A Hybrid Optimization Algorithm with Search Vector Based Automatic Switching

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ABSTRACT

Many optimization algorithms are ideally suited for certain objective function topologies, but are seriously underperforming or fail outright for others. This paper proposes a hybrid optimization algorithm that utilizes basic information about objective function topology to determine which constitutive optimization algorithm is currently best suited for a given problema, thus, increasing the overall robustness and convergence speed of the optimization process. During each iteration, the hybrid optimizer automatically selects from a set of constituent algorithms the algorithm that best searches in a pre-determined search direction. The hybrid presented here selects from a set of five nature-inspired algorithms (particle swarm, modified quantum particle swarm, not-yet published variations of particle swarm and differential evolution, as well as cuckoo search) and utilizes over twelve search direction schemes. A sixth algorithm called the firefly algorithm, is currently under consideration for inclusion. The performance of each search direction scheme was compared using a subset of the Schittkowski & Hock's analytical test cases. Standard particle swarm and differential evolution (rand/1/bin) will be used for benchmarking. The hybrid can be extended to work with any search scheme and any number of individual optimization algorithms, making it a versatile and robust platform.

The current search schemes are divided into two broad groups: (1) the hybrid searches based on a fixed formulation that automatically switches between algorithms; (2) the hybrid that switches between formulations and algorithms. The first group selects among algorithms based on a fixed scheme, such as "always search in the direction of the current global best." This approach overrides the search logic of the constituent algorithms and while it is very restrictive, it also provides valuable information about the behavior of certain algorithms on certain function topologies as some constituent algorithms are heavily preferred over the others under certain search schemes. The second group partially alleviates the restrictions of the first group by dynamically selecting the direction in which to search. This group evaluates the objective function at the various proposed search locations and compares their relative fitness before deciding which direction is best to search. Future search schemes can be developed that take into account such topology features as smoothness of the function topology, the scale of the range of the objective function, and detection of convex regions.