Financial Time Series Prediction

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1 Introduction

The future is often predictable from present and past events. Which of those are more important? Which are less? What is prediction in general? What factors influence its accuracy? Is it possible to build software, which will be able to imitate experienced investor's decision process? What should the system consists of? How good results can be obtained? These are only few out of many questions which motivated research in Time Series Prediction and were investigated in this paper. Focus has been put into speed of calculations and architecture of the prediction system

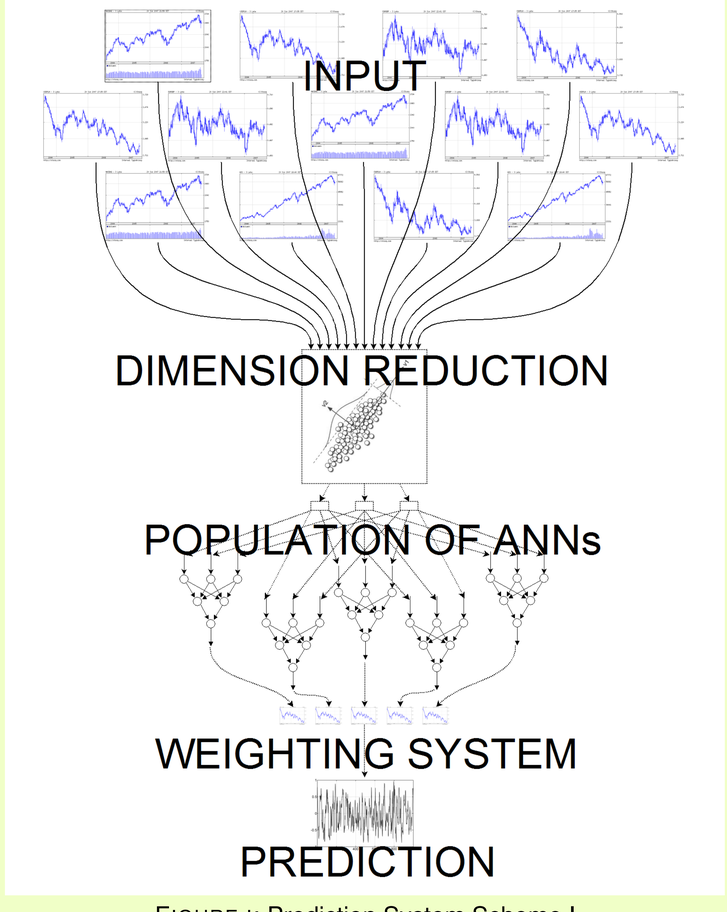

FIGURE I: Prediction System Scheme I

2 Human Prediction Model

The process of experienced investor's decision making, although very complex, can be modularized:

- Collect as much information as possible
- Decide what is significant and exclude unimportant factors
- Analyze preprocessed information creating different scenarios
- Decide which predictions are more likely to happen
- Give most favorable opinion
- Combine this decision with previous experience

The developed system follows an analogous process. Each module corresponds to above thinking step.

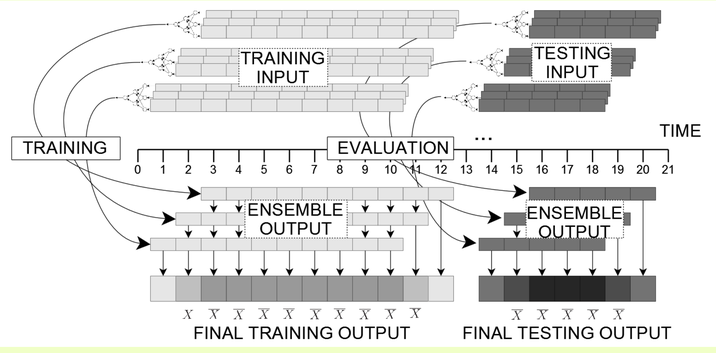

FIGURE II: Prediction System Scheme II

System accomplishes following sequence successively (Fig. I): collect different inputs from various sources. Reduce dimension using PCA [1] to prepare input for population of ANNs which is further evolved using Evolutionary Programming (EP) algorithm [2]. Each ANN from population of solutions is a member of ensemble. Their outputs are weighted to produce Ensemble Output. To save time, training from the beginning might be avoided, when new data becomes available. Finally, output for current time step is added to previous one and mean for common points is calculated (Fig. II).

3 Results

System has been tested on real data: daily GBP/PLN Forex exchange rates for a period from 21/01/03 to 12/01/07. Training has been performed until 1000 epochs have been reached, RMSE was lower than 0.02 or gradient was lower than 10^{-6}. 30 independent trials have been performed to obtain statistically significant results, which have been presented in Table I.

Table I. System performance based on how population is initialized for each step, with varying steps ahead

		No rand	Half rand	All rand
50 days ahead	rmse Mn(TR)	0.090	0.093	0.115
	rmse Std(TR)	0.002	0.002	0.002
	rmse Mn(EV)	0.233	0.243	0.211
	rmse Std(EV)	0.002	0.037	0.005
	FCalls Mn	76	98	498
	FCalls Std	117	175	278
	T-Test (% of 0)	13	30	70
	Corr Coeff	0.89	0.89	0.91
100 days ahead	rmse Mn(TR)	0.086	0.088	0.112
	rmse Std(TR)	0.004	0.004	0.002
	rmse Mn(EV)	0.224	0.236	0.200
	rmse Std(EV)	0.021	0.020	0.005
	FCalls Mn	52	53	447
	FCalls Std	26	29	200
	T-Test (% of 0)	40	33	76
	Corr Coeff	0.90	0.89	0.92

4 Conclusion

Although, task of predicting stock market is very difficult, i.e. considered type of data is influenced by tremendous number of factors which are often unmeasurable, it is possible, with satisfactory precision, to predict future movements. Developed system is a proof (Fig III). However, one should be careful when setting parameters. Only minimum evaluation error (min. bias and variance) will lead to good results and often small training error does not guarantee a success. There is also a tradeoff between speed and accuracy (Table I).
Finally, one should never solely rely on the output of these kind of systems: stock markets are often influenced by psychological factors, which are not provided in digital form. Therefore, system will always lack full accuracy. Even though, it is still a great supplement for a decision maker.

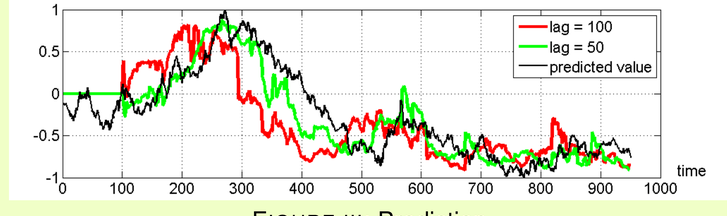

FIGURE III: Prediction

REFERENCES:

[1] J. Edward Jackson, A User's Guide To Principal Components, Wiley, 1991.

[2] Xin Yao, Evolving Artificial Neural Network. *Proceedings of the IEEE*, volume 87, number 9, 1998.