Thesis for the Degree of Ph. D.

Deep Neuro-Fuzzy Networks with interpretability for classification

School of Electronics Engineering, Major in Signal Processing
The Graduate School

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June 2020

The Graduate School
Kyungpook National University

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June 2020

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I. INTRODUCTION

Deep Learning (DL) has emerged as a family of powerful machine learning models with superior classification performance in AI applications to improve diagnosis [1], classification, and prediction of clinical outcome [2]. This can be attributed to the deep hierarchical structure that can effectively capture relevant high-level abstractions and characterize training data very well in a layer-by-layer manner [3]. It has been mentioned that deep neural networks are forming an efficient internal representation of the learning problem. Still, it is unclear how this competent representation is distributed layer-wise and how it arises from learning [4]. This lack of transparency in the training process often causes crucial trust-related problems in critical application areas such as health care where validation is essential. A vital component of an AI system is the ability to explain the decisions made by it and the process through which they are made. These explanations offer an insight into why a particular action has been chosen.

Convolutional Neural Networks (CNNs) are amongst the most prevalent architectures for deep learning (DL), that empower big data feature extraction with robustness and accurateness. They effectively draw out from low-level input data to high-level abstraction features due to the benefit of a massive number of samples. However, due to inadequate information or complexity in the input feature, data may be ambiguous or vague which is mostly considered as data ambiguity [5]. Performance of CNNs in emotion understanding from video clips which have essential syntactic, semantic, and visual ambiguity is insufficient. CNN is a totally deterministic system used in a ‘‘black-box’’ behavior that impossible to manipulate data ambiguity [6].

Fuzzy inference system (FIS) is an effective mechanism for modeling human perception and reasoning [7]. The mathematical framework for ambiguous data processing may be provided by the possibility theory of fuzzy logic. Numerical computations performed by fuzzy logic using linguistic labels and fuzzy degrees of membership, which are represented as degrees of truth [6]. Humans could easily interpret the feature extraction and the reasoning process from fuzzy rules and fuzzy inference. Nevertheless, fuzzy rules are needed to determine by human experts, and the learning capability of fuzzy systems is deficient. By incorporating fuzzy logic with neural network, neuro-fuzzy networks can automatically learn the fuzzy membership functions [8]. Therefore, the fuzzy system parameter could be obtained from a large volume of training data.

Today, throughout the era of the Internet, and with the explosion of social media, it is imperative to dig into key and relevant knowledge from the multitude of data available in it. These usually come in the form of text and express the reader's love for content such as goods, utilities, books, hotels, etc. Text is a good source for sharing your opinions, emotions, and feelings. Languages are not only used for communication, but they also convey the