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The Nature of AI: A reply to Schank

Citation for published version:

Bundy, A 1983, 'The Nature of AI: A reply to Schank', *AI Magazine*, vol. 4, no. 4.
<<http://www.aaai.org/ojs/index.php/aimagazine/article/view/414>>

Link:

[Link to publication record in Edinburgh Research Explorer](#)

Document Version:

Peer reviewed version

Published In:

AI Magazine

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The Nature of AI: A Reply to Schank

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IN HIS ARTICLE IN THE AI MAGAZINE, Vol. IV, No. 1, "The Current State of AI: One Man's Opinion," Roger Schank puts forward various views on the nature of AI. In fact, there are enough opinions for four men. That is, the views advanced are contradictory. I agree with one of the Roger Schanks, and disagree with the other three.

Schank hoped that his article would start a debate on the issues he raised. This is my contribution.

Schank's Four Views of AI

What are Schank's four views?

In answer to his question "What is AI all about?", he claims to see only two possible answers. These are:

- The Scientific Answer: "that AI is concerned with finding out how people think" and
- The Technological Answer: "that AI is an attempt to create certain new technology."

Later in the text, two other answers are advanced, and each is asserted to be The answer. Thus, we read:

- The Learning Answer: "an AI program that does not learn is no AI program" and
- The Techniques Answer: "Really what AI is, potentially, is the algorithmic study of processes in every field of inquiry."

A fifth answer is also advanced, but is immediately withdrawn. This is:

- The Innovative Answer: "It also usually means getting a machine to do what previously only humans have done before."

As Schank points out, this is unsatisfactory because it leads to a shifting definition of AI.

The Learning Answer

Another of these answers, the learning answer, can also be quickly disposed of. Anyone who attempts to clarify a vague term, like AI, is allowed a certain amount of license in excluding some uses of the term from his/her definition and highlighting other uses, but there are limits to this license. The definer must pay some attention to the majority usage of the term and to previous definitions. Otherwise, we are in a 'Humpty Dumpty' world, where words mean 'what I want them to mean', and communication becomes impossible. The learning answer is just too far from the majority view to be tenable. As Schank himself has said, the learning answer would exclude most previous AI work. So what would that work then be called?

The only way that I can make sense of the learning answer is as part of a definition of AI as the attempt to build the all-singing, all-dancing, artificial person. Since

people learn, any AI program must learn, but so must it sing and dance! This definition not only excludes all known AI programs, but all those we are likely to build in the next 100 years. AI will not exist until it is achieved!

This seems to be what is behind Schank's claim that "It is important that AI concentrate on building complex integrated systems that make some stab at doing a total walk through of some real task." There is some truth in this, but it would be bad methodology to build only complex systems. 'Divide and conquer' is as true for AI as for any science. We need to develop and study individual techniques and their properties as well as put them together into integrated systems. We must also study techniques for the clean integration of small systems to make big systems. Our experiences with integrated systems can then feed back into the redesign of their constituent parts. Otherwise, we will wallow in confusion.

Reconciling the Remaining Three Views

The remaining three Schankian views are less easily disposed of because each corresponds to a popular definition of all or part of AI. Faced with conflicting definitions of a concept, one standard device is to divide the concept into subconcepts so that each definition corresponds to one subconcept. It is standard to so divide the AI field into the 'technological' subfield, e.g. knowledge engineering, and the 'scientific' subfield, e.g. computational psychology. Schank's technological and scientific answers reflect just this subdivision.

But this twofold subdivision does not accommodate the techniques answer. For that, as I have argued elsewhere,¹ we need a three-fold subdivision. The third subfield I call 'mainstream AI', because it is what most AI researchers are actually engaged on most of the time, namely:

The investigation of computational techniques which have the potential for exhibiting intelligent behavior.

Very few AI researchers actually put in the development work required to produce a technological product with commercial potential. Very few AI researchers conduct the experiments necessary to show that their program has psychological validity. Most AI researchers try to build a program which performs some task that no previous program has been able to perform, and in the process they develop new techniques or explore the potential of existing techniques.

This is not the only methodology for investigating AI techniques, but it is the most popular. Once the AI community recognizes that investigating techniques is what they are about, then the methodology of the field will be liberated from the mental chaos of big program building, with enormous benefit for the future development of AI. We will be en-

couraged to develop a more precise terminology for describing AI techniques, to explore the tradeoffs of different techniques, to appreciate the value of negative results, and to extend and improve existing techniques.

