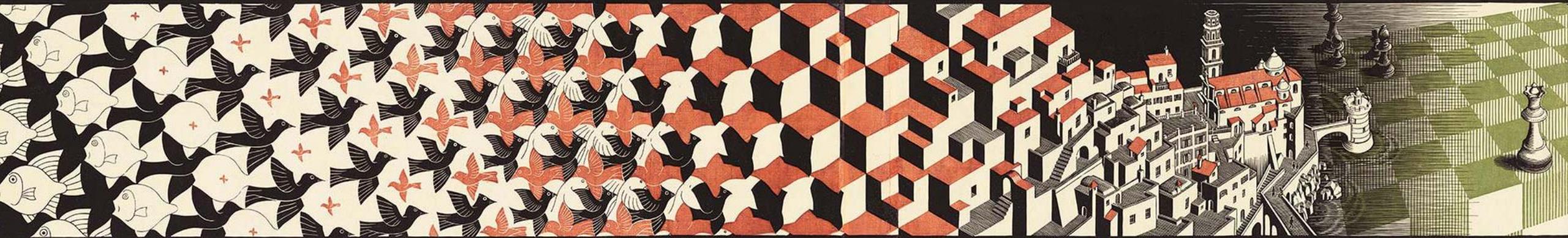


# Data, Math and Methods

## Week 1, Introduction



~ Vítek Růžička

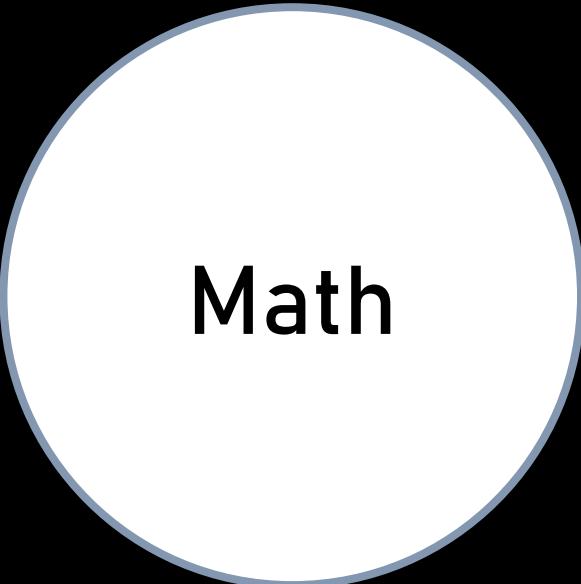
# What is this class about?

- Data, Math and Methods
- Data – datasciences + Art
- Math – mathematics + Art = Creative Computing
- Methods – algorithms + Art

# When? What? How?

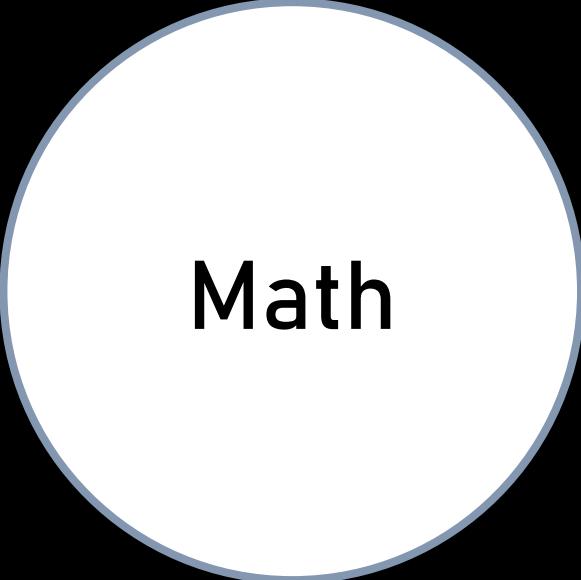
- When:
  - Wednesdays 13:30 – 17:30, usually 2 pauses per class
- Marking:
  - 50% Multiple Choice test
  - 50% Practical Exam
  - Attendance
- Repository + Recording

# Data, Math and Methods



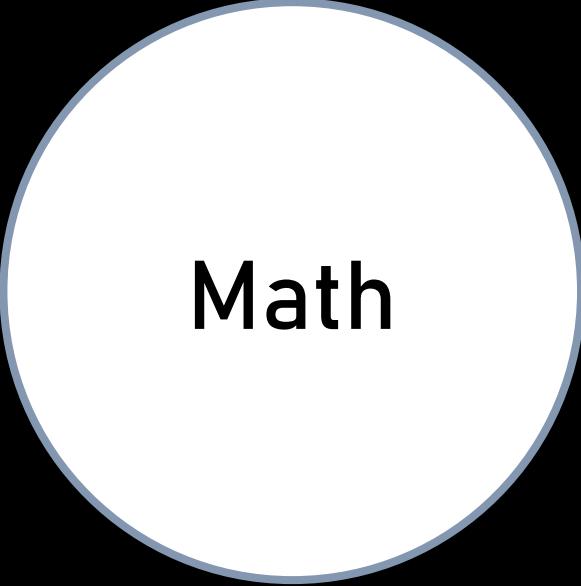
Math

- Abstraction of messy reality into a perfect word
  - of numbers
  - of rules of solving, converting, rephrasing



Math

- Abstraction of messy reality into a perfect word
  - of numbers
  - of rules of solving, converting, rephrasing
- Well defined
- But also chaotic / random / *stochastic* (**Statistics**)



Math

- Abstraction of messy reality into a perfect word
  - of numbers
  - of rules of solving, converting, rephrasing
- Well defined
- But also chaotic / random / *stochastic* (**Statistics**)
  
- With precise formula solutions  
(Analytical solution)
- Or with *good enough* approximation of the solutions (Numerical approach)

