Modalities, Forms & Systems from the Future

The Art in AI Art
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1. ABSTRACT

Artists and designers have always employed tools in the creation of their work. However, these external technologies have evolved rapidly from analogue to digital, brush to the camera, and intelligent software. As a result, recurring questions of art, authorship, and appreciation have re-emerged between the artist, the art, and the tools/processes involved. Furthermore, whether computers can create art and where it lies has become increasingly blurry as complicated systems like artificial intelligence have entered the creative world as a comprehensive tool that artists can wield. This paper seeks to discuss what these systems are and how they function, the nature of their contested creativity, how artists use them, and where the art lies in the work produced.

Keywords: Artificial Intelligence / Art & Design / Machine Learning / Perception / Aesthetics / Practice

2. INTRODUCTION

The advent of technology has brought many systems and tools at our fingertips. With each passing year, our machines get smaller, more complex, and more efficient at usually handling more than one task. As a result, the terms 'smart' or 'artificially intelligent' have recently come to describe these systems as they seemingly display these human traits in their functioning. As Director Emeritus of the Artificial Intelligence Lab, Nicholas V. Findler puts it, most of these systems aim to mimic human decision-making, problem-solving, and perception processes.[1] Moreover, these algorithms have become so ubiquitous that we no longer realise when an algorithm underpins the interaction of a digital exchange. As a result, Artificial Intelligence has been injected into every practical aspect of daily life, from email filtering,[2] to fraud detection in credit card transactions,[3] to air traffic control.[4]

Alongside their improvements, their accessibility has also increased, allowing more people to use them as a result. With more people becoming familiar with these tools, their potential for creative uses becomes increasingly apparent. Consequently, a growing number of artists and designers have begun experimenting and incorporating these systems into their work. What's more, the adoption of computers has led to various new artworks and processes that utilise them as tools and as a medium in themselves. Artificial intelligence has sparked debates and criticisms due to its potential to automate professions and remove human agency.[5] AI has also sparked the debate on authorship and appreciation in art and design. Many papers investigate the perception of AI anthropomorphicity and how the language used influences allocations to the responsibility of AI.[6] Although all these points are relevant when discussing artificial intelligence, this essay seeks to answer the question—where does the art lie in AI Art?

The word *artificial* indeed originates from the Latin word 'artificiālis,' meaning 'belonging to art' and based on the words 'ars' and 'facere,' which combined mean 'make art'.[7] However, to identify the art in AI Art, we must first define what art is. What are the criteria by which an object can be deemed art? We must also understand where artificial intelligence originated and how machine learning operates to answer the question of where the art exists in these systems. Understanding the inner workings will help gauge whether AI is

1 Nicholas V. Findler, 'On Artificial Intelligence', Department of Lists <https://emerituscollege.asu.edu/sites/default/files/ecdw/EVoice1/n1%20Findler.htm>

2 Emmanuel Gbenga Dada and others, 'Machine Learning for Email Spam Filtering: Review, Approaches and Open Research Problems', Heliyon, 5.6 (2019), 1–2.

3 Imane Sadgali, Nawal Sael, and Faouzia Benabbou, 'Fraud Detection in Credit Card Transaction Using Neural Networks', in Proceedings of the 4th International Conference on Smart City Applications, SCA '19 (New York, NY, USA: Association for Computing Machinery, 2019), 1–4.

4 Heinemann, Stephan, Hausi A. Müller, and Afzal Suleman, 'Smart Autoflight Control Systems', in Proceedings of 24th Annual International Conference on Computer Science and Software Engineering, CASCON '14 (USA: IBM Corp., 2014), 343–46.

5 Andra Irbite and Aina Strode, 'Artificial Intelligence vs. Designer: The Impact of Artificial Intelligence on Design Practice', iv (2021), 539-549 (p. 540).

6 Ziv Epstein and others, 'Who Gets Credit for AI-Generated Art?', IScience, 23.9 (2020).

7 Wiktionary contributors, 'artificial', Wiktionary, The Free Dictionary, 9 February 2022, 22:40 UTC.

simply a glorified brush in the artist's tool-kit or if AI itself and its complex processes infuse artistic value. In this regard, through a literature review, I take a look at various definitions of art and provide a brief history of AI Art, followed by case studies and comparisons between specific examples that have made waves in the field. However, since this domain is still a relatively new and burgeoning field, the examples presented in this paper cannot provide an exhaustive list of the systems currently in use. After that, I draw parallels to historical moments where new technology, such as photography, had posed similar discussions and eventually reinvigorated artistic practice. The scope of this paper is also limited to systems that generate visual output in the form of images or moving pictures. Furthermore, this paper expresses my point of view as a visual artist/designer who routinely incorporates various tools in my practice.

3. DEFINING ART IN RELATION TO AI ART

The Merriam-Webster dictionary defines art in six different ways. According to one of these definitions, *art* consists of 'the conscious use of skill and creativity in the production of aesthetic objects'.[8] Likewise, the Oxford Dictionary defines *art* as 'the use of the imagination to express ideas or feelings, particularly in painting, drawing or sculpture'.[9] This amorphous nature of art could even be considered one of its fundamental characteristics. It allows people to constantly explore and push the boundaries of creativity and expression.

Dr. Thomas Adajian, a professor of philosophy at James Madison University, looks at various definitions of art throughout history from a philosophical point of view in his journal article in the Stanford Encyclopaedia of Philosophy.[10] However, even here, we can see contradictory perspectives based on the time period these definitions were imagined and the tools and techniques employed. In one definition, the conventionalist school of thought describes art as rejecting past ideas of aesthetic interest, formal consideration, and artistic expression. Consequently, this rejection of the old resulted in the creation of new pieces of artwork that were radically different from those that had previously existed. In essence, the avant-garde and experimental nature of the artworks and the methods used in creating them justified their status of being considered art. Considering that every art movement in history began with radical ways of generating art that rejected and abandoned normative methods and themes, we can see that this definition brings about revolutionary new forms of art that revive the artistic practice and keep it from becoming stale. Furthermore, with their computing power, precision, and unpredictable nature, machines have produced artworks that would be impossible to produce in any other way, as we shall see in some examples below. In addition, tools such as these have brought forth new forms of creative expression that were unavailable previously, laying the groundwork for a future filled with captivating visuals that are almost unimaginable today.