We will also be in a better position to assess AI research, including Ph.D. theses and conference papers—two areas where Schank complains about standards. For instance, even another rule-based system has a research role if it extends our understanding of the limitations/potential of production rule systems as a computational technique,² but the outcome has to be at least mildly surprising (e.g. Max Bramer's difficulties in implementing MYCIN in EMYCIN). There is no doubt that most such systems are uninteresting from the research point of view, but this is precisely because of the lack of appreciation by their implementors of how they **could** be useful in drawing attention to the limitations of the rule-based technique. The implementors usually try to hide any such limitation, lest it cost them their Ph.D., and are encouraged to do so by the refereeing system of the field.

Mainstream AI as Applied Mathematics

What is the relationship between mainstream AI, knowledge engineering, computational psychology and computer science? I believe it can be best seen by drawing an analogy with applied mathematics, engineering, physics and pure mathematics, respectively. Just as applied mathematics investigates those areas of mathematics which can be used to model physical phenomena, so AI investigates those computational techniques which can be used to model cognitive phenomena. Just as applied mathematics was often in the forefront of discovering or motivating mathematical advances, e.g. calculus, so AI is often in the forefront of discovering or motivating computational techniques, e.g. inference. Neither applied mathematics nor mainstream AI is an empirical science, i.e. they are not studies of natural phenomena, only of abstract entities, e.g. numbers and networks. However, both can be applied to empirical sciences such as physics and psychology, and both can be applied to technologies such as mechanical engineering or knowledge engineering.

Of course, the analogy breaks down at points 'The nature of an AI model' is different from an applied mathematics model. No one would claim that planets make arithmetic calculations before deciding what gravitation attraction to exert, but computational psychologists do claim that human mental processes can be regarded as computational 'calculation'.

Does it Matter?

Does it matter what view one takes of the nature of AI?

¹"Some suggested criteria for assessing AI research," AISB Quarterly 40-41, 1981

²A similar story applies to the linguistics theses despised by Schank, which applied transformational grammar to yet another language. The linguists were investigating the limitations/potential of the syntactic apparatus.

It does. The problems that prompted Schank to write his article are important, and different views of the nature of AI suggest different solutions to these problems. We consider some of these problems and solutions below.

"The field has always been somewhat fragmented," with lack of agreement about its goals and methodology. Each of the five views above suggests different goals and different methodologies. Many researchers simultaneously hold a mixture of these views, which causes them confusion about what research to do and how to do it. Any success in clarifying the nature of AI should also help to sort out this confusion. The techniques answer advanced above suggests the goal of developing and investigating techniques. This can be done not only by building programs, but also by teasing out neat techniques from scruffy programs, and by explicit comparison of techniques.

There is wide disagreement about "what constitutes a reasonable piece of AI research." This is witnessed by the large number (50%) of conference and journal articles where one referee recommends acceptance and the other rejection. I explicitly addressed this problem in my AISBQ 40-41 article, where I tried to show how the techniques answer suggests criteria for assessing AI research. One theme of that article was that there was wide agreement on what constitutes bad research, and that one could extract criteria from these agreements by negating the reasons for rejecting pieces of work.

The discovery that AI can be applied commercially has created several problems: a shortage of people, the danger of neglecting fundamental research, the danger of a backlash if AI does not deliver. These are all aspects of a single problem: ignorance—ignorance about how to do AI research, ignorance of the nature and need for fundamental research, and ignorance about what AI has to offer commerce. The applied mathematic analogy implies that fundamental research in AI is the development and investigation of AI techniques and that applied research is the application of these techniques. If these definitions were taken seriously then AI would be easier to teach and its contribution to commerce easier to appreciate.

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crop of judgmental expert systems, a qualitative Bayesian machine may be the perfect tool.

Unfortunately, as mentioned previously, algorithms and techniques (approximate, probabilistic, or otherwise) for mechanizing these computations have not yet been worked out, and there is some chance that these computations are provably infeasible even for supercomputers. Also requiring attention is adaptation of any success with logic-based systems to the alternative non-logical production systems, for the same general ideas involved in Carnap's constructions apply even when logical structure is not available—see Doyle, 1982 for suggestions.

There are also other functionalities one might desire of supercomputers in addition to those discussed above, such as the ability to supply proofs when answering deductive questions, and the ability to make non-monotonic, reasoned assumptions. The former are invaluable in explanations, the latter important in problem-solving and representation. But we cannot pursue these here, except to note that both fit well with the proposed constructional approach (Doyle, 1982, 1983a, 1983b).

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