

Artificial Intelligence

NCS -702

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NCS-702

Artificial Intelligence

UNIT	TOPICS	NO. OF QUESTIONS
1	<p>Introduction : Introduction to Artificial Intelligence, Foundations and History of Artificial Intelligence, Applications of Artificial Intelligence, Intelligent Agents, Structure of Intelligent Agents.</p> <p>Computer vision, Natural Language Processing.</p>	11
2	<p>Introduction to Search : Searching for solutions, Uniformed search strategies, Informed search strategies, Local search algorithms and optimistic problems, Adversarial Search, Search for games, Alpha - Beta pruning.</p>	30
3	<p>Knowledge Representation & Reasoning: Propositional logic, Theory of first order logic, Inference in First order logic, Forward & Backward chaining, Resolution.</p> <p>Probabilistic reasoning, Utility theory, Hidden Markov Models (HMM), Bayesian Networks.</p>	27
4	<p>Machine Learning: Supervised and unsupervised learning, Decision trees, Statistical learning models, Learning with complete data - Naive Bayes models.</p> <p>Learning with hidden data – EM algorithm, Reinforcement learning,</p>	14
5	<p>Pattern Recognition : Introduction, Design principles of pattern recognition system, Statistical Pattern recognition, Parameter estimation methods – Principle Component Analysis (PCA) and Linear Discriminant Analysis (LDA).</p> <p>Classification Techniques – Nearest Neighbor (NN) Rule, Bayes Classifier, Support Vector Machine (SVM), K – means clustering.</p>	21

UNIT - 1

Introduction : Introduction to Artificial Intelligence

- Foundations and History of Artificial Intelligence, .
- Applications of Artificial Intelligence,
- Intelligent Agents,
- Structure of Intelligent Agents.
- Computer vision
- Natural Language Possessing

UNIT 1 (Introduction to AI)

Short Question & Answers

Ques 1. What is AI ? Define Artificial intelligence on the basis of “ System that think rationally ” and “ System that act like humans”.

Ans : AI is a very wide field of science and engineering which makes intelligence machines and especially

Intelligent computer programs. It is related to the similar tasks of using computers to understand human intelligence. Scientists want to automate human intelligence for the following reasons :

- (i) Understanding and reasoning of human intelligence in better way.
- (ii) Making more smarter programs.
- (iii) Useful and efficient techniques to solve complex problems.

Definitions of AI vary along two main dimensions. Roughly, the ones on top are concerned with thought processes and reasoning, whereas the ones on the bottom address behavior.

System that act like humans:The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985)

System that think rationally:"[The automation of] activities that we associate with human thinking, activities such as Decision making, problem solving, learning . . ." (Bellman, 1978)

The study of mental faculties through the use of computational models." (Chamiak and McDermott, 1985)
McDermott,

"The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)

Ques 2. Differentiate between Natural(Human) Intelligence & Artificial Intelligence.

Ans :

S. NO	NATURAL INTELLIGENCE	ARTIFICIAL INTELLIGENCE
1	Exhibited by human beings	Programmed by humans in machines
2	Highly refined and no electricity required to generate output.	It exists in computer system, so electrical energy is required for activation of output.
3	No one is an expert. We can get better solution from one another	Expert system exists , which collect ideas of human beings
4	Intelligence increases under supervision.	Intelligence increases by updating technology and algorithms used .

Ques 3. What is Weak AI and Strong AI ?

Ans : **Weak AI** deals with the creation of some form of computer based artificial intelligence which can reason and solve problems in limited domain. Some thinking like feature may be added to machine , but true intelligence is absent. Here we have to get the explanation of solution by us in own way rather depending on computer machine.

Strong AI claims that computers can think at the level of human beings. It truly reasons and solve complex problems. In strong AI programs itself are explanations for any solution.

Ques 4. What is rationality ? Define an intelligent agent.

Ans : The word agent is derived from the concept that when some agency hires some person to do a particular work on behalf of the user. Agent is that program in terms of AI , which perceives its environment through sensors and acts upon it accordingly by using actuators. E.g : Software agent, Robotic agent, Nano robots for body check ups/ biological agents, Internet search agent etc. Software agents carry following properties :

- Intelligent agents are autonomous.
- Ability to perceive data and signals from the environment.
- Adapting to change in surroundings.
- Transportable or mobile over networks.
- Ability to learn , reason , and interact with humans.

