Emergent Design

DM II Week 3

DES 212| Winter Term 2 | 2026 | 3 Credits

Instructor: Xun Liu

GTAs: Lea Papillon, Wylie Moorman

Content

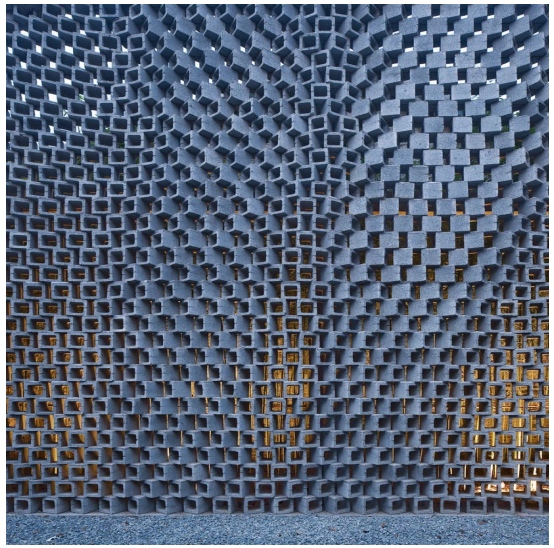
Basic Syntax: Conditionals and Loops

Recursion & Fractal

Automata

Agent-Based Form

The VOCABULARY



Aggregation

Tiling

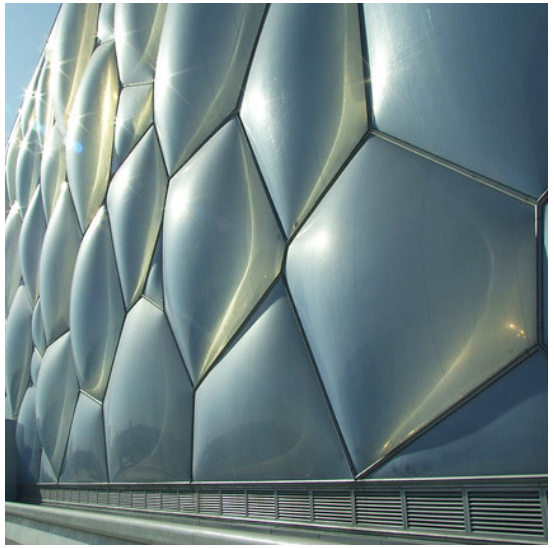
Modular Systems



Sectioning

Stacking

Contouring



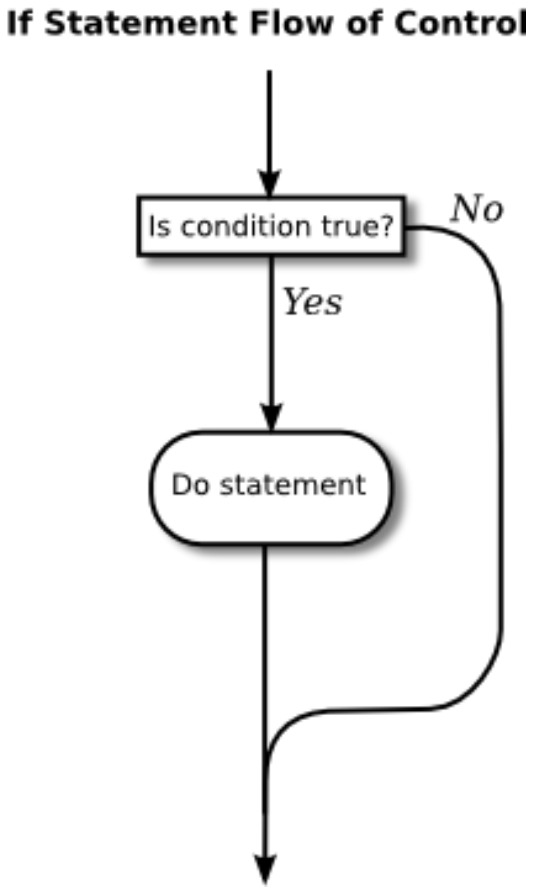
Paneling

Subdivision

Cellular Logic

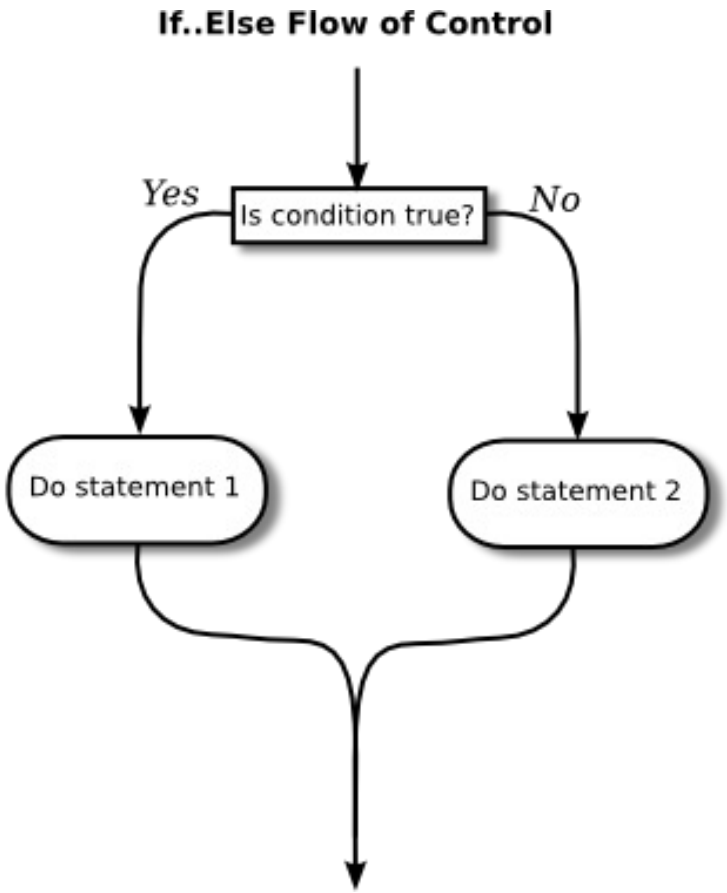
Basic Syntax:
Conditionals and Loops

If Statement



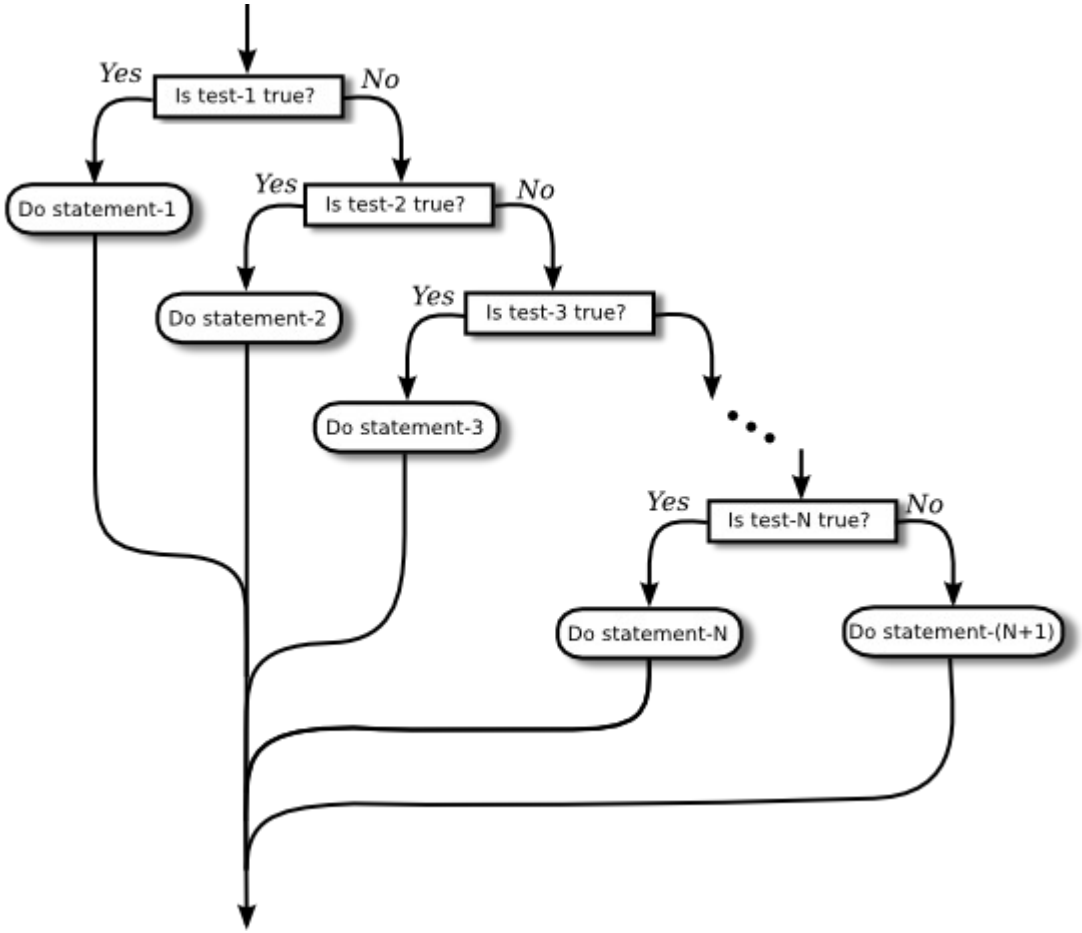

```
if <condition>:
    <body>
```

If Statement




```
if <condition>:
    <body1>
else:
    <body2>
```

If Statement




```
if <condition1>:
    <body1>
elif <condition2>:
    <body2>
else:
    <body3>
```

If Statement



Al-bahr Towers in Abu Dhabi

Aedas, 2012

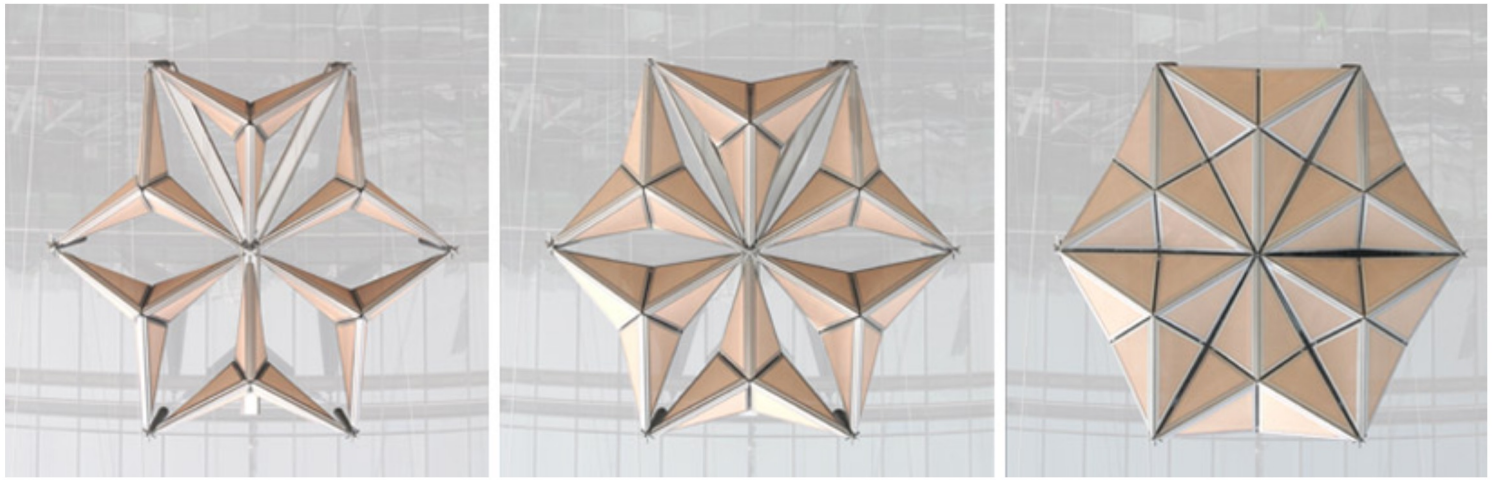
If Statement

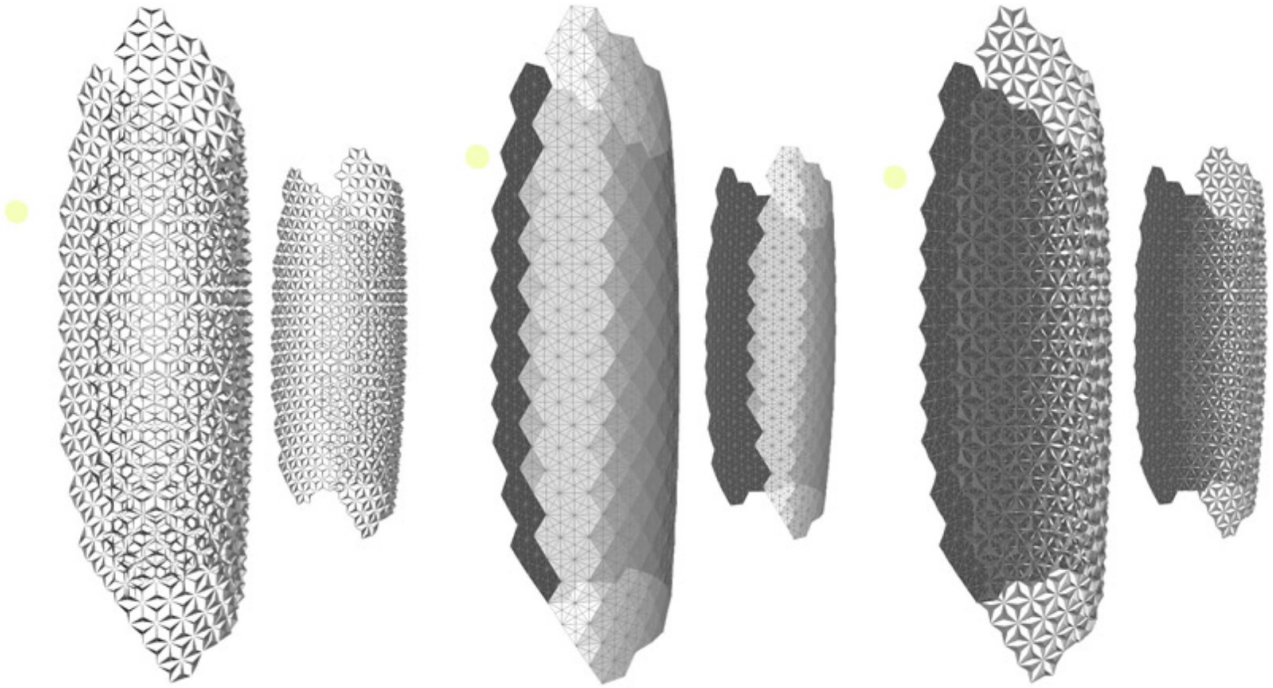


Al-bahr Towers in Abu Dhabi

Aedas, 2012

If Statement



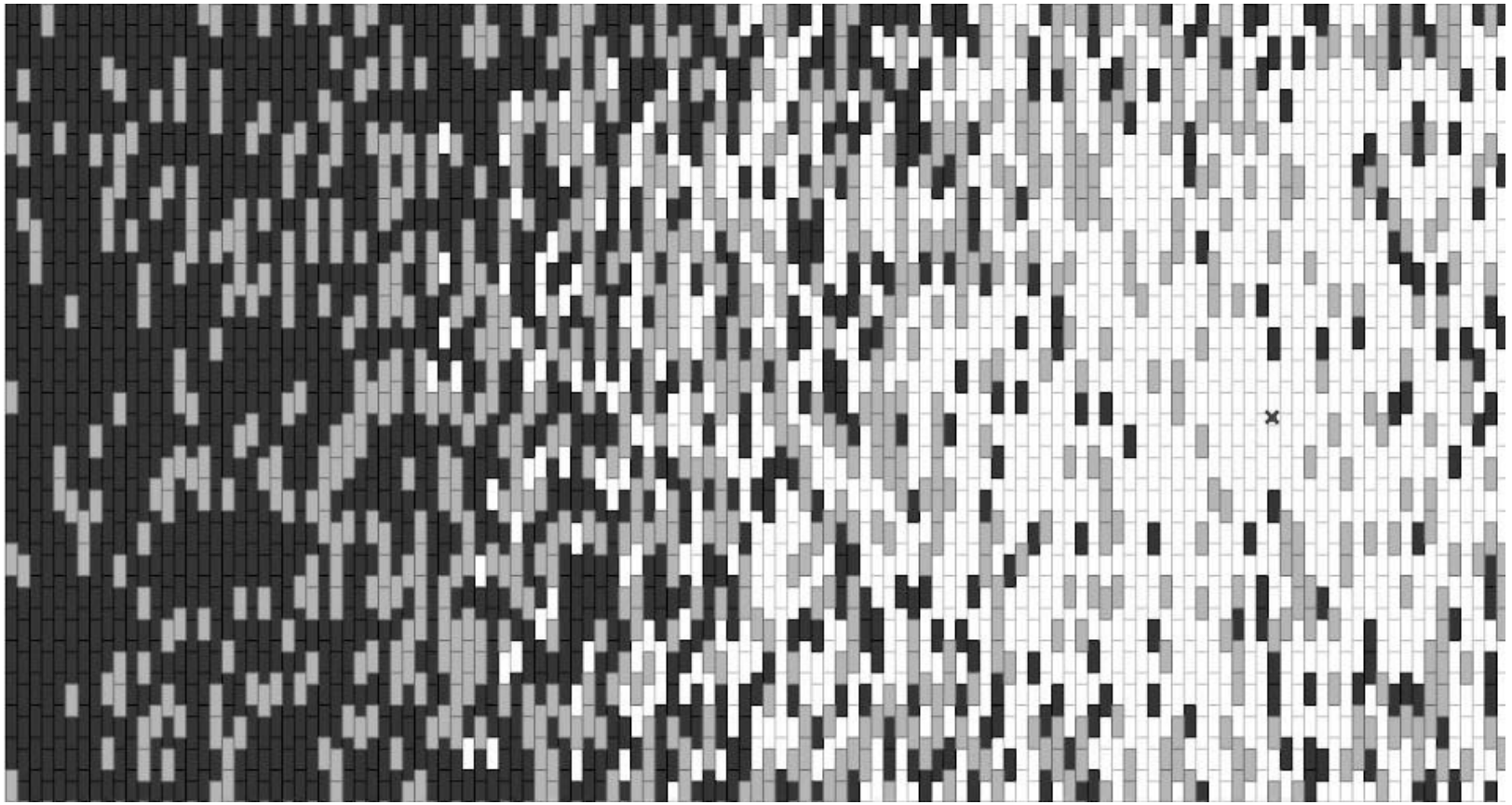


geometric make-up of the panel system and its structure, opened (left) and closed (right)

Al-bahr Towers in Abu Dhabi

Aedas, 2012

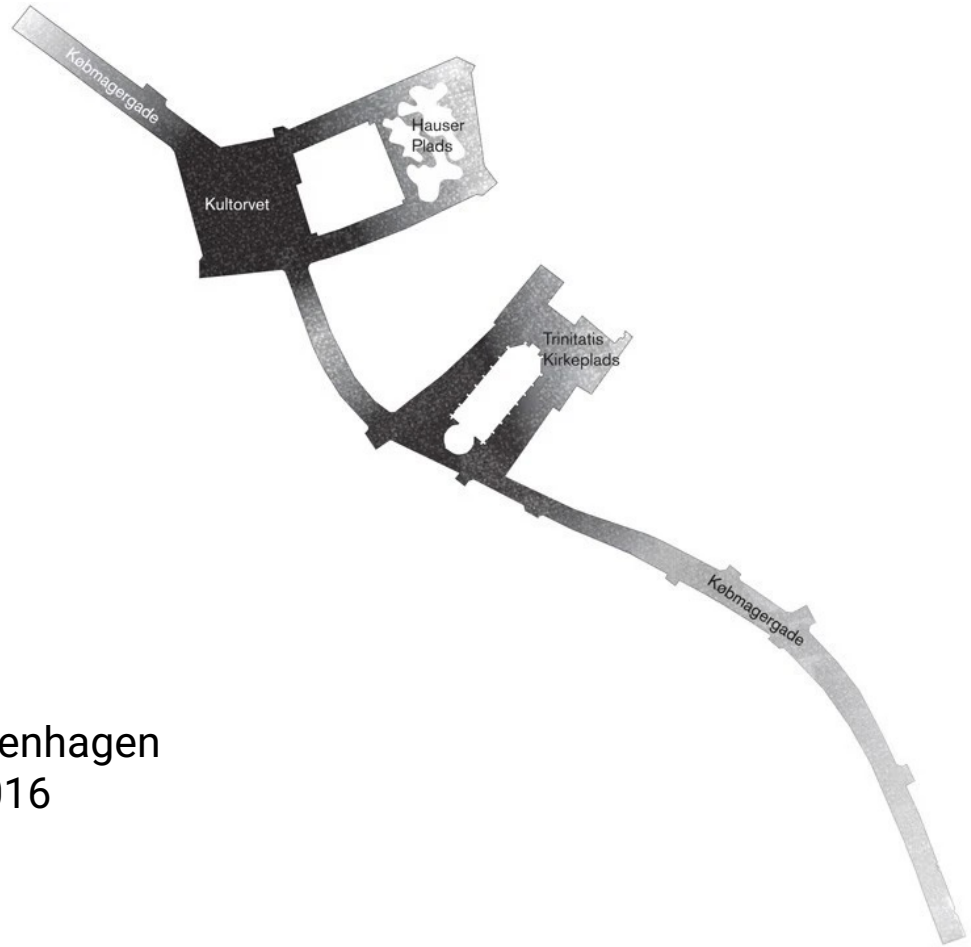
If Statement



Købmagergade, Copenhagen
Karres en Brands, 2016

https://generative-landscapes.com/kobmagergade-copenhagen-karres-en-brands-case-study-3/

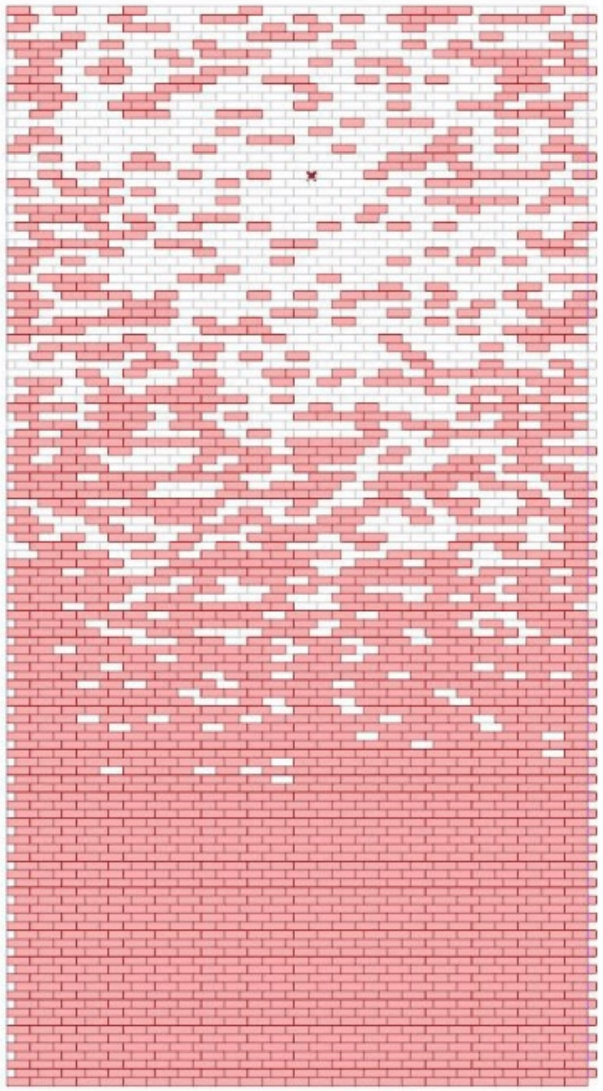
If Statement

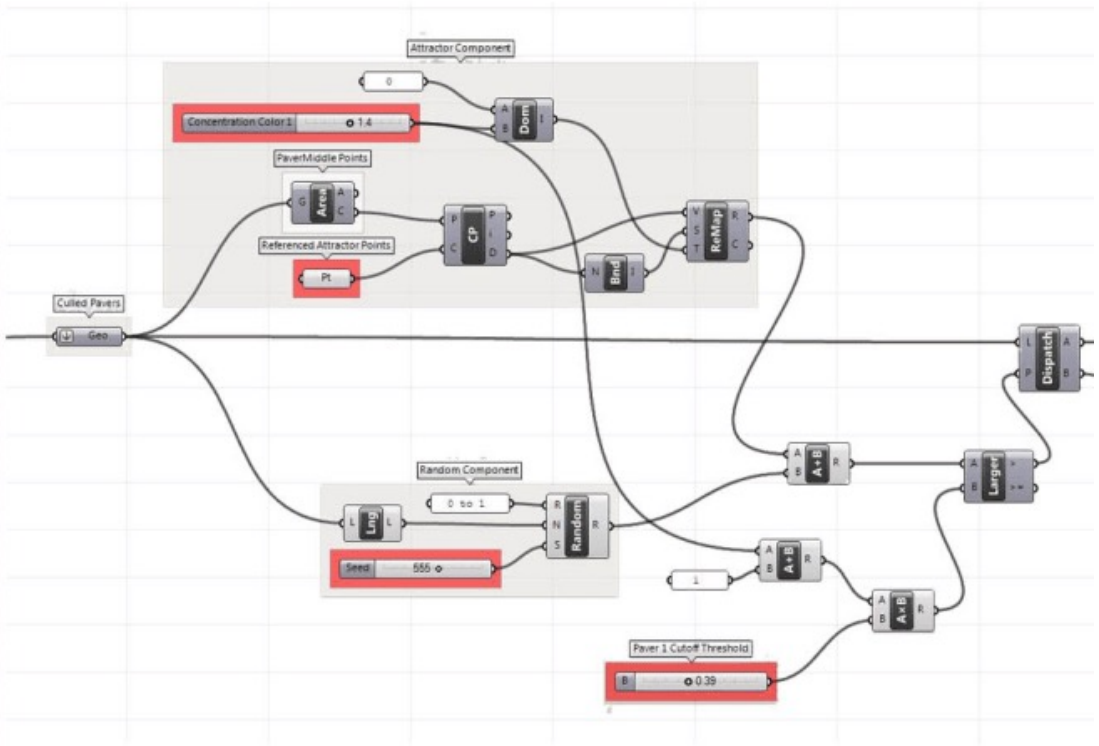




Købmagergade, Copenhagen
Karres en Brands, 2016

If Statement

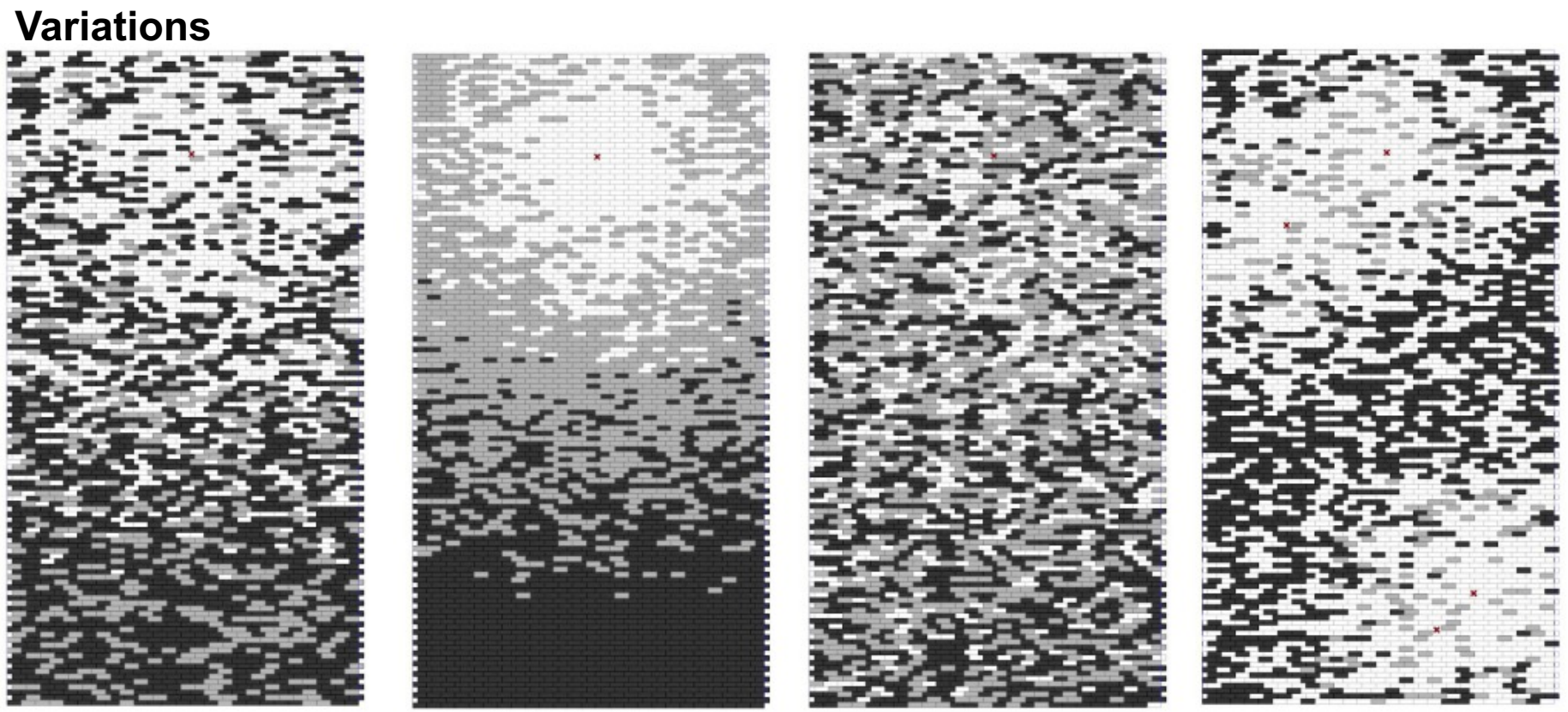




Købmagergade, Copenhagen
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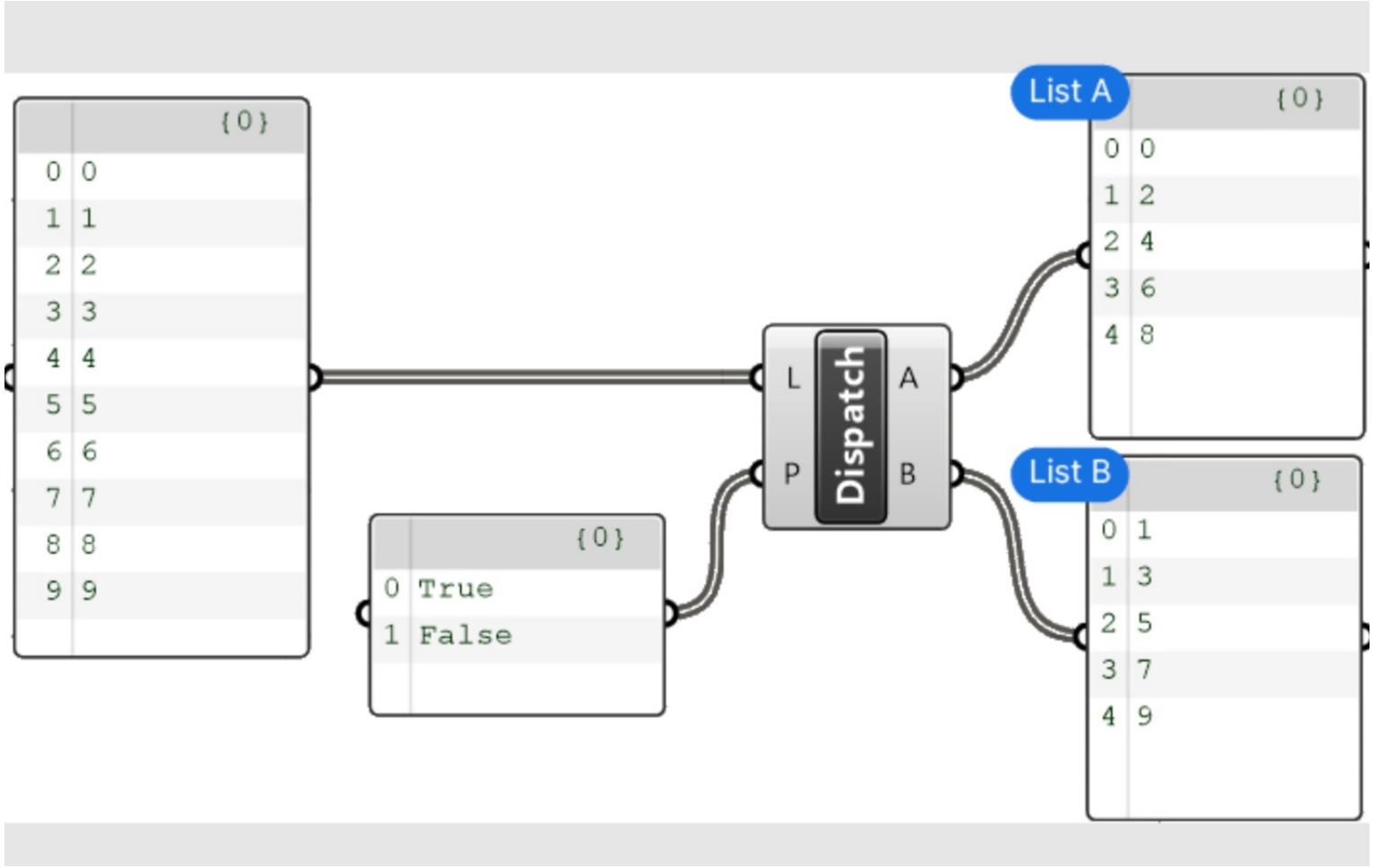
If Statement



