Computational and Applied Mathematics Seminar

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Simultaneous optimization of well placement and control using a hybrid global-local strategy

Abstract:

Optimal placement and control of wells is essential to ensuring maximal net present value (NPV) or total oil recovery when developing an oil field. The majority of academic literature treats optimal placement and control as two separate problems; well placement problems, in particular, are often solved assuming some fixed flow rate or bottom-hole pressure (BHP) at injection and production wells. Truly optimal well locations, however, depend on the control strategy being employed. These locations can only be determined by allowing the control parameters to vary as well. This presents a challenging problem since it features two distinct variable types. Well locations are discrete variables (grid co-ordinates), over which the objective function may vary nonsmoothly due to inhomogenous features of the reservoir. Control parameters, which can be altered at specified time intervals, are continuous variables, and the objective function will tend to vary smoothly as these are changed.

In this paper we address the placement and control optimization problem simultaneously with an approach that combines a global search strategy (particle swarm optimization, or PSO) with a local generalized pattern search (GPS) strategy. This approach promotes a full, semi-random exploration of the search space with PSO, while the GPS technique allows us to optimize the control strategy in a systematic way. We present simulation experiments showing that the hybrid algorithm outperforms the independent application of PSO to this problem, providing NPVs that are higher on average while also requiring fewer simulation runs.