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Who or what is creative? Collaborating with machines to make visual art

Eleanor Sandry

ABSTRACT

This paper considers how creative agency can be positioned as part of visual art practice that involves humans and machines working together. Examples analysed include projects where complex "intelligent" software systems support text creation, or the combination and transformation of digital images, alongside one where a human artist works with a physically instantiated robotic arm to co-create drawings. The paper's argument uses ideas from actor-network theory (ANT) and more object-oriented perspectives to theorise agency not only as emerging from the association of humans and machines in networks, but also with the specific humans and machines involved in each creative project.

KEYWORDS

human-machine interaction, actor-network theory, object-oriented ontology, behavioural objects, creative agency

Introduction

This paper analyses examples of creative collaborations between humans and machines in visual art practice. It begins with a consideration of projects involving complex "intelligent" systems that provide support in text creation and digital image combination, transformation and creation. The discussion of these systems is extended by an example in which a physically instantiated robotic system collaborates with a human artist to create drawings.

The paper investigates how agency can be positioned within such collaborations, not only as emerging from the relation between human and machine, that is, through the process of creative collaboration itself, but also with the specific humans and machines involved. Some of the theory discussed here comes from research into computational creativity directly, but the paper's ideas are also drawn from research that considers the possibilities of human relations with nonhuman others more broadly. Although appraisals of machine agency are becoming increasingly familiar with developments in artificial intelligence (AI) and machine learning (ML), not all the examples discussed here use such sophisticated technology. Nevertheless, human interactions with even relatively simple software (sometimes with a physical instantiation) often seem to flow as collaborations, within which human and machine interplay is essential to the resulting creative practice.

The analysis of creative practice in this paper sets aside ideas of machines as surrogates for human agency to consider how an actor-network theory (ANT) framework offers more flexible ways to regard agency as attributed to participants in a network or distributed through the network. Alongside this, the paper acknowledges object-oriented critiques of ANT as too focused on the network at the expense of considering the specific activities of humans and machines. The paper therefore works through conceptions of behavioural objects that notice the activity and agency of machines, both performative and memetic, alongside humans in artist-machine collaborations.

The difficulty of definitively locating agency in creative contexts involving humans and machines raises questions about how to credit artists and authors. In addition, it highlights how human-machine collaborations may result in the creation not just of new pieces of art, but also new approaches to making art in the future.

AI Am I? (The New Aesthetic)

The first sentence of the project website for *AI Am I? (The New Aesthetic)* describes it as "a series of artworks dreamed up by an AI and produced in real-life by the artist or others" (Reben and GPT-3). [1] This is immediately qualified with a more detailed explanation of the process by which artist Alexander Reben feeds "carefully curated 'start texts' … into a text generation AI called GPT, which then outputs text that includes a description of an imaginary artwork, along with analysis of that artwork and other supporting text" (Reben and GPT-3). Following much the same process, it is worth noting that, while the initial paragraph of the website was written by artist Alexander

[1] The artworks and associated texts created for the *AI Am I? (The New Aesthetic)* project can be viewed on Reben's website: https://areben.com/project/ai-am-i/

Reben, subsequent paragraphs were generated by GPT-3, hence the citation used here. It is the original statement that is carried across to the title of the *Forbes* article about the project, "In This Exhibition, An AI Dreams Up Imaginary Artworks That Artist Alexander Reben Then Creates IRL" (Damiani), and which might therefore be expected to stick most in readers' minds. The initial framing of the project as shaped by the creative "dreams" of an AI is notable since it grants the AI agency and anthropomorphises its contribution to its partnership with a human. The sense in which the AI has agency in a relation with the artist is reinforced when Reben explains that "[u]sually, a creative idea is conceived by a human and rendered with the help of technology," whereas he regards *AI Am I?* as "a human-machine collaboration" (Reben and GPT-3). Reben's experience is of interacting with GPT-3 in a partnership that produces a creative idea to shape each of the final artworks.

As the website statement continues in the words of GPT-3, albeit likely seeded and curated by Reben at various points, the agency of the AI is defined more carefully. It is hoped that "the project will help people see that AI is still at its very earliest stages of developing a sense of creativity," since "AI is still very much a tool that helps humans make decisions, rather than being a replacement for human creativity" (Reben and GPT-3). Alongside this though, it is fair to say that "[t]he artworks in this series are a great example of how computational creativity can be used to augment human creativity" (Reben and GPT-3), since Reben notes elsewhere that the collaboration sparked his imagination, and yet had "more of a human side" than he originally envisaged (Reben interviewed in Damiani).

