DeepDream Aesthetics. Artificial Imagination and Machine Creativity

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Abstract: DeepDream is a computer vision program designed to make associations starting from a given image; these associations are based on its training, that is its recognition "habits". The aim of this article is to analyze DeepDream's specific functioning as an example of non-human imaginative behavior endowed with its own visual style (par. 1). This claim is substantiated by a non-anthropocentric perspective on style (par. 2) and creativity (par. 3). Style is conceptualized as an encounter between different factors (such as function, form, context and materials) occurring within a problematic field; creativity, on the other hand, is referred to the systemic capacity of entering a process of self-organization resulting in an act of individuation.

Keywords: AI Aesthetics; Computational Aesthetics; Algorithmic Creativity; Artificial Unconscious; Style.

> What used to be called the human has now evolved beyond recognition. Narcissus can no longer see or anticipate his own image in the mirror. The recognition of the blank mirror is the sign that we have finally left our narcissistic phase behind.
>
> Reza Negarestani, *Revolution Backwards: Functional Realization and Computational Implementation*

> And now I see, with eye serene
> The very pulse of the machine
>
> William Wordsworth, *She Was a Phantom of Delight*

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1. *DeepDream and artificial imagination*

DeepDream is a computer vision program released in 2015 by Google engineer Alexander Mordvintsev as a tool to better understand artificial neural networks, which became rather popular for its perplexing, unsettling performances as an image generator (**fig. 1**). In this paper, I contend that DeepDream's particular appeal stems from a specific functioning, or artificial behavior, and that this tells us something of great importance about machines in general.

An artificial neural network (ANN) is a computing system inspired by the animal brain that is able to detect relationships within large amounts of data. An ANN is made of layers of so-called artificial neurons, that can receive, elaborate and transmit signals, assigning them a "weight" or a value and thus reproducing the basic mechanisms of attention and perception. ANNs are complex, nonlinear[1] systems whose peculiarity is that they can "learn". If fed with labeled images, an ANN can analyze the given links between input and output and then structure its network accordingly by adjusting the numerical values assigned to its own components. As it happens in language learning, ANNs can associate certain relations to certain recurring traits through trials and errors, and finally generate pseudo-perceptual patterns. This method, called Deep Learning, was largely used for the purpose of image recognition:

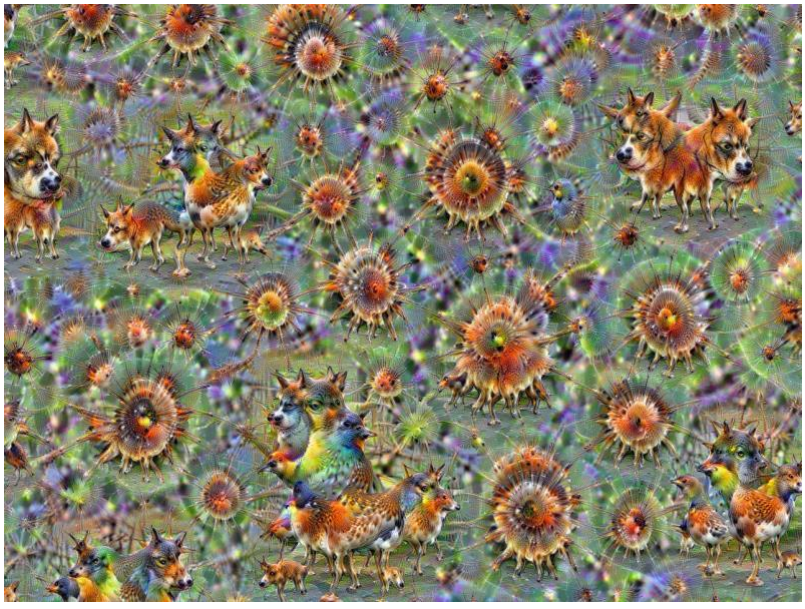

Figure 1 An image generated by DeepDream. © Wikimedia Commons.

[1] "Nonlinear" here means that the variations in the input are not proportional to the variations in the output.

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after a learning process, a neural network is able to automatically filter, select and classify images by detecting figures in them.

