

Artificial Intelligence in the Evolving Nature of Visual Art

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Abstract

The idea of AI-assisted artwork was established through the program AARON by Harold Cohen. By breaking down multiple images' components, it creates an accurate representation of authentic items within our society. This program's development dispersed a creation method classified as Generative Adversarial Networks (GANs). The prominence of this network allowed for a more nuanced arsenal of artistic creativity among artists. Using GANs, many artists and organizations implemented AI-controlled softwares such as AICAN (artificial intelligence creative adversarial network) and Perception Engines by Tom White.

The origins of data visualization trace back to a unique combination of science and design, much like the idea of AI-assisted artwork. Through AI programs, independent and collaborative groups of artists have made many projects, such as the interactive and automated data visualization in the Art Nabi Center. These practices build on the more traditional interactive art methods established in the late twentieth century by artists like Rirkrit Tiravanija and others. The addition of AI into this practice has drastically changed the process of visual creation, especially in regards to interactive artworks.

Organizations such as Artists Who Code and programs like Dynamic Brushes have aided in the transition of artists into programming. On the other hand, some programmers utilize their skills to create a portfolio to get recruited into renowned companies such as the designer Jong Min Kim.

Through various computer programs which evolve over time to become more complex and detailed, AI art is proving itself a significant shift in artmaking processes. Through independent and collective organizations, the publicization of this form of artmaking has been on a constant increase within the 21st century.

Introduction

Technology has become a leading indicator of development within our society. Artificial Intelligence (AI) is one of the most advanced technologies permanently altering industries within the 21st century. AI supports the idea of controlled automation, which has been proven effective in fast repetitions and calculations to produce intricate patterns. The most accepted fields which involve a significant amount of human thought and creativity are considered the arts. While the AI currently available cannot replicate or follow cognitive human functions, a joint partnership between an artist and a computer is at the forefront of aesthetic creation. The primary research goal behind this paper is to discuss AI-assisted artwork, which is becoming a prominent method in contemporary artmaking. As a growing subject in society, I believe that it is imperative to investigate how the use of AI can affect creative fields such as visual art.

As an artist who specializes in algorithmic art, observing the qualities of how computer science is integrated into creative processes is a subject I am very familiar with and interested in. As a result of prior investigations into the topic, I have published a study determining how traditional art movements have shown some correlation and relation to modern elements of algorithmic art. The extent of mathematics involved in traditional artmaking processes and the element of recursion and repetition present in specific art movements draw significant parallels to coding and processing.

I have also published a paper regarding the relationship of algorithmic art, Virtual Reality (VR), and Augmented Reality (AR) to the expansion of contemporary art into digital technology. The primary motivation for this research paper stems from my interest in observing how AI and machine learning can become pioneers for the future of contemporary art. A research topic about the future motivated me through my past and present studies.

The Effects of AI on the Tools Artists Utilize

The development of autonomy within AI networks has led to significant controversy on the acceptability of this medium. These networks have been considered efficient tools for artists by some and a blockade in developing contemporary artmaking to others. A programmer named Harold Cohen was the first to create the earliest stages of AI-controlled artmaking with a robotic system known as AARON. This program is a plotter that uses a robotic arm to produce artwork physically. Conceptually, humans rely on their experiences and individual interpretations to understand a specific idea or topic. On the other hand, AARON can only utilize the images input by the artist through a cumulative method of gathering information. AARON works by analyzing a data set or image by breaking the news into individual components of the original data set or image. For instance, once it comprehends the idea of a leaf cluster, it may employ that understanding whenever necessary into diverse

visual productions. For AARON, plants differ in size, the thickness of their limbs relative to their height, the angle at which they become thinner close to their spreading, the number of branches they have, the angular spread at which those branches are located, and other characteristics. By adjusting these variables, AARON may produce many configurations of the same plant and will never draw the same plant twice, even if it draws several plants that are clearly of the same type (Mantaras). However, AARON can not precisely replicate human creativity or processes that involve breaking the parameters of its restricted knowledge. When considering the example, AARON can't create a plant to stand on two stems since that breaks its computational limitation. Therefore, AARON always follows its fundamental design to carry out duties as instructed by the artist, though recent innovations in AI and machine learning technology give the computer greater autonomy in creating images beyond its original limitations (Elgammal).

