Assessing the Evolutionary Algorithm Paradigm to Solve Hard Problems

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Evolutionary Algorithms (EAs) have been imagined in the 60's in three places, with different goals in mind:

- in Germany, both H-P. Schwefel [Schwefel, 1981] and H. Rechenberg [Rechenberg, 1973] proposed the evolution strategies (ES) to optimize real-valued functions,
- at UCSD, L.J. Fogel, A.J. Owens, and M.J. Walsh [Fogel *et al.*, 1966] introduced the evolutionary programming (EP) techniques in the field of machine learning,
- at the University of Michigan, J.H. Holland [Holland, 1975] developed the genetic algorithms (GA) to model and understand the *adaptation in artificial and natural species*.

Though invented separately and having been used by totally separate communities, these three kinds of algorithms shared much resemblances. Their application to the resolution of many combinatorial optimization problems have been studied. The traveling salesman problem, scheduling problems, graph coloring, graph partitioning, set partitioning, quadratic assignment, and SAT problems have been subject of many works with various success when tackling real-world sized problems. Our experience in using GAs to solve robot motion planning problems (robot with six or more degrees of freedom) [Ahuactzin *et al.*, 1993] shows that GAs are well adapted to search solutions in high dimensionality search space with many optimal solutions.

As a heuristic, EAs face two kinds of problems:

1. the representation of solutions, and the operators that are used should be carefully designed, in close relationship with the structure of individuals;
2. the exploration of the search space performed by the EA is not thorough (of course), and there are regions that may be interesting that are not searched.

Furthermore, EAs require large computational resources for big-sized problems. This prompts us with the use of parallel EA models that have a series of advantages:

- computational power of parallel computing environments
- natural implementation of parallel models
- using different algorithms that cooperate, each algorithm having a certain kind of intrinsic parallelism, we obtain a somewhat natural utilization of networks of heterogeneous computers.

Based on early works [Talbi, 1993][Talbi *et al.*, 1994], we are currently studying the following issues:

- cooperation of algorithms: EAs, hill-climber, tabu search, greedy algorithms, various heuristics
- assessment of the EA paradigm on known benchmarks.

References

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