Example: *math in the real world*



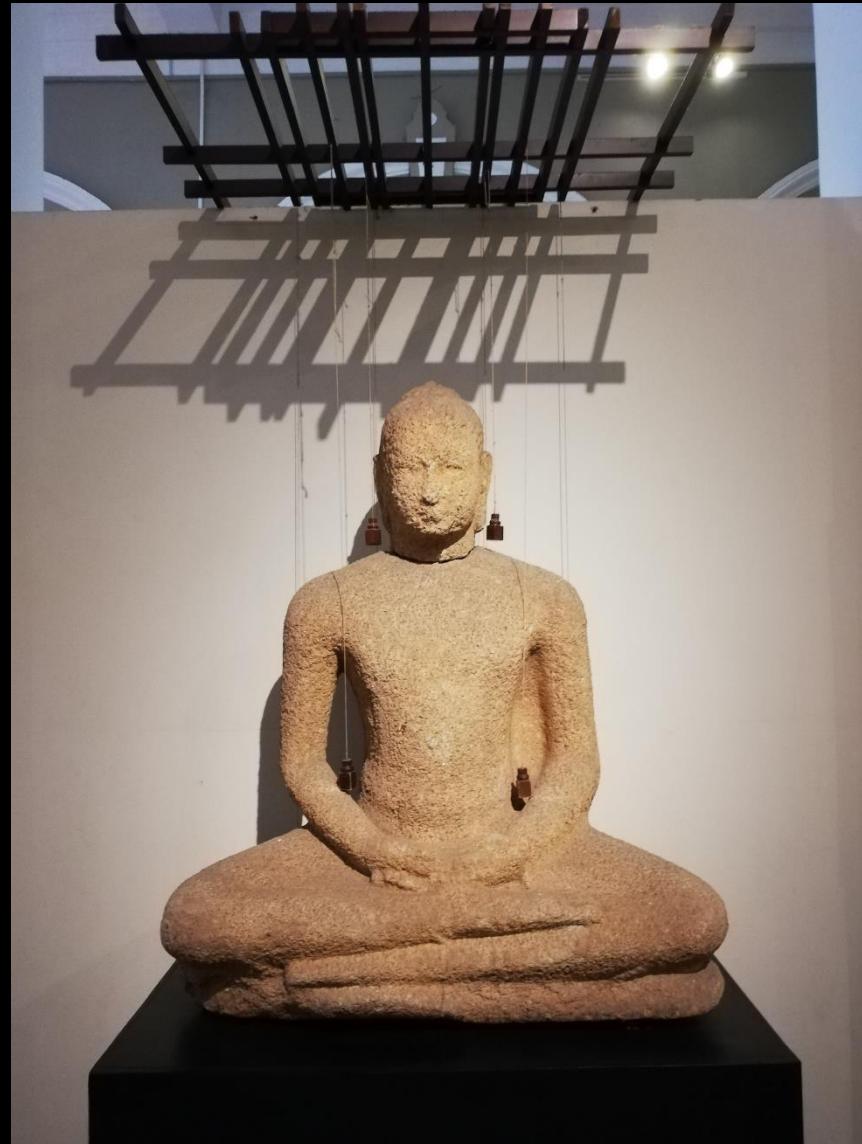
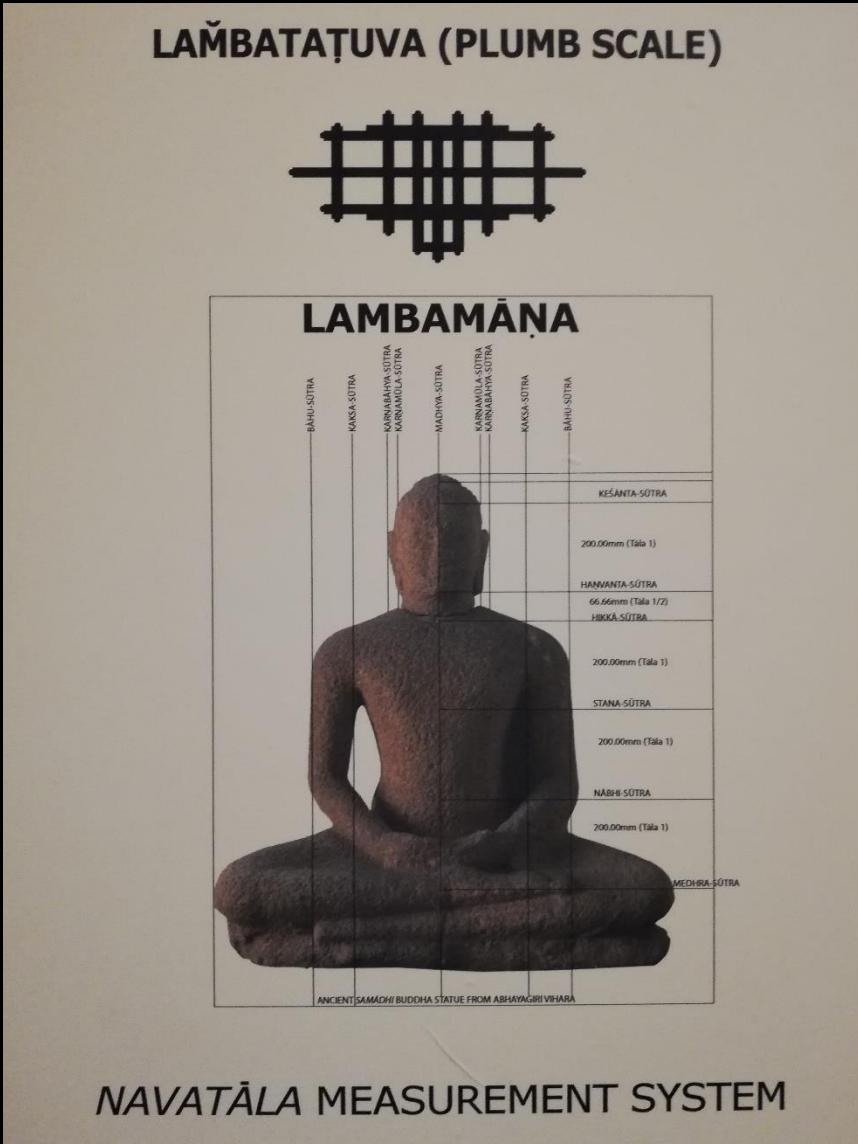
Natural Sciences

