Interdisciplinary Description of Complex Systems 19(4), 457-469, 2021

ON PAUL CILLIERS' APPROACH TO COMPLEXITY: POST-STRUCTURALISM VERSUS MODEL EXCLUSIVITY

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DOI: 10.7906/indecs.19.4.1
Regular article

Received: 7 October 2021.
Accepted: 8 December 2021.

ABSTRACT

Paul Cilliers has developed a novel post-structural approach to complexity that has influenced several writers contributing to the current complexity literature. Concomitantly however, Cilliers advocates for modelling complex systems using connectionist neural networks (rather than analytic, rule-based models). In this article, I argue that it is dilemmic to simultaneously hold these two positions. Cilliers' post-structural interpretation of complexity states that models of complex systems are always contextual and provisional; there is no exclusive model of complex systems. This sentiment however appears at odds with Cilliers' promotion of connectionist neural networks as the best way to model complex systems. The lesson is that those who currently follow Cilliers' post-structural approach to complexity cannot also develop a preferred model of complex systems, and those who currently advocate for some preferred model of complex systems cannot adopt the post-structural approach to complexity without giving up the purported objectivity and/or superiority of their preferred model.

KEY WORDS

Paul Cilliers, Jacques Derrida, complexity theory, post-structuralism, connectionism, neural networks

CLASSIFICATION

JEL: C51

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INTRODUCTION

It is generally recognised that one cannot model a complex system[1] without losing certain features of that system. Those who adopt a Derridean post-structural approach to complexity are particularly concerned with this loss – this *excess* – of meaning and therefore knowledge [1]. Meaning in and knowledge of complex systems cannot be reduced to some simple algorithm or set of rules; complex systems are informationally incompressible [2; pp.9-10, 3, 4]. In other words, complex systems cannot be reduced to simple models (otherwise they were not complex to begin with). Pockets of stability "make it possible to provisionally model a system", but "any model is contingent upon the context under which it is established" [3; p.9, 5].

It should follow from this line of thinking that post-structural complexity theorists do not attempt to develop a *specific* (i.e. non-provisional, non-contextual) model of complex systems. One must either argue for model provisionality, contingency, contextuality etc and forgo model exclusivity *or* advocate for some specific model and forgo model provisionality, contingency, contextuality etc. However, we find this ostensibly dilemmic approach in the work of Paul Cilliers who originated the post-structural approach to complexity. He argues both for post-structuralist provisionality, contingency, contextuality etc *and* that connectionist neural networks are the best way to model complex systems. Cilliers considers connectionist models superior to rival models of complex systems, and this is in tension with post-structural motifs of provisionality, contingency and the like, or so I will argue.

This dilemmic aspect of Cilliers' work has not been highlighted and thoroughly critiqued up until now, and this article should therefore make a novel contribution to the complexity literature. It should be of particular interest to those contemporary writers – e.g. Human [6], Hurst [7], Woermann [8] and Preiser [9] – who draw inspiration from Cilliers in continuing to develop the post-structural approach to complexity. It should also be of potential interest to those non-post-structural complexity theorists who currently advocate for some specific model of complex systems but may be considering adopting the post-structural interpretation.

The structure of this article is as follows. In section 1, I discuss how Derrida's semantics influences Cilliers' post-structural approach of complexity, specifically his modelling of complex systems. In section 2, I outline Cilliers' conclusion that connectionist neural networks better model complex systems than what he calls analytic or rule-based models. In section 3, I highlight the dilemma that follows from concurrently holding the views discussed in the previous two sections; I also respond to three potential counter-arguments. Lastly, I conclude by outlining what implications my argument has for those currently engaged in the debate over the modelling of complex systems. This conclusion is twofold:

1. Post-structural complexity theorists cannot propose that complex systems should be modelled some specific way rather than some other way.
2. Those who advocate for some specific model of complex systems – i.e. most scientists working on complex systems [10] – cannot adopt the post-structural interpretation of complexity without giving up the purported objectivity and/or superiority of their preferred model.

DERRIDA'S SEMANTICS AND CONNECTIONIST MODELLING

Cilliers notices a synonymy between Derridean post-structural semantics and connectionist neural network models. Both emphasise processes and relations; both are dynamic and qualitative. Conversely, what Cilliers calls the analytic or rule-based approach to modelling complex systems is static, reductionist, algorithmic and quantitative [2; Ch.1, 8; Ch.1]. Advocates of the analytic approach include Descartes, Newton, Chomsky, Fodor, Searle and

Habermas [2, 11]. For Cilliers, analytic approaches – reliant on strict measurement and deterministic rule-based methods – cannot model the subtle relational nature of truly complex systems such as language or the brain in the way that neural networks can.

