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Modeling an aquatic ecosystem: application of an evolutionary algorithm with genetic doping to reduce prediction uncertainty

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Aquatic ecosystem models can potentially be used to understand the influence of stresses on catchment resource quality. Given that catchment responses are functions of natural and anthropogenic stresses reflected in sparse and spatiotemporal biological, physical, and chemical measurements, an ecosystem is difficult to model using statistical or numerical methods. We propose an artificial adaptive systems approach to model ecosystems. First, an unsupervised machine-learning (ML) network is trained using the set of available sparse and disparate data variables. Second, an evolutionary algorithm with genetic doping is applied to reduce the number of ecosystem variables to an optimal set. Third, the optimal set of ecosystem variables is used to retrain the ML network. Fourth, a stochastic cross-validation approach is applied to quantify and compare the nonlinear uncertainty in selected predictions of the original and reduced models. Results are presented for aquatic ecosystems (tens of thousands of square kilometers) undergoing landscape change in the USA: Upper Illinois River Basin and Central Colorado Assessment Project Area, and Southland region, NZ.