*Example: math in the real world*

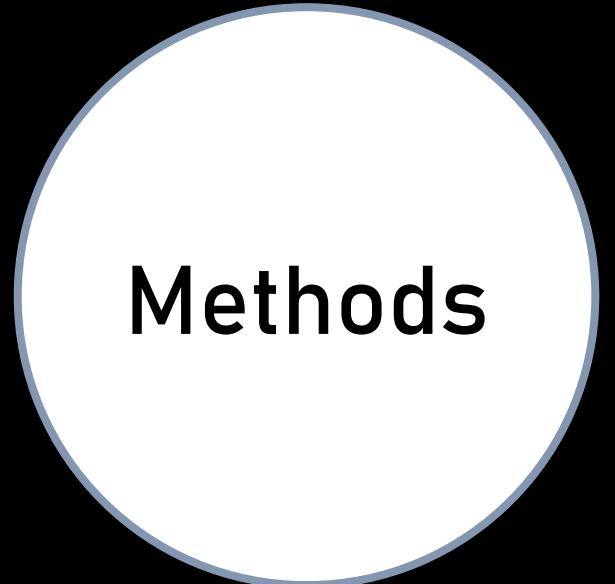


Architecture

Example: *math in the real world*



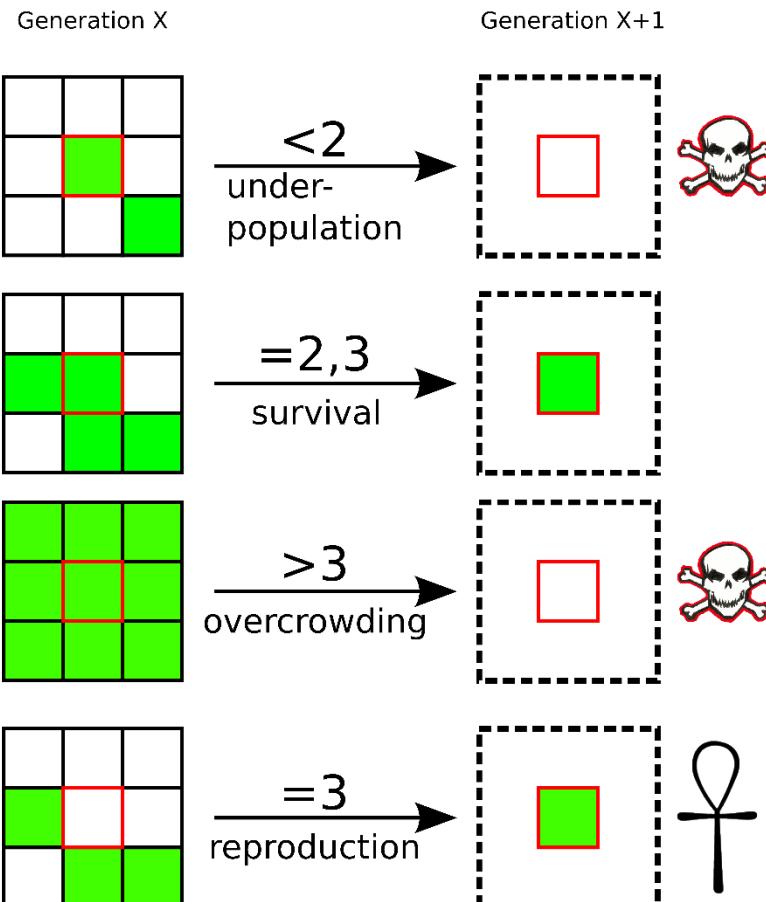
- Algorithms – recipes of steps taken to solve a problem
- Simple rules building up into more complex systems (Example: **Game of Life**)



Methods

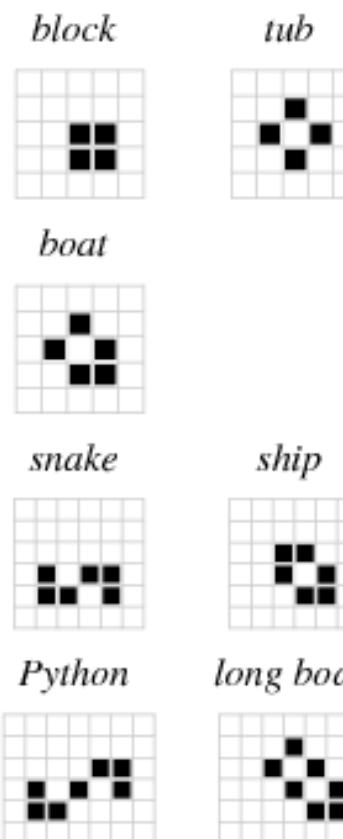
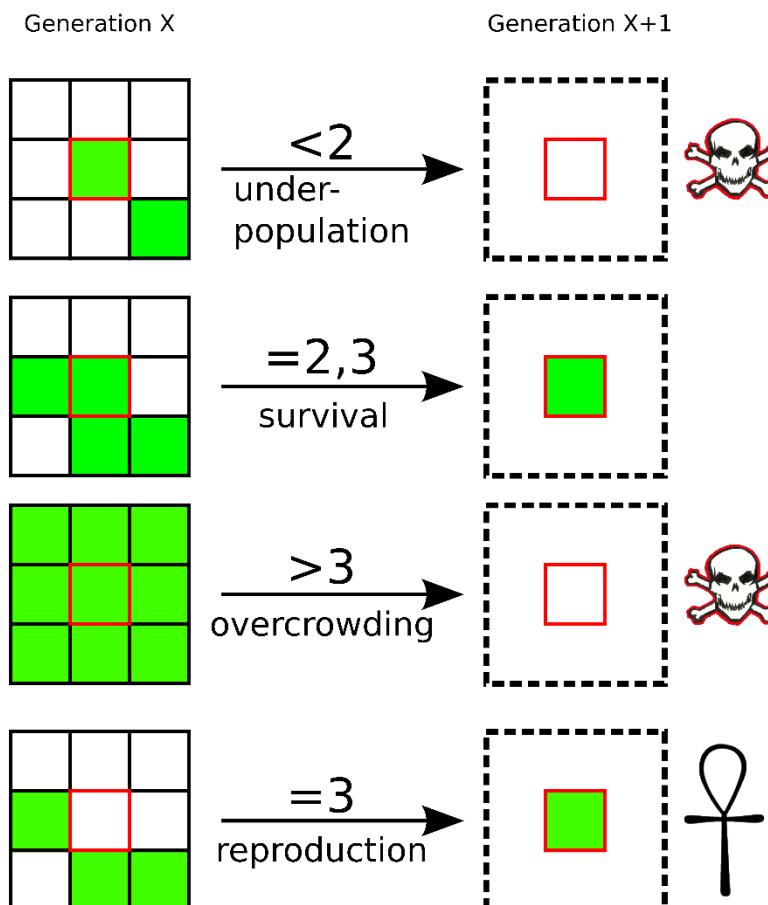
## Example: Conway's Game of Life (1970)

