# MODELING METAPHYSICS:
# THE RISE OF SIMULATION AND THE REVERSAL OF PLATONISM

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## ABSTRACT

Philosophical reflection on and around Modeling and Simulation (M&S) is often focused on the ethical and epistemological implications of empirical findings or innovative methods within the field. In this paper I highlight some of the *metaphysical* implications of developments within M&S. I argue that the rise of simulation within and across scientific disciplines is accelerating the reversal of Platonism, whose emphasis on transcendence and reliance on hierarchical, static categories has dominated western philosophy for over two millennia. The success of M&S methodologies opens up new conceptual space for articulating a metaphysics of immanence that may provide a more adequate basis for understanding and solving many of the problems facing contemporary human societies.

**Keywords:** human simulation, metaphysics, philosophy, Manuel DeLanda

## 1 INTRODUCTION

Like most normal people, computer scientists have typically had little interest in the apparently arcane arguments of philosophers about the nature of being(s) and non-being or the metaphysical conditions for any and all human experience whatsoever. Such debates have seemed wholly irrelevant to their work. Like most scholars in the humanities, philosophers have typically had little interest in the apparently arcane algorithms used by computer scientists to model and simulate the behavior of complex adaptive systems. Such tools have seemed wholly irrelevant to their work. In recent years, however, all of this has begun to change. On the one hand, a growing number of scientists in the Modeling and Simulation (M&S) community are exploring ways in which developments in their field bear on philosophical issues related to ethics, epistemology, and even ontology (Tolk, 2013; Elsenbroich & Gilbert, 2014; Gräbner, 2018). On the other hand, a growing number of philosophers are recognizing the value of computational models and social simulation for guiding reflection on and providing insight into some of these classical philosophical issues (Mascaro, 2010; Grim et al., 2016; Shults & Wildman, in press).

In a recent call for proposals for a special issue of *Open Philosophy* on "Computer Modeling in Philosophy," Patrick Grim has even suggested that computer modeling may soon come to play a role in philosophy analogous to that traditionally played by logic (https://www.degruyter.com/page/1776). Logic had a powerful generative and regulative function in the work of 19th century thinkers such as Hegel, Frege, Cantor, Meinong, and Peirce – albeit in vastly different ways, which would have ramifications for the split between analytic and continental philosophy in the 20th century. Given the analytic and synthetic capacities of computational methods in general, and the productivity of social simulation in particular, these new tools for thinking could well have a similarly transformative effect on 21st century philosophy.

My argument in this paper is structurally similar to the one Wesley Wildman and I made in another context about the impact of M&S on philosophical debates on the topic of *emergence* – another theme that has direct bearing on metaphysical questions about the nature (and types) of being(s). We claimed that the ongoing success of computer engineers in constructing virtual complex systems that can explain emergent properties makes it increasingly unlikely that strong-emergence hypotheses of the sort that rely on appeals to mystical entelechies or supernatural beings will make a comeback in philosophy. We also invited computer scientists to take some time, at least occasionally, "to chat with us philosopher types to learn more about the havoc you are wreaking in our disciplines" (Wildman & Shults, 2018, 33). In this context, I make a similar invitation to my M&S colleagues: come and chat with us philosopher types to hear how work in your field is facilitating a revolution in metaphysics! Hopefully some of my philosophy colleagues will also feel invited to come and chat with some of you engineering types in order to discover firsthand the role that computer modeling can play in fostering conceptual analysis and the creative synthesis of ideas.

The relevance of computer science to philosophical issues related to epistemology and ethics is relatively easy to grasp, but what about the material concerns of *metaphysics*? It is not immediately obvious what M&S has to do with what Aristotle called "first philosophy," which considers "being *qua* being – both what it is and the attributes which belong to it *qua* being" (*Metaphysics* 1026a30). In this article, however, I will argue that developments in computer modeling – especially in social and human simulation – have the potential to contribute to what may be the most significant sea change in western philosophy since the foundational work of Aristotle's teacher Plato in the 4th century BCE. As one might infer from my subtitle, my claim is that "the rise of simulation" is accelerating "the reversal of Platonism." A full defense of such a claim would require, among other things, tracing the historical precursors of this reversal of the Platonic obsession with transcendent essences (which was already initiated in the work of some of the ancient Stoics, promoted by early modern philosophers such as Spinoza and Hume, and further intensified by late modern philosophers such as Nietzsche and Deleuze), as well as describing the pragmatic ramifications of this shift on a wide variety of scientific disciplines that neighbor computer science and engineering.

