A particle swarm paradigm for nonlinear constrained global optimization

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We propose an algorithm based on the particle swarm paradigm (PSP) to address nonlinear equality and inequality constrained optimization problems. While some algorithms based on the PSP have already been proposed in this context, namely by making use of a penalty framework or by imposing strict feasibility of all particles, the equality constraints have posed some difficulties.

The PSP tries to simulate the social behavior of a population of agents or particles denoted by swarm. The success histories of the particles influence both their own behavior and those of their peers in looking for a certain objective.

In the context of optimization, the swarm objective is to find the global optimum of a given problem where each particle follows a direction (velocity) according to its previous velocity and the distances of its current position to its own best position and to the swarm best position.

While in unconstrained optimization, the objective function is used to select the best particle position and the best ever particle swarm position, in constrained optimization, the selection should also consider a measure of infeasibility. To account for these two simultaneous objectives, our algorithm extends the dominance concept of multi-objective optimization. A best particle position is said to be obtained if either an improvement in the feasibility is attained, regardless of the objective function progress, or an improvement in the objective function is present when no feasibility improvement is attained.

A new stopping criterion based on the maximum velocity of the particles is proposed. The algorithm is implemented in a solver connected with AMPL modelling language, allowing an easy coding and solving of problems. Numerical results with some problems collected from the literature are also shown. Equality constrained problems were also included in the test set to illustrate this approach ability to find an optimum for general problems.

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