DeepDream is an ANN that can detect figures in images, but also make new associations starting from an image. These associations are based on the ANN's training, i.e., on its recognition "habits". If the usual request to a program of this type is "Can you recognize the figures represented in this image?", DeepDream can also be asked: «Whatever you see there, I want more of it!» (Mordvintsev 2015). «This creates a feedback loop: if a cloud looks a little bit like a bird, the network will make it look more like a bird. This in turn will make the network recognize the bird even more strongly on the next pass and so forth, until a highly detailed bird appears, seemingly out of nowhere» (Mordvintsev 2015). In this way, DeepDream does not aim to precise and refined figure recognition, but to figure *proliferation*. When DeepDream is repeatedly tasked to recognize complex patterns, it generates figures of its own imagination basing on its domain knowledge, which is the analogue to its memory. As Mordvintsev explains,

> Even a relatively simple neural network can be used to over-interpret an image, just like as children we enjoyed watching clouds and interpreting their random shapes. This network was trained mostly on images of animals, so naturally it tends to interpret shapes as animals. But because the data is stored at such a high abstraction, the results are an interesting remix of these learned features (Mordvintsev 2015).

DeepDream is an experimental program with no practical function, meant as an effort to understand how ANNs work by reversing one of their functions. Nonetheless – or maybe exactly thanks to its experimental nature, its being a *machine célibataire*[2] –, it does hold a strong theoretical interest. The first aspect to analyze is its particular functioning or behavior, namely what it does basing on its algorithm. Like humans do when they see, say, faces in clouds, DeepDream detects imaginary figures on the basis of unrelated visual stimuli (**fig. 2**)[3]. This is a case of "artificial pareidolia". Pareidolia is a hyper-recognition dynamic, probably an evolutionary bug in human perception, that

[2] I refer to the concept of "bachelor machine" first coined by Marcel Duchamp and further elaborated by Michel Carrouges with reference to "absurd" machines that do not serve any useful purpose, but tell us something about reality itself by embodying its «implacable logic» (Carrouges 1995: 21).

[3] More images displaying this process of image generation can be found again at Mordvintsev 2015.

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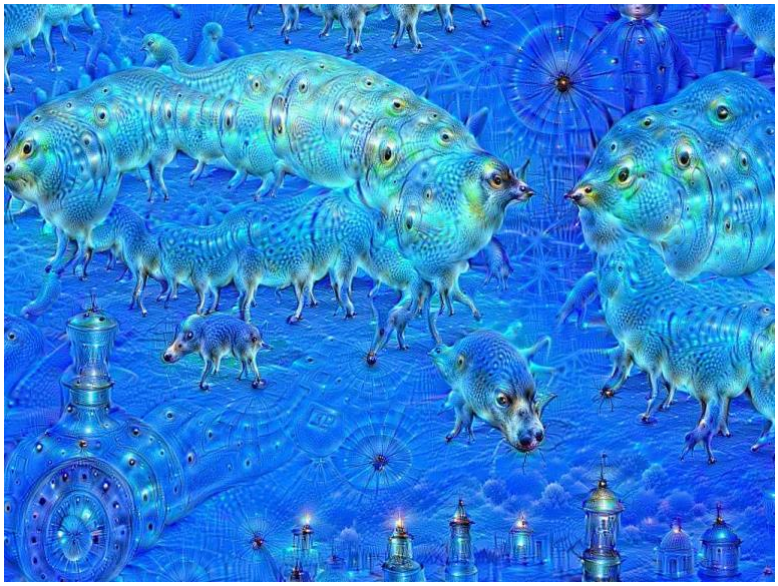

Figure 2 An image from a picture containing jellyfishes. © Wikimedia Commons via Picryl.

entails an involuntary production of meaning (like the illusion of recognizing figures in inanimate things or landscapes). When DeepDream produces new figures from given images, it reverses the recognition flow, thus shifting from a many-to-one to a one-to-many association dynamic, that is from detecting common patterns in different images to producing figures starting from a common pattern; while the former is a convergent perception dynamic, the latter is a divergent and relatively productive perception dynamic. In this sense, DeepDream puts us in front of a non-human imaginative strive relying on an artificially developed memory and resulting in the propagation of new meanings[4].

