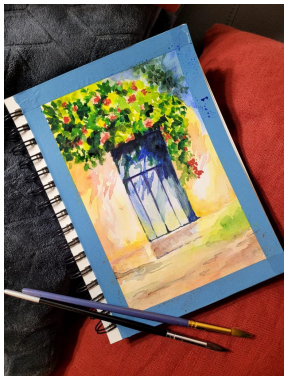
Generating Art using Python and Machine Learning

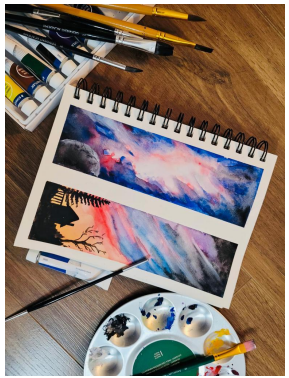
Computer Generated: Created using Dreamstudio

Who Am I?

srishti.dev

- Machine Learning Engineer at **CubicFarms Corp.**
- **Research, Create and Optimize** deep learning and machine learning algorithm
- Specialize in **Computer Vision**: AgTech, Earth Observation, Medical Imagery
- **Hobby**: Painting

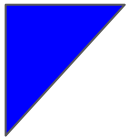




Some of my paintings

How to Follow The Slides

QR Code: Important links also have QR code. Keep camera handy



Blue Borders: Little technical slides

Missed A Concept: Don’t worry. Last slide will have link to all resources

Abstract: The field of machine learning has progressed way more rapidly in past years than we anticipated. This rapid change also brought with itself users and developers trying to explore its possibilities in creative fields. One such field is art and what in the world of machine learning is now called *Generative Art* (not to be confused with deepfakes). In this talk we will cover what is generative art, how this change came through, what are some of the latest developments happening in this field and how you can be a part of this field. Towards the end, we will also dip our toes in this space ourselves when we will do a small demo with python and ML and generate some art ourselves. It might not be the best art you have seen but art can be imaginative and we will make it fun.

What is Generative Art?

- Sort of a collaboration between artist + computer.
- Based on an algorithmic code or a mathematical formula.

Goal:

- Artists can **unlock** the doors of **creativity**
- **Lower the time** between intention and realization
- Making **art accessible** even to the untrained.

An example of generative art

Ex-Machina: A History of Generative Art

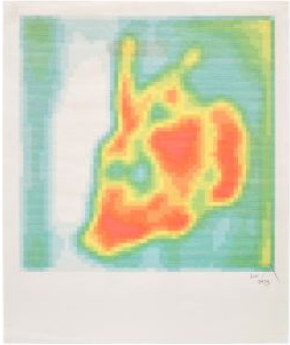
Online Auction 13-20 July 2022

Print

Showing 44 lots | Show Lot 1 | Sort By Lot Number

1
Snowfro
Chromie Squiggle #9304
Estimate £10,000 - 15,000
SOLD FOR £22,680

2
Herbert W. Franke
Untitled (from the Oszillogramme (195...
Estimate £8,500 - 10,000
SOLD FOR £10,710



3
Herbert W. Franke
Untitled (from the Dürer Hase Digital s...
Estimate £10,000 - 12,000
SOLD FOR £17,640

Philips Exhibition on Generative Art: https://www.phillips.com/auctions/auction/UK090322

Generative Art Using Python

- Art + Programming is not new
- Popular Medium: Turtle programming

Website:
https://trinket.io/python/47bbc2fc2b

trinket ▶ Run ? Modules Draft Saved

main.py

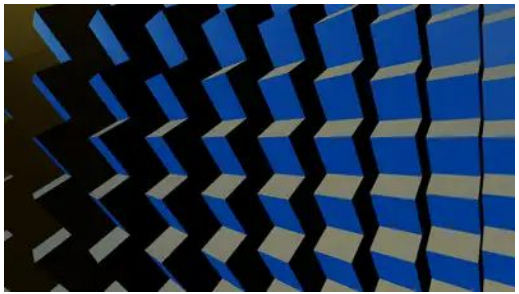
```
# Geek Gurl Diaries Episode 33: Xmas Special Make Snowflakes with Turtle
# By Carrie Anne Philbin
# https://www.youtube.com/watch?v=DHneX7YTHBY

import turtle
import random

# setup the window with a background colour
wn = turtle.Screen()
wn.bgcolor("light green")

# assign a name to your turtle
elsa = turtle.Turtle()
elsa.speed(0)

# create a list of colours
sfcolor = ["white", "blue", "purple", "grey", "magenta"]

# create a function to create different size snowflakes
def snowflake(size):
# move the pen into starting position
    elsa.penup()
    elsa.forward(10*size)
    elsa.left(45)
    elsa.pendown()
    elsa.color(random.choice(sfcolor))
    # draw branch 8 times to make a snowflake
    for i in range(8):
        branch(size)
        elsa.left(45)


# create one branch of the snowflake
def branch(size):
    for i in range(3):
        for i in range(3):
            elsa.forward(10.0*size/3)
            elsa.backward(10.0*size/3)
            elsa.right(45)
        elsa.left(90)
        elsa.backward(10.0*size/3)
        elsa.left(45)
```

