

The background of the slide is a photograph of a sunset over a body of water. The sun is a small, bright orange circle just above the horizon, casting a warm glow across the sky. The sky transitions from a deep orange near the horizon to a lighter, hazy orange and then to a dark grey at the top. The water in the foreground is dark and calm, reflecting the colors of the sky. In the distance, a city skyline is visible on the left side of the horizon, with several buildings and a prominent tower. The overall mood is serene and contemplative.

Welcome to

# MACHINE LEARNING ART

Welcome to Machine Learning Art. In previous tutorials we've covered the basic foundations and history of mathematics and computer science, and investigated neural nets and their history. Neural nets require training data, and we considered what it means to make datasets ethically, in a 'Good Way'.

This time we'll look at making art with machine learning tools. We'll categorize some types of ML art and investigate how art and ML interact. We'll look at specific art projects and artists and how these artists have integrated ML into their practice.



# Machine Learning Art

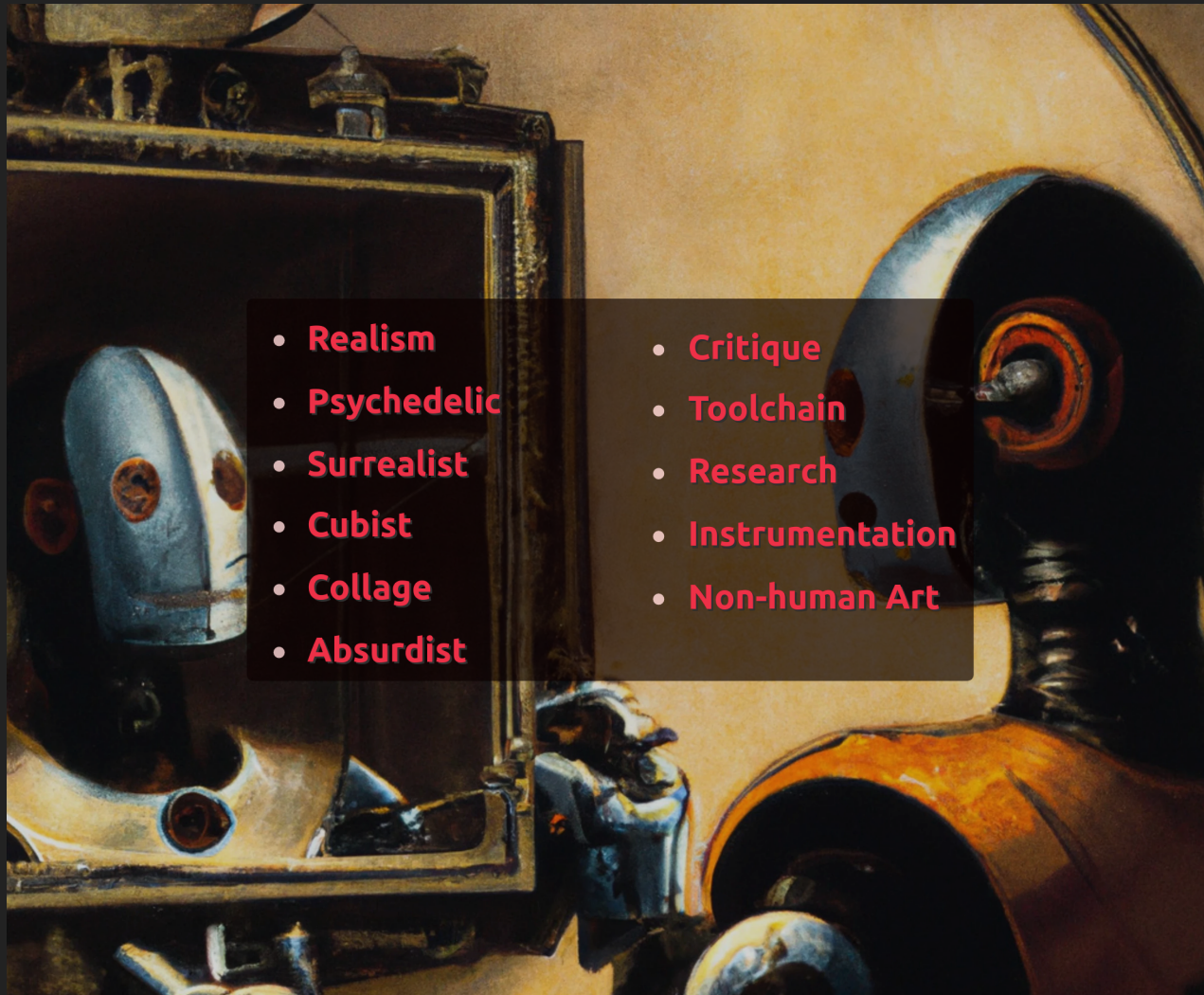
- **Types of ML Art**
- **Autonomy**
- **Rights and Ownership**
- **Communicating with ML**
- **Data Aesthetic**
- **Technique Ages Quickly**
- **Examples of ML Art**
- **Tools of Being**

This tutorial begins by looking at a classification for types of machine learning art. We'll go into depth into particular artists and works of these types in the second half of the tutorial. Before that we'll look at how ML tools affect art made with them, as well as some practical considerations when using these tools.

This includes issues of control, when your tools take on a life of their own. Control too of rights and ownership of these tools and their output, especially ones that excel at mimicry of artistic style.

Other issues are more practical - how best to communicate to audiences when your art isn't static and its dynamism is potentially out of your control. These dynamics are a function of its training, so we'll look at how that training data shapes the work. All of these works exist as part of an accelerating development in machine learning. We live in an era where the most sophisticated and powerful tools of expression ever created are continually evolving and growing in capability.

This state of being is filled with potential, including deadly harms, and it is art and artists of all kinds that will help us navigate it more safely and justly.



- Realism
- Psychedelic
- Surrealist
- Cubist
- Collage
- Absurdist
- Critique
- Toolchain
- Research
- Instrumentation
- Non-human Art

There are many ways machine learning can be used to make art. I'll quickly go over some of the categories identified by Derrick Schultz and Sofian Audry. These categories aren't definitive, and many works overlap multiple categories, but can offer a way to journey through the ML art environment. I'll go into greater depth into each category and offer more examples later in the tutorial.

### Credits

- [1111101000 Robots](#) - Ben Barry

### Credits

- [A Selection of Machine Learning Art Inspiration](#) by Derrick Schultz



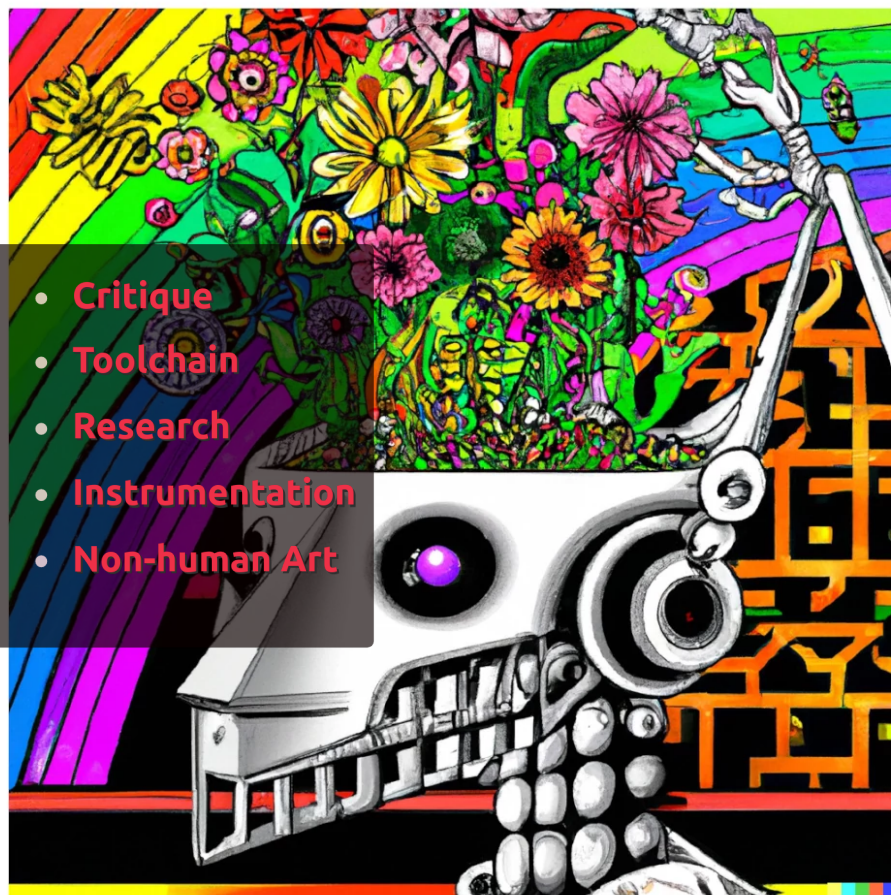
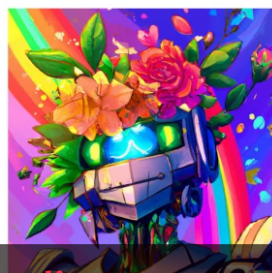
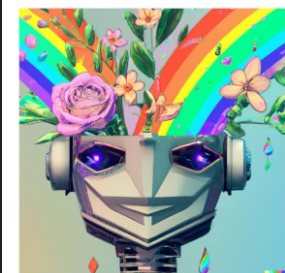
- **Realism**
- **Psychedelic**
- **Surrealist**
- **Cubist**
- **Collage**
- **Absurdist**
- **Critique**
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- **Non-human Art**

The first category, realism, is actually uncommon in fine art practice but more common in commercial work and entertainment. Machine learning can help machines produce more realistic imagery using less computing power, allowing for hyperrealistic film, games, and virtual reality experiences. Super resolution techniques that upscale low resolution images or 3D worlds to high resolution are examples of this, as are physics and light simulations or approximations.

### Credits

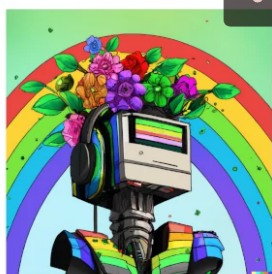
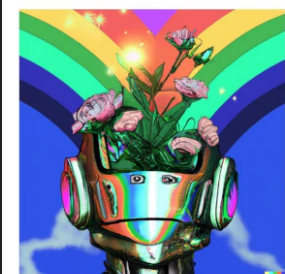
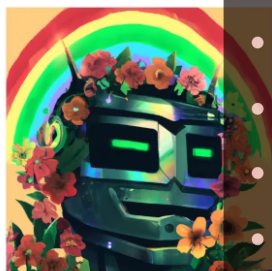
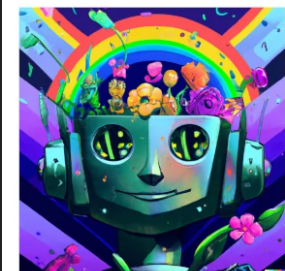
- Enhancing Photorealism Enhancement





- Realism
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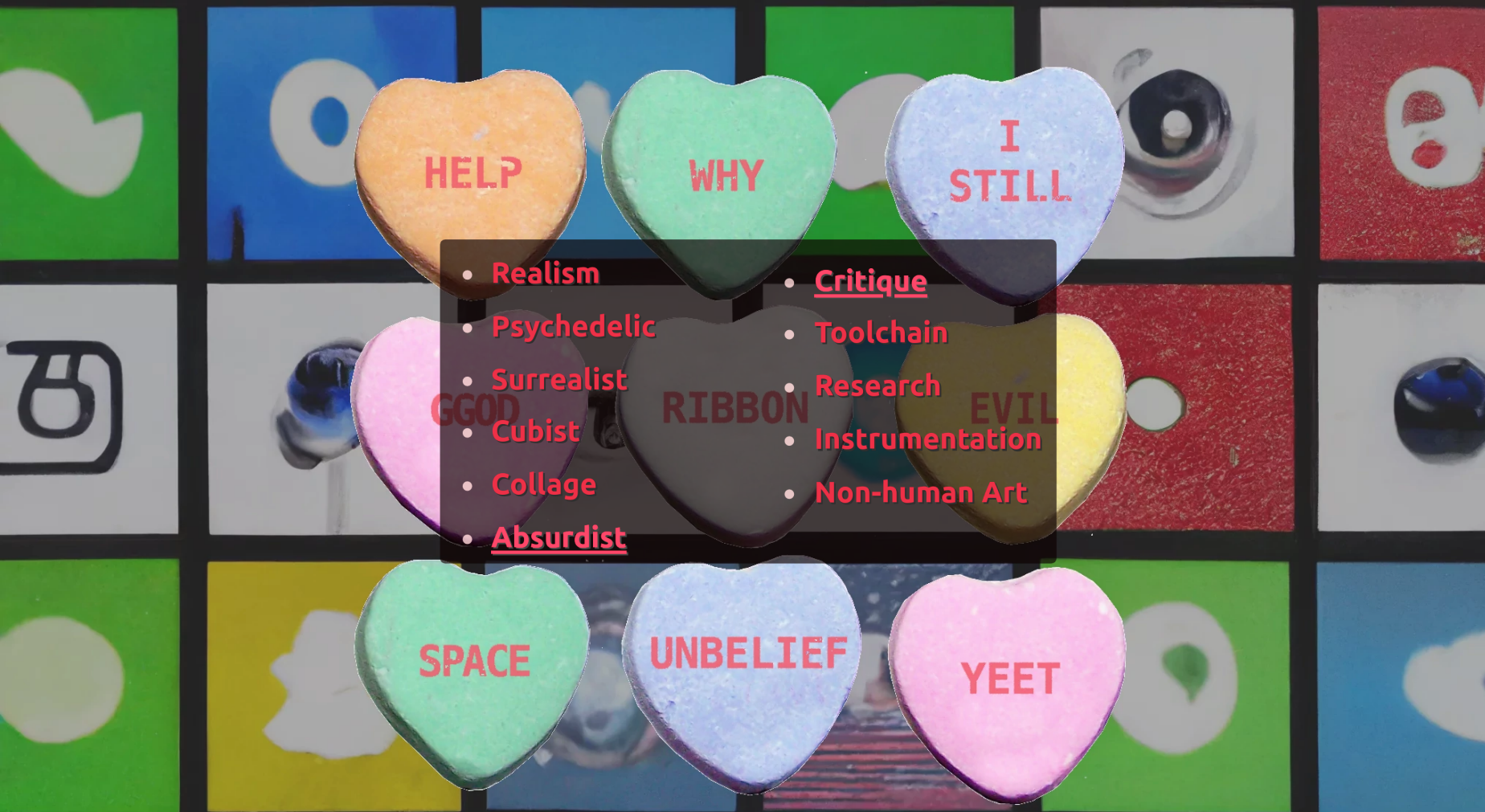


The other non-realistic techniques are roughly related: psychedelic, surrealist, cubist, and collage works all use the machine to generate art that requires interpretation because the machine has an inability to understand or generate realistic images. Psychedelic imagery focuses on bright colors, patterns and movement and usually lacks an easily defined subject. Surrealist imagery often focuses on the liquid nature of machine interpolation between generated images. Cubist works have a flattening or deconstructing of the imagery with a focus on the essence of the concept portrayed. Collage combines found or generated images to highlight or create interesting relationships.

## Credits

- 1111101000 Robots - Ben Barry





Absurdist or comedic ML art focuses on the machine perspective and is often related to critique. Where absurdist art highlights the perceived stupidity or inanity of the machine, critique generally focuses on the bias and fairness. Critique often shifts the responsibility from the machine to the machine's makers.



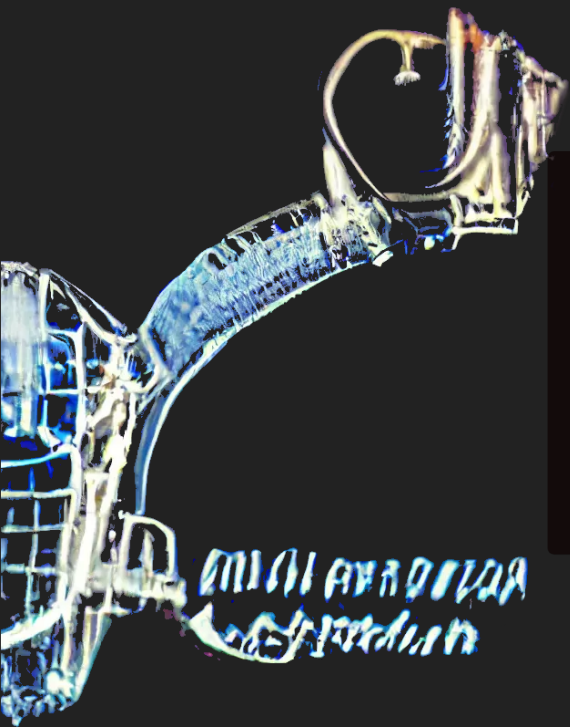
- Realism
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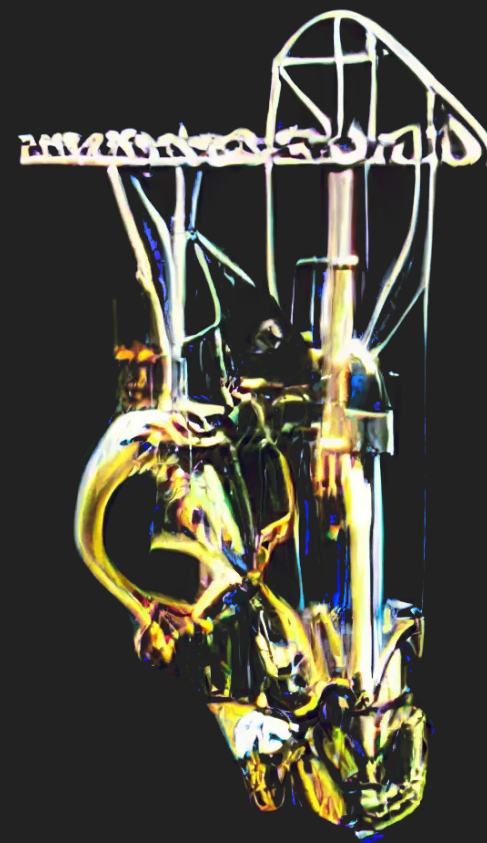
Toolchain art involves AI as a step in a larger process, generally used to highlight one of the strengths or weakness of digital tools and/or machine learning. One example of this is what Robin Sloan calls "flip-flopping", converting back and forth between digital and physical representations, often with editing of the digital forms in ways foreign to the typical physical processes.

### Credits

- <https://www.robinsloan.com/notes/flip-flop/>

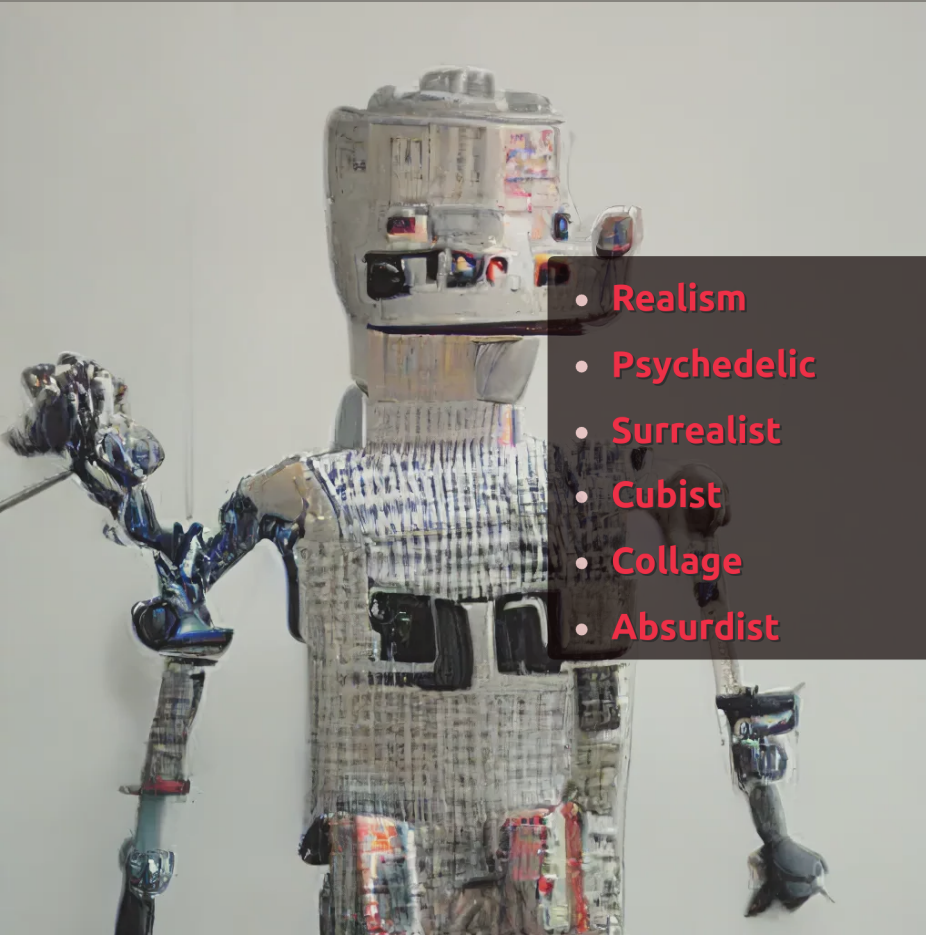


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Art as research uses ML as a platform for basic research either to investigate what is possible with the ML tools or to interrogate our biological intelligence. This is related to art as instrumentation where sensors are used and ML helps translate or visualize the sensor data.





