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New VNP for automatic programming

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Abstract

In this paper we propose a new local search method for solving automatic programing problem and we use it within recent Variable Neighborhood Programming (VNP) method. In automatic programming area the solution is a program and the most common way is to present it by a tree T with the specific structure (i.e., it has different types of nodes). New local search tries to adapt well known "elementary tree transformation" in generating neighboring trees (programs) $N(T)$ to the incumbent tree T. Several other neighborhoods $N_k(T)$ are used for the shaking step of the VNP. Method is implemented on some typical problems from the literature. Results are compared with the old VNP method.

Keywords: Automatic programming, variable neighborhood programming, local search

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1 Introduction

Automatic problem solving (using computers) is the focus of artificial intelligence and machine learning concepts. This field is called Automatic Programming (AP). It has always aimed to produce systems with an intelligent behavior. Genetic programming (GP)[10] is one of the well-known techniques in automatic programming. It's based on Genetic Algorithm (GA) and evolve programs. This algorithm is applied on many fields like symbolic regression [11,3,9], forecasting [1,4], datamining [6] and classification [5]. In addition, we can found many methods, which are based on GP and include local searches [4,8]. They reach good results on symbolic regression [8] and on Energy consumption forecasting [4]. We can note that local searches merged with GP can improve the quality of results.
In 2016, a new automatic programming method, called Variable Neighborhood Programming (VNP) [7], is introduced.This method is different from GP, since it does not use GP operators. It uses the evolution strategy of the Variable Neighborhood Search algorithm [13]. The performance of VNP method is shown on forecasting and classification problems.
An automatic programming method evolves programs. A program can be presented in many way. The most commonly used form is the tree structure [10]. A tree is composed by functional nodes and terminal nodes. Figure 1 (a) shows an example which illustrates the expression :

$$\max\left\{\frac{3}{x_1+(-2)}; 1.8-x_2\right\} \tag{1}$$

The functional set is presented with $F=\{fn_1, fn_2, ..., fn_n\}$ and the terminal set is $E=X\cup C$ where $X=\{x_1, x_2, ..., x_{k'}\}$ is the set of the problem variables, and $C=\{c_1, c_2, ..., c_{k''}\}$ is the constant set; $k=k'+k''$ is the cardinality of E. In VNP algorithm, the authors suggest a new tree structure which is more general and able to solve more difficult problems (Figure 1 (b)) [7]. The difference between GP tree structure and VNP tree structure is the add of the parameter set presented by $P=\{\alpha_1, \alpha_2, ..., \alpha_k\}$. Each parameter is attached to each terminal node of the tree. It allows the adjustment of the terminal set values by multiplying variables with corresponding coefficients. Therefore, the cardinality of the parameter set is k. Figure 1 (a) represents the maximization problem (1) in a new way, with parameter values taken randomly from $[0, 1]$.

There has recently been growing interest in the use of methods inspired by local searches. In this work we suggest a new Local Search Programming (LSP) called Elementary Tree Transformation Local Search (ETTLS). The