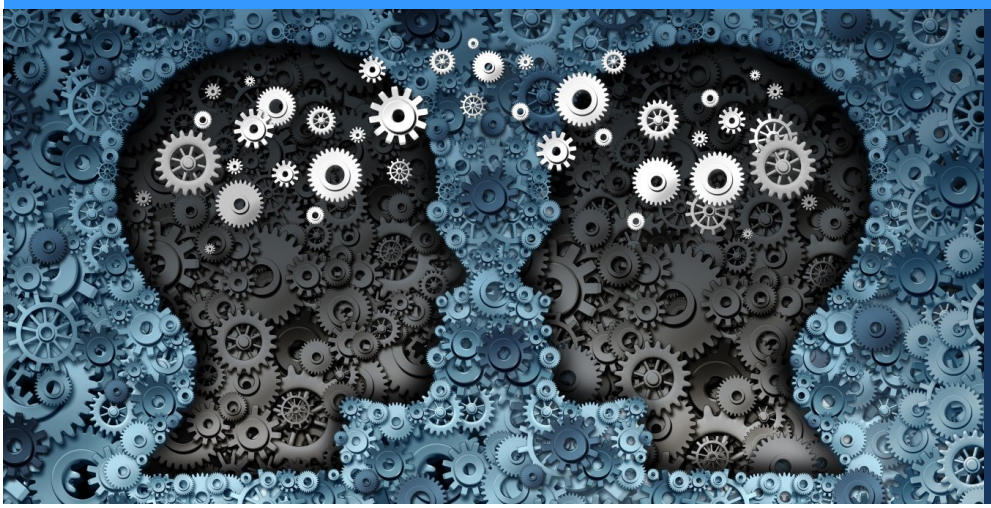
Tech Insights: Machine Learning

Office of Technology Strategies (TS) / Architecture, Strategy, and Design (ASD) | V3 Issue 12 | December 2016



The TS office within OI&T's ASD, interacts not only with the Enterprise Architecture pillar offices, but also with multiple external vendors, stakeholders within OI&T, and with strategic offices across the enterprise. TS works closely with IT and business owners to capture business rules and provide technical guidance as it relates to Data Sharing across the enterprise, specifically for interagency operability.

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VA OFFICE OF TECHNOLOGY STRATEGIES

Introduction

In today's tech-focused society, it is no surprise that machines now have the ability to come to life as we do – evolving and changing in response to the environment and information exposure. This technology is known as "machine learning," a type of artificial intelligence (AI) that provides computers the ability to learn, without providing programmed instructions. This Tech Insight explores how machine learning works and where it is used, how the deep learning approach to machine learning is utilized, and how the Department of Veterans Affairs (VA) is implementing machine learning.

Overview

Machine learning evolved from the study of pattern recognition, in which similarities or repeated sequences are identified within deconstructed parts of complex problems. Computational learning theory, a subfield of AI, is dedicated to studying the design and analysis of machine learning algorithms, the set of rules used in operations to solve problems. Like humans, machine learning programs teach themselves, grow, and transform on their own, as a result of their exposure to data. In short, machine learning attempts to translate human decision-making processes into fast-thinking algorithms.

Considerations exist for programs to use machine learning to explore and solve problems. First, a pattern must exist in the input data from which to draw a conclusion. Second, there must be sufficient data to apply to the problem. Third, a learning program must derive meaning from the data and learn how to arrive at a mathematical value to describe the behavior of the problem.

History

Machine learning solves problems that cannot be solved by numerical means alone. The roots of machine learning technology stem from AI research in the 1950s. The first computer that could learn from its own experience was developed by using the game of checkers. Since checker players have several strategies for good and bad moves, the guidance of checker experts was used to adjust criteria in a program designed to choose the best strategic moves. It became one of the earliest program models for non-numerical computation, since it used algorithms, not numerical approximation, to quickly and efficiently solve problems.

How It Works

Machine learning tasks are usually categorized by two areas of learning: *supervised* learning, where the machine is trained to map inputs to outputs after the presentation of specific examples; and *unsupervised* learning, where an abundance of data is used to find structure.

