sub tree and therefore decide whether its worth re expanding the sub tree sometimes later.

24.Define iterative deepening search.
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.

25.What are the 2 ways to use all availablememory?
i. Memory bounded A*(MA*)
ii. Simplified Memory bounded A*(SMA*)

26.What is SMA*search?
SMA* expands the best leaf until memory is full and it drops the oldest worst leaf node and expands the newest best leaf node.

27.What is called as bidirectional search?
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.

28.Give the drawback of DFS.

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

29.What is local search?

It operates using a single current state rather than multiple paths and generally moves only to neighbors of that state.

30.Define Optimization Problems.

The aim of this problem is to find the best state according to an objective function.

31.What are the 2 parts of Landscape?

i. Location defined by the state.
ii. Elevation defined by the value of the heuristic cost function (or) objective function.

32.Define GlobalMaximum and Globalminimum.

If elevation corresponds to an objective function, then the aim is to find the highest peak is called global maximum.
If elevation corresponds to cost, then the aim is to find the lowest valley is called global minimum.

33.Define Hill Climbing search.

It is a loop that continually moves in a increasing value direction (i.e.) up hill and terminates when it reaches a "peak" where no neighbor has a higher value.

34.List some drawbacks of hill climbing process.

Local maxima: A local maxima as opposed to a goal maximum is a peak that is lower that the highest peak in the state space. Once a local maxima is reached the algorithm will halt even though the solution may be far from satisfactory.
Plateaux: A plateaux is an area of the state space where the evaluation fn is essentially flat. The search will conduct a random walk.

35.What is the meaning for greedy local search?

It goals (picks) a good neighbor state without thinking ahead about where to go next.

36.Define Local maxima.

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

37.What are the variants of hill climbing?

i. Stochastic hillclimbing
ii. First choice hillclimbing
iii. Simulated annealingsearch
iv. Local beamsearch
v. Stochastic beamsearch

38.Define annealing.

Annealing is the process used to harden metals (or) glass by heating them to a high temperature and then gradually cooling them, thus allowing the material to coalesce into a low energy crystalline state.

39.Define simulatedannealing.

This algorithm, instead of picking the best move, it picks a random move. If the move improves the situation, it is always accepted.

40.What is Genetic Algorithms?

Genetic Algorithm is a variant of stochastic beam search in which successor states are generated by combining two parent states, rather than by modifying a single state.

41.Define Online Search agent.

Agent operates by interleaving computation and action (i.e.) first it takes an action, and then it observes the environment and computes the next action.

42.What are the things that agent knows in online searchproblems?

a. Actions(s)
b. Step cost function C(s, a,s')
c. GoalTEST(s)

43.DefineCSP.

Constraint Satisfaction problem (CSP) is defined by a set of variables X1,X2,…Xn and set of constraints C1,C2,…Cm.

44.Define Successor function.

A value can be assigned to any unassigned variable, provided that does not conflict with previously assigned variables.

45.What are the types of constraints?

There are 5types,

a. Unary constraints relates one variable.
b. A binary constraint relates twovariables.
c. Higher order constraints relate more than two variables.
d. Absolute constraints.
e. Preference constraints.

46.Define MRV.

Minimum remaining values heuristic chooses the variable with the fewest "legal" values.

47.Define LCV.

Least constraining value heuristic prefers the value that rules out the fewest choices for the neighboring variables in the constraint graph.

48.Define Conflict directed back jumping.

A back jumping algorithm that uses conflict sets defined in this way is called Conflict directed back jumping.

49.Define constraintpropagation.

It is the general term for propagating (i.e.) spreading the implications of constraints on the variable on to other variable.

50.Define Alpha beta pruning.

Alpha beta pruning eliminates away branches that cannot possibly influence the final decision

UNIT III KNOWLEDGE REPRESENTATION

PART - A

1. **Define First Order logic(FOL).**

FOL is a first order logic. It is a representational language of knowledge which is powerful than propositional logic (i.e.) Boolean Logic. It is an expressive, declarative, compositional language.

2. **Define a knowledge Base:**

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

3. **With an example, show objects, properties functions and relations.**

Example

"EVIL KING JOHN BROTHER OF RICHARD RULED ENGLAND IN 1200"

Objects : John, Richard, England, 1200

Relation : Ruled

Properties : Evil,

King **Functions :**

BROTHER OF

4.Name two standard quantifiers

A quantifier is a language element which generates quantification and identify the range and scope of the variable in the logical expression.

