Adaptive Learning Using A Qualitative Feedback Loop

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Abstract

Most of the example-based learning algorithms developed so far are limited by the fact that they learn unidirectionally, i.e., they just transform the presented examples into a fixed internal representation form and do not adapt their learning strategy according to the results of this transformation process. Only a few learning algorithms incorporate such a feedback from an evaluation of the learned problem representation to the input for the next learning step. But all those rely on quantitative evaluation of the problem representation only, qualitative criteria are always neglected.

In this paper we present the automatic learning environment ALEX which allows for adaptive learning by applying a **feedback loop** based on quantitative and qualitative evaluation of the problem representation. We follow the idea that the **quality** of a problem representation determines further knowledge acquisition activities in a certain problem domain. Hence, we derive qualitative evaluation criteria for problem representations and exemplify their successful applicability for an inductive learning strategy, namely example-based learning, in ALEX.

1 Introduction

Knowledge acquisition has been identified as the bottleneck in developing AI-applications e.g., Carbonell, 1989. It involves problem definition, concept clustering and refinement, and problem-solving strategies. Most knowledge acquisition strategies developed so far are limited by the fact that they learn unidirectionally, and thus lack adaptive behavior (Dietterich, 1989). For instance, example-based learning algorithms merely transform the presented examples into a fixed internal representation and do not adapt their learning strategy according to the results of this transformation process. To achieve steady progress in knowledge acquisition, learning strategies have to **adapt** according to the results of the addressed transformation process. Thus, evaluation of the already learned representation is the key to achieve adaptive behavior.

Only a few knowledge acquisition strategies incorporate **feedback** from an evaluation of the learned problem representation to the input for the next learning step e.g., Van der Velde, 1988. Similar to analytical learning approaches such as SOAR (Laird et al., 1986), feedback loops enhance the ability to replicate the success of learning efficiently. In most of all feedback systems the evaluation of the problem representation mostly relies on quantitative criteria, usually accuracy in the coverage of the problem domain, or the efficiency (e.g., number of rules generated) of the problem representation. There are only few approaches e.g., Bergadano et al., 1988, which use quality constraints for concept descriptions. Thus the problem representation is only evaluated according to its performance, the quality (i.e., the meaning, etc.) of the generated representation is neglected. Even more than quantitative criteria, qualitative criteria can be used to identify "weak spots" in the problem representation learned so far, in order to determine the learning strategy for the next acquisition phase. Feedback loops applying qualitative evaluation criteria can significantly improve the coverage of the problem domain.

In the following, the automatic learning environment ALEX is introduced, which supports adaptive learning by using a feedback loop between the evaluation of its problem representation and the learning strategy in the next learning step. The evaluation is based on quantitative and qualitative criteria, which are developed throughout the presentation of ALEX.

2 The Learning Environment ALEX

ALEX has been developed to enable the application and evaluation of knowledge acquisition strategies in different problem domains (Winkelbauer and Fedra, 1990). It consists of an example generation