Rule-based models are strictly formal; they conform to a precise logic and consist of sets of symbols standing in logical relations [2; Ch.1]. These symbols stand for only the 'important' parts of the system being represented, says Cilliers, resulting in invariable loss of fidelity. The behaviour of a complex system is simplified or reduced to a set of rules that attempt to describe the system. Rule-based models also require a central controller – the "meta-rules of the system" – that decides which rules should become active in the system. Importantly, "[i]f the central control fails, the whole system fails" [2; p.15].

Conversely, connectionist neural networks are modelled on the brain which consists of neurons and synapses in rich, informational interrelations. Neural networks contain multiple densely interconnected processing *nodes* (*viz.* neurons). Each node is influenced by and influences multiple other nodes. Nodes usually form three layers: the *input layer* that receives data to be processed by the network; the *output layer* that presents the output of the network's computations; and one or more *hidden layers* that form associations between the input layer and the output layer (and do not have any link to the outside of the network). Information flows from the input layer through the hidden layer/s to the output layer. According to Buckner and Garson,

> [i]f a neural net were to model the whole human nervous system, the input units would be analogous to the sensory neurons, the output units to the motor neurons, and the hidden units to all other neurons [12].

Each node (whether in the input, hidden or output layer) has a certain *activation value* determined by the information it receives. Above a certain threshold value, it will 'fire' and send information (determined by its input) to the next node; below the threshold value, it will remain dormant. The links between nodes have a certain numerical value or *weight* that represents the strength of that link. The sum of the inputs determines the output of the node which in turn influences the activation value of the next node and so on. All the nodes in the network are processing in parallel, and the values of the weights rather than features of the nodes determine the characteristics of the network.

When *training* neural networks, all the weights and thresholds are set to random values. Training examples are fed to the input layer and propagate through the network giving some random output. The weights and thresholds are then continuously adjusted until certain kinds of inputs reliably generate certain kinds of desired outputs. After some time, the network should be able to *generalize* these input/output computations to examples not in the original training set. Thus, concludes Cilliers,

> a network provided with enough examples of the problem it has to solve will generate the values of the weights by itself... It 'evolves' in the direction of a solution... The value of any specific weight has no significance; it is the patterns of weight values in the whole system that bear information. Since these patterns are complex, and are generated by the network itself... there is no abstract procedure available to describe the process used by the network to solve the problem. There are only complex patterns of relationships [2; p.28][2].

Let us now briefly survey Saussure's structural semantics (section 1.1), then look at Derrida's transformation of Saussure's structural semantics into a post-structural semantics (section 1.2). This exposition is necessary to understand which aspects of post-structuralism Cilliers considers informative to complexity studies. Before turning to Cilliers' argument that connectionist models are superior to rule-based models of complex systems, we also discuss three core concepts Cilliers adopts from Derrida to inform his post-structural understanding of complex systems; these are openness, trace and *différance* (section 1.3).

SAUSSURE'S STRUCTURAL SEMANTICS

For Saussure [13] the meaning of a linguistic sign (composed of signifier and signified) is determined by how it *differs* from all the other signs in a linguistic system. We can think of a sign as a semantic node in a relational network. The sign does not determine the relations however; instead, the sign is the result of – it 'emerges' from – the relations. Further, the linguistic system changes as a result of its contingent and contextual use by a community of speakers and not by the decree of a central dictator or telos.

Saussure's influence has spread through the humanities [14]. Barthes [15] notably reinvented Saussurean signs as interwoven narratives or 'myths' that constitute the saturated cultural milieu surrounding us moment-to-moment. Saussure's linguistics, in its original form, has however fallen out of favour since the mid-20th century. The post-structuralist tradition in philosophy, of which Derrida and Cilliers are part, has – as the name suggests – largely superseded Saussure's structuralism[3].

For Cilliers, Saussurean models consisting of discrete signs are 'somewhat 'rigid' and

> Derrida's transformation of the system by means of a sophisticated description of how the relationships interact in time… provides us with an excellent way of conceptualising the dynamics of complex systems from a philosophical perspective [2, 16].

In Saussurean models each word has its place and its meaning in a mostly stable linguistic system. Although the system evolves, it remains in a relatively steady state near equilibrium. According to Cilliers, this is not how linguistic systems and complex systems in general behave. Derrida's critique and adaptation of Saussure better capture the non-linear and dynamic nature of complex systems [8; pp.134-135, 17; p.262].

