Chapter 13
Recognition of Patterns With Fractal Structure in Time Series

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ABSTRACT
The chapter is focused on an analysis and pattern recognition in time series, which are fractal in nature. Our goal is to find and recognize important Elliott wave patterns which repeatedly appear in the market history for the purpose of prediction of subsequent trader’s action. The pattern recognition approach is based on neural networks. Artificial neural networks are suitable for pattern recognition in time series mainly because of learning only from examples. This chapter introduces a methodology that allows analysis of Elliot wave’s patterns in time series for the purpose of a trend prediction. The functionality of the proposed methodology was validated in experimental simulations, for whose implementation was designed and created an application environment. In conclusion, all results were evaluated and compared with each other. This chapter is composed only from our published works that present our proposed methodology. We see the main contribution of this chapter in its range, which allows us to present all our published works concerning our proposed methodology together.

INTRODUCTION
This chapter is composed only from our published works (Kotyrba et al. 2012; Kotyrba, Volná, & Jarušek, 2012; Kotyrba et al. 2013; Volna, Kotyrba, & Jarusek, 2013; Volná, Kotyrba, & Kominkova Oplatkova, 2013), that present our proposed methodology including experimental verification. We see the main contribution of this chapter in its range, which allows us to present all our published works concerning our proposed methodology together.

The main topic of the chapter is to develop and optimize the pattern recognition algorithm in order to recognize Elliott wave patterns in time series for the purpose of prediction. Elliott wave theory is a form of market analysis based on the theory that market patterns repeat and unfold in cycles. Ralph Nelson
Elliott developed this theory in the 1930s. Elliott argued that upward and downward market price action was based on mass psychology and always showed up in the same repetitive patterns. These patterns were divided into what Elliott called “waves.” According to Elliott, crowd psychology moves from optimism to pessimism and back again and this is seen in the price movements of market trend which are identified in waves. The Elliott Wave Principle is a detailed description of how groups of people behave (Poser 2003). It reveals that mass psychology swings from pessimism to optimism and back in a natural sequence, creating specific and measurable patterns. One of the easiest places to see the Elliott Wave Principle at work are the financial markets, where changing investor psychology is recorded in the form of price movements. When people are optimistic about the future of a given issue, they bid the price up. Two observations will help to grasp this: First, investors have noticed for hundreds of years that events external to the stock markets seem to have no consistent effect on the progress. The same news that today it seems to drive the markets up is as likely to drive them down tomorrow. The only reasonable conclusion is that the markets simply do not react consistently to outside events. Second, when historical charts are studied, it can be seen that the markets continuously unfold in waves. Using the Elliott Wave Principle is an exercise in probability. Elliott wave patterns are not exact, they are slightly different every time they appear. They can have different amplitude and different duration, albeit visually the same pattern can look differently despite being the same. Moreover, these patterns do not cover every time point in the series, but are optimized so that the developed classifier would be able to learn their key characteristics and accurately recognize them. Such optimized inputs also reduce calculation costs. One of important challenges is to recognize the input pattern reliably.

The aim of this experimental study is focused on recognition Elliott models in the chart. The proposed classifiers have been tested in this paper for Elliott wave’s pattern recognition. We use an interdisciplinary approach (see Figure 1), which consists from artificial neural networks, Elliott wave theory and knowledge modelling (Kotyrba, Volná, and Jarušek, 2012). We used an artificial neural network that is adapted by backpropagation (Atsalakis, Dimitrakakis, & Zopounidis, 2011). Neural network uses Elliot wave’s patterns in order to extract them and recognize. Artificial neural networks are suitable for pattern recognition in time series mainly because of learning only from examples. There is no need to add additional information that could bring more confusion than recognition effect. Neural networks are able to generalize and are resistant to noise. On the other hand, it is generally not possible to determine exactly what a neural network learned and it is also hard to estimate possible recognition error. They are ideal especially when we do not have any other description of the observed series.

The chapter proposes the Elliott waves pattern recognition approach based on a backpropagation neural network. We focus on prediction by means of Elliott wave’s recognition. Our experimental studies show that the patterns of Elliott wave theory can be also observed on the Volume waveforms. Volume (often abbreviated VOL), or the volume of trading is simply an indicator expressing the total number of contracts traded within a specific time period (e.g., hour, day, week, month ...).

THE ELLIOTT WAVE-PRINCIPLE

The Elliott Wave Principle is based on the fact that prices usually move in fives waves in the direction of the larger trend and in three waves contrary to it. In an uptrend a five wave advance will be followed by a three wave decline; in a down trend a five wave decline will be followed by a three wave advance.
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