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Bayesian Multi-objective Optimization with Noisy Evaluations using the Knowledge Gradient

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We consider the problem of multi-objective optimization in the case where each objective is a stochastic black box that provides noisy evaluation results. More precisely, let $f_1, \dots f_q$ be q real-valued objective functions defined on a search domain $\mathbb{X} \subset \mathbb{R}^d$, and assume that, for each $x \in \mathbb{X}$, we can observe a noisy version of the objectives: $Z_1 = f_1(x) + \varepsilon_1, \dots, Z_q = f_q(x) + \varepsilon_q$, where the ε_is are zero-mean random variables. Our objective is to estimate the Pareto-optimal solutions of the problem:

$$\min f_1, \dots, f_q \,. \tag{1}$$

We adopt a Bayesian optimization approach, which is a classical approach when the affordable number of evaluations is severely limited—see, e.g., [1], in the context of multi-objective optimization. In essence, Bayesian optimization consists in choosing a probabilistic model for the outputs Z_i and defining a sampling criterion to select evaluation points in the search domain $\mathbb{X}$.

Here, we propose to discuss the extension of the Knowledge Gradient approach [2] for solving the multi-objective problem (1). For instance, such an extension has been recently proposed by Astudillo and Frazier [3].

References

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