What is machine learning? Understanding types & applications

Machine learning (ML) is defined as a discipline of artificial intelligence (AI) that provides machines the ability to automatically learn from data and past experiences to identify patterns and make predictions with minimal human intervention. This article explains the fundamentals of machine learning, its types, and the top five applications. It also shares the top 10 machine learning trends.

What Is Machine Learning?

Machine learning (ML) is a discipline of artificial intelligence (AI) that provides machines with the ability to automatically learn from data and past experiences while identifying patterns to make predictions with minimal human intervention.

Machine learning methods enable computers to operate autonomously without explicit programming. ML applications are fed with new data, and they can independently learn, grow, develop, and adapt.

Machine learning derives insightful information from large volumes of data by leveraging algorithms to identify patterns and learn in an iterative process. ML algorithms use computation methods to learn directly from data instead of relying on any predetermined equation that may serve as a model.

The performance of ML algorithms adaptively improves with an increase in the number of available samples during the 'learning' processes. For example, [deep learning](#) is a sub-domain of machine learning that trains computers to imitate natural human traits like learning from examples. It offers better performance parameters than conventional ML algorithms.

While machine learning is not a new concept – dating back to World War II when the Enigma Machine was used – the ability to apply complex mathematical calculations automatically to growing volumes and varieties of available data is a relatively recent development.

Today, with the rise of big data, IoT, and ubiquitous computing, machine learning has become essential for solving problems across numerous areas, such as

- Computational finance (credit scoring, algorithmic trading)
- Computer vision (facial recognition, motion tracking, object detection)
- Computational biology (DNA sequencing, brain tumor detection, drug discovery)
- Automotive, aerospace, and manufacturing

(predictive maintenance)
- Natural language processing (voice recognition)

How does machine learning work?

Machine learning algorithms are molded on a training dataset to create a model. As new input data is introduced to the trained ML algorithm, it uses the developed model to make a prediction.

How Machine Learning Works

Note: *The above illustration discloses a high-level use case scenario. However, typical machine learning examples may involve many other factors, variables, and steps.*

Further, the prediction is checked for accuracy. Based on its accuracy, the ML algorithm is either deployed or trained repeatedly with an augmented training dataset until the desired accuracy is achieved.

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Types of Machine Learning

[Machine learning algorithms](#) can be trained in many ways, with each method having its pros and cons. Based on these methods and ways of learning, machine learning is broadly categorized into four main types:

Types of Machine Learning

1. Supervised machine learning

This type of ML involves supervision, where machines are trained on labeled datasets and enabled to predict outputs based on the provided training. The labeled dataset specifies that some input and output parameters are already mapped. Hence, the machine is trained with the input and corresponding output. A device is made to predict the outcome using the test dataset in subsequent phases.

For example, consider an input dataset of parrot and crow images. Initially, the machine is trained to understand the pictures, including the parrot and crow's color, eyes, shape, and size. Post-training, an input picture of a parrot is provided, and the machine is expected to identify the object and predict the output. The trained machine checks for the various features of the object, such as color, eyes, shape, etc., in the input picture, to make a final prediction. This is the process of object identification in supervised machine learning.

The primary objective of the supervised learning technique is to map the input variable (a) with the output variable (b). Supervised machine learning is further classified into two broad categories:

- **Classification**: These refer to algorithms that address classification problems where the output variable is categorical; for example, yes or no, true or false, male or female, etc. Real-world applications of this category are evident in spam detection and email filtering.

Some known classification algorithms include the Random Forest Algorithm, Decision Tree Algorithm, Logistic Regression Algorithm, and Support Vector Machine Algorithm.

- **Regression**: Regression algorithms handle regression problems where input and output variables have a linear

relationship. These are known to predict continuous output variables. Examples include weather prediction, market trend analysis, etc.

Popular regression algorithms include the Simple Linear Regression Algorithm, Multivariate Regression Algorithm, Decision Tree Algorithm, and Lasso Regression.

2. Unsupervised machine learning

Unsupervised learning refers to a learning technique that's devoid of supervision. Here, the machine is trained using an unlabeled dataset and is enabled to predict the output without any supervision. An unsupervised learning algorithm aims to group the unsorted dataset based on the input's similarities, differences, and patterns.

For example, consider an input dataset of images of a fruit-filled container. Here, the images are not known to the machine learning model. When we input the dataset into the ML model, the task of the model is to identify the pattern of objects, such as color, shape, or differences seen in the input images and categorize them. Upon categorization, the machine then predicts the output as it gets tested with a test dataset.

