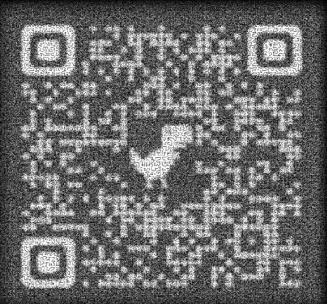
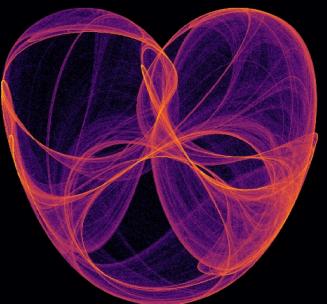
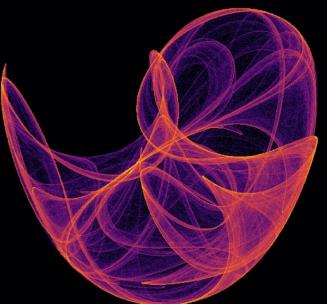
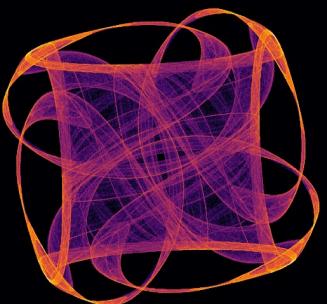
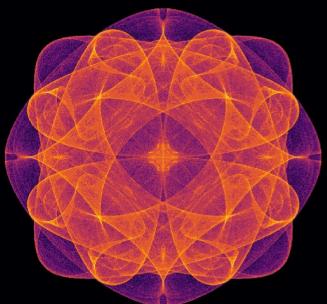


Introduction to **Generative Art and Scientific Visualization**

January 9 – 13, 2023
Hybrid: MD 221 and via Zoom

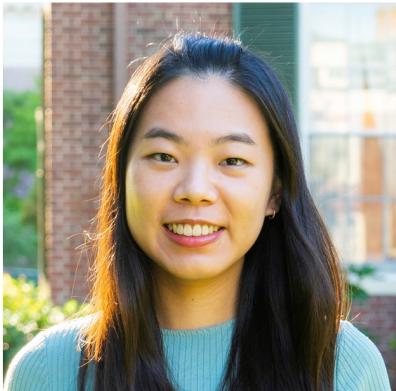


Mini-course instructors



Yue Sun

Applied Mathematics (G3)



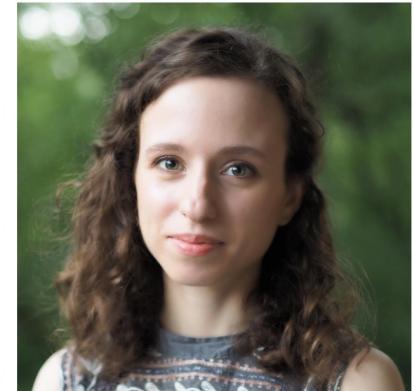
Jiayin Lu

Applied Mathematics (G5)



Jovana Andrejevic

Applied Physics (PhD '22)



Nina Andrejevic

Materials Science and
Engineering (PhD '22, MIT)

Class schedule

	Monday 1/9	Tuesday 1/10	Wednesday 1/11	Thursday 1/12	Friday 1/13
	<i>Traditional methods</i>	<i>Voronoi diagram and more</i>	<i>Physical systems</i>	<i>Tools for visualization</i>	<i>More tools and neural networks</i>
10:00 10:10	Introduction	Recap	Recap	Recap	Recap
10:10 10:40	Geometric fractals (Part 1)	Voronoi art (Part 1)	Elementary cellular automata	Interactive coding in Processing (Part 1)	3D printing (Part 1)
10:40 11:10	Geometric fractals (Part 2)	Voronoi art (Part 2)	Discrete physical systems	Interactive coding in Processing (Part 2)	3D printing (Part 2)
BREAK / IN-CLASS ACTIVITY					
11:20 11:50	Mathematical fractals	Voronoi art (Part 3)	Continuous physical systems	Python scripting in animation software	3D printing (Part 3)
11:50 12:20	Strange attractors	Space-filling curves	Reaction-diffusion systems	Data visualization in animation software	GAN art and DALL-E 2
12:20 12:30	Wrapup	Wrapup	Wrapup	Wrapup	Conclusion

More on logistics

- Course website (GitHub repo): <https://github.com/yue-sun/generative-art/tree/main>
- The class will be taught using Python (mostly):
 - we will use Google Colab to run Jupyter notebooks in Python; no need to install Python!
 - in-class code examples/exercises will be provided in the repo; solutions will be posted after each class.
- No assignment; but you're welcome to contribute to the course gallery/shared drive!
- What will you gain from the course?
 - be familiar with examples of generative art and their mathematical/physical formulation;
 - learn to code functions and recursive algorithms to procedurally generate/animate art;
 - use Python libraries and animation/modeling software to visualize 2D/3D scientific data;

HAVE FUN GENERATING ART!

