Time and Money

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Sometimes our body of knowledge reminds us that we look at this field with a specific point of view. There are other ways of approaching computing.

"Remember that time is money," wrote American Founding Father Benjamin Franklin. Waste neither, he added, "but make the best use of both."[1] The current addition to our body of knowledge is concerned with time and money. A careful examination of the article "Algorithmic Trading,"[7] by Giuseppe Nuti, Mahnoosh Mirghaemi, Philip Treleaven, and Chaiyakorn Yingsaeree (see "Article Facts"), suggests that time and money may be very different subjects in computer science and engineering. Rather than have the kind of equivalence that Franklin suggested, they can point in quite different directions.[1]

Algorithmic trading is the use of programs, often termed *agents* in the literature, to identify, initiate, and complete the purchase and sale of securities in electronic markets. It has been heavily influenced by a number of topics in computer science, including machine learning, logic systems, distributed processing, and cybersecurity.

The authors have strong connections to computer science. All were either professors or students in the Department of Computer Science, University College London. Yet, in the last paragraph, they suggest that algorithmic trading is a field slightly apart from computing. "Algorithmic trading might be described as an arms race drawing on the skills of top computing professionals," they wrote; for "computing professionals interested in finance, it is a stimulating and certainly well-paid career."[7]

Like most works featured in this column, "Algorithmic Trading" was far from the first *Computer* article on the subject of the stock market. In 1976, *Computer*

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published “Minicomputers in Security Dealing.” It appeared barely five years after the founding of the NASDAQ stock market, which was created to deliver stock quotes over telephone lines. The article carefully described the requirements of a stockbroker’s office and suggested that the minicomputers of its day were adequate. A fair amount of time in the article was spent arguing that the limited arithmetic of those computers—they were generally 16-bit machines—was sufficient.[3]

At the time, brokers used computers in limited ways. Primarily, the machines were employed to get information about stock prices. They have since been called *request-for-quote systems*. It took another five years before most brokers could place an order with a computer.[5] At that point, the orders were not completed electronically but passed to human traders who worked the floors of the New York Stock Exchange, the pits of the Chicago Mercantile Exchange, and the trading rooms of European and Asian markets. To get fully automated trades, those that were identified, initiated, and completed by software, would require substantially more work.

As “Algorithmic Trading” makes clear, computers can easily make electronic stock transactions. They find the problem of controlling transactions and managing risk much more difficult. You are putting assets in the hands of a program that can easily lose them if it malfunctions, fails to read the market properly, and faces an aggressive and perhaps unscrupulous trader. Our article notes that most algorithmic trading programs divide the process into three steps and treat each individually. They begin by analyzing a stock to see if a purchase or sale would meet preset goals. Once they have identified a transaction, they generate what is called a *trading signal*. This identifies financial instruments to exchange and builds a model of the final portfolio. Finally, the programs executive the trade. In this step, they identify the proper market and the best ways of engaging it. In a large purchase, for example, they might divide the acquisition into a series of small steps to avoid increasing the prices.

The ideas behind algorithmic trading predate the electronic computer, and this history suggests the great challenge of building algorithmic trading systems. Beginning in the 1910s and 1920s, individuals began tracking stock process and transaction volumes. From this information, traders would develop rules about when to hold, when to buy, and when to sell. Perhaps the most famous was Jesse Livermore, who articulated his ideas in *How to Trade in Stocks*.[4] Livermore’s impact was so great that he has spawned avatars on modern social media. On Twitter, some person or group uses his identity to tweet ideas from his book (https://twitter.com/Jesse_Livermore). But Livermore, as well as most of the precomputer rule-based traders, relied on a key piece of market structure: the floor or pit where trades were actually made. Today, those pits seem a quaint reflection of a bygone era. They were tight spaces, hot and sweaty. They favored traders with loud voices. They relied on arcane hand signals to conduct business. Yet, they were also a concentrated place of information exchange.