In order to make my task more manageable, in the two major sections of this paper I focus primarily on the work of Manuel DeLanda, a philosopher and computer programmer (as well as an artist and architect), who has done more than any other scholar to illuminate the potential of computer modeling and simulation to help resolve longstanding debates about whether philosophers need to postulate transcendent essences or types in order to makes sense of the metaphysical conditions for the existence of actual entities or events. The short answer is no: we *can* account for the morphogenesis of all existing things by describing the immanent intensive processes that generate actual forms, showing how that individuation is actualized by resources immanent to the world of matter and energy, and explaining the mechanisms of immanence by which virtual multiplicities are produced out of the actual. I will only have space to briefly outline the first two of these metaphysical accounting tasks and hint at the third. The main point, however, which I will spell out in sections 3 and 4 below, is that this philosophical breakthrough has been facilitated by developments in the mathematics and methodologies behind M&S. First, however, I need to back up and explain precisely what is meant here by "Platonism" and convey the philosophical (and scientific) significance of attempts to bring about its reversal.

## 2 SUBSTANCE, STASIS, AND SAMENESS

The philosophical sub-discipline of "metaphysics" gets its name from the (posthumously titled) book by Aristotle cited above. However, Aristotle's analysis of (and proposals for) the study of "being" or "that which is" was explicitly framed within the context of a long series of debates that had recently culminated in the integrative efforts of his teacher Plato. In the *Sophist*, Plato had portrayed a dialogue between Theaetetus, a young participant in Socrates's circle of philosophical friends, and a Visitor who engages him in a dialectical discussion about types of being. What does one mean to signify when one says "being?" In the course of the dialogue, the Visitor leads Theaetetus to affirm the appropriateness of five generic categories, that is, five ways of signifying things that are: "being," "rest," and "motion," "the same" and "the different" (*Sophist* 254d-259d).

For Plato, and indeed for the vast majority of western philosophers over the last two millennia, the categories of *substance*, *stasis*, and *sameness* have been more strongly emphasized and valued than the categories of relation, motion, and difference. *Substance* (being or essence) comes first in the list because Plato's metaphysical theory (outlined in more detail in other places, such as the *Republic* and *Timaeus*) seems to presuppose that everything that "is" has an essence, a transcendent Form (or Idea) in which it participates. The fact that things are *related* to other things is secondary and is relevant to their being only indirectly (in the sense that the essence of one thing is – or is not – the same as the essence of another thing). For Aristotle too "the relative" is "least of all things a real thing or substance" (*Metaphysics* 1088$^{a}$22). As the Neo-Platonist Plotinus would put it some centuries later, the term "Relation" is "remote from Being" (*Enneads* 6.2.16).

When it comes to the dyads *stasis/kinesis* and *sameness/difference*, Plato clearly privileges the first member of each pair over the second. Both stasis (rest) and kinesis (motion) are generic categories – that is, can be used to signify the being of things – but static being is in some sense more valuable and even more "real" than being-in-motion (or becoming). In the case of the last dyad too, the sameness of a thing (its identity) is typically thought of as more important than its difference (alterity) from other things, although the latter is in some sense constitutive of its being. This becomes more obvious when we think about Plato's vision of the Forms, which are eternally static and identical, in contrast to the material things that populate the world we perceive, which are susceptible to decay and alteration, because they merely "participate" in the reality of the Forms. Plato's own view is more complex than this, and he is not always consistent across his writings, but this all too brief synopsis does capture the most common interpretation of his metaphysics, which dominated western philosophy until the early modern period.