Mini-course gallery

Google Photos

Search your photos

Photos

Explore

Sharing

Print store

LIBRARY

Favorites

Albums

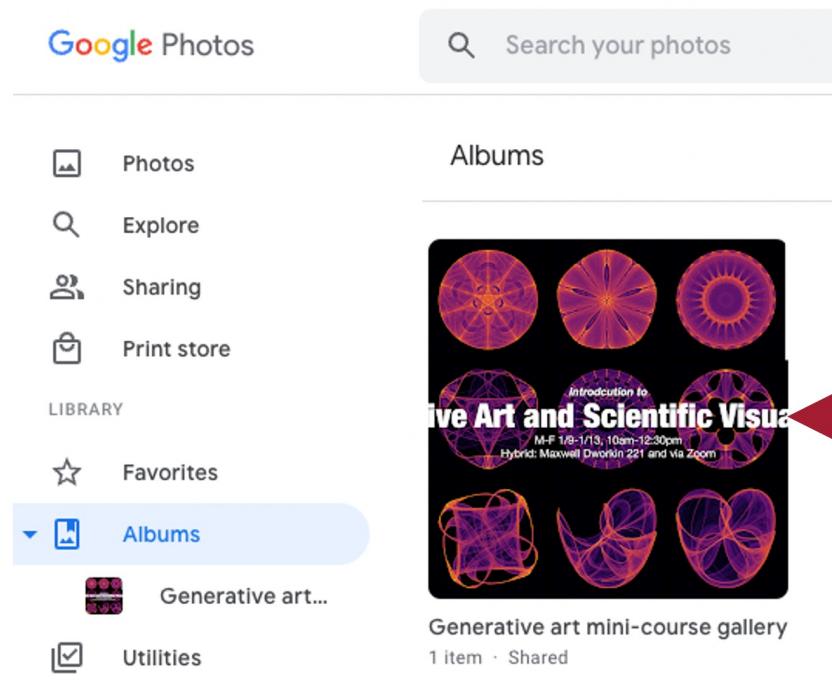
Generative art...

Utilities

Albums

Generative art mini-course gallery

1 item · Shared



X Info upload your work with some descriptions!

Add a description

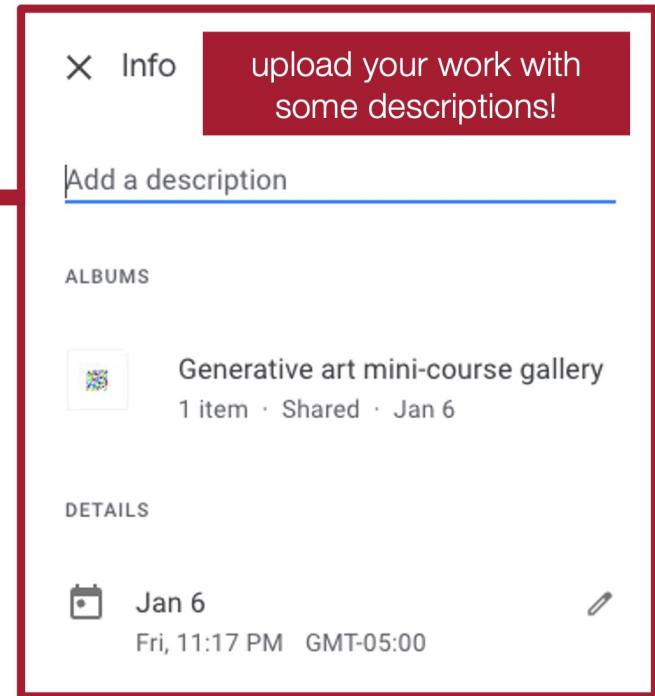
ALBUMS

Generative art mini-course gallery
1 item · Shared · Jan 6

DETAILS

Jan 6

Fri, 11:17 PM GMT-05:00

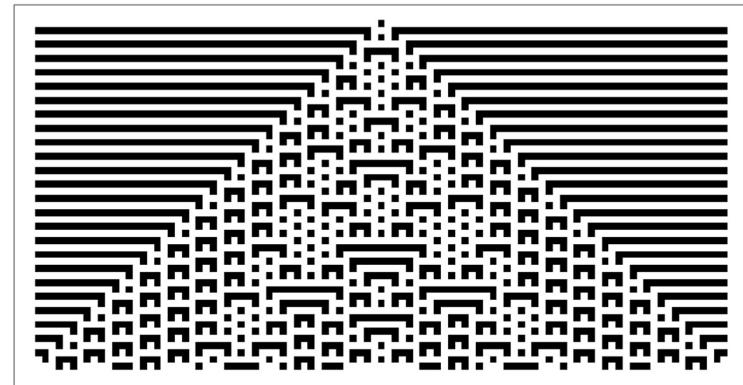


What is generative art?

