

# 1. What is Artificial Intelligence (AI)?

## □ Definition:

**Artificial Intelligence (AI)** is the field of computer science focused on building machines and software that can perform tasks that usually require **human intelligence**.

These tasks include:

- Understanding language (like talking or reading)
- Recognizing images and speech
- Learning from data
- Making decisions
- Solving problems

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## Origin of the Term "AI":

The term "**Artificial Intelligence**" was first coined in **1956** by **John McCarthy** during the **Dartmouth Conference**, which is considered the birth of AI as a field.

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## Key Components of AI:

Component	What It Means
<b>Perception</b>	Seeing (via cameras), hearing (via microphones), etc. — like human senses
<b>Learning</b>	Improving performance from experience (this is where <b>Machine Learning</b> fits)
<b>Reasoning</b>	Making logical decisions or inferences
<b>Language Understanding</b>	Reading, writing, or speaking natural human languages
<b>Motion/Action</b>	Moving through and interacting with the world (e.g., robots)

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## Applications of AI

Area	Use Case Example
Healthcare	Diagnosing diseases, personalized medicine, drug discovery
Finance	Fraud detection, credit scoring, stock prediction
Retail	Product recommendations, customer support
Transportation	Self-driving cars, route optimization
Education	Personalized learning, AI tutors
Entertainment	Music generation, game AI, video recommendations
Security	Facial recognition, surveillance systems

## Subfields of AI

1. **Machine Learning (ML):** AI that learns from data
2. **Deep Learning:** ML using neural networks with many layers
3. **Natural Language Processing (NLP):** AI that understands and generates human language
4. **Computer Vision:** AI that understands images and videos
5. **Robotics:** AI for controlling robots
6. **Expert Systems:** Rule-based systems that mimic human decision-making

### 1. Machine Learning (ML)

#### What it is:

Machine Learning is a subfield of AI where **computers learn from data**, instead of being explicitly programmed with rules.

ML systems improve their performance **automatically** by analyzing patterns in data.

#### How it works:

- You provide **input data** and **labels** (for supervised learning).
- The algorithm learns the relationship between input and output.

- Once trained, it can **predict** or classify new, unseen data.

☐ **Types of ML:**

Type	Description	Example
<b>Supervised Learning</b>	Learns from labeled data	Email spam detection
<b>Unsupervised Learning</b>	Finds patterns in unlabeled data	Customer segmentation
<b>Reinforcement Learning</b>	Learns by trial and error with rewards	Game-playing AI like AlphaGo

☐ **Real-world examples:**

- YouTube recommending videos based on your watch history
- Predicting loan defaults in banking
- Personalized ads on social media

## 2. Deep Learning (DL)

☐ **What it is:**

Deep Learning is a **subset of Machine Learning** that uses **artificial neural networks** with many layers (hence "deep"). It mimics how the human brain processes information.

☐ **Key concepts:**

- **Neural Networks:** Composed of layers of neurons (nodes) that process and pass information.
- **Training:** The model learns by adjusting weights to minimize error.
- Needs **lots of data and computing power**, but can achieve **very high accuracy**.

☐ **Common Architectures:**

Type	Use Case
<b>CNN (Convolutional Neural Network)</b>	Image recognition
<b>RNN (Recurrent Neural Network)</b>	Time-series or text data

Type	Use Case
Transformer	Used in LLMs like GPT, BERT

**Real-world examples:**

- Self-driving cars detecting objects
- Voice assistants understanding speech
- Face recognition on phones

### 3. Natural Language Processing (NLP)

**What it is:**

NLP is the branch of AI focused on **understanding, interpreting, and generating human language** (text and speech).

**What it does:**

- Understands grammar, context, sentiment
- Converts text to data and vice versa
- Enables conversation with machines

**Key tasks:**

Task	Example
Text Classification	Spam detection
Machine Translation	English → Spanish
Sentiment Analysis	Is this review positive or negative?
Question Answering	ChatGPT, Siri
Text Generation	Writing articles, summaries

**Real-world examples:**

- Chatbots and virtual assistants (like ChatGPT, Alexa)

- Auto-correct and predictive text in keyboards
  - Translation apps (Google Translate)
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## 4. Computer Vision

### What it is:

Computer Vision is a field of AI that enables machines to **see and understand images or videos**, similar to human vision.

