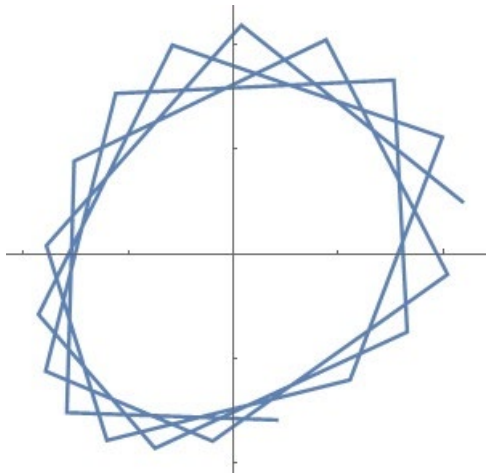
Cellular Automata (part 2): Creative Applications

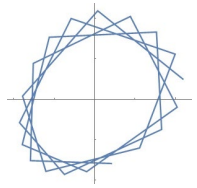
Notes for CAS, 18-5-2021

Loe Feijs



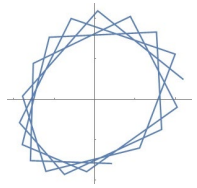
Cellular automata: research and applications

- Fundamentals of computation
  - ✓ Von Neumann, Conway, Wolfram
- Models of social behavior
  - ✓ Modeling language shifts
  - ✓ Land use change
  - ✓ Building evacuation
- Aesthetics and awareness in design
  - ✓ Lukas, Troy, Loe -> next time



Models of social behavior

- ✓ Beltran, F. S., Herrando, S., Estreder, V., Ferreres, D., Adell, M. A., & Ruiz-Soler, M. (2011). Social simulation based on cellular automata: Modeling language shifts. In Cellular Automata—Simplicity Behind Complexity (p. 323). InTech.
- ✓ Lu, Y., Laffan, S., Pettit, C., & Cao, M. (2020). Land use change simulation and analysis using a vector cellular automata (CA) model: A case study of Ipswich City, Queensland, Australia. Environment and Planning B: Urban Analytics and City Science, 47(9), 1605-1621.
- ✓ Ding, N., Chen, T., & Zhang, H. (2017, June). Simulation of high-rise building evacuation considering fatigue factor based on cellular automata: A case study in China. In Building Simulation (Vol. 10, No. 3, pp. 407-418). Tsinghua University Press.



Paper: Beltran, F. S., Herrando, S., Estreder, V., Ferreres, D., Adell, M. A., & Ruiz-Soler, M. (2011). Social simulation based on cellular automata: Modeling language shifts. In Cellular Automata—Simplicity Behind Complexity (p. 323). InTech.

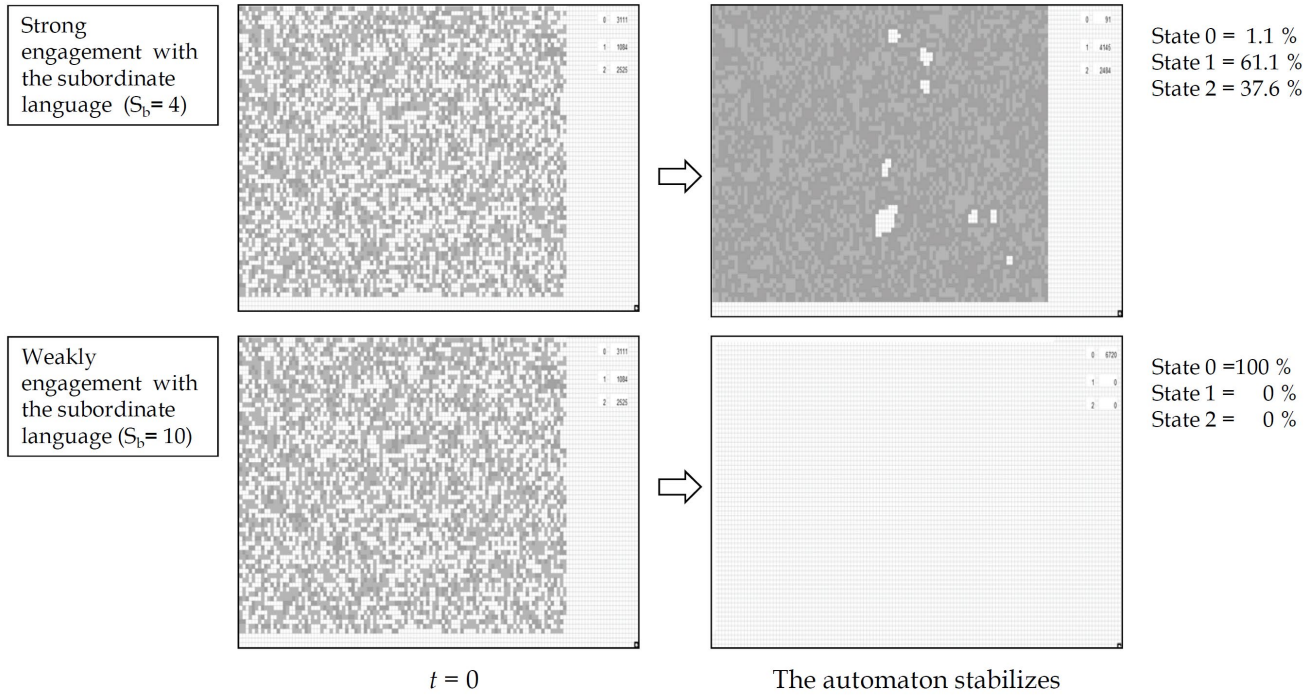


Fig. 4. An example of the dynamics of the cellular automaton that simulates language shifts.

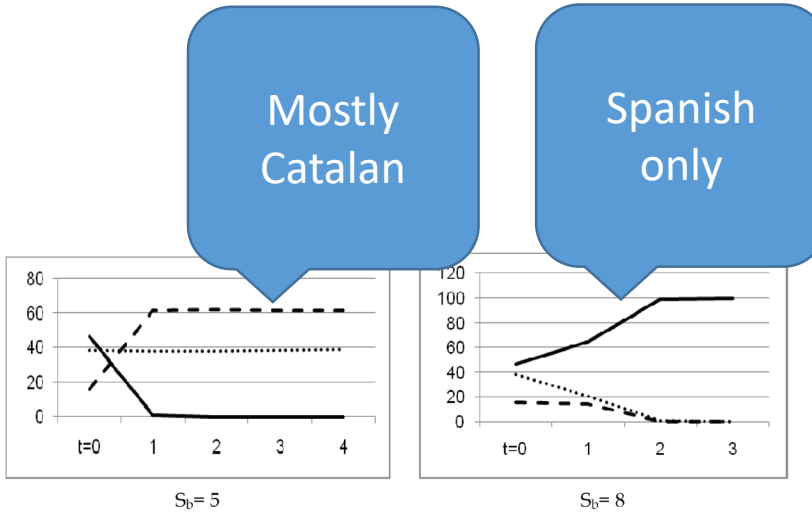
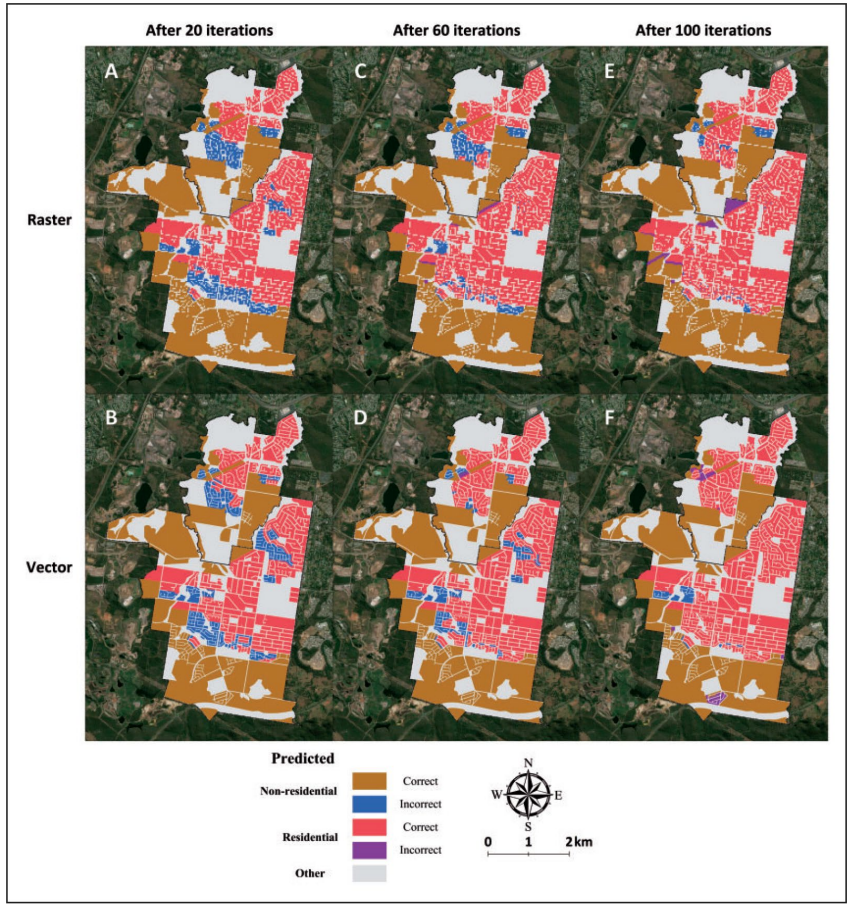
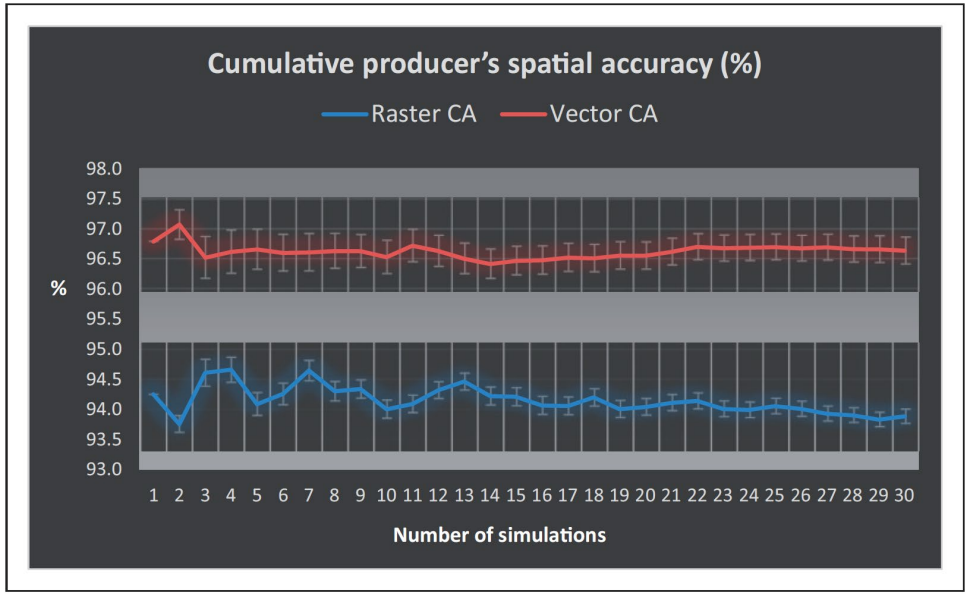


Fig. 6. Mean percentages of states 0 (solid), 1 (dashed) and 2 (dotted) for the values of threshold S_b when the automaton stabilized (values of S_b= 4 to 9) for the social context *home*. The x-axis indicates the generations of speakers. The percentage of initial values (*t=0*) is also shown. (Note that for the values S_b= 8 and S_b= 9, state 2 quickly reaches value 0).

Conclusions: the transition threshold S_b is critical. Catalan will survive.

