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Spectral and Procedural Creativity: A Perspective from Computational Art

Miguel Carvalhais & Rosemary Lee

ABSTRACT

This paper questions how computational art can be interpreted as creative by humans and the theoretical implications this may have. It explores how the affordances of computational art lead to radically new aesthetic experiences. The computational is manifested sensuously but it is nevertheless non-perceptual as although it requires a physical substrate, it is nevertheless not located there. It exists within, between and beyond its material instantiations as tangible objects and the process of that articulation. The computational is deterministic, which may appear to counter any potential for creativity, but it is often also irreducible, and as such its outcomes are impossible to anticipate. This paper undertakes an analysis of computational arts as spectral phenomena, ghostly in the sense that they are non-localisable, irreducible, situated between an algorithmic past and a futural becoming. Through this lens, computational arts offer glimpses into the possibility – and aesthetic potential – of autonomously creative systems.

KEYWORDS

computational art, artificial creativity, computational aesthetics, futurality, black boxes

AUTHOR BIO

Miguel Carvalhais is a designer, musician, and an assistant professor at the Department of Design of the Faculty of Fine Arts of the University of Porto, where he studies computational media, design, art, and aesthetics. His practice is developed between computer music, sound art, and performance. He runs the Crónica label for experimental music and sound art and the xCoAx conference on computation, communication, aesthetics, and x. http://carvalhais.org

Rosemary Lee is a practising artist and media studies researcher. She completed her PhD at the IT-University of Copenhagen, examining the influence machine learning has on notions of the image. Through practice-led, interdisciplinary research, Lee's artistic and theoretical investigations critically engage with historical tendencies in discourse surrounding technology which continue to shape current perspectives. Her work has been disseminated internationally in art and research contexts including the Dark Eden Transdisciplinary Imaging Conference (UNSW Sydney), Transmediale Festival (Haus der Kulturen der Welt, Berlin), Reprogramming Earth (Neme, Limassol), Screenshots (Galleri Image, Aarhus), and Machines Will Watch Us Die (The Holden Gallery, Manchester). http://rosemary-lee.com

Introduction: What is artificial creativity?

Artificial creativity is conventionally understood as a subfield of artificial intelligence that focuses on understanding and replicating human inventiveness through its study in humans and the development of creative computational systems. Creativity itself is not easy to define (Wooldridge) and different authors offer seemingly divergent definitions (as Glăveanu and Kaufman or Runco and Jaeger discuss). Some consider creativity to be a defining human trait, an idea that has been used to ground several arguments against the possibility of artificial creativity, such as that articulated by Ada Lovelace in the 1800s (Boden; Turing). As with artificial intelligence, there is a divide between proponents and opponents of *even the possibility* of a general, human-level, artificial creativity. This debate is less starkly divided, however, if we consider a *narrow* artificial creativity that acts in specific and well-defined domains (Mitchell) and that does not try to model human creativity but instead to engineer solutions for the development of creativity in specific and non-generalisable contexts.

In the regime of computation in which we currently live (Hayles), computational systems have increasing agency, autonomy, and creativity. Because of our human identification with creativity, there is a tendency to view artificial creativity as something of a leap forward from basic forms of artificial intelligence. Contrary to a technical definition that sees creativity as a subset of intelligence (Cope), humans regard it as perhaps one of its pinnacles, and therefore find that the possibility of its existence in the machinic phylum is endowed with limitless potential (Mould). Humans are sometimes caught in the paradox that while our belief in human exceptionalism may be threatened by the possibility of creativity outside of *us*, we also regard the inability to create artificial creativity as a limitation of our own human creativity (Cope).

Much like creativity, art is often viewed as a singularly human endeavour that is antithetical to automation by machines (Taylor), a line of thinking that is challenged by the engagement of art with various technological approaches, including computation or machine learning. While art involves creativity, it is not interchangeable with it: not all things that are creative count as art. In fact, artificial creativity alone may lack crucial elements that are found in art, but these are often difficult to define outright.

In this paper, we propose to look at creativity through the lens of computational art. Framing this in terms of aesthetics, we consider not what the inherent properties of creativity may be in such contexts, but how the actions and outputs of computational systems can be creative or can be interpreted as such by their human counterparts and other systems. Creative processes may involve humans and nonhuman agents in complex modes of collaboration that may sometimes feel counterintuitive. By setting up the conversation in this way, we aim to address creativity as something that is spectral. Like a spectre, computational creativity is ephemeral, "wavering between appearance and being" (Morton *Humankind* 55), difficult to pin down concretely, yet can be accessed through computational art.

