AI + Art = Human

Antonio Daniele and **Yi-Zhe Song**

EECS - Queen Mary University of London
Mile End Rd, London E1 4NS, UK

Abstract

Over the past few years, specialised online and offline press blossomed with articles about art made "with" Artificial Intelligence (AI) but the narrative is rapidly changing. In fact, in October 2018, the auction house Christie's sold an art piece allegedly made "by" an AI. We draw from philosophy of art and science arguing that AI as a technical object is always intertwined with human nature despite its level of autonomy. However, the use of creative autonomous agents has cultural and social implications in the way we experience art as creators as well as audience. Therefore, we highlight the importance of an interdisciplinary dialogue by promoting a culture of transparency of the technology used, awareness of the meaning of technology in our society and the value of creativity in our lives.

The advancements in Artificial Intelligence (AI) are reaching new peaks of excellence with unprecedented speed. The applications of these technologies in fields like medicine, transportation, agriculture, retail, security, to name a few, are silently influencing the way we live everyday and have the potential to radically shape our future society.

AI is also gaining a larger role in the creative industry as a tool or co-creative agent in activities that have been human prerogative until now. In the last few years we assisted at the emergence of computational models for parametric architecture (Nagy et al. 2017), generative fashion design (Kang et al. 2017), procedural videogames (Cook, Colton, and Gow 2017) that allowed designers to augment their creative possibilities.

The art field is not excluded from this wave of creative AIs. In fact, artists around the globe have started tinkering with open source computational architectures like Deep Neural Networks (DNN), producing art which is commonly labelled as "Neural Art" or "AI Art". In February 2016, a work made by the computational artist Memo Akten using "Deepdream" (Mordvintsev, Olah, and Tyka 2015), was sold at a benefit auction for 8,000 USD (Akten 2016). Only two years after, the narrative of Neural Art is verging towards a sci-fi scenario. In October 2018, as reported in the auction house website (Christies 2018),

Christies becomes the first auction house to offer a work of art created by an algorithm.

The work was estimated between 7,000 and 10,000 USD but it sold for the stellar figure of 432,500 USD, almost 45 times its highest estimate, questioning the experts if we are witnessing the birth of a new art market. The interesting fact is that the collective "Obvious", the people behind this work, don't have an art background and don't appear as the artists but as the publishers. This point was largely used to speculate about the autonomy and the creative agency of the algorithm which, for the larger public, now becomes the "real artist".

This has direct implications in fields like law and economy, where our expertise is limited. Therefore, we won't consider the problem from an economic point of view or debating whether algorithms will replace human artists. However, we encourage the community to keep investigating such issues like Somaya and Varshney (2018) recently did in regard to the IP rights of autonomous agents.

The interest of the art market into this work is a social indicator raising deeper questions about the relation between art, technology and society that go beyond the commercial facts. This event is giving us the chance to rethink about the role that art and technology have in our lives and how autonomous systems may change this paradigm.

Therefore, this work takes into account the social and cultural value of art as a means of human agency (Altieri 1987) as well as a representation of a culture's identity through time (Weitz 1956). Whereas the most frequent issue among the specialists concerns the ontology of AI Art or whether machines/algorithms can create "real" art (Hertzmann 2018; Coeckelbergh 2017), we think a further question, equally important, is left behind and needs to be addressed soon: what are the social and cultural implications of interfacing with art autonomously generated by non-human creative agents?

In this work we connect the philosophy of art and the philosophy of science to reflect on the epistemological value of works generated "with" and "by" artificial intelligence. We argue that, by accepting this new paradigm, we are indirectly granting artificial agents to produce a meaningful dialogue with humans. As a result, this may create a further layer of separation between the human creator and the human audience. We conclude by arguing the importance of promoting a culture of responsibility within public institutions and industries, where the endorsement of automation in creative

fields is always supported by the development of humans' creative potential.

Background

Before starting our discussion, we define the concepts that we use throughout the paper so to delimit our scope, avoid misunderstandings and facilitate the reader's comprehension. The examples proposed are mostly referring to the visual arts and music, hence the choice to use the generic term "audience", but we believe the concepts are equally applicable to other art forms.