Paper: Lu, Y., Laffan, S., Pettit, C., & Cao, M. (2020). Land use change simulation and analysis using a vector cellular automata (CA) model: A case study of Ipswich City, Queensland, Australia. Environment and Planning B: Urban Analytics and City Science, 47(9), 1605-1621.





Conclusions: vector CA is more accurate than grid CA

Paper: Ding, N., Chen, T., & Zhang, H. (2017, June). Simulation of high-rise building evacuation considering fatigue factor based on cellular automata: A case study in China. In Building Simulation (Vol. 10, No. 3, pp. 407-418). Tsinghua University Press.

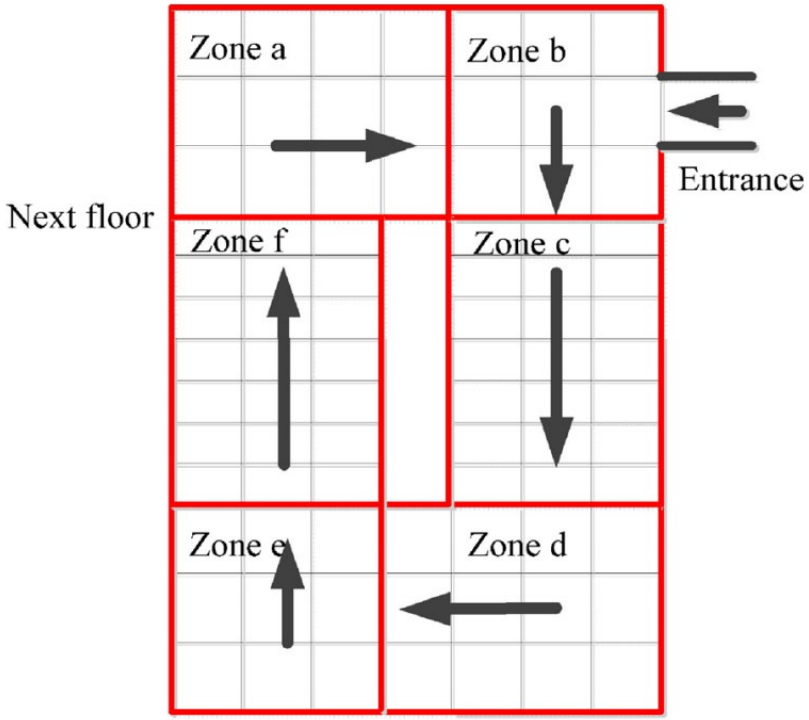
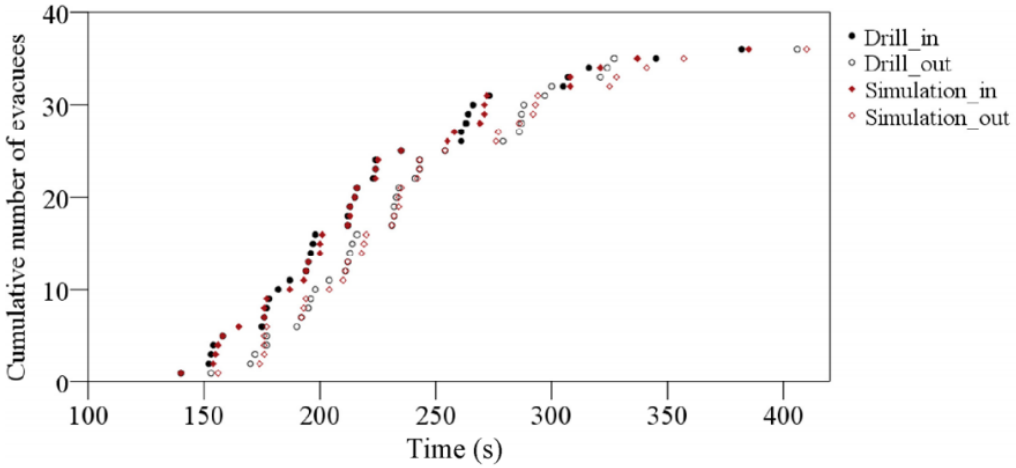


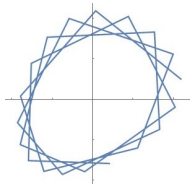
Fig. 1 Grid map and six zones



(a) Cumulative number of evacuees between floors 7 and 5

Fig. 12 Drill and simulation data between floors 7 and 5

Conclusions: the simulation matches real the data from drill, fatigue can be modelled

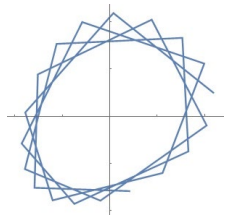


Models of social behavior: details from the papers

topic	tool	neighbourhood	grid	states	rule
Language shift (Catalan language)	Excel	3×3 Moore	105x64 torus	Level of engagement (DL only/ bi DL++/ bi SL++)	totalistic rule with thresholds
Land use change (Ipswich City, Australia)	Matlab → ArcObjects	5×5 Moore	≈25000 land cells	Residential/non-residential (+distances to roads and services)	trained neural net
Building evacuation (Beijing, China)	Matlab → SPSS	3×3 Moore	15 floors of 84 cells staircases	#persons, fatigue level	probabilistic get-out/avoid-others

What else can ID do with CA besides predictive models?

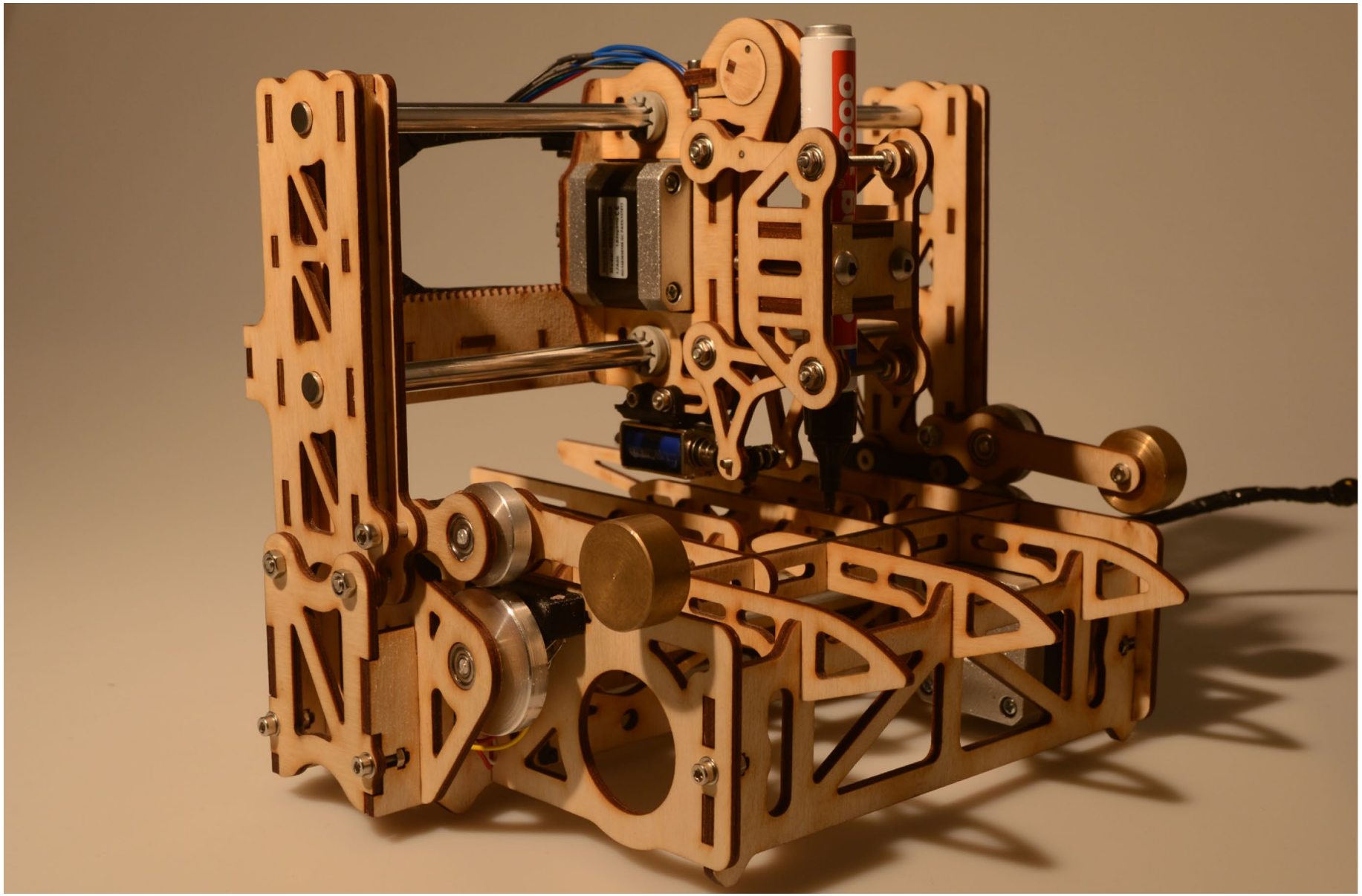
- Educate young people to see the beauty of generated patterns
  - ✓ Lucas Haude's CA plotting machine:
  - ✓ research.tue.nl/en/publications/creating-an-interaction-with-cellular-automata-for-science-and-te
- Visualise the complexities of the fashion system
  - ✓ Troy Nachtigall's aproach:
  - ✓ "The Life of Fashion Trends"
  - ✓ https://thelifeoffashiontrends.wordpress.com/howto/
- Support the complexity-science community via fashion
  - ✓ A cellular automaton for pied-de-poule:
  - ✓ Feijs, L., & Toeters, M. (2018). *International Journal of Design*, *12*(3), 127-144.

