AI Literacy

Overview of Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning (DL)

Engage and Think

The CEO of a midsized e-commerce company is looking for ways to improve business performance using AI. At a recent industry summit, business leaders shared how AI-driven automation, predictive analytics, and personalization are transforming companies. Intrigued by the possibilities, the CEO wants to explore how machine learning (ML) and deep learning (DL) can help optimize operations.

If you were in this position, which business functions would you prioritize for AI implementation? Would you start with machine learning models for customer behavior analysis, deep learning for fraud detection, or AI-powered automation for marketing and logistics?

Learning Objectives

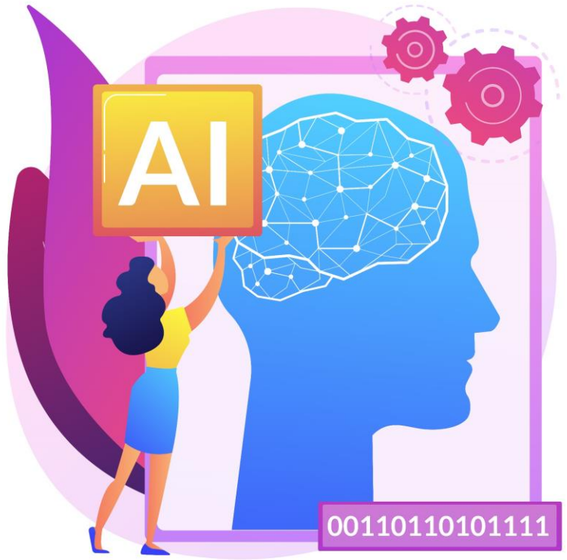
By the end of this lesson, you will be able to:

- Describe the fundamental concepts of artificial intelligence (AI), including its types (narrow AI, general AI, super AI) and key milestones in AI development
- Differentiate between machine learning and deep learning, identifying how supervised, unsupervised, semi-supervised, and reinforcement learning contribute to AI-driven decision-making
- Apply knowledge of neural networks and deep learning models to analyze real-world AI applications

Introduction to Artificial Intelligence (AI)

Artificial Intelligence (AI)

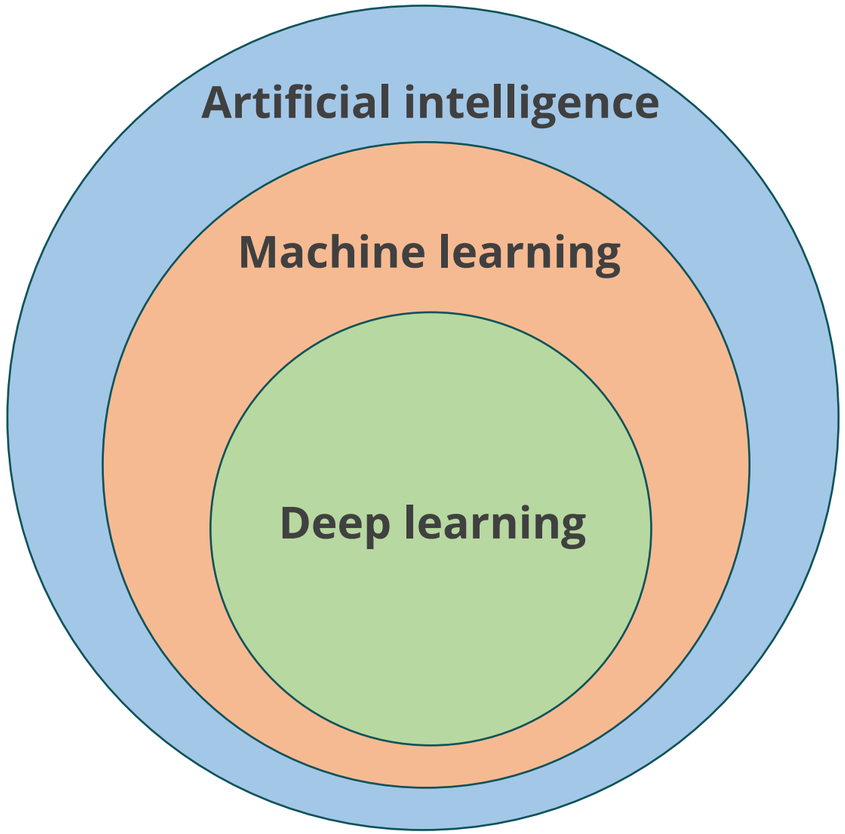
This branch of computer science focuses on creating systems capable of performing tasks that typically require human intelligence.



These tasks involve reasoning, learning, problem-solving, perception, language understanding, and decision-making. AI uses algorithms, statistical models, and neural networks, leveraging data and computing power to enhance performance.

Artificial Intelligence (AI)

AI is a broad term that includes machine learning and deep learning, forming the core of modern AI technologies.