### Game of Life Rules

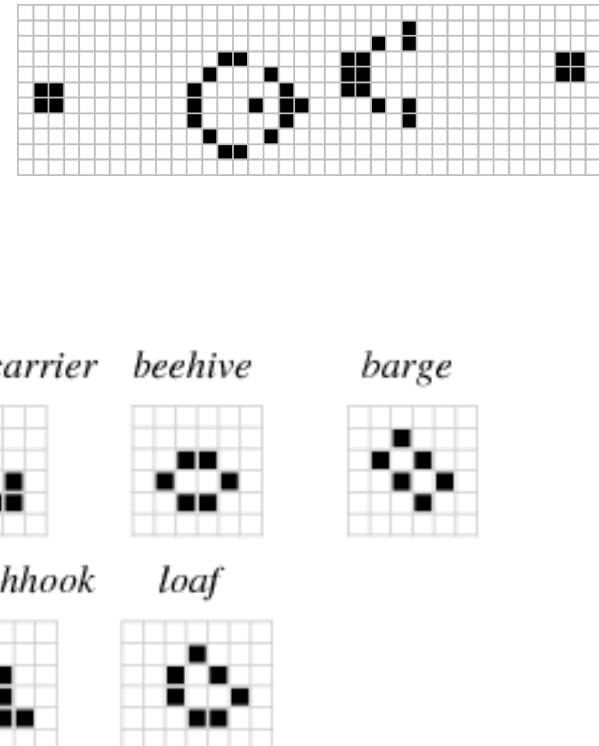


# Example: Conway's Game of Life (1970)

# Game of Life Rules

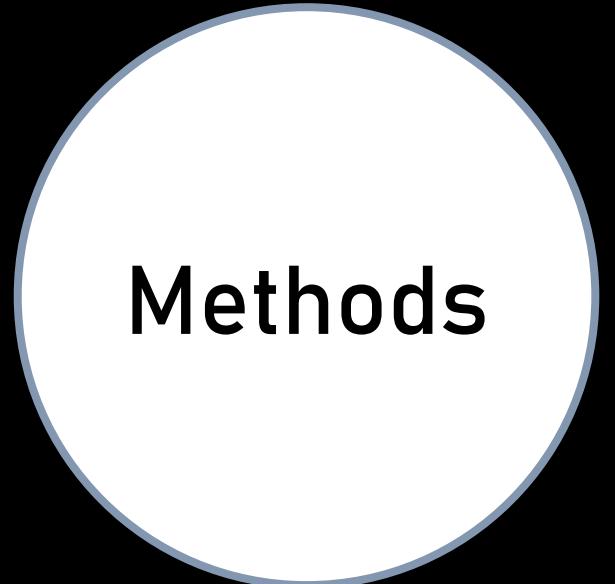


## Guns and gliders



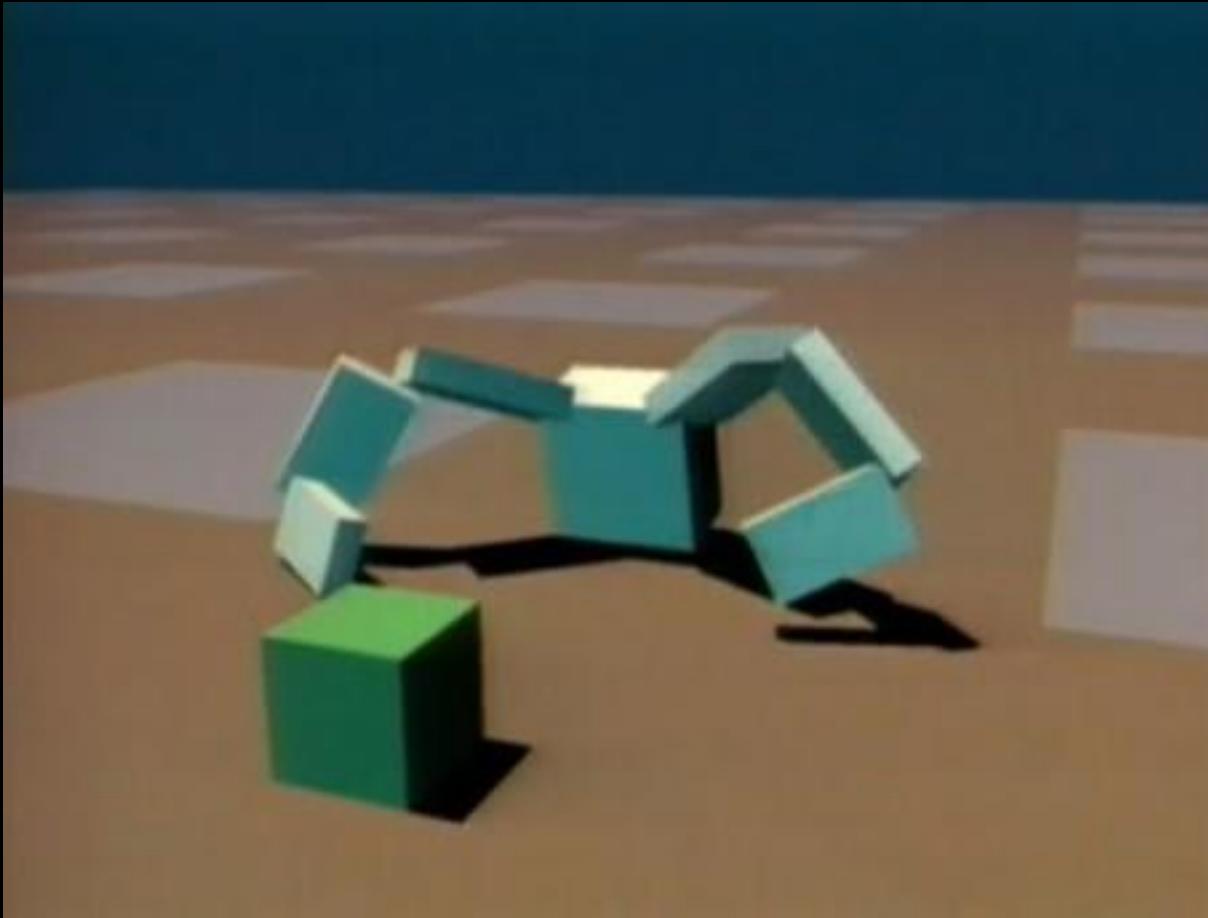
[youtube.com/watch?v=xP5-iIeKXE8](https://youtube.com/watch?v=xP5-iIeKXE8)

- Algorithms – recipes of steps taken to solve a problem
- Simple rules building up into more complex systems (Example: **Game of Life**)
- Simulated worlds full of rules, watching what happens to the experiments we run in it  
(Examples: genetic algorithms by **Karl Sims**, Learning to walk, other biologically inspired algorithms)