The *AI Am I?* project supports the idea of computational creativity throughout its process, with GPT-3 (and Reben) generating not just descriptions of artworks, but also critical responses to those descriptions. Although Reben himself goes on to create the artworks, sometimes inspired and sometimes constrained by the GPT-3 text, fictional artist and critic names are produced by "a neural network trained on names" with other details, such as the artwork year and artist's birth location and date, being generated by a custom algorithm, unless GPT-3's description already contained that information (Reben and GPT-3). Reben's collaboration with GPT-3 is iterative, first seeding with a "start text," then curating and feeding output back into the system until a final version of the complete text is chosen. Technical issues in the final text are corrected, but without changing the meaning, before it is used as the basis for Reben's production of the artwork itself. The GPT-3 text accompanies the artwork, presented as the fictional artist's statement together with a fictional critic's analysis and response.

Reben's work with GPT-3 is in line with the way this AI system has been used elsewhere. In 2020, *The Guardian* published an opinion piece titled, "A robot wrote this entire article. Are you scared yet, human?", crediting GPT-3 as the writer. It was accompanied by an editor's note explaining a process of seeding and curation similar to the one Reben describes. This article was not produced by the AI alone, involving a great deal of human labour. The title of the article and the GPT-3 byline, though, were clearly designed to provoke a reaction in the reader, resonating with people's broader qualms about robots and AI

taking people's jobs and affecting livelihoods that are regularly circulated in mainstream media. Negotiating claims positioning AI as a creator are therefore relevant in many areas including journalism, with the idea of machine or computational creativity in art and music seen as a particular threat by those who argue that people's creative practice is a vital part of defining what it means to be human.

Are humans the only agents, the only creators?

Following publication of the 2020 article, *The Guardian* was accused of deliberately misleading people about the AI's writing ability, unduly raising both people's expectations and their anxieties (Dale). In comparison, Reben's website clearly explains the iterative process upon which his work with GPT-3 relies. This transparency is carried through into discussions about *AI Am I?* on popular news sites, notably *Forbes* (Damiani), so their readers are similarly not misled. To an extent then, Reben's work avoids overhyping the ability of GPT-3. However, while Reben's human contribution to the project is made clear, the labour of people involved in the creation of GPT-3 itself (and potentially also the other neural networks and algorithms employed in creating *AI Am I?*) is not acknowledged.

It is certainly possible to argue that considering GPT-3 and other AI or ML algorithms as AI collaborators, without recognising the human agents involved in their design and development, is unwarranted and potentially unfair. Ardavan Bidgoli et al., for example, suggest that the autonomous behaviour of machines built with AI or ML is too easily regarded as enabling "collaboration" or "co-creation" with people in creative practice, because "the socio-technical nature of AI systems, and the different human agencies involved in their design, implementation, and operation" are ignored (1). Instead, they regard "AI-enabled tools" as "machinic surrogates," a term that stresses how these systems derive their agency from the agency of the humans involved in every stage of their design and development, as well as their eventual use (Bidgoli et al. 1-2). Therefore, in spite of claims about the "autonomous creativity" of such machines, "it is the agency of the authors and toolmakers which is crystallized in the tool, creative process, and the outcomes" of that process (Bidgoli et al. 5). While their argument raises the importance of looking carefully at the networks in and around all elements of AI or ML in such projects to understand the range of creative agencies at play, Bidgoli et al. use this to support the idea that only humans can have agency. Their perspective positions technologies, including "intelligent" technologies, merely as tools that human agents use.