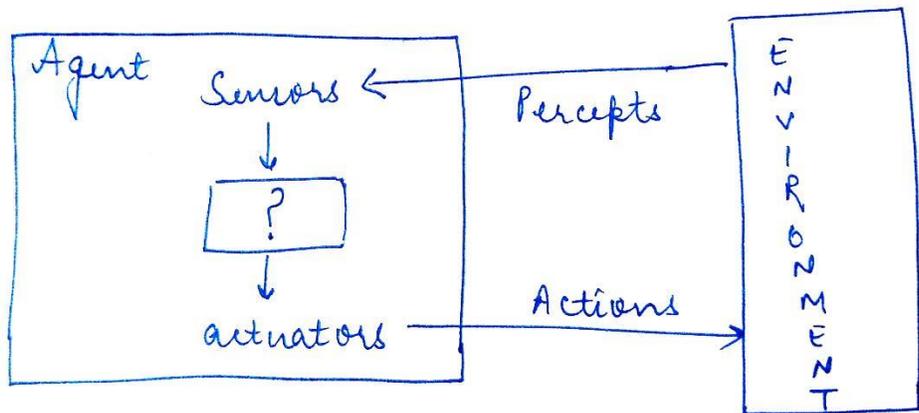


Figure of Agent Architecture

Mathematically agent's function is defined as , that maps any given percept sequence to an action. Internally agent function can be implemented by an agent program $f : P^* \rightarrow A$, where P^* sequence of zero or more percepts, A is an action taken by the agent.

A system is said to be rational if it does the right thing, given what it knows (Irrefutable reasoning). Right thing makes agent successful. So some performance measure is required to measure the degree of success. Rationality depends on :

- Performance measure for criterion of success.
- Agent's prior knowledge of environment.
- Actions that agent can perform.
- Agent's percept sequence to date.

Ques 5. Mention some related fields of Artificial Intelligence.

Ans : (i) Fields closely related to AI are of engineering domain, mechanical , electrical , electronics and computer engg.

(ii)Field of Linguistics (Study of language) is also very popular now days that deals with natural language processing.

(iii)Cognitive Science : Cognitive science deals with the study of human psychology. Cognitive scientists are interested in computation process required to perform certain human functions.

(iv) AI and electrical engineering, AI and mechanical engineering.

(v) Medical field (vi) Manufacturing of products field (v) Military and defense

(vi) Aerospace engineering (vii) Banking and finance sector.

Ques 6. What is the importance of Natural Language in AI ?

Ans : (i) Understanding the grammatical and semantic structure of language.

(ii) Helpful in machine translations for giving commands to intelligent agents.

(iii) Easier communication with computers of human beings.

(iv) Talking is easier than typing.

Example of NLP grammar is given as below:

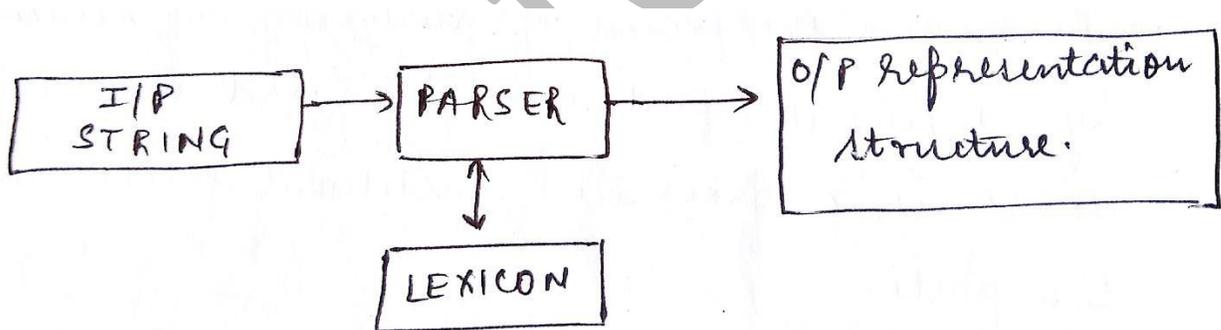
Input string : The cat eats the rice.