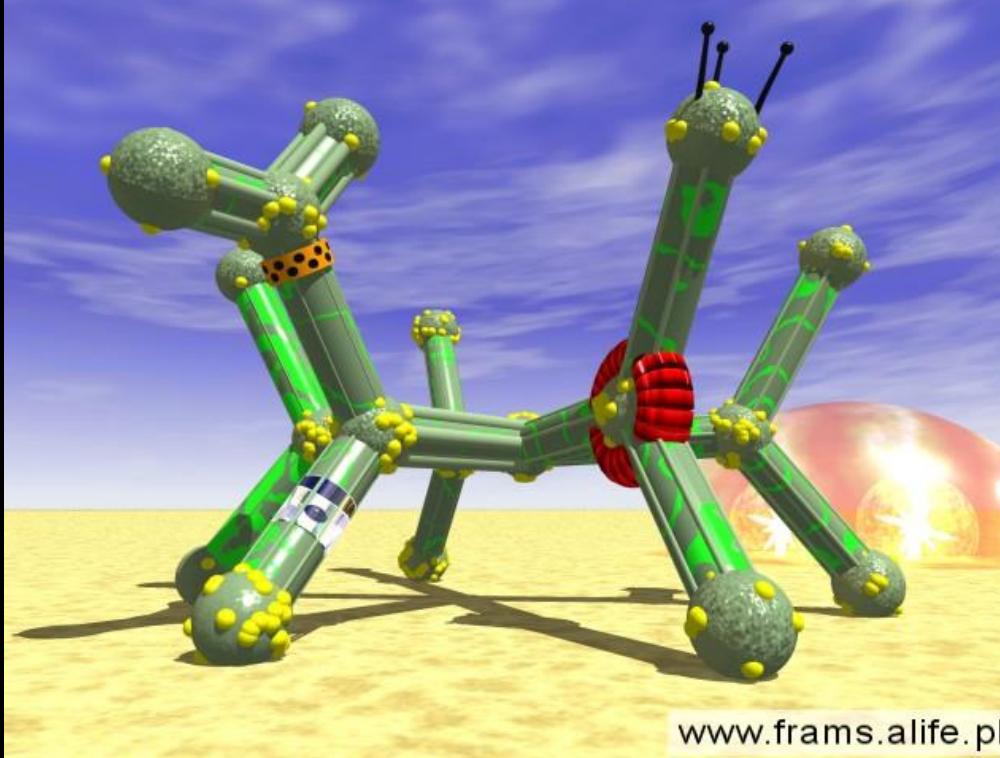
Methods

## Example: Karl Sims - Evolved Virtual Creatures (1994)



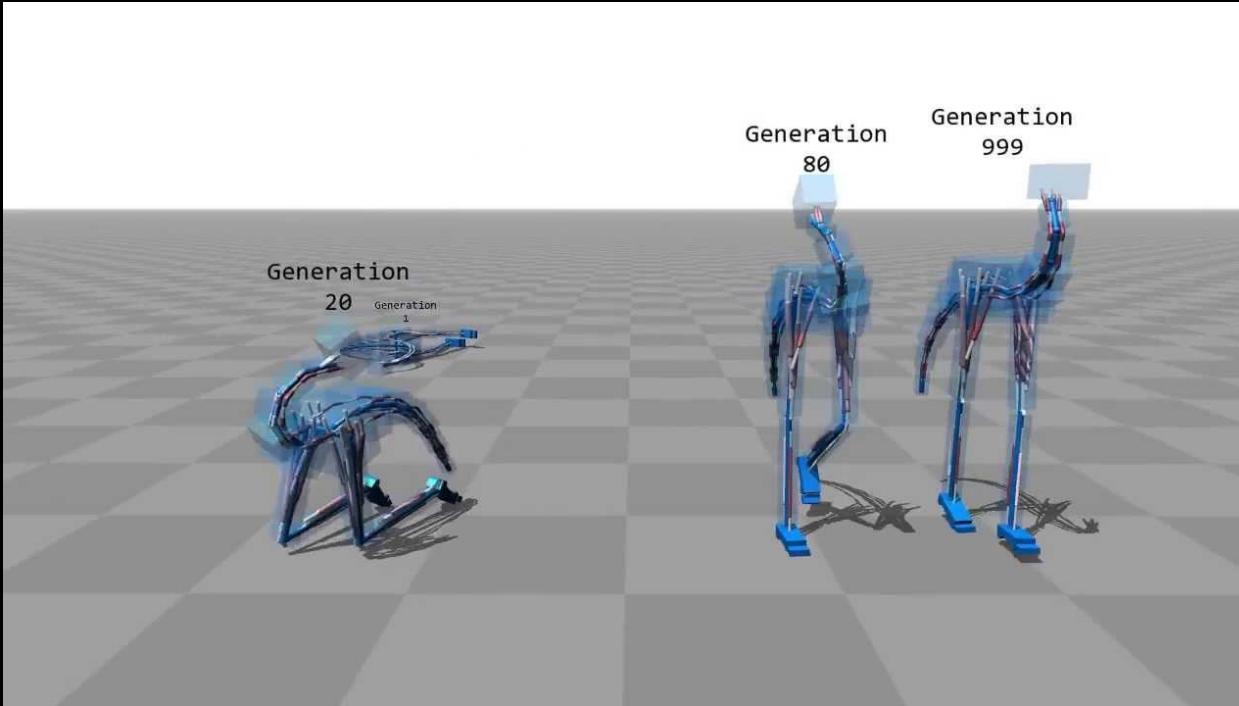
[youtube.com/watch?v=RZtZia4ZkX8](https://www.youtube.com/watch?v=RZtZia4ZkX8)

Example: **Framsticks** experiment with genetic algorithms



[youtube.com/watch?v=SoZguPlXGPA](https://www.youtube.com/watch?v=SoZguPlXGPA)

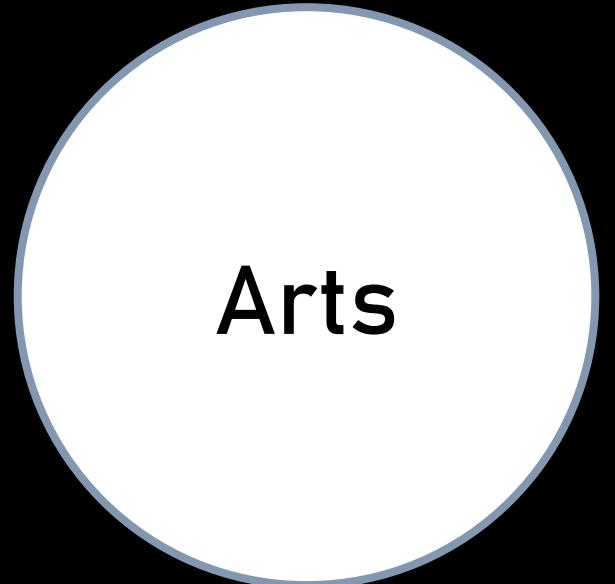
## Example: Flexible Muscle-Based Locomotion for Bipedal Creatures



[youtube.com/watch?v=pgaEE27nsQw](https://youtube.com/watch?v=pgaEE27nsQw)



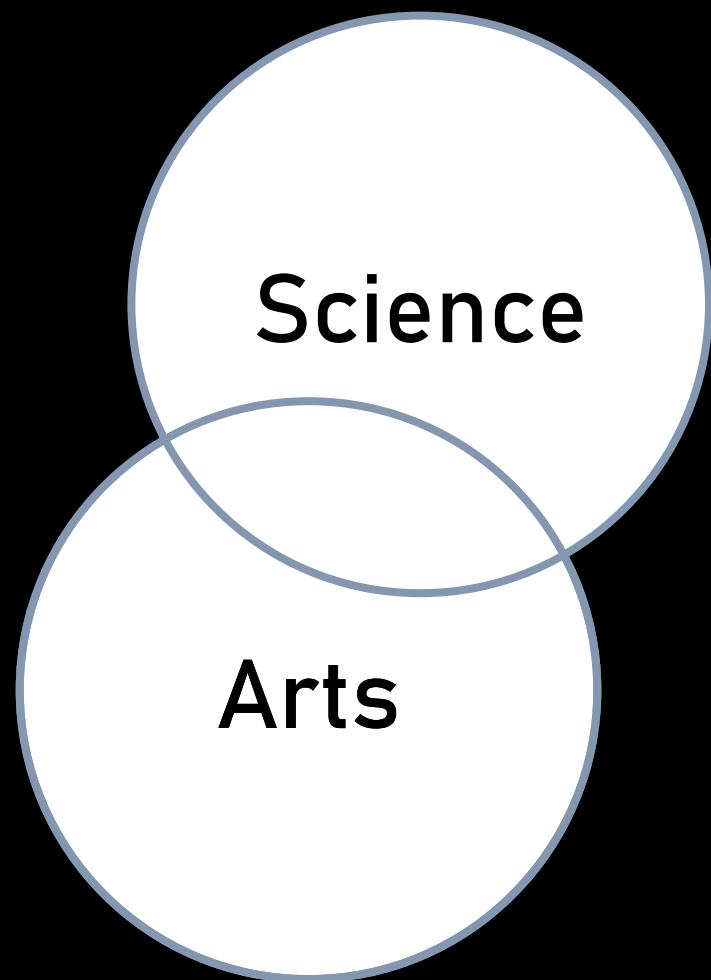
- Information (theoretically absolutely anything more *interesting* than noise)
- Why would we care? (Fair question, *data is just data!*)
  - Large quantities (“Big Data”) and smart methods and algorithms (Machine Learning ;-))
- Visualization
- Modelling, learning to understand, generate



