ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS

AI:

AI (Artificial Intelligence) is a technology that enables machines to mimic human-like behavior, such as learning, problem-solving, and decision-making.

Examples:

1. **Virtual Assistants:** Siri or Google Assistant answering questions.
2. **Recommendation Systems:** Netflix suggesting movies based on your interests.
3. **Self-Driving Cars:** Cars navigating traffic on their own using sensors and data analysis.

ANI:

ANI (Artificial Narrow Intelligence) refers to AI that is designed to perform a specific task or a limited range of tasks very well. It lacks general intelligence and cannot perform beyond its programmed capabilities.

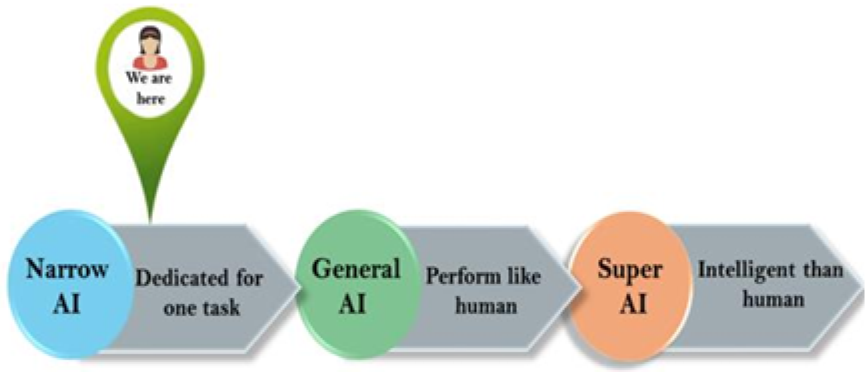
Examples:

1. **Spam Filters:** Identifies and filters out spam emails.
2. **Chess Programs:** Plays chess at a high level but can't perform unrelated tasks.
3. **Voice Assistants:** Recognizes voice commands but can't understand complex emotions or contexts.

AGI:

AGI (Artificial General Intelligence) is a type of AI that has human-like cognitive abilities. It can understand, learn, and apply knowledge across a wide range of tasks, just like a human can.

Example: An AGI system could not only play chess but also learn a new language, solve complex problems, and understand emotions, showing flexibility and reasoning similar to a person. However, AGI does not currently exist and is still a concept in research and development.



HOMOGRAPHY:

Homography is a transformation technique used in computer vision and image processing to map points from one plane to another.

Using homography, you can align two images taken from different viewpoints as long as they are related by a planar surface.

Mathematical Formula:

A homography is represented by a 3x3 matrix, denoted as **H**, that transforms a point (x,y) in one image to a point (x′,y′) in another image:

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = H \cdot \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

Where:

$$H = \begin{bmatrix} h_{11} & h_{12} & h_{13} \\ h_{21} & h_{22} & h_{23} \\ h_{31} & h_{32} & h_{33} \end{bmatrix}$$

Why Do We Use Homography?

- **Image Alignment**: To align images taken from different angles.
- **Perspective Transformation**: To correct the perspective of images (e.g., making a tilted picture appear straight).
- **Object Detection**: To detect planar objects even when viewed from different angles.

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1. AI (Artificial Intelligence)

- **Definition**: AI refers to the creation of machines that can perform tasks requiring human intelligence, like decision-making, problem-solving, and understanding language.
- **Example**: Virtual assistants like **Siri** and **Google Assistant** can answer questions and set reminders.
- **Future**: AI will continue to evolve, integrating into various industries like healthcare and education, leading to smarter cities, better automation, and improved quality of life.

2. ML (Machine Learning)

- **Definition**: ML is a subset of AI that allows machines to learn from data and improve their performance over time without being explicitly programmed.
- **Example**: **Netflix** uses ML to recommend shows based on your viewing habits.
- **Future**: ML will be used for more complex tasks, like detecting diseases earlier and enabling advanced self-driving systems, making technology more personalized and efficient.

3. GI (General Intelligence)

- **Definition**: GI (General Intelligence) refers to AI systems that possess human-like intelligence, allowing them to perform any cognitive task that a human can do.
- **Example**: A theoretical robot that can cook, understand emotions, and solve complex problems across various domains.
- **Future**: If achieved, GI could transform every aspect of human life, from solving global issues like climate change to revolutionizing research and technology development. However, it also brings significant ethical and safety concerns.