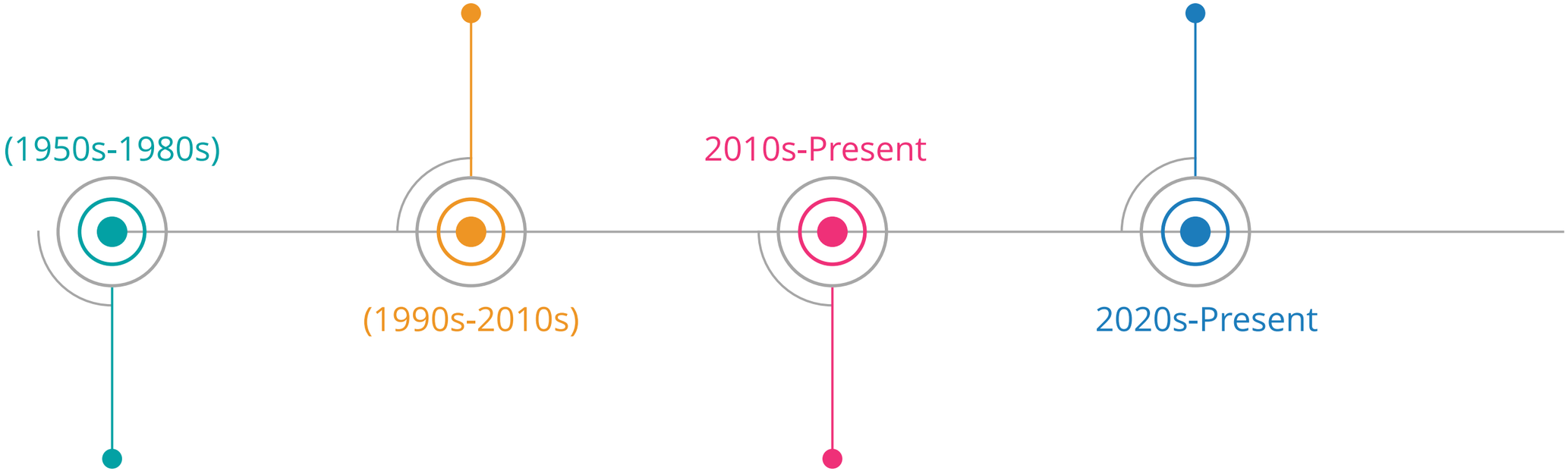


Evolution of AI

AI has evolved over decades, transforming from simple rule-based systems to complex, self-learning models.

Machine learning era:
AI shifts from rules to data-driven learning

Generative AI revolution:
AI now creates text, images, music, and code



Rule-based AI:
Logic-driven systems based on if-then rules

Deep learning breakthrough:
Multi-layered neural networks enable complex AI tasks

Evolution of AI

1940 to 1950

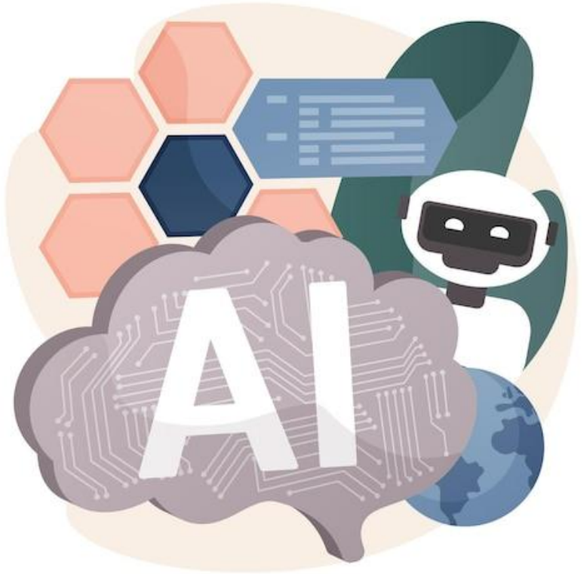
Warren McCulloch and Walter Pits proposed a model of artificial neurons in 1943.

Alan Turing proposed a test, the Turing Test, to check a machine's ability to exhibit intelligent behavior equivalent to, or indistinguishable from that of a human.

Evolution of AI

1940 to 1950

1950s



The word **Artificial Intelligence** was coined.

Perceptron was invented in 1957.

High-level programming languages like COBOL, FORTRAN, and LISP were invented.

Evolution of AI

1940 to 1950

1950s

1960s

Researchers solved mathematical problems using statistical methods.

Joseph Weizenbaum invented the first chatbot, ELIZA, in 1966.

Evolution of AI

1940 to 1950 | 1950s | 1960s | 1970 to 1980

Interest in AI research dropped significantly.

Funding for AI projects from the government was insufficient.

Evolution of AI

1940 to 1950 | 1950s | 1960s | 1970 to 1980 | **1980 to 1987**

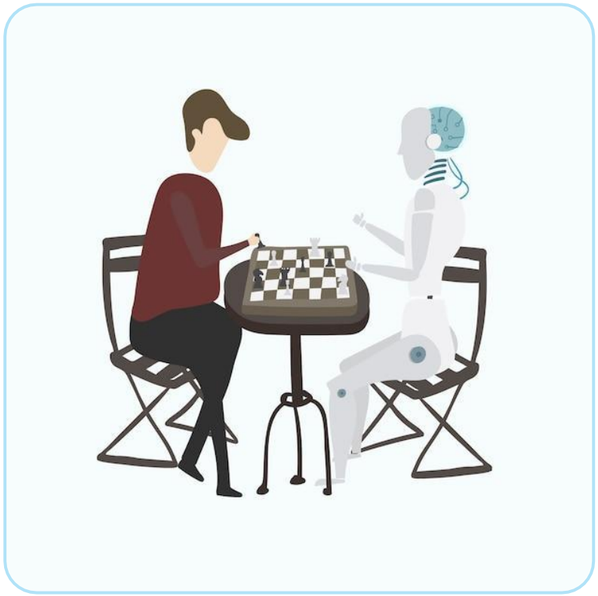
AI was revived as expert systems replicating human decision-making abilities.

Stanford University hosted the inaugural national conference of the American Association of Artificial Intelligence (AAAI) in 1980.

There was a shortage in funding for AI research and development after 1987.

Evolution of AI

1940 to 1950 | 1950s | 1960s | 1970 to 1980 | 1980 to 1987 | 1997 to 2006



1997: IBM Deep Blue beat world chess champion Gary Kasparov in 1997.

Companies like Facebook, Twitter, and Netflix also started using AI from 2006 onwards.

Evolution of AI

1940 to 1950 → 1950s → 1960s → 1970 to 1980 → 1980 to 1987 → 1997 to 2006 → 2012 onwards

Considered to be a golden period, deep learning emerged as a giant in 2012.

Computer vision and natural language processing benefitted the most.

Evolution of AI

Era	Key characteristics	Examples
Rule-based AI (1950s-1980s)	Logical, If-Then rules	Expert systems (MYCIN)
Machine learning (1990s-2010s)	Learns from data, statistical models	Decision trees, SVM
Deep learning (2010s-present)	Neural networks, self-learning	CNNs (Image recognition), RNNs (Chatbots)
Generative AI (2020s-present)	AI creates text, images, and code	ChatGPT, DALL·E, Codex

AI has evolved from rigid rule-based systems to flexible, self-learning, and creative models, shaping the future of technology and business.

