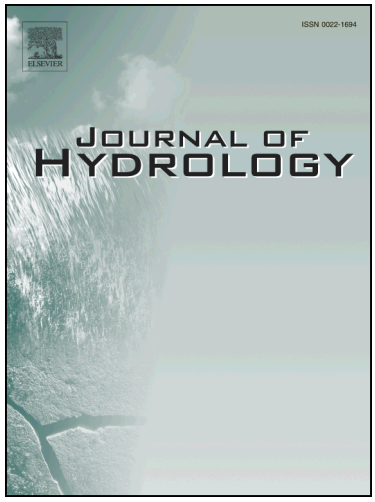

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PII: S0022-1694(17)30713-8
DOI: https://doi.org/10.1016/j.jhydrol.2017.10.037
Reference: HYDROL 22317

To appear in: *Journal of Hydrology*

Received Date: 3 June 2017
Revised Date: 25 August 2017
Accepted Date: 19 October 2017

Please cite this article as: Lima, A.R., Hsieh, W.W., Cannon, A.J., Variable complexity online sequential extreme learning machine, with applications to streamflow prediction, *Journal of Hydrology* (2017), doi: https://doi.org/10.1016/j.jhydrol.2017.10.037

Variable complexity online sequential extreme learning machine, with applications to streamflow prediction

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Abstract

In situations where new data arrive continually, online learning algorithms are computationally much less costly than batch learning ones in maintaining the model up-to-date. The extreme learning machine (ELM), a single hidden layer artificial neural network with random weights in the hidden layer, is solved by linear least squares, and has an online learning version, the online sequential ELM (OSELM). As more data become available during online learning, information on the longer time scale becomes available, so ideally the model complexity should be allowed to change, but the number of hidden nodes (HN) remains fixed in OSELM. A variable complexity VC-OSELM algorithm is proposed to dynamically add or remove HN in the OSELM, allowing the model complexity to vary automatically as online learning proceeds. The performance of VC-OSELM was compared with OSELM in daily streamflow predictions at two hydrological stations in British Columbia, Canada, with VC-OSELM significantly outperforming OSELM in mean absolute error, root mean squared error and Nash-Sutcliffe efficiency at both stations.

Keywords: streamflow, forecast, online learning, randomized neural networks, extreme learning machine (ELM), online sequential ELM (OSELM)

1. Introduction

Artificial neural networks (ANN) have been widely studied and used in hydrology and water resources (Shamseldin, 2010; Rasouli et al., 2012; Abrahart et al., 2012; Maier et al.,

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