NEXT GENERATION GENETIC ALGORITHMS

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New developments in Gray Box Optimization makes it possible to construct new forms of Genetic Algorithms that do not use random mutation or random recombination. Instead, for certain classes of NP Hard problems (ranging from MAXSAT to the Traveling Salesman Problem), it is possible to exactly compute the location of improving moves (often in constant time), and to use highly efficient forms of greedy deterministic recombination. In some cases, this makes random mutation and random recombination unnecessary and obsolete.

Deterministic "Partition Crossover" can be applied to k-bounded pseudo-Boolean optimization problems (such as MAXSAT and NK Landscapes) as well as problems such as the Traveling Salesman Problem (TSP). Partition Crossover locally decomposes a recombination graph into q subgraphs in O(n) time. It can then identify the best of possible offspring. For example, for q=40, partition crossover returns the best of one trillion (possible offspring. If the parents are local optima, the offspring are guaranteed to be locally optimal in the largest hyperplane subspace containing both parents, and offspring are typically also local optima in the full space. This allows partition crossover to directly "tunnel" between local optima, moving directly from local optimum to local optimum.

For the TSP, these results can be use to improve the best existing TSP solvers (e.g., LKH and EAX). It can also be used to improve exact Branch and Bound algorithms such as Concorde.

For k-bounded pseudo-Boolean optimization problems these new algorithms are able to solve problems with 1 million variables.

Other recent results also use a similar form of local decomposition coupled with greedy and deterministic optimization. When applied to multiply constrained scheduling problems, the genetic algorithm is able to solve industrial problems with unto 1 billion variables.

These results have the potential to revolutionized evolutionary computation. The methods are decidedly not black box optimizers, and the new algorithms trivially solve many black box benchmarks: ONEMAX, Leading Ones and Trap functions are solved in O(n) time using only 1 evaluation.