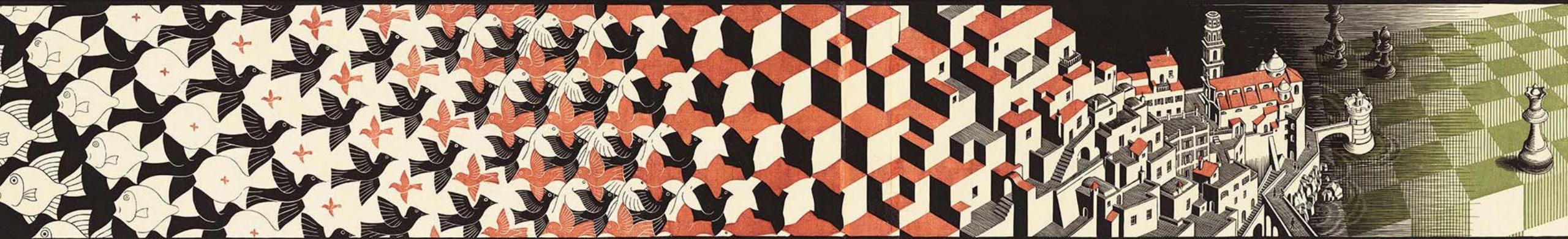


Data, Math and Methods

Week 1, Introduction



~ Vítek Růžička

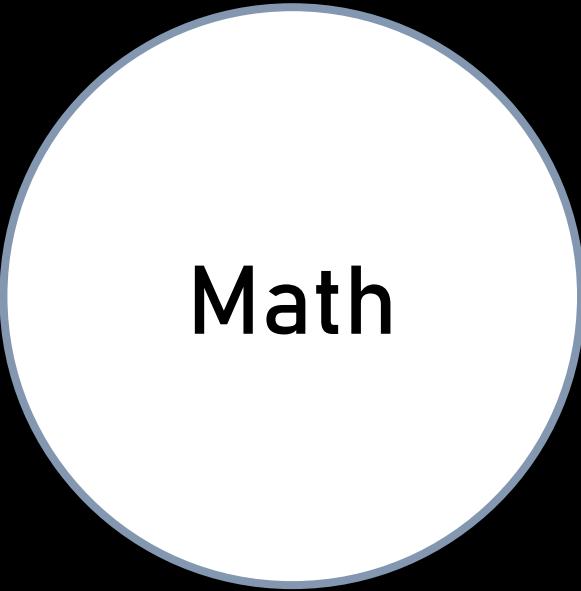
What is this class about?

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

When? What? How?

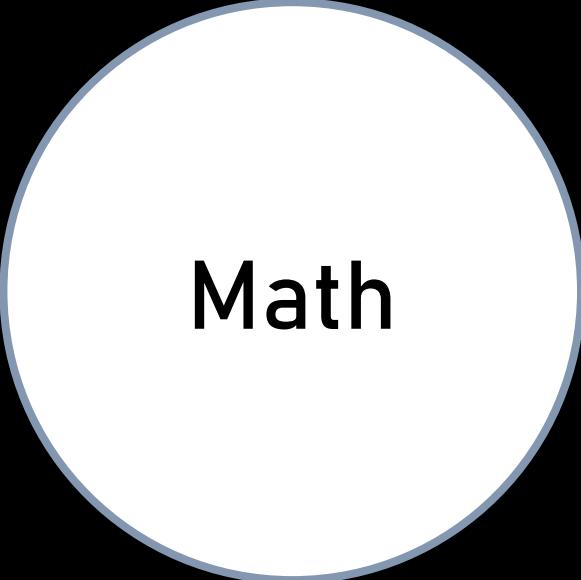
- When:
 - Wednesdays 13:30 – 17:30, usually 2 pauses per class
- Marking:
 - 50% Multiple Choice test
 - 50% Practical Exam
 - Attendance
- Repository + Recording