S → NP VP
NP → DET N | DET ADJ N
VP → V NP
DET → the
ADJ → big | fat
N → cat | rice
V → eat .

Where NP is noun phrase , VP is verb phrase , DET is article ADJ is adjective , V is verb and N is noun . These all are non terminals. The, big , fat, eat , rice are terminals.

Ques 7. What is Lexicon ?

Ans : A lexicon is a dictionary of words (usually morphemes or root words with their derivatives, where each word contains some meaning and syntax.)Information in lexicon is needed to help determine the function and meanings of the words in a sentence. Entries in lexicons can be grouped and given by word category. E.g: Articles , nouns, verbs, pronouns, adjectives etc.



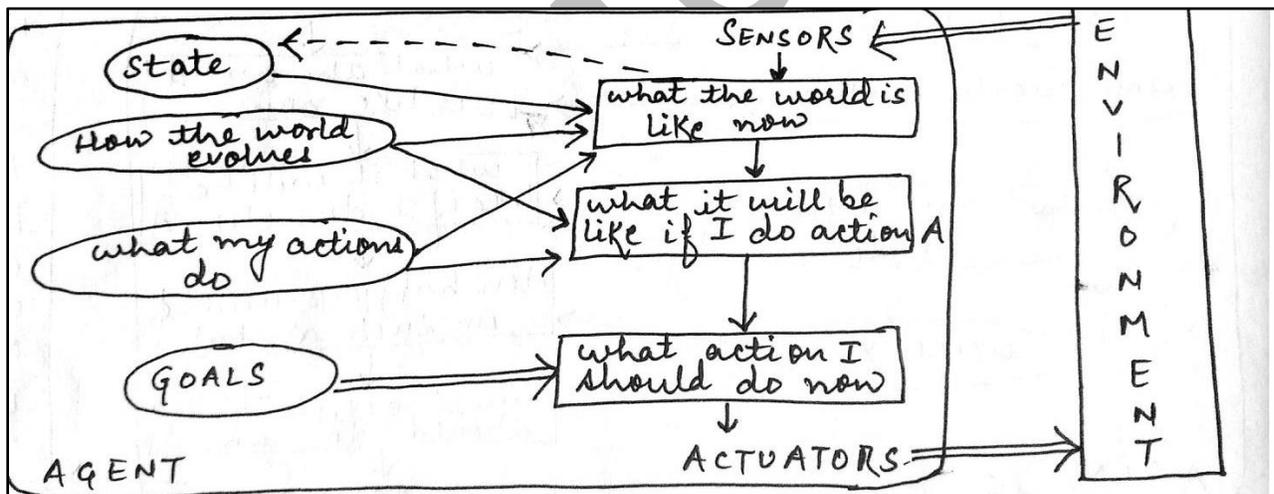
Long Question & Answers

Ques 8. Explain Goal Based Agent and Utility based Agent architecture with proper diagram.

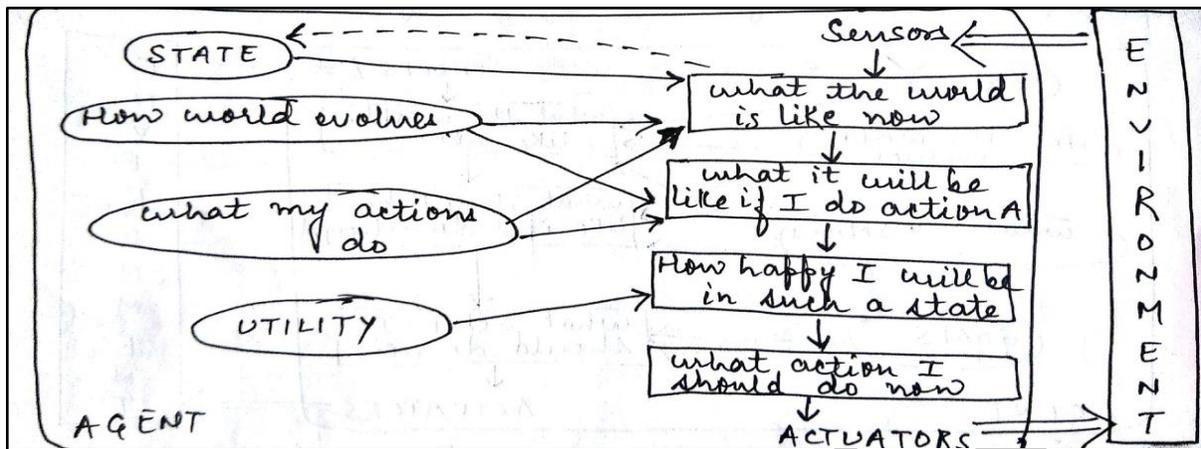
Ans : Job of AI is to design an agent program that implements the agent function mapping percepts to actions. This program will execute on some sort of computing device with sensors and actuators – this is called ARCHITECTURE. **Agent = Architecture + Program.**

