Individuating mind: Deleuze, Simondon and the free energy principle

by ARAGORN ELOFF

Abstract

Neuroscientist Karl Friston has in recent years developed a highly influential and ambitious framework called the free energy principle (hereafter FEP) which, combined with its corollary, active inference, describes how living systems endure, in the face of dissipative thermodynamic tendencies, through modelling and responding to their environments. In this paper, I explore one provisional way of bringing the FEP, which proposes a general self-organising systems ontology, together with Deleuze's notion of individuation. To accomplish this task, I employ the work of Gilbert Simondon as the dark precursor that draws these two disparate projects together at the meeting point of science and philosophy. As ontogenesis is, for Simondon and Deleuze, the simultaneous unfolding of thought and extension — the thought of individuation as the individuation of thought — I also pose some tentative questions around the epistemological traction of scientifically inflected models like the FEP and ontogenesis. Given that, as Simondon argues, the notion of ontogenesis applies to epistemology, logic and other foundational forms of thought themselves, I leave these questions necessarily open and conclude by examining one particularly salient way in which the FEP and ontogenesis can be brought together in order to think about psychedelics and, by extension, consciousness more broadly. First, however, I take a brief look at cellular automata, for reasons that will become clear at the end.

An introductory digression: What is A-Life?

On 13 April 2020, popular web comic XKCD released an animated tribute to the mathematician, John Conway, who had died of Covid a few days earlier. The animation opens with a simple image of a person, constructed from 20-odd black squares set against a white background. Over the course of a couple of seconds, the image breaks apart and dissolves, apart from one group of five squares that moves slowly to the top right of the screen before disappearing.

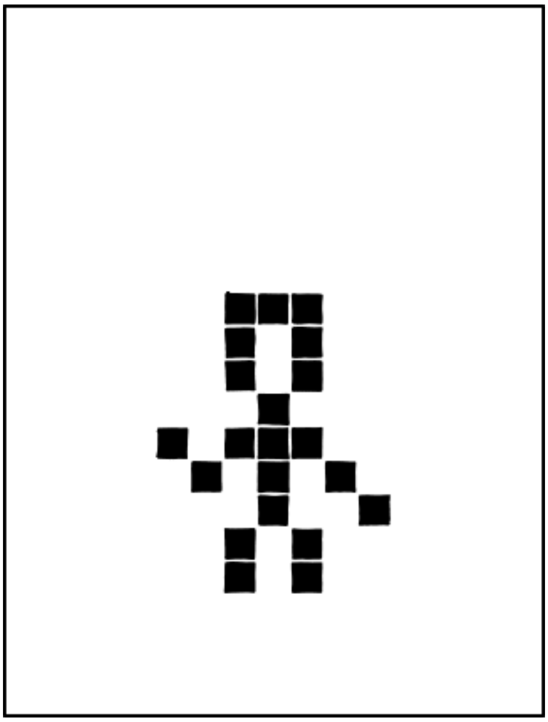

Figure 1: XKCD's tribute to John Conway, available online at https://xkcd.com/2293.

What makes this tribute remarkable is that the animation is in fact a cellular automata (hereafter CA) — an abstract mathematical model of computation that usually takes the form of a grid of cells, each of which can be in a number of initial states and is influenced, across a number of generations, by the iteration of a set of rules that leads to the visual evolution of the system in ways that can range from random to dissipative to highly complex and patterned[1]. Specifically, the CA employed in the tribute is none other than Conway's Game of Life, devised by the late mathematician. In the Game of Life, each cell interacts with the cells that are immediately horizontally, vertically or diagonally adjacent to it on a two-dimensional grid, and can toggle between two states: 'alive' (black cells) and 'dead' (white cells). At each iteration, a living cell dies if it is surrounded by less than two or more than three live neighbours, or remains alive if it has exactly two or three neighbours. A dead cell can be brought back to life if it has exactly three live neighbours. From these simple premises emerge remarkable forms of behaviour; while certain initial configurations (or 'seeds') of live and dead cells result in rapid death due to over- or under-crowding (CA are often described in the same language as population biology, and referred to as 'artificial life' or 'A-Life'), many result in visually striking periodic phenomena that are given descriptive terms like 'oscillators', 'toads', 'pulsars', 'gliders' and 'spaceships'. Some of these repeating patterns emerge relatively quickly, while others, like 'Acorn', can take thousands of generations for their full repertoire to unfold[2]. Even more remarkably, some patterns can make copies of themselves over millions of

1 A useful overview of CAs can be found at https://mathworld.wolfram.com/CellularAutomaton.html.

2 A wide variety of patterned CAs are demonstrated in this video: https://www.youtube.com/watch?v=C2vgICfQawE&ab_channel=RationalAnimations

generations[3]. In fact, the Game of Life is Turing complete, meaning that in principle it can function as a programming language interpreter and perform any task that can be accomplished by a computer[4]. It is also mathematically undecidable, meaning that there is no algorithmic way to determine in advance, without actually running a simulation based on an initial seed state, what the result of that state will be, something that makes the poetic nature of the XKCD tribute — the way it captures life, death and the migration of a soul to the heavens — all the more astonishing.

The complex, patterned behaviour exhibited by CA has led numerous mathematicians, computer scientists, biologists and philosophers — as well as some artists and musicians — to employ them as a model for emergence, or as an analogy for how complexity can arise immanently from within simple systems. Undoubtedly the most famous example of this is physicist-mathematician Stephen Wolfram's work in modelling complex dynamic systems with CA, beginning with the elementary (one-dimensional) CA known as Rule 110 — which is, like the Game of Life, capable of universal computation — and expanding into a huge range of related approaches like mobile automata, register machines and recursive and network-based iterative functions in his 2002 study of the universe of elementary computational systems, 'A New Kind of Science' (Wolfram 2002). This book, which sets itself the ambitious goal of describing an entirely new branch of science based on experimenting with simple systems and deriving knowledge from their emergent properties, has been both widely praised and strongly critiqued by experts in a number of scientific fields. On the one hand, Wolfram's argument that complex systems, including those described in fields like chaos mathematics, can be near-exhaustively described via the kinds of rudimentary computing systems exemplified by CA is viewed as lacking empirical support, as is his claim to have founded anything like an entirely new scientific field; on the other hand, some of the programs explored in Wolfram's work — which, in its focus on actually *running* the systems as opposed to *a priori* determining their outcomes can perhaps be viewed as a *nomadic* science — have exhibited behaviour that provides remarkably accurate models of everything from thermodynamic behaviour to traffic jams to the growth of crystals. Whether these programs are simply vivid visual analogies that trigger a kind of apophenia in their viewers or, on the other hand, have some kind of traction on reality is an open question. Some, like the philosopher of complex systems theory Manuel DeLanda, argue that the fact that CA and other simulations of simple systems can exhibit similar emergent dynamics to the real-world systems they're viewed as analogous to suggests that, on a realist view, there may be some underlying property of these elementary computer programs that could help us to think about their ostensible real correlates (DeLanda 2011).

On 14 April 2020, the day after the XKCD tribute was published, Wolfram published an astonishing announcement on his website titled 'Finally We May Have a Path to the

[3] See, for instance, https://conwaylife.com/forums/viewtopic.php?f=2&t=399&p=2327#p2327.
[4] This video provides a useful non-technical introduction to the use of CAs as Turing machines: https://www.youtube.com/watch?v=Kk2MH9O4pXY&ab_channel=AlanZucconi.

Fundamental Theory of Physics… and It's Beautiful' (Wolfram 2020a), in which he claims that the same kinds of simple CA-type systems he has been exploring for almost half a century can give rise to all the fundamental rules with which the universe operates. Specifically, Wolfram Physics describes the *fundamental ontology of the universe* — not just space, time and so forth, but the primitives that operate anterior to, and give rise to, the entire content of physical reality. Or, as Wolfram describes the outcomes of the recent computer experiments he has been conducting,

> from tiny, structureless rules out were coming space, time, relativity, gravity… We started understanding how quantum mechanics works… we realized what energy is. We found an outline derivation of… Richard Feynman's path integral… We started seeing some deep structural connections between relativity and quantum mechanics. Everything just started falling into place.(Wolfram 2020a)

It is not possible to overstate the ambition of these claims. A fundamental theory of physics that brings together relativity and quantum mechanics is widely viewed as a holy grail of contemporary theoretical physics, and the suggestion that systems running on rules so simple 'their basic structure can be expressed in a fraction of a line of symbolic Wolfram Language code'[5] (ibid) can express 'huge chunks of the most sophisticated things that are known about physics' is almost a limit case for grandiose claims about the import of computer models. Wolfram's ambitions go even beyond this though: not only does he aim to determine the rule responsible for the physics of our universe, he is developing an entire registry of notable universes based on different rulesets[6]. The exact mechanisms by which these rules give rise to complexity is described in a highly technical 448-page paper by Wolfram (2020b). Simplifying somewhat, we begin with a collection of abstract relations between abstract elements — what we would describe in mathematical terms as a graph or hypergraph, or a collection of nodes and edges (put simply, points connected by lines — the same kind of formalism employed by category theory). These relations are described in simple nested array notation, e.g., {{1, 2}, {2, 3}, {3, 4}, {2, 4}} (node one is connected to node two, node two is connected to node three and so on). This set of relations can in turn be visually depicted in Mathematica[7]. From this initial state, a transformation rule is iteratively applied, e.g., {{x, y}, {x, z}} → {{x, z}, {x, w}, {y, w}, {z, w}} and the resulting array and visual depiction is updated. Over sufficient iterations, this can result in the transformation from an initial state like this (which is the example mentioned above):

5 Wolfram Language is the programming language used in Mathematica and the Wolfram Physics project. Laudably, Wolfram has open sourced a range of software tools used by the Wolfram Physics project online: https://www.wolframphysics.org/tools.