There are two types of quantifier:

1. **Universal Quantifier**, (for all, everyone, everything)
2. **Existential quantifier**, (for some, at least one).

Example:**Universal Quantifier**,

All man drink coffee.

$\forall$ x man(x) $\rightarrow$ drink (x, coffee).

Example:**Existential Quantifier**,

Some boys are intelligent.

$\exists$ x: boys(x) $\wedge$ intelligent(x)

5.What is the purpose of Unification?

Unification is a process of making two different logical atomic expressions identical by finding a substitution. Unification depends on the substitution process.

It takes two literals as input and makes them identical using substitution. Let Ψ_1 and Ψ_2 be two atomic sentences and be a unifier such that, $\Psi_1 = \Psi_2$, then it can be expressed as UNIFY(Ψ_1, Ψ_2).

Example: Unify{King(x), King(John)}

Let Ψ_1 = King(x), Ψ_2 = King(John),

Substitution θ = {John/x} is a unifier for these atoms and applying this substitution, and both expressions will be identical.

6. Difference between First order logic(or Predicate logic) and

Propositional logicLogic (Write any four differences)

Sl No	**Propositional Logic**	**Predicate Logic**
1	Propositional logic is the logic that deals with a collection of declarative statements which have a truth value, true or false.	Predicate logic is an expression consisting of variables with a specified domain. It consists of objects, relations and functions between the objects.
2	It is the basic and most widely used logic. Also known as Boolean logic.	It is an extension of propositional logic covering predicates and quantification.
3	A proposition has a specific truth value, either true or false.	A predicate's truth value depends on the variables' value.
4	Scope analysis is not done in propositional logic.	Predicate logic helps analyze the scope of the subject over the predicate.s : Universal Quantifier (∀) depicts for all, Existential Quantifier (∃) depicting there exists some .
5	It is a more generalized representation.	It is a more specialized representation.

7) Represent the following sentences using First order Logic

i)All the Children like sweets
∀x: child(x) → likes(x, sweets)
ii)Brothers are Siblings
∀x,y[brother(x,y)→silings(x,y)]

8)What is Skolemization?
Skolemization: remove existential quantifiers by introducing new function symbols. This is done by introducing a n-place function for each existentially quantified variable where n is the number of previously appearing universal quantifiers.
Skolemization - Example

Every philosopher writes at least one book.

∀x[Philo(x) → ∃y[Book(y) ∧ Write(x, y)]]

Eliminate Implication:

∀x[¬Philo(x) ∨ ∃y[Book(y) ∧ Write(x, y)]]

Skolemize: substitute y by g(x)
∀x[¬Philo(x) ∨ [Book(g(x)) ∧ Write(x, g(x))]]

9.Write the generalized Modus Ponens Rule
Modus Ponens:
The Modus Ponens rule is one of the most important rules of inference, and it states that if P and P → Q is true, then we can infer that Q will be true. It can be represented as:

Notation for Modus ponens: $\frac{P \rightarrow Q, \quad P}{\therefore Q}$

Example:
Statement-1: "If I am sleepy then I go to bed" ==> P→ Q
Statement-2: "I am sleepy" ==> P
Conclusion: "I go to bed." ==> Q.
Hence, we can say that, if P→ Q is true and P is true then Q will be true.

10.Define atomic sentence and complex sentences in AI

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

Syntax:Atomic Sentence =predicate (term1,.....,termn)

or term1 = term2

Examples:

Boy(john)

Complex Sentences

Complex sentence is formed by combining two or more atomic sentences with connectives (just like in propositional logic)

Examples

Brother(Richard, John) ∧ Brother(John, Richard)

.

11, Differentiate forward and backward chaining

Sl.No	Forward Chaining	Backward chaining
1.	Forward chaining is known as data-driven technique because we reaches to the goal using the available data.	Backward chaining is known as goal-driven technique because we start from the goal and reaches the initial state in order to extract the facts.
2	It is a bottom-up approach.	It is a top-down approach.
3	It applies the Breadth-First Strategy.	It applies the Depth-First Strategy.
4	It operates in forward direction i.e it works from initial state to final decision.	It operates in backward direction i.e it works from goal to reach initial state.

12.Define Meta rules

The rules that determine the conflict resolution strategy are called meta rules.Meta rules define knowledge about how the system will work

13. Define skolem constant.

The existential sentence says there is some object satisfying a condition, and the instantiation process is just giving a name to that object. That name must not belong to another object. The new name is called skolem constant.

