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SURROGATE BASED HYBRID OPTIMIZATION APPLIED TO RESERVOIR MANAGEMENT

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Reservoir simulation is used extensively to identify opportunities to increase oil production in heavy oil reservoirs. In this scenario water flooding is one the most common used method to improve oil recovery after primary depletion. The management of the field can be formulated as an optimization problem in which the rates in the producers and injectors wells as well as the duration of control cycles are to be obtained fulfilling specific constraints.
Single and multiobjective solutions will be considered here. The objective functions are cumulative oil production and cumulative water injection. These function evaluations will require a complete reservoir simulation which may turn the optimization task in a very time consuming process. In order to ameliorate such drawback surrogate models are built to be used in substitution to the numerical reservoir simulations [1].
The optimization problem described above presents multimodal characteristics which would be adequate to solve considering a global optimization strategy. As natural choices for this type of solution emerges the class of evolutionary algorithms such as genetic algorithm (GA), smarms methodologies among others [2]. In general such algorithms, present fast convergence at initial stages of global search, but in the neighbourhood of the global optimum, the search process becomes very slow. To overcome that, mathematic programming algorithms would be ideal to be combined with global strategies as they provide very fast convergence around a pre specified initial point. The resulting tool will provide a balance between a global search process and the efficiency of a local process. In this sense, the combination of global and local algorithms appears as a promising strategy to solve the dynamic optimization of water flooding management problem, as a computation reduction cost can be obtained without comprising the global search properties.
Here hybrid strategy for uniobjective problems are built in which GA is used as an initial point to the local optimization strategy that is faster and more efficient for local search. The sequential approximate optimization (SAO) [3] technique is the local strategy of choice which considers the sequential quadratic programming (SQP) [4] as optimizer.
Multiobjective solutions will be conducted using the Pareto concept. In the global search the technique employed is the Non-dominated Sorting Genetic Algorithm – (NSGA) [5], which will produce the pareto front tendency, as starting front for the local multiobjective stage that will be solved by the Normal boundary intersection method (NBI) [6] employing here the SAO strategy. For both uni and multi objective problems in the global search stage the optimizers are run cheaper with low number of generations, low number of function

evaluations and setting an aggressive mutation rate to explore better the whole space. The idea is to identify promising optimum areas from which the local optimizer proceeds towards optimum solution. Kriging models [3] are built to be used both in global as well as local search strategies.

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