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Synthetic epistemology and ontology

Abstract: The synthetic methodology is often presented as "understanding by building". The question I wish to ask is: what does it reveal about the world in which we live that essential cognitive gains can be made by building? Alternatively, what would it mean to live in world where no such gain was possible? That is to say, in a world in which building was the mere application of preexisting knowledge. In a sense we know that world quite well because many philosophers and scientists, pasts and presents, have argued that thist is the world in which we do live. How is the world in which essential cognitive gains can be had from building different from a world where no such gain is possible? If it is the case that we live in a world where (essential) cognitive gains can be made by building, this, I will argue, has important consequences for our concept of 'model' and the partial revision of the epistemic role of model that follows will lead me to adduce to some of the other questions especially concerning the normative dimension of synthetic methodology.

Introduction

The descriptive note to this workshop[1] mentions some of the following as questions that may be addressed concerning synthetic methodology: "What are the status and the value of the insights coming from the exploration of synthetic models of life and cognition? Are there criteria to warrant a positive transfer of knowledge from the sciences of the artificial to traditional sciences of life and cognition? Can systems built with different materials, and different organizations, be considered models of natural living and cognitive systems? If yes, in what sense, under what conditions, and in what ways? Can simple abstract models be useful to investigate complex phenomena? How and to what extent?" and finally as one of the other speaker in this workshop asks: "Is there room for intrinsic normativity in synthetic systems?". The question I wish to address is slightly different. All of the above questions, apart from the last one, are epistemological or methodological. Their intent is to inquire, in one way or another, into the extent and criteria of the success of the synthetic method. It what follows I will take that success for granted, at least to some extent, and ask

1 This text was originally prepared for a workshop on the synthetic methodology held in the 2018 Tokyo meeting on Artificial Life. The present version has been expanded and modified from that presented there.

Mechane, n. 1, 2021 • Mimesis Edizioni, Milano-Udine Web: mimesisjournals.com/ojs/index.php/mechane • ISBN: 9788857581156

an ontological or metaphysical, rather than epistemological question. What does it mean – in the sense of what does it reveal about the universe – that we live in a world where the synthetic method is possible? Or, to put it otherwise, what does the success of the synthetic method reveal about the structure of the universe in which we practice it? By the success of the synthetic methodology, at this point I do not mean this or that particular important achievement, but the simple fact that it works, that essential cognitive gains can be made through building?

At first sight this may seem like a strange question and it is not clear how one should go about answering it. However, a moment reflection should be enough to realize that it is not so strange a question after all, and this realization provides us, I think, with an indirect way to address it. For the fact is that many philosophers and scientists, past and present, have argued, implicitly or explicitly, that we live in world where no essential cognitive gain can be made through building. They consider that building is and should be essentially construed as the mere application of knowledge which we already have. They consider that making or building in itself is not a source of fundamental knowledge, but can only be useful to ascertain the power of an already existing theory. That building, to put it otherwise, cannot be an investigative tool. To think otherwise they argue is a mistake. This opposite claim, that building is cognitively subordinate to preexisting knowledge suggests an indirect approach to answering our question. It is to first ask: what is it to live in *that* world? That is to say, what are the characteristics of the image of the world which argues against the relevance of building as a source of fundamental cognitive gains? For that second question may be easier to answer than our original one and its answer may provide us with a counterpoint allowing us to determine those aspects of the world which make the synthetic method possible. Before going there however a (not so) short historical detour may be useful.

Genealogy of the synthetic method

If many philosophers and scientists have argued against the importance and relevance of building and making as a source of knowledge, it should be remembered that this has not universally been the case. John Watkins reminds us in his book on Hobbes (Watkins 1965), that the early beginning of scientific method in Padua Italy when Aristotelianism was rejected, and experimentation began to be adopted, were called the analytico-synthetic method. Nor is it an accident that Galileo located his three dialogues on a new science not in a University, church or palace, not in a recognized place of knowledge, but in the Arsenal of Venice. That is to say, in a shipyard. The explicit claim was that more could be learned about the nature of materials, their resistance, time and space from studying the practice of shipbuilders than the books of philosophers and ancient treaties.[2] Furthermore,

2 For an extensive presentation of the importance of machines, 'mechanics' as they were called in the Renaissance and of making in the birth of modern science, see Rossi 1962; 2001.

many early modern philosophers like Hobbes, Locke or somewhat later Vico and still later Marx, claimed that *we can only really know what we can make*.

However, for Hobbes and Locke at least, the idea that we only truly know what we can make was inseparable from their view of the greater certainty of moral and mathematical knowledge over empirical knowledge, of the greater certainty of mathematics and political science over physics. In moral or political science, as in mathematics, they argued, we give to ourselves the premises of our arguments that is why our deduction can be absolutely certain. To the opposite, in the physical sciences, and the empirical sciences in general there is a fundamental uncertainty concerning the causes of phenomena and that uncertainty carries over to our conclusions. That is why, empiricists that they were, they thought, contrary to Descartes and Spinoza, that metaphysics and physics could not be done *more geometrico*, the same way as geometry was.[3] However, that impossibility was the sign of the inferiority and lesser certainty of empirical sciences.