- Generative art is art or design generated through an autonomous process.
- An autonomous process algorithmically generates new works based on preset rules:
 - it can create new shapes, colors, patterns, and even sounds;
 - by simply setting the creation process rules, we can enable computers to follow the rules to create art;
 - these rules can be based on mathematics, physics, biology, or machine learning!



cellular automata rule 30



cellular automata rule 73

Examples in nature...



fractals

Romanesco broccoli
showing self-similar form¹



more fractals

frost crystals on cold glass
forming fractal patterns²



cellular automata

Conus textile exhibiting the
rule 30 pattern on its shell³



reaction–diffusion systems

giant pufferfish skin resembling
the Gray–Scott model⁴

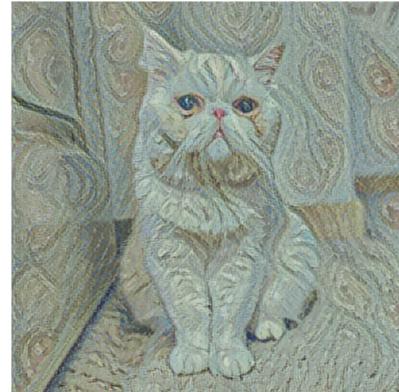
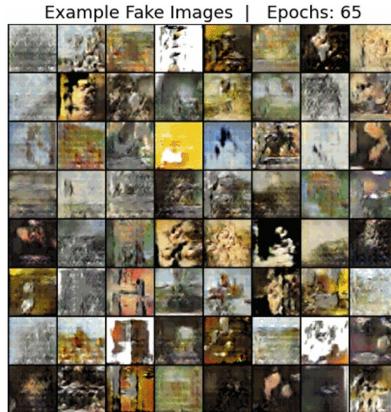
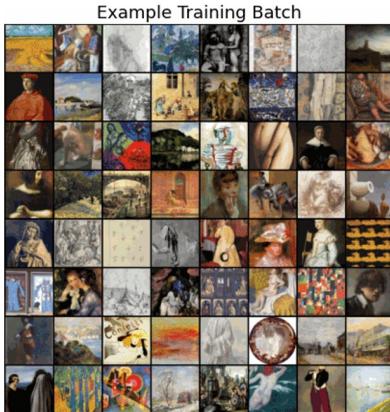
¹ Wikipedia: "Fractal (Romanesco broccoli)", [https://en.wikipedia.org/wiki/Fractal#/media/File:Romanesco_broccoli_\(Brassica_oleracea\).jpg](https://en.wikipedia.org/wiki/Fractal#/media/File:Romanesco_broccoli_(Brassica_oleracea).jpg)

² Wikipedia: "Fractal (frost patterns)", https://en.wikipedia.org/wiki/Fractal#/media/File:Frost_patterns_2.jpg

³ Wikipedia: "Cellular automata (applications in biology)", https://en.wikipedia.org/wiki/Cellular_automaton#/media/File:Textile_cone.JPG

⁴ Wikipedia: "Patterns in nature (pattern formation)", https://en.wikipedia.org/wiki/Patterns_in_nature#/media/File:Giant_Pufferfish_skin_pattern_detail.jpg

...in machine learning...



generative adversarial networks¹ (GANs)

generate fake artwork that
emulates famous real paintings

neural style transfer²

cat photo in the style of van
Gogh's self-portrait (1889)

diffusion model³

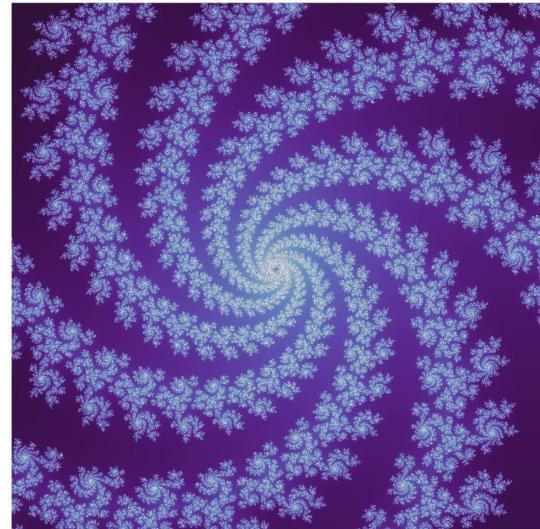
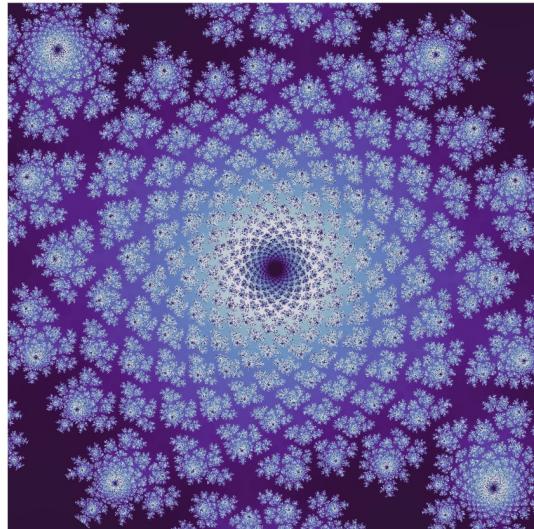
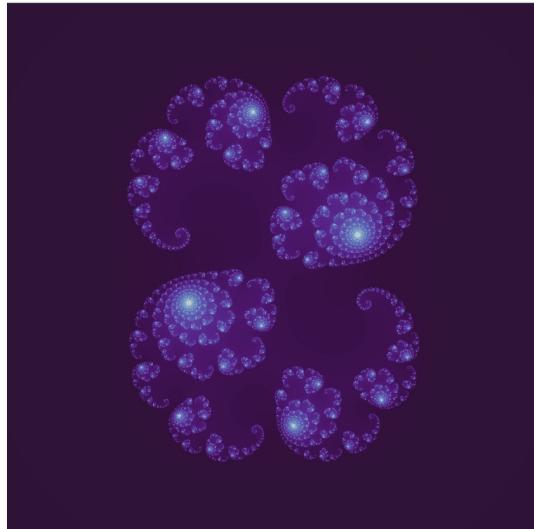
"an impressionist painting of
Harvard Yard" by DALL·E 2

