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Multi-objective Optimization Using Adaptive Explicit Non-Dominated Region Sampling

Anirban Basudhar
Livermore Software Technology Corporation, Livermore, CA, USA, abasudhar@lstc;

Abstract

A new method to efficiently perform multi-objective optimization (MOO), referred to as Adaptive Explicit Multi-objective Optimization (AEMOO), is presented. Unlike existing methods, it uses binary classification to explicitly define the decision boundary between dominated and non-dominated (ND) regions in the design space. An adaptively refined support vector machine (SVM) is used to define the boundary. AEMOO has several advantages that stem from the availability of the estimated explicit boundary bounding the ND design space, which represents Pareto-optimal (PO) designs at convergence. It allows for an effective adaptive sampling strategy that samples "important" regions in the design space. Additionally, explicit knowledge of the PO design space facilitates efficient real time Pareto-optimality decisions. AEMOO uses a hybrid approach that considers the distribution of samples in both design and objective spaces. Two variants of AEMOO are presented - one based purely on classification and the other based on both classification and metamodel approximation. The results are compared to the widely used NSGAII method and Pareto Domain Reduction (PDR) using test problems up to 30 variables. AEMOO shows significantly better efficiency and robustness compared to these existing methods.

Keywords: support vector machine; hybrid adaptive sampling; real time optimality decision; binary response.