Defining art

From Plato, Aristotle to Kant and Adorno, philosophers in every age reflected about the meaning of art and tried to find its definition. This paper will point out some of the theories from the philosophy of art that align with our personal view and are functional to analysing the problem. In particular, we refer to Croce (1904) idea that art is a higher form of intuition, therefore a higher type of knowledge reached through expression. Also Altieri (1987) describes artistic expressivity as a creative and profound manifestation of human agency. On the other hand, to use the words of Benjamin (2008), the work of art contains an "aura", which is connected in part to its uniqueness but also to the intersubjectivity with the audience. It is a quality, hard to define, similar to the "atmosphere of artistic theory" described in Danto (1964). A more pragmatic approach is proposed by Dickie (1969) who poses two conditions for art to exist: 1) to be an artifact; 2) some society or sub-group needs to confer the status of "candidate for appreciation". This sub-group could be the artist or more generically what Danto calls the "artworld". These theories reveal some of the properties that Art shows across time and cultures but they are far from being an exhaustive definition. In fact, we agree with Weitz (1956, p. 28, p. 27) that art cannot be defined because it "has no set of necessary and sufficient properties".

> Each age, each art-movement, each philosophy of art, tries over and over again to establish the stated ideal only to be succeeded by a new or revised theory, rooted, at least in part, in the repudiation of preceding ones.

Then, he concludes, the problem is not understanding "what is art", rather "what sort of concept is art" and what is the use of it, because "...its very use reveals and demands its openness" (Weitz 1956, p. 30).

Art as a value

What is the use of art then? Why is art so important for us? The fact that art cannot be accounted for the production of knowledge as true, justified belief was discussed in Stolnitz (1992). However, this view was recently challenged by John (2001) who proposes that art creates experiential, conceptual and moral knowledge. According to her, art possesses the epistemic value of initiating a public conversation about the meaning of the works of art. Moreover, it allows comparing one another's views of the world through direct experience, what Novitz (1987) calls "empathic knowledge".

Besides, others debated that art is rooted in human biology, stimulates cognitive activity and responds to evolutionary theories (Dissanayake 2001) making us the "Artful Species" (Davies 2012). This is supported by the view expressed in Deacon (1998) and DeLoache (2004) that human evolution is strongly conditioned by our ability to create symbols like language. Furthermore, in Gesture and Speech (Leroi-Gourhan 1993), primitive figurative art is also proposed as first form of language, not as mimicry rather as symbolic transposition.

Art and technology

From an evolutionary point of view, art gave us advantage over other species by stimulating our cognitive activities like creativity and imagination, reinforcing social structures and working as a symbolic form of language. Equally important for human evolution is technology. Our ability to stand on two feet allowed us to use hands for grasping tools, freeing the frontal organs like the face and the mouth, facilitating the development of the frontal cortex and the language (Leroi-Gourhan 1993).

The development of the technical tools and our biological evolution are therefore two-way coupled. As proposed by Leroi-Gourhan (2012), the technical tools are a manifestation of the "milieu interieur", the ensemble of cultural and mental traditions of a group, including art. In other words, humans evolve technical tools to express their nature. The technical tools, then, shape the environment, which, in return, influences our evolution in a feedback loop.

These views are shared by Simondon (1980) who strongly argues against the conceptual division between human nature and technology inasmuch technology is the human's interface to nature. Similarly to Leroi-Gourhan, he proposes that technical objects are not just instruments but embed humanity and possess different "modes of existence". In his view, the technical objects genesis is conditioned by their embedded functions and the usage humans make of them. This vision shifts the technical evolution from an anthropocentric to a coupling system where it is not just the person deciding what to change in the tool but it is the device itself that "calls" for a particular change. Any alienation from technology, therefore, comes from the misunderstanding of its "essence".

The strong link between technology and art was also discussed by Heidegger (1977) who proposes art as the "realm" in which technology brings forward its "essence". He concludes arguing that both art and technology are means through which humans "reveal" epistemic knowledge.

A more contemporary approach to understand how technology is deeply intertwined with our biological system (and our society) is proposed by Katherine Hayles (2014; 2017) who coined the idea of the "Cognitive Nonconscious" (CN), an "assemblage" of human and technical "cognizers". Halyes explains that algorithms differ from traditional devices (e.g., a hammer), because they show "modes of awareness", cognitive and biological properties like recursivity and autopoiesis. She also anticipates that the CN will show its influence in the creative arts, which is what we are experiencing these days with the AI Art.

In this framework, technology and art are entangled agents that shape our species, not only biologically but also culturally.

