Sri Lanka Institute of Information Technology

Faculty of Computing

IT2011 - Artificial Intelligence and Machine Learning

Dr.Lakmini Abeywardhana

Year 02 and Semester 01

Introduction to Artificial Intelligence and Machine Learning

Outline

- Traditional programming vs Artificial Intelligence (AI) and Machine Learning (ML)
- Difference between Artificial Intelligence (AI) and Machine Learning (ML)
- Branches of Artificial Intelligence (AI)
- Branches of Machine Learning (ML)

ENIAC (1946): The Beginning of the Digital Era

- The **Electronic Numerical Integrator and Computer (ENIAC)** was the **first general-purpose electronic digital computer**, developed in the United States during World War II.
- Though not AI itself, ENIAC paved the way for programmable machines by showing that machines could be built to perform complex computations.
- It marked the **starting point for computational thinking**, which is foundational for AI.

Foundations and Evolution of Artificial Intelligence

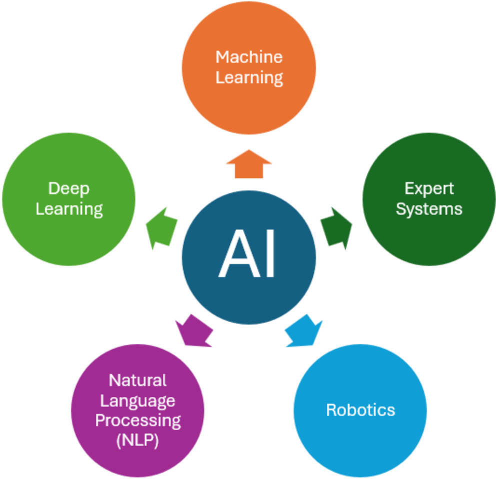
1956 Dartmouth Workshop: The Birth of AI

- Organized by **John McCarthy**, **Marvin Minsky**, **Nathaniel Rochester**, and **Claude Shannon**.
- This historic workshop formally introduced the term **"Artificial Intelligence"**.
- Objective: "To find how to make a machine that can simulate every aspect of learning or any other feature of intelligence."
- Considered the **official birth of the AI field**.
- Sparked early research in problem-solving, logic, and symbolic reasoning.


1956 Dartmouth Conference:
The Founding Fathers of AI
John MacCarthy
Marvin Minsky
Claude Shannon
Ray Solomonoff
Alan Newell
Herbert Simon
Arthur Samuel
Oliver Selfridge
Nathaniel Rochester
Trenchard More

AI Milestones Across Decades

Core Branches of AI



Traditional Programming vs AI/ML

Traditional Programming (Rule-Based Systems)
How It Works:

- A programmer **explicitly writes rules** to process data.
- The logic is hand-coded: **every condition and action** must be predefined.
- The system operates strictly based on what has been coded.

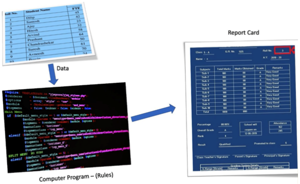
Input + Human-Written Rules ß Output

Traditional Programming

Example:

If you're writing a program to classify whether a number is even or odd:

```python
if number % 2 == 0:
    print("Even")
else:
    print("Odd")
```



The **rule** is directly embedded in the code by the human.

Traditional Programming : characteristics

Feature	**Traditional Programming**
Logic Source	Written by human developers
Flexibility	Low – must update code to change behavior
Predictability	High – same input always gives same output
Learning Capability	None – does not improve with data

AI/ML-Based Systems

How It Works:

- The machine is given **examples of inputs and correct outputs**.
- It **learns patterns or rules** from the data using algorithms (e.g., decision trees, neural networks).
- The logic is not explicitly coded — it is inferred from **data**.