The specific example Bidgoli et al. discuss, the creation and sale of the *Portrait of Edmond Belamy* (4), may drive the anthropocentricism of their argument about agency, since this case highlights the question of not only who should be credited, but also who should profit from art that is created with a particular AI system. "Obvious" is a team of three human artists creating portraits using a form of ML system known as a generalised adversarial network (GAN). While Obvious do acknowledge their role in guiding the GAN, choosing both inputs and the eventual outputs that should be printed for display and sale,

they have chosen to sign the portraits with the mathematical function core to the GAN's operation. Obvious therefore credit the ML system as the artist, as opposed to recognising their own work formally, although they do still profit from any sales. As Bidgoli et al. (4) and Ziv Epstein et al. (1) note, other people who played key roles in developing the original idea for GAN systems (Ian Goodfellow) and creating the Art-DCGAN (Robbie Barratt) that inspired the Obvious GAN could potentially also be credited as human agents for which this ML system is now acting as a machinic surrogate (to use Bidgoli et al.'s term). In fact, deep convoluted GANs (DCGANs) were originally developed by Alec Radford, Luke Metz and Soumith Chintala, while the process of building Barratt's Art-DCGAN specifically relies upon a training set of paintings by recognised Renaissance masters (Epstein et al. 1). Deciding who should be credited for the resulting artworks, and who might be due a portion of the profits, is clearly as convoluted as the DCGAN itself.

The question of whether machines might ever be considered as intelligent agents or forever remain tools for human use has a long history, with Alan Turing famously developing what has become known as the Turing Test in 1950. Turing focused on whether machines might become intelligent enough communicators to be indistinguishable from a human at a distance. An alternative standpoint was offered by Ada Lovelace, who suggested instead that machines could only prove their intelligence by being creative and originating something new (Bringsjord et al.). This seems particularly relevant to any discussion of machine creativity, but also raises the question of whether it is possible even for humans to pass this test. Turing, responding to Lovelace, asks whether anyone can be certain an idea originates with them, as opposed to growing out of a prior learning or experience, a question also raised in more recent scholarship.

In relation to creative art in particular, Julie Van Camp notes that while it is possible to say that an artwork is original in that it originates with an artist, because it has "'come from' them in some way," this does not mean that artworks are "created in complete ignorance, free from the influences of other artists and works of art" (256). Originality can therefore only be appraised on the basis of whether a work advances "the known possibilities of the art form when compared with prior work and other contemporaneous work" (Van Camp 256). Van Camp's argument is compatible with ideas about the value of "remix" as a form of creativity (Gunkel; Lessig) as well as with the broader conception of a systems model for understanding creative processes (Csikszentmihalyi). This approach to defining and appraising originality "preserves the image of the artist as an individual who makes an original contribution to cultural dialogue," without requiring their work to demonstrate "isolated bursts of genius de novo" (Van Camp 257). The idea that many prior influences can be accommodated, as "long as a dialogue goes forward with that artist's contribution" (257), opens up the possibility of recognising the creativity of machines, whose development often relies on a large bank of past human works and whose implementation may need "seed" information from a person as well as their critical appraisal of the output.

Allowing for non-human agency by flattening networks

Given this possibility, is it necessary or helpful to argue that art generation systems such as GANs and DCGANs, or text generation systems such as GPT-3, can act only as machinic surrogates for human agents? An alternative is to consider human-machine interactions in ways that are more open to the material impacts of machines on people and their activities in the world. Actor network theory (ANT), for example, positions nonhumans, whether "mundane objects" or "exotic technologies," as active participants within social and relational networks that also include humans (Michael 5). ANT has developed along many paths, becoming "a complex, and oftentimes disparate, resource" for understanding how things happen in the world (3). As Bruno Latour explains, while early ANT descriptions often considered physical technical networks, the term network is actually conceptual within the ANT framework more broadly ("Reassembling the social" 131). From this perspective, a project such as *AI Am I?* is revealed to involve networks of many kinds. There is the technical network that enables the operation of GPT-3, but also a network of humans and machines involved in the production of this system (including those who wrote the texts upon which it was trained), as well as the network within which GPT-3 is positioned as an active element working alongside Reben.

It might make sense to set aside GPT-3's own networked nature for an analysis that concentrates on its contributions to the artistic process at hand. Latour notes the difficulty of acknowledging the activity of nonhumans alongside human actors, introducing the term "actant" to refer to both humans and nonhumans in a network ("Reassembling the social" 54). As Michael notes, this term supports ANT's insistence "that the social world needs to be understood as a flat network" (29), within which humans and nonhumans operate on the same ontological level (Collin 206). From this perspective, GPT-3 could simply be regarded as an actant, operating as a complex entity alongside Reben, acknowledging its capability as an interactive partner in creating art. Alternatively, to retain and embed a sense of the networked nature of GPT-3's own creation and operation, it might be better regarded as a *hybrid* within which past interactions between human and nonhuman actants have already been so "closely entwined" as to be inseparable (Michael 17). In whatever way GPT-3 is described, its operation in the network alongside Reben is characterised by the way he understands their association, recognising how GPT-3 actively shapes the project, sparking his imagination and augmenting his creativity.