Types of AI

AI can be classified into different types based on its capabilities and functions, structured as follows:

Narrow AI (Weak AI)

It is designed for specific tasks, like chatbots and recommendation systems.

General AI (Strong AI)

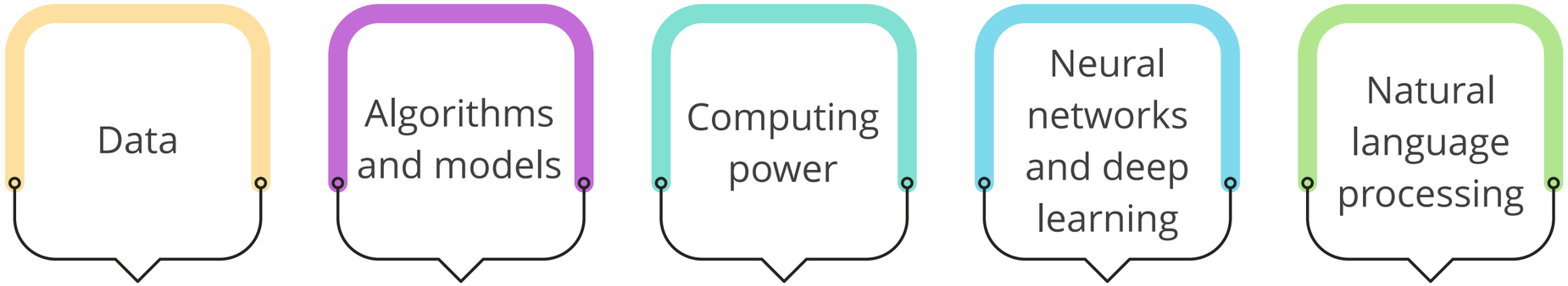
It is a hypothetical AI with human-like intelligence and reasoning.

Superintelligent AI

It is a theoretical AI surpassing human intelligence in all aspects.

Key Components of AI

The key components of AI include:



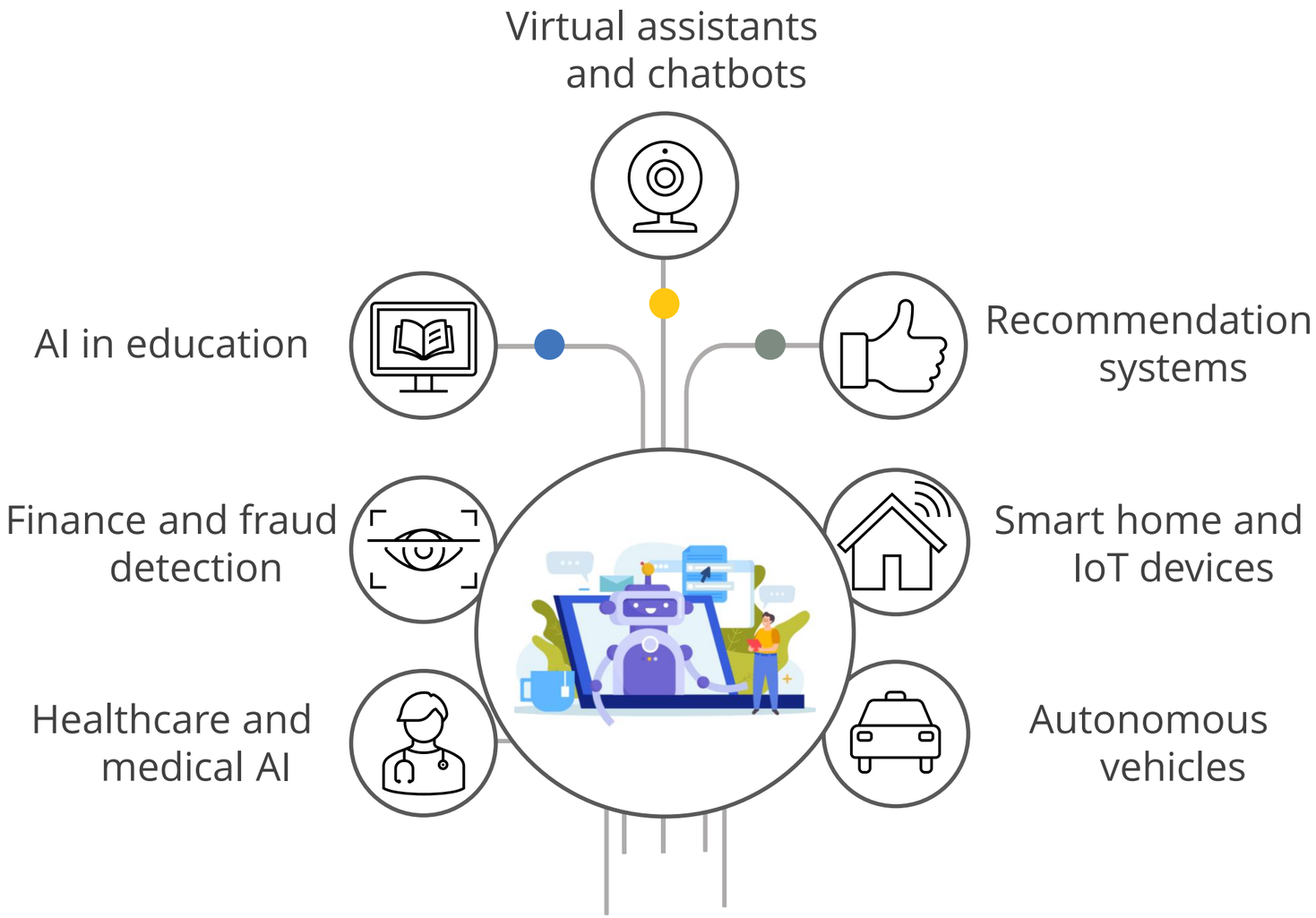
Key Components of AI

The key components of AI include:

- Computer vision
- Robotics and automation
- Edge AI and IoT integration
- Ethics and responsible AI
- AI frameworks and tools