4.. PI (Personnel Intelligence)

- **Definition:** PI refers to the capability of AI to understand, interpret, and respond to an individual's personal preferences, emotions, and needs. It focuses on creating a personalized experience for users by considering their unique characteristics and contexts.
- **Example:** A personalized AI health coach that monitors your physical and mental well-being, offers customized advice, and adapts its communication style based on your mood.
- **Future:** PI could revolutionize personal assistants, mental health support, and personalized learning. AI systems would become more intuitive, offering tailored services and emotional understanding, creating a more personalized interaction between humans and machines.

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1. VR (Virtual Reality)

- **Definition**: VR is a technology that creates a fully immersive digital environment, replacing the real world with a virtual one.
- Users interact with this environment using headsets, gloves, or controllers.
- **Example**: **Oculus Rift** or **HTC Vive** headsets allow users to experience a virtual 3D world, like playing a game in a completely digital environment.
- **Applications**:
  - **Gaming**: Immersive gaming experiences.
  - **Education**: Virtual lab experiments and historical site tours.
  - **Healthcare**: Simulated surgeries for training doctors.

2. AR (Augmented Reality)

- **Definition**: AR overlays digital information (images, text, or graphics) onto the real world using devices like smartphones, tablets, or AR glasses.
- **Example**: **Pokémon Go** places digital creatures in the real world using your phone's camera.
- **Applications**:
  - **Retail**: Virtual try-on for clothes or makeup.
  - **Navigation**: Real-time directions overlaid on streets.
  - **Maintenance**: Technicians can see instructions overlaid on machinery.

3. MR (Mixed Reality)

- **Definition**: MR blends the physical and digital worlds, allowing virtual and real objects to interact in real-time. It provides more interaction and integration between real and digital elements compared to AR.
- **Example**: **Microsoft HoloLens** lets users see and interact with holograms in their real environment, such as manipulating a virtual 3D model on a table.
- **Applications**:
    - **Product Design**: Designers can create and interact with 3D models in real space.
    - **Training**: Simulations where users can interact with both virtual and real objects.
    - **Collaboration**: Remote teams can work on a shared virtual project while seeing each other's real-world environment.

Possible Future Applications:

1. **Architecture and Real Estate**: VR and MR can be used for virtual walkthroughs of buildings and interior design planning.
2. **Education and Training**: AR, VR, and MR can create engaging learning environments, from virtual classrooms to simulated job training.
3. **Healthcare**: Use AR and MR for augmented surgeries and patient rehabilitation through virtual exercises.
4. **Tourism**: Virtual tours and interactive travel guides can bring destinations to life before you visit them.
5. **Manufacturing**: MR can assist with real-time guidance during complex assembly and maintenance tasks.

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1. Web 1.0 (Static Web)

- **Definition**: Web 1.0 is the first stage of the internet, where websites were static and only provided information without interaction. Users could only read content but couldn't contribute or engage.
- **Example**: Early websites like **Yahoo** or **Netscape**, where users could only read news or articles.
- **Key Feature**: *Read-only content.*

2. Web 2.0 (Social Web)

- **Definition**: Web 2.0 brought interactivity, allowing users to create, share, and engage with content. It introduced social networking, blogs, and multimedia sharing.
- **Example**: **Facebook**, **YouTube**, and **Wikipedia**, where users can post content, comment, and interact.
- **Key Feature**: *User-generated content and social interaction.*

3. Web 3.0 (Semantic Web or Decentralized Web)

- **Definition**: Web 3.0 is the next stage of the web that focuses on decentralization, AI integration, and more personalized user experiences. It aims to make data more connected and accessible using technologies like blockchain.
- **Example**: **Cryptocurrencies** (like Bitcoin), **Decentralized Apps (DApps)**, and smart contracts on the **Ethereum** blockchain.
- **Key Feature**: *Decentralized, intelligent, and personalized web.*

