A study on search points generating mechanisms in evolutionary computation

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https://doi.org/10.15017/458554

出版情報：Kyushu Institute of Design, 2002, 博士（芸術工学）, 課程博士
バージョン：
権利関係：

Abstract

This dissertation discusses evolutionary computation (EC), a framework of optimization methods inspired by biological evolution. The objectives of this study are (1) to propose extended EC algorithms using information rarely used by conventional EC algorithms, (2) to conduct experimental comparison among the proposed and conventional EC algorithms, (3) to deeply understand EC through the comparison, and (4) to suggest next directions of EC research. The algorithms are all realized for numerical optimization problems.

Conventional EC uses information collected from three spaces, the genotype space, the phenotype space, and the fitness landscape. The phenotype space is a set of all solution candidates for the given optimization problem. The genotype space is an alternative expression to the phenotype space. EC searches for a solution in the genotype space. A mapping between genotype and phenotype spaces is defined, which is usually a bijection. Lastly, the fitness landscape is the distribution of fitness values in the genotype space. A fitness value is calculated for a solution candidate, which is also assigned to its corresponding search point in the genotype space.

The procedures common in conventional EC are (a) holding several search points in the genotype space, (b) generating a new distribution of search points from the current, and (c) using the fitness values for selecting search points held in their next distribution or to use for generating new search points.

The extended EC algorithms realized in this paper are based on two concepts. One concept is that the methods of generating search points use structural information of the fitness landscape. In this concept, the methods convert the distribution of points in the fitness landscape into that of search points in the genotype space. The other concept is that the genotype space is constructed by a set of search points-generating mechanisms. In this case, a point in the genotype space represents such a mechanism, which is a subject in competition and evolution. The mechanism also generate various search points by itself. By the latter extension, the mapping from the genotype to the phenotype spaces changes from conventional one-to-one to many-to-one.

This paper consists of nine chapters. The backgrounds and the objectives of this study are described in Chapter 1. The related works are reviewed in Chapter 2. Chapters 3 and 4 discuss the first concept extending the conventional EC. Chapters 5, 6, and 7 discuss the second concept. Chapter 8 discusses the author's understanding of EC through this study. Chapter 9 is the conclusion.