Multi-criteria decision making for a risk-averse manufacturer

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Maximizing the long-run expected profit per period is appropriate for risk-neutral decision makers. In practice, however, decision makers are often risk-averse, meaning that they are willing to make a trade-off between the expected profit per period and the profit risk, where the latter is often quantified in literature as the standard deviation of profit per period. The goal of the decision maker is to set the price, quality, and base-stock inventory level of a product in order to obtain a desired trade-off between maximizing the mean profit and minimizing the profit standard deviation (i.e., find a set of Pareto-optimal points).

Given that the analytical derivation of the profit standard deviation per period is intractable for this integrated production/inventory system, and resorting to exhaustive simulation incurs very high computational costs, we employ stochastic kriging to (meta) model our problem. Inspired by the ParEGO multi-objective optimization framework of [1] and the sequential search criterion of [2], the resulting algorithm is, to the best of our knowledge, the first multiobjective Kriging-based optimization algorithm being proposed for stochastic simulation optimization with heterogeneous noise.

It is well known that the quality assessment of multiobjective optimizers is a non-trivial task. An extensive list of unary, binary and combinations of quality indicators have been proposed to evaluate the performance of *deterministic* multiobjective optimizers, such as the R indicator family, the hypervolume indicator and the ε indicator family. In contrast, there exists significantly less research on developing quality indicators for stochastic multiobjective optimizers. Though, there has been progress on adapting deterministic indicators to stochastic settings. For the deterministic case, computing any performance indicator will directly determine which set of points is better; for the stochastic case, the *expected* values of any indicator should be statistically tested. We use the *dominance ranking* and *quality-indicator* comparison methodologies to test the quality of the proposed algorithm. In both approaches the sample of approximation sets associated with an algorithm is first transformed into another representation before (non-parametric) statistical testing methods are applied.

References

[1] Knowles, J. ParEGO: A hybrid algorithm with on-line landscape approximation for expensive multiobjective optimization problems. IEEE Transactions on Evolutionary Computation, 10(1), 50-66, 2006.

[2] Quan, N., Yin, J., Ng, S.H. and Lee, L.H. Simulation optimization via kriging: a sequential search using expected improvement with computing budget constraints. IIE Transactions, 45, 763–780, 2013.