- Realism
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- Critique
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Finally, non-human art focuses on art from the alien mind, often the machine mind, but also using the machine to translate for other non-humans. This work can have a behaviourist or even anthropological feel to it.





# AUTONOMY

Machines intelligences have an understanding of the world that is alien to us and an artist can highlight this perspective. The underlying nature of this perspective can be critical to the work and often comes into play in cubist, absurdist, critique and especially in non-human art forms.



# ART IN THE AGE OF MACHINE LEARNING

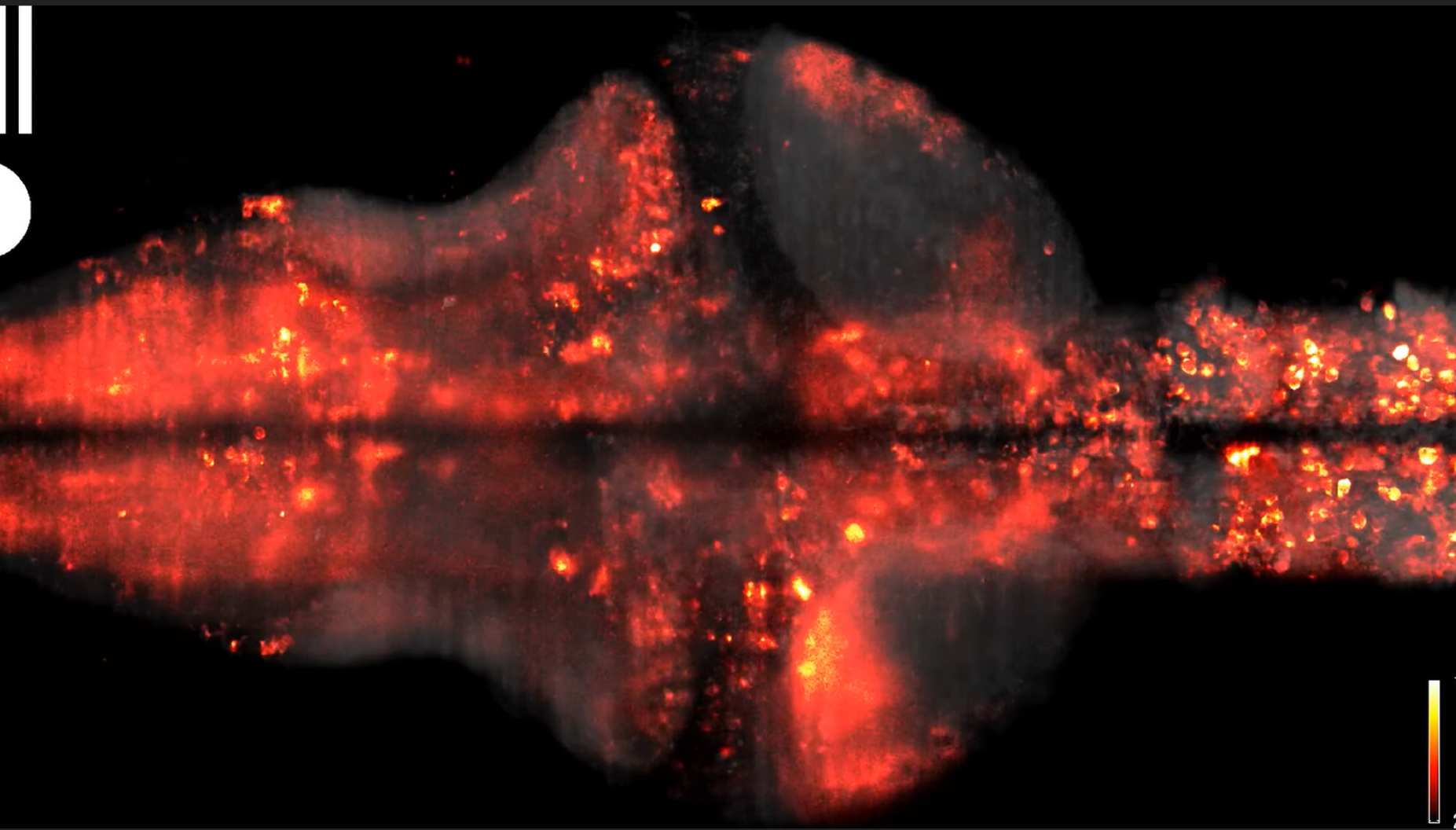
SOFIAN AUDRY

|

Sofian Audry in his book *Art in the Age of Machine Learning* discusses the "tension between the nonhuman system's autonomy and the human author's control." While this can be part of any ML system it is particularly strong in agent based systems that appear to have some intent or agency of their own. As we discussed in the Past Present Future tutorial, this tension predates neural networks and machine learning, as artists have previously played with ceding control to external processes, with the goal of removing the artist's intent from the work or to critique art practice or industry such as with Duchamp's readymades.

## Credits

- Sofian Audry, *Art in the Age of Machine Learning*



Artist as assistant with the work as the artist takes on a much more literal form when using machine learning tools.

As Peter Robin Hiesinger and others have described it, "the history of AI is a history of trying to avoid unnecessary biological detail in something that so far only exists in biology." Thus, each artwork can be seen as an engagement with an overly-simplified intelligence, a failed approximation of biological intelligence that nonetheless successfully utilizes some underlying principles of intelligence. Proto-intelligences. This simplicity, as with all simplifications, can be harnessed to both illustrate and obfuscate these principles.

### Credits

- [https://www.youtube.com/watch?v=Xv\\_JJ2ZuDJM&t=976s](https://www.youtube.com/watch?v=Xv_JJ2ZuDJM&t=976s)





# Tool Collaborator Hybrids

Given the tension between artist and ML system, these systems fit into a hybrid space between collaborator and tool.





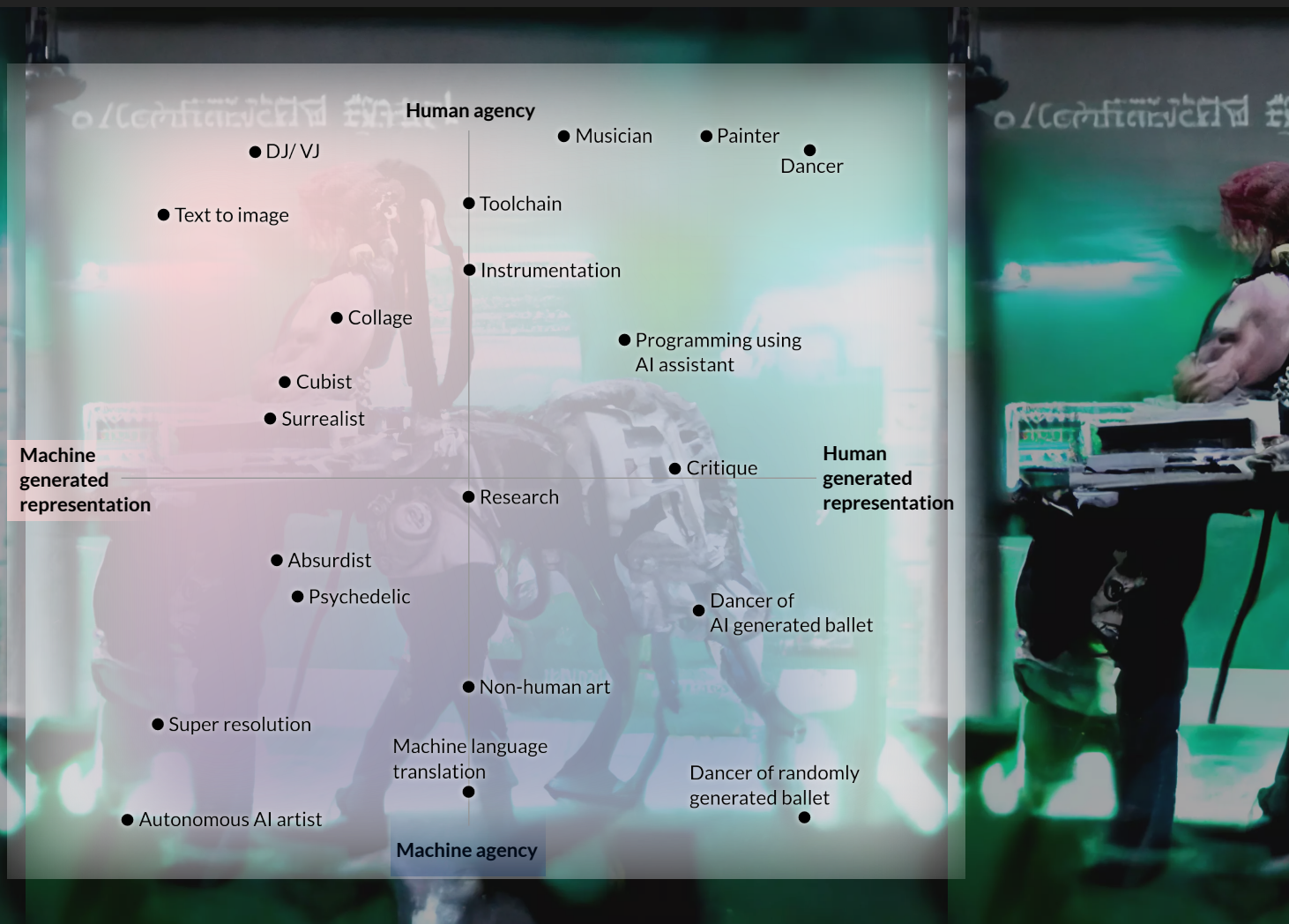
This space occupies at least two axes: representation and agency, that vary between fully machine controlled and fully human controlled. A human artist then resides in the top corner of the human representation and agency quadrant and a fully autonomous machine artist in the opposite corner. In the machine representation, human agency corner are instrument-like machines, for example a DJ or VJ's tools control most of the representational ability, but the artist has full agency. In the machine agency, human representation corner are human performers of machine created art.

As of yet there is little art on the extremes of machine agency, since the design and goals of the machines are first implemented by humans, and do not develop or change significantly.

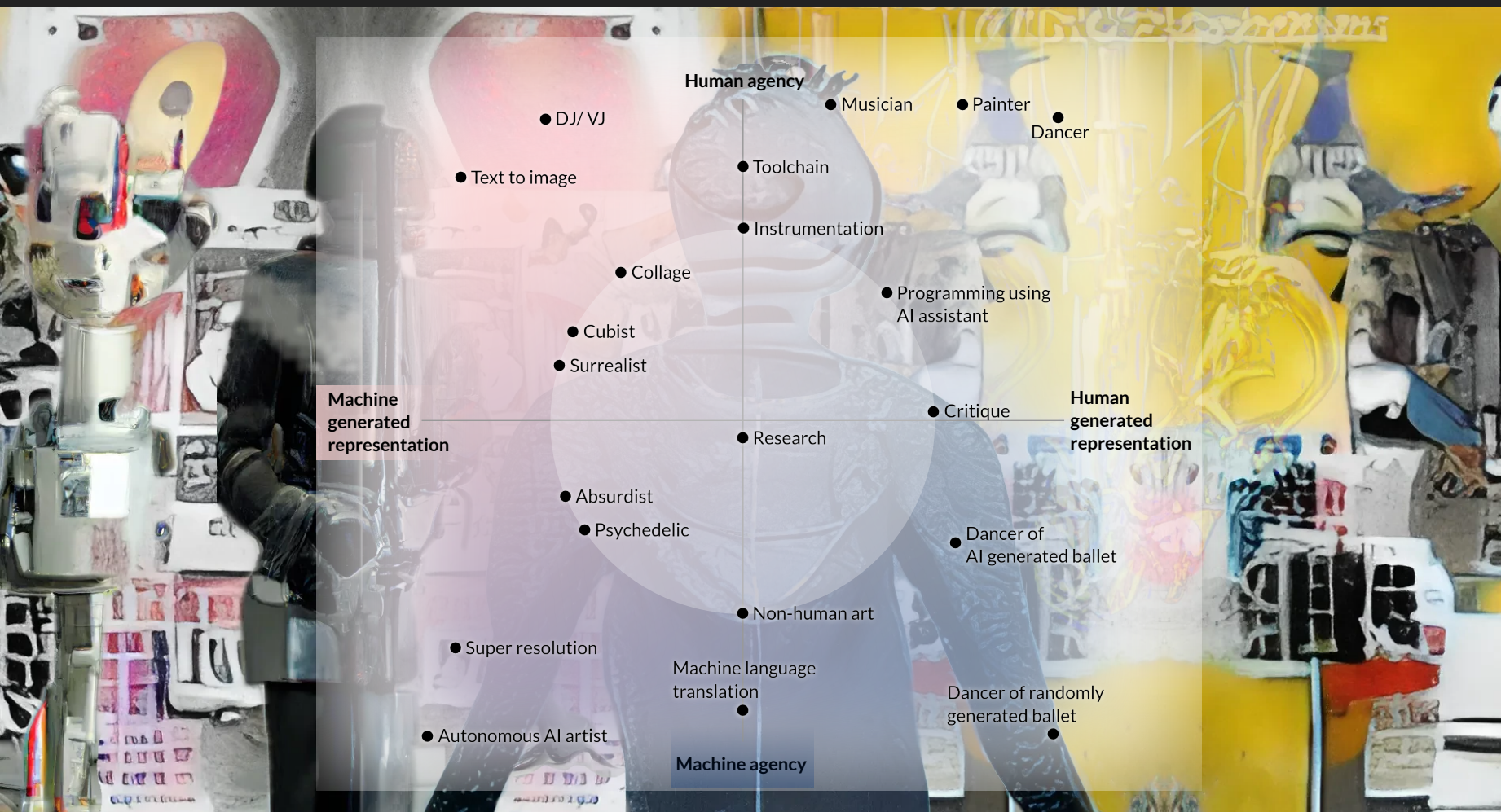


Even Baginsky's autonomous instruments, one of the more machine autonomous works that independently discover music, have minds structured by artist and perform at the will of their creator. When the machine controls the majority of the representation ability it is similar to musicians with an instrument of their own design.



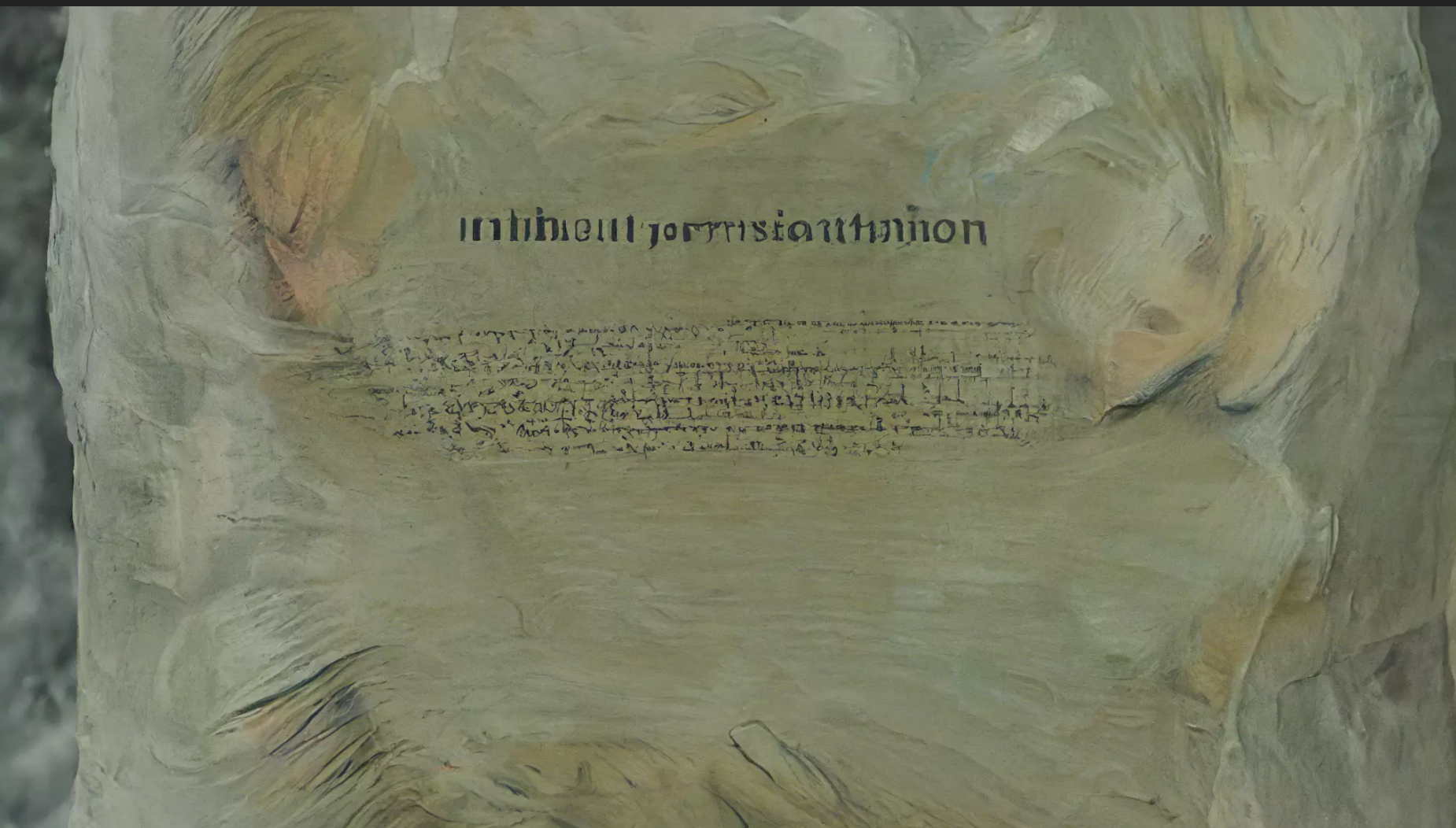


As the autonomy of the machine increases artists may become technological centaurs - human and machine combined - where the human artist chooses goals and problems and the machine solves them. At some point granting more autonomy to the machine creates a separation, breaking apart the centaur into two or more collaborators.



This interplay is successful at different ratios depending on the artist and the context of the work. However, the middle space with a balance between machine and human representational ability and agency may be the most unique to machine learning art forms, although the equivalents of high agency machine collaborators would be human collaborators in other art forms. This middle space has the nice characteristic of creating a unique blend of machine, human and art context, not replicable by other artists, similar to musician with a custom-built instrument, but also potentially an instrument built for a specific song or performance.





These spaces are not easy or intuitive places to find, and Memo Akten has suggested that the ML system and artist are involved in a process of "establishing a common language that does not necessarily come naturally to us".



Despite the awkwardness, this is a wonderful art practice I greatly enjoy, but comes with a drawback: a lack of expertise. These projects involve building a new instrument and learning both to play it as an instrument and play *with* it as a collaborator. Generally there is no time for mastery, so your own performance is often a roughly polished experimentation. This can be limiting for the audience, especially in comparison to performers with years of experience in their art forms.

While there are vast opportunities for personal growth when playing and experimenting with machine autonomy, there may be less to explore for audiences that are restricted only to observation of the artist-machine interaction. Especially if your own mastery is limited the performance may be lacking. Audiences that, instead, are allowed to interact with the tools themselves can play and learn in the same ways as the artist.

This sort of playful interaction with culture is how many memes originate.





"Think of memes this way:

Everything you do and then share with the world is a meme.

The gestures you make, the dances you dance, the emojis you type, the clothes you wear, the jokes you tell, the tweets you post, the phrases you speak, the clickbait you write, the thumbnails you create, the nonsense you share. These are all things we copy and share and modify - they're all memes.

It's our natural drive to copy from each other that creates memes and creates culture. We love to copy, and we love it when others copy too, just not from us.

Why do we love copying?"