Another approach to determining art focuses on the final output. According to Mark Coeckelbergh, a Professor of Philosophy of Media and Technology at the Department of Philosophy of the University of Vienna, when looking at the oppositional criteria of determining art through either an objective or subjective lens, he argues that computer-generated products can be considered art as they can fulfil both agendas.[11] The objective lens aligns with traditional definitions of art wherein the work is evaluated based on specific properties. Here, objects can be classified as art based on aesthetic properties like representation or mimesis, expressive traits, and formal traits.[12] If using this model to classify art, Coeckelbergh states, computers can fulfil these requirements as the articulation of the required criteria can be programmed. Looking at specific case studies below, we will see how certain algorithms, known as GANs (Generative Adversarial Networks), can produce brand new imagery by imitating pre-existing target imagery. These systems can emulate a variety of objects, classical paintings, and even entire artistic styles. If we can engineer machines capable of recreating imagery akin to human artists, their output, according to the objective criteria by Coeckelbergh, naturally qualify as works of art. Inversely, the subjective lens declares

8 'Definition of ART', Merriam Webster <https://www.merriam-webster.com/dictionary/art>.

9 'Art Noun', Oxford Advanced Learner's Dictionary <https://www.oxfordlearnersdictionaries.com/definition/english/art_1?q=Art>.

10 Thomas Adajian, 'The Definition of Art', The Stanford Encyclopedia of Philosophy, Spring 2022 Edition (2007) <https://plato.stanford.edu/archives/spr2022/entries/art-definition/>.

11 Mark Coeckelbergh, 'Can Machines Create Art?', Philosophy & Technology, 30.3 (2017), 285–303.

12 Adajian, 'The Definition of Art'.

there are no criteria when determining art and that it simply boils down to what we decide and agree to call art. Coeckelbergh claims that artificial intelligence products can be regarded as art using this subjective criterion as they need only social acceptance and agreement to become so.[13] Though sweeping in nature, this viewpoint can be a little audacious; however, bringing some specificity might help tame it. For example, a gallery or exhibition space elevates objects to the status of art, regardless of their origin or creator.

Furthermore, the curation of these artworks lends them a heightened status that demands closer attention from people who inhabit the space. When the attention becomes appreciation, this further solidifies the object's status as an art object. Within the realm of art, the social decisions made regarding context, curation, attention, and appreciation become attributes that determine what art is.

The matter of what constitutes art can also be derived from analysing its various processes. According to Joseph M. Hall and Johnson M. Eric, two professors from the Tuck's School of Business at Dartmouth, the common thread that connects art and craftwork is the element of variability in the process, the inputs, and the outputs.[14] They explain that art processes are required when the input or raw materials are irregular and require judgment-based adjustments. Regarding AI, I will discuss how learning-based algorithms can analyse large amounts of input data and extract patterns while relying on logic created independently by the algorithm. Finally, when distinctive or unique, the resulting output requires user or audience appreciation, which renders the process of producing the work an artistic one. When considering AI Art, it stands to reason that the process is very much part of the art.

The challenge of defining and categorising art, primarily through a theoretical lens, presents many constraints and pitfalls. Conventional definitions of art do an adequate job of determining classical art, yet its most significant flaw lies in its difficulty in accounting for the universality of art. Additionally, Western definitions and their imperialistic and colonial histories cannot be ignored when categorizing something that exists in cultures worldwide.[15] Also, as Aaron Hertzmann points out, these definitions all presume that the artist is always a human.[16] As a result, they do not explore whether non-humans are capable of creating art. For that reason, he states, they might not be instrumental in providing insight into answering the question of whether machines can produce art. Nevertheless, they demonstrate how the nature of art is amorphous and changes over time as new ideas, techniques, and tools are introduced to the field. This dynamic nature allows the products of practitioners, and maybe even machines, the flexibility to be considered art.

Through a more contemporary perspective, Hertzmann presents a definition of art as an interaction between social agents. He defines a social agent as anything with a status equivalent to personhood, an entity deserving of compassionate consideration. He categorically states that machines cannot be considered artists through this lens as they do not qualify as social agents.[17] While I agree with that determination, I disagree with his conclusion that computers cannot create art. Ahmed Elgammel, a computer scientist and professor at Rutgers University, displayed a mix of artworks painted by humans and created by his algorithm called CAN (Creative Adversarial Network) in a visual Turing test.[18] A viewer was asked which of the CAN artworks they thought were made by humans and which were computer-generated. More than half of CAN artworks were considered human-made. Furthermore, viewers still rated the CAN artworks higher on average after revealing which artworks were created by computers. We can see that the artist's knowledge is not a requisite for something to be recognised and even appreciated as art.

From the various definitions described above, we can combine them to define art as a status given to objects created by social agents with the creative use of tools that are stimulating enough to be acknowledged and appreciated by others. Revolutionary art requires the added attributes of using new tools and innovative techniques previously not employed, breaking away from established styles

13 Coeckelbergh, 'Can Machines Create Art?'.

14 Joseph M. Hall and M. Eric Johnson, 'When Should a Process Be Art, Not Science?', Harvard Business Review, 1 March 2009.

15 Adajian, 'The Definition of Art'.

16 Aaron Hertzmann, 'Can Computers Create Art?', Arts, 7.2 (2018), 18, p. 20.

17 Ibid., p. 17.

18 Arthur I. Miller, *The Artist in the Machine: The World of AI-Powered Creativity* (Cambridge, UNITED STATES: MIT Press, 2019) <http://ebookcentral.proquest.com/lib/rcauk/detail.action?docID=5894152> [accessed 11 March 2022].

that preceded it. On all accounts, we can conclude that AI Art qualifies as art because these systems are designed, engineered, and used by artists and scientists whose outputs are then curated, shared, and enjoyed by other users and viewers. Not only can these algorithms mimic existing art, but they are also able to create new styles that did not exist in the past. In addition, AI Art is well-positioned to be the seeds of revolutionary new art because these tools are still very much in their infancy. Hence, the ways they are being designed and used to create work are far from their full potential, which in and of itself is challenging but equally exciting to imagine.

4. HISTORY AND CURRENT CONSENSUS

When situating the art produced by artificial intelligence, it is fundamental to consider the history of AI Art and the relationship between technology and art, as they are historically inseparable. Before looking at the origin of artificial intelligence, we should be mindful of previous moments in history where technology has interfaced and, to an extent, been perceived as a threat to artistic practice and human creativity. This retrospective relates to the many fears that have cropped up around artificial intelligence as having the potential of automating and displacing artists.