By looking at one another, traders would get hints about how the market was moving. They could perceive the behavior of their peers by their postures and facial expressions. They could ascertain if other traders were aggressive or reluctant, if they were confident or worried. From those signs, they could identify whether a market was on a downward trend and avoid taking a loss, and they could see if others were gaining profits that they that might wish to take. The trading pit was “enormous, thundering, suck[ing] in and spew[ing] out,” wrote the novelist Frank Norris in his description of the Chicago markets, “sending the swirl of its mighty central eddy” into the city.[6]

Of course, creating that kind of information exchange in a digital system is a difficult thing to do. Numbers, no matter in what volume and what detail, cannot convey the information traders could see through a simple glance around the pit or floor. As a result, traders were reluctant to switch to computer systems and to algorithmic systems specifically. Sociologist Donald MacKenzie wrote that traders were deeply attached to the physical aspects of market pits, and hence “it was unsurprising that mechanization, which threatened to sweep it away altogether, should have been so adamantly opposed.”[5] Only when traders began to lose business did they begin to accept digital trading.

With these digital trading systems came new concerns, issues that largely lay outside the world of computer science. The systems not only made the process of trading securities cheaper and faster but they introduced a new

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dynamic into the market. Beginning in the 1980s, markets experienced large swings that seemed to be caused by digital trading. The Black Monday crash of 1987 was perhaps the first collapse in prices that was linked to electronic systems. A short-lived crash on 6 May 2010 may have been more frightening, as it seemed to have no obvious cause.

As we expanded the use of these systems, our research shifted from computer science to economics, from questions about the most efficient ways to build the systems to questions about the impact they were having on markets, firms, and investors. At some level, this research could have easily been conducted within the computing community. If everything is digital, then digital experts should have something to say. However, the study of algorithmic trading systems tended to focus on quantities that had little precedent in computer science: volatility and liquidity, the extent to which markets were suddenly changing, and the extent to which markets were willing to continue trading. As a result, research about trading systems shifted from computer science. There was still a little sophisticated computer science adding to trading systems, but its value was determined by its impact on a market.[2]

This gets us back to the question of whether time is money and the place "Algorithmic Trading" has in the IEEE Computer Society's body of knowledge. As has been argued in this column before, computing is a remarkably broad subject that touches almost every facet of human endeavor. The Computer Society has done a remarkable job providing a technological home for the professionals involved in many of these fields. The fact that a single professional organization can support work in fields as diverse as pattern recognition, software engineering, cybersecurity, and hardware design is notable.

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Of course, there are many technical fields that have computing components that are not supported by the Computer Society. Transportation, for example, includes a community of software engineers that has little contact with the Computer Society. Fintech, a group of workers developing software and processes within the financial community, occupies a similar position. Hence, articles such as "Algorithmic Trading" play a linking role in our body of knowledge. They join our communities. They remind us that it is possible and good for one group of technical professionals to look at a system and ask questions about time and efficiency. At the same time, another group will look at the same system and consider the issues of money and markets.

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For 2021, the "Body of Knowledge" column takes its information from a report prepared by the IEEE Publications office on 20 November 2020, and the statistics were current as of that date. Other citation services can and do give different numbers.

REFERENCES

1. B. Franklin, "Advice to a young tradesman," in *The American Instructor: Or Young Man's Best Companion*, 9th revised and corrected ed., G. Fisher, Ed. Philadelphia: New-Printing-Office, 1748. [Online]. Available: https://founders.archives.gov/documents/Franklin/01-03-02-0130
2. A. Chaboud, B. Chiquoine, E. Hjalmarsson, and C. Vega, "Rise of the machines: Algorithmic trading in the foreign exchange market," The Federal Reserve Board, Oct. 2009. https://www.federalreserve.gov/pubs/ifdp/2009/980/ifdp980.htm
3. B. R. Gaines, P. V. Facey, and J. Sams, "Minicomputers in security dealing," *Computer*, vol. 9, no. 9, pp. 1–19, 1976. doi: 10.1109/C-M.1976.218697.
4. J. Livermore, *How to Trade in Stocks: The Livermore Formula for Combining Time Element and Price*. New York: Duel Sloan Pierce, 1940.
5. D. MacKenzie, "Mechanizing the Merc: The Chicago mercantile exchange and the rise of high-frequency trading," *Technol. Culture*, vol. 56, no. 3, pp, 646–675, July 2015. doi: 10.1353/tech.2015.0102.
6. F. Norris, *The Pit*. New York: Doubleday, 1903.
7. G. Nuti, M. Mirghaemi, P. Treleaven, and C. Yingsaeree, "Algorithmic trading," *Computer*, vol. 44, no. 11, pp. 61–69, 2011. doi: 10.1109/MC.2011.31.

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