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Forecasting the NYSE composite index with technical analysis, pattern recognizer, neural network, and genetic algorithm: a case study in *romantic* decision support

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Abstract

The 21st century is seeing technological advances that make it possible to build more robust and sophisticated decision support systems than ever before. But the effectiveness of these systems may be limited if we do not consider more eclectic (or *romantic*) options. This paper exemplifies the potential that lies in the novel application and combination of methods, in this case to evaluating stock market purchasing opportunities using the "technical analysis" school of stock market prediction. Members of the technical analysis school predict market prices and movements based on the dynamics of market price and volume, rather than on economic fundamentals such as earnings and market share. The results of this paper support the effectiveness of the technical analysis approach through use of the "bull flag" price and volume pattern heuristic. The *romantic* approach to decision support exemplified in this paper is made possible by the recent development of: (1) high-performance desktop computing, (2) the methods and techniques of machine learning and soft computing, including neural networks and genetic algorithms, and (3) approaches recently developed that combine diverse classification and forecasting systems. The contribution of this paper lies in the novel application and combination of the decision-making methods and in the nature and superior quality of the results achieved. © 2002 Elsevier Science B.V. All rights reserved.

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1. Introduction

This new century opens on an unprecedented availability and selection of development tools for building decision support systems [4]. These tools have reduced the complexity and long development time inherent in building systems that offer valuable insights into the complex problems offered in today's business world. But will these technological enhancements manifest into systems that exploit the vast opportunities that are now available?

This century also promises to be a time of discontinuous and increasingly rapid change, with new risks taking the place of ones we understand. Time pressures and the rush of events will require that

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decision support tools be used in an efficient, unified and adaptive manner. This will require satisficing with good results, often without understanding "scientifically" the underlying decision contexts that we analyze. Decision support systems, however, cannot meet these opportunities without changing the way the systems are approached and built. Indeed, a bolder, more eclectic style will be necessary, which we term *romantic*.

Classical connotes beauty of form, good taste, restraint, and clarity. *Romantic* is extravagant, wild, free, imaginative, and fantastic, and is in revolt from that which is classical. We contend that in the early 21st century, the classical style in decision support practice will be supplanted by a more romantic style. A romantic style for decision support combines seemingly disparate sets of theories, data, and techniques, uses radically new data analysis and machine learning techniques, which employ nonlinear and connectionist models, realizes systems through the assembly of powerful hardware and software components, combines tools and techniques to develop hybrid decision-making mechanisms, may involve assaults on the accepted wisdom of decision-making, and achieves superior results.

The work in this paper is empirical. We cannot explain the results attained here, or the results claimed by practitioners for technical analysis, with any strong theoretical basis. The romantic style is pragmatic and values decision-making results over understanding and values data over theory. The romantic style is data-driven, rather than theory-driven (but, of course, there is nothing more pragmatic than a bit of good theory at the right time). Diebold discusses this tension, which is more palpable in some firmly ensconced branches of academia, including finance, than in industry (page 589, Ref. [7]):

> There is a long and unfortunate tradition in economics, however, of placing too much emphasis on theory—as opposed to evidence (data)—in guiding the specification and evaluation of forecasting models. Within such a framework, one is led to focus on the task of estimating the parameters of a relationship suggested by a priori theory (at the cost of neglecting the model selection problem), after which the optimal prediction problem is easily solved (conditional upon the assumed model).

Winkler agrees (page 606, Ref. [53]):

> I prefer, however, to take the view that, in many situations, there is no such thing as a 'true' model for forecasting purposes. The world around us is continually changing, with new uncertainties replacing old ones. As a result, the longer-term search for a 'true' model is doomed to fail in many cases because unanticipated changes prevent us from enjoying the luxury of getting to the longer term in a stable environment. This suggests that models should be adaptive, but even adaptive models only represent our best state of knowledge at a given time; they do not represent the 'truth' in any sense.

Decision support systems, as a discipline, owes much to artificial intelligence, which has been predominantly pragmatic and data-driven from the beginning, and as such has always evidenced the attributes of what we are calling *romantic*, to a degree. But the need for adaptability and the achievement of results is more compelling in the 21st century than before, and the opportunity is greater than before. The new elements that are present now are the methods and techniques of soft computing and machine learning for decision-making and forecasting, in particular neural networks and genetic algorithms, and the new science of the combination of those tools. These new elements make possible decision support systems that are more *romantic* than those which have gone before to an extent that by comparison, the decision support systems of today appear *classical*.

The way in which different decision-making and forecasting methods are combined is critical. The objective is for a coordinated use of different methods to arrive at a better decision than the employment of any of the methods alone. There is reason to believe that this not overly difficult to achieve (for the case of classification algorithms, see Ref. [2], and for forecasting, see Ref. [34]); and that greater diversity in the decision-making methods which are combined leads to better combined decisions (for the case of classifier systems, see Ref. [52]). The development and use of effective methods of decision tool integration and combining are critical to realizing successful decision support systems of this romantic style. We explore, exemplify, and survey such combining methods in this paper.