Particle Swarm Optimization and Social Interactions Between Agents

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Abstract

Particle Swarm Optimization is a method of optimization used in n-dimensional infinite search space problems. This paper presents a test of different social influences and topologies of the particle swarms and comparisons between them. Social influence of the particle swarm is a very crucial part of the implementation and possible success of the particle swarm. Specifically, it is the way in which the particles communicate with each other in order to find a global minimum. The different versions of the social interactions are tested against each other using various benchmark functions based upon iterative cost to run the swarm.

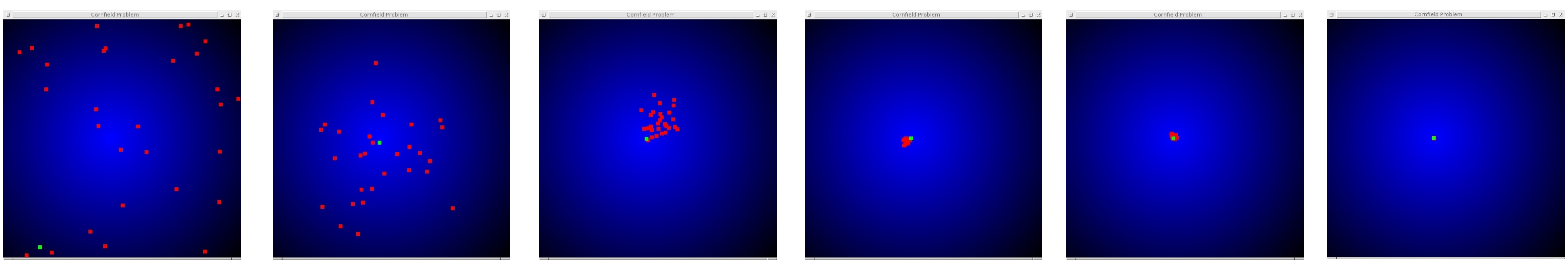

Figure 1: This series of photos shows a run of the Fully Informed Particle Swarm on the Sphere Function. Specifically it shows the 0th, 10th, 20th, 30th, and 40th, and 50th iterations of the run. As the particles continue in the run they reach lower and lower fitness values (signified by an increased amount of blue) thus minimizing the function.

Background

Particle Swarm Optimization was invented as a way to model flocks of birds. Its value as an optimizer was quickly realized. Later, in order to increase the efficiency of the algorithm many of the facets of the bird model were removed. The motion of the birds now resembled more of a swarm than a flock of birds. Therefore, it was named Particle Swarm Optimization. It was not until the work of Maurice Clerc that the swarm was analyzed analytically, who wrote a condensed form of the velocity modification (right).

$$v_{t+1} = \alpha v_t + \wp_1 \left(P_i - X_t \right) + \wp_2 \left(P_g - X_t \right)$$

$$v_{t+1} = x \left(v_t + \wp \left(P_m - X_t \right) \right)$$

Figure 2: This figure shows the two forms of velocity modification. The traditional method is shown (above), but was reduced by Clerc into the following form (below)

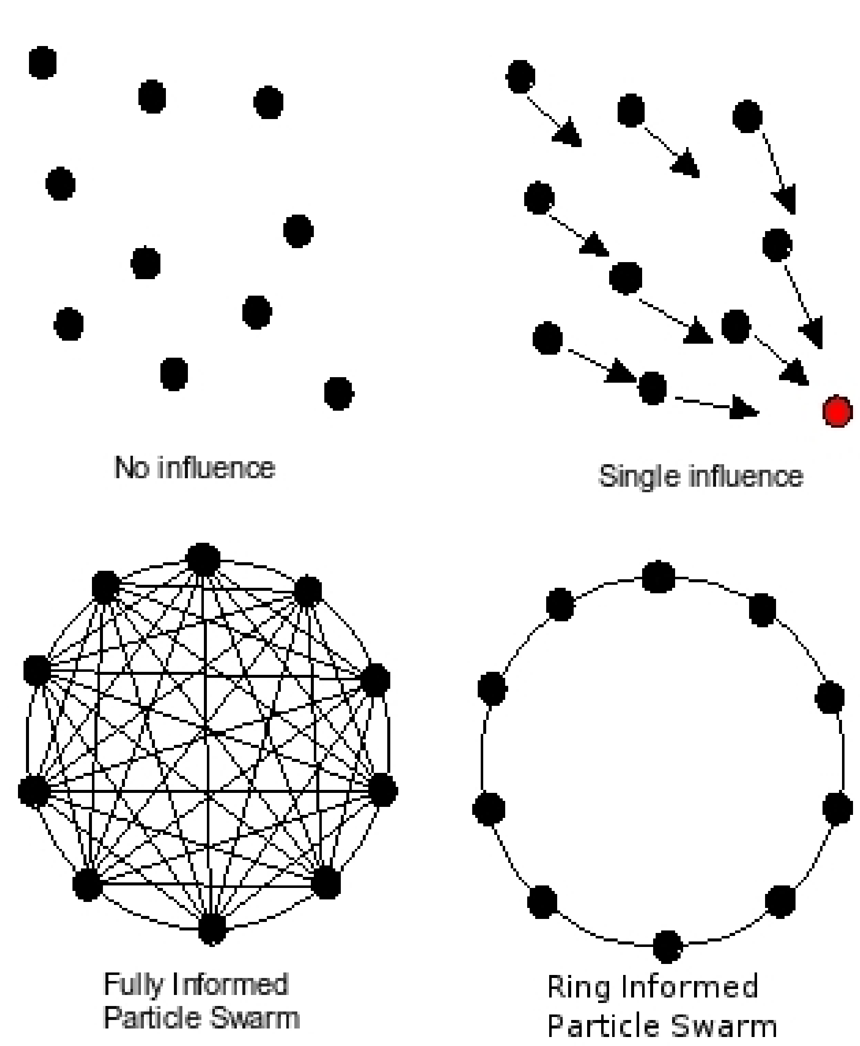

Figure 3: This figure shows the different particle swarms tested by this project. The results of these particle swarms are described in the results section of the poster.

Results

As seen in the tables below, the Fully Informed Particle Swarm seems to have done better than other types of Social Interactions tested here. Reasons for this could be that even though the Fully Informed Particle Swarm(FIPS) has a tendency to fall into local optima, the functions tested here did not have substantial false optima as to have the swarm converge at that point. NIPS (Non-Informed Particle Swarm) seems to have done the worse due to its lack of communication between particles. DIPS (Dynamically-Informed Particle Swarm) did somewhat well, and had the speed of FIPS, but for some reason did not have the same accuracy that FIPS enjoyed.

Rastrigin (100 Tests)

Swarm	% Success	Iterative Cost
NIPS	0%	0.00
RIPS	1%	184,894.00
SIPS	100%	9,088.02
FIPS	100%	100.78
DIPS	48%	5,101.10

Sphere (100 Tests)

Swarm	% Success	Iterative Cost
NIPS	0%	0.00
RIPS	100%	27,438.77
SIPS	100%	10,460.37
FIPS	100%	73.19
DIPS	100%	4,309.20