GeLog - A System Combining Genetic Algorithm with Inductive Logic Programming

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Abstract. We have developed a genetic logic programming system (GeLog) which implements a combination of two different approaches for automatic programming: inductive logic programming and genetic algorithm. The paper presents the system and discusses its performance on a benchmark problem.

1 Introduction

This paper describes a genetic logic programming system. GeLog is an automatic programming system which combines the approaches of inductive logic programming (ILP, [9]) and genetic algorithm (EA, [4]). During conceptualization our major aims were focused on good and easy expansion in order to be able to deal with a wide range of problems, which often creates difficulties with already existing systems. The individuals in GeLog-System represent PROLOG programs, which can be regarded as a potential solution to a given problem. The first generation is generated by given basic knowledge. A favorable initial distribution can be reached through formulation of this basic knowledge and the algorithm for the generation of individuals. The course of evolution can therefore already be influenced at this point. For the evolutionary transformation of a population, various recombination and mutation operators are available, which can be adapted to different kinds of problems. The generated individuals are evaluated through positive and negative examples of the ILP problems. The best representatives of the newly generated individuals and in some cases also of the parental generation form the basis of the next step of evolution.

Both automatic programming methods (EA and ILP) have already proved their efficiency during work with different kinds of problems [14]. In order to combine the strengths of these two approaches, first Whigham and McKay ([16]) suggest the techniques of generalization and specialization deriving from inductive logic programming for development of recombination- and mutation operators in order to be able to realize a directed search on the whole search space. Several other system were developed [5], [2] and [17].

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In the remainder of this paper first a brief overview of the related works. Section 3 contains the description of GeLog, and discusses matters of its implementation. Some discussion about other existing systems can be found in section 4. In Section 5 two examples are given to demonstrate the learning ability. We evaluate the achieved results in Section 6. Finally in Section 7 a summary and outlook of future works will be made.

2 Theoretical Background

In this section the different learning methods used in this paper methods are introduced briefly.

2.1 Evolutionary Algorithms

Evolutionary algorithms are a model of natural evolution ([3]) that is often used to solve optimization problems ([4]). These algorithms are based on the collective adaptation and learning ability of individuals. Individuals form a population and each individual represents a possible solution of the problem. At the beginning, the individuals in the population are initialized randomly and they can be modified by the operators selection, mutation and recombination. These modifications lead to the evolution of the individuals; during the process better and better individuals appear. Thus in later generations individuals representing better solutions appear more likely. The flow chart of EA can be seen in the Figure 1.

![Fig. 1. The evolution process]

2.2 Inductive Logic Programming

Inductive logic programming (ILP, [9], [12]) is a research area lying at the intersection of inductive machine learning and logic programming. The general aim