DERRIDA'S POST-STRUCTURAL SEMANTICS

In Saussure's model the meaning of a sign is *present* to a speaker. The meaning of language is grounded in the subjectivity of the community of speakers using that language. Derrida argues however that the meaning of signs is ungrounded, unstable and unpredictable; there is always *excess of meaning*. As Cilliers puts it,

> the signified (or 'mental' component) never has any immediate self-present meaning. It is itself only a sign that derives its meaning from other signs. Such a viewpoint entails that the sign is, in a sense, stripped of its 'signified' component [2; p.42, 8; p.72].

For Derrida, there is only the endless interaction of signifiers (the 'physical' component of the sign), and the subject itself is constituted by this play of signifiers [2; p.43]. Meaning is never immediately given; there is always *interpretation*, and interpretation is always limited. This is Derrida's famous *deconstruction* of the sign [18][4].

Each time a sign is used, it interacts with the other nodes in the linguistic network, and this semantic interplay shifts the meaning of the sign [17]. For Derrida and Cilliers, language is in a sense *alive*. It mutates, adapts and evolves; it acts on and reacts to its environment (including other languages). Like any complex system, a living language is in a state far from equilibrium, and if "language is closed off, if it is formalised into a stable system in which meaning is fixed, it will die..." [1, 2].

OPENNESS, TRACE AND DIFFÉRANCE

Openness

For Derrida and Cilliers, language and meaning are not closed off from the world; semantics cannot be pulled apart from metaphysics, and we cannot describe the world in any complete, finite way [2; Ch.3, 19; p.35]. The same applies to complex systems: we cannot identify their boundaries in a way that is objective or complete. Complex systems are entwined with their environment which is itself a complex system composed of complex systems.

Delineating complex systems involves only a provisional, conceptual or heuristic demarcation;

> [w]hat occurs inside our models cannot be easily separated from what is excluded because what we exclude from our models constitutes them as much as that which is included [6; p.9, 7, 10].

Citing Cilliers, Woermann et al state, "our models are distorted... models are static representations of a necessarily fluid reality" [3; p.10]. As mentioned in the introduction, for post-structural complexity theorists, we cannot get a semantic or epistemic fix on complex systems. Thus, instead of trying to decomplexify complexity, we should "abandon our reductionist tendencies" and "learn to dance with" complexity [5, 7, 8]. Post-structuralism suggests a "'playful' approach", writes Cilliers,

> [w]hen dealing with complex phenomena, no single method will yield the whole truth. Approaching a complex system playfully allows for different avenues of advance, different viewpoints, and, perhaps, a better understanding of its characteristics [2; p.23].

In other words, we cannot semantically or epistemically capture – i.e. model – complex systems in any general, perspective-independent way.

Trace

Derrida calls the relationship between any two signs in a semantic system a *trace*. An individual trace does not have meaning in and of itself; instead, meaning emerges through the interaction of traces [20; pp.3-27, 21]. Cilliers equates Derrida's traces with connectionist weights in a neural network:

> The significance of a node in a network is not a result of some characteristic of the node itself; it is a result of the pattern of weighted inputs and outputs that connects the node to other nodes [2; p.81].

Likewise, no individual weight in a neural network has meaning; meaning is constituted by multiple interactions in the system. "Because of the 'distributed' nature of these relationships, a specific weight has no ideational content"; it "only gains significance in large patterns of interaction" [2; p.46][5]. In other words, all the small meaningless differences between the many components in a complex system comingle to engender the emergence of meaning within the system.

According to Cilliers, the patterns of activity generated in a complex system cause traces of that activity to reverberate through the system. These patterns of traces collectively constitute the overall behaviour of the system. Moreover, a complex system is continuously being transformed by both its environment and itself. The system is

> constituted only by the distributed interaction of traces in a network... there is nothing outside the system of signs which could determine the trace, since the 'outside' itself does not escape the logic of the trace [2; p.82].

This entwinement of system and environment *deconstructs* the conventional binary of inside versus outside the system; the traditional gap between the two collapses. That is, traces ripple and recoil – they dance – through the system; they are "reflected back after a certain propagation delay (deferral), and alter (make different) the activity that produced them in the first place" [2; p.46].

Différance

Although reluctant to define *différance*, Derrida suggests at times that his famous concept *qua* non-concept is "the process of scission and division... an expenditure without reserve, as the irreparable loss of presence... that apparently interrupts every economy" [20; pp.8-19], i.e. every complex system [6, 17]. For Cilliers, *différance* is

> a concept that indicates difference and deference, that is suspended between the passive and active modes, and that has both spatial and temporal components [20; pp.1-27, 21; p.7].

In the context of complexity theory, Woermann thinks of *différance* as the play of disorder and entropy within a complex system [8; p.64]. *Différance* constitutes the activity of multitudinous traces: the exuberant and limitless play of differences. *Différance* disrupts, displaces and defers apparent closure of order, logic, meaning and knowledge [3, 8; pp.100-104]. The play of *différance* through and between complex systems constitutes their meaning and this can never be epistemically captured by formal methods. *Différance* "signifies the irreparable loss of meaning"; it "threatens the total ruination of meaning" [8; p.100, 9].