### What it does:

- Identifies objects, people, or scenes
- Tracks motion and interprets visual input
- Converts visual content into data

### Key tasks:

Task	Example
Image Classification	Is this a dog or a cat?
Object Detection	Find all cars in a photo
Face Recognition	Unlock phone with your face
Image Segmentation	Identify parts of an image (e.g., background, person)

### Real-world examples:

- Self-driving cars identifying pedestrians and traffic signs
  - Medical imaging (detecting tumors)
  - Social media photo tagging
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## 5. Robotics

### What it is:

Robotics combines AI with physical hardware to create **intelligent machines that can interact with the physical world**.

**What it does:**

- **Senses** the environment using sensors
- **Processes** information using AI/ML
- **Acts** using motors or limbs to move or manipulate objects

**Components:**

Component	Role
Sensors	Perceive the world (cameras, LiDAR)
AI Processor	Makes decisions
Actuators/Motors	Enable movement

**Real-world examples:**

- Robotic vacuum cleaners (Roomba)
  - Factory robots assembling cars
  - Surgical robots in hospitals
  - Drones for delivery or surveillance
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## 6. Expert Systems

**What it is:**

Expert Systems are AI programs that **mimic the decision-making ability of a human expert** using predefined rules.

**How it works:**

- Based on an **if-then rule base**.
- Uses an **inference engine** to apply rules to known facts and derive conclusions.

**Components:**

Component	Description
Knowledge Base	Stores expert knowledge (rules, facts)

Component	Description
Inference Engine	Applies logic to deduce answers

☐ **Real-world examples:**

- **MYCIN** (early medical diagnosis system)
- Legal reasoning tools
- Troubleshooting systems in tech support

### Summary Table

Subfield	Main Function	Real-World Examples
Machine Learning	Learns from data	Recommendation systems, fraud detection
Deep Learning	Learns deep patterns using neural networks	Face recognition, LLMs like GPT
Natural Language Processing	Understands and generates language	Chatbots, language translation
Computer Vision	Understands visual content	Self-driving cars, photo tagging
Robotics	Interacts with physical world using AI	Drones, factory robots, autonomous vacuums
Expert Systems	Uses rule-based logic to simulate experts	Medical diagnosis systems, legal advisors

## 2. Machine Learning (ML)

- **Definition:** A subset of AI focused on training computers to learn from data without being explicitly programmed.
- **How it works:** ML algorithms find patterns in data and improve their performance over time with more data.
- **Types:**
  - **Supervised Learning:** Learns from labeled data (input-output pairs).

- **Unsupervised Learning:** Finds patterns in unlabeled data.
  - **Reinforcement Learning:** Learns by trial and error, receiving rewards or penalties.
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### 3. AI Models

- **Definition:** Mathematical models or algorithms that perform AI tasks after being trained on data.
  - **Examples:**
    - Decision Trees
    - Neural Networks
    - Support Vector Machines (SVM)
    - Convolutional Neural Networks (CNNs) for image tasks
    - Recurrent Neural Networks (RNNs) for sequence data
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### 4. Large Language Models (LLMs)

- **Definition:** A type of AI model trained on vast amounts of text to understand and generate human-like language.
  - **Examples:** GPT (like me!), BERT, T5.
  - **Key features:**
    - Can generate text, summarize, translate, answer questions.
    - Use architectures like Transformers.
    - Trained on massive datasets with billions of parameters.
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### 5. Generative AI

- **Definition:** AI systems that can create new content, such as text, images, music, or videos, instead of just analyzing or classifying existing data.
- **Examples:**
  - Text generation (ChatGPT, GPT-4)
  - Image generation (DALL·E, Midjourney)
  - Music generation
- **How it works:** Learns patterns from training data and generates new data that resembles it.

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## Summary Table

Concept	What It Is	Key Example	Main Use
AI	Machines simulating human intelligence	Chatbots, Vision AI	Broad tasks involving intelligence
ML	AI subset learning from data	Neural Networks	Predicting, classifying data
AI Models	Algorithms trained to perform AI tasks	CNN, RNN, SVM	Specific AI functions
LLM Models	Large models trained on language data	GPT-4, BERT	Language understanding & generation
Generative AI	AI creating new content	DALL·E, GPT	Content creation

## AI model, AI agent, Generative AI, and Machine Learning basics — all in one place:-

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### 1. AI Model

#### □ What is it?

An **AI model** is a **mathematical representation** of a problem that has been trained to recognize patterns or make decisions based on input data.

