AI Unit 4

Applications of AI

Learning: Introduction, Types of Learning: Rote Learning, Learning by taking advice, Learning by Induction

Computer Vision: Human Vision Processing, Edge detection, The Waltz algorithm.

Expert System: Architecture of Expert System, Role of Expert system in Knowledge acquisition.

LEARNING

Explain the following with examples. 8
i) Rote learning
ii) Learning by taking advice
iii) Learning in problem solving
iv) Inductive learning

1.

i) Rote Learning: means Memorization.

- This method enables the machine to acquire and store organised information. This information can be used as and when repetition of some task is performed as it's faster to use stored information instead of recollecting it.
- Saves knowledge so it can be used again. Retrieval is the only problem.
- No repeated computation/query is necessary.
- We get generalised information stored in the database.
- It fails when complexities increase in stored information itself and it becomes difficult to access the right information at the right time. It cannot be used in sophisticated applications.
- Computational aspect - data caching → stores computed values and recalls this information needed by computation.
- E.g. Samual's checkers program - stored chess moves played by its creator, thus, learning to play chess.

ii) Learning by taking advice: It is the easiest and simplest way of learning.

- Programmer writes a program giving instructions to perform a task to the computer, once programmed(learned) the system can do new things.
- Computer follows the instructions given by the programmer, thus, taking advice from the creator of the programmer.
- Stored knowledge is transformed into operational knowledge, Therefore reliability reduces.
- It is also known as Direct Instruction

- Eg: EMYCIN → constructs a consultation program. Ie. offers advice on problems within its domain of expertise.
- E.g FOO program that plays the game called 'Hearts'. The program takes advice from the programmer to decide the moves.

iii) Learning in Problem Solving: There are 3 methods:

- **C1:** Learning by parameter adjustment: start with some estimate of the correct weight settings, modify the weight in the program on the basis of accumulated experiences.
- Features that are good predictors will have their weights increased & bad ones will be decreased. Eg. Samual's Checkers program
- **C2:** Learning by Macro Operators: similar to rote learning.
- Avoid expensive recomputation. Macro-operators can be used to group a whole series of actions into one.
- Eg. STRIPS problem solving → Operators unstack, putdown, pickup, stack. STRIPS can build a macro operator MACROP with pre conditions like ON(A,B), ONTABLE(B) etc.
- **C3:** Learning by chunking: originates from psychological ideas on memory & problem solving, computational basis in production systems.
- Eg. SOAR → systems that use production rules to represent knowledge. Uses chunking to learn from experience by detecting useful sequences of productions fixed, creates chunks & stores them.

iv) Inductive Learning: Learning by example.

- Learning by example where a large number of examples are given and the machine learns to perform similar actions in similar situations.
- Induction means 'the inferring of general laws from particular instances'
- Inductive learning means generalisation of knowledge gathered from real world examples and to use them to solve similar problems.
- System tries to induce general rules from a set of observed instances through supervised learning.
- Eg. Blocks World Learning → constructs representation of Definition of concepts in this domain by learning similar constructions

2. Differentiate supervised, unsupervised and reinforcement learning. Give examples. **07**

Criteria	Supervised Learning	Unsupervised Learning	Reinforcement Learning
Input Data	Input data is labelled.	Input data is not labelled.	Input data is not predefined.
Problem	Learn the pattern of inputs and their labels.	Divide data into classes.	Find the best reward between a start and an end state.
Solution	Finds a mapping equation on input data and its labels.	Finds similar features in input data to classify it into classes.	Maximises reward by assessing the results of state-action pairs
Model Building	Model is built and trained prior to testing.	Model is built and trained prior to testing.	The model is trained and tested simultaneously.
Applications	Deal with regression and classification problems.	Deals with clustering and associative rule mining problems.	Deals with exploration and exploitation problems.
Algorithms Used	Decision trees, linear regression, K-nearest neighbours	K-means clustering, k-medoids clustering, agglomerative clustering	Q-learning, SARSA, Deep Q Network
Examples	Image detection, Population growth prediction	Customer segmentation, feature elicitation, targeted marketing, etc	Drive-less cars, self-navigating vacuum cleaners, stock trading, etc