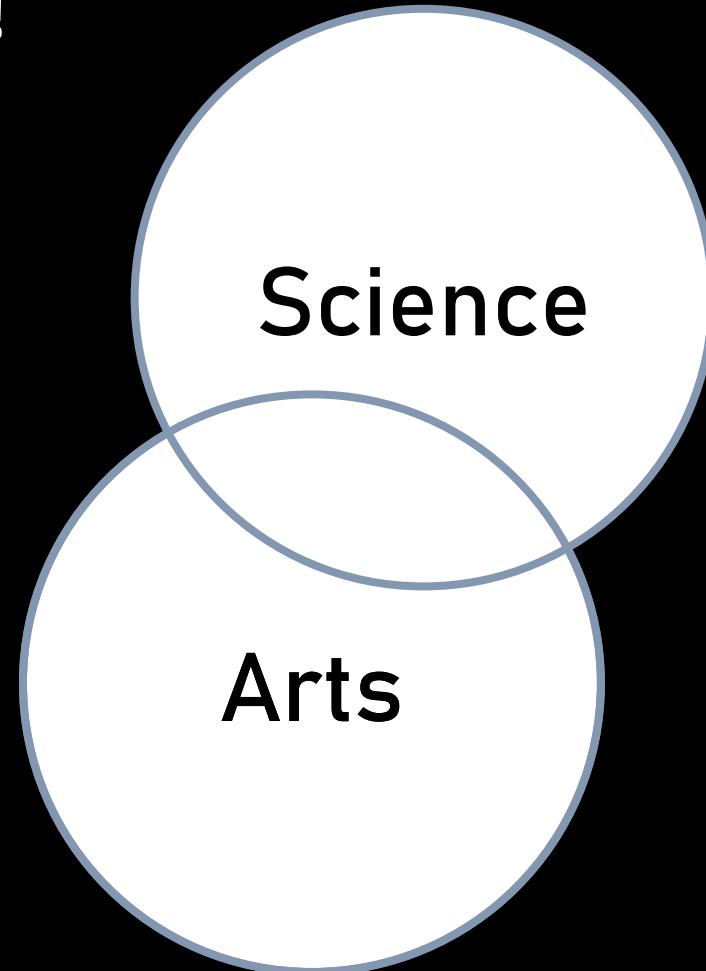
Arts

- Exploration of the unknown!
- Through displaying, comparison, criticism, self-reflection, self-self-reflection, provocation, joke, ... Creation, showing off.
- Trying to portray the **complexity?**  
**Complicatedness? Messiness?**

- Exploration of the unknown!
  - Explainability? Clarity?
- 
- Exploration of the unknown!
  - Through displaying, comparison, criticism, self-reflection, self-self-reflection, provocation, joke, ... Creation, showing off.
  - Trying to portray the complexity? Complicatedness? Messiness?



- Exploration of the unknown!



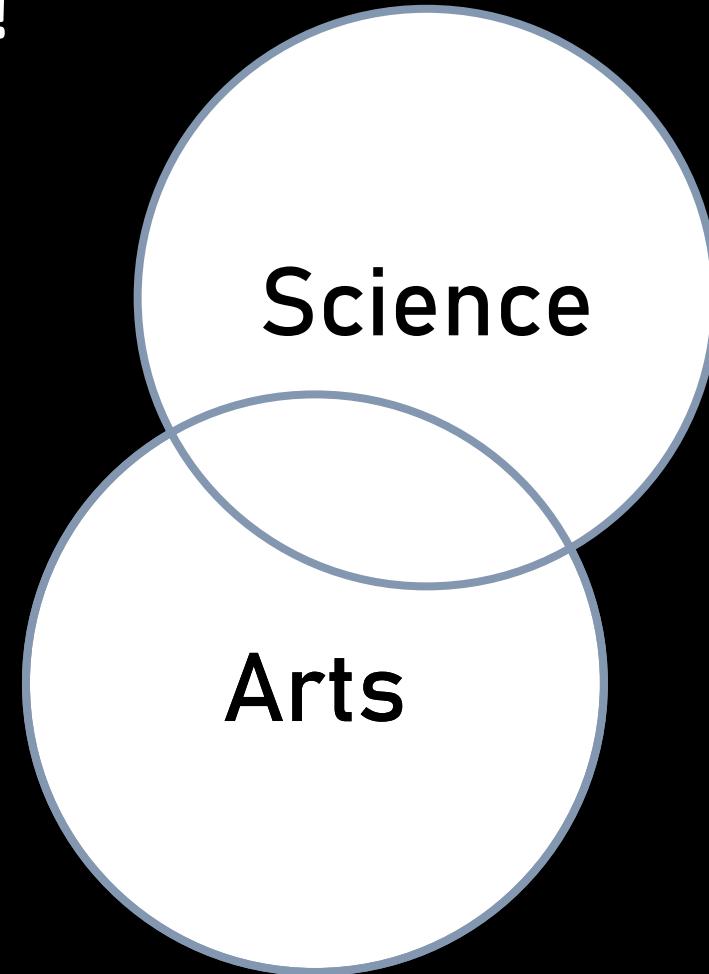
- Exploration of the unknown!

- Science -> Arts:

- Modernism
- Abstraction
- (via theories of Systems)

- Art -> Sciences:

- Complicatedness?