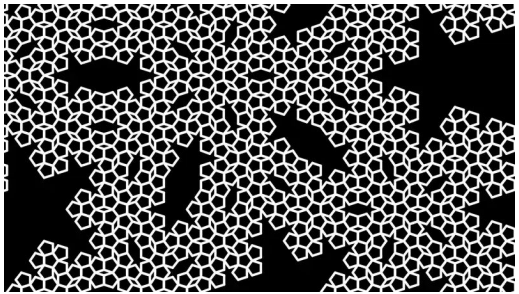
Use `import` to use external modules.

Result | Instructions

Generative Art Using Processing

- Encourages visual arts +visual literacy within technology

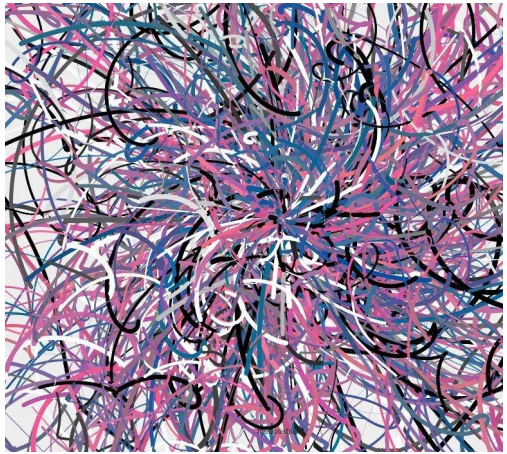




Sample art that can be made using processing

Website:
https://processing.org/

Machine Learning + Generative Art



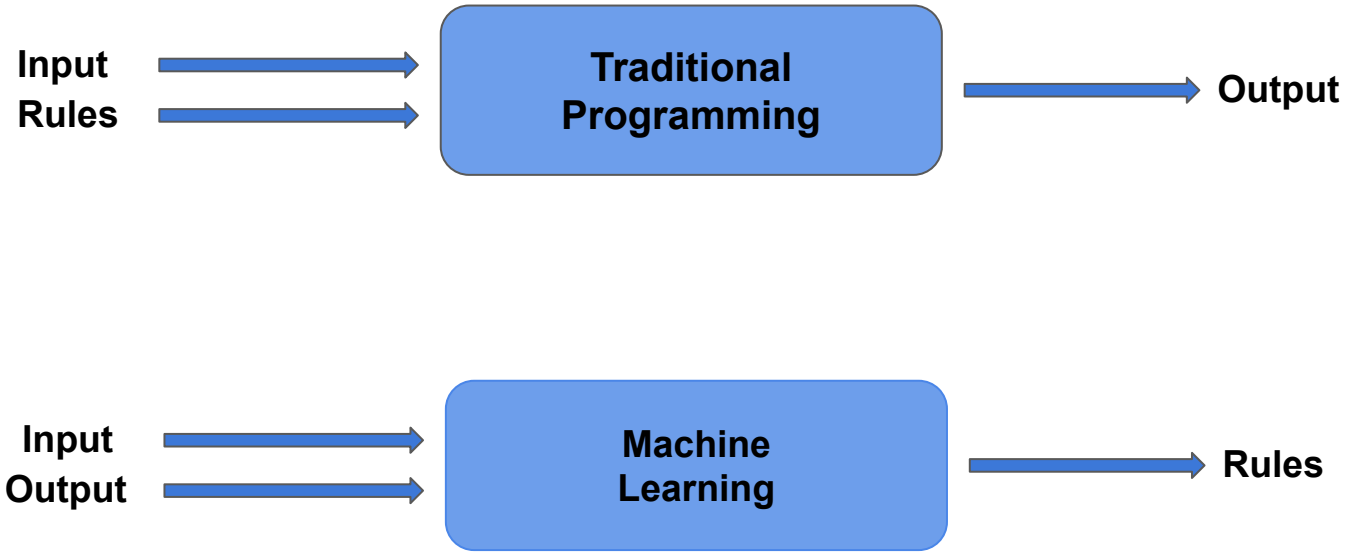
Sample art using processing

Sample art using VQ-GAN (ML)

Sample art using DALLE (ML)

The progression of how art has been generated over years programmatically

Machine Learning: A Rough Idea



How Machine Learning/AI Popularized Art?

