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A SURROGATE-ASSISTED COOPERATIVE CO-EVOLUTIONARY ALGORITHM FOR SOLVING HIGH DIMENSIONAL, EXPENSIVE AND BLACK BOX OPTIMIZATION PROBLEMS

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Abstract: Many research efforts have been recently put to solve large-scale global optimization (LSGO) problems by means of evolutionary algorithms (EAs). Unfortunately, standard EAs are usually not well-suited for such LSGO problems and their performance declines once the number of variables increases. This issue is mainly explained by the exponential growth of the search space and is referred as the "curse of dimensionality". Cooperative co-evolution has been proposed to solve such problems involving thousand of variables. This methodology consists in dividing the LSGO problems into several subproblems, each of them being optimized in a round-robin fashion with an EA. The latter has proved to be very efficient to solve a wide range of LSGO problems. Nevertheless, it often requires a huge number of function evaluations to reach a suitable solution. This is somewhat problematic when the function evaluation is computationally expensive. To overcome this costly issue and still get suitable precision accuracy, one can take advantage of surrogate models. They act as cheap-to-evaluate alternatives to the original high-fidelity models reducing the computational cost, while still providing improved designs. This kind of optimization process, called surrogate-assisted optimization, has been shown to be very efficient on small-dimensional problems but suffers from the curse of dimensionality to solve LSGO problems. Indeed, this curse affects the EA optimization but also affects the quality of the surrogate models. In this paper, cooperative co-evolution relying on dynamic random decompositions is combined with surrogate-assisted optimization in order to efficiently solve high dimensional, expensive and black-box (HEB) problems. The proposed algorithm is based on two pillars: on the one hand, the achievement, in a limited number of function evaluations, of a satisfactory solution required by the HEB nature of the studied problems; on the other hand, its potentially scalable architecture by means of parallel function evaluations. Our study provides good results when solving a wide set of benchmark problems with 100, 500 and 1000 variables. The benefit of the parallel architecture is shown very attractive when comparing with a standard surrogate-assisted algorithm. Furthermore, the presented algorithm is compared with the state-of-the-art algorithm SACCJADE. The comparison has shown that our algorithm is very efficient to find a satisfactory solution with a very small budget in terms of function evaluations.