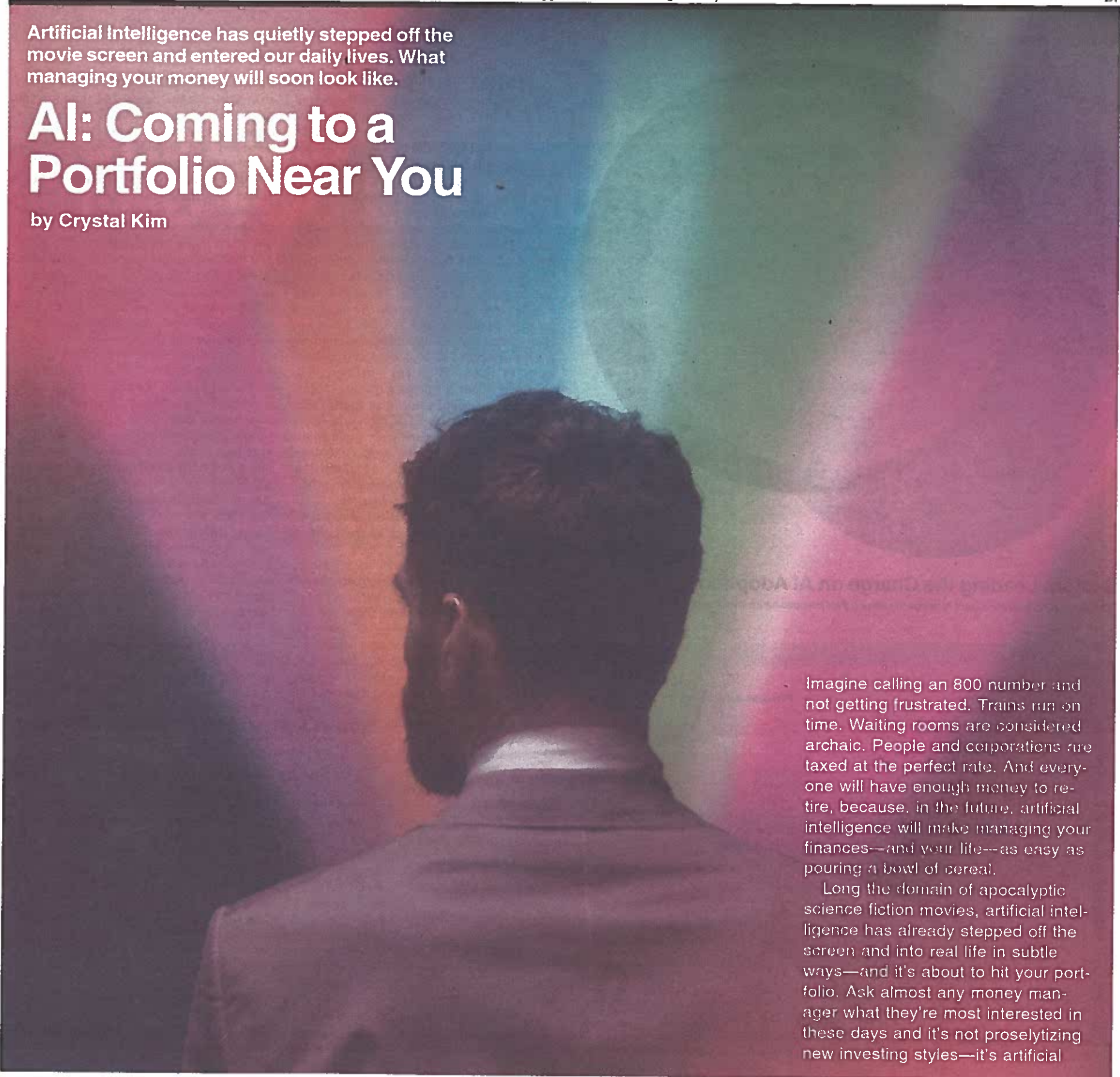


Artificial intelligence has quietly stepped off the movie screen and entered our daily lives. What managing your money will soon look like.