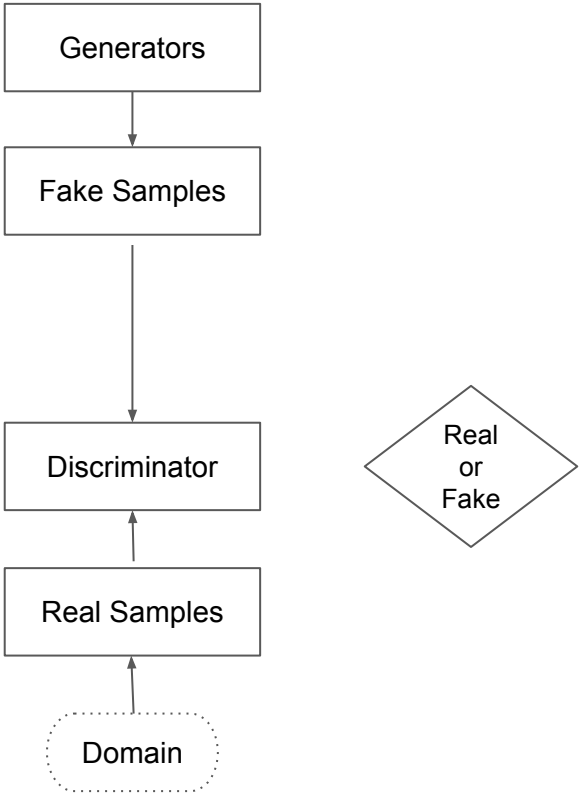
GAN: Generative Adversarial Network

What does GAN do:

- We give some training data
- Model looks at it
- Create new data instances that look *like* your training data (note: not same but similar)

Cool website:
https://www.thispersondoesnotexist.com/

Technical



Note: For people who are an expert in this topic, you can take a break for 2 min. You won't miss much :)

This led to ***deepfakes***

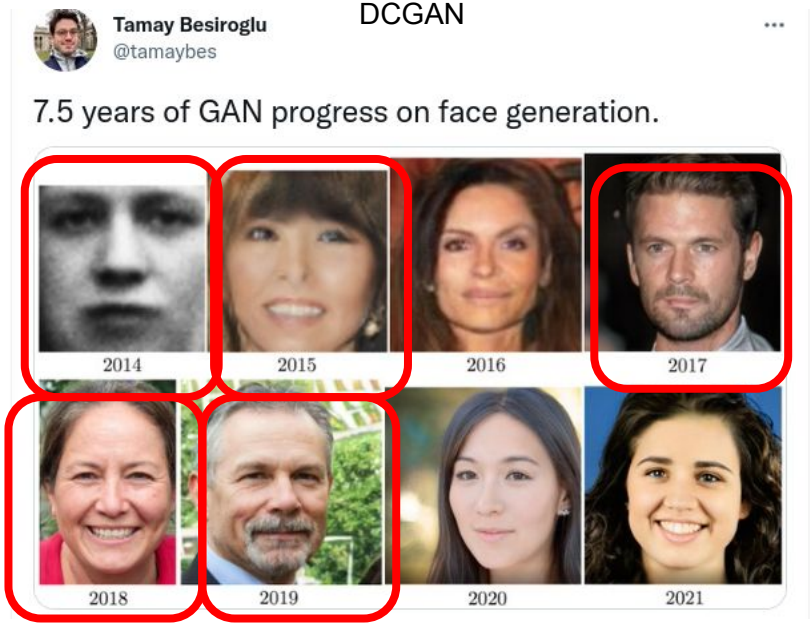
Note: Generative art is a much broader term so generative art != only deepfakes

GAN research exploded between 2014-2021 and continues..

GAN

DCGAN

ProgressiveGAN



StyleGAN

StyleGAN2

Enters CLIP by OpenAI: Adds language

In the beginning of **2021**, OpenAI (a for-profit R&D lab) released CLIP

Goal: Learn visual concepts from language

Dataset Trained on: Text paired with images found across the internet

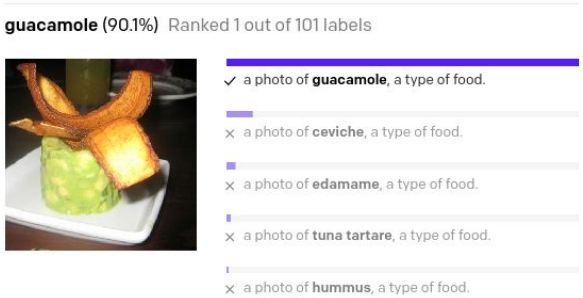


Fig. CLIP used for object detection

Youtube link for how CLIP works: https://www.youtube.com/watch?v=T9XSU0pKX2E

GAN + CLIP

Language prompted generative art
Eg. VQGAN + CLIP
Demo Time

VQGAN + CLIP Paper:
https://arxiv.org/abs/2204.08583

VQ-GAN + CLIP Demo!

