Solving No Free Lunch Issues from a Practical Perspective

Crina Grosan and Ajith Abraham
Department of Computer Science, Babeş-Bolyai University, Romania
School of Computer Science and Engineering, Chung-Ang University, Seoul
cgrosan@cs.ubbcluj.ro, ajith.abraham@ieee.org

Recently the No Free Lunch (NFL) theorem [3] has been a widely used as an argument in a global optimization context, which says that for any algorithm, elevated performance over one class of problems is exactly paid for in performance over another class. In sum, one should be skeptical of claims in the literature on machine learning algorithms that one being proposed is substantially better than most others. Such claims are often defended through some simulations based on applications in which the proposed algorithm performed better than some familiar alternatives. Assuming that NFL also holds for various intelligent paradigms, our first research aim is to show how an ensemble approach could be used to combine the different paradigms to benefit from the synergistic advantages of the various paradigms. Further, we illustrate how an evolutionary multiobjective optimization approach [1] could be useful to optimize the various error measures using an ensemble approach. The algorithms are validated using two function approximation problems involving prediction of stock indices for Nasdaq-100 and NIFTY [2]. The stock index time series behaves more like a random walk process and time varying. We considered 7 year's stock data for Nasdaq-100 and 4 year's for NIFTY index. Our target is to develop efficient forecast models that could predict the index value of the following trade day based on the opening, closing and maximum values of the same on a given day. The stock indices are first modeled using an Artificial Neural Network (ANN) trained using Levenberg-Marquardt algorithm, Support Vector Machine (SVM), Takagi-Sugeno Neuro-Nuzzy (TSNF) model, a Difference Boosting Neural Network (DBNN) and Multi-Expression Programming (MEP) algorithm. Empirical results as depicted in Figure 1 clearly indicates that none of the five paradigms could perform well to optimize the error measures considered namely Root Mean Squared Error (RMSE), Correlation Coefficient (CC), Maximum Absolute Percentage Error (MAP) and Mean Absolute Percentage Error (MAPE). To enhance the performance an Evolutionary Multiobjective Optimization (EMO) algorithm is proposed to ensemble the results (outputs) obtained by the five algorithms. Suppose the daily index value predicted by DBNN, SVM, NF, ANN and MEP are a_n, b_n, c_n, d_n and e_n respectively and the corresponding desired value is x_n. The task is to combine a_n, b_n, c_n, d_n and e_n so as to get the best output value that maximizes the CC and minimizes the RMSE, MAP and MAPE values.

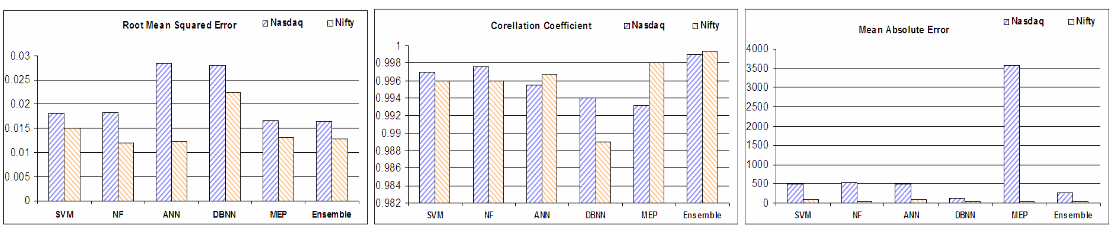

Figure 1. Performance of the various paradigms and the ensemble approach

The ensemble method is able to optimize at least three error measures using a simple linear combination of the five paradigms. For the Nasdaq and Nifty indices, the linear combinations between SVM, NF, ANN, DBNN and MEP obtained are given by (1) and (2):

$$0.207014 * a_n + 0.249155 * b_n + 0.398496 * c_n + 0.0659003 * d_n + 0.0979577 * e_n \quad (1)$$

$$0.616713 * a_n + 0.133108 * b_n + 0.137237 * c_n + 0.0978478 * d_n + 0.0385043 * e_n \quad (2)$$

Since we have a population of solutions the user has the option to choose a solution instead of another taking into account the objective which is considered more important. For instance, in the case of Nasdaq index, a lower RMSE solution can be: RMSE = 0.0156289, CC = 0.9997, MAP = 1269.42, MAPE = 9.45763 by using a combination of ($-0.0260046 * a_n + 0.0972428 * b_n + 0.40443 * c_n - 0.0262572 * d_n + 0.561556 * e_n$). If a higher CC solution is required the combination could be ($0.371175 * a_n + 0.106965 * b_n + 0.170682 * c_n + 0.213156 * d_n + 0.160997 * e_n$) with RMSE = 0.0185781, CC = 0.9999, MAP = 171.594 and MAPE = 12.4258. Similarly a solution which gives the lowest MAP will have a combination ($0.616713 * a_n + 0.133108 * b_n + 0.137237 * c_n + 0.0978478 * d_n + 0.0385043 * e_n$) with RMSE = 0.0209444, CC = 0.9994, MAP = 96.2665 and MAPE = 14.2463.

Our research results reveal that NFL also clearly holds for the intelligent paradigms considered and the importance of the EMO based ensemble approach to optimize the various error measures. The results obtained by an ensemble of paradigms clearly outperform the individual techniques. In this research, our focus was to evolve a set of coefficients in order to obtain a linear combination of the five techniques. Our further research is to improve the EMO algorithm in order to obtain faster convergence and optimal performance.

References

[1] Grosan C. and Abraham A., Multiobjective Optimization Approach for Evolving Ensemble of Intelligent Paradigms for Stock Market Modeling, 2005 IEEE Congress on Evolutionary Computation, Edinburgh, UK, September 2nd-5th, 2005 (under review).

[2] Abraham A., Ninan Sajith Philip and P. Saratchandran, Modeling Chaotic Behavior of Stock Indices Using Intelligent Paradigms, International Journal of Neural, Parallel & Scientific Computations, USA, Volume 11, Issue (1/2), pp. 143-160, 2003.

[3] W.G. Macready W.G. and Wolpert D.H., The No Free Lunch theorems. *IEEE Trans. Evol. Comput.* 1, pp. 67–82, 1997.