

Innovation and AI in the World of Financial Trading

Elizabeth Byrnes, Thomas Campfield and Bruce Connor

Manufacturers Hanover Trust Company
270 Park Avenue
New York, New York 10017

Abstract

An expert system called TARA, for Technical Analysis and Reasoning Assistant, has been built and deployed to assist foreign currency traders in their decisions to buy, sell, or hold market positions. Trading with the system began in May, 1988. Since then, TARA has paid back all of its development costs plus an attractive return on investment. This achievement represents a major breakthrough for AI in financial services. Trading is a high risk, high reward profession that at first glance appears unsuitable for an expert system solution. The knowledge is fuzzy, no two experts seem to agree and, for a system to offer significant benefit, a large volume of data must be analyzed in real time. TARA's success demonstrates that expert systems technology can be effective in the financial trading environment.

Introduction

Foreign exchange currency traders can not afford to think over multi-million dollar positions for very long. In real time, they must examine large quantities of data, consider historical trends, determine what is relevant, and many times in the course of a day, make the ever critical decision to buy or to sell. It is a high risk, high reward job of prediction where even the best traders are pleased with being right 60 percent of the time.

At Manufacturers Hanover Trust (MHT) an expert system called TARA, for Technical Analysis and Reasoning Assistant, has been built and deployed to assist foreign currency traders.

A Word About Trading

Currency trading is a form of price forecasting that deals with a deceptively simple question: *Where are prices going?* There are only three possible answers: up, down, or sideways. The success of a trader's forecast is based upon the accuracy of analysis related to the timeliness of

prediction. Large amounts of money can be lost or gained in instants.

Two popular approaches for determining price movement are fundamental and technical analysis. In fundamental analysis, the goal is to predict the supply and demand for a commodity, such as currencies. Fundamental analysts study economic forecasts, political events, and market psychology. Technical analysis is a forecasting method based upon historical trend analysis. Technical analysts draw heavily on charting and statistical techniques. Neither approach has a standard formula for prediction and both require substantial interpretation by a skilled trader.

While some traders religiously pursue one strategy or another, most use a combination of technical and fundamental analyses. Since the technical approach is better documented, the initial deployment of TARA heavily favors this methodology. The fundamental knowledge base has been developed however, and is in the process of being tested. Like the wise trader, TARA will integrate both approaches in the future.

A Breakthrough for AI in Financial Services

Applying AI and expert systems technology and techniques to the poorly understood and undocumented field of financial trading is viewed by many as risky and bold. Traditionally, expert systems have been successfully applied to domains characterized by recognized experts, bounded knowledge, adequate documentation, and small databases. In trading, the knowledge is fuzzy, no two experts seem to agree, and the volume of data needed in real time is large. The major breakthrough that TARA's success demonstrates is that expert systems can be applied to a much broader class of financial problems.

Why TARA Succeeded

TARA is successful for three reasons. First, the organizational structure for research and development was ideal. This project could be a textbook case study for implementing new technologies. TARA had the support of top level senior management who, from the beginning, committed trained AI people and a dedicated expert to the project. This expert, who was critical to the project's success, was selected by management for his outstanding performance and responsiveness to new ideas.

The second success factor involved the actual design of TARA. Because the domain was poorly understood, building TARA was a continuous, iterative process that involved hundreds of tactical decisions. Two questions continuously came up: What specific information, from the vast amount available, does the trader need to know? Can we capture and represent this on a computer in real time? Since few experts agree in this domain, it was also critical to build around one expert but add flexibility to accommodate the preferences of many individuals.

Finally, the development team strongly believes that TARA could not have been implemented without a powerful AI development environment. The development tools provided by Symbolics and KEE greatly facilitated the iterative design process.

The Development Challenges

To build TARA, many technological and psychological hurdles had to be overcome. The biggest technological problem was that of integrating the live data feed with the technical models and the knowledge base without losing critical response time. The major psychological hurdles were gaining interest among traders with widely varying styles, holding that interest with a rich yet logical and responsive user interface, and finally, teaching traders how to use this higher level tool to enhance their personal trading strategies.

TARA began as an experimental expert system project and quickly evolved into a powerful and sophisticated trader's workstation. The decision to buy or sell could not be made without the technical models which identified historical trends and predicted major, minor and intermediate changes in price. In addition, a mechanism for improving models through applying what-if analysis and examining past history was needed. This feature could not be implemented without a library of algorithms and an underlying database. Finally, unless the results could be offered quickly to the trader, the information was useless. Live data was critical and a sophisticated user interface that supported both text and graphics had to be designed.

Deployment

The decision to explore AI's potential use on the trading floor was made in January, 1987. After three months of interviewing the most successful traders and studying the domain, prototyping began. By June, a robust prototype was shown to traders and senior management, and approval to proceed was given. An additional Symbolics machine was purchased, bringing the total number of computers to two.