AI: Coming to a Portfolio Near You

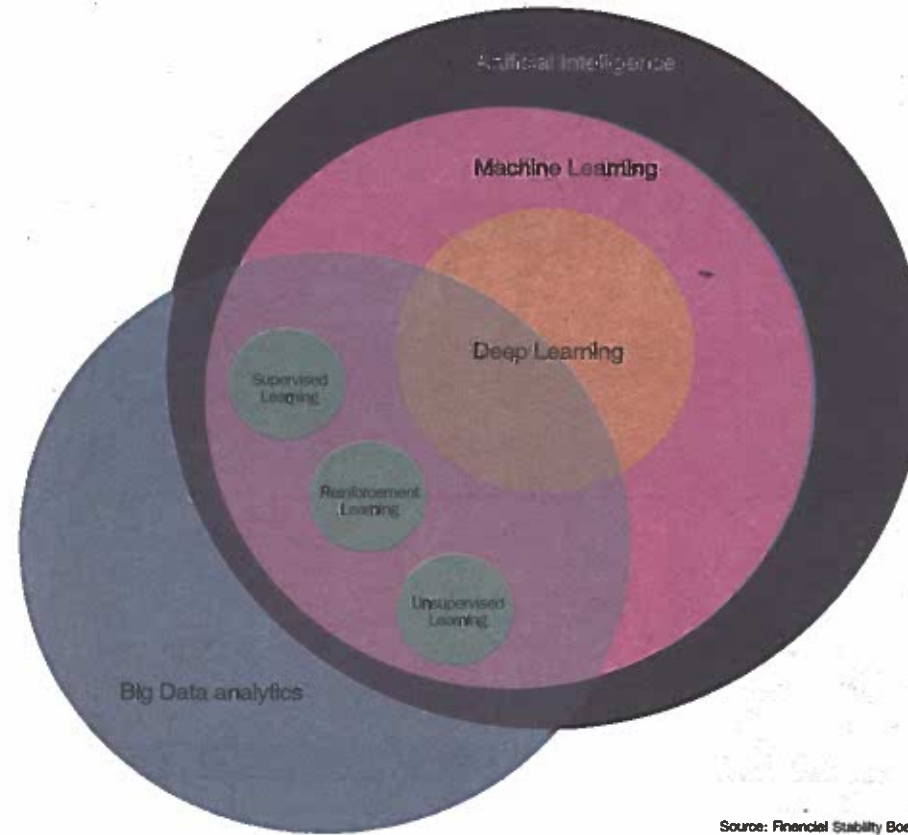
by Crystal Kim

A man in a dark suit is seen from the back, looking at a large, glowing screen. The screen displays various data visualizations, including a prominent circular chart with a blue-to-green gradient. The background is a soft, colorful gradient of purple, blue, and green, suggesting a futuristic or digital environment.

Imagine calling an 800 number and not getting frustrated. Trains run on time. Waiting rooms are considered archaic. People and corporations are taxed at the perfect rate. And everyone will have enough money to retire, because, in the future, artificial intelligence will make managing your finances—and your life—as easy as pouring a bowl of cereal.

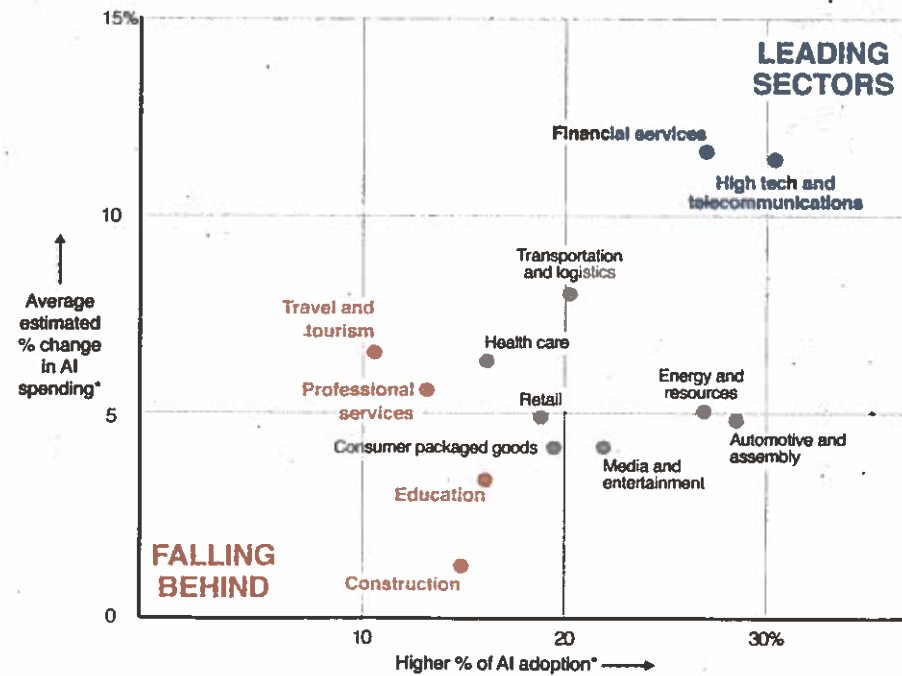
Long the domain of apocalyptic science fiction movies, artificial intelligence has already stepped off the screen and into real life in subtle ways—and it's about to hit your portfolio. Ask almost any money manager what they're most interested in these days and it's not proselytizing new investing styles—it's artificial