Defining AI

As it happens in philosophy of art, there are also many attempts to define intelligence by psychologists and scientists (Legg, Hutter, and others 2007) which makes it difficult to agree on what an artificial intelligence may be. In this work, we refer to the most accepted definition of Artificial Intelligence commonly attributed to Marvin Minsky (Wiggins 2006):

> The performance of tasks, which, if performed by a human, would be deemed to require intelligence.

An artificial intelligence can be simple cellular automata, as well as a deep learning architecture, an evolutionary algorithm or any other computational system that responds to the above definition. The intelligence in these computational systems is not only defined by their technical complexity, rather by the way they interact with their physical or virtual environment, including themselves. For instance, the ability to walk is a form of intelligence that belongs to both the kinetic sculptures by Theo Jansen and to a walking robot (Kuindersma et al. 2016). Both enact the walking by virtue of computational means and in both systems the environment influences their behaviour. The substantial difference between these systems is their ability to learn. Despite their uncanny naturalistic behaviour, Jansen's "Strandbeests" possess only a mechanical function that is producing the walking, whereas a robot can compute its own internal representation of the world and adapt to the environment. According to Lake et al. (2017), this type of model-based reasoning is crucial for an AI to simulate human-like learning, decision making and, most importantly, autonomy (Botvinick et al. 2017). There are generically two types of AI: the one that emulates human cognition and the one that doesn't. Although creativity, together with higher forms of cognition, are computationally difficult to emulate (Lake et al. 2017) any AI able of showing creative features and produce a work of art, should belong to the first group, more specifically to Computational Creativity.

Computational Creativity

Computational Creativity (CC) is that branch of AI that deals with both natural and artificial creativity (Wiggins 2006). The field lives at the intersection of AI, cognitive science and philosophy with the aim to understand human creativity through computational models. Boden (1992) is one of the first attempts to discuss the similarities between human creativity and a computational process.

In the next subsection, we will explain when Computational Arts (CA) and Computational Creativity start overlapping.

Computational Arts

Computers have been used to make art since the early 60's by both computer scientists with artistic inclination like Frieder Nake or Michael Noll (Noll, 1994) and by artists interested in using computational tools as a new medium like Vera Molnar (Molnar, 1975) or Harold Cohen (Cohen, 1988). Although the word "computational" in the arts can assume very different nuances, here we focus on those works using software.

We talk about CC when the computational element is able to produce novelty through a process of creation and evaluation as described, for instance, in Colton, Charnley and Pease (2011). So, the computational arts can be seen as a spectrum of activities defined by the margin of control the human artist has on the final output or, to reverse the viewpoint, the level of autonomy of the computational system.

On one side of the spectrum we have tools, like Processing (Reas and Fry 2007) or OpenFrameworks (Lieberman et al. 2009) which give the artists complete control to write their own software and make art using code as a medium. Moving along, there are interactive tools built for augmenting the artist's expressivity, for instance by using bio-signals or gestures (Tanaka 2000). In this case, the feedback loop between the device and the human gives the artist just partial control on the final output. On the other hand, the computational element is still completely dependent on the human input and has no creative agency, autonomy or ability to learn. Then, towards the other end of the spectrum, there are tools like the Wekinator (Fiebrink, Trueman, and Cook 2009), a meta-instrument that learns from the artist expressivity "on-the-fly". The Wekinator uses machine learning (ML) methods but it is still actively guided by the user. Another example of intelligent tool is "Paul" (Tresset and Leymarie 2013) the drawing robot which, in this case, becomes an extension of its creator, the artist Patrick Tresset. The robot has a high level of autonomy but the algorithms allowing Paul's drawings control both its behaviour and drawing style, somehow limiting its creative agency. Almost at the end of the spectrum there are intelligent systems collaborating with the artist. Some examples are the "drawing investigations" series by Sougwen Chung and her robots or the flying spheres by Random International, moved by swarm algorithms responding to dancers' movements. Finally, there is Computer Generative Art where the human intervention is zero or minimal (Boden and Edmonds 2009). To this group belong works made with AI like AARON (Cohen 1988) or the Painting Fool (Colton 2012), evolutionary algorithms (Antunes, Leymarie, and Latham 2014) or the most recent works by artists like Mario Klingemann, Anna Riddler or Robbie Barrat made using Generative Adversarial Networks (GAN) (Goodfellow et al. 2014). In these works, the creative agency of the artificial agent becomes more complex and has the potential to achieve a higher autonomy.