3. Differentiate the inductive learning and the deductive learning. 05

Basis for comparison	Deductive Reasoning	Inductive Reasoning
Definition	Deductive reasoning is the form of valid reasoning, to deduce new information or conclusion from known related facts and information.	Inductive reasoning arrives at a conclusion by the process of generalization using specific facts or data.
Approach	Deductive reasoning follows a top-down approach.	Inductive reasoning follows a bottom-up approach.
Starts from	Deductive reasoning starts from Premises.	Inductive reasoning starts from the Conclusion.
Validity	In deductive reasoning conclusion must be true if the premises are true.	In inductive reasoning, the truth of premises does not guarantee the truth of conclusions.
Usage	Use of deductive reasoning is difficult, as we need facts which must be true.	Use of inductive reasoning is fast and easy, as we need evidence instead of true facts. We often use it in our daily life.
Process	Theory→ hypothesis→ patterns→confirmation.	Observations-→patterns→hypothesis→Theory.
Argument	In deductive reasoning, arguments may be valid or invalid.	In inductive reasoning, arguments may be weak or strong.
Structure	Deductive reasoning reaches from general facts to specific facts.	Inductive reasoning reaches from specific facts to general facts.

4. What do you mean by inductive learning? Explain the strategy used to choose a hypothesis from the set of consistent hypothesis. **06**

- Learning by example where a large number of examples are given and machine learns to perform similar actions in similar situations
- Induction means 'the inferring of general laws from particular instances'
- Inductive learning means generalisation of knowledge gathered from real world examples and to use them to solve similar problems.
- System tries to induce general rules from a set of observed instances through supervised learning.
- Eg. Blocks World Learning → constructs representation of Definition of concepts in this domain by learning similar constructions
- Strategy to choose a hypothesis from consistent hypotheses:
    - This Occam's razor advocates that when presented with competing hypotheses about the same prediction, one should select the solution with the fewest assumptions, and that this is not meant to be a way of choosing between hypotheses that make different predictions.

- Inductive bias (or the inherent bias of the algorithm) are assumptions that are made by the learning algorithm to form a hypothesis or a generalisation beyond the set of training instances in order to classify unobserved data.
- Occam's razor is one of the simplest examples of inductive bias. It involves a preference for a simpler hypothesis that best fits the data. Though the razor can be used to eliminate other hypotheses, relevant justification may be needed to do so.

EXPERT SYSTEMS

5. Explain the different ways of representing and using the domain knowledge in expert system. 4

- Expert system is built around a knowledge base module. Expert system contains a formal representation of the information provided by the domain expert.
- Three common methods of knowledge representation evolved over the years are *IF-THEN rules*, *Semantic networks* and *Frames*.

1. IF-THEN rules

Human experts usually tend to think along :

condition ⇒ action or Situation ⇒ conclusion

- Rules **"if-then"** are predominant forms of encoding knowledge in expert systems. It states that a conclusion or action is sure to take place, if the situation on IF part arises. A rule is said to be fired if the condition of the IF part is satisfied.

These are of the form :

If a1 , a2 , ... , an

Then b1 , b2 , ... , bn where

each 'ai' is a condition or situation, and

Each 'bi' is an action or a conclusion.

2. Semantic Networks

In this scheme, knowledge is represented in terms of objects and relationships between objects.

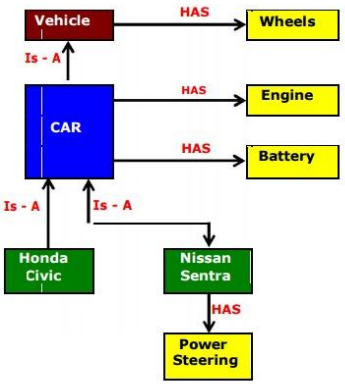
The objects are denoted as nodes of a graph. The relationship between two objects is denoted as a link between the corresponding two nodes.