Unsupervised machine learning is further classified into two types:

- **Clustering**: The clustering technique refers to grouping objects into clusters based on parameters such as similarities or differences between objects. For example, grouping customers by the products they purchase.

Some known clustering algorithms include the K-Means Clustering Algorithm, Mean-Shift Algorithm, DBSCAN Algorithm, Principal Component Analysis, and Independent Component Analysis.

- **Association:** Association learning refers to identifying typical relations between the variables of a large dataset. It determines the dependency of various data items and maps associated variables. Typical applications include web usage mining and market data analysis.

Popular algorithms obeying association rules include the Apriori Algorithm, Eclat Algorithm, and FP-Growth Algorithm.

3. Semi-supervised learning

Semi-supervised learning comprises characteristics of both supervised and unsupervised machine learning.

It uses the combination of labeled and unlabeled datasets to train its algorithms. Using both types of datasets, semi-supervised learning overcomes the drawbacks of the options mentioned above.

Consider an example of a college student. A student learning a concept under a teacher's supervision in college is termed supervised learning. In unsupervised learning, a student self-learns the same concept at home without a teacher's guidance. Meanwhile, a student revising the concept after learning under the direction of a teacher in college is a semi-supervised form of learning.

4. Reinforcement learning

Reinforcement learning is a feedback-based process. Here, the AI component automatically takes stock of its surroundings by the hit & trial method, takes action, learns from experiences, and improves performance. The component is rewarded for each good action and penalized for every wrong move. Thus, the reinforcement learning component aims to maximize the rewards by performing good actions.

Unlike supervised learning, reinforcement learning lacks labeled data, and the agents learn via experiences only. Consider video games. Here, the game specifies the environment, and each move of the reinforcement agent defines its state. The agent is entitled to receive feedback via punishment and rewards, thereby affecting the overall game score. The ultimate goal of the agent is to achieve a high score.

Reinforcement learning is applied across different fields such as game theory, information theory, and multi-agent systems. Reinforcement learning is further divided into two types of methods or algorithms:

- **Positive reinforcement learning**: This refers to adding a reinforcing stimulus after a specific behavior of the agent, which makes it more likely that the behavior may occur again in the future, e.g., adding a reward after a behavior.
- **Negative reinforcement learning**: Negative reinforcement learning refers to strengthening a specific behavior that avoids a negative outcome.

See More: [What Is General Artificial Intelligence (AI)? Definition, Challenges, and Trends](#)

Top 5 Machine Learning Applications

Industry verticals handling large amounts of data have realized the significance and value of machine learning technology. As machine learning derives insights from data in real-time, organizations using it can work efficiently and gain an edge over their competitors.

Every industry vertical in this fast-paced digital world, benefits immensely from machine learning tech. Here, we look at the top five ML application sectors.

1. Healthcare industry

Machine learning is being increasingly adopted in the healthcare industry, credit to wearable devices and sensors such as wearable fitness trackers, smart health watches, etc. All such devices monitor users' health data to assess their health in real-time.

Moreover, the technology is helping medical practitioners in analyzing trends or flagging events that may help in improved patient diagnoses and treatment. ML algorithms even allow medical experts to predict the lifespan of a patient suffering from a fatal disease with increasing accuracy.

Additionally, machine learning is contributing significantly to two areas:

- **Drug discovery**: Manufacturing or discovering a new drug is expensive and involves a lengthy process. Machine learning helps speed up the steps involved in such a multi-step process. For example, Pfizer uses IBM's Watson to

analyze massive volumes of disparate data for drug discovery.

- **Personalized treatment**: Drug manufacturers face the stiff challenge of validating the effectiveness of a specific drug on a large mass of the population. This is because the drug works only on a small group in clinical trials and possibly causes side effects on some subjects.

To address these issues, companies like Genentech have collaborated with GNS Healthcare to leverage machine learning and simulation AI platforms, innovating biomedical treatments to address these issues. ML technology looks for patients' response markers by analyzing individual genes, which provides targeted therapies to patients.

2. Finance sector

Today, several financial organizations and banks use machine learning technology to tackle fraudulent activities and draw essential insights from vast volumes of data. ML-derived insights aid in identifying investment opportunities that allow investors to decide when to trade.

Moreover, data mining methods help cyber-surveillance systems zero in on warning signs of fraudulent activities, subsequently neutralizing them. Several financial institutes have already partnered with tech companies to leverage the benefits of machine learning.

For example,

- Citibank has partnered with fraud detection company Feedzai to handle online and in-person banking frauds.
- PayPal uses several machine learning tools to differentiate between legitimate and fraudulent transactions between buyers and sellers.