6 See, for example, universe wm1172, where complex patterned visual structures emerge from a simple nested array of numbers: https://wolframphysics.org/universes/wm1172.

7 The example I describe here can be viewed at Wolfram (2020a).

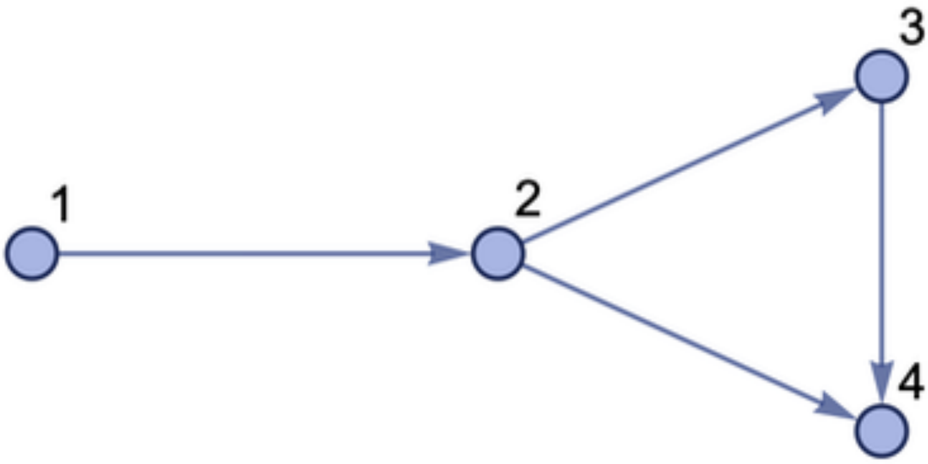

Figure 2: An initial graph state of abstract relations

To this:

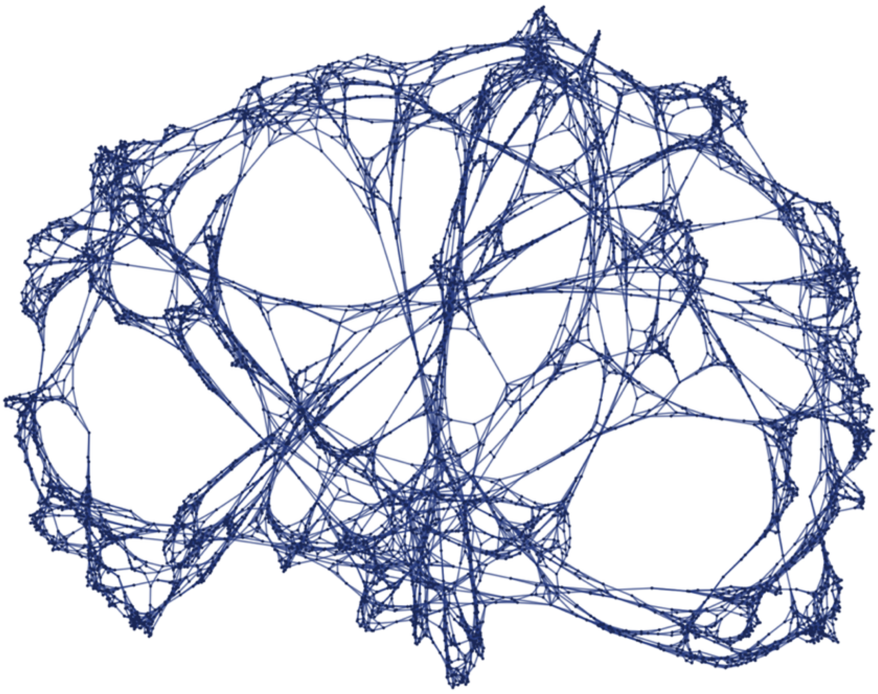

Figure 3: The resulting emergent state after many iterations of a particular rule.

These kinds of vivid visual depictions of the highly detailed, in some cases almost organic-looking results, of the application of simple rules to starting states of a handful of abstract relations between abstract elements may provide some impetus for taking Wolfram seriously when he asks 'if we were to run rules like these long enough, would they end up making something that reproduces our physical universe? Or, put another way, out in this computational universe of simple rules, can we find our physical universe?' (Wolfram 2020a)[8]. Philosophically, there are multiple ways to conceive of what is happening here. On the one hand, Wolfram's argument is remarkably Hegelian — one could almost understand it as a formal generalisation of a rule-space within which Hegelian dialectics would represent just one particular rule. It also bears similarities to mathematician George Spencer-Brown's famous 'Laws of Form' (1969), a singularly strange book of applied mathematical philosophy in which the author describes an austere system consisting of the drawing of a single distinction between marked and unmarked space and then proceeds to derive, from the application of just two rules (the law of Calling and the law of Crossing), an entire arithmetic and algebra[9]. On the other hand, I suspect I am not the only Deleuzian who, when reading *Difference and Repetition* (1994), has visualised becoming — the asymmetrical synthesis of the sensible (Deleuze 1994: 222-61) as a cascade of broken symmetries that progressively determines the actual (DeLanda 2002: 11), or the whole process of indi-drama-different/ciation (Deleuze 2004: 94-116) — in a manner similar to the above visual depictions, even as we remind ourselves that it is a thought without an image that should be borne in mind. Indeed, it seems to offer a vivid visual description of DeLanda's complex systems theory reinterpretation of the method of dramatization, wherein "metric spaces would be literally born from non-metric ones as the latter progressively lose symmetry (or break symmetry) and gain invariants… a process of progressive differentiation, that… takes relatively undifferentiated topological figures and through successive broken symmetries generates all the different metric figures" (DeLanda 2010: 120). In other words, frameworks like CA and Wolfram Physics seem to be aiming towards a description not just of ontology, but of *ontogenesis*[10]. From an initial configuration of difference differing, i.e., a virtual multiplicity consisting of series of singular and ordinary points (think nodes and edges as defined by the abovementioned nested arrays, or the seed state in a CA, with becoming as a progressively defined ruleset), there is an intensive unfolding into dimensionality, extension, qualities and properties, etc. As with Simondonian

8 In this regard, Wolfram does make an important proviso that it is by no means certain that the 'rule for our universe' will be as simple as those described above. Indeed, the determination of this is computationally irreducible, meaning that we cannot decide on it *a priori* but instead only incrementally solve through the actualisation of the problem through the application of the rules. Even then, as Wolfram puts it, "[i]t could have been that in a sense the rule for the universe would have a special case in it for every element of the universe—every particle, every position in space, etc." However, "the very fact that we've been able to find definite scientific laws—and that systematic physics has even been possible—suggests that the rule at least doesn't have that level of complexity" (Wolfram 2020a).

9 Spencer-Brown has ambitions analogous to those of Wolfram when discussing the utility of his system. As he puts it, in quasi-autopoietic terms, "a universe comes into being when a space is severed or taken apart. The skin of a living organism cuts off an outside from an inside. So does a circumference of a circle in a plane. By tracing the way we represent such a severance, we can begin to reconstruct, with an accuracy and coverage that appear almost uncanny, the basic forms underlying linguistic, mathematical, physical and biological science, and can begin to see how the familiar laws of our own experience follow inexorably from the original act of severance" (Spencer-Brown, 1969: 1).

10 There are analogies here with the focus on ontogenesis as a way to think about unsupervised machine learning I've argued for in previous work (Eloff 2021).

individuation, "time emerges from the pre-individual just like the other dimensions according to which individuation effectuates itself" (Simondon 2020: 16).