Data, or the "input," is the starting point in machine learning – without the input, there is nothing to process and inform decision-making. Then, *structured* learning is used by the machine learning algorithm to understand the pattern used when the input data provides the output or decision. Machine learning forms the "mapping function," the communication to learn a "target function." The algorithm forms a communication that maps input to output (or data to a decision). The target function (f) is always unknown, since we cannot decipher it mathematically.

Machine learning technology performs learning tasks that are used to predict future outcomes (y) when given new input examples or data (x). Therefore, y = f(x). We use machine learning to approximate the target function by learning from examples or data (x). Using a

sizable amount of data is important; it provides additional examples to develop algorithms to more precisely describe patterns in data.

Deep Learning

Deep learning is an approach to machine learning based on algorithms that emulate the structure and function of the brain's artificial neural networks. Deep learning models data in order to solve problems such as facial recognition, natural language processing, and speech recognition. Each layer of *virtual* neurons is trained to build on outputs from the layer before it. The learning process is "deep" because it includes several layers – the output from one layer formulates input for the next. This continues through multiple layers, each one searching for more complex data, until the entire system can accurately come to a decision or "final output."

For example, one layer may search for lines that form a letter, and the next layer determines how these lines connect in order to form the letter. This process continues until the system correctly identifies a full word.

Implementation

Machine learning is a common tool used in data analytics, statistics, data queries, and predictive analysis. While it is a major part of medical device technology, it is also utilized for Internet of Things (IoT). Pandora uses your listening history to recommend music for you; Amazon recommends products to you after learning about your purchases and searches. Are you an iPhone user? Think about Siri's ability to understand your requests and how your phone identifies callers who are not on your contact list, or brings up a map location for the hotel you reserved, without typing it in. That's right; your iPhone can process data like you do.

Facebook's entire experience is made possible by machine learning programs that develop the personalization of your news feed and ranks its stories. It highlights trending topics, ranks search results, and provides advertisements based on your Internet browsing history. In May 2016, Facebook built a brand new platform, called FBLearner Flow, which can easily "reuse algorithms in different products, scale to run thousands of simultaneous custom experiments, and manage experiments with ease." Removing the manual work for experimentation allows machine learning engineers to focus on specific features to produce more accurate improvements to the Facebook platform.

Machine learning also accounts for a great deal of the innovation behind IoT. Wearable devices can track your health through the internet to provide real-time updates to doctors, who can receive notifications for certain conditions – such as your heart rate increasing dramatically or stopping entirely. Machine learning helps identify what conditions are normal and which are not, and is able to generate and collect big data to learn patient behaviors.

Machine learning and its approaches, such as deep learning, and AI are transforming the healthcare industry by improving diagnostics and predicting results that personalize care. Computers help radiologists detect problems in Magnetic Resonance Imaging (MRI) scans that may be too small for humans to see. Machines can search through your family medical records and compare them to the best research for your particular case, suggesting treatments or procedures to doctors.

Conclusion

VA is implementing machine learning technology to conduct analyses in big data, predictive, and trend topics, and provide precision medicine to Veterans through commercial off-the-shelf (COTS) services. VA recognizes the need for an enterprise-wide machine learning capability to analyze its large volume of data. The Office of Technology Strategies (TS) includes machine learning in Enterprise Design Patterns (EDPs) for Data Storage and Data Analytics. Further, machine learning technologies support VA's data architecture evolution and big data roadmaps, in accordance with the Enterprise Technology Strategic Plan (ETSP).

Machine learning programs are rapidly being adopted in all areas of our lives from healthcare to smart phones, websites, appliances, and even transportation. As stated by analytics thought leader, Thomas Davenport, "Humans can typically create one or two good models a week; machine learning can create thousands of models a week." Despite all the progress we have had, machine learning is still a topic that is wildly unknown and must be dissected further. There is a whole world of machine learning waiting to be discovered and understood.

Read more technology topics in TS Tech Insights and Enterprise Design Patterns. If you have any questions regarding machine learning, don't hesitate to ask TS for assistance.