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Health care's guide to machine learning

What you need to know about AI's latest buzzword

What is machine learning?

There's a good chance you've heard the term "machine learning," but, if you're like most people, you might not know exactly what it means. Machine learning (ML) is one form of artificial intelligence (AI), and it refers to software that has self-learning or self-improving capabilities — in other words, computers that can learn without humans intervening or assisting.

Part of our everyday lives

If you've ever received a fraud inquiry from your credit card company asking about a suspicious charge, you've experienced the results of ML. Likewise, if you've received movie recommendations based on your viewing history from a streaming service.

How machine learning works

ML uses historical and real-time data to take action, and it can restate subject for clarity either minimize the need for or augment human judgment. How it works depends on your goal. For example, you may be trying to:

- Classify patients or members into one group or another, helping identify the number of patients who are at risk for a specific condition, such as COPD
- Identify outliers in a large group of data, like the handful of suspicious reimbursement claims mixed in with millions of accurate ones

When you know the desired output of the model ahead of time, it is called "supervised" learning.

ML can also be used when you don't know what you're looking for ahead of time, which is called "unsupervised" learning. This approach is good for answering open-ended questions, like "which service lines should we invest in to increase our market share?" or "which members are most likely to engage when offered a treatment plan?" The output from the model will use existing patterns within the data to help leaders uncover potential areas for investment or new understanding.

“Supervised” models

What they do:
Supervised models use labeled training data to identify the connections between input variables and output variables.

How they work:
The training data includes all of the available information about two known populations — for example, patients with a specific diagnosis and patients without that diagnosis.

The algorithm will then identify which variables of input data most accurately predict who will receive the diagnosis and who will not.

After sufficient training, the model is put into production — meaning it begins to analyze data it has never seen before — and can flag individuals who share many of the traits that suggest they have or will develop the diagnosis.

Best suited for:
Tactical purposes and workflow automation.

Supervised ML models are good for scenarios where you are trying to increase efficiency by letting the algorithm scour thousands or millions of records to find bits of information that are helpful and actionable.

To borrow a common metaphor, supervised ML models are great for finding the needle in the haystack.

“Unsupervised” models

What they do:
Unsupervised models use unlabeled data to teach themselves how to “cluster” information together based on shared traits that may or may not be immediately apparent to the human eye.

How they work:
The training data includes all of the available information, but it is unlabeled.

The algorithm teaches itself to sort data into groups with shared characteristics. The more groups that are created, the more granular the analysis becomes.

Human expertise is needed to provide meaning and context for each of the clusters and to identify the number of clusters that is most relevant to the question you are trying to address.

Best suited for:
Answering open-ended, strategic questions.

Unsupervised ML models are good for scenarios where you want to narrow down a list of possible options or evaluate the relative merits of different groups.

To adapt a common metaphor, unsupervised ML models are great for deciding which haystack to look in.

Advantages in health care

The health care industry is known for being late to adopt new technologies — partly due to the highly-sensitive nature of health information data. Yet other industries with similarly onerous regulation, such as the financial industry, have figured out how to benefit from ML in a secure way.

Why should health care embrace ML?

The following trends are quickly forcing an evolution in how AI is used.

1. **Consumerism**
   Consumers increasingly expect the same types of experiences from health care that they get from their credit card companies, retailers, etc. — intuitive, quick and personalized interactions.

2. **Access to data**
   More data is being generated and captured than ever before — approximately 30% of the world's stored data is related to health care. Technology is essential to cleanse, catalog and convert that information into useful insights.

3. **Generational expectations**
   Younger generations are more open to sharing information in exchange for products and services that are highly tailored to their needs.

4. **Quadruple aim**
   Automating business processes and scanning records to flag at-risk populations — so care teams can be proactive in helping prevent health issues before they actually occur and avoid administrative burnout — require predictive and prescriptive analytics models. Efficiently sorting through information and identifying where action will lead to the greatest benefit helps improve outcomes, reduce expenditures, and keep patients happy and staff engaged.

How can health care benefit?

As ML moves from retrospective to real-time analysis, these technologies have the power to help influence healthy decisions, reduce costs and enable efficiencies. With ML, it's possible to:

- Monitor patient data to predict hospitalizations, readmissions and disease progression — and take preventive action
- Automate prior authorizations to remove friction from the system
- Streamline more mundane legal, HR, benefit plan and call center tasks such as processing paperwork to better allocate resources
- Predict the likely outcome of events and recommend specific actions to take to avoid waste
- Anticipate documentation needs to accelerate the revenue cycle and achieve a denial-free future
- Connect consumers with the right resource at the right time through behavioral pairing — delighting customers and resolving issues faster

Health care use cases

Clinical applications

With predictive modeling, clinical staff can proactively identify patients who are at risk of adverse events or chronic conditions. For example, a model backed by ML can help diagnose patients with untreated atrial fibrillation. Researchers can also use ML to help identify early markers of diseases like Alzheimer's years before diagnosis, to enable earlier testing of potential treatments.