Input + Output Data → Learn Rules → Model

AI/ML-Based Systems

Example:

In spam email classification:

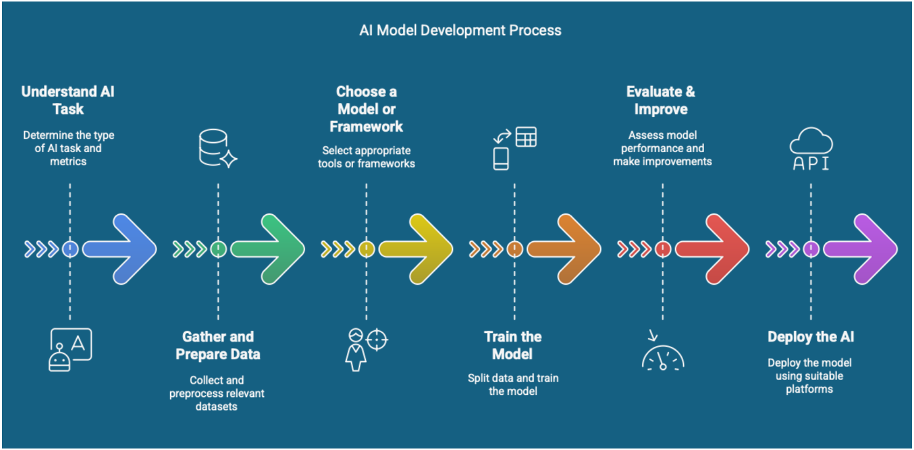
- Input: Email content
- Output: "Spam" or "Not Spam"
- The model **learns** from hundreds/thousands of labeled examples to classify new emails.

AI/ML-Based Systems: characteristics

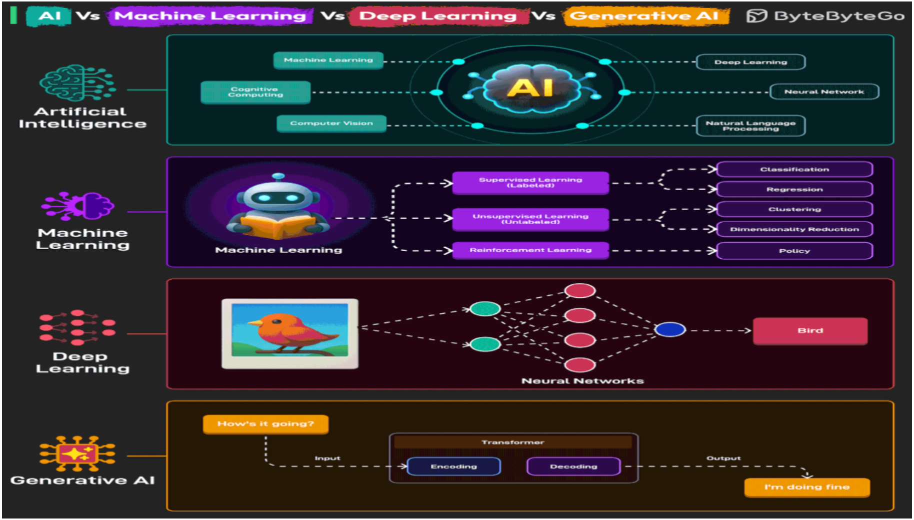
Feature	**AI/ML-Based Programming**
Logic Source	Learned from data using algorithms
Flexibility	High – adapts to new patterns in data
Predictability	Moderate – may vary depending on training
Learning Capability	Yes – improves with more data and feedback

Key Shift in Programming Paradigm

Aspect	Traditional Programming	AI/ML Approach
Input/Output Relation	Input + Rules → Output	Input + Output → Learn Rules
Development Process	Rule design, implementation	Data preparation, model training
Adaptability	Hard to change	Easily retrained on new data
Debugging	Through step-by-step logic	Through performance metrics (e.g., accuracy, loss)


AI Model Development Process
Understand AI Task
Determine the type of AI task and metrics
Gather and Prepare Data
Collect and preprocess relevant datasets
Choose a Model or Framework
Select appropriate tools or frameworks
Train the Model
Split data and train the model
Evaluate & Improve
Assess model performance and make improvements
API
Deploy the AI
Deploy the model using suitable platforms