There are numerous ways in which Wolfram's project can be read through a Deleuzo-Guattarian lens[11]. The remarkable idea of rulial space as the simultaneity of all possible sets of rules inhering in a single universe but diverging and converging in multiple ways in their different actualisations resonates strongly with Deleuze's "complexes of coexistence" (Deleuze 1994: 186) — the reciprocal and complete determination of difference and singularities that constitute the plane of immanence — for instance[12]. We should proceed with caution, however. It may turn out that Wolfram has discovered some profound fundamental fact about what gives rise to the known universe, but it is equally possible that, as several critics of his new project have pointed out, there may be a fair bit of retrofitting and tautology at play in justifying his findings (Becker 2020). More pointedly, some theorists argue that the very premise that some as-yet undiscovered elegant catch-all formulae can exhaustively describe the laws of the universe is a misleading pursuit that has more to do with human notions of beauty, symmetry, etc., than with any inherent properties of the natural world (Hossenfelder 2018). In this regard, it is worth reflecting on the fact that Stephen Wolfram's father was a textile maker, a field in which simple rules for working with thread give rise to complex and beautiful patterns. Regardless of our views on Wolfram Physics, however, there remains a lingering question as to its exact philosophical status. What, for instance, does contemporary philosophy of science have to say about these kinds of metaphysical extrapolations from simulations? Do they draw us closer to a unified model of how the universe works or are Wolfram and his ilk merely indulging in the worst kinds of unsubstantiated metaphysical speculation? DeLanda and other realists certainly seem to think a third option is possible here (DeLanda 2011), and on a Deleuzian view we could read Wolfram Physics through the framework of *What is Philosophy* (1994) and see it as exemplifying the bringing together of science and philosophy, i.e., as operating at the intersection of the creation of philosophical concepts and of scientific functives. Going further, we could, as non-naïve scientific realists of a Deleuzian persuasion, view science itself through an ontogenetic lens in terms of stabilities and metastabilities. This is the view taken by Simondon:

> There can be a type of knowledge that is the most stable possible for a certain subjective condition and a certain objective condition; if a later modification of subjective conditions (for example, the discovery of new mathematical relations) or

---

[11] Deleuze and Guattari never discuss cellular automata specifically, but they do briefly discuss finite state automata as a way of thinking about the rhizome in that most over-cited of chapters in A Thousand Plateaus (Deleuze & Guattari 1987: 17).

[12] "Well, how about if actually the universe in effect just runs every possible rule? What would this mean? It means that in a sense the "full story" of the universe is just the ruliad… In the end, the ruliad involves infinite rules, infinite initial conditions, and infinite time. But any way of assembling the ruliad from pieces effectively involves making particular choices about how we take those infinite limits… One of the remarkable aspects of the ruliad is that it's in some sense the unique ultimately inevitable and necessary formal object" (Wolfram 2021).

> objective conditions turns up, the old type of knowledge can become metastable with respect to a new type of knowledge. The rapport of the inadequate to the adequate is in fact that of the metastable relative to the stable. Truth and error are not opposed as two substances but are opposed as a relation enveloped in a stable state to a relation enveloped in a metastable state. Knowledge is not a rapport between an object substance and a subject substance, but a relation between two relations, one of which is in the domain of the object and the other of which is in the domain of the subject. (Simondon 2020:75-6)[13]

This view is also reflected to a degree in Bayesian epistemology, which reduces traditional problems of knowledge to calculations of the statistical probabilities of subjective beliefs and their degrees of confirmation (Hájek & Lin 2017). Leaving this problem open, let's explore it indirectly by shifting our attention from the Game of Life to perhaps the most controversial and widely-discussed contemporary framework for thinking about living systems: neuroscientist Karl Friston's free energy principle and the related field of active inference[14].

Make a mark, then make a Markov blanket

> A philosophical concept can never be confused with a scientific function or an artistic construction, but finds itself in affinity with these in this or that domain of science or style of art... Philosophy cannot be undertaken independently of science or art. It is in this sense that we tried to constitute a philosophical concept from the mathematical function of differentiation and the biological function of differenciation, in asking whether there was not a statable relation between these two concepts which could not appear at the level of their respective objects**.** (Deleuze 1994: xvi)

The FEP has been described by numerous interlocutors as notoriously difficult to understand (Freed 2010), and many of the technical accounts provided by Friston and others, even those that attempt to 'simplify' matters (Friston et al. 2022), contain large amounts of highly specialised mathematical equations from fields like machine learning,

---

13 Similarly, "According to this perspective, ontogenesis would become the starting point for philosophical thought; it would really be first philosophy, anterior to the theory of knowledge and to an ontology that would follow this theory. Ontogenesis would be the theory of the phases of the being, anterior to objective knowledge, which is a relation of the individuated being to the milieu after individuation. The existence of the individuated being as subject is anterior to knowledge; a first study of the individuated being must precede the theory of knowledge. The science [savoir] of ontogenesis is prior to any critique of knowledge [connaissance]. Ontogenesis precedes ontology and critique. Unfortunately, it is impossible for the human subject to witness its own genesis, for the subject must exist in order for it to think" (Simondon 2020: 319).

14 This article was submitted before the publication of "Active Inference: The Free Energy Principle in Mind, Brain, and Behavior" (Parr, Pezzulo & Friston 2022) – a book that promises to provide the first comprehensive treatment of these topics, and which readers seeking an accessible introduction are referred to.

statistical physics and computational neuroscience. Here, therefore, we will rely on a broad, non-technical introduction that omits the underlying formal argumentation for the FEP[15]. Friston, an acclaimed neuroscientist, originally developed the FEP as a framework for describing the operations of the brain as a complex, non-equilibrium system[16] that seeks to maintain a steady state of operation (Friston 2007; 2010) and has subsequently developed this framework into an ambitious model that seeks to explain the organising principle of all living systems (Friston 2013). Friston argues that we can understand any system that seeks to endure, i.e., any system that can reasonably be said to be alive, as behaving as though it has a model of the world that it's trying to gather evidence for, or, more technically, as minimising a free energy[17] function of its internal states. Said otherwise, systems maintain themselves by iteratively reducing the mismatch — also known as 'surprisal'[18], or 'negative model evidence' — between internal states, or 'models' (also sometimes referred to as 'beliefs', although this folk psychological term can be misleading, and Friston uses it in the narrower technical sense in which it is employed within fields like hierarchical predictive coding (Clark 2016)) and the Bayesian brain hypothesis (Friston 2012)), and the external states that form the content of these models and which are hidden from these internal states[19]. The term 'hidden' is key here: Friston's view, like that expressed in Maturana and Varela's work on autopoiesis (Maturana & Varela 1980), and emerging from the related field of embodied neuroscience, is that there is a kind of operational closure between a living system and everything that is not that system (i.e., its environment). Between said system and its outside is what Friston describes as a Markov blanket[20] that separates system from environment and mediates interaction between the two. As Friston and colleagues explain: "A Markov blanket defines the boundaries of a system (e.g., a cell or a multi-cellular organism) in a statistical sense. It is a statistical partitioning of a system into internal states and external states, where the blanket itself consists of the states that separate the two" (Kirchhoff et al.

[15] For a complementary account of the FEP and its use by neuropsychoanalyst Mark Solms, who we discuss further down, see Chantelle Gray's contribution to this issue. For a short, accessible video introduction to the FEP, see Friston's account here: https://www.youtube.com/watch?v=NIu_dJGyIQI.

[16] That is, a system that exhibits non-linearities, dissipative or similar non-equilibrium dynamics in its behaviour. This includes most natural systems, e.g., water in a state of turbulence. DeLanda describes these systems in detail in his novel account of Deleuze's 'ontology' in DeLanda (2002). See also Prigogine (1967).

[17] Free energy is here not used in the classical thermodynamic sense of the amount of energy available to a system to do work, but as an information-theoretic analogue (Kirchhoff, Parr, Palacios, et al 2018).

[18] "One can understand surprisal as a measure of how unlikely an observation would be by associating a system's sensory state with an observation or sensory sample. Reducing free energy is therefore the same as optimizing Bayesian model evidence (negative surprisal) for a model (the system) reflected in the probability distributions over sensory data sampled by a system" (ibid).

[19] Friston relates this process to the variational Bayesian methods used in machine learning, in which Bayesian statistical inference is used to approximate the probability for a certain set of observed data given a particular model, which results in Bayesian model evidence that can be employed to select between multiple models. This is close to the field of Bayesian epistemology mentioned below.

[20] We should recall here that Deleuze and Guattari describe desiring machines as Markov chains (Deleuze & Guattari 1977: 39).

2018). A Markov blanket is partitioned into active and sensory states[21], which are the only ways in which internal and external states, which are mutually conditionally independent, can influence each other. Free energy minimisation functions via what is described as active inference (Friston 2016): sensory states flow from the external states to the internal states, and the difference between the resulting perceptions and the internal state, or model, leads to either a) an iterative updating of that model, or b) the undertaking of an action to bring the external states in line with the current model. As Friston and his co-authors summarise:

> The partitioning rule governing Markov blankets illustrates that external states — which are 'hidden' behind the Markov blanket — cause sensory states, which influence, but are not themselves influenced by, internal states, while internal states cause active states, which influence, but are not themselves influenced by, external states. Internal and external states can therefore be understood as influencing one another in a continuous and reciprocal fashion, given dependencies between sensory and active states. The independencies established by a Markov blanket are then suggestive of an elemental form of active inference, where internal and active states are directly involved in maintaining the structural and functional integrity of the Markov blanket [and thus the system]. (Kirchhoff et al. 2018: 3)

This description maps closely to the good regulator theorem of the functioning of self-organizing systems described in cybernetics (Conant & Ashby 1970), another major influence on the FEP, and is described by Friston as the "self-evidencing dynamics underlying the autonomous organization of life, as we know it" (ibid), where 'evidence' is used in the technical sense of Bayesian model evidence. For Friston, this is almost a tautology: to exist simply *is* to maximise Bayesian model evidence. Importantly, Markov blankets are nested in complex systems — such systems "are hierarchically composed of Markov blankets of Markov blankets—all the way down to individual cells, all the way up to you and me, and all the way out to include elements of the local environment", and these blankets "can self-assemble into a global system that itself has a Markov blanket" (ibid).