Købmagergade, Copenhagen
Karres en Brands, 2016

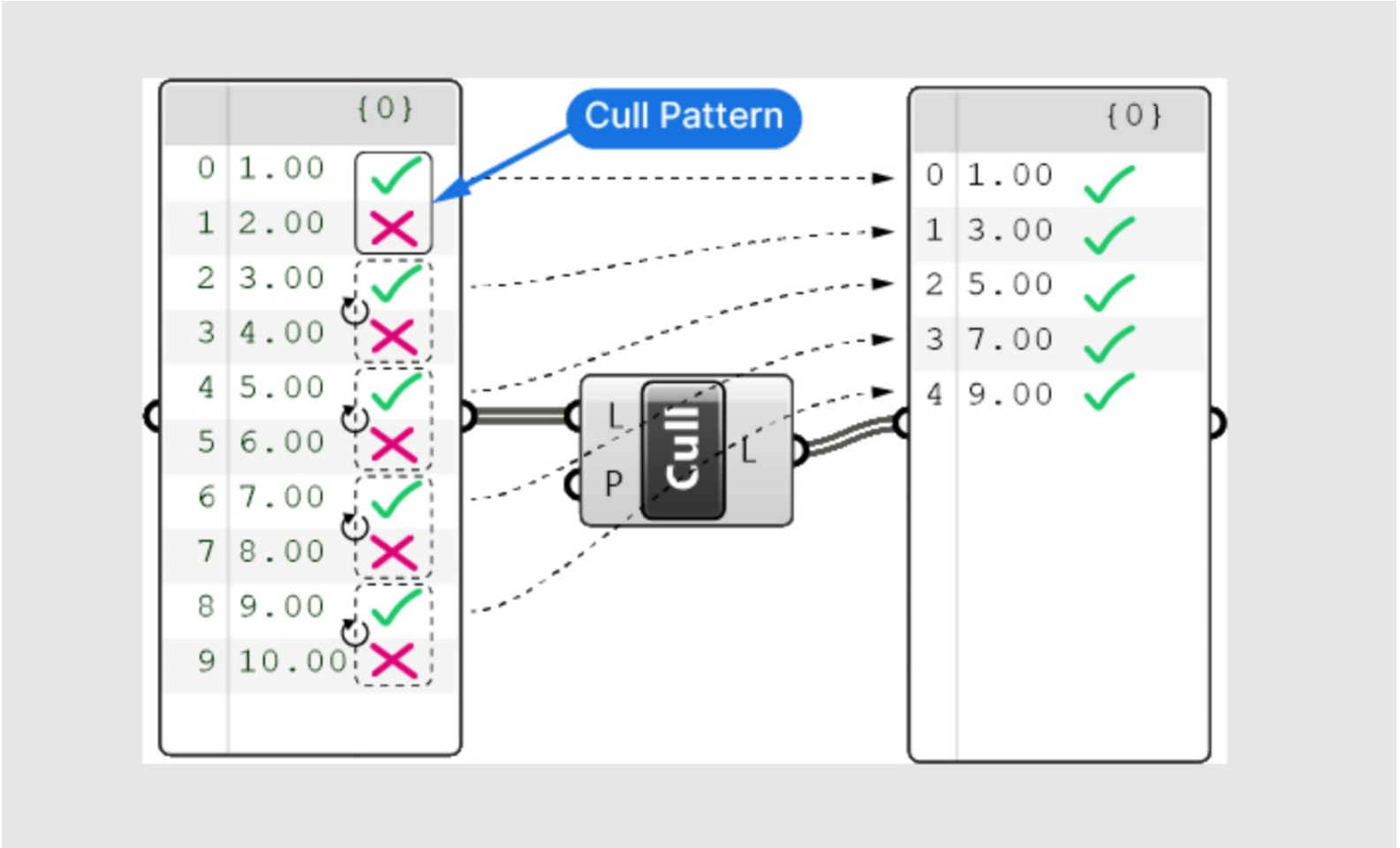
https://generative-landscapes.com/kobmagergade-copenhagen-karres-en-brands-case-study-3/

If Statement



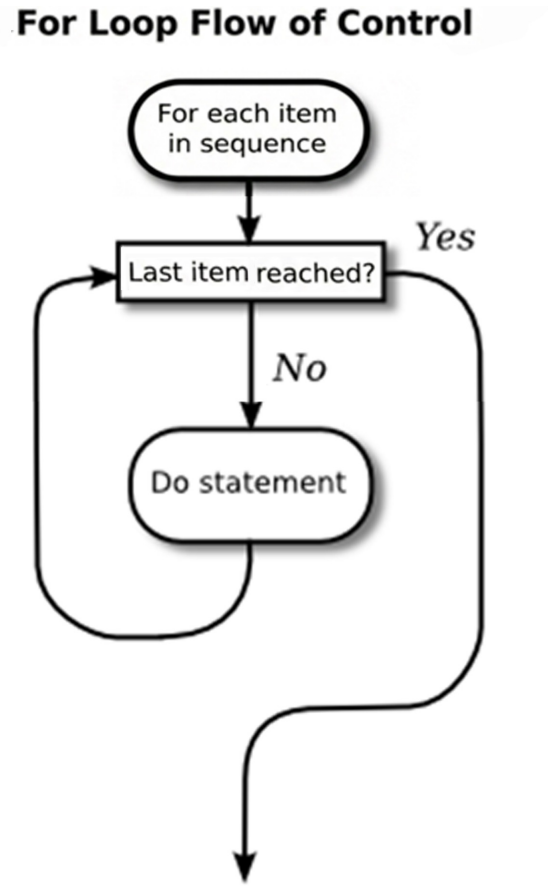
Construction If logic
in Grasshopper

If Statement



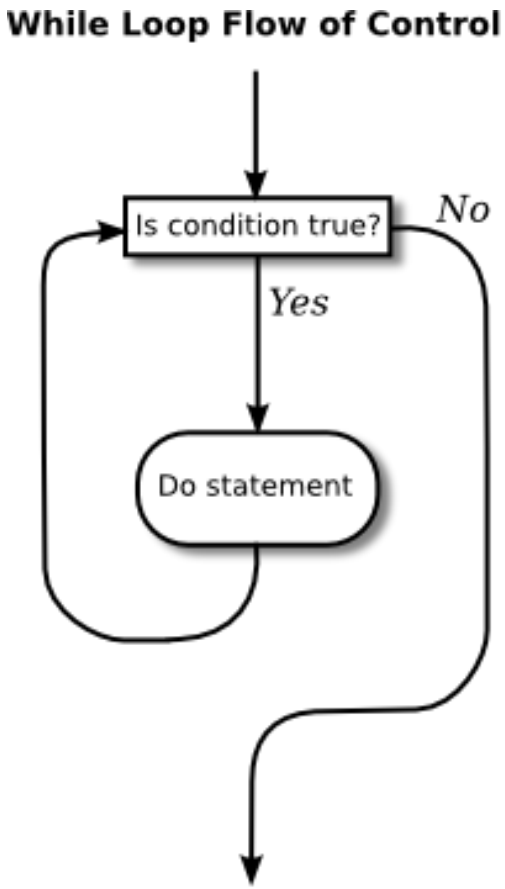
Construction If logic
in Grasshopper

For/While Loops



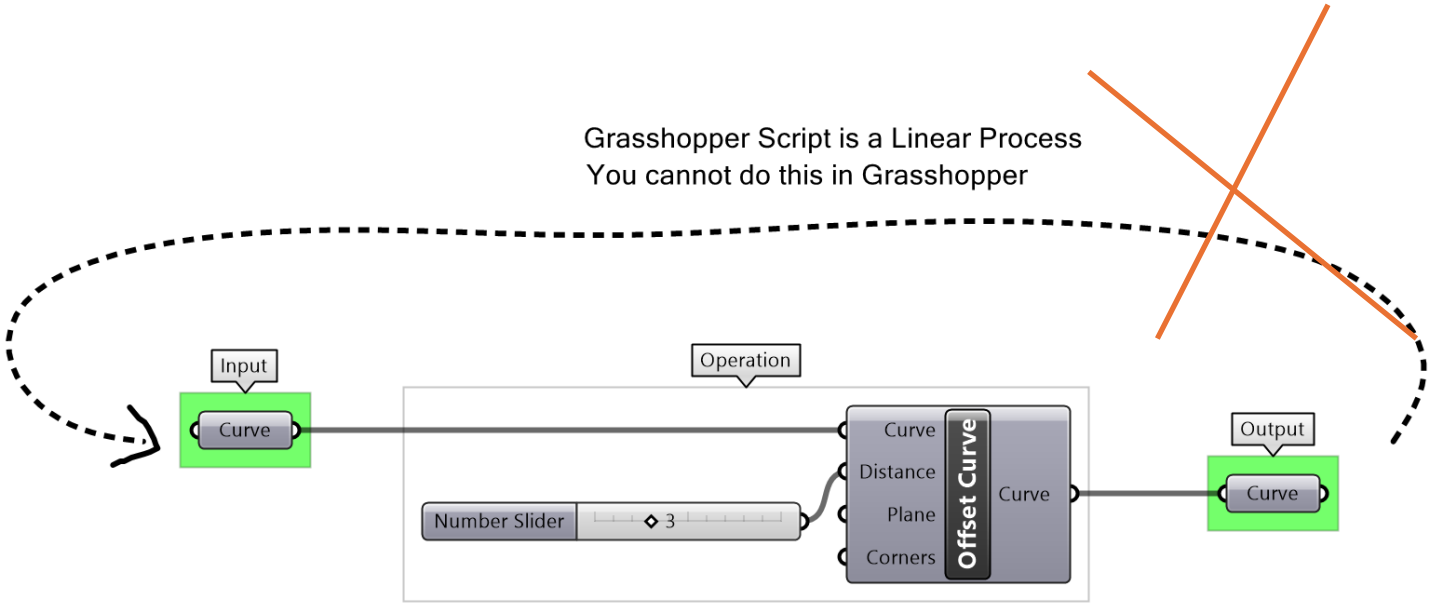

```
for <var> in <sequence>:
    <body>
```

For/While Loops



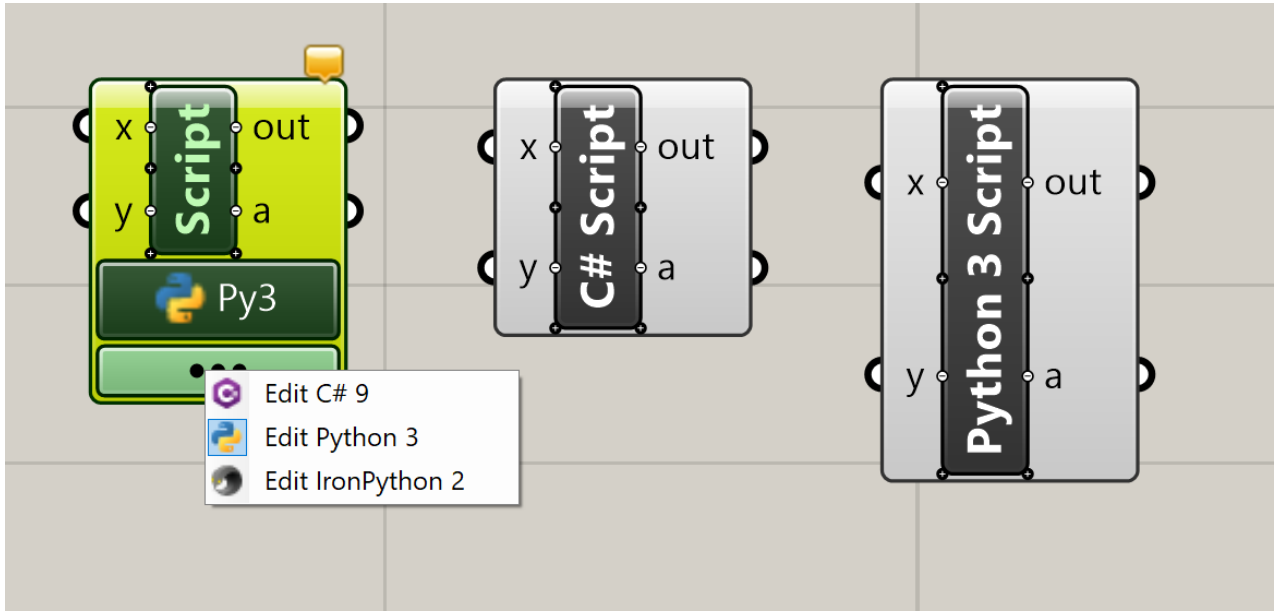

```
while <condition>:
    <body>
```

For/While Loops



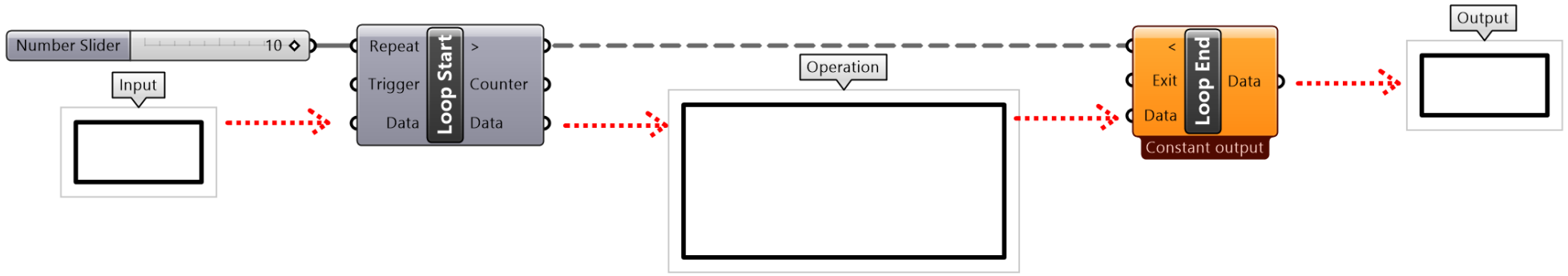
Construction Loops
in Grasshopper

For/While Loops



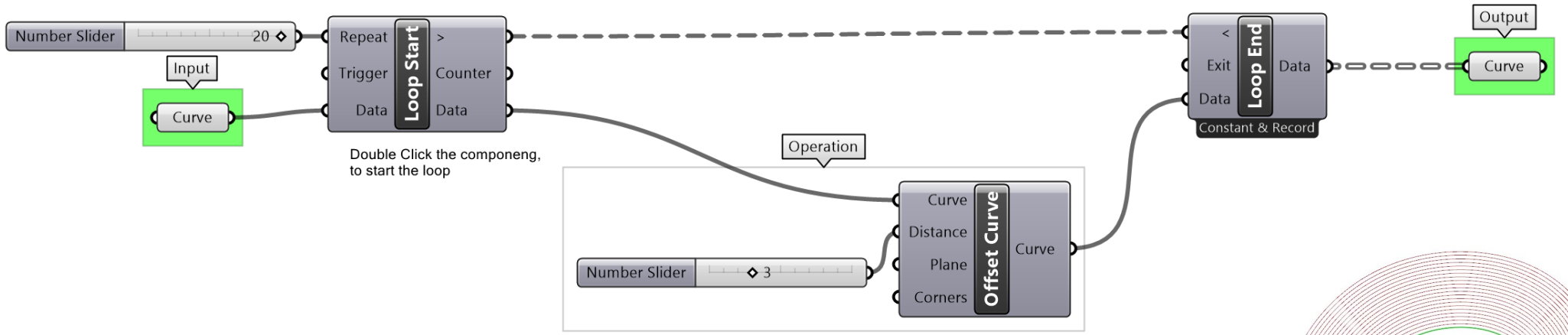
Construction Loops
in Grasshopper
Using Customized ”Script”

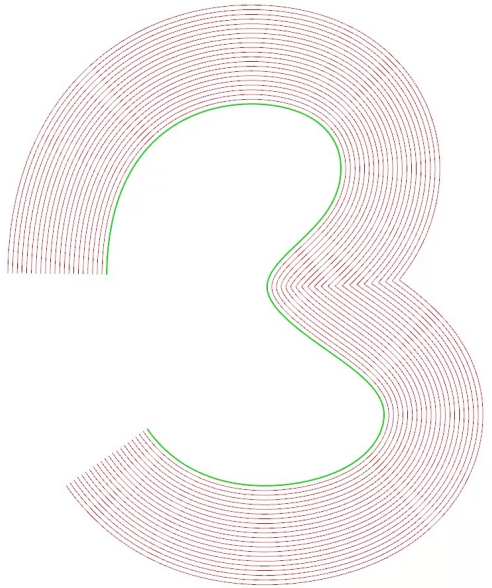
For/While Loops



Construction Loops
in Grasshopper
Plugin: **ANEMONE**

For/While Loops





Construction Loops
in Grasshopper
Plugin: **ANEMONE**



For/While Loops



Contour

Andreas Amador Arts

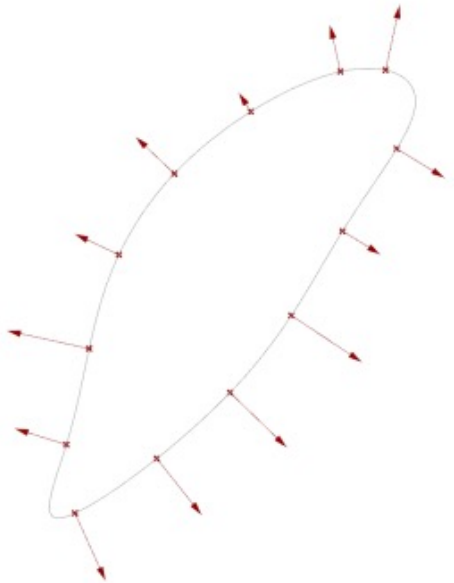
For/While Loops

Contour

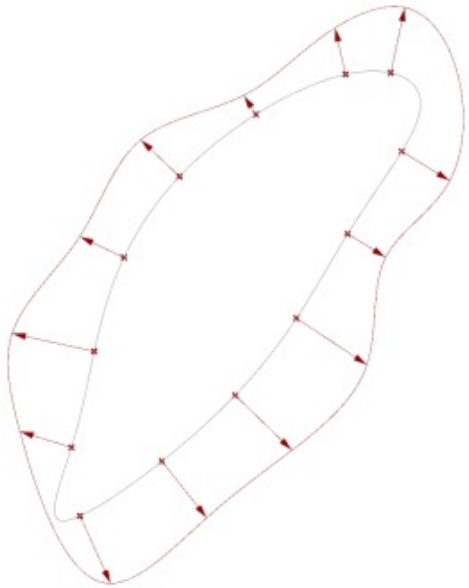
Andreas Amador Arts



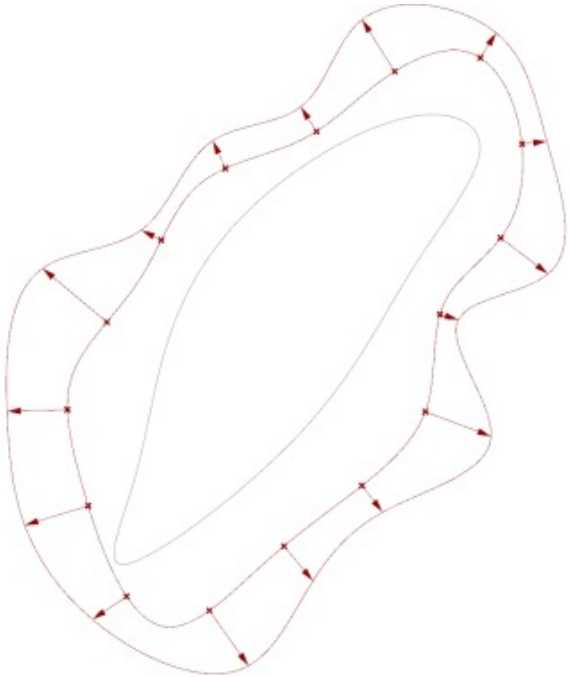
For/While Loops



1 - Curve is subdivided.
Points Are moved Perpendicular to curve within a random Domain



2- New Curve is constructed with points that have been moved

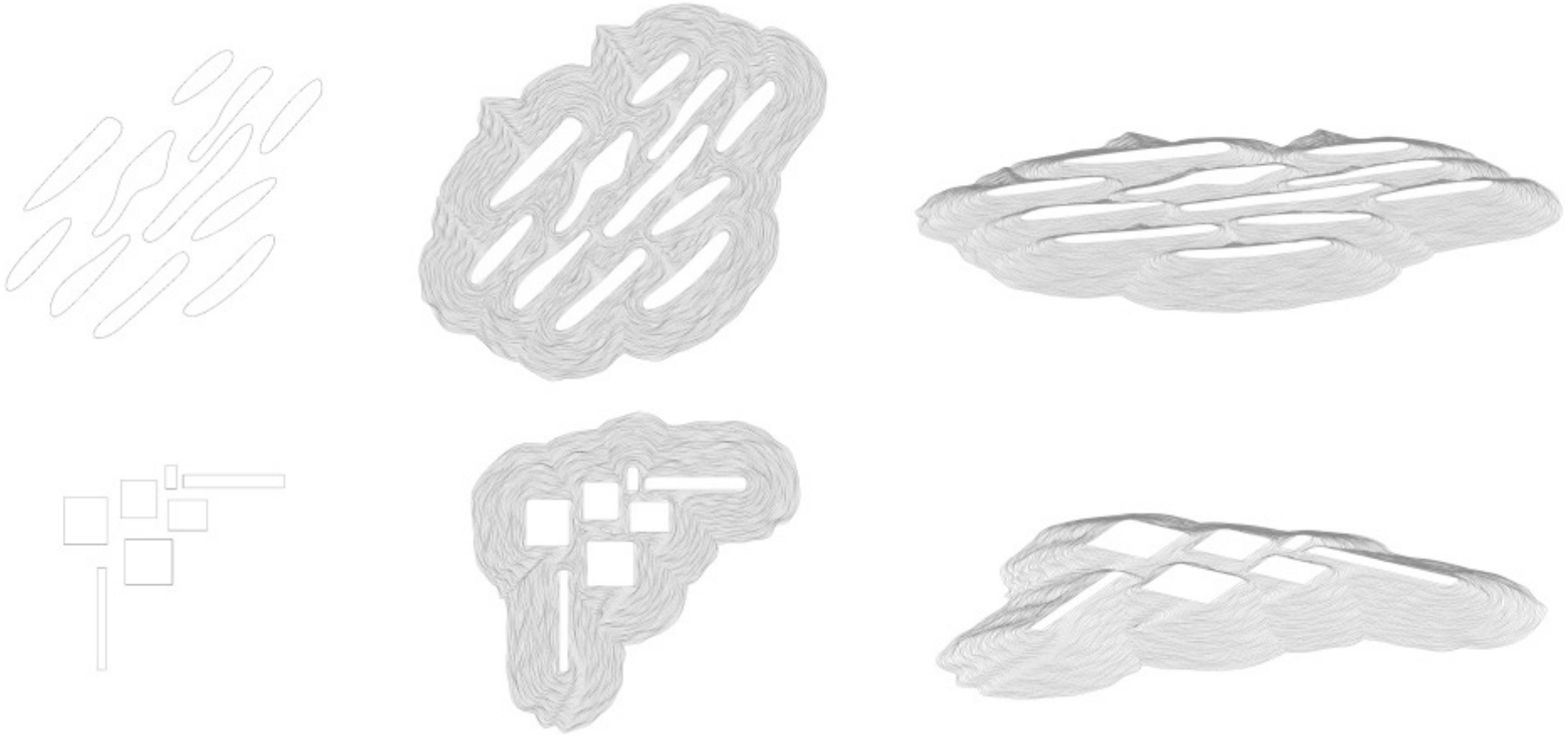


3- Process repeats with the new curve

Contour

Andreas Amador Arts

For/While Loops

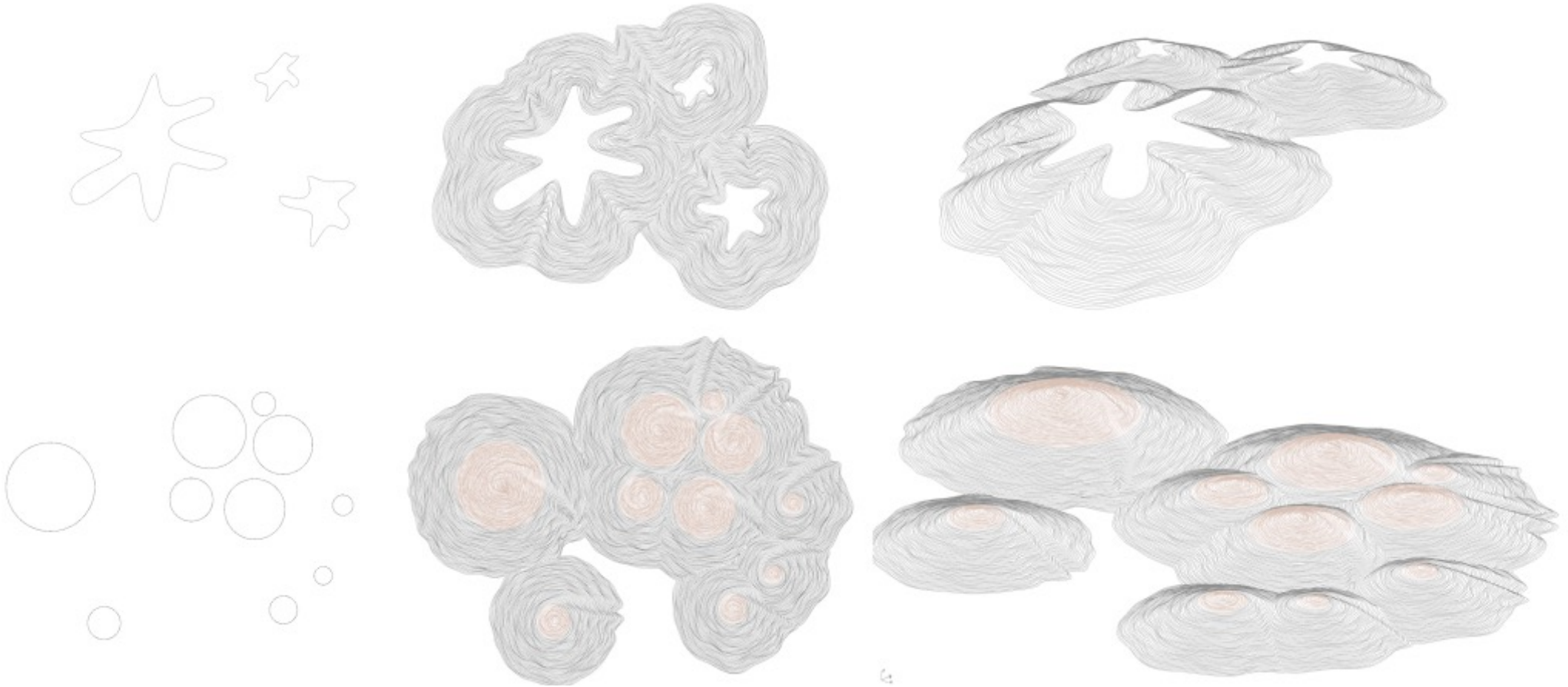


Contour

Andreas Amador Arts

https://generative-landscapes.com/curve-evolution-example-8-4/

For/While Loops



Contour

Andreas Amador Arts

https://generative-landscapes.com/curve-evolution-example-8-4/

Recursion & Fractal

Recursion & Fractal

“Clouds are not spheres, mountains are not cones, coastlines are not circles, and bark is not smooth, nor does lighting travel in a straight line.”