AI vs ML vs DL vs Generative AI



AI Vs Machine Learning Vs Deep Learning Vs Generative AI
ByteByteGo
Artificial Intelligence
Machine Learning
Cognitive Computing
Computer Vision
AI
Deep Learning
Neural Network
Natural Language Processing
Machine Learning
Supervised Learning (Labeled)
Unsupervised Learning (Unlabeled)
Reinforcement Learning
Classification
Regression
Clustering
Dimensionality Reduction
Policy
Deep Learning
Bird
Neural Networks
Generative AI
How's it going?
Input
Transformer
Encoding
Decoding
Output
I'm doing fine

AI vs ML vs DL vs Generative AI

- Artificial Intelligence (AI)

Definition:
Artificial Intelligence is a **broad field** of computer science focused on building systems that can **simulate human intelligence.**

Capabilities of AI include:

- Reasoning
- Learning
- Perception (e.g., vision, hearing)
- Language understanding
- Problem-solving
- Decision-making

Examples:

- Chess-playing programs
- Voice assistants (e.g., Siri, Alexa)
- Self-driving cars
- Facial recognition systems
- **Note**: AI is the **umbrella term** under which Machine Learning, Deep Learning, and Generative AI fall.

Machine Learning (ML)

Definition:
Machine Learning is a **subset of AI** that enables computers to learn from data and improve their performance without being explicitly programmed for each task.

Key Idea:
Rather than being told how to perform a task (as in traditional programming), the system learns **patterns and rules from examples**.

Types of ML:

- **Supervised Learning** (labeled data)
- **Unsupervised Learning** (unlabeled data)
- **Reinforcement Learning** (learning via rewards)

Examples:

- Email spam filters
- Fraud detection in banking
- Recommendation systems (Netflix, YouTube)

Deep Learning (DL)

Definition:
Deep Learning is a subset of Machine Learning that uses multi-layered neural networks to learn from data.

Key Characteristics:

- Can automatically extract features from raw data
- Works well with large and complex datasets
- Mimics the human brain's layered structure

Popular Architectures:

- **CNN (Convolutional Neural Networks)**: Image processing
- **RNN (Recurrent Neural Networks)**: Sequence data (e.g., text, time series)
- **Transformers:** Used in language models (e.g., GPT)

Examples:

- Face recognition on smartphones
- Voice assistants understanding spoken commands
- Self-driving cars interpreting surroundings

Generative AI (GenAI)

Definition:

Generative AI is a specialized area of AI that focuses on **creating new** content such as text, images, music, and code using **learned patterns** from data.

Key Technologies:

- **Transformer Models** (e.g., GPT-4, Gemini)
- **GANs** (Generative Adversarial Networks)
- **Diffusion Models** (used in image generation like DALL·E, Midjourney)

Use Cases:

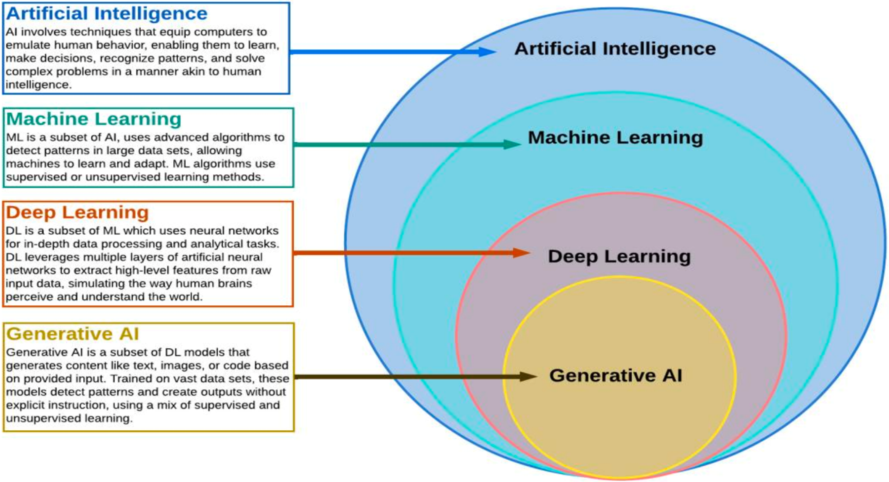
- Writing essays, summaries, code
- Creating artwork, illustrations, animations
- Enhancing and colorizing old photos
- Designing new products or music

