Generative Art

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Outline

- Definition & history
- Most popular algorithm: GANs
- Art piece example
- Generative Art, Art Blocks, NFT, and Blockchain

What is Generative Art?

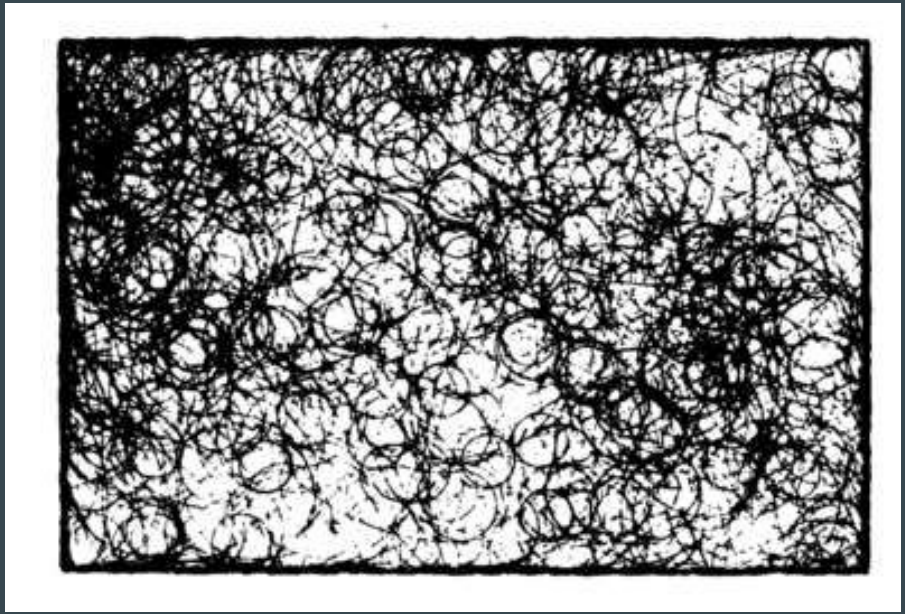
- Art that in whole or in part has been created with the **use of an autonomous system**;
  - autonomous system: non-human and can independently determine features of an artwork that would otherwise require decisions made directly by the artist

  Generated, at least in part, by some process that is not under the artist's direct control [1]

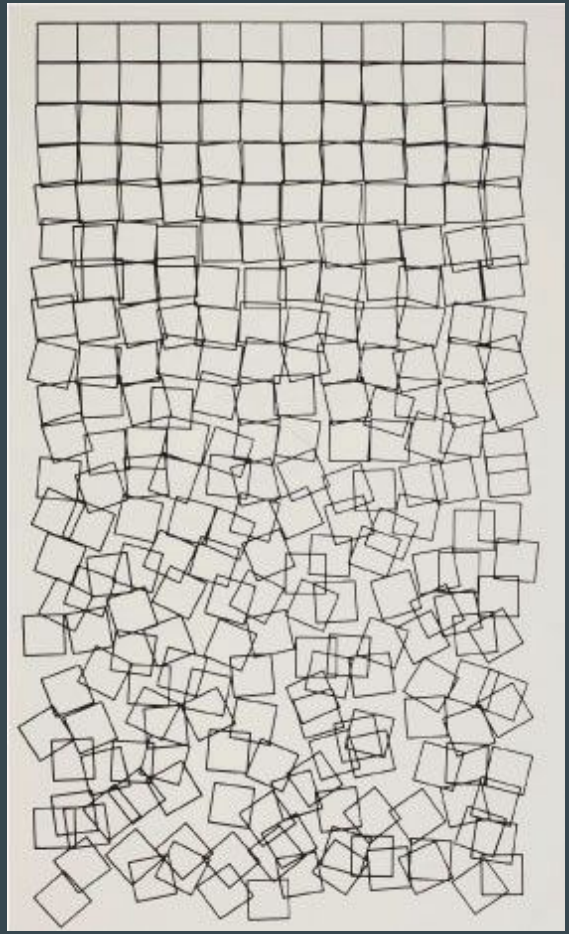
- Loose definition vs. strict definition
- Algorithmic art / synthetic media