– Benoit Mandelbrot. The Fractal Geometry of Nature



Recursion & Fractal

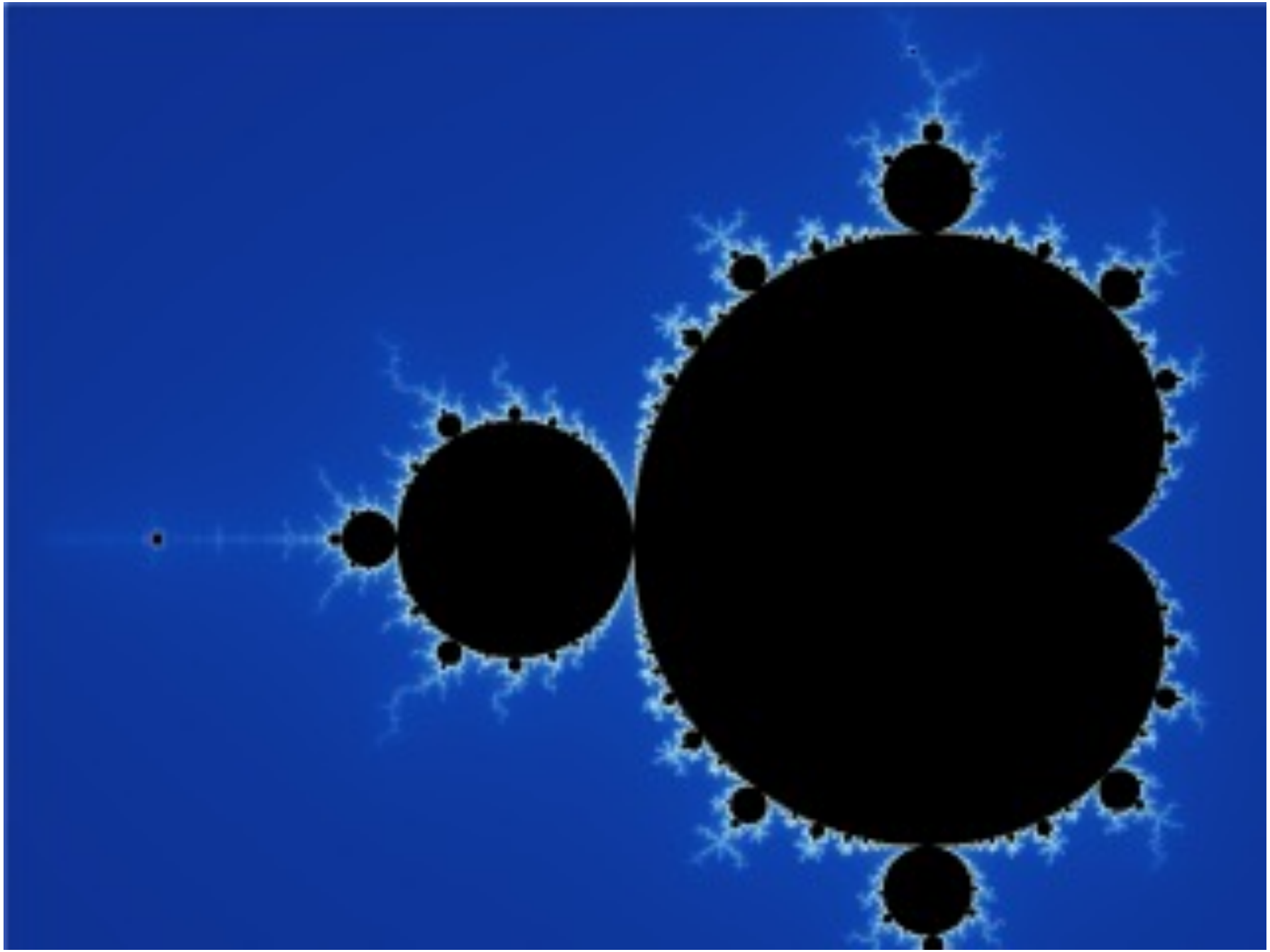
Fractals in Nature



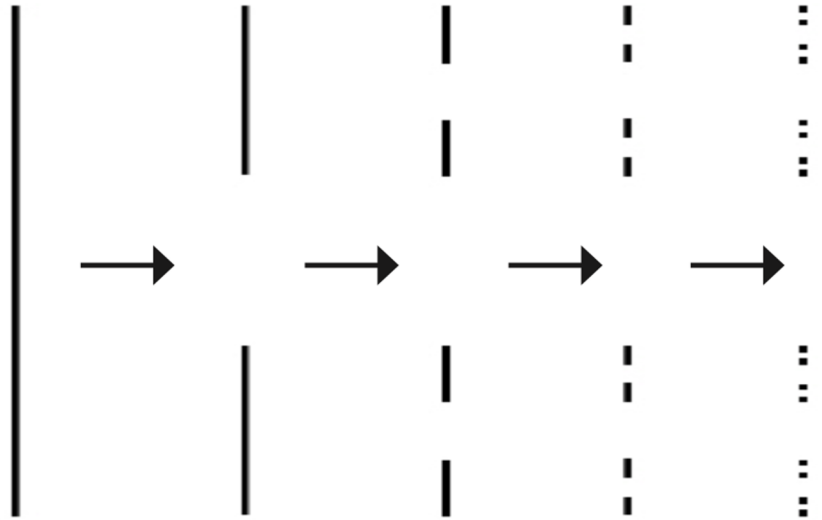
Recursion & Fractal

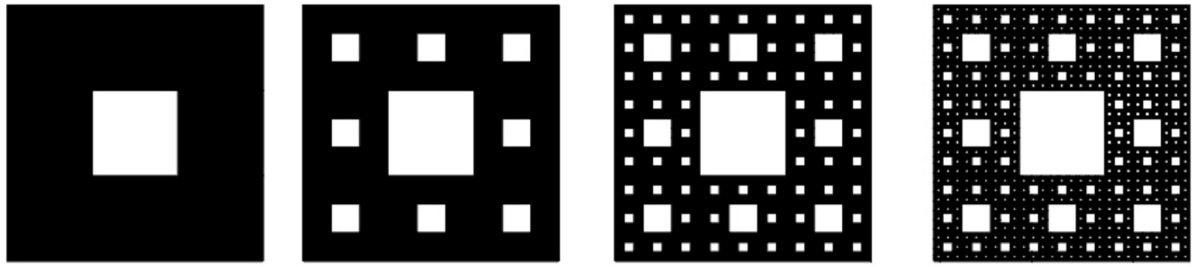
$z_{n+1} = z_n^2 + c$

Mandelbrot Set



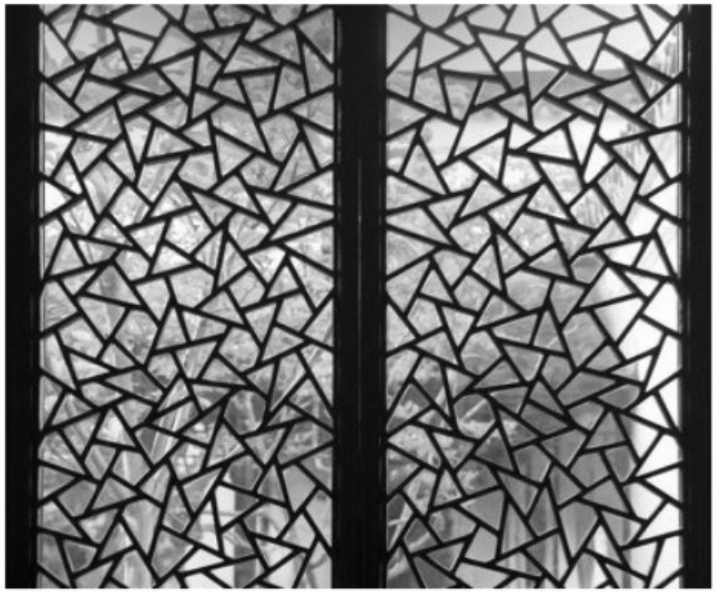
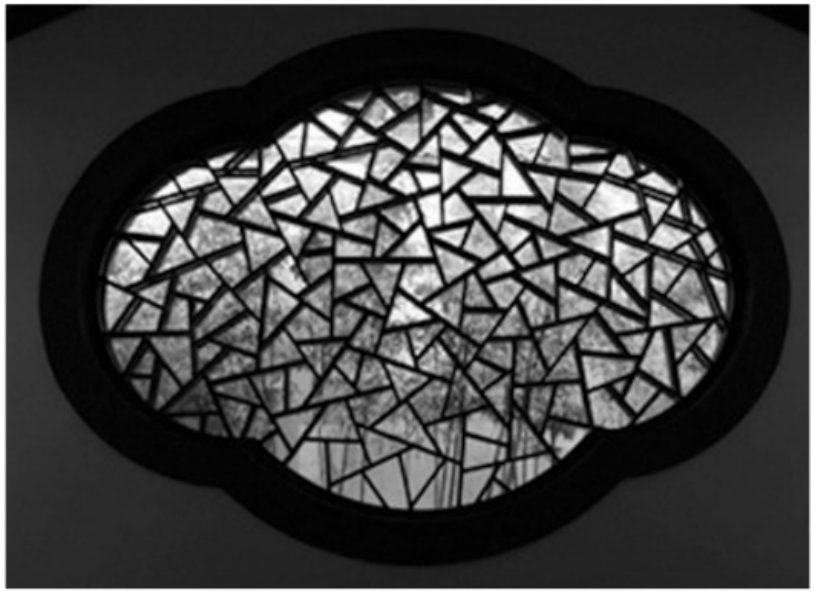
Recursion & Fractal





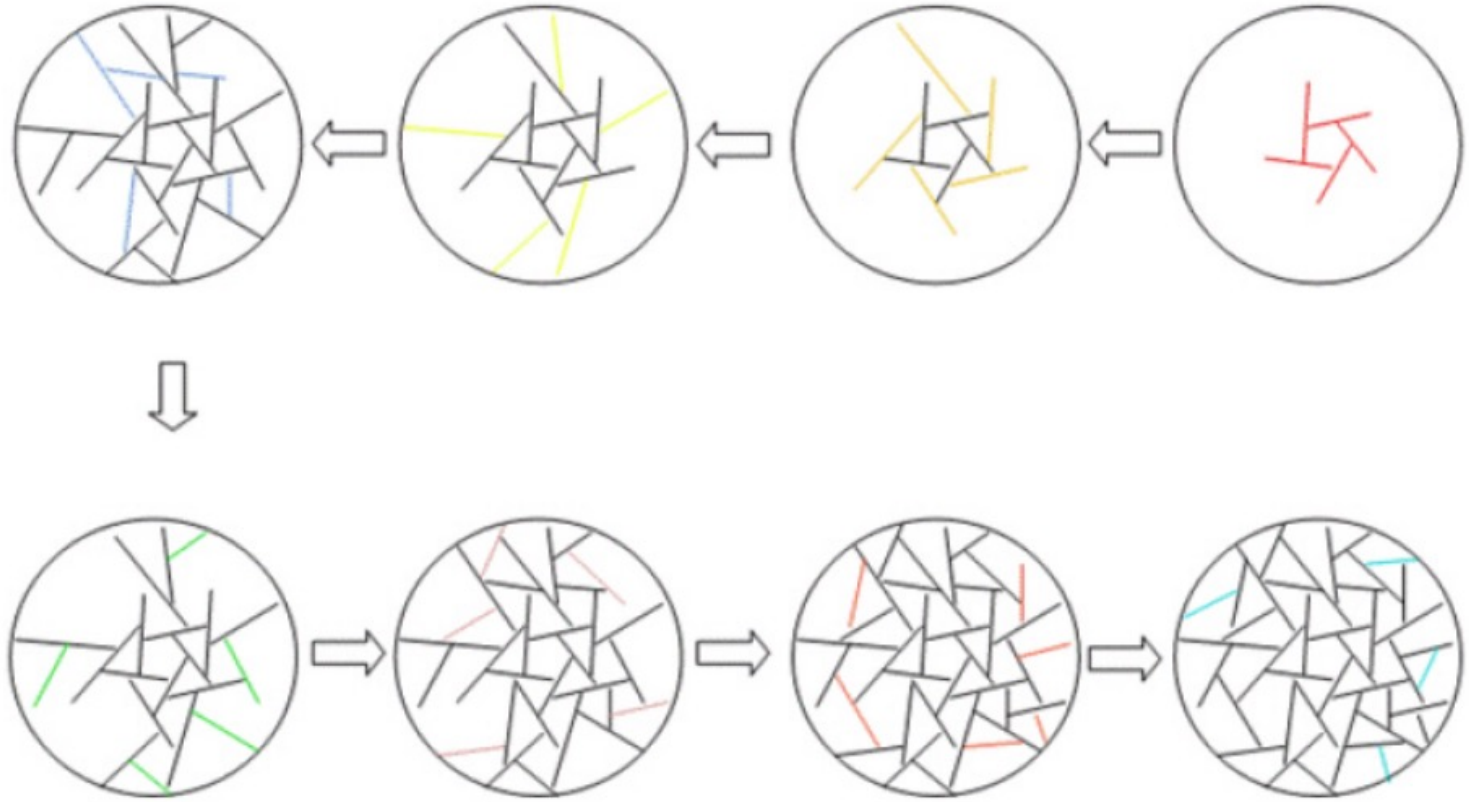
Two Early fractal descriptions:
Cantor Set and Sierpinski Carpet

Recursion & Fractal


Ice-ray Lattices in Chinese gardens

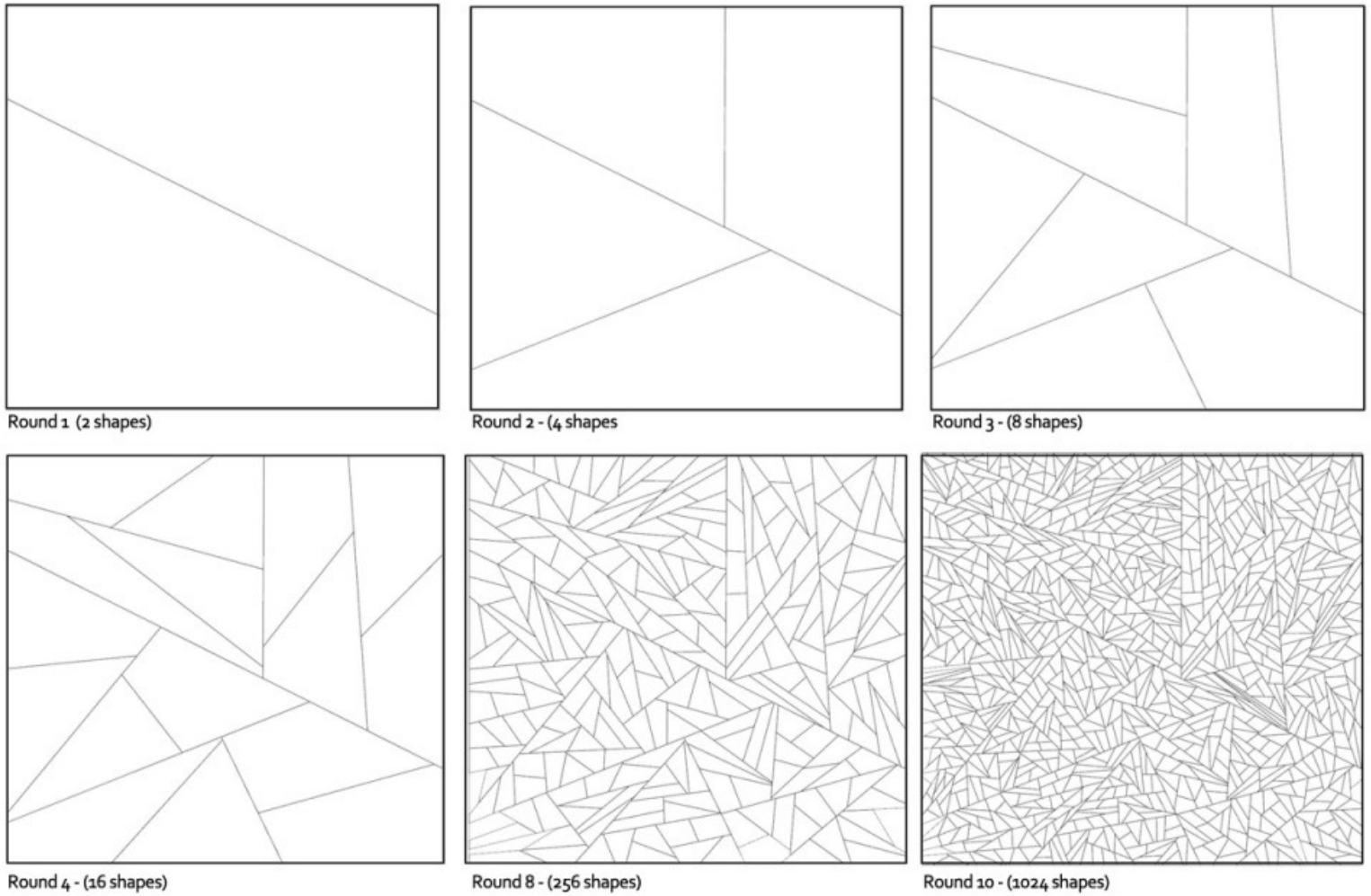
Recursion & Fractal



Digital generation of Ice-ray Lattices (Yuan et al, 2011)

Recursion & Fractal

Digital generation of Ice-ray Lattices (Generative Landscapes)