For Cilliers, *différance* describes the *dynamics* of a complex system. It is not simply part of the activity of a system; "it constitutes the system" [21; p.15]. We can say that the play of *différance* determines the structure or organisation of the system; the complexity of the system is a function of *différance's* dynamics.

Having discussed how Cilliers imports Derrida's post-structural semantics into complexity theory, let us now look at his proceeding conclusion that connectionist models are better suited to modelling complex systems than rule-based models.

THEREFORE, CONNECTIONIST MODELS TRUMP RULE-BASED MODELS

Cilliers prefers (post-structural) connectionist models to (analytic) rule-based models because of their avowed ability to capture the contingent, evolutionary nature of complex systems. Moreover, neural networks are based on the most complex of all known systems: the brain [2; p.112][6]. Like complex systems, neural networks have no central controller; "[p]rocessing is distributed over the network and the roles of the various components (or groups of components) change dynamically" [2; p.19]. Neural networks can also *learn* to perform complex tasks either when shown examples of these tasks successfully performed, or by using criteria internal to the network that signal success[7].

Neural networks are mostly self-contained, says Cilliers, they require only a *sensor* that inputs information to the network and a *motor* that allows the output of the system to have some external effect [2; p.18]. Inside the network there are only neurons responding to and influencing other neurons *locally*. The behaviour of the system is determined only by the values of its weights. Each neuron is simple, but the system of neurons as a whole can exhibit highly complex behaviour[8].

Neural networks can also cope with contradictory information; they are 'robust'. Part of the strength of neural networks, says Cilliers, is that they can often bypass a contradiction by redistributing the weight in the system [21; pp.19-21]. Rule-based systems conversely are "brittle"; they "blow up" when given contradictory information[9].

THE PROBLEM WITH CILLIERS' APPROACH TO COMPLEXITY

As we have seen, Cilliers argues that using neural networks is the best way to model complex systems while concurrently arguing that post-structuralist semantics shows that there are no general models for complex systems. In this section, I suggest that it is dilemmic to do so (section 3.1); I then engage with three potential counter-arguments (section 3.2).

CILLIERS' DILEMMA

As Cilliers recognises, modelling necessarily involves a simplification or reduction of the system being modelled; "we have to reduce ... complexity when we try to understand it" [6, 22]. *A fortiori*, this reduction applies equally to analytic *and* connectionist models. Although Cilliers does not explicitly state as much, connectionist modelling clearly involves a reduction of complex systems to simple or simpler neural networks (consisting of nodes, weights etc). As we have seen however, Cilliers advocates for this connectionist reductionism while concurrently advocating for Derridean anti-reductionism.

Cilliers states further that "complexity is 'incompressible' " [2; p.24]; "[r]eduction of complexity always leads to distortion" [23; pp.9-10]. However, we are also told that connectionist neural networks are the best way to model – i.e. compress/reduce – complex systems. Cilliers also argues that a post-structural understanding of complexity shows that reductive strategies are "seriously flawed" [8; pp.31, 9, 21]. If so, it follows that Cilliers' own connectionist strategy is seriously flawed, and thereby inept at modelling complex systems. De Villiers-Botha and Cilliers likewise argue that one cannot replace a complex system with some simpler system without losing "vital characteristics of the system" [9; p.29]. It should follow that connectionist models lose vital characteristics of their target system.

Cilliers claims further that models are always indexed to some contingent framework, and that the success of a model will depend on the norms or values operant in that framework [6, 24; pp.45-46]. There are no objectively correct models of complex systems; there are no meta-narratives expressed from meta-perspectives [25; pp.458-450]. However, at other times, Cilliers argues that we should employ

> post-structural perspectives (mainly those of Derrida) in order to show that the intricate and dynamic network of relationships between the components of a complex system can be understood better in terms of connectionist (or neural network) models [24; p.40].

Cilliers seem to be arguing both for *and* against contingency, perspectivism and objectivity about modelling complex systems[10]. This suggests a logical tension at the core of his general account of complex systems.

Interestingly, Holland argues that connectionist models are – at bottom – themselves rule-based; the functioning of neural networks is based on the workings of Hebb's rule [26; pp.81-114][11]. If so, then Cilliers' connectionism is subject the very criticism he levels against rule-based models. Cilliers however argues against Holland that Hebb's 'rule' is, in fact, not a rule at all; it is instead a kind of low-level *principle*. Citing Winston [27] Cilliers posits two features that constitute a rule:

1. A rule implies a certain generality; a specific case where the rule applies must be generalisable to many cases.
2. Rules must be suitably linked: the output of one rule must serve as the input for the next rule. That is, a system of rules must be algorithmic [24; pp.44-45].

