

# Mathematics, AI, and Art

2022 Spring Math 400 group

## Abstract

We present some different views on the connections between mathematics, AI, and art. In particular, we share experiences and views on the impact of technology on different art activities such as music, visual arts, poems, etc. We discuss how quantitative methods can help analyze and “create” music and paintings, etc. Critical questions include: how well one can use AI to replace creation activities, and how AI will affect the teaching of art and creative subjects

## 1 Introduction

Researchers have use tools, from mathematics, CS, AI, to analyze or even create art work. For example, see [1, 2, 3, 4, 5]. We present some different views on the connections between mathematics, AI, and art. In particular, we share experiences and views on the impact of technology on different art activities such as music, visual arts, poems, etc. We discuss how quantitative methods can help analyze and “create” music and paintings, etc. Critical questions include: how well one can use AI to replace creation activities, and how AI will affect the teaching of art and creative subjects.

In the next few sections, we will describe the experiences and views of the group of participants. Specifically, participants will talk about their opinions on the following.

- 1) Interesting example(s) on connection of Mathematics, AI and art.
- 2) How would mathematics, CS, AI tools help analyze and study art and creative subjects.
- 3) How would it hinder the teaching or study of art and creative subjects.
- 4) Could AI produce good create art work (present and future), and replace humans?
- 5) What is the best way to use quantitative tools to help analyze, learn, study, create(?) art work.
- 6) Additional ideas and comments.

## 2 Different opinions

Here are the responses of our participants to the questions mentioned in the last section.

- 1) I find fractal art to be interesting. Not only does it look visually appealing and rich with different shapes and designs, but I also think it is a prime example that captures math, AI, and art all in one. An AI could easily create art using fractals since all it essentially needs is a recursion of a particular shape/structure, and a pattern to create using this recursion.
- 2) Related to one of Jing's and Genevieve's presentations, I think math can help with creating balanced and symmetric art with things lighting, placement, spacing and layout, etc. Desired ratios and scales could be programmed into AI or CS tools and then used to analyze existing art to measure how it looks with respect to the factors one wants to consider (balance and symmetry, or other qualities that can be quantified).
- 3) I think a well-developed AI system that could generate art on its own would significantly reduce the need for students to learn the finer techniques that goes into any art piece. For example, an AI could produce paintings that are as good as the best ones out there, with all the fine details like brush strokes and depth of color, etc.; But without continuous teaching, students will never know how to recreate or use these skills on their own. Or in music, an AI could reproduce all the sounds and vibration patterns of a skilled musician, (crescendos, decrescendos, vibrato, etc.) If AI becomes so good that it could create the art that we can today, and better, I think these sorts of finer skills will slowly become lost and forgotten over time. There will simply be no need to teach them since the AI can create it on its own.
- 4) I think with enough time and development, AI could produce and create good artwork. I don't think its art would replace human artwork, but I think it could get close to the best that humans can produce.
- 5) As I mentioned in an earlier, I think the best use of quantitative tools is to measure the intervals or spacings (defined differently for the artwork) that exist within the piece. For music, these would be tempos, note length, or the size of the pauses between notes. Each piece has a different combination of these three things, and I think examining or understanding them helps determine what makes that piece unique and great in its own way. Even when creating something like music, two different pieces with the same notes could be created with different feeling/emotion just by decreasing the tempo. That is why I think quantitative tools that measure something like spacing is important when analyzing or studying various artworks.
- 1) An interesting connection of mathematics and art is the use of hyperbolic geometry in optical illusions, in order to trick the eye into accepting two-dimensional visual imagery as three-dimensional by pushing objects 'out' into space.
- 2) Mathematics has been useful to study art in the past in order to figure out the artist's intentions. For example, the last supper is famously analyzed from a geometric standpoint, and from extensive analysis, we are able to draw conclusions about the true focal point of the painting, the meaning of some biblical imagery, as well as the purpose of the expressions in each figure, among other characteristics.