Think of it like a virtual brain that learns from data and can then perform tasks like predictions, recognition, translation, etc.

#### □ How it Works:

1. You collect data.
2. Choose an algorithm (e.g., neural network, decision tree).
3. Train the model using this data.
4. Use the trained model to make predictions or decisions.

## □ Example:

- A spam filter trained on emails can tell whether a new email is spam or not.
- A facial recognition model identifies people in a photo.

## □ Types of AI Models:

- **Classification models** (e.g., email spam or not spam)
- **Regression models** (e.g., predicting housing prices)
- **Clustering models** (e.g., segmenting customers by behavior)
- **Generative models** (e.g., creating text or images)

## □ Common Algorithms:

- Decision Trees
  - Logistic Regression
  - Support Vector Machines (SVM)
  - Neural Networks (used in deep learning)
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## 2. AI Agent

### □ What is it?

An **AI agent** is a **software entity** that **perceives its environment**, makes **decisions**, and performs **actions** to achieve goals.

It's **more than just a model** — it's an interactive system with a feedback loop.

### □ The Agent Cycle:

1. **Perceive**: Observes the environment (input).
2. **Decide**: Uses models or rules to choose an action.
3. **Act**: Performs the action.
4. **Learn**: Updates its behavior based on outcomes.

### □ Types of AI Agents:

- **Simple reflex agent**: Acts on current input only (e.g., thermostat).
- **Model-based agent**: Maintains internal state (e.g., robot with memory).
- **Goal-based agent**: Acts to reach specific goals.
- **Learning agent**: Improves over time using data.

## □ Examples:

- **Self-driving cars:** Sense the road, make driving decisions, and steer.
  - **Game AI:** NPCs that adapt and respond to players.
  - **Virtual assistants:** Chatbots that handle tasks for users (e.g., Siri, Alexa).
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## 3. Generative AI

### □ What is it?

**Generative AI** refers to systems that **generate new data** — such as text, images, audio, or code — that mimics human-created content.

It **creates** rather than just analyzes.

### □ How it Works:

Trained on **large datasets**, generative models learn the patterns and structure of the data. Once trained, they can **create original content** that looks similar to what they were trained on.

### □ Common Architectures:

- **GANs (Generative Adversarial Networks)** – for images
- **Transformers (e.g., GPT, T5)** – for text
- **VAEs (Variational Autoencoders)** – for general-purpose generation

### □ Examples:

- **Text:** ChatGPT (writes text, answers questions)
- **Images:** DALL·E, Midjourney (generates pictures from text)
- **Music:** AI that composes original songs
- **Code:** GitHub Copilot (helps write code)

### □ Use Cases:

- Content creation (writing, design)
- Product design (AI-generated prototypes)
- Marketing (ad copy, social posts)
- Education (auto-generating summaries, quizzes)

- Entertainment (games, stories, music)
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## 4. Machine Learning (ML) Basics

### □ What is it?

**Machine Learning** is a **subset of AI** where models are trained to learn patterns from data and improve automatically with experience.

### □ Key Idea:

Instead of programming rules by hand, you provide **examples** (data), and the machine learns the rules.

### □ Types of ML:

#### 1. Supervised Learning

- **Data has labels** (input → correct output)
- Model learns to map input to output.
- □ Examples:
  - Email spam detection
  - House price prediction

#### 2. Unsupervised Learning

- **No labels** – model finds hidden patterns.
- □ Examples:
  - Customer segmentation
  - Market basket analysis

#### 3. Reinforcement Learning

- Agent learns by **interacting** with an environment and getting rewards/punishments.
- □ Examples:
  - Game-playing AI (e.g., AlphaGo)
  - Robot navigation