Initially, an 18 month development schedule was planned but after six months, pressure to test the viability of the system began to mount. Deployment was advanced to May, 1988. When this happened, the development emphasis shifted from adding intelligence to stabilizing the environment, perfecting the user interface, and connecting the live data feed. In addition, TARA began daily "paper trading" in preparation for the real money it would be handling.

In May, one of the Symbolics, equipped with a high resolution 19 inch color monitor, was moved to the foreign exchange trading floor. In December, after eight consecutive profitable months, two additional machines were ordered. One of these machines is for foreign exchange, the other is for another trading area. In the case of the latter, new rules and features will be required, but the underlying analytical capabilities, access to live data, and user interface, have immediate value.

TARA has evolved into a robust and powerful workstation. Typically, 50 windows are active (but not simultaneously displayed) and more will be added as additional prices are tracked. Fifteen years of historical data can be called into memory and accessed from any model running in one of these windows. For example, a six month intraday model for Japanese Yen may require 300,000 data points. On the Symbolics, over ten synchronized processes are either running or waiting to be run. The system is connected to a live, in-house data feed that is active 24 hours a day. Most of TARA is written in Lisp, but Intellicorp's KEE was used for inferencing and knowledge representation.

Throughout deployment, new development and enhancements to TARA have been ongoing. The trading environment is dynamic and fiercely competitive. TARA must maintain its leading edge.

TARA

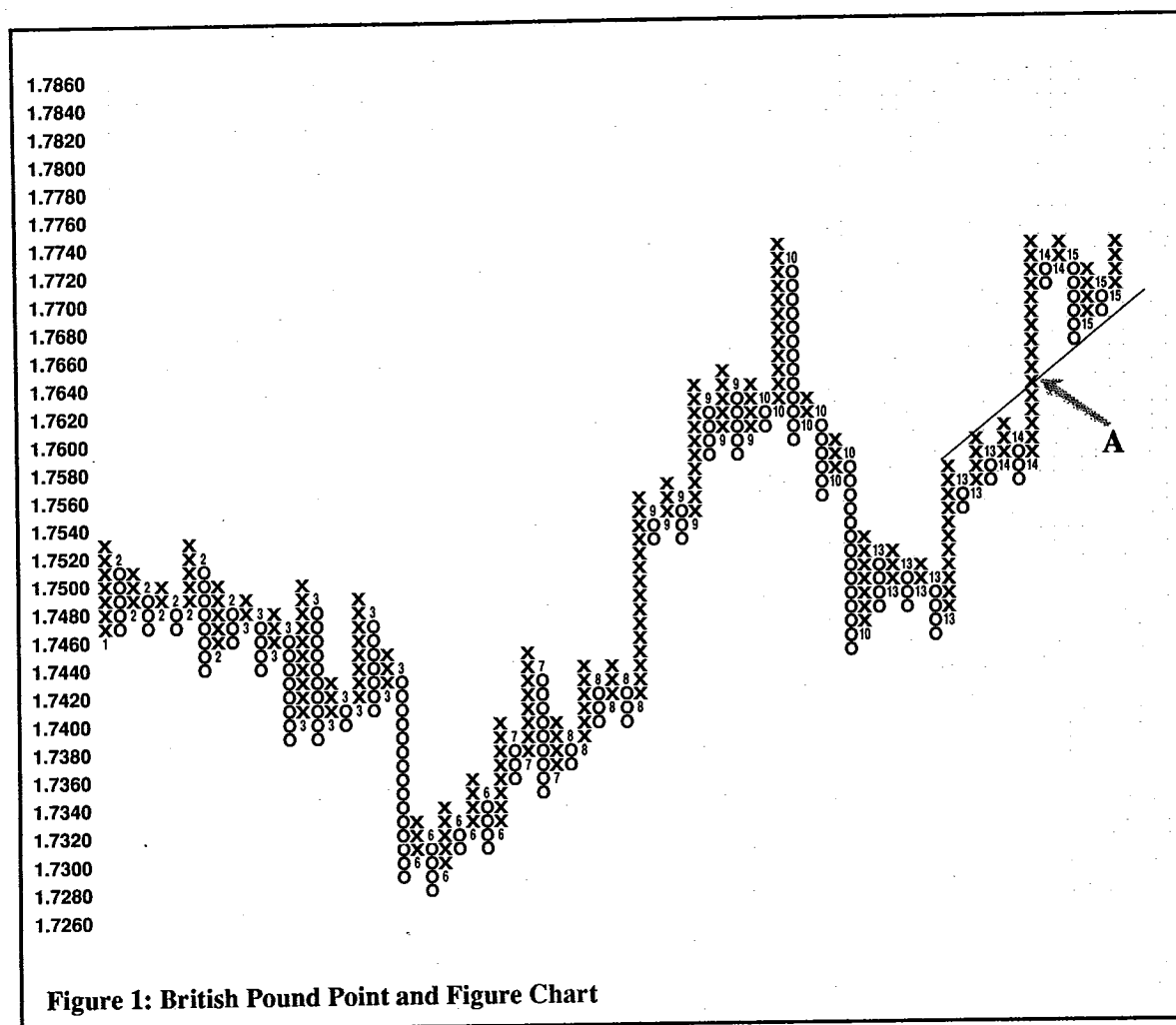
TARA is a stand alone, real time system that has four interdependent components; a live international data feed, a sophisticated graphical user interface, a model development and optimization program, and a knowledge base of technical and fundamental trading