ANT descriptions of humans and nonhumans as working together suggest that it may not be possible to identify who, or what, has "played the decisive part" in any network outcome (Michael 12). Related to this, ANT does not consider agency as a permanent or fixed property of an individual actant. As Latour notes, the "actor," and it seems reasonable to extend this to actants, does not "play the role of agency" in sociological terms ("On recalling ANT" 18). Instead, ANT more often notices the presence of either distributive agency that is "enacted in the relations 'between' entities" or attributive agency as "ascribed" to an actant (Michael 68). More generally, Latour suggests that it is better to proceed "by following circulations … than by defining entities,

essences or provinces" ("On recalling ANT" 20). The acknowledgment of either distributive or attributive agency, alongside the idea of agency circulating in a network, may not assist anyone trying to make legal decisions about who deserves to be paid for a commercial artwork when it is sold; but, as a framework for understanding existing and planning new creative projects, it does drive analyses of artistic processes for which the network itself might be considered creative.

[2] The section for neural painting on Choi's website contains the images (and more recently videos) she has created working with an ANN. "The Drowned World" series is the focus for her paper cited here: https://sukkyoungchoi.com/category/project/neural-painting/

Suk Kyoung Choi, for example, describes working with an artificial neural network (ANN) to blend digital images using a "conversational 'call and response' metaphor borrowed from jazz improvisation" (103). [2] This sounds somewhat similar to Reben's interplay with GPT-3, as they work together to develop the final description of an artwork through an iterative exchange of growing texts. The impact of the ANN on the creative output is a key part of the creative process. Choi says it "produces surprising, compelling results," although she feels it is not possible to "claim that the computer is reflectively subjective in itself" (110). In spite of this, she notes that its responses, in promoting her own reflections, position the ANN as "intersubjectively improvisational by nature" (110). From an ANT perspective, although Choi remains wary of attributing the ability for thoughtful reflection to the computer, she and the ANN operate together in a networked relation from which creative artworks emerge.

Looking back on a project, Reben and Choi might be willing to accept the distributed creativity of the human-nonhuman network of which they were a part, while their descriptions of what it is like to engage with GPT-3 and the ANN in the moment might be regarded as attributions of agency. However, although it provides useful ways to analyse human-machine networks of creativity, ANT has been charged with focusing too closely on associations, overlooking the details of what people and nonhuman others bring to interactions (Bogost). In terms of the examples discussed above, Reben describes working with GPT-3 as being "a real human-machine collaboration" (quoted in Damiani), while Choi, in spite of her reservations about seeing it as reflective, notes how the ANN's "response is unpredictable but intriguing and only partially controllable, giving the sense of playing against another perception" (110). Reben and Choi thus identify the AI technologies with which they interact as active entities that bring specific abilities into the association, directly impacting on the creative practice and its outcomes.

Objects as behavioural, performative and memetic agents

In art contexts, the creativity and agency of machines in their own right is often discussed for installations that engage audiences in physical interactions with an embodied artwork. Petra Gemeinboeck and Rob Saunders for example start "from the position that creativity and embodiment are critically linked" in discussing their work, *Zwischenräume* (215), while Christian Kroos et al. recognise that "agency emerges from the interplay" between robot, environment and humans in their work *Articulated Head* (402). Simon Penny, writing about both a physically instantiated robot (*Petit Mal*) and digital installations with which audiences interact through physical movement

(*Fugitive* and *Traces*), suggests that "the fundamental novelty of computational media and computational art practice is the capacity for behavior" (272). The artist-machine interactions discussed earlier in this paper are, of course, not embodied, but highlighting the importance of machine behaviour may nonetheless be useful in promoting a focus on a machine and its actions.

