# A Comprehensive Approach to Optimizing Complex Systems

## BIOGRAPHY

Zelda B. Zabinsky is an Emeritus Professor in Industrial & Systems Engineering at the University of Washington. She has held adjunct appointments in the departments of Mechanical Engineering, Electrical & Computer Engineering, and Civil & Environmental Engineering. She is a Fellow of both the Institute for Operations Research and the Management Sciences (INFORMS) and the Institute of Industrial and Systems Engineers (IISE). She has published numerous papers and a book, Stochastic Adaptive Search in Global Optimization, on the theory and practice of algorithms useful for solving problems with multimodal objective functions in high dimension. Her research has been applied to engineering design, supply chain, healthcare, power systems with renewable resources, air traffic flow management, vehicle routing, and communication scheduling. The National Science Foundation (NSF), NASA-Langley, Federal Aviation Administration (FAA), and the Office of Naval Research (ONR) have funded her research, as well as local industries including Boeing Commercial Airplane Company, Microsoft, and the Port of Tacoma. Professor Zabinsky has served on the editorial board of the Journal of Global Optimization, on the board of the Pacific Institute of Mathematical Sciences (PIMS), and on the Women in Engineering (WIE) Initiative. She has received the annual teaching award in Industrial Engineering at the University of Washington several times.

## ABSTRACT

Optimization viewed broadly can aid in designing, analyzing, and operating complex systems, from strategic policy planning to last-mile distribution to optimal control of dynamical systems. The optimization model, including decision variables, objective functions, and constraints, requires performance metrics that are often evaluated via black-box simulations. We summarize algorithms that can address black-box noisy functions, mixed integer- and real-valued variables, and multiple objectives. Multiple models (e.g., Gaussian processes, neural networks, queueing networks) can be used in conjunction with a computationally expensive model (e.g., simulation) to predict performance and reduce overall computation. A key issue in solving an optimization model is to dynamically allocate computational effort to efficiently search for the global optimum. The dilemma of exploration vs exploitation vs estimation is evident in machine learning and global optimization. We discuss sampling distributions that provide insights into this balancing act, and how ideas in quantum optimization provide approaches to optimizing complex systems.