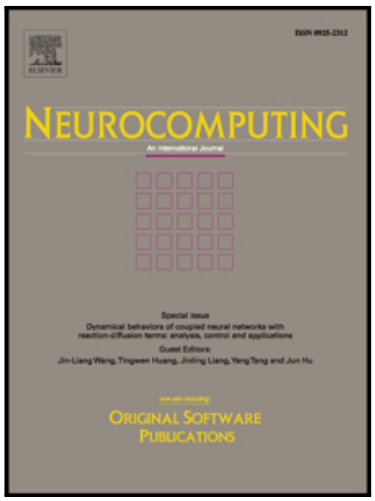

Learning with Similarity Functions: a Novel Design for the Extreme Learning Machine

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PII: S0925-2312(17)30214-X
DOI: 10.1016/j.neucom.2016.05.116
Reference: NEUCOM 18011

To appear in: *Neurocomputing*

Received date: 30 September 2015
Revised date: 22 February 2016
Accepted date: 5 May 2016

Please cite this article as: P. Gastaldo , F. Bisio , C. Gianoglio , E. Ragusa , R. Zunino , Learning with Similarity Functions: a Novel Design for the Extreme Learning Machine, *Neurocomputing* (2017), doi: 10.1016/j.neucom.2016.05.116

Learning with Similarity Functions: a Novel Design for the Extreme Learning Machine

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Abstract The paper addresses the role of randomization in the training process of a learning machine, and analyses the affinities between two well-known schemes, namely, Extreme Learning Machines (ELMs) and the learning framework using similarity functions. These paradigms share a common approach to inductive learning, which combines an explicit remapping of data with a linear separator; however, they seem to exploit different strategies in the design of the mapping layer. The paper shows that, in fact, the theory of learning with similarity functions can stimulate a novel interpretation of the ELM paradigm, thus leading to a common framework. New insights into the ELM model are obtained, and the ELM strategy for the setup of the neurons' parameters can be significantly improved. Experimental results confirm that the novel method improves over conventional approaches, especially in the trade-off between classification accuracy and machine complexity (i.e., the dimensionality of the remapped space). This, in turn, supports the reliability of the unified framework envisioned in this paper.

Keywords: extreme learning machine, similarity functions, single-layer feedforward neural networks

1. Introduction

Feedforward neural networks [1] possibly represent the most popular class of neural networks (NNs). Feedforward NNs provide a powerful paradigm for inductive learning; on the other hand, the training process may bring about some crucial issues, such as convergence speed, the setting of free parameters, and the risk of overfitting. The literature shows one can exploit randomization to set up specialized configurations of feed forward NNs, which exhibit a simpler training procedure while maintaining a notable generalization performance. RBF networks with randomly fixed hidden neurons (RHN) [2], random vector functional-link (RVFL) networks [3], and the Extreme Learning Machine (ELM) [4] give most interesting examples toward that end, and confirm that randomization can play a significant role in inductive learning.

This paper aims to provide new insights into the ELM model, which recently emerged as a powerful and flexible paradigm. The ELM framework actually implements a Single-hidden-Layer