The origin, proliferation, and adoption of film and photography are the closest parallels to the current development of AI. Fabian Offert, an Assistant Professor in History and Theory of Digital Humanities at the University of California, describes how they evolved from simple technology demonstrations to emulate more traditional media, eventually becoming tangible art forms themselves.[19] Even during their growth, there was a fear that photography would substitute and replace painting entirely. When Paul Delaroche, a famous French painter, saw his first daguerreotype around 1840, he declared: 'From today, painting is dead.'[20] Nevertheless, as we are aware, photography did not replace painting. Not only did painting and photography settle their artistic dispute, but the two spheres ostensibly took cues from each other's practice to help inform and take forward their respective fields in innovative ways. In her book, *Painting and Photography: 1839-1914*, Dominique de Font-Réaulx, the chief curator at the Musée du Louvre in Paris, talks about the influence photography and painting had on each other. In the book, she says, 'photography gave rise to a new relationship to reality and its representation, which then boomeranged on its elder sister.'[21] Artists closely followed photography and, with the newfound liberation from representation, explored new techniques that gave rise to movements such as Impressionism. At the same time, photographers were inspired by the aesthetic and formal attributes of painting which helped propel the medium beyond simply serving as a representative and mimetic tool. This dialogue between the two fields allowed artists and photographers to see differently based on their experiences with the other medium. The acceptance of photography as an art form and the positive symbiotic relationship it fostered with painting presents a hopeful future for AI Art's acknowledgment, adoption, and influence as an established art practice that will perhaps fuel adjacent practices.

In addition to dispelling the fear of artist displacement, the long-standing debate on machine authorship has also been settled as of today. According to Mario Klingemann, an artist whose practice involves using the Pix2Pix GAN (Generative Adversarial Network) to produce imagery, says, 'Like with any other machine, the owner or the operator of the machine owns it. Ask any photographer or pianist.'[22] While reading various literature and examples of AI Art, the human behind the algorithm is always credited and mentioned. This human accreditation will very likely always be the case. However, there is something to be said about the difference between tools like the paintbrush,

19 Fabian Offert, 'The Past, Present, and Future of AI Art', The Gradient, 2019 <https://thegradient.pub/the-past-present-and-future-of-ai-art/> [accessed 2 March 2022].

20 Caterina Bellineti, '"From Today Painting Is Dead": Photography's Revolutionary Effect', Art & Object, 2019 <https://www.artandobject.com/news/today-painting-dead-photographys-revolutionary-effect> [accessed 22 June 2022].

21 Dominique de Font-Réaulx, *Painting and Photography, 1839-1914* (Paris : [London]: Flammarion ; [Thames & Hudson, distributor], 2012).

22 Jason Bailey, 'Why Love Generative Art?', Artnome, 2022 <https://www.artnome.com/news/2018/8/8/why-love-generative-art> [accessed 29 March 2022].

pencil, and camera compared to AI systems, as the latter has some element of the unexpected introduced by the inaccessible logic wherein the artist themselves cannot fully predict or control the outcome. Machine learning systems may not be aware of or understand what they are trained on to generate a result; however, they can solve problems in seemingly innovative and dare-say creative ways.

Like most origins of significant art, using computers to make art came from engineers experimenting with computer graphics in the 1950s at Max Bense's laboratory at the University of Stuttgart.[23] These explorations took the form of instruction-based image-making wherein the computer is given specific directives that it follows precisely to produce a visual output. These are analogous to an artist using a brush to paint a picture as the artist directs the tool based on their intention and control. However, in contrast to early computer art, AI Art employs neural networks that produce variations of images using the range of visual likeness distributed within an image dataset.

5. THE INNER WORKINGS

Several definitions of the process-oriented approach to art imply judgment-based artistic intentionality that requires experience and appropriate knowledge in wielding raw material to produce an artistic output.[24] Usually, we attribute this process of cognitive making to human artists, who receive a deserved appreciation that is added to their work.[25] However, in creating art with artificial intelligence, one can see that a significant part of cognition, not necessarily in the same sense as human cognition, occurs within the algorithm itself. Therefore, it is essential to note that many terms used in describing how these systems work, such as 'training,' 'learning,' 'intelligence,' should be understood with caution as they do not resemble the same processes present in human cognition. Hence, it is essential to dissect and understand how it operates as an alternative form of logic, different and inaccessible to humans, potentially lending its own value to the work produced.

A subset of these systems known as machine learning uses algorithmic structures called neural networks that process large amounts of data. The input data can be structured (pre-labelled or supervised) or unstructured (unlabelled or unsupervised). A neural network identifies patterns in the data that are both recognisable and unrecognisable to humans as the input data is read in the form of numbers ranging between 0 and 1. Then, these networks can make predictions based on the patterns they extract from the data. The larger the data set used to train the neural network, the more accurate the resulting predictions are said to be. For example, several language recognition systems teach their algorithms using human answers to reCaptchas on the internet, including pictures of numbers and letters.[26]

Traditional coding is suitable for solving simple tasks and can be programmed by hand. However, to solve complex tasks that a human cannot code, programmers create algorithms capable of building their own programmatically structured systems to fulfil those tasks. The way this is achieved is by the use of 'builder' bots that can build 'prediction' bots. The 'prediction' bots are trained on vast amounts of structured and appropriately labelled historical data. Testing is then conducted to determine if these bots can accurately distinguish and parse the data. At first, the preliminary outcomes are usually wrong as they are random guesses made by the 'prediction' bots. Thereafter, the 'builder' bots clone the 'prediction' bots with higher accuracy, even though their accuracy was through random chance, and discard the others. After tweaking the parameters, the 'prediction' bots are tested again. Continually repeating this cycle of testing, cloning, discarding, and adjusting produces an effect similar to evolution whereby, with each passing generation, a more accurate algorithm emerges.[27] In other words, it mimics the process of trial and error through aggressive brute force. Once the accuracy of the projections crosses a reliable threshold, the algorithm can make accurate predictions on new data—untrained data it has never seen before.

The ability of the algorithm to analyse and learn from data and then be able to make predictions on new data sets it apart from traditional coding. The

23 Offert, 'The Past, Present, and Future of AI Art'.

24 Hall and Johnson, 'When Should a Process Be Art, Not Science?'.

25 Coeckelbergh, 'Can Machines Create Art?', p. 294.

26 Gugliotta, Guy, 'Deciphering Old Texts, One Woozy, Curvy Word at a Time', The New York Times, 28 March 2011, section Science.

27 CGP Grey, How Machines Learn, 2017 <https://www.youtube.com/watch?v=R9OHn5ZF4Uo> [accessed 11 March 2022].

precise and strict instructions coded by human programmers mean there is no flexibility for the algorithm to function outside its mandated programming. While machine learning effectively gets computers to develop their own code. The evolved logic through training is inaccessible to humans, and hence we cannot understand how they truly function when making forecasts. Unlike traditional code, it is impossible to know the resulting outcomes, where our instructions determine the outcome.