History of Generative Art

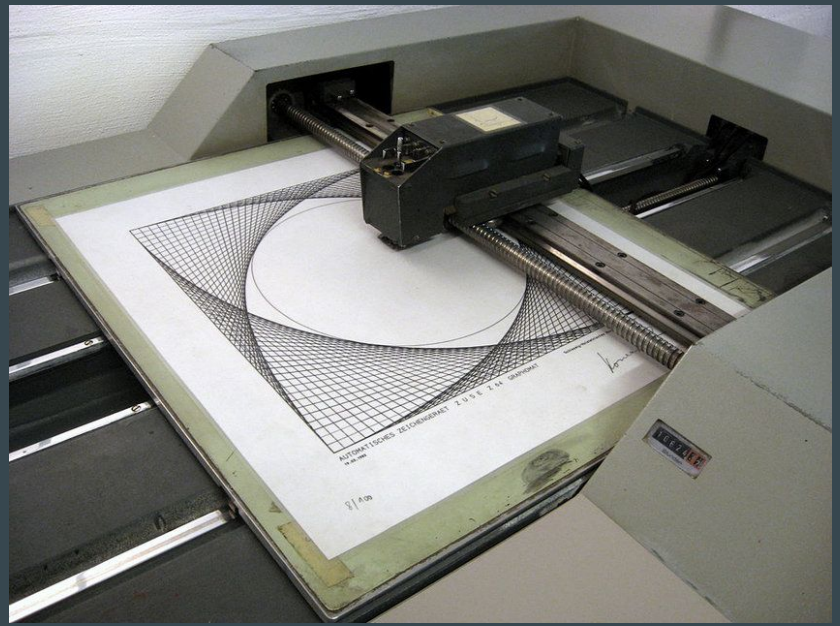
- 1960s: Refer to automated computer graphics as "generative art" in the 1960s
    - 1965: first public exhibition of generative art [2]
    - “3N” - Georg Nees, Frieder Nake, A. Michael Noll
    - Manfred Mohr, Vera Molnár

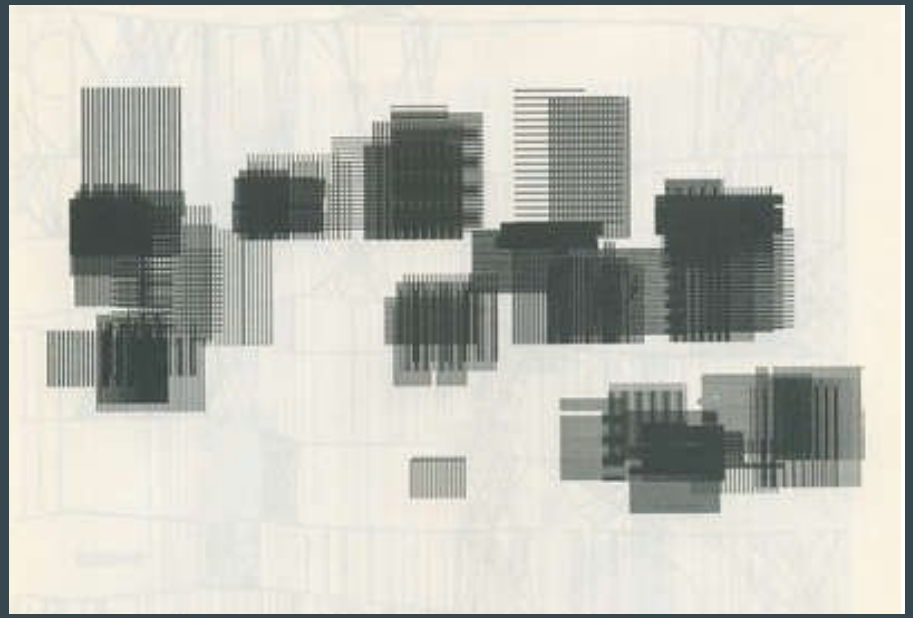


Georg Nees
Kreisbogengewirre (arc confusion)
before 1969 [3]

