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BOOK REVIEW

AN ARTIFICIAL INTELLIGENCE APPROACH TO LEGAL REASONING

By Anne von der Lieth Gardner.
Cambridge, Massachusetts: The MIT Press, 1987, pp. 193.

*Reviewed by Edwina L. Rissland**

Anne Gardner is both a lawyer and a computer scientist. She obtained her J.D. from Stanford in 1958, and her book is a revision of her 1984 dissertation submitted to Stanford's Department of Computer Science. She plays, in part, the role of pioneer; artificial intelligence ("AI") techniques have not yet been widely applied to perform legal tasks. Therefore Gardner, and this review, first describe and define the field, then demonstrate a working model in the domain of contract offer and acceptance.

I. THE FIELD: AI AND THE LAW

A. Artificial Intelligence

Marvin Minsky, in his preface to the collection *Semantic Information Processing*, defined artificial intelligence as "the science of making machines do things that would require intelligence if done by [people]."[1] Better known successful applications have included playing chess, identifying bacterial strains, recognizing and manipulating structures built with childrens' blocks and formulating concepts in set theory.[2] Typical programming languages include LISP and PROLOG, while typical specialties in AI research include case-based reasoning, expert (rule-based) systems, natural language processing, nonmonotonic reasoning, and learning from examples. Above all, the field is marked by its current diversity, rapid growth, and apparent potential.[3]

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1. SEMANTIC INFORMATION PROCESSING (M. Minsky ed. 1968).

2. *See generally* Waltz, *Artificial Intelligence*, SCI. AM., Oct. 1982. For a recent, readable overview, see Linden, *Putting Knowledge to Work*, TIME, March 28, 1988.

3. Optimism is founded in part upon parallel developments in hardware and operating systems, such as Intel's 386 and Microsoft's OS/2. *See, e.g.*, Gralla, *Chips Off the Old Block: A History*, PC WEEK, Jan. 19, 1988 at S/13 (noting the AI capabilities of new microcomputers).

B. Attraction

The law is an attractive domain for AI research for several reasons. First, the law has a tradition of examining its own reasoning process. Second, legal reasoning is stylized: one reasons according to *stare decisis*, with cases and by analogy. Third, much legal knowledge is readily accessible and relatively well structured, codified and indexed. Nevertheless it will not surprise, and may even please, lawyers to learn that the Restatement, the Uniform Commercial Code, and case law, like the theories of legal reasoning proposed by Karl Llewellyn, Ronald Dworkin, Edward Levi, and H. L. A. Hart, are of limited immediate use to AI programmers. There is want amidst plenty because the central questions–what we know and how we know it–are answered only partially by such material, and even these partial answers prove difficult to harness computationally.

Lawyers' interest in AI techniques and software is nascent but concisely expressed in marketing terms. Lawyers use tools that gather, sift, and/or structure legal arguments in a cost-effective manner. LEXIS and WESTLAW, which are essentially keyword-based programs sifting large full-text databases, operate at a level of sophistication far below that contemplated by AI programmers such as Alane Gardner, Marek Sergot,[4] my colleague Kevin Ashley,[5] or many others.[6] Yet products such as LEXIS and WESTLAW do indicate the potential ubiquity of legal analysis software and the symbiosis between computer science and legal research.

C. The Hurdles

Several specific, familiar aspects of legal analysis that challenge AI may be noted.

First, logical deduction alone cannot resolve all legal issues. In Gardner's terms, legal reasoning is a "rule-guided" rather than rule-governed activity (p. 3). Legal rules have the status more of heuristics than of theorems, in that all rules have exceptions, and rules may contradict.

Second, the terms employed in legal discourse are "open-textured." That is, the meanings or definitions of many legal terms

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4. Sergot & Sadri, *The British Nationality Act as a Logic Program*, 29 COMMUNICATIONS OF THE ACM 370 (1987).

5. Rissland & Ashley, *A Case-Based System for Trade Secrets Law*, PROC. OF THE ANN. CONF. OF THE AM. A. FOR ARTIFICIAL INTELLIGENCE 60 (1984); Ashley, *Modelling Legal Argument: Reasoning with Cases and Hypotheticals* (unpublished manuscript).

6. *See, e.g.*, PROC. OF THE FIRST INT'L CONF. ON ARTIFICIAL INTELLIGENCE AND LAW (ACM 1987). Gardner herself offers an excellent bibliography (pp. 201-14), and presents in Chapter 4 a survey of the field complete through the spring of 1986.

and predicates are inherently indeterminate in the philosophical sense of *natural kind* classes.

Third, legal questions commonly invite more than one answer, yet legal argument is both time constrained and resource limited. For while conflict, disagreement, and argument are part and parcel of the law,[7] the law must provide a timely answer for one side or the other, reached at a socially acceptable cost.