Paradoxically, from our point of view at least, Hobbes and Locke thought of making as fundamentally a deductive process, rather than as an essentially empirical and synthetic activity. Making a perfect society for Hobbes was like constructing a mathematical (or geometrical) proof, the result in itself was absolutely certain. The main difference between geometry and moral disciplines was that while men are convinced by mathematical proofs, because these do not contradict their interests or desires, they resist the conclusions of moral and political science that challenge their prejudice. Yet in both cases the conclusion is just as certain. As Hobbes wrote:

> For I doubt not, but if it had been a thing contrary to any man's right of dominion, or to the interest of men who have dominion, *That the three Angles of a Triangle should be equall to the two Angles of a Square*; that doctrine should have been, if not disputed, yet by the burning of all books of Geometry, suppressed, as far as he whom it concerned was able. (Hobbes 1976 [1651], p. 166)

In other words the greater certainty of mathematics over moral and political philosophy according to Hobbes is only apparent, it has no epistemological foundation. It is an illusion that derives from social conflicts.

This conception of making or building as a deductive procedure is also found in many older and even in some contemporary views of scientific experimentation in philosophy of science. For a scientific experiment is something that is built. It is not naturally given but an artificial constructed situation that is generally (or classically) construed as an empirical set up whose goal is produce (or fail to produce) a given conclusion derived from a scientific hypothesis and initial conditions or minor accepted premises. The prepared environment, the isolation of the experimental apparatus from outside noise and influence cooperate

3 Moral and political philosophy for their part can be developed *more geometrico* as Hobbes early treatises clearly indicate.

to ensure that the experiment functions as an 'empirical deduction', so to speak, whose conclusion is as certain as possible because it is as close as possible to an analytic deduction. Within this context though building through the construction of experimental devices and situations is fundamental to the development of our knowledge of the world, building remains in a sense 'mere application'. It is not in and of itself that building brings important cognitive gains, but as a means of ascertaining what in a way we already know: the theory that guided the design of the experiment. The goal of building and experimentation is, to put it otherwise, to reduce the uncertainty of empirical knowledge of which Hobbes and Locke complained. By itself, however, it cannot teach us anything, as frequent and repeated criticism of Bacon claim.[4]

Historically, there are two factors that will help to bring about a different way of understanding building. First is a phenomenon that greatly puzzled philosophers of science (and to some extent still does), serendipity, chance discovery. The most famous example of which is the discovery of x-rays by Röntgen. While working with a device that had been built to investigate cathode rays, or as they were known Cooks rays, he realized that this scientific instrument was actually a machine that produced something entirely different. (Roberts 1989, pp. 139-142) As he did not what it was he referred to it as x-rays. Such events suggest that building can constitute an investigative procedure in its own right, independently of the theory that presided over the building. However, reducing these events to mere chance, which is construed simply as a measure of our ignorance, or to contingent accidents, rather than asking: what must be the case about the world in order for building to lead to unforeseen discoveries? Simply attributes serendipity, chance discoveries to our lack of knowledge, rather than it considers them meaningful.

The second factor is the discovery of what is generally called the modal structure of the universe. The "if – then" structure of scientific deduction and experimentation progressively brought about the realization that the universe must be or contain more than the sum of what actually is, or to put it in a slightly less paradoxical way, that world is more than what-is-in-actuality. In a sense this is implicit in the idea of time, but the general consensus has been to side step the issue by claiming that the basic constituents of the universe are eternal and do not change. However that may be, it is clear that the patterns that appear or emerge at a higher level neither have that stability nor that finality. If some of these patterns, especially in the biological sciences may seem to correspond to the 'natural' unfolding of what is, it nonetheless remains that authors as different as Stephen J. Gould (Gould 1989) and Daniel Dennett (Dennett 1995) agree

4 This sketch of the role of experiments corresponds to the hypothetico-deductive approach that was favored by both Popper and neo-(or logico)-positivism. However, I think that a somewhat different, but fundamentally similar argument regarding the role of experiments can be made concerning the Bayesian approach where experimentation ultimately boils down to upgrading prior probabilities. For a different interpretation of Bacon that is more sympathetic to the synthetic method, see Rossi 2001.

that natural selection has not and likely cannot exhaust the universal library of viable forms of organisms. In the physical sciences, novelty often seems to be the result of human interventions (constructions?) which makes it even more contingent. Do transuranium elements exist in nature? The question may seem of limited interest to most, but what about alternative current? Though the basic rules that characterize its behavior are generally viewed as "laws of nature" it is exclusively produced artificially. These and myriads of other examples raise the issue of what is the ontological status of what does not exist in actuality? The classical answer is that what does not exist actually, but could exist, is possible. That answer however, designates a problem more than it provides a solution or even a real entry to the difficulty.

