

### *Expert Knowledge*

People argue over whether or not expert systems adequately represent human knowledge. If they cannot, then many experts have wasted time creating those systems. As it can be seen from the case of DENDRAL, expert systems should not merely be said to represent human knowledge. People should argue over whether or not expert systems adequately mimic human systems. In particular, do they adequately represent systems capable of learning and storing new knowledge?

The creation of DENDRAL was a stepping stone for future expert systems. As stated by Lederberg, DENDRAL was created to take in mass spectrometer readings for the contents and weights of a molecule. Using a set of tables, rules, and known exceptions, DENDRAL would output all the possible geometric structures and shapes that the molecule could take. As Lindsay writes, DENDRAL was “the first major application of heuristic programming to experimental analysis in an empirical science.”

If one wants to define human knowledge as the information that a human being possesses, then Lindsay and Lederberg agree that expert systems, and in particular, DENDRAL, meet that requirement. DENDRAL was built to include a database of the known rules (valence requirements) and exceptions in organic chemistry that determine the structures of molecules – the data and knowledge a human chemist might possess and use. Therefore, by definition, it possesses and utilizes this human knowledge. I want to go a step further and agree with Lindsay that expert systems, specifically DENDRAL’s Meta-DENDRAL, possess the learning aspect of human behavior. Others may argue that DENDRAL and other expert systems cannot possibly learn as humans do, and do not even represent human knowledge. Lederberg even himself points out in retrospect that DENDRAL had flawed rules and knowledge, and even knowingly left out specific “rules” or data.

I agree that DENDRAL and expert systems like it adequately represent human knowledge. As stated above, it clearly possesses the knowledge of rules, and the exceptions to those rules, that a chemist might have. In response to the flawed knowledge argument that Lederberg presents, even humans possess flawed knowledge. Humans sometimes do not have all the data or even intentionally leave out arguable data when trying to solve problems, and similarly, so does DENDRAL.

Now is where the idea of expert systems acting as human learning systems. First of all, just as humans can be made aware of their faulty data and thus change their knowledge accordingly, so can DENDRAL and other systems. Expert systems separate the knowledge database part of the system from the problem solving part of the system, and can thus have their “knowledge” or data altered without really changing the system. Thus expert systems can “learn” new data/knowledge and apply it in the future.

Taking it one step further, Lederberg points out that Meta-DENDRAL can use its knowledge of known mass spectra/structure pairs to infer the structures of unknown mass spectra, just as a human might. This predicted structure can then be tested in the

laboratory. More broadly, expert systems such as CONGEN have been built to be able to accept input or “learn” from many sources. This is truly similar to human learning, where systems can accept inputs from multiple places, compare that input to known data and rules (i.e. knowledge), and if no matching result is found, apply their programmed logic to deduce new results.

With the computing power available today, expert systems not only possess human knowledge in the form of coded tables, databases, and programmed logic, but are coming closer and closer to adequately and truly representing human systems that think. Built to include the ever popular modular structure, expert systems can be refined and improved, just as a human’s thoughts can. While expert systems can represent human knowledge, as of today, many can argue they only come close to truly imitating human learning, and on a larger scale, human systems. While these expert systems can accept and use the ever expanding amount of new human knowledge as it is discovered, they cannot change or adapt themselves as a human being would. They need a human to update their databases or make updates to their logic code as new theories and laws of science and nature are discovered. Until the day comes when expert systems have enough of this so called human knowledge to realize they need to change their own data or logic, these systems will never truly adequately represent human systems.