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MARKETS

The Future Is Bumpy: High-Tech Hedge Fund Hits Limits of Robot Stock Picking

Voleon is among investors deploying machine learning, a technology in which computers develop trading strategies. It's harder than it sounds.



Voleon co-founder Jon McAuliffe at the hedge fund's offices in Berkeley, Calif. PHOTO: JASON HENRY FOR THE WALL STREET JOURNAL

By Bradley Hope and Juliet Chung

Updated Dec. 11, 2017 7:23 p.m. ET

BERKELEY, Calif.—For Michael Kharitonov, building a hedge fund based on machine learning has been a rule of threes: It was three times as hard, and it took three times as long, as anticipated.

“Most of the things we’ve tried have failed,” said the co-founder of a little-known firm called Voleon Group.

Machine learning, a set of techniques that empowers computers to find patterns in data without using rules prescribed by humans, has been producing advances in a range of fields, from robotics to weather forecasting to language translation. The technique is at the heart of efforts to build self-driving cars.

Why not use it to crack financial markets? The notion has led to an arms race of sorts, as multibillion-dollar investment firms that already were mathematically focused have been signing up the smartest computer scientists and statisticians they can find.

The gambit seems to be working for two of this year’s top-performing hedge funds. Quantitative Investment Management LLC, up 68% this year in its biggest fund, attributes its success to the technique. Teza Capital Management LLC credits machine learning in part for its more than 50% gain so far this year.

Yet instances of parlaying machine learning into investing success over a sustained period are rare. Much of the reason can be seen in the yearslong struggle of Voleon, one of the first investment firms to commit itself fully to the kind of machine learning that is producing many advances in other fields.

One early lesson: Those other advances might not apply to trading, a messier environment where patterns are often muffled. “The idea that we could just take the machine-learning techniques in speech recognition and computer vision to generate better forecasts just didn’t work,” said Mr. Kharitonov, a curly-haired computer scientist who immigrated from Russia with his family when he was 18. “That was our initial idea.”

Mr. Kharitonov, 54 years old, and co-founder Jon McAuliffe, 43, have Ph.D.s in computer science and statistics, respectively. Both went into finance and became researchers at D.E. Shaw Group, one of the oldest and most successful “quant” hedge funds. Mr. Kharitonov at one point reported to a young Jeff Bezos, before his boss left to found Amazon.com.

For several years, Messrs. Kharitonov and McAuliffe believed the tools of machine learning, which both had studied, were too crude to use in investing. The methodology was sound, but computers weren’t fast enough and there weren’t enough large data sets to comb.

In contrast to the more common case where a scientist has a hypothesis and writes an algorithm for a computer to carry out, in machine learning a person seeds the

computer with vast quantities of data and asks it to figure out patterns all by itself.

The computer, in effect, writes its own algorithm, and uses it to make predictions. How it came up with these, it doesn't say.

By 2007, new data sets and more-powerful computers had persuaded Mr.

Kharitonov, who is known as Misha, and Mr. McAuliffe to start their own firm devoted to investing via machine learning. They formed Voleon, picking the name, which has no particular meaning, because the domain for the website was available to register.

Raising money, they faced deeply skeptical institutional investors. Big quant firms can explain fairly well what their algorithms are doing, having built them. In machine learning, only the computer knows why it did what it did.

The inherent mystery of the approach, where computers detect patterns too subtle for humans to easily comprehend, gave the Voleon principals little hope of being able to explain to potential investors why their firm would buy or sell a stock.

"A lot of people simply weren't interested," said Mr. Kharitonov. "But we found a few who understood the potential of machine learning."

Live trading began in fall 2008, the depths of the financial crisis. For the following two full years, the firm lost money, despite the U.S. stock market's gradual recovery from its low in March 2009. The Voleon founders plowed ahead, believing they were tackling one of machine learning's hardest problems and it would take time to hone their system enough to earn profits.

The basic problem they faced was that markets are so chaotic. Machine-learning systems have been best applied so far to situations where patterns are more of a repeating nature, and thus easier to discern, such as in playing the ancient game of Go or even guiding a driverless car. The financial markets are "noisier"—continually being affected by new events, the relationships among which are frequently shifting.

The protean nature of the markets also means yesterday's relationships can vanish as investors figure them out and move to take advantage of them. This isn't a problem faced by machine learning in other fields, such as converting human speech to text; computer engineers can count on human speech continuing to have the same basic characteristics.