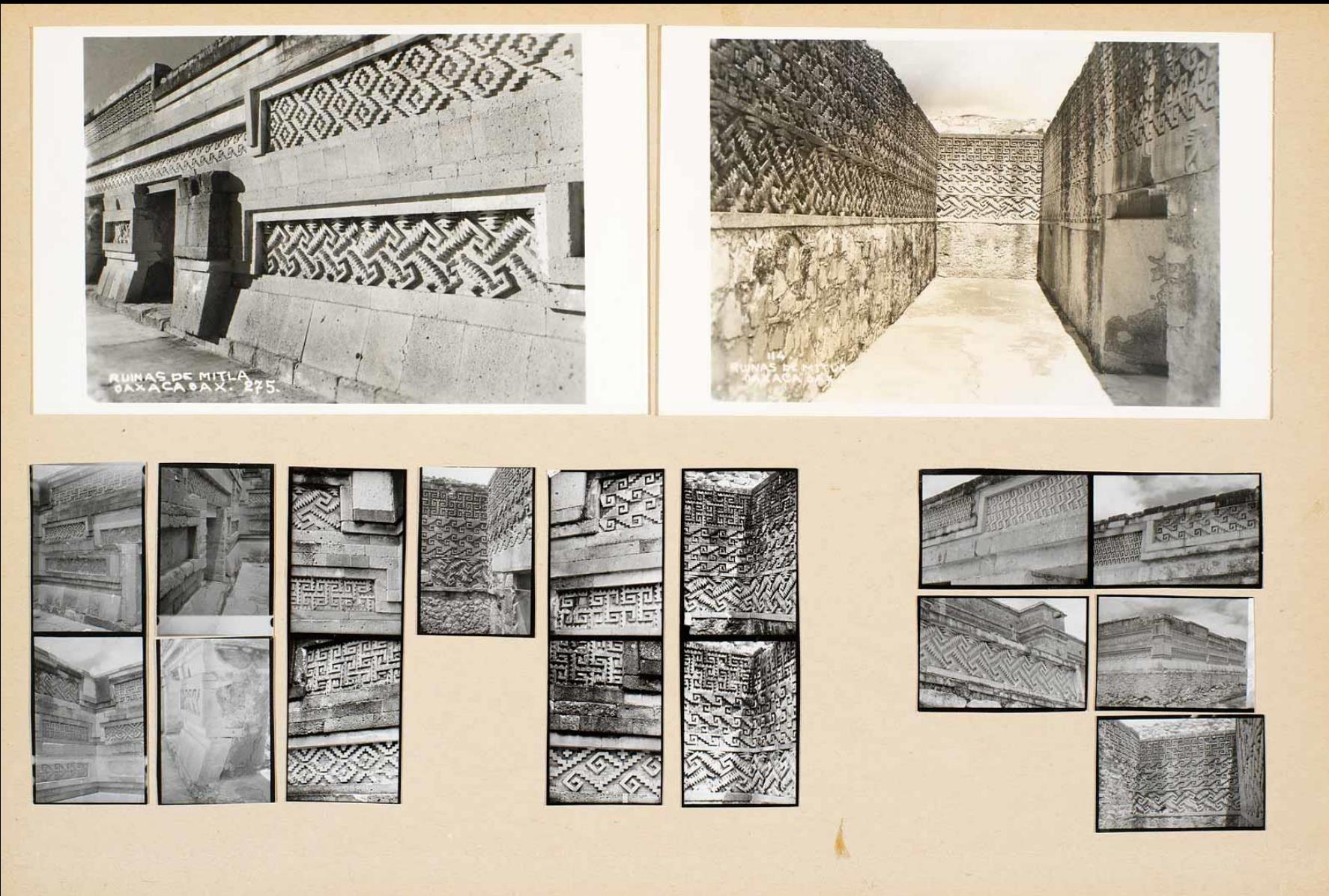
## Example: **Johannes Vermeer** - Girl with a Pearl Earring (1665)



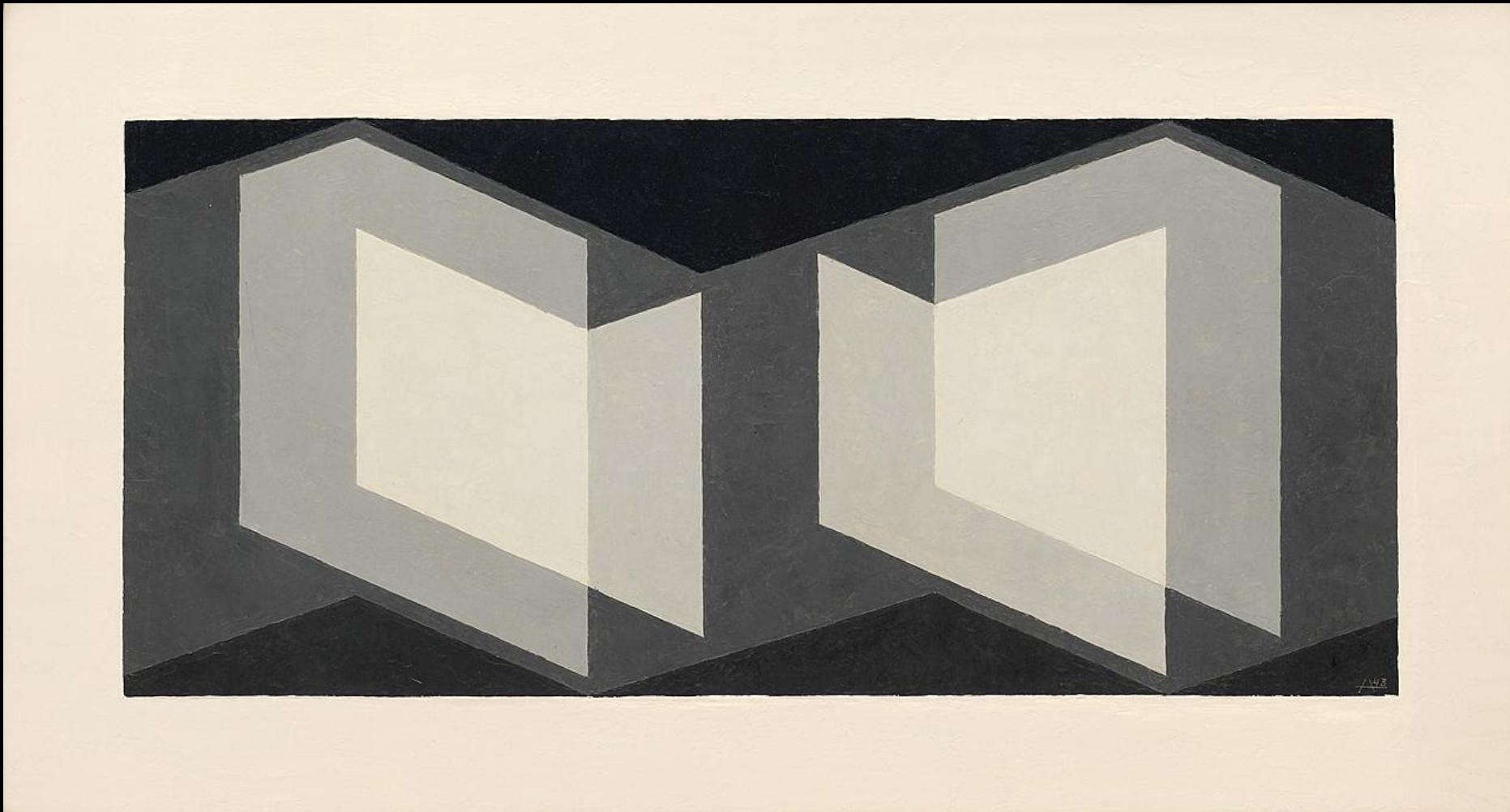
## Example: **Georges Seurat** - A Sunday on La Grande Jatte (1884)



