

## Lecture Series in "Optimization Methods for Engineering Applications"

Speaker: Prof. Kalyanmoy Deb, Koenig Endowed Chair Professor, Michigan State University, East Lansing, USA

### Aim:

Optimization methods can be generically applied to solve many engineering problems. Hence, they are probably the most-used topics in PhD theses and on scholarly literature. However, a generic optimization algorithm may require a huge computational cost in arriving at an acceptable solution, simply due to the enormity of the ensuing search space. A computationally efficient use of an optimization method requires problem information and some knowledge of their working principles. In addition, there exists a long list of optimization methods in the literature and it is certainly not easy to choose a single one most suitable for a task. This lecture series with four lectures will introduce the scope of optimization in practice, describe a few popular methods, present different modifications of them for their efficient use in handling various practicalities encountered in industries, introduce multi-criterion optimization and customized optimization methods for their routine practical use. The lecture series does not assume any prior knowledge on any optimization method, but attendance to all four lectures will provide a comprehensive concept to optimization methods and demonstration of their use in engineering problems. These lectures are recommended for starting and matured PhD students and to all those interested in knowing current state-of-the-art on applied optimization methods. There will be a Q&A session at the end of each lecture.

### Lecture 1: Scope of Optimization in Engineering and Introduction to Optimization Methodologies

Date: 15 July 2019 (Monday)

Abstract: Many engineering, scientific, and business related problems can be solved by formulating them as optimization problems. An optimization problem is formulated with one or more objective functions which are to be minimized or maximized and a number of constraints which must be satisfied. In this first lecture, we shall discuss different practical problems which can be solved using an optimization method and then discuss a few popular point-based and population-based optimization methods for solving them. Methods will include gradient based approaches

to population-based genetic algorithms and other evolutionary methods. This lecture will lay the foundation for the subsequent lectures on more specific topics.

## Lecture 2: Optimization Methods for Handling Practicalities

Date: 16 July 2019 (Tuesday)

Abstract: Practical problems come with a number of complexities, which will require special handling in an optimization method. Following practicalities will be discussed in detail: (i) constrained optimization, (ii) integer and mixed-integer programming, (iii) computationally expensive problems using surrogate-assisted optimization, (iv) robust and reliability-based optimization for handling uncertainty in variables and parameters, and (v) dynamic and on-line optimization.

## Lecture 3: Multi-Criterion Optimization and Decision Making

Date: 17 July 2019 (Wednesday)

Abstract: Most problems in practice involve more than one and conflicting objectives. In these problems, there does not exist a single optimal solution to the problem; rather they give rise to a number of trade-off Pareto-optimal solutions. In this lecture, a number of point-based and population-based optimization algorithms will be presented for finding multiple trade-off solutions. These problems require a decision-making activity after trade-off solutions are found. The lecture will cover a few multi-criterion decision-making methodologies.

## Lecture 4: Customized Optimization for Practical Problem Solving

Date: 18 July 2019 (Thursday)

Abstract: Optimization methods discussed in Lectures 1 and 2 are often too generic to be applied to large-scale, complex, and routine applications. They usually require different types of customizations, initially to make a suitable variable transformation and at algorithmic and operator levels. Customizations are problem-specific, hence a few case studies will be presented to describe the concept of customization in the context of optimization applications. Optimization has now been used to discover inherent knowledge about a problem. We shall conclude the lecture by describing and presenting case studies on the concept of "innovization" -- innovation through optimization.

Bio-sketch of Speaker:

Kalyanmoy Deb is International Visiting Professor of the Department of Mechanical Engineering and Department of Computer Science and Engineering at IIT Kharagpur. He is Koenig Endowed Chair Professor at Department of Electrical and Computer Engineering in Michigan State University, USA. Prof. Deb's research interests are in evolutionary optimization and their application in multi-criterion optimization, modeling, and machine learning. He has been a visiting professor at various universities across the world including IIT Kharagpur in India, Aalto University in Finland, University of Skovde in Sweden, Nanyang Technological University in Singapore. He was awarded IEEE EC Pioneer award, Infosys Prize, TWAS Prize in Engineering Sciences, CajAstur Mamdani Prize, Distinguished Alumni Award from IIT Kharagpur, Edgeworth-Pareto award, Bhatnagar Prize in Engineering Sciences, and Bessel Research award from Germany. He is fellow of IEEE, ASME, and three Indian science and engineering academies. He has published over 485 research papers with Google Scholar citation of over 127,000 with h-index 114. He is in the editorial board on 18 major international journals. More information about his research contribution can be found from <http://www.coin-laboratory.com>.

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