Even philosophers who preferred Aristotle's more extensive (and more science-friendly) list of genera in his *Categories*, have usually still bought into the basic Platonic assumptions about the metaphysical priority of "being," "rest," and "the same." As I noted above, Aristotle emphasized that the relativity of a thing is not as real as its essence or substance – the latter term appearing, as with Plato, at the top of his list of categories for signifying being. Although Aristotle did indeed stress the value of particular, material things more than Plato he still postulated an "Unmoved Mover" as the metaphysical ground and telos of all other realities. This most valuable reality is "thought thinking itself" – unchanging immaterial substance reflecting its own static identity. Even Aristotle's epistemology and ethics were shaped by these categories: e.g., like is known from like, and true friendship is based on similarity. For most of its history, western philosophy has labored under the constraints of a metaphysics of substance, stasis, and sameness.

All of this may sound quite strange to computer modelers whose day jobs involve the simulation of *dynamic relations* in complex systems using *differential* equations in order to discover and analyze the effects that altering parameters can have on the *processes* that shape the *relations* among *variables*. Indeed, most M&S professionals will be able to live their entire lives without worrying about the long shadow cast by Platonism and go about their work in the scientific sunshine happily (and productively) using relational, dynamic, and differentiating categories. This is the case for the vast majority of scientists in other disciplines as well. It is often surprising to non-humanities scholars, and especially non-philosophers, that people still spend so much energy arguing about the role that categories can play in human thought. It is important to note that essentialist categorizing can have a significant psychological and political impact on human life by structuring the way we think and engage in social discourse and practice, which in itself is a sufficient reason to keep on arguing about it. My main point here, however, is that the weakening of the influence of Platonic categories in the work of practicing scientists, and increasingly in the thought worlds of everyday people, has had – and continues to have – an enormously profound impact on those of us whose day jobs involve philosophizing about metaphysics.

In fact, for several centuries philosophers have been participating in (or resisting) what we might call a turn to relationality, celerity, and alterity – a shift in the valuation of categories that had already begun in earnest in the work of early modern philosophers such as Locke, Hume and Kant, but was intensified in the work of late modern philosophers such as Kierkegaard, Whitehead, and Levinas. Even these latter thinkers, however, still relied on the category of transcendence to account for the metaphysical ground of being (and becoming). Many philosophers today still assume that the only way to account for the genesis (and duration) of actual entities or events is to posit a distinction between the field of immanence in which they exist and a transcendent dimension that somehow serves as the ground of their existence (and subsistence). The metaphysical models that are based on this assumption may vary significantly, but insofar as they appeal to some transcendent reality to make sense of the existence of being(s) they are "Platonic" in the broad sense I am using the term here.

The "reversal of Platonism," then, would mean the reconstruction of metaphysics in purely immanent terms without any appeal to transcendence. This would rather obviously have a profoundly erosive effect on theological edifices erected within the Abrahamic monotheist traditions whose coherence and cohesion rely on belief in a transcendent personal creator upon whom the existence of all creaturely beings depends. I have discussed the fate of theism in light of these philosophical (and other scientific) shifts elsewhere (Shults, 2014, 2015, 2018a, 2018b), but my focus here is on the fate of the metaphysics of transcendence in general in light of developments in the field of M&S in particular. The latter is a relatively new field and stands on the shoulders of a gigantic number of other scientific disciplines. Although it did not initiate the process, the emergence of computational modeling and simulation methodologies has had an powerful accelerating effect on the dissolution of Plato's hierarchical transcendence-reinforcing categories and, as we will see in section 4, opened up new paths for articulating a metaphysics of immanence with an absolutely flat ontology.

## 3 THE RISE OF SIMULATION

Although M&S techniques have been a staple in the physical sciences for over half a century, their use in the social sciences only began to pick up in the 1990s, where they have grown in popularity ever since (Gilbert & Conte, 1995; Alvarez, 2016). More recently, these tools for thinking have been making their way into the humanities (Dignum & Dignum, 2014; Wildman, Fishwick, & Shults, 2017). This trend is illustrated in several chapters of a forthcoming book on *Human Simulation* (Diallo, Wildman, Shults, & Tolk, in press). In the remainder of this article I explore ways in which a classical issue in philosophy (a discipline with traditionally deep roots in the humanities) – namely, the tension between transcendence and immanence in metaphysics – might be illuminated by developments in M&S.

