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Neural network rainfall-runoff modelling: structural explorations based on neuroevolution and topological complexification

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Neural network solutions based on fixed topologies and full connections are often criticised since the default configuration will in most cases contain an excessive number of internal components. This makes the model susceptible to overfitting. The use of trial and error procedures to discover an optimal structure can help to reduce the number of hidden units and weighted connections. Limited effort has however been made to explore the potential benefits of using constructive algorithms such as 'cascade correlation'; or to implement destructive algorithms that will remove either unwanted units or unwanted connections. This paper will present some initial findings in terms of neural network structures and parameterisations that were obtained from a neuroevolution method in which both the structure and the parameterisation of a model are evolved. "NeuroEvolution of Augmenting Topologies" (NEAT; Stanley & Miikkulainen, 2002) starts with a minimal configuration that is thereafter augmented in an incremental manner. No fixed topological framework is used to control the structural organisation of the hidden units or weighted connections. Evolution-based mechanisms develop a parsimonious solution using a simultaneous optimisation and complexification function which supports the development of more complex structures that contain fewer components. The model at the same time becomes more optimal in terms of the principal reinforcement learning task or goal. Some initial results are provided for a rainfall-runoff model of the River Ouse in Northern England. The main advantages of such methods will be discussed. Particular emphasis will be placed on a consideration of structures and complexities and on the impact that such factors can have in terms of forecasting accuracies and the potential for improved generalisation to unseen datasets.