It is essential to distinguish between traditional programming and machine learning algorithms as the latter has been developed keeping the human brain in mind as the structures that make up the inner layers comprise neural networks, not unlike the architecture found in the brain. Furthermore, like the human brain, these neural networks generate multiple answers to a problem instead of a singular 'correct' answer based on different training data. These differences are similar to how people respond to the same challenge differently. This brings about a similar distinction as mentioned above with traditional coding and machine learning algorithms. Early computer art fell into generative art that employed precise maths or randomness to produce imagery. Whereas AI Art, even though it works in the language of numbers, is not exclusively based on maths to produce imagery.

5.1 The Black Box and Intelligence

A notable feature within machine learning systems is that the adjustments made by the 'builder' bots to increase the accuracy of the resulting predictions are inaccessible and incomprehensible to the human programmers themselves.

The inability to understand the logic and parameters used in these systems is known as the *Black Box*. The self-coded nature of the algorithms is what makes comprehending the black box impossible. The logic that emerges from the black box is where the concept of 'intelligence' originates through extensive testing. However, in her book *Atlas of AI*, Kate Crawford states that this perceived intelligence is unlike human intelligence in any way.[28] She says, 'AI systems are not autonomous, rational, or able to discern anything without extensive, computationally intensive training with large datasets or predefined rules and rewards.'[29]

As mentioned at the start of this section, the terms like 'intelligence,' 'learning,' and 'training' all use language to anthropomorphise the inner workings; however, this thinking implies that computer logic is comparable to human reasoning. As we have only access to human logic, we are at risk of mistakenly believing that these machines employ a similar logic – however, this could not be further from the truth. Even when programmed to use English, machine learning systems develop their own language indecipherable to humans.[30]

However, ultimately, it may be less relevant to understand how logic works within the system, but instead how we as users can harness this alternative logic in the pursuit of art. Much of the appeal and novelty of art produced by these systems comes from the uncertainty and unpredictable yet intuitive nature of the end result. In the next section, I look at four case studies where machine learning has been used to produce various artwork.

6. AI ART

6.1 DeepDream

In his book *The Artist in the Machine: The World of AI-Powered Creativity*, Arthur Miller interviews several prominent figures in the field of AI Art. He speaks to Alexander Mordvintsev, a Google researcher specifically interested in computer vision in 2015, to shed light on the subject. Mordvintsev devised a method for peering inside the inner layers of a machine learning algorithm designed to recognise and classify objects within images.[31] He worked with what is called a Convolutional Neural Network that is specifically trained on visual data. These neural networks comprise up to thirty layers that are made up of thousands of artificial nodes or neurons that are able to detect pixel-based data. Trained on millions of labelled images from databases such as ImageNet, the ConvNet can recognise anything like faces, animals,

28 Kate Crawford, *Atlas of AI: Power, Politics, and the Planetary Costs of Artificial Intelligence* (New Haven: Yale University Press, 2021).

29 Ibid., p. 8.

30 Mark Wilson, 'AI Is Inventing Languages Humans Can't Understand. Should We Stop It?', Fast Company, 2017 <https://www.fastcompany.com/90132632/ai-is-inventing-its-own-perfect-languages-should-we-let-it> [accessed 16 March 2022].

31 Miller, *The Artist in the Machine: The World of AI-Powered Creativity*, p. 81.

cars, buildings, etc. As stated in the sections above, a key point to remember is that these machines do not actually 'see' the objects they recognise as we do but instead see each pixel represented as numbers. The neurons in each layer parse the input image, with each layer picking up more detail than the last in terms of edges and shapes. The final layer uses the combined convoluted predictions of all the previous layers to calculate a percentage of the machine's confidence that it 'sees' a dog or a cat in the input image.

Mordvintsev was particularly keen on exposing the hidden inner layers as he wanted to gain insight and understand how these systems could detect patterns so accurately and see what the machine 'sees'. To that end, he fed an image the ConvNet was already trained on, stopped the processing midway, and had the system generate an image from that middle stopping point. The first image he tried contained a cat and a dog but only fed in the part that contained the cat (see figure 6.1).

What emerged after stopping the system in the middle and having it generate an image then and there resulted in a monstrous concoction of a cat-like creature that seemed to have multiple sets of eyes and spidery shapes rendered in a winding worm-like psychedelia across the entire image (figure 6.2).

To Mordvintsev's surprise, the machine seemed to be seeing things that were present and also not present in the input image. With each image passed into this system, the machine would spit out hallucinogenic versions with dog faces, slugs, spiders, and other non-existent features from the original. Entirely governed by the labelled dataset it was trained on, there is almost a sense that the machine is trying so hard to spot these objects that it, in turn, generates them on its own in parts of the image where it thinks they might be present.

These images were not necessarily considered revolutionary or even high 'Art'. However, they did show the first signs of a new type of

Figure 6.1
Mordvintsev's input image of a cat and a dog, 2015.

Figure 6.2
Alexander Mordvintsev, nightmare beast created using DeepDream, 2015.

image-making that involved some semblance of self-taught logic introduced by a computer. Furthermore, the innovative and creative use of the machine to produce these images fuelled a new wave of artists and encouraged them to experiment with this new tool and medium.

Although a human still uses the machine as a tool, it exerts some creative control on the final picture in contrast to an unthinking paintbrush where the human has total control and has a good idea of what the result will look like because of that control. In addition, this is unlike other forms of image-making that are composed of non-human artefacts such as

generative art, glitch art, and imperfections in the medium itself since these appear through random processes. DeepDream, as stated by several others like the AI Artist, Memo Akten, seems to reflect how we perceive the world, making sense of the input images based on what it already knows.[32] In some sense, this may be true; however, the computer does not have any semantic understanding of what it sees, and part of the attraction in these outputs comes from the intriguing mistakes or failures it makes.

6.2 Pix2Pix

Pix2Pix is an AI tool that creates images using a machine learning framework called a Generative Adversarial Network (GAN). The engineer who devised the architecture incorporated in GANs was Ian Goodfellow from the University of Montreal.[33] Before we look at how Pix2Pix is used to make artwork, we need to understand how GANs work to draw out differences between other AI systems like the aforementioned DeepDream algorithm. Wanting to achieve a way to allow the computer to create realistic images entirely by itself, Goodfellow developed a system that plotted two kinds of neural networks against each other, resulting in the creation of new imagery from scratch. This method is similar to the training method described in the section dealing with the inner working of machine learning in that one of the neural networks presents its outputs to a second neural network that verifies if the outputs qualify as a target object or not. Broken down, the Discriminator neural network (D) that has been fed with images from the real world can distinguish various objects such as dogs from each other. The second neural network, called the Generator (G), produces images to send to D to get a positive result stating that the image contains a dog. If D returns a negative result, that information is sent back to G through a process called *back-propagation*. G then tweaks the parameters in its deep neurons between the hidden layers and produces a new image, which gets sent to be evaluated by the Discriminator. It is a process that repeatedly occurs as the resulting images get closer and closer to the images of real dogs that D was taught how to recognise. Eventually, G can produce images that successfully trick D into thinking they are authentic images of dogs.