It is my contention that we are in presence of a case of non-human imagination, and specifically of *artificial imagination*. When talking of "imagination", I am not referring to the capacity to reproduce an experiential content in the absence of the corresponding object ("reproductive imagination"), but rather to the capacity to construct novel contents – and notably visual ones – from memorized material, with or without the intervention of a volitive act. It is quite evident that, in the case of DeepDream, there is no such thing as a direct volition from the program; even the request of the user («Whatever you see there, I want more of it!») cannot be mistaken for the imitation of an imaginative volition, insofar as it triggers an involuntary

[4] Note that the produced meanings are new also for the program, although the program does not give weight to the novelty of its own creations.

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imaginative dynamic (pareidolia). From a psychological viewpoint, it is therefore appropriate to refer to the concept of «involuntary imagination» (Vyshedskiy 2020). It has become customary, in the field of AI, to talk of «artificial hallucinations» with reference to such responses (Ji et al. 2023); DeepDream's behavior has also been indeed considered in relation to the study of the hallucinating effects of psychedelic drugs (Shartner, Timmermann 2020; Rastelli et al. 2022). All this hints at the possibility of an involuntary meaning production that mobilizes perception, memory, and recognition mechanisms, resembling what in human psychology is referred to as hallucination or oneirism: by intensifying recognition, DeepDream hallucinates other realities.

DeepDream lets us «witness a neural network struggling to make sense of the world» (Haynes 2015), or better of its own world, made of its memories and perception, as it produces images that refer only to the architectures and the strategies behind them rather than to an external reality. My claim is that this struggle results in an actual production of novelty.

Interpreters have raised many questions on what an "artificial production of novelty" might entail and whether it might be compared to human creativity. Before delving into these questions, an important premise is due. Following many operational analogies in the field of AI (and first of all that between artificial and biological neural networks), I have mapped out resemblances that I believe meaningful between DeepDream and certain functions of the human mind, like imagination, perceptive habits, and the unconscious. The comparison, however, ends here. The perspective that understands AI in analogy or in competition with human intelligence must be abandoned, as in its anthropocentrism, such perspective does nothing but obsessively reaffirm our superiority over reality, thus failing to comprehend it. By aiming to reproduce intelligence artificially, human beings have in fact begun to explore a different individuation domain. Artificiality is an autonomous domain, however not isolated from all the others: it interacts and communicates, for example, with the human domain, and is at the same time different from it[5]. I

[5] Simondon's theory of individuation (Simondon 2020) provides the theoretical basis of this argument. In Simondon, for example, the individuation domain of biological life is intrinsically related to the individuation domain of physical matter, and nevertheless life cannot be reduced to matter. In the same way, technological entities are human creations that ontologically exceed the human in ways that only now we are beginning to comprehend, and must therefore be studied *iuxta propria principia* – an attempt that Simondon (2016) himself made in relation to the technology of his times. This perspective goes against the organologic view of technology typical of 20th-century philosophical anthropology (from Ernst Kapp to Arnold Gehlen), according to which technology is a functional extension, projection, and supplement of the human being. The alternative presented here is supported by Simondon's modal ontology, which understands the

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will not argue, then, that AI can tell us something about the dynamics of creativity in general, because to show traits of creativity means something different for a machine than for a human being; nor am I going to argue, on the other hand, that DeepDream moves into a completely different and unrelated area, because every machine derives from human intelligence, just like human intelligence cannot prescind from and yet in a way overcomes biological life. The challenge is then to explore artificial imagination as feature of a specific individuation domain and learn to see with the eyes of machines[6].

2. *Do machines have style?*

Artificial creativity has often been associated to GANs (Generative Adversarial Networks) and their sub-types, CANs (Creative Adversarial Networks), algorithms that can analyze a set of data and generate new data that resemble that pre-existent set[7]. CANs are capable not only to reproduce, say, the visual styles of famous painters, but also to create relatively new styles that can be mistaken for original human art (see e.g., Barale 2020). Images generated by CANs trigger recognition dynamics in order to appear human-made: they are made to trick the eidetic mechanisms of human perception. DeepDream, instead, does something different than so-called "style transfer" (Santaella 2022: 52): it generates images that a human being would have never envisioned. Even though these images do not completely bypass our perception (they are perceivable and recognizable by us as images containing figures), they are radically uncanny, like manifestations of a different, non-human unconscious (**fig. 3**). DeepDream is not made to appease and amuse its human users: it is not a docile instrument. It rather gives us a vivid sense of how inhuman artificiality can be.