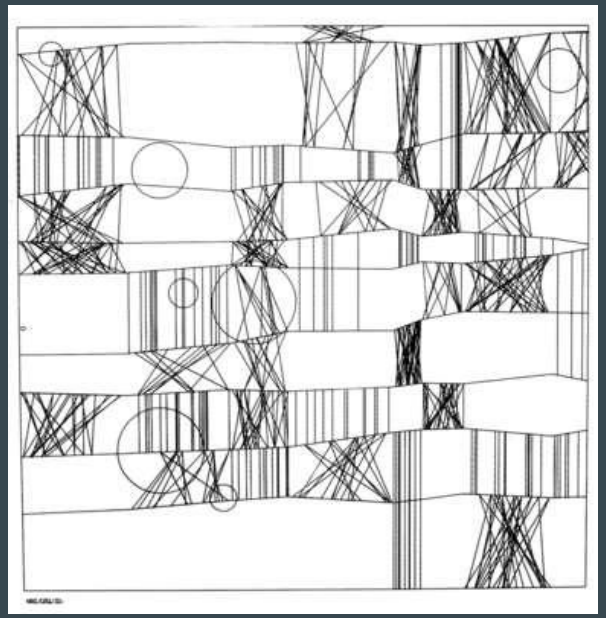


Georg Nees
Gravel
1968 [4]

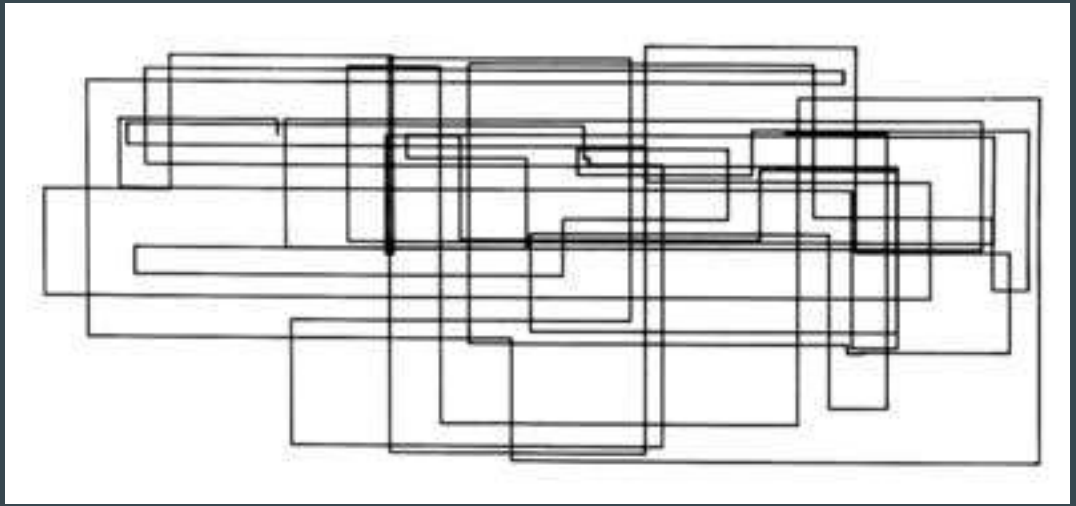




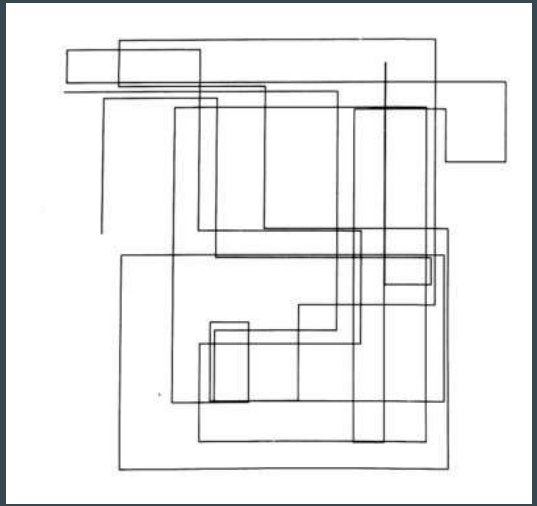
Frieder Nake
Felder mit Rechteckschraffuren Nr. 6
02.09.1965 [5]