For Cilliers, this characterisation of a rule is at odds with a nonalgorithmic principle like Hebb's rule. Hebb's 'rule', says Cilliers, in fact functions at the level of Derrida's *trace*. It only applies to local interactions between components of a complex systems. It operates on low-level, contingent information, and is non-selective. The 'rule' operates everywhere in all connectionist networks; it does not tell us anything essential about a specific complex system nor make any generalisations about complex systems.

In any event, neural networks are still clearly simpler that the complex systems they purport to model; they are still a reduction of complexity [26; p.24]. If they were not, we would not be able to comprehend them or work with them; the model would be as complex as what it attempts to model. As noted, modelling – whether by way of analytic rules or neural networks – by definition involves a reduction of complexity so that the subject matter at hand can be understood and managed.

In sum, Cilliers faces a dilemma. On the one horn, if he claims that the connectionist approach to modelling complex systems is the correct one, then he contradicts post-structural themes of perspectivism, contingency and the like. On the other horn, if he claims that models of complex systems are relative to perspectives, always contingent and so on, then he contradicts his claim for the correctness of connectionist models of complex systems[12].

POSSIBLE RESPONSES

Cilliers may respond that connectionism is the best way to model complex systems given the scientific paradigm we currently occupy even if there is no absolute fact of the matter. There are no meta-models or meta-perspectives, but some norms or methods are more 'long-lived' than others due to provisional, contingent or heuristic factors [1, 7]. However, by *reductio*, it should then follow that our best scientific models – e.g. in quantum theory, general relativity and the theory of natural selection – are ultimately no better than those employed in pseudo-sciences such as astrology, Scientology or creation biology. All are in the end equally provisional; the only reason we prefer the former is due to our currently dominant contingent norms. It would be grossly counter-intuitive to assert as much; one wonders whether post-structural complexity theorists are prepared to bite this bullet.

A second possible objection is that there are two domains of applicability when it comes to understanding complex systems. At times, Cilliers follows Morin [10] in distinguishing between *restricted* complexity and *general* complexity[13]. Cilliers may state that connectionism applies to restricted complexity while post-structuralism applies to general complexity. These two domains involve adopting a certain approach or mode of thinking towards modelling complex systems. Regarding restricted complexity, says Cilliers, "if you work hard enough, with clever enough techniques, you can figure the system out" [21; p.7]. Conversely, general complexity "requires a more reflexive and transformative approach" where we remain sensitive to the recalcitrance of complex systems and the normativity this introduces [21; p.7]. As Woermann et al put it,

> [i]n the restricted paradigm, complexity is treated as a problem that can be overcome (complex problems are understood as complicated problems);

> whereas in the general paradigm, complexity is treated as an ontological fact, which holds certain epistemological and cognitive implications for the manner in which we deal with complexity [3; p.5].

In the restricted mode, complex systems are considered to be epistemically complex but ontologically simple; in the general mode, complex systems are considered to be both epistemically and ontologically complex. Restricted complexity applies to Saussure, Chomsky and other reductive strategists, while general complexity applies to Derrida and likeminded post-structuralists.

Thus, Cilliers may claim that connectionist models are useful in the restricted mode, while post-structural thinking is useful in the general mode, and my dilemma therefore does not bite. However, drawing such demarcations is at odds with post-structural themes of *différance* and deconstruction [7, 28]. As mentioned in the section 1.3, *différance* disrupts all (non-provisional/non-heuristic) distinctions. Post-structuralism disallows robust demarcations; all substantial binaries are vulnerable to deconstruction [8; pp.173-176, 28; p.116].

Thus, claiming that there are two separate domains – one applicable to connectionism and the other applicable to post-structuralism – violates post-structuralism's own taboo on strict demarcations. Cilliers cannot claim that connectionism only applies to restricted complexity. This is because the force of *différance* should disrupt any attempt at isolating or closing off some system or domain [3; pp.7-10, 6]. On the post-structuralists' own account, *différance* should render connectionist modelling efforts as contingent, incomplete and contextual as rule-based efforts. However, as discussed, Cilliers does not consider connectionism relativised in this way. Instead, he argues for the superiority of connectionist models over rule-based models *simpliciter*; the correctness of connectionism is a putative consequence of Derrida's semantics.

Moreover, as we saw in section 1, Cilliers' advocation of post-structuralism is premised in its *similarities* to connectionism and *vice versa*. Cilliers therefore cannot claim that post-structuralism and connectionism apply to separate domains since they would then be disanalogous. If post-structuralism and connectionism are distinct, then they cannot support each other in the kind of argument by analogy that Cilliers puts forward.

