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Integrated Machine Learning Techniques in Streamflow Forecasting and Reservoir Operation

Mansour Ganji, Isfahan University of Technology, 00983113913840, m_g294i@yahoo.com

1. Mansour Ganji, Graduate Student,Isfahan University of Technology
2. Keyvan Asghari, Assistant Professor,Isfahan University of Technology

The central part of Iran's water system and supplying its water demands is highly dependent on a short seasonal precipitation and hence has great potential to suffer from unbalanced distribution of both demand and supply sides of water. Reservoirs in this region are the main water structures to reduce the shortages and help to balance the monthly water needs based on limited supply. Historical data indicates that the region is susceptible to hydrological drought periods where consecutive years of below-average annual streamflow occur. This paper attempts to investigate the integration of new and emerging machine learning techniques for high-performance evaluation of climate change impacts on hydrology and consequently its influence on water resource systems planning such as reservoir operations. In a new trend of modeling, combinations of decision-type models and simulating models (hybrid modeling) suggest a complementary strategy to solve reservoir operation problems. For real time operation of reservoirs, proper forecasting of surface inflow into the reservoirs and efficient robust optimization technique is essential. Recent advanced data-driven techniques such as support vector machines (SVM) and harmony search (HS) proved to be computationally efficient for analyzing the historical patterns of data and developing a forecasting trained and optimized model for inflow estimation. The regression capability of SVM, the so called SVR, together with the classification feature (SVC) will be employed to improve the efficacy of the model in real-world applications. The support vector classification part of modeling will enable us to classify hydrological periods into different climatic conditions. The combined usage of a data-driven model and an evolutionary efficient optimization algorithm such as HS will allow overcoming the reported limitations such as uncertainty in convergence to global optimum in training the network. Finally, the optimal strategy for reservoir releases is determined based on actual monthly inflows for different climatic conditions. The proposed methodology will be applied to Zayandeh-rud reservoir system and its potential for real time prediction of monthly releases for adaptive planning and management will be compared to the results of an ordinary combined ANN-GA on the basis of computational efficiency and accuracy.