The idea of machine behaviour is formalised in the work of Florent Levillain and Elisabetta Zibetti, who define "*behavioral objects"* as neither humanlike nor animal-like, but nonetheless "able to carry spatial transformations that can be interpreted as actions executed toward a goal, possibly motivated, and possibly intelligent" (5 italics in source). Importantly, their definition notes that behaviour as "action on the world" can include "mental behavior" (10), opening the way to consider digital AI technologies, such as GPT-3, ANNs, GANs and DCGANs discussed above, as behavioural objects alongside the physically instantiated machines of art installations. However, Levillain and Zibetti's insistence that, in general, behavioural objects "are not designed to accomplish functional tasks" (10) is more problematic, given that artists work with machines with a functional goal in mind, whether that involves creating written texts, or combining, transforming and creating images. When considering artist-machine interactions, as opposed to audience-machine interactions, it is therefore useful to consider an alternative perspective on objects and their behaviours, originally developed to explain the interactions of musicians with digital technologies and systems.

Oliver Bown et al. argue that the development of contemporary digital music, in particular the use of digital technology, introduces types of interaction that involve people and what they also term, a few years earlier than Levillain and Zibetti discussed above, "*behavioural objects*" (188 italics in source). Specifically, a behavioural object "can act as a medium for interaction between people through its dissemination and evolution, can develop interactively with individuals in processes of creative musical development, and can interact with other behavioural objects to produce musical output" (193). While developed to analyse digital music creation contexts, leading into a focus on "behavioural models" for Bown's "live, improvising software system, *Zamyatin*" (Bown 41, 37), there seems no reason why this idea cannot be extended to other creative art practice. From Bown et al.'s perspective behavioural objects have a purpose that frames people's interactions with them and, while they are concerned mainly with software systems, their description does not rule out machines that are physically instantiated (as discussed later in this paper).

Bown et al.'s conception of the behavioural object does share much in common with the nonhuman actants that coexist alongside humans in ANT. In particular, ANT also acknowledges how "technological artefacts" are able to shape "inter-relations amongst human actors" (Michael 17), as well as interacting directly with other human and nonhuman actants in the network. Considering *AI Am I?* discussed above, Reben's experience of GPT-3 would seem compatible with the idea of this AI system's activity in their relation as a behavioural object in Bown et al.'s terms. In addition to its direct interactions with Reben, GPT-3 can be understood to act as a medium for interaction between people (its designers and users) as well as Reben and his audience. Throughout its development, as well as in the way the *AI Am I?* project

juxtaposes it and its output alongside other AI systems, GPT-3 also interacts with other behavioural objects as it creates texts.

However, in contrast with ANT accounts of agency as distributive and attributive, Bown et al. "distinguish between two senses in which a behavioural object has agency in itself: performative agency (in performance time) and memetic agency (out of performance time)" (195). Bown et al.'s perspective therefore lends itself to considerations of what participants, whether human or machine, bring to a musical performance (performative agency) and to the development of cultures and styles of music beyond individual performance settings (memetic agency).

Although not involved in live music performances for an audience, as Choi notes, the process of working with a computer system to produce visual art can involve interactions that resemble the call and response structure familiar in jazz improvisation. Something similar, although not explained in these terms, is seen in the iterative process Reben follows with GPT-3. When actively working with GPT-3 and an ANN, it can therefore be suggested that Reben and Choi experience the performative agency of those machines in ways that impact on the development of new artworks: in the case of Reben, writing texts that provide a description and critique of a piece of art the artist goes on to create; and, in the case of Choi, enabling the complex combination and transformation of images that her projects require for success.

The broader memetic agency of technologies such as GPT-3, ANNs and DCGANs can be seen in people's responses to situations where these technologies have been attributed as authors or creators (discussed earlier). These technologies not only impact on people's understandings of how art can be inspired and created, but also raise important questions about whether machines themselves can be creative and should be credited as authors or artists.

In developing their understanding of behavioural objects further, Bown et al. note that the way these technologies behave musically is not dependent on their being humanlike in any way (194), an observation shared by Levillain and Zibetti in relation to object behaviours more broadly. Considering the examples under discussion here, Reben's work with GPT-3 and Choi's with the ANN are successful to a large extent because these machines are not creative in the same ways as humans. Their nonhuman abilities – including the processing of large amounts of training information, responding to seed information, and then producing text or visual outputs in decidedly machinic as opposed to human ways – are vital parts of the creative process at hand.