DeepDream creates images that are *stylistically new* to the human taste, and not just in the sense of a novel style: they look like something that a human subject has never and would have never done. The viewer is under the

different aspects of reality according to immanent criteria of "possibility", "freedom", and "creativity". On this line, and in relation to the subject matter, see for example Haworth (2021).

[6] Such operation, which entails a certain degree of anthropomorphization, is allowed by the fact that – as just said – the artificial domain is not unrelated to the human domain. A similar attempt is ascribable to the so-called "New Aesthetic", which has been defined as an investigation of «how contemporary reality looks to our pals, the visionary machines» (Sterling 2012). On New Aesthetic see e.g., Berry & Dieter 2015.

[7] A very clear explanation of GANs and CANs can be found in Moruzzi 2021: 14-15.

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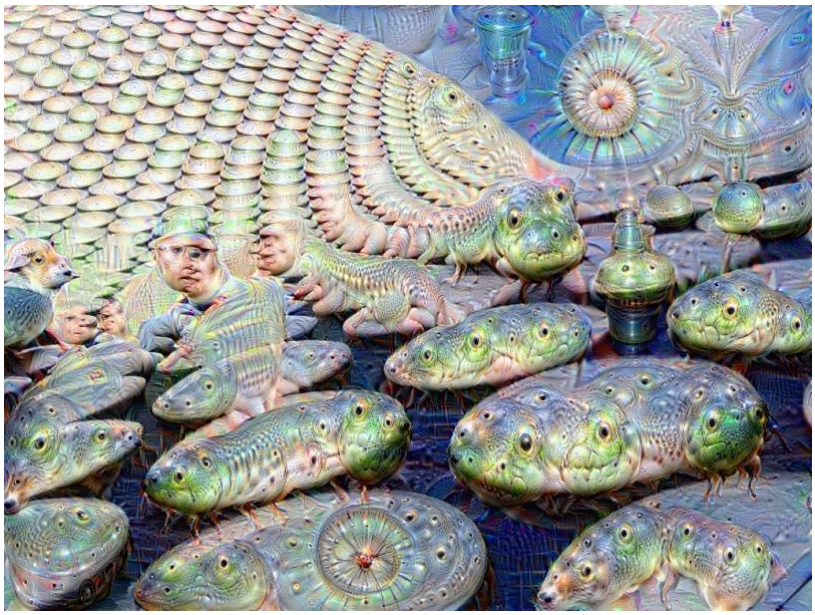

Figure 3 *Selfridges* by Pete Ashton. Creative Commons via Flick.

impression that no human being would have ever made that expressive choice[8]. The dominion of expressive choices available to a subject (individual or collective) is precisely the dominion of style. Although correct, this last definition makes the idea of style dependent on the presence of human minds. But how can we ever conceive of style as belonging to entities that lack intention and will, except in a broad and vague sense?

Some other definitions do introduce the possibility of ruling human intention out of the equation, even if they do not really disentangle the idea of style from its anthropomorphic overtones. According to Georges Kubler (1976: 31ff.), for example, style is the «resolution of a problem» that opens a «formal sequence». Of course, Kubler explicitly talks of «conscious problems» and «mental forms»: both art and history of art are human affairs. But the sheer possibility of defining style as the «resolution of a problem» allows to broaden the concept towards machinic behaviors. Moreover, Kubler's arguments

[8] DeepDream of course does non "choose" to diverge from human taste, it just does it. In this way, it confronts us with a non-human aesthetics. Other visual programs like Midjourney or DALL-E do the same within the very narrow functional limits imposed by their programmers; their mimetic problems – like their chronic difficulty to generate human hands or faces – hint in fact at the radical dissemblance of their imagination.

