Towards Realistic Optimization Benchmarks: A Questionnaire on the Properties of Real-World Problems

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ABSTRACT

Benchmarks are a useful tool for empirical performance comparisons. However, one of the main shortcomings of existing benchmarks is that it remains largely unclear how they relate to real-world problems. What does an algorithm's performance on a benchmark say about its potential on a specific real-world problem? This work aims to identify properties of real-world problems through a questionnaire on real-world single-, multi-, and many-objective optimization problems. Based on initial responses, a few challenges that have to be considered in the design of realistic benchmarks can already be identified. A key point for future work is to gather more responses to the questionnaire to allow an analysis of common combinations of properties. In turn, such common combinations can then be included in improved benchmark suites. To gather more data, the reader is invited to participate in the questionnaire at: https://tinyurl.com/opt-survey

CCS CONCEPTS

• **General and reference** → **Surveys and overviews**; • **Applied computing** → **Multi-criterion optimization and decision-making**; • **Computing methodologies** → *Discrete space search*; *Continuous space search*; *Randomized search.*

KEYWORDS

benchmarking, real-world problems

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1 INTRODUCTION

As is the case in most empirical research, the optimization community employs benchmarks to compare the performance of algorithms. Unfortunately, issues in both the design and the use of benchmarks are common. These can, for instance, relate to how well benchmarks are able to differentiate between algorithms, but also to how well they reflect properties of real-world application problems. For example, Ishibuchi et al. mention that the performance of an algorithm on popular benchmark problems can be different from that on real-world problems [1]. Tanabe et al. show that C-DTLZ functions and widely-used real-world-like problems have some unnatural problem features [2]. A connection between benchmarks and the properties of real-world problems is important because this allows benchmark results to give a clear idea of how useful different algorithms are in practice. Not only is it valuable to have test functions that imitate real-world problems, some real-world problems may be suitable to be used as a test problem as is, or may have a simplified version that correlates with their true objective(s). The contributor of the problem can benefit from improved solutions and improved algorithms, while academics gain a better understanding of the properties of this optimization problem.

This work focuses on identifying real-world problems and their properties to enable their integration in newly developed benchmark problems. To this end, a questionnaire is developed here to be distributed to specialists working on real-world optimization problems. In addition to learning properties of real-world problems, this work also encourages increased discussion in the optimization community on how to design high quality benchmarks. A few results based on initial responses to the questionnaire are briefly analyzed and discussed. This paper also aims to increase the reach of the questionnaire to get more responses which would allow statistically meaningful conclusions to be drawn.

Besides its obvious relevance to benchmarks, this study is also important for research on optimization algorithms in general. Information obtained through the questionnaire can indicate give an indication about which research directions should be explored more in order to solve problems in the real world. Insights from the questionnaire can thus motivate new directions for research as well as rekindle interest in existing ones, and thus hopefully increase the number of optimization algorithms that are relevant for applications in the real world.

2 QUESTIONNAIRE

In Figure 1 the structure of the questionnaire is given. While there are a total of 75 questions, depending on the route, only between 27 and 53 questions are actually posed.

3 DISCUSSION AND OUTLOOK

Through a newly proposed questionnaire this work aims to improve the understanding of the properties of real-world problems in order to improve the quality of benchmarks in relation to realistic problems.

The initial set of 21 responses already suggests a few things about real-world problems. Firstly, constrained and continuous optimization problems are most common. Secondly, evaluation times are long and can frequently require hours of computation. Thirdly, topological characteristics of a problem's objective space are often unknown. This last point makes designing realistic benchmarks challenging, while the second point requires attention to mitigate evaluation time in a benchmarking setting.

In order to gather more results, and improve the accuracy of any conclusions about the properties of real-world problems, we invite you to participate in the questionnaire at: https://tinyurl.com/opt-survey.

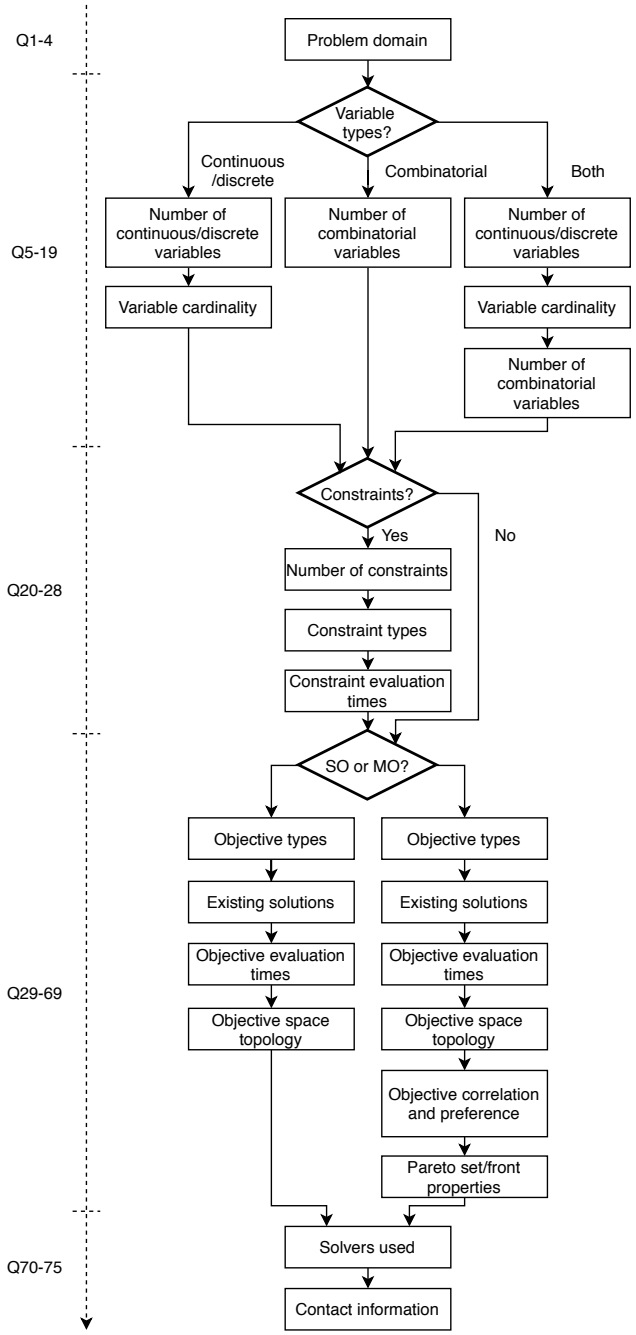

Figure 1: Questionnaire structure.

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