

SIMULATING NON-DEDUCTIVE REASONING

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ABSTRACT

This paper is intended to draw attention to a literature in Philosophy that would be of great use and interest to researchers attempting to simulate non-deductive reasoning. Two models of such reasoning are discussed, and the kernel role of the concept of explanation common to them both is revealed. Finally, the relevance of the conceptual insights to computing by appealing to Scriven's comprehension theorem which facilitates a link between the concepts of explanation, understanding and processing efficiency under certain constraints.

evidence to hypotheses, actions and predictions, which is by and large non-deductive. Attempts to simulate such reasoning typically devolve to attempts to reconstruct non-deductive reasoning as a deductive system with exotic properties such as probabilistic truth values or non-monotonicity. An examination of the philosophic literature reveals several important abstract traits which programs simulating intellection must reckon with that are probably incompatible with a straightward deductive system. It is only by avoiding deductive reconstruction that salient features of such reasoning such as its value dependance and its intimate connection with concept of explanation is revealed.

1. Introduction

A fairly recent survey found that researchers in Artificial Intelligence considered Philosophy of more immediate relevance to their work than Psychology (Newell, 1980). This is a plausible attitude toward a discipline that is traditionally preoccupied with the mental, with knowledge and with reasoning. It is a reasonable hope that the body of philosophic ruminations about these domains, though are univocal, will help the formulation of precise characterizations of the properties intelligent programs are supposed to exhibit, i.e., specifications of the behavior to be simulated.

The first two of the three philosophic preoccupations mentioned above have fairly old titles, philosophy of mind and epistemology, respectively. The third concern, the characterization of reasoning properly belongs to logic. In what follows, however, I wish to call attention to and draw upon a literature that is not precisely at home in any one titled field of philosophy.

The literature in question is one concerned at a conceptual and not a psychological level with the characterization of reasoning, ordinary reasoning from

2. Describing Non-deduction

It is convenient to describe non-deductive reasoning as a kind of departure from full deduction. This is done by posing some paradigm argument schemes appropriate to given problem areas and then describing the stratagms that ensue when one of the premises of the model argument is false. I will be concerned with two such paradigms, one for evidential reasoning and one for reasoning to actions.

3. Evidential Reasoning

The paradigm argument is,

- (1) X explains (why) Y (is true).
 - (2) Nothing but X would explain (why) Y (is true).
 - (3) Y is explained by something or other.
- (C) X (is true)

Roughly, the context in which the paradigm is relevant is one in which some fact Y inviting explanation is known and some other fact X, if true, would explain Y. With premises (1), (2) and (3) the

argument to X is a deductive one. In the normal life of reasoning, something like (1) is frequently known and (3) is simply presupposed (though it is false in some domains such as Quantum Mechanics). However, (3) is almost always false, because there are always explanations that rival the one isolated in the conclusion.

In response to the fact that (2) is false reasoners engage in various stratagems designed to isolate some conclusion from the other candidates as clearly better or more plausible. Such strategies exhibit a structure at least as complicated as the following method of procedure.

(1) Articulate (formulate, identify) a fact (or facts) inviting explanation.

(2) Articulate (& *et cetera*) facts (hypotheses) which, if true, would explain the facts gathered in (1).

(3) Rank the yieldings of (2) in order of plausibility.

(4) Articulate (& *et cetera*) facts which, if discovered, would alter the order provided in (3), or continue.

(5) Either goto (2), (3) or continue.

(6) Infer, pick, go with, the conclusion at the top of the plausibility ranking provided most recently in (3).

Thus, some fact, such as a noise in the next room, may initiate step (1), followed by step (2), the formulation of explanations of the fact, followed in turn by (3), a ranking of the explanations in order of plausibility. One may then articulate some fact, which if discovered would clearly alter the ranking. One must either return to the formulation of new explanations or to (4) to determine whether any of the facts devised in (3) obtain and alter the current ranking accordingly. Eventually, the method of procedure will be abandoned, in a sense to be discussed anon, by acting on the conclusion at the top of the plausibility ranking.