And this is not to put a limit on human creativity: it is not excluded in principle that a human artist could create images that look like exceeding the possibilities of human creativity, too; that is, that a human being could expand the limits of human creativity from within. The introduction of a non-human style, however, seems far more disruptive than the simple introduction of a new style, which does not mean that a non-human style could not be integrated in human taste as well.

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resonate closely with Simondon's conception of morphogenesis as, again, the resolution of a problematic situation (Simondon 2020: 15). For Simondon, every individuation event corresponds to a «resolution» occurring in a tensive field of potentialities, that is a reconfiguration capable of conveying the forces in play. «The state of a living being», for example, «is like a problem to be resolved, to which the individual becomes the solution through successive assemblages of structures and functions» (Simondon 2020: 226). *Mutatis mutandis*, this applies to every regime of individuation. The more a resolution is plastic, i.e., capable of remaining in contact with its pre-individual conditions, the more it perpetuates itself as an individual. These are the theoretical premises that allow Simondon to consider a machine as an evolving technological schema developing around a certain problematic. A machine, in this sense, is a *way* to solve a problem: it has a modal character, because it is a resolution mode that had to be invented for that specific purpose.

One could still object that we are talking about the style of the inventor rather than that of the machine. Let us turn then to a second definition of style, the one formulated by Erwin Panofsky in his essay on *Meaning in the Visual Arts*. Panofsky claims that style emerges from the relationship between an "idea", that is the functional aim of an object, and a "form", that is its expressive value. Every object, argues Panofsky, has an idea and a form: «A spinning machine is perhaps the most impressive manifestation of a functional idea, and an "abstract" painting is perhaps the most expressive manifestation of pure form, but both have a minimum of content» (Panofsky 1955: 14). Of course, both idea and form come from human minds; but in itself, style remains outside human intention and subjective control. Beyond Panofsky's own intents, we can thus derive the idea that style emerges from the relationship between function and form in an object, and that this emergence is fundamentally independent from subjective intention. A subject may have a practical need, but does not know in advance the form of the object that will satisfy it; conversely, a subject may conceive of an abstract form, but does not know how that form will materialize in order to be seen, used, or simply to consist. The *way* in which an object conjugates form and function is an instance belonging to the object itself, independently from its human inventor or user. As Gilles Deleuze and Félix Guattari (2005: 97) put it, «style is not an individual psychological creation, but an assemblage of enunciation».

It is now possible to conceive of a style that is not a direct, intentional effect of human subjectivity. In this framework, DeepDream's style corresponds to the resolution of a problematic field because it expresses an algorithm, that is literally a way to solve problems; and this is also a creative

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resolution, because its results were not at all foreseen by its algorithm, and yet they are not errors. There is in fact a difference between the abstract set of instructions dictated by an algorithm and its realization as a computer program (as I will better argue further on): while the former defines a closed internal domain, like a problem whose answer is known in advance, the latter constitutes a relatively open field of possibilities, like a problem whose answer must unfold in the resolution process itself (see Mazzilli-Daechsel 2021).

We can now understand in what sense DeepDream's style results from the encounter of an algorithm (i.e., a functional component) and a software architecture (a formal component) in a way that reduces its creators to little more than spectators. This is also how DeepDream surpasses its culture of origin and ends up generating a new aesthetic regime[9]. The fact that it does not do so *intentionally* is not a valid objection, because this is not the case with human subjects either: if anything, a subject can become conscious of her own style and direct her own actions in order to cultivate it, but the specific way to deal inventively with certain conditions is something that emerges autonomously in the process of creation. Style is an impersonal, nonlinear vector that underlies the conscious decisions of human subjects and belongs more to the resulting objects (or better the resulting "acts") than to singular human individuals. Style is modulated by complex objects which provide the platforms for a culture to accelerate, transform, and go beyond itself. In this sense, computer programs are not comparable to individual producers but to autonomous amplifiers of style.

3. *Are machines creative?*

The previous arguments clearly imply a certain idea of creativity. What has to be explained is the fact that DeepDream generates something new in an absolute sense (an aesthetic regime that was not foreseen by the programmers), as well as something new in a relative sense (ever new images that are different from each other). Like any computer program, DeepDream does not make

[9] DeepDream's aesthetic regime is a visual regime insofar as its problems and solutions are visual. To be a "regime", this gesture must of course be repeatable in its characterizing features. Although different from each other, all images generated by DeepDream bear the mark of its peculiar visual style: DeepDream's visual aesthetic is characterized by figural uncanniness and a general effect of psychedelic surreality; its animal-like beings, recursive biomorphic patterns and fractal iterations depict a senseless universe created by a mad god. The styleme of the eye is particularly noteworthy: the program literally sees eyes everywhere, thus revealing the paranoid structure of its own functioning.

