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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 \( f_1, \ldots, f_q \) be \( q \) real-valued objective functions defined on a search domain \( X \subset \mathbb{R}^d \), and assume that, for each \( x \in X \), we can observe a noisy version of the objectives: \( Z_1 = f_1(x) + \varepsilon_1, \ldots, Z_q = f_q(x) + \varepsilon_q \), where the \( \varepsilon_i \)s are zero-mean random variables. Our objective is to estimate the Pareto-optimal solutions of the problem:

\[
\min f_1, \ldots, f_q. \tag{1}
\]

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 \( X \). 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

