Dynamically Adjusting Categories to Accommodate Changing Contexts

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Context

Concept formation is the process by which generalizations are formed through observation of *instances* from the environment. These instances are described along a number of *attributes*, which are selected according to their *relevance* to the problem or task for which the concepts will be used. The *context* of a concept learning problem consists of the goals and tasks of the learner, as well as its background knowledge and domain theories and the external environment in which it operates. Context is essential to inductive concept learning for it determines which *attributes* to use for a given problem out of the infinitely many available, providing a *bias* for the learner (Mitchell, 1980). Furthermore, context is not a static entity, but is constantly changing, especially in the types of learning tasks faced by humans (e.g. Seifert 1989, Barsalou 1991). As concept formation systems are employed in tasks more typical of natural domains and "real-world" problems, the ability to respond to changing contexts becomes increasingly important.

Attribute-incrementation

Toward this end, we introduce the notion of *attribute-incrementation*, the dynamic incorporation and removal of attributes from existing concepts. This ability allows a concept learner to accommodate changing contexts by altering the set of attributes used to describe instances in a problem domain while retaining its prior knowledge of that domain. This capability has been implemented in a concept formation system called AICC (Attribute Incremental Concept Creator), an extension of an existing concept learner, COBWEB (Fisher, 1987). AICC is capable of both adding new attributes and removing existing ones from a COBWEB concept hierarchy and restructuring it accordingly.

Performance

We have performed extensive evaluations of AICC and compared its performance along several dimensions to that of COBWEB. One of the conclusions of this research is that AICC is able to construct concept hierarchies by incrementally incorporating attributes in significantly less time than COBWEB. These hierarchies achieve comparable predictive accuracy and classification efficiency to those produced by COBWEB. In additional experiments, AICC has been used to remove attributes from existing concept hierarchies as well as add new attributes to hierarchies constructed with varying numbers of initial attributes. These experiments have been replicated with a wide variety of data, with similar results.

Conclusions

Current concept learners are referred to as incremental if they incorporate *instances* one-at-a-time into their concept hierarchies. However, the attribute set used to describe these instances is an integral part of the concept formation problem. The ability to incorporate *attributes* incrementally allows concept learners to dynamically modify their bias and respond to a wider variety of changes in context without discarding prior domain knowledge. This ability is important given the trend toward creating systems that must face real-world tasks and their corresponding constraints.

References

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