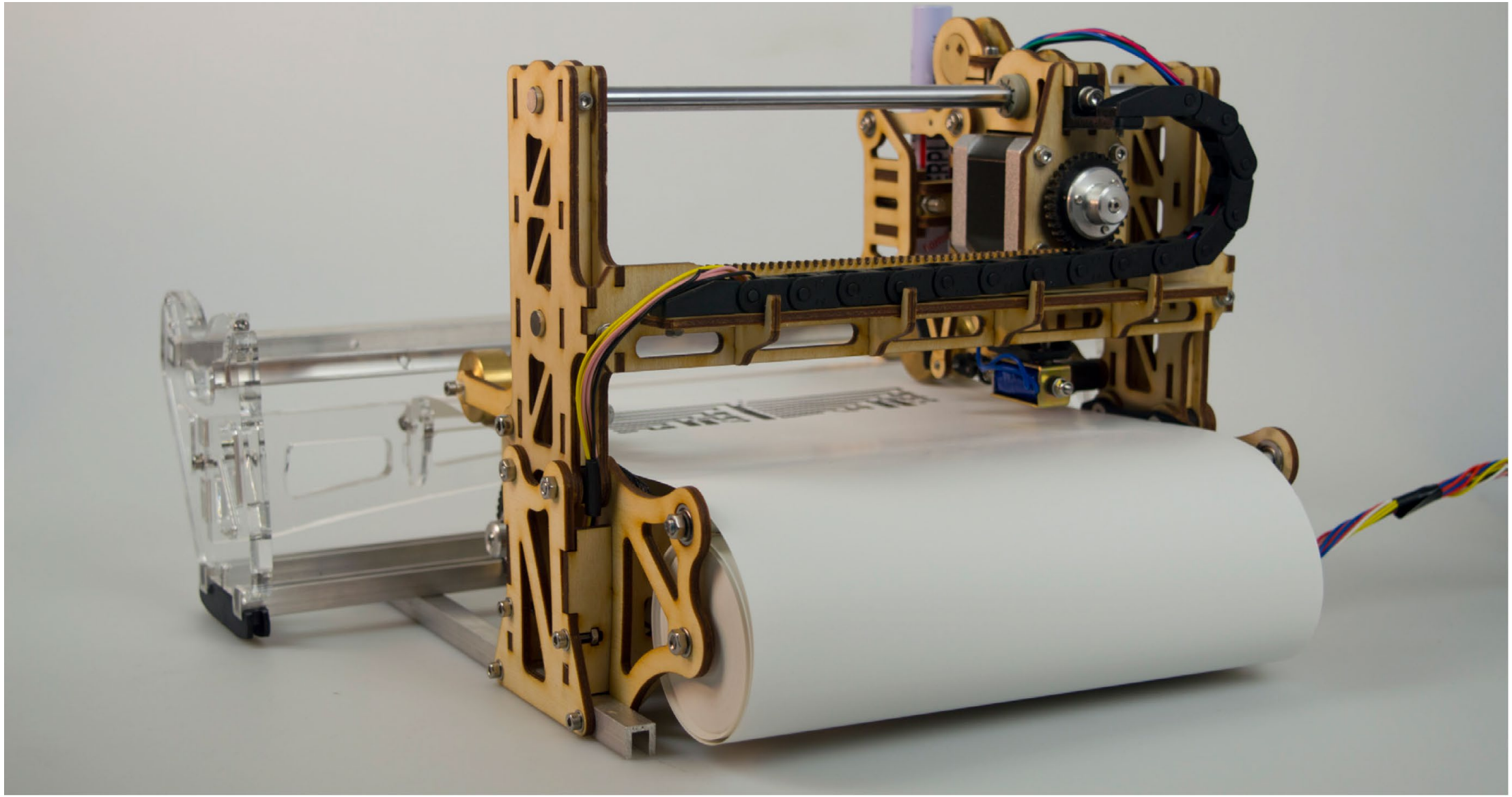


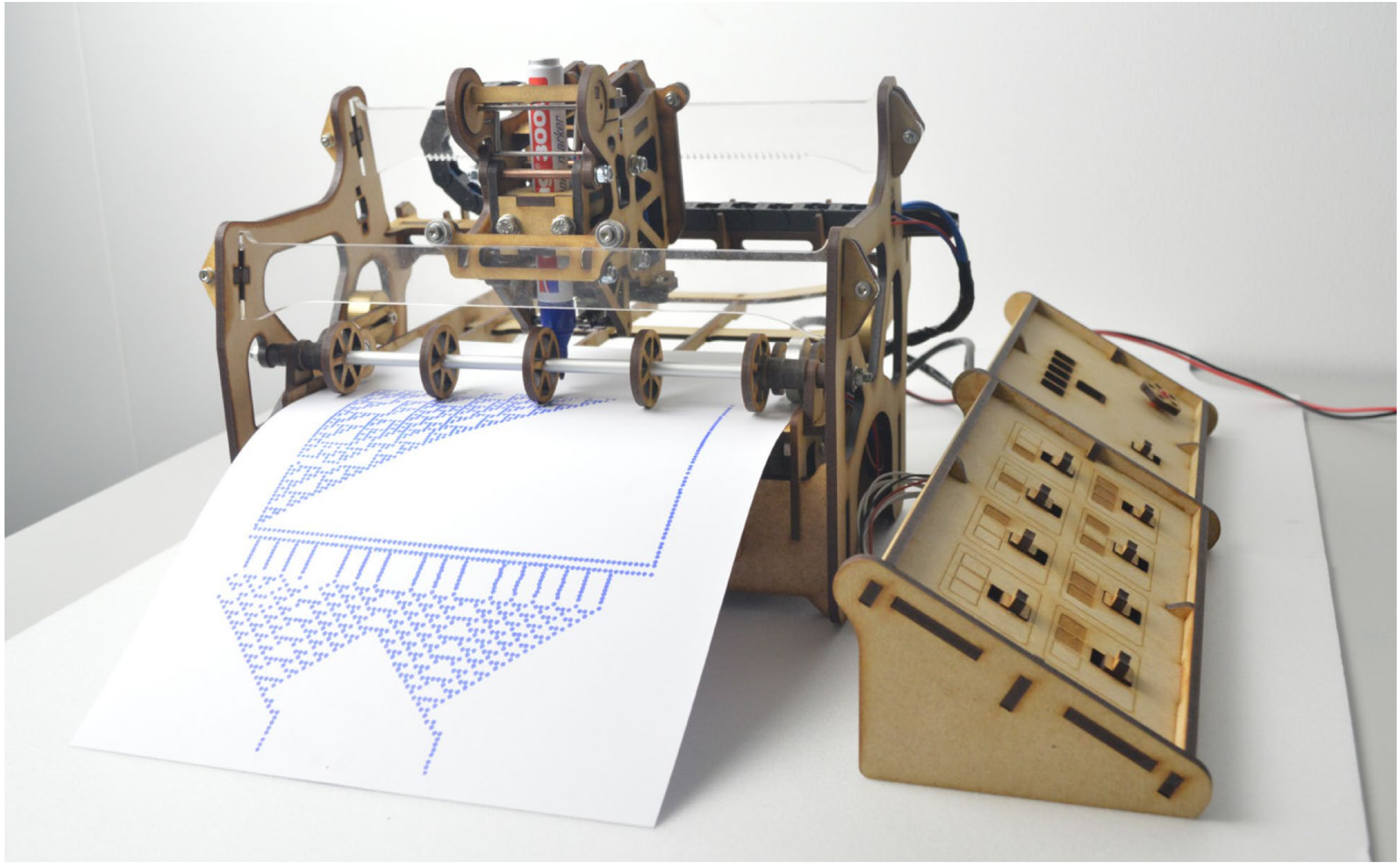
CASE STUDY 1

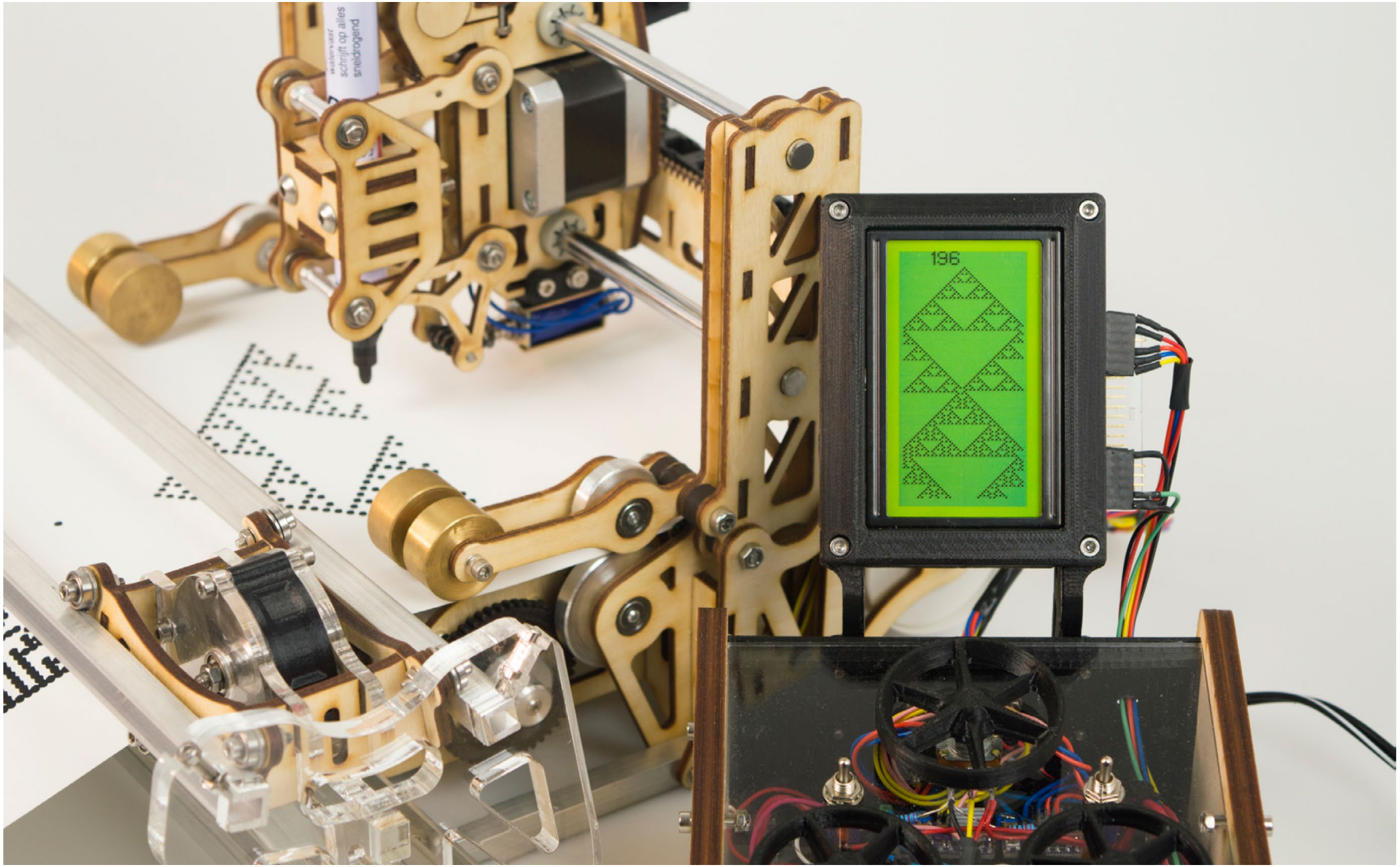
- Educate / stimulate young people to play with generating patterns

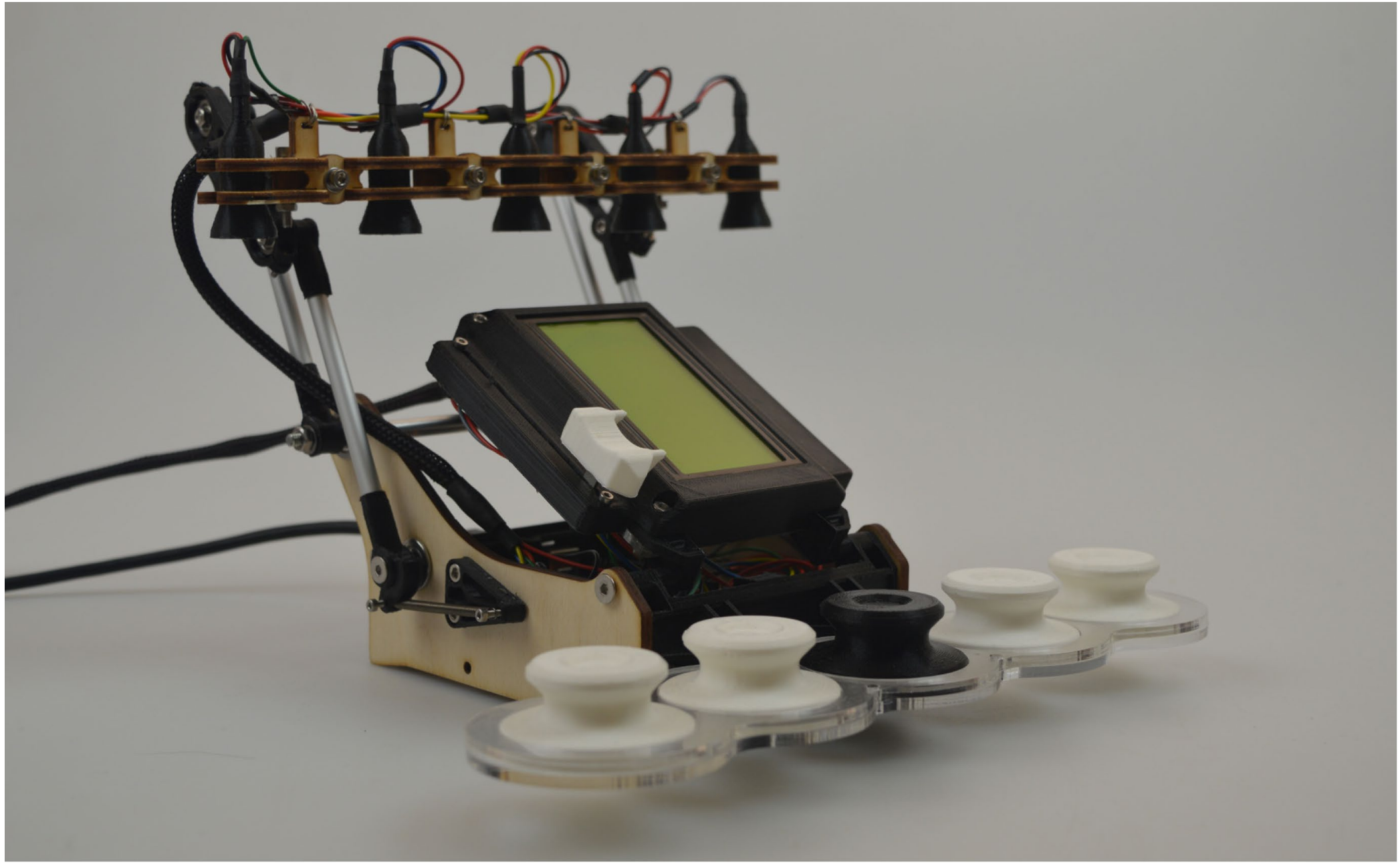
  - ✓ Lukas Haude's machine
  - ✓ Haude, L. (2018, January). Creating an interaction with cellular automata for science and technology museums. In *17th Conference on Applied Mathematics (APLIMAT 2018)* (pp. 420-433). Slovak University of Technology in Bratislava.
  - ✓ http://www.lhau.de/assets/m22_interaction_cellularautomata_01.pdf