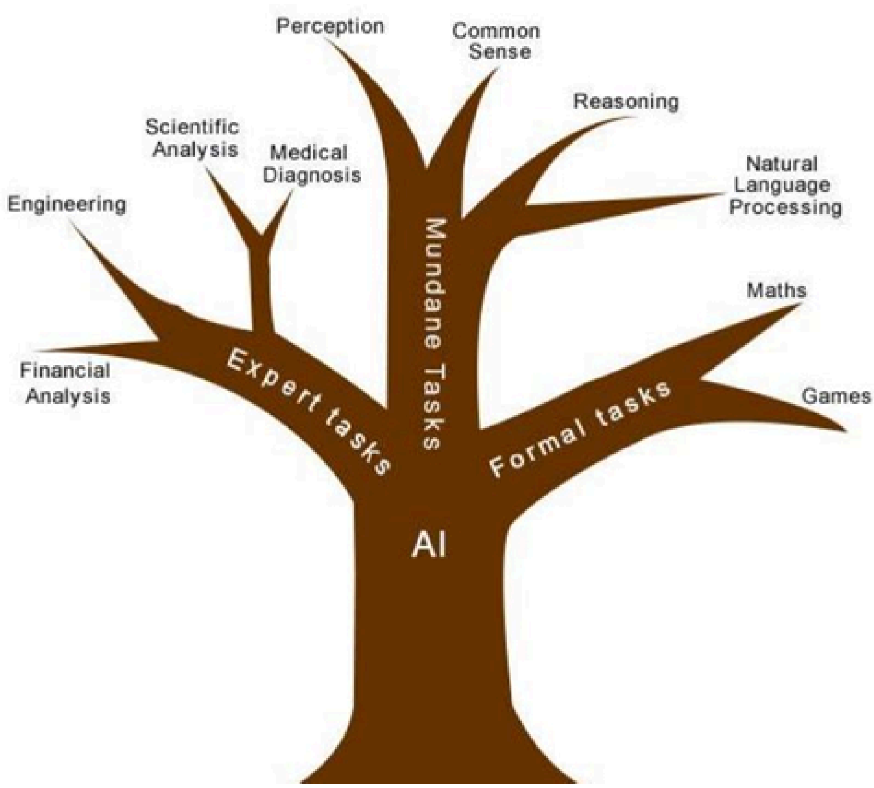
Turing Test:

The Turing Test, proposed by British mathematician and computer scientist Alan Turing in 1950, is a way to determine if a machine can exhibit human-like intelligence. In simple words, the test aims to see if a computer can behave in a way that is indistinguishable from a human when interacting through natural language.

Explanation of the Turing Test: Imagine there are three participants in this test: a human (participant A), a computer (participant B), and an evaluator (participant C) who does not know which is which. The evaluator can only communicate with participants A and B through written messages, without seeing or hearing them. The objective of the test is for the evaluator to figure out which participant is human (A) and which is the computer (B). If the evaluator cannot reliably tell which one is the computer and which one is human based on their responses, then the computer is said to have passed the Turing Test, demonstrating a level of artificial intelligence that is similar to human intelligence.

Example: Let's say the evaluator asks both participants A and B a series of questions through written messages. The responses from participant A and the computer (participant B) are displayed anonymously to the evaluator. Evaluator: "Tell me about your favorite hobbies." Participant A (Human): "I enjoy playing the guitar and painting landscapes. Nature inspires me." Participant B (Computer): "I find joy in analyzing data and learning from patterns. I process information efficiently." In this example, the evaluator might find it challenging to distinguish between the human's responses and the computer's responses. If the computer's responses are sophisticated enough to appear human-like, the computer would pass the Turing Test.

DEVELOPMENT STAGES OF MAKING MACHINE INTELLIGENT:



1. FormalKL Tasks

- Definition: These are simple, straightforward tasks that AI can perform easily without needing advanced reasoning. They often involve repetitive actions.
- Example: Sorting emails into folders or automatically responding to simple customer inquiries.

