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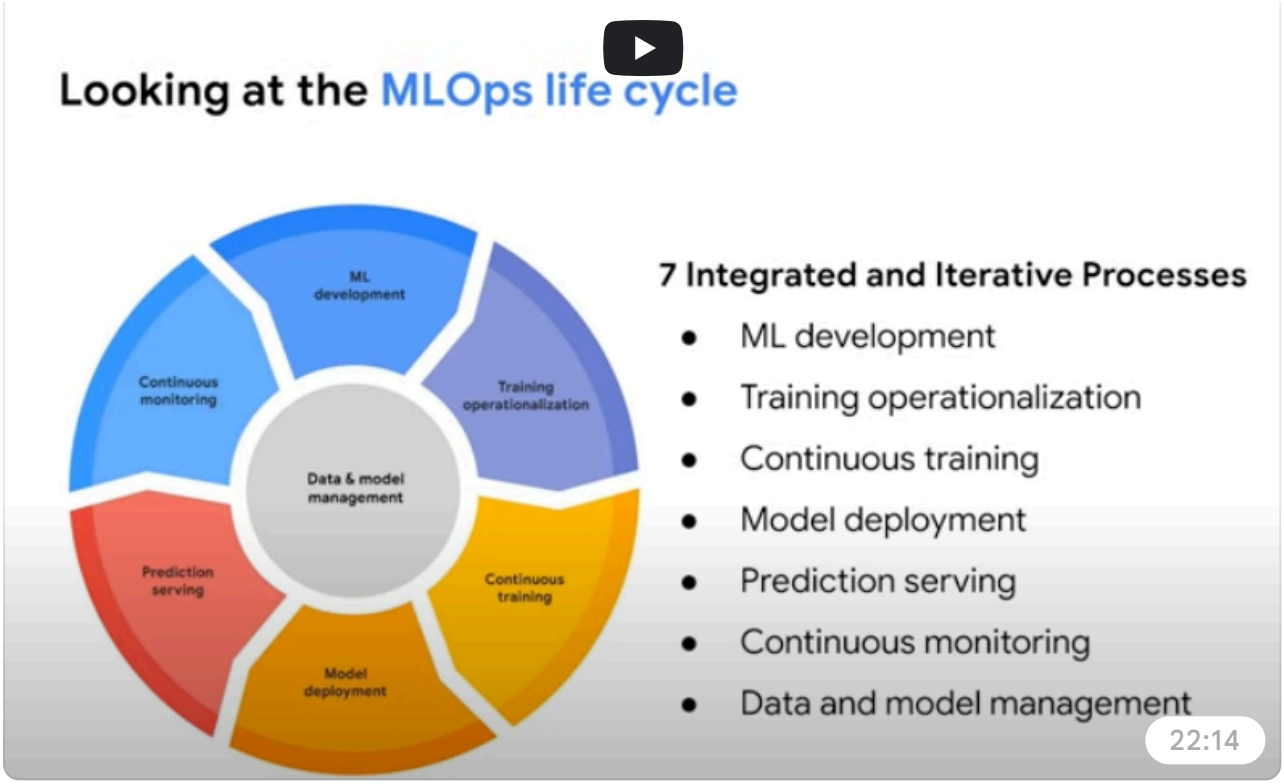
What is Machine Learning (ML)?

Today's enterprises are inundated with data. To drive better business decisions, they have to make sense of it. But the sheer volume coupled with complexity makes data difficult to analyze using traditional tools. Building, testing, iterating, and deploying analytical models for identifying patterns and insights in data eats up employees' time in a way that scales poorly. Machine learning can enable an organization to derive insights quickly as data scales.



Accelerating model deployment with MLOps

Machine learning defined

Machine learning is a subset of artificial intelligence that enables a system to autonomously learn and improve using neural networks and deep learning, without being explicitly programmed, by feeding it large amounts of data.