schrijft op alles
sneldrogend
196



- ✓ Maker Fair Eindhoven September 2017
- ✓ Dutch Design Week 2017
- ✓ International Conference on Applied Mathematics Bratislava
- ✓ InScience International Science Film Festival Nijmegen
- ✓ De Ontdekfabriek Eindhoven

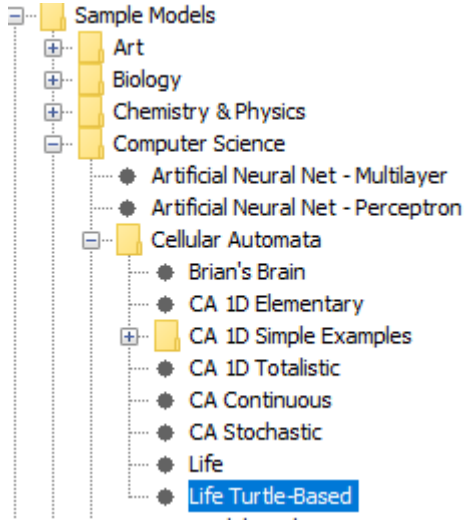
CASE STUDY 2

- Visualise the complexities of the fashion system

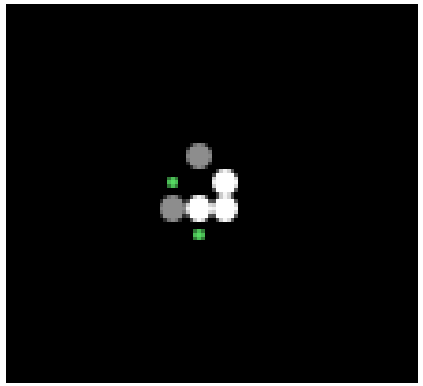
  - ✓ Troy Nachtigall's aproach:
  - ✓ The Life of Fashion Trends
  - ✓ https://thelifeoffashiontrends.wordpress.com/howto/

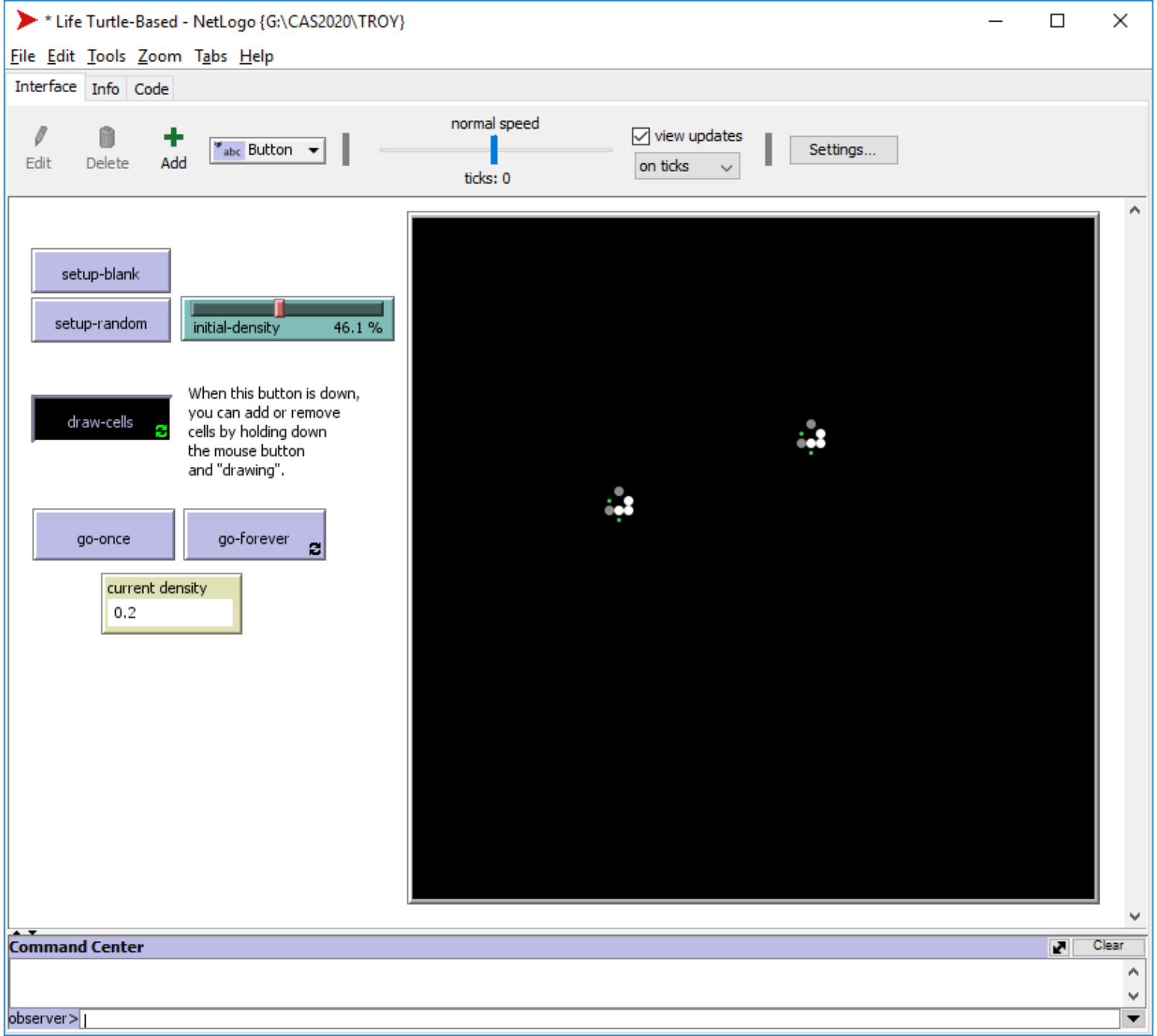
Step one :

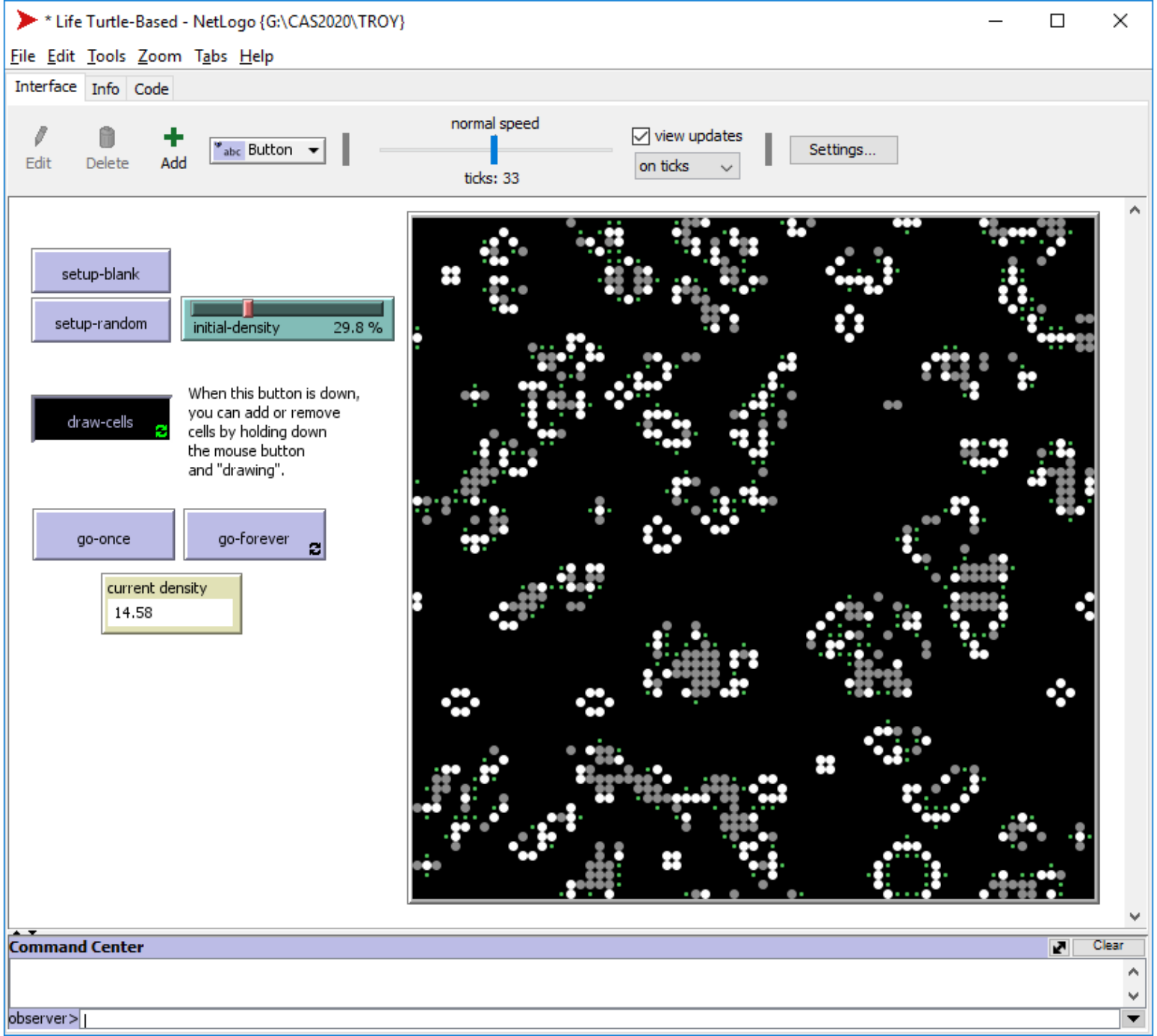
Uri Wilensky: Life Turtle-Based – Netlogo.nlogo



- Patches: in a grid, to model the cellular structure
  - One variable for each patch: `live-neighbors`
- Two breeds of Turtles:
  - `cells`
  - `babies`
  - The `sprout` procedure is used to create a baby in the present patch
  - Neither `cells` nor `babies` actually move
- During each go several things happen
  - The `babies` change breed to become a live cell
  - Gray `cells` die
  - The `cells` about to die become gray
  - Update the `live-neighbors` of each cell
  - And apply the famous rule of Conway's Game of Life




