

## Accepted Manuscript

The Universal Consistency of Extreme Learning Machine

Xia Liu, Lin Xu

PII: S0925-2312(18)30651-9  
DOI: [10.1016/j.neucom.2018.05.066](https://doi.org/10.1016/j.neucom.2018.05.066)  
Reference: NEUCOM 19627

To appear in: *Neurocomputing*

Received date: 29 September 2017  
Revised date: 6 April 2018  
Accepted date: 23 May 2018

Please cite this article as: Xia Liu, Lin Xu, The Universal Consistency of Extreme Learning Machine, *Neurocomputing* (2018), doi: [10.1016/j.neucom.2018.05.066](https://doi.org/10.1016/j.neucom.2018.05.066)



This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

# The Universal Consistency of Extreme Learning Machine

Xia Liu<sup>1\*</sup>, Lin Xu<sup>2</sup>

1. School of Sciences, Xi'an University of Technology, Xi'an 710048, China

2. Department of Electrical and Computer Engineering, New York University, Abu Dhabi 129188, UAE

---

## Abstract

Extreme learning machine (ELM) can be considered as a single-hidden layer feedforward neural network (FNN)-type learning system, whose input weights and hidden layer biases are randomly assigned, while output weights need tuning. In the framework of regression, a fundamental problem of ELM learning is whether the ELM estimator is universally consistent, that is, whether it can approximate arbitrary regression function to any accuracy, provided the number of training samples is sufficiently large. The aim of this paper is two-fold. One is to verify the strongly universal consistency of the ELM estimator, and the other is to present a sufficient and the necessary condition for the activation function, where the corresponding ELM estimator is strongly universally consistent. The obtained results underlie the feasibility of ELM and provide a theoretical guidance of the selection of activation functions in ELM learning.

*Keywords:* Extreme learning machine, neural networks, universal consistency, activation function.

---

## 1. Introduction

Extreme learning machine (ELM), proposed by Huang et al. [11], is a special single-hidden layer feedforward neural network (FNN) learning system, whose input weights and hidden layer biases are randomly assigned. ELM then only needs to adjust the output weights which leads to ELM learning being a linear learning problem. Obviously, the computational burden of ELM learning is significantly less than that of the classical FNN training [9]. Various experimental studies [11, 13, 17] showed that such a computa-

---

\*Corresponding author: liuxia1232007@163.com

Download English Version:

<https://daneshyari.com/en/article/6863625>

Download Persian Version:

<https://daneshyari.com/article/6863625>

[Daneshyari.com](https://daneshyari.com)