- 3) The increasing reliance on generative art, i.e, applications from AI generators to auto-corrections in digital mediums like procreate, can hinder the influence and intentions of the artist, as well as create a false standard for traditional mediums (that is, hand-created mediums rather than digitally created). Similar to the effect that photoshop has on self perception on social media, generative and auto-correcting art may have the same effect on artists who work in traditional mediums.
- 4) I do not think AI could replace artists. Generated art could be pleasing to look at, but the artists' discipline itself does not carry itself on pure aesthetics. The most important question for an artist to ask before creating a piece, is, what do they intend to express? This can manifest itself in the nuances of color interpretation, visual skew, or compositional shifts, to name some methods. This is lacking in auto-generated art, and becomes clear when compared to art created by hand, by an artist.
- 5) Personally, I think the best way to use quantitative skills to learn and create artwork is in the construction phase. Especially geometrically, much of two-dimensional art is created with a foundation of sight measuring to compare the size of objects, the length of the distance, and the perspective of the viewer. This is ultimately rooted in geometric principles, and studying such principles can improve the artists' capabilities in composition and help to create a more compelling end result.
- 1) I was planning on talking about math in movies and tv shows, not how math is used to create them, but how we see math portrayed in them. I was curious about whether or not there are mathematicians who go over scenes where math is being used and it seems that the answer is it depends. The first movie that comes to mind when I think of this is Good Will Hunting. The math scene in that movie is apparently just a problem from a graph theory textbook and not some very complicated problem as it is portrayed. For this reason, some mathematicians don't like it, because it gives the impression that very hard math problems can be solved by a "genius" in a matter of minutes, when in reality, this is rarely ever the case. Interestingly, in the show The Simpsons, there are several mathematicians on it's writing staff who are able to make sure the mathematics used in the show is sound.
- 2) I think that AI and mathematics are very useful tools in analyzing any type of art. There are certain patterns that many pieces of art use that can be described by math, things like line of sight and the illusion of depth in a painting. AI can also be very useful in identifying the artist of a certain piece. Most artists will follow a style of use a certain type of paint or have some sort of distinguishing characteristic, that AI would be able to pick up on when analyzing many many pieces of art.
- 3) A person could pass of some sort of AI generated piece of art as their own, whether it be a poem or actual painting, and it may be difficult to prove that it was done by AI. However, I believe that people who really want to be artists will still produce their own work and not rely on AI to do it for them.

- 4) I don't know that AI could produce art so good that it replaces humans. AI can certainly produce good pieces of art, but I think that one of the things that makes a piece of art great is the human connection to it. In a great piece of art, you can feel the emotions that the artist is portraying and you can relate to them, since you are a human as well.
- 5) I think that there are a lot of good ways to analyze art and it depends on what you're analyzing/what you're looking for. I think that anything that can be used to recognize patterns would be useful for analyzing all types of art, but things like poems and paintings deserve to be analyzed in a different way, perhaps using different techniques.
- 1) The tritone, also known as the Devil in music, has a frequency ratio of  $\sqrt{2} : 1$  since notes double their frequencies as they travel up an octave, and tritone – separated by three whole tones – would need to exhibit such frequency ratio so that the frequency doubling rule between octave-separated notes is respected.
  - 2) I think they (Mathematics, CS, AI tools) mostly serve as visual and precision aids for creators. Architectural model, for example, could be illustrated through AutoCAD and subsequently 3D printed to obtain a physical model.
  - 3) I think using AI tools would not so much hinder but rather shift the paradigm in which creative subjects are being taught. Modern artists must, in addition to mastering conventional skills that define an artist, acquire technical expertise to properly engage with technology. The study of art would therefore broaden and art itself would acquire new meaning.
  - 4) I think this is highly dependent upon how one defines art. If a piece of work possesses market value, but lack human involvement, is it art? The same could be asked of artifacts that bears no market value. . I personally wouldn't consider works manufactured by AI art regardless of how well-executed and aesthetically pleasing they turn out to be. It is for this reason that I find the angst that AI can ultimately take over human creative endeavor to be absurd and unreasonable.
  - 5) As previously stated, I think quantitative tools are best used as visual and precision aides to artworks that require high color acuity and precise dimensionality. As long as the tools remain passive in the process of generating art, their presence can be benign.
  - 1) Although some may not consider it art, journalism is perhaps the primary intake of writing for most Americans. There are certainly many highly artistic works of journalism, and some publications pride themselves on their long-form, literary form of journalism. However, there has been a stark increase in the number of computer-generated news pieces. Automated journalism ([https://en.wikipedia.org/wiki/Automated\\_journalism](https://en.wikipedia.org/wiki/Automated_journalism)) has been used by many big news aggregator services, resulting in the unemployment of many journalists.
  - 2/3) AI could probably do a pretty good job in identifying patterns and authenticity in art works that the human eye might miss. Indeed, perhaps AI could be used to identify unexpected trademarks of a certain artist or even prove/disprove the authenticity of a certain