No scholar has explored this topic as deeply as Manuel DeLanda, whose books *Philosophy and Simulation: The Emergence of Synthetic Reason* (2011) and *Intensive Science and Virtual Philosophy* (2013) will guide my brief programmatic comments in this context. Prior to these publications DeLanda was already well-known for his work on the relevance of cybernetics, intelligent machines, and nonlinear dynamics for understanding and explaining emergent phenomena in human history such as warfare (DeLanda, 1997; DeLanda, 1991). His more recent work has had an impact on the field of artificial intelligence in general (e.g., van der Zant, Kouw, & Schomaker, 2013), and is now beginning to shape conversations among scholars interested in multi-agent artificial intelligence and other forms of social simulation. My goal in sections 3 and 4 of this paper is to introduce both M&S professionals and philosophers to the creative way in which DeLanda teases out the implications of the scientific efforts of the former for the metaphysical reflections of the latter.

In the Introduction I indicated that my argument here will be structurally similar to an earlier argument developed with Wesley Wildman related to the impact of M&S on philosophical debates about the concept of emergence. There is also a material connection between these arguments because ever since Plato the most common philosophical ways of explaining the *emergence* or formation of new material beings have involved appeals to static transcendental *essences* or types (genera and species). Today, after centuries of scientific analysis of actually emergent phenomena, most philosophers would accept the idea that interactions among a population of entities can lead to the emergence of new complex wholes or assemblages with new properties, capacities, and tendencies irreducible to their parts (although they might want to continue arguing about whether this involves "weak" or "strong" emergence; see Wildman & Shults, 2018). But what does this have to do with M&S? As DeLanda explains:

> Simulations are partly responsible for the restoration of the legitimacy of the concept of emergence because they can stage interactions between virtual entities from which properties, tendencies, and capacities actually emerge. Since this emergence is reproducible in many computers it can be probed and studied by different scientists as if it were a laboratory phenomenon. In other words, simulations can play the role of laboratory experiments in the study of emergence complementing the role of mathematics in deciphering the structure of possibility spaces. And philosophy can be the mechanism through which these insights can be synthesized into an emergent materialist world view that finally does justice to the creative powers of matter and energy (2011, p. 6).

Let's briefly unpack these claims. First, why was the legitimacy of the concept of emergence under scrutiny in the first place? The short answer is that philosophers who promoted the term in the late 19th and early 20th centuries loaded it with baggage about transcendent essences (Life, Soul, Deity) they inherited from Plato and the vast majority of the western tradition, baggage that most practicing scientists have increasingly found unnecessary, embarrassing, or even detrimental to their work.

Second, how, precisely, did computer simulations help restore the legitimacy of the concept? As DeLanda notes, successful simulations are able to produce the actual emergence of new assemblages from the staged interaction of virtual entities, i.e., from the "parts" of a now emergent "whole." To use the terminology of Joshua Epstein, simulations can enable a modeler to "grow" the macro-level phenomena in which she is interested from behaviors and interactions at the micro-level; this is the sense in which such methodologies foster a "generative" social science (Epstein, 2006, 2014). By offering a new way of computationally reproducing and "experimenting" with the conditions under which – and mechanisms by which – emergence occurs, simulations provide "laboratories" for testing claims about such phenomena. Insofar as M&S provides scientific techniques for actually generating wholes with emergent properties, tendencies, and capacities that are irreducible to their parts, it not only strengthens the case for "weak emergence" but also weakens the case for what we might call "strong essentialism" (which relies on the postulation of empirically intractable transcendent forces), thereby lending credibility to philosophies of immanence.

The citation above also highlights the way in which computer simulation can complement the role of mathematics in making sense of the structure of possibility spaces. This will take a bit more space to unpack. For DeLanda, the "mechanism-independent" structure of possibility spaces is a clue to solving the philosophical problem of figuring out how to construct an ontology (and metaphysics) with purely immanent mechanisms. When approaching the issue of "possibility" spaces, it is important to distinguish between emergent properties, on the one hand, and emergent tendencies and capacities, on the other. The former, as DeLanda points out, "are always actual – actual characteristics of the state of a whole at any given point in time – while the latter need not be" (2011, p. 16). Liquid water, for example, has *properties* that the individual molecules of which it is composed do not have (cohesion, surface tension, specific heat). As long as it is water, it has these properties. However, liquid water also has *tendencies* (e.g., to solidify at a critical point of temperature) that may not be manifested (if the temperature remains high), as well as *capacities* (e.g., to act as a solvent) that may not be exercised (if it does not encounter a soluble substance). This suggests that tendencies and capacities have a different ontological status than properties.