The most common form of semantic networks uses the links between nodes to represent **IS-A** and **HAS** relationships between objects.

Example of Semantic Network

The Fig. Below shows a car IS-A vehicle; a vehicle HAS wheels.

This kind of relationship establishes an inheritance hierarchy in the network, with the objects lower down in the network inheriting properties from the objects higher up.



3. Frames

In this technique, knowledge is decomposed into highly modular pieces called frames, which are generalised record structures.

‡ Each concept may be represented as a separate frame.

‡ The attributes, the relationships between concepts, and the procedures are allotted to slots in a frame.

‡ The contents of a slot may be of any data type - numbers, strings, functions or procedures and so on.

‡ The frames may be linked to other frames, providing the same kind of inheritance as that provided by a semantic network.

A frame-based representation is ideally suited for object-oriented programming techniques.

✓ 6. Explain the advantages of an Expert System over a Human Expert. 04

Advantages of Expert Systems over Human Experts:

i) Easy Availability: ES once developed is easily available to any computer. Can be used at different places at same time. Human Experts have limitations on working hours and can deal with one problem at a time.

ii) Economy: use of expert systems is much more economical compared to humans.

iii) Permanence: expertise of expert systems is forever, they'll last indefinitely. Humans may quit or die.

iv) Multiple Expertise: can be used to work simultaneously on one problem and the combined expertise may exceed that of a single human expert.

v) Fast Response: ES respond faster than humans depending upon the hardware and software used in developing them

vi) Steady and unemotional: ES do not have emotions, hence their results are unaffected by circumstances. Efficiency of the ES remains the same irrespective of the duration of their use, while human experts get fatigued and their working efficiency tends to decrease with time.

vi) Intelligent tutor: ES can act as tutor to someone who is interested in learning the reasoning and approach used in solving a particular problem by using the system for various examples.

vii) Intelligent database: One can access the db of an ES and use it for some other purpose.

viii) Refined knowledge base: Knowledge base of ES can be refined and improved by exploring it. Knowledge possessed by human experts cannot be explored and refined by others.

7. Describe the main components of an Expert System. 6

Explain the Structure of Expert System

Main components:

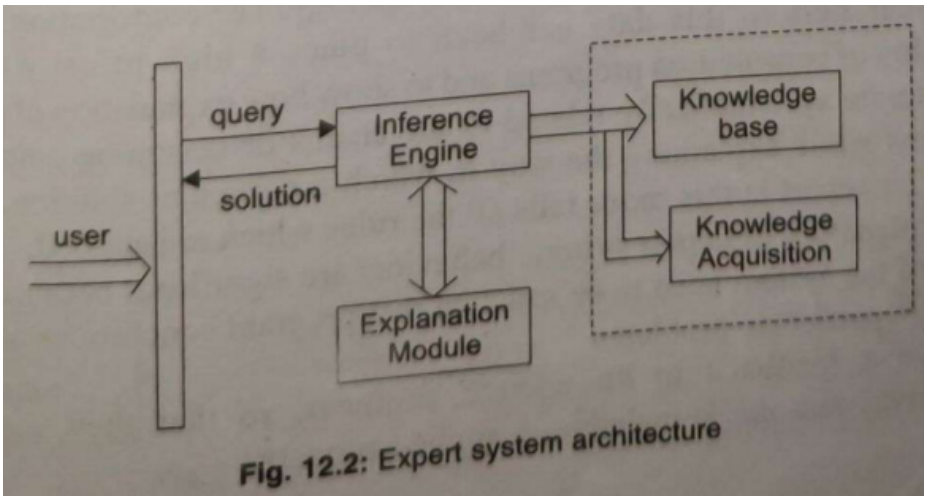


Fig. 12.2: Expert system architecture

- **User interface**
  - ❖ User interacts with the system through a user interface.
  - ❖ It acts as a bridge between user and expert system. This module accepts the user queries and submits those to the expert system.
  - ❖ The user normally consults the expert system for following reasons:
    - ★ To get answers to his queries.
    - ★ To get an explanation about the solution for psychological satisfaction.
  - ❖ The user interface module is designed in such a way that at user level it accepts the query in a language understandable by the user and transforms it in appropriate form, which is understandable by the expert system.

- **Explanation system**

- ❖ The explanation facilities allow the program to explain its reasoning to the user. The credibility of the expert system will be established only when it is able to explain how and why a particular conclusion is drawn. This explanation increases the belief of users in the expert system.
- ❖ The explanation of expert system behaviours are significant because:
  - ★ Users of the system need to be satisfied that program conclusions are correct for their particular problems,
  - ★ To give feedback to knowledge engineers, so that they can satisfy themselves that the knowledge is applied properly.
  - ★ Domain experts need to see a trace of the way in which their knowledge is being applied in order to judge whether knowledge elicitation is proceeding successfully.
  - ★ Managers of expert system technology need to convince themselves that a system module is working properly.

- **Knowledge base**
  - ❖ Knowledge base is the heart of an expert system. It is a repository of knowledge in the expert system.
  - ❖ The expert system uses this knowledge to answer the queries or give a consultation to the user.
  - ❖ The knowledge can be of various types like commonsense knowledge, task oriented knowledge, domain specific knowledge etc.
  - ❖ It stores task oriented knowledge.
  - ❖ The capabilities of expert system are dependent on the amount of knowledge it contains
- **Inference engine**
  - ❖ Inference engine is the module, which finds an answer from the knowledge base. It applies the knowledge to find the solution of the problem.
  - ❖ In general, the inference engine makes inferences by deciding which rules are satisfied by facts, decides the priorities of the satisfied rules and executes the rule with the highest priority. It is also called rule interpreter, as the knowledge is normally stored in terms of rules.
  - ❖ The inference engine performs following tasks:
    - ★ It matches the IF condition of a rule with a given input condition, if a match occurs then triggers that rule and similarly triggers many rules to reach a conclusion.
    - ★ Adds the previously drawn conclusion to the knowledge base as inferred facts for future use.
    - ★ The major task of the inference engine is to trace its way through a collection of rules to arrive at some answer according to the user's query. The technique of drawing the conclusion is called inferencing.

★ The inferencing can be of two types:
Forward chaining and **Backward chaining**

- **Knowledge base editor**
  - ❖ The function of a knowledge base editor is to help the programmer to locate the deficiencies in the performance of the program and to correct those.
  - ❖ This is done by often accessing the information provided by the explanation system.
  - ❖ They also assist in addition of new knowledge to the knowledge base, help make correct rule syntax and perform consistency checks on the updated knowledge base.
- **Knowledge acquisition facilities**
  - ❖ Knowledge acquisition facilities impart methods and tools in an expert system that make it capable to acquire knowledge automatically by the user while using it instead of requiring the knowledge to be coded by a knowledge engineer before entering into the knowledge base.
  - ❖ These facilities make the system capable of enhancing its knowledge while in use and thus help in improving the performance of the system.

8. Why is the machine learning technique important in context of developing an expert system? 4

- The machine learning techniques are supervised learning, unsupervised learning, semi-supervised learning and reinforcement learning,
- Expert systems are meant to solve real world problems, hence, require deep knowledge of the particular area.
- The most challenging job for knowledge engineers is to acquire and represent a sufficient amount of knowledge for developing an expert system.
- This requires making use of machine learning techniques to train the expert system model on the training data for it to learn.
- When the solution to a problem involves more variability and uncertainty, machine learning is often a better choice over an expert system.