Even though the success of machine learning in other fields was partly what persuaded them to try it in investing, by late 2011 the Voleon founders had thrown out most of the

techniques from other applications. Replacing them was the founders' own, custom-designed system for the unruly markets.

Books with titles such as "Elements of Large-Sample Theory" and "BDA3" lined the bookshelves in the tidy office of Mr. McAuliffe on a recent visit. Mr. Kharitonov's office sported a circuit board he had taken apart and a jumble of boxes overflowing with papers.

One challenge the two faced was the need to run 15-year simulations of the stock market using every "tick" of the price of every share. This involved terabytes of data. Voleon needed to run the simulations in hours, but they were taking days and weeks.

At the time, the whole company was around 10 or 12 people. The team tried buying more computing power and using special chips built for computer gaming known as graphics processing units, or GPUs. But it still took too long.

Mr. McAuliffe spent months alone in his office working the problem through in a painstaking process, focusing on intricate details. Finally he cracked it, and Voleon was able to launch a second-generation platform in July 2012.

"The brute-force approach didn't work," Mr. Kharitonov said. "The standard techniques didn't work."

Their new trading system brought in much better profits, and more investor interest. After modest 2011 returns in its flagship fund, Voleon notched gains of 34.9% in 2012 and 46.3% in 2013, according to an investor.

Still, following two more up years, Voleon suffered a loss of more than 9% in 2016, prompting concern among some of its investors.

"Nothing focuses your mind like a drawdown," Mr. Kharitonov said, referring to the loss. "We learned a lot from last year."

This year has been better. The firm, which has about \$1.8 billion under management, was up about 4.5% through October in its flagship fund, one investor said. Its annualized return since inception is about 10.5%.

The firm's uneven results, complicated strategy—and Mr. Kharitonov's habit of occasionally pausing client meetings to hold phone conversations in Russian—haven't stopped Voleon from growing. It is broadening its investing target beyond U.S. and European stocks and has expanded into another building near the University of California, Berkeley, campus.

Some investment firms that have tried machine learning use it only for limited tasks, among them AQR Capital Management LLC, which is experimenting with the technique to find the optimal time to roll over futures contracts. Voleon not only is fully focused on machine learning— trading more than \$1 billion worth of stocks a day using the technique— but stands out for its complete lack of interest in the reason its system buys one stock and sells another.

The more predictive a machine-learning system is, the more difficult it is for people to comprehend what it is up to, according to Mr. Kharitonov. “You can have maximum explainability or maximum predictive power,” he said, paraphrasing the late Berkeley statistician Leo Breiman.

At the root of this, mathematicians say, is that the human mind is set up to understand scenarios with about three dimensions, while dozens or hundreds are within the grasp of machine-learning systems. Their power comes in discovering connections, often nonlinear, among those dimensions.

This “doesn’t mean we don’t think about what’s going on,” Mr. McAuliffe said. Voleon researchers sometimes design what they call “perturbations” to study the importance of various inputs into the prediction system.

This testing also helps them figure out whether, in certain cases, it might be too tuned to historical data to be useful for forecasts. In statistics, this is known as the problem of “overfitting.”

Voleon’s computers look for relationships in not just financial information but also nonfinancial data sets. Broadly, these could include anything from analyses of satellite images and shipping manifests to credit-card receipts and social-media sentiment about particular companies. Successfully analyzing such data is a goal of quants and non-quants alike as they look for a heads-up about changes in the health of an industry or the supply of a commodity.

The Voleon principals won’t reveal what data they feed into their system, to say nothing of how they have trained it to assess the data. Like other quant firms, Voleon guards its techniques and strategies. Frosted glass on its quarters provides privacy. No sign on the property identifies the firm.

Investors uncomfortable with the mystery of it all have “self-selected” out of the firm, Mr. Kharitonov said. While he understands their discomfort, he believes computers make fewer mistakes than people.



“The application of machine learning science to financial prediction is still in its early stage,” he said. “We are just scratching the surface.”

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*Appeared in
the December
12, 2017, print
edition as
'High-Tech
Hedge Fund*

Voleon co-founder Jon McAuliffe PHOTO: JASON HENRY FOR THE WALL STREET JOURNAL

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