IOWA STATE UNIVERSITY
Department of Mechanical Engineering

Optimization Methods for Complex Designs

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Faculty host: Cris Schwartz

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2004 Black

Abstract

Optimization involves finding the 'best' according to specified criteria. In Engineering Design, this might typically be minimum cost or weight, maximum quality or efficiency, or some other performance index pertaining to a disciplinary objective. Realistic optimal design involves not only an objective function to be minimized or maximized, but also constraints, which represent limitations on the design space. Numerical programming requires the mathematical representation of the design space (objective function and constraints) in terms of 'design variables' (parameters that signify some potential for change). Generally, the problems of interest in engineering are of a non-linear nature, in that the dependence of the objective function and constraints on the design variables is non-linear.

This course looks at a range of optimization methods from traditional non-linear ones to modern evolutionary methods such as Genetic Algorithms (GA) and Particle Swarm Optimization (PSO). PSO, for example, mimics social skills exhibited by birds and insects for solving complex engineering optimization problems. The course will explore how these methods can be used to solve a wide variety of design problems across disciplines, including mechanical systems design, biomedical imaging, and path planning of unmanned aerial vehicles. By the end of the semester, the student will have gained a basic knowledge of numerical optimization algorithms and will have sufficient understanding of the strengths and weaknesses of these algorithms to apply them appropriately in engineering design. Students will write code as well as use off-the-shelf routines to gain this experience. Students will also be exposed to several case-studies of real-world situations in which problems were modeled and solved using advanced optimization techniques.

Biosketch:

Vijay Kalivarapu, Ph.D. is currently a Robotics Tools Software Engineer at John Deere, Urbandale, IA. Vijay earned his Ph.D. at Iowa State University (ISU) with a major in Mechanical Engineering and a co-major in Human-Computer Interaction in 2008. Vijay's dissertation research involved the use of numerical digital pheromone models for improving the performance of particle swarm optimization. Beyond his Ph.D., Vijay worked as a post-doctoral research associate followed by taking up a position as a research scientist at the Virtual Reality Applications Center at ISU. During this time, Vijay worked on numerous state, federal, and industry research projects related to design optimization, Virtual & Augmented Reality technologies, and web development. He has also taught undergrad/grad-level courses in design optimization and computer graphics & geometric modeling at ISU. Vijay authored or co-authored 36 publications in the areas of design optimization, 3D visualization, and Virtual Reality applications.