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SUPPOSITIONAL REASONING, INDUCTION, AND NONMONOTONIC INFERENCES

Review of
ISAAC LEVI, *FOR THE SAKE OF ARGUMENT: RAMSEY TEST CONDITIONALS, INDUCTIVE INFERENCE, AND NONMONOTONIC REASONING*
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I

The book collects Levi's recent results concerning the imaginative use of *suppositional reasoning* relevant to *practical deliberation, explanation, prediction, hypothesis testing, scientific inquiry*.

In suppositional reasoning, we add to the initial state of full belief a proposition supposed to be true *for the sake of the argument*: "Like a change in the state of full belief, the result is an altered way of distinguishing between the possible and impossible or between what is judged true, what is judged false, and what is held in suspense. But the transformed state is not the inquirer's new state of full belief. [...] A new state of full belief is simulated in the sense that the ramifications of moving to that state are explored without actually making the change" (pp. 2–3). Hence, changing full beliefs calls for some sort of assessment or *justification* but supposition does not, consequently it is necessary to pay attention to the distinction between *genuine change in belief* and *suppositional change*.

Practical deliberation involves evaluation with respect to the decision-maker's goals and value options: this evaluation can be obtained by considering consequences of the supposition adopted purely for the sake of the argument. The "potential" new state of full belief will contain the initial state of full belief and the consequences of the supposition previously added. Only when the decision-maker decides to implement

a given option, does he or she come fully to believe not by inference from what he or she believes but in virtue of his or her choice.

Also, in any *intelligently conducted inquiry* the aim is to modify the state of full belief. As Levi stresses, in this case it is necessary to identify potential answers (i.e. conjectures) to a given question at the "*abductive*" (see below) phase of inquiry. These and their negations are serious possibilities held in suspense. The concern is to change the state of full belief by incorporating one of these potential answers (or its negation) into the state of full belief. To do this it is sometimes necessary to explore experimental consequences of the truth of the several competing answers.

"The inquirer may add h to his *current belief state* **K** or the corpus (theory or deductively closed set of sentences in regimented language $\underline{L}$) $\underline{K}$ representing **K** and examine the logical consequences of doing so. That is to say, $\underline{K}$ is *expanded* by adding h and forming the logical closure of $\underline{K}$ and h. If the inquirer subsequently adopts the potential answer represented by expanding $\underline{K}$ through adding h as his or her state of full belief, the formal structure of the shift from $\underline{K}$ is the same as when $\underline{K}$ is expanded by supposing h to be true for the sake of the argument" (p. 4). When we form several different conjectures (possible answers) we are exploring the merits of alternative potential solutions to the problem at hand. When we come to "believe" (not simply "suppose") that h is true we have terminated the inquiry by adopting the answer h to the question under investigation.

We have to stress that suppositional reasoning is *from* suppositions and not *to* suppositions. Moreover, Levi observes that an account of suppositional reasoning cannot constitute, contrary to Alchourrón, Gärdenfors, and Makinson [1], a "logic" of belief change or "theory change": as stated above the inquirer guesses via *abduction* (correctly considered as noninferential, see pp. 161–162) a set of potential answers to the question under study as cognitive options, that is *potential expansion strategies*. To have an account of rational belief change one needs an account of criteria for choosing among potential expansion strategies for the purpose of promoting cognitive goals.

Despite Levi's intellectual mistrust of computational models of reasoning, I would refer the reader to Thagard's related (not logical) way of treating the question of choosing between different sets of answers ("hypotheses"): the approach is in terms of the so-called *explanatory coherence* [11] and belongs to the area of computational philosophy. With reference to the other related problem of *abduction* (in its different meanings, including abduction as "inference" to the best explanation or to the best choice, as well as in its philosophical and cognitive

aspects, including the computational models of concept and theory formation) I would recommend [4] and [7], even if they do not consider formal representations.