Finally, in law, the answers change. Whether the change is incremental, as in the mode of Kuhn's normal science, or abrupt, as in a Kuhnian paradigm shift,[8] hard learning issues lurk close to the surface of the legal issues that AI programs attempt to resolve. To accomodate even gradual change, the algorithms must adapt to a dynamic knowledge base: a shifting foundation of cases, statutes, and the indices, rules, and norms which manipulate them. Eventually one must confront the change in predicates and in the representation itself, either through the emergence of new legal concepts or through the substantial modification of old ones.[9]

In summary, legal reasoning requires certain minimum capabilities:

1. the ability to reason with cases and examples, particularly through analogy;
2. the ability to handle ill-defined, open-textured predicates;
3. the ability to handle exceptions;
4. the ability to handle fundamental conflicts between rules; and
5. the ability to handle change and nonmonotonicity.[10]

D. Several Possible Approaches

Each AI specialty mentioned in Section A above is described briefly below. The distinctions drawn are not absolute; these specialties are complementary and often overlap.

Case-based reasoning seeks to emulate the case-based reasoning of legal practitioners. Current research is focused in part on case memory and indexing, assessment of similarity and relevancy, context-dependent case comparison, and argument generation and evaluation. Ashley's work with trade secrets[11] is a fairly inclusive current effort.

Logic and expert systems, adapted to the doctrine of precedent,

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7. As Gardner points out, not only are actors in our legal system free to argue, on hard questions they are expected to do so (p. 3).

8. T. KUHN, THE STRUCTURE OF SCIENTIFIC REVOLUTIONS (1970).

9. Legal reasoning thus inevitably involves the hardest problems in learning, such as bias (the problem that any knowledge representation language disposes one to emphasize or miss certain concepts) and the new term problem (concerning the program's own creation of new concepts as needed).

10. Nonmonotonic reasoning involves the rejection and/or reform of prior decisions.

11. Rissland & Ashley, *supra* note 5.

employ "backchaining" to resolve legal predicates. The programs proceed toward conclusion by executing actions necessary to achieve identified subgoals. The danger courted here, as Gardner points out, is that the "rules will run out" before predicates have been resolved. Conflicting resolutions also may be output.

Natural language processing, including techniques for story understanding, is most readily applied where stereotypical fact patterns and party roles are recognized.[12] Script-based understanding techniques might prove especially fruitful when restricted to short case summaries, such as headnotes. In general, however, natural language processing in the law confronts the same daunting challenges of language in other domains. The law, as a microcosm of human experience, presents in aggregate the widest range of expression and interpretation, while the sense of even common words is problematic,[13] and shifts with context.

Finally, *nonmonotonic reasoning* systems may be adapted to handle law's propensity to limit or overturn prior results. *Example-based learning* may emulate any system, including the legal process, which develops primarily in response to examples.

II. THE BOOK AND THE PROGRAM: GARDNER'S APPROACH

A. Gardner's Theory of Hard and Easy Cases

Gardner's AI model reflects the jurisprudence of hard/easy questions, particularly as discussed by H.L.A. Hart, Lon Fuller, and Ronald Dworkin (pp. 38-39). In Gardner's model, hard questions can arise in three ways:

1. There exist competing rules.
2. There exist unresolved predicates.
3. There exist competing cases.

Hard cases are detected by three heuristics which resolve predicates:

1. "If an answer can be derived using [the program's Common Sense Knowledge (CSK)] rules and if no objections (i.e., oppositely-decided cases) to using this answer can be found, assume the question of predicate satisfaction is easy and that its answer is the answer just derived." (p. 45).

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12. Gardner herself adopted this approach in the simpler context of sentences and phrases rather than in a continuous story.

13. *E.g.*, Allen & Saxon, *Computer-Aided Normalizing and Unpacking: Some Interesting Machine-Processible Transformations of Legal Rules*, in COMPUTER POWER AND LEGAL REASONING (West 1985).

2. "If no answer about the satisfaction of a legal predicate can be derived using the CSK rules, then look at cases." (p. 46).
3. "Whatever tentative answer has been derived using non-legal knowledge, look for cases calling for the opposite answer." (p. 46).

The hard/easy analysis proceeds in the manner of generate-and-test. As Gardner says, "[T]he general idea is, first, to allow every undefined predicate in a legal rule the potential for raising a hard question and, second, to provide means for concluding fairly quickly, in any particular case, that most questions of predicate application are easy." (p. 43) If the question of predicate satisfaction can be determined by applying the CSK rules to the facts, the program has reached a *tentative answer*. Tentative answers can be *overridden* by opposite cases that object. Overriding allows the program to conclude that what appeared at first glance to be a hard question (because meanings couldn't be resolved) is in fact easy (because the law has shown how to resolve them), or to spot hard questions (where legal rules or cases conflict) to which the CSK rules were applied without difficulty. While the easy mislabeled as hard leads to a waste of resources, the hard masquerading as easy may lead to fatally flawed arguments and lost cases.