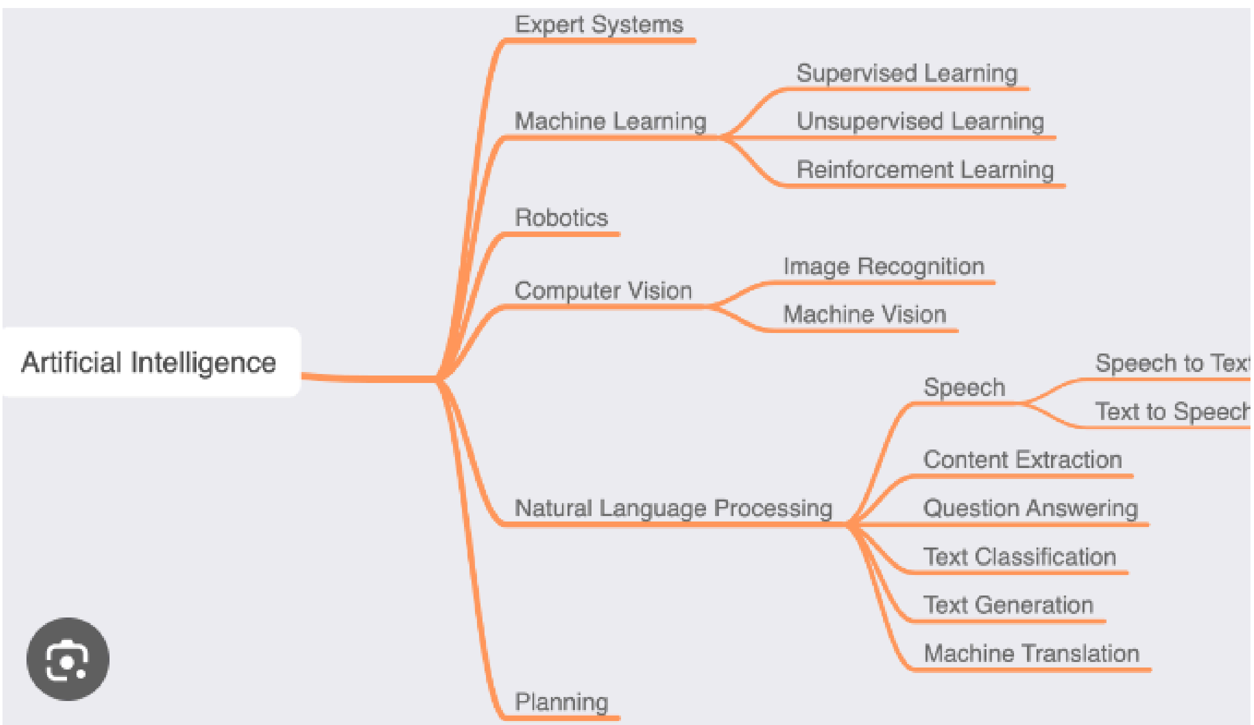
2. Expert Tasks

- Definition: These tasks require specialized knowledge and are often complex. AI systems designed for expert tasks typically use advanced algorithms and large datasets.
- Example: Diagnosing medical conditions based on patient data or analyzing financial markets to predict stock trends.

3. Mundane Tasks

- Definition: Mundane tasks are routine activities that can be automated by AI to improve efficiency and reduce human workload. They may not require high-level skills but are essential for smooth operations.
- Example: Data entry, updating inventory records, or automating report generation.

BRANCHES OF AI :



1. Machine Learning (ML)

- **Definition**: ML enables computers to learn from data and improve their performance over time without being explicitly programmed.
- **Application**: Predicting customer preferences, spam email detection, and recommendation systems (e.g., Netflix).

2. Natural Language Processing (NLP)

- **Definition**: NLP helps computers understand, interpret, and respond to human language.
- **Application**: Chatbots, sentiment analysis, and language translation (e.g., Google Translate).

3. Robotics

- **Definition**: Robotics involves creating machines (robots) that can perform physical tasks automatically or with human assistance.
- **Application**: Manufacturing automation, space exploration (e.g., Mars rovers), and medical surgery robots.

4. Expert Systems

- **Definition**: Expert systems use a set of rules and logic to mimic human expertise in specific fields.
- **Application**: Medical diagnosis, financial decision-making, and troubleshooting technical issues.

5. Computer Vision

- **Definition**: Computer Vision enables machines to interpret and understand visual information from the world, such as images and videos.
- **Application**: Face recognition, object detection in self-driving cars, and surveillance systems.