Most AI art from the past decade was created through Generative Adversarial Networks (GANs). Developed by Ian Goodfellow and his colleagues in June 2014, GANs are systems employed in various areas such as cybersecurity, computer gaming, and photography. GANs are a form of neural network that may create new images from a set of existing photos comparable to the current dataset yet individually distinct. This neural network is made up of a generator and a discriminator. The generator acquires new sample

development skills while the discriminator learns to distinguish between produced and actual instances of information created by the generator. These two models are used in tandem to train the generative adversarial network to create and discriminate recent plausible examples from the current dataset (Joshi). In an art context, for instance, let's say an artist inputs 500-year-old pictures into a generative AI program. After that, the algorithms attempt to recreate these pictures, yielding a variety of output pictures. This process is known as post-curation, where the artist must go through the output images and choose the ones they want to use. The artist strongly influences the outcome throughout this process; they are heavily involved in pre and post-curation and may even change the algorithm necessary to produce their desired results (Elgammal). This is where human creativity works to produce and curate designated artworks. Compared to the AARON system, there is an apparent increase in autonomy found within the AI through GANs. More specifically, the diversification of production is found through a collection of multiple images instead of a strict set of inputs, allowing a more expansive realm of creation.

Recently, there have been numerous applications of GANs towards creating more autonomous AI systems. One of these programs is AICAN (artificial intelligence creative adversarial network).



Fig. 1: AICAN Produced Artwork

This program is considered an almost entirely autonomous artist as it can innovate and generate images on its own through existing styles and aesthetic principles. AICAN works with two opposing forces: one learns the aesthetics of existing artwork, and the other penalizes the system if its work emulates an established style too closely. This creates a balanced order of novelty in the artwork AICAN produces where it uses inspiration from previous work to create something new (Elgammal).

Undoubtedly, AI-assisted programs have established new creative pathways for artists. Throughout time there have been significant improvements to the autonomy of creative systems, leading to more realistic and detailed artwork. This begs the question: will AI eventually replace human artists in the future? While computers can take elements of a picture or artwork and modify it into another abstract form at rapid speeds,

ultimately, human experience can not be replaced by AI machines. According to Anne Ploin, an Oxford Internet Institute researcher and one of the team members behind the report on the potential impact of machine learning (ML) on creative work, machines can not yet replicate all elements of the artistic process. She says, "Parts of the creative process can be automated in interesting ways using AI (generating many versions of an image, for example), but the creative decision-making which results in artworks cannot be replicated by current AI technology." In the end, artists have control over what medium they choose to use, what political or environmental message they wish to send, and how they express their personal experiences through their creativity.

AI Becoming a Foundation for New Forms of Expression

Through the development of advanced AI systems, numerous artists use AI to create their work with different purposes and processes: Some believe that the machine's autonomy is essential to convey through art. Other artists believe it is vital to maintain the collaboration between humans and machines while producing art. However, a few artists believe in creating the rules for the AI program instead of allowing it to create the rules due to learning. In other words, using programmed limitations to guide the AI into a specific artwork where the human has more autonomy over the creative process.

The first method produces artwork by granting the machine almost complete autonomy. While there is human influence over the procedure controlling AI learning, most of the artmaking is done by the computer. One of the primary artists who is deeply involved in the utilization of AI systems is Tom White, a lecturer in computational design at the University of Wellington in New Zealand, whose art depicts the world, not as humans see it but as algorithms do (Vincent). White began his experimentation through a series of prints called “The Treachery of ImageNet” in late 2017. The title is a combination of ImageNet, an image database widely used in the industry to develop and test machine vision algorithms, and the title of René Magritte's well-known painting *The Treachery of Images*.

White expands his idea of the machine viewing the world through a different lens with his “Perception Engines.” Essentially, this engine is a modification of the GANs that typical AI systems dedicated to creative production. GANs are usually constrained to making small incremental changes to an existing image. However, perception engines permit random alterations within a drawing system's limitations. Additionally, GANs often target specific neural networks. But in White's study, he intends to produce visuals that generalize to all neural networks (White). For these generalized arbitrary changes to happen, the architecture of the perception engines are cleanly divided into three different submodules: the

drawing system, creative objective, and planning system.