AI Deconstructed



Sectors Leading the Charge on AI Adoption

Comparing each sector's current AI adoption rate and their intended future investment



intelligence. Artificial intelligence is the ultimate competitive edge. It has the potential to deliver an infinite workforce that never tires and virtually never makes mistakes. Can AI save the beleaguered asset management industry? Could it make investing even easier, cheaper, more effective? The biggest fund firms have been spending billions to find out.

BlackRock, Vanguard, Fidelity, and T. Rowe Price, among others, have all invested time and money setting up tech centers in major cities, apart from their headquarters. BlackRock's digs are in Palo Alto, Fidelity's in Boston, Vanguard's in downtown Philadelphia, and T. Rowe Price's in New York City—all satellites designed for a very specific set of people and type of work in mind. They are outfitted with standing desks, mock-garage project rooms, shag rugs, Christmas lights, puzzles, Kit Kat bars, and LaCroix soda—more start-up chic, less grandfather's mahogany and leather. It's part of the effort to draw the best minds, data scientists, information architects, and algorithm wranglers otherwise headed to Google or Amazon.

"We are in a technological arms race," says Andrew Lo, director of the Laboratory for Financial Engineering at the Massachusetts Institute of Technology. "Financial institutions have to participate just to keep up with the competition."

What are they competing for? Cost savings, for starters—anything to offset the shrinking margins as investment products get cheaper and cheaper. AI, done right, could also give portfolio managers an edge, and better serve investors with a wider array of financial planning tools that make today's robo-advisors look like an abacus. "Every major CEO of every major company is bullish on AI. Everyone is chasing the nugget of gold," says Vipin Mayar, head of Fidelity's AI initiatives.

Artificial intelligence starts with a machine learning data, as a child might, as opposed to being programmed to execute a specific task. Machines learn by being fed data via a set of statistical techniques, which are unique and proprietary. The term "Big Data" refers to the bazillions of data points—where you are at any given moment, how much you've spent on coffee this month, even who your friends are—that could be available to data scientists to help create and feed into these statistical models.

Deep learning is a sub-methodology of machine learning, where the biggest breakthroughs are happening now. Deep learn-

ing is basically teaching computers to process information more like humans do. Natural language processing, for instance, means computers can come to actually understand and develop responses to language, rather than react according to a series of programmed rules. Computer vision allows a computer to see and recognize visual images, not only making the distinction between a photo of an apple, a drawing of an apple, and an actual apple, but also distinguishing a multitude of variations of each. This type of AI has enabled self-driving cars, and machines that can identify tumors or choose the best grapes to make a Cabernet. And, of course, augment financial data analysis.

AI has limitations, as any film buff (or sentient being) can tell you. Self-driving cars crash. IBM's Watson can beat world-renowned chess players, but can't explain why people play chess. HAL tried to kill people. Financial firms are thinking big but starting small. Could AI one day bring about better financial education, empowerment, equalizing access to and opportunities for individualized advice? Probably. But right now, most financial firms are focusing their initial efforts around cost savings—for themselves. "Asset managers can't afford the business model they operate today," says John Lehner, State Street's global head of investment manager services, on the urgency of AI adoption.

