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Particle Swarm Optimization for Identifying Rainfall-Runoff Relationships

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ABSTRACT
Rainfall-runoff processes can be considered a single input-output system where the observed rainfall and runoff are inputs and outputs, respectively. Conventional models of these processes cannot simultaneously identify unknown structures of the system and estimate unknown parameters. This study applied a combinational optimization and Particle Swarm Optimization (PSO) for simultaneous identification of system structure and parameters of the rainfall-runoff relationship. Subsystems in proposed model are modeled using combinations of classic models. Classic models are used to transform the system structure identification problem into a combinational optimization and can be selected from those typically used in the hydrological field. A PSO is then applied to select the optimized subsystem model with the best data fit. The parameters are estimated simultaneously. The proposed model is tested in a case study of daily rainfall-runoff for the upstream Kee-Lung River. Comparison of the proposed method with simple linear model (SLM) shows that, in both calibration and validation, the PSO simulates the time of peak arrival more accurately compared to the SLM. Analytical results also confirm that the PSO accurately identifies the system structure and parameters of the rainfall-runoff relationship, which are a useful reference for water resource planning and application.

KEYWORDS
Rainfall-Runoff; System Identification; Particle Swarm Optimization; Classic Models; Simple Linear Model

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References

[1] C. T. Cheng, C. P. Ou and K. W. Chau, "Combining a Fuzzy Optimal Model with a Genetic Algorithm to Solve Multiobjective Rainfall-Runoff Model Calibration," Journal of Hydrology, Vol. 268, No. 1-4, 2002, pp. 72-86. doi:10.1016/S0022-1694(02)00122-1

[2] K. W. Chau, C. L. Wu and Y. S. Li, "Comparison of Several Flood Forecasting Models in Yangtze River," Journal of Hydrologic Engineering, Vol. 10, No. 6, 2005, pp. 485-491. doi:10.1061/(ASCE)1084-0699(2005)10:6(485)

[3] J. Y. Lin, C. T. Cheng and K. W. Chau, "Using Support Vector Machines for Long-Term Discharge Prediction," Hydrological Sciences Journal, Vol. 51, No. 4, 2006, pp. 599-612. doi:10.1623/hysj.51.4.599

[4] C. T. Cheng, W. C. Wang, D. M. Xu and K. W. Chau, "Optimizing Hydropower Reservoir Operation Using Hybrid Genetic Algorithm and Chaos," Water Resources Management, Vol. 22, No. 7, 2008, pp. 895-909. doi:10.1007/s11269-007-9200-1

[5] W. C. Wang, K. W. Chau, C. T. Cheng and L. Qiu, "A Comparison of Performance of Several Artificial Intelligence Methods for Forecasting Monthly Discharge Time Series," Journal of Hydrology, Vol. 374, No. 3-4, 2009, pp. 294-306. doi:10.1016/j.jhydrol.2009.06.019

[6] C. L. Wu, K. W. Chau and Y. S. Li, "Predicting Monthly Streamflow Using Data-Driven Models Coupled

with Data-Preprocessing Techniques," Water Resources Research, 45, W08432, 2009, 23 Pages. doi:10.1029/2007WR006737

[7] F. Wang, K. Xing and X. Xu, "A System Identification Method Using Particle Swarm Optimization," Journal of Xi ' an Jiaotong University, Vol. 43, No. 2, 2009, pp. 116-120 (in Chinese).

[8] J. Kennedy and R. C. Eberhart, "Particle Swarm Optimization," Proceedings of IEEE International Conference on Neural Networks, Perth, Vol. 4, 1995, pp. 1942-1948. doi:10.1109/ICNN.1995.488968

[9] K. W. Chau, "Particle Swarm Optimization Training Algorithm for ANNs in Stage Prediction of Shing Mun River," Journal of Hydrology, Vol. 329, No. 3-4, 2006, pp. 363-367. doi:10.1016/j.jhydrol.2006.02.025

[10] M. K. Gill, Y. H. Kaheil, A. Khalil, M. McKee and L. Bastidas, "Multiobjective Particle Swarm Optimization for Parameter Estimation in Hydrology," Water Resources Research, Vol. 42, W07417, 2006, 14 Pages. doi:10.1029/2005WR004528

[11] K. W. Chau, "A Split-Step Particle Swarm Optimization Algorithm in River Stage Forecasting," Journal of Hydrology, Vol. 346, No. 3-4, 2007, pp. 131-135.

[12] Y. Luo and X. G. Yuan, "Global Optimization for the Synthesis of Integrated Water Systems with Particle Swarm Optimization Algorithm," Chinese Journal of Chemical Engineering, Vol. 16, No. 1, 2008, pp. 11-15. doi:10.1016/S1004-9541(08)60027-0

[13] X. S. Zhang, R. Srinivasan, K. G. Zhao and M. V. Liew, "Evaluation of Global Optimization Algorithms for Para- meter Calibration of a Computationally Intensive Hydrologic Model," Hydrological Processes, Vol. 23, No. 3, 2008, pp. 430-441. doi:10.1002/hyp.7152

[14] W. C. Wang, X. T. Nie and L. Qiu, "Support Vector Machine with Particle Swarm Optimization for Reservoir Annual Inflow Forecasting," Proceedings of International Conference on Artificial Intelligence and Computation Intelligence (AICI), Sanya, China, 2010, pp. 184-188. doi:10.1109/AICI.2010.45

[15] S. Gaur, B. R. Chahar and D. Graillot, "Analytic Elements Method and Particle Swarm Optimization Based Simulation—Optimization Model for Groundwater Management," Journal of Hydrology, Vol.