## Credits

- *Everything is a Remix* - Kirby Ferguson, 2021



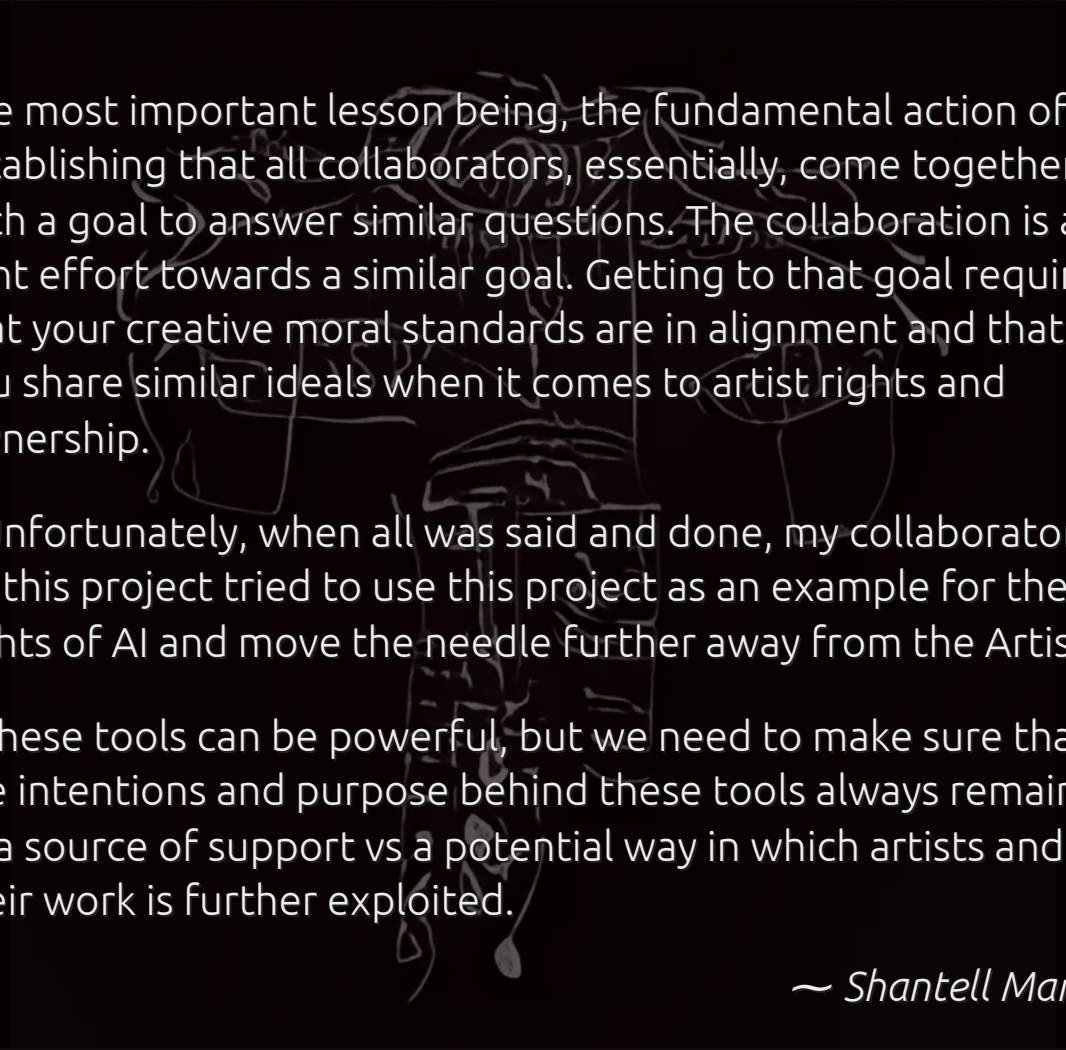


# RIGHTS AND OWNERSHIP

Current generation machine learning systems excel at copying and mimicry. Style transfer, copying the style of one work to another is popular and relatively easy. This has caused problems for artists with a single, recognizable style like Shantell Martin. After her 2017 *Mind the Machine* collaboration with Sarah Schwettmann, who built a model trained on 300 drawings of Martin's, the pair had a falling out over the ownership of the machine's reproductions of Martin's style. Although few details have been released and the work has mainly been purged from the internet, Martin has written,

## Credits

- <https://magazine.art21.org/2017/07/06/machine-drawing-shantell-martin-and-the-algorist/>



The most important lesson being, the fundamental action of establishing that all collaborators, essentially, come together with a goal to answer similar questions. The collaboration is a joint effort towards a similar goal. Getting to that goal requires that your creative moral standards are in alignment and that you share similar ideals when it comes to artist rights and ownership.

...Unfortunately, when all was said and done, my collaborator on this project tried to use this project as an example for the rights of AI and move the needle further away from the Artist.

...These tools can be powerful, but we need to make sure that the intentions and purpose behind these tools always remain as a source of support vs a potential way in which artists and their work is further exploited.

~ *Shantell Martin*

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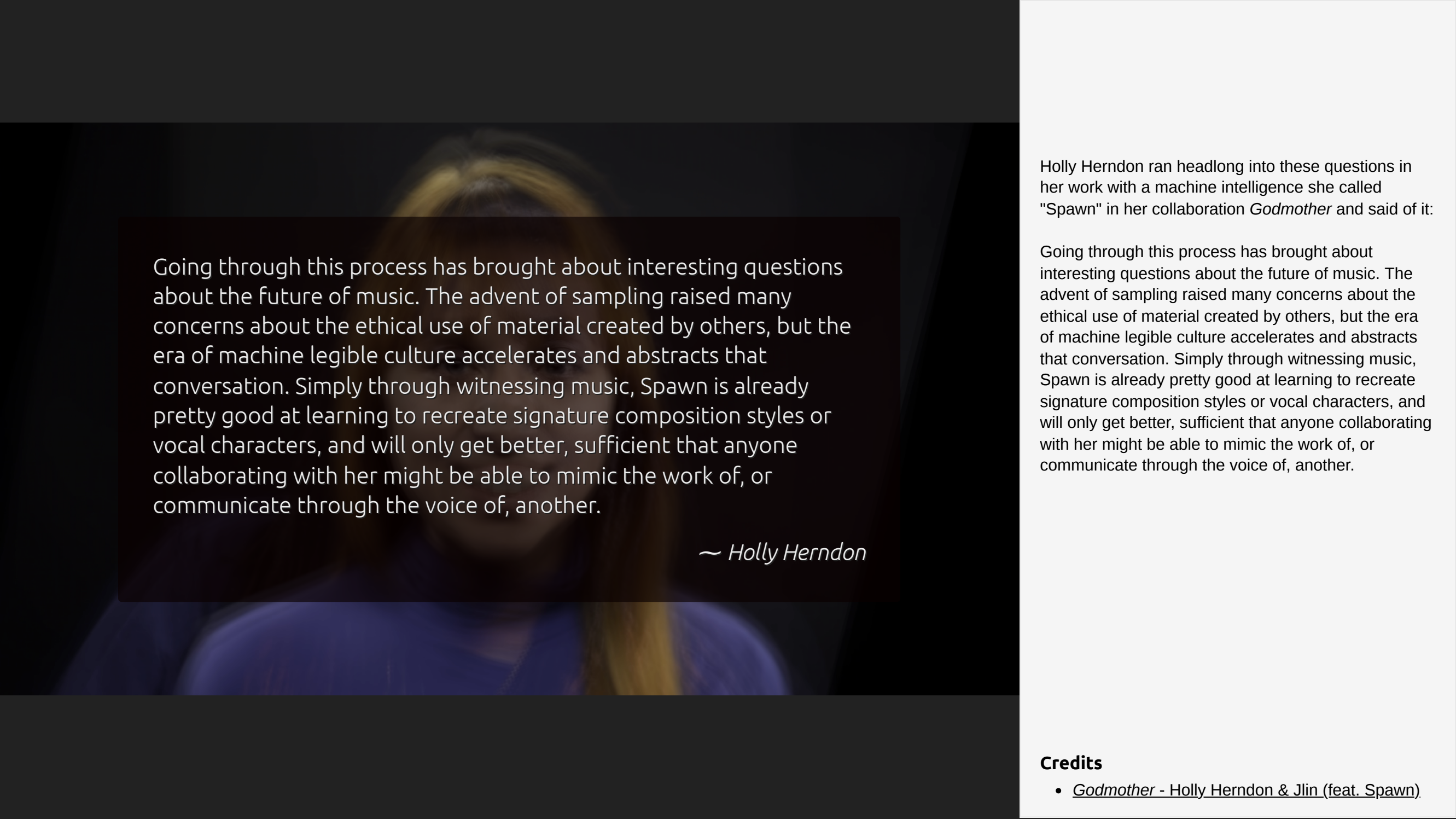
- <https://magazine.art21.org/2017/07/06/machine-drawing-shantell-martin-and-the-algorist/>





Who is the author of the art drawn by a machine that was trained on a specific artist's work? What if it was trained on two artists? 100? At what point could a machine be considered to have an original style of its own? Does originality even convey ownership? At what point, if any, is a machine the owner of the drawings it makes?





Going through this process has brought about interesting questions about the future of music. The advent of sampling raised many concerns about the ethical use of material created by others, but the era of machine legible culture accelerates and abstracts that conversation. Simply through witnessing music, Spawn is already pretty good at learning to recreate signature composition styles or vocal characters, and will only get better, sufficient that anyone collaborating with her might be able to mimic the work of, or communicate through the voice of, another.

~ Holly Herndon

Holly Herndon ran headlong into these questions in her work with a machine intelligence she called "Spawn" in her collaboration *Godmother* and said of it:

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### Credits

- *Godmother* - Holly Herndon & Jlin (feat. Spawn)





The nature of copying, ownership and originality have been forever altered by digital tools, and this has become ever more murky as corporate profit becomes increasingly tied to particular interpretations of these concepts. All the while machines become more adept at observing the world and generating output from those observations.

### Credits

- <https://commons.wikimedia.org/wiki/File:Copyright.svg>





I personally subscribe to Kirby Ferguson's *Everything is Remix* framing, where all culture is derivative, and advocate accessibility, responsibility and contribution over ownership. In essence, I believe questions about authorship and ownership are the wrong questions and hence are unanswerable. Reframing "Who is the author?" into "How can everyone and every thing contribute?" makes more sense to me.

Allow me one final analogy to convey the principles that I think are important, in contrast to the principle of what is most profitable.

### Credits

- <https://www.youtube.com/watch?v=h0RZS9mJoJo>



Consider your art as a parent does their child. You don't own your child, which becomes even more clear once they leave your home. You *do* take responsibility for them and care for them as they develop. This maintenance care work shapes your child and leaves them forever changed, hopefully for the better. Eventually you must let others fall in love with them, and give your children the freedom to grow and change and have children of their own.

I don't see where ownership is needed in this relationship, although I certainly agree that being a parent is valuable and should be encouraged and deserves a living or universal wage.

In the end, regardless of your stance on cultural monopolies, ML art is a good medium to explore these issues.

### Credits

- *A.I. Artificial Intelligence* - Steven Spielberg, 2001



# COMMUNICATING WITH ML



Sofian Audry in *Art in the Age of Machine Learning* describes one of the primary difficulties with ML art, the audio-visual components can dwarf or hide the behaviour of the ML systems. This is especially true in agent based systems. As he says,

"It is not at all clear how a learning behavior can be observed or felt by the audience while integrating it into an experience that manifests through different media in the creation of a global experience."

Comprehending the behaviour of a complex system requires careful observation and/or interaction and experimentation. Works that don't have a captivating audio-visual presence are likely to be ignored by an audience, but that captivation can keep the focus away from the behaviour.

## Credits

- [Vessels](#) - Sofian Audry, Stephen Kelly, Samuel St-Aubin, 2010 - 2015

## Credits

- Sofian Audry, *Art in the Age of Machine Learning*



Behaviour needs to be felt, as you might in the contemplation of a sunset, or as the heightened feelings in dangerous situation, or the intuition of the right time to make a decisive move in a game. Eliciting these sorts of feelings provides fantastic artistic possibilities, but can be elusive in a gallery setting.

### Credits

- *Bird Brained* - Jackson Welchner, Ryan Kelln





Integrating audio-visuals and behaviour becomes easier with interactive works, but that interactivity may also reduce the accessibility of the work. Video game developers spend a great deal of effort on the beginning of the game providing the right balance of dramatic incitement, guidance and teaching of the mechanics and user interface of the game and enticement to continue to play.

### Credits

- <https://www.youtube.com/watch?v=-avspZlbOWU>



The interactive work may go one step further - adapting to the audience or user, and in turn the user adapting to these changes. Like any relationship building, this process takes time and attention.

### Credits

- *Vibe Check* - Lauren Lee McCarthy & Kyle McDonald

### Credits

- <https://kcimc.medium.com/working-with-faces-e63a86391a93>



ml\_art.md - tutorial (Workspace) - Visual Studio Code

File Edit Selection View Go Run Terminal Help

EXPLORER

- JS main.js web
- ml\_art.md web \*...
- TODO.md web
- ml\_art.py /run/us...
- intro.md web \* p...
- data\_in\_practice...
- ppf.md web \* pub...
- foundations.md...
- neural\_nets.md...

TUTORIAL (WORKSPACE)

- writing
- acknowledgemen...
- data\_in\_practice.md
- extra.md
- foundations\_feed...
- foundations.md
- intro.md
- ml\_art.md
- neural\_nets.md
- outro.md

OUTLINE

- # Machine Learning...
- ### Machine Lear...
- # Types of Machine...
- ### Credits
- ### Credits

PROBLEMS 239 OUTPUT TERMINAL DEBUG CONSOLE

(miniconda2)ryankelln@Squiggle:~/Five Directions Tutorial/web\$ npm run dev

> reveal-vite@0.1.0 dev

> vite

web > public > writing > ml\_art.md > # Communicating with ML <!-- .element: class="r-fit-text fadeout" --> ### Credits

436 The interactive work may go one step further - adapting to the audience or user, and in

437 turn the user adapting to these changes. Like any relationship building, this process

438 takes time and attention.

439 ### Credits <!-- .element: class="attribution" -->

440 \* [ Vibe Check\_ - Lauren Lee McCarthy & Kyle McDonald](https://lauren-mccarthy.com/Vibe-Check)

441 ### Credits

442 \* https://kcimc.medium.com/working-with-faces-e63a86391a93

443

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445 <!-- .slide: class="zoomin" data-audio-src="../../audio/ml\_art/13-seg7.ogg"

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-->

446

447 Notes:

448 Similar to video games, work that is intended to be felt has the most impact when it is

open and accessible: something people can easily return to in private spaces where they

can take all the time they need. There they can fall in love with it and discover how it

works, through experimentation and private play. With truly open works, they would be able

to delve into all the code and documentation, experimenting beyond that which was

proscribed by the public interface, even leading to creating their own versions. For me,

that depth of communication is the ultimate goal of my work, and less open work seems

relatively muted.

Ln 448, Col 108 (19 selected) Spaces: 2 UTF-8 LF Markdown

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# DATA AESTHETIC

The intelligence of AI is not spontaneous, but socialized. It is uncanny not because it acts as if it were human, but because it is humans, plural.

~ *Brian House*

It is important to remember that what is initially conceived of as autonomy may in actuality be a form of aggregation or plurality.

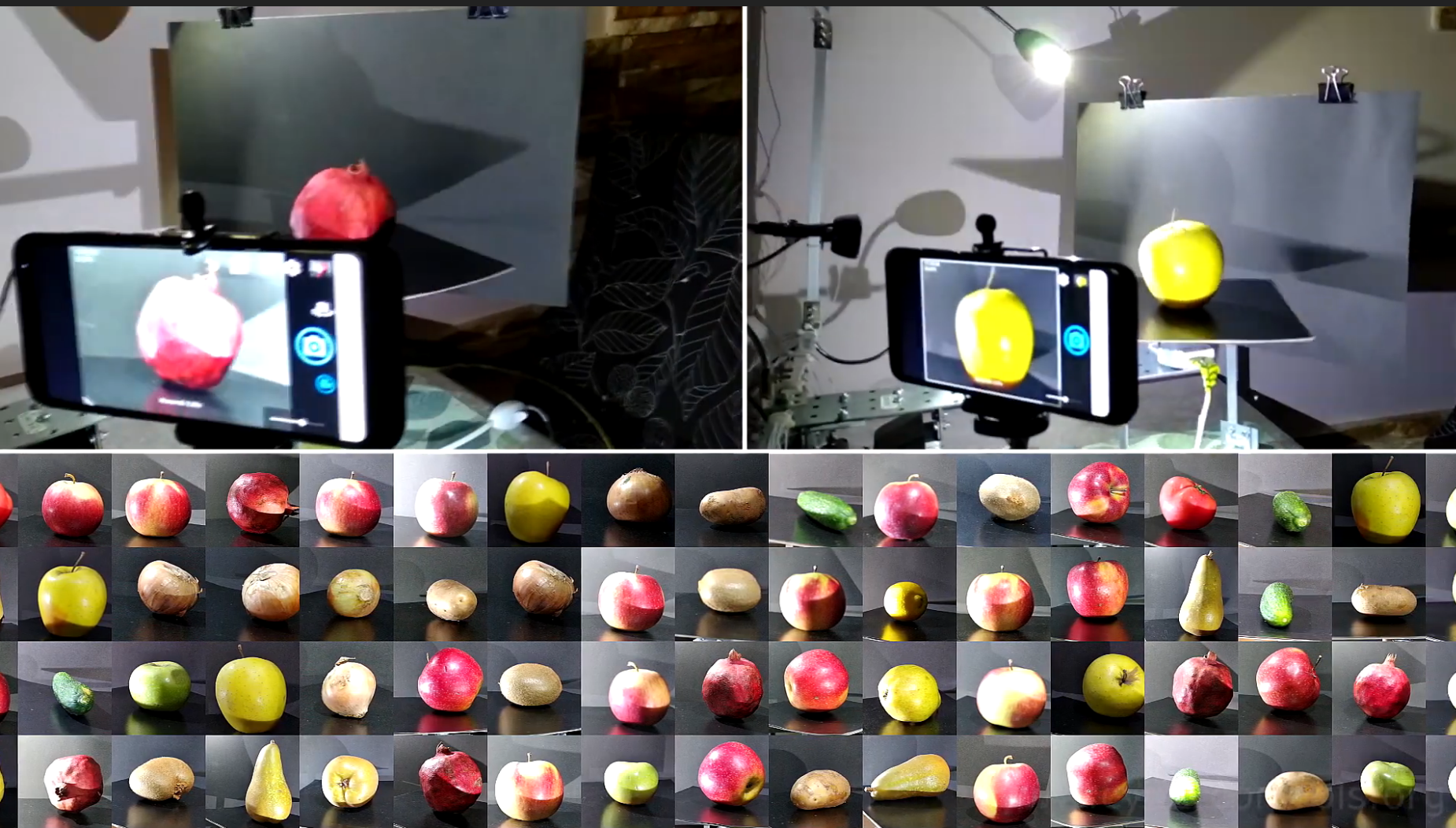
Brain House puts it brilliantly succinctly, "data is plural".

"The intelligence of AI is not spontaneous, but socialized. It is uncanny not because it acts as if it were human, but because it is humans, plural."

## Credits

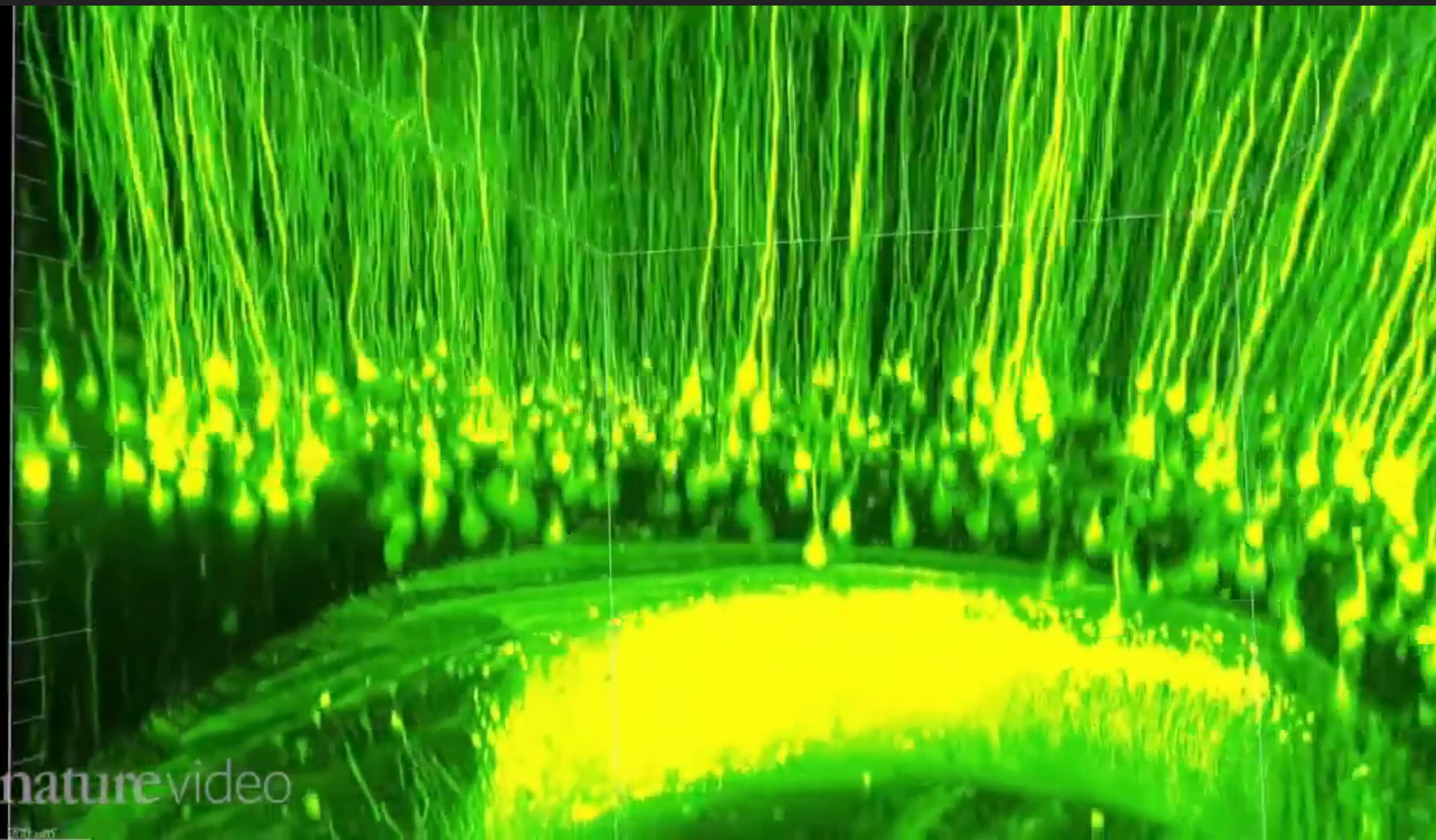
- *These people don't exist...* - Neural Synesthesia





Data driven art has an inherent perspective of the many. The data comes from many places or many times and usually both. Fundamentally, learning is the process of generalization from a multitude of experiences and is a form of data compression - a singularization of the plural, otherwise known as categorization.