piece. This analysis could be useful in the teaching of art, as it could show long-overlooked observations in certain artworks.

4) I do not think that any piece generated completely by AI is art. Art is defined by the creativity, skill, or inspiration imbued into a work by a human creator. Perhaps if an AI could become sentient and gain a kind of personhood, its creation should and could be considered art. However, as long as the AI could not be considered a sentient person, I do not think its product should philosophically be considered art.

5) I think AI/computational methods should be primarily used to analyze rather than create artistic works. We should leverage the ability of computers to analyze large datasets without the fatigue/bias/imprecision of a human analyst. However, humans should be heavily involved in setting up the AI and directing it to a proper dataset created to maximize its observational potential.

- 1) I would mention a different kind of connection between math and art than those we discussed in class. I was going to mention the theory of beauty (in art) that I heard on this podcast by the Partially Examined Life. One of the theorists proposes that beauty is experienced when we experience a kind of uniformity in variety or unity in multiplicity. The examples he gives are geometric ones: he thinks, if you ask anyone, basically always they will agree that the square is more beautiful than, say, a rhombus or a trapezoid because there is more unity among multiplicity in it (e.g., four sides, four angles, but also same angle measures, same lengths of sides, more lines of symmetry, etc.). Likewise, a regular hexagon is more beautiful than the square because it unites more variety. I think they suggest this in the podcast, but I wonder how much this is connected to the idea of an 'elegant' or 'beautiful' proof in mathematics. Namely, is it generally true that proofs that are considered elegant or beautiful are ones which unite diverse ideas in a simple result, uniting, say, sequence analysis with statistics, etc? Or are they ones that prove something with simple-to-state constructions with a lot of distinctive conceptual content that then prove, in one statement, something with even an infinite variety? Euclid's proof that there are infinitely many primes comes to mind.
- 2) I think mathematics is a good tool to use to discuss the elements of an artistic composition, so that we can find distinct patterns or constructions in a work that follow an identifiable mathematical structure and then discuss how the work uses these patterns. I think AI could do something similar in analyzing art, since it might be able to detect patterns more easily in some cases, though I don't know much about AI. I also like the concept that the artist we listened to in class who described his work as trying to capture "the moment of data" discussed, and so I think AI and mathematical kinds of tech have an interesting role on those frontiers.
- 3) I think the most obvious difficulty these things create for the study of art is probably the invention of AI that can create things which students might submit as their own work. I don't know that this is a huge problem, though, since it is not like the next great artist is

going to be lost because they're submitting AI-generated works instead of real works. Artists are usually driven enough to make art that being assigned the task for a class is not the most important factor.

4) I am suspicious of AI-generated art on some levels, though whether they can make good art depends on what makes art 'good' art. It would not be surprising at all to me if AI could make art that human beings find quite pleasing, but this is different than making art that is historically good on an aesthetic level. The very greatest paintings, music, poetry, etc. is so exceptionally rare that even an amazing artist will only produce a handful of absolute masterpieces in their whole life. This kind of genius is not entirely about whether something can be judged to be a pleasing piece or something like that, which we could feed into a machine learning algorithm. It is a complicated (not entirely propositional) affair of constructing something with certain emotional undertones, with a definite concept behind it, in dialogue with the history of art, associations of the language which have little to do with its literal meaning, sound, or grammar, etc. Just as an example, I have heard the interpretation of Picasso's *Les Femmes d'Alger (O. J. R. Version O)* as playing with the distinction between the imaginary, depicted world of the artwork and the real world in which the artwork is observed; the idea is that the boundary is broken in a way opposite to the breaking of the 'fourth wall', in that instead of the imagined beings speaking to the observers and breaking out into the real world, it is like they are looking back at you because you have intruded into the imagined world and are staring at them from the real world. That level of meaning and historical context is something I suspect a computer will only be able to do if designed to. And if we compound things like this, along with the fact that there is usually no perfect psychological pair of any given mathematical pattern, it looks very unlikely to me that AI generated art will reach the heights of human art without a lot of human planning, at which point the distinction between the two forms of art starts to break down.

