# Genetic Programming: Principles, Applications and Opportunities for Hydrological Modelling

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**Abstract :** Hydrological modelling plays a crucial role in the planning and management of water resources, most especially in water stressed regions where the need to effectively manage the available water resources is of critical importance. However, due to the complex, nonlinear and dynamic behaviour of hydro-climatic interactions, achieving reliable modelling of water resource systems and accurate projection of hydrological parameters are extremely challenging. Although a significant number of modelling techniques (process-based and data-driven) have been developed and adopted in that regard, the field of hydrological modelling is still considered as one that has sluggishly progressed over the past decades. This is majorly as a result of the identification of some degree of uncertainty in the methodologies and results of techniques adopted. In recent times, evolutionary computation (EC) techniques have been developed and introduced in response to the search for efficient and reliable means of providing accurate solutions to hydrological related problems. This paper presents a comprehensive review of the underlying principles, methodological needs and applications of a promising evolutionary computation modelling technique – genetic programming (GP). It examines the specific characteristics of the technique which makes it suitable to solving hydrological modelling problems. It discusses the opportunities inherent in the application of GP in water related-studies such as rainfall estimation, rainfall-runoff modelling, streamflow forecasting, sediment transport modelling, water quality modelling and groundwater modelling among others. Furthermore, the means by which such opportunities could be harnessed in the near future are discussed. In all, a case for total embracement of GP and its variants in hydrological modelling studies is made so as to put in place strategies that would translate into achieving meaningful progress as it relates to modelling of water resource systems, and also positively influence decision-making by relevant stakeholders.

**Keywords :** computational modelling, evolutionary algorithms, genetic programming, hydrological modelling