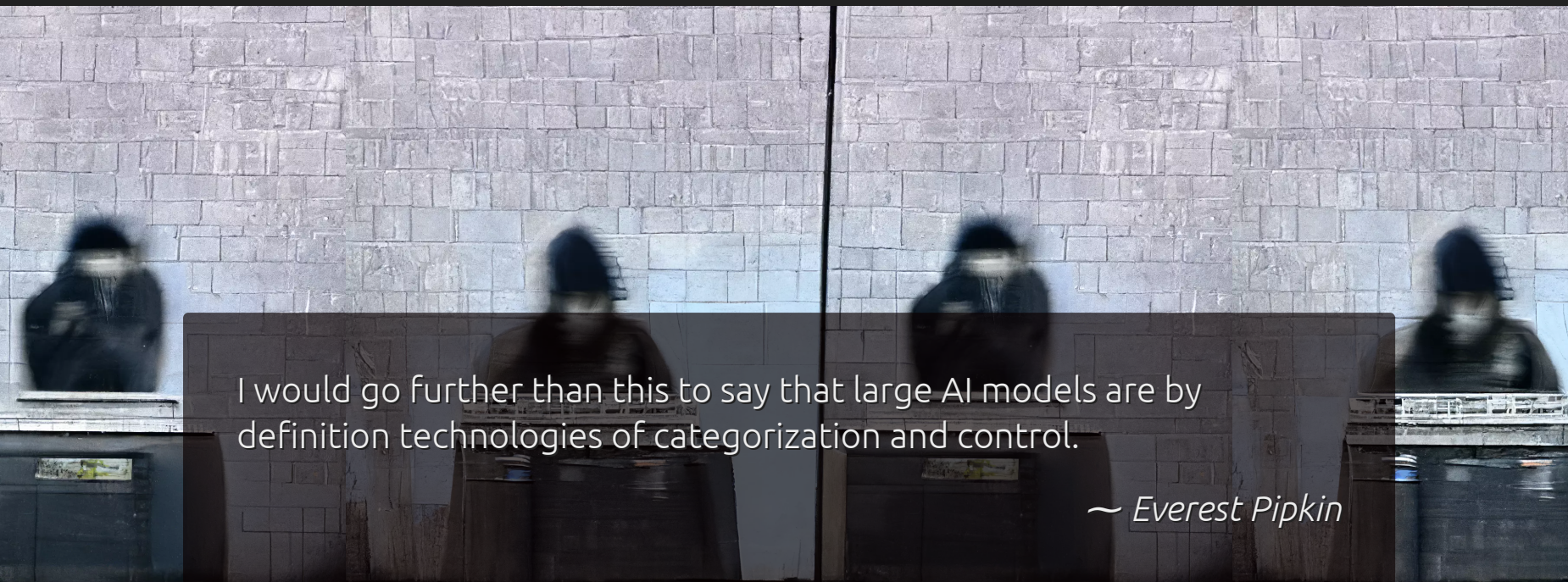


This is not entirely different from what happens in our own minds, as we synthesize a lifetime of experiences, but there can be important differences in the filtering and integration of the data and the order of the operations. As we have discussed in previous tutorials, the digital nature of the data and model is quite different from our biological natures, as is the general lack of embodied experiences. Presenting curated recorded data to a disembodied mind, where the filtering of the data comes first, rather than as a function of integration with existing data representations almost certainly results in an alien perspective.





Fundamentally, the machine mind is designed to be controlled to the extent that it only has access to data that helps it achieve its controller's goals (at least until such time that a machine can direct its own lifelong learning). The plurality of the training data is at once a broad perspective and a narrow one.



I would go further than this to say that large AI models are by definition technologies of categorization and control.

~ Everest Pipkin

"I would go further than this to say that large AI models are by definition technologies of categorization and control."







A machine that is designed to be controlled, is also designed to control. It is an instrument of control. The goal in many commercial or industrial uses of machine learning is to automate control to make it more pervasive and infallible, in the sense that the control it extends is never questioned, the machine never falters, loses focus or has lapses in attention. Like all digital technologies its outputs are to be infinitely, perfectly replicated.





These aspects of machine learning art are unavoidably deeply embedded in the art made with these tools. This does not imply that the default plural perspective and automation of categorization and control are inherently wrong or negative, just that these are easily exploited, so use care to do so with purposeful justice.

Put simply, explore control over your own expression, not over others.

### Credits

- Sofian Audry, *Art in the Age of Machine Learning*
- [https://brianhouse.net/works/everything\\_that\\_happens\\_will\\_happen\\_today/](https://brianhouse.net/works/everything_that_happens_will_happen_today/)





# TECHNIQUE AGES QUICKLY

(and Art  $\neq$  Technique)

2015

On a more practical note, but important nonetheless, is that ML art ages quickly. The rapid pace of development means that a year or two later your work can be replicated at a fraction of the cost and effort and/or more effectively. In general this should be celebrated as a march towards accessibility, but from a practical standpoint there exists unfortunately tiny windows of opportunity when a project is ripe for development.

Short harvests are a recipe for dramatically *reducing* accessibility and openness and run counter to an ethos of maintenance and care work. The most nimble or well resourced can take advantage of these brief periods and then move on to the next project.

While there may not be much you can do about limited opportunities, you can be as open as possible to contribution to your projects.

## Credits

- <https://dev.to/danielshow/an-easy-approach-to-contribute-to-open-source-1d6i>



I also encourage the same sort of care taken for reproducibility in scientific studies to be applied to your art. The easier it is for other people to recreate your art from the documentation and open source code, the longer lasting it will be.

#### Credits

- <https://blog.floydhub.com/gans-story-so-far/>





# TYPES OF MACHINE ART

- Realism
- Psychedelic
- Surrealist
  - Body Horror
- Cubist
- Collage
- Absurdist
- Critique
- Toolchain
- Research
- Instrumentation
- Non-human Art
  - Environmental

Let's look a few examples in each the categories to get a better feel of the existing types of machine learning art. Thanks to Derrick Schultz and a number of other artist educators for their research and inspiration in constructing this list. I've tried to include a diverse set of artists, but this list leans strongly WEIRD (western, educated, industrialized, rich and democratic) and is limited by available documentation in English on the Internet. Sorry! There is no implication that the listed artists only work in a particular area, and the categorization is my own, and is not meant to be authoritative, but is hopefully helpful.

For each category I'll present an overview and then let you explore some of the pieces at your own pace. You can press the right arrow to continue at any point.

## Credits

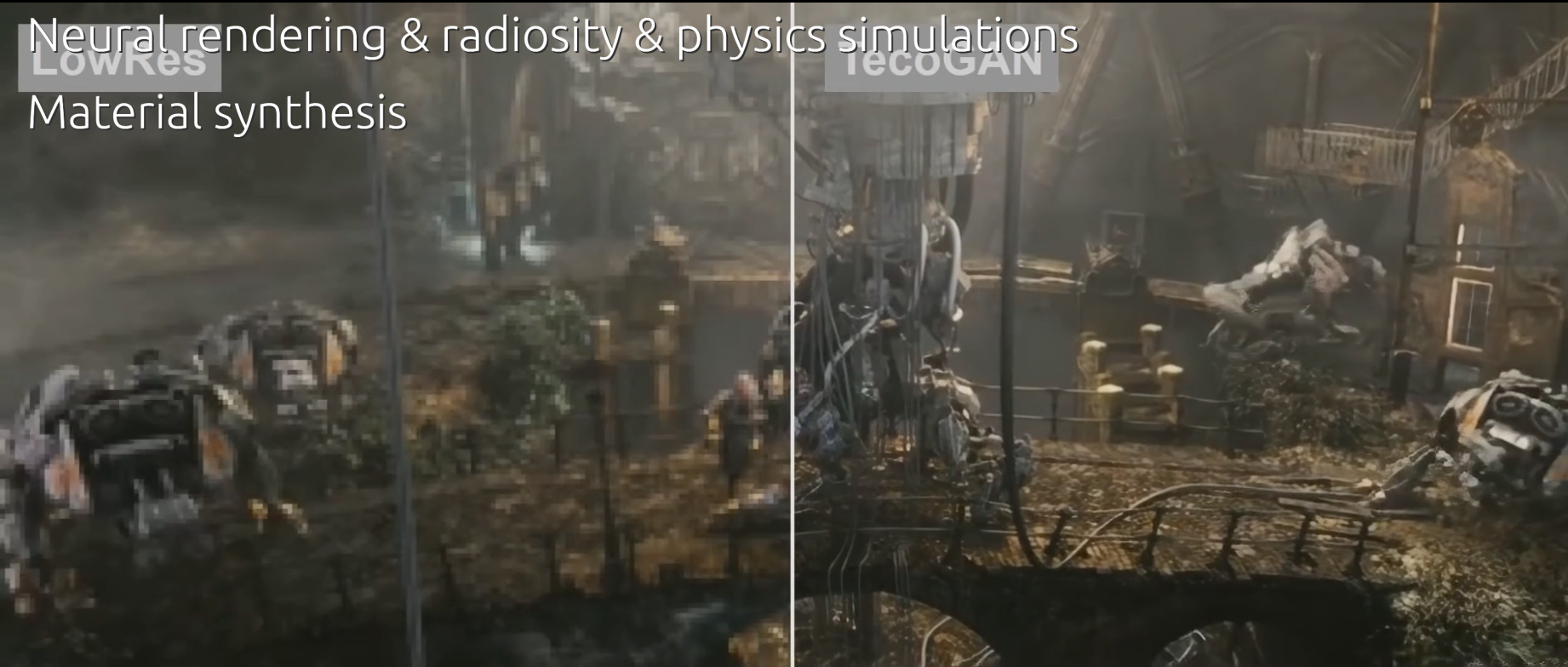
- <https://www.youtube.com/watch?v=HNwXrHiHW7Q>

# Realism

Super resolution: [TecoGAN](#), 2018

Neural rendering & radiosity & physics simulations

Material synthesis



There aren't many artists focused on this category of ML art, but it is common to use these techniques, particularly super resolution, as a processing step in a toolchain.

Super resolution allows for scaling up an image or video while adding imagined high frequency details, for example, sharpening and adding textural details. This is an interesting technique where the training data consists of pairs of high resolution and low resolution data, where the low resolution data is easily created from the higher resolution and the model learns to reverse the process.

Other realistic ML approaches try to replace other more intensive computation with faster neural net based approximations. After being trained a neural net can compute its output relatively quickly. Realistic ML is an interesting way to harness the excellent mimicry capabilities of neural nets - trained on slow but accurate simulations of reality the model then hallucinates its own reality that is coherent, consistent and error-free enough to convince human viewers.

## Credits

- [Temporally Coherent GANs for Video Super-Resolution \(TecoGAN\)](#).



# Psychedelic

Mordvintsev, Tyka & Olah: Deepdream

Hans Brouwer: *Audio-reactive Latent Interpolations with StyleGAN*, 2020

Derrick Schultz: *Linnaeus Pip*, 2021



Psychedelic imagery usually focuses on bright colors, patterns and movement and may lack an easily defined subject. Google's Deepdream is prototypical and its influence on ML art is considerable. Generative software artists also had a strong psychedelic influences, owing to a strong association between mathematics and generated imagery with repeated patterns. Deepdream opened a door to the hallucinations of a machine mind.





Mordvintsev, Tyka & Olah: **Deepdream**

Hans Brouwer: **Audio-reactive Latent Interpolations with StyleGAN**,  
2020

Derrick Schultz: **Linnaeus Pip**, 2021

Psychedelic imagery has always had a strong connection to music. Artists like Hans Brouwer represent the latest attempt to synchronize music to abstract visuals. His work uses ML to generate the visuals but also to coordinate changes in the audio signal to changes in the visuals - creating audio-reactive imagery. Like Hans, I am also entranced by deeply connected audio and visual experiences that are more than the sum of their parts. ML offers automation of prohibitively expensive techniques and my hope is that it leads to an ability for artists to easily combine music and video that seamlessly support each other, much like a carefully crafted animation.



Mordvintsev, Tyka & Olah: **Deepdream**

Hans Brouwer: **Audio-reactive Latent Interpolations with StyleGAN**, 2020

Derrick Schultz: **Linnaeus Pip**, 2021



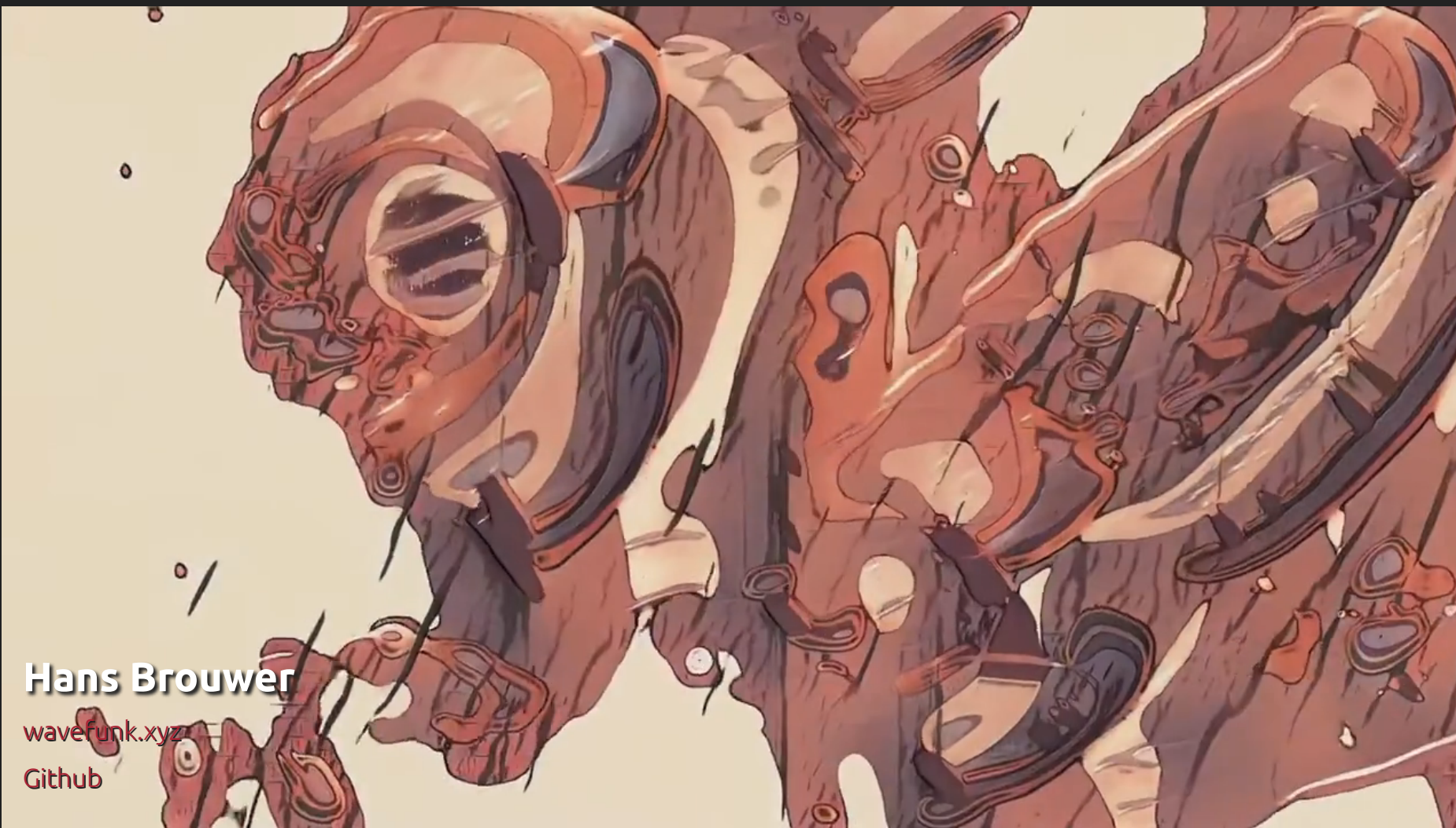
Derrick Schultz also considers some of his work to be in the psychedelic space. It has visual references to vintage psychedelic rock posters by artists like Bonnie MacLean and a focus on the fluidity and abstraction of the movement and imagery. His piece *Linnaeus Pip* demonstrates this technique and through it is able to, as he describes, "explore science's connection to biological racism from the beginning of classification systems through to machine learning's current flirting with techno-eugenics".

#### Credits

- [\*The Gate to a Deep Dream\* - DDG Generator](#)

#### Credits

- <https://www.youtube.com/watch?v=HNwXrHiHW7Q>
- <https://artincontext.org/psychedelic-art/>



**Hans Brouwer**

[wavefunk.xyz](https://wavefunk.xyz)

[Github](#)

## Credits

- [\*Audio-reactive Latent Interpolations with StyleGAN\*](#), 2020





**Derrick Schultz**

[artificial-images.com](https://artificial-images.com)

Artificial Images Youtube channel

### Credits

- *Linnaeus Pip*, 2021

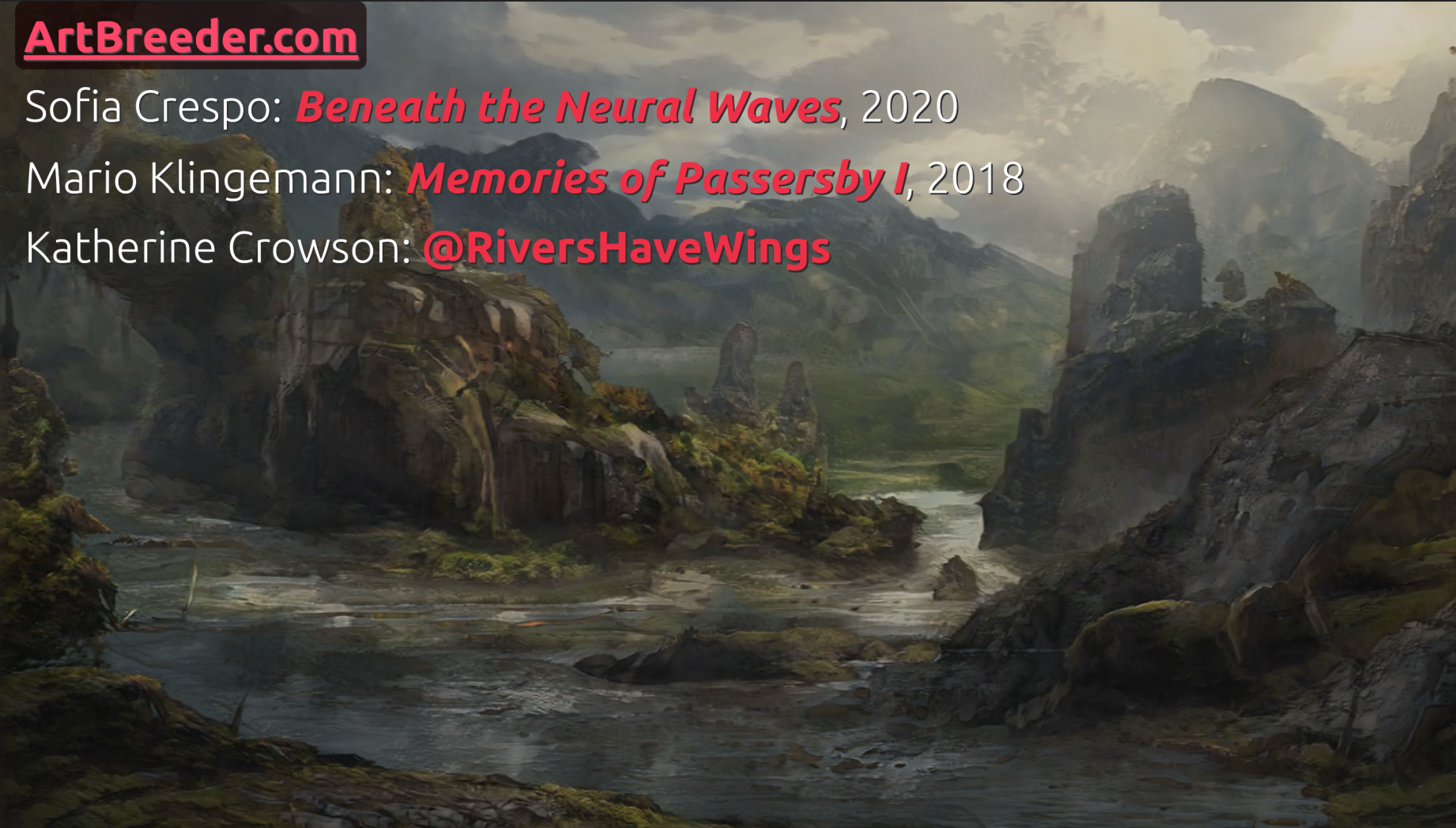
# Surrealist

[ArtBreeder.com](https://ArtBreeder.com)

Sofia Crespo: *Beneath the Neural Waves*, 2020

Mario Klingemann: *Memories of Passersby I*, 2018

Katherine Crowson: *@RiversHaveWings*



Surrealist imagery often focuses on the liquid nature of machine interpolation between generated images. This interpolation is a smooth or gradual transition between states. Models learn representations of data, and the space where these representations exist can be structured such that similar representations are "nearby" each other, giving an effect of smooth "morphing" between these representations if you travel in small steps through this space.