9. Discuss applications of expert system. 4

Application	Description
Design Domain	Camera lens design, automobile design.
Medical Domain	Diagnosis Systems to deduce cause of disease from observed data, conduction medical operations on humans.
Monitoring Systems	Comparing data continuously with observed system or with prescribed behavior such as leakage monitoring in long petroleum pipeline.
Process Control Systems	Controlling a physical process based on monitoring.
Knowledge Domain	Finding out faults in vehicles, computers.
Finance/Commerce	Detection of possible fraud, suspicious transactions, stock market trading, Airline scheduling, cargo scheduling.

OR

Applications of Expert System

- **In designing and manufacturing domain**
  It can be broadly used for designing and manufacturing physical devices such as camera lenses and automobiles.
- **In the knowledge domain**
  These systems are primarily used for publishing the relevant knowledge to the users. The two popular ES used for this domain is an advisor and a tax advisor.
- **In the finance domain**
  In the finance industry, it is used to detect any type of possible fraud, suspicious activity, and advise bankers on whether they should provide loans for business or not.
- **In the diagnosis and troubleshooting of devices**
  In medical diagnosis, the ES system is used, and it was the first area where these systems were used.
- **Planning and Scheduling**
  The expert systems can also be used for planning and scheduling some particular tasks for achieving the goal of that task.

10. What is the use of machine learning? Give Examples and methods. 06

- Machine learning is used to build algorithms that can receive input data and use statistical analysis to predict the output.
- ML is used to train computer algorithms to learn, reason and make decisions without human interaction so as to make data-driven recommendations based on input data.
- Image Recognition - identification of an object as a digital image based on the intensity of the pixels in a black and white or colored image. Facial recognition also uses ML.
  E.g. recognise a handwriting by segmenting a letter into smaller labels, or label and x-ray as cancerous or not.
- Speech Recognition - ML can translate speech to text and convert live audio or recorded speech into a text file.
  E.g. voice searching, voice dialling, appliance control
- MEdical Diagnosis - ML helps in diagnosis of diseases. Facial recognition and ML together can scan patient photos and identify the genetic diseases.
  E.g. analyse bodily fluids, oncology or pathology to recognise cancer tissues.
- Predictive analysis -classify data into groups which are then defined by rules set by analysts. Can be used to calculate the probability of fault.
  E.g. proving if a transaction is fraudulent.
- Social Media platforms - provides ads, suggestions and news based on user's likes and interests. Extracts user info.
  E.g. Amazon product ads on a facebook page.

11. How do you think expert systems will evolve in the next ten years? Justify your answer. (04)

12. Why explanation facilities are important in Expert System. 5

- Most expert systems have explanation facilities that allow the user to ask *why* it asked some question, and *how* it reached some conclusion. These questions are answered by referring to the system goals, the rules being used, and any existing problem data.
- Providing such an explanation facility involves recording what rules are used in drawing conclusions, and using these records to compose explanations like the ones above.
- Explanation facilities allow the program to explain its reasoning to the user. Thus, the credibility of the ES established increases the belief of the user in the ES.

- The explanation of expert system behaviours are significant because:
    - ★ Users of the system need to be satisfied that program conclusions are correct for their particular problems,
    - ★ To give feedback to knowledge engineers, so that they can satisfy themselves that the knowledge is applied properly.
    - ★ Domain experts need to see a trace of the way in which their knowledge is being applied in order to judge whether knowledge elicitation is proceeding successfully.
    - ★ Managers of expert system technology need to convince themselves that a system module is working properly.

13. Discuss the application of experts system in PC Maintenance. (05)

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14. Define the term 'Knowledge' as it applies to Expert Systems. Discuss the role of a Knowledge Engineer in development of an Expert System. (05)

Ans:

knowledge:

The data is collection of facts. The information is organized as data and facts about the task domain. Data, information, and past experience combined together are termed as **knowledge**.

