Entropy optimization via swarm intelligence

In recent years there have been rapid development of a class of optimization techniques based on modeling simple behavior of individuals and the local interaction between the individual with the environment in an effort to study more complex problems, which appear in the context of optimization problems. Swarm intelligence is an example of such a method, which is based on the principle of bounded rationality and the collective behavior of decision-making approach to solve difficult global optimization (GO) problems. Originally proposed by Eberhart and Kennedy in 1995, to simulate the social behavior of a population, for example, the movement a flock of birds or a school of fish, a variant of this approach is known as particle swarm optimization (PSO) and can be effectively used to solve difficult GO problems. In the context of materials modeling, one often confronts a difficult optimization problem: a certain set of data, obtained experimentally or otherwise, needs to be satisfied by a proposed solution (a model), subject to the fact that the total energy or a suitable generalized cost function is minimized. In presence of conflicting constraints, there may exist no single solution but a number of feasible solutions that are often termed as pareto-optimal solutions.

In the context of entropy optimization, our preliminary calculations based on this new approach have clearly indicated that the method can deal with a very complex and difficult optimization problems in higher dimensions, which are difficult to treat via classical gradient-based optimization methods. We are presently studying the reconstruction of a number of non-trivial density functions, using stochastic PSO algorithms, that appear frequently in many problems in mathematical physics. We are also interested in studying the nature of the MEP solutions and their dependence on the definition of the entropy. The structural relationship between MEP solutions obtained from extensive and non-extensive definitions of entropy is of particular importance. The group is currently working with Dr. Sung Lee (Mathematics, USM) and Dr. Khin Maung (Physics, USM) to address some of the questions.