Computational arts

We define computational arts as those artistic practices that depend on computation for their realisation, regardless of computers being used as tools for creation or as their primary medium. The main aesthetic driver of computational art is computation, manifested through processes, behaviours, and, ultimately, morphologies. This definition is informed by the recognition that computational art forms are not necessarily digital, however, at a time when most of our tools and media *are* digital, *being digital* is more or less a default.

We do not need to focus on the presence of computational tools or infrastructure, which would limit our understanding of computational art to a subset of works that exist in a particular medium. Instead, we look for artworks that engage with the computational substrate, a layer of behaviour and causality that is neither physical machine nor software but that which emerges from their interactions, works where we can find a computational *raison d'être*, as Hiroshi Kawano would put it. However, it is possible for artworks created and mediated by computers to be paradoxically *non*-computational in the sense that they constrain the expression of computation in their endeavours to replicate, remediate and simulate the stability of classical media.

We do not think that it is of primary importance to computational art whether a computer is a partner or a participant in the making of art, or if it "is used as an aid (in principle, non-essential) in the art-making process", as Margaret Boden and Ernest Edmonds discuss in their taxonomy. Computational art does not depend on the instruments (as in Herbert Franke's definition) but rather on the existence of computation itself in the artwork. It does not hinge on whether computation was at some point used in the work's creation or documentation, but rather on if computation is present and can be experienced in the *work in itself*. Therefore, we can define computational art as art where computation is central to the artwork and its aesthetic experience. [1]

Some of computational art's early steps can be traced back to the mid-1950s (Reichardt; Taylor) and the 1960s, with the work of artists such as Georg Nees, Frieder Nake, or Vera Molnár, who explored the use of computation and computers to produce images. In fact, given that digital computers are not indispensable for computational art, we can trace a deep-time history of artworks where computation is latent or expressed through methods that are not commonly associated with the computational. [2]

In aesthetic experiences, computation may exist independently of its embodiment, enactment, or execution in the form of an artwork. Computational artworks are therefore not so much artefacts as they are abstract machines that become concrete assemblages whenever and wherever they are executed. And artworks are also not the outputs that these machines produce, but rather the machines in themselves, alongside their outputs and the interactions developed during their operation. This recalls Sol Lewitt's famous aphorism that "The idea becomes a machine that makes the art", one of the many points of contact between conceptual and computational art, both

[1] Much as it was already suggested by Edward Ihnatowicz, that distinguished between "those artists whose inspiration comes from outside the world of computing and who use the computer simply for convenience from those whose ideas have originated as a result of computing experience."

[2] For a longer discussion and analysis of examples of this deep-time computational forms, see Carvalhais (*Artificial Aesthetics*) or Lee ("Machine Learning and Notions of the Image").

often developing systems that are highly generative (Galanter) and that work as "cultural software" (Penny 348).

In both conceptual and computational art, we find systems that do not seek to produce or exhibit individual artefacts as their primary goal (Groys) and that rather focus their attention on relationships of objects and actions in space and time. These relationships can be spatial and temporal, but they can also be logical and political (Hui), and they can be developed among things, texts, humans and other data and agents, involving very diverse media. However, information and process remain the fundamental elements for the dynamic creation and development of these relationships, only being developed – and becoming apparent – in time. As such, a static view of any system may not afford understanding of the relationships within it, and it is only through direct contact and engagement with a system that we are gradually able to understand the relationships and rules that govern it. In this sense, the core content of a computational artwork is not form, or any sign or message that may be encoded into it, but rather, computation.

Given the nature of computation, our human nature, and the mechanics of our informationally driven relationships with media, the mere communication of computation may directly lead to its existence. Although the human brain is both computational and universal, that does not mean that it is – or acts as – a digital computer. The human brain can process information and is Turing-complete in the sense that, given the right conditions, it is able to emulate any type of behaviour that can be found in other computational systems (Wolfram). Humans are endowed with a boundless and flexible representational system (Hofstadter) that allows us to understand and develop computations that are triggered by information passed on to us by media. Because we can understand computation and are able to enact it mentally or by resorting to external mental aids, we are able to become the computational engine driving the machinery of a computational artwork. We can become part of a work, and make the work become part of ourselves.

Beyond their potential immateriality, computational artworks also recede and continuously withdraw as they execute their "moment-to-moment procedural unfolding" (Morton *Hyperobjects*). Each step in the execution of a computational artwork, and each of the sensual effusions that it may generate, are not the artwork in itself, but nevertheless give us a faint glimmer of its real essence. Computational art exists in the Duchampian *infrathin*, a state defined by differences that may be barely noticeable. The aesthetic experience in computational art arises from what Graham Harman (*Art and Objects*) describes as the theatrical enactment of a rift between the artwork's real object that we cannot access, and its sensual qualities, which we can access. And even not being able to access its real qualities, we are able to become part of the artwork in a process that starts by recognising computational art as an art of aversion (Groys), where one doesn't so much look at an object as gazes beyond its physicality and sensual surface (Bogost; Lee). By reading and sometimes embodying the work and its computational core, "we are made to perform the work" and we achieve the aesthetic experience (Harman *Art and Objects* 140).

