106a Particle Swarm Optimization in Discontinuous Function Spaces

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We investigate the suitability of particle swarm optimization1,2,3 (PSO) on discontinuous function spaces. Such function spaces are often encountered in design of separation and other networks. Often such spaces pose certain practical difficulties for mathematical programming techniques. In certain extreme cases involving excessively flat function spaces, the gradient at any point is either close to zero in most cases, or infinity at discontinuities. This causes gradient-based and higher-order optimization techniques to break down. Also, while mathematical programming techniques often give solutions that are optimal in terms of cost, they return only one optimal solution. It may however be desirable to have several good candidate solutions, from which the best solution may be chosen on the basis of operability, or other factors that cannot always be easily posed in the objective function. In other words, we seek a list of good candidate solutions for further refinement by a human expert, who has specific knowledge of the domain under examination.

In this work, we try to find multiple minima in discontinuous function spaces through stochastic methods such as PSO, genetic algorithms and simulated annealing. We compare the performance of PSO in these discontinuous function spaces with the other stochastic methods. We quantify the performance of the swarm by both the number of distinct solutions it finds and the objective function values at each of these minima. We investigate the effect of swarm topology and optimization parameters on the performance of PSO and the computational effort it requires. We investigate the use of random noise in inter-particle communication in the swarm optimization to simulate uncertainty in the data and also to provide higher driving forces in excessively flat function spaces. In this work, we summarize all our results and offer some general conclusions.

References 1. Eberhart, R. C. and Kennedy, S., Proc. Sixth International Symposium on Micro Machine and Human Science, Nagoya, Japan, pp. 39-43 (1995). 2. Kennedy, S. and Eberhart, R.C., Swarm Intelligence, Morgan Kaufman, San Francisco (2001). 3. Bonabeau, E., Dorigo, M. and Theraulaz, G., Nature, 406, 39 (2000).