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PII: S1568-4946(18)30081-4
DOI: https://doi.org/doi:10.1016/j.asoc.2018.02.022
Reference: ASOC 4714

To appear in: *Applied Soft Computing*

Received date: 8-10-2016
Revised date: 11-2-2018
Accepted date: 13-2-2018

Please cite this article as: Marta Režnáková, Lukas Tencer, Mohamed Cheriet, Elastic Memory Learning for Fuzzy Inference Models, *<![CDATA[Applied Soft Computing Journal]]>* (2018), https://doi.org/10.1016/j.asoc.2018.02.022

Elastic Memory Learning for Fuzzy Inference Models

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Abstract

In this paper we present a novel approach for solving the consequent part of Neuro-Fuzzy modeling with an emphasis on the forgetting factor in the multi-class learning problem. Our solution is based on Recursive Least Squares (RLS) for online and incremental learning applications, where the data stream is not necessarily uniformly distributed over time. Such a setup can lead to forgetting of specific classes that have not been used for a period of time. In this work we present a reasoned and detailed description of Elastic Memory Learning (EML) and EML with the use of Confidence Interval (EML+) to avoid unnecessary treatment of the forgetting factor. We present the experimental results and evaluation of our methods in order to show their usefulness not only against forgetting of unused classes, but also for dealing with the lowered recognition rate after all classes have been learned. We note that by using EML, forgetting is significantly eliminated and the recognition rate is slightly affected as well, while EML+ puts more emphasis on keeping the recognition rate higher than the forgetting. Thus, this paper presents two methods that significantly eliminate the forgetting factor for incremental learning with a different focus on its importance, i.e. high recognition rate vs high immunity to forgetting; both of these methods perform significantly better than RLS for these aspects.

Keywords: Incremental Learning, Online Learning, Neuro-Fuzzy models, Takagi-Sugeno Fuzzy model, Elastic Memory Learning, Classification

1. Introduction

Neuro-Fuzzy models divide the feature space into a number of fuzzy rules that are responsible for the local inferences (1). To derive the final inference

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