Data, Math and Methods



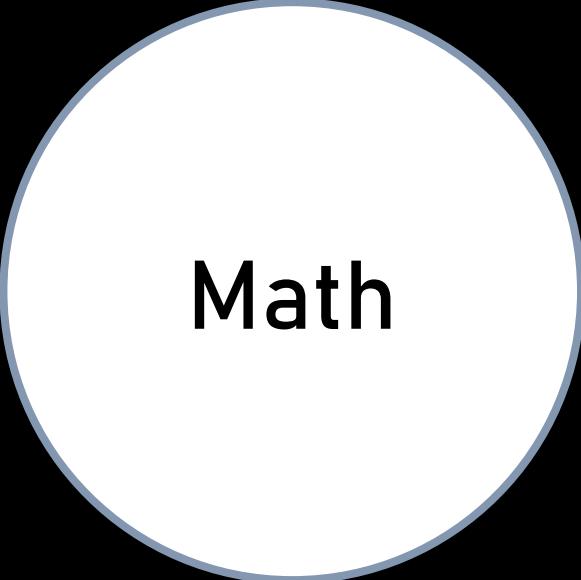
Math

- 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 world
 - 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



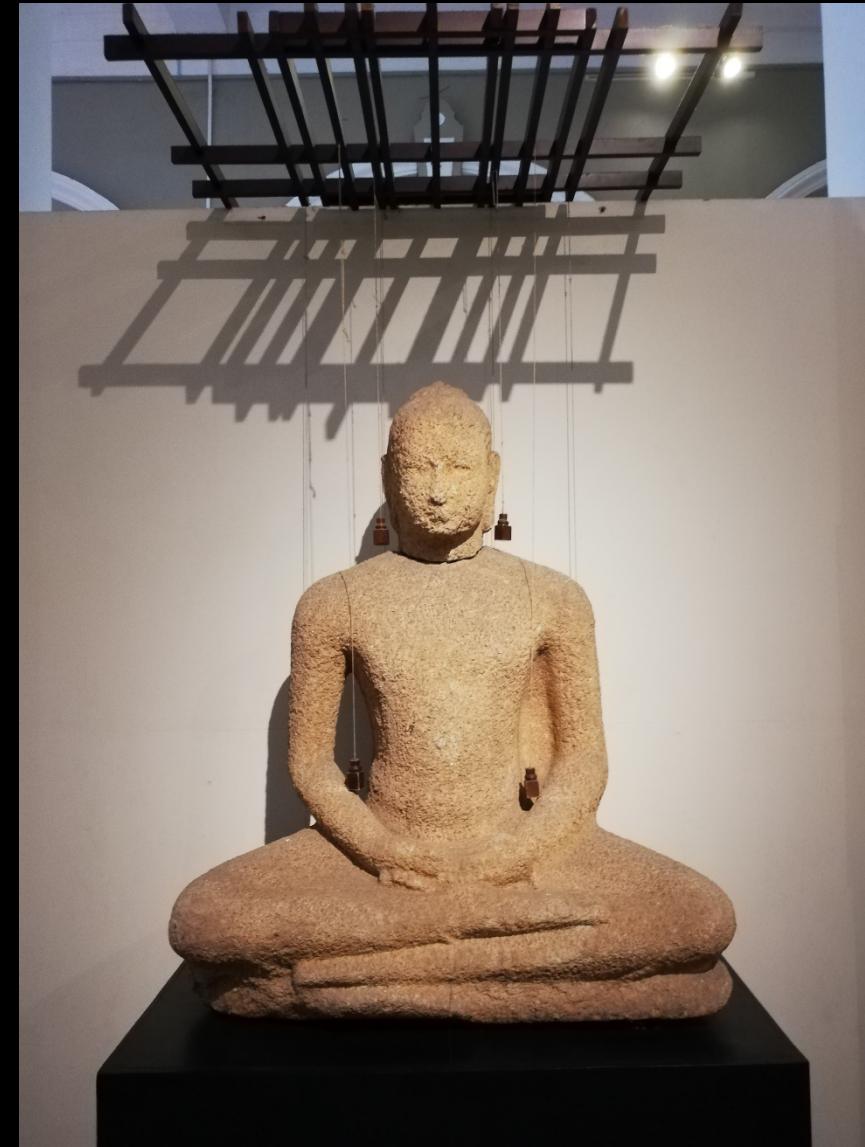
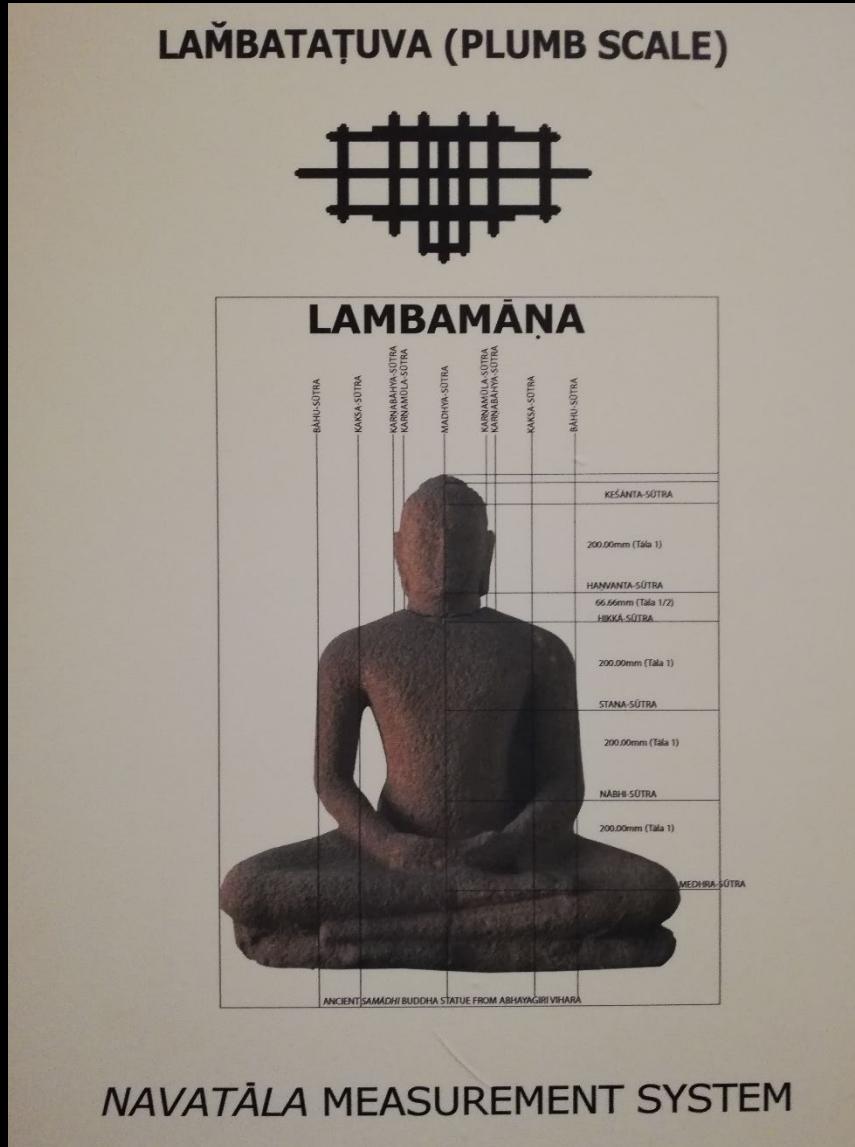
Example: *math in the real world*