* Life Turtle-Based - NetLogo {G:\CAS2020\TROY}
File Edit Tools Zoom Tabs Help
Interface Info Code
Edit
Delete
Add
Button
normal speed
ticks: 0
view updates
on ticks
Settings...
setup-blank
setup-random
initial-density 46.1 %
draw-cells
When this button is down, you can add or remove cells by holding down the mouse button and "drawing".
go-once
go-forever
current density
0.2
Command Center
Clear
observer>


* Life Turtle-Based - NetLogo {G:\CAS2020\TROY}
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Settings...
setup-blank
setup-random
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draw-cells
When this button is down, you can add or remove cells by holding down the mouse button and "drawing".
go-once
go-forever
current density
14.58
Command Center
Clear
observer>

Step two :

Troy Nachtigall: The Life of Fashion Trends

- Patches: in a grid, to model the cellular structure
  - As before
- Three extra breeds of Turtles:
  - `oldcells`
  - `eternals`
  - `stucks`
- During each go several things happen
  - The `oldcells` stay visible for 52 steps
  - The `babies` get the `trendcolor`
  - The `eternals` inflate other's `live-neighbors`
  - The `stucks` decrease `live-neighbors`
  - In the user interface these are "hotspots" and "notspots"

troykyo / CAS

Code | Issues 0 | Pull requests 0 | Actions

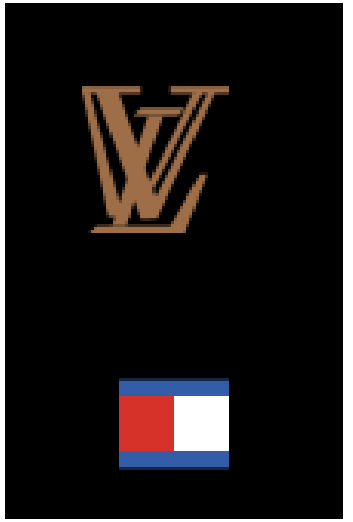
Branch: master ▾ CAS / Troy Life Turtle-Based 10.nlogo

troykyo Sourcecode for netlogo

1 contributor

857 lines (732 sloc) | 21.5 KB

```
1  breed [cells cell]    ;; living cells
2  breed [babies baby]   ;; show where a cell will be
3  breed [oldcells oldcell];;remain for a while
4  breed [eternals eternal];;some things are forever
5  breed [stucks stuck];;some things are forever
```



```
set-default-shape cells "dot"
set-default-shape babies "circle"
set-default-shape eternals "lw"
set-default-shap  stucks "th"
```

Louis Wie?

Tommy Hoezo?

* Troy Life Turtle-Based 10 - NetLogo {G:\CAS2020\TROY}

Start your own Trend

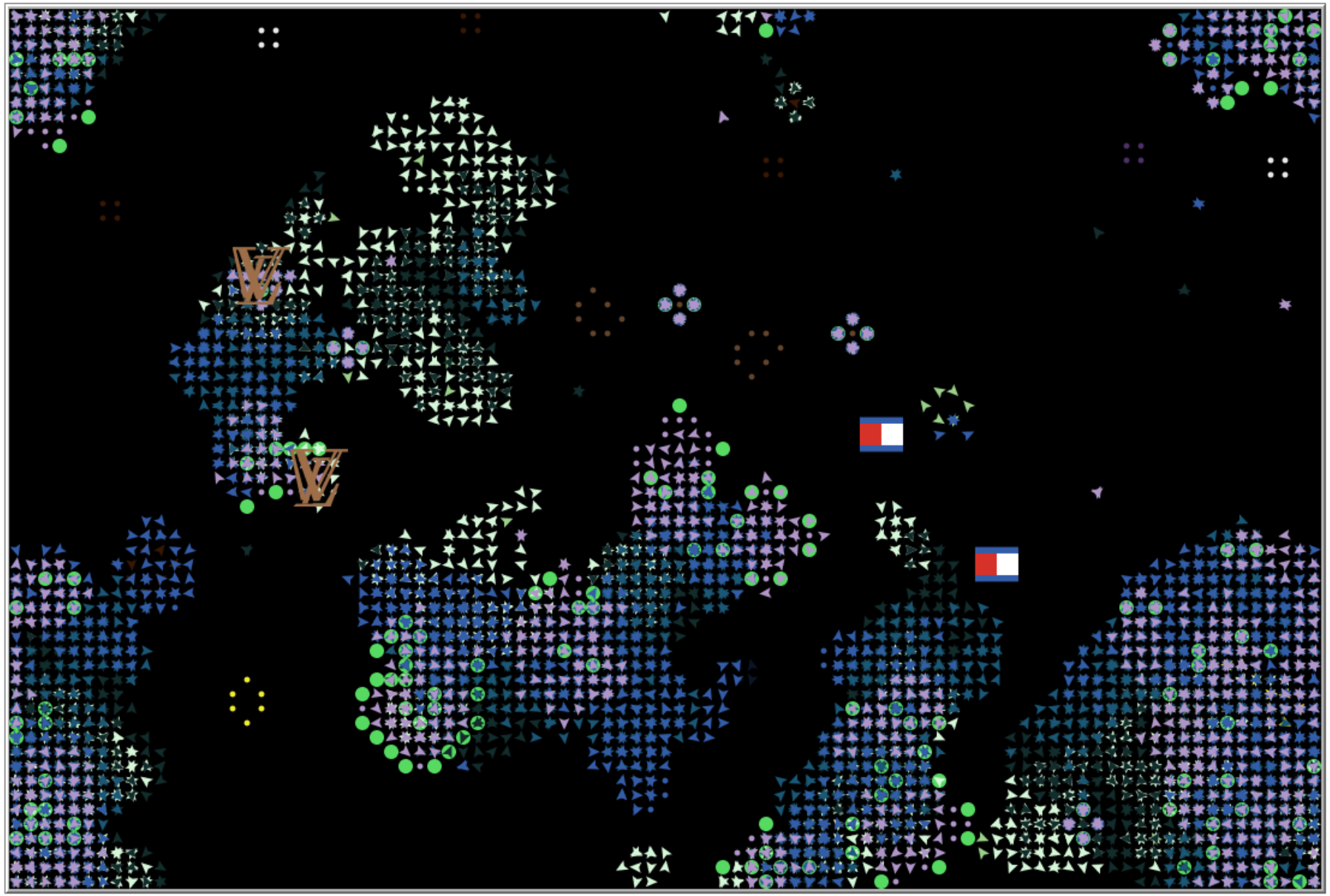
Press here to add your own Fashion Trend!

Add Hot Spots

These are people or places where fashion flourishes.

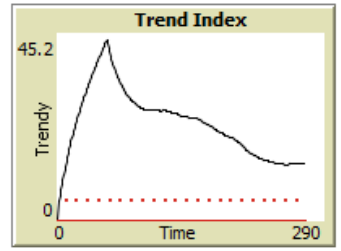
Add Not Spots

These are people and places where fashion goes to die.



How Trendy is the moment we live in?

42.15



"Trends come and go, but style is eternal." -Yves Saint Laurent

TrendColor

117 (violet + 2)

setup-random

initial-density 31.2 %

go-once

go-forever

https://thelifeoffashiontrends.wordpress.com/

Click me

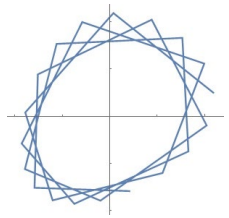
The Life of Fashion Trends

Speculating on how fashion trends happen using Complex Adaptive Systems

HOME · ABOUT FASHION · HOW IT WORKS · SIMULATION

- ✓ Style as an oscillator
- ✓ Style as a social phenomenon
- ✓ Fashion trend shuttles
- ✓ Symmetry – The Big Trend
- ✓ Inspiration

The Executive Board of the Amsterdam University of Applied Science (AUAS - Hogeschool van Amsterdam) has appointed Troy Nachtigall on 4 February 2020 as Professor of Fashion Research and Technology. The professorship is part of the Center for Applied Research (Create-IT) at the Faculty of Digital Media & Creative Industries (FDMCI) and is closely aligned with the Amsterdam Fashion Institute (AMFI). Nachtigall has a solid career in design and his research is often very innovative. Within the professorship, he will further strengthen the link between education and research.



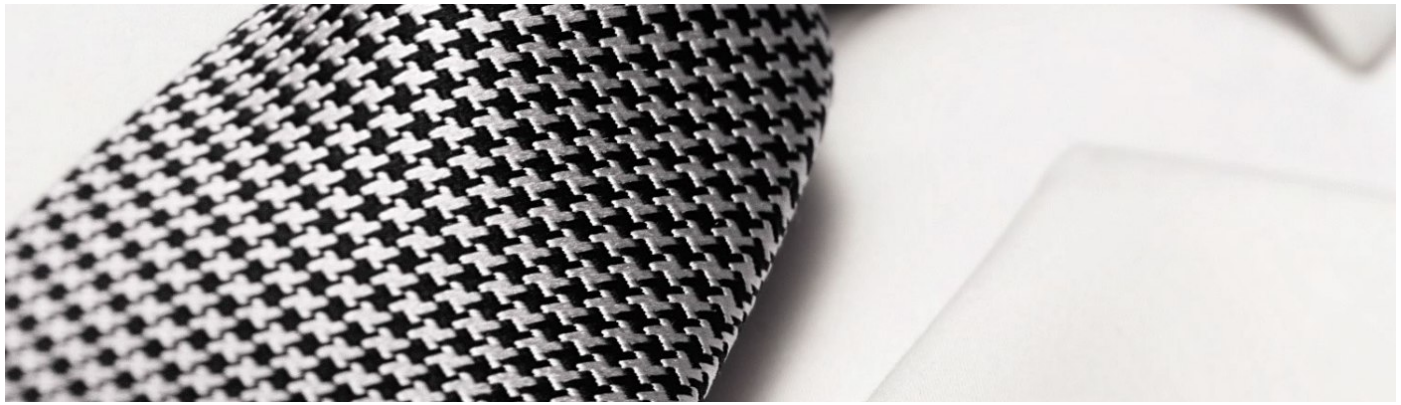
CASE STUDY 3

- Support the complexity-science community via fashion

  - ✓ A cellular automaton for pied-de-poule
  - ✓ Feijs, L., & Toeters, M. (2018). Cellular automata-based generative design of Pied-de-poule patterns using emergent behavior: Case study of how fashion pieces can help to understand modern complexity. *International Journal of Design*, *12*(3), 127-144.