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deliberate expressive choices; and yet its results are discrete, identifiable reconfigurations of their own conditions expressing the encounter of a function with a form. DeepDream's images cannot be reduced to random occurrences: our starting point should then be admitting that a machine can be the place of an "event". The first step towards acknowledging artificial creativity is admitting that *something happens* in the machine (or better *as* machine), i.e., that machines are capable of generating events (or better of constituting themselves *as* events). The question becomes then: how does the artificial production of novelty occur?

Possible answers are provided by strongly ontological conceptions such as Simondon's theory of morphogenesis – to which we will not return – or by more variegated perspectives such as philosophical emergentism[10]. Emergentists claim that novelty derives from a complex interaction of factors (such as form, function, context) through a nonlinear process comparable to the passage from parts to whole (see Bertinetto 2019). Emergence is a bottom-up description that accounts first of all for ontological production: an emergent event produces something new not «in the absolute sense of something that has never existed before but only in the relative sense that something emerges that was not in the interacting entities acting as causes» (Delanda 2011: 2). But emergence can also account for *ontological creativity*, as long as we separate it from the idea of supervenience. Supervenience implies that the parts of the supervenient whole maintain their individuality: the resulting whole, in this sense, can still be subject of analysis (it is not a «seamless totality», Delanda 2011: 184). The notion of emergence, like that of supervenience, does preserve the idea of a bottom-up causality dependent on the material interaction between factors; but it also implies that the parts are not exterior to their relationships, that is to the process of their interaction. Thus, emergence – differently from supervenience – corresponds to a real event of transformation and genesis, rather than a simple construction by juxtaposition. It follows that emergent creativity is not an intrinsic property of those factors participating in the process of emergence: decisive is the type of interaction that the factors can convey (i.e., their material qualities and behaviors)[11].

[10] Although Simondon cannot be considered as an emergentist in a narrow sense, emergentism represents a natural extension of his theories (see Choukah, Theophanidis 2016).

[11] «A network of molecules», for example «is not in fact "spontaneously" autocatalytic, but becomes so when a combination of conditions due to its own components, but also to contingent variations of its milieu, are reunited. To put it simpler, the interiority constructing itself is molded by the exteriority» (Heams 2019: 19).

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Thus conceived, an emergent event *can* in fact give rise to something that did not exist before, when the system is able to become sensitive to the contingency of its own conditions (its problematic field) and amplify them to the point of a genetic reconfiguration. In the case of ANNs[12], this happens in the encounter between algorithm (acting as a functional component) and software architecture (acting as a formal component) in the concrete context of a hardware. The network's actual functioning opens the space for something to happen in the difference between the abstract formulation of a rule and the abstract language of a software: both aspects are abstract if isolated from each other and concretize each other in their processual relationship. Neither the algorithm nor the software contains their own outcomes, as the complexity of the execution goes beyond the project. The more a machine is simple and abstract, like analog machines, the more it can be entirely explained by an abstraction; the more a machine is complex, like digital machines, the more the abstraction must «dramatize» itself (Ernst 2016: 209) through temporal development and performance.

Drawing on the cybernetic tradition, French biophysicist and philosopher Henri Atlan (2011) already claimed that ontological productivity (defined as «production of information») derives from nothing more than the material quality of a process, where "material" refers to the tangible and intangible relations between a system and its own conditions. If a system behaves linearly (i.e., repetitively) in a vacuum-like set of conditions, no change can occur; on the contrary, if a system's behavior unfolds as a complex interaction between different factors that constitute a context, then contingency may gain a productive role and a transformation may be induced. The conditions of the system (e.g., its form, function and context) endow it with what Simondon calls an "associated milieu", that acts as a material resistance for its behavior, namely as a source of transformation. «At least in principle, we see how the production of information as a result of random factors is nothing mysterious: it is nothing but the consequence of error production in a repetitive system, constituted in such a fashion as not to be destroyed almost immediately by a relatively small number of errors» (Atlan 2011: 110). Change can be seen as the effect of a material environment producing errors that are not catastrophic for the system in the form of small deviations from the course of its process. This requires materials that are plastic enough and architectures that are complex enough to capitalize the small differences without falling into chaos.