Code from Katherine Crowsen:

https://colab.research.google.com/github/justinjohn0306/VQGAN-CLIP/blob/main/VQGAN%2BCLIP(Updated).ipynb

Credits: Katherine Crowson

Technical

Issues in GAN

What if one of the two blocks (generator vs discriminator) get too good at the job

Condition 1: Discriminator - too good

- Knows good and fake too successfully
- Generator doesn’t get good feedback

Condition 2: Generator gets too good:

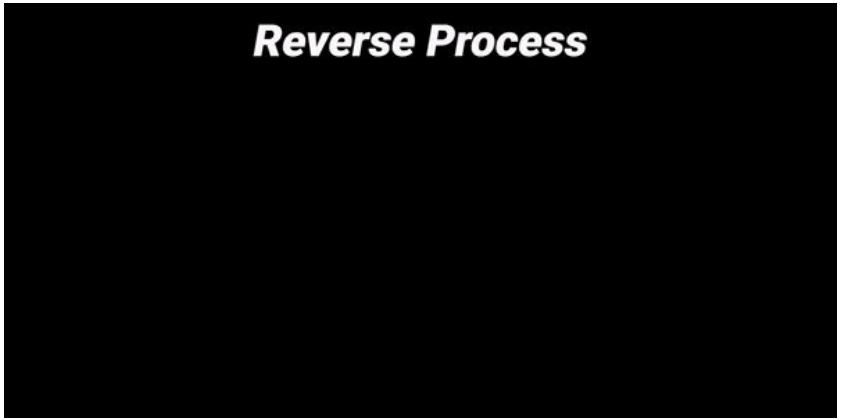
- Finds small number of images that can be discriminated
- Try to produce that one image or some variation of it.

Result: Game becomes one sided: you don’t know when to stop training.

Technical

The Latest: Diffusion Model

- Generative models
- Generate data similar to the data on which they are trained.
  - Forward Pass: Destroy training data by adding noise
  - Reverse Pass: Learn to recover the data by reversing this noising process.



Source: https://www.youtube.com/watch?v=HoKDTa5jHvg

Dall-E 2 (Open AI)

2022

What was new: Uses both CLIP and Diffusion

- **Code Available:** No
- **Use it:** Yes but limited - Open AI account

Dall-E 2: A bowl of soup that is portal to another dimension as digital art

Imagen (Google)

2022

What was new: Similar to DALLE2 but diffusion model was slightly different

- **Code Available:** No
- **Use it:** No

Imagen: Three spheres made of glass falling into ocean. Water is splashing. Sun is setting.

Lastly: Stability AI: Democratizing Diffusion Model

- Solution to closed source nature of many such research.
- Funded an open source project to replicate stable diffusion model and made it open source
- **Code Available:** Yes
- **Use it:** Yes

Website: https://stability.ai/

Let’s Play with Stabilty.ai Dreamstudio

https://beta.dreamstudio.ai/dream

How Can You Be A Part Of It?

- Play with the models yourself:
  - DALLE 2: available to use
  - Dreamstudio: available to use
  - Stability AI diffusion model on Hugging face: available to use
- Be part of the community building them:
  - Discord; LAION
  - Discord:
- Use existing repository and make API for people to use

References:

- History of generative Art: : Generative art, a comprehensive composition - Dane Wesolko
- Philips Exhibition on Generative Art: Ex-Machina: A History of Generative Art: London Auction July 2022
- Trinket.io for python Art: Modern Art Finished
- Processing.org: Processing
- GAN based deepfake: https://www.thispersondoesnotexist.com/
- Youtube link for how CLIP works: https://www.youtube.com/watch?v=T9XSU0pKX2E
- VQGAN + CLIP paper: [2204.08583] VQGAN-CLIP: Open Domain Image Generation and Editing with Natural Language Guidance
- VQGAN + CLIP Demo: Generate images from text phrases with VQGAN and CLIP (z + quantize method with augmentations).
- Diffusion Model Tutorial: Diffusion Models | Paper Explanation | Math Explained
- Diffusion Model beat GAN: https://arxiv.org/pdf/2105.05233.pdf
- Dalle 2: DALL·E 2
- Dall-E 2 Paper: https://arxiv.org/pdf/2204.06125.pdf
- Dall-E 2 Blog: How DALL·E 2 Works
- Imagen: Imagen
- Stabilty.ai Website: Stability.Ai
- Stability.ai Github: GitHub - CompVis/stable-diffusion: A latent text-to-image diffusion model