When a major bank approached MIT's Lo several years ago, it was hemorrhaging \$50 million a day in losses from people not paying their credit-card debts. Its initial solution was to cut credit lines across the board by 50%. Lo and his team combined statistical credit bureau data, FICO scores, past history of delinquencies and defaults with banking records, ATM transactions, and direct deposits, into their machine-learning models. The models found that people whose direct deposits stopped in the last three months were five times more likely to be delinquent or default.

Any human could surmise that being unemployed makes it harder to pay your bills. But the machine was able to identify who among the massive customer base were the most hard-pressed. The bank reduced its risk by eliminating the credit lines of the 4% of customers who showed the highest likelihood of default instead of cutting the credit lines of everyone by 50%.

On the fund side, hedge fund firm Man Group is one of the AI pioneers. Its AHL unit, the quantitative investing side of the firm, is using AI to reduce slippage, the

difference between the expected price of a trade and the price at which it was actually executed. In probability theory, the “multi-armed bandit” is a mathematical problem in which resources have to be distributed across a number of different choices to maximize the reward. Think of strategically putting a bucket of coins in a row of slot machines. “I was reading about that and thought ‘this is similar to trade execution,’ but instead of receiving a reward, we incur a cost when we pick certain trade execution algorithms,” says Anthony Ledford, chief scientist at Man AHL.

Usually, humans determine which algorithm to use to incur the lowest possible expense and least market impact. But Man’s research found that an algorithm was best-suited to pick the right algorithm for the job. “It did two things: It got rid of all that human time spent by delegating it to machine learning algorithms and reduced slippage by about 10%,” says Ledford. That AI has been so successful, it is being deployed in Man Group’s other units. Fidelity Investments is developing these capabilities as well.

Next Up: AI and Stock-Picking

Some of the most interesting developments in AI are in portfolio management. Machines have already commandeered the passive investing trend: The \$3 trillion exchange-traded fund industry couldn’t have happened without modern computing, and the newest ETFs are likely to make even greater use of AI.

Passive investing is simply the buying and selling according to a set of rules on a particular schedule. The best-known passive investment, a Standard & Poor’s 500 index fund, only adjusts its holdings according to its criteria around market value. Others, like the Russell indexes, rebalance annually. But funds using much more complicated—though still technically passive—rules are being launched, and embraced. These new products are passive in that the securities they own and when they’re bought or sold adhere to a set of rules, but those rules have become so complex that they are essentially active products. AI can take the decision-making even further, using Big Data—satellite images of foot traffic on New York’s Fifth Avenue or the shadows cast by oil tankers—to process massive amounts of information, filter out the “noise,” and seize on the “signals” to buy or sell.

AI will make the distinction between active and passive even more subtle, perhaps

subsuming the debate into a completely new form of investing, says Jeff Shen, co-head of BlackRock’s scientific active equity group. “We just don’t have a name for it yet.”

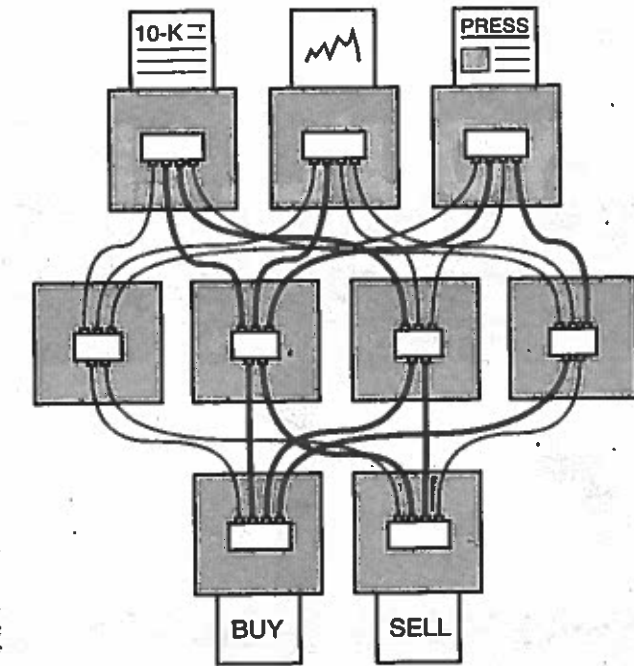
Machine learning combined with natural language processing can tell portfolio managers how bullish a CEO sounds in an earnings call by mining transcripts for specific language it was trained to identify. It can be used to scout tweets to get real-time analysis of consumers’ changing tastes and trends. Fidelity has been mining social media to figure out how, for example, Under Armour’s popularity compares with competitors and how customers feel about Chipotle’s “queso” rollout, says Tim Cohen, co-head of equity. “What we’re not doing is automating investing decisions. We’re exploring and trying to enhance our existing models. The challenge is finding new techniques that we can use long-term.”