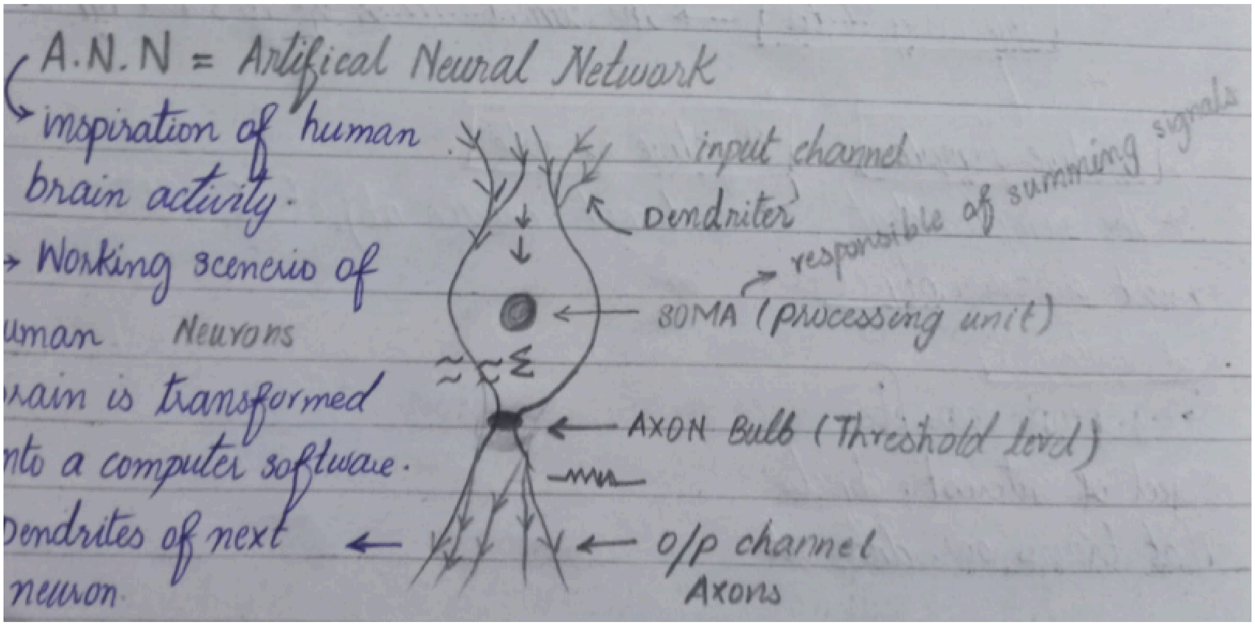
6. Image Processing

- **Definition**: Image Processing focuses on manipulating and enhancing images to extract information or improve quality.
- **Application**: Medical imaging (e.g., X-ray analysis), photo editing software, and optical character recognition (OCR).

7. Artificial Neural Networks (ANN)

- **Definition**: ANNs are models inspired by the human brain's network of neurons, used for recognizing patterns and solving complex problems.
- **Application**: Handwriting recognition, voice recognition, and deep learning models for image classification.

STRUCTURE OF HUMAN'S NEURON:



Dendrites: These are like branches that receive signals from other neurons. They act as input channels.

SOMA (Processing Unit): This is the cell body of the neuron, where all incoming signals are combined and processed.

Axon Bulb (Threshold Level): This is the point where the decision is made whether to send the signal forward or not, based on a threshold value.

Axons (O/P Channel): These are the output channels that carry the processed signal away from the neuron to other neurons or muscles.

