A Prototype Expert System with Applications in Teacher Training and the Diagnosis Remediation of Reading Problems

Attempts to apply expert systems in education should begin by considering two distinctive features of problem solving in education. One feature is that most educational decisions are based on incomplete information due to the cost or trouble of acquiring that information (e.g., IQ scores). A second feature is that most solutions to educational problems are tentative, being subject to revision on the basis of subsequent information. Traditionally, expert system developers have employed monotonic inference engines. Monotonic inference engines are relatively easy to implement on a computer and integrate well with probabilistic inferencing methods. Expert systems based on monotonic inference engines, however, may not represent the best approach to educational decision making, given the constraints described above. The purpose of this paper is to describe a prototype non-monotonic (Nute, 1985) expert system with specifically educational applications.

The expert system described in this paper is written in the Prolog programming language (Arity Corp., 1988) and employs a non-monotonic extension of the standard Prolog inference engine (Nute, 1986, 1989). The system has been developed to assist users in the analysis and interpretation of the informal reading inventory or IRI (Johnson, Kress, & Pikulski, 1987). An IRI consists of graded word lists and reading passages with comprehension questions. Oral reading errors or miscues, are noted as the student reads. Student miscues and responses to questions are an-

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lyzed with the purpose of identifying independent, instructional, and frustra-
tion reading levels.

In addition to reading levels, an IRI can also provide important diagnosti-
c information through a qualitative analysis of miscues and comprehen-
sion errors. Although the calculation of reading levels from miscues and 
comprehension questions is a trivial programming task, the qualitative
analysis of global patterns of errors requires substantial expertise. One
purpose of the expert system described in this paper, hereafter referred to
as the IRI Advisor, is to provide non-expert users with a system that will
aid in the diagnosis of specific reading problems. A second purpose of the
IRI Advisor is as an instructional tool that can be used in the training of
reading diagnosticians and teachers.

Like most expert systems, the IRI Advisor is founded on a knowledge
base of facts and rules. Unlike other expert systems, the IRI Advisor dis-
tinguishes different kinds of facts and rules. A fact represents information
that is known to be true (e.g., a child’s name, age, etc. are represented as
facts). A presumption, on the other hand, represents information that is
presumed to be true. One way the IRI Advisor deals with incomplete
information is by relying on presumptions (e.g., presume a child’s IQ is
average unless other information suggests it is not.)

In addition to facts and presumptions, the IRI Advisor includes rules
that allow the system to derive conclusions from what is already known.
An absolute rule represents an inference that is guaranteed. Most absolute
rules in the IRI Advisor represent definitions. If we know a child is a
disabled reader, for example, the system’s inference that the child is an
underachiever is guaranteed since a disabled reader is an underachiever by
definition. In fact, however, most inferences reading diagnosticians make
are not guaranteed. In addition to absolute rules, therefore, the IRI Ad-
visor also includes defeasible rules which allow the system to make tenta-
tive conclusions which can be defeated if certain other information be-
comes available. Most of the rules in the IRI Advisor are defeasible rules
(e.g., tentatively infer the client uses phonics rules if mispronunciations
are phonetically regular.)

A third kind of rule in the IRI Advisor is a defeater, a rule that can
defeat earlier tentative conclusions. An example of a defeater is “If a
child’s IQ is below average, do not infer that the child is reading dis-
abled.” At an early point in the consultation, the IRI Advisor might con-
clude that the child is a disabled reader, yet if an IQ score becomes avail-
able it will defeat its earlier conclusion and revise its diagnosis appropri-
ately.

Non-monotonic expert systems, like the IRI Advisor, appear to offer a
number of important advantages to educators. One advantage is that a non-monotonic system is especially well-suited to operate under constraints that are typical of educational decision making (i.e., tentative conclusions and incomplete information). A second advantage is that a non-monotonic system provides a better model of the decision making process that educators actually apply. Probabilistic reasoning, typical of monotonic systems, does not provide a plausible model for diagnosticians in training, however well it may work in a stand-alone system. Non-monotonic systems therefore offer a distinct advantage if a goal of the system is to provide a basis for a computer-based training system.

REFERENCES