On the one hand, explanations of emergence involve the identification of mechanisms related to the manifestation of tendencies and the exercise of capacities. On the other hand, DeLanda insists we should not miss the importance of the *mechanism-independent* component of an explanation. It is important to clarify "the status of tendencies and capacities when they are not actually manifested or exercised. We could, of course, characterize that status as that of a possibility but that would be too vague: an unmanifested tendency and an unexercised capacity are not just possible but define a concrete *space of possibilities with a definite structure*" (2011, p. 17). The tendencies of a system can be studied by the mathematical analysis of state spaces, but capacities involve a much larger set of possibilities "because entities can exercise their capacities in interaction with a potentially innumerable variety of other entities." The nature of the singularities that structure possibility spaces associated with capacities are not as well understood as those of tendencies. However, "computers can supply the means to explore these other possibility spaces in a rigorous way because the interactions in which capacities are exercised can be staged in a simulation and varied in multiple ways until the singular features of the possibility space are made visible" (2011, p. 21).

The ability of mathematics to model the behavior of material processes in the "real world" has occasionally been seen as something of a miracle, leading some mathematicians and philosophers to interpret this as evidence for a divine creator or, at least, for some transcendent realm as the ground of this capacity. Some might be tempted to interpret the (relative) success of computer modeling and simulation of complex adaptive systems as similarly miraculous. However, as DeLanda argues, we can make sense of this success by postulating an overlap between the space of possible solutions in a mathematical or computational model and the space of possible solutions in a material process. Insofar as "the singularities that structure both spaces are independent of both causal mechanisms in a process and formal relations in an equation," any overlap would only need to capture behaviors within "a certain range of values of their control parameters." Such a postulation would require an ontological commitment "to the autonomous existence of topological singularities, or more generally, to the structure of possibility spaces" (2011, p. 19). And this brings us to the last sentence of the indented citation on the previous page, which makes a claim about the potential role of philosophical reflection vis-à-vis computer simulation.

An ontological commitment to the reality and causality of "singularities," DeLanda suggests, opens up a properly philosophical question. "Do they exist, for example as *transcendent* entities in a world beyond that of matter and energy? Or are they *immanent* to the material world?" If all matter and energy in the universe disappeared, would singularities continue to exist (implying their transcendence) or would they also disappear (implying their immanence)? DeLanda points out that the way in which singularities are studied suggests that at least two conditions for their immanence can be met: "If singularities are immanent they must be both irreducible to any particular material process while at the same time requiring that some process or another actually exists." When topologists study models with different numbers of dimensions or degrees of freedom, they focus not on specific mechanisms or material gradients but on the kinds of singularities that exist in all models of that sort (e.g., models with two degrees of freedom). This implies that "topological facts about possibility spaces can be discovered without reference to the nature of the degrees of freedom, only to their number, and without reference to the nature of the gradient (thermal, gravitational, mechanical, chemical) only to its existence. But the fact that the *existence* of a gradient, any gradient, is necessary confirms the *immanent* status of singularities. Singularities are, therefore, perfectly acceptable entities in a materialist philosophy" (2011, p. 20, last emphasis added).

Throughout the middle chapters of *Philosophy and Simulation*, DeLanda illustrates the power of computer simulation methodologies (e.g., cellular automata, artificial chemistries, genetic algorithms, neural nets, and multiagent simulations) to help explain key mechanisms and processes in the emergence of complex systems (e.g., ancient organisms, insect intelligence, mammalian memory, primate strategies, and stone age economics). Each of these is "discussed in terms of the mechanisms of emergence involved, drawing ideas and insights from the relevant fields of science, as well as in terms of the structure of their possibility spaces, using the results of both mathematical analysis and the outcomes of computer simulations" (2011, p. 6). All of that will be relatively familiar to M&S scholars. In the next section, I describe some of the insights that DeLanda takes from these scientific developments as he begins to engage in what may for some be a less familiar philosophical task: articulating a flat ontology within the context of a transcendence-free, naturalistic metaphysics in which morphogenesis is explained purely with mechanisms of immanence.