Examples of Tools:

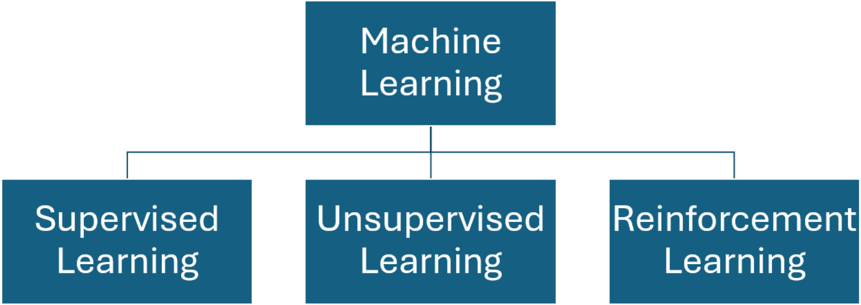
- ChatGPT (text generation)
- DALL·E (image generation)
- DeepArt, Artbreeder (AI art)
- GitHub Copilot (code generation)

Summary

Concept	Category	Function	Examples
AI	Broadest scope	Simulate human intelligence	Siri, Self-driving cars
ML	Subfield of AI	Learn from data	Spam filters, Recommendations
DL	Subfield of ML	Learn from large data via neural nets	Face recognition, Voice AI
Generative AI	Subfield of DL/AI	Create new, original content	ChatGPT, DALL·E, Bard


Artificial Intelligence
AI involves techniques that equip computers to emulate human behavior, enabling them to learn, make decisions, recognize patterns, and solve complex problems in a manner akin to human intelligence.
Machine Learning
ML is a subset of AI, uses advanced algorithms to detect patterns in large data sets, allowing machines to learn and adapt. ML algorithms use supervised or unsupervised learning methods.
Deep Learning
DL is a subset of ML which uses neural networks for in-depth data processing and analytical tasks. DL leverages multiple layers of artificial neural networks to extract high-level features from raw input data, simulating the way human brains perceive and understand the world.
Generative AI
Generative AI is a subset of DL models that generates content like text, images, or code based on provided input. Trained on vast data sets, these models detect patterns and create outputs without explicit instruction, using a mix of supervised and unsupervised learning.
Artificial Intelligence
Machine Learning
Deep Learning
Generative AI

Types of Machine Learning



Supervised Learning

Definition:
The algorithm learns from a **labeled dataset**, where each training example is paired with the correct output.

Goal:
To **predict outputs** for new, unseen data.
Common Tasks:

- **Classification:** Predict categories (e.g., spam or not spam)
- **Regression:** Predict numerical values (e.g., house price)

Examples:

- Email spam detection (spam/ham)
- Credit scoring (good/bad risk)
- Stock price prediction

Analogy:

Like learning with an **answer key.**

Unsupervised Learning

Definition:
The algorithm works on unlabeled data and tries to find hidden patterns or structures without explicit instructions.

Goal:
To **discover groupings, associations, or patterns** in data.

Common Techniques:

- **Clustering** Group similar data points (e.g., customer segmentation)
- **Dimensionality Reduction:** Reduce number of input variables (e.g., PCA)

Examples:

- Grouping customers based on buying behavior
- Recommending products using similarity
- Anomaly detection in cybersecurity

Analogy:

Like exploring a **puzzle with no hints**.

Reinforcement Learning

Definition:
The model learns by interacting with an environment and receiving **rewards or penalties**.

Goal:
To take actions that **maximize cumulative rewards** over time.