A crucial point to note is that the Generator neural network starts off generating pure noise but soon manages to produce realistic images from scratch without having ever 'seen' images from the real world. Its only purpose is to get a positive response from the Discriminator, and in doing so, it creates realism almost as a by-product of achieving this goal.

Phillip Isola, an associate professor in EECS (Electrical Engineering. Computer Science. Artificial Intelligence + Decision-making) at MIT studying computer vision, machine learning, and AI, modified the process used in GANs by conditioning it against an actual image instead of starting from noise.[34] This variation on GANs is called a Conditional Generative Network (CGAN), where the Discriminator network is trained on pairs of black-and-white and colourised images. As soon as a black and white image is introduced to the system, D rejects it, sending it back to the Generator network and colourised. Consequently, Pix2Pix translates the input image into the output image, where pixels from the input image are translated into pixels of the output image. This allows users to inject a crude drawing of a cat, for example, and the algorithm produces a somewhat realistic cat based on the recognised cat-like features in the input image (figure 6.3).

Christopher Hesse was particularly taken by Pix2Pix and trained it on various objects. In his words, it is a tool that empowers those who lack the necessary skill-set to visualise and express their imagination. Although not entirely realistic, the resulting image demonstrates potential and hope to change how people, artists, and even non-artists express their creative ideas.

32 Miller, *The Artist in the Machine: The World of AI-Powered Creativity*, p. 83.

33 Ibid., p. 102.

34 Ibid., p. 114.

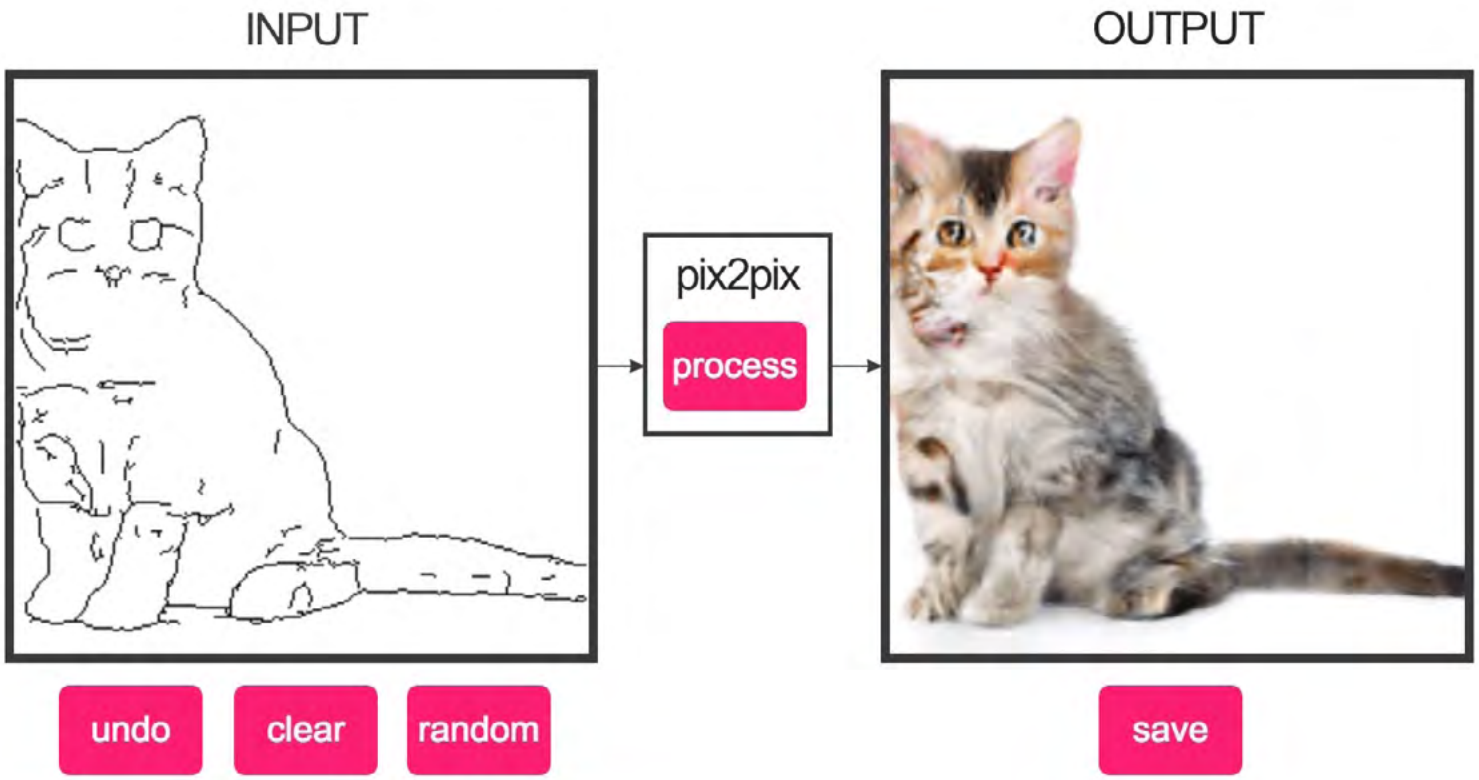

Figure 6.3
Edges2Cats, Christopher Hesse, 2017 .

6.3 Creative Adversarial Network (CAN)

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Ahmed Elgammal wanted to create a system capable of creating new and original styles of art that did not exist before, styles that were not utterly alien so as not to be disregarded. He sees the current trend in AI Art emulating past art as unimportant as he believes that 'art is not just generating things that look like art'.[35] Considering revolutionary art that can spur new movements, Elgammal's stance of not having AI Art mimic other art, I believe, is vital as the potential of these systems is much greater than simply emulating human-made paintings. In his interview with Miller, Elgammal describes how, inspired by ConvNets used in computer vision and the process of GANs, he and his coworkers tweaked their functionality to create what he calls a Creative Adversarial Network (CAN). Based on the definition of novelty in art similar to the one stated above, they trained a neural network to detect the measure of how novel a painting was compared to the ones that preceded it. The measure of novelty was essential to make sure the art generated differed from anything else the machine had been trained on but was not too novel so as not to elicit repulsion from viewers. For example, the psychedelic images by DeepDream are considered repulsive to viewers despite their novelty, according to Elgammal.