5) This question depends on the medium. I don't know what is best, but geometry is usually quite good for describing visual arts. Meanwhile, I suspect algebra, number theory, and arithmetic would be best for describing musical patterns.

6) Like I mentioned in some of the points above, I do think there is value in exploring the math/AI connection in that I think it creates interesting concepts that can be materialized in the work of art. For example, I think the idea I mentioned at the end of 4th point is interesting: to try to create a work of art that breaks down the line where the machine begins and the human being ends.

- 1) I think that math, art and AI and the connection is very interesting. One example is with linear perspective of art. Because it is so geometrically based, I think that it would be a good starting point for the development of AI for art. Something very easy to grasp and conceptualize is patterns and with the idea of linear perspective, I think it would be the easiest way to program an AI to recognize for itself.

- 2) With AI, I think it can make a great contribution in the abstract art space. Because abstract art is meant to be with no pattern and up to the viewer for interpretation, if an AI could find a pattern in the abstract art, it would help viewers make their own conclusions on the pieces of art work.
- 3) To my last point, it may hinder the abstract art experience if a pattern is found as then it may no longer be abstract. One of art's great strengths is the subjectivity of it and how everyone can have their own interpretations. AI could go on to take out the human factor which in my opinion is the best part about art.
- 4) I think that an AI can produce great art as it can learn in an instant and be able to create on its own. Currently I do not think that AI is complex enough however, the future of it has great possibilities.
- 5) I think the best way to use quantitative tools is to use it in the aspect of linear perspective. Being able to create effects and the illusions of certain spaces on a 2-D canvas is sometimes very important and with the help of quantitative tools, I think that would be a great use of it.
- 1) The use of Euclidean shapes in works of art has been interesting to me, since it relates to an old assumption that Euclidean space is aesthetically preferable to non-Euclidean space, in mathematical and artistic terms. Why exactly we have tended towards this preference seems unclear. Nonetheless, many artists have applied or assumed Euclidean space for their works, beginning with a basis of 'straight' lines, squares, and other such objects, and moving from them towards more complicated constructions.
- 2) Mathematics can be a helpful tool in analyzing certain artworks because it allows us to investigate the rules used by artists to produce certain effects. For example, certain geometric concepts allow mathematicians to generalize how ellipses are drawn realistically using a projective plane and a horizon line. However, while it seems possible to use mathematics to study art, I do not believe it is possible to use mathematics to learn how to create art. Great works of art are not references to a system of rules, they are portals that allow us to access the deep, intangible truths of the universe that human beings are capable of understanding. The field of mathematics involves itself in that process, but not in the same way as traditional artistic fields such as painting; those fields rely much more heavily on abstract, emotional, or intuitive content in communicating truth than does mathematics.
- 3) If by 'art' we mean 'portals that allow us to access the intangible truths of the universe that human beings are capable of understanding', then I think mathematics is clearly a field of art. However, mathematics is a field of entirely different character than the traditional arts, such as painting. The overwhelming part of mathematics is stated in discrete terms, and history's greatest mathematicians have even been capable of reaching the 'intangible truths' in discrete terms. The truths accessed by the traditional arts are stated entirely in non-discrete terms:

feeling, instinct, memory, intuition. If by applying mathematics to works of art we attempt to reduce its non-discrete terms to discrete terms, then we are hindering our ability to study the field because we are erasing its truths. If we reduce a painting to its shapes – how well they interact in space, whether they are rendered accurately according to a given structure – then we have lost access to the truth that the painting is speaking. Mathematics is, I believe, quite useful in discussing the discrete items in such a painting, but it should not be used to recast these items as representing the whole truth, or communicated knowledge, of the painting.

