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Cairo University
Institute of Statistical Studies and Research
Department of Operations Research

A Comparative Study for Approximation Techniques to Nonlinear Optimization Problems

By

Gamal El-Dean Abdel Hakim Mohamed El-Emam

A Thesis Submitted to the Institute of Statistical Studies & Research

Cairo University

In Partial Fulfillment of the Requirements for the Degree of

Master of Science
In

Operations Research

Under the Supervision of

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Cairo University
Institute of Statistical Studies
and Research, Egypt

Approval Sheet

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ABSTRACT

Constrained nonlinear programming problems often arise in many engineering applications and much of today's engineering analysis consists of running complex computer codes. Despite a steady increase in computing power, the complexity of engineering analyses seems to advance at the same rate. The use of statistical techniques to build approximations of expensive computer analysis codes pervades much of today's engineering design. These statistical approximations, or meta-models, are used to replace the actual expensive computer analyses, facilitating multidisciplinary and concept exploration. In this thesis, we review some of these techniques, especially Response Surface Methodology (RSM) and Kriging. Both methods are applied to thirty widely used classes' of single objective optimization problems. We compare the results of both Response Surface Methodology and Kriging model with the solutions of the original nonlinear optimization solutions. Generally speaking, Kriging method is able to return almost the same solution as the original model optimum for the majority of problems. Response Surface Methodology comes next to Kriging is finding the optimum to the original model. As a remedy, a new approach is proposed to split the model into several smaller sub-models. The problem is transformed into a number of sub-problems with an impact on increased model CPU processing time. A set of test bed problems is verified using both approximation methods. When Splitting is employed prior to approximation, both techniques are able to capture system optima consistently. Monotonicity and continuity are still important and valid concerns in any approximation.