7 Conclusion

There exist numerous articles and papers on various approaches to the prediction of financial time series. Each of these focuses on the specific qualities of the data at hand and attempts to optimize the predictions for it based on historic values. On the other hand, the theory of portfolio management is documented and widely agreed, in its basic form. Though these two components must be combined to form a coherent portfolio management system, academic papers have largely ignored this comprehensive approach.

The goal of this thesis was to build a fully integrated Internet-based system that helps a private investor focus on promising opportunities from the vast amount of financial data that is available. NELION retrieves historic stock data from the World Wide Web, stores it on a local database and uses four mathematical model types to predict stock prices at different intervals in the future.

At the same time, it allows an investor to choose from four risk adversity parameters to establish a risk profile that matches his needs. Given the investor preferences and stock predictions, the system calculates the optimal portfolio for the investor and sends him an e-mail with these recommendations. The investor can then evaluate these

suggestions based on qualitative indicators, which cannot be captured in the mathematical models. NELION tracks his portfolio, provides regular transaction recommendations, and updates via e-mail and alerts via SMS to his mobile phone in case any one of the stocks in his portfolio undergoes dramatic swings.

The Auto-Investor function in NELION autonomously simulates the trading behavior without intervention, providing an objective means to evaluate the success of the system as a real world application. Our comparisons of the U.S. markets show that on average our fully automated investment agents performed better than the major indexes in our test period of one year.

As an initial experiment, these are promising results. However, the system has also shown that a number of further features could increase the flexibility and profitability of the system.

Increased Diversity in the Input Data Set

The models are currently only based on historic data of the time series itself. It is reasonable to assume that adding other information to the input vector of the model will improve the quality of the predictions by reducing the model error. This information can include stock prices and trading volumes of other stocks or indexes as well as price/earnings or other ratios. A genetic algorithm can then search for effective input combinations for each stock.

Generalized Data Pre-processing

Parkinson proposed an idea of pre-processing the input data of time series analysis in order to improve the model quality [Parkinson 1999]. By generalizing this approach and allowing any number of combinations of both pre- and post-processing, one can assume that the quality of the models can be enhanced. Again, a genetic algorithm could be used to search the parameter space for the best combinations.

Identifying Appropriate Age of Historic Input Data

Presently, NELION uses all available historic data to generate models. This is likely to include periods where the dynamic of the stock has undergone changes, leading to reduced overall performance. It is possible to shorten the input data to an appropriate length by identifying specific, current characteristics of it. This measure would improve the model quality and will reduce computation time, offsetting the increase in parameter space proposed by the previous suggestions.

Additional Attributes for each Stock

Each stock can be associated with a region and industry. By allowing each investor to assign a subjective risk factor for these categories and factoring this value into the risk equation, the investor can focus on opportunities that conform to his preference or that, in his estimation, promise above-average returns.

Including a Prediction Error for each Forecast

The current approach defines the reliability of the model by using the out-of-sample error. By enhancing all models to associate an error with each specific prediction, it should be possible to identify stocks, which have entered a phase of unpredictability.

Include Qualitative Explanation Module

With its current functionality, NELION offers valuable assistance to the informed investor, by directing his attention to promising opportunities. In order to appeal to novices as well, the system would need to include a qualitative explanation module. This function would support the recommendations with copies or links to articles on the Internet that shed more light on the suggestion. Additionally, the module could automate the explanation of financial ratios and charting techniques, helping less experienced investors judge the validity of the forecasts by the system.

NELION represents a first attempt to automate a stock prediction and portfolio management system. In its present form, it shows promise and can be used effectively as a tool. Based on the experiences gained from the extensive tests, it is possible to refine the first version and take this integrated approach to the next level of sophistication.