From these premises, Friston develops the FEP via an array of technical argumentation, making use of mathematical objects such as differential geometry, Kullback–Leibler divergence, Bayesian log likelihood and dynamic causal modelling. While an elaboration of these is not crucial to the argument here, it is worth discussing gradient descent, a mathematical optimisation algorithm. To get a sense of what this algorithm does, imagine that you are at the top of a hill and you're trying to reach the bottom (known as the 'global minimum'). There are multiple paths down, but there's also

[21] A 'state' here refers to the specific position of a system within the state space that defines the range of possible states of a system given its variables. For instance, the state space of my highly abstracted cat, who is either asleep or awake, full or hungry, happy or stressed, is a three-dimensional space – one for each state variable – with eight possible states representing actual situations I may find my cat in, although the strength of the sleep attractor makes this subset of states far more likely.

a thick mist, so you can't see a thing. At various intervals along the way, if you're applying gradient descent reasoning, you feel around in front of you with your feet and move forward in the direction that seems to descent the most sharply (we'll imagine for the sake of the analogy that there are no dangerous cliffs to fall from). However, it's impractical to stop and feel around at every single step, so there's a careful balancing act between how often you stop to check that you're still on the best path and how much of the time you just forge ahead in the most recently determined direction. Now imagine that the algorithm is trying to reduce error — or surprisal — to a minimum and that the degree of slope of the hill at each given point is loosely equivalent to the amount of error. Once you reach the bottom of the hill, you're reached an optimal minimal error condition. Thinking back to the FEP, you could understand this as representing the free energy minimum of a particular system, i.e., its ideal state of maximum model evidence. So far so good, but now imagine that, along the way, you wander into a dried-out lakebed halfway down the hill. At some point, you reach the bottom of the lakebed, which means that no matter which direction you choose to walk in next, it's going to be in an uphill direction. This situation, of arriving at a *local* minimum, could easily lead you to believe that you've reached the global minimum when in fact you're still halfway up the hill.

Keeping this local minimum problem in mind, let's now turn to what is undoubtedly the most ambitious recent usage of the FEP. While the FEP and active inference been employed a wide range of fields, from schizophrenia research to machine learning to climate science, and have formed the basis of numerous claims ranging from the measured (the FEP as a useful model of perception, e.g., Friston (2009)) to the speculative (the FEP has 'solved' the meaning of life, e.g., Friston (2013)), it is in neuropsychoanalyst Mark Solms's argument that the FEP provides a solution for nothing less than Chalmers's famous hard problem of consciousness[22] (Chalmers 1996), that we are perhaps presented with the limit case for the framework. Combining work from computational and affective neuroscience with psychoanalysis, Solms, who has collaborated with Friston, develops, in his recent book, *The Hidden Spring* (Solms 2021), what he calls the 'free energy theory of consciousness' (ibid: 2), rallying against the 'cortical fallacy' that views consciousness as centred in the relatively evolutionarily recent cerebral cortex (the seat of intelligence, which Solms argues should not be conflated with consciousness) and claiming instead that consciousness essentially arises from affect, as mediated by the much older periaqueductal grey (PAG) in the brainstem region of the brain, along with the neighbouring reticular activating system (RAS)[23]. On this view, according to Solms, consciousness is simply "about feeling, and feeling, in turn, is about how well or badly you

[22] Solms succinctly describes the hard problem as the question "why and how does the subjective quality of experience arise from objective neurophysiological events?" (Solms 2021:301).

[23] Solms builds here on the foundational work of his colleagues and fellow affective neuroscientists Jaak Panksepp and Antonio Damasio. Notably, "[t]he main difference between these nuclei and the PAG is the direction of information flow between them and the forebrain. Whereas the reticular activating system mainly exerts its influence *upwards* into the cortex, the cortex only transmits signals back *down* to the PAG" (2021: 135).

are doing in life. Consciousness exists to help you do better" (ibid: 4). Here, "*[t]he cortex becomes conscious only to the extent that it is aroused by the brainstem*. The relationship between the two is hierarchical; cortical consciousness *depends* upon brainstem arousal." (ibid: 128 — emphasis in original)[24] This is an important move. For Solms, "what is lacking in the neuroscience of our time is a clear focus on the embodied nature of *lived experience*" (ibid: 4). Adjusting our focus therefore entails a return to Freud, for whom feeling, instinct and so forth were such crucial parts of the mind, through the lens of the latest findings in neuroscience; for example, research into hydranencephalic children who were born without frontal cortex and are thus often assumed to exist in an entirely *unconscious*, vegetative state but who are, for Solms, still clearly subjects of experience in that they are able to express nuanced emotions in response to situations (ibid: 52-54). It is at this point that Solms moves to a discussion of the FEP as a way of understanding the complex relations between the PAG, affect, conscious experience and the frontal cortex in order to respond to the hard problem. Simply put, Solms claims that while the question posed by the hard problem is relevant for most cognitive functions, which could be imagined to operate automatically without any subjective valence, the same cannot be said to be true for affect, which is a necessarily subjective state. As he bluntly puts it: "How can you have a feeling without feeling it?" (ibid: 302). If we accept that this is the case[25], and given the argument for the centrality of the PAG/RAS in mediating consciousness, then it is the case that "affect is revealed to be the foundational form of consciousness. The sentient subject is literally constituted by affect" (ibid: 302). Affect, of course, serves an evolutionary biological function, specifically that of regulating homeostasis in living systems. More accurately, in terms that should be familiar by now, "[a]ffect hedonically valences biological needs, so that increasing and decreasing deviations from homeostatic settling points (increasing and decreasing prediction errors) are felt as unpleasure and pleasure respectively" (ibid: 303). Solms employs Panksepp's taxonomy of needs here[26], which reduces our affective experience to the categories of LUST, SEEKING, RAGE, FEAR, PANIC/GRIEF, CARE and PLAY (ibid: 122-147). Each of these "has an affective quality of its own and each triggers action programmes which are predicted to return the organism

---

[24] More technically, "The PAG is the final assembly point of all the affect circuits of the brain. So, whereas the forebrain is aroused by the reticular activating system, the PAG is aroused (as it were) by the forebrain. We might think of the reticular activating system and PAG, respectively, as the origin and destination of forebrain arousal" (ibid: 136).

[25] At this point we may object that there's a kind of misleading folk psychological vividness here: our subjective experience of affect is, after all, just like any other subjective experience - an epiphenomenal or emergent property of brain activity and not an explanation of the link between 'brain' and 'mind' or why the former should give rise to the latter. However, Solms argues convincingly, with reference to a number of neuroscientific experiments, that this is not the case and that consciousness is directly, inexorably entailed by the brain functions associated with affect. Quite simply, if we believe that our brains have evolved the ability to navigate conflicting simultaneous needs, and if we accept the reasonable hypothesis that this happens via affect, then it's difficult not to conclude that consciousness is baked into neurobiological functioning.

[26] "As far as we know, these are the basic ingredients of the entire human emotional repertoire. All our myriad joys and sorrows appear to be the outputs of these seven systems, blending with each other and with higher cognitive processes" (Solms 2021: 103-104).

to its viable bounds" (ibid: 302). The link with Markov blankets should be getting clearer: our affective states represent the relationship between internal models and external states; we respond to these affective states (e.g., the feeling of fear) based on the degree of mismatch — or free energy — between them and a desired affective state, or a need, via said action programmes, which serve to either update our internal state (changing beliefs in view of changes in affective experience) or update the external state (changing what we're doing). Due to the complex nature of both ourselves and the world, however, we are presented, at any given juncture, with a range of overlapping affective states that we have to prioritise, something that we slowly learn how to do first via reflexes and instincts and then, increasingly, because of what we've learned from previous experience. In other words, the biological function of experience, and the 'reason' for consciousness, is simply for us to be able to choose how to respond to — and learn from — the continuous flow of conflicting heterogeneous needs we experience from moment to moment in order to maintain as great a state of stability as possible, both in the present and in as wide a range as possible of unpredictable future situations. In short, consciousness, which is primarily affective, is how we navigate free energy minimisation in complex contexts. Here is Solms's neuroscientific gloss of his core argument:

> Needs cannot all be felt at once. They are prioritised by a midbrain decision triangle, where current needs (residual prediction errors, quantified as free energy) converging on the periaqueductal grey are ranked in relation to current opportunities (displayed in the form of a two-dimensional 'saliency map' in the superior colliculi). This triggers conditioned action programmes, which unfold in expected contexts over a deep hierarchy of predictions (the generative model of the expanded forebrain). The actions that are generated by prioritised affects are voluntary, which means they are subject to here-and-now choices rather than pre-established algorithms. Such choices are felt in exteroceptive consciousness, which contextualises affect. The choices are made on the basis of fluctuating precision-weighting (a.k.a. arousal, modulation, post-synaptic gain) of the incoming error signals that are rendered salient by prioritised needs, while they are buffered in working memory, with the aim of minimising uncertainty (maximising confidence) in a current prediction as to how the need can be met. (Solms 2021: 303-304)

