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Multi objective nested reinforcement learning algorithm for optimal reservoir operation

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The multipurpose reservoir model is based on the mass balance equation accompanied by multiple conflicting objectives water user demands, reservoir levels targets hydropower, etc. defining a multi objective optimization problem. The multi objective problem can be aggregated into a single objective problem using weights for each of the objectives which is often referred as “scalarization”. Each weight describes the relative importance of the particular objective. Depending on the problem, the modeler can decide how many multi-objective single search solutions will generate that define the Pareto set.
We present the design and implementation of the multi objective nested reinforcement learning (MOnRL) and compare it to multi objective nested dynamic programming (MOnDP) and multi objective nested stochastic dynamic programming (MOnSDP). All algorithms are based on the so-called “nested” approach which was found to be an effective way for alleviating the curse of dimensionality in case of the dependent decision variables (e.g. in cases when there are several water demands to satisfy at each time step). The MOnRL design and implementation details include a) the state/action variables selection and their model inclusion and impact to the memory requirements, b) the nRL parameters tuning of the learning rate α, the discount parameter γ, the exploration/exploitation parameter ε, and the maximum number of episodes M, c) establishment of the boundary conditions, starting state, dynamic-static action list, convergence criteria and other. These algorithms are tested on Zletovica river basin with eight objectives and six decision variables. It is shown that the MOnRL produce better reservoir policies than the MOnSDP. The main conclusion and findings can be applied to any MO RL multipurpose reservoir problem.