Salvatore Ferragamo, Fall Winter 2017

Michael Kors,
pre-fall 2017



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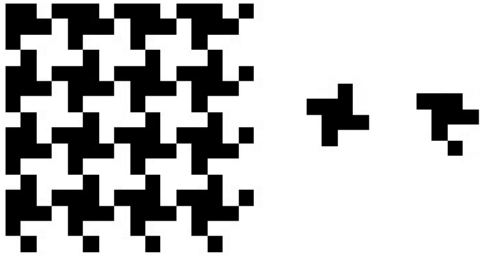
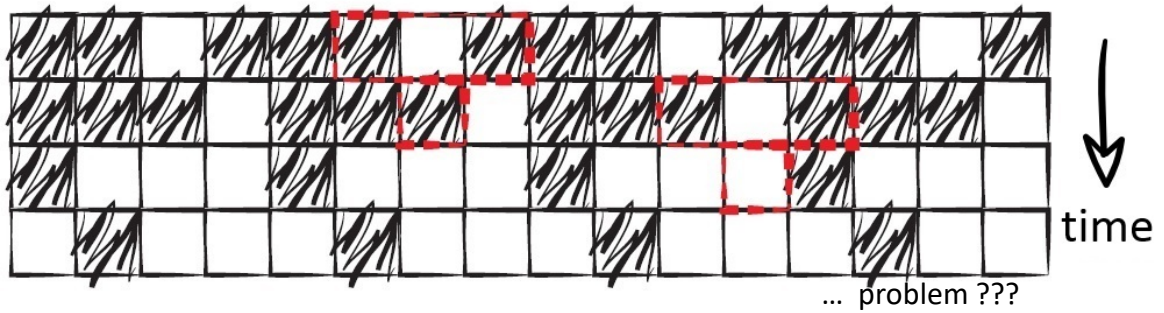
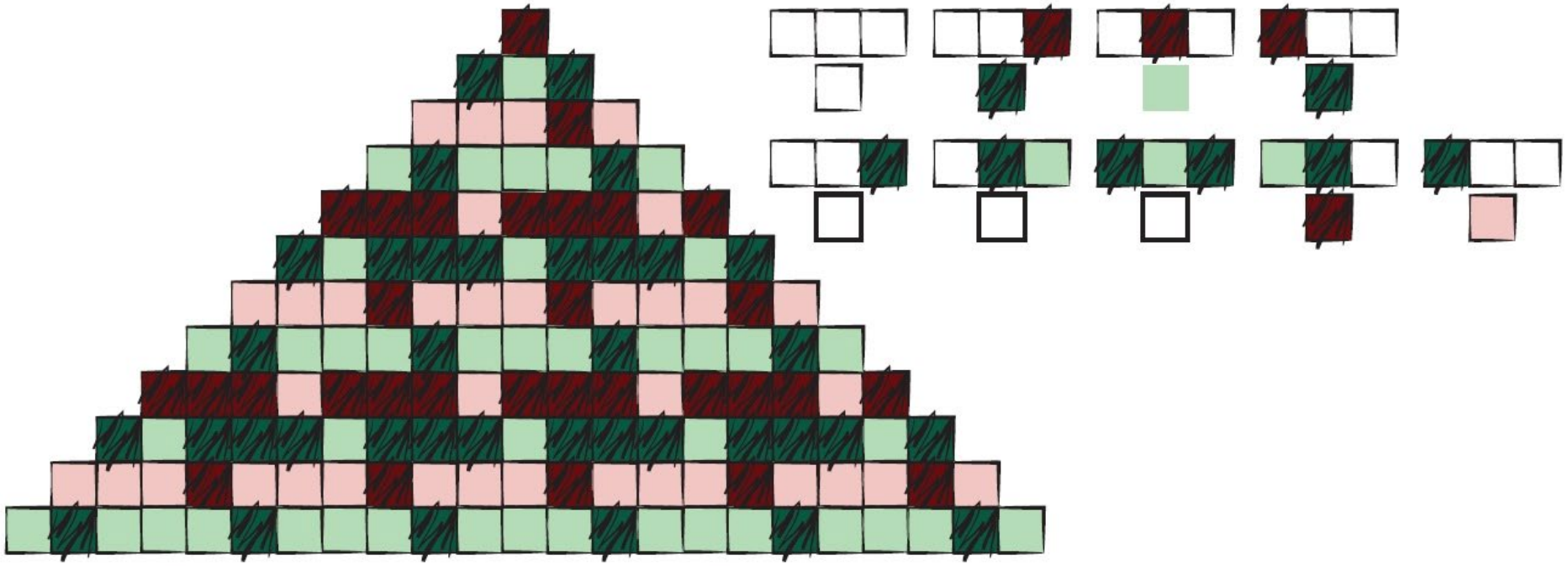


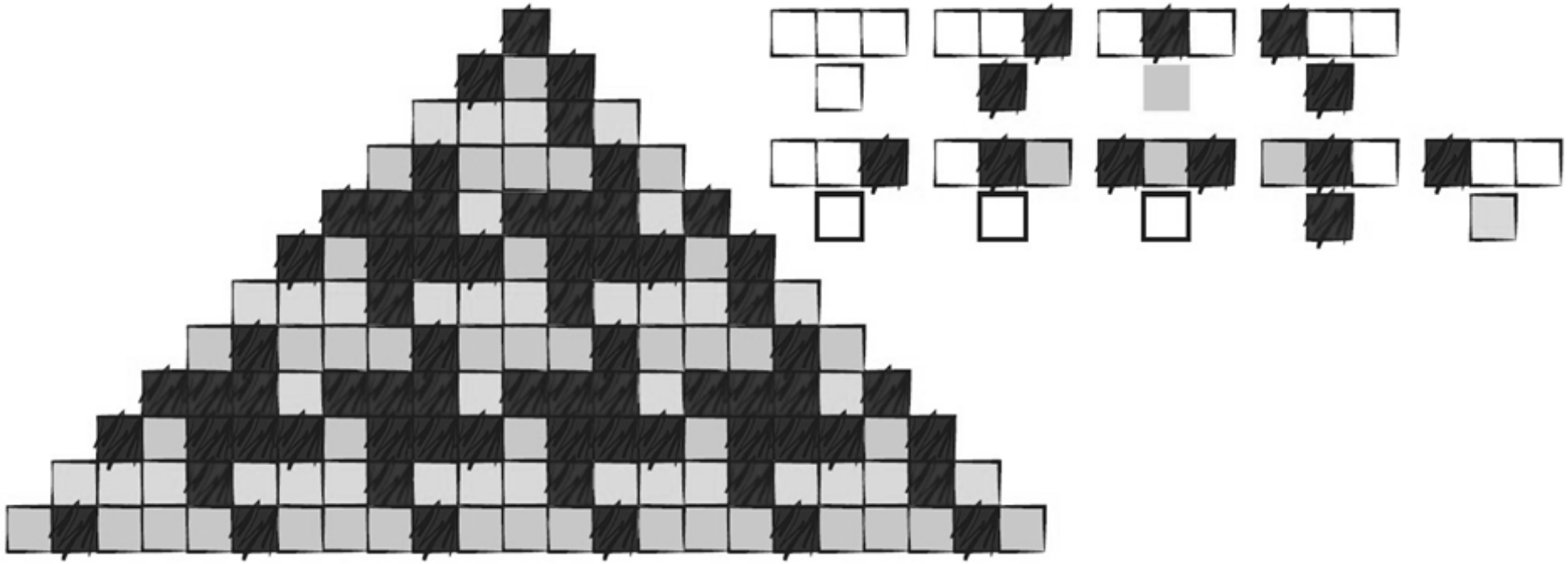


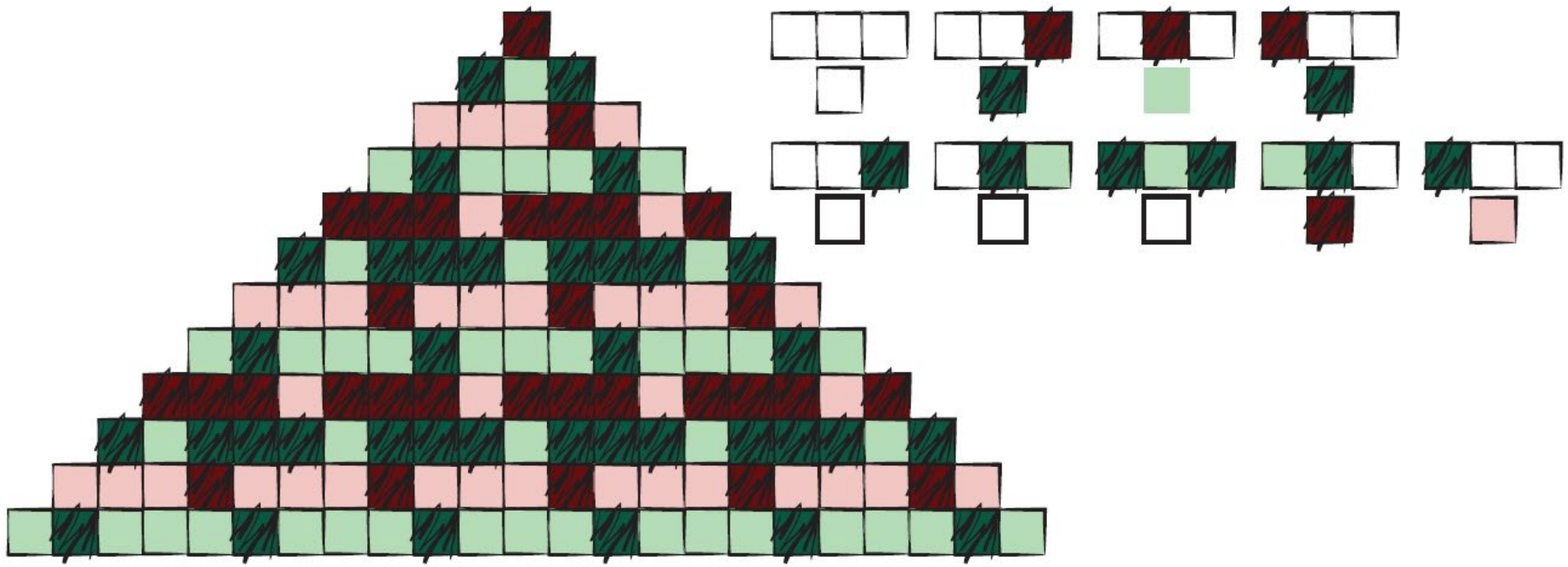
… problem ???

Joint work with

by-wire.net







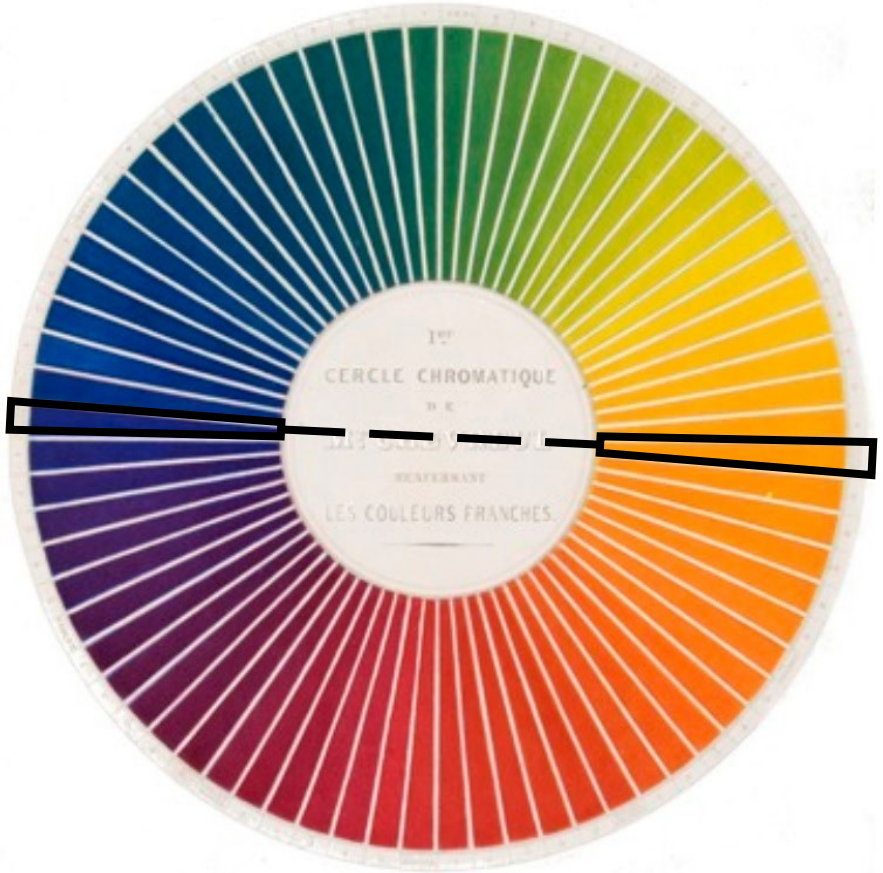
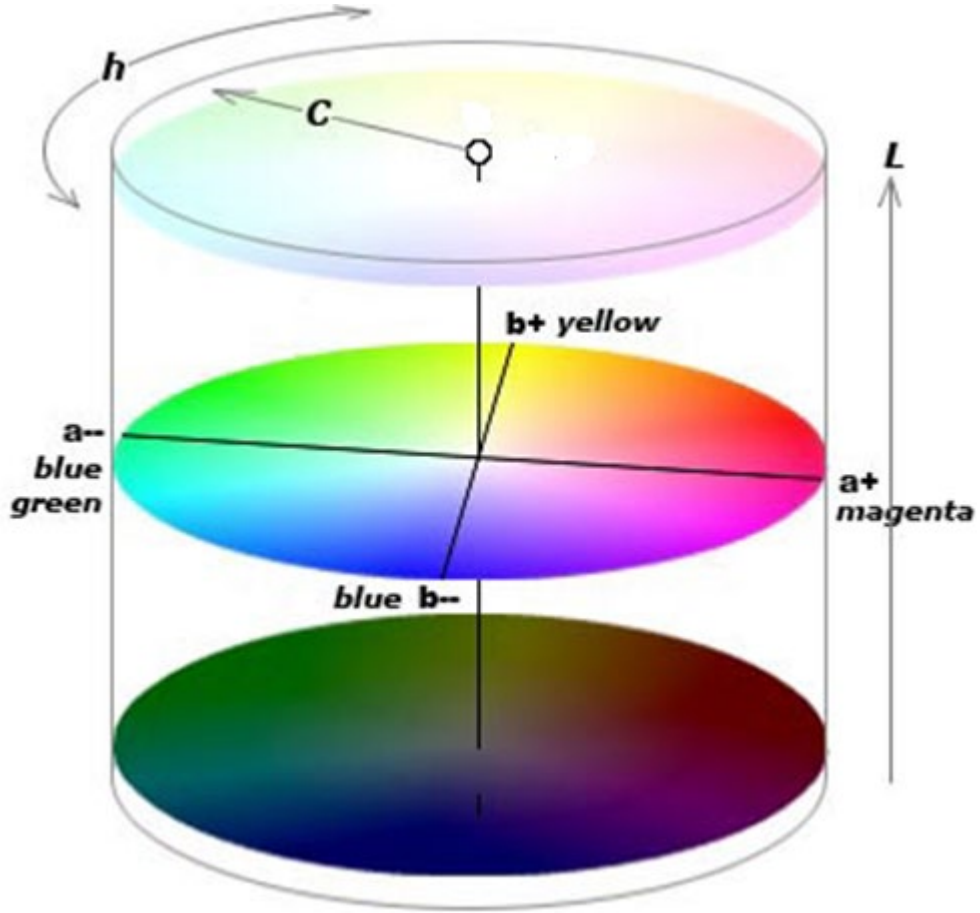


