کارگاه مبانی نظریه محاسبات نرم

Model-free or Intelligent optimization

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Abstract

Optimization is a mathematical discipline that concerns how to find optimum (minima or maxima) of functions, subject to some given constraints. Optimization was formally formulated in the 1940s, when George Dantzig employed mathematical techniques to generate pseudo code instructions for some military applications. Today, optimization comprises a wide variety of techniques from Operations Research, computational intelligence, mathematics and computer science, and is used to improve performance of many processes in practically all industries and real world applications.

Classical mathematical optimization (alternatively, optimization or mathematical programming) refers to the selection of a best element from some set of available alternatives using some information about the main characteristics of the underlying process. In the simplest case, this means solving problems in which one seeks to minimize or maximize a real function by systematically choosing the values of real or integer variables from within an allowed set. This formulation, using a real-valued objective function, is probably the simplest example; the generalization of optimization theory and techniques to other formulations comprises a large area of applied mathematics. More generally, it means finding "best available" values of some objective function given a pre-specified region, including a variety of different types of objective functions and different types of domains. There are a range of algorithms to deal with optimization problems including linear programming, integer programming, nonlinear programming, non-smooth and etc.

In contrast, meta-heuristic optimization techniques have attracted increasing attentions in recent years for solving complex optimization problems. They are more robust than traditional methods based on formal logics or mathematical programming for many real world applications. These techniques have obviously progressed and new ideas in the area of optimization algorithms have been developed during recent decades. Although different meta-heuristic algorithms applied for various kinds of real world optimization exist, bio-inspired algorithms apparently stand out in comparison with others and construct a main category of meta-heuristic algorithms.

Further, biologically-inspired computation rapidly advanced over the past decade is a covering term for different computational methods that are based on principles or models of biological systems. This class of methods such as evolutionary algorithms (EAs), ant colony optimization (ACO), particle swarm optimization (PSO), artificial neural networks (ANNs), artificial immune

systems (AISs) complements traditional techniques in the sense that the former can be applied to large-scale applications where little is known about the underlying problem and where the latter approaches encounter difficulties such as the risk of trapping in local minima. Therefore, bio-inspired methods are becoming increasingly important in face of the complexity of today's demanding applications, and accordingly they have successfully been used in various fields.

In this workshop, after a review over classical methods and intelligent algorithms will be discussed with the outline given below.

1- Introduction to Optimization
   a. Optimization Problem Setup
      b. Optimization Problems Classification
         c. Linear vs. Nonlinear Optimization
            d. Convex vs. Non-convex Optimization
               e. Smooth vs. Non-smooth
                  f. Model based Optimization vs. Model Free Optimization
2- Classical Methods of Optimization
   a. Linear Method
      b. Gradient based Optimization methods
         c. Constrained Optimization classical methods
            d. Combinatorial Optimization classical methods
3- Heuristic Methods
   a. Hill Climbing
      b. Tabu Search
         c. Simulated Annealing
4- Evolutionary Optimization
   a. Introduction to Genetic Algorithm
      b. Co-evolutionary Algorithm
         c. Memetic Algorithm
            d. Differential Evolution Algorithm