The way in which behavioural objects, whether from Levillain and Zibetti's or Bown et al.'s perspective, are understood as having agency in themselves can also be connected with object-oriented ontology (OOO), which offers a general acknowledgement of the activity and agency of all objects in the world. This theoretical framework adopts the term object to refer to any and all entities, whether they are "human, non-human, natural, cultural, real or fictional" (Harman 9). In contrast with the actants identified by ANT, objects do not only "emerge as the effects of networks" (Michael 40); instead, they

exist as "ontologically prior to their relations" (Morton 208). An OOO perspective insists that objects, whatever they are, must "be given equal attention" (Harman 9). In comparison with ANT, OOO is therefore more concerned with human and nonhuman entities and their actions, as opposed to the associations into which they enter.

While they might seem incompatible, some theorists argue that ANT and OOO can be used together to develop understandings of human-machine interactions. For example, Teodor Mitew applies a combined viewpoint in his analysis focused on Internet of Things (IoT) technologies, whereas Jane Bennett argues that it is not necessary to "choose between objects or their relations" in any context, noting that people's everyday experiences tend to identify "some effects as coming from individual objects and some from larger systems" (228). She therefore suggests it might make more sense to "aim for a theory that toggles between both kinds or magnitudes of 'unit'," making "both objects and relations the periodic focus of theoretical attention" (228). Bennett sees great value in this type of attempt "to do justice to systems and things" (229). Mike Michael, in setting out potential post-ANT theoretical pathways, also emphasises that it seems increasingly important to find ways to engage with humans and nonhumans that follow their "heterogeneity, multiplicity and complexity" (151).

The discussion above has begun to demonstrate the potential of analysing human collaborations with digital technologies from both ANT and more object-oriented perspectives. The next section continues this analytical theme, but its consideration of an embodied machine that draws with a human artist also highlights the impacts of physical instantiation on understandings of machine agency in artist-machine collaborations and their creative outputs.

Agency as "temporally emergent in practice"

Drawing Operations Unit (Generation One), D.O.U.G._1, is a table-mounted robotic arm that, when mounted opposite her, draws with artist Sougwen Chung. [3] Human and robot draw simultaneously on the same sheet of paper, the robot shaping its actions based on its perception of Chung's movements, processing input from a camera mounted above the paper. The robot is constrained somewhat by its physical limitations, and it effectively improvises a creative variation of Chung's line, resulting in an intricate and evolving pattern as the two work together. The beginning of a series of *Drawing Operations* projects, and other projects that see the artist creating art with a variety of machines, Chung's responses to the first and second phases of the project are particularly helpful here.

Chung describes her work with *D.O.U.G._1*, also referred to as *Generation 1: Mimicry*, as "[a]n ongoing collaboration between an artist and a robotic arm" ("Drawing Operations"), with this project also relying on the work of developer Yotam Mann. Much of the information shared about the project focuses on what it is like to draw with *D.O.U.G._1* (detailed below), but Chung also alludes to the iterative process of "calibration, selecting algorithms, and tweaking numeric thresholds" that follows the careful choice of physical

[3] Information about and images for Sung's *Drawing Operations Generation 1: Mimicry* project are on her website: https://sougwen.com/project/drawing-operations. This video of Chung drawing with D.O.U.G._1 also shows the interplay between human and robot: https://vimeo.com/138487938.

components for the initial construction of the robotic arm (Chung quoted in Varner). During development, interactions between Chung, Mann and *D.O.U.G._1* might seem to be wholly reliant on the actions, and therefore the agency, of the two humans involved. Chung and Mann aren't on record discussing *D.O.U.G._1*'s activity or agency during development directly. However, from an ANT perspective, humans and machines as actants could be regarded as involved in a joint process both during the development and implementation phases of the project.

Ideas about nonhuman agency relevant to the development process Chung describes are found in the work of Andrew Pickering, in particular his conception of "the mangle," within which a continuous interaction between humans and machines supports processes of "tuning in goal-oriented practice" (loc. 446). Pickering was working on ways to understand the relationships of humans, instruments and machines in scientific contexts, but the idea of "tuning" also seems particularly relevant when considering the construction of *D.O.U.G._1*, with its iterative cycles of calibration, programming, threshold choice and testing. More broadly, the idea of tuning can be seen in the way artists explain the iterative process necessary to work with GPT-3, a DCGAN and an ANN over specific periods of time and towards a specific outcome.