Fig. 2: Piece from *The Treachery of ImageNet*

The drawing system is the set of limitations used when making the artwork. The creative objective is a neural network pre-trained on ImageNet with a clear and expressive goal for the image. The planning system is dedicated to maximizing the objective through BlackBox optimization (meaning no visual gradients are output in the final image). It is a straightforward strategy that functions best when set to iterate at a high amount of repetitions, even though it is not exceptionally efficient (White). Although the work may seem fully autonomous, White controls many of the artwork's aesthetic elements. More specifically, he sets several starting parameters for his perception engines.

Many critics view White's work differently and highlight how his process changes the contemporary landscape. Karthik Kalyanaraman,

one-half of the curation team responsible for the Nature Morte exhibition, believes that the AI involved in White's work should have credit as creative actors. Many aspects of this system are similar to the process in how humans learn the art. He says, "If a machine can make humanly surprising, stylistically new kinds of art, I think it is foolish to say well, it's not creative because it doesn't have consciousness." On the contrary, some people judge art in economic terms, claiming that AI in art like White's just serves capitalist goals of replacing the labor market with cheaper resources. Mike Pepi, writing for contemporary art magazine Frieze, suggests that the development of AI innovation serves business interests. He believes the ultimate goal of artificial intelligence research is to replace human labor, particularly creatively demanding white-collar employment.

Many artists who use AI in their art limit the autonomy of the machine in the artmaking process, so the artist has more control over foundational elements such as the medium of the artwork. For instance, Tom White would utilize multiple printed layers with the same technology to create his final pieces. Similar to this individual artist, some organizations specialize in the wide-scale production of intriguing mediums to produce AI art on a larger scale. One organization, the Art Nabi Center, primarily specializes in telling stories of how technology and art intersect to create something new. This art center presents a diverse array of artworks that use different types of data, such as the collection of different sounds,

news reports, national statistical profiles, and financial stock data. The work of this center could be considered a form of data visualization which promotes the connection between science and art. A piece that directly correlates to data visualization is called "Making Art - for Stock Market." The art piece is a collaboration between an organization called teamVOID, which specializes in collecting Korean stock index data. The artwork is a primary example of how robotics can be integrated into artmaking. The art piece utilizes a machine known as a pen plotter which is being utilized with a correlation to the rise in AI-generated artwork. The sound and drawing of the pen plotter changes based on the size and frequency of the data readings.

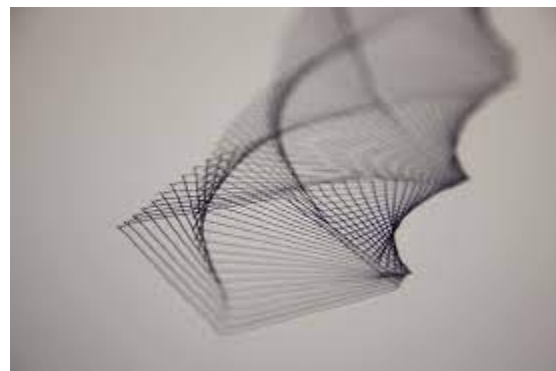


Fig. 3: Making Art - for Stock Market

Plotters are unique in that they are a combination of both physical and digital elements. The process is heavily involved with the physical movement of pens. However, they are maneuvered and controlled digitally (Geere). This allows data representation and configuring unique geometrical shapes created through generative art elements. An aspect that differentiates printers

and plotters is that printers use dots to generate images while plotters use vectors from the use of multiple pens (Geere). Through this method, it is possible to create seamless and detailed products. There are many correlations between the function of a plotter and the processes of drawing as an artist. Watching a machine perform a task the human hand is accustomed to performing while interacting with things like paper and ink truly humanizes it (Chong). Similar to Tom White's work, pen plotters seem to be utilized extensively in artwork generated with the help of AI resources, further reciprocating the roles of humans and machines in this subcategory of artmaking.

Another piece within the Art Nabi Center is the "Data Pump Jack," which emphasizes interactive elements. The machine uses data from a Korean wedding consulting agency's letter based grade system depending on how well you answered the questions. Upon approaching the pump machine, it will ask you questions from the Korean wedding consulting agency. After completing the questions, the artwork will send you a data coupon for your phone where the amount depends on the grade you get upon completing the questions.