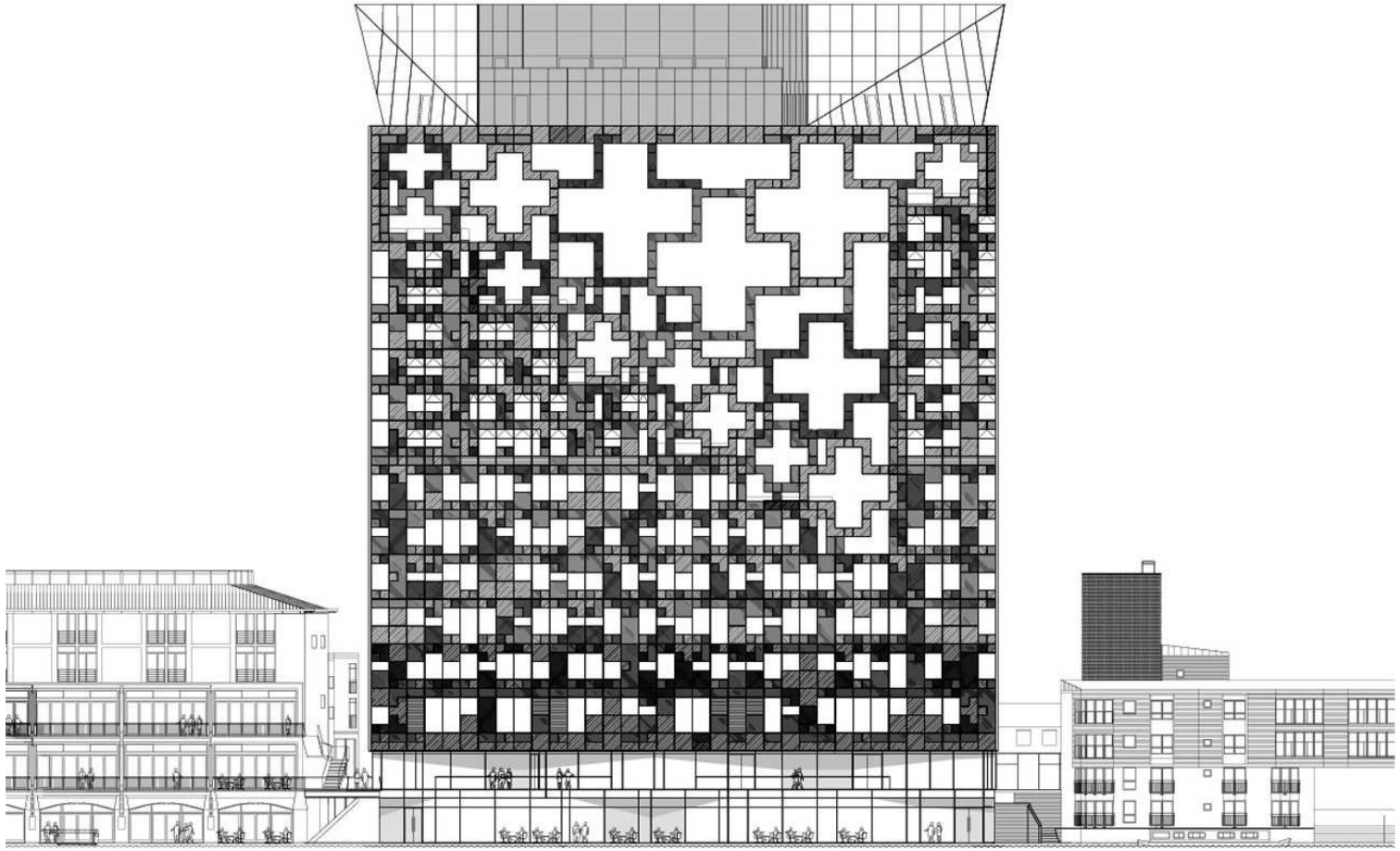
Recursion & Fractal



The Cube

Make Architects

Recursion & Fractal



The Cube

Make Architects

Recursion & Fractal

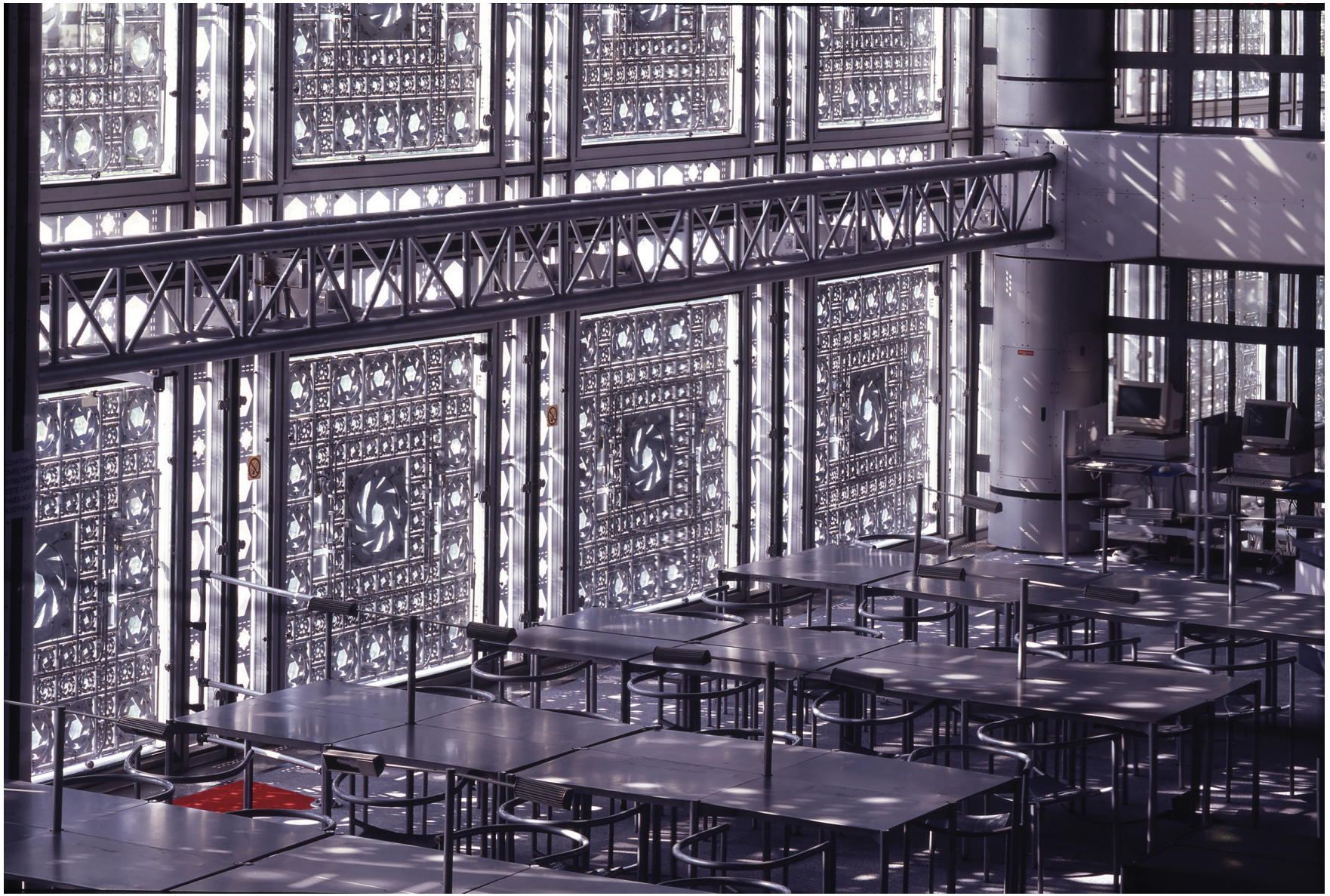




The Cube

Make Architects

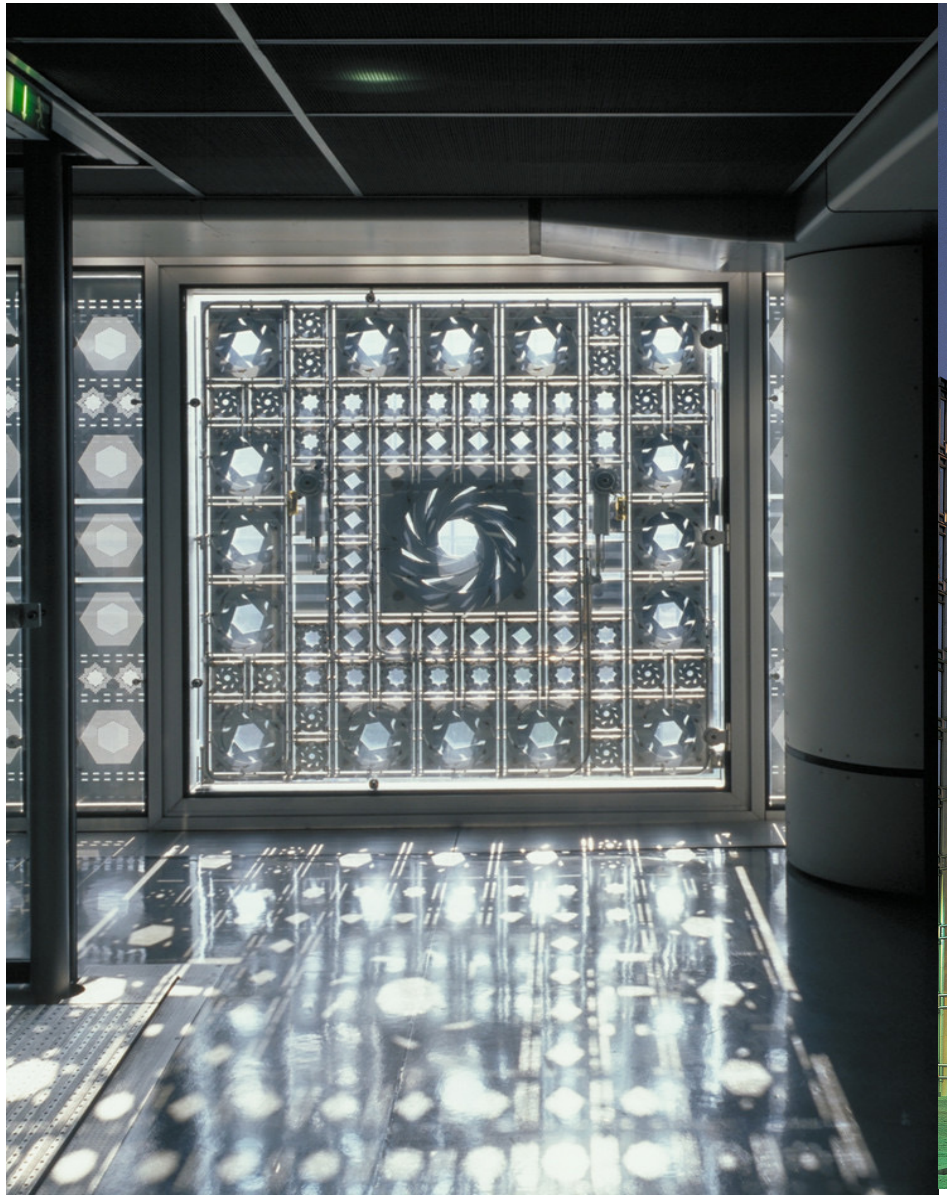
Recursion & Fractal



Institut du Monde Arabe Paris

Jean Nouvel, 1987

Recursion & Fractal

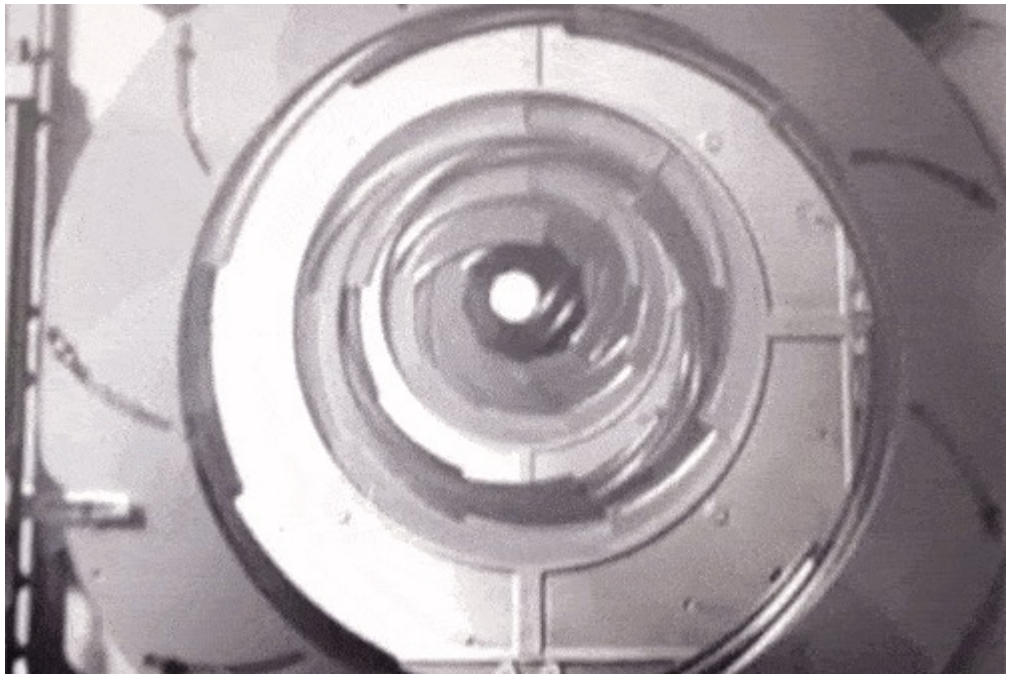


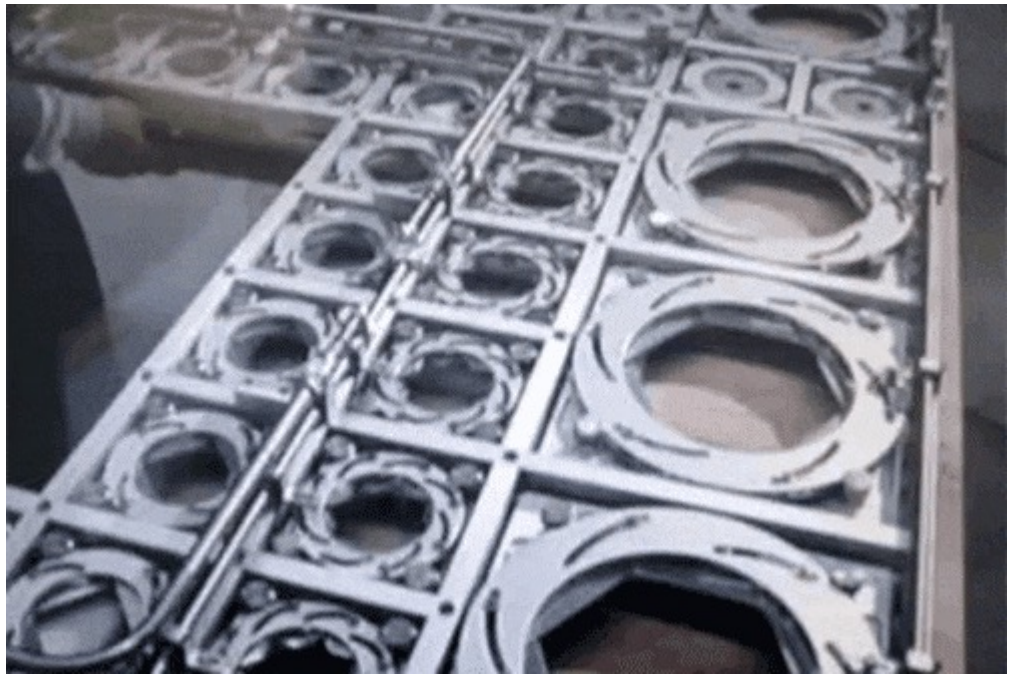


Institut du Monde Arabe Paris

Jean Nouvel, 1987

Recursion & Fractal

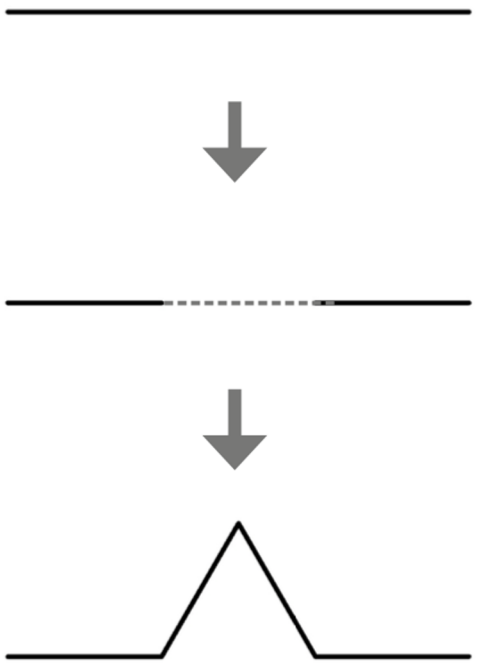




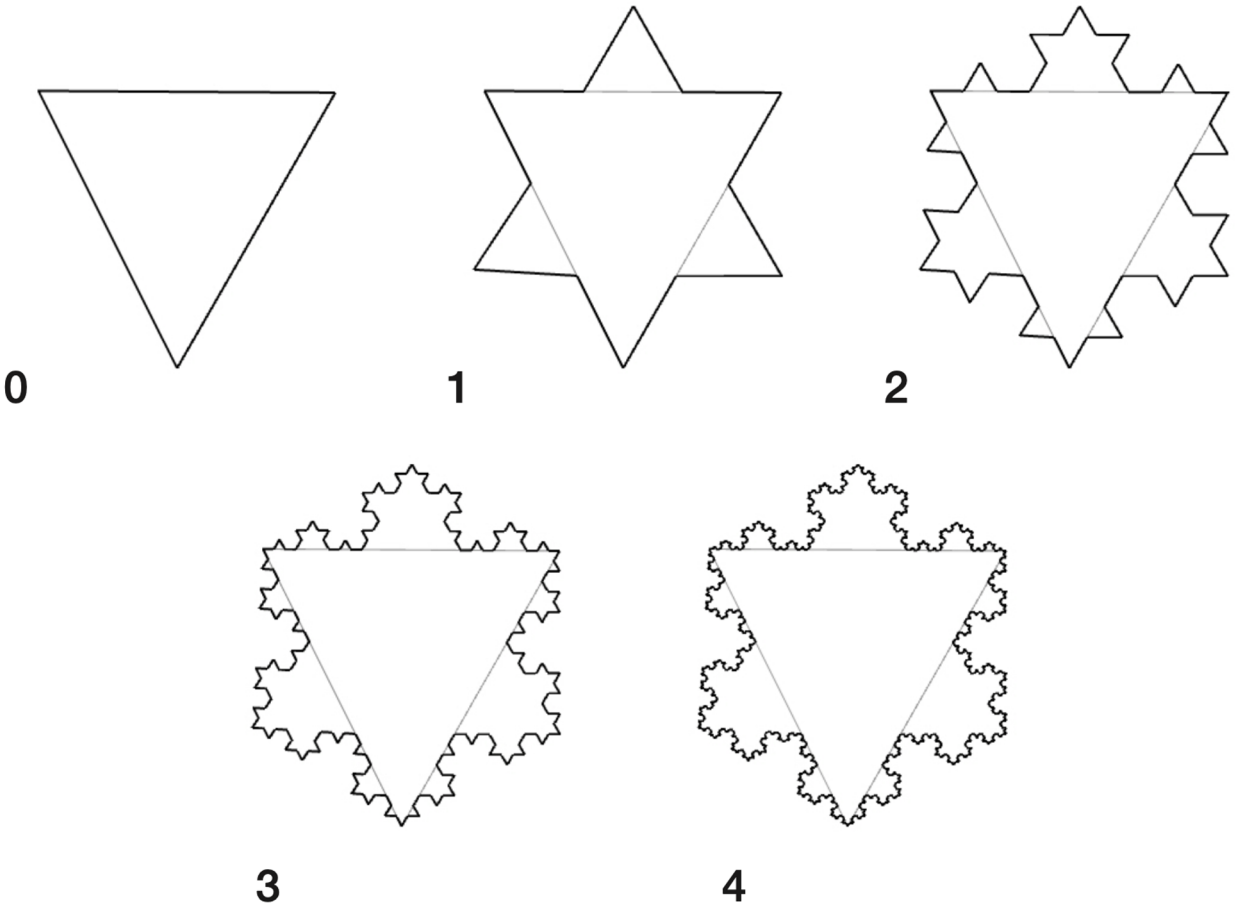
Institut du Monde Arabe Paris

Jean Nouvel, 1987

Recursion & Fractal



The Koch Curve



Recursion & Fractal



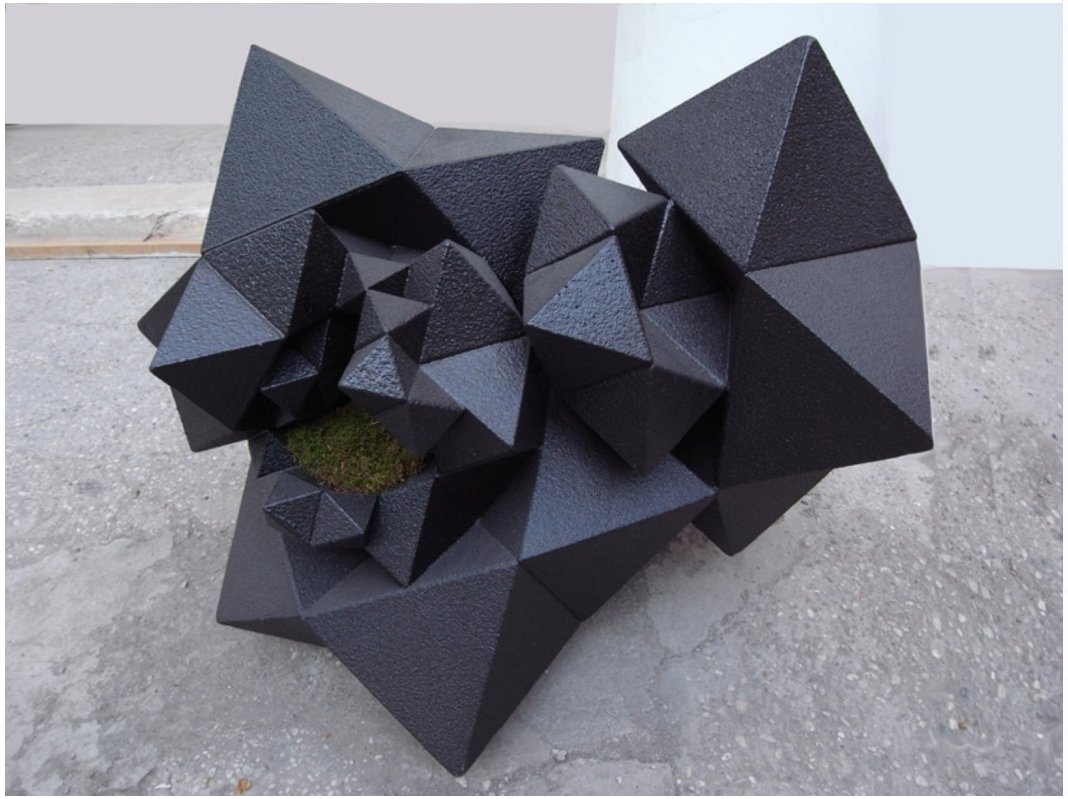
"Primitives“

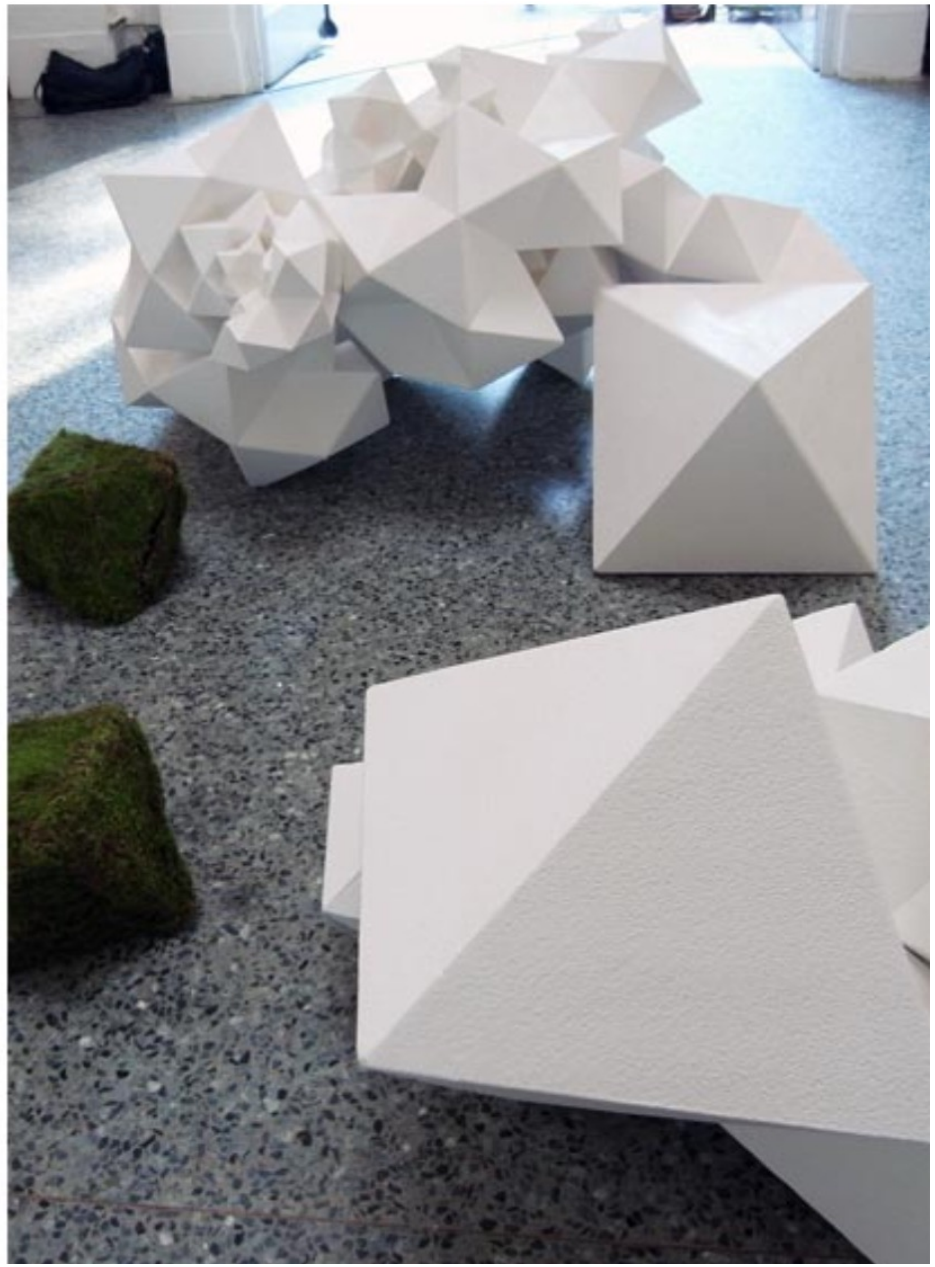
Aranda\Lasch

Recursion & Fractal

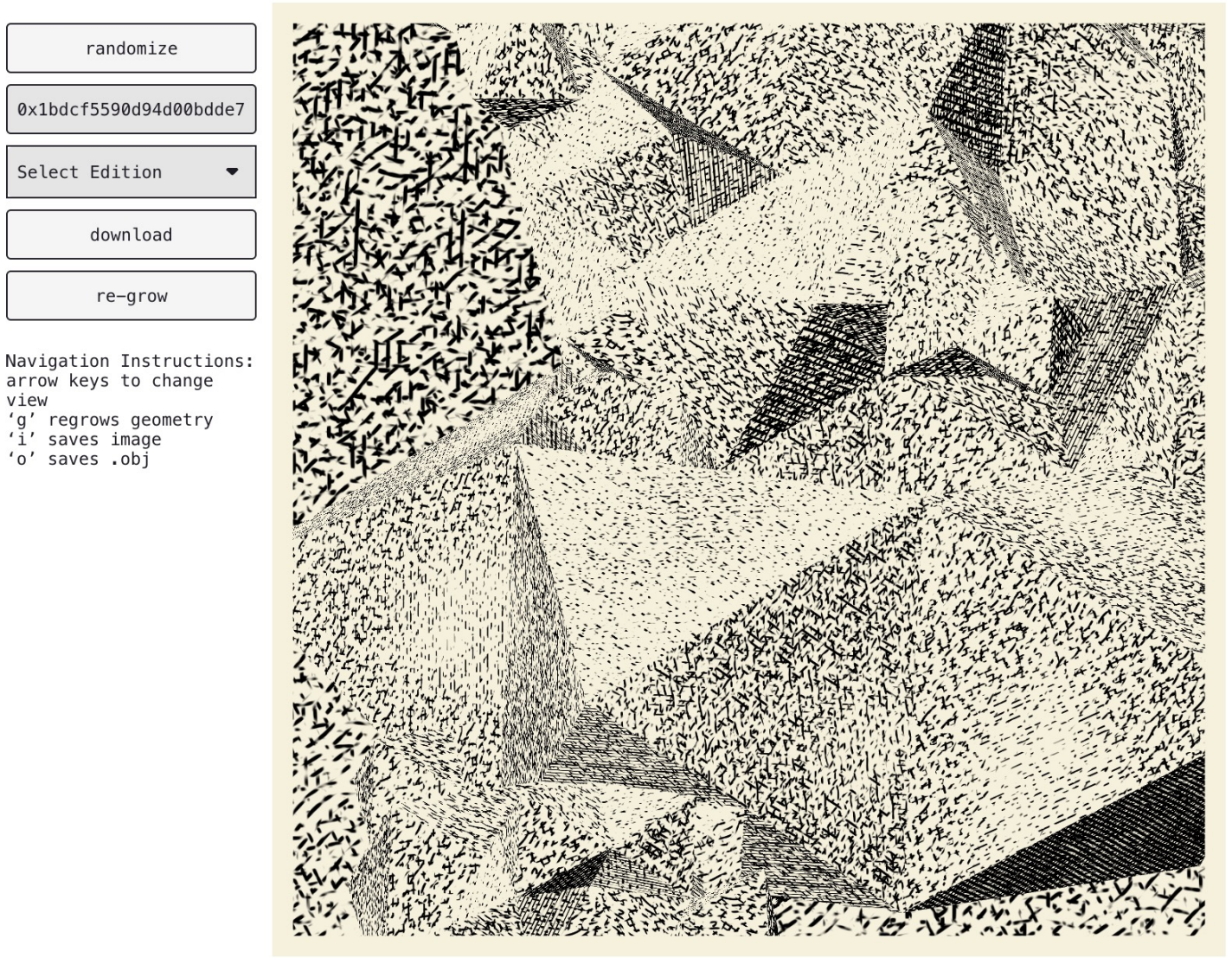
"Primitives“

Aranda\Lasch





Recursion & Fractal



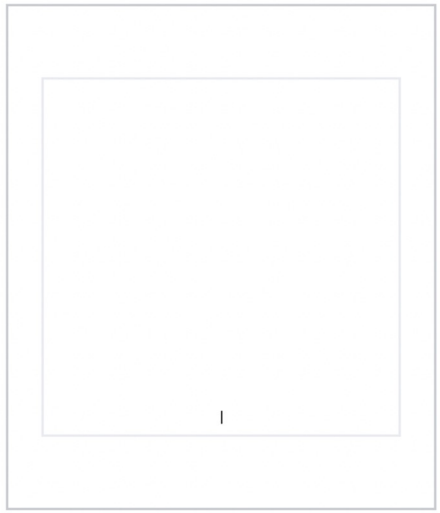
"Primitives“

Aranda\Lasch

- https://arandalasch.com/project/primitives/

Recursion & Fractal

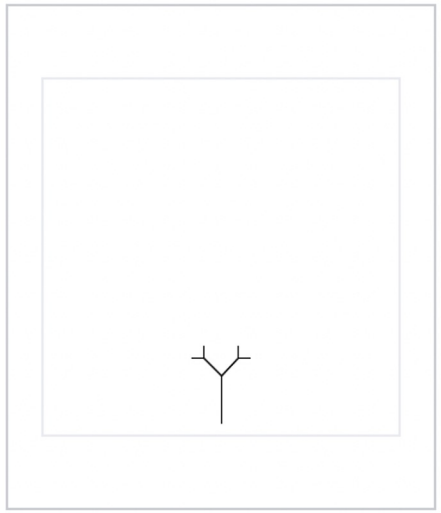
L System



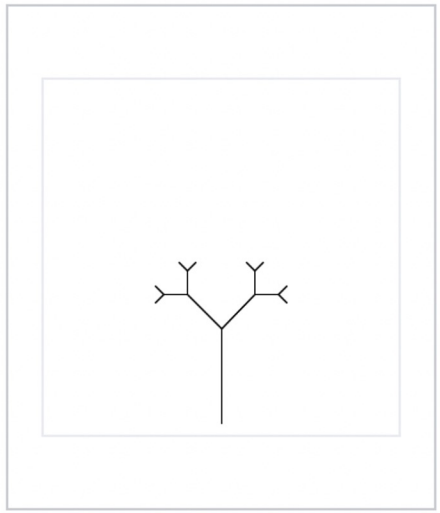
Axiom



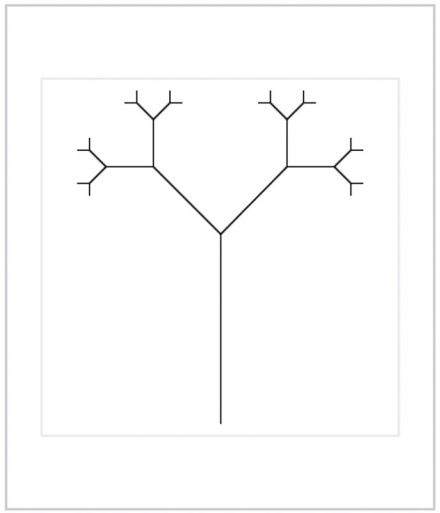
First recursion



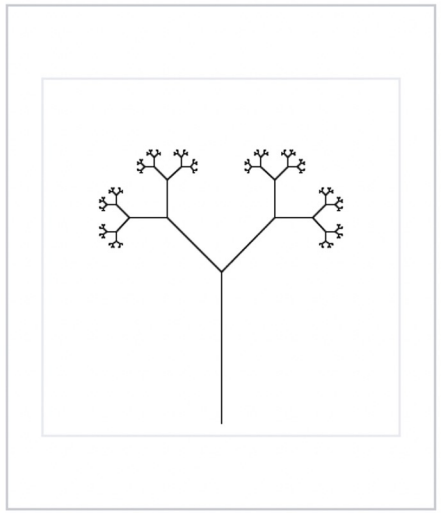
Second recursion



Third recursion



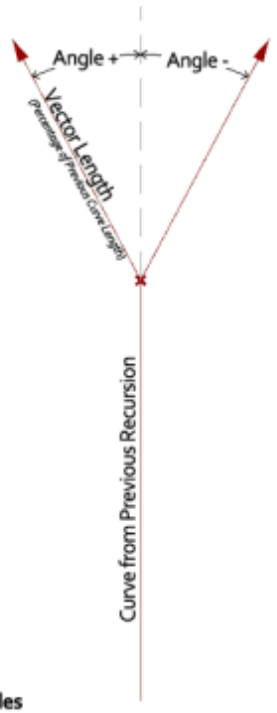
Fourth recursion



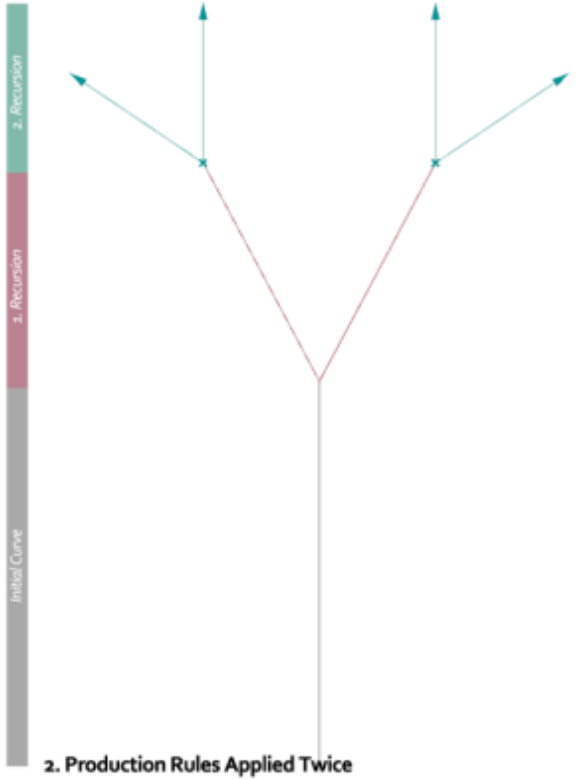
Seventh recursion, scaled down ten times