¹ Generating Art using GANs: <https://blog.jovian.ai/generating-art-with-gans-352ceef3d51f>

² TensorFlow Core: Neural style transfer, https://www.tensorflow.org/tutorials/generative/style_transfer

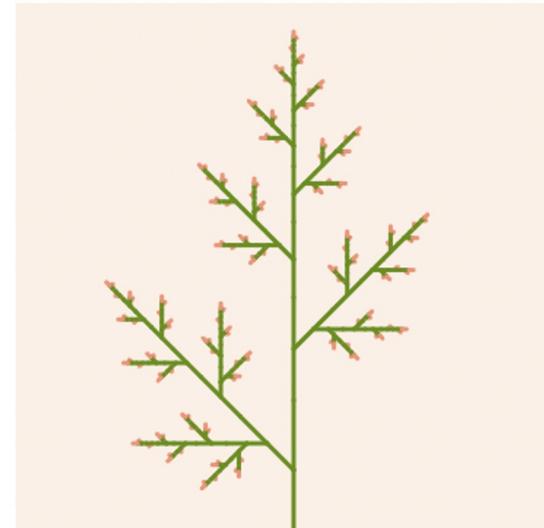
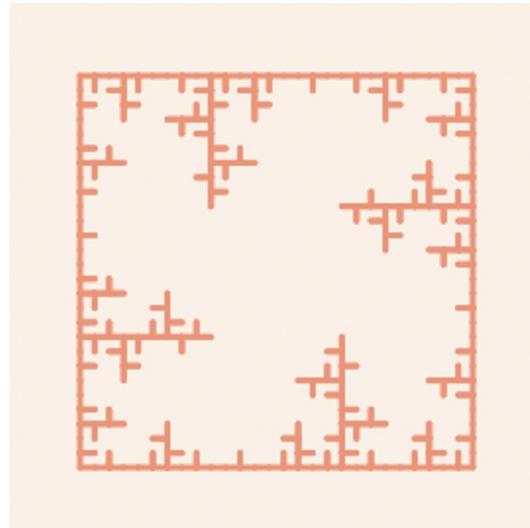
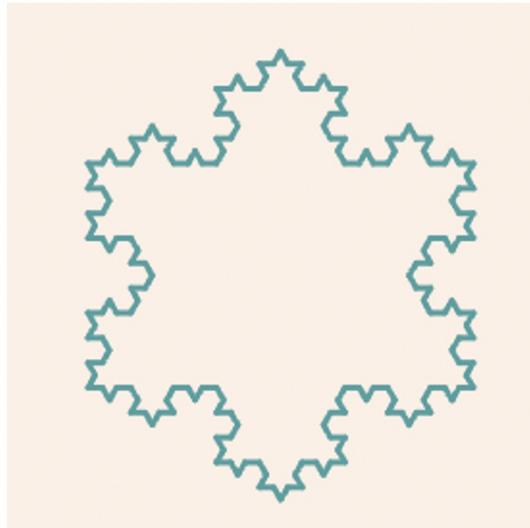
³ OpenAI: DALL·E 2, <https://openai.com/dall-e-2/>

...and in this class!



mathematical fractals
(Day 1)

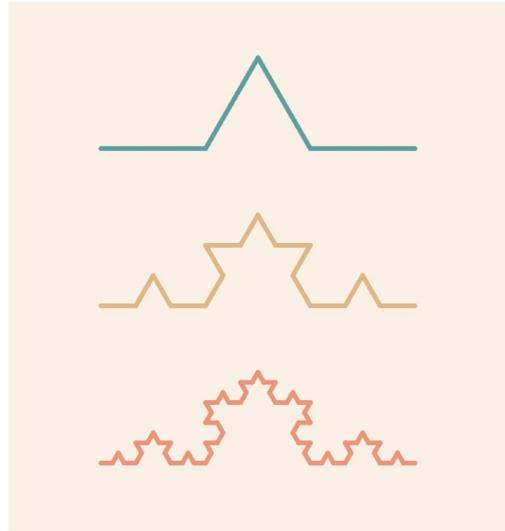
...and in this class!



