

## Understanding Research

Nils J. Nilsson, SRI International  
1977 IJCAI Panel on Speech Understanding Systems

Artificial Intelligence has recently completed an extensive and coordinated exploration into the terra incognita of large scale, knowledge-based systems. To the brave and resourceful explorers, we stay-at-homes must say, "Congratulations and well-done! We enjoyed your slide shows and marveled at your specimens." But when the celebrations are over it will be important for us all to digest the new knowledge uncovered by these explorations.

We need to ask more than "What have we learned?" It is too tempting to answer that question using our current vocabulary. We might for example fall into adopting the rough and ready frontier parlance and metaphors of the explorers themselves and start speaking about "multiple cooperating sources of knowledge," "blackboards," and "island growing." Or we might attempt to describe the new vistas with older and perhaps inadequate phrases such as "rule-based systems," "left-to-right parsing," and "heuristic search."

The question before us, I think, is harder than "What have we learned?" It is "How are we going to express what we have learned?" A major expedition just completed is too precious an occasion to let pass heralded only by accounts from the explorers. It is an opportunity for attempts at synthesis and for inventing new concepts and new paradigms. We should not be discouraged merely because there is no guarantee that these attempts will be successful or because the odds against useful new paradigms are always high. We have just spent about 100 man-years on exploring. We can afford to follow this up with a few man-years of thinking about how to say what we have learned.

As good as they are at speech understanding, it is unfortunately true that HARPY and HEARSAY and friends cannot speak for themselves. The major product of the 100 man-years is not the total body of code that was produced nor is it what that code accomplished in the demonstrations. The memorable output, what can be taught to future generations of students, will be a description of that code. It is not even necessary that the descriptions be completely accurate. Simplifications and even fabrications are justified if they have pedagogic value and do not overly mislead posterity. My major point is that it is important that these descriptions be elegant and that they have a certain, hard-to-define, esthetic appeal so that they will be memorable, easy to

use for teaching purposes, and provocative for the design of new systems.

In creating the kinds of descriptions that I think will be important, inventive talent will be more important than reportorial skill. Suppose, for example, that one could invent some imaginary system that was something like one of the actual speech understanding systems but different in many details. Since our imaginary system doesn't really have to run on a computer we can strip it of the various ad hoc features of real systems so necessary for efficiency. Now maybe we can reorganize it a bit to give it a more coherent internal organization and to relate it more closely to existing well-understood AI mechanisms. There may be some tension in trying to do this. Maybe the existing AI mechanisms aren't so well-understood or as general as we thought. Perhaps the effort of trying to build our imaginary system out of these mechanisms stretches them a bit. Maybe we'll be fortunate enough to think of a major generalization of some of these mechanisms to make them more useful for our fictional system. Now, maybe we'll reorganize the fictional system some more and go through the loop again. Once in a decade or so, and if our interests are broad, we might notice that the new AI concepts just invented could also be profitably used to describe the results of other explorations. At the very least our new synthesis will greatly simplify the process of designing new systems of a similar kind.

These steps are important if a field is to grow into a mature scientific or engineering discipline. Artificial Intelligence has to take several such steps before it can be as productive as we all would like it to be. AI has not yet really developed what could be called a set of universally adopted methodologies that can be followed in the design of new systems. If six different AI laboratories were given the task of building a "rule-based system" for some well-understood application, I would not be surprised to see several quite different designs. Much of the terminology used by AI people is still pre-technical at best and meaningless jargon at worst. Let's try to use the plentiful and excellent experiences of the speech understanding projects to climb a rung or two in the conceptual understanding of our field.