The spectrum metaphor is obviously a simplification of the whole range of computational tools available, which is functional for us to summarise the dynamics between computers and humans in the arts and introduce the next subsection.

AI, art and autonomy

At the end of the spectrum described above, there is a list of open source DNNs used to create AI art. For instance, Deepdream and Style Transfer (ST) (Gatys, Ecker, and Bethge

2016) are based on Convolutional Neural Networks (CNN), which are architectures inspired by biological features like animal's visual perception. Further architectures used in the arts are the Recursive Neural Network (RNN) and Long Short-Term Memory (LSTM), models inspired by cognitive features of the human brain like memory. These networks are largely used for tasks involving sequentiality, for instance handwriting or related to language. In particular, the Variational Auto Encoder (VAE) published by Magenta (Ha and Eck 2018) has found applications in the arts related to music and drawing. A more recent architecture is the Generative Adversarial Network (GAN), model able to generate visual or sonic outputs (Donahue, McAuley, and Puckette 2018) by using a minimax game between a generative and discriminative network (Goodfellow et al. 2014). Both RNNs and GANs are generative models that can be deemed, to a certain extent, as "creative" and "autonomous" because, once properly trained, they can potentially produce novelty with little human intervention.

Special types of GANs are the Creative Adversarial Networks (CAN) (Elgammal et al. 2017) which were used in a recent experiment to investigate the creative potential of autonomous agents. In this case, according to the authors, there is no human intervention during the creative process of the CAN, however, the models were still trained on existing human creative works. CANs differ from GANs by introducing a second signal from the discriminator model, which acts as an antagonist of the first one and allows the generator model to produce more interesting results.

Nonetheless, the concept of autonomy is not only defined by the architecture itself, rather by how that architecture is used. Although DNNs have an embedded level of autonomy even in supervised learning (Lipton 2018), the margin of control the artist has on the final output is still considerably wide. The human artist can chose the type of data used to train the model and the training parameters which concur to influence the aesthetic of the work. Most importantly, there can be human judgment in the evaluation of what will be considered the final work of art. However, it is also true that these parameters could be automated.

Therefore, the level of autonomy in computational systems is something left to the human to decide during the software design phase. Two significant examples are AARON (McCorduck 1991) and The Painting Fool (Colton 2012), creative artificial intelligence designed to produce art in complete autonomy, including the evaluation phase.

Discussion

Who is making the art then, the human, the machine or both? We find ourselves facing again the dilemma of the division between humans and technology, which, as we have suggested earlier, is a conceptual misunderstanding. As much as humans and technology are deeply entwined, also art making is never separated by the tools needed for crafting that work.

A good work of art is the result of a synergy between the human artist and the tools used. The device can be the voice, the body, the language, a brush, a chisel, a violin or an algorithm. However, in AI Art, the problem of the devices' autonomy seems central. Therefore, trying to understand what "autonomous" means is crucial. Without delving into the philosophical facets of the term, at today, we may agree that autonomy in the computational arts, should be seen as a spectrum and never as a binary feature.

So, how is it possible that one of the world's most important auction houses sold a piece of art made "by" an AI? Is this just a clever marketing strategy or is there something more to reflect about? If we consider the facts, Christie's has already promoted the print as made "by" an AI, which means that the "artworld" (or at least an influential part of it) is recognising and reinforcing this narrative for the larger audience. Although the collective Obvious demystified AI as the real artist (Bailey 2018), this doesn't change the fact that the make-believe system (Walton 1978) is triggered and that the general public is already engaged with this plot. In 20 years from now, this work of art might not represent the best example of AI Art at present, rather what AI means in the popular culture today: the idea of complete "autonomy" of an artificial system, able to achieve high forms of human abilities like art making.

If we think about both Simondon and Leroi-Gourhan theories of technical evolution, we may argue that these could be those events allowing the technical objects to evolve. The idea of AI has an embedded quality of "complete autonomy" that pings back to the environment (in this case our society) and "calls" for its evolution. In other words, it is by injecting in the collective imagination the idea of "complete autonomy" of an artificial system that this technical object aims for its next evolutionary step.

An important point expressed by Leroi-Gourhan (1993) concerns the balance between the biological and technical human nature. He thought the high rate of technical evolution may risk to reduce, rather than augment, human abilities like creativity (Johnson 2011). Nevertheless, we don't know what new artificial systems would be capable of, neither how they will integrate in the CN and influence our biological and cognitive beings. This is why, promoting the importance of a transparent technology, also in the mass-media, could prevent the spread of distorted information and at the same time it may balance the speed of the technical evolution with our biological needs.