In contrast with ANT, and similar to Bown et al., Pickering's work adopts a performative stance that allows him to acknowledge the agency of nonhumans as "temporally emergent in practice" (loc. 338). Working with a machine therefore involves a "dance of agency," within which humans and nonhuman agents are "reciprocally engaged in a play of resistance and accommodation" for a particular time period (loc. 464). Pickering's perspective involves an ontological turn away from ANT's semiotic representations of agency towards a temporal and practice-based understanding that acknowledges the importance of the behaviours of objects in interaction with humans.

The contrast between Chung's explanation of the outcome of *Generation 1: Mimicry*, versus her description of the process of drawing with *D.O.U.G._1*, emphasises the value of holding the importance of networks, as well as objects and their performative agency, in mind. Considering the overall outcome, Chung says that for *Generation 1: Mimicry* "the authorship of the resulting artwork is un-ascribable," since "the producer and the impersonator" are indistinguishable from one another ("Myths"). Looking back at the performance of drawing and the artwork created, her understanding therefore echoes the way that ANT theorists argue that who, or what, has "played the decisive part" cannot be judged (Michael 12); instead, it is the creativity that emerges in the networked relation that matters.

Videos of Chung with *D.O.U.G._1*, while showing human and machine as separate active entities in the drawing process, also support an understanding of the drawing process as a form of dance involving a human-nonhuman partnership from which creativity emerges. This links back with ANT's idea of distributive agency, in particular when one considers the distributed system upon which *D.O.U.G._1* depends, physically instantiated as a drawing arm, but relying upon computer vision processing from a camera suspended above the page, as well as the work of Mann.

Alongside this though, Chung also explains how working with *D.O.U.G._1* allows her to experiment with a new form of drawing, which involves "slowing down" and "paying attention" to the robot (quoted in Varner). Therefore, although the technical description of the robot positions Chung as in complete control – *D.O.U.G._1* is, after all, designed to track Chung's movements while she draws, producing its own line as a direct result – her words acknowledge a dance of interaction, within which she and *D.O.U.G._1* circle around each other to produce a drawing. *D.O.U.G._1* takes part in a dance of agency, sometimes resisting and sometimes accommodating the actions of its makers. Chung responds to the alterations *D.O.U.G._1*'s constraints introduce to the pattern, such that human and robot are watching and responding to each other constantly. *D.O.U.G._1*'s nonhuman agency can be understood to emerge within the process of interaction, performative and temporal as Pickering suggests. The presence of the robot as a behavioural object is brought to the fore.

This understanding is further emphasised by Chung, who notes that the robot's "physical form is powerful" and, when combined with "computer vision and an algorithm to generate movement," it is "easy to assign agency personality and intent" to this machine (quoted in Varner). Chung recognises her response as a form of anthropomorphism, a form of attributive agency according to ANT. While Chung links her response with the robot's "physical form," it is worth noting that in many ways *D.O.U.G._1*'s form is clearly not humanlike, being constructed from metal with joints articulated differently from those of a human arm. Instead, it is reasonable to suggest that it is the robot's behaviour that is most important in evoking Chung's response, anthropomorphising its ability to draw with her, but tempered by the way this machine, as a behavioural object, is not actually humanlike, and need not be humanlike, to work alongside the person.

Generation 1: Mimicry doesn't use the breadth of complex networks encompassing many other humans and machines seen in *AI am I?*, with its reliance on GPT-3, or other work using ANNs, for example. Even when positioned as a mimic, Chung does perceive D.O.U.G._1 as a creative agent with which she collaborates to create artworks inside the interaction, but the novelty this robot brings to the process is more about its physical limitations than its own creativity. In *Generation 2: Memory* though, the presence of the robotic arm as a nonhuman other that brings something new to the relation is more clearly defined. The interaction model for *Generation 2* is matured "from mimicry to memory via machine learning" (Chung, "Myths"). [4] For this version of the project, Chung uses an ANN, which interprets an archive of her work that spans 20 years (Tan and Chung). In this way, the robot's drawing style for *Generation 2: Memory* is based on machine interpretations of "the stylistic patterns of its human counterpart" (Chung, "Myths"). Chung suggests the system learns "to 'independently' produce its own conclusion," "implicating the machine as artistic collaborator, or possibly, originator" ("Myths"). As for *Generation 1*, Chung and this more intelligent robot take part in performances together, but this time the robot isn't restricted to attempting to mimic Chung's line; instead, it can improvise based on its coded memory of her past work.