B. The Program

1. Domain and Task

Gardner's program works in the subfield of offer and acceptance from contract law. Contract law is relatively stable, what Edward Levi would call a "second stage" domain,[14] roughly corresponding to Kuhn's normal science stage.[15] Contract law is fairly reliably structured by the *Restatement (Second) of Contracts*, abundant case law, and the Uniform Commercial Code. Gardner discusses in greatest detail her program's treatment of *Adams v. Lindsell*, the classic classroom crossed-offers case. Input is presented in the text in the guise of "[a] typical examination question" (p. 4). The familiar task, in brief, is to spot the issues, a quintessentially "intelligent" process.

The issue-spotting task may be viewed as a search through a space of possible alternative interpretations of the facts. Since not

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14. E. LEVI, AN INTRODUCTION TO LEGAL REASONING 9 (1949) ("The second stage is the period when the concept is more or less fixed, although reasoning by example continues to classify items inside and out of the concept.").

15. T. KUHN, *supra* note 8.

all issues are worth arguing about, and in the context of an exam or litigation there are time and space constraints, the nature of the search must of necessity be heuristic. The task is how to select issues which raise *defensible* arguments, or, in the language of search, how to distinguish the plausible from the merely possible.[16]

2. Input

Gardner's program–which is never given a persona with a name–starts with a set of facts which have been entered by hand into a form acceptable to her program.

3. Structure

Legal knowledge in Gardner's program is contained in two sources: network structures and legal rules. An Augmented Transition Network ("ATN") represents the standard states in a contract situation with interpretations of events as the links, or "arcs,"[17] between them. Legal rules represent certain prototypical legal fact patterns and are drawn upon to resolve whether an ATN arc may be traversed. Legal antecedents necessary to conclude whether a contract exists are formalized (*e.g.*, reasonable-certainty, exchange, may-be-willing-to-enter).

Gardner's program has an ATN with twenty-three states, twenty legal rules (of which two pairs are conflicting and three pairs are complementary), and approximately 100 generalized fact patterns. Her simplified transition network is reproduced below:[18]

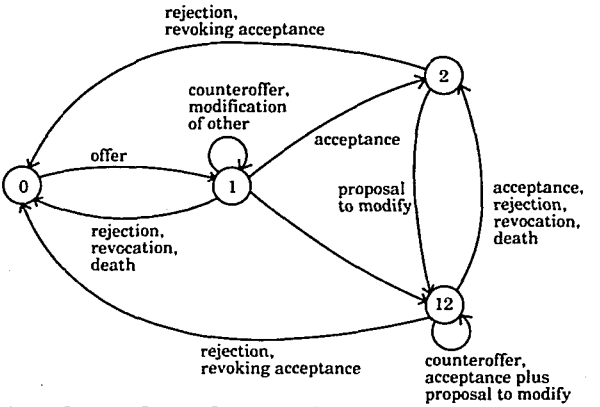
4. Algorithm

To produce the analysis of legal choices, Gardner's program employs several sources of legal, linguistic, and common sense knowledge. Common sense knowledge is represented in two ways: (1) a slot-filler language is used to describe fact situations; and (2) a hierarchy of such things as events, states, and objects, is implemented through a mechanism of Common Sense Knowledge

16. Gardner relies upon Llewellyn to make this point (p. 9): "[W]hile it is possible to build a number of divergent logical ladders up out of the same cases and down again to the same dispute, there are not so many that can be built defensibly. And of these few there are some, or there is one, toward which the prior cases pretty definitely press." (K. LLEWELLYN, THE BRAMBLE BUSH: ON OUR LAW AND ITS STUDY 73 (Oceana Publications 1960)).

17. "The arcs of the network correspond to events that can change the legal relations between the parties." (p. 124) There is no arc to represent the lapse of time.

18. "State 0: No legal relations exist.
State 1: One or more offers are pending; the offeree has the power to accept.
State 2: A contract exists.
State 12: A contract exists, and a proposal to modify is pending." (pp. 123-24)



Transition Network for Offer and Acceptance Problems (p.124)

rules. The rules themselves are highly structured objects with "extra" components (such as "eliminate-on-failure" and "eliminate-on-success," which prune ATN arcs from consideration), and "secondary" antecedents, which provide some look-ahead for information useful in resolving hard questions.[19]

These ideas are embodied in an algorithm which forms the backbone of Gardner's program. This algorithm is outlined below. The mechanisms of applying CSK and legal rules to work one's way around the ATN are in fact quite involved and are discussed at length in Chapters 5 and 6.