Suppositional reasoning is also involved in *prediction*: making predictions (or retrodictions) is conditional on the truth of propositions that are not believed to be true, a conditionality that is suppositional conditionality. Finally, suppositional reasoning is at the heart of *explanation*. Levi shows that in this case the "supposition is information the inquirer already fully believes" (p. 5) (See the example of explaining why a litmus paper immersed in acid turns red: in explaining, the inquirer will cite the fact that the paper was immersed in acid and some principles covering chemical interactions). The problem here is that the inquirer is only requested to doubt where he is in no doubt and then suppose for the sake of the argument that the litmus paper was immersed in acid and to determine from this supposition whether the litmus paper turned red or not. It seems to me also that in this case we can make a bridge across suppositional reasoning in explanation in Levi's sense, and the mechanism of abduction (at least of what I call "selective abduction", implicit in Peircean thought), so important in the field of diagnostic reasoning [7], when the inquirer has to choose between several hypotheses.

Finally, let's remember that sometimes a supposition contravenes the current state of belief, sometimes it agrees with it, and sometimes the current state reflects suspense concerning the status of the supposition. To resume: when a new proposition added to the belief state generates a supposition made "for the sake of the argument" that *conflicts* with our beliefs, at the end of the whole process of changing full beliefs, some beliefs are *refuted* and others *retained*. Producing new content and adding it to a supposition may subvert conclusions reached without it. Hence, suppositional reasoning is *ampliative*. Moreover, as Levi stresses, especially in Chapters 5 and 6 of the book, *nonmonotonicity* is a central theme related to suppositional reasoning.

As stated above, changing full beliefs calls for some sort of assessment or *justification* but supposition does not, consequently it is necessary to pay attention to the distinction between *genuine change in belief* and *suppositional change*: to face the problem of justification, Levi is primarily concerned with a critique of the attempts made by Alchourrón, Gärdenfors, and Makinson [1] to provide an account of the conditions under which a change in a state of full belief by *expansion* is legitimate. In these attempts expansion is characterized as adding new information h to $\underline{K}$ and closing under deduction, but no satisfying explanation of the condition under which such expansion is justified is given. In

the case of new conflicting information (that makes $\underline{K}$ *inconsistent*) Gärdenfors [3] proposes *minimal revision* as a basis of belief change (that is a process that removes from $\underline{H}$ only the mimimum amount of information to secure $\underline{H}$ as a new corpus of deductively closed theory that is consistent). Sometimes h itself is called into question and the background information retained. Sometimes new input and background information are both questioned. Of course it is only in the case of expansion by adding new information that the justification is needed.

Levi's suggestion to improve the minimal revision approach relates to the possibility of representing it as a problem of *choosing between rival contractions* of the inconsistent belief state. There are many situations where we can observe belief contravention that leads to different kinds of contraction of the background information: for example, in scientific change there is the need of thinking through consequences of belief contravening suppositions in *Gedankenexperimenten*.

Both judgments in practical deliberation and suppositional reasoning from conjectures in scientific inquiry can be expressed in terms of conditionals. To supplement the minimal revision approach by a consideration of supposition, Levi explores the role of suppositional reasoning in explicating conditional judgment.

II

In Chapter 2 Levi describes three versions of the Ramsey test for the acceptability of conditionals: two of them satisfy the requirement Ramsey laid down for the acceptability of open conditionals (where both supposition and its negation are *serious possibilities* from the inquirer's point of view), capturing the same kind of conditional appraisal of serious possibility (*informational-value-based Ramsey tests*). The third satisfies the requirement provided the open character of the "if" clause is relative to a point of view that represents a *consensus* between several different perspectives (*consensus Ramsey test*). The author contrasts the three versions of the Ramsey test with the imaging test that is derived from D. Lewis semantics of conditionals and proposes the so-called *revision according to Ramsey* (p. 40), that violates some of the postulates of the above-cited minimal theory of Alchourrón, Gärdenfors, and Makinson. This kind of revision is shown as preferable in cases of suppositional reasoning in practical deliberation and scientific inquiry.

Chapter 3 of the book introduces extended languages that can include judgments of serious possibility, credal probability, value or desire, and shows the behavior of the correspondent conditional judgments: dealing with an account of the *acceptability* of iterated conditionals, Levi observes that (*i*) a great part of the logic of conditionals depends on the constraints imposed on suppositional reasoning, and (*ii*) retaining the Ramsey test approach to conditinals is preferable to abandoning the Ramsey test for the sake of the reduction condition. The *imaging* revisions are also considered.

In Chapter 4 the efforts by Gärdenfors to mimic the formal properties of Lewis's favorite version of conditional logic [6] using a variant of Alchourrón, Gärdenfors, and Makinson revision are shown to fail regardless of whether the logic is designed for formal languages with or without iterated conditionals.

