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Hybrid Optimization: Combining the Best to Overcome the Worst

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Every optimization technique has inherent strengths and weaknesses. Moreover, some optimization algorithms contain characteristics which make them better suited to solve particular kinds of problems. Hybridization, or the combining of two or more complementary, but distinct approaches, allows the user to take advantage of the beneficial elements of multiple methods. For example, consider two methods A and B where method A is capable of handling noise and undefined points and method B excels in smooth regions with small amounts of noise. In this case, method A may be unacceptably slow to find a solution while method B may fail in noisy or discontinuous regions of the domain. By forming a hybrid, method A can help overcome difficult regions of the domain and method B can be applied for fast convergence and efficiency.

In this talk, we will examine the application of hybrid optimization to water resources management problems. Hybrids are particularly suited to these problems as the objective function is often non-smooth or discontinuous and the feasible region is usually disconnected. We will describe an algorithm which combines statistical emulation via treed Gaussian process with pattern search optimization. We will demonstrate the applicability of our hybrid method to a plume containment problem that was proposed in the literature specifically for benchmarking purposes, and has already been used for the comparison of a variety of derivative-free optimization algorithms. In addition, we will describe how the treed Gaussian process can also be used as a post-processing tool to increase insight into the problem.