- The knowledge base is a type of storage that stores knowledge acquired from the different experts of the particular domain.
- It is considered as a big storage of knowledge.
- The more the knowledge base, the more precise will be the Expert System.
- It is similar to a database that contains information and rules of a particular domain or subject.
- One can also view the knowledge base as collections of objects and their attributes. Such as a Lion is an object and its attributes are it is a mammal, it is not a domestic animal, etc.

Role of knowledge engineer

- An expert provides the necessary knowledge of the problem domain through a general discussion of his/her problem solving techniques and by demonstrating those skills by a set of sample problems.
- **The knowledge engineer** then codes this knowledge explicitly in knowledge base and uses the same for developing a computer program that is both effective and intelligent in its behavior. Once such a program is developed, its expertise is refined by giving to it example problems for solving, getting

comments of the human experts about the results produced and getting modifications done to the expert's knowledge as suggested by human experts.

- This process is repeated until the program achieves desired level of performance in solving the problems.
- In expert system architecture, for imparting required character in an expert system, knowledge engineers design various components which work together to perform functions.

15. Discuss the factors that would need to be considered when deciding on whether developing an Expert system would be an appropriate solution to a problem. **(05)**

16. Explain any four properties the system should have for representing the knowledge in a particular domain. **4**

ans: STUDY ANY 4

- The **performance** of an expert system must match that of human experts. The solution provided by the system of a given problem should be of high quality.
- The **response time** of the system should be adequate. The system should produce results in reasonable amount of time comparable or better than that of human experts.
- The expert system must exhibit **high-level performance** in terms of **speed** and **reliability** in order to be a useful tool. It should not be prone to crashes and should be able to give steady and consistent performance,
- System asks many questions to the user for finding the correct path to reach required solution. It should be able to **justify the questions** it is asking because unnecessary discourse of the system with the user would make the process lengthy, time consuming and may develop complicacies that may affect the final out come.
- The system must be able to **solve the problem** by use of more and more **heuristic knowledge**. This ability makes them comparable with human experts.
- It must be capable of explaining and justifying solutions or recommendations order to convince the user that its reasoning is correct.

17. Describe the types of situations where expert systems should be considered for use. **5**

- It is widely used in many areas such as medical diagnosis, accounting, coding, games etc.
- An expert system is AI software that uses knowledge stored in a knowledge base to solve problems that would usually require a human expert thus preserving a human expert's knowledge in its knowledge base.
- Different types of medical diagnosis like internal medicine, blood diseases and show on.
- Diagnosis of the complex electronic and electromechanical system.
- Diagnosis of a software development project.
- Planning experiment in biology, chemistry and molecular genetics.
- Forecasting crop damage.
- Diagnosis of the diesel-electric locomotive system.
- Identification of chemical compound structure.
- Scheduling of customer order, computer resources and various manufacturing task.
- Assessment of geologic structure from dip meter logs.
- Assessment of space structure through satellite and robot.
- The design of VLSI system.
- Teaching students specialize task.
- Assessment of log including civil case evaluation, product liability etc.