Lastly, Cilliers may respond that the dilemma at hand is exactly the sort of paradox post-structuralists revel in. According to Human and Cilliers, we deal with paradox by utilising a type of 'reason' "defined as a wager between the calculable and the incalculable" [6; p.34]; the post-structural approach "harbours a somewhat ironic dimension" [29]. This involves an *aporetic logic* – a kind of dialethism – premised on *différance* that embraces paradoxes and contradictions [8; pp.67-81, 7; pp.243-246, 28; p.116]. Here, we must concurrently think both closed *and* open, both random *and* predictable, p *and* ∼p, true *and* false.

Perhaps appeal to *différance* with its aporetic logic dispels all putative dilemmas: precisely where there is contradiction there is epistemic illumination. As Woermann states, the relationship between the restricted and the general dimensions of complexity is "better understood in terms of *aporia* than unification" [8; p.73]. Further,

> [i]n trying to think together the restricted and general dimensions of meaning, Derrida's logic aims to transgress the limitations that our traditional binary logical schema (which is necessary restricted) places on us [8].

However, embracing contradiction to dissolve a dilemma potentially leads to a debilitating kind of relativism. It seems that no positive argument can sustain the force of *différance*. *Différance* ruins all non-aporetic logics – it disrupts meaning, order and structure [8, 20] and one therefore wonders what kind of statement can actually be meaningful or be known. If all positive claims are prone to disruption, then how can there be norms of epistemic correctness? Any claim to knowledge introduces a binary between known and unknown that should *itself* be vulnerable to the disruptive power of *différance* [8; pp.174-175, 28; p.116][14]. The result seems to be a version of what Goldman [30] calls *nihilistic relativism*: there are no non-contextual epistemic norms governing which claims are right or wrong or more right or wrong than others.

CONCLUSION

The conclusion to this article is twofold:

1. Post-structural complexity theorists cannot advocate for a specific model of complex systems.
2. Conversely, complexity theorists who advocate for a specific model of complex systems cannot embrace the post-structural interpretation.

Regarding 1, to my knowledge, none of the complexity theorists who follow Cilliers' post-structural approach currently attempt to develop or advocate for a specific model of complex systems[15]. As such, my argument here amounts to a warning to these theorists that they should not attempt to develop any exclusive model of complex systems in the future. To do so would entail falling prey to Cilliers' dilemma.

Conclusion 2 however has more pertinent implications. Much of Cilliers' writings and the writings of those who follow his approach are taken up with arguing that complexity theorists who adopt the restricted mode of understanding complex systems should be cognisant of the general mode. In other words, complexity theorists working in the analytic, reductive traditional would do well to embrace a post-structural way of thinking that is sensitive to the provisionality, contextuality and contingency involved in modelling complex systems. However, if my argument above holds, such potential converts cannot do so without ceasing to hold to any specific model they may have already developed or subscribed to.

Most non-post-structural complexity theorists currently advocate for some preferred modelling method. The frontier of the discipline involves methodical testing and engaged debate over the best way to model complex systems. These modellers are often post-structural complexity theorists' target audience. One wonders however whether these modellers are aware that embracing the post-structural mode of thinking will necessitate giving up any claims to the objectivity or superiority of their favourite model.

In sum, those non-post-structural modellers who may find aspects of the post-structural approach convincing, and who may be considering adopting it, would do well to note the sacrifice their conversion would entail. Likewise, post-structural complexity theorists who aim to convince others to embrace the post-structural approach would do well to make explicit the sacrifice entailed therein.

REMARKS

[1]For the purposes of this article, we can follow Richardson and Cilliers in defining a complex system as "a system that is comprised of a large number of entities that display a high level of nonlinear interactivity" [31]. See however Cilliers and Preiser [2; Ch.1, 21] for detailed lists of characteristics of complex systems. We can further define 'complexity theory' broadly as any practice that involves the attempt to gain knowledge and/or understanding of complex systems. A 'complexity theorist' is someone who engages in such a practice.

[2]See Cilliers and Buckner and Garson for more detail on neural networks [2; Ch.2, 10].

[3]Lazard is however a notable exception. Using the Saussurean approach, he attempts to develop a science of linguistics or what he calls "pure linguistics" [32] where a language can be an ideal object of genuine scientific investigation, as are biological species, a pure body and a perfect gas.

