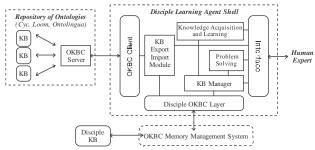# Building agents from shared ontologies through apprenticeship multistrategy learning

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The goal of this research is to create the Disciple Learning Agent Shell for efficient development of personal agents, that relies on importing ontologies from existing repositories using the Open Knowledge Base Connectivity (OKBC) protocol (Chaudhri et al, 1997) and on teaching the agents to perform various tasks through apprenticeship and multistrategy learning (Tecuci, 1998). We are performing significant developments of Disciple, and we are integrating it with OKBC into the following architecture of the Learning Agent Shell:

The knowledge base of a Disciple agent consists of an ontology that defines and organizes the concepts from the application domain, and a set of problem solving rules expressed in terms of these concepts. The process of building this knowledge base starts with creating a domain ontology by importing concepts from the shared ontologies of an OKBC server. Next the domain expert will teach the agent how to solve domain specific problems by providing a specific example of a problem and its solution, and by helping it to understand them. The explanations of the example will guide the agent to generalize the example to a general problem solving rule.

We are developing analogical reasoning methods that allow the Disciple agent to hypothesize the explanations of a problem solving episode by analogy with the explanations of a similar problem solving episode. For instance, if the agent "understands" why a company can build a floating bridge over a river then, by analogy, it can hypothesize many of the conditions required to use a floating bridge as a ferry, or to simply ford the river.

We are also developing methods that allow numbers to be generalized to intervals, functional and relational expressions, or symbolic concepts (such as "odd-number"). For instance, the explanation piece

floating-bridge-1 total-length 480m and river-segment-1 width 300m < 480m

is automatically generalized to

?f1 total-length ?t1, ?t1 is (* ?u1 ?n1), ?r1 width ?w1, ?w1 is-in [0, 2000], ?w1 < ?t1

Another development of Disciple is inspired by the Theory of Inductive Probability developed by the philosopher L. Jonathan Cohen (1989). As opposed to the Bayesian network approaches, Cohen's theory has the advantage that it does not require the assignment of numeric or traditional probabilistic measures to elements in the knowledge base. In this theory, probability is a generalization of the notion of provability. Following the inductive probability theory, the rules learned by Disciple are refined through a systematic process of experimentation which attempts to falsify the rule, using several heuristics as well as analogy with other rules and the conditions under which they fail. This results in a list of conditions under which rule failures occur and in a measure of inductive support of the rule.

We are also developing problem solving capabilities in Disciple which implement the use of inductive probabilities during rule evaluation and selection. The inductive probability of a rule instance is based upon the measure of the inductive support accorded to the rule and how much is known about the falsifying conditions.

To conclude, we investigate the claim that using existing ontologies, and a synergistic integration of symbolic multistrategy learning, knowledge acquisition and inductive probabilistic reasoning can form the basis of an efficient agent development environment.

References

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