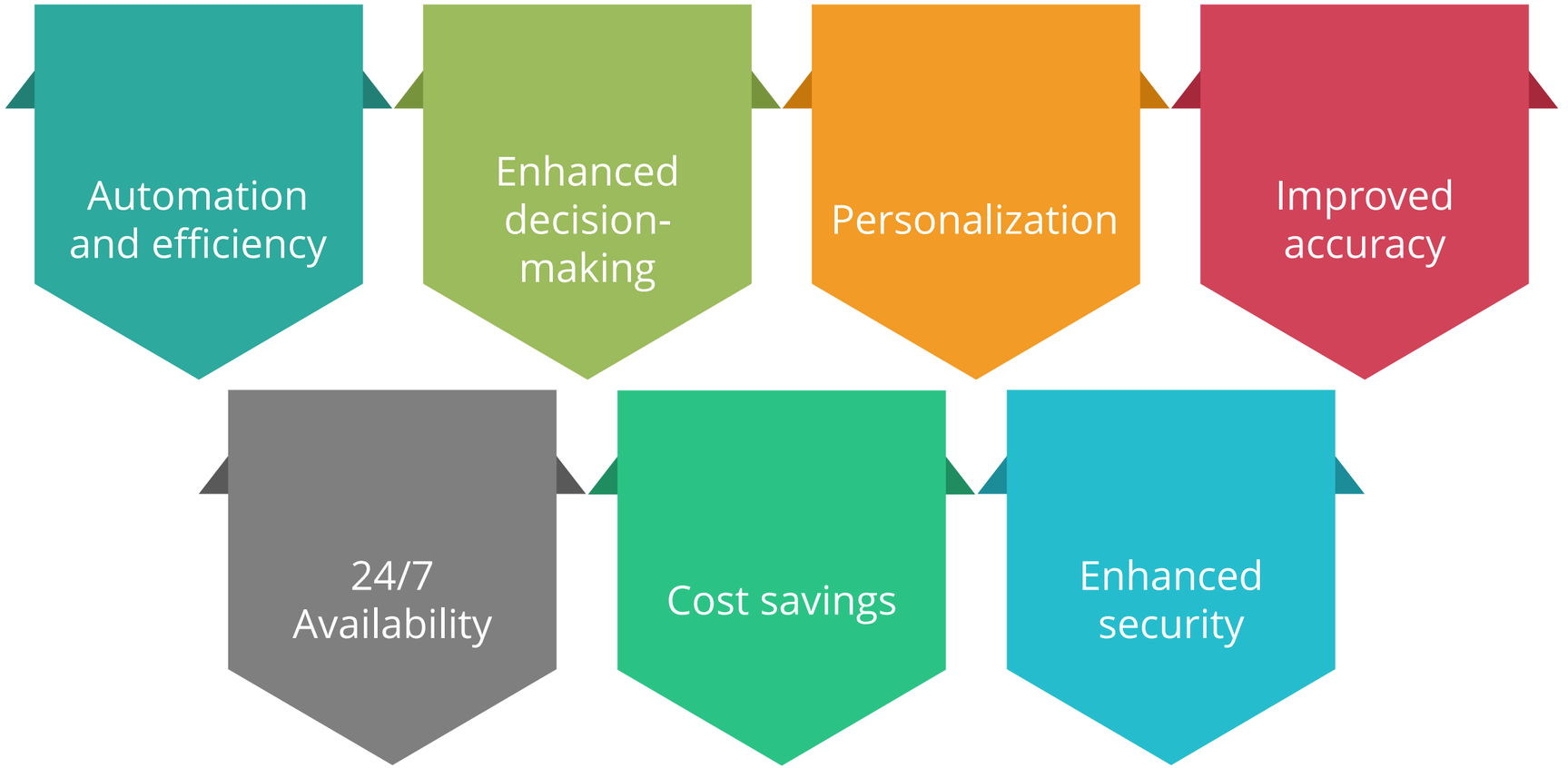
AI in Everyday Life: Real-World Applications

Some of the applications are listed below:



Benefits of AI

The following are some key benefits:



Challenges of AI

1. Data privacy and security
2. Bias and fairness
3. High implementation costs
4. Lack of transparency
5. Job displacement
6. Dependence on quality data

Why Is AI Powerful?

AI is transforming businesses by enabling:

Innovation and new business models

Scalability and global reach

Agility, faster decision-making, and competitive advantage

Early AI Milestones

1943	Alan Turing's paper Computing Machinery and Intelligence introduces the Turing Test, a measure of machine intelligence.
1950s	The term artificial intelligence is coined at the Dartmouth Conference. Initial research focuses on symbolic AI and rule-based systems.
1956	John McCarthy develops the LISP programming language, which becomes a key tool for AI research.
1960s	Early expert systems like ELIZA and DENDRAL are developed.
1970s	AI research encounters difficulties and funding declines (AI Winter).

Rise of Machine Learning (ML)

The evolution of machine learning from statistical models to intelligent systems took place during the 1990s to 2000s, marking a shift towards more advanced data-driven approaches.

Shift from rule-based systems to data-driven learning: AI moved from expert systems to statistical learning approaches.

Advancements in algorithms: The development of support vector machines (SVMs), decision trees, and ensemble methods (for example, random forest) significantly enhanced machine learning capabilities.

Neural network revival: Introduction of deep learning concepts with improved training techniques paved the way for more advanced and efficient AI models.

Rise of Machine Learning (ML)

Increase in computational power: The growth of faster processors and GPUs enabled more complex ML models.

Availability of large datasets: The rise of the internet, digitization, and data storage fueled machine learning progress.

Emergence of early ML applications: Machine learning used in spam filtering, fraud detection, speech recognition, and recommendation systems enhanced accuracy and efficiency in various applications.

Emergence of Deep Learning (DL)

Traditional ML relies on feature engineering, while deep learning (DL) automates feature extraction.