14.. **Define the first order definite clause**

A Horn clause with exactly one positive literal is a **definite clause**; a definite clause with no negative literals is sometimes called a **fact**; and a Horn clause without a positive literal is sometimes called a **goal clause**

15.What is Ontological engineering?

The process of representing the abstract concepts like events, actions, time and beliefs which are related to world domains is defined as **Ontological engineering**

16.Define terms:objects and categories

Objects are organized into categories, since much reasoning takes place at the level of categories rather than about individual objects.

E.g., a shopper has goal of buying something like a basketball, rather than a particular basketball such as BB 9 . Categories also serve to make predictions about objects once they are categorized

Ex:basketball(bb9) bb9-is the object categorized as Basketball

17.What is situation calculus?

Situation calculus is specifically designed for representing dynamically changing worlds.

- a dynamical world is a sequence of situations
- a situation is a static world
- all changes to the world are the result of actions

Unit IV Software Agents

Part A

1.Define Intelligent AI agent?

An intelligent agent that is capable of flexible autonomous action in order to meet its design objectives and the important characteristics are

1.Reactivity-intelligent agents **are able to perceive their environment and respond in a timely fashion to changes** that occur in it

2.Pro-activeness – intelligent agents are **able to exhibit goal-directed behavior**

3.Social ability – intelligent agents are capable of interact with other agents

2. What is a purely reactive agent?

There can agents who decide their action without referring to earlier history. Their decision making is purely based on current situation that has nothing to do with the past situations. Such agents are are termed as purely reactive.

Formally the behavior of a purely reactive agent can be represent by a function action :S->A

3.What are the characteristics of multi agent systems?

1.Each agent has just incomplete information and is restricted in is capabilities.

2. The system control is distributed .

3.Data is decentralized.

4.Computation is asynchronous

5.Multi agent environments are typically open ad have no centralized designer.

6.Multi agent environments provide an infrastructure specifying communication and interaction protocols.

7.Multi agent environments have agents that are autonomous and distributed, and may be self – interested or cooperative.

4. What is KQML

1.The **K**nowledge **Q**uery and **M**anipulation **L**anguage **(KQML**) is a protocol for exchanging information and knowledge among the agents in a multiagent system.

It is the best known ACL developed by the ARPA for knowledge sharing initiative

2.It is a high-level, message-oriented communication language and protocol for information exchange, independent of content syntax(KIF,SQL,Prolog…,) and application ontology.

5. What is cooperation?

Cooperation is the practice of working in common with mutually agreed-upon goals and possibly methods, instead of working separately in competition, and in which the success of one is dependent and contingent upon the success of another. Cooperation requires coordination. Cooperative agent uses various protocols for communication like CONTRACT NET.

6. Define Agent architectures?

An architecture proposes a particular methodology for building an autonomous agent

7.What are called as Collaborative Agents ?

A multi-agent system(MAS) may be seen as a collection of collaborative agents

They can communicate and cooperate with other agents, while keeping their autonomy

They usually *negotiate* with their peers to reach mutually acceptable agreements during *cooperative problem solving*

8.Mention the applications of multi-agents.

Collaborative Agents: Applications :

Provide solutions to physically distributed problems

(Disaster in a city (police, firemen, ambulances)

Provide solutions to problems with distributed data sources

(Sensor network monitoring a given area)
Provide solutions that need distributed expertise
Health care provision (family doctors)

9.Why do we need Agent Communication?
Multi agent systems allow distributed problem solving. This requires the agents to coordinate their actions.Agent communication facilitates this by allowing individual agents to interact

- allows cooperation
- allows information sharing

10. What is Speech Act Theory?
A theory of how utterances are used to achieve intentions is a speech act theory
11.Define Speech Acts and list out Types of speech
act A speech act is an act of communication
inform other agents about some data
query others about their current situation
answer questions
request others to act
promise to do something
offer deals
acknowledge offers and requests
12.What is negotiation?
A form of interaction in which a group of agents with conflicting interests try to come to a mutually acceptable agreement over some outcome
13.What is meant by Utility functions ?

