Improving Time Series Prediction using Recurrent Neural Networks and Evolutionary Algorithms

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Abstract

In this thesis, artificial neural networks (ANNs) are used for prediction of financial and macroeconomic time series. ANNs build internal models of the problem and are therefore suited for fields in which accurate mathematical models cannot be formed, e.g. meteorology and economics. Feedforward neural networks (FFNNs), often trained with backpropagation, constitute a common type of ANNs. However, FFNNs suffer from lack of short-term memory, i.e. they respond with the same output for a given input, regardless of earlier inputs. In addition, backpropagation only tunes the weights of the networks and does not generate an optimal design. In this thesis, recurrent neural networks (RNNs), trained with an evolutionary algorithm (EA) have been used instead. RNNs can have short-term memory and the EA has the advantage that it affects the architecture of the networks and not only the weights. However, the RNNs are often hard to train, i.e. the training algorithm tends to get stuck in local optima. In order to overcome this problem, a method is presented in which the initial population in the EA is an FFNN, pre-trained with backpropagation. During the evolution feedback connections are allowed, which will transform the FFNN to an RNN.

The RNNs obtained with both methods outperform both a predictor and the FFNN trained with backpropagation on several financial and macroeconomic time series. The improvement of the prediction error is small, but significant (a few per cent for the validation data set).

Key words: time series prediction, evolutionary algorithms, recurrent neural networks