Chapters 5 and 6 are devoted to a very interesting analysis of the *nonmonotonic* character of suppositional reasoning. The aim is to derive nonmonotonic inferences from principles of inductive inference and not characterize them by specifying how they deviate from deductive reasoning. Levi's description of this problem tells us that "given a set of background beliefs $\underline{K}$, supposing the p is true for the sake of argument may warrant judging q true relative to the transformed corpus; but supposing $p \wedge r$ true for the sake of the argument may require suspending judgment regarding q or, in some cases, judging $\sim q$ true relative to the same $\underline{K}$" (p. 15).

As is well-known, many authors in the area of computer science and artificial intelligence (for example [8]) are involved in studying this subject especially from the point of view of suppositional reasoning due to belief contravention (*cf.* the famous Tweety example): Levi shows that also *inductive inferences* are nonmonotonic and outlines a comparison of the two kinds of nonmonotonicity. Inductive inferences may be based on full beliefs as well as on such beliefs supplemented by suppositions created for the sake of the argument: they can consequently be expressed by "inductively extended" conditionals.

Levi compares the standards of nonmonotonic reasoning generated when induction is taken into account with situations where attention is restricted to belief-contravening nonmonotonicity. The conclusion is that the only kind of inference that can be nonmonotonic (p. 158) must be *ampliative* (*i.e.*, reasoning that adds information to the belief state not entailed by the belief state and does so without belief contravention. Levi defends the line that nonmonotonicity related to mere belief-contravening reasoning is noninferential): this is the case for the

several kinds of inferences involved in reasoning from data to hypotheses, from statistical hypotheses to outcomes of experiments, and from samples to predictions. We have to say that Levi is also perfectly aware of the character of verbal dispute of the many discussions concerning the inductivist or antiinductivist nature of the ampliative inference. Criteria for legitimate inductive expansion are proposed in Chapter 6, where the important process of inductive expansion with *bookkeeping* rules is illustrated.

Chapters 7 and 9 of the book are devoted to criticizing the fact that the focus in the recent interest in nonmonotonic logic (Reiter, Poole, Brewka, McCarthy, Moore) is always on jumping to conclusions, and considerations of statistical and inductive reasoning are almost avoided. Levi considers the problem of the relationships between *default* reasoning (supposed to be ampliative – inductive – and belief contravening) and nonmonotonic reasoning, by analyzing some ideas of Reiter [10], Doyle [2] and Poole [9]. He shows, with the help of many interesting and sophisticated suggestions – some of them, full of epistemological interest, against foundationalism – that default inference is not belief contravening and can be treated as inductive inference (*inductive expansion with bookkeeping*) when the inquirer is maximally audacious and when the result of inductive inference is inserted into the background evidence and the process of inductive inference is reiterated until a point is reached where no more information can be obtained. This result is concluded also by considering the recent proposal of Gärdenfors and Makinson for reasoning from defaults using expectations. The aim is to link default reasoning with probabilistic and decision-theoretic thinking the author has already developed in previous works. It is only in Chapter 8 that Levi deals with the approaches to nonmonotonic inference that assign finer-grained evaluations to conclusions and that include probability, entrenchment, degrees of belief and of possibility.

III

The book is stimulating, very rich and erudite, and not important only for students of "belief revision". Its attention to suppositional reasoning addresses also the interest of philosophers, logicians, and cognitive scientists concerned with abduction, theory choice, conditionals, inductive inference, and nonmonotonic reasoning (this wide area of potentially interested readers suggests that a sharper focus would have been better). To conclude, the "inductivist" Levi explains the virtues of suppositional reasoning and the reasons of its success in many central tasks of decision-making and inquiry, "rediscovering" and "repainting"

Ramsey test conditionals and nonmonotonic inference in a very innovative manner. He denies that we can abandon the philosophical and logical interest in ampliative inductive inference, but neglects to explain why it should have such central significance from the point of view of computational models (we have to say that he repeatedly observes that his work is not addressed to this subject). Ultimately, from a general philosophical point of view, I think that at present the book is the most sophisticated and learned version of the "celebration of induction" we have at our disposal, beyond the antiinductivism of Carnap and Popper.

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