geometric fractals
(Day 1)



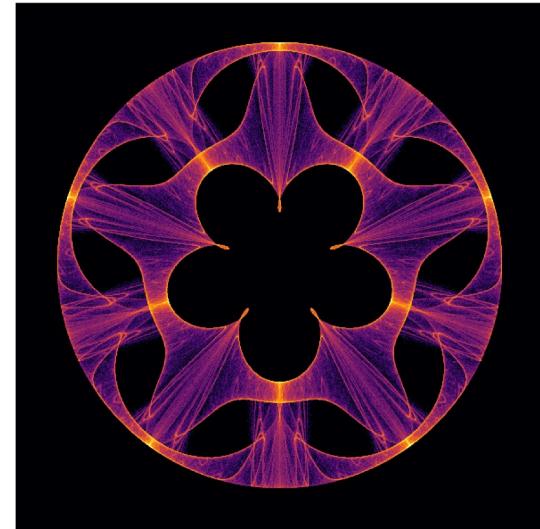
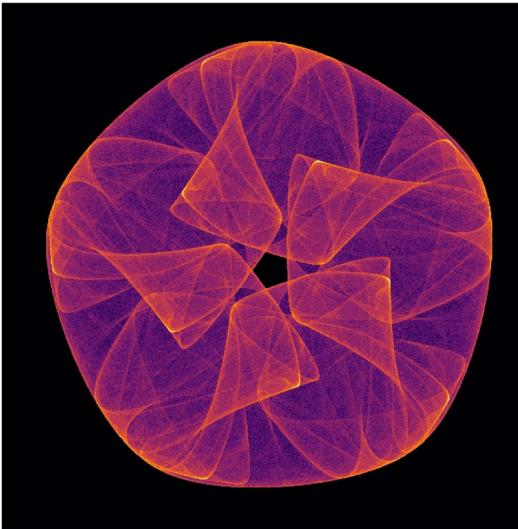
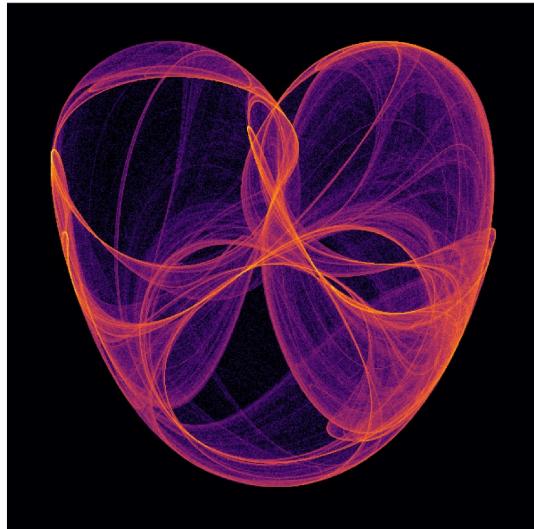
...and in this class!



A musical score for three voices. The top voice is in treble clef, the middle voice in treble clef, and the bottom voice in bass clef. The score consists of two staves per system, with the first system starting at measure 1 and the second system starting at measure 3. The music features eighth-note patterns and quarter notes.

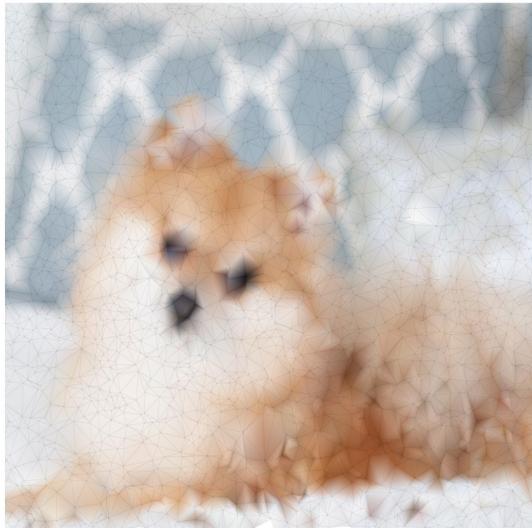
fractal symphony
(Day 1)

...and in this class!