[4]According to Cilliers, post-structural deconstruction involves showing the contradictions that result from fixing the boundaries [of a complex system] from one perspective. Pointing out the contradictions that follow from such a closure is an activity that Derrida calls 'deconstruction' [2; p.81]. Deconstruction is not an action performed by a deconstructor on a system. Instead, "[i]nterventions from the outside enter into the play of differences always already at work in the system" [21; p.15]. Derrida, says Cilliers, "sometimes refers to deconstruction as a characteristic of the system itself: *it* deconstructs" [21].

[5]These weights "store information at a sub-symbolic level, as *traces* of memory" [2].

[6]See Ladyman and Wiesner for an informative explication of the brain as a highly complex system [33; pp.57-61].

[7]Cilliers also emphasises two "indispensable capabilities" of complex systems. A complex system must "be able to store information concerning the environment for future use; and it must be able to adapt its structure when necessary" [2]. The first capability is *representation* and the second *self-organisation.* According to Cilliers, connectionist models of complex systems correctly capture these capabilities [2; Ch.1-2].

[8]To perform their function, neural networks also cannot be too small (too few neurons) or too large (too many neurons), and they must not be under- or over-trained. Some noise should also be added to the input of the network to increase its robustness. [2; pp.74-79].

[9]Smolensky [34] thinks of rule-based symbol systems as "hard" and connectionist systems as "soft" [2; p.34].

[10]Morçöl criticises Cilliers along similar lines [35; pp.117-118].

[11]Hebb's rule describes the local interaction between neurons responsible for the organization of structure in a neural network; it states that "the connection strength between two neurons will increase if the two neurons are active simultaneously" [23; p.44].

[12]Ladyman and Wiesner suggest that this kind of paradoxical thinking runs throughout the complexity literature [33; p.84].

[13]Morin's *general complexity/restricted complexity* distinction approximately maps onto the more familiar complex system/complicated system distinction [4, 36].

[14]As solution to this dilemma, Derrida appeals to a kind of mystical moral force in the world that serves as first philosophy [37]. Cilliers however, does not follow Derrida in this regard.

[15]Woermann does however devote one paragraph to what appears to be an endorsement of neural networks as an appropriate model for complex systems [8; p.29]. Nonetheless, other than this token gesture, she does not argue for connectionism at any length nor attempt to develop her own specific model for complex systems.

REFERENCES

[1] Cilliers, P.: *Knowledge, limits and boundaries.*
In: Preiser, R., ed.: *Critical Complexity: Collected Essays.* De Gruyter, Berlin, pp.105-114, 2016,

[2] Cilliers, P.: *Complexity and Postmodernism: Understanding Complex Systems.*
Routledge, London, 1998,

[3] Woermann, M.; Human, O. and Preiser, R.: *General Complexity: A Philosophical and Critical Perspective.*
Emergence: Complexity and Organization, 2018,
http://dx.doi.org/10.emerg/10.17357.c9734094d98458109d25b79d546318af,

[4] Preiser, R. and Woermann, M.: *Complexity, Philosophy and Ethics.*
In: Galaz, V., ed.: *Global Challenges, Governance, and Complexity: Applications and Frontiers.* Edward Elgar Publishing, Northampton, pp.38-62, 2019,

[5] Cilliers, P.: *Complexity, Deconstruction and Relativism.*
Theory, Culture & Society **22**(5), 255-267, 2005,
http://dx.doi.org/10.1177/0263276405058052,

