

Incorporation of Fixed Installation Costs into Optimization of Groundwater Remediation with a New Efficient Surrogate Nonlinear Mixed Integer Optimization Algorithm

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Optimization of nonlinear water resources management issues which have a mixture of fixed (e.g. construction cost for a well) and variable (e.g. cost per gallon of water pumped) costs has been not well addressed because prior algorithms for the resulting nonlinear mixed integer problems have required many groundwater simulations (with different configurations of decision variable), especially when the solution space is multimodal. In particular heuristic methods like genetic algorithms have often been used in the water resources area, but they require so many groundwater simulations that only small systems have been solved. Hence there is a need to have a method that reduces the number of expensive groundwater simulations. A recently published algorithm for nonlinear mixed integer programming using surrogates was shown in this study to greatly reduce the computational effort for obtaining accurate answers to problems involving fixed costs for well construction as well as variable costs for pumping because of a substantial reduction in the number of groundwater simulations required to obtain an accurate answer. Results are presented for a US EPA hazardous waste site. The nonlinear mixed integer surrogate algorithm is general and can be used on other problems arising in hydrology with open source codes in Matlab and python (“pySOT” in Bitbucket).