Frieder Nake
13/9/65 Nr. 2 ("Hommage à Paul Klee")
13.09.1965 [6]



A. Michael Noll
Vertical-Horizontal No.3
1964 [7]



A. Michael Noll
Waveform
1965 [8]

History of Generative Art

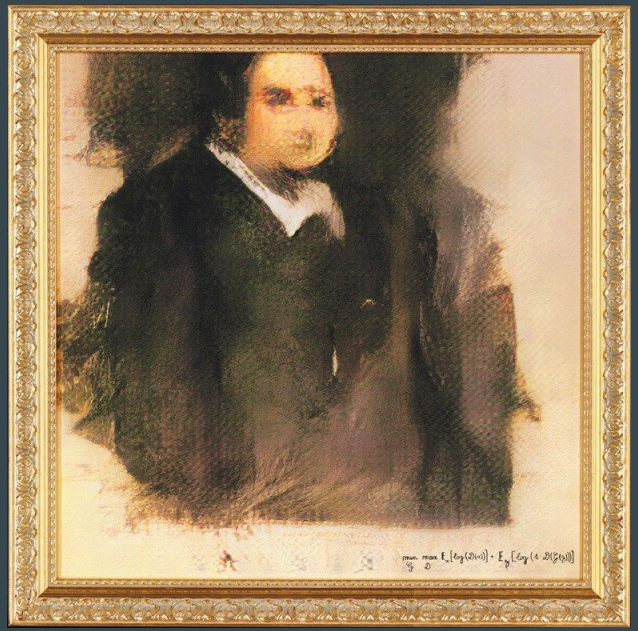
- 1970: Generative Systems department in the School of the Art Institute of Chicago
  - using the then new technologies for the capture, inter-machine transfer, printing and transmission of images, as well as the exploration of the aspect of time in the transformation of image information

- mid-1990s: Brian Eno popularized generative music
- end-1990s: cross-disciplinary perspectives formed from generative artists, designers, musicians and theoreticians
- 1998: "Generative Art" Conference at Milan University
  - The term with the meaning of dynamic artwork-systems able to generate multiple artwork-events was clearly used for the first time

Algorithms

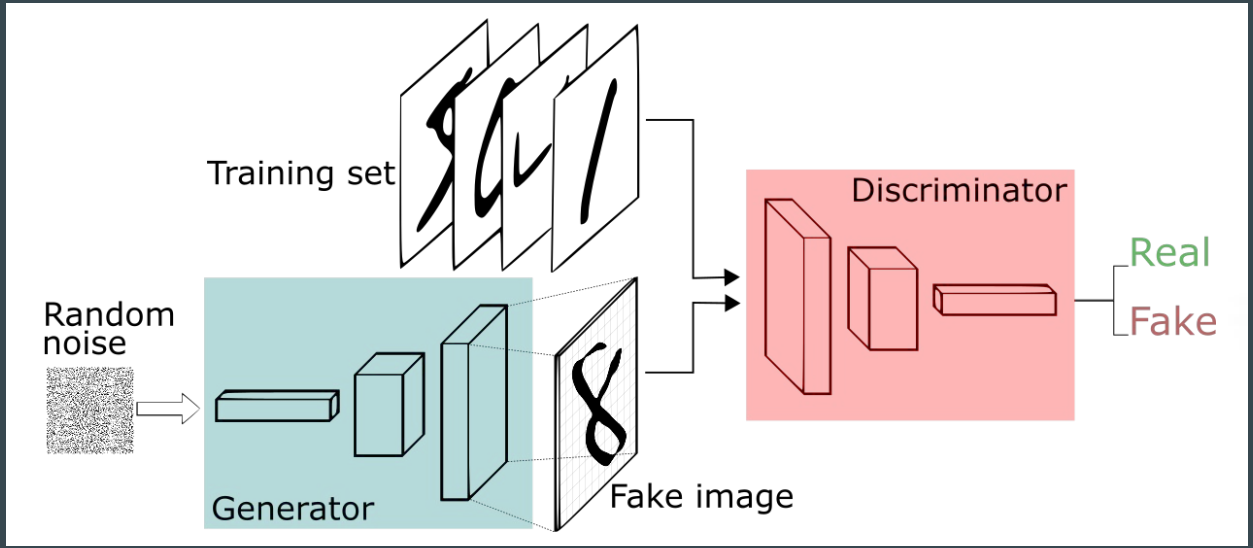
- GANs:

  Generative Adversarial Networks



GANs

- System of two neural networks:
  - Discriminator + Generator
  - Optimize the system in ways that generated output is impossible to distinguish from the real inputs



GANs

- Two GAN Loss functions introduced
  - Minimax GAN Loss VS. Non-Saturating GAN Loss

- Discriminator Loss
  - Aim to maximize the probability assigned to real and fake images
  - Maximize E[log D(x) + log(1 – D(G(z)))]
- Generator Loss
  - Aim to let D producing high prob for fake, i.e. generate samples with low prob for fake
  - Minimize E[log(1 – D(G(z)))]

- Combined Loss
  -

$$\min_G \max_D V(D,G) = \mathbb{E}_{\boldsymbol{x}\sim p_{\text{data}}(\boldsymbol{x})}[\log D(\boldsymbol{x})] + \mathbb{E}_{\boldsymbol{z}\sim p_{\boldsymbol{z}}(\boldsymbol{z})}[\log(1 - D(G(\boldsymbol{z})))].$$

GANs

GAN	Discriminator Loss	Generator Loss
MM GAN	$\mathcal{L}_{\mathrm{D}}^{\mathrm{GAN}} = -\mathbb{E}_{x\sim p_d}[\log(D(x))] - \mathbb{E}_{\hat{x}\sim p_g}[\log(1-D(\hat{x}))]$	$\mathcal{L}_{\mathrm{G}}^{\mathrm{GAN}} = \mathbb{E}_{\hat{x}\sim p_g}[\log(1-D(\hat{x}))]$
NS GAN	$\mathcal{L}_{\mathrm{D}}^{\mathrm{NSGAN}} = -\mathbb{E}_{x\sim p_d}[\log(D(x))] - \mathbb{E}_{\hat{x}\sim p_g}[\log(1-D(\hat{x}))]$	$\mathcal{L}_{\mathrm{G}}^{\mathrm{NSGAN}} = -\mathbb{E}_{\hat{x}\sim p_g}[\log(D(\hat{x}))]$
WGAN	$\mathcal{L}_{\mathrm{D}}^{\mathrm{WGAN}} = -\mathbb{E}_{x\sim p_d}[D(x)] + \mathbb{E}_{\hat{x}\sim p_g}[D(\hat{x})]$	$\mathcal{L}_{\mathrm{G}}^{\mathrm{WGAN}} = -\mathbb{E}_{\hat{x}\sim p_g}[D(\hat{x})]$
WGAN GP	$\mathcal{L}_{\mathrm{D}}^{\mathrm{WGANGP}} = \mathcal{L}_{\mathrm{D}}^{\mathrm{WGAN}} + \lambda\mathbb{E}_{\hat{x}\sim p_g}[(\|\nabla D(\alpha x + (1-\alpha\hat{x})\|_2 - 1)^2]$	$\mathcal{L}_{\mathrm{G}}^{\mathrm{WGANGP}} = -\mathbb{E}_{\hat{x}\sim p_g}[D(\hat{x})]$
LS GAN	$\mathcal{L}_{\mathrm{D}}^{\mathrm{LSGAN}} = -\mathbb{E}_{x\sim p_d}[(D(x)-1)^2] + \mathbb{E}_{\hat{x}\sim p_g}[D(\hat{x})^2]$	$\mathcal{L}_{\mathrm{G}}^{\mathrm{LSGAN}} = -\mathbb{E}_{\hat{x}\sim p_g}[(D(\hat{x}-1))^2]$
DRAGAN	$\mathcal{L}_{\mathrm{D}}^{\mathrm{DRAGAN}} = \mathcal{L}_{\mathrm{D}}^{\mathrm{GAN}} + \lambda\mathbb{E}_{\hat{x}\sim p_d+\mathcal{N}(0,c)}[(\|\nabla D(\hat{x})\|_2 - 1)^2]$	$\mathcal{L}_{\mathrm{G}}^{\mathrm{DRAGAN}} = \mathbb{E}_{\hat{x}\sim p_g}[\log(1-D(\hat{x}))]$
BEGAN	$\mathcal{L}_{\mathrm{D}}^{\mathrm{BEGAN}} = \mathbb{E}_{x\sim p_d}[\|x-\mathrm{AE}(x)\|_1] - k_t\mathbb{E}_{\hat{x}\sim p_g}[\|\hat{x}-\mathrm{AE}(\hat{x})\|_1]$	$\mathcal{L}_{\mathrm{G}}^{\mathrm{BEGAN}} = \mathbb{E}_{\hat{x}\sim p_g}[\|\hat{x}-\mathrm{AE}(\hat{x})\|_1]$