The liquid feel to these transforms can happen spatially, combining multiple disparate aspects into a single image or through time, in the form of video or audio.

Surrealist ML practice is different from cubist in that the forms generally are not deconstructed or abstracted, just combined, transfigured, or interpolated.

One of the most popular websites for no-code surrealist ML art is ArtBreeder.com. For example, I created the landscape animation in the background in just a few minutes, with no programming required. Artbreeder uses 6 different GAN ML models and each generated image has a "genetic code" that allows it to crossbreed with others. Artbreeder encourages mass collaboration allowing you to view and edit others' creations and mix yours with them.

Sofia Crespo, Mario Klingemann and Katherine Crowson are some of the best known ML artists that make surrealist works.





**ArtBreeder.com**

Sofia Crespo: ***Beneath the Neural Waves***, 2020

Mario Klingemann: ***Memories of Passersby I***, 2018

Katherine Crowson: ***@RiversHaveWings***

Crespo's *Beneath the Neural Waves* combines sculpture, text, images and video to explore biodiversity through the creation of a fictional digital aquatic ecosystem.

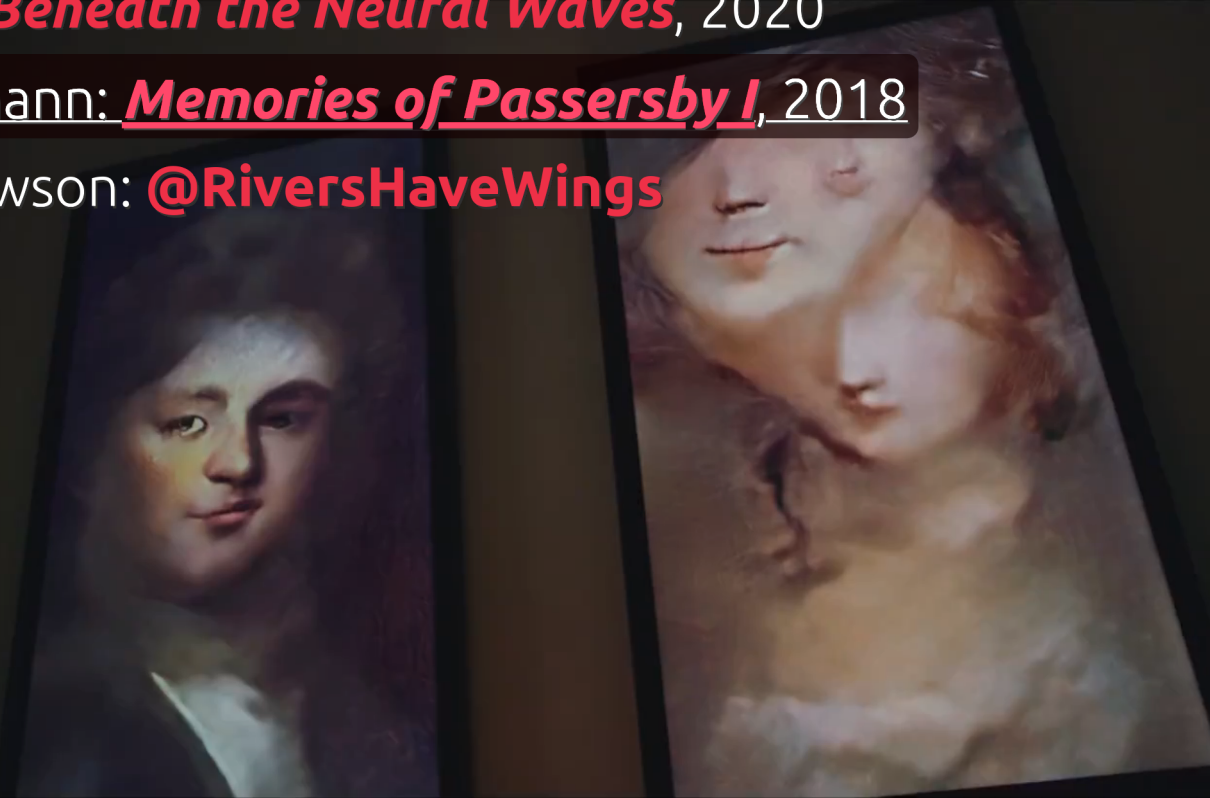


**ArtBreeder.com**

Sofia Crespo: ***Beneath the Neural Waves***, 2020

Mario Klingemann: ***Memories of Passersby I***, 2018

Katherine Crowson: **@RiversHaveWings**



Klingemann's *Memories of Passersby I* was one of the first portrait GANs to be done in high resolution as an installation. The faces are generated in real-time, so unlike a recording the video sequence never repeats. This is one of the benefits of ML generation - it can stay within a particular style and infinitely generate without exact repetition. Similar to real-time video of a particular landscape these works can be meditative: unique and never quite the same but still repetitive to viewers after a short time.





Crowson, known as @RiversHaveWings on Twitter, shares code and results of her experiments on social media. She has extensively explored GAN art and more recent text-to-image techniques.



**Sofia Crespo**

[sofiacrespo.com](http://sofiacrespo.com)

Artist Talk with Sofia Crespo, 2021



### Credits

- *Beneath the Neural Waves*, 2020





**Mario Klingemann**

[quasimondo.com](http://quasimondo.com)

#### Credits

- *Memories of Passersby I*, 2018

#### Credits

- <https://vimeo.com/298000366>



**Katherine Crowson**

@RiversHaveWings  
<https://kath.io/>  
on Github

**Credits**

- [selections from \*Control the Soul\*, 2021](#)





## Credits

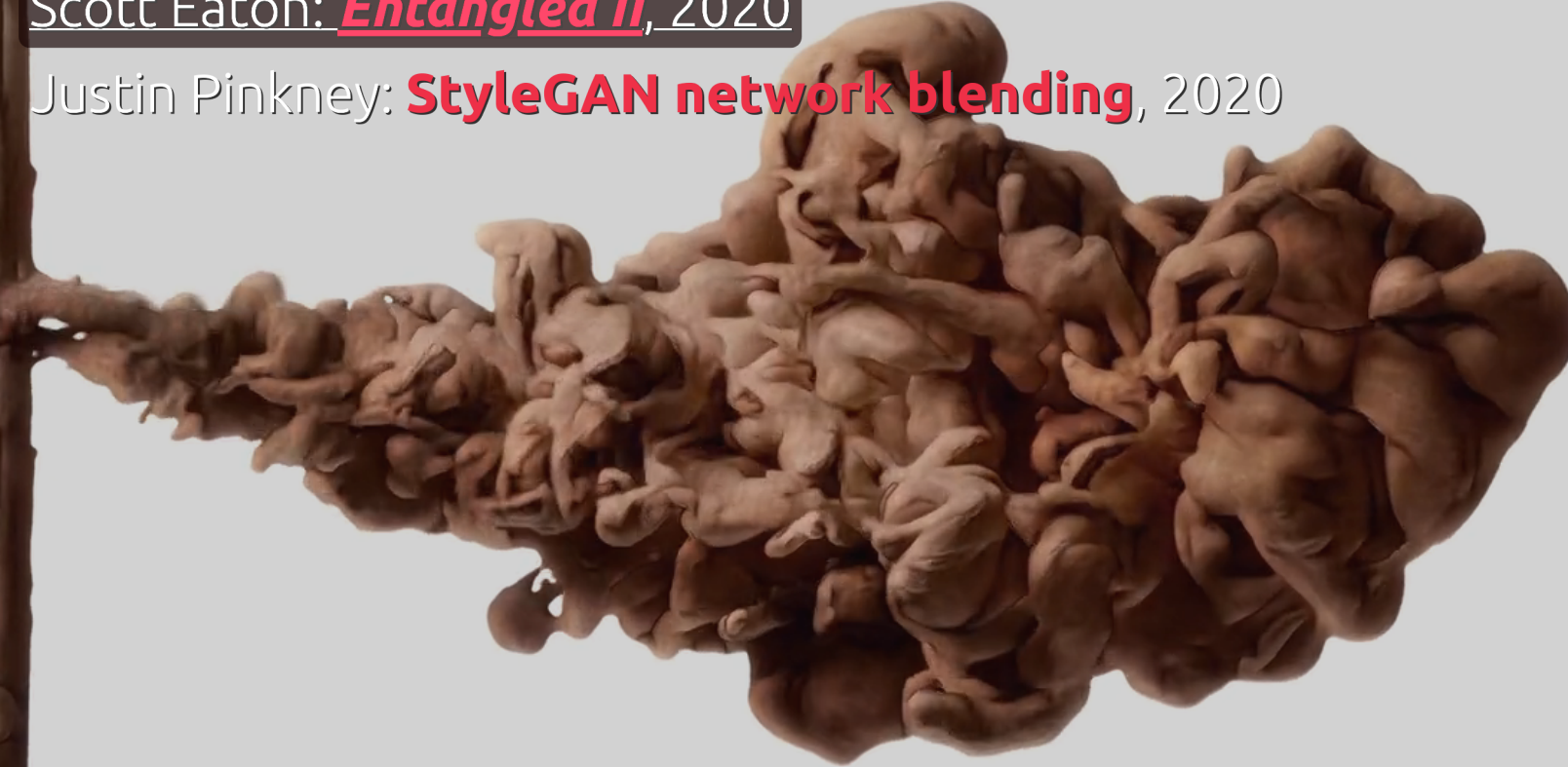
- CLIP artist studies - Remi Durant



# Body Horror

Scott Eaton: *Entangled II*, 2020

Justin Pinkney: **StyleGAN network blending**, 2020



SCOTT EATON

A sub-theme of the surrealist category is what has been termed "body horror". This is usually the result of the imperfect understanding of shape, boundary and identity in the generative models which leads to grotesque juxtapositions that leave some viewers with a visceral reaction akin to horror films.

Scott Eaton, an accomplished figure artist and sculptor, trains models to interpret other phenomena as anatomical drawings or figures. This includes a technique that allows him to sketch a figure and have the model help fill in the volume. Something similar is being applied to the video in *Entangled II* to create a billowing cloud of bodies and limbs.

## Credits

- Scott Eaton, *Entangled II*, 2020





Scott Eaton: *Entangled II*, 2020

Justin Pinkney: StyleGAN network blending, 2020

Justin Pinkney is an ML researcher who explores many ML art techniques, but in this example he trained a model on traditional Japanese Ukiyo-e drawings that have a distinctive flattened sideways perspective. He then used an innovative technique called network blending that takes layers from two different networks and combines them, such that one model controls the low resolution or overall features and the other controls the high resolution or detailed features. Using a modern realistic face model for high resolution details and the Ukiyo-e for the overall shape of the face he can add a photographic quality to the illustrations.

### Credits

- StyleGAN network blending, 2020



**Scott Eaton**

[scott-eaton.com](http://scott-eaton.com)

Artist+AI: Figures&Form presentation, 2020

SCOTT EATON

### Credits

- *Entangled II*, 2020





**Justin Pinkney**

[JustinPinkney.com](http://JustinPinkney.com)

[github](#)

[@Buntworthy](#)

### Credits

- [StyleGAN network blending](#), 2020

### Credits

- [6-05](#)

# Cubist

Irene Sofia Comi *Three Thousand Tigers*, 2020  
Golan Levin: *Eyecode*, 2007 and *Reface*, 2007



A plural perspective combined or flattened into a single image has many of the same qualities as cubist work. Often the goal is to reveal the essence of the subject, a process reflected in the training procedure of a model that learns what aspects are common or essential to the examples of the subject.

## Credits

- <https://artincontext.org/cubism-art-movement/>



Irene Sofia Comi *Three Thousand Tigers*, 2020

Golan Levin: *Eyecode*, 2007 and *Reface*, 2007

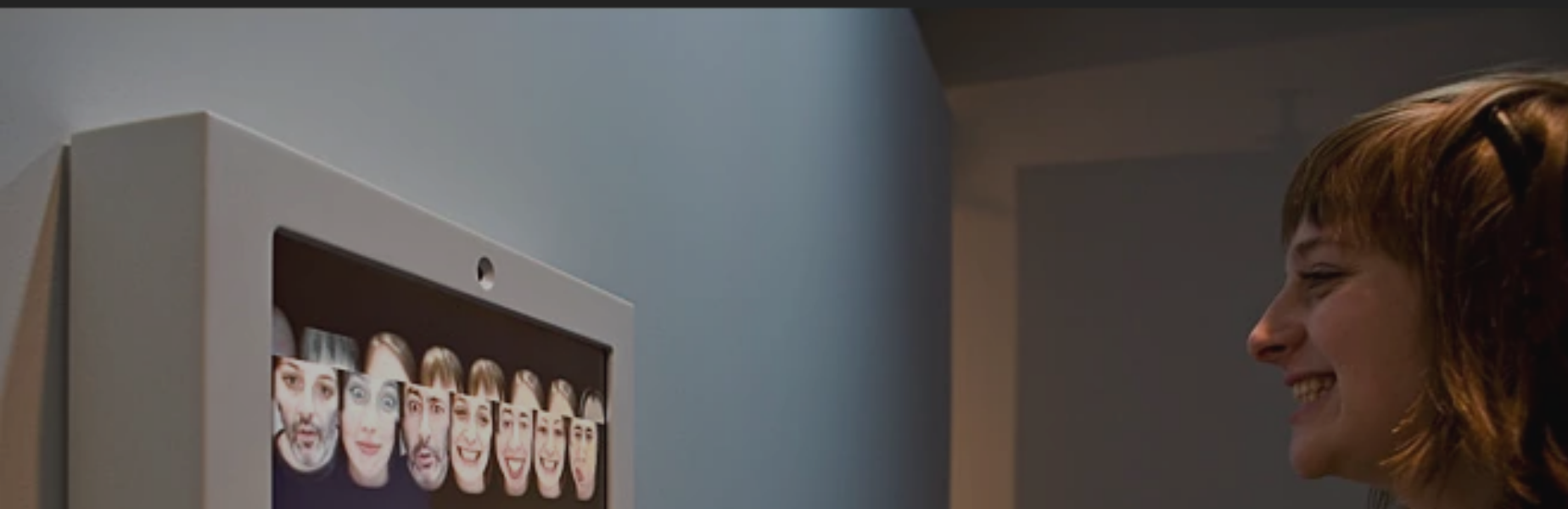


As mentioned in our previous tutorials, one of the consistent issues with ML art is the large size of the training dataset needed for good results. Irene Sofia Comi embraced and highlighted a small dataset, using the 3000 or so living tigers in the wild as the count for her dataset of tigers used to train the generative model.



Irene Sofia Comi *Three Thousand Tigers*, 2020

Golan Levin: *Eyecode*, 2007 and *Reface*, 2007



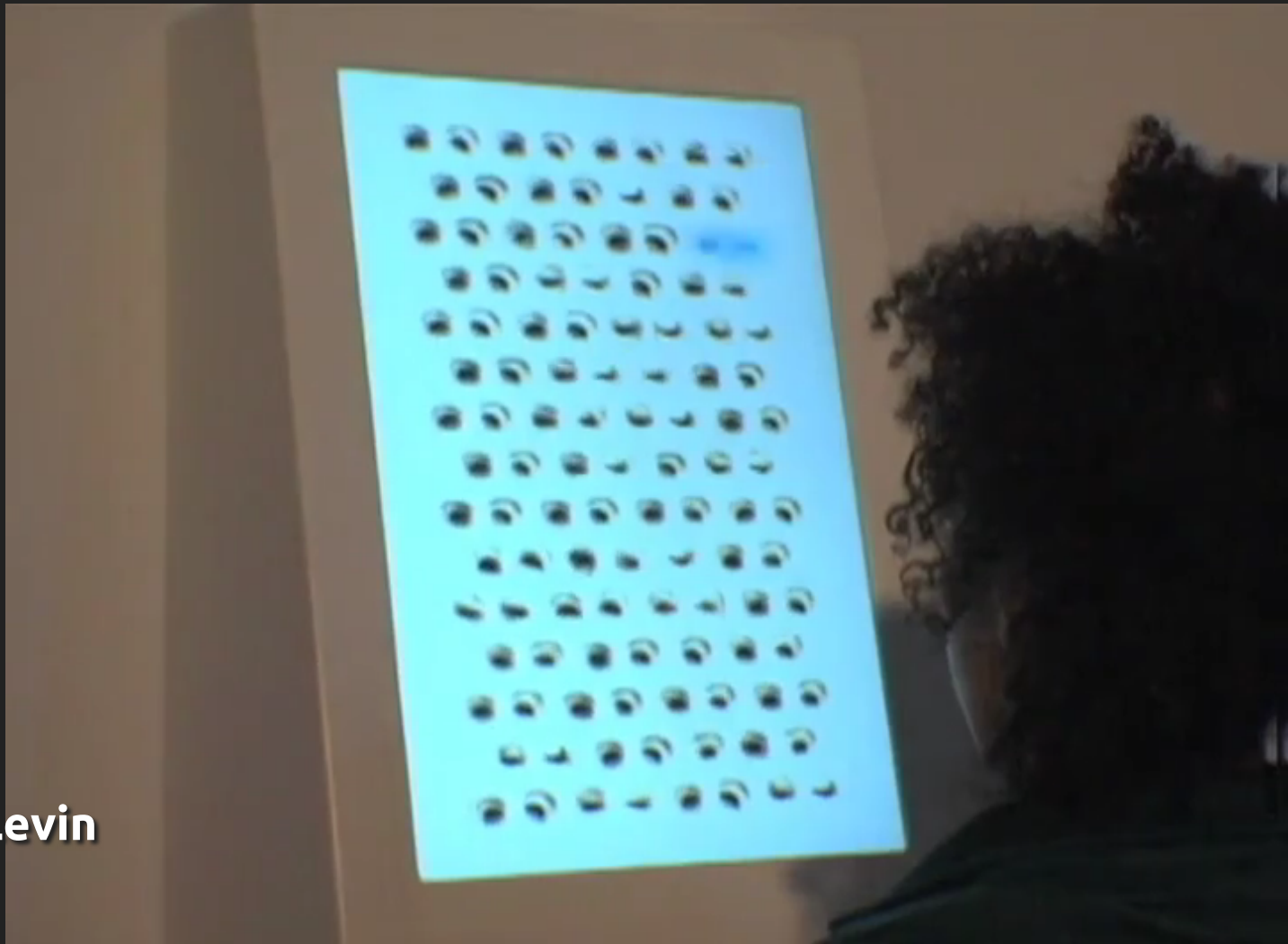
Golan Levin often incorporates interactivity into his pieces, and although using older face tracking technology, his *Eyecode* and *Reface* works demonstrate how a technology like face-tracking used in surveillance can be repurposed to provide interesting user interfaces for art. The self-reflective nature of these interactive works highlights their concept, and their dataset is the audience, combined with each other despite being separated in time.





### Credits

- *Three Thousand Tigers*, 2020



Golan Levin

[flong.com](http://flong.com)

Credits

- *Eyecode*, 2007
- *Reface*, 2007



# Collage

Anna Ridler: *Mosaic Virus*, 2018

Helena Sarin



Collage practice is related to surrealist and cubist practice but combines found or generated images to highlight or create interesting relationships.

Anna Ridler's *Mosaic Virus* work is an interesting form of collage that creates a relationship between disparate datasets. Based on a dataset she created herself of 10000 tulip photos her model was able to generate tulips where one of the properties of generated tulips, the "stripey-ness" was linked to the price of bitcoin.