AI models are evolving rapidly and their results are surprising the specialists by the day. The uncanny results of today's GANs were probably not imaginable 4 years ago. So, we cannot think that these models will stop evolving. In AI Art, we are not referring just to the realism of the output, but mostly about how the architecture itself will be able to emulate our cognitive systems or predict our sense of beauty.

This last point, in particular, is something that we should care about because it could be exploited for capitalistic aims. The cognitive potential of algorithms as described in Hayles (2014), could be used to condition our preferences and choices, similarly to the subliminal messages in the commercial ads of the 60's.

Imagine the scenario where, at a party, the music and the digital art on the walls are generated so to maximise the guest's comfort. Imagine also that this generative art syn-

chronises with the guest's bio-signals. As nice as this may sound, these features could be a powerful application for art therapy, for instance, but it is easy to imagine how it could be used to control people's behaviour for other aims and in other fields. So, the real question to ask here is "cui prodest?" Who will benefit from this and also, how this may change our relation with art overall?

Implications for our society

Considering how much art is rooted in our evolution, we are not keen to believe that human artists will be completely replaced by artificial systems. However, we cannot just undergo the changes happening in the creative industry as much as in the art field, without opening a constructive critique.

Here we discuss the implications of autonomous creative AI in the arts from three main perspectives: 1) the artist; 2) the audience; 3) the medium.

From the artist's perspective

Artificial automation in the arts is a powerful feature: it can help artists to boost their creative process but it may also produce the opposite effect. By continuously automating tasks, there is risk to "unlearn" that specific ability, as observed in Schirrmacher (2010) and Greenfield (2004). The plasticity of the brain works in two ways and although the complete unlearning process is not easy to achieve (Clark 2014), since the boom of internet, we have already changed some fundamental cognitive skills like the way we use our memory (Sparrow, Liu, and Wegner 2011).

Compared to more traditional devices, automatic creative systems may offer the artists an easier way to create pleasant works. At the same time, this may increase the risk, for those artists, to "unlearn" their own creative process or for young artists to bypass this important stage. As Croce (1904) observes, it is indeed the very process of creation and expression that leads the artists to a higher knowledge of the world and themselves.

Algorithms can already produce paintings in the style of Picasso or music in the style of Bach. What algorithms still miss are the symbolic values and life experiences allowing those artists to create their works. These could be intended as the "artworld" from the artist's perspective, essential for the emergence of the artist's style which is the artist's deepest essence (Altieri 1987).

A more conceptual risk for the artists working with autonomous systems is to confuse the technical achievement with the aim of the artwork, reducing the piece to an empty technical virtuosity. Although the technical achievement can be an important part of the creative process, as Heidegger (1977) observed, technology concerns mostly with the action of "ordering" which prevents the full achievement of epistemic knowledge.

This shouldn't prevent the artists to explore the potentialities of any new technical tool because the concept of art changes continuously and this may be just a new way to experience it. Nonetheless, we wouldn't advocate for a complete shift of the creative process into the technical realm because this could create a separation between the artist and the audience as we explain further.

From the audience's perspective

In the previous section, we discussed how art could benefit society by producing experiential knowledge, social debate about moral problems and empathic knowledge. We have also presented theories arguing that art is a form of symbolic language that highly influenced how we evolved as a species. We can therefore think the work of art as an interface between the artist and the audience, a symbolic layer that works as a meta-dialogue between humans.

Similarly, we referred to technology as an interface between humans and nature, a coupling system that helps the understanding and the shaping of the world around us. In this sense, the differences between art and technology reduce whereas the similarities of their roles in our lives increase: both are functional for revealing epistemic knowledge.

So, in what way is a work made "by" an AI different from an art piece made by a human when it comes to the subjective experience?

The experiment by Moffat and Kelly (2006) shows that there is human bias against machine-generated music, greater in musicians than non-musicians. However, a most recent study with CANs (Elgammal et al. 2017) shows a higher human preference for works made by an AI. This suggests that there is much more to investigate about our relation with artificially generated art.

How we react to a piece of music, words of a poem, colours of a painting or the moves of a dancer, are highly conditioned by our biology and the aesthetic of that work. However, the way in which we experience that work is very subjective (Levine 1983) and conditioned by our personal beliefs. The knowledge we get from a work of art, in fact, may be very much rooted in our personal history.