## 4 THE REVERSAL OF PLATONISM

In *Philosophy and Simulation*, DeLanda focused primarily on the techniques of computer modeling and secondarily on the implications for philosophy (especially epistemology and ontology). The latter are in the forefront of his more recent book on *Intensive Science and Virtual Philosophy*, which he described as an attempt "to present the work of philosopher Gilles Deleuze to an audience of analytic philosophers of science, and of scientists interested in philosophical questions" (2013, p. 3). Deleuze is sometimes all too quickly lumped into the same category as "postmodernists" such as Derrida, Marion, and Baudrillard who are not taken very seriously (to put it mildly) by either analytic philosophers or working scientists. This is unfortunate because, as DeLanda demonstrates, Deleuze "has nothing to do with that tradition," and his work is deeply influenced by his engagement with the history of mathematics and developments in modern science. In fact, Deleuze is probably the first scholar to have recognized the radical philosophical consequences of the efforts of mathematicians such as Lagrange, Abel, and Galois whose work transformed the problem-solution relation embedded within traditional differential calculus and led to what we today call group theory – a transformation that was, in Deleuze's words, "a more considerable revolution than the Copernican" (Deleuze, 1995, p. 180).

There is no space in this context even to mention all of the philosophical implications of such mathematical and computational developments that DeLanda draws out in his work, and so I limit myself here to the same strategy followed in the previous section. I begin with a lengthy citation, and then unpack some of its key ideas, showing how they can contribute to the reversal of Platonism.

> From a Deleuzian point of view, it is this *universality* (or mechanism-independence) of multiplicities which is highly significant. Unlike essences which are always abstract and general entities, multiplicities are *concrete universals*. That is, concrete sets of attractors (realized as tendencies in physical processes) linked together by bifurcations (realized as abrupt transitions in the tendencies of physical processes). Unlike the generality of essences, and the resemblance with which this generality endows instantiations of an essence, the universality of a multiplicity is typically *divergent*… unlike essences, which as abstract general entities coexist side by side sharply distinguished from one another, concrete universals must be thought as *meshed together into a continuum*… a continuous immanent space very different from a reservoir of eternal archetypes… Unlike a transcendent heaven which exists as a *separate dimension* from reality, Deleuze asks us to imagine a continuum of multiplicities which *differenciates itself* into our familiar three-dimensional space as well as its spatially structured contents" (DeLanda, 2013, p. 21).

This citation begins by referring to the mechanism-independence of the structures of possibility spaces, an idea already discussed above in section 3. However, it also introduces several new ideas, the most important of which (for our purposes) is the "continuum of multiplicities." As we will see below, DeLanda follows

Deleuze in referring to this continuous immanent space as *the virtual*, a novel ontological category meant to replace the transcendent realm of Forms (or Ideas, or Archetypes). This concept of "virtual" reality has nothing to do with digitally simulated environments of the sort popular in some video games; it refers to a *real virtuality* that is an objective ontological component of the world. But first let's unpack the idea of *multiplicities,* which are said to populate this real continuous immanent space(time).

Deleuze introduced the concept of *multiplicity* to replace the philosophical concept of *essence*. For Plato, a thing's essence is supposed to be that which explains its identity, those key characteristics without which it would not be what it is. The fact that some entities resemble one another is a result of their participating in a common essence. Aristotle's metaphysics was less obviously essentialist but it was still typological; that is, he still explained the resemblance of members of a species (for example) as a result of their belonging to the same type of being, the same "natural kind" of thing. For Deleuze, however, "a species (or any other natural kind) is not defined by its essential traits but rather by the *morphogenetic process* that gave rise to it." Species are not timeless categories but historically constituted entities, and the fact that they resemble one another is explained by the common processes of natural selection that produced their shared phylogenetic inheritance. "In short, while an essentialist account of species is basically static, a morphogenetic account is inherently dynamic. And while an essentialist account may rely on factors that transcend the realm of matter and energy (eternal archetypes, for instance), a morphogenetic account gets rid of all *transcendent* factors using exclusively form-generating resources which are *immanent* to the material world" (DeLanda, 2013, pp. 9-10).