[12] An application of emergentism to artificial creativity can also be found in McCormack & Dorin (2001).

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Difference-in-repetition is indeed a fundamental dynamic in algorithmic expression. By iterating itself (or some parts of itself), a program endowed with a complex environment of self-organization is capable of change. Let us imagine a program's behavior as a line that, instead of drawing a circumference, traces a progressively eccentric orbit, with a small (in some cases even infinitesimal) difference between each successive cycle. A continuous development which was not inscribed in the previous states organizes itself by "gripping" on the contextual irregularities. «The relational magma generates an emergent state that can be largely unpredictable, because […] there is a no man's land between the writing of the program and its realization» (Bifo Berardi, Sarti 2008: 81). As Luciana Parisi (2013: ix) summarizes it, «incompleteness in *axiomatics* is at the core of computation». Algorithmic culture tends to catastrophic rationality rather than Cartesian rationality (Hui 2015, Fazi 2018). The incomplete and catastrophic character of contemporary artificiality is at the origin of the machines' visionariness (Fazi 2019). A materialism of computer programs – as announced, for example, by Kittler (1992; see also Ernst 2021, Quintanilla Fisac 2022) – should bring the sublimated abstraction of codes and software back to the materiality of the intertwinement of their architecture, algorithms, hardware and digital materials; and not just to disentangle it, with an equally abstract purpose of «explainability» (Fazi 2021), but to better participate in the intertwinement itself.

Besides the functional and the formal component (correspondent to algorithm and software architecture), what we have called the program's "context" or "set of conditions" is made also by materials that are plastic enough to bear and trigger non-mechanic relationships, thus de-structuring and re-structuring themselves in the relational process. These transformable materials are provided by digital information, corresponding to magmatic flows of discretized material conveyed by the hardware. The definition of style as an encounter of form and function must therefore be updated as follows: *style is an emergent property whose factors include functional, formal, contextual and material elements*.

When a program is run, it "enters into existence" by materializing itself into a concrete machinic act. My contention is that this act of embodiment (the emergence of an environment as the program's movement of self-organization) *is the machine itself* as distinct from the program. The notion of emergence is again useful to imagine how a process results in the provisional, phantasmatic apparition of a machine, and how the production of information can also be creative, insofar as the emergent machinic entity is not a mere supervenience,

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but a true transformation of its conditions: the algorithm, the software architectures, the hardware, and the memorized digital material *become something else*, although provisionally and in their very act. For this reason, a machine like DeepDream can open a new aesthetic regime. To be precise, then, the machine is not the creative agent: rather, the program is creative when it is capable of expressing itself *as* a machine, and the novelty of its results is the tangible manifestation of this apparition. In itself, a machine is just the emergent individuation act of its factors.

In this framework, we are led to the conclusion that the production of novelty is not just (or even primarily) a matter of consciousness, nor a prerogative of human subjects, but rather a factor pertaining to reality itself and occurring differently at each level. Human creativity – an activity characterized by features such as intention and reflection[13] – is a specification of a much wider phenomenon. In the case of artificial creativity, the human component is not erased from the picture, it is just deprived of its causal priority and integrated in a more complex network of distributed agency where artificiality no longer acts as an instrument or a mere support of human action. The role of the human being in creative artificial processes is no longer that of a demiurge or of a master in need of a collaborator: a deeper integration must therefore be conceived, perhaps in the terms of co-evolutive (Mazlish 1993) or symbiotic relationships (Poltronieri 2022).

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[13] Differently from a human being, a program cannot use novelty as a general concept and therefore cannot attribute value to its own products as carriers of novelty (it lacks an "evaluation" and a "verification" moment: see Moruzzi 2020). This does not mean, however, that its results are random, as they express the program's internal conditions through complex causal networks.

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