COMPUTER VISION

18. Explain the vision processing with the help of a block diagram.

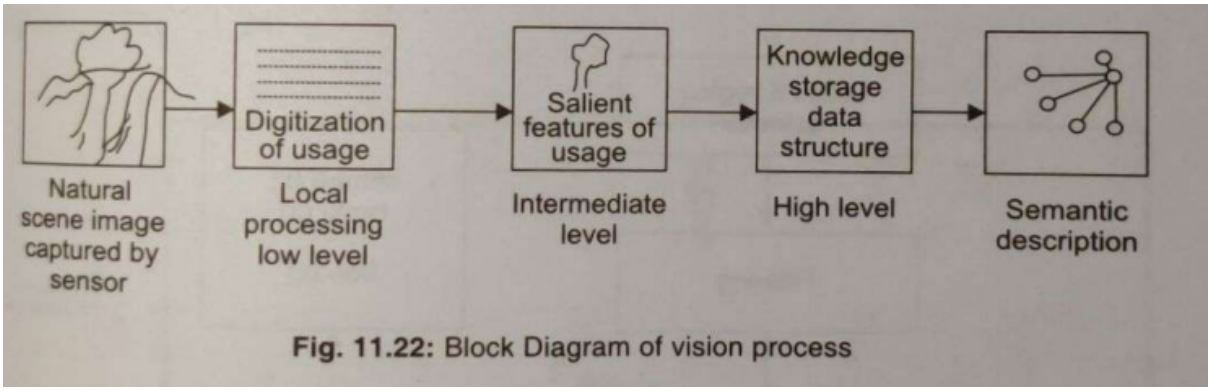


Fig. 11.22: Block Diagram of vision process

The basic input to the vision process is a two dimensional image collected from light sensitive surface. After scanning, the image is formed in terms of continuously varying voltage patterns. These scanned images are digitized. That

i.e., red, green, and blue.

After digitization, some low level processing is done on this digitalized image. This is smoothing of neighbouring points to reduce noise, finding outlines of object or edge elements, performing the threshold analysis and determining the texture, color and other object feature. These initial processing steps are one, which are used to locate object boundaries and other structures within the image.

The second stage is intermediate level processing. The functions performed in this stage are connecting, filling in, combining boundaries, determining regions, and assigning descriptive labels to objects. This stage builds higher level structures from the lower level elements of the first stage.

The last step is higher level image processing. It consists of identifying the important objects in the image and their conversion in the well formed knowledge structures.

19. Explain the techniques used for digital filtering.

Smoothing

This is a form of digital filtering. It is used to reduce the noise and other unwanted features and to enhance certain other image features. It gives some sort of smoothing effect to the image. It eliminates the spikes and flattens widely fluctuating intensity values. Popular smoothing techniques are local averaging, the use of modeling techniques, parametric form filtering.

In local averaging method of smoothing, each pixel in the array is replaced by weighted average of pixel and its neighbouring values. It is done using filter masks, which use some configuration of neighbouring pixel values to compute a smooth replacement value. For example, average of eight neighbouring pixel values

this average intensity value. The effect of smoothing in terms of image quality becomes loss of brightness or fast intensity variations, and in terms of image storage, is reduces amount of data. The degree of smoothing and hence blurring,

otherwise contrast regions.

Many filters can be applied for smoothing. The *Gaussian filter* is one such filter. The Gaussain filter is a special smoothing filter based on the bell shaped Gaussian curve, well known in the statistics as normal distribution. We imagine a window of infinite size, where the weights w(x, y) assigned to the pixel at position x, y from the centre are given as:

$$w(x, y) = 1 / \sqrt{\pi \sigma^2} = \exp [(x^2 + y^2)]$$

where the constant σ is a measure of the spread of the window, i.e., how much

20. Why do we need to detect edges in a digital image? Discuss the techniques for edge detection.

We need to detect edges in a digital image because edge represent discontinuities in or more aspects & form a key part of human visual understanding.

- Techniques of edge detection:

① Edge following – After identifying the pixels, they are arranged together to make lines to identify which group makes an edge
Select an unused potential edge pixel, find adjoining pixel in a chosen direction, accept the pixel if orientation is not too different & if a pixel is not found, scan one or two pixels away. If found, repeat steps else choose opposite dir"

② Region detection :- to identify a region, region is a connected group of pixels whose intensity is almost same. First identify identical pixels & group them together, then estimate the boundaries b/w these regions, if diff > threshold., merge regions.