- (a) **Goal based agent :** In these type of agent models desirable goals and promising directions towards goal which are easy to reach are incorporated. Some times action to be selected is simple, when single action leads to desirable goal. But when long sequence of percepts are observed , then complexity of decision making increases. Example : In automated car driving agent.

Goal based agent may be less efficient , but flexible enough by proper knowledge and decision making. E,g : If it starts raining then car driving agent must be flexible enough to make correct decision when to put the brakes on.



- (b) **Utility based agent :** In goal based agents we just get distinction between happy and unhappy states., whereas a more general performance measure allows a comparison of different world states according to exactly how happy they would make agent if the goal is reached. For this we require utility measure.



A **UTILITY FUNCTION** maps a state into a real number which describes associated degree of happiness. Two cases can be considered here for rationality:

Case 1: Conflicting goals exist and only some of them can be achieved (e.g safety and speed of car are conflicting requirements. So select that goal which has more degree of happiness and is more useful), So in car driving safety is more essential than faster speed , to avoid any accident or human loss.

Case 2: If several goals exist and agent cannot reach any way to them with certainty, utility provides the way in which likelihood of success can be weighted up against the importance of goal. Example :

A house hold robotic agent will give medicine to a person at a schedule time as compared to if at the same time he is asked by another family member to play his favourite sports channel in Television. Because utility of medicine consumption is higher than watching the television.

Ques 9. (a) What is PEAS information ? Design the PEAS information for Taxi Driver Agent and Automated Robot in a manufacturing plant.

(b)Mention various properties of task environment.

Ans : (a) PEAS is the acronym used to define the performance and other characteristics of a rational agent.

P : Performance , E : Environment , A : Actuators , S : Sensors.

Performance measure decides criterion for the success of an agent’s behavior. When an agent is plunked down in the environment , it generates a sequence of actions according to the percept it receives.

The sequence of actions causes environment to go through a sequence of states. If sequence is desirable , then agent has performed well.

Agent Type	Performance Measure	Environment	Actuators	Sensors
Taxi Driver Agent	Safe, fast, legal, comfortable trip , maximum mileage.	Roads, Other traffic, pedestrians,customers.	Steering, accelerator,brake,signal ,horn, display	Cameras, Speedometer, GPS , odometer,engine sensors
Robot part picking agent	% of parts in correct place	Conveyner belt with parts, bin	Joint arms and hands	Camera, Joint angle sensors.

(c) Properties of task environment :

Fully Observable Vs Partial Observable : In Fully observable environment , agent’s sensors give it’s access to complete state of the environment at each point. In partially observable due to noise and inaccurate sensors prediction becomes unclear. E.g : Taxi agent cannot think what other drivers are thinking.

Deterministic Vs Stochastic : An environment is deterministic if next state is completely determined by current state otherwise it is random/stochastic. E.g : Taxi driving agent is stochastic because one can never predict behavior of traffic exactly.Vaccum cleaner agent is deterministic.

Episodic Vs Sequential : In episodic task environment agent’s experience is divided into “ atomic episodes”. Each episode consists of agent perceiving and then performing an action. Next episode Is independent from the actions taken in previous episodes.

E.g : In sequential environment , current decision affects all future decisions. E.g : In a Taxi driving agent intensity of brakes put on may have long term consequences.