Computational agents that interact with our biological feedback have been used already to explore human empathy (Colton, Valstar, and Pantic 2008; Daniele 2016), which could be seen as a primitive emulation of "empathic knowledge". Similarly, artificial moral agents (Allen, Varner, and Zinser 2000) could be used by an artificial artist to challenge the audience moral opinion. Therefore, we cannot exclude a priori that a work of art could cause in the audience a significant experiential knowledge just because is generated by an AI.

So, there seem to be no real differences for the audience if an art piece is made by a human or by an AI. Later, we will explain why we think this is not the case.

From the medium's perspective

Drawing from Hayles (2017), an AI differs from a brush or a violin because is a cognitive "actor", part of the Cognitive Nonconscious assemblage. If the work of art, as we described above, is the interface between the artist and the audience, in the scenario where an AI autonomously generates a piece of art, we would assist to an unprecedented division between the human artist and the human audience.

We can see this as a bifurcation of the discourse that for ages we had as a collective, using art as a language. At the same way we are shifting from human interlocutors to AI for solving daily task like navigating the cities or answering personal questions, similarly, we could end up by preferring an artificial creative agent to generate our music instead of promoting independent young musicians. Is this direction leading to further social isolation?

It can be argued artificial artists could represent a new "mode of existence" of the technical object and as such, they will always contain humanity. The dialogue, in this sense, would be between that "humanity" and the human audience. However, the cognitive properties of the artificial system will co-exist with the ones of the human creator. Therefore, unless the human involvement in the technical process is made explicit, this could still be considered as a further layer of separation between the human creator and the audience.

Conclusion

Today's AI models are still very dependent on human input and the myth of complete creative autonomy doesn't seem impending, at least for some AI experts.

Although none of the scenarios depicted above are intrinsically good or bad, we need to bring attention on the role that human have now in creating the artificial models, and what type of human bias will be used to make them because these factors will condition the evolution of the technical objects of tomorrow, so us.

Creativity and imagination are defining characteristics of our species and we think it is fundamental that artists keep exploring technical tools like AI for the benefits of both science and art. However, automating creativity, expressivity and imagination needs particular care and a joint discussion between the humanities and the science. The complexity of this subject should extend beyond the CC community and reach towards the larger fields of philosophy, neuroscience, the arts and the AI, which we aim to promote with this work.

In different modes, art and technology are both mirrors of ourselves. On one hand, art making is a meta-language to expresses things we cannot communicate with other means. It is a way to make sense of the world around us as well as ourselves as a species. Similarly, technology helps us to reveal the nature of things. In fact, the same idea of AI is arguably today's highest form of "humanised" technology, yet another way to know human nature. Therefore, in the framework of "human-technology" as the Cognitive Nonconscious assemblage, it seems almost physiological that art and AI are merging.

To the best of our knowledge there are no studies investigating how automation influences human creativity and expressivity or the audience's experience and behaviour, probably because it would require a long-term observation. This, along with the other questions emerged in this paper, suggests that further interdisciplinary research in this direction is greatly needed. This could help improving the artists' awareness of technology as well as the scientists' understanding of creative process with overall positive outcomes for our collective.

In conclusion, we believe it is fundamental to reinforce the link between the sciences and the arts by fostering human imagination, promoting a culture of awareness of both human creativity and expressivity as well as the meaning of technology in our everyday lives. We think these are things to be achieved only with the support of public institutions, industries and a continued interdisciplinary dialogue.

Acknowledgments

References

Akten, M. 2016. All watched over by machines of loving grace: Deepdream edition. https://goo.gl/Ut33ha.

Allen, C.; Varner, G.; and Zinser, J. 2000. Prolegomena to any future artificial moral agent. *Journal of Experimental & Theoretical Artificial Intelligence* 12(3):251–261.

Altieri, C. 1987. Style as the Man: What Wittgenstein offers for speculating on Expressive Activity. *The Journal of aesthetics and art criticism* 46:177–192.

Antunes, R. F.; Leymarie, F. F.; and Latham, W. 2014. Two decades of evolutionary art using computational ecosystems and its potential for virtual worlds. *Journal For Virtual Worlds Research* 7(3).

Bailey, J. 2018. The AI Art At Christies Is Not What You Think. https://goo.gl/CS8fiS.

Benjamin, W. 2008. *The Work of Art in the Age of Mechanical Reproduction*. Penguin Books Limited.