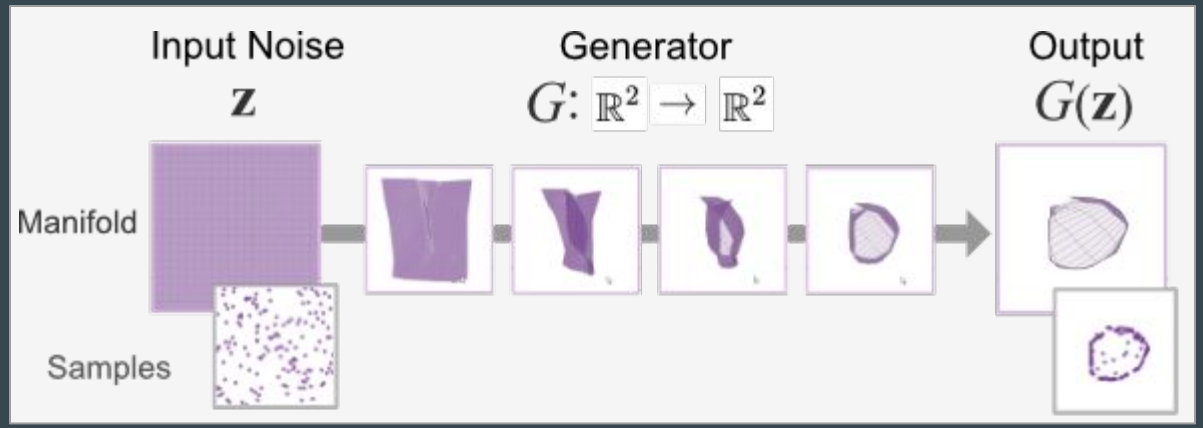
Difference in the choice of loss function disappears when the other concerns of the model are held constant