Perhaps the most intuitively unsettling aspect of Solms's argument is that, because consciousness is only required to mediate mismatches between internal and external states, the more adaptively and predictively reliable our model becomes, the more our behaviour becomes automated, operating below the level of conscious experience. Consciousness is needed in situations where surprisal needs to be minimised. When there's no surprisal, there's not much need for consciousness. Consciousness, then, is a process that seeks to overcome itself. Fortunately, however, the inherent imperfection of this process due, in part, to the practically infinite opportunities the world provides for surprisal, means the ends of consciousness, in both senses of this term, are never met and we are thus left to enjoy at least some degree of irreducibly conscious experience centred on exploration and novelty, or the maintenance of a close-to-equilibrium state experienced as pleasurable[27]. "We aspire to automaticity — absolute confidence — but we can never achieve it completely. To the extent that we fail, we suffer feelings. Since we never achieve errorless prediction, the default drive (when all goes well) is SEEKING", a form of epistemic foraging that reflects "a proactive engagement with uncertainty, with the aim of resolving it in advance", and which "is felt as curiosity and interest in the world" (ibid: 304). And that's it. As austere as this proposed solution to the hard problem is, it is "no less capable of explaining how and why proactively resisting entropy (i.e. oblivion) feels like something than other scientific laws are capable of explaining other natural things" (ibid). For Solms, consciousness is simply a perfectly ordinary, mathematically tractable feature of nature (ibid).

The import of the FEP, and of Solms's ambitious usage of it specifically, comes down in part to the same difficult questions around models and epistemology we alluded to earlier. Friston and his colleagues tend to err on the side of caution in this regard, viewing the FEP as simply a useful framework, although some have recently argued that the realist option, i.e., the view that the FEP describes a real organising principle of living systems, is viable (Kirchoff et al. 2022). Here, the nuanced epistemological work undertaken in contemporary philosophy of science and biology underscores a need for caution, especially given the multiple subtly different ways in which the relations between models and reality are conceived of in these fields (Andrews 2021). Also, on a Deleuzian view, "[i]t is possible that notions such as singular and regular, or remarkable and ordinary, have a greater epistemological and ontological importance for philosophy than do the notions of true and false, because sense depends on the distinction and distribution of these brilliant points in the Idea" (Deleuze 2004: 100), and that "the movement of scientific concepts participates in a dialectic that surpasses them" (ibid: 107). Here we should recall that when we shift our focus from the individuated to the individuating, we confront the need for a transductive thought, or "an epistemology that would be anterior to any logic" (Simondon 2020: 87,363) because logic, like ontology or any other forms of scientific or philosophical thought, represents a particular end-point of the individuation of thought itself[28], "the distribution of the real according to a measure, a mutual criterion of extension and comprehension" (ibid: 108), and "the conditions of possibility of knowledge are in fact the individuated being's causes of existence" (ibid: 293). Let us continue down this path, or rather "back up the path that science descends, and at the

[27] This is interestingly close to Deleuze's view that "[b]iophysical life implies a field of individuation in which differences in intensity are distributed here and there in the form of excitations. The quantitative and qualitative process of the resolution of such differences is what we call pleasure" (Deleuze 1994: 96).

[28] "If it were true that logic bears on statements relative to being only after individuation, a theory of being anterior to all logic would have to be established; this theory could serve as the foundation to logic, for nothing proves in advance that being is individuated in a single possible way; if several types of individuation existed, several logics would also have to exist, each corresponding to a definite type of individuation. The classification of ontogeneses would make it possible to pluralize logic with a valid foundation of plurality" (Simondon 2020: 17).

very end of which logic sets its camp" (Deleuze & Guattari 1994: 140), leaving aside 'framework' vs 'realist' arguments in order to think about what Deleuze, who has been largely absent until now, could add to the FEP. The reasons for such a speculative undertaking are simple: the FEP, although it may not seem initially obvious, shares a number of features with Deleuze's and Simondon's accounts of ontogenesis. While the FEP's focus is on ontology, i.e., on how systems endure, it can also be viewed as a framework for thinking about ongoing individuation. The FEP also provides an entirely immanent, emergent account that operates almost entirely without an 'image of thought'. By expanding on the FEP through providing a fuller account of ontogenesis, we may in turn be able to enhance Solms's account, moving beyond the hard problem of 'why is it like something' to 'what could it be like?' by developing an account of the individuation of consciousness itself in line with contemporary neuroscience. Let's begin by reminding ourselves of the idea of ontogenesis in Deleuze, as influenced by Simondon.

From ontology to ontogenesis

> To live consists in being agent, milieu, and element of individuation. Perceptive, active, and adaptive behaviors are aspects of the fundamental and perpetuated operation of individuation that constitutes life. (Simondon 2020: 236-7)

In this section, I assume broad familiarity with the argument developed in the last two chapters of 'Difference and Repetition', where Deleuze provides his most detailed account of ontogenesis; I will not rehearse that account here beyond observing, as others have, that it bears striking similarities to the one Simondon outlines in *Individuation in Light of Notions of Form and Information* (2020). While there are some differences I will, in what follows, weave Simondon and Deleuze together as, in turn, I weave their theory of ontogenesis together with the ontological framework of the FEP. First, we should remind ourselves of the underlying justification for the focus on individuation — and by extension the method of transcendental empiricism –as opposed to ontology, which is simply that "[t]he hylomorphic schema improperly replaces the knowledge of the genesis of a real; it prevents the knowledge of ontogenesis" (Simondon 2020: 351). Said otherwise, we tend to model individuation on the basis of already-formed individuals, whereas "the individual can only be contemporaneous with its individuation, and individuation, contemporaneous with the principle: the principle must be truly genetic, and not simply a principle of reflection" (Deleuze 2004: 86). In order to think ontogenesis *qua* ontogenesis, we thus need to think difference in itself — difference differing. This is a more difficult task than we may at first imagine; as Simondon puts it, if we are trying to think about the more-than-unity[29] of pre-phased, metastable being as it exists before any individuation, i.e., the pre-ontological, then "the principle of the excluded middle and the principle of identity are no longer applicable; these principles only apply to the already individuated being, and they define an impoverished being that is separated into milieu and individual" (Simondon 2020: 13). In other words, we cannot use "classical logic… to think individuation" (ibid). In fact, we have to develop a thought of individuation that is itself an individuation of thought; "we must consider being not as substance or matter or form, but as a tense, supersaturated system above the level of unity, as not merely consisting in itself, and as unable to be thought adequately by means of the principle of the excluded middle; the concrete being or complete being, i.e. pre-individual being, is a being that is more than a unity" (Simondon 2020: 4). It is differences between differences — "infinitely doubled difference which resonates to infinity" or "the unequal in itself", that is "[t]he reason of the sensible, the condition of that which appears" (Deleuze 1994: 222-223). Already, there is an initial resonance with the FEP: a Markov blanket is simply a way of describing a relation between two relations — a disparation — that produces information[30]. The blanket is what causes two series to communicate, triggering resonances and forced movements, i.e., redistributions of weightings in a differential field, based on the ongoing amelioration of asymmetry. While the *emergence* of Markov blankets is to some extent assumed in Friston's work[31], how such blankets come to be, their individuation, is also the ongoing transductive result of an initial disparation. As Simondon explains, using his well-known example of how binocular vision gives rise to a sense of depth via an initial disparity in the visual information available to each eye, "preliminary disparation… becomes a condition of structure and operation in a state of metastable equilibrium: the living being is what maintains, transposes, prolongs, and sustains this metastable equilibrium through its activity" (Simondon 2020: 235). When considering psychic beings specifically, disparation gives rise to both the thought of individuation and the individuation of thought: as we navigate the world while wrapped in our Markov blankets, free energy minimisation via active inference entails an immediate correlation between internal and external states, where how we think about the world and choose to act in it via model updating is itself an individuation based on the affective differentials[32] that drive the ongoing functioning of the blanket. Or, in Simondon's terms, "[t]he individual is not a being but an act… It stores, transforms,

[29] "As pre-individual, being is more than one— metastable, superposed, simultaneous with itself. As individuated, it is still multiple, because it is 'multiphased', 'a phase of becoming that will lead to new processes'" (Simondon cited in Deleuze 2004: 89).

[30] Information is used within the FEP in a more traditional information-theoretic sense, but I am employing it here in the sense used by Simondon, which is closer to the idea of the dark precursor than to the common notion of information in fields like information theory: "unlike form, information is never a single term but the signification that emerges from a disparation" (Simondon 2020: 16).