- Neural network breakthrough (2006-2012): Hinton’s deep belief networks (DBNs) and AlexNet's 2012 success revived deep learning
- Computational advancements: GPUs, TPUs, and cloud computing enabled large-scale deep-learning training
- Key architectures: CNNs for images, RNNs for sequences, and transformers (for example, BERT, GPT) for NLP
- Real-world impact: Used in autonomous vehicles, healthcare, AI chatbots, and recommendation systems

Key Breakthroughs in AI

2016: AlphaGo defeats human champions in Go

Developed by DeepMind, AlphaGo used deep reinforcement learning to master Go, an ancient board game with infinite possibilities.

2020: GPT-3: Advancements in natural language processing

It demonstrated human-like text generation, summarization, and translation, revolutionizing NLP applications.

Key Breakthroughs in AI

2021: DALL·E: AI-powered image generation

DALL·E generated images from textual descriptions, showcasing AI’s ability to understand and create visual content.

2022 – ChatGPT and Generative AI boom

ChatGPT (GPT-3.5 and GPT-4) introduced powerful conversational AI, driving widespread adoption of AI-powered chatbots, automation, and content creation.

Artificial Intelligence: Google Ads Case Study

Google needed a scalable solution within Google Ads to enhance ad targeting and bidding, enabling advertisers to achieve greater financial efficiency while improving the user experience with more relevant ads.

Challenges faced

- Processing billions of search queries and ad requests daily
- Delivering highly relevant ads based on user intent and behavior
- Optimizing ad placement and bidding strategies in real time

Source: https://blog.google/products/ads-commerce/ai-powered-ads-google-marketing-live/

Artificial Intelligence: Google Ads Case Study

Google Ads implemented the following AI features:

Deployed AI-powered recommendation systems to match ads with user search intent using historical and contextual data

Leveraged reinforcement learning (RL) to optimize bidding strategies for maximum return on investment

Used natural language processing (NLP) to interpret user queries and identify intent accurately

Built predictive AI models to anticipate trends, forecast performance, and allocate ad budgets effectively

Artificial Intelligence: Google Ads Case Study

The following are the key results achieved by implementing AI features:

- AI’s predictive capabilities can transform industries by optimizing decision-making processes in real time.
- Combining AI with large-scale data processing unlocks new revenue opportunities and improves customer satisfaction.
- AI-driven platforms like these ad companies have created entire ecosystems by enabling businesses to achieve precise targeting and better outcomes.

Quick Check

A technology company is upgrading its AI system. Initially, it used a rule-based expert system, but now it wants to shift to an approach that can learn from data and improve over time. Which method best aligns with this transition?

A. Hardcoded rules-based system

B. Statistical learning models

C. Manual decision trees without training data

D. Fixed if-else logic programs

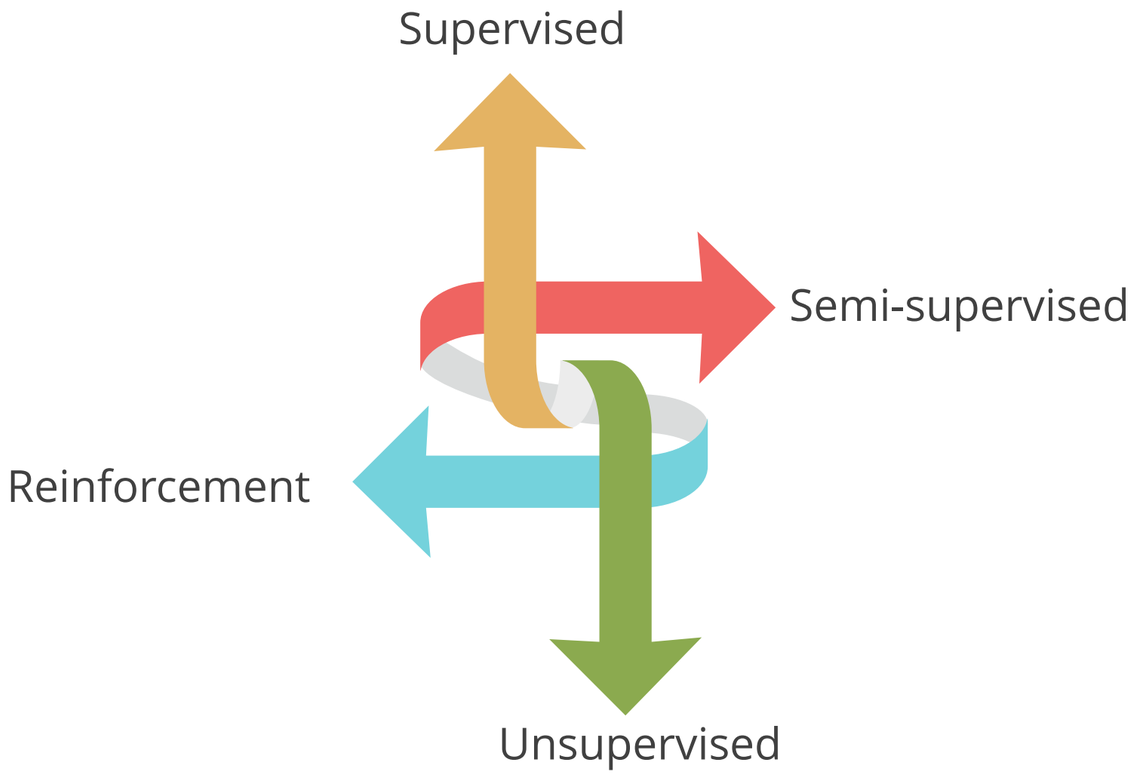
Machine Learning (ML) Overview

What Is Machine Learning?

It is a transformative technology that empowers machines to learn from data, adapt, and make decisions without explicit programming.

Types of ML

It can be categorized into four main types:



Each type has its own distinct methods and applications.