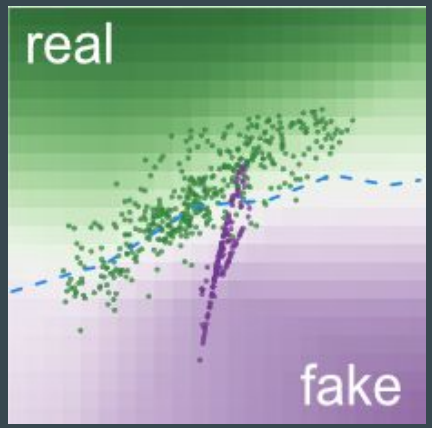
GANs

- Visualization of the training process: GAN Lab

  https://youtu.be/eTq9T_sPTYQ

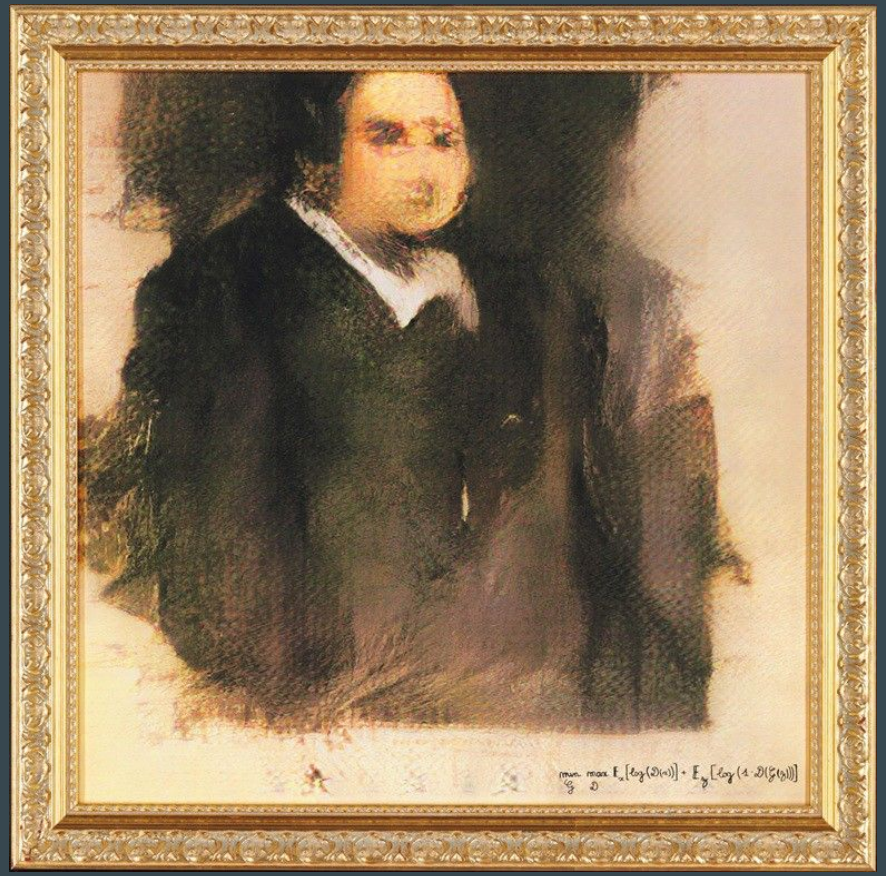
- A research collaboration between Georgia Tech and Google Brain





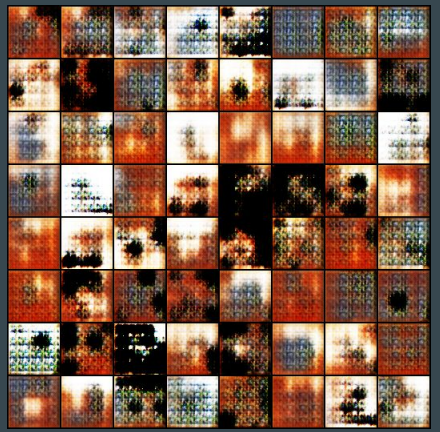
“Portrait of Edmond Belamy”

- Christie’s first to auction portrait created by artificial intelligence
- by Obvious
- min G max D Ex[log(D(x))] + Ez[log(1-D(G(z)))]
- https://youtu.be/bZiG6cxxHq0



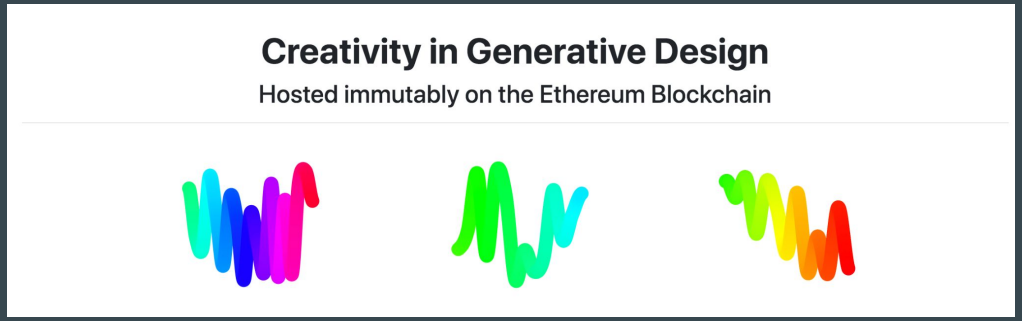
Random Face Generator

- https://www.thispersondoesnotexist.com/
- created by Nvidia, but not intentionally;
  generates a high quality image of a person who does not even exist
- https://thisxdoesnotexist.com/