Recursion & Fractal

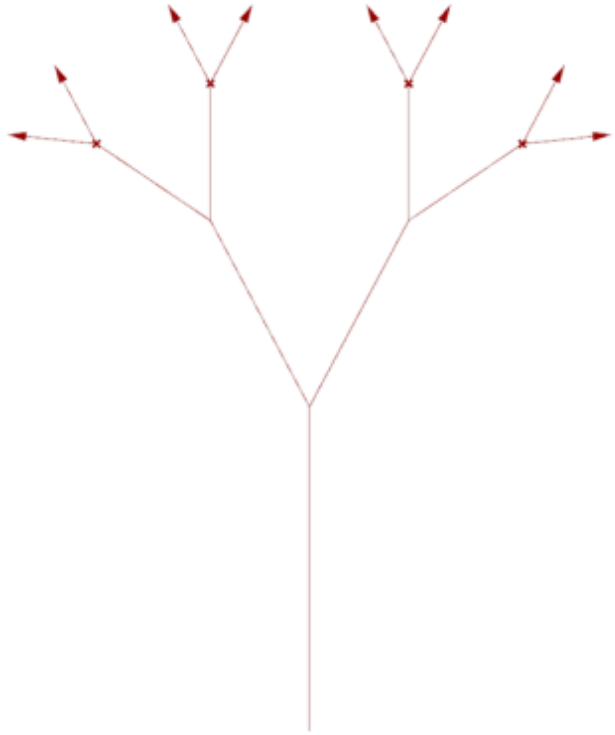
L System



1. Production Rules



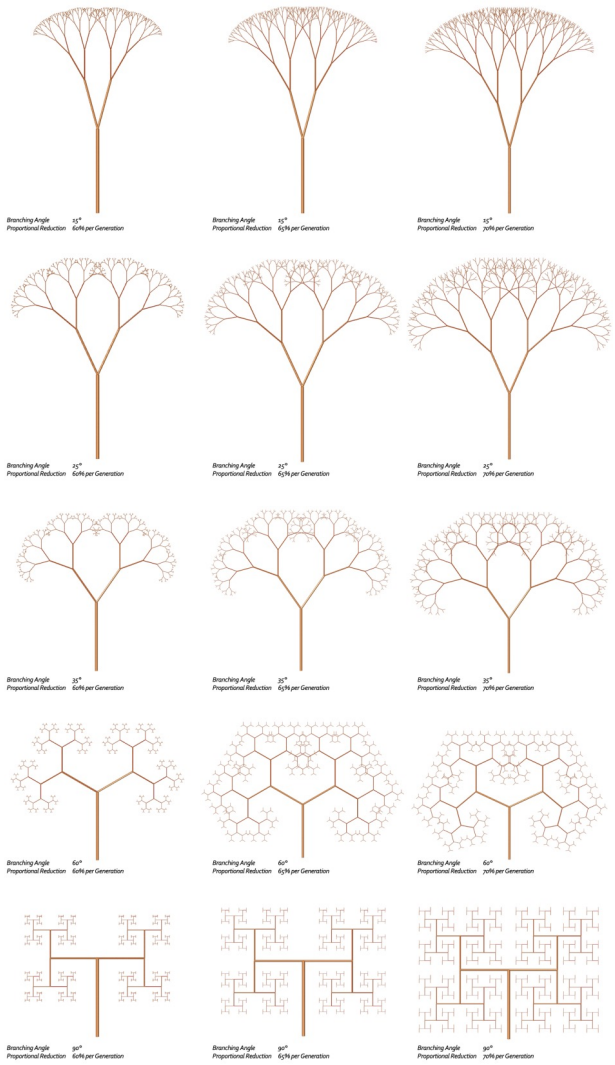
2. Production Rules Applied Twice



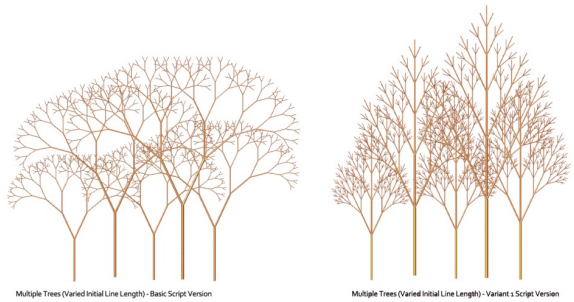
3. Production Rules Applied Three Times

Recursion & Fractal

L System









Recursion & Fractal



L System

Recursion & Fractal



L System

Recursion & Fractal



The Tote

Serie Architects

Recursion & Fractal

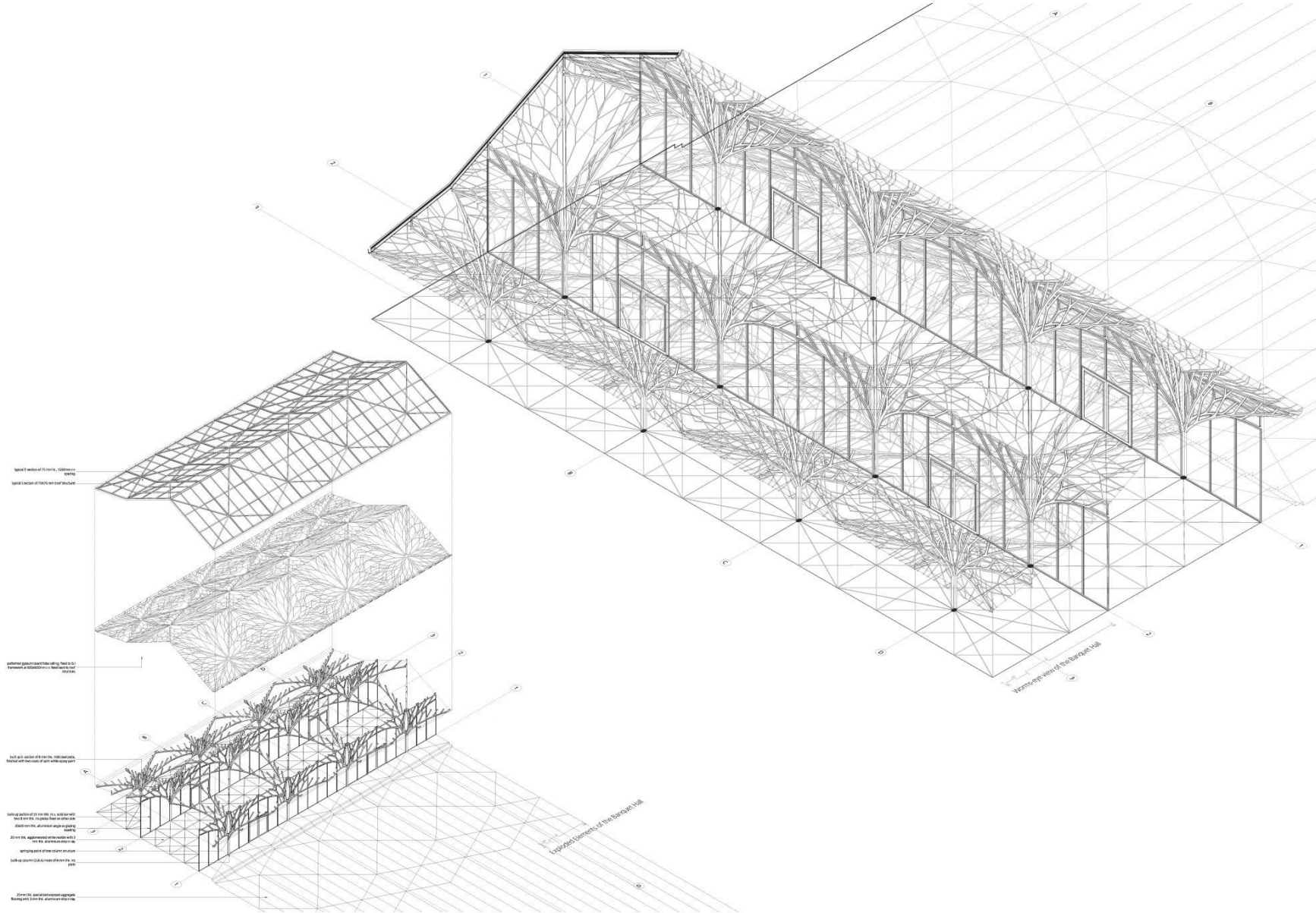




The Tote

Serie Architects

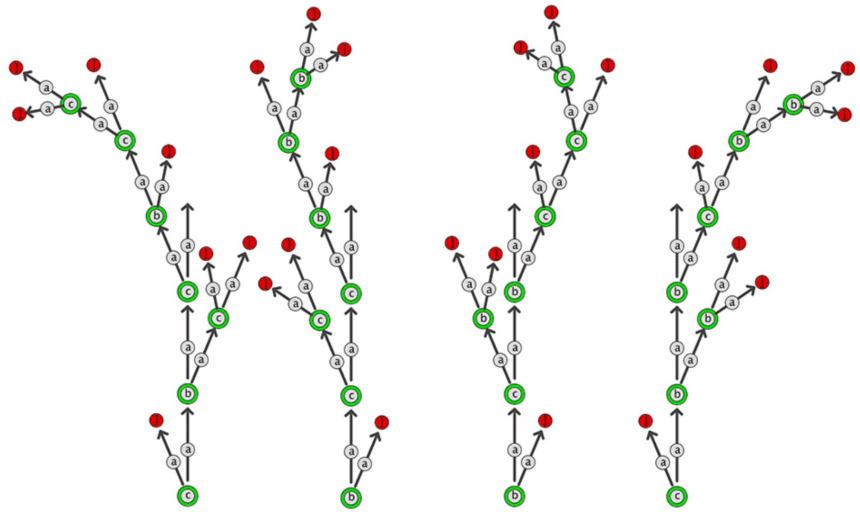
Recursion & Fractal

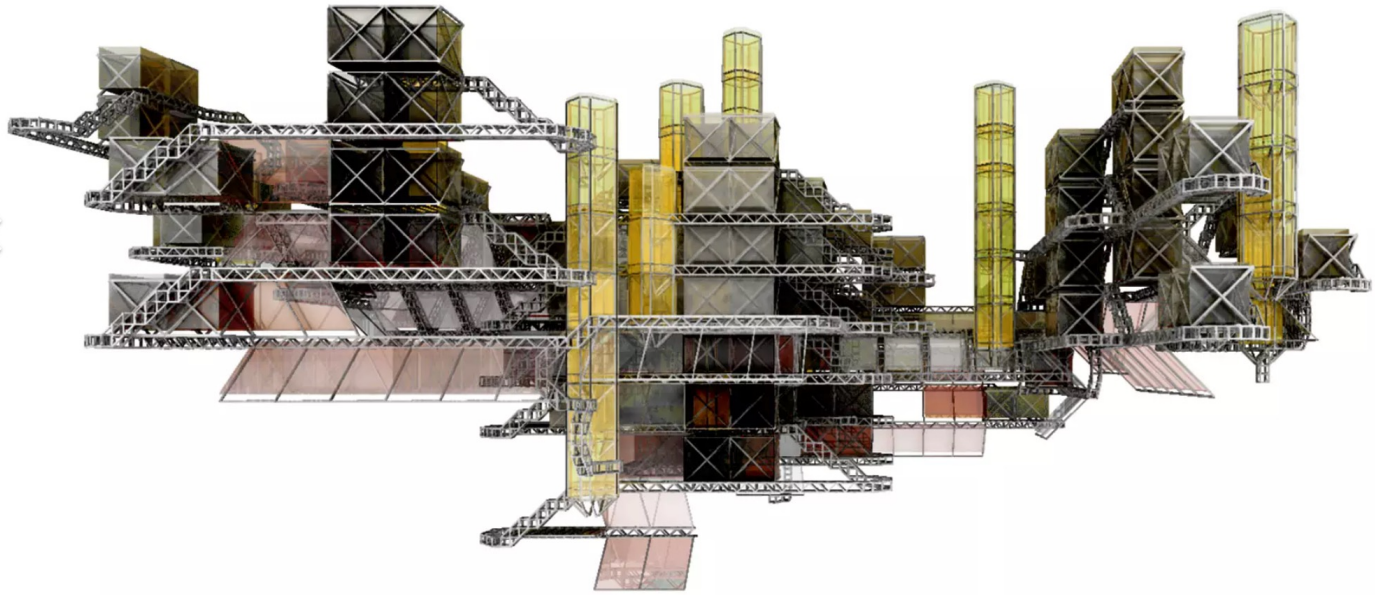


The Tote

Serie Architects

Recursion & Fractal





L Systems

Michael Hansmeyer

https://michael-hansmeyer.com/l-systems

Recursion & Fractal



L Systems

Michael Hansmeyer

https://michael-hansmeyer.com/l-systems

Automata

Automata



“Game of Life”
John Conway, 1974

Automata

“Game of Life”

Rules

For a space that is populated:

Each cell with one or no neighbors dies, as if by solitude.

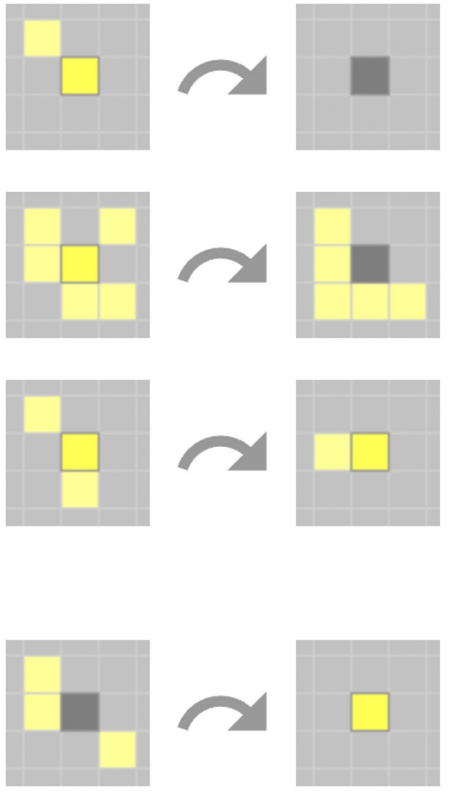
Each cell with four or more neighbors dies, as if by overpopulation.

Each cell with two or three neighbors survives.

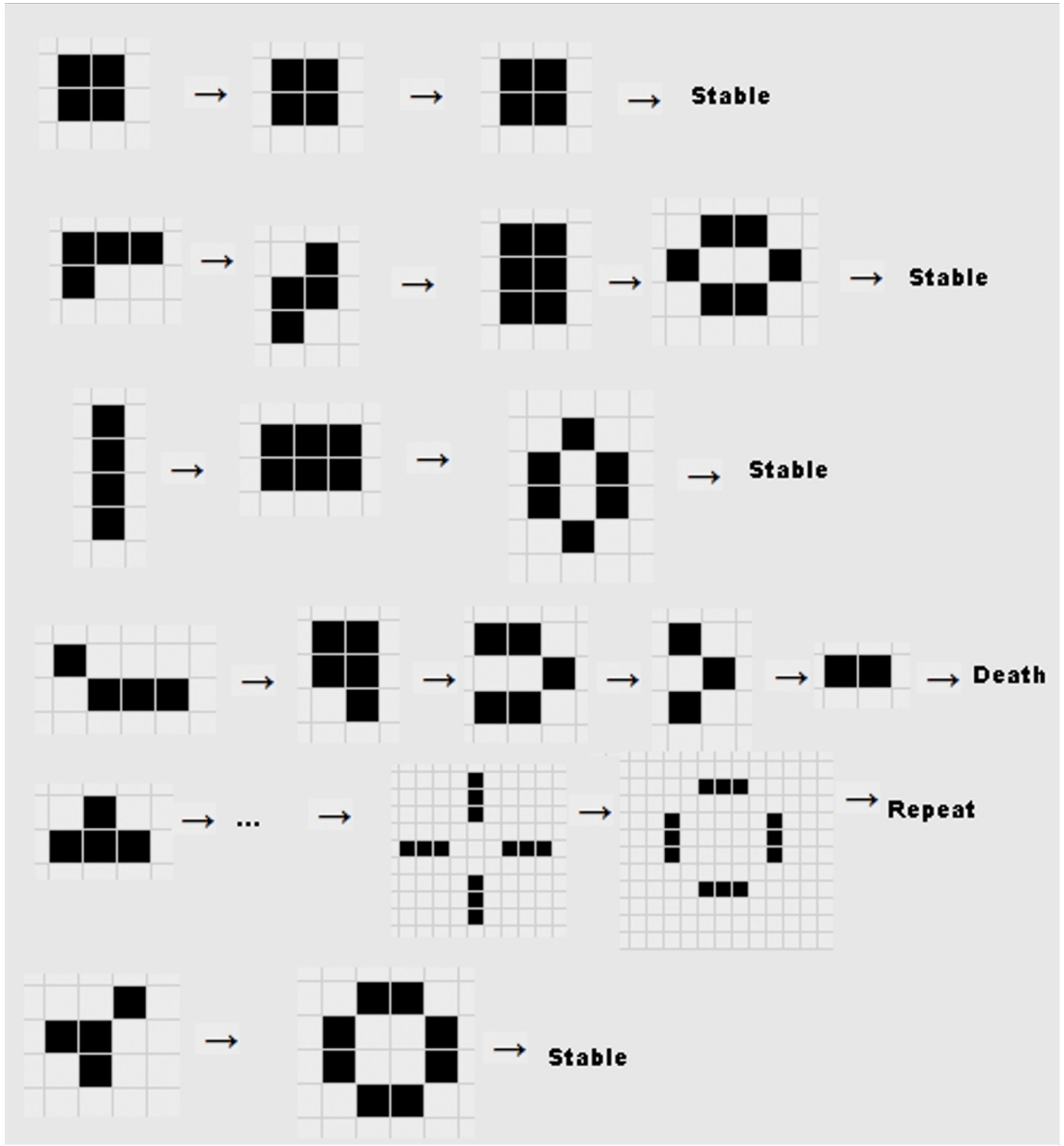
For a space that is empty or unpopulated:

Each cell with three neighbors becomes populated.

Examples

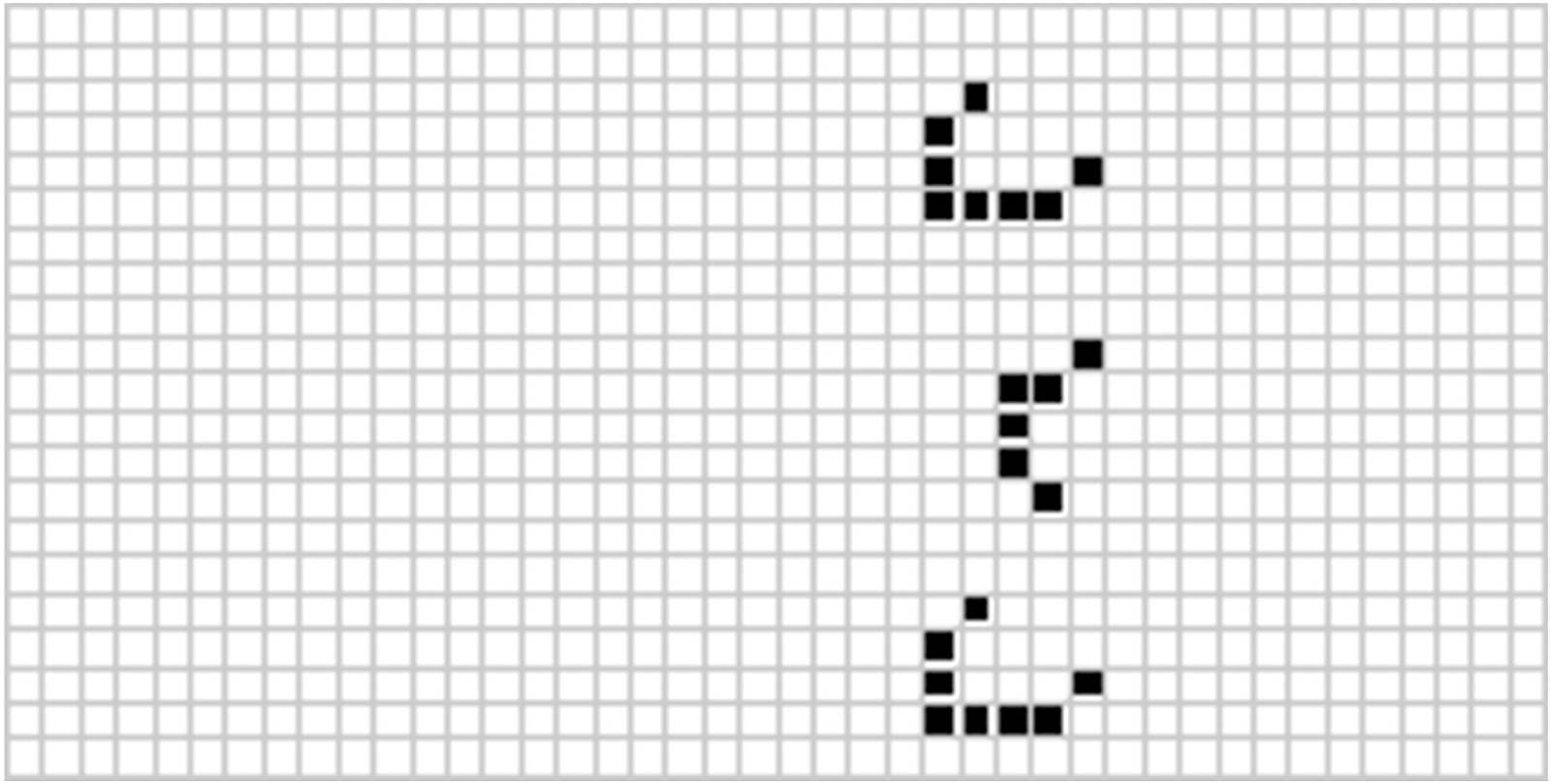


Automata



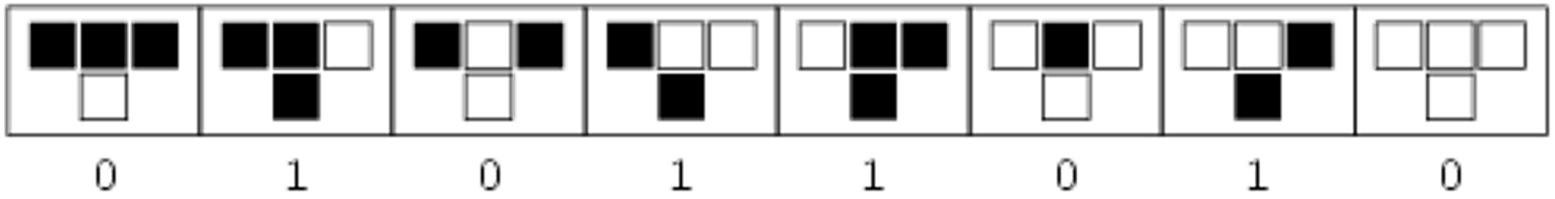
“Game of Life”

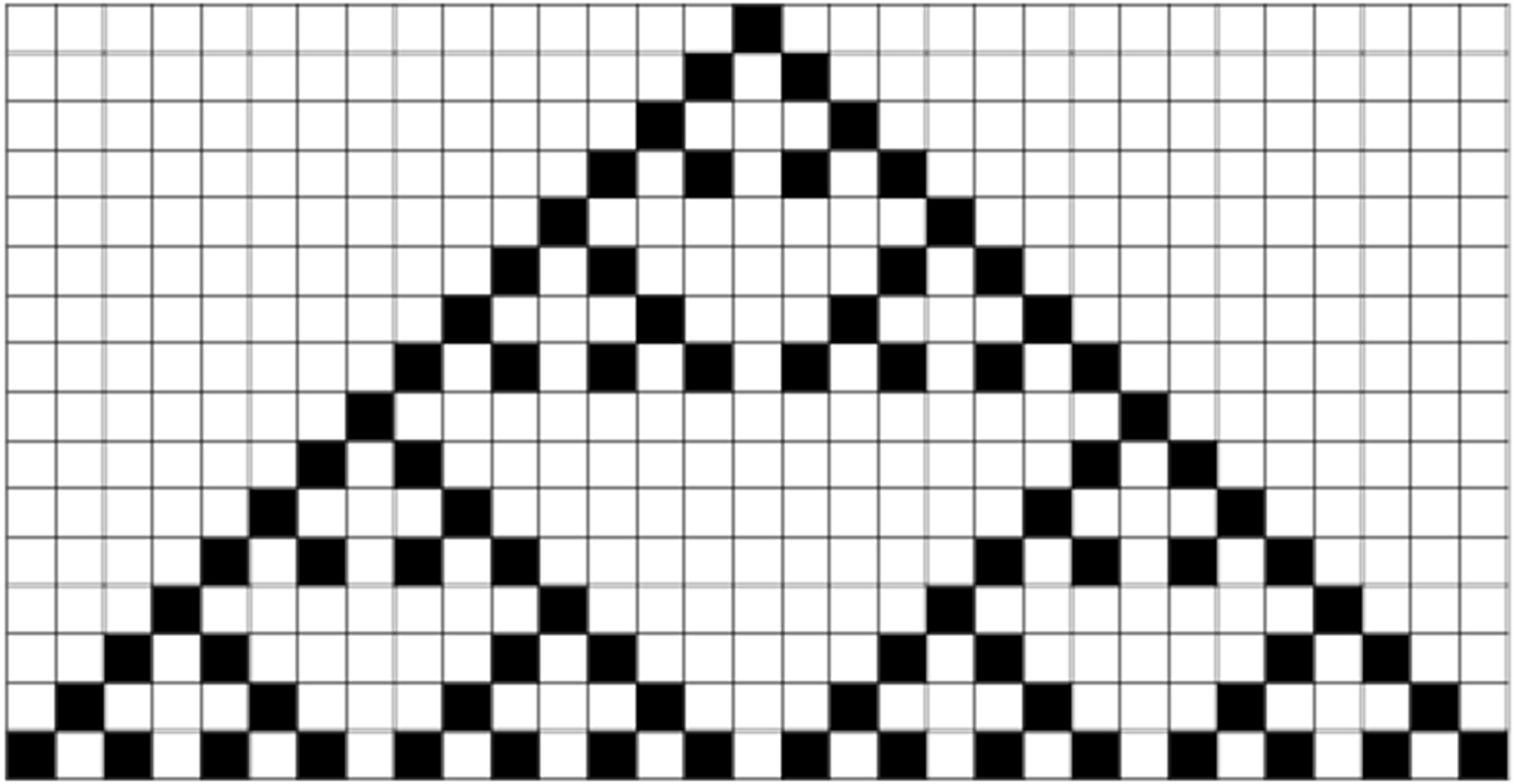
Automata



“Game of Life”

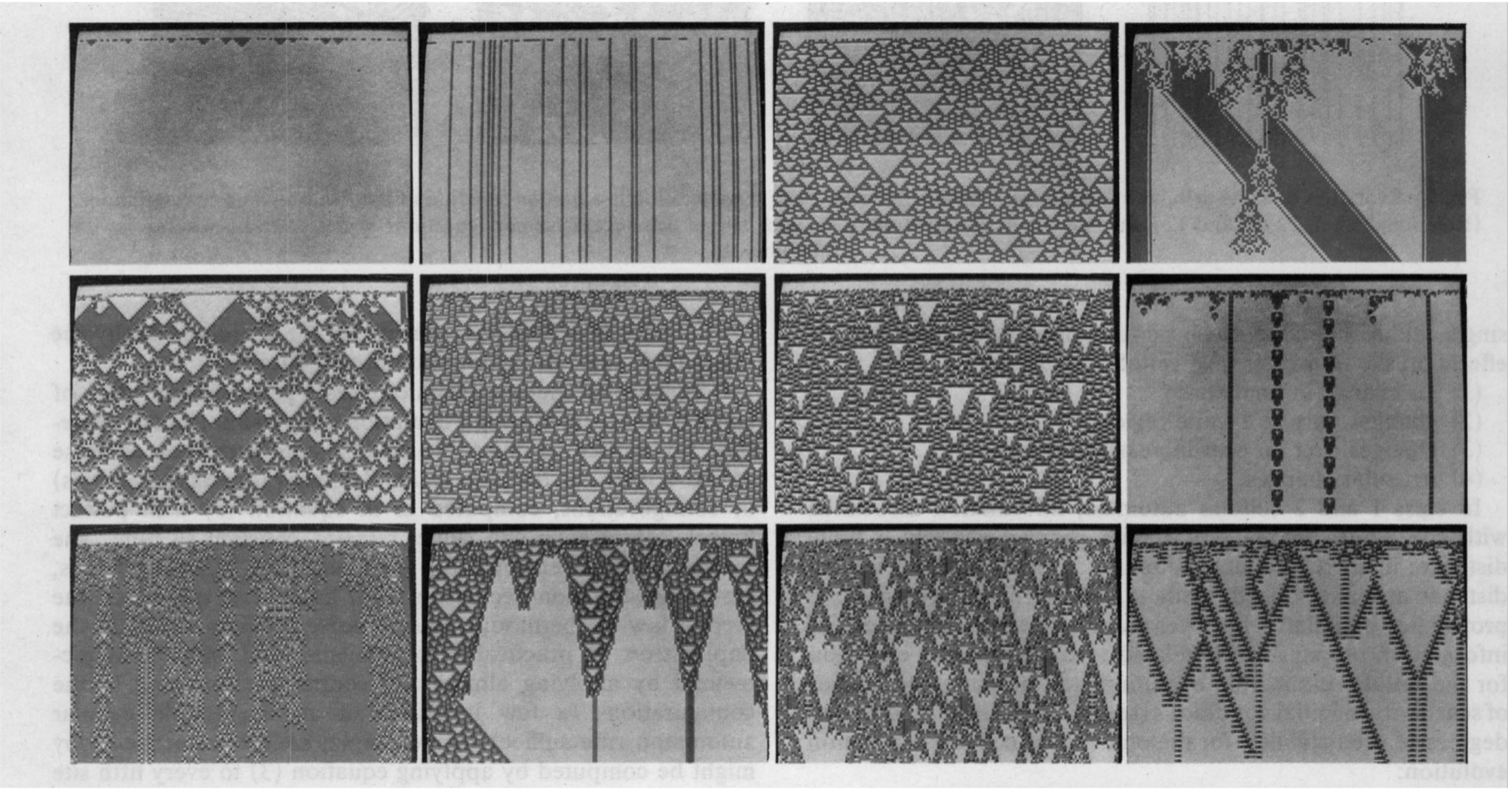
Automata





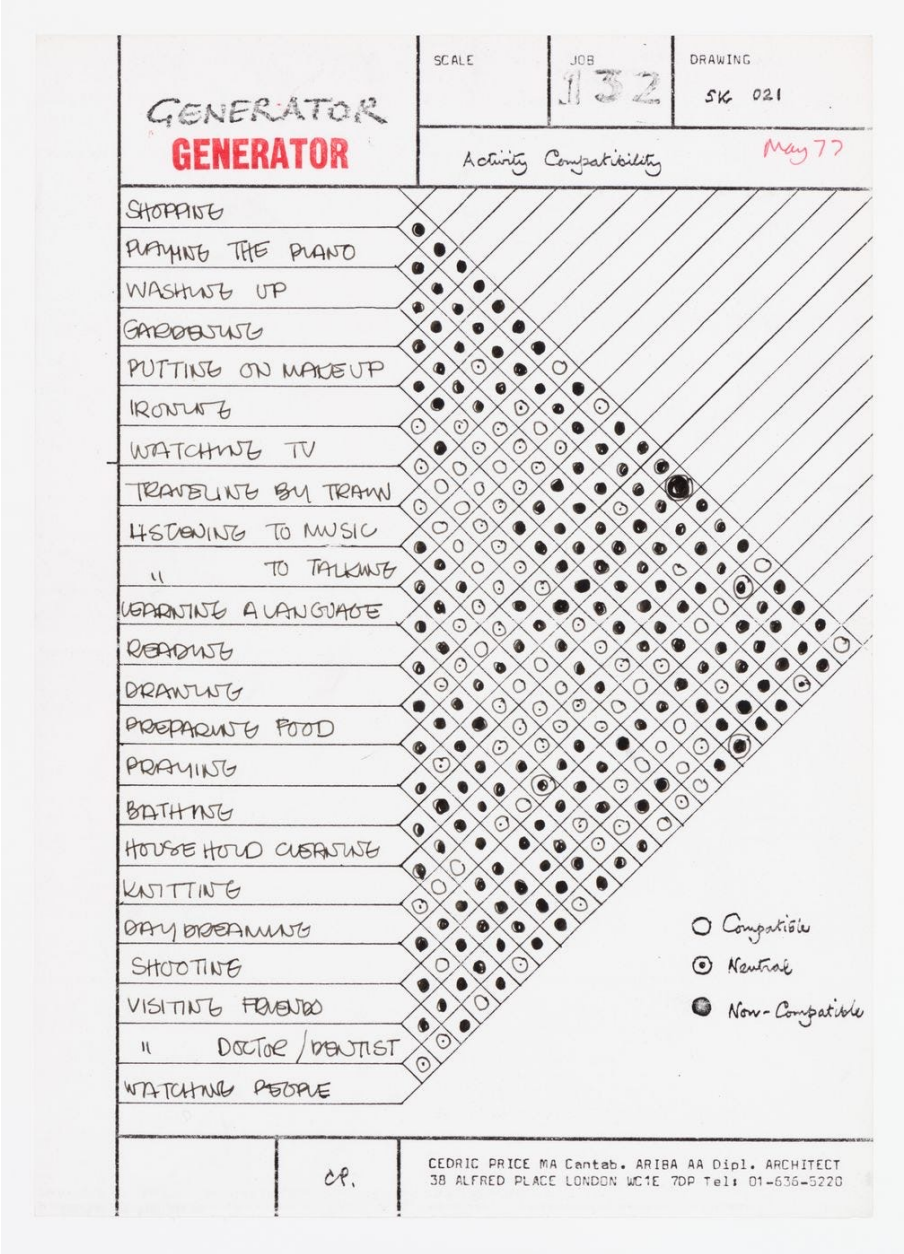
Cellular Automata as Models of Complexity