Types of ML

Here are the types of machine learning:

Supervised learning

- Uses labeled data for training, where each item has a predefined label or tag
- Example: Classifying emails as spam or not spam using labeled email data

Semi-supervised learning

- Combines a small amount of labeled data with a large amount of unlabeled data to improve model accuracy
- Example: Categorizing a large library of images into landscape and portrait using a few labeled images

Types of ML

Here are the types of machine learning:

Unsupervised learning

- Analyzes and clusters unlabeled data to uncover hidden patterns or groupings
- Example: Grouping customers into segments based on purchasing behavior

Reinforcement learning

- Learns through trial and error by receiving rewards or penalties for specific actions in an environment
- Example: Training a robot vacuum cleaner to navigate a room by rewarding it for avoiding obstacles

Applications of ML in Business Operations

ML enhances business efficiency by optimizing critical processes and improving decision-making.

Sales forecasting

Improves stock management, revenue planning, and sales performance by analyzing seasonal trends, generating actionable insights, and identifying high-demand regions

Supply chain optimization

Enhances logistics efficiency, optimizes inventory forecasting, and mitigates supplier risks using historical and real-time data

Customer segmentation

Facilitates personalized marketing, improves product targeting, and refines customer engagement by classifying consumers into meaningful segments

Advanced Applications of ML in Business

ML helps businesses solve complex challenges and enhance decision-making through data-driven insights.

Churn prediction

Minimizes customer loss by identifying behavioral patterns, implementing targeted retention strategies, and assessing loyalty program effectiveness

Fraud detection

Enhances financial security by detecting fraudulent transactions, adapting to new fraud techniques, and automating fraud prevention alerts

HR analytics

Improves workforce planning and employee retention by analyzing performance trends, hiring patterns, and job satisfaction metrics

Machine Learning: Netflix Case Study

Netflix faced challenges with high customer churn during its transition to streaming services in the late 2000s and early 2010s. To address this, the platform leveraged data analytics and machine learning to improve user engagement and retention through personalized content recommendations.

Challenges faced

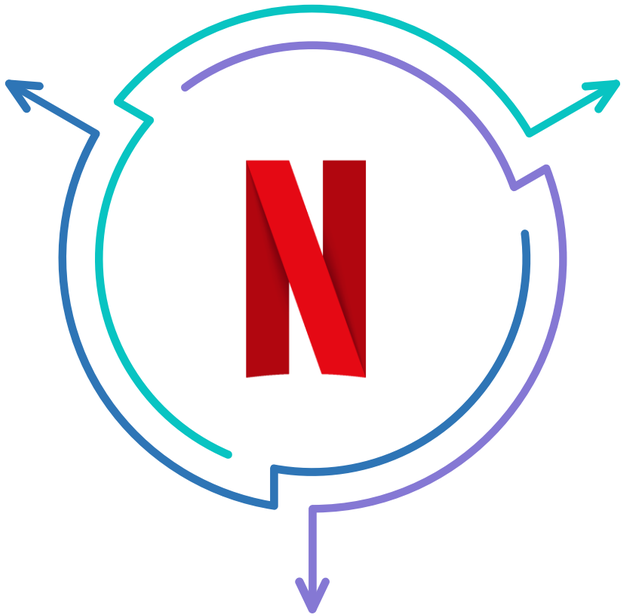
- Managing and processing massive amounts of user data, including viewing history, ratings, and search queries
- Understanding user preferences across a diverse global audience
- Balancing recommendations to align with individual preferences while promoting new and trending content

Source: https://research.netflix.com/publication/lessons-learnt-from-consolidating-ml-models-in-a-large-scale-recommendation

Machine Learning: Netflix Case Study

Here is how the challenges faced were resolved by implementing ML:

Netflix used collaborative filtering algorithms and ML models to analyze user behavior.



The model identified viewing patterns and personalized recommendations based on user preferences.

Hybrid recommendation techniques combine collaborative and content-based filtering to improve prediction accuracy.

Machine Learning: Netflix Case Study

The implementation of ML-based solutions impacted Netflix, addressing customer churn effectively and driving several key outcomes:

- Enhanced personalized content recommendations through collaborative filtering and hybrid systems
- Highlighted trending and new content while aligning with individual preferences, increasing engagement
- Set industry benchmarks by leveraging analytics to optimize customer satisfaction

Quick Check

A company is developing an AI-powered robotic assistant that learns to navigate a warehouse by avoiding obstacles and optimizing its path. The robot improves its performance over time by receiving rewards for efficient navigation and penalties for collisions. Which type of machine learning is being used?

A. Supervised Learning

B. Unsupervised Learning

C. Reinforcement Learning

D. Semi-Supervised Learning

Deep Learning (DL) Overview

What Is Deep Learning?

It is a subset of machine learning that imitates how the human brain processes information, using multi-layered neural networks to learn from vast amounts of data.

It enables machines to recognize patterns and understand natural language.

Deep Learning

DL can effectively utilize structured and unstructured data from diverse domains, encompassing images, text, audio, and video, to discover patterns and make accurate predictions or classifications.

DL surpasses traditional machine learning by leveraging deep neural networks to extract patterns from unstructured data, resulting in superior performance in domains like computer vision, natural language processing, and speech recognition.

This technique enables DL models to extract complex features and achieve highly accurate predictions or classifications.

Deep Learning: Amazon Alexa Case Study

Amazon needed an innovative solution to strengthen its ecosystem, enhance customer engagement, and drive e-commerce growth. Amazon Alexa was envisioned as a seamless, voice-driven interface that could integrate with its services and smart home devices while leveraging cutting-edge AI technologies.

Challenges faced

- Building robust speech recognition capable of handling diverse accents and languages.
- Ensuring the assistant understood context and intent accurately in conversational interactions.
- Processing voice data in real time to deliver quick, accurate responses.

Source: https://www.amazon.science/blog/amazon-scientists-applying-deep-neural-networks-to-custom-skills

Deep Learning: Amazon Alexa Case Study

The challenges were resolved by implementing DL in the following ways:

Utilized recurrent neural networks (RNNs) followed by transformers to enhance natural language understanding (NLU) for interpreting complex commands

Used deep neural networks (DNNs) for speech-to-text conversion and speech synthesis

Deployed transfer learning to adapt pre-trained models for different languages and accents

Integrated DL models into the cloud-based Alexa platform for real-time processing and updates

Deep Learning: Amazon Alexa Case Study

The implementation of DL-based solutions impacted the system, effectively addressing key outcomes.