Next up? Machines will evaluate and predict human behavior, such as how portfolio managers trade around management meetings and earnings. Today’s simple analytics are backward-looking, examining historical trading information around these specific events. Machine learning, one day, will sniff out a pattern that can be used to correct behavior and provide a competitive edge.

Man AHL offers an example of using AI today for a more traditional quantitative approach: Using machine learning, the firm tried to “re-learn” momentum characteristics. In most cases, the AI corroborated that the firm was doing something right in its system of buying and selling stocks based on how fast and in what direction they were moving. But momentum strategies are tricky, particularly when prices are rising or falling rapidly. Most momentum ETFs aren’t able to capture and respond to the “signals” that surface in especially volatile markets, which is why many have spotty track records. Man’s AI uncovered those signals reversing during extremely volatile markets, and the model pivoted quickly to capture the turnaround. “That’s the kind of thing which is impossible to write down in a model and capture with a more traditional approach,” Ledford says. “Deep learning helps find signals we don’t know about.”

Machine learning is starting to show up in more mainstream products, but early efforts are a little underwhelming. BlackRock launched seven new sector ETFs last month, such as the iShares Evolved U.S. Technology ETF (ticker: IETC) and iShares Evolved U.S. Consumer Staples ETF (IECS). The firm uses natural lan-

Deep Learning in Action



INPUT LAYER

Large amounts of relevant data are necessary for deep learning to tackle a problem. In deep learning, the neural net can process raw data without the aid of a human.

HIDDEN LAYER

“Neurons” test and attempt to understand a myriad of different inputs, mimicking brain activity. Usually, there are many hidden layers of neurons and many hidden layers of information within each. Connections are weighted to allow each input to have degrees of influence.

OUTPUT LAYER

Data scientists can use confidence intervals, the best guess of predicted outcomes, plus a range of likely outcomes around the best guess, to determine accuracy and evaluate performance.

Sources: TensorFlow; Stanford

guage processing to sift through public filings for specific words and phrases describing the business. That determines which companies go in which ETFs and at what weighting. The end result is similar to traditional sector categories, though some companies appear in more than one sector. IBM’s Watson is also on the ETF bandwagon. The \$134 million large-company AI Powered Equity ETF (AIEQ) launched six months ago.

Expect to see more AI-inspired products, but investors should be as wary of them as they would any other new product that seems based more on buzzwords than proven track records. Artificial Intelligence processes can be as unique as the people building them.

“A massive amount of data is required to make AI work, and machine learning is not just one thing, but many different things,” says Campbell Harvey, a Duke University professor and Man Group consultant. “This is a common problem with robo-advisors. People are fooled thinking it’s algorithmic or whatever, but some are just garbage. Be very careful.”

Plus, markets are complicated. “The market is a biological system, not an immutable one, and we don’t have laws that can

explain how this ecology evolves over the course of a year or even decades,” says Lo. “AI can address the who, what, when, where and how, but the underlying logic of the decision—which is what makes Warren Buffett successful—is lacking.”

AI Will Become Your Fund Manager, Financial Advisor, and Therapist

That uniquely human ability to reason means that Buffett, Fidelity’s Will Danoff, DoubleLine Capital’s Jeffrey Gundlach, and the like can breathe easy. But it’s not just about portfolio management: Some financial firms are betting that AI can accurately ascertain behavioral traits and predict individual reactions to financial and market events.

When the AI team at Fidelity got wind that it was going to have access to supercomputers to crunch massive amounts of data, James Aylward left the office, got in his car, and headed home. He wanted to know what kinds of problems the families in his neighborhood needed solved. Top of the list: They wanted to know how they measure up to families that look just like them, and learn how their counterparts paid for college or child care, where they chose to live, and what trade-offs they made.



