

# Chapter 11

## Prediction of Electroencephalogram Time Series via Artificial Neuro–Fuzzy Inference System Trained by League Championship Algorithm

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### ABSTRACT

*Time series analysis has a wide application interest in artificial-intelligence-oriented research studies. Because it is easy to run machine-learning-based solutions directly over time series, it has been a popular approach to use alternative types of intelligent systems to analyze time series. Regarding such works, time series prediction is known as a remarkable topic as followed by researchers from different fields. The objective of this chapter is to provide an alternative work by using artificial neuro-fuzzy inference system trained by the league championship algorithm, which is an optimization algorithm from the associated literature. As the application objective, electroencephalogram (EEG) time series have been tried to be predicted by using the designed ANFIS-LCA approach. The chapter briefly introduces details about the approach and reports findings from the performed prediction operations.*

### INTRODUCTION

It is certain that the humankind is currently experiencing a golden era in terms of technological developments and improvements. Although it is also often discussed that technological changes come with also some disadvantages, the big picture is known as full of practical and effective solutions for works – tasks – activities that we do. As a result of critical discoveries in both social and natural sciences, the

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humankind had had a chance to focus more on inventions to form the future. In time, different kinds of inventions had led the humankind to deal with environmental factors and understand the nature better. Eventually, all these changes and remarkable additions to the human life have enabled us to live in fast transforming community. In this context, today's related transformations are associated with especially computer and communication technologies. The society of informatics in which we currently take active part is a result of innovative developments associated with computer and communication technologies. If we consider today's top trend research topics, Artificial Intelligence has a remarkable place among cause of these developments.

Artificial Intelligent is a flexible, effective and efficient scientific field, which is widely used for solving difficult problems. Today, there is almost no field in which Artificial Intelligence is not used. From natural sciences to social sciences, intelligent solution ways are often used in different kinds of problems and in that way, mathematically and logically effective systems often find their place in not only traditional difficult problem but also newly encountered problems (Akerkar, 2014; Flasiński, 2016). The literature of Artificial Intelligence is currently almost an infinite source of scientific approaches for difficult problems. Among all different difficult problem types, time series analysis has taken place in the context of research work introduced in this chapter. As the form of information – data points observed in a time period, time series are usable tools for understanding many facts and events related to the life. By just examining a graphical flow of changes regarding facts or events, it is possible for us to derive new information – explanations or understand easier about the objective fact or events (Box et al., 2015; Brown, 2004; Elliot et al., 2017; Weigend, 1994). It is possible to see use of time series in many remarkable fields including economy – business, education, health and even social media (Brooks et al., 2014; Costa et al., 200; Enders, 2008; Nguyen et al., 2012; Zeger et al., 2006). So, time series is a popular research topic attracting researchers' attention always.

Time series analysis has a wide application interest in Artificial Intelligence oriented research studies. Because it is easy to run Machine Learning based solutions directly over time series, it has been a popular approach to use alternative types of intelligent systems to analyze time series. Regarding to such works, time series prediction is known as a remarkable topic as followed by researchers from even different fields. In detail, the associated literature has many alternative examples of such research focuses benefiting from intelligent techniques for time series analysis (As some examples: Chatfield, 2016; Formisano et al., 2008; Långkvist et al., 2014; Prudêncio & Ludermir, 2004; Singh & Balasundaram, 2007; Tang et al., 2009).

When the research interest of time series analysis is examined, it can be seen that also time series prediction (forecasting) is one of popular problem approach under time series analysis done via Artificial Intelligence – Machine Learning. At this point, prediction capability of especially Machine Learning techniques within Artificial Intelligence is a remarkable factor on that and the literature is enough for having information about comprehensive applications of predictions (Alm et al., 2005; Chen & Asch, 2017; Mair et al., 2000; Shah, 2007; Shipp et al., 2002; Weiss & Kulikowski, 1991; Yuksel et al., 2017). Because it has been always important to have some idea about future states of an information – data flow even it is chaotic, intelligent techniques have also been applied in time series prediction. In that way, faster and effective prediction processes have been achieved easily. In the associated literature of intelligently time series analysis, it is possible to see also wide applications of intelligent time series prediction (Readers are referred to some recent examples as: Borovykh et al., 2017; Brockwell & Davis, 2016; Coelho et al., 2017; Elliot et al., 2017; Ince & Trafalis, 2017; Kose & Arslan, 2017; Qiu et al., 2017; Shi & Han, 2007; Toriyama et al., 2017; Xing et al., 2017; Yao et al., 2017; Zhang et al., 2017).

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