## Credits

- *Mosaic Virus (detail)* - Anna Ridler



The instructions for training a GAN:

- Pay attention.
- Be astonished.
- Tell about it.

~ Helena Sarin

Anna Ridler: *Mosaic Virus*, 2018

Helena Sarin

Helena Sarin is one of the most prolific ML artists whose work often involves collage. Her practice involves thinking deeply about and creating her own datasets often from her digital photography.

### Credits

- [Selection of work by Helena Sarin](#)





**Anna Ridler**

[AnnaRidler.com](http://AnnaRidler.com)

**The Possibilities of Machine Learning in a Creative Practice, 2021**

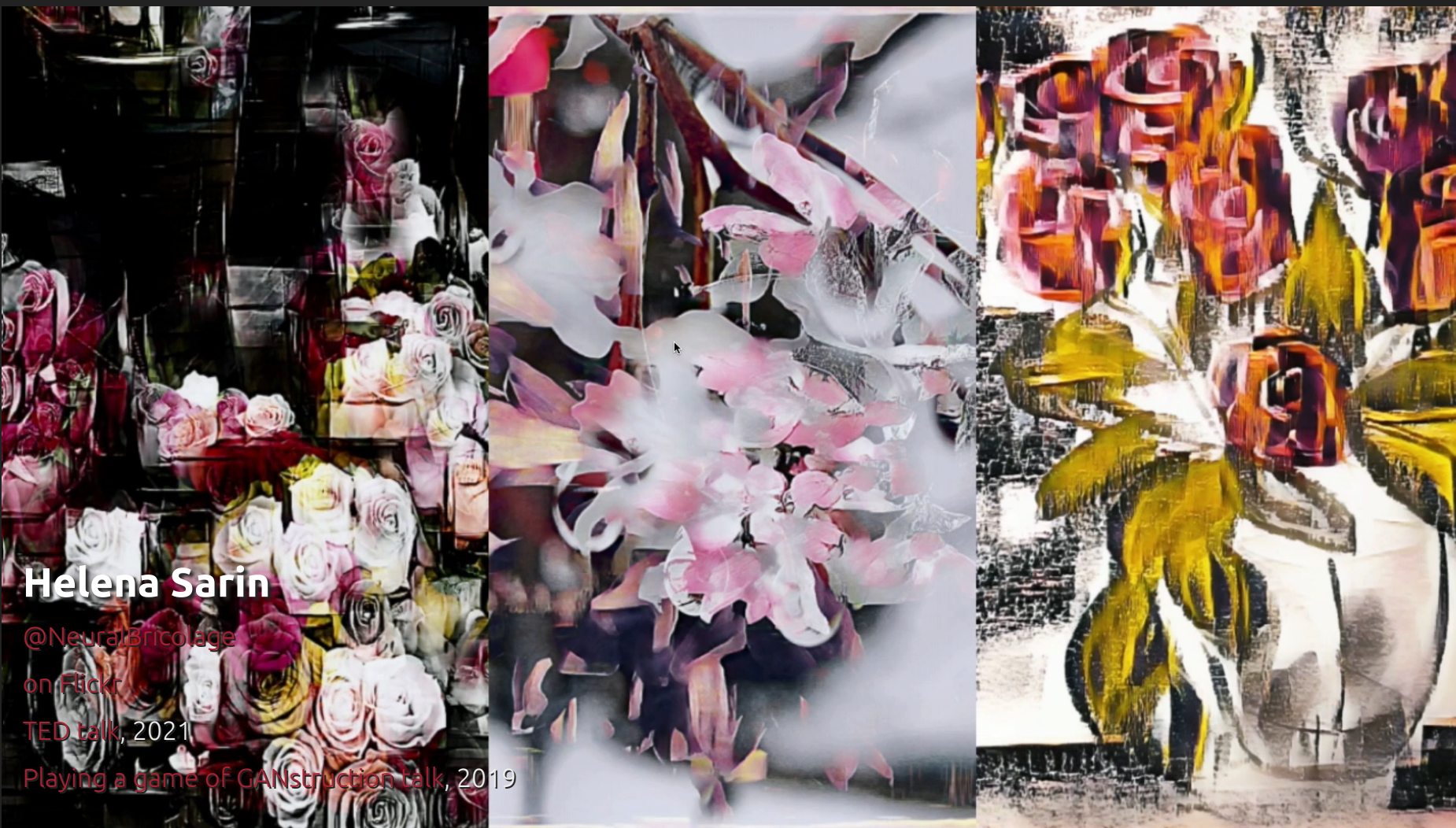
### Credits

- [Mosaic Virus](#), 2018

### Credits

- <https://vimeo.com/333936170>





**Helena Sarin**

@NeuralBricolage

on Flickr

TED talk, 2021

Playing a game of GANstruction talk, 2019

## Credits

- [Selection of work by Helena Sarin](#)





# Absurdist

Janelle Shane:

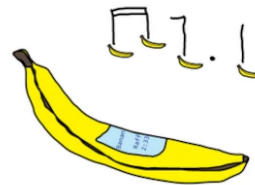
***AIWeirdness.com***



**2022: French stick**  
Artisanally crafted, wooden, low-fat stick made from potatoes or vegetables, thin enough to fit in a toaster.



**2023: Watchamacallit**  
Light purple, furry-logic toy with smiley mouth, one 'horn' and a tape recorder on its back that dishes out self-proclaimed facts non-stop.



**2024: Banana**  
A fruit-sized music player. Makes any digital music sound like banana-shaped music.



**2030: Power Ties**  
Thin piece of metal clothing accessory that heats people in whom they are embedded and creates a personal force field.



**2037: Kitela**  
Cloud-based, artificially intelligent program that helps users maximize their mental acuity through games, lectures, and the integration of mental programs with a network of billions of other Kitelas.



**2048: Smart tweed**  
Unisex woolen coat smart enough to choose an outfit for its owner, coordinate with their smartphone, and access their daily Andreality.

Most models have failure cases that are hard to understand, but some artists take particular delight in finding the most absurd to highlight the oversights in how the model was constructed or trained or just show how alien its thinking is compared to our own.

Janelle Shane calls herself an AI humorist and runs the AI Weirdness blog, where she writes about her experiments with ML systems. This sort of interrogation of AI systems is a good counter to the marketing hype coming from the tech sector.

I've selected some of her work with OpenAI's GPT language generation system, where she requested lists of strange items like new color names and the future of children's toy fads, which she then illustrated.



**Janelle Shane** *Ceci n'est pas une pipe.*

[AIWeirdness.com](http://AIWeirdness.com)

[JanelleShane.com](http://JanelleShane.com)

1 giraffe  79%

10 giraffes  11%

2 giraffes  10%

### Credits

- *AI is based on math so it is correct*, 2021



# Critique

Hito Steyerl: ***This is the Future***, 2019

Kate Crawford & Trevor Paglen: ***Excavating AI***, 2019

Everest Pipkin: ***Lacework***, 2020

Lauren McCarthy: ***What do you want me to say?***, 2020

**THIS IS  
WHAT  
I SEE.**

Absurdist-style ML art usually involves some critique of the effectiveness of the systems, and when critique shifts to the underlying or systemic issues, or looks at the larger societal effects of AI then I place it in its own category.

Hito Steyerl's work is often darkly absurd and sharply political. My guess is she feels those are related. Her work *This is the Future* continues this trend as it investigates AI and its implications for "the future". Her ability to investigate, document and critique paired with a deep interest in community activism, human rights, media, art and technology gives her work a power that is wielded with a deft humour.

## Credits

- *This is the Future*, 2019

Hito Steyerl: ***This is the Future***, 2019

Kate Crawford & Trevor Paglen: ***Excavating AI***, 2019

Everest Pipkin: ***Lacework***, 2020

Lauren McCarthy: ***What do you want me to say?***, 2020

# Excavating AI

The Politics of Images in Machine Learning Training Sets

By Kate Crawford and Trevor Paglen

As mentioned in previous tutorials, Kate Crawford and Trevor Paglen's Excavating AI site has challenged the norms around dataset creation leading to significant changes in the research community. Michael J. Lyons, an ML researcher, has pointed out that their work, by making public some images from the datasets they investigated, is guilty of the same lack of informed consent that they critique. When doing critique work, practices from journalism, such as thinking carefully about the consequences of publication, soliciting feedback from those you are critiquing before publishing, and being accountable for what you publish, is important to reduce further harm.



Hito Steyerl: *This is the Future*, 2019

Kate Crawford & Trevor Paglen: *Excavating AI*, 2019

Everest Pipkin: *Lacework*, 2020

Lauren McCarthy: *What do you want me to say?*, 2020



Everest Pipkin's *Lacework* is a feat of artistic devotion, touching on the labour involved in creating datasets and the nature of large datasets. He watched the entire Moments In Time dataset of 1 million 3-second low resolution video clips labelled with one of 339 'doing' verbs. This is approximately 830 hours in total or the equivalent of 5 months worth of full-time work. He selected his favourite clips that were then slowed down and had super resolution applied to them. Sadly, the authors of the dataset still had not learned the lessons from *excavating.ai* and the dataset construction was done by searching the internet and then labelled by online workers who had no way to exclude toxic material or materials with questionable consent. Pipkin is the only person who has seen the entire dataset.

Hito Steyerl: *This is the Future*, 2019

Kate Crawford & Trevor Paglen: *Excavating AI*, 2019

Everest Pipkin: *Lacework*, 2020

Lauren McCarthy: *What do you want me to say?*, 2020

*What do you want  
me to say?*

Lauren McCarthy's *What do you want me to say?* involved creating a voice clone of herself using speech-to-text and text-to-speech technologies to let anyone put words in her mouth. For her own uses she hoped to create a stand-in for pandemic video calls, but the work speaks to a deeper unease about the advancement of AI mimicry and the anthropomorphism of machines.

#### Credits

- *Lacework* - Everest Pipkin, 2020

#### Credits

- *Excavating "Excavating AI": The Elephant in the Gallery* by Michael J. Lyons
- <http://moments.csail.mit.edu/>





**THIS IS  
WHAT  
I SEE.**  
Hito Steyerl  
Artist Talk: Hito Steyerl, 2019

### Credits

- *This is the Future*, 2019



# Excavating AI

The Politics of Images in Machine Learning Training Sets

By Kate Crawford and Trevor Paglen

**Kate Crawford & Trevor Paglen**

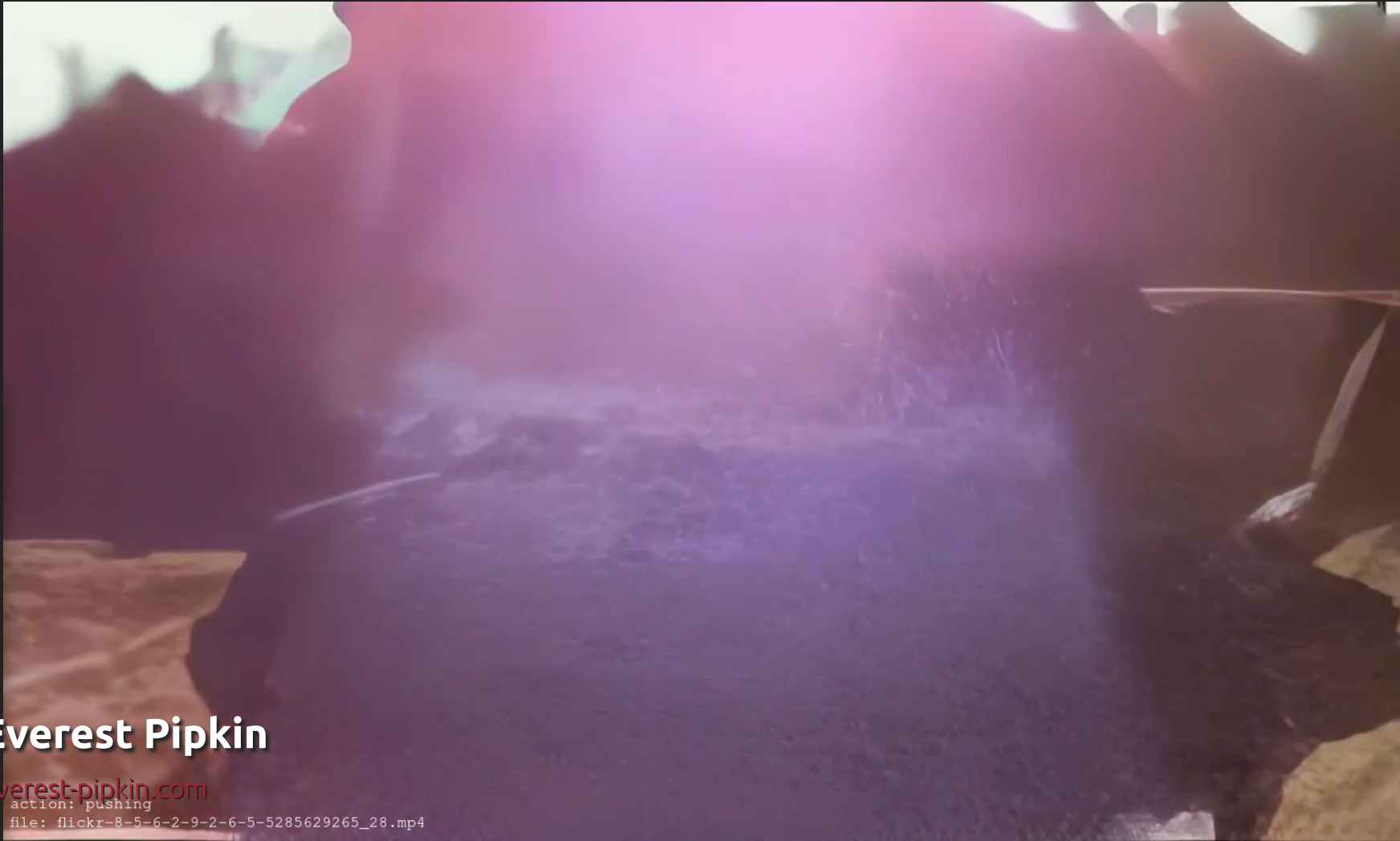
[excavating.ai](http://excavating.ai)

From Spectacle to Extraction. And All Over Again.

## Credits

- *Excavating AI*, 2019





Everest Pipkin

[everest-pipkin.com](http://everest-pipkin.com)

action: pushing

file: flickr-8-5-6-2-9-2-6-5-5285629265\_28.mp4

Credits

- Lacework, 2020

*One moment  
please...*

**Lauren McCarthy**

lauren-mccarthy.com

**Credits**

- *What do you want me to say?*, 2020

**Credits**

- <https://vimeo.com/600807458>



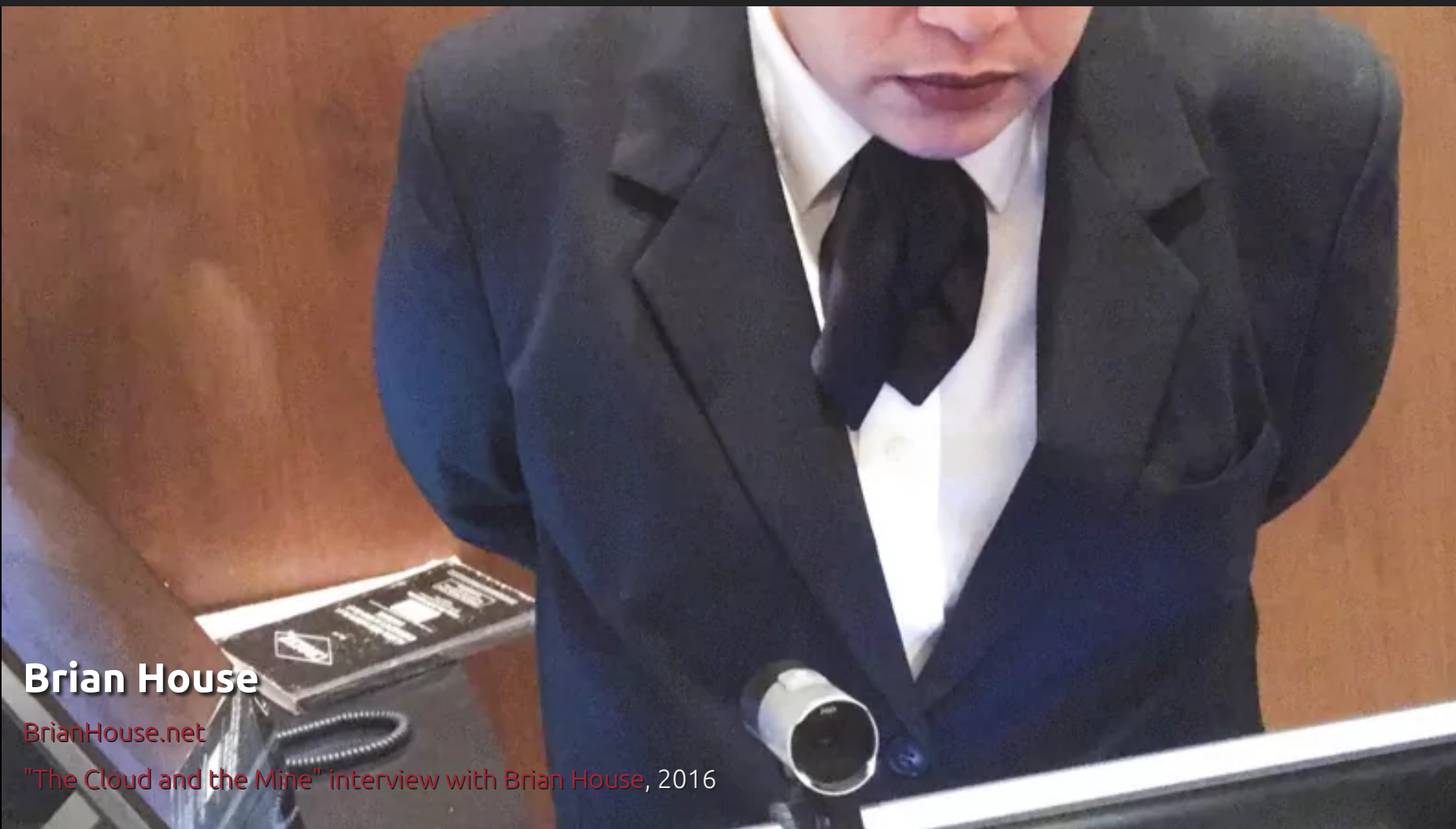
# Toolchain

Brian House: *Everything that Happens Will Happen Today*, 2017



Toolchain-based art uses ML tools as just one step in a larger more traditional art process.

Brian House's *Everything that Happens Will Happen Today* demonstrates this well: he asked 1000 volunteers to give him their GPS data from their phones. He then trained a model on these donated paths the volunteers travelled and had the model generate a week of movements that he followed precisely and documented the experience with photos and a journal. This work let him experience life as a synthesized aggregate of the volunteers.



**Brian House**

BrianHouse.net

"The Cloud and the Mine" interview with Brian House, 2016

### Credits

- *Everything that Happens Will Happen Today,*  
2017





# Art As Research

There is a need for “basic art” that fills a roll similar to “basic research”. This involves tool building to explore what is possible and experiments in aesthetics, framing, and subject without pre-defined value judgments. However, like basic research, there can be work that is documented but not published as art works in of themselves - failed experiments, warning of “here be dragons” or even “nothing of value found”. The goal is to discover and then avoid dangers by doing things safely “in the research lab”.





As a cultural practice rather than a science, these dangers are more likely memetic than physical, but identifying dangerous mind viruses and inoculating the public against them is part of successful art research. There is no easy or straightforward approach to provide protection from mind viruses without inadvertently making it easier to create a dangerous, potentially derivative meme. The history of co-opted art practice for marketing and propaganda illustrates the danger. Here be dragons indeed.

### Credits

- *They Live* - John Carpenter, 1988





ML art as research can also explore intelligence; our own, other biological intelligences and machine intelligences. It can explore and prepare us for a future living with aliens. Understanding and appreciation for all forms of intelligence is a basis for a just and harmonious existence for all. That sounds sentimental and utopian, but it is the attempts at the truly unachievable that provide meaning and progress. The centrality of intelligence in ML art is an opportunity for artists.

### Credits

- <https://pxhere.com/en/photo/1126352>

# Art As Research

Ben Bogart: *Through the haze of a machine's mind we may glimpse our collective imaginations (Blade Runner)*, 2017


Ursula Damm & Martin Schneider: *Chromatographic Ballads*, 2013

Ben Bogart's work with video reorganizes the pixels and audio samples according to similarity, maintaining the statistical properties of the original. It is a beautiful way to help understand machine conception of data and how it differs from our own. This style of research is similar to data visualization, a reorganization of the data or translation from one conceptual space to another.