But what does this have to do with multiplicities? DeLanda defines a multiplicity as "*a nested set of vector fields related to each other by symmetry-breaking bifurcations, together with the distributions of attractors which define each of its embedded levels*" (2013, p. 30; emphasis in original). It is important to note how this is connected to the idea of the mechanism-independent structure of possibility spaces discussed above. Insofar as they are defined in terms of differential relations and singularities, multiplicities can be understood as concrete sets of attractors that are linked through cascades of symmetry-breaking bifurcations, which can be actualized as tendencies and transitions in material processes. However, this definition "separates out the part of the model which carries information about the actual world (trajectories as series of possible states) from that part which is, in principle, *never actualized*" (p. 30). The mechanism-independent structure of multiplicities allows for divergent actualizations (e.g., topological spaces with a particular number of degrees of freedom may be actualized through different gradients), actualizations that bear no resemblance to the multiplicities (unlike essences, which bear an image-copy relation to their instantiations). But there are aspects of a multiplicity that are never actualized in principle because of their mechanism-independent nature, and a host of tendencies and capacities that are never actualized because they are not manifested or exercised by the actual assemblages that emerge as a result of the intensive processes and mechanisms through which they are unfolded.

Essences are eternally identical and static substances, while multiplicities are relational, dynamic, and differentiated. Plato describes the former as transcendent forms in relation to which matter serves as a passive receptacle. Deleuze describes the latter as immanent to material processes, as differential manifolds with an intimate relation to the morphogenesis of actually emergent entities. But replacing the role played by essences in metaphysics with multiplicities requires more than a description of their formal differences; it also requires an alternative account of morphogenetic processes. DeLanda provides this account in great detail in *Intensive Science and Virtual Philosophy*, reviewing the relevant mathematical and scientific developments that informed Deleuze's view of the world, outlining a theory of virtual space and virtual time, and explaining how the idea of general laws of physics can be replaced by universal multiplicities while maintaining a robust commitment to philosophical realism. He also articulates the role of "the intensive" in relating "the actual" and "the virtual" (the three ontological "dimensions" of Deleuze's world). Just as "virtual multiplicities are meant to replace eternal essences, the intensive individuations that embody them, as well as the individuals that are their final product, are meant to replace general classes, a natural replacement given that general classes are often defined in terms of essences" (DeLanda, 2013, p. 61).

In this context, however, I want to stay focused on the unique ontological status that Deleuze (and DeLanda) grant to multiplicities (their *real* virtuality), and the role they play in the articulation of a metaphysics of pure immanence. Multiplicities are concrete universals that are part of "a real dimension of the world, a nonmetric continuous space which progressively specifies itself giving rise to our familiar metric spaces as well as the discontinuous spatial structures that inhabit it" (DeLanda, 2013, 26). The concept of a singularity (borrowed from mathematical discussions of state space) is particularly important here. As indicated above, singularities can undergo transitions or bifurcations at particular thresholds of intensity when control parameters display critical values. For example, a state space structured by one point attractor may "bifurcate into another with two such attractors, or a point attractor may bifurcate into a periodic one, losing some of its original symmetry… this symmetry-breaking cascade of bifurcations can, in turn, be related to actual recurring sequences in physical processes [e.g., steady-state, cyclic, and turbulent flow]" (DeLanda, 2013, 19). When such cascades of bifurcations are actualized within a physical system, however, this actualization does not resemble the mathematical cascade. The former involves specific mechanisms, but the latter is mechanism-independent.

But both are *real*. For Deleuze, "the virtual is opposed to not to the real but to the actual. *The virtual is fully real in so far as it is virtual*… the reality of the virtual consists of the differential elements and relations along with the singular points which correspond to them. The reality of the virtual is structural. We must avoid giving the elements and relations which form a structure an actuality which they do not have, and withdrawing from them a reality which they have" (Deleuze, 1995, pp. 208–209). The virtual does not "transcend" the actual, nor does the latter "resemble" the former. The multiplicities that populate the virtual are differentiated through processes of intensification into what we experience as a spatio-temporal field. Intensive processes and mechanisms are material and energetic, while the mechanism-independent structures of multiplicities are not, "but even the latter remain *immanent* to the world of matter and energy." (DeLanda, 2013, 5). The ontological visions inspired by Plato and Aristotle, which are based on general types and particular instances, are "*hierarchical*, each level representing a different ontological category (organism, species, genera)," but "an approach in terms of interacting parts and emergent wholes leads to a *flat ontology*, one made exclusively of unique, singular individuals, differing in spatio-temporal scale but not in ontological status" (DeLanda, 2013, 58).