4) For me, a work of art represents the intersection of human understanding and the fundamental truths of the universe. AI has nothing to do with this process. AI may be capable of using algorithms to mimic the methods that human beings have historically used to create art and access these truths, but it is incapable of playing any role in that process itself. The ‘art’ that these algorithms produce may, by coincidence, be sensually pleasing to some people, but these projects have no content in themselves; AI does not conceive of truth external to itself, so it cannot participate in artistic processes. This is easy to see if we study the question of whether AI can produce art using ‘mathematics’ as a substitution for ‘art’, assuming that we accept that mathematics is a field of art. We do not believe that AI is capable of solving unsolved mathematical problems such as the Riemann Hypothesis, so we are convinced that it is incapable in itself of communicating truth through mathematics; likewise for all fields of art.

5) While they may be interesting, I do not personally find these tools to be useful on a deep level. Real understanding of art has nothing to do with mathematics because the species of truth that works of art access and communicate are entirely non-discrete; they are communicated through feeling, instinct, memory, or intuition, and there is no way to describe or analyze them mathematically. So, mathematics can be used to analyze only the technical aspects of art, for example how certain shapes are drawn realistically or in certain proportions.

- 1) I remember when I was in elementary school, my music teacher once demonstrate how to make music using a software. Essentially, each song is separated into different sections, and each section has certain number of note. Then we assign each note with a number, and randomly fill numbers in those sections. When we play it out, we can then make little changes to make the song more fluent. I wonder if we can let the AI to study all the hit songs by transferring each songs into a string of numbers, and then create its own.
- 2) I think it would give a precise analysis of why some art is visually appealing, such as the golden ratio found in many famous pieces. Also the number of overlap syllables is also a factor in determining if one song is coping another. In the end, I think Math and AI can transfer every thing in numbers and analyze it.
- 3) I don't think it would help in teaching art. Since our minds do not work like AI, so it is better we are taught to perceive the emotions inside the art. Like when we play piano, it is

not just about pressing the right key, we also need to be able to put our emotions into it.

4) No, I think the creativity part of human kind is irreplaceable.

5) I think when we are analyzing some of the most popular songs, and find what they have in common, and then make other music based on this analysis, this tool might be helpful.

- 1) I REALLY HAVE TO share this coolest AI drawing ever: <https://colab.research.google.com/github/alembics/disco-diffusion/> It is able to draw based on given words or sentences or overall color or drawing styles (water color, oil paint, etc., or even a given picture and it will mimic the style)

2) Speaking of art in general, one topic I worked on this semester is origami. This modern paper-folding art form relies heavily on the algorithms carried out by computer programming (See my paper 1 for more details). One cool thing I want to highlight is that, with CS, we are able to discover new structures to fold the paper into certain shape, while such structures can in return inspire general structures for science or new artworks of origami. This virtuous cycle gave me the feeling that it works the same way as deep learning in AI.

3) From my personal experience, I learn drawing by first mimicking the existed masterpiece. AI creates mores similar pieces that I may take as reference, which I think would help with my drawing. Also, CS tends to break everyone down into pure logic, which kind of inspires me with the question “what general rules are followed in arts?” This kind of echos the presentation on “Perspective in Paintings” during the second round of presentations we had.

4) I don’t think art can replace humans because our mind works different from AI and I believe we need both human and AI in the future, but AI could produce good art work. Put Disco Diffusion in your search bar and you will be literally frightened by how well AI can draw.

5) The first thing I can think about is accuracy. I think that is, again, showed in the presentation “Perspective in Paintings.”

6) Adding a personal story to why I think AI cannot completely replace human. During one of my high school classes, our teacher gave us a problem to work on: how to make a program that can distinguish photos of chocolate chip cookies from the face of Shiba Inu. Even a 3-year-old can tell the difference, but with computers, you have to write some obscure codes to fulfill the goal, and it still sometimes make mistakes.

### 3 Conclusion

#### References

- [1] [https://en.wikipedia.org/wiki/Music\\_and\\_artificial\\_intelligence](https://en.wikipedia.org/wiki/Music_and_artificial_intelligence)
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