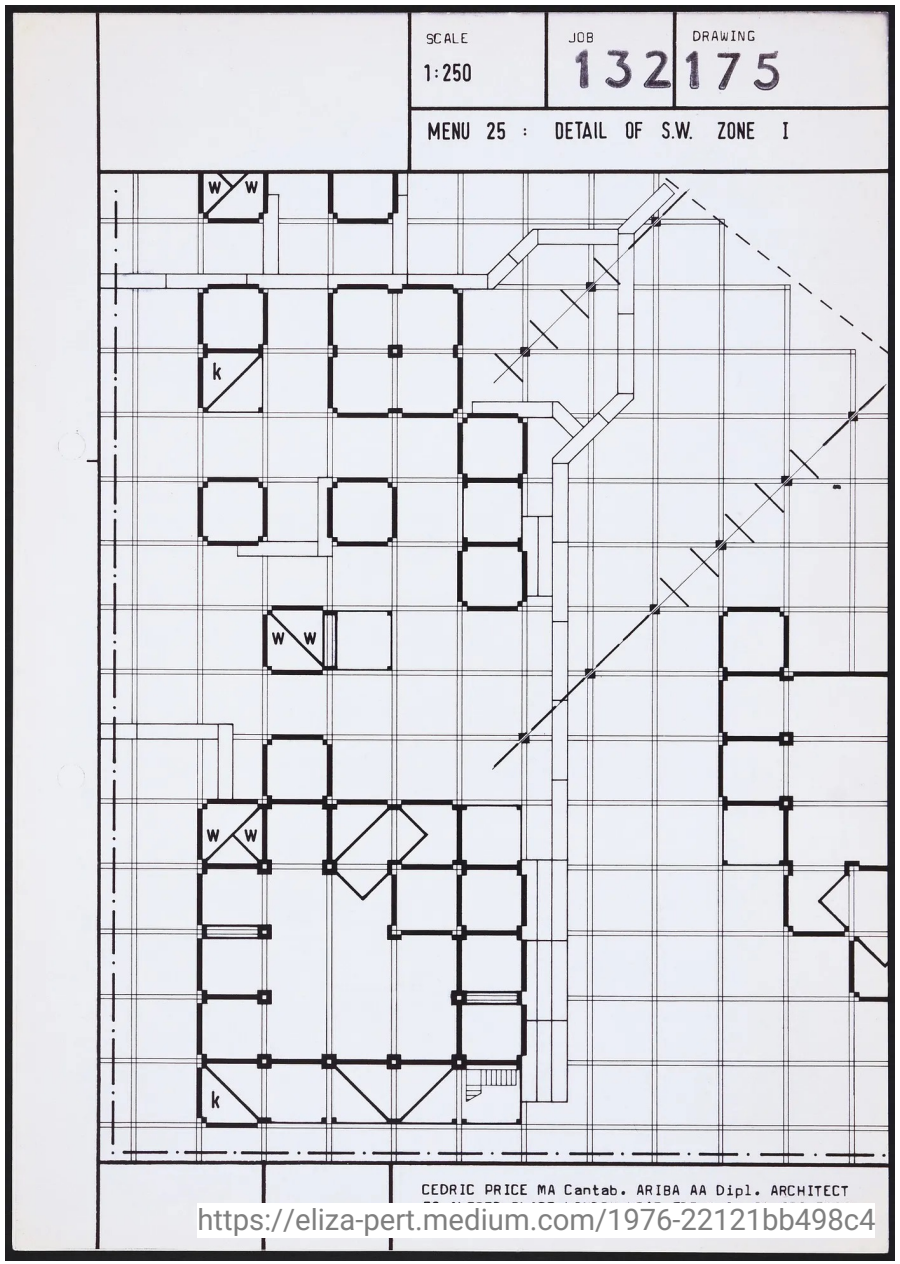
Automata



Cellular Automata as Models of Complexity

Automata



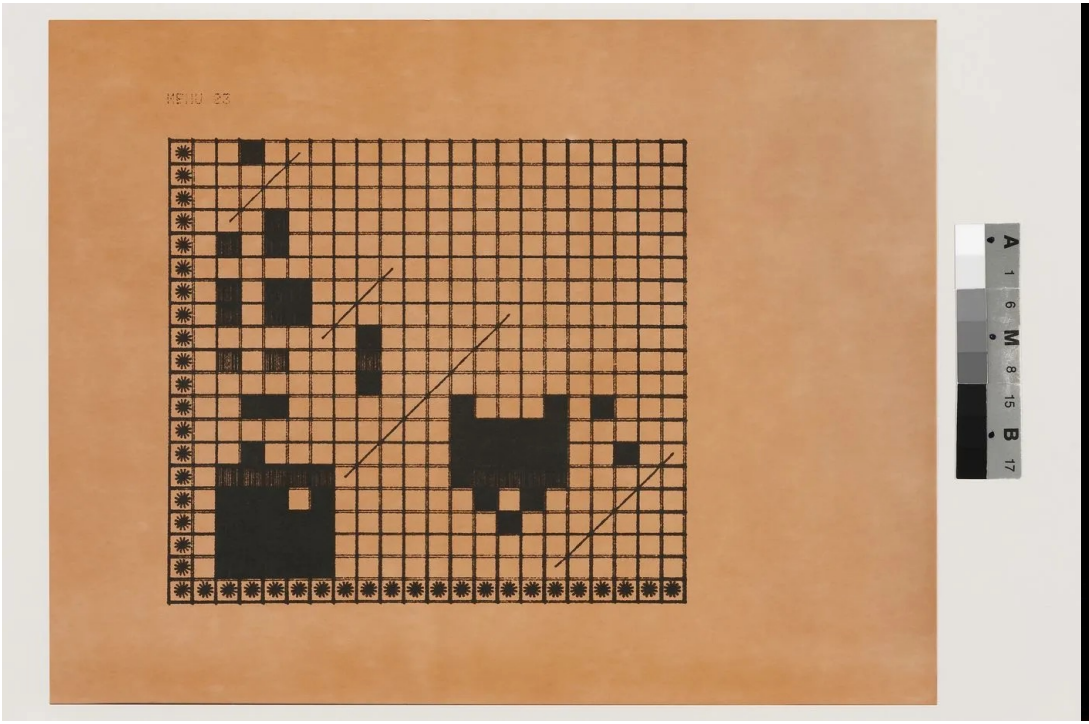


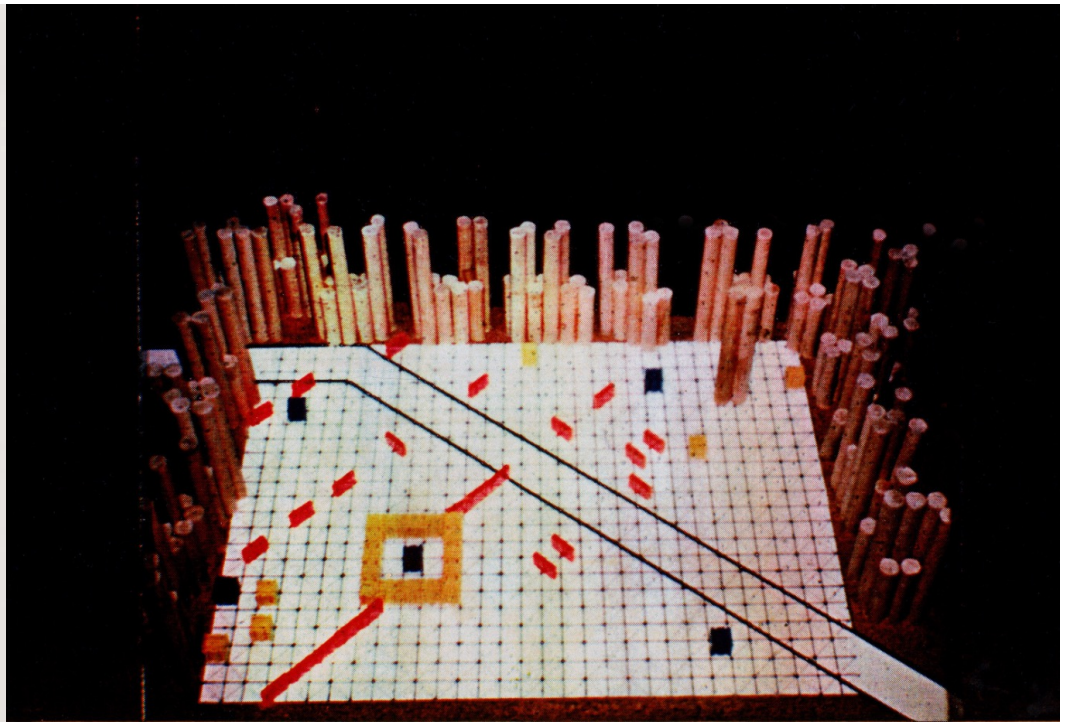
The Generator project

Cedric Price 1976

https://eliza-pert.medium.com/1976-22121bb498c4

Automata

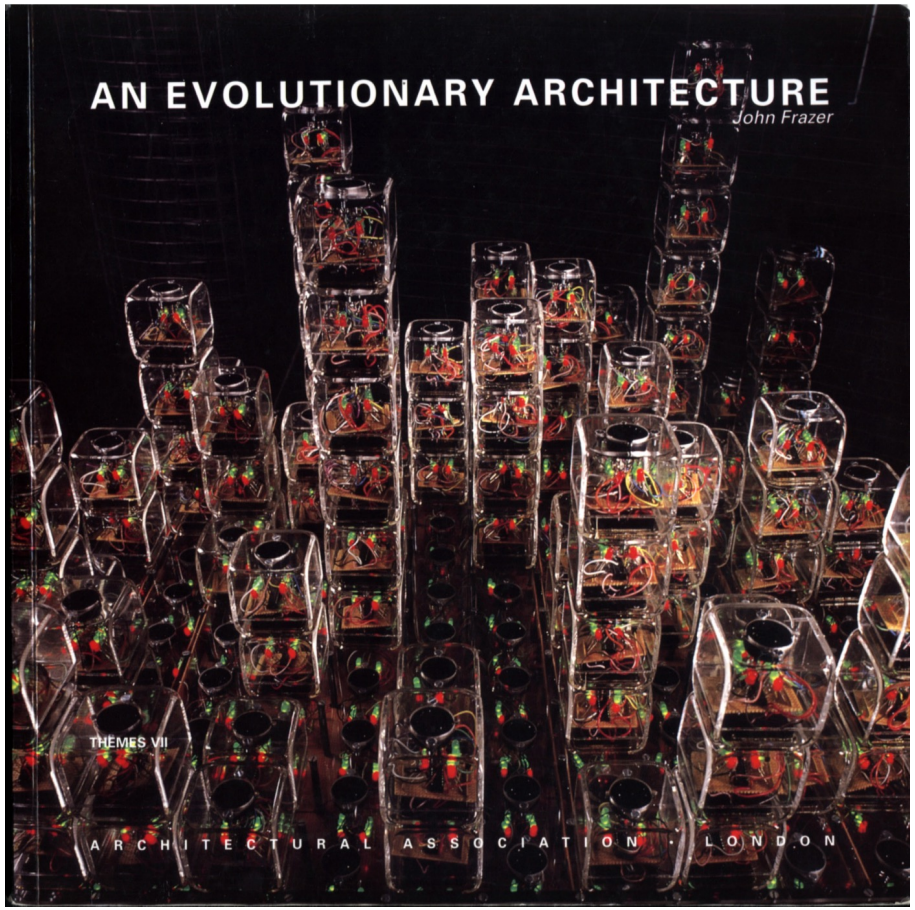


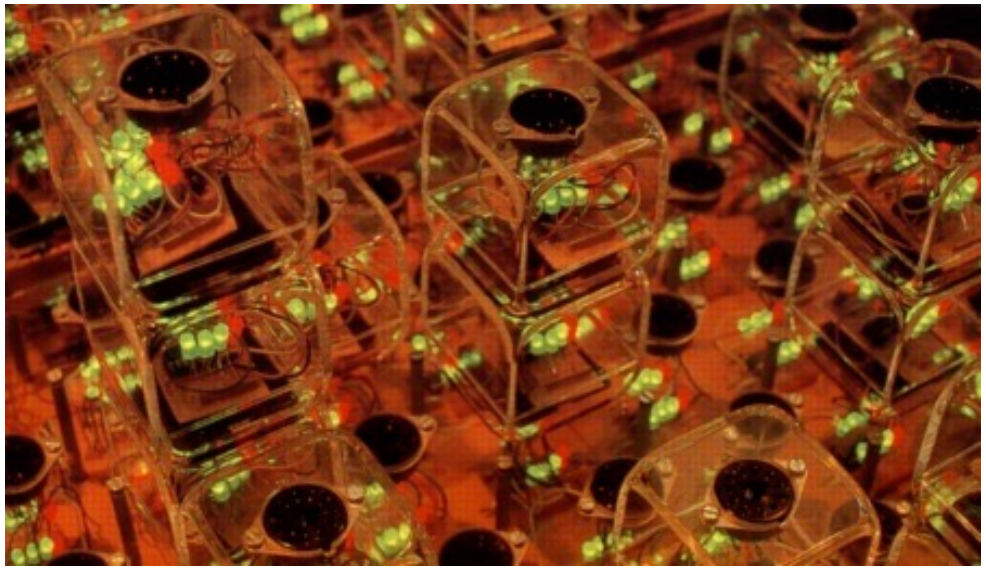


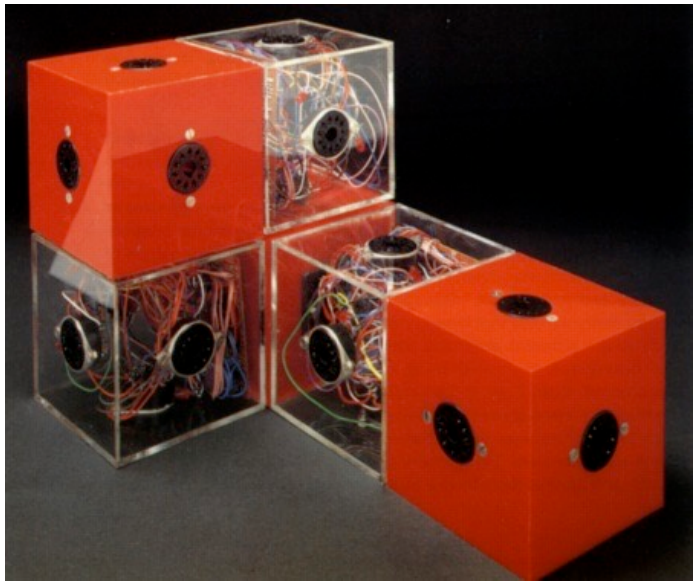
The Generator project

Cedric Price 1976

Automata



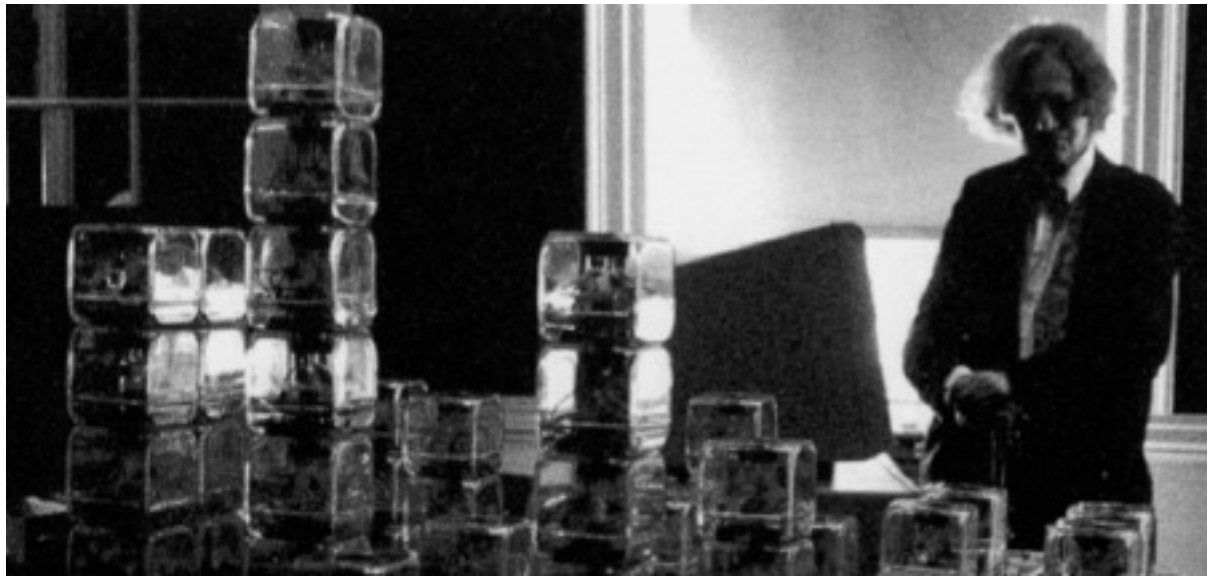




Universal Constructor

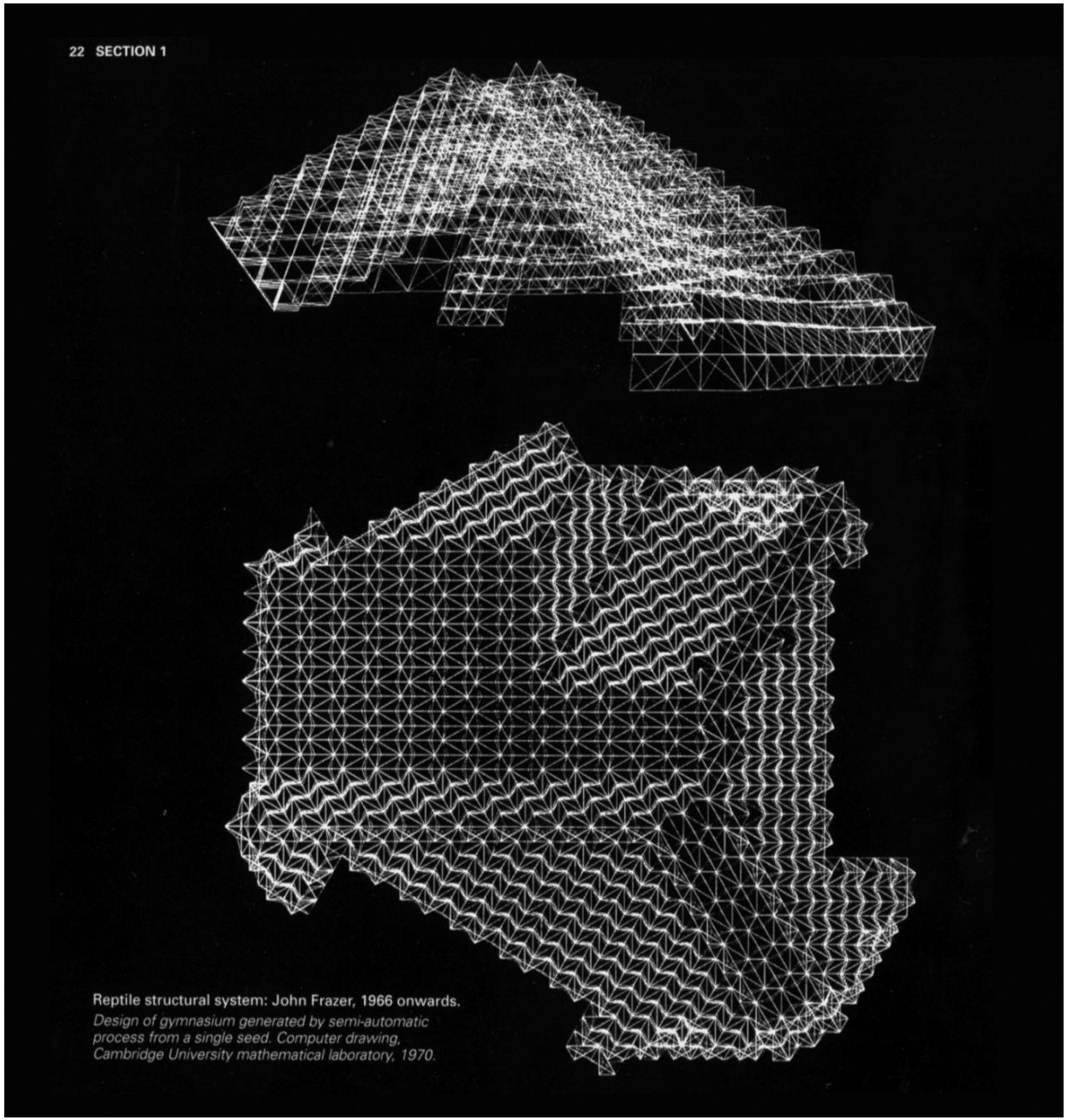
John Frazer, 1980s

Automata

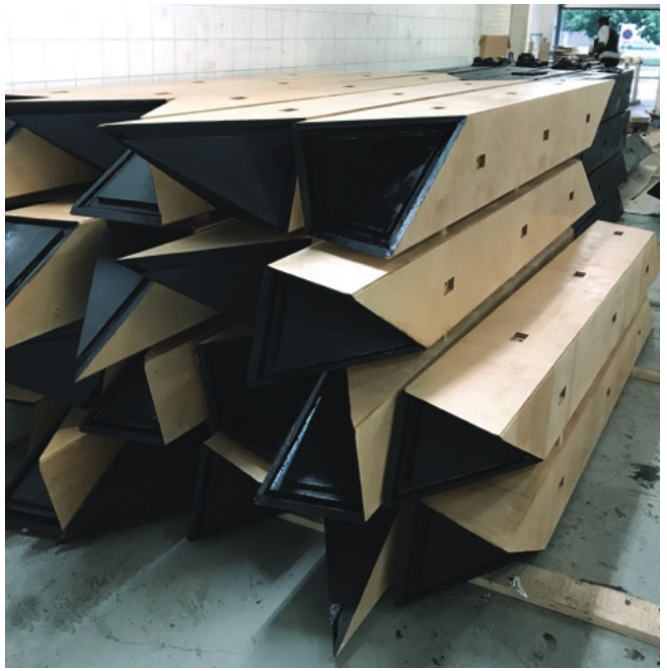


Universal Constructor

John Frazer, 1980s



Automata

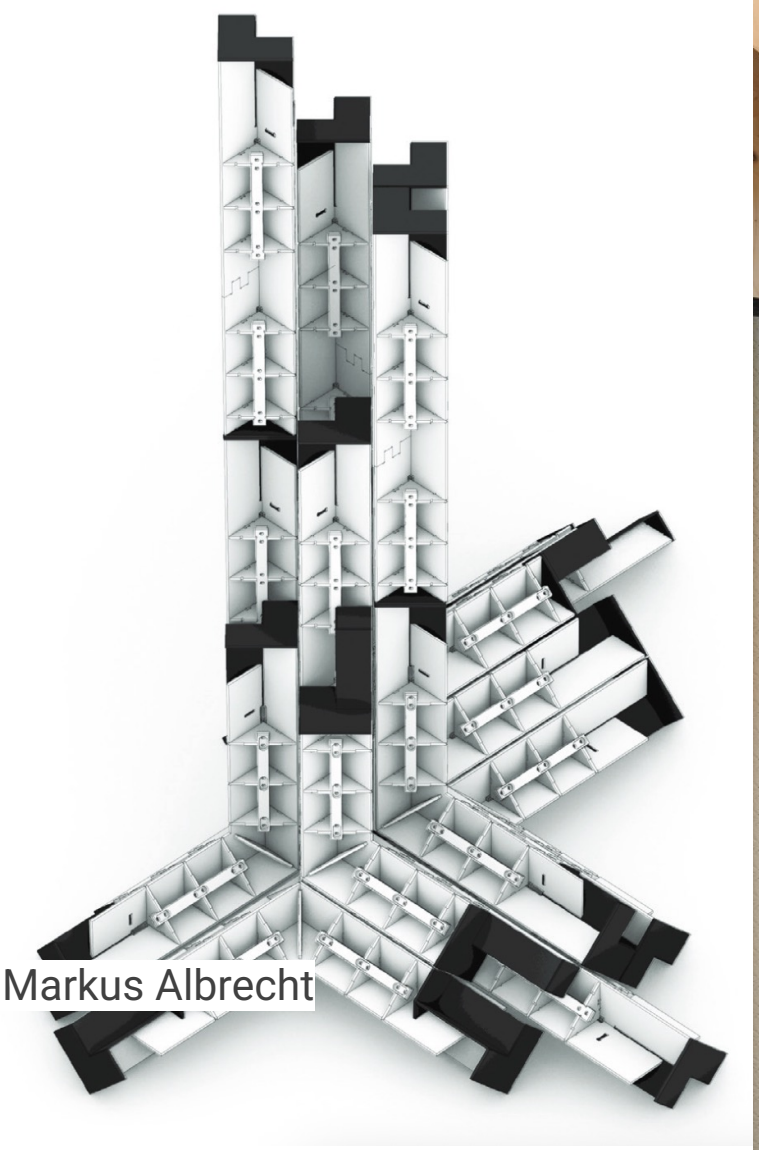


Discrete Automata

Gilles Retsin / Stephan Markus Albrecht



Automata



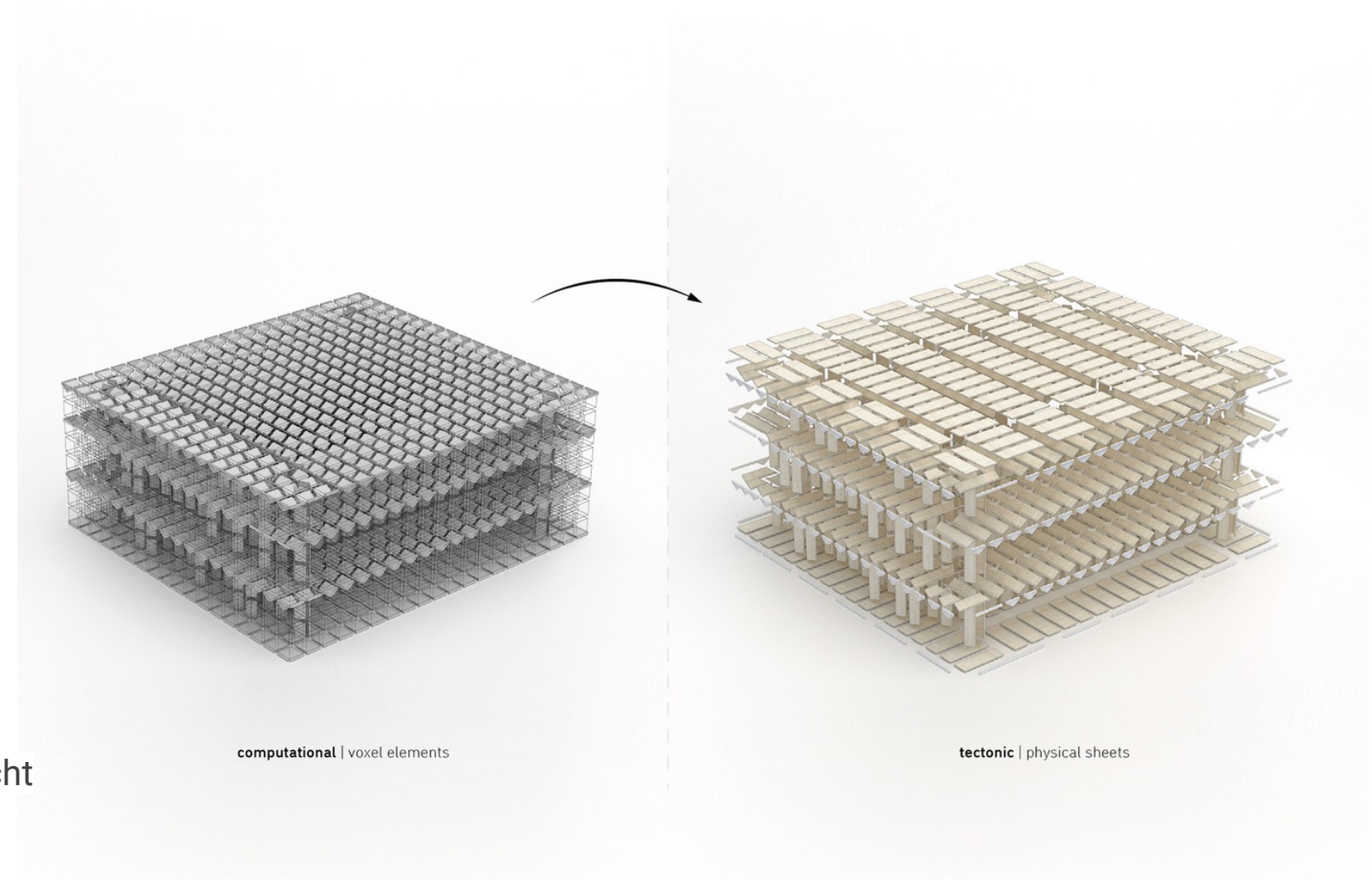
Discrete Automata

Gilles Retsin / Stephan Markus Albrecht



https://papers.cumincad.org/data/works/att/acadia19_532.pdf

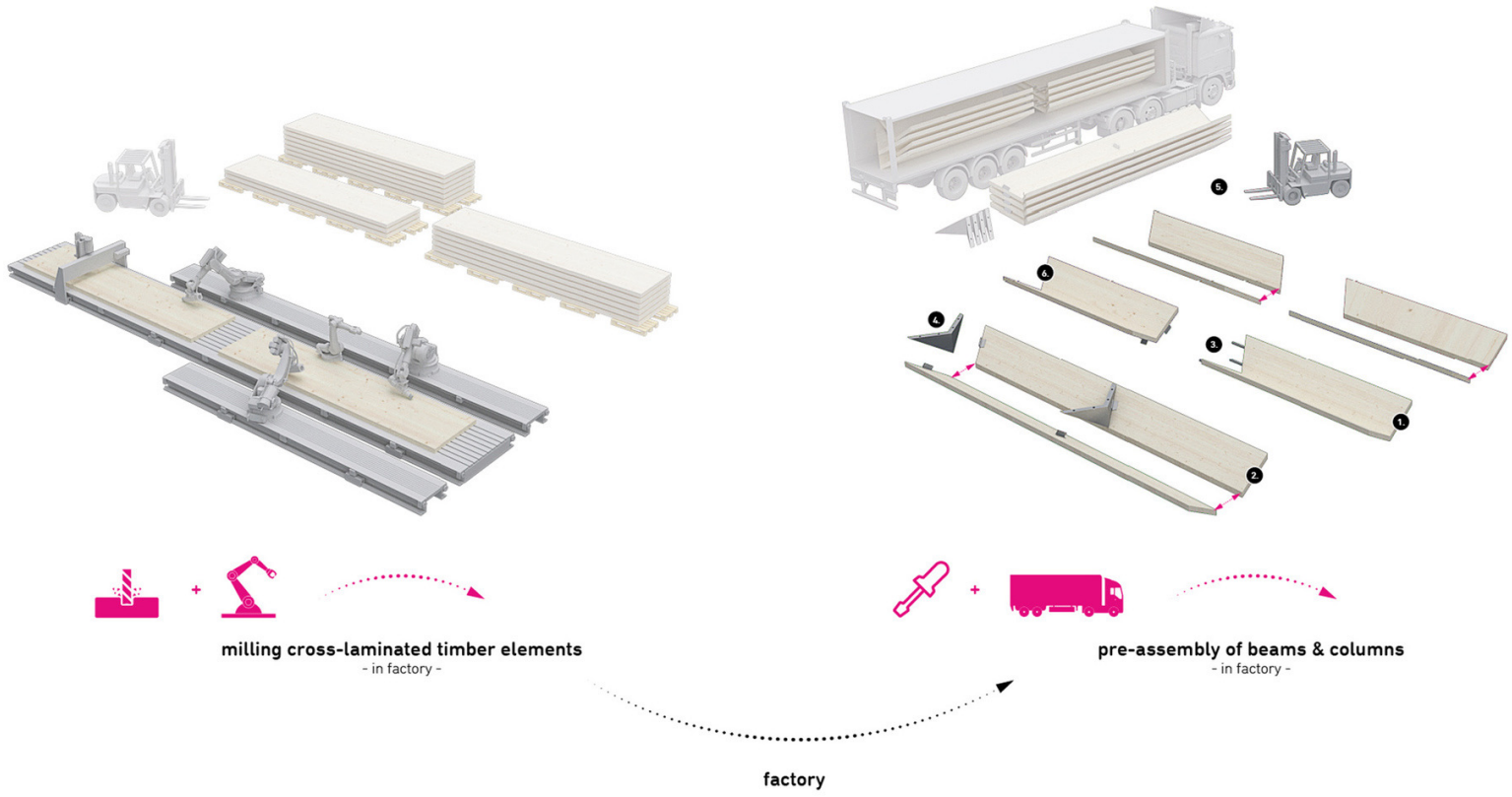
Automata



Discrete Automata

Gilles Retsin / Stephan Markus Albrecht

Automata



Discrete Automata

Gilles Retsin / Stephan Markus Albrecht

Automata

Discrete Automata:

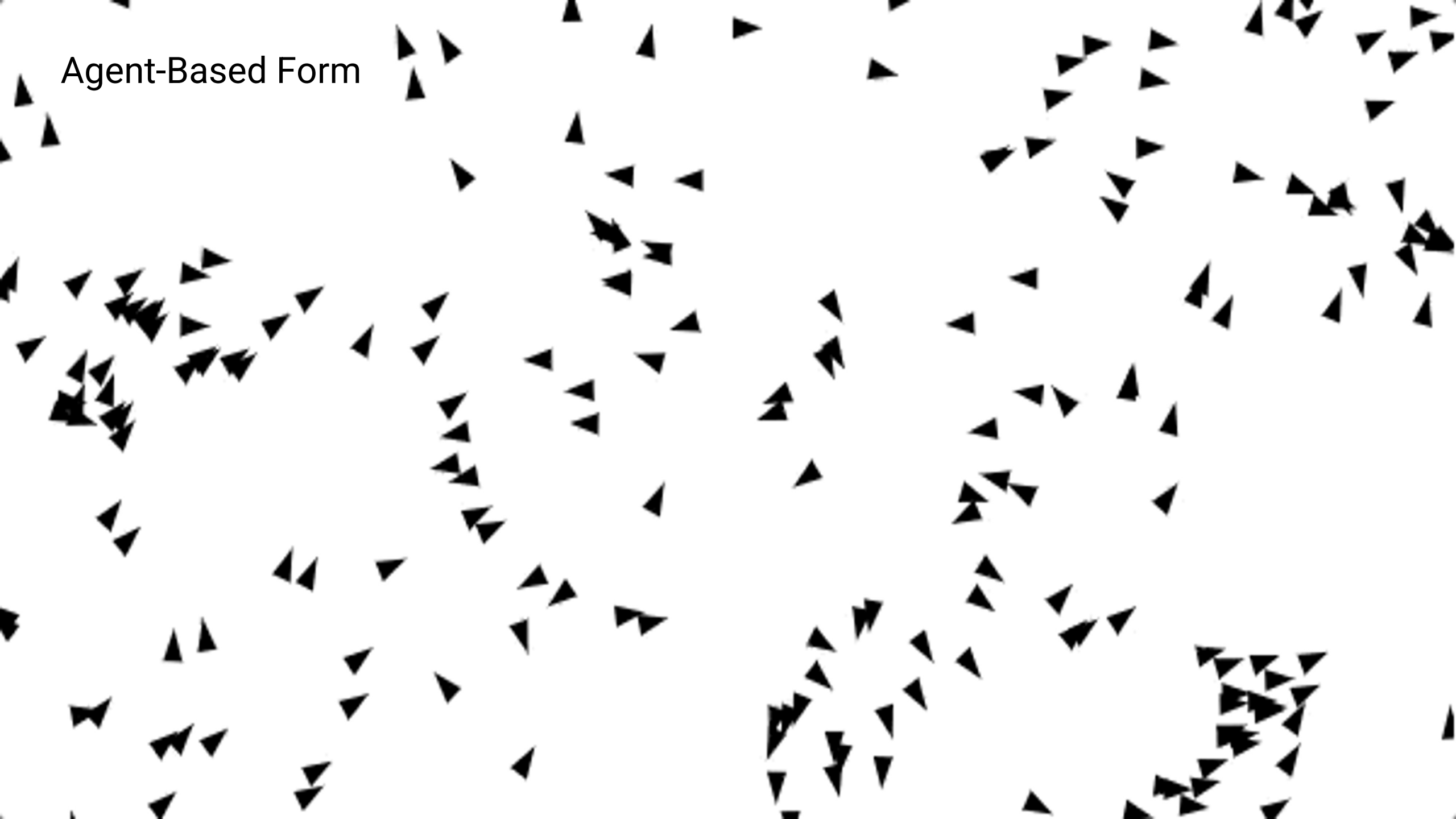
Nuremberg Concert Hall

Gilles Retsin / Stephan Markus Albrecht

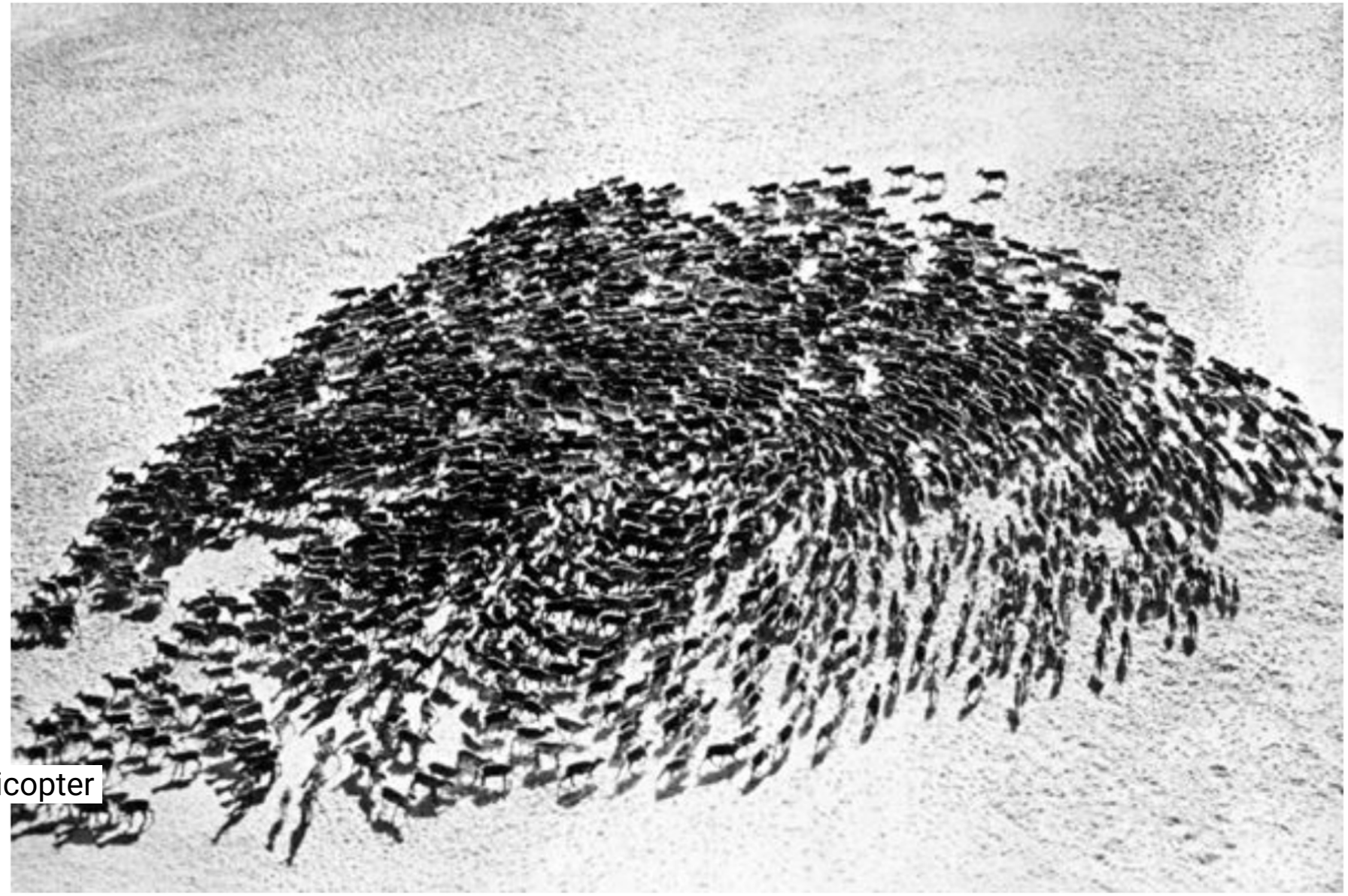


Agent-Based Form

Agent-Based Form

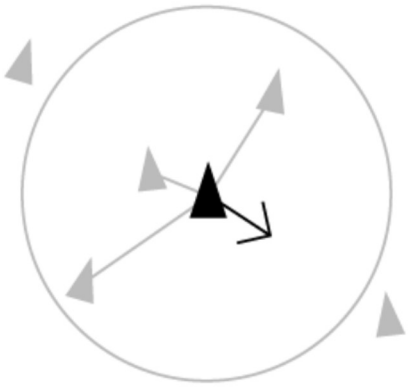


Agent-Based Form

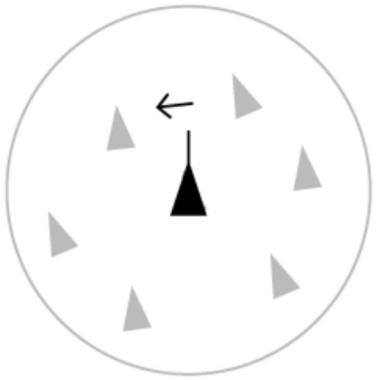


Flocks, Swarms, Crowds.
Reindeer Herd Reacting to Helicopter Overhead.
Oto Bihalji-Merin,1966

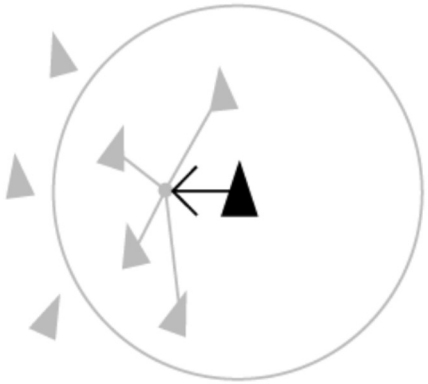
Agent-Based Form



Separation:
Steer to avoid crowding local flockmates



Alignment:
Steer toward the average heading of local flockmates



Cohesion:
Steer to move toward the average position of local flockmates

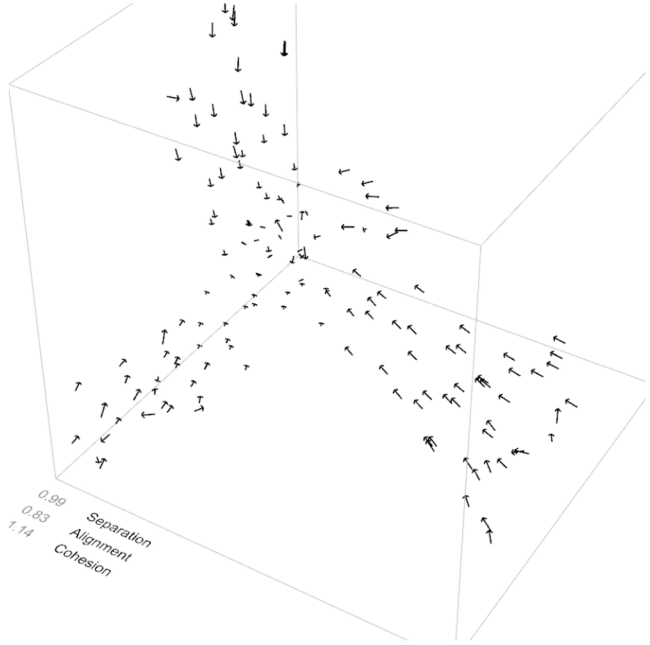
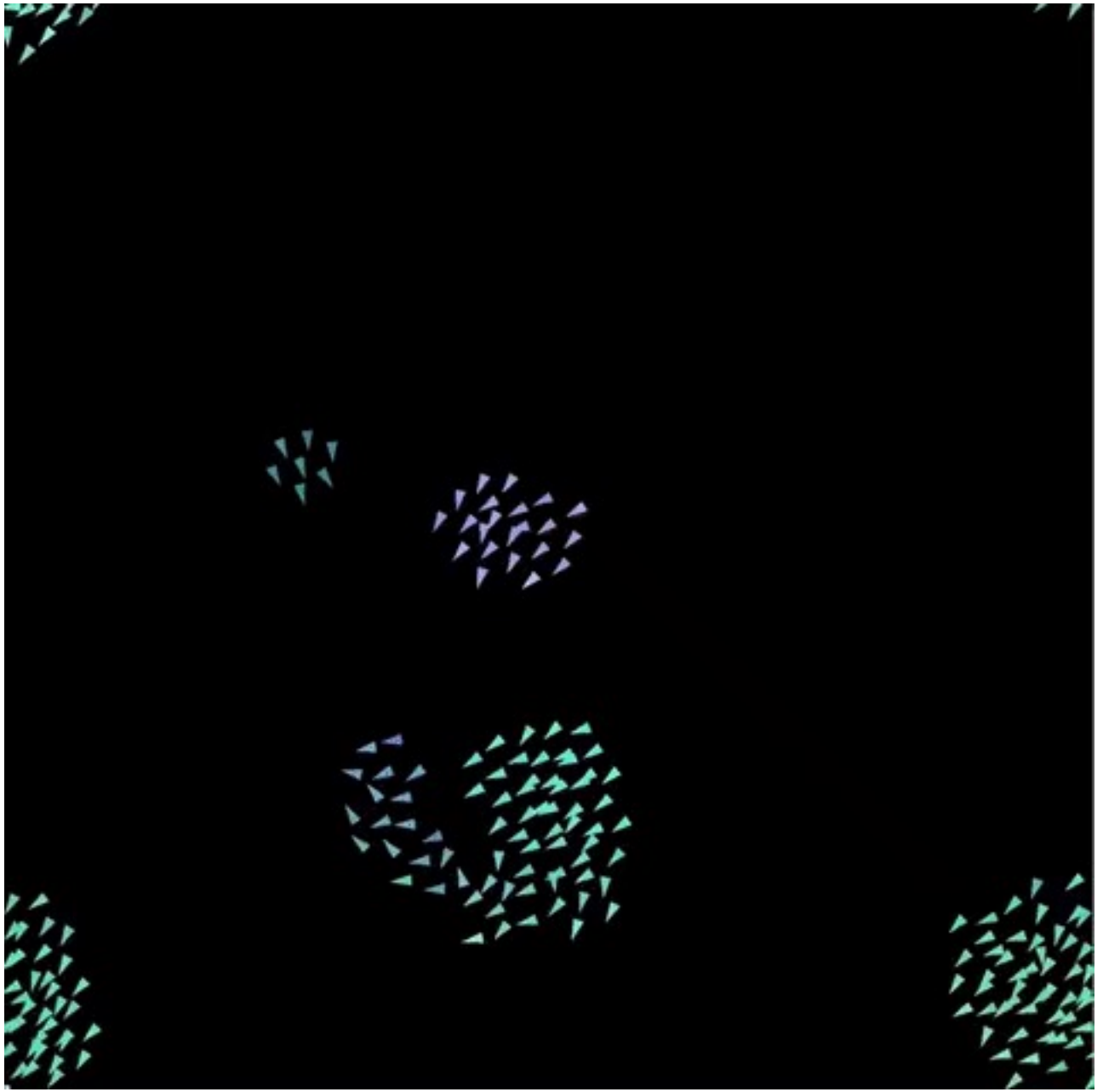
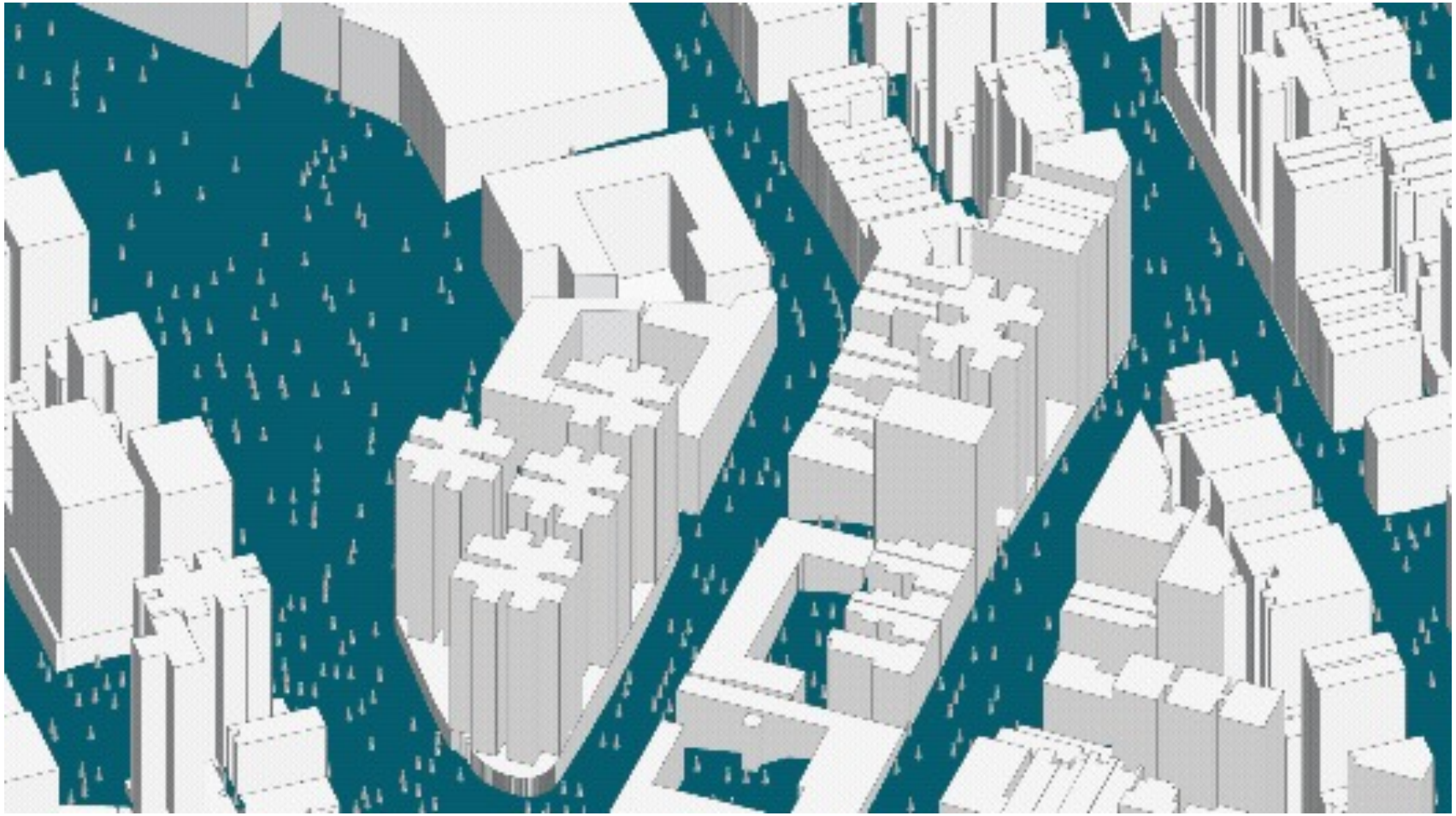


Figure 12.3: (*above*) The three behaviors of Craig Reynolds‘ Boids, with a representation of the flocking behavior shown below.

Agent-Based Form



Agent-Based Form



Pedestrian Simulation
In Grasshopper (PedSim)

Agent-Based Form



Pedestrian Simulation
In Grasshopper (PedSim)

Agent-Based Form

Agent Based Modeling
In Grasshopper (Quelea)