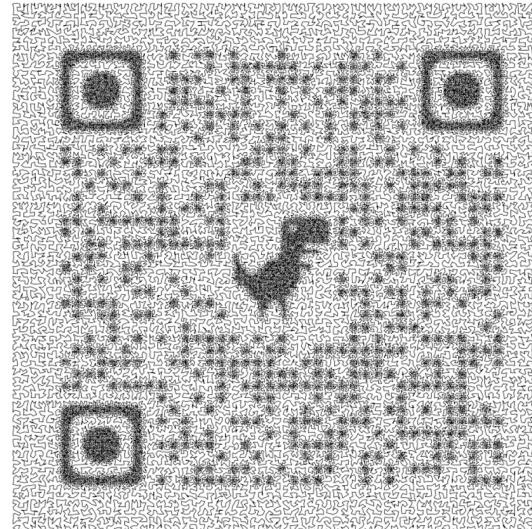
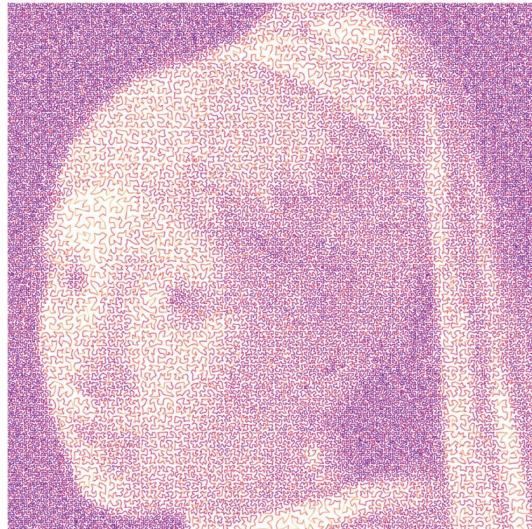
strange attractors
(Day 1)

...and in this class!



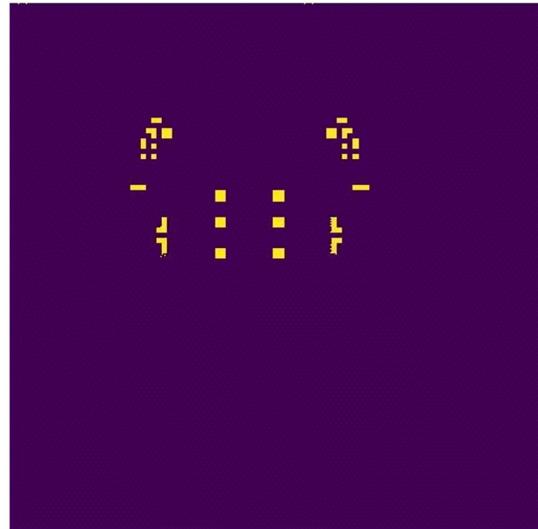
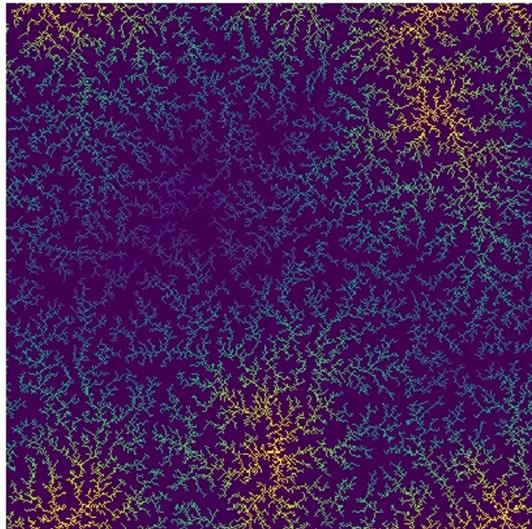
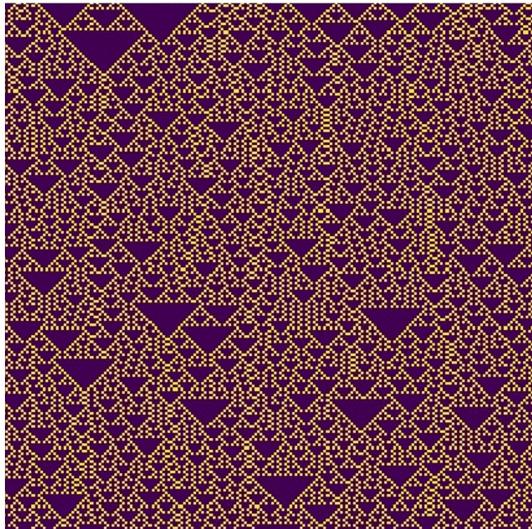
Voronoi art
(Day 2)

...and in this class!



space-filling curves
(Day 2)

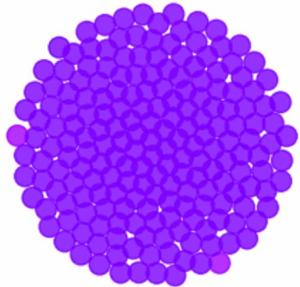
...and in this class!



