Inductive Generalizations and Manipulative Abduction

Lorenzo Magnani
Department of Philosophy and Computational Philosophy Laboratory,
University of Pavia, 27100 Pavia, Italy,
Department of Philosophy,
Sun Yat-sen University, 510275 Guangzhou (Canton), P.R.China
lmagnani@unipv.it

Abstract

A better understanding of manipulative abduction at the level of scientific experiment could improve our knowledge of induction and its distinction from abduction: manipulative abduction can be considered as a kind of basis for further meaningful inductive generalizations. For example different generated "construals" can give rise to different inductive generalizations. It is difficult to grasp this distinction through present logical models of the induction/abduction puzzle.

1 Manipulative Abduction

I have introduced the concept of *manipulative abduction* - contrasted with theoretical abduction [Magnani, 2001] - to illustrate situations where we are thinking through doing and not only, in a pragmatic sense, about doing. So the idea of manipulative abduction goes beyond the well-known role of experiments as capable of forming new scientific laws by means of the results (nature's answers to the investigator's question) they present, or of merely playing a predictive role (in confirmation and in falsification). Manipulative abduction refers to an extra-theoretical behavior that aims at creating communicable accounts of new experiences to integrate them into previously existing systems of experimental and linguistic (theoretical) practices.

The existence of this kind of extra-theoretical cognitive behavior is also testified by the many everyday situations in which humans are perfectly able to perform very efficacious (and habitual) tasks without the immediate possibility of realizing their conceptual explanation. In some cases the conceptual account for doing these things was at one point present in the memory, but now has deteriorated, and it is necessary to reproduce it, in other cases the account has to be constructed for the first time, like in creative settings of manipulative abduction in science.

Hutchins (1995) illustrates the case of a navigation instructor that for 3 years performed an automatized task involving a complicated set of plotting manipulations and procedures. The insight concerning the conceptual relationships between relative and geographic motion came to him suddenly "as lay in his bunk one night". This example explains that many forms of learning can be represented as the result of the capability of giving conceptual and theoretical details to already automatized manipulative executions. The instructor does not discover anything new from the point of view of the objective knowledge about the involved skill, however, we can say that his conceptual awareness is new from the local perspective of his individuality.

In this kind of action-based abduction the suggested hypotheses are inherently ambiguous until articulated into configurations of real or imagined entities (images, models or concrete apparatus and instruments). In these cases only by experimenting we can discriminate between possibilities: they are articulated behaviorally and concretely by manipulations and then, increasingly, by words and pictures.

Gooding [Gooding, 1990] refers to this kind of concrete manipulative reasoning when he illustrates the role in science of the so-called "construals" that embody tacit inferences in procedures that are often apparatus and machine based. They belong to the pre-verbal context of ostensive operations, that are practical, situational, and often made with help of words, visualizations, or concrete artifacts. The embodiment is of course an expert manipulation of objects in a highly constrained experimental environment, and is directed by abductive movements that imply the strategic application of old and new *templates* of behavior mainly connected with extra-theoretical components, for instance emotional, esthetical, ethical, and economic.

The hypothetical character of construals is clear: they can be developed to examine further chances, or discarded; they are provisional creative organization of experience and some of them become in their turn hypothetical *interpretations* of experience, that is more theory-oriented, their reference is gradually stabilized in terms of established observational practices. Step by step the new interpretation – that at the beginning is completely "practice-laden" – relates to more "theoretical" modes of understanding (narrative, visual, diagrammatic, symbolic, conceptual, simulative), closer to the constructive effects of theoretical abduction.

When the reference is stabilized the effects of incommensurability with other established observations can become evident. But it is just the construal of certain phenomena that can be shared by the sustainers of rival theories. [Gooding, 1990] shows how Davy and Faraday could see the same attractive and repulsive actions at work in the phenomena they

respectively produced; their discourse and practice as to the role of their construals of phenomena clearly demonstrate they did not inhabit different, incommensurable worlds in some cases. Moreover, the experience is constructed, reconstructed, and distributed across a social network of negotiations among the different scientists by means of construals.

These construals aim at arriving to a shared understanding overcoming all conceptual conflicts. As I said above they constitute a provisional creative organization of experience: when they become in their turn hypothetical interpretations of experience, that is more theory-oriented, their reference is gradually stabilized in terms of established and shared observational practices that also exhibit a cumulative character. It is in this way that scientists are able to communicate the new and unexpected information acquired by experiment and action.

