Evolutionary Computing for Practical Optimization

Kalyanmoy Deb
Department of Mechanical Engineering
Indian Institute of Technology Kanpur
e-mail : deb@iitk.ac.in

Classical optimization methods are often too restrictive to be applied to practical problem solving due to a number of limitations in their working principles: convexity, continuity of search space, unimodality, single-objectiveness etc. Unfortunately, most practical optimization problems have all but the above properties. Evolutionary algorithms (EAs) belong to a class of stochastic optimization algorithms which, although do not always guarantee finding the optimal solution, often are the only viable choices to solve these problems to near-optimality. In this lecture, we shall present a brief introduction to EA methodology and discuss a number of properties and operators which provide EAs the necessary platform to solve such complex optimization problems. Specifically, the following properties of practical optimization problems will be discussed in the light of their solution methodologies using EAs:

- Large dimension (variables and constraints)
- Non-linear constraints
- Discontinuities, non-differentiability, discreteness of search space
- Multi-modalities (multiple local and global optima)
- Multi-objectivity (multiple conflicting objectives resulting in trade-off solutions)
- Uncertainties in variables and objectives (robust design, reliability-based design, handling noise)
- Large computational time for evaluation (need for approximate evaluation using RSM, Kriging, artificial neural nets etc.)
- Imprecise description of variables and objectives (need for fuzzy logic and rough set descriptions)
- Dynamic optimization problems in which optimization problem changes with time

Evolutionary algorithms have a bright future beyond optimization in terms of their abilities in deciphering innovative principles for being optimal -- a matter which will be well-illustrated with a number of interesting practical case studies.