https://www.food4rhino.com/en/app/quelea-agent-based-design-grasshopper

Agent-Based Form

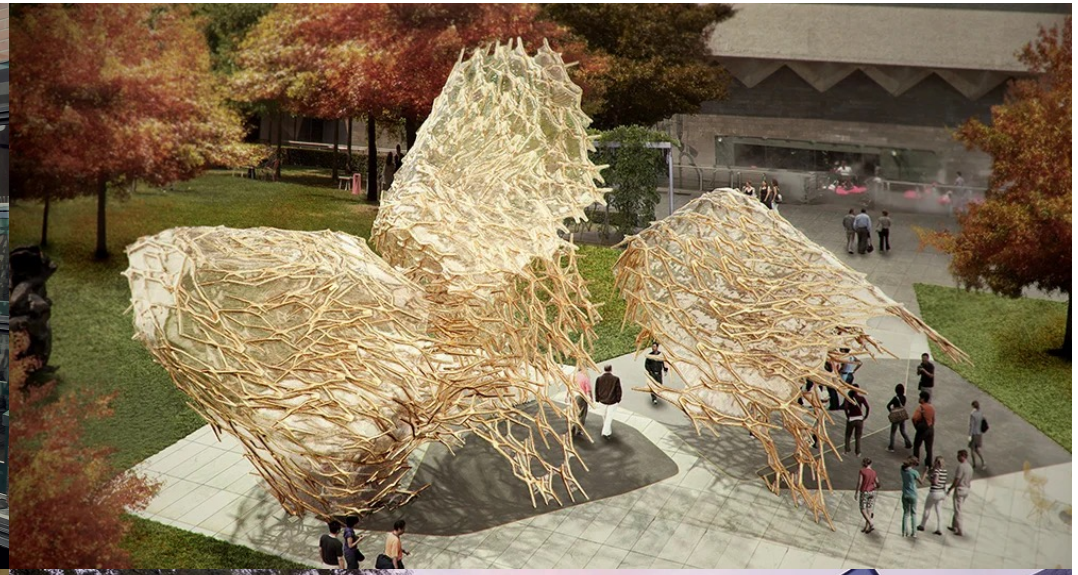


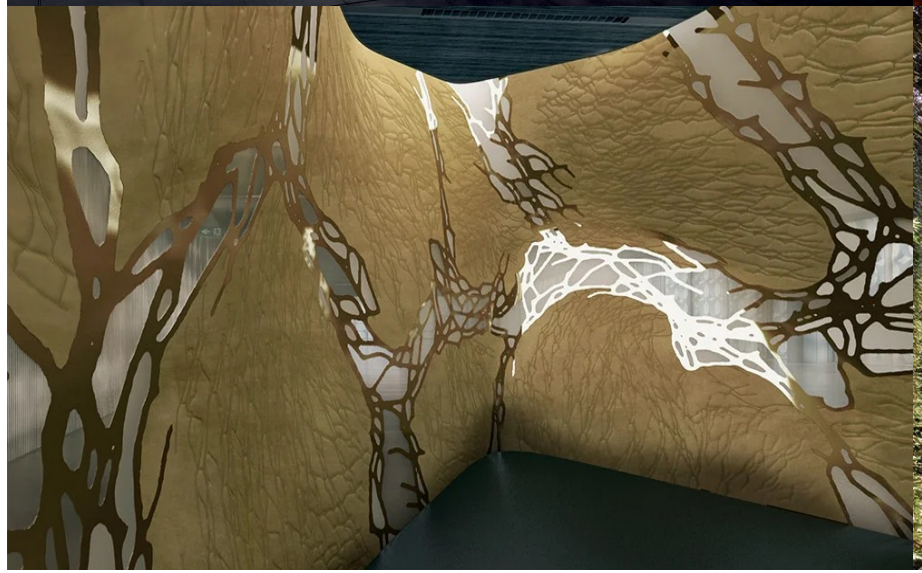
Composite Wing

Roland Snooks

Agent-Based Form





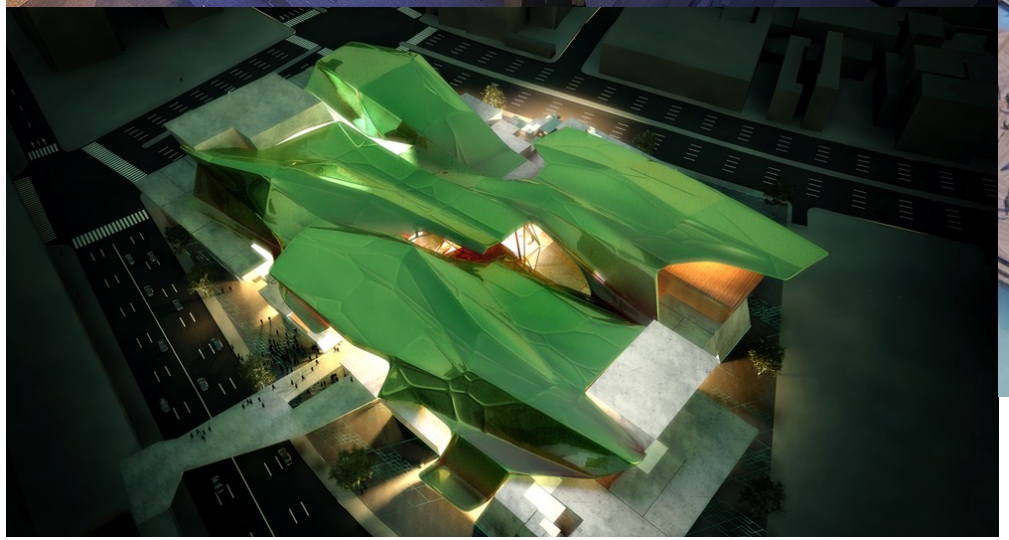


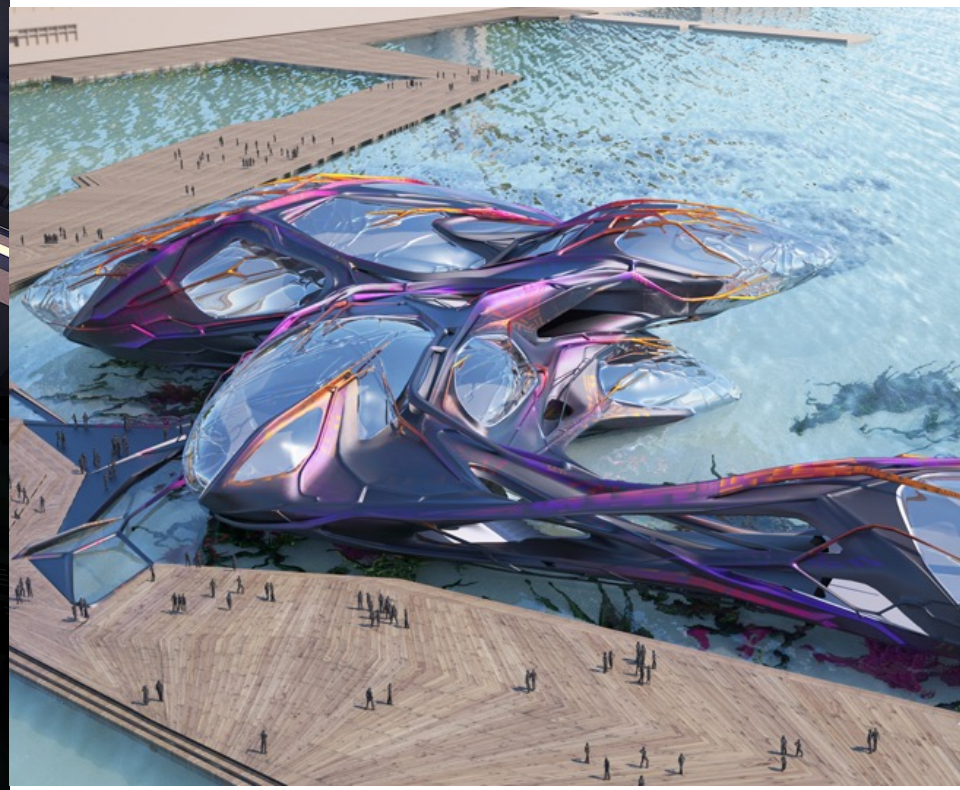


Roland Snooks

Agent-Based Form

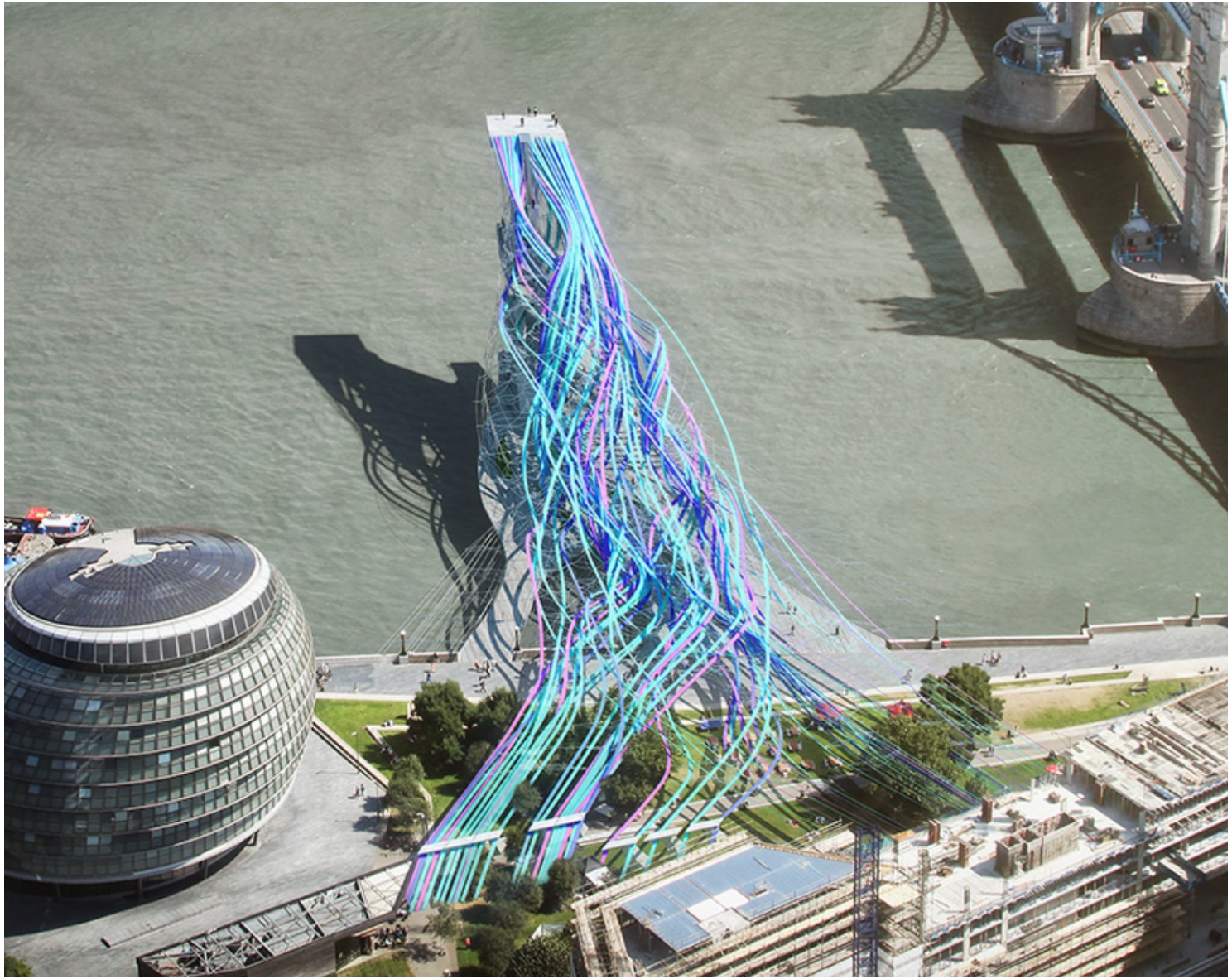






Roland Snooks

Agent-Based Form

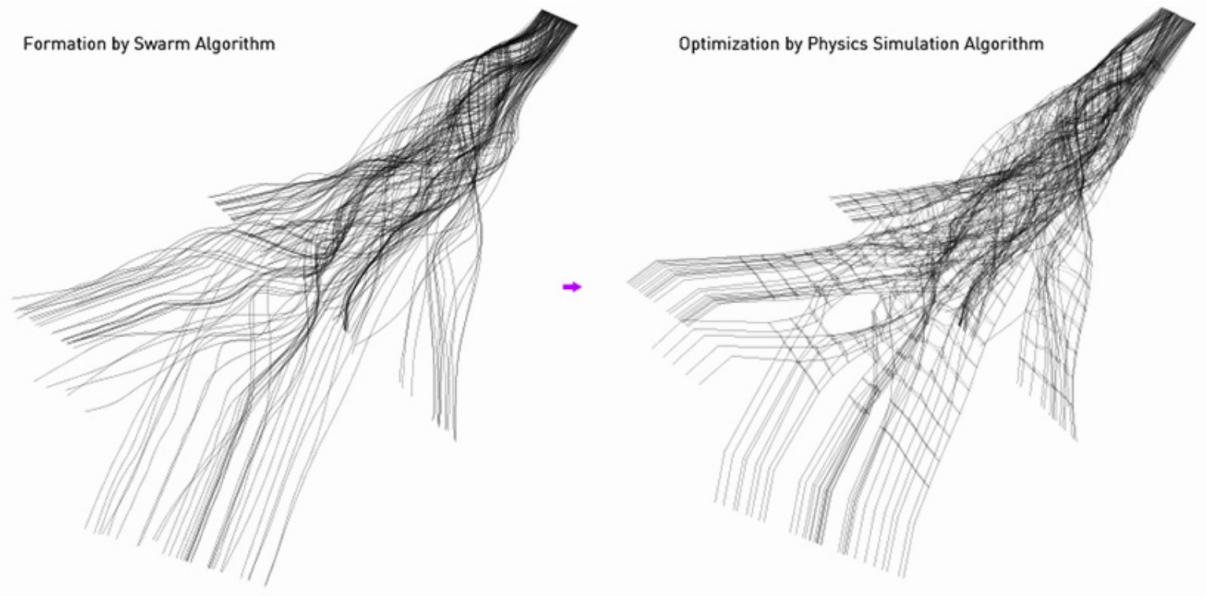


Tower Pier

ATLV

Agent-Based Form

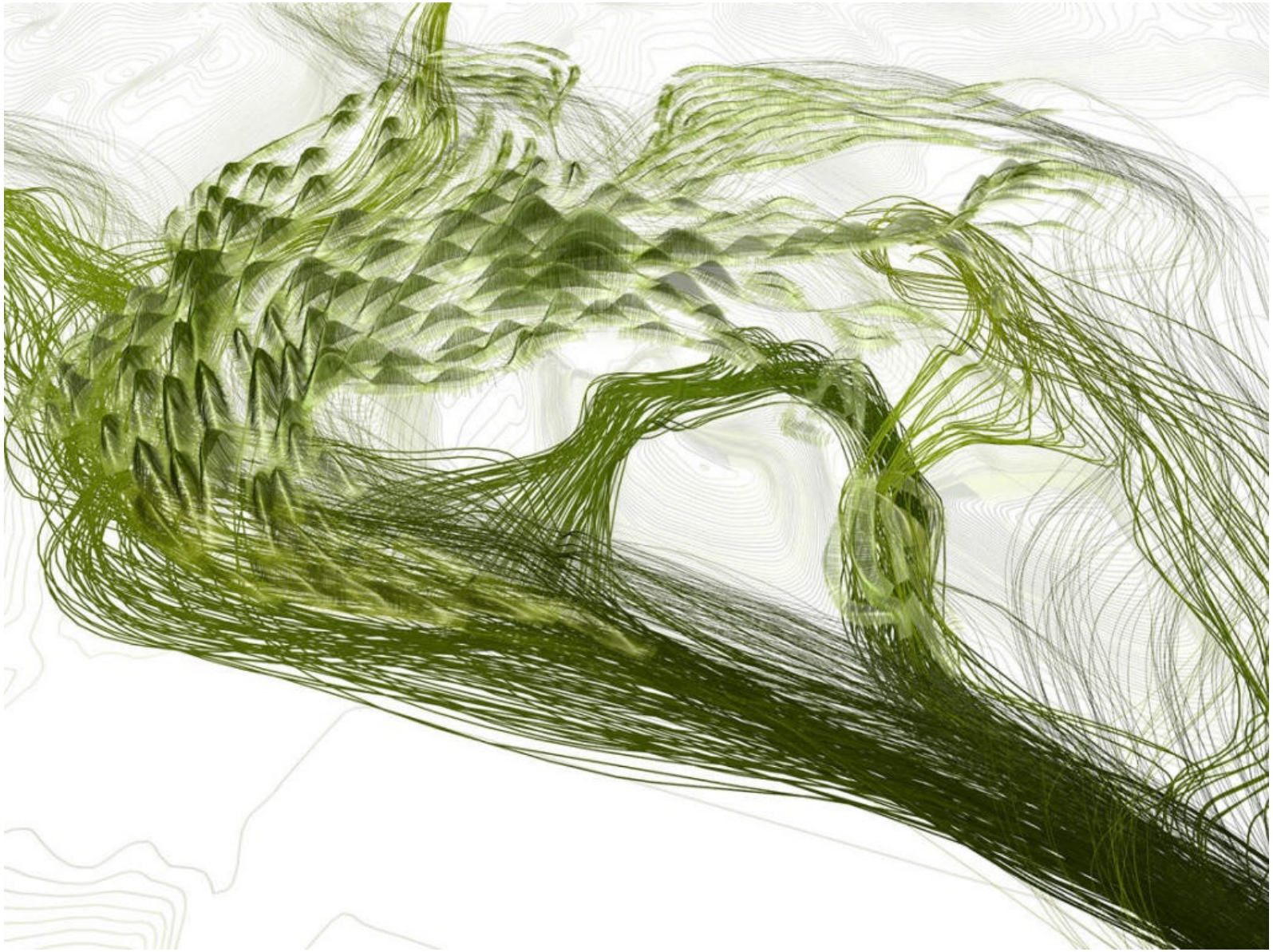




Tower Pier

ATLV

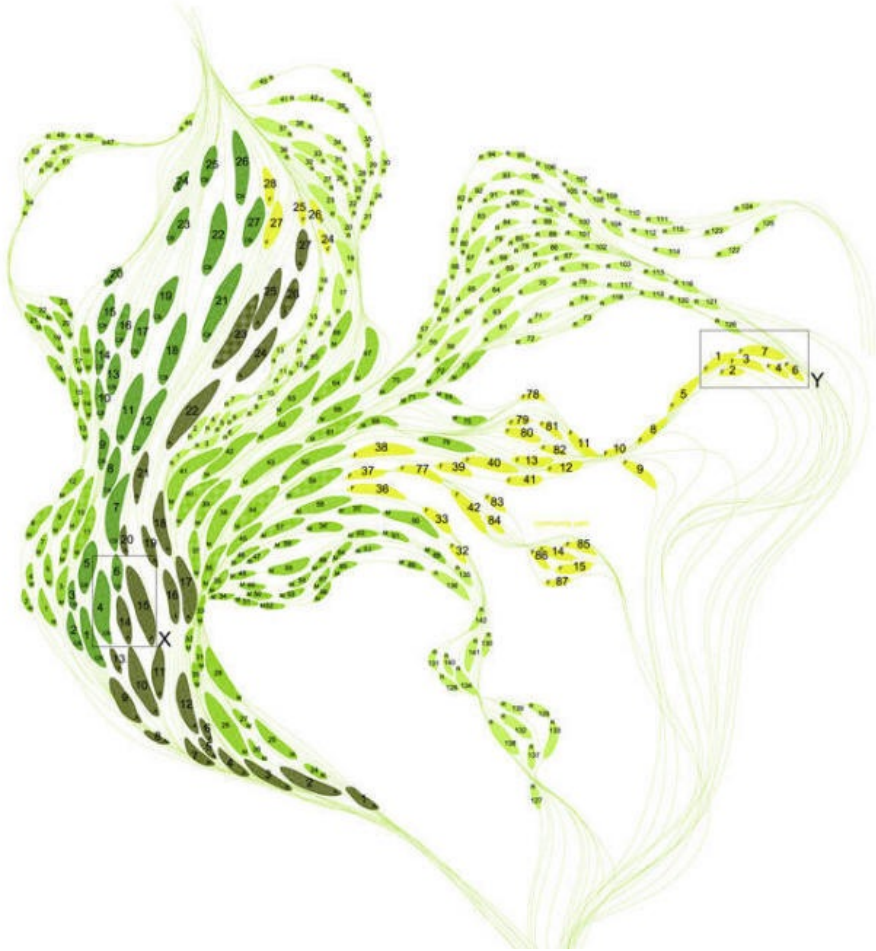
Agent-Based Form



Smart Town

New Territories/R&Sie(n)

Agent-Based Form



A
Public administration use
1, 2, 3, 4, 5, 6, 12 /health and social welfare
7, 8, 9, 10, 11, 13, 15 /comprehensive public management
14 /government convention center
16, 17 /spatial management and environmental protection
18, 19 /agriculture, forestry and fisheries
20, 21, 22, 23 /general economics and industrial affairs
24, 25, 26, 27 /education, culture and recreation

CB
Commercial and business use
9, 10, 11, 13, 15, 16, 17, 19 /convention

M
Mixed-use residential commercial and business
6 400 housings
255 000 m² commercial/business

R
Residential use
1>23, 55>77 / 1 600 medium-high density dwelling units
24>46, 78>103 / 700 medium density dwelling units
47>54, 104>142 / 300 low density dwelling units

F
Public facility use
1>8 /art gallery/museum
9, 24, 32 /child day care centers
10 /kindergarten
11, 78, 79, 80, 81, 82 /elementary school
14, 15, 85, 86, 87 /middle school
12, 13, 39, 40, 41 /high school
42, 83, 84 /gymnasium
33 /graduate school of public administration
37, 36, 77 /community complex and private facilities
38 /public library
25, 26 /community supporting facilities
27, 28 /elementary school

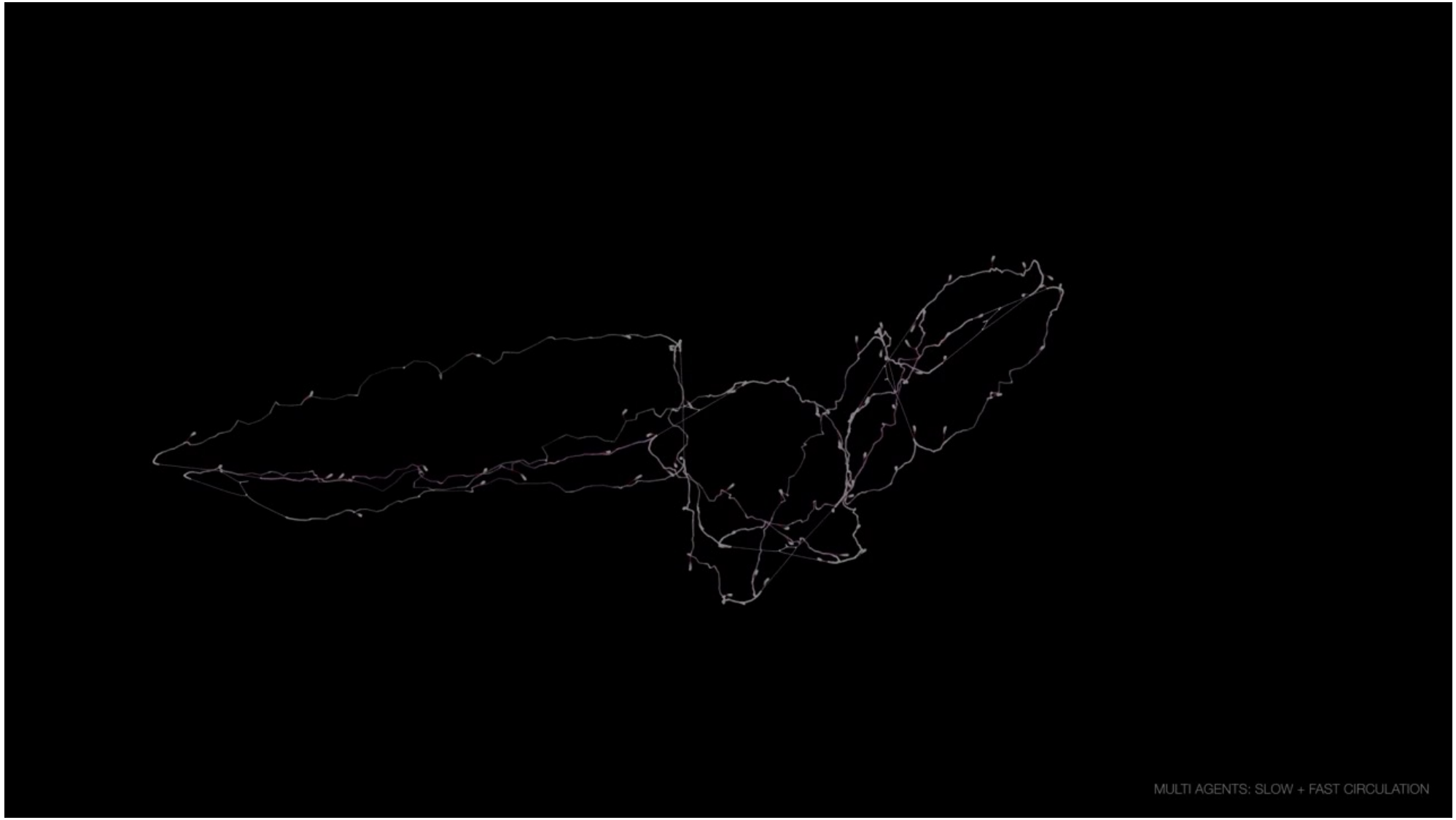
X, Y look at details scale 1/1000

Smart Town

New Territories/R&Sie(n)



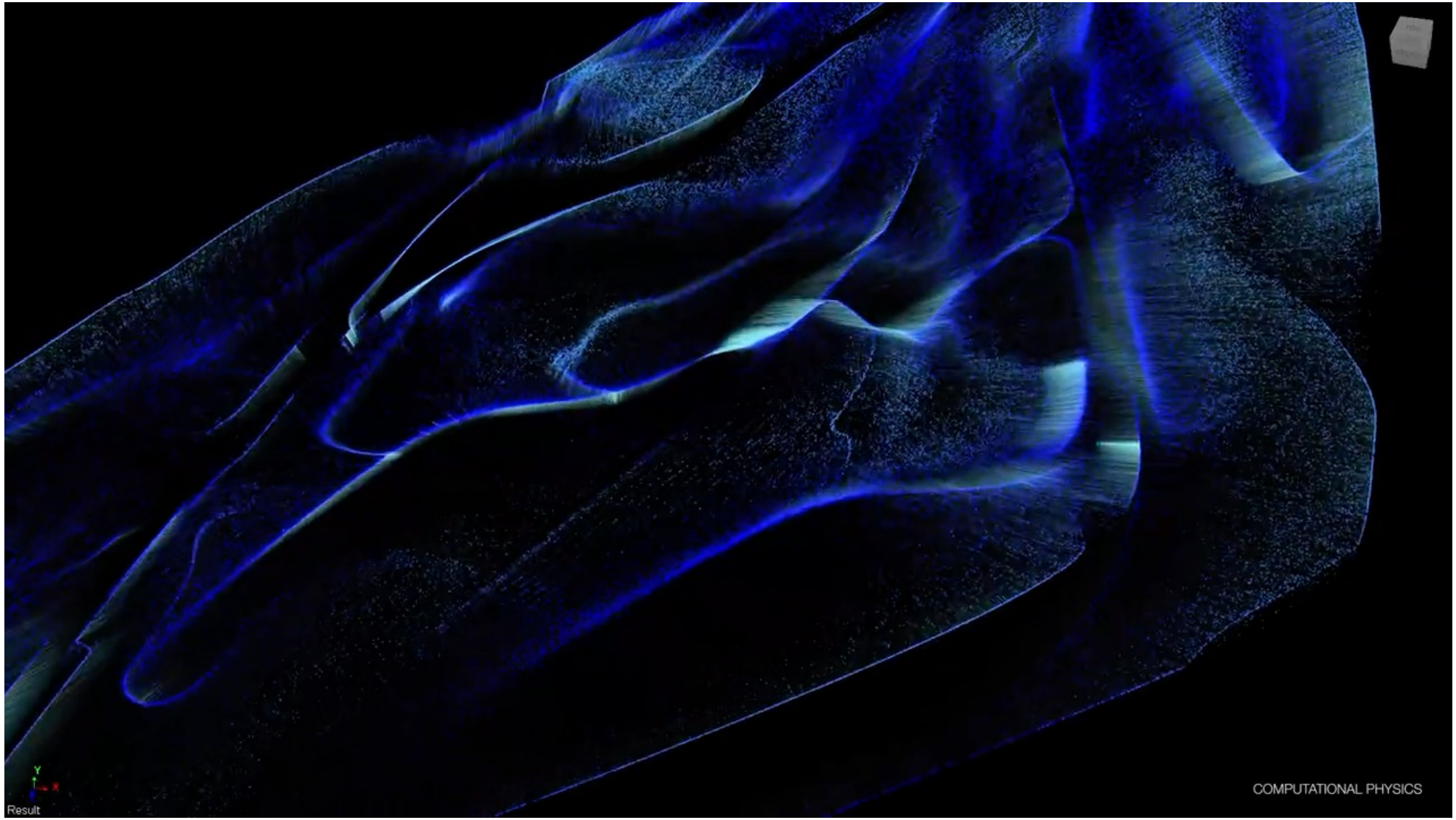
Agent-Based Form



Cloud Osaka

Alisa Andrasek

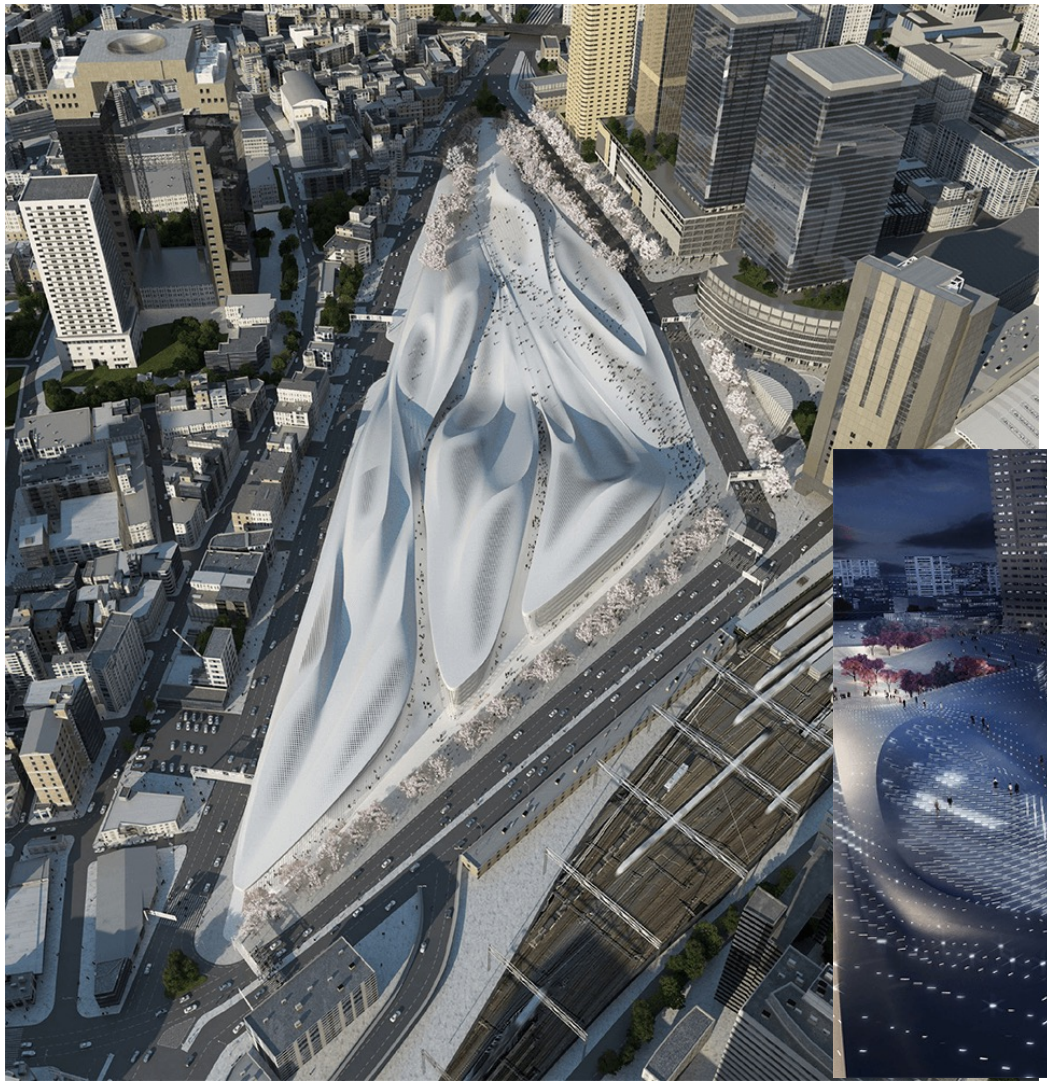
Agent-Based Form

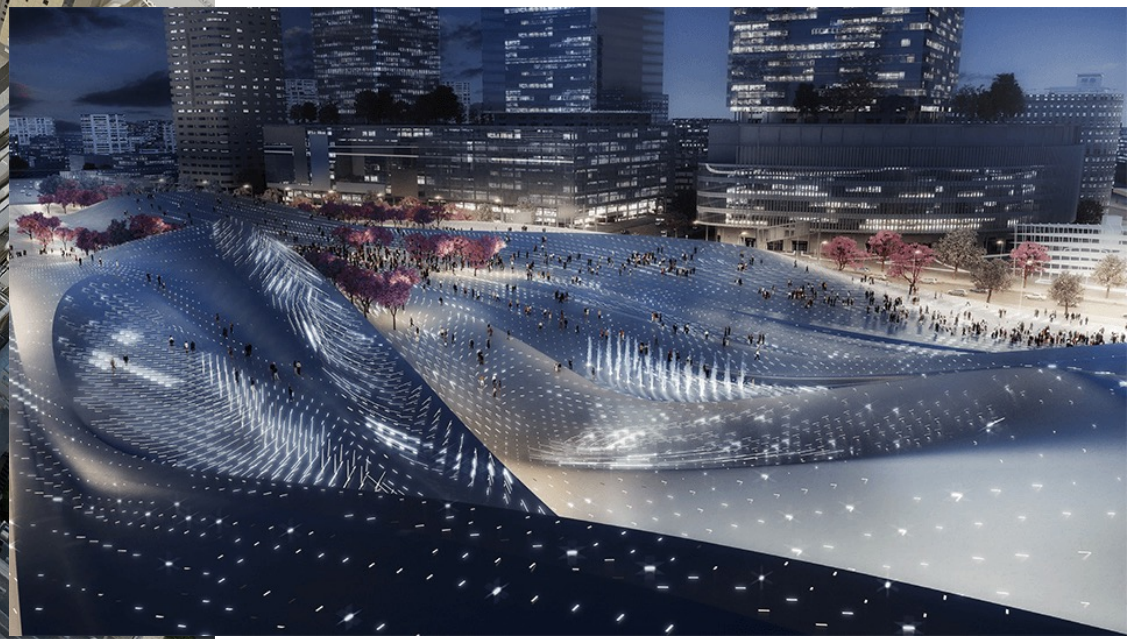


Cloud Osaka

Alisa Andrasek

Agent-Based Form





Cloud Osaka

Alisa Andrasek

Agent-Based Form

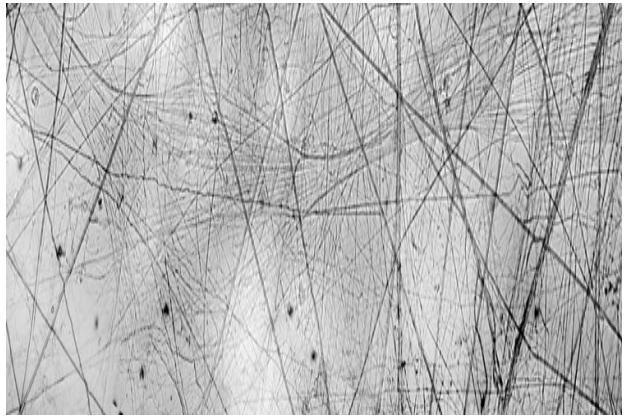


ICD Pavilion 2014

University of Stuttgart

Archi Menges

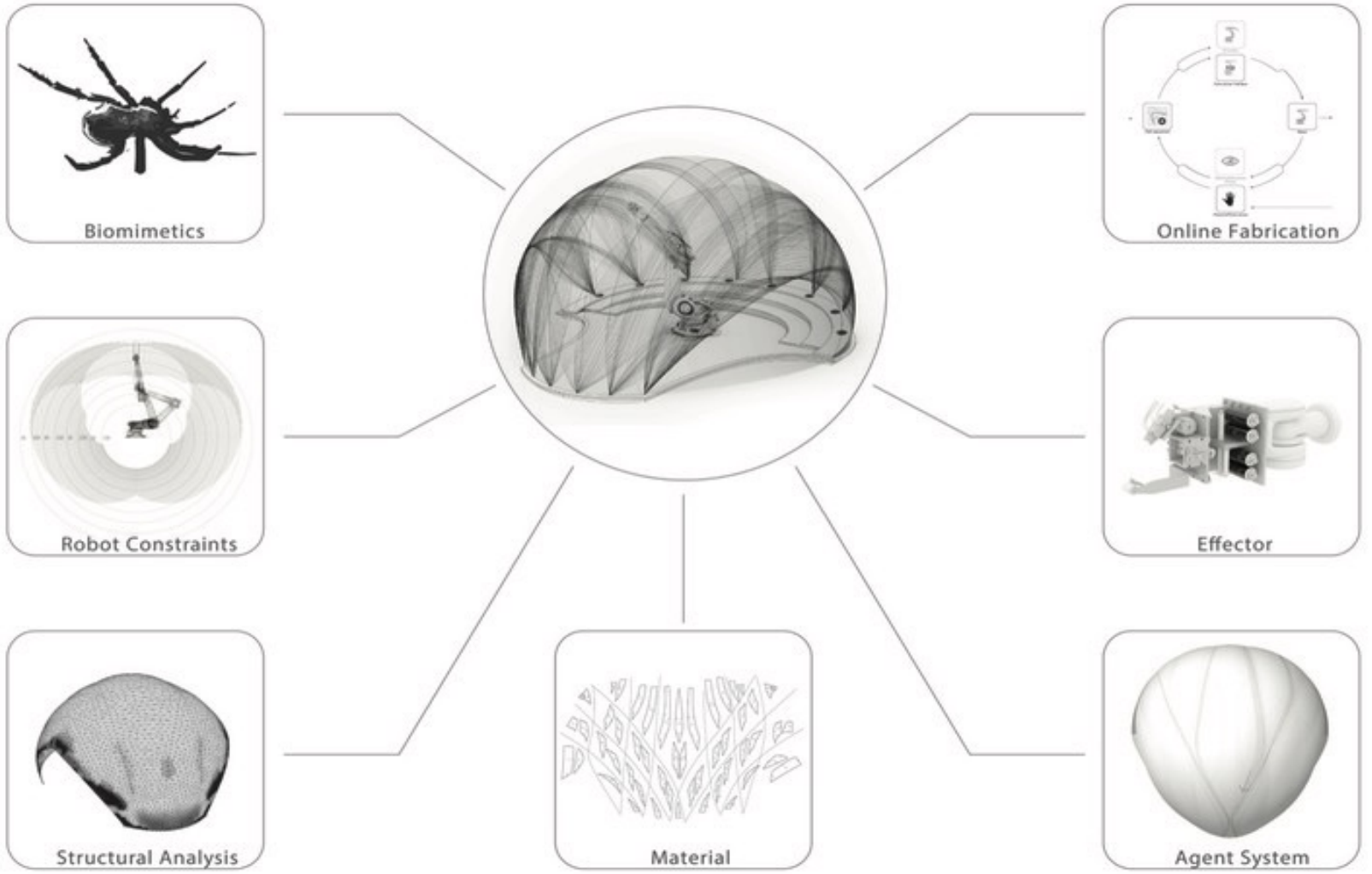
Agent-Based Form



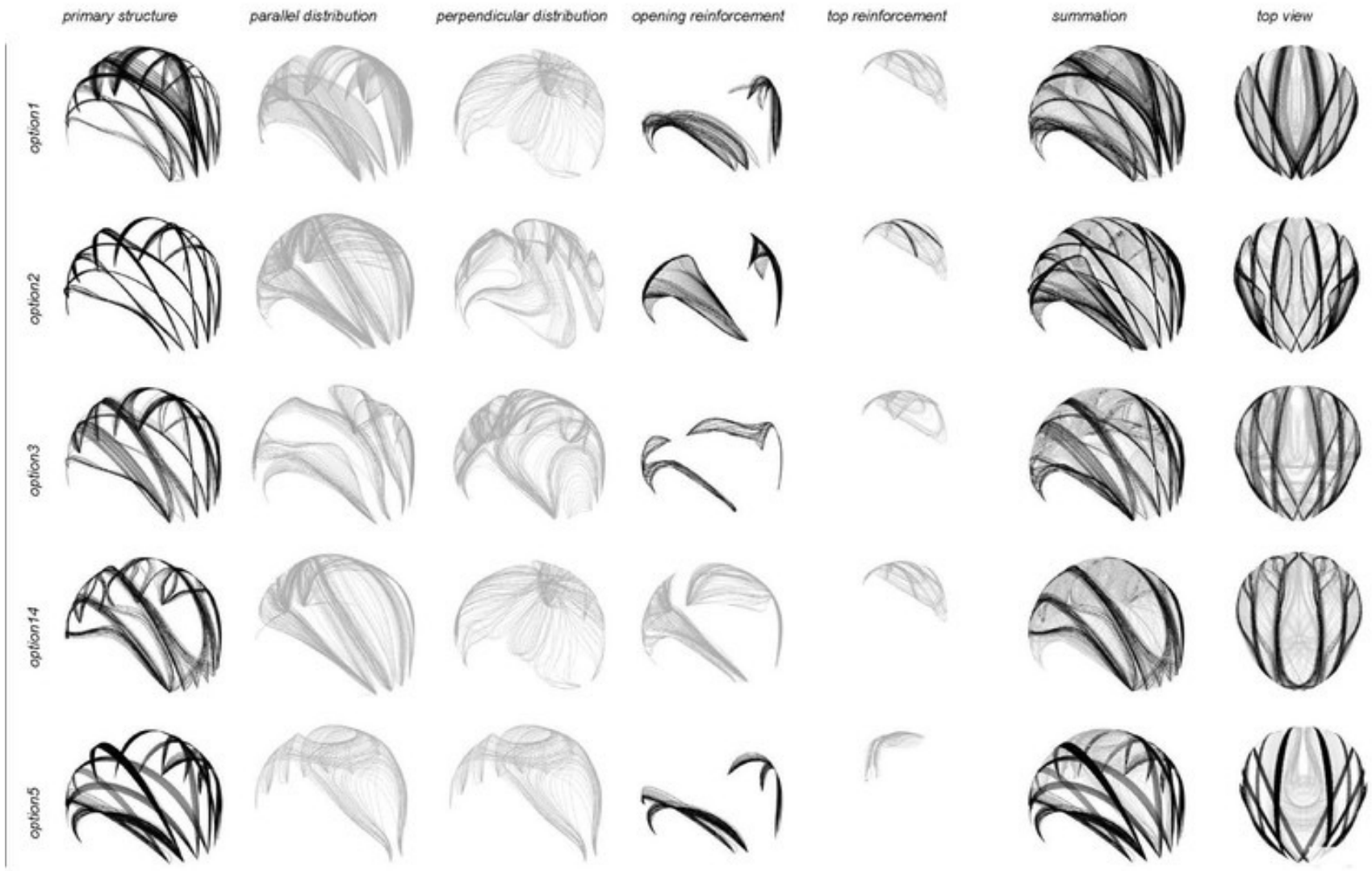
ICD Pavilion 2014

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Archi Menges



Agent-Based Form



ICD Pavilion 2014

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Archi Menges

Some Critical Notes