An Overview of Metaheuristic Algorithms with a focus on Particle Swarm Optimization for Searching Efficient Experimental Designs

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Abstract

The class of nature-inspired metaheuristic algorithms is increasingly used to tackle all kinds of optimization problems across disciplines. It also plays an important component in artificial intelligence and machine learning. Members in this class are general purpose optimization tools that virtually require no assumptions for them to be applicable. An intriguing feature of these algorithms is that they tend to work well even though they invariably do not come with mathematical proofs of convergence. There are many such algorithms and to fix ideas, we focus on one of its exemplary members called particle swarm optimization (PSO).

We review optimal design theory and discuss new applications of PSO to find different types of efficient experimental designs, including large scale experiments for complicated nonlinear models with several interacting factors. As applications, we use PSO to generate different types of efficient designs, ranging from early phase II clinical trial designs, minimax or standardized maximin types of designs, and multi objective global recruitment trials with multiple constraints.