strategies. Currently TARA tracks multiple currency, bond, and interest rates, updates over 30 different technical trading models, runs algorithms and applies rules to interpret the models. This results in recommendations to buy, to sell, or to hold a market position.

TARA is designed to play two roles: skilled assistant and experienced colleague. As an assistant, TARA is very efficient. With every price change, it evaluates whether to update any of the 30 or more active models. When an update is required, rules and algorithms are activated and if appropriate, recommendations and alerts are displayed. All this occurs in a matter of seconds.

In Figure 1, one of these models, a point and figure

chart for the British pound, is shown. This technical trading technique filters out insignificant price movements and allows the trader to more easily target the beginnings and ends of minor, intermediate and major trends. Time is not a variable, that is, a column may take a minute or a week to complete. Each box on a point and figure chart represents a trader specified unit of price, in this case, 100 points. A column of X's represents a steady increase in price, a column of O's indicates the reverse. There are also rules governing when to switch from one column to the next, the most common being the three box reversal rule. This rule states that a new column can be started only when the price jumps three boxes, or in this example, 300 points.



If TARA stopped here, it would not be very different from the existing technical charting programs available through vendors. What makes TARA unique is a sophisticated knowledge base of technical trading rules that helps traders decide which charts to use for a particular currency and how to interpret the patterns and trends. This is where TARA begins to cross the line between assistant and colleague. The system builds sophisticated charts, but it also has knowledge about how to best use them in trading. For instance, suppose the system were tracking the point and figure chart in Figure 1 and a new price was read, analyzed, and plotted at point A. A set of trend analysis rules would fire and a "buy British pound" recommendation would be given.

For the purpose of illustration, the example just given was oversimplified. TARA's trading decisions are actually the result of multiple technical and fundamental factors. One model may be a good indicator in certain economic situations, but terrible in others. Some models work well in tandem, but are not useful alone. One of TARA's great strengths is the ability to perform this multifaceted analysis in real time.

TARA's knowledge base does not yet include rules about the unforeseen business, economic and political events that influence the market. This information usually travels by newswire or word-of-mouth. A trader can act on this information immediately, but TARA can not, at least for now. This broader, more complete market perspective is what the trader adds to TARA's analysis.

In sum, TARA adds objectivity, thoroughness, and speed to the decision making process, but it does not replace traders. Instead, the system is a tool that enhances their abilities.

Development Costs

TARA's development costs are straightforward, consisting of the hardware and software mentioned above as well as the time of a four person team. No outside consulting or resources were used beyond those typically provided by the software and hardware vendors. Since

trading began, TARA has paid back all of its development costs plus an attractive return on investment.

Measuring Success

This project has two criteria for measuring its success: profitability and trader acceptance. TARA's technical analysis capabilities are extensive and proved profitable when tested historically. However, senior management wanted to see the system perform in live markets with real money. The profitability criteria also played a significant role in the traders' acceptance of TARA. After the first few months of profitability, traders began to consult the system regularly, either to request specific recommendations or to use the system's analytic capabilities to check hypotheses and test new models. By the end of 1988, requests for additional systems were received.

How MHT Has Benefited

In addition to its contribution to bottom line profitability, TARA has had a widespread effect on the organization's attitude toward technological innovation. Technology in banking typically meant back office accounting, not front office profit making.

For our trading business, TARA has given us a competitive edge in a rapidly changing business environment. More specifically, TARA's architecture provides a solid foundation for the trading floor of the future. Our sights are higher and our goals are more tangible. TARA is not a hypothetical system, it is real and working.

Conclusion

TARA's benefits can be measured by more than dollar profits. TARA's architecture provides a solid foundation for trader workstations of the future, where design is based on AI techniques integrated with state-of-the-art technology.

Many have questioned whether expert systems could ever work in a difficult domain like financial trading. TARA adds a positive reply.