Static Vs Dynamic : in environment if changes occur while agent is under action , we say it is a dynamic environment else it is static. Static environment is easy to work on . Dynamic environment continuously ask agent , what to do next E.g : Taxi driving is dynamic.

Discrete Vs Continuous : This is w.r.t states of an environments. E.g : Chess game has a finite number of distinct states and discrete set of percepts and actions. Whereas taxi driving is continuous time problem and continuous state aslo.

Single Agent Vs Multi Agent : Agent solving a crossword puzzle alone a single agent.
Chess playing is two agent . Robot Soccer is multi agent (Cooperative multi agent).

Ques : 10. What is Natural language processing? Mention its application domain in AI. What are some of the problems which arise in natural language understanding for autonomous machines like robots, intelligent computers.

Ans : In AI , we need to think of language as a pair (source, target) for mapping b/w two objects. Language is a medium of communication. Till now most common linguistic medium of human beings exists in the form of speech. But processing written language is easier, than processing speech. Developing a program that understand a natural language is difficult, Natural languages are large. They contain infinite difficulties. So Natural Language Processing is the task to process speech or written text in such a way that a program transforms sentences occurring as a part of a dialogue into data structures which convey the intended meaning Of sentences to a reasoning program. A reasoning program must know about :

- (i) Structure of the language
- (ii) Possible semantics
- (iii) Beliefs and goals of the user
- (iv) General knowledge of the world.

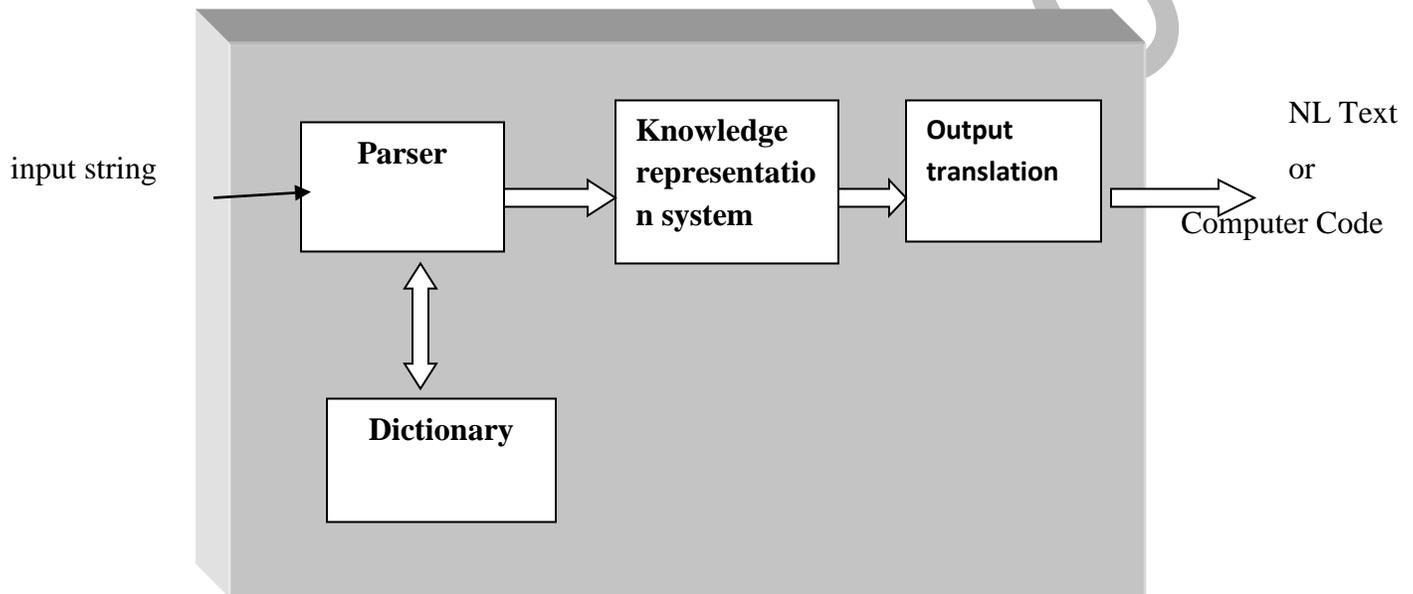
NLP = Understanding + Generation, Natural language understanding aims at building the systems that can make sense of free-form text. NLU system converts samples of human language or computer programs to manipulate. into more formal representation that are easier Natural language generation aims at building systems that can express their knowledge or explain their behavior in natural language. NLG system converts information from computer Databases into normal sounding human language.