- An agent's preferences over the set of possible outcomes O is defined as a utility function
- An agent's (say i's) utility function assigns a real number to each possible outcome. It is a mapping of the form

Ui : O → R
14.What do you meant by Argumentation among Agents? Arguing with Others
A verbal and social activity of reason aimed at increasing (or decreasing) the acceptability of a controversial standpoint for the listener or reader, by putting forward a constellation of propositions (i.e. arguments) intended to justify (or refute) the standpoint before a rational judge"

Argumentation versus Reasoning
If you are the judge, argumentation becomes (nonmonotonic) reasoning.

15.List the types of Software Agent Architectures

1.Reactive architecture
2.Deliberative Architecture
3.Blackboard Architecture
4.Belief-Desires-Intend Architecture
5.Mobile Architectures
6.Hybrid Architecture

Unit V Applications of AI

Part A

1.List the applications of AI.

- Google search engine
- Google Assistant,Alexa
- Google Translate
- Autonomous car
- Robots

2. **Information retrieval-Define.**

Information Retrieval is the activity of obtaining material that can usually be documented on an unstructured nature i.e. usually text which satisfies an information need from within large collections which is stored on computers. For example, Information Retrieval can be when a user enters a query into the system.Eg:Google Search Engine

3.Define Information Extraction and list out its applications

Information extraction is the process of extracting information from unstructured textual sources to enable finding entities as well as classifying and storing them in a database

Applications:

- **Information extraction benefits many text/web applications**
- **Integration of product information from various websites**
- **Question answering**
- **Contact information search**
- **Finding the proteins mentioned in a biomedical journal article**

4.Mention the Information extraction techniques

- Regular expression and patterns
- Finite Automata
- Probabilistic models-Hiidden markov model and Conditional Random Field model

4. **What is Natural Language processing(NLP) and its applications?**

By combining the power of artificial intelligence, computational linguistics and computer science, Natural Language Processing (NLP) is the ability of the software program to read/ write and understand natural language as like human

Applications:

- Machine Translation
- Automatic Summarization
- Question-answering
- Sentiment Analysis

5. What is Speech recognition?

Speech recognition, also known as automatic speech recognition is a capability which enables a program to process human speech into a written format

6. **What are the** applications of Speech recognition **?**

Speech recognition technologies such as Alexa, Cortana, Google Assistant and Siri are changing the way people interact with their devices, homes, cars, and jobs. The technology allows us to talk to a computer or device that interprets what we're saying in order to respond to our question or command.

Applications:

1. In the workplace
- Search for reports or documents on your computer
- Schedule meetings
- Record minutes
- Make travel arrangements

2. In banking
- Make payments
- Receive information about your transaction history

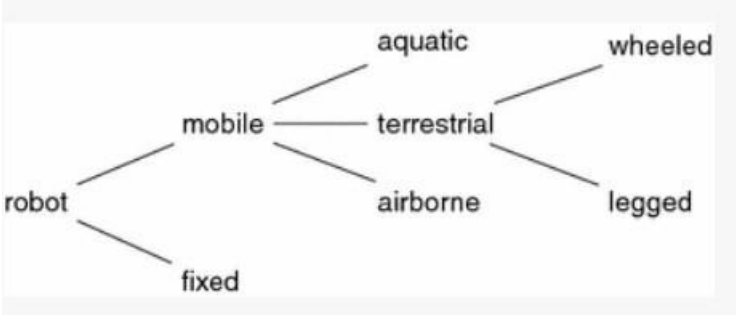
3. In marketing- or developing trends in user data and behaviour ng

4. In Healthcare
- Quickly finding information from medical records
- Less paperwork19
- Less time inputting data20
- Improved workflows

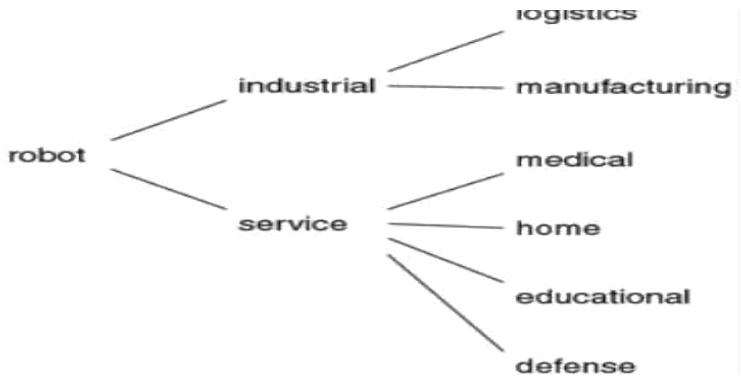
7.Define Robots?