[31] Although Friston does allow for complex nestings of Markov blankets, where the interplay of systems mediated by blankets can give rise to blankets of blankets and so forth. This maps closely to the nesting of individuation in living systems in Simondon (2020: 51).

reactualizes, and carries out the schema that has constituted it; it propagates the schema by individuating" (ibid: 208). It is interesting in this regard that Simondon, Deleuze and Friston all employ a thermodynamic framework in thinking about 'differences that make a difference' vis-à-vis individuation, although Deleuze famously challenges the scope of thermodynamics as inapplicable to the pre-individual in a particularly abstruse section of *Difference and Repetition* (Deleuze 1994: 223-224). Deleuze and Friston also both use mathematical models like phase portraits and topological manifolds to describe, for the latter, the possibility space of a system, i.e., the states it can be in, and for the former, the structure of the virtual and its dramatization, as well as the *tendencies* of systems, or virtual multiplicities, as ongoing processes of becoming, the latter via the description of the attractors that define where a system is likely to end up. DeLanda describes these as "certain special topological features of two-dimensional manifolds (called singularities) which have a large influence in the behaviour of the trajectories, and since the latter represent actual series of states of a physical system, a large influence in the behaviour of the physical system itself" (DeLanda 2002: 7). This is resonant with Simondon's observation that being, or the individual, "which is the result but also the milieu of individuation" (Simondon 2020: 361), is multi-phased, "multiple insofar as it is polyphasic, multiple not as if it harbored within it a plurality of more localized and more momentary secondary individuals, but because it is a provisional solution, a phase of becoming that will lead to new operations" (ibid). Thus, a metastable system can individuate into a number of different partial, relative realities and contains within it the potential to phase into yet others; the intensive is enveloped by the extensive but continues to harbour the capacity for ongoing individuation; it is "a partial and relative resolution that manifests in a system which contains potentials and includes a certain incompatibility with respect to itself" (Simondon 2020: 3-4). This uncancelled incompatibility is also sometimes described by Deleuze as the structure of the problematic (virtual) field of which any individuation provides only a partial resolution; again, we can here view the ongoing operations of a system qua free energy minimization as ongoing partial resolutions to virtual problems defined by its differential structure qua internal model as a "system that is objectively problematic" (Deleuze 2004: 88), this all as mediated by the Markov blanket[33]. Deleuze describes virtual multiplicities or problematic fields as Ideas — "complexes of coexistence", and elaborates that "all Ideas coexist, but they do so at points, on the edges", and "combine the greatest power of being differentiated with an inability to be differenciated" (ibid: 235). This state of coexistence is referred to as 'perplication', a kind of probabilistic simultaneity — or metastability — that is quite close to the Bayesian statistical probabilities that, for Friston, provide the structural composition of internal models; here, as in machine learning, there is a probability distribution over system states — or beliefs — that is constantly redistributed through active inference as part of an energy

[33] "The veritable principle of individuation is mediation, which generally supposes an original duality of orders of magnitude and an initial absence of interactive communication between them, and then a communication between orders of magnitude and stabilization" (Simondon 2020: 6).

minimisation function. Here, in turn, we have something close to Deleuze's ideas of vice-diction and counteractualisation, i.e., understanding systems in their genesis and counter-effectuating them by seeking to redistribute their singular and ordinary points through throws of the dice. While active inference operates in the context of a differential field of probabilities representing a system that has already stabilised its boundaries and thus its Markov blanket, it is simple to shift the focus to its ongoing individuation — the spatio-temporal dyamisms and larval subjects enveloped by said system — and thus to expand the repertoire of active inference beyond ongoing redistributions of a probability space marked out by certain tendencies, or attractors, and towards the counteractualisation of the space itself via a redistribution of these attractors. In either case, through active inference we encounter an ongoing doubling of events, a reciprocal transduction, internal and external — the events in the world that we perceive or enact, and the events that, through the quasi-causality of the blanket[34], modulate the weightings of our models, sometimes slowly and incrementally, descending shallow gradients, sometimes rapidly, shocking them into new configurations and tearing holes in the blanket or throwing it off altogether.

There are undoubtedly many more ways we can bring the principle of ontogenesis together with the FEP[35]. While work in this direction on the implications of the philosophy of individuation for science has, beyond Deleuze and Simondon's own seminal oeuvres, been pursued mainly within post-Deleuzian philosophy, e.g., the Deleuze-inspired systems theory of DeLanda and Protevi, there have been some recent developments along these lines within the field of science proper, notably the field of physics, where biologist Stuart Kauffman has argued, with reference to Whitehead and to the exact-same concepts in quantum physics — superposition and uncertainty — that influenced Simondon's concept of metastability (Simondon 2020: 150), that we need to add the notion of "Res potentia, ontologically real possibilities" to our usual conception of "Res extensa, ontologically real actualities", the two "linked by, hence united by, quantum measurement." (Kauffman 2016). Here, of course, the collapse of superposition via measurement strongly echoes the symmetry-breaking cascades of individuation — the phasing of metastable being. Returning to the current task of bringing the FEP into conversation with a Simondonian-Deleuzian account of ontogenesis, what can we conclude? On the one hand, we have a rigorous systems theoretic ontological approach to living systems on all scales via the FEP and active inference. On the other, we have a

[34] Solms suggests something roughly analogous to quasi-causality, even relying on the same famous example of lighting Deleuze employs, when he observes that "[n]europhysiological events can no more produce psychological events than lightning can produce thunder. They are parallel manifestations of a single underlying process. The underlying cause of both lightning and thunder is electricity, the lawful mechanisms of which explain them both. Physiological and psychological phenomena can likewise be reduced to unitary causes, but not to each other" (Solms 2021: 301).

[35] Via Deleuze's 'Other structure', for instance, "which is implemented only by variable terms in different perceptual worlds - me for you in yours, you for me in mine. It is not even enough to see in the Other a specific or particular structure of the perceptual world in general: in fact, it is a structure which grounds and ensures the overall functioning of this world as a whole" (Deleuze 1994: 281).

focus on how these systems come to be. Further, given that active inference essentially entails an ongoing individuation of individual and milieu via the mediation of various nestings of Markov blankets, an implicit account of ontogenesis is already gestured at in the FEP. Said mediation can be understood as transductive relation, in the sense Simondon discusses when he talks about the reality of relations: "Individuation and relation are inseparable; the capacity of relation belongs to the being and enters into its definition and into the determination of its limits: there is no limit between the individual and its activity of relation; relation is contemporaneous with being; it belongs to being energetically and spatially… the potential that relation defines is veritable, not formal" (Simondon 2020: 152). Through this transductive relation, "a system reacts on itself not only in the sense of the principle of entropy through the general law of its internal energetic transformations, but also by modifying its own structure through time" (ibid: 159). This iterative self-modification of a system "is characterized by the fact that it discovers in its field of reality structural conditions that allow it to resolve its own incompatibilities, the distance between the orders of magnitude of its reality" (ibid: 162). There is, in other words, a "variation in the individual's levels accompanied by a structural change that is the internal correlative of an exchange of information or energy with the outside" (ibid: 171-2) [36]. Many more parallels could be elucidated. However, it's important to underscore that, while "[t]he equilibrium between integration and differentiation is what characterizes life… homeostasis is not full vital stability" (ibid: 172). The development and self-maintenance of a system can be understood as "successive inventions of functions and structures that resolve, step by step, the internal problematic carried by the individual as a message", with each of that system's "stages is presented as the solution of the previous states", but these resolutions remain partial, and "cannot be presented as a nullification of the being's tensions" (ibid: 225-6). Problems are not exhausted in their solutions because a problem is different "in kind from solutions"'; it is "transcendent in relation to the solutions that it engenders on the basis of its own determinant conditions", albeit remaining immanent "in the solutions which cover it" (Deleuze 1994: 178). Global optima are never reached because systems are

[36] At some points, Simondon's account could come straight from a paper on the FEP: "In the biological being, transduction is not direct but indirect according to a twofold ascending and descending chain; along each of these chains, transduction is what allows for signals of information to pass, but this passage, instead of being a simple conveyance of information, is integration or differentiation… Ultimately, transduction is carried out by affectivity and by all the systems that play the role in the organism of transductors on various levels" (Simondon 2020: 171). Or, "the living substance within the membrane regenerates the membrane but that the membrane is what guarantees that the living being is alive each moment, since this membrane is selective: it is what maintains the milieu of interiority as a milieu of interiority relative to the milieu of exteriority" (ibid: 251). Or "Perception is not the grasping of a form but the resolution of a conflict, the discovery of a compatibility, the invention of a form. This form that perception is modifies not only the relation between the object and the subject, but also the structure of the object and the structure of the subject" (ibid: 259). Indeed, when discussing how psychic individuation should focus on affectivity, he even explicitly refers to the foundational nature of the same ancient layers of the nervous system as Solms, i.e., the midbrain (ibid: 274).

never completely closed[37] — there is always the possibility of rupture, event, counteractualisation and "intensity is only suspect because it seems to rush headlong into suicide" (Deleuze 1994: 224). While a "particular form of empirical energy, qualified in extensity, can be at rest; one in which the difference in intensity is already cancelled because it is drawn outside itself and distributed among the elements of the system", this is not the case for "energy in general or intensive quantity" as this "is the spatium, the theatre of all metamorphosis or difference in itself which envelops all its degrees in the production of each" (Deleuze 1994: 240-241). As Deleuze underscores, "energy or intensive quantity is a transcendental principle, not a scientific concept" (ibid: 241).
It seems that our Simondonian-Deleuzian ontogenetic account can indeed enhance the FEP and that our monstrous coupling has perhaps provided us with a potentially very useful framework for thinking about systems in general and consciousness specifically. In concluding, let's briefly gesture towards one possible application of our heterogeneous SD-FEP framework: the effects of psychedelics on consciousness[38].