cellular automata

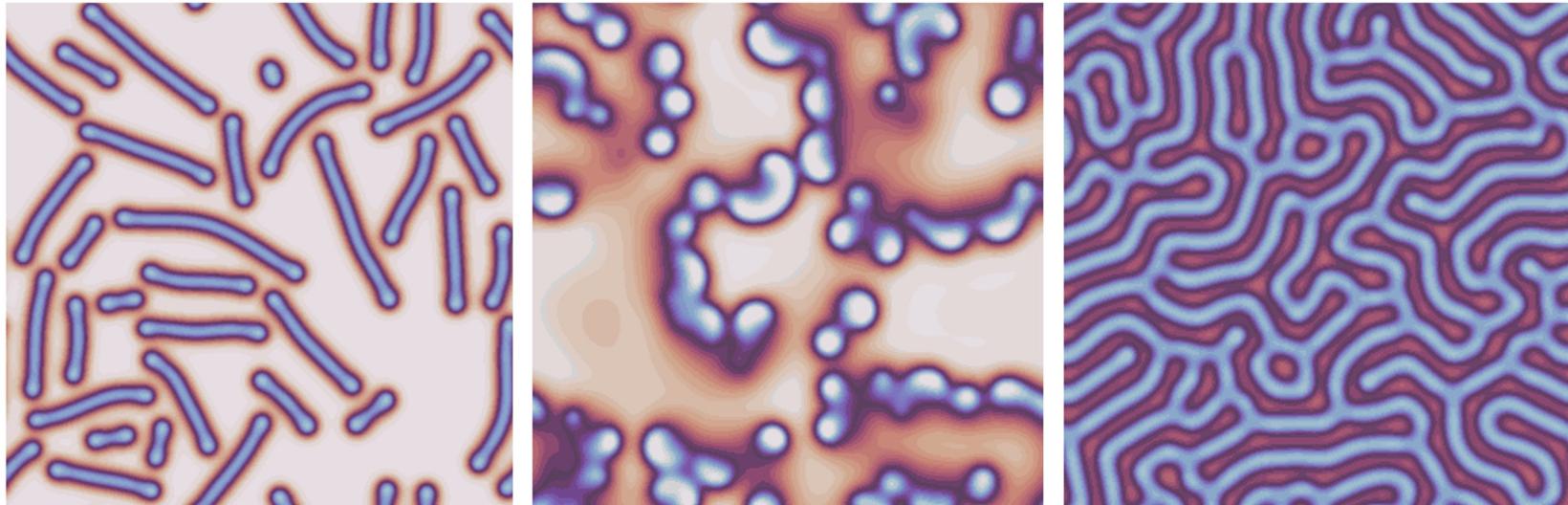
(Day 3)

...and in this class!



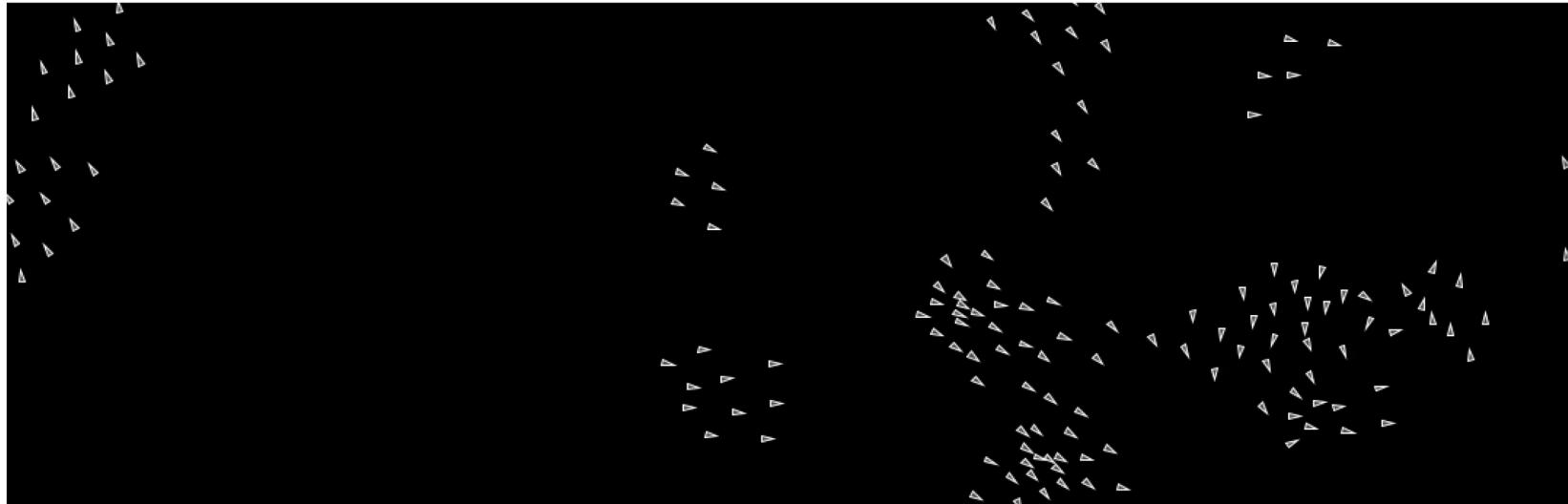
continuous physical systems
(Day 3)

...and in this class!



reaction–diffusion systems
(Day 3)

...and in this class!



