

Set-based Multiobjective Fitness Landscapes: definition, properties.

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Abstract

One of the most commonly-used metaphors to describe the process of heuristic search methods in solving combinatorial optimization problems is the Fitness Landscape (FiL). This landscape metaphor appears most commonly in works related to single-objective optimization: the search space can then be regarded as a spatial structure where each point (solution) has some neighbor's points, determined according to a neighborhood operator, and has a height (its objective function value), both forming a landscape surface.

However, no definition of FiL establishes an equivalence in the context of multiobjective optimization. As a first step, we examine a possible definition where the points represents feasible solutions in the decision space and the "height" represents their vector fitness function. In such a case, the standard definitions of local optimum turns into the definition of Pareto local optimum, and the global optimum one to the Pareto optimal set. In this context, it is still possible to define the ruggedness of a given landscape. The analysis of such concepts for a given problem is relevant to obtain deep information about its optimization difficulty. But unfortunately, they fail to explain the dynamics of some local search heuristics.

Another possible definition of a multiobjective Fitness Landscape (moFiL) may map each point to a set of feasible solutions. A neighbor is then defined by either i) inserting a solution into the set, ii) deleting iii) or mutating one solution of the set. The height can be given in terms of an arbitrary quality indicator, like the hypervolume. This definition follows recent works dealing with set-based search heuristics. We will examine and discuss the challenging questions of this definition of moFiL.