To achieve this, the Discriminator network is trained on the WikiArt dataset to determine between art and non-art imagery. However, D can also detect styles of art and hence learns to categorise them. When the Generator starts producing imagery from its initial noise state, D rejects any imagery it does not classify as art. As soon as G creates any imagery that resembles a particular art style, another component of D called style ambiguity takes effect and drives G away from learned art styles. By steering the Generator in this manner, it creates images D recognises as art, but which do not fit into any of the art styles it has defined (Figure 4).

As can be seen in Figure 6.4, Elgammal noticed that the artwork seems to settle on abstraction as a way to avoid fitting any particular mould that could be associated with previously seen art styles.[36] He believes that the movement towards abstraction 'captures the trajectory of art history'.[37] There does

35 Miller, *The Artist in the Machine: The world of AI Powered Creativity*, p. 130.

36 Ahmed Elgammal, Artist Profile (Photos, Videos, Exhibitions) <https://aiartists.org/ahmed-elgammal> [accessed 15 June 2022].

37 Miller, *The Artist in the Machine: The world of AI Powered Creativity*, p. 132.

Figure 6.4
Artworks made by AICAN, Elgammal, 2017.

seem to be some truth in that analysis; as mentioned before, the adoption of photography liberated painting from being exclusively mimetic and propelled artists towards more nuanced and subjectively diverse styles that moved away from realism.

6.4 Dall•E 2

The convergence of object recognition and visual generation, combined with the increasing efficiency of these systems, has resulted in increasingly more human-like artworks. OpenAI, backed by Microsoft, has been working on such an algorithm in an attempt to achieve artificial general intelligence – a machine that can perform any task the brain can accomplish.[38] Dall•E 2 has shown how indistinguishable AI-generated art can be from that made by a human. The algorithm uses prompt-based natural language inputs to create what it claims to be 'original, realistic images and art'.[39] In their explainer video on their website, they explain how Dall•E 2 works using a variation on a GAN wherein not only is the Discriminator network able to distinguish objects but also the relationship of objects from each other. This, when combined with the ability to process natural language, provides seemingly accurate representations of the prompts inputted into the system. From the examples in Figures 6.5-6.8, one can only imagine the potential of being able to generate visuals of such high fidelity.[40] Not only does it create images from text descriptions, but it also generates multiple iterations allowing the user to select whichever output they prefer. Much like Pix2Pix, no longer is the ability to

38 Cade Metz, 'With $1 Billion From Microsoft, an A.I. Lab Wants to Mimic the Brain', The New York Times, 22 July 2019, section Technology <https://www.nytimes.com/2019/07/22/technology/open-ai-microsoft.html> [accessed 13 June 2022].

39 DALL·E 2, 2022 <https://openai.com/dall-e-2/> [accessed 13 June 2022].

40 Aditya Ramesh and others, Hierarchical Text-Conditional Image Generation with CLIP Latents (arXiv, 12 April 2022) <https://doi.org/10.48550/arXiv.2204.06125>.

Figure 6.5
A shiba inu wearing a beret and black turtleneck, Dall•E 2, 2022.

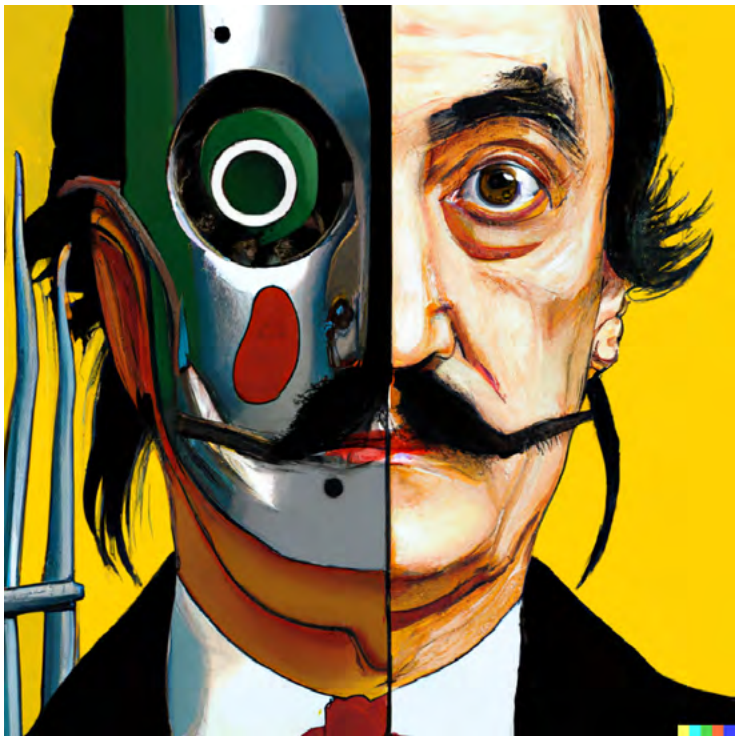

Figure 6.7
Vibrant portrait painting of Salvador Dalí with a robotic half face, Dall•E 2, 2022.

Figure 6.6
A dolphin in an astronaut suit on saturn, Dall•E 2, 2022.

Figure 6.8
A teddy bear on a skateboard in times square, Dall•E 2, 2022.

create imagery of this calibre exclusive to those with the skills to manifest them, i.e., artists and designers. As this reality further takes root and disseminates into various fields, artists' perception and skill-set will have a societal shift similar to that of photographers and painters, as mentioned previously. Due to the ability to create a multitude of imagery, the need for curation will likely equal, if not surpass, that of image creation. It is likely, just as it did with painters, albeit more subtly, that artists and designers will be freed to express themselves in ways not influenced by the current zeitgeist or societal expectations.

Unlike generative art that uses precision-based calculations to visualise and plot mathematical representations, Dall•E 2 makes intuitive decisions on the entered text prompts. We know this because it can produce multiple generations of artwork,

unlike a mathematical equation that usually has only one right solution. Furthermore, it makes independent decisions on visual parameters not explicitly described in text prompts, such as colour, size, lighting, etc., as seen in the examples above.

7. CREATIVE RECEPTION/ PERCEPTION

There is much varying discourse around AI Art which helps get closer to exploring what elements of it are considered artistic and hold value. Throughout its history, artificial intelligence has evolved alongside technological developments, which, in turn, has influenced its artistic value.