ETFs BUILT
AROUND
THE WAY
INVESTORS
THINK

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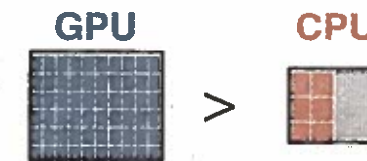
Before investing consider the fund's investment objectives, risks, charges and expenses. Go to flexshares.com for a prospectus containing this information. Read it carefully. Foreside Fund Services, LLC, distributor.

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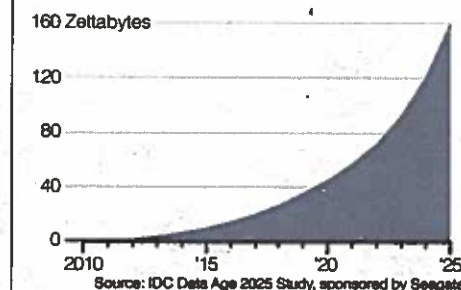
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Catalysts of the AI Boom

A graphics processing unit (GPU) can calculate math problems many times faster than a standard central processing unit (CPU). That power plus the explosion of data to crunch catalyzed the AI boom.



IDC projects the world's data will reach 163 zettabytes by 2025. One zettabyte is one trillion gigabytes, or 300 trillion photos of your cat.



AI can't advise families what trade-offs to make now, but the Fidelity team, led by Aylward, has the capacity to identify households with common traits. Next up is building a predictive app customers can use to learn what steps they should take to feel more financially secure. This is tricky business, since there are so many moving parts, and ultimately no benchmark to measure against, says Mayar, Fidelity's head of AI: "Google Maps solves an easy problem. Get from point A to point B. The path to financial health is far more complicated, but our research found the AI opportunity."

Aylward, the lead on this particular project, points out that the promise of AI is that its capabilities strengthen and expand over time. "AI builds on itself, starting with a diagnostics approach, and then becoming predictive: 'If you take this path, this will probably happen to you,'" he says. "Then, as it learns, it gets prescriptive: 'You should do A or B.'"

Lo, meanwhile, is working with a large brokerage firm to develop a measure of investor behavior his team is calling the "freakout factor." There are many algorithms that say what investors ought to do, but none that account for what they actually do, he says. He is using data from hundreds of thousands of anonymized accounts, spanning 12 years, to measure

behavior. They've constructed demographic profiles to identify the investors most at risk of "freaking out" during a market correction or downturn. Imagine how much pain that AI could have saved investors during the last financial crisis, says Lo.

"We need artificial stupidity. We can tell people all day long that the market will come back, but that's like trying to prevent teenage pregnancy by preaching abstinence. It's not realistic because it doesn't account for human nature," Lo says. He expects research results in months. Models like his could be commercially available in two to three years.

Research firm Morningstar is also applying AI technology to its very human-oriented tasks. The firm launched its new quantitative rating system in February. A machine-learning model aims to mimic the firm's analyst ratings, which are qualitative assessments of how analysts view the outlook for a fund. Analyst ratings are predictive and qualitative, versus the firm's star ratings, which are backward-looking and quantitative.

The methodology report shows that the learning model in testing matched existing analyst ratings 55% of the time for negative ratings and 78% of the time for positive ratings. That's a level of accuracy Morningstar's head quant Timothy Strauts told *Barron's* the firm was comfortable with. Whether advisors will agree with that assessment is another matter.

Perhaps the greatest obstacle for AI isn't technology but perception. With privacy issues moving to the forefront of public debate, more than one CEO of an asset manager told *Barron's* that they had far more data on their customers, and far more technological use for that data, than they were willing to acknowledge to those customers for fear of unsettling them—even if the end result was to improve the customer experience. "How do we deliver a solution that doesn't feel intrusive and strange and Big Brother-ish?," wonders Lisha Davis, the head of Vanguard's tech center, adding that she asks that question regularly. "We're trying to strike that right balance between being helpful and being a nuisance," says Davis.

What AI is asked to do today will determine what it becomes tomorrow. The transition can be hard to spot, though. "Data scientists joke that when AI is turned into a product [like Apple's Siri or Google Maps] it is no longer AI—it's just the name of the product," says Aylward with a laugh. "So AI is always in the future." ■