- By employing advanced deep learning, context and intent recognition were improved, making interactions more natural.
- Deep learning enabled instant voice input processing for faster, more accurate responses.
- Deep learning sets new standards for AI-driven systems, enhancing user experience and engagement.

Deep Learning vs. Machine Learning

Deep Learning

- Subset of machine learning that focuses on training deep neural networks
- Excels in handling unstructured data such as images, audio, text, and video
- Eliminates the need for manual feature engineering

Machine learning

- A broad field of training algorithms to make predictions or decisions based on data
- Works with structured and unstructured data
- Performance depends on the quality and relevance of engineered features

Deep Learning vs. Machine Learning

Deep Learning

- Excels in tasks like image recognition, natural language processing, and speech synthesis
- Requires substantial computational resources and large labeled datasets
- Utilizes deep neural networks with multiple layers and requires substantial computational resources

Machine learning

- Utilizes techniques like decision trees, support vector machines, and random forests
- Can be effective in a wide range of applications
- Utilizes neural networks with limited layers and requires fewer computational resources

Deep Learning vs. Machine Learning

Deep Learning

- To train DL models effectively, high-quality GPUs with ample RAM are crucial.

Machine learning

- Most problems like Data preprocessing, running simple ML models can be executed using a single powerful CPU.

In conclusion, deep learning is designed for handling large datasets and performing extensive computations and is generally considered more expensive than machine learning.

ML and DL: Applications

ML and DL are transforming industries by enabling automation, insights, and decision-making.

Healthcare: Medical imaging, drug discovery, personalized treatment, health monitoring
Example: Google's DeepMind AI detecting eye diseases with DL

Finance and banking: Fraud detection, algorithmic trading, credit scoring, chatbots and virtual assistants
Example: JPMorgan Chase using AI for fraud detection and investment strategies

Automotive and transportation: Autonomous vehicles, traffic prediction and route optimization, fleet management
Example: Tesla's Autopilot and Waymo's self-driving taxis

Agriculture: Crop disease detection, yield prediction, automated irrigation, livestock monitoring
Example: John Deere's AI-driven precision farming

Quick Check

Which of the following is a key characteristic of deep learning as compared to machine learning?

A. Uses techniques like decision trees and support vector machines

B. Requires less computational power and small datasets

C. Utilizes deep neural networks with multiple layers and high computational resources

D. Can be effective in a wide range of applications

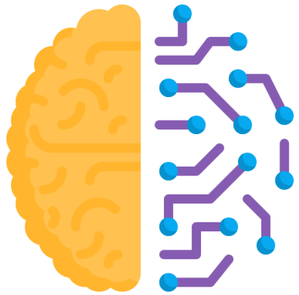
Introduction to Neural Networks

What Are Neural Networks?

A network inspired by the human brain to make computers recognize patterns and make decisions.

Real-life neural network (Human brain)

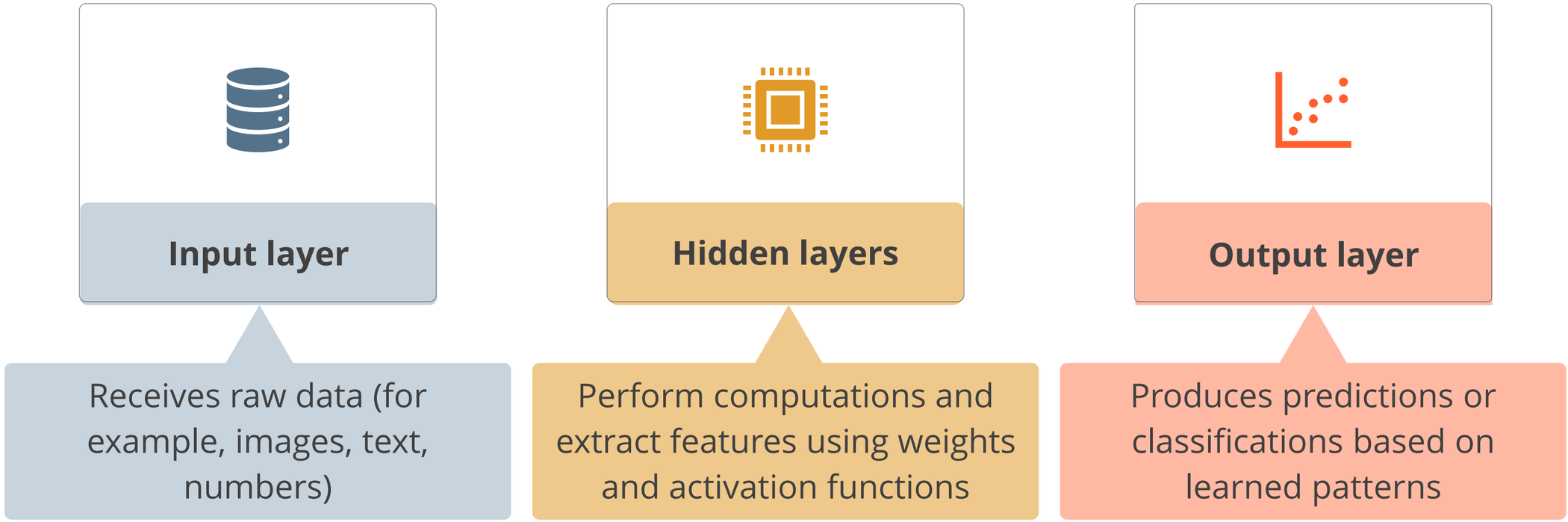
In the brain, billions of neurons connect and communicate, processing information to help us understand what we see, hear, and feel.



Mimicking this in technology

In deep learning, artificial neurons, which are mathematical nodes, process data through layers, enabling computers to recognize patterns and make decisions like human learning.

Neural Network: Key Components



Weights determine the strength of connections between neurons, while activation functions decide whether a neuron activates by transforming input signals, enabling the network to learn complex patterns.

How Neural Networks Work?

Neural networks process data through layers, learning patterns and making predictions using forward propagation, backpropagation, and activation functions.