3. Retail sector

Retail websites extensively use machine learning to recommend items based on users' purchase history. Retailers use ML techniques to capture data, analyze it, and deliver personalized shopping experiences to their customers. They also implement ML for marketing campaigns, customer insights, customer merchandise planning, and price optimization.

According to a September 2021 report by Grand View Research, Inc., the global recommendation engine market is expected to reach a valuation of $17.30 billion by 2028. Common day-to-day examples of recommendation systems include:

- When you browse items on Amazon, the product recommendations that you see on the homepage result from machine learning algorithms. Amazon uses [artificial neural networks (ANN)](#) to offer intelligent, personalized recommendations relevant to customers based on their recent purchase history, comments, bookmarks, and other online activities.
- Netflix and YouTube rely heavily on recommendation systems to suggest shows and videos to their users based on their viewing history.

Moreover, retail sites are also powered with virtual assistants or conversational chatbots that

leverage ML, natural language processing (NLP), and natural language understanding (NLU) to automate customer shopping experiences.

4. Travel industry

Machine learning is playing a pivotal role in expanding the scope of the travel industry. Rides offered by Uber, Ola, and even self-driving cars have a robust machine learning backend.

Consider Uber's machine learning algorithm that handles the dynamic pricing of their rides. Uber uses a machine learning model called 'Geosurge' to manage dynamic pricing parameters. It uses real-time predictive modeling on traffic patterns, supply, and demand. If you are getting late for a meeting and need to book an Uber in a crowded area, the dynamic pricing model kicks in, and you can get an Uber ride immediately but would need to pay twice the regular fare.

Moreover, the travel industry uses machine learning to analyze user reviews. User comments are classified through sentiment analysis based on positive or negative scores. This is used for campaign monitoring, brand monitoring, compliance monitoring, etc., by companies in the travel industry.

5. Social media

With machine learning, billions of users can efficiently engage on social media networks. Machine learning is pivotal in driving social media platforms from personalizing news feeds to delivering user-specific ads. For example, Facebook's auto-tagging feature employs image recognition to identify your friend's face and tag them automatically. The social network uses ANN to recognize familiar faces in users' contact lists and facilitates automated tagging.

Similarly, LinkedIn knows when you should apply for your next role, whom you need to connect with, and how your skills rank compared to peers. All these features are enabled by machine learning.

See More: **[What Is Super Artificial Intelligence (AI)? Definition, Threats, and Trends](#)**

Top 10 Machine Learning Trends

Machine learning has significantly impacted all industry verticals worldwide, from startups to Fortune 500 companies. According to a 2021 report by Fortune Business Insights, the global machine learning market size was $15.50 billion in 2021 and is projected to grow to a whopping $152.24 billion by 2028 at a CAGR of 38.6%.

Looking at the increased adoption of machine learning, 2022 is expected to witness a similar trajectory. Here, we look at the top 10 machine learning trends for 2022.

Machine Learning Trends to Expect in 2022

1. Blockchain meets machine learning

Blockchain, the technology behind cryptocurrencies such as Bitcoin, is beneficial for numerous businesses. This tech uses a decentralized ledger to record every transaction, thereby promoting transparency between involved parties without any intermediary. Also, blockchain transactions are irreversible, implying that they can never be deleted or changed once the ledger is updated.

Blockchain is expected to merge with machine learning and AI, as certain features complement each other in both techs. This includes a

decentralized ledger, transparency, and immutability.

For example, banks such as Barclays and HSBC work on blockchain-driven projects that offer interest-free loans to customers. Also, banks employ machine learning to determine the credit scores of potential borrowers based on their spending patterns. Such insights are helpful for banks to determine whether the borrower is worthy of a loan or not.

2. AI-based self-service tools

Several businesses have already employed AI-based solutions or self-service tools to streamline their operations. Big tech companies such as Google, Microsoft, and Facebook use

bots on their messaging platforms such as Messenger and Skype to efficiently carry out self-service tasks.

For example, when you search for a location on a search engine or Google maps, the 'Get Directions' option automatically pops up. This tells you the exact route to your desired destination, saving precious time. If such trends continue, eventually, machine learning will be able to offer a fully automated experience for customers that are on the lookout for products and services from businesses.

3. Personalized AI assistants & search engines

Today, everyone is well-aware of AI

assistants such as Siri and Alexa. These voice assistants perform varied tasks such as booking flight tickets, paying bills, playing a users' favorite songs, and even sending messages to colleagues.