Machine learning allows computer systems to continuously adjust and enhance themselves as they accrue more “experiences.” Thus, the performance of these systems can be improved by providing larger and more varied datasets to be processed.

Scope of use cases

Machine learning is being used in nearly every industry and business activity. Machine learning helps the logistics industry optimize shipping and delivery

routes, the retail industry personalize shopping experiences and manage inventory, manufacturers automate factories, and helps secure organizations everywhere. When a person uses their voice to query their smartphone or speaker, machine learning is used to understand the request, and to help find the result. The scope of use cases for machine learning is vast and constantly expanding.

Importance of machine learning

The rate of data generation is accelerating every day. The world is creating more data every day than it ever has in its history. It would be nearly impossible to analyze and utilize all that data without machine learning. As such, machine learning is opening an entirely new realm of what humans can do with computers and other machines. Machine learning helps businesses with important functions like fraud detection, identifying security threats, personalization and recommendations, automated customer service through chatbots, transcription and translation, data analysis, and more. Machine learning is also driving the exciting innovation of tomorrow, such as autonomous vehicles, drones, and airplanes, augmented and virtual reality, and robotics.

What is the difference between machine learning, artificial intelligence, and deep learning?

While artificial intelligence (AI) and machine learning (ML) are often used synonymously, they are not interchangeable terms.

Artificial intelligence is an area of computer science concerned with building computers and machines that can reason, learn, and act in a way resembling human intelligence, or systems that involve data whose scale exceeds what humans can analyze. The field includes many different disciplines including data analytics, statistics, hardware and software engineering, neuroscience, and even philosophy.

Whereas artificial intelligence is a broad category of computer science, machine learning is an application of AI that involves training machines to execute a task without being specifically programmed for it. Machine learning is more explicitly used as a means to extract knowledge from data through techniques such as neural networks, supervised and unsupervised learning, decision trees, and linear regression.

Just as machine learning is a subset of artificial intelligence, deep learning is a subset of machine learning. Deep learning works by training neural networks on sets of data. A neural network is a model that uses a system of artificial neurons that are computational nodes used to classify and analyze data. Data is fed into the first layer of a neural network, with each node making a decision, and then passing that information onto multiple nodes in the next layer. Training models with more than three layers are referred to as “deep neural networks” or “deep learning.” Some modern neural networks have hundreds or thousands of layers.

How does machine learning work?

Machine learning works by training algorithms on sets of data to achieve an expected outcome such as identifying a pattern or recognizing an object. Machine learning is the process of optimizing the model so that it can predict the correct response based on the training data samples.

Assuming the training data is of high quality, the more training samples the machine learning algorithm receives, the more accurate the model will become. The algorithm fits the model to the data during training, in what is called the “fitting process.” If the outcome does not fit the expected outcome, the algorithm is re-trained again and again until it outputs the accurate response. In essence, the algorithm learns from the data and reaches outcomes based on whether the input and response fit with a line, cluster, or other statistical correlation.

Types of machine learning

What is training data in machine learning? It depends on the type of machine learning model being used.

In broad strokes, there are three kinds of models used in machine learning.

Supervised learning is a machine learning model that uses labeled training data (structured data) to map a specific feature to a label. In supervised learning, the output is known (such as recognizing a picture of an apple) and the model is trained on data of the known output. In simple terms, to train the algorithm to recognize pictures of apples, feed it pictures labeled as apples.

The most common supervised learning algorithms used today include:

- Linear regression
- Polynomial regression
- K-nearest neighbors
- Naive Bayes
- Decision trees

Unsupervised learning is a machine learning model that uses unlabeled data (unstructured data) to learn patterns. Unlike supervised learning, the "correctness" of the output is not known ahead of time. Rather, the algorithm learns *from* the data without human input (and is thus, unsupervised) and categorizes it into groups based on attributes. For instance, if the algorithm is given pictures of apples and bananas, it will work by itself to categorize which picture is an apple and which is a banana. Unsupervised learning is good at descriptive modeling and pattern matching.