As is usually the characteristic strength of technology, even outside art and design, AI Artists harness its exponential efficiency to produce a rich and diverse body of imagery. Unlike more traditional forms, these systems can generate an extensive collection of visual outputs in an incredibly shorter time without much human physical effort. According to Offert, computer artists have begun to appreciate multitudes of images instead of focusing on a single image.[41] In a 2010 interview with the computer art innovator Frieder Nake, he says that computer art has no masterpieces because the field is not concerned with producing singular pieces of work but more about system designs. The value lies in the collective series as a whole alongside the methods and the raw materials used in their creation instead of the artefact itself. Nake uses the phrase 'painting with a brain' to encapsulate the process of conceiving infinity. In his statement, we can see the computer as the brain and appreciate infinity through the endless multiplicity these systems seem able to generate. Obviously, it would be impossible to conceive and make an infinite number of artworks, which naturally leads to some level of human curation. In all the case studies examined above, each showcased multiple pieces of work. This multiplicity denotes a shift in artistic practice in appreciating a body of work as a set when it comes to AI Art compared to viewing the singular Mona Lisa or Les Demoiselles d'Avignon. With conceptual art in mind, Nake's statement also echoes that of Sol LeWitt, who said, 'The idea becomes a machine that makes art.'[42] While Offert and Lewitt made their comments before Pix2Pix and Dall•E 2 were developed, they still seem to ring true, particularly now that these machines use a self-taught logic when discerning the real and the unreal world and have the computational power to make multiples if not infinite iterations.

As DeepDream was one of the first systems able to produce imagery using machine learning, there was a concerted effort by the engineers at Google to involve artists and build a bridge between the arts and the world of technology. As a result, in 2016, the DeepDream: The Art of Neural Networks exhibition was held in San Francisco, which was attended by over eight hundred people, including those from art, science, and technology. The founder and head of Artists and Machine Intelligence (AMI) at Google presented the show as a convergence across not only disciplines but also brains and computers.[43] Twenty-nine artworks were sold, amounting to almost $100,000. Figure 7.1 below shows a piece made by one of the prominent artists in the show, Mike Tyka. It was a significant milestone for machine learning to be considered a serious player in the art world in the wake of the exhibition's success.

By enabling people to express their creativity without the necessary skill-set, Pix2Pix brought science and art even closer together. Moreover, unlike DeepDream, users could actively guide the system to produce realistic imagery based on a crude input drawing forming the skeletal structure. Artists even experimented with different types of training data to see what solutions the GAN could produce. For example, Chris Hesse's edges2cats allowed users to draw a cat and see it change in real-time.[44] This direct manipulation allows creators to see the end results as they engage with the medium much like moulding clay and seeing the form emerge with each press.

Thanks to the increasing ease of use of GANs, more and more people developed creative applications for them. In his version, Mario Klingemann trained his version on multiple types

41 Offert, 'The Past, Present, and Future of AI Art'.

42 'Paragraphs on Conceptual Art - Sol LeWitt', ART THEORY <https://theoria.art-zoo.com/paragraphs-on-conceptual-art-sol-lewitt/> [accessed 29 March 2022].

43 Miller, *The Artist in the Machine: The world of AI Powered Creativity*, p. 89.

44 Ibid., p. 115.

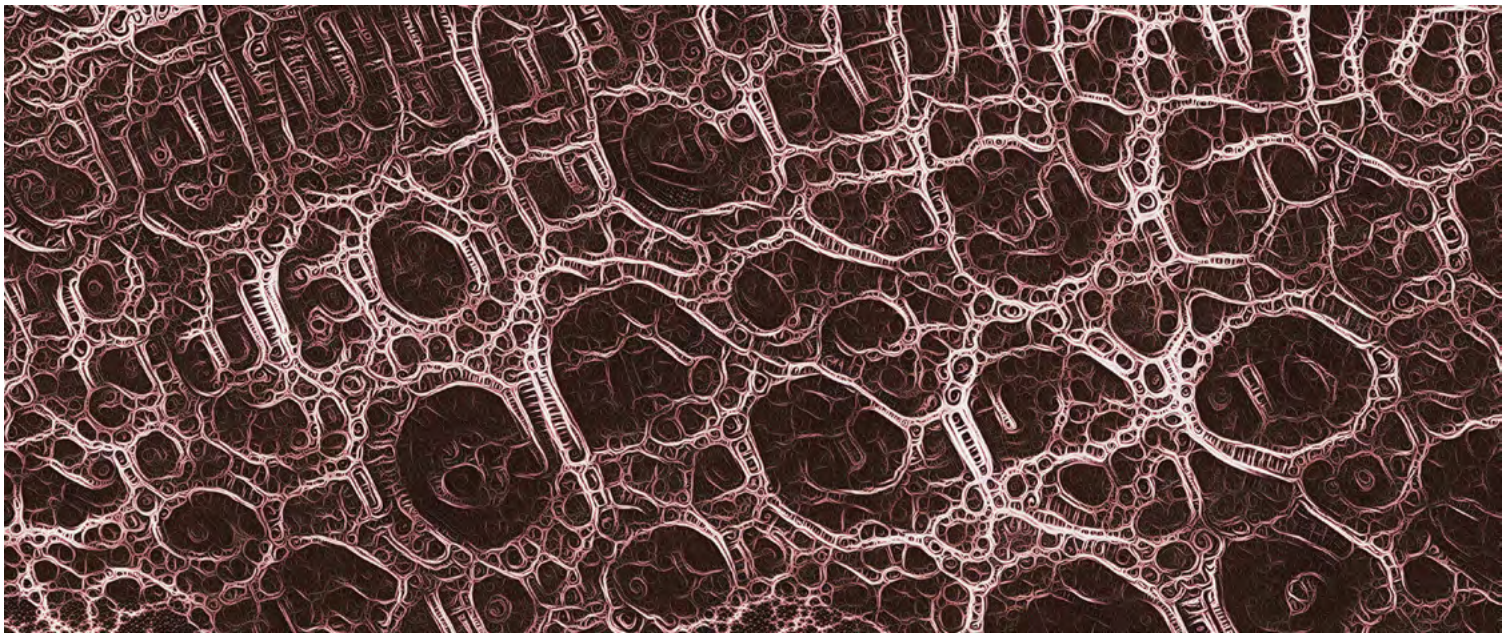

Figure 7.1
Fabric Of Mind, Neural net, Archival print, Mike Tyka, 2016.

of facial imagery to create faces never before seen. He won the Lumen Prize Gold Award for Art and Technology in 2018, improving perceptions and acceptance of AI Art through his efforts.