Robot, any automatically operated machine that replaces human effort, though it may not resemble human beings in appearance or perform functions in a humanlike manner. By extension, robotics is the engineering discipline dealing with the design, construction, and operation of robots.

8.Explain classification of Robots.



Classification of robots by environment and mechanism of interaction



Classification of robots by application field

9.What is meant by degree of Freedom(DOF) in robots?

- Degrees of freedom is defined the modes in which a mechanical device or system can move. The number of degrees of freedom is equal to the total number of independent displacements or aspects of motion.
- The number of joints determines the manipulator degrees of freedom (DOF).
- Typically, a manipulator should possess at least six independent DOF, three for positioning and three for orientation

9. List the components of Robot

Components of a Robot

1. Power Supply

Every electronic device draws power from an electric source. The robots need power to supply the **voltage** signals that make the motors turn, the sensors operate and therefore the robot brain.

2. Actuators

Actuators are the components responsible for converting the electric energy of the source to mechanical energy.

3. Electric motors (AC/DC)

Motors have the application for the rotation movement required by the robot.

4. Pneumatic Air Muscles

These are arm devices that extend or contract and are operated with the help of **pressurized** air. These are very lightweight because their main element may be a thin membrane.

5. Muscle Wires

Muscle wires are a temperature-dependent conductor of electricity that turns harder when an electric current is passed through it.It has a unique ability to **contract** on demand.

6. Piezo Motors

These types of motors undergo rotational movement on the application of an electric field.

7. Sensors

Sensors are devices to detect various signals in the surroundings.A sensor makes “sense” of property — it turns something about the physical world into data upon which a system can **act**.

10.State the Applications of Robots

a. Robotics a. Industries

In industries, we **deploy** AI robots' purposes like assembly lines, CNC mill machining processes, machining processes, packaging of finished goods, etc.

b. Healthcare

Robots with the help of AI can now perform highly **complicated** surgeries with a high degree of precision.

c. Exploration

AI robots are an **alternative** in places where human lives are at risk. For example, for deep-sea mineral exploration, AI robots are perfect.

d. Transportation

For transporting humans from one place to another without any **external** aid, we can use AI robots.

11.Mention the various sensors used in Robots.

1) Light Sensor

Light sensor is a transducer used for detecting light and creates a voltage difference equivalent to the light intensity fall on a light sensor.The two main light sensors used in robots are Photovoltaic cells and Photo resistor. Other kind of light sensors like phototransistors, phototubes are rarely used.

2) Proximity Sensor

Proximity sensor can detect the presence of nearby object without any physical contact.

Infrared (IR) Transceivers - In IR sensor LED transmit the beam of IR light and if it find an obstacle then the light is reflected back which is captured by an IR receiver

3) Sound Sensor-SONAR

Sound sensors are generally a microphone used to detect sound and return a voltage equivalent to the sound level. Using sound sensor a simple robot can be designed to navigate based on the sound receives.

4) Temperature Sensor

Temperature sensors are used for sensing the change in temperature of the surrounding.

5) Acceleration Sensor

Acceleration sensor is used for measuring acceleration and tilt. The two kinds of forces which affect an accelerometer is:-

Static Force - It is the frictional force between any two objects. By measuring this gravitational force we can determine the how much robot is tilting.

Dynamic Force - It is the amount of acceleration required to move an object.

12.What is perception in robotics? And How they perceive?

In robotics, perception is understood as a system that endows the robot with the ability to perceive, comprehend, and reason about the surrounding environment.

Robots need to use sensors to create a picture of whatever environment they are in. An example of a sensor used in some robots is called LIDAR (Light Detection And Ranging). LIDAR is a technology that uses a laser to measure distance.

13.What is meant by Motion planning ?

Motion planning, also path planning (also known as the navigation problem or the piano mover's problem) is a computational problem to find a sequence of valid configurations that moves the object from the source to destination. The term is used in computational geometry, computer animation, robotics and computer games.

14.Name the methods of motion planning of Robots.

1.Cell Decomposition methods

2.Modified cost functions

3.Skeletonization methods

15)Define Configuration space.

A configuration describes the pose of the robot, and the configuration space C is the set of all possible configurations. For example:If the robot is a single point (zero-sized) translating in a 2-dimensional plane (the workspace), C is a plane, and a configuration can be represented using two parameters (x, y).