If (there is a tentative answer)
then if (there are no "opposite" cases)
  then (the case is *easy*);
but if (there **are** opposite cases)
  then if (there are also similarly aligned cases)
    then (the law is unsettled and the question is *hard*);
  otherwise (let the technical legal rule override the
    confilicting CSK rule; the answer is *easy*).

If (there is **no** tentative answer)
then if (no cases match)
  or if (two or more cases match but conflict)
  then (the cases fail to resolve the issue and the question
    is *hard*);
  otherwise (the question is *easy* and the answer is that
    indicated by the case(s) that match.

19. These CSK rules are encoded in a standard fashion using Michael Genesereth's MRS language (e.g., "one carload of salt" is "(carloads C1) (number C1 1)"), described in The MRS Dictionary, Memo HPP-80-24, Stanford Heuristic Programming Project, Stanford University.

5. Output

The output of Gardner's program is a two-level analysis represented in two graphs (Figures 7.4 and 7.5, pp. 173-76). The upper level of Figure 7.5 summarizes interpretations of the events in the fact situation. Branch points represent hard questions–points where alternative, competing interpretations must be recognized. In effect, the upper level is a decision tree whose branching nodes represent hard questions and whose leaf nodes correspond to separate sequences of interpretations of the events. From such a representation of issues, it is a short inferential hop to answer the big questions of whether a contract exists and what are the arguable issues. For each upper level branch point there is a lower level detailed analysis (such as in Figure 7.4) supporting the diverging interpretations.

Gardner's model thus is able to analyze issue spotter questions such as that presented by a stylized *Adams v. Lindsell*. As she discusses, her program's eight major two-way branch points and nine concomitant analyses are perhaps more than a human lawyer might consider, but these branch points compare well to her estimate of a possible search space of five to the ninth power. The program reportedly performed creditably on an assortment of problems from *Gilbert's Law Summaries* (pp. 183-88).

III. COMMENT AND CONCLUSION

Anne Gardner is entirely correct in stressing such paradigms as "open texture" and "hard/easy." These are central to legal reasoning and open up valuable linkages to other AI disciplines as well as legal philosophy. Moreover, Gardner's work gives some real computational flesh to the philosophical skeleton of the hard/easy distinction, providing a model for critique by both legal and AI practitioners.

However, with specific regard to Gardner's manner of distinguishing hard and easy questions, I suggest that any realistic case base will invariably provide contrary, opposite cases. Consequently, her heuristics will characterize nearly all questions as hard. One answer is to recognize that not all opposite cases are equal, and that some contrary arguments are more robust than others. Of course, this requires one to reason with cases and, more difficultly, about arguments–a tremendous task, but preferable to overreliance upon rules and generalized fact patterns. In particular, I see cases as playing a much more central role than they do in Gardner's model. Therefore, I would address with some care the details of individual cases which are critical for indexing, anal-

ogy, and other aspects of case-based reasoning. However, using cases in a more central role and not just as annotations or existential embodiments of concepts would require deep changes in Gardner's program.

Nevertheless, Anne Gardner has done landmark research in the field of AI and legal reasoning. Notwithstanding our "jurisprudential" differences, I feel that Gardner has made a substantial contribution to AI and legal reasoning which will have major impact upon both disciplines. Not only has she performed ground-breaking work on such topics as issue spotting, open textured predicates, and the hard/easy paradigm, she has also pointed the way to further work on case-based reasoning and argumentation. The book is well written and has served my classes at Harvard and Amherst well. In particular, her introduction and explication of legal philosophy from the perspective of AI (Chapters 2 and 3) are unrivalled in the current literature. *An Artificial Intelligence Approach to Legal Reasoning* is essential to anyone working in the field, and invaluable to those who wish to work in the field. And that is an easy question.

BOOKS RECEIVED

IF WE CAN KEEP A SEVERED HEAD ALIVE . . ., by Chet Fleming. Polinym Press, P.O. Box 22140, St. Louis, Missouri 63116. pp. 461 (1987).

AN INTRODUCTION TO KOREAN INTELLECTUAL PROPERTY LAW, by Byong Ho Lee. Central International Law Firm, Korea Reinsurance Building, 80 Soosong-dong, Chogno-ku, Seoul, Korea. pp. 453 (1987).

ENGINEERS AND THE LAW / AN OVERVIEW, by Bruce Schoumacher. Van Nostrand Reinhold, 115 Fifth Avenue, New York, New York, 10003. pp. 337 (1986).