Accepted Manuscript

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PII: S0377-2217(17)30580-5
DOI: 10.1016/j.ejor.2017.06.039
Reference: EOR 14521

To appear in: *European Journal of Operational Research*

Received date: 8 February 2016
Revised date: 1 May 2017
Accepted date: 14 June 2017

Please cite this article as: Honggang Wang, Multi-objective Retrospective Optimization Using Stochastic Zigzag Search, *European Journal of Operational Research* (2017), doi: 10.1016/j.ejor.2017.06.039

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European Journal of Operational Research 00 (2017) 1–29

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Abstract

We propose a new retrospective optimization (RO) method for multi-objective simulation optimization (MOSO) problems. RO algorithms generate a sequence of sample-path (SP) problems and solve these SP problems iteratively using a nonlinear optimizer. In this study, a stochastic zigzag search algorithm is chosen in the RO framework to solve SP problems. The key idea of zigzag search is searching around the Pareto front by applying an efficient local-search procedure using the gradients of the objective functions. Many continuous MOSO problems have smooth objective functions and their non-dominated objective function values form a smooth surface in the image space. This fact motivates developing the zigzag search method embedded in RO for such relatively well-posed MOSO problems. A numerical implementation of this method—multi-objective retrospective optimization using zigzag search (MOROZS)—is presented particularly for continuous bi-objective simulation optimization (BOSO) problems with well-connected Pareto optimal solutions. MOROZS is designed for BOSO problems in which a simulation oracle returns both objective function values and gradients. Due to the local nature of zigzag search, MOROZS can only guarantee the asymptotic convergence to local Pareto optimality. The efficiency of MOROZS is studied using three BOSO problems with noisy objective functions and is compared to that of Genetic Algorithms based NSGA-II and a recently developed method MO-COMPASS.

Keywords: Multiple criteria decision, Multi-objective optimization, Pareto optimum, Gradient local search, Stochastic optimization, Simulation

1. Introduction

Decision making with multiple criteria is ubiquitous in many fields of systems design and management sciences [1, 2, 3, 4, 5, 6]. It is often impossible that a solution simultaneously optimizes all the objective criteria. There are, rather, a set of solutions that trade off among the considered objectives. For multi-objective optimization (MOO) problems, identifying a set of such non-dominated (often called Pareto optimal as defined in Section 2) solutions is essential to engineering design and decision making.

While multi-objective deterministic optimization has been intensively studied for many decades [7, 8, 9, 10, 11, 9, 12, 13], multiple-objective simulation optimization (MOSO) has gained increasing interest in recent years [14, 15, 16].

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