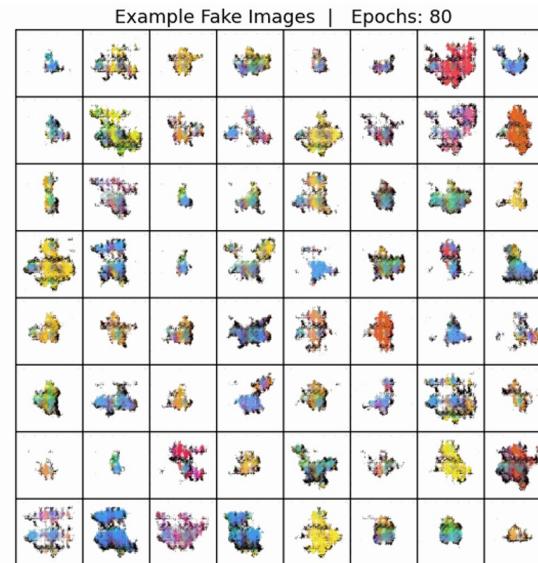
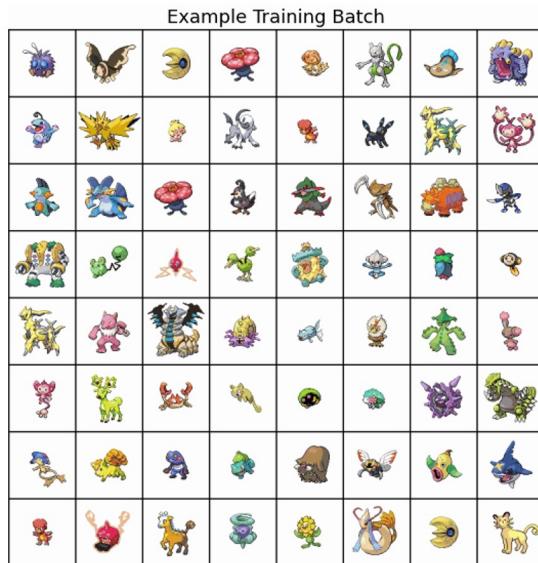
Boids flocking simulation¹²

(Day 4)

¹ Boids (background and update) by Craig Reynolds: <https://www.red3d.com/cwr/boids/>

² Example code of flocking in Processing: <https://processing.org/examples/flocking.html>

...and in this class!



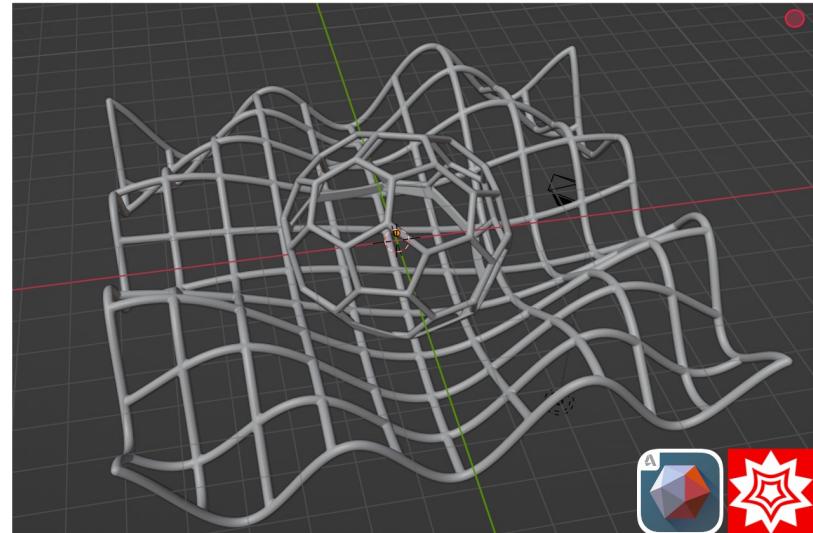
new Pokémon with GANs¹
(Day 5)

¹ Monster GANs: create monsters for your game: <https://medium.com/@yvanscher/using-gans-to-create-monsters-for-your-game-c1a3ece2f0a0>

Tools for visualization



rendering with animation software
(Day 4)



3D printing
(Day 5)

Access course materials

- Course website (GitHub repo): <https://github.com/yue-sun/generative-art/tree/main>

The image consists of three vertically stacked screenshots. The top screenshot shows a GitHub repository page for 'yue-sun/generative-art'. A white box highlights the '01_monday' folder, and a red arrow points from it to the middle screenshot. The middle screenshot is a preview of the '01_geometric_fractals.ipynb' notebook. It features four fractal images: Sierpinski triangle, Sierpinski carpet, Koch snowflake, and Vicsek snowflake. A red box contains the text 'click to open an interactive notebook'. The bottom screenshot shows the Jupyter Notebook interface with the same four fractal images. A red arrow points from the 'Copy to Drive' button at the bottom right to the bottom-most screenshot.

access code examples

Geometric Fractals

click to open an interactive notebook

Sierpinski triangle Sierpinski carpet Koch snowflake Vicsek snowflake

save your own copy!