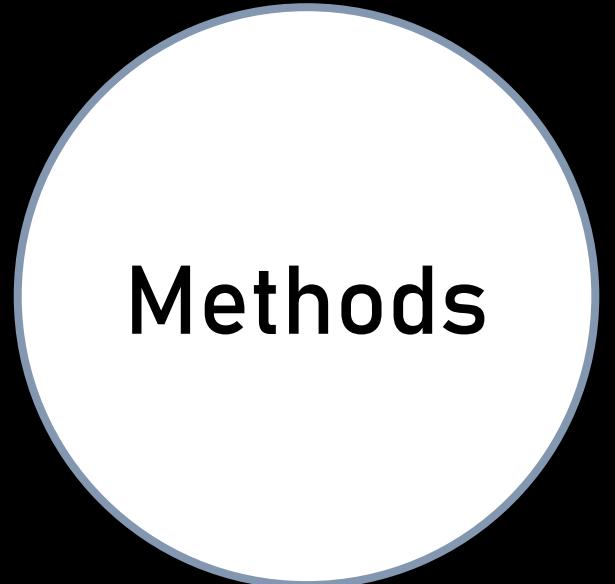
Architecture



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**)



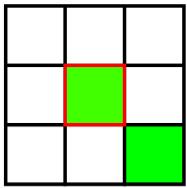
Methods



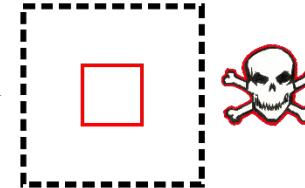
Example: Conway's Game of Life (1970)