8. Speech Processing

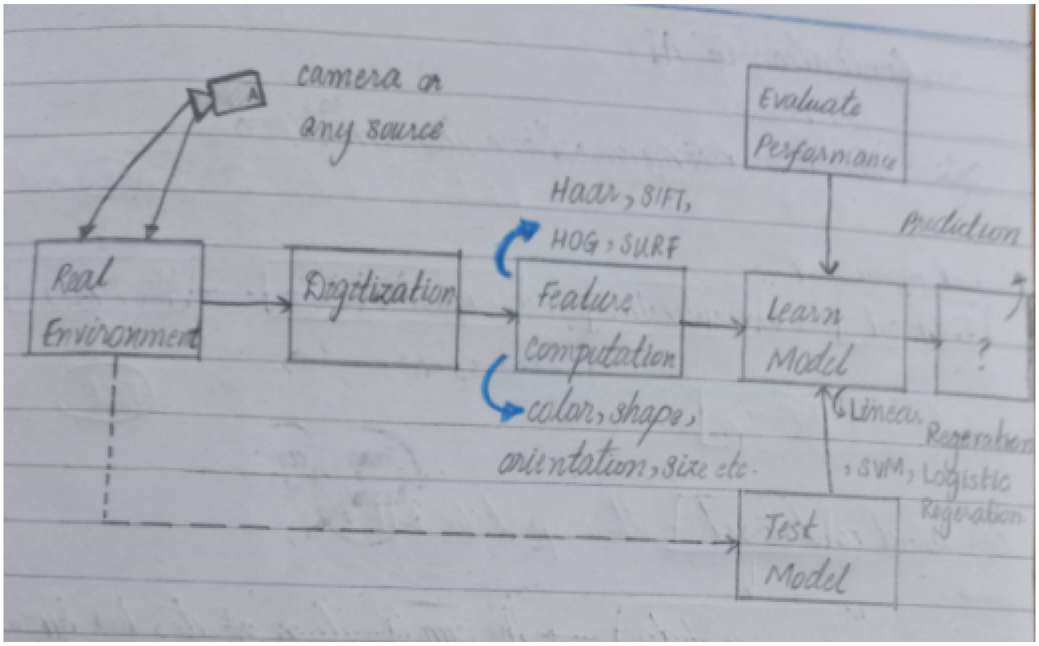
- **Definition**: Speech Processing involves converting spoken language into text or vice versa and understanding its context.
- **Application**: Voice assistants (e.g., Siri, Alexa), speech-to-text converters, and voice-controlled devices.

9. Generative AI

- **Definition**: Generative AI creates new content like text, images, or music by learning patterns from existing data.

- **Application**: Content creation, image generation (e.g., DALL-E), and chatbots that generate human-like text (e.g., ChatGPT).

OBJECT DETECTION USING MACHINE LEARNING:



Real environment

Data set → Digitization → Computes features → ML Algorithm Train model ← Test

← Object detector

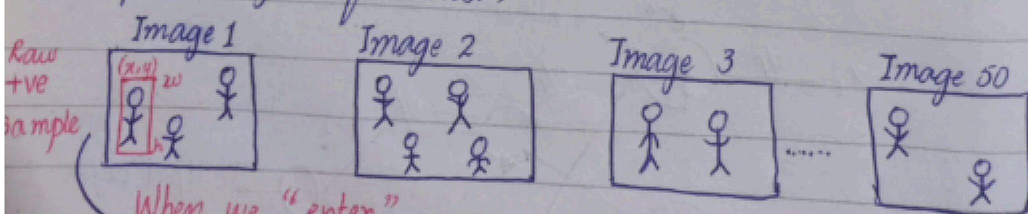
Q) What is dataset with respect to ML?

→ Training data → The combination of it's two types

- Positive samples → The samples that must contain object of interest.
  - ↳ e.g. people, car, etc.
- Negative sample → must not contain object of interest

Object of interest: objects that trains our data set.

→ People in Object of Interest;



When we "enter"

→ Image 1   30   40   15   35

$x \quad y \quad w \quad h$

→ Noise : Unwanted region / information

Steps of finding objects,

step 01
Mark object of interest
Use object-marked tool
use mouse press ↵

- If –ve sample no human/person.

Image should be in .bmp form.

* Every image stored in computer is in matrix form.

Model Performance Evaluation.

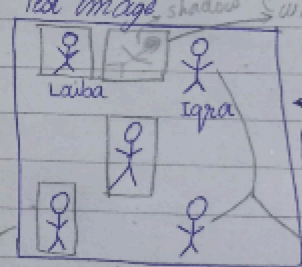
The performance can be evaluated by using standard tools in AI.
→ Precision & Recall
F-1 Ratio/Score
→ It is ratio of correct detection verses total detection

$$= \frac{\text{correct detection}}{\text{total detection}}$$

$$= \frac{\text{correct detection}}{\text{correct detection} + \text{wrong detect}}$$

o/p of model (object-detector)
e.g.:
Test image

shadow
False Positive (FP)
wrong detected



← Trained $\boxed{\text{Model}}$ (obj. detector)

missed detected
False Negative (FN)

correct detected
→ True positive (TP)

Because system is claiming it negative sample.

e,

$$P = \frac{T.P}{TP+FP}$$

If someone give decision, how much are correct?
Precision

Recall: Ratio of correct detections verses total (test) samples

$$= \frac{\text{correct detection}}{\text{Total samples}} = \frac{\text{correct detection}}{\cancel{\text{Total}}\ \text{Correct detection} + \text{missed}}$$

$$R = \frac{TP}{TP + FN}$$

PAST PAPER QUESTIONS:

CHATGPT AND ITS IMPACT OF EDUCATION:

Impact of ChatGPT on Education

ChatGPT is an AI tool that helps students and educators by providing instant information, explanations, and personalized support. It serves as a digital assistant, simplifying learning and making it more accessible.