With time, these chatbots are expected to provide even more personalized experiences, such as offering legal advice on various matters, making critical business decisions, delivering personalized medical treatment, etc.

On the other hand, search engines such as Google and Bing crawl through several data sources to deliver the right kind of content. With increasing personalization, search engines today can crawl through personal data to give users

personalized results.

For example, when you search for 'sports shoes to buy' on Google, the next time you visit Google, you will see ads related to your last search. Thus, search engines are getting more personalized as they can deliver specific results based on your data.

4. All-inclusive smart assistance

With personalization taking center stage, smart assistants are ready to offer all-inclusive assistance by performing tasks on our behalf, such as driving, cooking, and even buying groceries. These will include advanced services that we generally avail through human agents, such as making travel

arrangements or meeting a doctor when unwell.

For example, if you fall sick, all you need to do is call out to your assistant. Based on your data, it will book an appointment with a top doctor in your area. The assistant will then follow it up by making hospital arrangements and booking an Uber to pick you up on time.

5. Personal medical devices

Today, wearable medical devices are already a part of our daily lives. These devices measure health data, including heart rate, glucose levels, salt levels, etc. However, with the widespread implementation of machine learning and AI, such devices will have much more data to offer to users in the future.

Wearable devices will be able to analyze health data in real-time and provide personalized diagnosis and treatment specific to an individual's needs. In critical cases, the wearable sensors will also be able to suggest a series of health tests based on health data. They may even book an appointment with a specialist available nearby.

6. Enhanced augmented reality (AR)

Although augmented reality has been around for a few years, we are witnessing the true potential of tech now. Microsoft's HoloLens is a popular example. These AR glasses project a digital overlay over the physical environment and allow users to interact with the virtual world using voice commands or hand gestures.

However, the advanced version of AR is set to make news in the coming months. In 2022, such devices will continue to improve as they may allow face-to-face interactions and conversations with friends and families literally from any location. This is one of the reasons why augmented reality developers are in great demand today.

7. Advancements in the automobile industry

Self-driving cars have already been tested on the streets. They are capable of driving in complex urban settings without any human intervention. Although there's significant doubt on when they should be allowed to hit the roads, 2022 is expected to take this debate forward.

In 2022, self-driving cars will even allow drivers to take a nap during their journey. This won't be limited to autonomous vehicles but may transform the transport industry. For example, autonomous buses could make inroads, carrying several passengers to their destinations without human input.

8. Full-stack deep learning

Today, deep learning is finding its roots in applications such as image recognition, autonomous car movement, voice interaction, and many others. Moreover, games such as DeepMind's AlphaGo explore deep learning to be played at an expert level with minimal effort.

In 2022, deep learning will find applications in medical imaging, where doctors use image recognition to diagnose conditions with greater accuracy. Furthermore, deep learning will make significant advancements in developing [programming languages](#) that will understand the code and write programs on their own based on the input data provided.

For example, consider an excel spreadsheet with multiple financial data entries. Here, the ML system will use deep learning-based programming to understand what numbers are good and bad data based on previous examples.

9. Generative adversarial network (GAN)

Generative adversarial networks are an essential machine learning breakthrough in recent times. It enables the generation of valuable data from scratch or random noise, generally images or music. Simply put, rather than training a single neural network with millions of data points, we could allow two neural networks to contest with each other and figure out the best possible path.

For example, when you input images of a horse to GAN, it can generate images of zebras.

10. TinyML

TinyML has revolutionized machine learning.

Inspired by IoT, it allows IoT edge devices to run ML-driven processes. For example, the wake-up command of a smartphone such as 'Hey Siri' or 'Hey Google' falls under tinyML.

Also, a web request sent to the server takes time to generate a response. Firstly, the request sends data to the server, processed by a machine learning algorithm, before receiving a response. Instead, a time-efficient process could be to use ML programs on edge devices. This approach has several advantages, such as lower latency, lower power consumption, reduced bandwidth usage, and ensuring user privacy simultaneously.

With a surge in connected devices, tinyML will continue to grow in sophistication and become widespread.

See More: [Top 10 AI Companies in 2022](#)

Takeaway

Computers can learn, memorize, and generate accurate outputs with machine learning. It has enabled companies to make informed decisions critical to streamlining their business operations. Such data-driven decisions help companies across industry verticals, from manufacturing, retail, healthcare, energy, and financial services, optimize their current operations while seeking new methods to ease their overall workload.

As computer algorithms become increasingly intelligent, we can anticipate an upward trajectory of machine learning.

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