The complex nature of computational artworks makes them difficult to describe in terms of traditional aesthetic frameworks that were developed for other kinds of art. The split between *surface* and *subface* that Frieder Nake identified highlights the capacity of computational artefacts to involve a rift between computation and its experience in much the same way that an estrangement exists between real objects and their sensual qualities. These aspects are not grasped by ideas of art as a purely aesthetic expression, which would disregard the temporality, processual emphasis, and variable embodiment that computational art makes especially visible. Computational artworks require aesthetic frameworks that take into account their computational nature and their noumenal side, and that, instead of looking at those aspects in which computational artworks are similar to non-computational art forms, focus on those where there is greater contrast.

Computational Aesthetics

Because of this, computational artworks force us to engage with them in a subjective, situated, and enactive mode that leads to radically new aesthetic experiences. The computational gaze that one develops in these contexts is not unprecedented, as Matteo Pasquinelli discusses in *Three Thousand Years of Algorithmic Rituals*, but due to a long period of artistic exploration with non-computational media, it became somewhat lost, and now needs to be rediscovered. The computational gaze entails a focus on the processes of computation (Andersen and Pold) that are there but that subscend in runtime (Morton *Humankind*) and can only be perceived indirectly. It is in this sense that we understand computational aesthetics as spectral. The computational gaze is a type of aesthetic seeing attuned to the visual surface but also to the procedural subface of the artwork. It is at once detached and contemplative, thoughtful and inquiring (Noë), but also engaged with the computational substrate of the works and its causal connections with the surface.

The spectral nature of computational aesthetics is characterised by aspects of immanence, instability, performance, information, empathy, and embodiment. Computation does not happen in a single location to where one can point. Computation is not in the physical machine of the hardware nor in the logical machine of the software. Computation is an informational phenomenon that happens between things and levels, in the infrathin between hardware and software, between imitation and simulation, between irreducibility and the divergence of several instantiations of a programme. Therefore, computational art is non-perceptual, with its object being simultaneously in the subface and the surface, in computation and information, artwork and reader, and in the mesh of processes linking them. If reducible processes do not reveal anything new, repeating known processes to arrive at predictable outputs, irreducible computations confront us with the openness of the future and reveal the temporality of computation that leads to a feeling of temporalised subjectivity, of "discorrelation of human and computational time" (Denson 164), that makes us experience them as spectral, fuzzy, and gnarly, neither real nor unreal entities that allow us into their worlds by intersecting ours.

Computational art is non-representational and therefore not reflective or mediated, as other arts or even philosophy. While non-computational arts reveal "the conditions of possibility of things (but not those things themselves)" (Galloway xix), computational arts bring us closer to things themselves by giving us access to what lies beyond a specific instantiation of a work. For example, non-computational art may present us with *a* square, represented as such, while a computational work may bring us into closer contact with the "squareness" of a square by engaging in the defining qualities that make all squares square.

This aspiration towards things in themselves does not mean that computational artworks lose the potential for transcendence, quite the contrary in fact. Computational artworks are autopoietic beings-for-themselves (Carvalhais and Cardoso), not recordings or representations, but "something doing something" (Penny 319) that *becomes* (Bryant) through those actions.

Much like live music and other somatic forms of expression, computational arts' becoming through action inevitably leads to divergent behaviours and ultimately to formal instability. Although computation allows for the digitalisation and seemingly flawless preservation of information, this is only achieved through the continuous circulation of information within computational systems. Whenever there is a computational substrate, even in cases where the goal is to preserve information, there is also the potential for the computational to express itself (through glitches, bugs, or other means), and to disrupt the intended stability of the information. Computational systems also tend to be irreducible (Wolfram), making computational artworks prone to be unpredictable and futural. The aesthetic experience of computational artworks is then not so much predicated on their past forms or present actions as on their future actions and outputs, making their existence become a futural *not-yet* (Morton *Realist Magic* 212) that is an attractor to both the artwork as ourselves.

Procedurality is the fundamental affordance of computational systems (Murray). The capability to execute rules is very consequential because the mechanisation of logic leads to the emergence of contingent and complex behaviours that are expressed in *time*, in *runtime* and in *real-time*. Although software is essential in contemporary digital computers, software is distinct from computation. Software (or the code, or sets of rules) bootstraps computation but is not reducible to it. Computation is what continuously happens until a process is halted and is something deeply performative, situated, and contextual, contingent on external influences and deeply variable. [3]

Through the computational gaze, we can develop a procedural reading of computational artworks, trying to understand their computations through various exchanges of information. [4] Gathering information about a computational artwork is fundamental for developing our capability to access it, and in this process, aesthetics is of the essence.