Game of Life Rules

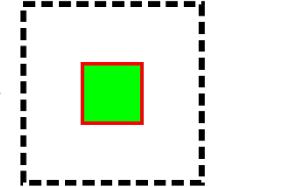
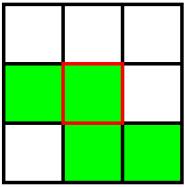
Generation X



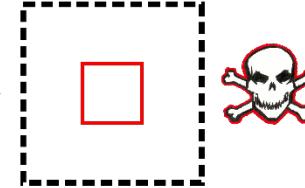
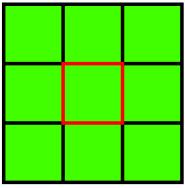
Generation X+1



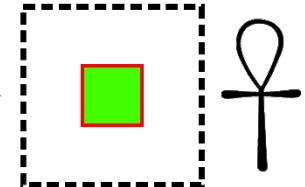
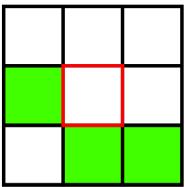
<2
under-population



$=2,3$
survival



>3
overcrowding



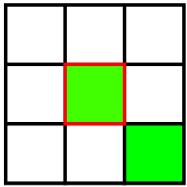
$=3$
reproduction



Example: Conway's Game of Life (1970)

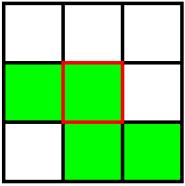
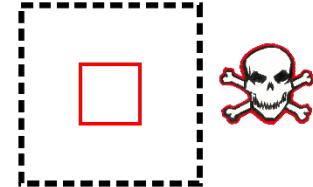
Game of Life Rules

Generation X

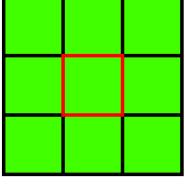
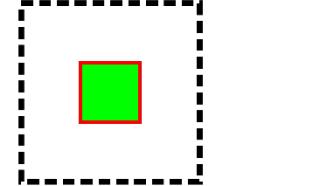


Generation X+1

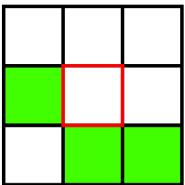
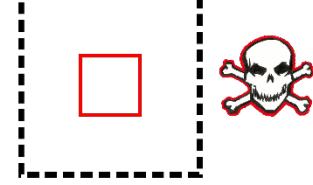
<2
under-population