2 Samples, Induction, and Abduction

I think that a better understanding of manipulative abduction at the level of scientific experiment could improve our knowledge of induction, and its distinction from abduction: manipulative abduction can be considered as a kind of basis for further meaningful inductive generalizations. For example different generated construals can give rise to different inductive generalizations. It is difficult to grasp this distinction through present logical models of the induction/abduction puzzle.

Josephson [Josephson, 2000] maintains that

"An inductive generalization is an inference that goes from the characteristics of some observed sample of individuals to a conclusion about the distribution of those characteristics in some larger populations" (p. 40). Then he stresses the attention to the fact that what characterizes the sample as "representative" is its effect (sample frequency) by reference to part of its cause (population frequency): this should be considered a conclusion about its cause. In this sense abduction plays an important role

> If we do not think of inductive generalizations as abductions, we are at a loss to explain why such inference is made stronger or more warranted, if in connecting data we make a systematic search for counter-instances and cannot find any, than it would be we just take the observation passively. Why is the generalization made stronger by making an effort to examine a wide variety of types of *A*'s? The answer is that it is made stronger because the failure of the active search of counter-instances tend to rule out various hypotheses about ways in which the sample might be biased, that is, it strengthens the abductive conclusion by ruling out alternative explanations for the observed frequency (p. 42).

Moreover

> If we think that a sampling method is fair and unbiased, then straight generalization gives the best explanation of the sample frequencies. But if the size is small, alternative explanations, where the frequencies differ, may still be plausible. These alternative explanations become less and less plausible as the sample size grows, because the sample being unrepresentative due to chance becomes more and more improbable. thus viewing inductive generalization as abductions show why sample size is important. Again, we see that analyzing inductive generalizations as abductions shows us how to evaluate the strenghts of these inferences (p. 42).

I plan to further illustrate and possibly disambiguate this problem by indicating that manipulative abduction is the correct way for describing the features of what are called "smart inductive genralizations", as contrasted to the trivial ones. For example, in science construals can shed light on this process of sample "production" and "appraisal": through construals, manipulative abduction generates abstract hypotheses but in the meantime can originate possible bases for further meaningful inductive generalizations through the identification of new samples (or of new features of already available samples). Different generated construals can give rise to different plausible inductive generalizations.

The whole activity of manipulation is in fact devoted to building various external *epistemic mediators*[1] that function as an enormous new source of information and knowledge appropriate for further appropriate inductive generalizations.

From the point of view of everyday situations manipulative abductive reasoning and epistemic mediators exhibit very other interesting templates for managing *samples*: 1. action elaborates a *simplification* of data and of the subsequent reasoning task and a redistribution of effort across time [Hutchins, 1995], when we need to manipulate concrete things in order to understand structures which are otherwise too abstract [Piaget, 1974]], or when we are in presence of *redundant* and unmanageable information; 2. action can be useful in presence of *incomplete* or *inconsistent* samples – not only from the "perceptual" point of view – or of a diminished capacity to act upon the world: it is used to get more data to restore coherence and to improve deficient knowledge; 3. action enables us to build *external artifactual models* of task mechanisms instead of the corresponding internal ones, that are adequate to adapt the samples found in the environment to the agent's needs; 4. action as a *control of sense data* illustrates how we can change the position of our body (and/or of the external objects) and how to exploit various kinds of prostheses (Galileo's telescope, technological instruments and interfaces) to get various new kinds of stimulation: action provides some tactile and visual information (e.g., in surgery), otherwise unavailable. I plan to further deepen the analysis

[1] This expression, introduced by Magnani [Magnani, 2001], is derived from the cognitive anthropologist Hutchins [Hutchins, 1995], who coined the expression "mediating structure" to refer to various external tools that can be built to cognitively help the activity of navigating in modern but also in "primitive" settings. Any written procedure is a simple example of a cognitive "mediating structure" with possible cognitive aims, so mathematical symbols and diagrams: "Language, cultural knowledge, mental models, arithmetic procedures, and rules of logic are all mediating structures too. So are traffic lights, supermarkets layouts, and the contexts we arrange for one another's behavior. Mediating structures can be embodied in artifacts, in ideas, in systems of social interactions [...]" [Hutchins, 1995, pp. 290–291].

of the manipulative behaviors above to the aim of improving our knowledge about the interplay between abductive and inductive reasoning.

References

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