SEEKING and HYPERSEEKING: The method of psychedelic dramatization

> [T]o live is to perpetuate an ongoing relative birth.
>
> Simondon 2020: 325

> Shining points pierce us, singularities turn us back upon ourselves: everywhere the tortoise's neck with its vertiginous sliding of proto-vertebrae. Even the sky suffers from its cardinal points and its constellations which, like 'actor-suns', inscribe Ideas in its flesh. There are indeed actors and subjects, but these are larvae, since they alone are capable of sustaining the lines, the slippages and the rotations. Afterwards it is too late. It is true that every Idea turns us into larvae, having put aside the identity of the I along with the resemblance of the self. (Deleuze 1994: 219)

Remember that local minimum problem? The benefit of adding ontogenesis to our account is that it allows us to discuss not just how systems preserve themselves, but also how they come to be and, crucially, how they can become otherwise. The gradient descent approach we mentioned earlier demonstrates how systems can become stuck in local minima that might not represent optimal functioning. Figuratively speaking, we can identify with this idea of getting 'stuck in a rut', and anyone who has engaged with popular discourse around the potential therapeutic and creative benefits of psychedelics has

[37] "We know how these themes of a reduction of difference, a uniformisation of diversity, and an equalisation of inequality stitched together for the last time a strange alliance at the end of the nineteenth century between science, good sense and philosophy. Thermodynamics was the powerful furnace of that alloy" (Deleuze 1994: 223).

[38] The following section is a cursory introduction to some topics that will be explored in an upcoming work on Deleuze, Guattari and psychedelics, written with Chantelle Gray.

probably heard them described as offering potential solutions in this regard. While this discourse has, historically, tended towards the hyperbolic and the folk psychological, neuroscientist Robin Carhart-Harris has in recent years, in collaboration with Friston, developed a scientifically grounded framework for describing the action of psychedelics on the brain that builds on the FEP, integrating it with the entropic brain hypothesis (Carhart-Harris et al. 2014)[39]. This framework, REBUS (relaxed beliefs under psychedelics) and its corollary, the anarchic brain, argues, with reference to the neurobiological effects of neurotransmitters like serotonin and dopamine, and the dynamics of receptor sites like the NMDA receptors that ketamine binds to, that psychedelics have a demonstrable "entropic effect on spontaneous cortical activity" and that through this they "work to relax the precision of high-level priors or beliefs, thereby liberating bottom-up information flow, particularly via intrinsic sources such as the limbic system" (Carhart-Harris & Friston 2019)[40]. On a neuroscientific level, this is described as the relaxation of "the precision weighting of prior beliefs encoded in the spontaneous activity of neuronal hierarchies", something which, on a subjective level, is "commensurate with felt confidence" (ibid). In other words, psychedelics cause a transient rupture in the relationship between our models and our data, amplifying prediction errors in a way that necessitates the production of new beliefs, i.e., redistributions of neurological weightings through a short-term increase in neuroplasticity and synaptic efficacy. Carhart-Harris et al. argue that this relaxation effect "is felt most profoundly when it occurs at the highest or deepest level of the brain's functional architecture, i.e., the levels that instantiate particularly high-level models such as those related to selfhood, identity, or ego"[41] (ibid). This is also described as an 'entropic hot state', wherein the Bayesian probability landscape is flattened as a psychedelic substance takes effect, which, in the language of complex systems, means that the force of usually dominant attractors representing ideal states vis-à-vis the FEP is dramatically attenuated, with the result that "attracting brain states (and accompanying mind states) encoding beliefs are less stable and influential, implying that interstate transitions can occur more freely… the mind and brain spontaneously transition between states with greater freedom — and in a less predictable way" (ibid). This brief plasticity window, where a system is operating far from equilibrium, near the thresholds at which bifurcations occur, can "leave a legacy of potentially enduring functional and perhaps anatomic change" (ibid), i.e., a redistribution not just of weightings but of attractors themselves — attractors may shift from steady state to cyclical to chaotic, or be replaced

39 "According to the entropic brain hypothesis, psychedelics increase brain entropy and therefore result in more diversity and vividness in subjective awareness" (Carhart Harris et al. 2018).

40 This 'bottom-up' flow is what is described as the 'anarchic brain'.

41 It is important to note here that free energy minimisation can be employed as a framework at various scales of abstraction. While "we know that an agent can minimize free energy via perceptual… and active inference… both of which entail sampling and sculpting the world to refine internal representations of it and thus reduce uncertainty or enhance confidence", free energy can also be minimised "via the selection and/or revision of beliefs about the acquired models themselves" (Carhart-Harris et al. 2019: 332).

by other attractors altogether. Or, in more folk psychological terms, "confidence in high-level models is first relinquished so that content previously hidden from consciousness by the occluding influence of overly confident priors is now allowed to emerge, thereby enabling fresh perspectives to be entertained" (ibid). If this view is correct, and if "overweighted high-level priors can be all consuming, exerting excessive influence throughout the mind and brain's (deep) hierarchy", then it may provide us with useful ways of understanding — and intervening in — undesirable cognitive states like depression and psychosis, eventually serving "a major role in the future of mental health care, potentially improving the efficacy of current treatment strategies by factoring in contextual variables when assessing the neurobiology of a given disorder and the viability of a specific intervention" (ibid).

The parallels with our ontogenetic account should be clear. Getting stuck in a local minima on our way down the hill, or an attractor distribution that maintains us in a small number of close-to-equilibrium states, is similar to what Simondon describes as exhaustions; these are systems that have lost their lines of flight and require "the violent shock of an encounter with pure intensive differences" (Deleuze 1994: 140) — the creation of larval subjects or a Body without Organs, "the only patient able to endure the demands of a systematic dynamism" (Deleuze 1997: 98). Just as the FEP pulled us in the direction of the thought of ontogenesis and individuation, so too does REBUS and the anarchic brain gesture towards vice-diction, counteractualisation and anarchy crowned, a useful exploratory framework for thinking about the production of the *new* within thought; not just how we can move to different stabilities or basins of attraction within a metastable system, but also how we can *redistribute* those attractors[42]. "The fundamental idea", Deleuze says, "is that the pre-individual, a 'source of future metastable states,' must remain associated with the individual" (Deleuze 2004: 89). If we cut ourselves off from the charge of pre-individual reality from which we emerged, "animated by all the potentials which characterise it" (Simondon 2020: 8), we end up "closed in on a singularity, refusing to communicate, and provoking a loss of information" (ibid). The pre-individual "is a source of future metastable states from whence new individuations will be able to emerge" (Simondon 2020: 8), Just as Solms discusses SEEKING as our default state, perhaps we could conceive of the psychedelic experience as a kind of HYPERSEEKING that occasionally becomes necessary — a reseeding of the game of life once it has become static or locked in a holding pattern, eschewing the distributions that flow from good sense for those "inspired by madness, mad repartitions" (Deleuze 1994: 224). Sometimes there's some sunshine through the mist and we can see a little more of the path ahead and realise that we're heading in the wrong direction. Perhaps "in order to grasp the other as such, we were right to insist upon special conditions of experience,

[42] "Typically, distributions of attractors are structurally stable and this, in part, is what accounts for their recurrence among different physical systems. On the other hand, if the perturbation is large enough a distribution of attractors may cease to be structurally stable and change or bifurcate into a different one. Such a bifurcation event is defined as a continuous deformation of one vector field into another topologically inequivalent one through a structural instability" (DeLanda 2002: 23).

however artificial" (ibid: 260); to seek a depth or groundlessness in which "forms decompose, every model breaks down and all faces perish, leaving only the abstract line as the determination absolutely adequate to the indeterminate, just as the flash of lightning is equal to the night, acid equal to the base, and distinction adequate to obscurity as a whole" (ibid: 275). Simondon describes this as the anxiety that "is like the inverse course of ontogenesis"; a point of departure which "unravels what has been woven, submerging individual being in the pre-individual" and serving as "a relinquishment and the acceptance to cross the destruction of individuality to venture toward another unknown individuation" (Simondon 2020: 284). This practice of HYPERSEEKING, of becoming worthy of the dice throw and the event, is what Simondon describes as an ethics; one "through which the subject remains subject, refusing to become an absolute individual, a closed domain of reality, or a detached singularity" (ibid: 380). This is "the meaning of perpetuated individuation, the stability of becoming, which is that of the being as pre-individuated, individuating, and tending toward the continuous that reconstructs in an organized form of communication a reality as vast as the pre-individual system" (ibid). Of course, there are many ways to create the Body without Organs; however we proceed, and we should always proceed with caution in order not to deterritorialise too fast, "[p]harmacodynamic experiences or physical experiences such as vertigo approach the same result: they reveal to us that difference in itself, that depth in itself or that intensity in itself at the original moment at which it is neither qualified nor extended", and it is at this point that "the harrowing character of intensity, however weak, restores its true meaning: not the anticipation of perception but the proper limit of sensibility from the point of view of a transcendent exercise" (Deleuze 1994: 237). This self-undoing, this folding, refolding and unfolding, is the infinite game of life. This is the power that "always springs from affirmation, from joy, from a cult of affirmation and joy, from the exigency of life against those who would mutilate and mortify it" (Deleuze 1997: 144).