For example, if a student struggles with math, they can ask ChatGPT to explain a concept step-by-step. This helps them understand topics at their own pace without needing to wait for a teacher's help.

Overall, ChatGPT makes learning more interactive, assists with homework, and helps clarify doubts, enhancing the overall educational experience.

Training Data for Machine Learning

Training data is the foundational dataset used to teach a machine learning (ML) model how to make decisions or predictions. It contains labeled examples, meaning that each data point has a corresponding output or "answer" that the model uses to learn patterns and relationships.

Example

If you're training an ML model to recognize animals in pictures, your training data would consist of images of various animals (cats, dogs, etc.) with their correct labels. The model learns to associate features like shape and color to identify different animals.

In short, training data is essential because it helps the model understand the problem and perform well when exposed to new, unseen data.

What is Machine Learning?

Machine Learning (ML) is a subset of Artificial Intelligence (AI) that enables machines to learn from data and improve their performance over time without being explicitly programmed. Instead of following a fixed set of rules as in traditional programming, ML algorithms identify patterns, make decisions, and provide predictions based on the data they receive.

In ML, a model is built by feeding it a large amount of data and allowing it to find relationships within that data. This model can then be used to make predictions or automate decision-making processes.

Block Diagram of the Machine Learning Process

Below is a simplified block diagram of the ML process, showcasing the key stages

```
+------------------+

 |  Problem        |

 |  Definition     |

 +------------------+

          ↓

 +------------------+

 |  Data Collection |
```

```
|  and Preparation |
+------------------+
         ↓
+------------------+
|  Feature         |
|  Engineering     |
+------------------+
         ↓
+------------------+
|  Model Training  |
+------------------+
         ↓
+------------------+
|  Model Evaluation|
+------------------+
         ↓
+------------------+
|  Model Tuning &  |
|  Optimization    |
+------------------+
         ↓
```

```
+-------------------+
|   Model Deployment|
|   & Monitoring    |
+-------------------+
```

1. **Problem Definition**: Identify the problem you want to solve and define success criteria.
2. **Data Collection and Preparation**: Gather and clean the data required for training.
3. **Feature Engineering**: Select and transform relevant features that can improve model performance.
4. **Model Training**: Train the model using various ML algorithms and adjust hyperparameters.
5. **Model Evaluation**: Evaluate the model using metrics like accuracy, precision, recall, etc.
6. **Model Tuning & Optimization**: Fine-tune the model to improve performance.
7. **Model Deployment & Monitoring**: Deploy the model in a real-world environment and monitor its performance over time.

How ML Algorithms are Different from Conventional Computer Programs

1. **Rule-Based vs. Data-Based Approach**:
   - **Conventional Programs**: Traditional programs follow a *rule-based approach* where every action or decision is dictated by predefined rules and logic set by the programmer.
     - **Example**: In a sorting program, rules are set to compare and swap elements until the list is ordered.
   - **Machine Learning Programs**: ML models follow a *data-based approach*. They are not explicitly programmed with rules; instead, they learn patterns and relationships from the data provided.
     - **Example**: A machine learning model for spam detection learns by analyzing a large number of emails labeled as spam or not spam, finding patterns that distinguish spam emails.
2. **Explicit Instructions vs. Pattern Recognition**:

    - **Conventional Programs**: Perform specific tasks based on hard-coded instructions.
        - **Example**: An email filter with rules like "If an email contains the word 'discount,' mark it as spam."
    - **Machine Learning Programs**: Recognize patterns and make decisions based on the learned model.
        - **Example**: An ML-based spam filter learns from past emails and adjusts its criteria dynamically to detect spam more accurately.
3. **Adaptability**:
    - **Conventional Programs**: Typically not adaptable. Any change in the environment or data requires rewriting the program.
    - **Machine Learning Programs**: Adaptable to changes. They can update their models by retraining on new data without rewriting the entire program.
4. **Performance with Large and Unstructured Data**:
    - **Conventional Programs**: Struggle with large-scale or unstructured data, as they require predefined structures and rules.
    - **Machine Learning Programs**: Efficiently handle large-scale and unstructured data (e.g., images, text) by learning features from the data itself.