21. Explain the following

a. Reconstruction of image

After the edges and regions are identified, the image is reconstructed. For this purpose, various hidden features of image need to be inferred about the objects. We can use constraint satisfaction algorithms to determine what possible objects can be constructed from the lines given. These lines are categorized into concave lines, convex lines and obscuring edges. An obscuring edge occurs where a part of one object lies in front of another object or in front of different parts of an object. To mark these edges + or – signs are used. The convention is to use a '+' to label a convex edge and '–' to label a concave image and 'arrow' for obscuring edge. Some line configurations are shown in the following Fig. 11.25.

b. The waltz algorithm

The Waltz algorithm is used for image reconstruction. In the process of image reconstruction, after identifying the constraints, these are applied to analyze the problem. The Waltz algorithm works as follows:

(i) Find the line at the border of scene boundary and label them. These can be found by finding an outline, such that no vertices are outside it. This is done first to perform the process of identification of related constraints propagation.

(ii) Number the vertices of the figure to be analyzed. These will correspond to order in which the vertices will be visited during the labeling process. For deciding on a numbering, following steps are followed:

(a) Start at any vertex on boundary of figure. As boundary lines are known, the vertex involving them are more highly constrained then interior boundaries.

(b) Move from vertex along the boundary to an adjacent unnumbered vertex and continue until all boundary vertices have been numbered.

(c) Number interior vertices by moving from a numbered vertex to some adjacent unnumbered one.

(iii) Visit each vertex V in order and attempt to label it by performing the following:

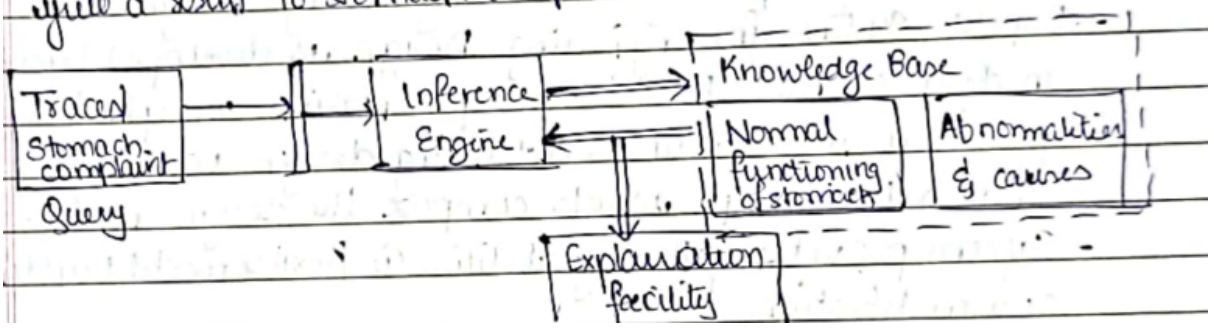
(a) Using the set of possible vertex labeling

(b) Eliminate some of labeling on the basis of local constraints. To do this, examine each vertex A, that is adjacent to V and that has already been visited. Check to see that for each proposed labeling for V, there is a way to label the line between V and A in such a way that at least one of the labeling listed for A is still possible. Eliminate from V's list any labeling for which this is not the case.

(c) Label the labeling to constrain the labeling at vertices adjacent to V.

22. Using an expert system for the diagnosis of stomach complaints as an example, show how why/how traces can be used to explain the functioning of the system

An expert system will accept query, i.e. the doctor will input the symptoms & complaints from patient. This will go to the inference engine which will communicate with the knowledge base. The knowledge base stores a huge amount of knowledge on normal functioning of stomach & what different abnormalities could signify. The explanation module will explain the reasoning to the user. Traces can be sent as queries & can yield a result to stomach complaints.



23. Discuss the application of expert systems in Engineering Design.

Application of Expert System in Engineering design:
- Expert system for Engineering Design is developed based on an object-oriented knowledge representation concept. Design process is understood as determining design variables & their relationships which compose the design model.
- System provides following abilities ① flexible model building & easy modification
② Effective diagnosis of design process
③ supporting method for design
④ hybrid function with numerical computat° & graphics.
- E.g for designing ships or construction layout.