Plate 1: First chromatic circle containing pure hues, from *Cercles Chromatiques de M. E. Chevreul* (Paris: Didot, 1861)

Plate 1: First chromatic circle containing pure hues, from *Cercles Chromatiques de M. E. Chevreul* (Paris: Didot, 1861)

Source: https://www.handprint.com/HP/WCL/IMG/CIELAB1976.jpg



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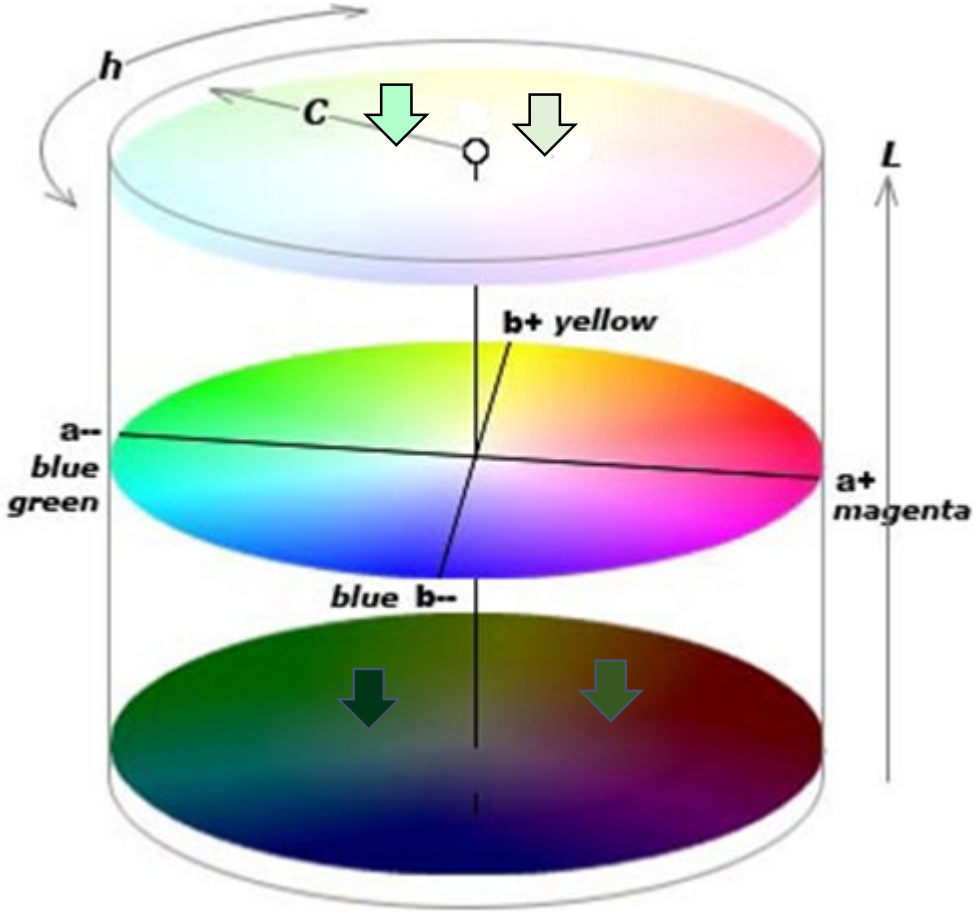