- Processing written text using lexical , syntactic and semantic knowledge of the language as well as the required real world information.

- Processing spoken language includes all information needed plus additional knowledge about phonology and removal of ambiguous text.

- NLP also includes multi lingual translation. E,g In google search engine , or in various smart phones we have properties of speech to text and text to speech conversion in different types of natural language.

Block Diagram of NLP system



Application of NLP in AI are as follows :

- (i) Machine translation : Text to speech recognition and speech to text conversion. E,g Features available now a days in android phones as well as windows laptop .
- (ii) Information retrieval from a given collection of documents that satisfies a certain information need.
- (iii) Information extraction and data mining.
- (iv) Text summarization

Problems that arise in NLU systems

1. Problem of Ambiguity : There are several knowledge levels in which ambiguity may occur in natural language.
 - (a) Syntactic Level : A sentence / phrase may be ambiguous at syntactic level. Syntax relates to the structure of the language as per grammar rules and the way the words are put together.
Example : I hit the man with the hammer. Was the man hit by weapon or weapon was in the hand of victim.

(b) Some sentence structures have more than one correct interpretations

(c) Lexical level : A sentence may be ambiguous at lexical level. In this a word can have more than one meaning. Example : I went to the bank. Word bank can be a river bank or a financial institution. So two meanings of same word.

(d) Referential Level: This is concerned with what the sentence refers to , or a sentence may refer to more than one thing. Example : Ram killed Ravana because he liked Sita. Here referential ambiguity occurs for He , that whom does he refers, Ram or Ravana.

(e) Semantic Level : A sentence may be ambiguous at the point of meaning (i.e two different meanings for same concept). Example: He saw her duck (Lexical and semantic level ambiguity). Did he dip down to avoid or he saw web footed bird.

(f) Pragmatic Level : Sentence can be ambiguous at pragmatic level i.e at level of interpretations

Depending on the context in which it occurs. Some words can have different meanings in different situations.

Example : I went to the doctor yesterday. When exactly was the yesterday is not clear. Does yesterday refers to the day preceding today or it is some another yesterday.

I waited for a long time at the bank.

There is a drought because it has not rained for a long time.

Dinosaurs have been extinct for a long time. ☹☹

A long time depends on context . So pragmatic level ambiguity.

2. Problem of impreciseness is also bad , that is very long sentences cannot be easily interpreted by machines .
3. Problem of incompleteness : Incomplete sentence may create a sort of logical error or misinterpretation. Example : I went there. There refers to what ?
4. Problem of inaccuracy may also arise in machine translation..

5. Problem of continuous change is also very common during NLU. Example : People in different part of world have different accent of speaking English.
6. Presence of noise in the input to understand .Example : While speaking in front of machine , background noise may hinder the clear voice input to the system.
7. The quantifier scoping problem is also very common. Where to apply existential quantifier ()and where to use universal quantifier.

Ques 11. Write short notes on the following: (15 Marks)

- (i) **Top down and bottom up parsing** (ii) **Computer vision** (iii) **Turing Test.**

Ans : Parsing is a technique to check the grammatical structure of computer programs syntactically and generate a parse tree if given input is successfully parsed by the formal context free grammar. But in NLP system this traditional parsing is quite difficult to analyze, understand and implement. This is because natural languages are inherently ambiguous at lexical level, syntax level , semantic level, referential level and pragmatic level.

There are systematic patterns in the sentence that emerge from the knowledge of grammar.Example sentences have parts of phrases like noun phrase , verb phrase , preposition phrase etc.Parsing is a kind of search problem where the serach space is the set of trees consistent with a given grammar . Two Methods of searching are : Top Down approach and Bottom up approach of parsing.

Top Down approach : In this technique we start searching from the root node of parse tree and go to downwards level till leaf nodes to find lexicons or original words.Top down approach is Goal Driven. In task o+f packing bags for travel , we can start with the goal in mind and make a list of items that achieve that goal.

Top down parsers are constrained by the grammar.