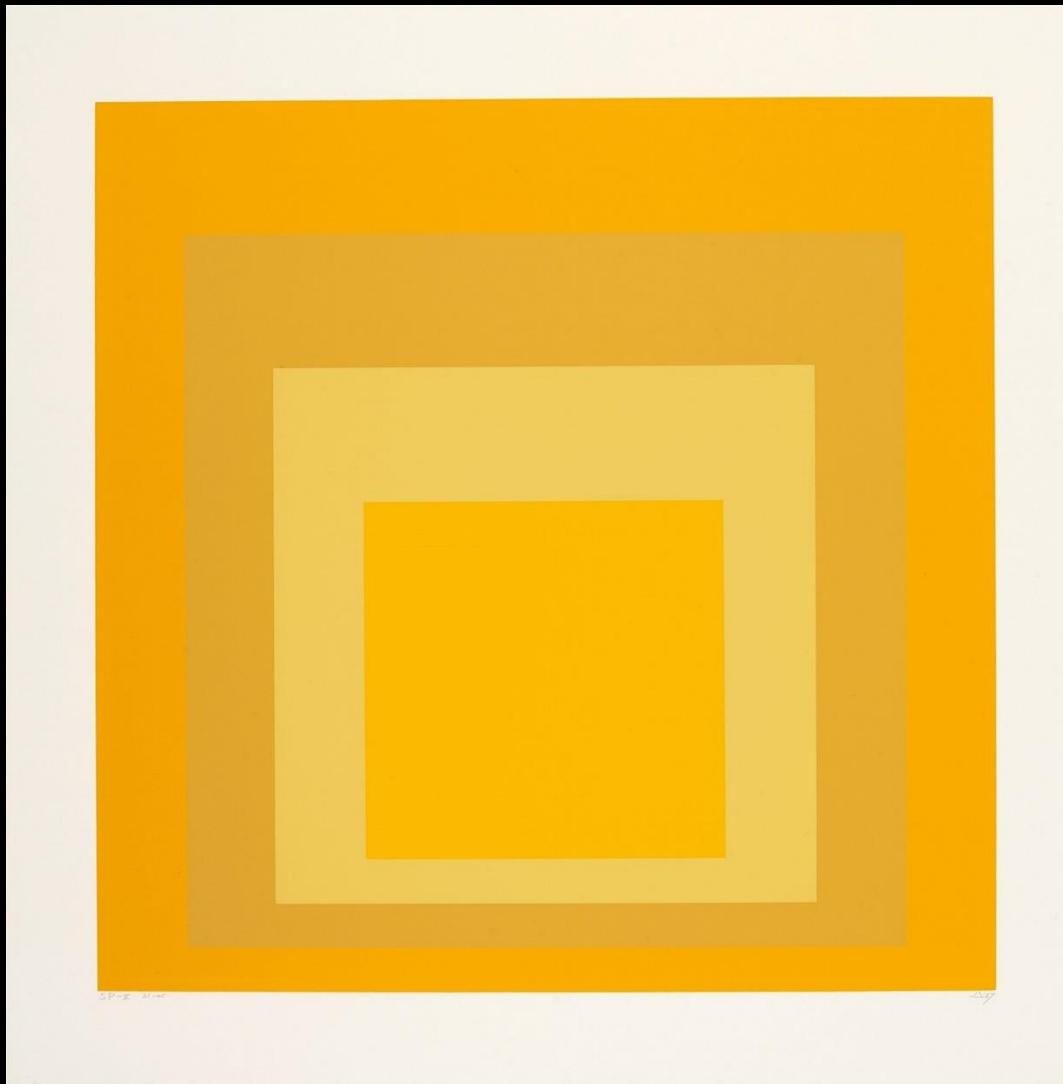
# Example: Josef Albers – journals from Mexico



Example: **Josef Albers** - Biconjugate (1943)



## Example: Josef Albers - Homage to the Square (1967)



Example: **Nicéphore Niépce** - View from the Window at Le Gras (1826)



## Example: D.J. Ruzicka - Penn Station (1920)



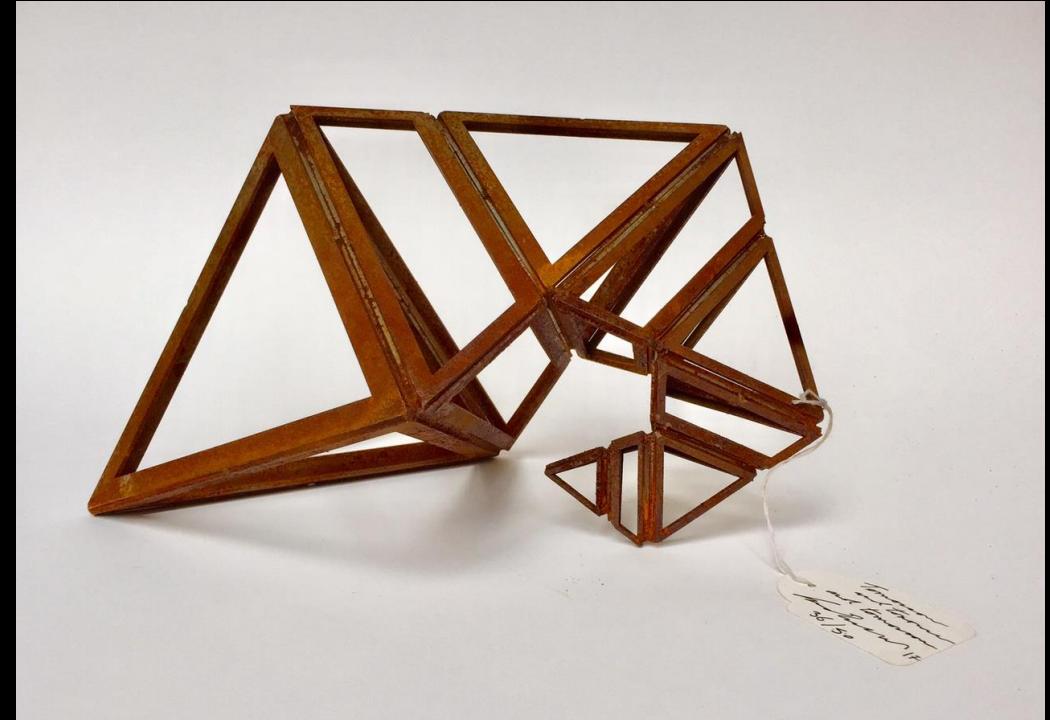
# Example: Ed Ruscha - Twentysix Gasoline Stations (1963)



Pause 1

# Example: When Science Meets Art (8 minutes podcast sample)

- Marcus Du Sautoy & Conrad Shawcross RA in conversation



<https://soundcloud.com/previtus/class-1-sample-marcus-du-sautoy-conrad-shawcross-when-science-meets-art/s-4kfnv>

# Play

- Game of Chess / GO / Prisoner's dilemma
- Two players making decisions depending on the state of the “board”,  
trying to win. **(Zero Sum Game)**

# Play

- Chess -> <http://plainchess.timwoelfle.de/>
- GO
- Prisoner's dilemma
- Describe:
  - What do you need for the game? Board? Players? Can you describe that?
- Action:
  - What can you do each “turn”?
- Decision:
  - How do you decide? (with the most possible detail) (strategy?)

Pause 2

# Task

- Online platforms to model formulas, plots, etc.
  - Wolfram Alpha
    - all examples: <https://www.wolframalpha.com/>
    - <https://www.wolframalpha.com/examples/society-and-culture/arts-and-media/>
    - Vaguely similar to the Hitchhiker's guide to the Galaxy!
  - GeoGebra - <https://www.geogebra.org/materials>
  - Google Colab demos, usually machine learning (reason being access to GPU's)
  - [www.gasp.gallery](http://www.gasp.gallery) Pattern creator
  - p5.js demos at <http://www.generative-gestaltung.de/2/>

# Bonus links

- Videos of simulations:
  - Game theory (“evolution of aggression”)  
<https://www.youtube.com/watch?v=YNMkADpvO4w>