At the beginning of our individuation of thought, we discussed cellular automata. We could, of course, have elaborated a whole other interweaving of Deleuze and Wolfram Physics as another discrete actualisation, but we took an alternative route and followed the free energy principle instead. We could offer the poetic justification that this is because our first individuation ended up stuck in a local minima, exhausting itself, and we thus needed to HYPERSEEK something else. However, perhaps it just underscores the provisionality of the route we did take, and the need to keep our underlying assumptions epistemologically open, because epistemology matters. As Varela reminds us, speaking about the Chilean civil war, it was a 'wrong epistemology' that his friends and 80 000 others paid for with their lives or their torture (Varela 1971). "If I am interested in doing anything at this point", he declares, "it is in creating a form of culture, knowledge, religion, or politics that does not view itself as replacing another, in any sense, but one that can contain in itself a way of undoing itself" (ibid).

Coda: The infinite game of life

In the closing minutes of the film Magnolia, we see a young boy standing at his window. It's raining frogs. The boy watches for a while and then says, simply, "this is a thing that happens."

The infinite game reseeds.

It's 1973 in Chile. The coup is underway. Francisco Varela is hiding from men with guns. He occupies himself with silly little things. He draws little pictures on the foggy windows.

The infinite game reseeds.
Deleuze is short of breath. He walks over to the window of his Parisian apartment. Looking out, he asks himself, "what is a life?"

The infinite game reseeds.

Outside the window, on the grass, a young Karl Friston is watching some woodlice scurrying around looking for shade. "What is a life?", he wonders.

The infinite game reseeds.

I have a fever. A storm rages outside my bedroom window. Delirious, I hallucinate the whole of history.

The infinite game reseeds.

BIBLIOGRAPHY

Andrews, M. (2021). "The Math is not the Territory: Navigating the Free Energy Principle". *Biology & Philosophy* volume 36, Article number: 30.

Becker, A. (2020). "Physicists Criticize Stephen Wolfram's 'Theory of Everything'". In *Scientific American.* Retrieved from: https://www.scientificamerican.com/article/physicists-criticize-stephen-wolframs-theory-of-everything.

Carhart-Harris, R. L. (2018). "The entropic brain – revisited." *Neuropharmacology* 142: 167-178.

Carhart-Harris, R. L., & Friston, K. (2019). "REBUS and the Anarchic Brain: Toward a Unified Model of the Brain Action of Psychedelics". *Pharmacological Reviews* July 2019, 71 (3): 316-344.

Chalmers, D. J. (1996). *The Conscious Mind*. Oxford: Oxford University Press.

Clark, A. (2016). *Surfing Uncertainty: Prediction, Action, and the Embodied Mind*. Oxford: Oxford University Press.

Conant, R.C., & Ashby, W.R. (1970). "Every good regulator of a system must be a model of that system." *International Journal of Systems Science*, 1(2): 89–97.

DeLanda, M. (2002). *Intensive Science and Virtual Philosophy.* London: Bloomsbury Academic.

DeLanda, M. (2010). *Deleuze: History and Science.* New York: Atropos Press.

DeLanda, M. (2011). *Philosophy and Simulation: The Emergence of Synthetic Reason.* Bloomsbury Academic.

Deleuze, G. (1994). *Difference and Repetition*. (Trans. by P. Patton). London: Athlone Press.

Deleuze, G. (1997). *Essays Critical and Clinical.* (Trans. by D. Smith). Minnesota: Minnesota Press.

Deleuze, G. (2004). *Desert Islands and Other Texts: 1953-1974.* (Trans. by M. Taomina). Los Angeles: Semiotext(e).

Deleuze, G., & Guattari, F. (1977). *Anti-Oedipus.* (Trans. by R. Hurley M. Seem and H. R. Lane). London, Minneapolis: University of Minnesota Press.

Deleuze, G., & Guattari, F. (1987). *A Thousand Plateaus: Capitalism and Schizophrenia.* (Trans. by B. Massumi). London, Minneapolis: University of Minnesota Press.

Deleuze, G. & Guattari, F. (1994). *What is Philosophy?* (Trans. by H. Tomlinson & G. Burchell). New York: Columbia University Press.

Eloff, A. (2021). "2006: The Topology of Morals (Who Does the Algorithm Think We Are?)." *Deleuze and Guattari Studies* 15(2): 178-96.

Freed, P. (2010). Research Digest. *Neuropsychoanalysis*, 12(1):103–106.

Friston, K., Kilner, J., & Harrison, L. (2007). "A free-energy principle for the brain." *J Physiol Paris* 100(1–3): 70–87.

Friston, K., & Kiebel, S. (2009). "Cortical circuits for perceptual inference". *Neural Networks* 22(8): 1093–1104.

Friston, K. (2010). "The free-energy principle: a unified brain theory?" *Nature Reviews Neuroscience*, 11 (2): 127-138.

Friston, K. (2012). "The history of the future of the Bayesian brain". *NeuroImage*, Volume 62, Issue 2: 1230-1233.

Friston, K. (2013). "Life as we know it." *J R Soc Interface* 10(86): 20130475.

Friston, K. (2016). "Active inference and learning." *Neuroscience & Biobehavioral Reviews,* Volume 68: 862-879.

Friston, K., Costa, L.D., Sajid, N., Heins, C., Ueltzhoffer, K., Pavliotis, G.A., & Parr, T. (2022). *The free energy principle made simpler but not too simple*. Preprint available online at https://arxiv.org/ftp/arxiv/papers/2201/2201.06387.pdf.

Hájek, A., & Lin, H. (2017). 'A Tale of Two Epistemologies'. *Res Philosophica*, Vol. 94, No. 2: 207–232.

Hossenfelder, S. (2018). *Lost in Math: How Beauty Leads Physics Astray.* New York: Basic Books.

Kauffman, S. (2016). "Res Potentia And Res Extensa Linked, Hence United, By Quantum Measurement". In D. R. Griffin, M. Epperson & T. E. Eastman (eds.), *Physics and Speculative Philosophy: Potentiality in Modern Science*. Berlin: De Gruyter, 47-52.

Kirchhoff, M., Parr, T., Palacios E., Friston K., & Kiverstein, J. (2018). "The Markov blankets of life: autonomy, active inference and the free energy principle." *Journal of the Royal Society Interface*. 15: 1-11.

Kirchhoff, M., Kiverstein, J., & Robertson, I. (2022). *The Literalist Fallacy & the Free Energy Principle: Model-building, Scientific Realism and Instrumentalism*. [Preprint]

Maturana, H. R., & Varela, F. J. (1980). *Autopoiesis and cognition*. Berlin: Springer Science & Business Media.

Parr, T., Pezzulo, G., & Friston, K. (2022). *Active Inference: The Free Energy Principle in Mind, Brain, and Behavior*. Massachusetts: MIT Press.

Prigogine, I. (1967). *Introduction to Thermodynamics of Irreversible Processes*. 3rd edition, New York: Wiley Interscience.

Simondon, G. (2020a). *Individuation in Light of Notions of Form and Information (Volume 1).* (Trans. by T. Adkins). London, Minneapolis: University of Minnesota Press.

Solms, M. (2021). *The Hidden Spring: A Journey to the Source of Consciousness.* London: Profile Books.

Solms, M., & Friston, K. (2018). "How and why consciousness arises: Some considerations from physics and physiology." *Journal of Consciousness Studies*, 25 (5-6): 202-238.

Spencer-Brown, G. (1969). *Laws of Form*. London: Allen & Unwin.

Varela, F. (1979). "Reflections on the Chilean Civil War." *Lindisfarne Letter* 8: 13–19.

Wolfram, S. (2002). *A new kind of science*. Champaign, Ill.: Wolfram Media.

Wolfram, S. (2020a). "Finally We May Have a Path to the Fundamental Theory of Physics… and It's Beautiful." Retrieved from: https://writings.stephenwolfram.com/2020/04/finally-we-may-have-a-path-to-the-fundamental-theory-of-physics-and-its-beautiful.

Wolfram, S. (2020b). "A Class of Models with the Potential to Represent Fundamental Physics." Retrieved from: https://www.wolframphysics.org/technical-introduction/.

Wolfram, S. (2021). "The Concept of the Ruliad." Retrieved from: https://writings.stephenwolfram.com/2021/11/the-concept-of-the-ruliad/.