The Book *of nature is written in mathematical symbols*

Galileo said (or wrote) that God wrote the book of nature in mathematical symbols. Many would agree today. They would probably drop God from the equation and extend mathematical symbols to include such things as code, data, symbolic logic, DNA or any system of writing that may be the object of a calculus. They would however retain what is essential in the metaphor of *the book* of nature. The idea that nature, the universe or what is, is written down somewhere or somehow and that there is a text which constitutes this *book*, a text that can be discovered and read. First, implicit in the claim that "God wrote *the* book of nature" is the idea that there is only one book and that it is complete. Written by God, *the* book of nature is understood to contain all that one needs to know the world. Just like with the coming of Christ revelation is complete[5] and the Bible is not an unfinished work anymore, there is nothing to add to the book of nature. Second, what is written can be read and science is equivalent to reading the book of nature. The metaphor of a book, of a code or the illusion that big data can give us unfettered access to what is stands for idea of a deterministic universe, but more importantly it stands for the illusion that knowledge exists outside of the universe, as a kind of double or blue-print, that contains the formula of all that can be. In this modern Platonism, what exists in the world where we live has less reality than the data that describes it. What is in actuality are rare instances among all that could be, possible objects to which we can have cognitive access through, for example Big data, the book in one of its modern incarnations. (McQuillan 2018)

When the universe is approached through such an image there is little or no room for construction as a major source of cognitive gain, and no place for building as a synthetic activity, because fundamentally all that we need to do is

5 However, during the Reformation some Protestants did consider that Revelation was an unfinished historical process and that was part of what drove Protestantism as a politically active enterprise. See Whitaker 1988, p. 45.

to read the book in which everything relevant is already written. Such a view is prevalent in classical computational cognitive science which construes thought as something that can be exhaustively reduced to operations over symbols (that represent or constitute it). It is also what underlies the grandiose claim of machine learning specialist Pedro Domingos who writes: "If it exists, the Master Algorithm can derive all knowledge in the world – past, present and future – from data." (Domingos 2015, p. xviii) In the context of this conception of the world and of knowledge, the role of construction is limited to making sure that we have read the book correctly. Building can never be a truly synthetic activity that brings about something new, something that we do not know, something that is not already in the book. This irrelevancy of construction is essentially due to the fact that the book, what is written is seen as more 'real', more complete than what is because it provides an answer to our previous query: what is the ontological status of all that does not exist in actuality but is merely possible, of all that is non-actual? How are such 'possible worlds' different from what strictly *is not*? The book provides a criterion to distinguish between these two categories: what is non-actual, but can be, is found in the book, and what cannot be found there, simply is not. Thus, the code, the book however it is written reveals itself to be richer than the world.

Therefore, the real question we should ask is not in which language is the book of nature written, but rather: what kind of book is it? Whether it is written, as data, DNA, in mentalese or mathematical symbols is it *the* book or is it simply an interesting short-story, or perhaps only the first volume of an unfinished trilogy or even only part of that, a few chapters? In other words, what is the place of knowledge? Is it an object in the world among others, or is it an exhaustive record of all that is or could be that is in some way external to the world?

The synthetic methodology

As long as we remain beholden to the metaphor, not of *a* book, but of *the* book of nature, no truly synthetic methodology is possible. Understanding through building requires a different conception of knowledge and cognition than as an unsubstantial and yet more real double or blue-print of what does exist and inventory of what can. Synthetic methodology, understanding by building, implies that knowledge and cognition are part of the substance and structure of the world, rather than a strange shadow that is more luminous than what it tracks. It presupposes a conception of cognition as action, or to paraphrase J. J. Gibson (Gibson 2014), an ecological theory of cognition, It also argues for an idea of knowledge and cognition as an operation that brings new elements into the world, actions, objects, patterns and relations that otherwise would not be there and could not be there. Cognition widens the domain of what exists rather than it merely discovers or reproduces "within the intentional self" or in the "theater of the mind" an unsubstantial copy what is already there. To put it otherwise, the synthetic methodology implies a different relationship to the modal structure of the universe. One

where knowledge is not the mere reading or perusing of *the book* of what could be but is an operation that brings forth what was not there before, of what may or may not be written somewhere.