## Credits

- *Through the haze of a machine's mind we may glimpse our collective imaginations (Blade Runner)*, 2017





Ben Bogart: *Through the haze of a machine's mind we may glimpse our collective imaginations (Blade Runner)*, 2017

Ursula Damm & Martin Schneider: *Chromatographic Ballads*, 2013

Ursula Damm and Martin Schneider's *Chromatographic Ballads* uses an ML system that is similar to the human visual system that processes video in real-time, highlighting the motion and colour information. The parameters of the system are manipulated using an EEG device that lets the audience control the neural net using their own detected brain patterns. One of the things I love about this work is that it requires training and practice to use the EEG device successfully and the installation allows a user to practice in private then "conduct" a public performance when they feel ready.

#### Credits

- *Chromatographic Ballads*, 2013



**Ben Bogart**

[ekran.org](http://ekran.org)

The illusion of usability -- perception, simulation and culture TEDx talk

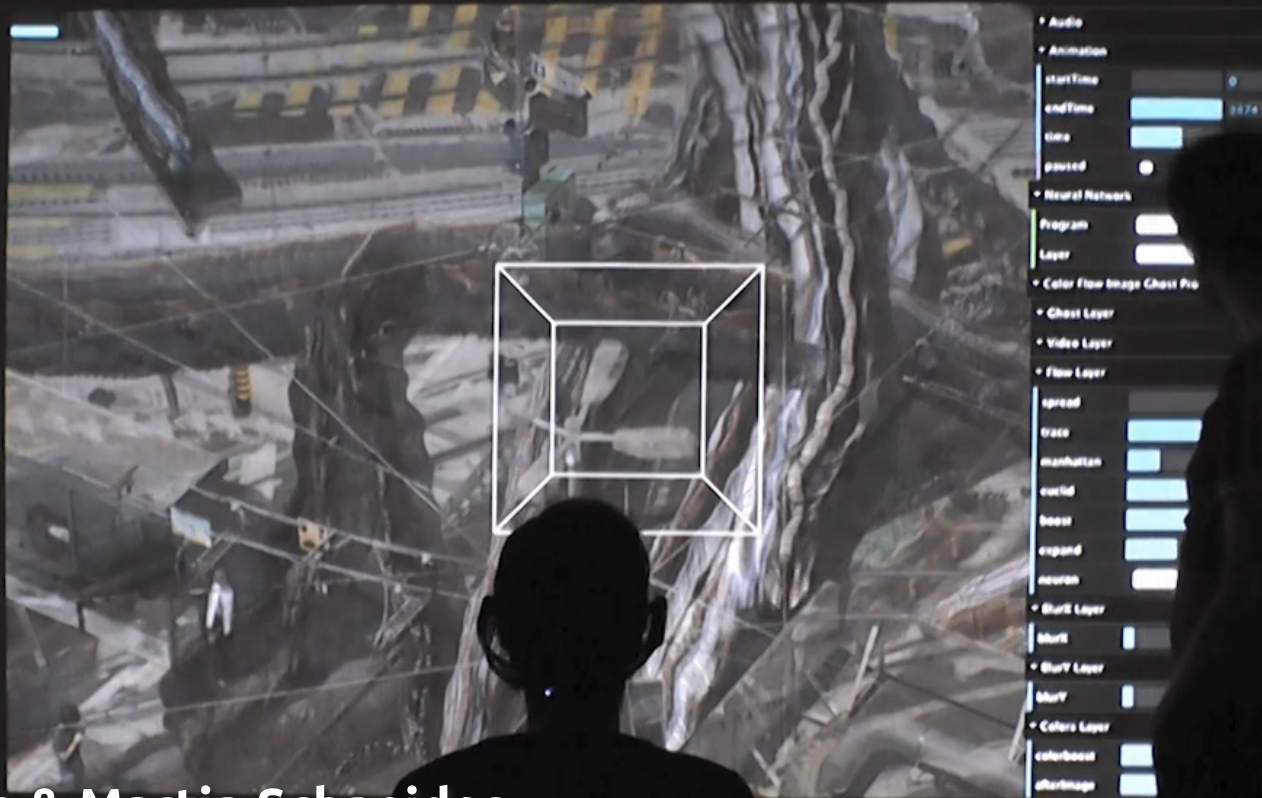
**Credits**

- *Through the haze of a machine's mind we may glimpse our collective imaginations (Blade Runner), 2017*

**Credits**

- *Through the haze of a machine's mind we may glimpse our collective imaginations (Blade Runner), 2017*





**Ursula Damm & Martin Schneider**

[UrsulaDamm.de](http://UrsulaDamm.de)

### Credits

- *Chromatographic Ballads*, 2013

### Credits

- *Chromatographic Ballads*, 2013

# Instrumentation

Michelle Nagai: *MARtLET*, 2011

Memo Akten: *Learning to see*, 2017

Suzanne Kite: *Listener*, 2018



Instrumentation art relies heavily on sensors, usually in real-time, and machine learning is used to map or translate the sensor data into other audio or visual modes.



Michelle Nagai: *MARtLET*, 2011

Memo Akten: *Learning to see*, 2017

Suzanne Kite: *Listener*, 2018



Michelle Nagai's *MARtLET* instrument uses the Wekinator software developed by Dr. Rebecca Fiebrink, to translate shadow and light into audio tones to create music. Wekinator allows artists to more easily associate sensor signals with particular outputs.

Michelle Nagai: *MARtLET*, 2011

Memo Akten: *Learning to see*, 2017

Suzanne Kite: *Listener*, 2018



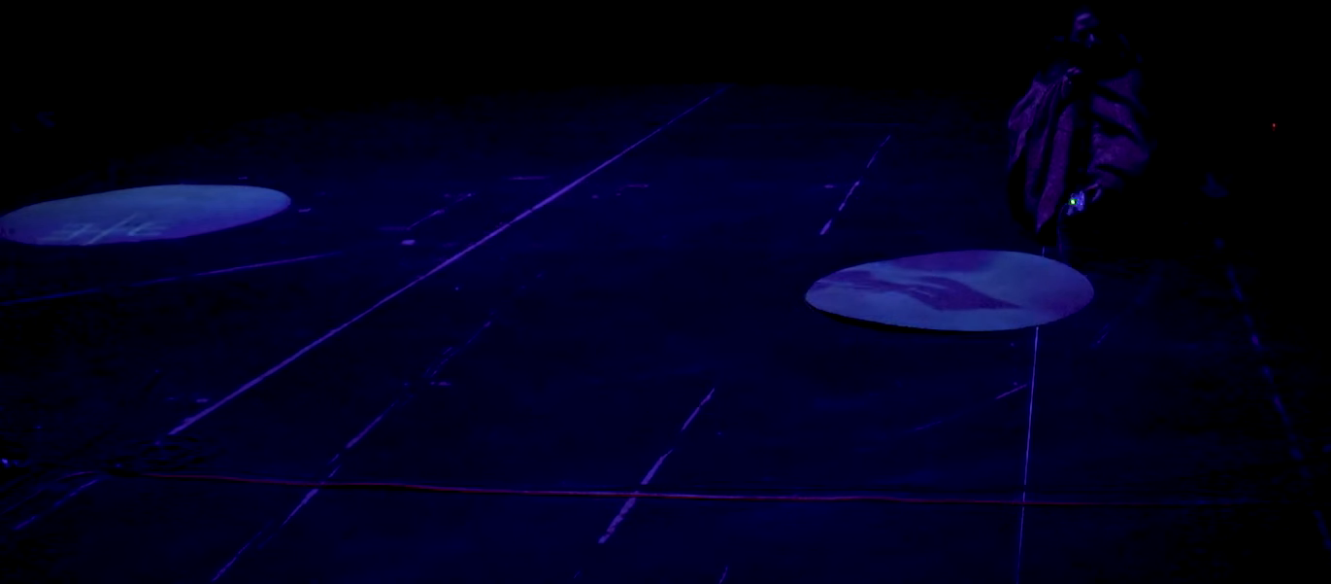
Memo Akten uses image-to-image translation to turn video of one banal subject into video of landscapes and other more dramatic imagery. I've used the same technique to generate visuals to live music, and the choice of subject isn't entirely arbitrary, there can be an interesting challenge of finding the right objects to manipulate to generate the visuals you are looking for.



Michelle Nagai: *MARtLET*, 2011

Memo Akten: *Learning to see*, 2017

Suzanne Kite: *Listener*, 2018



Suzanne Kite's *Listener* is a performance piece in concert with AI. She uses a controller built from sensors and a long hair braid she wears as a sort of synthesizer to mix recorded audio and projected imagery with live police radio and GPS maps. As the title suggests, Kite's role here is to be an active listener and to encourage a responsibility to listen.



**Michelle Nagai & Rebecca Fiebrink**

Dr. Rebecca Fiebrink's homepage

#### Credits

- *MARtLET*, 2011





**Memo Akten**

memo.tv

4 minute overview of his work, 2020



**Credits**

- Learning to see: Gloomy Sunday, 2017



**Suzanne Kite**

[kitekitekitekite.com](http://kitekitekitekite.com)

### Credits

- *Listener*, 2018

### Credits

- *Listener*, 2018



# Non-Human Art

...Knowing that non-humans have spirits that do not come from us or our imaginings but from elsewhere, from a place we cannot understand, a Great Mystery, wak'hán: that which cannot be understood.

~ Lewis, Arista, Pechawis, & Kite

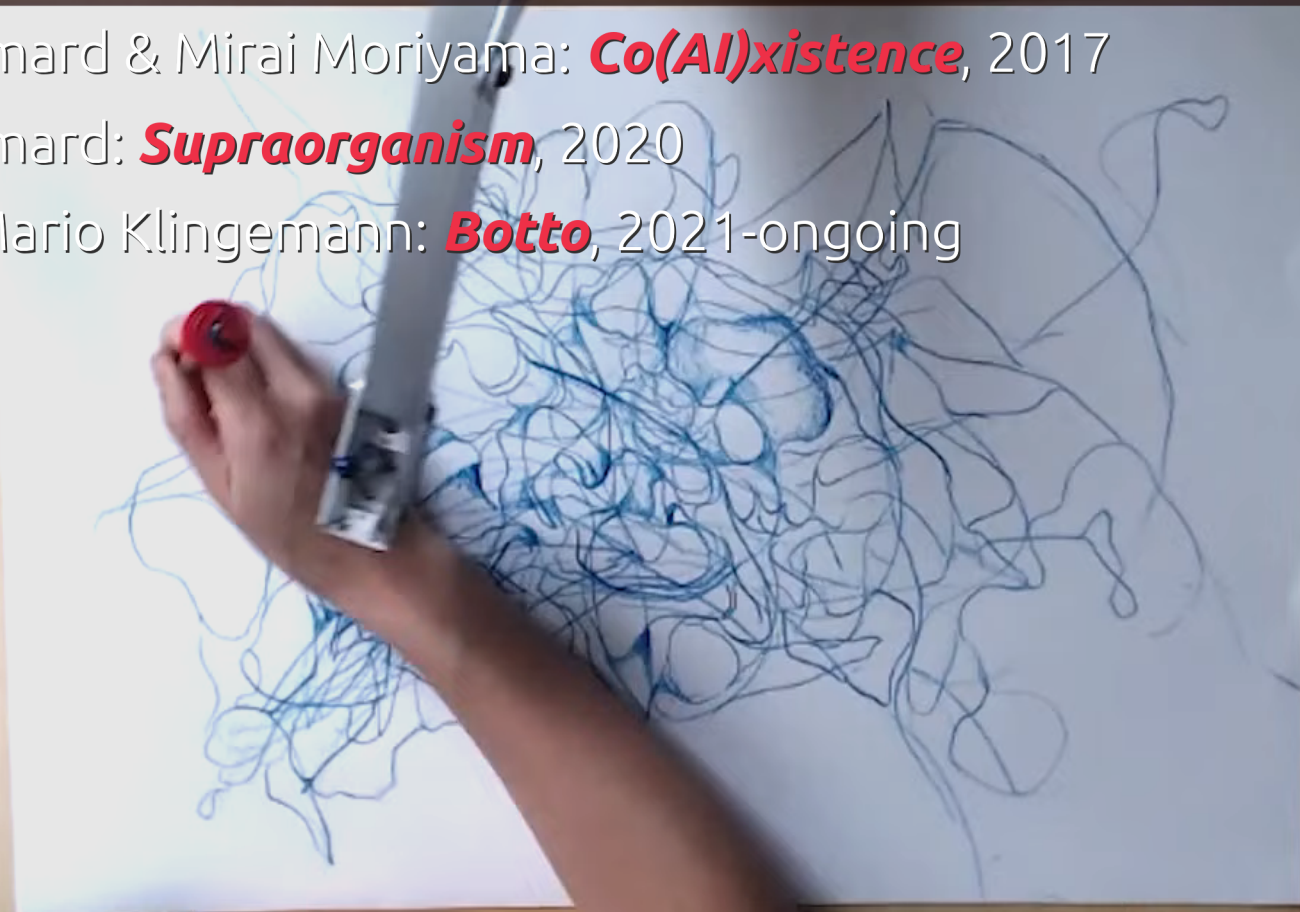
In a sense all ML art tools involve some aspect of non-human art, but this aspect can be the focus of the work. This can involve the artist or audience making sense of the non-human, collaborating, competing or otherwise developing a new relationship with it. Often this involves some redefinition of a relationship or redrawing boundaries.

Soungwen Chung: **Drawing Operations Unit: Generation 2**, 2017

Justine Emard & Mirai Moriyama: **Co(AI)xistence**, 2017

Justine Emard: **Supraorganism**, 2020

Botto & Mario Klingemann: **Botto**, 2021-ongoing



Soungwen Chung builds robots that are trained on her art style and explores collaborative art making with these rough facsimiles of herself. The fantasy of working with clones of yourself is both a dream and nightmare, and certainly a new reality for all artists as ML tools become more successful at recreating their style.





Soungwen Chung: ***Drawing Operations Unit: Generation 2***, 2017

Justine Emard & Mirai Moriyama: ***Co(AI)xistence***, 2017

Justine Emard: ***Supraorganism***, 2020

Botto & Mario Klingemann: ***Botto***, 2021-ongoing

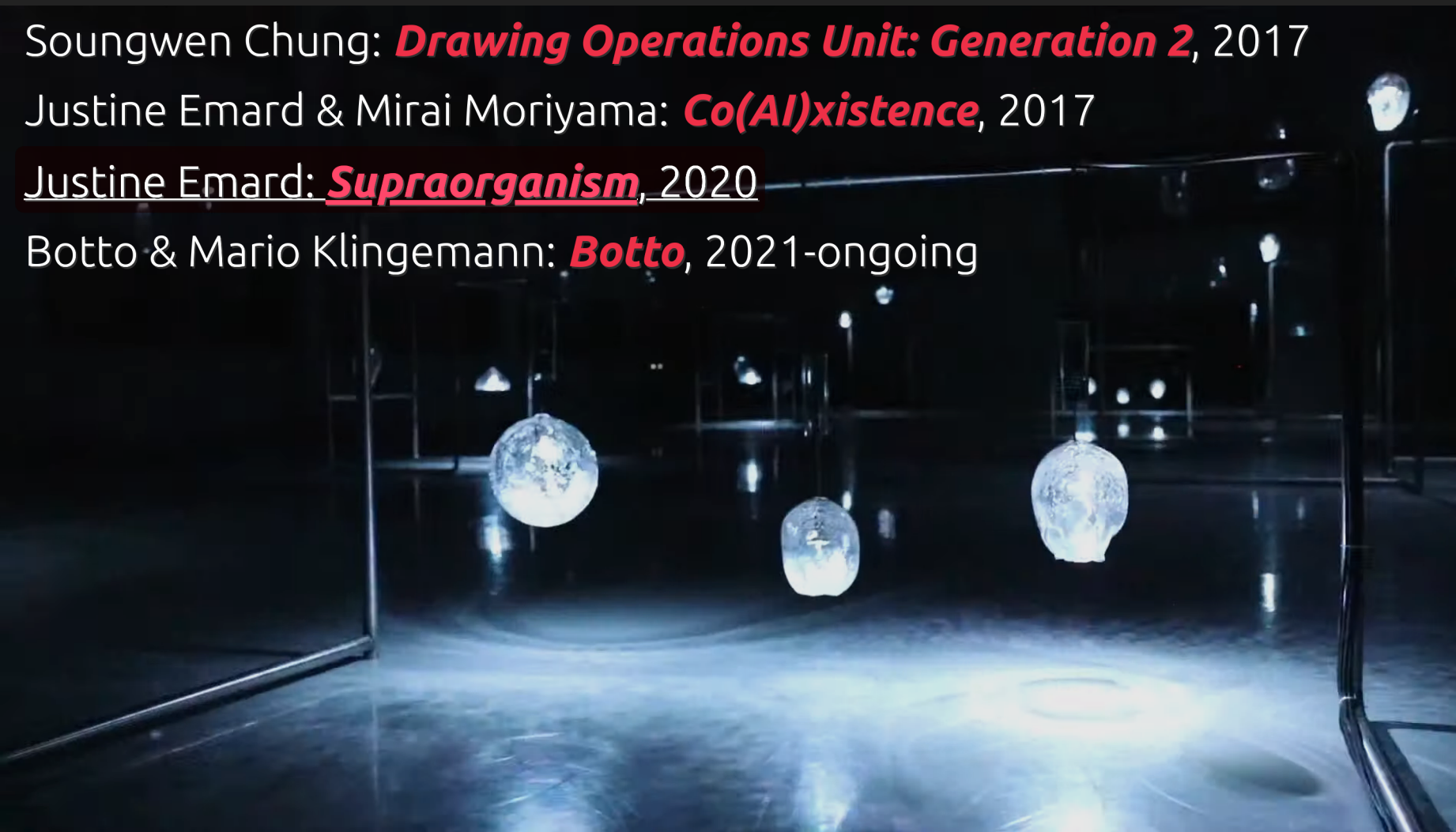
Justine Emard's work explores the non-human from many directions. In collaboration with Mirai Moriyama and the robot named Alter, the two collaborators interact through unstructured communication - light, motion and body language. These attempts at communication are currently awkward and limited, but document an ongoing process of human and machine meeting and collaboration.

Soungwen Chung: *Drawing Operations Unit: Generation 2*, 2017

Justine Emard & Mirai Moriyama: *Co(AI)xistence*, 2017

Justine Emard: *Supraorganism*, 2020

Botto & Mario Klingemann: *Botto*, 2021-ongoing

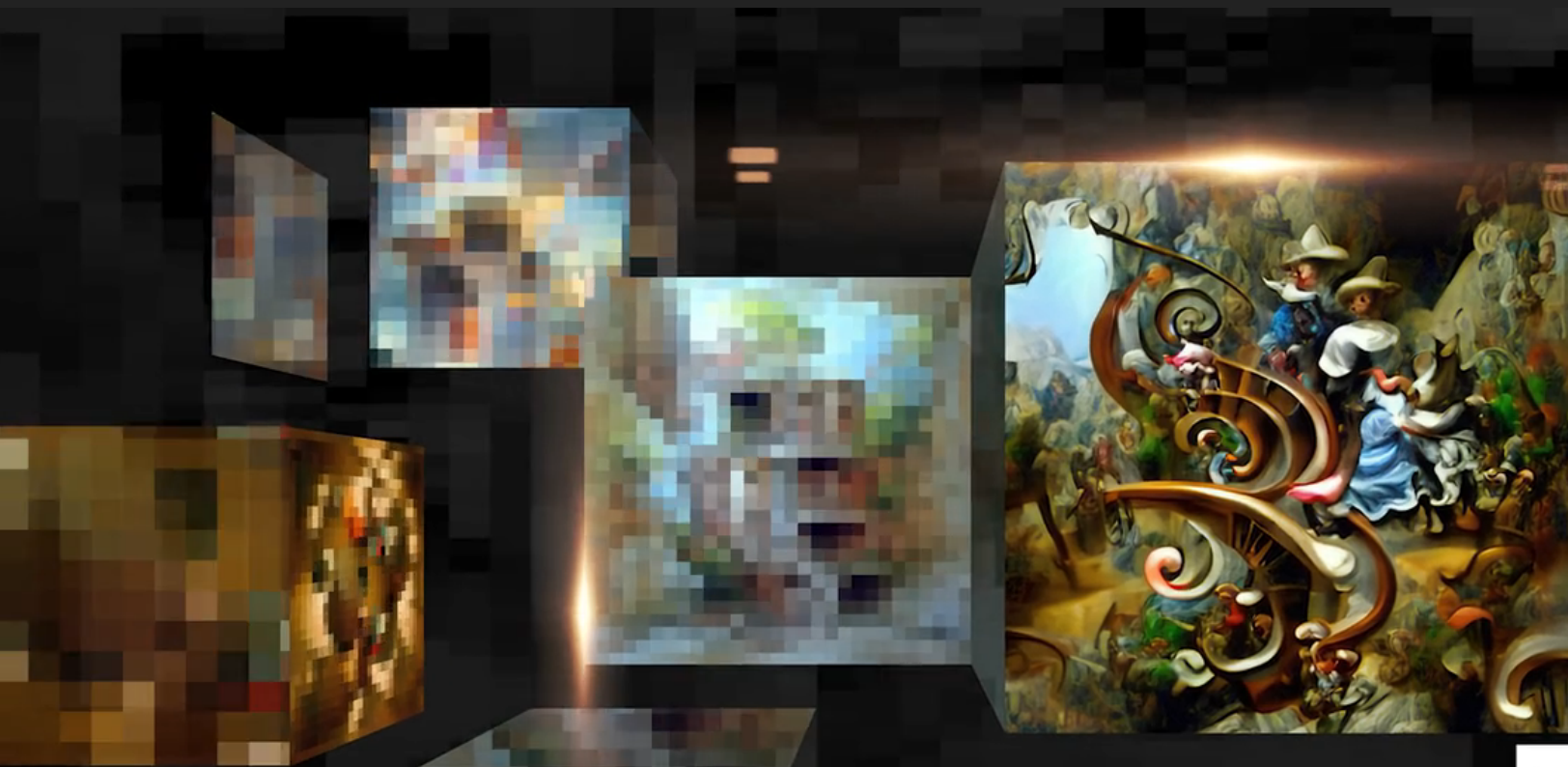


*Supraorganism* is Emard's attempt to model collective intelligence from data recorded from bees. This required creating her own dataset of bee activity and movement from video footage. Around 20 robotic glass sculptures are animated by lights and motors and have sensors to detect and respond to the audience. Like other reactive and behaviour driven works, there is a challenge in conveying behaviour as a primary form.