Key Concepts:

- **Agent**: Learner or decision-maker
- **Environment:** The world it interacts with
- **Reward:** Feedback from the environment
- **Policy:** Strategy used to determine next action

Examples:

- Game AI (e.g., AlphaGo, Dota 2 bots)
- Robotics (e.g., walking, grasping)
- Traffic signal optimization

Analogy:

Like learning to **ride a bike through trial and error**

Deep Learning Models

Deep Learning is a subfield of Machine Learning that uses artificial neural networks with multiple layers to learn abstract representations from large amounts of data. Below are the most widely used deep learning architectures and their use cases:

- Convolutional Neural Networks (CNNs)
- Recurrent Neural Networks (RNNs)
- Transformers

1. Convolutional Neural Networks (CNNs)

Purpose: Primarily used for **image processing and computer vision** tasks

How It Works:

- CNNs apply filters (kernels) over input images to detect patterns like edges, shapes, and textures.
- These features are then used to identify objects or classify images.

Key Features:

- **Convolutional Layers**: Extract spatial features
- **Pooling Layers**: Reduce dimensionality and overfitting
- **Fully Connected Layers**: Perform final classification

Examples:

- Handwritten digit recognition (MNIST)
- Face detection and recognition
- Medical image analysis

2. Recurrent Neural Networks (RNNs)

Purpose: Designed for **sequential data**, such as **text, speech, time series**, and **sensor signals**.

How It Works:

- RNNs maintain a **memory of previous inputs** via loops in the architecture.
- They can make predictions based on current input **and** previous context.

Variants:

- **LSTM (Long Short-Term Memory)** – solves the vanishing gradient problem
- **GRU (Gated Recurrent Unit)** – simplified version of LSTM

Examples:

- Language modeling and sentence generation
- Speech-to-text transcription
- Predicting stock prices or weather

3. Transformers

Purpose: : State-of-the-art models for **natural language processing (NLP)** and more recently **vision tasks**.

Key Innovation:

- Self-attention mechanism: Allows the model to focus on different parts of the input simultaneously.

Why Important?

- Unlike RNNs, Transformers process all tokens in parallel ß faster and scalable.
- Foundation of **modern large language models (LLMs)** like:
  - **GPT (Generative Pre-trained Transformer)**
  - **BERT (Bidirectional Encoder Representations from Transformers)**
  - **T5, Gemini, Claude, LLaMA**

Examples:

- ChatGPT (text generation)
- Google Translate (language translation)
- Document summarization and question answering

What is Generative AI?

- Generative AI is a type of **Artificial Intelligence that can CREATE new things** .
- It doesn't just recognize or classify — it can actually **produce content**.

What Can It Create?

- **Text** – Writes essays, emails, poems, or even books.
  Example: ChatGPT generating a story.
- **Images** – Draws faces, animals, logos, posters.
  Example: DALL·E creating a cat with sunglasses.
- **Music** – Composes melodies or background tunes.
- **Code** – Helps write programs or debug code.
  Example: GitHub Copilot completing Python code.

Tools That Use Generative AI:

- **ChatGPT** – For writing and conversation
- **DALL·E, Midjourney** – For image generation
- **GitHub Copilot** – For programming support

Real-Life Uses of Generative AI:

- Designing social media posts or **marketing visuals**
- **Helping students** summarize or draft essays
- Making new **logos**, clothes, or product designs
- Writing **stories**, poems, or even jokes for fun

A. GANs – Generative Adversarial Networks

- Consist of two neural networks:
  - **Generator:** Creates fake data
  - **Discriminator:** Detects real vs fake
- They compete, improving each other over time.
- GANs can generate **photorealistic images, deepfakes**, and **art**.

Examples:

- Artbreeder (face generation)
- Deepfake video creation
- AI-generated clothing designs

B.Diffusion Models

- Work by **adding noise to data and then learning to reverse that noise.**
- Capable of producing **ultra-high-quality images** and art.
- Power models like **DALL·E 2, Midjourney**, and **Stable Diffusion**.

Prompt Engineering

What is a Prompt?

- A **prompt** is the message or question you give to an AI tool like ChatGPT or DALL·E.
- **Prompt Engineering** is the skill of writing clear and effective prompts to get useful results.

Why is it Important?

- The **quality of the output depends on the quality of your prompt.**
- A better prompt = smarter, more accurate, more creative results.

Tips for Writing Great Prompts:

1. **Be clear and specific**
2. **Mention the style, tone, or format** you want
3. **Add examples** if needed