UCI Division of Continuing Education

A Primer on Machine Learning

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> "The core of Machine Learning revolves around a computer system consuming data and learning from the data."

QUESTION:

What is Machine Learning?

Simply put, Machine Learning is a form of data analysis. Using algorithms that continuously learn from data, Machine Learning allows computers to recognize hidden patterns without actually being programmed to do so. The key aspect of Machine Learning is that as models are exposed to new data sets, they adapt to produce reliable and consistent output.

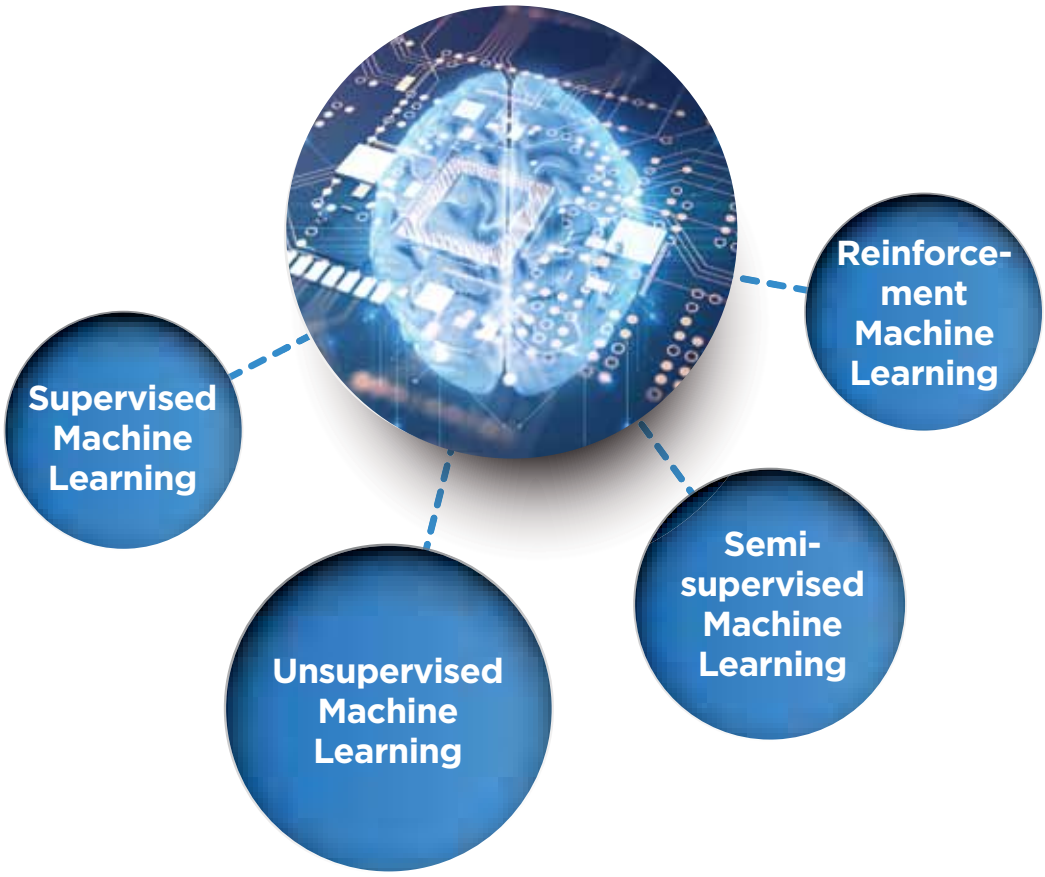
QUESTION:

What is driving the resurgence of Machine Learning?

There are four interrelated phenomena that are behind the growing prominence of Machine Learning: 1) the ever-increasing volume, variety and velocity of data, 2) the decrease in bandwidth and storage costs and 3) the exponential improvements in computational processing. In a nutshell, the ability to perform complex mathematical computations on big data is driving the resurgence in Machine Learning.

QUESTION:

What are some of the commonly used methods of Machine Learning?



Supervised Machine Learning

In Supervised Learning, algorithms are trained using labeled examples i.e. the desired output for an input is known. For example, a piece of mail could be labeled either as relevant or junk. The algorithm receives a set of inputs along with the corresponding correct outputs to foster learning. Once the algorithm is trained on a set of labeled data; the algorithm is run against the same labeled data and its actual output is compared against the correct output to detect errors. If errors are discovered, the model is refined to minimize the error in output. Learning stops when the algorithm achieves an acceptable level of performance. The algorithm is then applied to an unlabeled data set to predict the value of the label i.e. whether a new piece of mail is either relevant or junk. Supervised learning is commonly used in applications where historical data is leveraged to predict future outcomes. Regression analysis and classification analysis are some of the commonly used techniques in supervised machine learning.