Boden, M. A., and Edmonds, E. A. 2009. What is generative art? *Digital Creativity* 20(1-2):21–46.

Boden, M. A. 1992. *The creative mind: Myths and mechanisms*. Cardinal.

Botvinick, M.; Barrett, D. G.; Battaglia, P.; de Freitas, N.; Kumaran, D.; Leibo, J. Z.; Lillicrap, T.; Modayil, J.; Mohamed, S.; Rabinowitz, N. C.; et al. 2017. Building machines that learn and think for themselves. *Behavioral and Brain Sciences* 40.

Christies. 2018. Is artificial intelligence set to become art's next medium? https://goo.gl/4LDZjX.

Clark, R. E. 2014. Resistance to change: Unconscious knowledge and the challenge of unlearning. In *Fostering change in institutions, environments, and people*. Routledge. 83–102.

Coeckelbergh, M. 2017. Can Machines Create Art? *Philosophy & Technology* 30(3):285–303.

Cohen, H. 1988. How to Draw Three People in a Botanical Garden. In *AAAI*, volume 89, 846–855.

Colton, S.; Charnley, J. W.; and Pease, A. 2011. Computational Creativity Theory: The FACE and IDEA Descriptive Models. In *ICCC*, 90–95.

Colton, S.; Valstar, M. F.; and Pantic, M. 2008. Emotionally aware automated portrait painting. In *Proceedings of the 3rd international conference on Digital Interactive Media in Entertainment and Arts*, 304–311. ACM.

Colton, S. 2012. The painting fool: Stories from building an automated painter. In *Computers and creativity*. Springer. 3–38.

Cook, M.; Colton, S.; and Gow, J. 2017. The ANGELINA Videogame Design SystemPart II. *IEEE Transactions on Computational Intelligence and AI in Games* 9(3):254–266.

Croce, B. 1904. *Estetica come scienza dell'espressione e linguistica generale: teoria e storia*. R. Sandron.

Daniele, A. 2016. This Is Not Private. In *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, 3831–3834. ACM.

Danto, A. 1964. The artworld. *The journal of philosophy* 61(19):571–584.

Davies, S. 2012. *The artful species: aesthetics, art, and evolution.* OUP Oxford.

Deacon, T. W. 1998. *The symbolic species: The co-evolution of language and the brain.* WW Norton & Company.

DeLoache, J. S. 2004. Becoming symbol-minded. *Trends in cognitive sciences* 8(2):66–70.

Dickie, G. 1969. Defining art. *American philosophical quarterly* 6(3):253–256.

Dissanayake, E. 2001. *Homo aestheticus: Where art comes from and why.* University of Washington Press.

Donahue, C.; McAuley, J.; and Puckette, M. 2018. Synthesizing Audio with Generative Adversarial Networks. *arXiv preprint arXiv:1802.04208.*

Elgammal, A. M.; Liu, B.; Elhoseiny, M.; and Mazzone, M. 2017. CAN: Creative Adversarial Networks, Generating "Art" by Learning About Styles and Deviating from Style Norms. *CoRR* abs/1706.07068.

Fiebrink, R.; Trueman, D.; and Cook, P. R. 2009. A Meta-Instrument for Interactive, On-the-Fly Machine Learning. In *NIME*, 280–285.

Gatys, L. A.; Ecker, A. S.; and Bethge, M. 2016. Image Style Transfer Using Convolutional Neural Networks. In *The IEEE Conference on Computer Vision and Pattern Recognition (CVPR).*

Goodfellow, I.; Pouget-Abadie, J.; Mirza, M.; Xu, B.; Warde-Farley, D.; Ozair, S.; Courville, A.; and Bengio, Y. 2014. Generative adversarial nets. In *Advances in neural information processing systems*, 2672–2680.

Greenfield, S. 2004. *Tomorrow's people: how 21st-century technology is changing the way we think and feel.* Penguin UK.

Ha, D., and Eck, D. 2018. A Neural Representation of Sketch Drawings. In *International Conference on Learning Representations.*

Hayles, N. K. 2014. Cognition everywhere: The rise of the cognitive nonconscious and the costs of consciousness. *New Literary History* 45(2):199–220.

Hayles, N. K. 2017. *Unthought: The power of the cognitive nonconscious.* University of Chicago Press.

Heidegger, M. 1977. *The question concerning technology, and other essays.* Garland Publishing, INC.

