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Equidistant representations: connecting coverage and uniformity in biobjective optimization

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The nondominated frontier of a multiobjective optimization problem can be overwhelming to a decision maker, as it is often either very large or infinite in size. Instead, a discrete representation of this set in the form of a small sample of points is often preferred. In this paper we consider the Discrete Representation Problem (DRP), which is itself a triobjective optimization problem. The three objectives comprise three standard quality measures for discrete representations, namely coverage, uniformity and the cardinality of the set. We introduce the notion of complete equidistant representations, and prove that such a representation provides a nondominated solution to the DRP. In addition, we show through the help of complete equidistant representations that coverage and uniformity can be seen as dual problems given a fixed cardinality, and therefore that optimality gaps for coverage and uniformity can be obtained given any representation. Moreover, even though the definition of the coverage error requires the full nondominated set, we show how the coverage error for a given representation can be calculated by generating a much smaller set. Finally, we present a new method for finding discrete representations of a desired cardinality that outperforms existing methods w.r.t. coverage and uniformity on a set of mixed-integer programming benchmark instances.