[3] If in theory each step in a computation is reducible to software and code, this sampling of a state of the computation is also not the computation itself. Once again, the computation withdraws and subscends.

[4] For a more detailed analysis on procedural reading and the computational gaze see Carvalhais ("Breaking the Black Box").

Try as we might, we never achieve complete knowledge of a computational artwork. We can never be fully aware of its constituent parts or of all the scope and reach of its actions. [5] Humans are computational and universal, but our nature is quite different from that of digital computers or other forms of computation we come across. Furthermore, computational systems withhold themselves from complete and direct understanding, and all we can do is to try to understand causal connections and build models of their future behaviour through observation and trial and error. Through procedural reading and the computational gaze, we develop an empathy for the computation and an intuitive understanding of its phase-space and its futural development. [6]

[5] Arguably, because computations tend to be irreducible, not even the authors of computational artworks can be fully knowledgeable about them.

[6] For a more detailed discussion see Carvalhais "Breaking the Black Box" and Cardoso "Empathy in the Ergodic Experience of Computational Aesthetics."

Before computational media, we were awash with mechanical reproductions and replicas. Nowadays, we find ourselves immersed in individualised simulations that manifest unique and idiosyncratic behaviours and emergent developments. The term *simulation* can be somewhat misleading and should not be understood as a faithful reproduction or imitation of something – as was the case with mechanical reproductions – but rather as a model that embodies something and that, because it is computational, inevitably diverges from what it is trying to simulate. A model is also an agent that deviates while it expresses itself, therefore, multiple instances of the same simulation tend to manifest diverging behaviours and developments.

Computational Creativity

Given its nature, computational art doesn't so much extend other art forms by furnishing them with new codes or techniques, but it mutates from the other arts in a break that results in an emergence of representation that takes steps beyond representation. [7] Computational art depends on the subface-surface duality in which is found a rift between the two levels of the artwork as an object. It is from here that beauty emerges, and it is in this tension that the artwork becomes a compound with the human that assumes an indispensable position in the artwork-human system (Harman *Art and Objects*). The computational is not in an artwork's perceptual surface but is manifested through it, being found in the processes within and beyond its immediate objects. The computational is manifested sensuously but is, in essence, non-perceptual. Computation radiates from the artworks to humans and other systems, continuously muddling the borders of artworks where, conversely to conceptual art, *the machine becomes an idea*.

[7] Much as photography already doesn't extend painting, "even if it locally draws on it and furnishes it with new codes and new techniques," thus becoming "a mutation" (Laruelle 35).

Because all signs and data are created in or reduced to a common universal format, computation is independent of modality. Computation is also independent of its substrate, which does not mean that a physical substrate is not required, but rather that, from a computational point of view, most of the details of this substrate are not relevant to the computation and can be abstracted from the computation itself. It also means that if software and its sensorial effusions can be seen as an "automated past" (Morton *Humankind* 17), computation, much as *being*, is futural.

From a computer science viewpoint, computations are strictly deterministic, meaning that whenever they are executed from similar initial conditions, they will always arrive at the same output. This determinism is a trait that seems to counter the potential creativity of computational systems, and that has often been used as an argument against the possibility of artificial creativity or artificial intelligence (Ariza; Boden). Absolute determinism is grounded in the past, as it merely reprises known processes and outcomes, but, as most computations are *irreducible*, as Wolfram proposes, however simple their rules may seem to be, it is nevertheless impossible to anticipate their future states. Irreducible computations are unpredictable and paradoxical, because they are deterministic while being able to generate outputs where novelty is perceived (Mitchell). With the increasing complexity of the computational, more and more systems become black boxes: ambiguous, irreducible, and impenetrable substances with physical and cognitive prehensions (Parisi) that are also deeply metaphysical (Hui). The computational thus becomes a channel for what Morton calls an irreducible and unpredictable “future future” (*Being Ecological* 165).

Creative computations stand between the algorithmic past of known and predictable formulaic repetition and a futural being that is a phase-space created by the computation as it constructs itself through execution. This futurality is deeply connected to irreducibility and to the possibility of being understood by humans as autonomously creative: of being seen as not merely encoding a form of human creativity but rather as manifesting a degree of creative agency in an open-ended future that is able to take us by surprise. It is here that the possibility for creativity in the computational resides. Artworks withdraw and subscend during execution, building aesthetic experiences that leave behind artefactual remains. Creativity can be found in this spectral presence that is not past, nor present or future but that seems to exist outside of time. The computational hovers over its substrate and sensual effusions while permanently building relationships. This is, we argue, the essence of artificial creativity that, like creativity itself, is more a process than its outcomes.

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