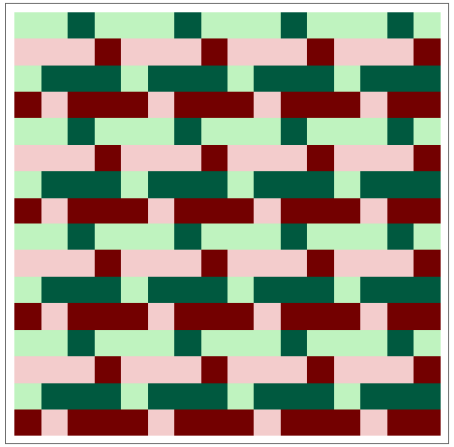

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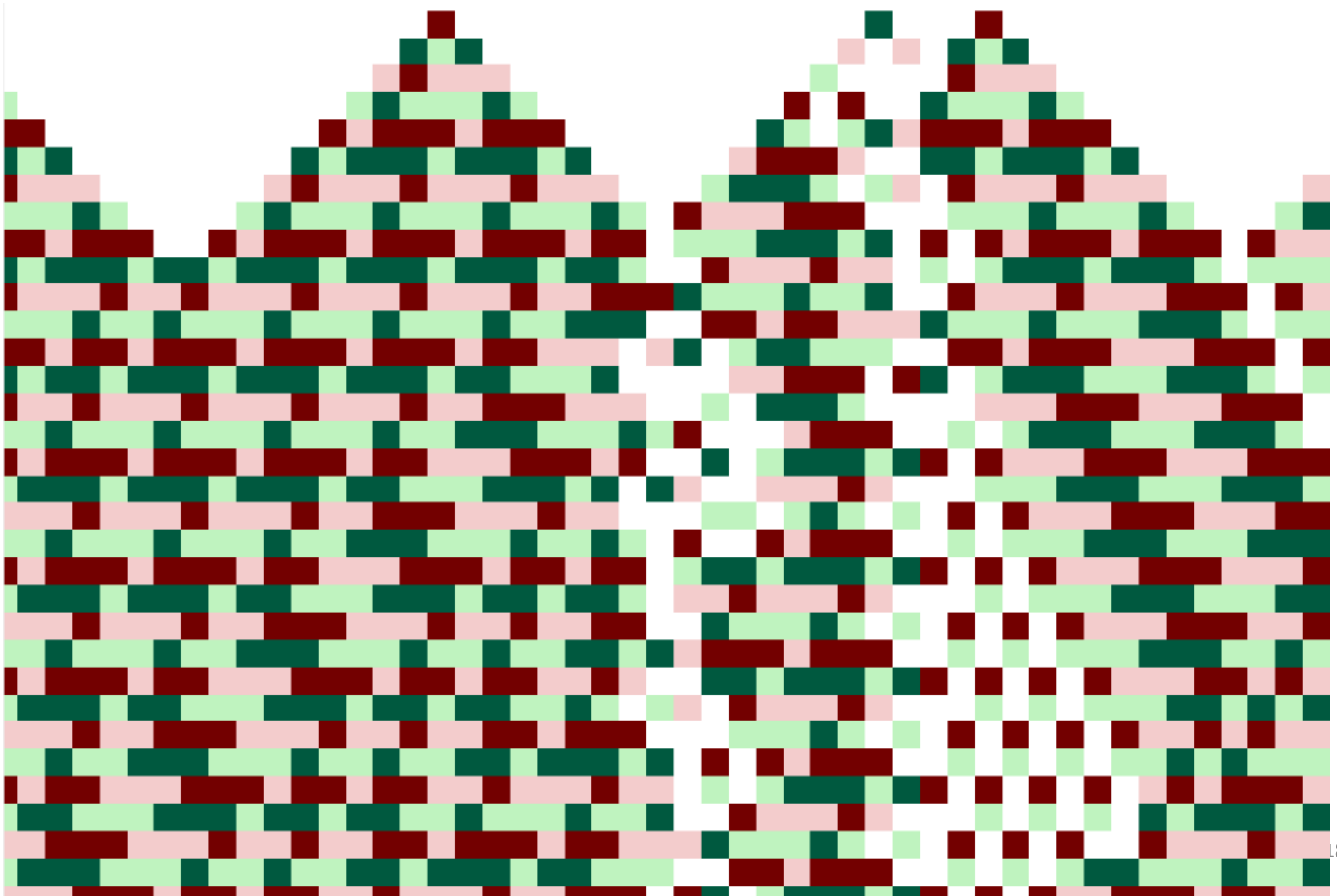
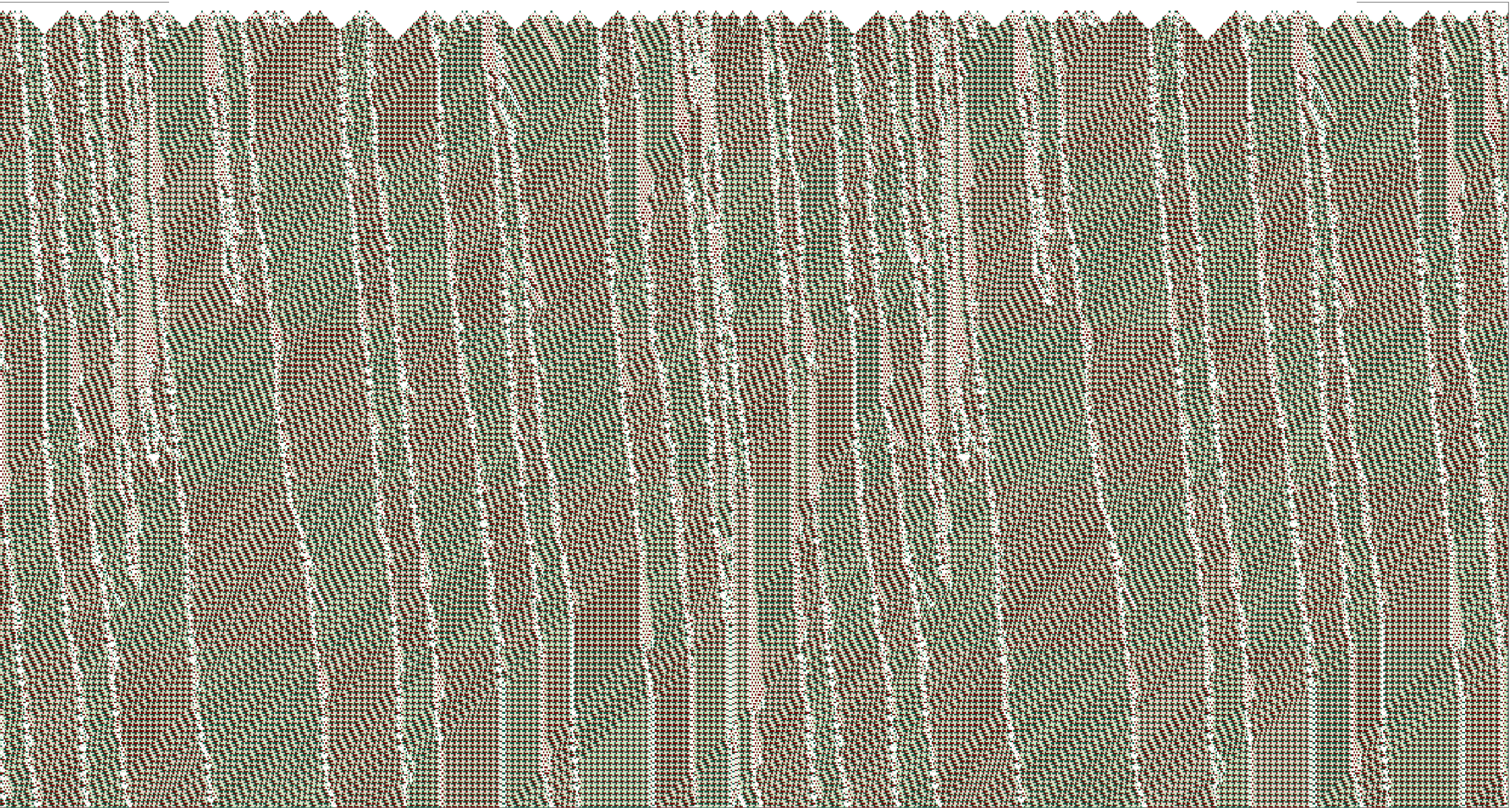
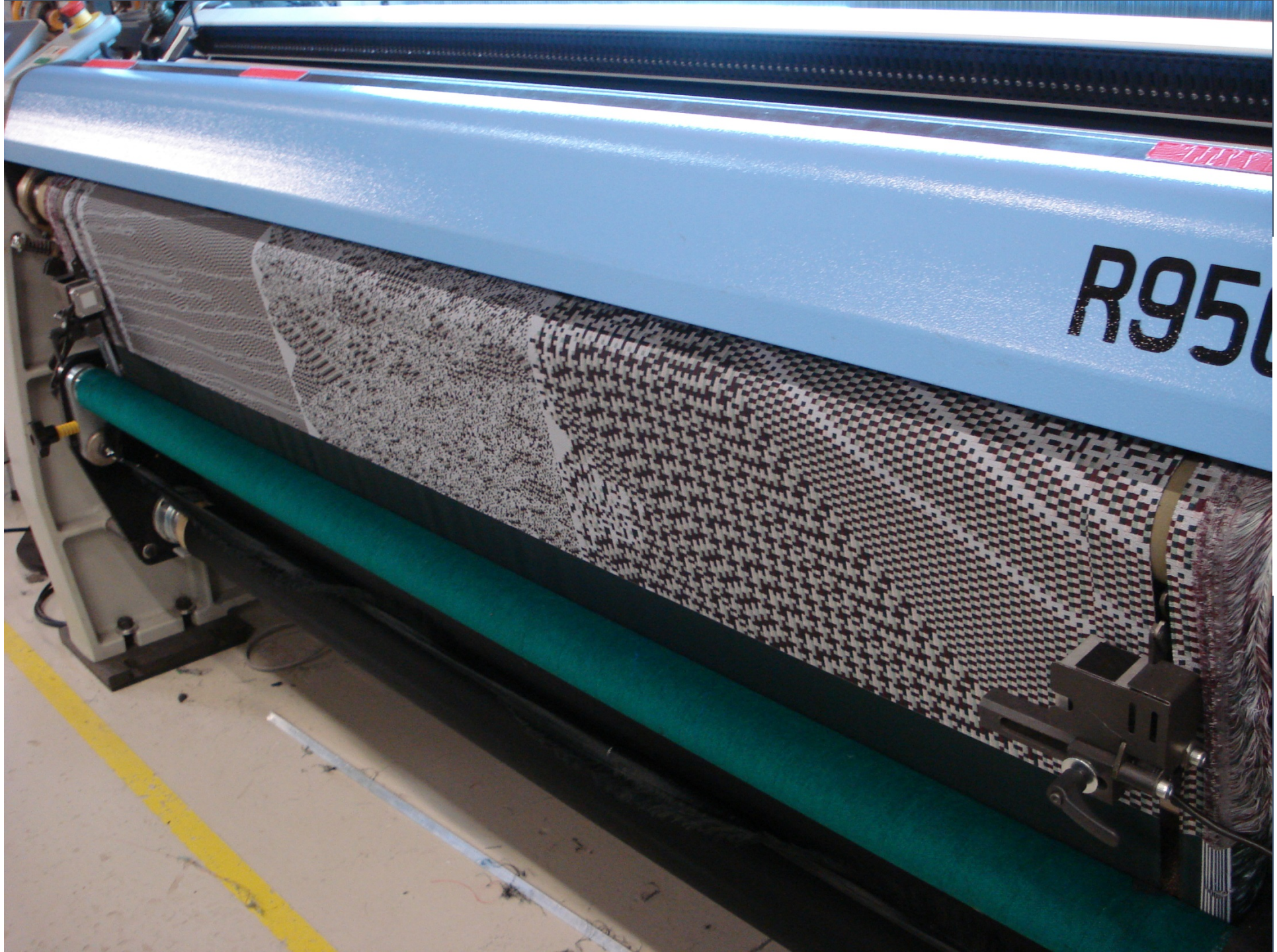
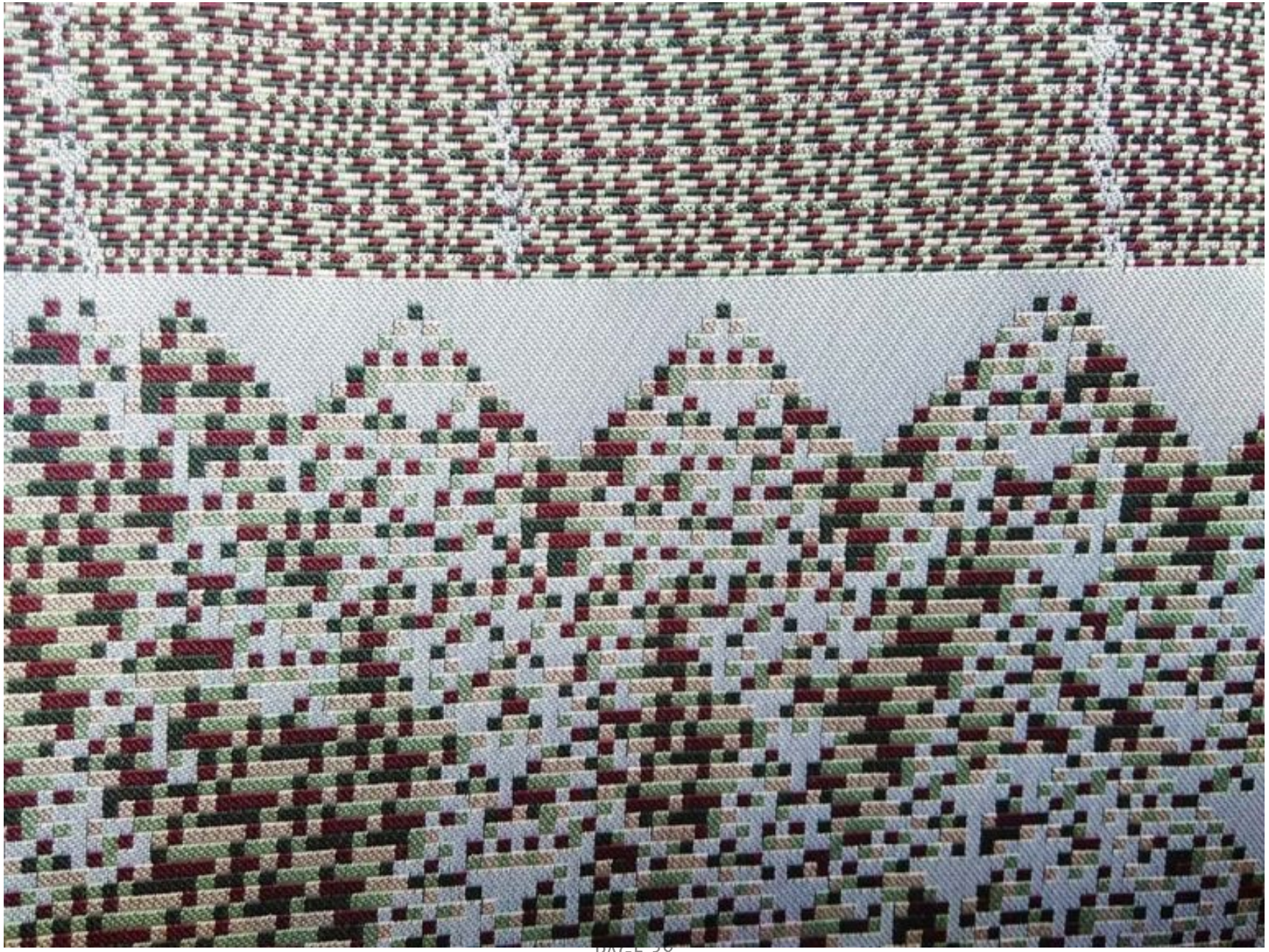
DGreen := RGBColor[0, .35, .25]; (0,89,64) LAB = (33,-30,8)
Pinky := RGBColor[.95, .8, .8]; = (242,204,204) LAB = (85,13,5)
DRed := RGBColor[.45, 0, 0]; = (115,0,0) LAB = (22,45,34)





GREEN 225
LABELS
PINK 71
LABELS
WHITE GLOSS
LABELS
GREEN 67
LABELS


R95



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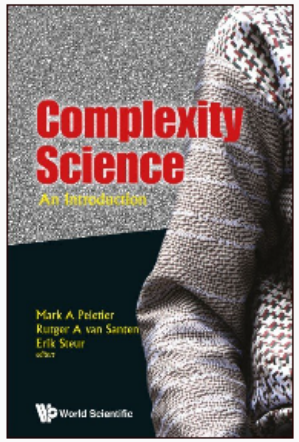

Complexity Science

An Introduction

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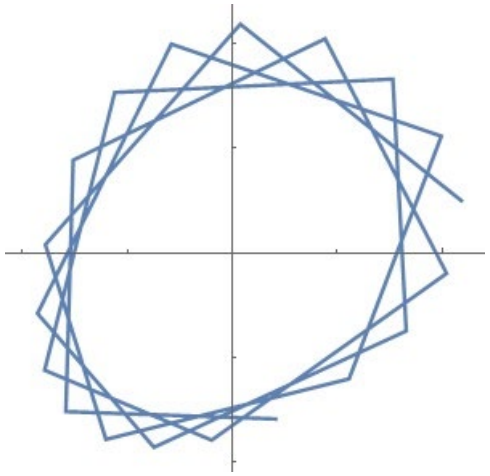
Description Chapters Supplementary

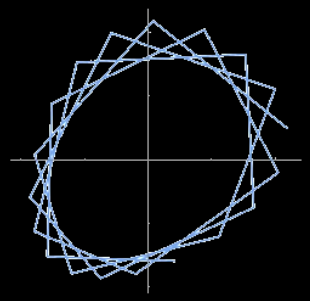
So:

What else can ID do with CA(S) besides predictive models?

Loe's tentative answer:

- Generate awareness of emergent behavior and chaos phenomena
- Develop new and rich visual and interactive perspectives





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