The method of procedure is not an algorithm, since the branching at steps (4) and (5), is the point at which abandonment (jumping out) occurs, is not deterministic. This is a reflection of the fact that the reasoning is non-deductive, i.e., though the argument from P to Q may be a perfectly good one, the denial of Q does not force the denial of P. This is due to the fact that P is sim-

ply the best of a collection of rival conclusions all of which must be (1) compatible with the evidence—since the evidence supports each—and (2) incompatible with one another, since they can't all be true.

4. Reasoning to Actions

A second sort of reasoning is reasoning to actions, represented by the following paradigm:

- (1) There is a reason to do X.
- (2) There is no reason to do other than X.
- (3) One ought to do something or other.
- (C) One ought to do X.

As before, premise (1) is frequently simply known, (3) is supplied by the context, but (2) is usually false, since reasons to do other than X are usually abundant. The falsity of (2) is met by an appropriate abstract rational procedure whose object it is to isolate one action as better supported than any other. In the interests of efficiency, we shall not rehearse the procedures (which can be rather complicated) we will use the method of procedure for evidential reasoning as grist for further investigation.

5. The Problem of Detachment

The procedures for rationally responding to the absence of deductive validity are not algorithms in a strong sense. In the procedure for evidential reasoning, steps (4) and (5) are non-deterministic. Most important, there is no provision for halting, i.e., the instructions do not determine when to jump out of or abandon the procedure and believe the conclusion, or do the action, currently best supported. Thus is the problem of detachment, the problem of articulating a criterion with which to 'detach' a conclusion (action or belief) from the rationincination it is embedded in.

Foremost is the problem of characterizing what it means to detach. In the case of reasoning to action this is fairly straightforward; one detaches by doing the action best supported. In the case of evidential reasoning, the characterization requires greater subtlety. For present purposes, we will use the unattractive expression—for which I have found to substitute—"go with". To detach is to go with the current best supported hypothesis or conclusion.

Detachment can be forced by circumstances. This is it may be rational to go with a conclusion because circumstances demand going with some hypothesis or other and rationality demands that this be the hypothesis at the top of the plausibility ranking. More importantly, detachability is a value dependant trait, as is shown by an example originally constructed by Scriven. Suppose that one wishes to haul a bail of hay to an upper story loft with a rope and pulley and there is some evidences as to whether the rope is strong enough. One can imagine the kinds of evidence marshalled to elevate the conclusion that the rope of sufficient strength to the top of the plausibility ranking. One may inspect the rope for defects, give it a strong yank, et *cetera*. Imagine the evidence that would settle the matter. Now imagine the item to be hoisted to be not a bail of hay but one's daughter, which we may assume weighs the same as the bail. One will probably observe that the evidence imagined to be sufficient for hay is inadequate to the question of hoisting one's daughter. What this reveals is that the value component in non-deductive reasoning, that what it is rational to detach—conclude--non-deductively is in part a function of one's values. This is of course untrue of deductive reasoning which is valid or not independent of the consequences of being wrong.

6. The Role of Explanation and Understanding

The two species of reasoning for which model arguments were provided share in common the concept of explanation--and its correlative concept, understanding--at their core. In the case of evidential reasoning, we judge that X is evidence for Y if and only if Y explains X. The role of explanation in reasoning to actions is less obvious. In general, to say that a person P does an action A for reason R means something like,

- (1) P knows (or believes) R, and
- (2) The fact that P knows (believes) R explains why P does A.

Thus, a reason is a fact an agent's knowledge of which would explain the his performance of some action.

What this is implies is that one global constraint on reasoning is explanatory coherence, or coherence of understanding. That is, plausibility judgements are driven by perceptions of the degree to which a given conclusion candidate coheres explanatorily with the remainder of one's

of comprehension are automatic consequences of information processing strategies designed to maximize efficient storage and retrieval while interacting with an informationally rich environment. Indeed, according to this view, comprehension is the disposition or capacity for effective storage and retrieval under the constraint of the impossibility of total storage; that is, maximizing storage and retrieval in an environment so rich that complete storage is impossible.

Thus, one can identify something like a connection between something computable and the apparently vague concepts of explanation and understanding that lie at the core of non-deductive reasoning--if the described paradigms are characteristic. In any case, the relevance of the philosophic literature on non-deductive reasoning that does not reconstruct such reasoning deductively is I hope made more plausible by these remarks.

References

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