Artificial Intelligence and Investing

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INTRODUCTION

The techniques of artificial intelligence include knowledge-based, machine learning, and natural language processing techniques. The discipline of investing requires data identification, asset valuation, and risk management. Artificial intelligence techniques apply to many aspects of financial investing, and published work has shown an emphasis on the application of knowledge-based techniques for credit risk assessment and machine learning techniques for stock valuation. However, in the future, knowledge-based, machine learning, and natural language processing techniques will be integrated into systems that simultaneously address data identification, asset valuation, and risk management.

WHAT IS ARTIFICIAL INTELLIGENCE?

Computers play a role in many aspects of investing. For example, program trading is computer-driven, automatically executed trading of large volumes of shares, and has become increasingly prominent on stock exchanges. Artificial intelligence is a technique of computing that is perpetually on the cutting edge of what can be done with computers. Artificial intelligence could apply to program trading, but also other aspects of investing.

In the early days of computing, a typical task for a computer program was a numerical computation, such as computing the trajectory of a bullet. In modern days, a typical task for a computer program may involve supporting many people in important decisions, backed by a massive database across a global network. As the tasks that computers typically perform have become more complex and more closely intertwined with the daily decisions of people, the behavior of the computer programs increasingly assumes characteristics that people associate with intelligence. When, exactly, a program earns the label of "artificial intelligence" is unclear. The classic test for whether a program is intelligent is that a person would not be able to distinguish a response from an intelligent program from the response of a person. This famous Turing Test is dependent on factors not easily standardized, such as what person is making the assessment under what conditions.

A range of computer programming techniques that are currently, popularly considered artificial intelligence techniques includes (Rada 2008):

- Knowledge-based techniques, such as in expert systems.
- Machine learning techniques, such as genetic algorithms and neural networks.
- Sensory or motor techniques, such as natural language processing and image processing.

These methods may apply to investing. For instance, expert systems have been used to predict whether a company will go bankrupt. Neural networks have been used to generate buy and sell decisions on stock exchange indices. Natural language processing programs have been used to analyze corporate news releases, and to suggest a buy or sell signal for the corporate stock.

While artificial intelligence (AI) could apply to many areas of investing, much of what happens in computer-supported investing comes from non-AI areas. For instance, computational techniques not considered primarily AI techniques include numerical analyses, operations research, and probabilistic analyses. These non-AI techniques are routinely used in investing.

INVESTING AND DATA

The process of investing has three stages of:

- Data identification,
- Asset valuation, and
- Risk management.

AI has been most often applied to asset valuation, but is also applicable to data identification and risk management.

Two, high-level types of data used in financial investing are technical data and fundamental data. The price of an asset across time is technical data, and lends itself to various computations, such as the moving average or the standard deviation (volatility). Fundamental data should support cause-and-effect relationships between an asset and its price. For instance, the quality of management of a company should influence the profitability of a company and thus, the price of its stock.

The universe of fundamental data is infinite. Many streams of data that might be relevant, such as corporate earnings or corporate debt, might also be related to one another. Various

non-AI tools, such as linear regression analysis and principal components analysis, might be used in identifying what sets of data are more likely to be useful than what other sets. Such non-AI, computational techniques can be combined with AI techniques in experimenting with various combinations of data and choosing what data to use in asset valuation.

ASSET VALUATION

Different computational techniques might be appropriate for different assets or for different types of data for a particular asset. For instance, both stocks and commodities have price histories that might be tracked by the same time series analysis methods. However, the knowledge bases that would apply to valuing these assets might be significantly different. For example, knowledge about corporate management is less germane to commodity valuation than to stock valuation, while knowledge about weather patterns is more germane to commodity valuation than stock valuation.

Many assets have derivatives, such as options, that are priced and exchanged on markets. The computational characteristic of the Black-Scholes option pricing equation means that option valuation is done with the support of computer programs. Solving the Black-Scholes equation is not an artificial intelligence operation, although adequately handling options valuation could well involve artificial intelligence techniques.

An index is a special kind of asset. For instance, Standard & Poor's 500 Index (S&P500) is a widely traded asset that represents, with a single number, the price of shares of 500 companies. Programs that would be appropriate for evaluating the fair price of the S&P500 would be different from programs designed to evaluate the fair price of a particular company's shares. Among other things, the S&P500 does not have corporate management, per se. Neural networks have been extensively applied to predicting prices of stock indices.

A typical technical approach to a market problem (Chun & Park, 2006) took daily values over 5 years for five attributes of the Korean stock price index: daily high and low values, daily opening and closing values, and daily trading volume. On the other hand, the bond rating work of (Kim & Lee, 1995) looks at fundamental data with an expert system The input data for the bond rating work considers the quality of management and the quality of financial policies. The expert system's approach has a professional interactively answer questions from the system. Through this user interactivity, the system might collect subjective information, such as a company's management quality.

If a bank considers lending money to a company, the bank would be interested in judging the likelihood that the company would go bankrupt. More generally, financial institutions that lend money want to judge the credit worthiness of the entities to which they might lend money. These valuations of credit worthiness are a kind of asset valuation, but the techniques for doing this credit assessment would tend to be different from those for assessing the fair price of a company share. In particular, expert systems are more likely to be used for bankruptcy predictions, and neural networks are more likely to be used for stock price prediction. A bank may take its time in deciding what conditions, if any, to offer for a loan. Once the loan is made, its conditions are not subject to ready change. Investing in stocks or financial derivatives may be a fast-moving activity based on a history of prices. Those prices may be volatile, and entry and exit from the market may occur any time. The speculative financial investing problem is more of a time-series problem than the financial accounting problem and is thus, amenable to a different set of computational tools.

RISK MANAGEMENT

Risk or portfolio management involves choosing the asset classes in which to invest, and modifying the held assets across time, so as to suit the investment objectives. Various mathematical models, such as the Markowitz portfolio selection model, may be used by professional managers to guide the diversification of holdings so as to minimize risk for any specified rate of return. Implementing this kind of portfolio management may rely on numerical computation at one level, but can also benefit from various artificial intelligence techniques.

Lee et al. (Lee, Trippi, Chu, & Kim,1990) have described a knowledge-based system for supporting portfolio management. The system has different agents for different tasks. One agent elicits client goals, another agent implements dynamic hedging strategies, and another suggests market-timing decisions. Lee et al. note that the agents are only successful in narrow domains, and intervention of the human, portfolio manager is regularly necessary. In more recent work, Abdelazim and Wahba (2006) use genetic algorithms and neural networks to modify the parameters suggested by the Markowitz portfolio selection model, and obtain portfolios that earn higher returns at a specified risk level.

AI TRENDS

A multiagent architecture for an integrated system that considers data identification, asset valuation, and risk management has been proposed by researchers at Carnegie Mellon University. The system is called WARREN, which refers to the first name of the famous investor Warren Buffet (Sycara, Decker, Pannu, Williamson, & Zeng, 1996). The WARREN