[4] Sung's project *Drawing Operations Generation 2: Memory* is also documented on her website: https://sougwen.com/project/drawingoperations-memory and in a video: https://vimeo.com/228868235.

This analysis of Chung's work with the *Drawing Operations* robots shows how keeping both their relation and their individuality in mind is an important part of understanding how the interaction works as a creative process. This is in line with Pickering's attempts "to keep both human and nonhuman agency in view at the same time," while also insisting "on the constitutive intertwining and reciprocal interdefinition of human and material agency" that occurs as humans and nonhumans work together (loc. 495). Pickering notes that his "way of understanding the interconnection of human and material agency is essentially temporal" (loc. 503), and thus evaluations of agency depend on who and what are interacting, in what way and over what time.

One way to formalise this idea is to consider human-machine interactions as a type of assemblage, being careful to note that here this term is not being used in the somewhat broad way that ANT theorists sometimes use it, interchangeably with the word network, but rather in a specific sense that draws on assemblage theory (AT) developed by Manuel DeLanda, who references the work of Gilles Deleuze and Félix Guattari. An assemblage is defined as a symbiotic, co-functioning set of disparate parts that work together often only for a particular time period (Müller 28-29), an idea that complements Pickering's theories about humans and machines. The concept of the assemblage provides a flexible way to consider not only the work of Chung and her robots, but also Choi and the ANN, Reben and GPT-3, encapsulating how they are drawn together in close associations at times, but also exist as separate entities outside of that relation. Indeed, GPT-3 enters into many such relations, as people use this system to produce text for a variety of reasons, including in journalism as discussed above. This offers yet another way to attribute creation of artworks then, to whatever assemblage is identified as enabling that specific production.

Locating creative agency in multiple ways

It is difficult to definitively locate agency in creative art practice that involves humans and machines working together. When human creative agency is seen to be of prime importance, machines may be positioned merely as machinic surrogates for the human agencies involved in their creation and implementation. However, as this paper has demonstrated, this perspective does not account for the experiences of audience members who physically interact with machines in art installations, or the experiences of artists as they work with machines whether digital or embodied as part of their creative practice.

Considerations of the network of interactions involved in working with some systems is valuable in that it identifies creative actants, both human and nonhuman, that might otherwise be overlooked. From a network-focused perspective, it is often possible to identify distributive creative agency that emerges within relations as opposed to belonging to individuals. On some occasions, it seems that agency is simply attributed to machines, whether through a process of anthropomorphism, or just as a response to the iterative interplay of creating art with a machine that affects your next move. However,

an acceptance of only distributive and attributive agency, may overlook how technologies identified as behavioural objects are active in the world, directly instigating creative choices as well as affecting the development not only of creativity in performance, but also in a memetic sense creative practice and culture more broadly.

Adopting an analytical approach that also considers the agency of behavioural objects highlights what human and machine participants bring to a relation, as well as what emerges through their interaction. In some situations, the agency of physically instantiated technologies may be easier to recognise than that of digital technologies. Discussion of audience participation with art installations in particular highlights links between creativity and embodiment, but artist-machine interactions may be less reliant on embodiment, being directed towards specific outcomes as opposed to being focused on the interaction without a clearly identified functional purpose.

The work of machines within creative practice contexts has many possibilities. Machines can challenge human artists to move in new directions (as seen with Reben), they can also open up new ways of working not possible without their presence (as seen with Choi). Machines can become temporally and performatively active in the creation of artworks in direct interaction with an artist (as seen with Chung). Alongside these possibilities though, the presence of machines adds complexity to understanding who should be credited for a piece of art.

This paper focuses its analysis on examples from visual art but draws on work relating to digital and improvisational human-machine music performances as well as computational creativity and human-technology relations research more broadly for its theoretical frameworks. During the process of writing this article, many more examples of human-machine creativity were located not only in visual art, but also in music. The musical examples in particular warrant their own paper to analyse how ideas of machine musicianship in composition and performance can be theorised and explored more fully along the lines introduced in this paper.

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