Unsupervised Machine Learning

In Unsupervised Machine Learning, the system is not trained on the "right answer". The algorithm must explore the data and detect hidden patterns or structure within the data. Unsupervised Machine Learning works well with transactional data in that it can be used to identify a group of individuals with similar purchase behavior who can then be treated as a single homogenous unit during marketing promotions. K-means clustering and Association models are common techniques used in Unsupervised Machine Learning.

Semi-supervised Machine Learning

In the case of semi-supervised machine learning, both labeled and unlabeled data is used to train an algorithm. A small amount of labeled data is combined with a large amount of unlabeled data. When the cost associated with labeling is too high to allow for a fully labeled training process, semi-supervised learning is normally utilized. An example where semi-supervised machine learning would be useful is classifying web pages. Let's say the requirement is to classify web pages into different categories (i.e. Sports, Politics, Finance, etc). In this case, it is prohibitively expensive to go through hundreds of millions of web pages and manually annotate it to make it labeled. However, web pages are abundantly available. It would be rather easy to write a web crawler to grab a large quantity of unlabeled web pages. Therefore in the case of semi-supervised machine learning, the intent is to take as much advantage of the unlabeled data as possible. Image Classification and Text Classification are good practical examples of semi-supervised machine learning. Co-training algorithm is a common techniques used in semi-supervised machine learning.

Reinforcement Machine Learning

In Reinforcement Machine Learning, trial and error is used by an algorithm to determine which action yields the highest reward. Reinforcement Machine Learning is predicated on 3 main components: 1) an agent who is the primary decision maker, 2) the environment which constitutes everything the agent interacts with and 3) actions which dictate what the agent does. The intent of Reinforcement Machine Learning is for the agent to perform actions that lead to maximum reward or drive the most optimal outcome. Reinforcement Machine Learning is often utilized in gaming and robotics. Optimization techniques are commonly used in Reinforcement Machine Learning.

QUESTION:

What is the difference between AI, Machine Learning and Deep Learning?

Artificial Intelligence, Machine Learning, and Deep Learning are gaining prominence in businesses. However, the terms are often used interchangeably. So, what's the difference between Artificial Learning, Machine Learning and Deep Learning?

> "…The terms are often used interchangeably. So, what's the difference?"

Artificial Intelligence:

AI can be thought of as advanced computer intelligence. In AI, every aspect of intelligence can be so precisely defined that a machine can be programmed to simulate it.

Machine Learning:

Machine Learning is a sub-discipline of Artificial Intelligence. The core of Machine Learning revolves around a computer system consuming data and learning from the data. Once trained on large data sets, the system can be leveraged to perform a myriad of tasks ranging from natural language processing to predicting outcomes to proactive/preventive maintenance. In traditional programming, a computer system completes tasks based on instructions whereas in Machine Learning, the system continuously learns from data and utilizes the knowledge to uncover patterns and make predictions.

Deep Learning:

Deep Learning is a branch of machine learning focused on algorithms called Artificial Neural Networks which tries to mimic the structure and functioning of the brain. As compared to traditional programming which uses a set of instruments to perform a task, Artificial Neural Networks use a network of nodes to recognize patterns. Many layers of software neurons are utilized to identity patterns of great complexity. Let's say you want a computer system to recognize an object. The Artificial Neural Network is blitzed with digital images containing those objects. Each individual layer of software neurons learns to recognize a specific feature. For example: the first layer may recognize primitive features like an edge in an image. Once the layer has successfully recognized a feature, it is fed to the next layer which trains itself to recognize more complex patterns like a corner in an image. This "divide and conquer" process is repeated in each layer until the system can reliably recognize the object.

QUESTION:

How is Machine Learning creating value in companies?

Some concrete examples where Machine Learning is helping companies create value are:

1) **Personalized, contextual customer engagement** – by combining customer profile information with data on past purchases and information on current interactions across channels, companies are able to engage with customers on a 1:1 basis and deliver on signature moments that win the hearts, minds and wallet of customers

2) **Next Best Offer** – by presenting the right offer through the right channel at the right time, companies are able to take advantage of cross sell/up sell opportunities

3) **Fraud Detection** – by leveraging machine learning algorithms to uncover anomalies, exceptions and outliers, financial institutions are identifying fraudulent/suspicious transactions in real time.

4) **Proactive/Preventive Maintenance** – by processing continuous streams of data emanating from devices, machine learning algorithms are leveraged to predict problems even before an outage so that proactive measures can be administered to prevent complete breakdown.