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DATA SCIENCE APPLICATIONS

The evolution of data science and advanced forms of analytics has given rise to a wide range of applications that are providing better insights and business value in the enterprise. In particular, data science practices, methodologies, tools and technologies give organizations the capabilities they need to gain valuable information from ever-increasing amounts of highly variable data.

Big data tooling and artificial intelligence provide the power needed to wrangle and analyze large pools of data for applications as diverse as predictive modeling, pattern recognition, anomaly detection, personalization, conversational AI and autonomous systems. Indeed, data science and the data scientists who primarily perform it have been elevated from what was once considered a wonky, academic side of IT to now be a core part of business operations.

Let's look more closely at eight common data science applications.

1. Anomaly detection

One powerful application of data science is the use of statistical analysis to spot anomalies in data sets, particularly large ones. While it might be a somewhat simple exercise to fit data into clusters or groups and then identify outliers when dealing with small amounts of data, this task becomes substantially more difficult for organizations that have to analyze petabytes or exabytes of data.

For example, financial services firms increasingly have been challenged to detect fraudulent spending behavior in transaction data that continues to explode in its volume and variety. American Express was an early pioneer in applying data science techniques and methods to big data in real time for fraud detection and other uses, enabling the company to quickly respond to events and changes. Anomaly detection is also useful in tasks like preventing cyber attacks and monitoring the performance of IT systems, and for eliminating outlier values in data sets to increase analytics accuracy.

2. Pattern recognition

Likewise, identifying patterns in data sets is a fundamental data science project. For example, pattern recognition helps retailers and e-commerce companies spot trends in customer purchasing behavior. Making product offerings relevant and ensuring the reliability of supply chains is crucial for organizations that want to keep their customers happy -- and stop them from purchasing from competitors instead.

Companies such as Amazon and Walmart have long used data science approaches to discover purchasing patterns. In one interesting early example, Walmart noticed that many customers making purchases in anticipation of a hurricane or tropical storm also bought strawberry Pop-Tarts. Such correlations, often unexpected, can help drive more effective purchasing, inventory management and marketing strategies.

Pattern recognition also has a wide variety of other data science use cases. For example, it can aid in stock trading, risk management, diagnosis of medical conditions, seismic analysis and things like natural language processing (NLP), speech recognition and computer vision.

3. Predictive modeling

In addition to spotting patterns and outliers, data science aims to make predictive modeling more accurate. While predictive analytics has been around for decades, data science applies machine learning and other algorithmic approaches to large data sets to improve decision-making capabilities by creating models that better predict customer behavior, financial risks, market trends and more.

Predictive analytics applications are used in a wide range of industries, including financial services, retail, manufacturing, healthcare, travel and government. For example, manufacturers use predictive maintenance systems to help reduce equipment breakdowns and improve production uptime. Airplane makers Boeing and Airbus also depend on predictive maintenance to improve their fleet availability. Similarly, Chevron, BP and other companies in the energy sector use

predictive modeling to improve equipment reliability in settings where maintenance is costly, difficult and expensive to perform.

In addition, organizations are using the predictive power of data science to improve business forecasting. As an example, formulaic approaches to purchasing by manufacturers and retailers failed in the face of the sudden changes in consumer and business spending driven by the COVID-19 pandemic. In forward-looking companies, though, these brittle systems have been replaced with data-driven forecasting applications that are better able to respond to evolving customer behavior.

4. Recommendation engines and personalization systems

User and customer satisfaction typically is highest when products and services are tailored to people's needs or interests -- especially if they can get the right product at the right time in the right channel, with the right offer communicated using the right message and the right level of service and attention. And keeping customers happy and engaged means they likely will continue to return.

However, it traditionally has been very difficult to tailor products and services to the specific needs of individuals; doing so was too time-consuming and costly. As such, most systems that personalize offerings or recommend items need to group people into buckets that generalize their characteristics. While this approach is better than no customization at all, it's still far from optimal.

Fortunately, the combination of data science, machine learning and big data now enables organizations to build a detailed profile of individual customers. Over time, their systems can learn people's preferences and match them with others who have similar preferences -- an approach known as hyper-personalization.

Companies such as Home Depot, Lowe's and Netflix use hyper-personalization techniques driven by data science to better focus their offerings to customers through recommendation engines and personalized marketing. Financial services firms are also making hyper-personalized offers to customers, while healthcare organizations are using the approach to provide treatments and care

to patients and educational institutions are delivering highly tailored, adaptive learning to students.

5. Classification and categorization

Data science tools have shown real capabilities to sort through large volumes of data and categorize or classify it based on learned characteristics. This is especially useful with unstructured data. While structured data can be easily searched and queried through a schema, unstructured data is much harder to process and analyze. Emails, documents, images, videos, audio files, text and binary information of all sorts are forms of unstructured data. Until recently, mining that data for valuable insights proved to be a challenge.

The emergence of deep learning, which uses artificial neural networks to analyze large data sets, has better enabled organizations to do unstructured data analysis, from image, object and audio recognition tasks to classification of data based on document type. For example, data science teams can train deep learning systems to recognize contracts and invoices among piles of documents and do various types of information identification.

Government agencies are also getting into classification and categorization applications powered by data science. Examples include NASA using image recognition to help uncover deeper insights about objects in space and the U.S. Bureau of Labor Statistics automating classification of workplace injuries based on analysis of incident reports.

6. Sentiment and behavioral analysis

Building on the data analysis capabilities of machine learning and deep learning systems, data scientists are digging through reams of data to understand the sentiments of customers or users and their behavior.

Through sentiment analysis and behavioral analysis applications, data science enables organizations to more effectively identify buying and usage patterns and know what people think about products and services and how satisfied they are

with their experience. These applications can also categorize customer sentiment and behavior and track how they change over time.

Travel and hospitality companies have adopted this high-powered approach to sentiment analysis to identify customers who have had highly positive or negative experiences so they can respond quickly. Law enforcement operations are also tapping into sentiment and behavior analysis to spot incidents, situations and trends as they emerge and evolve -- for example, by analyzing social media posts.

7. Conversational systems

One of the earliest applications of machine learning was the development of a chatbot that could have somewhat lifelike conversations without human intervention. In fact, the Turing Test, devised in 1950 by computing pioneer Alan Turing, uses a conversational format to indicate if a system can mimic human intelligence. As such, it's no wonder that organizations are looking to chatbots and other conversational systems to help augment existing workflows and take over some tasks previously handled by humans.

Data science has been extremely helpful in making conversational systems useful to businesses. Data scientists use machine learning algorithms to train these systems on large amounts of text so they can derive conversational patterns from the data. Combined with advanced NLP technology, chatbots, intelligent agents and voice assistants are now popping up everywhere from phones and websites to cars to engage in both text- and voice-based interactions with people -- for example, to find information, help process transactions and provide customer service and support.

8. Autonomous systems

Speaking of cars, one long-held dream of AI aficionados is the self-driving car. Wouldn't it be great to get in a car or truck and let it do the driving while you do other things without having to pay attention to what's happening on the road? Data science is playing a large role in the ongoing development of autonomous vehicles, as well as AI-driven robots and other intelligent machines.

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