### □ Popular Algorithms:

- Linear Regression
- Logistic Regression
- Decision Trees

- Random Forests
- K-Means Clustering
- Neural Networks

**□ ML Process:**

1. Data collection
2. Data preprocessing
3. Model selection
4. Training
5. Evaluation (using test data)
6. Deployment

### Summary Table

Concept	What It Is	Key Example	Main Use
<b>AI Model</b>	Trained system that makes predictions	Image classifier, chatbot model	Making decisions or predictions
<b>AI Agent</b>	Entity that acts in an environment	Self-driving car, Siri	Autonomous action-taking
<b>Generative AI</b>	AI that creates new content	ChatGPT, DALL·E, Copilot	Generating text, images, code
<b>Machine Learning</b>	AI that learns from data	Spam filter, recommendation engine	Pattern learning & prediction

### What are LLM Models? (Large Language Models)

- **Definition:**  
LLMs are AI models trained on huge amounts of text data to understand, generate, and manipulate natural language. They are “large” because they have **billions (or even trillions) of parameters**, which are like the “knobs” the model adjusts to learn patterns in language.
  - **How they work:**  
They use a type of neural network architecture called **Transformers** (introduced in 2017). Transformers can process language by paying attention to different parts of a sentence or paragraph simultaneously — this helps them understand context better.
  - **What they do:**
    - Generate human-like text (chatbots, story writing)
    - Answer questions
    - Summarize documents
    - Translate languages
    - Code generation and more
  - **Examples of big LLMs:**
    - GPT-4 (OpenAI)
    - PaLM (Google)
    - LLaMA (Meta)
    - BERT (Google, mainly for understanding)
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## Popular Open Source LLM Models

Here are some notable LLMs you can use or experiment with because their code and models are publicly available:

1. **GPT-J**
  - Developed by EleutherAI
  - 6 billion parameters
  - Similar architecture to GPT-3, good for general language tasks
  - [GitHub repo & model](#)
2. **GPT-Neo and GPT-NeoX**
  - Developed by EleutherAI
  - GPT-Neo: 1.3B and 2.7B parameter versions
  - GPT-NeoX: up to 20B parameters
  - Designed as open alternatives to GPT-3
  - [EleutherAI GitHub](#)
3. **LLaMA (Large Language Model Meta AI)**
  - Released by Meta (Facebook)
  - Comes in different sizes: 7B, 13B, 65B parameters
  - Highly efficient and performant
  - Requires application for access (not fully open but widely available in research)
4. **BLOOM**
  - Developed by BigScience (a large research collaboration)

- 176 billion parameters — one of the biggest open LLMs
- Supports many languages and tasks
- Fully open source and available on Hugging Face

#### 5. **Falcon**

- Released by Technology Innovation Institute (TII)
- Comes in 7B and 40B parameter versions
- Optimized for speed and accuracy in NLP tasks
- Open source and available on Hugging Face

#### 6. **OPT (Open Pretrained Transformer)**

- Developed by Meta
- Ranges from 125M to 175B parameters
- Designed to be a transparent alternative to GPT-3
- Open weights and code available

### 7. **Mistral has open-source LLMs — but not all of them.**

#### □ Open-source models released by Mistral AI:

##### 1. □ **Mistral-7B**

- **Parameters:** 7 billion
- **Released:** September 2023
- **License:** **Apache 2.0** (very permissive)
- **Highlights:**
  - High performance despite small size
  - Efficient for fine-tuning and deployment
  - Strong baseline for many NLP tasks
  - Competitive with larger models like LLaMA 13B

##### 2. □ **Mixtral (MoE model)**

- **Full name:** Mixtral-8x7B
- **Type:** Mixture of Experts (MoE)
- **Parameters:** 8 experts, each 7B, with 2 active per inference → effectively ~12.9B parameters used per request
- **Released:** December 2023
- **License:** **Apache 2.0**
- **Highlights:**
  - Combines expert models for higher efficiency and performance
  - Outperforms many models like GPT-3.5 and LLaMA 2–70B on various benchmarks

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## **Where to Find Open Source LLMs?**

- **Hugging Face Model Hub:** <https://huggingface.co/models> — Tons of models, including all the above, ready to download and use.
  - **GitHub repositories:** Usually contain training code and model checkpoints.
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### **Why Open Source LLMs Matter:**

- Researchers and developers can experiment and improve on them.
- They provide transparency (how the model works).
- You can customize or fine-tune them for specific tasks or industries.
- They lower the barrier for AI innovation.