Philosophers define the terms "metaphysics" and "ontology" in different ways, but here I have been implicitly thinking of the latter as a philosopher's list of existential inventory items (and sorts of existing things) and of the former as the way in which she explains the conditions for existence itself (if she does). For the most part, we have been exploring DeLanda's exposition of Deleuze's ontology, but he also tackles his metaphysics (in the sense of the term just mentioned). It involves not only the actualization of material entities and intensive processes, but also an account of the production of the virtual continuum itself which is immanent to both the actual and the intensive. Throughout his work, Deleuze articulated a metaphysics (and ontology) of pure immanence utilizing a diverse and divergent vocabulary referring, for example, to "machinic phylum," "the body without organs," "the aleatory or paradoxical point," "lines of flight," "desiring machines," and "the quasi-causal operator" (Deleuze & Guattari, 1983, 1996, 2004). It is hardly surprising that this is sometimes all too quickly dismissed as "postmodern" nonsense.

In my view, DeLanda has done philosophers (and scientists) a great favor by reconstructing Deleuze's view of the world using more straightforward and tractable terminology. Deleuze's philosophical engagement with the mathematical revolutions that made computer modeling and simulation possible produced a way of accounting for the becoming of beings without any appeals to transcendent realities or realms. He outlined one way in which Nietzsche's call for the overturning or "reversing" Platonism could be fulfilled.

As DeLanda points out, Deleuze was the first thinker in history to articulate mechanisms of immanence that could do the job. All of this may be unfamiliar to us, but “he must at least be given credit for working out in detail (however speculatively) the requirements for the elimination of an immutable world of transcendent archetypes” (DeLanda, 2013, 88).

## 5 CONCLUSION

I have argued that the rise of computer modeling and simulation techniques and practices across scientific disciplines has contributed to a philosophical reversal of Platonism. The latter privileges the abstract categories of substance, stasis, and sameness, while the former demonstrate the concrete explanatory power of relational, dynamic, and differentiating categories. Most of the western philosophical tradition has followed Plato in attempting to make sense of being(s) by appealing to a transcendent ground or ultimate reality. The development and relatively successful deployment of M&S methodologies have provided conceptual resources for scholars who want to renew and extend the efforts of a long line of philosophers (albeit a “minority report” in the tradition) who have tried to invert Platonism, and argue that the becoming of beings can be accounted for by mechanisms of pure immanence.

But does this have any practical relevance in the “real world?” Will this revolutionary metaphysical reversal of Platonism (if it continues to unfold) affect the way we think and live together as human beings? As DeLanda has argued in other contexts, the philosophical replacement of essences with multiplicities also enables a completely new way of understanding and explaining the emergent dynamics of social assemblages (2006, 2016). Some of our international research team’s computational models have explicitly attempted to simulate major shifts in the civilizational form of human societies (Shults & Wildman, 2018; Shults, Wildman, et al., 2018) or to discover the conditions under which – and the mechanisms by which – interactions between human groups can engender conflict or promote coexistence (Gore, Lemos, et al., 2018; Shults, Gore, et al., 2018).

We humans are just beginning to utilize multi-agent artificial intelligence models and other simulation technologies to figure out how to adapt to our contemporary environment with all of its social and ecological challenges. DeLanda suggests that “[p]erhaps one day virtual environments will become the tools we need to map attractors and bifurcations, so that we too can track the machinic phylum in search of a better destiny for humanity” (2005, 100). Taking advantage of these tools in order to *actualize* desirable human futures will not be easy; it will require a great deal of epistemic humility and ethical dialogue among a wide variety of stakeholders. Computer engineers and philosophers can help by articulating and exploring the *virtual* structures of the possibility space of human assemblages.

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