[6] Human, O. and Cilliers, P.: *Towards an Economy of Complexity: Derrida, Morin and Bataille.*
Theory, Culture and Society **30**(5), 24-44, 2013,
http://dx.doi.org/10.1177/0263276413484070,
[7] Hurst, A.: *Complexity and the Idea of Human Development.*
South African Journal of Philosophy **29**(3), 233-252, 2010,
http://dx.doi.org/10.4314/sajpem.v29i3.59144,
[8] Woermann, M.: *Bridging Complexity and Post-Structuralism: Insights and Implications.*
Springer, Cham, 2016,
[9] Preiser, R.: *Identifying General Trends and Patterns in Complex Systems Research: An Overview of Theoretical and Practical Implications.*
Systems Research and Behavioural Science **36**(5), 706-714, 2019,
http://dx.doi.org/10.1002/sres.2619,
[10] Morin, E.: *Restricted Complexity, General Complexity.*
In: Gershenson, C.; Aerts, D. and Edmonds, B., eds.: *Worldviews, Science and Us: Philosophy and Complexity.* World Scientific, Singapore, pp.5-29, 2007,
[11] Kauffman, S.: *A World Beyond Physics: The Emergence and Evolution of Life.*
Oxford University Press, New York, 2019,
[12] Buckner, C. and Garson, J.: *Connectionism.*
In: Zalta, E.N., ed.: *The Stanford Encyclopedia of Philosophy*, 2019,
http://dx.doi.org/10.4324/9781315643670,
[13] de Saussure, F.: *Course in General Linguistics.*
Fontana, London, 1974,
[14] Joseph, J.E.: *Trends in Twentieth-Century Linguistics: An Overview.*
In: Koerner, E.F.K. and Asher, R.E.: *Concise History of the Language Sciences: From the Sumerians to the Cognitivists.*
Pergamon Press, Oxford, 221-233, 1995,
[15] Barthes, R.: *Mythologies.*
J. Cape, London, 1972,
[16] Dillon, M.: *Poststructuralism, Complexity and Poetics.*
Theory, Culture and Society **17**(5), 1-26, 2000,
http://dx.doi.org/10.1177/02632760022051374,
[17] Preiser, R.; Cilliers, P. and Human, O.: *Deconstruction and Complexity: A Critical Economy.*
South African Journal of Philosophy **32**(3), 261-273, 2013,
http://dx.doi.org/10.1080/02580136.2013.837656,
[18] Lawlor, L.: *Jacques Derrida.*
The Stanford Encyclopedia of Philosophy, 2021,
[19] Derrida, J.: *Of Grammatology.*
Johns Hopkins University Press, Baltimore, 1976,
[20] Derrida, J.: *Différance.*
University of Chicago Press, Chicago, pp.1-28, 1982,
[21] Cilliers, P.: *Difference, Identity and Complexity.*
In: Cilliers, P. and Preiser, R., eds.: *Issues in Business Ethics: Complexity, Difference and Identity.*
Springer, London, pp.1-18, 2010,
[22] Cilliers, P. and Preiser, R.: *Preface.*
In: Cilliers, P. and Preiser, K.: *Issues in Business Ethics: Complexity, Difference and Identity.*
Springer, London, iv-ix, 2010,
[23] Cilliers, P.: *Knowledge, Complexity, and Understanding.*
Emergence **2**(4), 7-13, 2000,
http://dx.doi.org/10.1207/S15327000EM0204_03,

[24] Cilliers, P.: *Rules and Complex Systems.*
Emergence **2**(3), 40-50, 2000,
http://dx.doi.org/10.1207/S15327000EM0203_04,
[25] Woermann, M. and Cilliers, P.: *The Ethics of Complexity and the Complexity of Ethics.*
South African Journal of Philosophy **31**(2), 447-464, 2012,
http://dx.doi.org/10.1080/02580136.2012.10751787,
[26] Holland, J.H.: *Emergence: From Chaos to Order.*
Addison-Wesley, Boston, 1998,
[27] Winston, K.I.: *Justice and Rules: A Criticism.*
Logical Analysis **14**(1), 177-182, 1971,
[28] Derrida, J.: *Afterword.*
In: Graff, G., ed.: *Limited Inc.* Northern Western University Press, Evanston, pp.111-160, 1988,
[29] Human, O.: *Potential Novelty: Towards an Understanding of Novelty without an Event.*
Theory, Culture & Society **32**(4), 45-63, 2016,
[30] Goldman, A.: *Epistemic relativism and reasonable disagreement.*
In: Feldman, R. and Warfield, T.: *Disagreement.* Oxford University Press, Oxford, 187-215, 2010,
[31] Richardson, K. and Cilliers, P.: *Special Editors' Introduction: What Is Complexity Science? A View from Different Directions.*
Emergence **3**(1), 5-23, 2001,
http://dx.doi.org/10.1207/S15327000EM0301_02,
[32] Lazard, G.: *The Case for Pure Linguistics.*
Studies in Language **6**(2), 241-259, 2014,
[33] Ladyman, J. and Wiesner, K.: *What Is a Complex System?*
Yale University Press, London, 2020,
[34] Smolensky, P.: *The Constituent Structure of Connectionist Mental States: A Reply to Fodor and Pylyshyn.*
Southern Journal of Philosophy **26**, 137-161, 1987,
http://dx.doi.org/10.1007/978-94-011-3524-5_13,
[35] Morçöl, G.: *What Is Complexity Science? Postmodernist or Postpositivist?*
Emergence **3**(1), 104-119, 2001,
http://dx.doi.org/10.1207/S15327000EM0301_07,
[36] Poli, R.: *A Note on the Difference Between Complicated and Complex Social Systems.*
Cadmus **2**(1), 142-147, 2013,
[37] De Villiers-Botha, T. and Cilliers, P.: *The Complex 'I': The Formation of Identity in Complex Systems.*
In: Cilliers, P. and Preiser, R.: *Issues in Business Ethics: Complexity, Difference and Identity.* Springer, London, pp.19-38, 2010,
http://dx.doi.org/10.1007/978-90-481-9187-1_2.