Since the first publication of Particle Swarm Optimization (PSO) in 1995, the number of research papers on PSO and the number of researchers in PSO have exploded. Many variations of the PSO have been developed to improve its performance, studies have been carried out to understand the dynamics of particles, and adaptations have been made so that PSO can be applied to different optimization problem types.

This course begins with a gentle introduction to PSO, followed by some specialized topics. The introductory part will have as its objective to provide the attendee with an overview of PSO and its basic variations. A significant problem with the standard PSO will be illustrated, and a few results from studies of particle trajectories will be presented. The specialized topics will consider PSO models that are specifically designed for multimodal optimization, multiobjective optimization, coevolution, and constraint handling. The details of these topics are:

1. Basic PSO: The philosophy of PSO will be discussed, and the basic (original) PSO algorithms will be explained and illustrated. The need for social network structures will be discussed, as well as the importance of PSO control parameters, basic variations (velocity clamping, inertia, constriction). An overview of performance criteria will be given.
2. Particle Trajectories: Illustrations of particle trajectories and the influence of parameter choices on trajectories will be given. Heuristics for the selection of control parameter values will be discussed.
3. PSO problem: A problem with PSO that causes premature convergence will be discussed, and solutions proposed.
4. Multimodal optimization: speciation and niching techniques used in conjunction with PSO will be described. Illustration of a speciation-based PSO will be provided, as well as analysis of its performance and some research issues.
5. Multiobjective optimization: an overview of existing multiobjective PSO models will be provided. In addition, a multiobjective PSO will be shown to have a fast convergence and nice spread of solutions across the Pareto optimal front.
6. Coevolutionary PSO: an example of employing a cooperative coevolutionary PSO for solving large scale optimization optimization problem will be presented.
7. Constraint handling: a brief overview of existing constraint handling techniques adopted in PSO will be provided.