As was the case with photography, the field shifted from initially revolving around scientific mimetic representation to artistic expression; photographers began taking cues from painting and considered aesthetic attributes such as composition, lighting, and subject matter. We can see a similar trajectory as AI Art is evolving from simply being able to peek inside the inner workings of machine learning, such as DeepDream, to users harnessing the medium in creative ways to produce aesthetic and conceptually stimulating artworks. Elgammal's CAN artworks received much more acclaim than DeepDream as people viewed the pieces as having the same status as human-made paintings.[45] Public opinion has also shifted alongside how artists use these systems, as AI Art has become increasingly accepted and appreciated. A further indication of this is the fact that the valuation of AI Art has also increased. The combined value of the twenty-nine DeepDream artworks sold for $100,000, whereas the more recent sale of the singular Portrait of Edmond de Belamy went for $432,500. Likely, the combined growth of users, machine learning systems, and public opinion will only continue to rise until a point of stability or saturation is reached.

45 Miller, *The Artist in the Machine: The world of AI Powered Creativity*, p. 133.

7.1 Established Art World

Even though a lot of the value and appreciation of AI Art comes from its multitudinous nature, it is interesting to note that AI Art penetration is relatively minor in the established art world. In an interview with Arushi Kapoor, the founder of the cultural centre and art warehouse in Los Angeles, she says, '[there] will always be that reverence in the hearts of art lovers towards handmade art and crafts.' She refers to handmade paintings as having 'artistic glory' and that technology only serves to aid human creativity, not replace it.[46] As of yet, AI Art seems to be in its infancy in the art market. Nevertheless, Offert says that the small number of key players in the space has made it an 'insider's game,' to which most of the aesthetic and critical output can be attributed'.[47] Again, as is with most new kinds of artistic expression, they are born and developed outside the conventional practice and take time to penetrate the status quo of the established system.

7.2 Auctions

In 2018, Christie's New York auction house sold a 19th-century European portrait-style algorithm-

46 Annie Brown, 'Is Artificial Intelligence Set To Take Over The Art Industry?', Forbes <https://www.forbes.com/sites/anniebrown/2021/09/06/is-artificial-intelligence-set-to-take-over-the-art-industry/> [accessed 29 March 2022].

47 Offert, 'The Past, Present, and Future of AI Art'.

Figure 7.2
Edmond de Belamy, Neural net, Printed Canvas, Obvious (collective), 2018.

generated print for $432,500.[48] The 'Edmond de Belamy, from La Famille de Belamy' artwork, produced by the French art collective Obvious, represents the highest selling price for an algorithm-generated print (see Figure 7.2). The incident sparked widespread outrage in the AI Art circles and the general art world since the final sale was 40 times higher than its initial evaluation of $7,000-$10,000. To put this sale into perspective, in the previous week, an Andy Warhol print sold for $75,000, and a Roy Lichtenstein piece sold for $87,500.

In dissecting the various reasons why the distorted portrait sold for the amount it did, a significant proponent seems to be in how Christie's marketed the print. The piece was presented as 'the first portrait generated by an algorithm to come up for auction,' which bestowed unprecedented gravity and exclusivity

48 Gabe Cohn, 'AI Art at Christie's Sells for $432,500', The New York Times, 25 October 2018, section Arts <https://www.nytimes.com/2018/10/25/arts/design/ai-art-sold-christies.html> [accessed 29 March 2022].

upon the work. Moreover, according to Epstein, the anthropomorphic language used struck a chord about the nature of authorship and artificial intelligence.[49] This argument implies that the perception of AI as a social agent, as defined by Hertzmann, propelled the art's value and resulted in its inflated valuation.

The backlash from the AI Art community arose from questions of attribution and quality of the work.[50] The French collective Obvious, who financially benefited from the sale of the piece, used a GAN developed by another artist programmer named Robbie Barrat that used a data set of other people's Renaissance paintings. As Offert puts it, as of yet, AI Art in the auctioning world exists merely as a publicity stunt instead of a genuine appreciation of the art, artist, and machine.[51] 'Yet' is the key word as the current situation is not permanent and will eventually shift in favour of genuine appreciation rather than capitalizing on a gimmick through the combination of artist innovations and public opinion we discussed earlier.

8. CONCLUSION

Looking back in history to find parallels, we are starting to see a similar trajectory of appreciation of AI Art to that of photography again, wherein the excitement came from simply being able to record light to capture a moment. As the field matured and practitioners began to use cameras in creative ways, aesthetic aspects such as composition, conceptual practice, and subject matter developed as the technology became more powerful and accessible. Photography evolved from a passive act of capturing whatever was in front of the camera to an active procedure where the photographer choreographed what made it into the frame and how it was taken. In a very similar manner, with early machine learning systems like DeepDream, much of the excitement emerged simply from being able to extract imagery governed by the self-taught logic of the computer. As time has passed, more variations of machine learning have brought about a leap in the sophistication and creative application of these systems, such as with examples like Elgammal's CAN and Dall•E 2. Though more systems blur the line between art and artist, the active hand and direction of the user have also increased. Additionally, we can only expect this surge in artistry to continue due to the rapid advancements in computational power and its growing ubiquity.

As we can see from the various examples mentioned above, these systems at their core all use machine learning in their operation, albeit in slightly different ways. These tweaks show that much human creativity is flourishing, which is why we should consider these machines tools. However, we should not mistake them and equate them with tools such as brushes and pens that do not have a self-taught logic. On the contrary, these machines can distinguish and develop their independent logic in how they learn and perceive the real world to make intuitive decisions when producing imagery. These systems are also creating and bridging dialogue amongst multiple fields between art, science, and technology. We see these new modes of expression from these conversations. Since these systems are tools, they cannot be considered artists themselves. Nevertheless, they can perform much of the heavy lifting in generating images, especially for users who lack the skill-set to create images through any other means.

Moreover, the value and art lie not in the machines themselves, as they are never exhibited without the context of the work produced, but in the creative and innovative ways artists and scientists have embraced this machine-based logic to create these forms of art that have never existed before. The intuitive decisions made from this logic are why I consider them creative tools instead of simple tools like brushes that are at the complete whim of the human hand. It is in the innovative utilisation of these tools and in how they are evolving that the art exists. This evolution can be seen by the fact that there are differences between the four systems used and mentioned above, even though the underlying principle remains the same.

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49 Epstein and others, 'Who Gets Credit for AI-Generated Art?'.

50 James Vincent, 'How Three French Students Used Borrowed Code to Put the First AI Portrait in Christie's', The Verge, 2018 <https://www.theverge.com/2018/10/23/18013190/ai-art-portrait-auction-christies-belamy-obvious-robbie-barrat-gans> [accessed 30 March 2022].

51 Offert, 'The Past, Present, and Future of AI Art'.

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