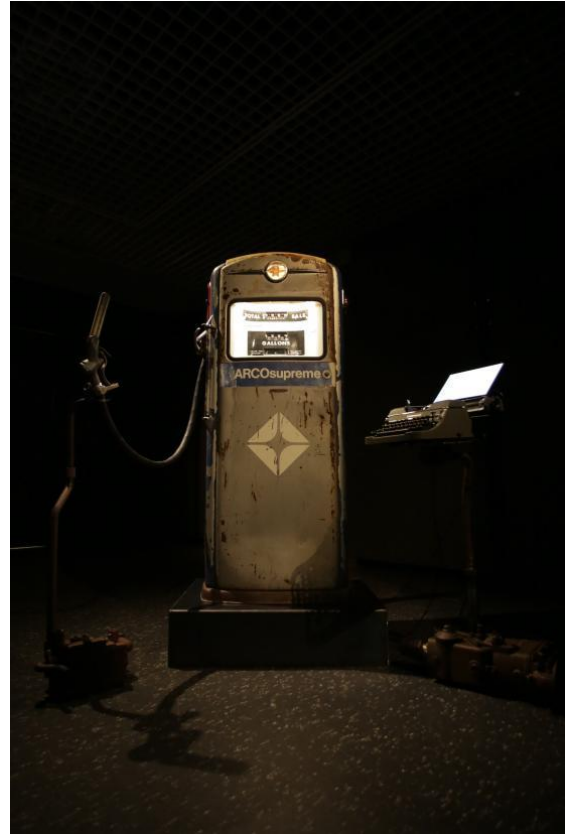


Fig. 4: Data Pump Jack

Unlike the previous artwork, which utilizes a plotter, the data pump jack is an interactive piece of artwork. Interactive art, a 20th-century concept gaining popularity as a valid form of creation, has also been expanded through AI. One of the pioneers of contemporary interactive art, Rirkrit Tiravanija creates installations that are considered incomplete until they are activated by viewer participation, acting morally in the circumstances the artist has physically placed them in. For instance, in his artwork *Untitled (police the police)*, this artist would allow the viewers to eat, sleep, and bathe in his apartment or invent unconventional surroundings built from objects we see daily in life (Lee). Although the pump jack

isn't in full-scale environments meant for the audience, it has a similar constraint of being incomplete without its audiences' interaction. Another aspect that makes the interaction of the data pump jack unique is that it is a communicative process between a technological entity and a human. The ironic nature of a computer-generated data system being integrated within a resource essential to humans, the data pump jack, makes the interactivity with the audience more significant by incorporating methods of data visualization.

While both of these artworks are significantly different, where one is meant to act as an autonomous piece and the other can't be complete without the presence of a human, they share one similarity in that they are forms of data visualization. Within the 21st century, we are surrounded by data. The creative representation of these methods has become a crucial resource for companies and individuals to interpret important information concisely and effectively. Data visualization has recently been pioneered to new heights with the use of enhanced artmaking to promote the interpretation of large and often complex pools of data (Pramod K & Kothiya). Similar to the concept of AI art, data visualization itself is a combination of aspects of science and aspects of artmaking. A distinct balance within both fields allows the visual communication of pools of data which often needs more than a thousand words to explain thoroughly (Unwin).

The evolving nature of art with the use of AI is apparent. Through unique interpretations of data visualization, individuals and organizations are artistically laying out foundations for the rise of AI. Although the Art Nabi Center creates artwork with the intention of more practical data visualizations which reflect issues or aspects of our world, the complexity of AI systems will allow for more nuanced and expanded visual representations. Through autonomous or interactive art, there is a role in AI which allows for creations with more sophisticated intentions. AI artmaking is shifting global perspectives through machine led production with plotters and emphasizing interactive art. While the consensus on plotters was to create visualizations of data that were separate from any professional art pieces, the Art Nabi Center has demonstrated that the experimentation of AI-guided artmaking can allow plotters to serve a more sophisticated role. Traditionally, plotters wouldn't be of any meaningful use within contemporary art because it would be the artist himself who would be physically creating the work. However, with the rise of computer-assisted software, the geometric precision of vector-guided plotters has been of significant use. On the other hand, interactive art was always perceived as the work created by the artist through different materials and combinations. However, through AI, the integration of data with the interaction of the audience has made interactive art more nuanced and noteworthy. As a third entity in the

relationship between an artist and their artwork, the consensus of the limits of what makes the interaction of artwork significant has been shifted.