Block Diagram of an Expert System

An expert system is a type of artificial intelligence that emulates the decision-making abilities of a human expert. It uses knowledge and inference rules to provide solutions, make decisions, or offer recommendations in specialized domains like medicine, engineering, or finance. Below is a simplified block diagram of an expert system:

sql

Copy code

```
    +--------------------+
     |  User Interface    |
     | (Interaction Layer)|
     +--------------------+
```

```
           ↓
+--------------------+
|  Inference Engine  |
| (Decision-Making)  |
+--------------------+
           ↓
+--------------------+
|  Knowledge Base    |
| (Facts & Rules)    |
+--------------------+
           ↑
+--------------------+
|  Knowledge         |
| Acquisition Module |
+--------------------+
```

Components Explained:

1. **User Interface**:
   - Allows users to interact with the expert system. Users can input queries or problems and receive responses or solutions from the system.
2. **Inference Engine**:
   - The brain of the expert system. It applies logical rules to the knowledge base to deduce new information or make decisions. The inference engine uses two main types of reasoning:

        - **Forward Chaining**: Starts with known facts and applies rules to derive conclusions or outcomes.
        - **Backward Chaining**: Starts with a goal and works backward to find supporting facts or data.
3. **Knowledge Base**:
    - Contains domain-specific facts, rules, and relationships provided by human experts. It is the core repository of the expert system, where all the information required for decision-making is stored.
4. **Knowledge Acquisition Module**:
    - Gather information and update the knowledge base by adding new facts and rules. This module helps the expert system to evolve and stay relevant.

How Expert Systems are More Advantageous than Human Experts

Expert systems can provide several advantages over human experts in certain scenarios due to their unique capabilities:

1. **Consistency**:
    - **Human Expert**: Prone to inconsistencies due to fatigue, emotions, or cognitive biases. Their performance can vary depending on external factors.
    - **Expert System**: Delivers consistent and reliable decisions every time. It uses the same logic and rules for every query, ensuring uniformity.
2. **Availability and Accessibility**:
    - **Human Expert**: May not be available 24/7. Access to domain-specific experts may be limited due to geographic, time, or financial constraints.
    - **Expert System**: Accessible anytime and anywhere. It can provide expert-level guidance around the clock without interruption.
3. **Speed and Efficiency**:
    - **Human Expert**: Requires time to analyze complex problems and make decisions, especially when dealing with large volumes of information.
    - **Expert System**: Processes large datasets and complex rules quickly, delivering instant responses.
4. **Handling Large Knowledge Bases**:
    - **Human Expert**: Limited by memory capacity and cognitive load when dealing with vast amounts of information.
    - **Expert System**: Can store, manage, and recall large volumes of data without any constraints.
5. **Cost-Effectiveness**:

    - **Human Expert**: Hiring, training, and retaining human experts can be expensive.
    - **Expert System**: Once developed and implemented, expert systems can operate at a lower cost and require minimal ongoing expenses.
6. **Knowledge Preservation**:
    - **Human Expert**: Knowledge can be lost when human experts retire, change fields, or leave an organization.
    - **Expert System**: Codifies and preserves knowledge, ensuring that valuable information is retained even if experts are no longer available.
7. **Objectivity**:
    - **Human Expert**: May be influenced by personal experiences, biases, or subjective opinions.
    - **Expert System**: Makes decisions based purely on factual data and predefined rules, resulting in objective conclusions.

Example of an Expert System in Practice

Consider a **medical diagnosis expert system** that assists doctors in diagnosing diseases based on symptoms and medical history:

- **Human Expert**: A doctor may have varying diagnostic outcomes depending on their experience and current state of mind.
- **Expert System**: The expert system uses a predefined set of medical knowledge and logical rules to suggest possible diseases based on symptoms. This can help doctors confirm or explore additional possibilities they might have overlooked.

Conclusion: Expert systems are advantageous in scenarios that require consistency, speed, scalability, and accessibility. While they are not a replacement for human experts, they can be powerful tools to assist in decision-making and provide support in specialized domains.

F1 RATIO/SCORE:

It is used to explicitly compare performance of multiple models.