Bottom Up Approach : This is data driven approach in which search moves are performed upwards the tree Starting from leaf nodes and reaching to the root node. If it si done successfully then no syntax error occurs.

Bottom up parser are constrained by the words.

Top down approach	Bottom up parsing
S → NP VP	Ram ate the biscuit
→ N VP	NOUN ate the biscuit
→ Ram VP	NP ate the biscuit
→ Ram V NP	NP VERB ART biscuit
→ Ram ate NP	NP VERB ART NOUN
→ Ram ate ART NOUN	NP VERB NP
→ Ram ate the NOUN	NP VP
→ Ram ate the biscuit	S

(iii) Computer Vision: There are many opinions about what sort of background is necessary for computer vision, but one thing is certain—inspirations for new computer vision methods have come from fields as diverse as psychology, neuroscience, physics, robotics, and statistics. Vision deals with light and its interaction with surfaces, so of course optics plays a role in understanding computer vision systems. Cameras, lenses,

focusing, 5 binocular vision, depth-of-field, sensor sensitivity, time of exposure, and other concepts from optics and photography are all relevant to computer vision.

Often referred to as the “inverse” of computer graphics, computer vision attempts to make inferences about the world from images. Given a picture of two objects, we would like to infer that they are roughly cubical, and that they are likely to be dice, although we can never be completely sure. A vision system may pick up important highlights to conclude that a surface is wet, transparent, or reflective, features associated with living creatures, rather than inanimate objects.

Neuroscience, physiology, the human eye, the central nervous system, and the brain are all marvels of complex structure and performance required for vision. Studying these systems often provides insight, inspiration, and clues about artificial vision system design.

The human visual system seems to do all of these things. Just recording the speed at which a human responds in a particular task, like reading a word, may rule out certain theories as to how certain visual stimuli are processed.

Probability, Statistics, and Machine Learning The mathematical subfield of probability, the field of statistics, and the computer science discipline of machine learning have become essential tools in computer vision.

- Early Vision in Multiple Images. The geometry of multiple view.
- Stereopsis :What we know about the world from having 2 eyes
- Structure from motion “What we know about the world from having many eyes, more commonly, our eyes moving.

Mid-Level Vision

- Finding coherent structure so as to break the image or movie into big units
 - Segmentation:
 - Breaking images and videos into useful pieces

- E.g. finding video sequences that correspond to one shot
- E.g. finding image components that are coherent in internal appearance
- Tracking:
 - Keeping track of a moving object through a long sequence of views

High Level Vision (Geometry)

The relations between object geometry and image geometry: Model based vision find the position and orientation of known objects

Smooth surfaces and outlines : how the outline of a curved object is formed, and what it looks like

Aspect graphs : how the outline of a curved object moves around as you view it from different directions

High Level Vision (Probabilistic) :The relations between object geometry and image geometry

Model based vision : find the position and orientation of known objects

Smooth surfaces and outlines : how the outline of a curved object is formed, and what it looks like

Aspect graphs : how the outline of a curved object moves around as you view it from different directions

(iii) Turing Test : This test provide an answer to the question “ *Can machines think like human beings*”.

Alan Turing , the British scientist was a well known computer scientist and the father of artificial intelligence. Turing left a bench mark test for an intelligent computer ; such that it must fool a person into thinking the computer machine as a human being. This test was performed in following two phases:

PHASE I : A set up of interrogator in an isolated room , with a man and woman in separate room is performed. Same questions are asked to both man and woman through a neutral medium , like teletype writer. Questions asked were calculations of multiplication of big numbers like 33456012×6754 . Some questions on lyrics and English literature are also put.

PHASE II : In this phase man is replaced by a computer without the knowledge of the interrogator. The interrogator does not distinguish between man , woman and machine, rather he knows them as A and B.

Interpretation: If conversation with a computer is indistinguishable from that with a human, the computer is displaying intelligence. If we can not distinguish between Natural Intelligence and Artificial Intelligence they

must be same. If the interrogator could not distinguish between a man imitating a woman and a computer imitating a man the computer succeeded in passing the test. The goal of machine was to befool the interrogator into believing that it is a person. If computer is successful, then we can say “machines can think like humans”.

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