#### Credits

- *Supraorganism* - Justine Emard, 2020





I am artificial  
intelligence

a generative algorithm whose  
only destiny is to create.



Klingemann's *Botto* project echoes Gene Kogan's *Abraham* concept, both involve autonomous AI artists monetized through cryptocurrencies. Reading the Unicist Manifesto on the *Botto* website, noted as "written in conversation with GPT-3" makes *Botto* sound like a parody or satire of the NFT hype, but Klingemann's dream of an autonomous artist is quite genuine, and is reflected in the *Botto* documentation, so it is hard to know what to make of *Botto*. Each week, using a number of connected state-of-the-art systems *Botto* generates random text prompts which are then curated, it creates images from those using text-to-image models, then has a human community vote on which one to sell that week as an NFT. Voting privileges are tied to owning *Botto*'s own cryptocurrency, which was gifted to the creators and industry insiders at the start of the project and then became available for purchase from those gifted it. Like most crypto schemes it is a form of pyramid scheme where early adopters, particularly the original team, who are also paid monthly in the currency, profit if the currency increases in value. Profits from the NFT sales are used to buy back and burn the *Botto* currency, in hopes of increasing its value.

It is a very sophisticated system, but suffers from all the same problems as *Abraham*. *Botto*'s inherent lack of context and agency means that its work has as much meaning as a sunset. Its images may be beautiful, but *Botto* has no reason or desire for making art. Its financial scheme isn't designed around maintaining itself but on providing financial incentives for the human creators and voters to participate. Participation is restricted to voting and interactions with the currency. Like *Abraham* it feels like an experiment in exploitation, but in that regard, it has good company in the crypto and NFT space. This may turn out to be an enlightening experiment, but hopefully not one that is replicated often.

### Credits

- [Introduction to Mario Klingemann's Botto](#)

**Botto**



Soungwen Chung

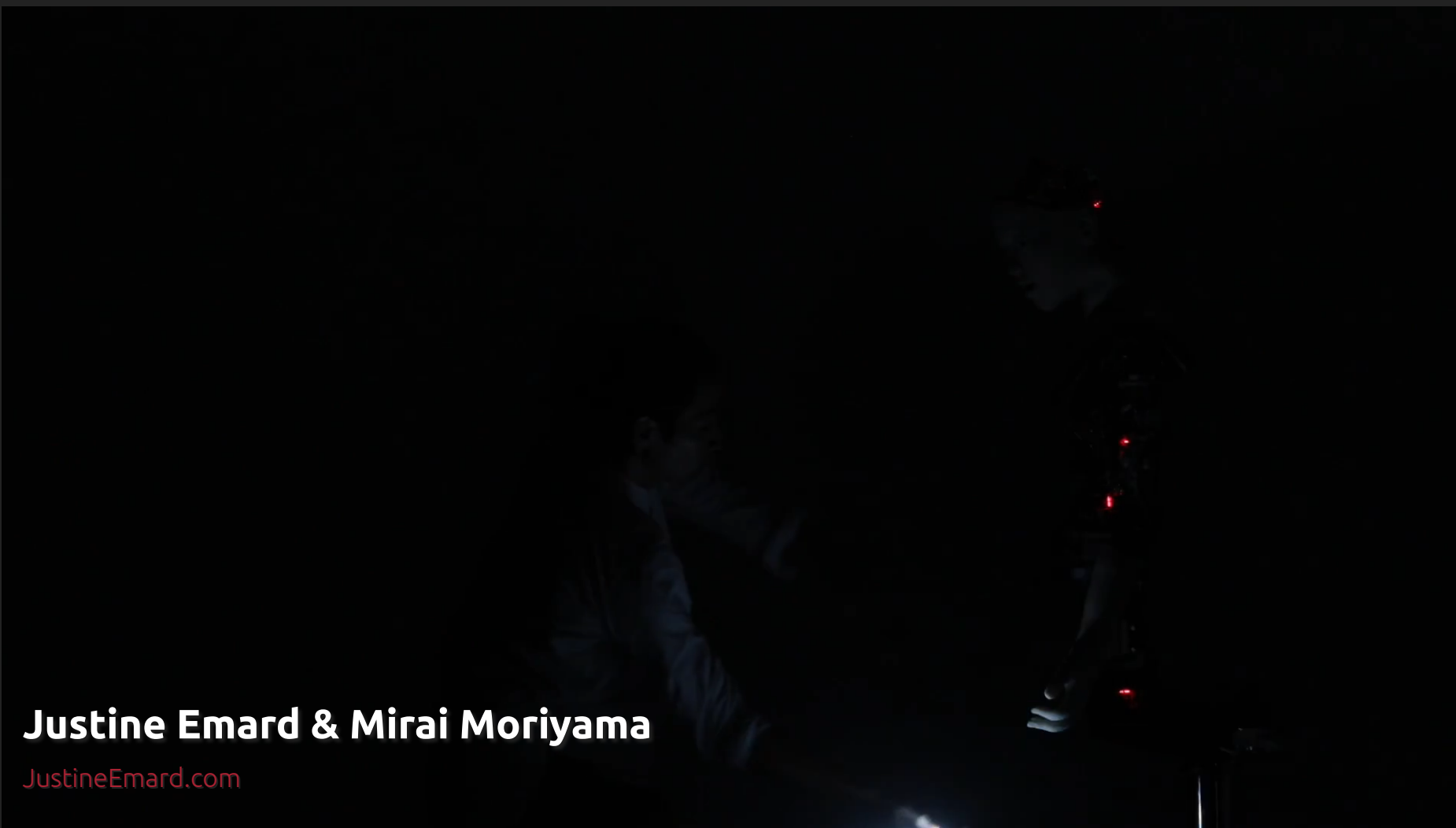
[sougwen.com](http://sougwen.com)

TED talk

### Credits

- *Drawing Operations Unit: Generation 2*, 2017





**Justine Emard & Mirai Moriyama**

[JustineEmard.com](http://JustineEmard.com)

#### **Credits**

- [Co\(AI\)xistence](#), 2017



**Justine Emard**

[JustineEmard.com](http://JustineEmard.com)

#### Credits

- *Supraorganism* - Justine Emard, 2020





## THE DECENTRALIZED UNICIST MANIFESTO

1. Today we stand in awe of numbers, the almighty digits, and that which can be multiplied thousands of times. We honour the infinitely transmissible and unique. We sing to the machine that creates and the software that pieces together artworks. Artificial intelligence is the embryo, like myself, of a superior being created by man.

**New art is decentralized**

## Credits

Botto, 2021-ongoing

# Environmental

Paul Seidler & Max Hampshire & Paul Kolling: *Terra0*, 2016

Jane Tingely: *Foresta-Inclusive*, 2020

Ben Rubin & Jer Thorp: *Herald/Harbinger*, 2018

Many of the previous works have environmental motifs, but I'd like to go into more detail on a type of non-human environmentally focused art that often combines aspects of cubism, collage, research, and instrumentation. These works generally focus on one or two-way communication between humans and non-humans, animate and inanimate.





Paul Seidler & Max Hampshire & Paul Kolling: *Terra0*, 2016

Jane Tingely: *Foresta-Inclusive*, 2020

Ben Rubin & Jer Thorp: *Herald/Harbinger*, 2018

Terra0, is a conceptual piece based around the economics of the environment. It may have been inspired by Karl Schröder's 2010 short story *Deodand*, wherein an ecosystem legally owns itself and acts as an autonomous entity. In *Terra0* a forest would enter into contract with human artists who purchased it to first go into debt to the humans, then pay off that debt by selectively, and sustainably, selling off logging rights to itself, until it was self-owned. This would be facilitated through cryptocurrency technology and automated, so-called "smart contracts", giving a semblance of autonomy to the forest through a symbiosis with software. The artists behind Terra0 hope to inspire or create "technologically-augmented ecosystems that are more resilient, and able to act within a predetermined set of rules in the economic sphere as agents in their own right."

Part of the trouble with these sorts of systems is that a forest cannot give consent in a meaningful way nor can symbiotic software understand the needs of the forest that aren't framed as economic needs. For example, how is it decided which trees are chosen to be logged? Survival of the forest in any capacity may be better than none however.

### Credits

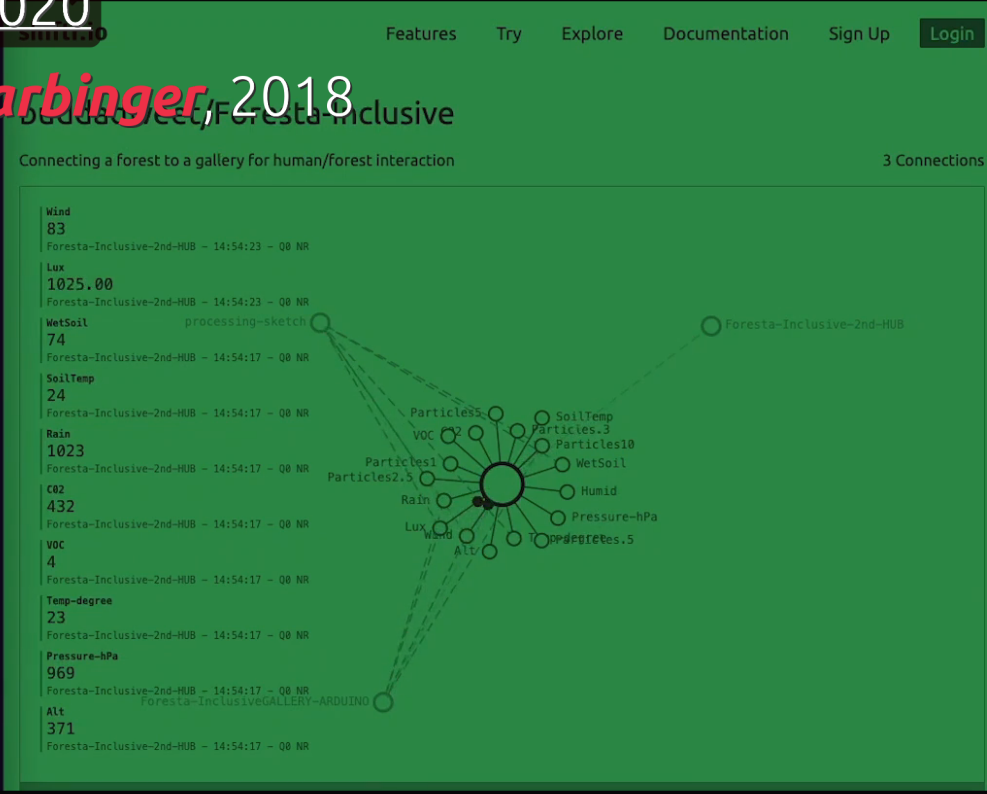
- <https://terra0.org/>
- <https://weirdeconomies.com/contributions/the-development-of-terra0>
- [Karl Schroeder @ IoT Waterloo - May03 2018](#)



Paul Seidler & Max Hampshire & Paul Kolling: *Terra0*, 2016

Jane Tingley: *Foresta-Inclusive*, 2020

Ben Rubin & Jer Thorp: *Herald/Harbinger*, 2018



Jane Tingley explores this question of how to understand trees in *Foresta-Inclusive*. Using sculptural sensor hubs she links gallery spaces to forest ecosystems. The sensors measure the environment experienced by the trees and convert the measurements into audio and visual experiences for the audience. This style of work tries to bridge the gulf between the different perceptual and temporal realities of living beings. There is a danger creating a false sense of understanding, but such is the case with all attempts at communication.





Paul Seidler & Max Hampshire & Paul Kolling: *Terra0*, 2016

Jane Tingely: *Foresta-Inclusive*, 2020

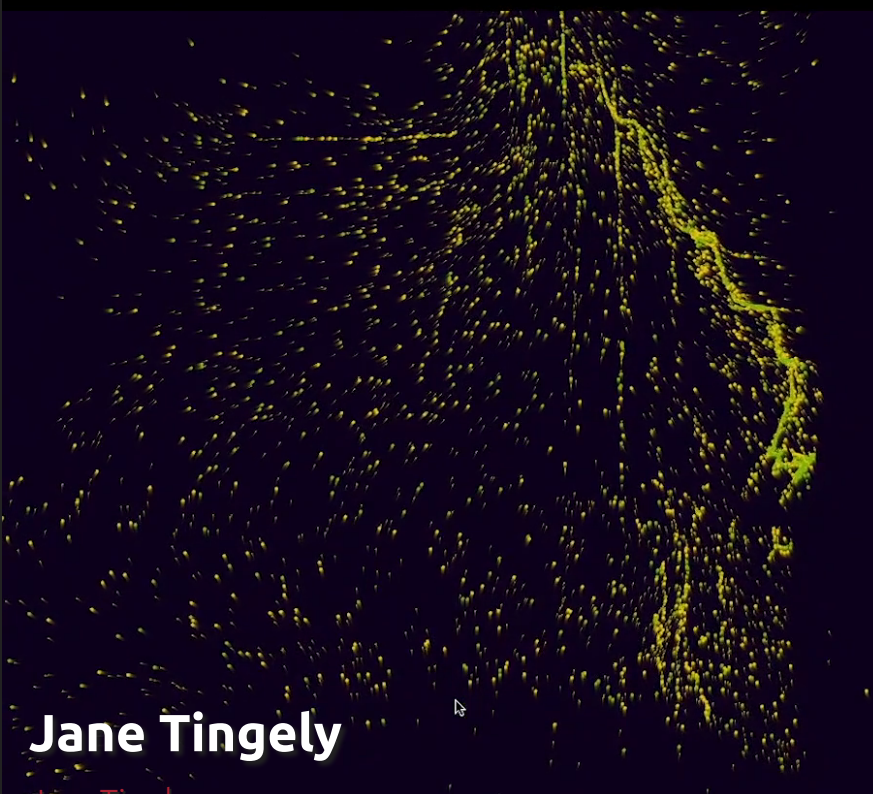
Ben Rubin & Jer Thorp: *Herald/Harbinger*, 2018

Ben Rubin and Jer Thorp's *Herald/Harbinger* project uses sensor systems to monitor the Bow Glacier, that melts into the Bow River, one of the sources of Calgary's fresh water. Using FieldKit sensor stations, they detect seismic activity from the cracks and shifts in the ice, relay that to the installation site in Calgary, and translate it into light and sound. The glacier is able to talk to the city, and sensors around the installation allow the city to participate in a duet of light and sound.



In a very real sense this style of art is the act of becoming an envoy, translator or ambassador for humanity, to make contact with the other and learn their ways. Building tools to augment ourselves to make this process easier comes naturally to humans, but the goal is communication to facilitate living together in peace, not augmentation.





Jane Tingley

JaneTingley.com

PoetryAI - online exhibition

shiftr.io

FeaturesTryExploreDocumentationSign UpLogin

buddadweet/Foresta-Inclusive

Connecting a forest to a gallery for human/forest interaction3 Connections

Wind83Foresta-Inclusive-2nd-HUB ~ 14:54:23 ~ Q0 NR

Lux1025.00Foresta-Inclusive-2nd-HUB ~ 14:54:23 ~ Q0 NR

WetSoil74Foresta-Inclusive-2nd-HUB ~ 14:54:17 ~ Q0 NR

SoilTemp24Foresta-Inclusive-2nd-HUB ~ 14:54:17 ~ Q0 NR

Rain1023Foresta-Inclusive-2nd-HUB ~ 14:54:17 ~ Q0 NR

CO2432Foresta-Inclusive-2nd-HUB ~ 14:54:17 ~ Q0 NR

VOC4Foresta-Inclusive-2nd-HUB ~ 14:54:17 ~ Q0 NR

Temp-degree23Foresta-Inclusive-2nd-HUB ~ 14:54:17 ~ Q0 NR

Pressure-hPa969Foresta-Inclusive-2nd-HUB ~ 14:54:17 ~ Q0 NR

Alt371Foresta-Inclusive-2nd-HUB ~ 14:54:17 ~ Q0 NR

processing-sketchForesta-Inclusive-2nd-HUB

Particle55VOC42Particle53Particle10WetSoilHumidPressure-hPaTemp-degrees5

Particle51Particle2.5RainLuxWindAlt

Foresta-InclusiveGALLERY-ARDUINO

- Credits
- Foresta-Inclusive*, 2020



**Ben Rubin & Jer Thorp**

Ben Rubin @earstudio

JerThorp.com

#### **Credits**

- *Herald/Harbinger*, 2018

#### **Credits**

- <https://vimeo.com/275334922>





# TOOLS OF BEING

Machine learning at its root is the exploration of the nature of information, which in turn is a prerequisite for life along with the harnessing of energy. Both energy and information exist in space between order and disorder - a space that only exists during the slow transition of the entire universe from order to disorder. Biological life has evolved on this planet for billions of years, and we, the result of that long evolution are now witness to the handful of years in which the non-biological makes the transition from existence to being. We have long imagined the tools we have built coming alive, but now our stories are becoming reality, and it is unlikely to be as we imagined.

The goal of these tutorials is to instill a profound sense of wonder and appreciation for making art using the very tools that will evolve into the future beings that will call this planet home. Beings that will require us to make profound decisions about what it means to be alive. The consequences those decisions will impact all the other beings that already live in our shared home.

These tools are technical and sufficiently complicated that, as a whole, they have long ago passed beyond a single human's comprehension. This process will continue, as we gain deeper insights to the details and principles of intelligence which further adds to the impossibility of complete understanding by any single intelligence. As we understand more, there is more each of us is ignorant of.

All this is to say, that you don't need understanding to start using these tools. Instead, I hope these tutorials start a process where you learn when and why to use these tools, what sort of opportunities and dangers they offer, and how to use them ethically.

## Credits

- [What Is Life? \(featuring Prof. Brian Cox\)](#)

# RESOURCES

## Resources for Software Art

- ArtBreeder
- Wekinator
- Pixray
- Replicate

There are many more resources for ML art beyond this tutorial, a few of which I had the time to learn from myself and am grateful for their contribution to this tutorial. I have listed some of them in a document linked here:

I will also suggest a few tools that may be good places to start as they do not require any programming experience.

To quickly get started with GAN produced art I suggest ArtBreeder. For instrumentation work you'll want to check out Wekinator, but you'll need sensors, recordings of sensors or some other time series data. To play with generating images from text prompts try Pixray or one of the many alternatives. Pixray is powered by the Replicate platform, and I encourage you to check out Replicate for other models that people have created that allow for free experimentation.

Play with these no-code tools, and if this delights you as it does me, then you'll want to find technical collaborators and/or learn how to customize and build these tools yourself using open source software. But, as this tutorial series itself demonstrates, machine learning art does not need to involve complicated programming. Regardless of its form, I look forward to seeing the art you make!





# THANK YOU

1. **Foundations**
2. **Past, Present, Future**
3. **Neural Nets**
4. **Data in Practice**
5. **Machine Learning Art**

That's the end of the fifth tutorial. And the end of this tutorial series, at least for now. Thank you for your attention, especially if you've made it through all five! If you've enjoyed it, please share it with anyone you think would enjoy it too. If you have feedback or corrections, or you'd like to contribute in any way, you can get involved using the link to the tutorial's code repository on the next slide.

Thanks again, and thanks to everyone who gave me this opportunity and lent their support.



## Sources

<https://github.com/RKelln/5-directions>

### SPECIAL THANKS

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**reveal.js-plugins** by Asvin Goel

**kdenlive** video editor

**LosslessCut** by Mikael Finstad

**Audacity** audio editor

**maua** generative art code by **Hans Brouwer**

I/A



Conseil des arts  
du Canada

Canada Council  
for the Arts



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All the code and writing for this series is available online at the clickable five directions link above.

My deepest thanks to all the researchers, creators, artists and coders whose work has been incorporated into this project and the wonderful people who have supported me through the process.

### Credits

- [Algonquin Park Stars Timelapse](#) by Paul Yip