Financial applications

Billions of transactions make up the nearly $4 trillion Americans spent on health care in 2018.[1] Reviewing all of them is an impossible task for any human to accomplish. With ML-enabled capabilities, health plans, state governments and the federal government can identify potential fraud, waste and abuse to help lower the cost of care and the burden on taxpayers.

Administrative applications

Automating processes can help add efficiency, lower costs and free up resources to work on higher-value efforts. When combined with natural language processing (NLP), ML models can be particularly effective for documentation review. For example, AI can scan thousands of medical records and predict which ones will need a manual assessment by a highly skilled reviewer — an application with clear advantages in retrospective and prospective risk adjustment and medical necessity review.

Key considerations

When you're considering a health care use case, keep these key steps in mind[2]:

- Identify an opportunity for improvement: today's AI is best suited for very narrow use cases, like predicting readmissions following a specific surgical procedure or improving call center responsiveness. Consider two different applications: an unsupervised model to identify these areas for improvement, and a supervised model to enable your people to take action.
- Determine your organization's place in the maturity curve. Use descriptive analytics to understand your current performance and the populations you serve, and then graduate on to more advanced predictive or prescriptive analytics once that foundation is in place. Cross-functional alignment and leadership support are critical.
- Conduct a thorough evaluation of technology vendors to ensure they provide transparency and deliver results.
- Determine which metrics you'll use to measure performance.
- After deploying your solution, iterate and optimize it.

A continuous process

To keep ML projects running effectively, remember the following:

- Data collection and maintenance — Data must constantly be refreshed to keep predictions accurate.
- Measuring ROI — Pick use cases where you can set metrics and measure progress over time.

Developer's guide to machine learning

Appendix: The growth of ML and AI

The theory behind ML — a technique called backpropagation — was established in the late 1980s, but it has just begun to make a big impact. Why? Because its three prerequisites didn't exist until recently: data, technology and talent.

Data: The quantity of recorded data has exploded in recent years, thanks to trends like digitization and the evolution of the Internet of Things. In health care, the adoption of electronic medical records (EMRs) in the early 2000s created vast stores of previously inaccessible information. Even so, while a seemingly endless amount of data exists, most companies aren't using it to its fullest potential due to cost and limited expertise.

- Organizations must first be able to generate and collect data at scale.
- Then they must be able to curate and clean the data to make it useful.
- To use data in a way that fully enables sophisticated decision-making, organizations need:
  - Strategic data acquisition: The infrastructure to generate and capture proprietary data and supplement it with relevant third-party data.
  - Central data warehouse and access: If data is trapped in silos, its utility is limited.
  - Pervasive automation: Digitizing processes and reducing manual interventions makes it easier to track metrics more accurately and offers further opportunities for improvement.

Expected growth in health care data

1. Stanford Medicine 2017 Health Trends Report: Harnessing the Power of Data in Health. June 2017.

Technology: Computing power has finally reached the tipping point that allows it to crunch these big number sets. Graphic processing units (GPUs) have been especially impactful. Their processing power allows data scientists to create complex ML and deep learning models that are capable of ingesting larger and more diverse data sets.

Talent: Getting the right data — and sufficient quantity — is just the beginning. Creating systems that maximize data's potential requires an interdisciplinary team.

- In order to make algorithms that are useful, organizations need more than mathematicians and coders. They need full-fledged data scientists and experts in the use cases they are pursuing — especially in health care.

ML and the AI ecosystem

AI broadly refers to machines that can act in a smart way. It's easy to get many of the terms mixed up, so let's take a moment to define other forms of AI, how they are applied in health care, and how they relate to or differ from ML:

Deep learning

This more advanced form of ML is based on artificial neural networks that mimic how the human brain makes connections. It is well suited for the complex multivariate analysis often needed in health care.

Natural language processing (NLP)

NLP is a computational linguistics technology that allows the computer to read, interpret and organize data that is buried in unstructured free-text fields.

Robotics

Robotics includes motion planning, navigation and sensing. In health care, robotic-assisted surgery is a prime example of the potential for AI to help improve outcomes — for example, by sensing proximity to a critical structure and alerting the surgeon appropriately.

Conversational AI

Conversational AI uses NLP to allow conversational interactions between humans and robots or software. It includes intelligent assistants, social intelligence, speech recognition, speech biometrics and voice interface.

In health care, the use of chatbots can greatly enhance the consumer experience by automating customer service and other consumer-facing communication channels. Chatbots often learn how to respond to customer inquiries based on training through ML methods.

Vision systems

Vision systems include image recognition and immersive computing. Their applications in health care vary widely, from digitizing paper-based records to analyzing diagnostic imagery. ML plays an important complementary role for this form of AI — it and deep learning are often used to enable image recognition by analyzing individual pixels of the digital image.

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Sources:

1. Richard K. Miller & Associates. Healthcare Business Market Research Handbook 2017–2018, p. 61.
2. Health IT Analytics. 5 steps for planning a healthcare artificial intelligence project. Available at https://healthitanalytics.com/features/5-steps-for-planning-a-healthcare-artificial-intelligence-project. Accessed March 12, 2019.

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