Hertzmann, A. 2018. Can Computers Create Art? In *Arts*, volume 7, 18. Multidisciplinary Digital Publishing Institute.

John, E. 2001. Art and knowledge. *The Routledge Companion to Aesthetics.*

Johnson, C. 2011. Leroi-Gourhan and the Limits of the Human. *French studies* 65(4):471–487.

Kang, W.-C.; Fang, C.; Wang, Z.; and McAuley, J. 2017. Visually-aware fashion recommendation and design with generative image models. In *Data Mining (ICDM), 2017 IEEE International Conference on*, 207–216. IEEE.

Kuindersma, S.; Deits, R.; Fallon, M.; Valenzuela, A.; Dai, H.; Permenter, F.; Koolen, T.; Marion, P.; and Tedrake, R. 2016. Optimization-based locomotion planning, estimation, and control design for the atlas humanoid robot. *Autonomous Robots* 40(3):429–455.

Lake, B. M.; Ullman, T. D.; Tenenbaum, J. B.; and Gershman, S. J. 2017. Building machines that learn and think like people. *Behavioral and Brain Sciences* 40.

Legg, S.; Hutter, M.; et al. 2007. A collection of definitions of intelligence. *Frontiers in Artificial Intelligence and applications* 157:17.

Leroi-Gourhan, A. 1993. *Gesture and speech.* miT Press.

Leroi-Gourhan, A. 2012. *Milieu et techniques: évolution et techniques.* Albin Michel.

Levine, J. 1983. Materialism and qualia: The explanatory gap. *Pacific philosophical quarterly* 64(4):354–361.

Lieberman, Z.; Watson, T.; Castro, A.; et al. 2009. Openframeworks. https://goo.gl/41tycE.

Lipton, Z. C. 2018. The mythos of model interpretability. *Queue* 16(3):30.

McCorduck, P. 1991. *Aaron's code: meta-art, artificial intelligence, and the work of Harold Cohen.* Macmillan.

Moffat, D., and Kelly, M. 2006. An investigation into people's bias against computational creativity in music composition. In *The Third Joint Workshop on Computational Creativity*, ECAI 2006. Trento, Italy: Universita di Trento.

Mordvintsev, A.; Olah, C.; and Tyka, M. 2015. Inceptionism: Going deeper into neural networks. https://goo.gl/W5hjt3.

Nagy, D.; Lau, D.; Locke, J.; Stoddart, J.; Villaggi, L.; Wang, R.; Zhao, D.; and Benjamin, D. 2017. Project Discover: An application of generative design for architectural space planning. In *SimAUD 2017 Conference proceedings: Symposium on Simulation for Architecture and Urban Design.*

Novitz, D. 1987. *Knowledge, Fiction, and Imagination.* Temple University Press.

Reas, C., and Fry, B. 2007. *Processing: a programming handbook for visual designers and artists.* Number 6812. Mit Press.

Schirrmacher, F. 2010. *La libertà ritrovata. Come (continuare a) pensare nella era digitale.* Codice Edizioni.

Simondon, G. 1980. On the mode of existence of technical objects. Translated from the French by Ninian Mellamphy. *University of Western Ontario.*

Somaya, D., and Varshney, L. R. 2018. Embodiment, Anthropomorphism, and Intellectual Property Rights for AI Creations. In *AAAI/ACM Conference on Artificial Intelligence, Ethics and Society.*

Sparrow, B.; Liu, J.; and Wegner, D. M. 2011. Google effects on memory: Cognitive consequences of having information at our fingertips. *science* 1207745.

Stolnitz, J. 1992. On the cognitive triviality of art. *Aesthetics and the Philosophy of Art: The Analytic Tradition: An Anthology* 32(3):191–200.

Tanaka, A. 2000. Musical performance practice on sensor-based instruments. *Trends in Gestural Control of Music* 13(389-405):284.

Tresset, P., and Leymarie, F. F. 2013. Portrait drawing by Paul the robot. *Computers & Graphics* 37(5):348–363.

Walton, K. L. 1978. Fearing fictions. *The Journal of Philosophy* 75(1):5–27.

Weitz, M. 1956. The role of theory in aesthetics. *The journal of aesthetics and art criticism* 15(1):27–35.

Wiggins, G. A. 2006. A preliminary framework for description, analysis and comparison of creative systems. *Knowledge-Based Systems* 19(7):449–458.