Gilbert Simondon once wrote that "the artificial is induced nature" (Simondon 2016). The metaphor here is not of induction as a logical procedure, but of an 'induced current', something that is brought into existence through a particular procedure, but that is neither foreign to, nor contradictory with nature; otherwise it could not be made present. He argues that technology cannot be bent at will this way or that way to satisfy the whims of the subject or the demands for what is useful and urgent, for it brings into play, says Simondon, the true laws of 'natural reality'. The implication is that the synthetic methodology, the methodology of the artificial is profoundly realist. The proof of the pudding is in the eating, as we say in English. Robots, artificial cells and life exist, they are part of the real and that they can be made reveals something of its deepest structure. Yet this is a realism that is suffused with contingency, because what knowledge brings forth, not as a mere application, but in the very process of discovering the world could very well not have existed.

The synthetic methodology that rests on the idea that building artificial realities allows us to understand and discover the world better implies that knowledge as an activity, rather than simply the consequences of what is known, changes and transforms the world. It implies that through knowledge and cognition newness enters the world. Thus, what does the success of the synthetic methodology reveal about the structure of the universe in which we practice it? It reveals that it is an open universe, a world in becoming that has no predetermined future.

Models and Ethics

This conception of knowledge clearly has consequence on how we should construe the notion of model. Is an artificial cell a model of a real one? (Or perhaps vice versa, is a natural cell a model for an artificial one?) Can we construe the interactions of a social robot as a form of artificial sociality that is a model allowing us to understand normal sociality? There is in philosophy of science a lot, if not of confusion, at least of disagreements as to what a model is, its relationship to a theory and what we can learn from models, artificial and otherwise.[6] Nonetheless in all cases we usually conceive of a model as a kind of double. Either a simplified and idealized representation of something or, in philosophy of science, sometimes a model can be a particular concrete instance of a theory which is itself a purely mathematical object. (Suppe 1989) In that sense, any instance of a particular cellular mechanism, for example, is a model of the theory that explains its functioning because every such concrete realization is particular and reveals some minor (or perhaps not so minor) difference relative to the theory. As these two understanding

6 See for example Morrison, Morgan 1999; Steel 2008.

of model indicate a model is always seen as being, in a sense, both more and less than what it is a kind of double. To put it otherwise, unlike what is the case in the notion of theory, lack of adequacy is inherent in the concept of model. A model is always an imperfect representation or copy of what it models.

This lack of adequacy and imperfect representation are classically at the heart of epistemic cautions concerning models. I do not want to argue that such precautions are useless or should be disregarded, but it seems to me that from the point of view of the synthetic methodology, of understanding by building, it is precisely on this lack of adequacy that rests the model's ability to provide cognitive gain. To put it otherwise, it seems to me that artificial model building allows one to engage in what could be called "disciplined serendipity". That is to say, the epistemic interests of artificial models is their ability to reveal aspects of the world that were not part of what was modeled. From this point of view, the inevitable imperfection of a model relative to what it models is what allows us to see it as an original rather than a copy. Therefore the question changes: rather than "can artificial systems built of different material be effective models (understood as informative copies) of living systems?" it becomes "what can the ability to build in different material artificial models (understood as further instances) of living systems teach us about such systems?" It may be argued that this formulation avoids the essential question which is at the heart of classical epistemic worries about models which is: are such artificial systems living systems or sufficient like living systems? Actually, it does not avoid that question but lodges it elsewhere so to speak, at the heart of the claim "the ability to build". It is through building the artificial systems that is to be answered the question: are such systems living systems?

What are the consequences of this understanding of the synthetic methodology for the ethics of such systems? Luisa Damiano and I argued elsewhere (Dumouchel, Damiano 2017) that the ethical issues concerning, in that case social robots, but actually all artificial systems do not arise at the border where these systems meet society at large. For ethical questions are not about, and from the point of view of synthetic methodology cannot without contradiction be construed as simply being about applying new scientific and technological developments. Ethical issues are part and parcel of the very development and deployment of the synthetic methodology. In relation to social robots we introduced the idea of a synthetic ethics that incorporates human–robot interactions in experimental scenarios, analyzing emergent behaviors from an ethical point of view to deepen our knowledge of humans, and of the spontaneous and changing ethics (mores) of human–robot interactions. This knowledge can then be used to review and improve the practices of robotics and of robots themselves, and to inquire into the ethical (and political) opportunities and dangers of their integration into our social ecology. The focus should be on the concrete problems that social robots create, or are likely to create, as well as on those issues that can productively be addressed using social robots as research instruments and co-objects of exploration. In short, the applied anthropomorphism of social robotics can also be a method of inquiry in ethics. This means that the ethics of social robotics should not be reduced to apply

a predetermined set of rules concerning an innovative technology. Rather, these technological and scientific developments should be conceived as an occasion to enrich our moral knowledge. *Mutatis mutandis* the same applies to the use of the synthetic methodology in general. That is to say, ethics and ethical questions cannot be something that only appear "at the border" when science is "applied" because the synthetic methodology blurs from the beginning the distinction between scientific research and application.

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