AI Manipulating the Required Skills In Artists

While the development of AI systems has opened the opportunities for more enhanced and efficient artistic creations, many programmers have used a more direct creation method. There is an apparent fundamental difference between the utilization of traditional coding and AI. According to Harini Suresh, a Ph.D. student in computer science at the Massachusetts Institute of Technology, "Coding is testing a human's skill to which rate it can reduce the complexity of the computer program. AI is testing human's skill in making machines learn to behave like humans." When translating this into the art context, coders must create the AI to mimic the creativity of a human artist as accurately as possible. However, in creative coding, the coder's job is to direct the computer to perform specific tasks with the least amount of complexity. As our world sees a rise in the popularity of coding and the essential nature of that skill as more technology develops, many creative programmers have rendered great visual displays through computer softwares.

Unsurprisingly, many of these programmers originate as artists who look to integrate their artmaking with more digital sophistication. For instance, take the group Artists Who Code whose primary goal is to allow artists to transition into working with technology amidst a pandemic that

halted the progression of their work. Catherine Ricafort McCreary and Scott McCreary, the founders of this organization, were both dedicated artists on Broadway, in music, and acting who decided to switch careers to software engineers. They saw many of their colleagues and fellow artists suffer from a decline in their annual net worth due to the pandemic. As the tech field can be challenging to navigate, this couple dedicated their time to creating mini-curriculums for their peers who were struggling in the field. Their ultimate goal is to create a source of income for these artists and help them make a more significant impact in the future of contemporary art with their newfound knowledge (Easter). Aside from organizations, there has been a significant shift in the distinction between programmers and artists through softwares. Today, many artists are learning how to code while computer scientists create algorithms with aesthetics in mind. Anyone can utilize AI techniques to manufacture, purportedly, art thanks to projects like Deep Dream, a tool that employs neural networks to create new graphics (Ornes). Studio artist and computer scientist Jennifer Jacobs created a software tool called "Dynamic Brushes" that mixes coding with digital sketching. To balance the things you can accomplish with code and hand, Jacobs claims that creating the program required "a kind of negotiation between different modes of expression." Some artists she hired to test her software first expressed reluctance to learn to program. Although they were aware of and

enthusiastic about adopting tools like Processing or code, Jacobs claims they were cautious since they understood they would lose the manual tools they had invested in. She created Dynamic Brushes, a programming environment for painters who typically work by hand, using their input (Ornes).

While many organizations are dedicated to helping artists transition into programmers, some programmers find themselves transitioning to art. Take, for example, Jong Min Kim, a creative programmer who displayed his work as a digital portfolio on his website.

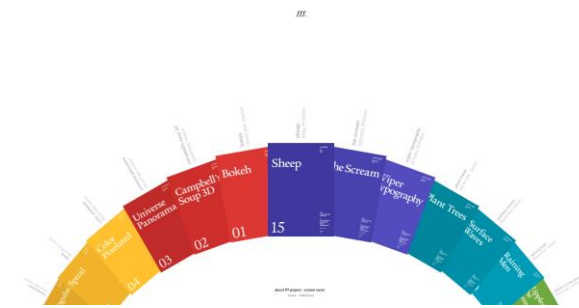


Fig. 5: Picture of Jong Min Kim's digital portfolio

He created many interactive and visual codes presented as a series of artworks for the audience to experience. Through this portfolio, Jong Min Kim was able to get recruited to a UX team at Google and navigate towards a career in design.

Conclusion

The impacts of AI are undeniably present in modern society. Through the constant development of new technologies, we are witnessing a rise in the nuances of creativity these machines offer. Through the effects of AI on the tools available to artists, beginning with AARON,

developing into more complex systems known as GANs, and dispersing into AI-controlled softwares such as AICAN, there will be continuous developments in machines that optimize the creativity of artists in collaboration with AI. That AI is becoming a foundation for new forms of expression for artists has been undeniable through data visualization and interaction of artworks from the Art Nabi Center and perspective illustrations from Tom Whites AI engines. Finally, the focus on skills required to operate AI software has been sustained through organizations and individuals to transition artists struggling financially during the COVID-19 pandemic into more lucrative streams of income. Through my research, I have determined that these three aspects have been most impacted by machine learning within the artmaking world so far. However, AI-assisted artwork has long struggled to gain popularity due to specific traditional values in artmaking. Although we live in a digital age where technology has become an integral part of global development, critics still doubt AI's reliability. For now, their reasons are entirely justified, as AI has yet to demonstrate significant correlations with human creativity. Still, with a continual renewal of information and revisions, the only way is forward for the future of generative art.

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