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Challenges and Benefits of Direct Policy Search in Advancing Multiobjective Reservoir Management

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Optimal management policies for water reservoir operation are generally designed via stochastic dynamic programming (SDP). Yet, the adoption of SDP in complex real-world problems is challenged by the three curses of dimensionality, of modeling, and of multiple objectives. These three curses considerably limit SDP's practical application.

Alternatively, in this study, we focus on the use of evolutionary multi-objective direct policy search (EMODPS), a simulation-based optimization approach that combines direct policy search, nonlinear approximating networks and multi-objective evolutionary algorithms to design Pareto approximate operating policies for multi-purpose water reservoirs. Our analysis explores the technical and practical implications of using EMODPS through a careful diagnostic assessment of the EMODPS Pareto approximate solutions attained and the overall reliability of the policy design process. A key choice in the EMODPS approach is the selection of alternative formulations of the operating policies. In this study, we distinguish the relative performance of two widely used nonlinear approximating networks, namely Artificial Neural Networks and Radial Basis Functions, and we further compare them with SDP. Besides, we comparatively assess state-of-the-art multi-objective evolutionary algorithms (MOEAs) in terms of efficiency, effectiveness, reliability, and controllability.

Our diagnostic results show that RBFs solutions are more effective that ANNs in designing Pareto approximate policies for several water reservoir systems. They also highlight that EMODPS is very challenging for modern MOEAs and that epsilon dominance is critical for attaining high levels of performance. Epsilon dominance algorithms epsilon-MOEA, epsilon-NSGAII and the auto adaptive Borg MOEA, are statistically superior for the class of problems considered.