

source is, to some extent, the best judge of its own performance. The motivation for this becomes apparent if one considers the factors which are normally embedded in the process of developing any given expert system:

- The knowledge of the context in which it expects to operate; i.e., an expectation of the form which the environment will take and the types of interrelationships that may occur.
- The type of boundary or limiting conditions it expects to encounter; i.e., what information can occur in the environment which is close to what is expected but is actually different.
- The type of misclassifications it postulates can occur; i.e., what information may be present in the environment that is often confused with the desired information.

Implementing the concept of characteristic error requires that each knowledge source posit an *a priori* estimate of the error classes which it might encounter. This estimate is an explicit ranking of its expectations for the immediately local context, and is independent of the strength of the knowledge source's opinion in any particular instance of its application. It is based only upon the expert's knowledge of the underlying structure of its environment and decisions. For example, a region growing knowledge source, designed for road finding within an image understanding system, will know that local classification error may occur because a portion of the road may be partially obscured by trees. By the same token, it will also be aware of the fact that it is very uncharacteristic for any region designated as deep water to actually be a road. The same source will, however, have no real opinion as to the likely misclassification of shallow water. These considerations are independent of its specific belief of the existence of roads in any particular instance.

This error class information is dependent only upon the context *assumed* by the knowledge source. It is independent of the *actual* context of any particular instance in which the knowledge source is utilized. In other words, the knowledge source's characteristic error list explicitly states the context which was assumed to be part of the underlying structure of the environment during knowledge acquisition. Therefore, no *a priori* controls need be imposed upon the overall system using the knowledge source, since all context information is explicitly stated by the knowledge source itself.

To illustrate these points, Table 1 shows the structure of two road finders. The road finder which antici-

pates being called upon to process satellite information might expect partial road covering by treetops. The ground level road finder on the other hand, has no expectation of such a conflict.

Such *a priori* identification of errors also promotes the graceful performance degradation of a group of knowledge sources, if and when any knowledge source is operating outside of its area of expertise. A source operating in an unfamiliar area should not have the conflicting class appearing anywhere in its characteristic error list. This absence serves as an immediate flag for the conflict resolver to investigate the situation further.

The minimum implementation of the characteristic error technique requires the following information:

- The characteristic *a priori* errors expected to be encountered by the knowledge source in the environment
- The knowledge source's strength of opinion in a particular instance
- A methodology for evaluating the error list and determining the context.

The system works by comparing the characteristic error lists of the conflicting knowledge sources. This determines the conflict's local context. This context is, in essence, an indicator of the similarity and structure of these error lists. The implementation is such that similar error lists create a context controlling the relative strength of opinion necessary from the knowledge sources to alter a decision. For example, if all sources agree that a given error is characteristic of the situation, it will not take a large (absolute) opinion strength to shift the decision in another direction. By the same token, if the context is relatively incoherent, a knowledge source's opinion must be stronger for the opinion to change. The interaction of these two factors is the basis for the implementation of the most likely error approach.

The items listed above serve as background information for knowledge (rule) based management of the conflict. However, given the existence of a central (top level) conflict resolving system, additional rule based manipulation is possible. The rules used for this manipulation/management of the conflict will be specific to a given system, and perhaps even a specific instance of its use. It should be noted that these manipulations

* Sidewalks would not appear on the overhead expert due to lack of resolution

Classes for structural knowledge sources				
Knowledge Source	target class	characteristic error	uncharacteristic	neutral
ROADS (overhead)	concrete asphalt	oil-slick tree-tops	deep water	shallow water patchy snow
ROADS 1 (ground)	concrete asphalt	oil-slick tires	deep water sidewalks*	shallow water patchy snow 1

Table 1: Knowledge source structure.