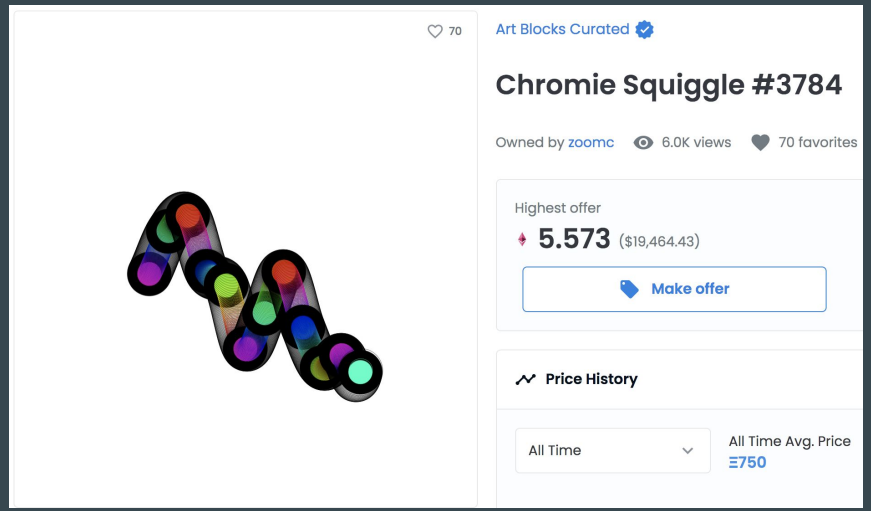
Generative Art, Art Blocks, NFT, and Blockchain

- NFT: Non-fungible tokens
- Art Blocks NFT platform: soly focus on generative art
  - Not only showcase and sell;
    Host artist's generative script itself, allow collector to interact with the script to receive a unique output (the artwork itself)
  - In August 2021 alone, Art Blocks did well over $600,000,000 in NFT sales volume;
    Performed well in secondary market



Art Blocks

- Art Blocks Curated
  - top tier for generative art NFTs
  - Many artworks have multiplied in value thousands of times since first released



Chromie Squiggle #3784 sold for 750 ETH (about $2.4M today) in August 2021.

Art Blocks

- Artist Playground
  - For artists to expand on experimental NFT ideas
  - Schvembldr's Alien Clock series
    - series of 362 NFTs imagining an extraterrestrial watching its galactic timepiece
    - https://generator.artblocks.io/112000000
  - Beatboxes by Zeblocks
    - https://www.artblocks.io/token/145000000

Art Blocks

- Art blocks Factory
- Curated and Playground projects push generative art forward into a formal crypto art discipline, Factory NFT drops introduce more playfulness and spontaneity.

Dino Pals #41
Price: 375 ETH(~1.2 M dollars)

Generative Art, Art Blocks, NFT, and Blockchain

- Create new dynamics for the generative art market
  - How artists and collectors encounter & make the deal
  - New way to present, buy, sell, and store generative art piece
  - Generative art form seems to be more appreciated then ever, at least in value
- Alter the art creation process
  - Art creation on chain
  - Collector be a part of the creation process
- Chaotic Market
  - Opportunist
  - Cannot last long?
  - Creativity in question?

Discussion

McCormack and others proposed the following questions:

- Can a machine originate anything? Related to machine intelligence: can a machine generate something new, meaningful, surprising and of value ?
- What would it be like from the computer's perspective to create art?
- Can human aesthetics be formalised?
- What does generative computer art bring that is new? And what is it representing?
- What is the role of randomness in generative art?
- What can computational generative art tell us about creativity?
- What characterises good generative art? How can we form a more critical understanding of generative art?
- What future developments would force us to rethink our answers?
- Are generative art systems the ultimate expression of the postmodern condition, or do they point to a new synthesis based on a complexity-inspired world-view?

Reference

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