The most common unsupervised learning algorithms used today include:

- Fuzzy means
- K-means clustering
- Hierarchical clustering
- Partial least squares

There's also a mixed approach to machine learning called semi-supervised learning in which only some data is labeled. In semi-supervised learning, the algorithm must figure out how to organize and structure the data to achieve a known result. For instance, the machine learning model is told that the result is a pear, but only some training data is labeled as a pear.

Reinforcement learning is a machine learning model that can be described as “learn by doing” through a series of trial and error experiments. An “agent” learns to perform a defined task through a feedback loop until its performance is within a desirable range. The agent receives positive reinforcement when it performs the task well and negative reinforcement when it performs poorly. An example of reinforcement learning is when Google researchers taught a reinforcement learning algorithm to play the game Go. The model, which had no prior knowledge of the rules of Go, simply moved pieces at random and “learned” the best moves to make. The algorithm was trained via positive and negative reinforcement to the point that the machine learning model could beat a human player at the game.

Advantages of machine learning

Pattern recognition

The more data consumed by a machine learning algorithm, the better it gets in finding trends and patterns in that data. For instance, an ecommerce website might use machine learning to understand how people shop on their site and use that information to give people better recommendations or find trend data that can lead to new product opportunities.

Automation

Machine learning and artificial intelligence can take away much of the dull and dreary work from human workers. Utilities like robotic process automation can perform some of the tedious business tasks that keep people from performing more meaningful work. Computer vision and objection detection algorithms can help robots pick and pack items from an assembly line. Always-on fraud detection and threat-assessment machine learning can find security flaws before they become a problem.

Continuous improvement

Given the right kinds of data, machine learning algorithms will continue to improve to be faster and more accurate. A good example is the GPT-3 dataset that continues to improve how it generates text.

Disadvantages of machine learning

Bias potential

Machine learning is often only as good as the data it is being fed. If a machine learning algorithm is fed a biased dataset, it will deliver biased results.

Data acquisition

Machine learning can require a lot of data before it can be useful. As many machine learning use cases are based on supervised learning, acquiring and cleaning structured data to train the algorithms is an important first step, which can be difficult if data resides in a variety of siloed locations within an organization.

Technical expertise required

While machine learning, artificial intelligence, and cloud vendors try to make it as easy as possible to set up and run machine learning algorithms, organizations often need programmers and data scientists to understand and utilize the training algorithms and their results.

Resource intensive

Machine learning can be time consuming, requiring a lot of computing resources and employee hours to begin processing data and achieving results.

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Machine learning uses

Here are some examples of what machine learning is used for:

Robotic process automation

RPA combined with machine learning creates intelligent automation that's capable of automating complex tasks, such as processing mortgage applications.

Sales optimization

Customer data can train machine learning algorithms for customer sentiment analysis, sales forecasting analysis, and customer churn predictions.

Customer service

Machine learning applications include chatbots and automated virtual assistants to automate routine customer service tasks and speed up issue resolution.

Security

Machine learning helps enterprises improve their threat analysis capabilities and how they respond to cyberattacks, hackers, and malware.

Digital marketing

Machine learning enables marketers to identify new customers and to offer the right marketing materials to the right people at the right time.

Fraud prevention

Machine learning helps credit card companies and banks review vast amounts of transactional data to identify suspicious activity in real time.

Related products and services

Google offers a number of innovative machine learning products, solutions, and applications on a trusted cloud platform that enables businesses to easily build and implement machine learning algorithms and models.

By using products like Vertex AI and BigQuery ML, organizations can make sense of all the data they're producing, collecting, or otherwise inquiring, no matter what format it's in, to make actionable business decisions.

Vertex AI

Fully managed, end-to-end platform for data science and machine learning to build, deploy, and manage models.

BigQuery ML

Create and execute ML models in BigQuery using standard SQL queries - while democratizing machine learning and promoting application development.

AI infrastructure

Options for every business to train deep learning and machine learning models cost-effectively.