Forward propagation

Moves data through layers to generate an output

Backpropagation

Adjusts weights based on errors to improve accuracy

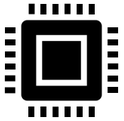
Activation functions

Determine whether a neuron should activate

Applications of Neural Networks

Computer vision

Facial recognition and medical imaging



Natural language processing (NLP)

Chatbots and language translation

Financial forecasting

Stock price prediction and fraud detection

Types of Neural Networks

Some of the common types of neural networks are:

Artificial neural networks (ANNs)

ANNs identify complex data patterns using interconnected layers of nodes, working with diverse inputs and adapting to unpredictable data like stock prices.

Recurrent neural networks (RNNs)

RNNs excel in sequential data analysis, using feedback loops for tasks like speech recognition, text generation, and time-series forecasting.

Deep neural networks (DNNs)

DNNs leverage multiple layers of nodes to analyze structured and tabular data, powering applications like natural language processing and large-scale data analysis.

Convolutional neural networks (CNNs)

CNNs specialize in image processing by detecting patterns, such as edges and textures, making them ideal for facial recognition and autonomous vehicles.

Neural Network: Amazon Case Study

Amazon, one of the world's largest e-commerce platforms, faced challenges in providing personalized shopping experiences:

Challenges faced

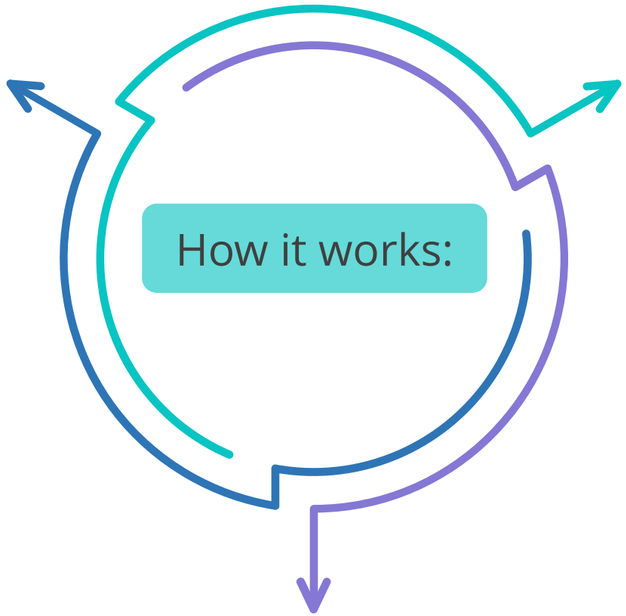
- **Massive product catalog:** Millions of products made it difficult to show relevant items to users.
- **Customer retention issues:** Users needed help finding products they would like, leading to drop-offs.
- **Enhancing user experience:** Customers expected personalized suggestions based on their preferences.

Source: https://aiexpert.network/case-study-amazons-evolution-as-an-ai-driven-powerhouse/

Neural Network: Amazon Case Study

Amazon implemented AI-powered recommendations to analyze user browsing and purchase history.

The system learns from past purchases to suggest related products.

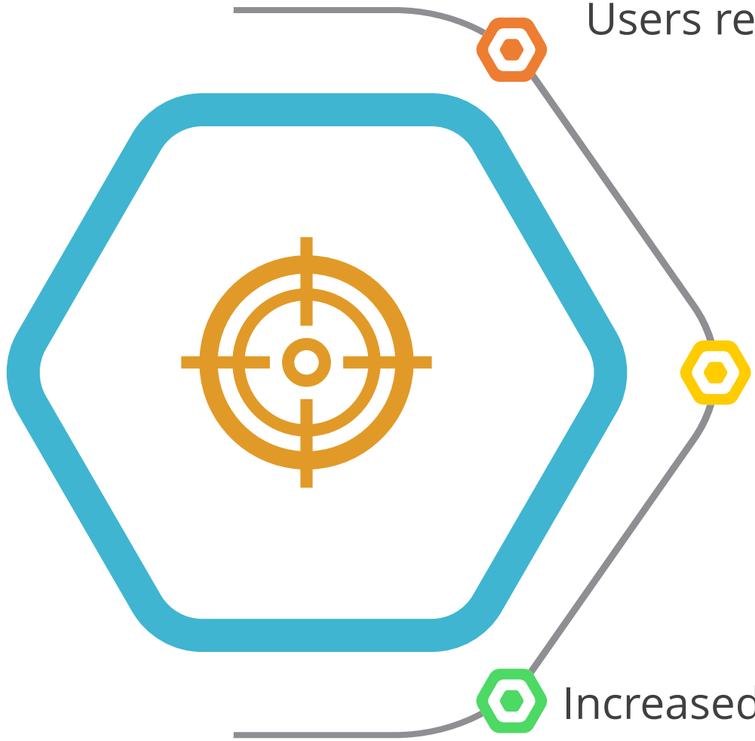


It identifies patterns in customer behavior like items frequently bought together.

The more a customer shops, the better the recommendations become, creating a highly personalized experience.

Neural Network: Amazon Case Study

The impact of neural networks on Amazon’s success:



Users receive tailored product recommendations, increasing satisfaction.

Frequently bought together and **customers also bought** sections help users discover new products.

Increased purchases result from smarter and more relevant product suggestions.

Quick Check

A self-driving car needs to process real-time images from traffic cameras to detect pedestrians, road signs, and lane markings. Which type of neural network would be best suited for this task?

A. Recurrent neural networks (RNNs)

B. Convolutional neural networks (CNNs)

C. Artificial neural networks (ANNs)

D. Deep neural networks (DNNs)

Key Takeaways

- AI has evolved from rule-based systems to advanced deep learning models, with significant breakthroughs, such as AlphaGo, GPT, and DALL-E, driving innovation in various industries.
- Machine learning (ML) enables AI systems to learn from data and improve performance over time, while deep learning (DL) uses neural networks to process complex patterns, making it ideal for image recognition, speech processing, and automation.
- Neural networks form the backbone of DL, enabling AI to recognize patterns, process language, and make predictions with minimal human intervention.

Q&A