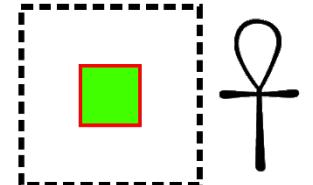
$=2,3$
survival



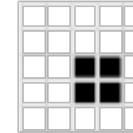
>3
overcrowding



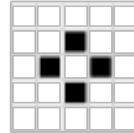
$=3$
reproduction



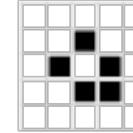
block



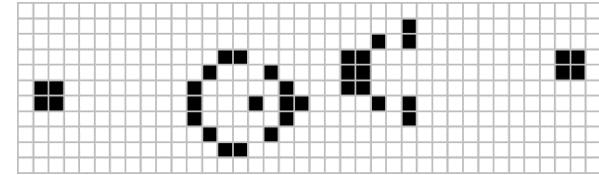
tub



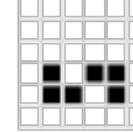
boat



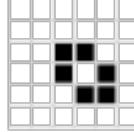
Guns and gliders



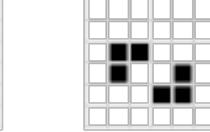
snake



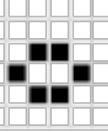
ship



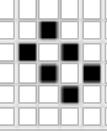
aircraft carrier



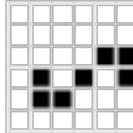
beehive



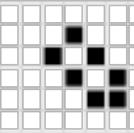
barge



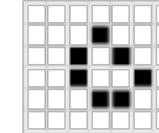
Python



long boat *eater, fishhook*

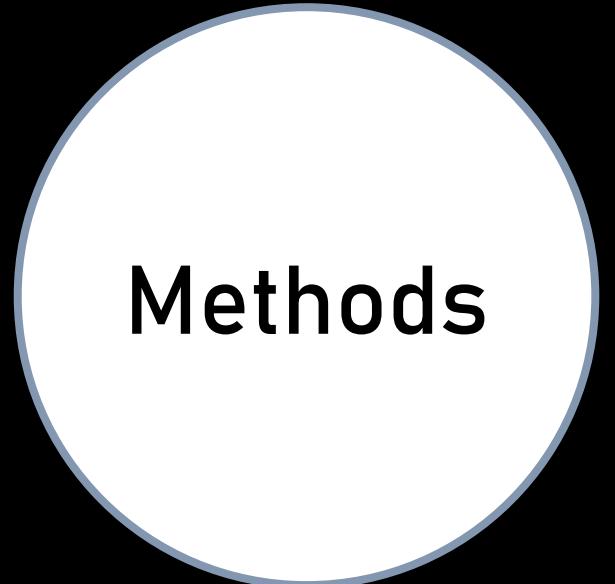


loaf



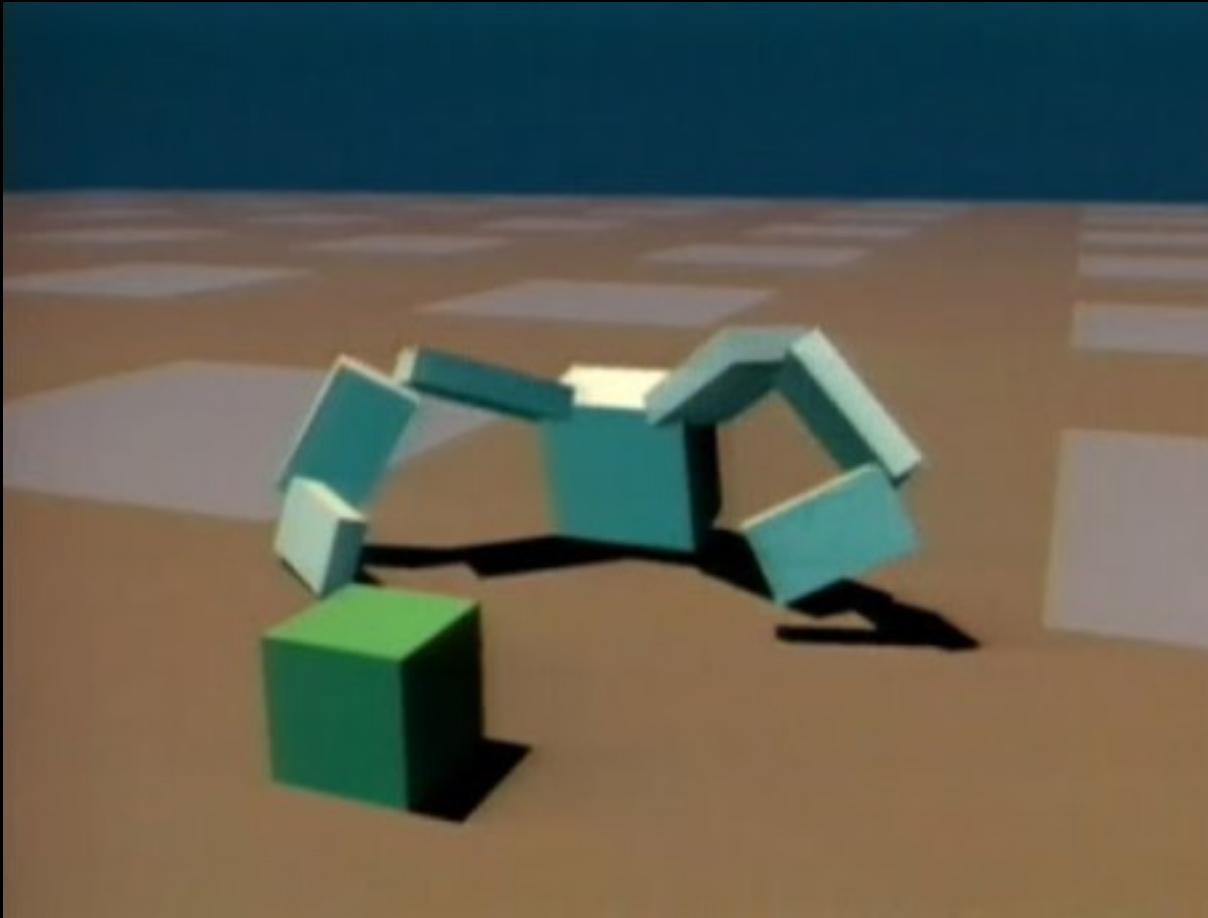
youtube.com/watch?v=xP5-ileKXE8

- 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)



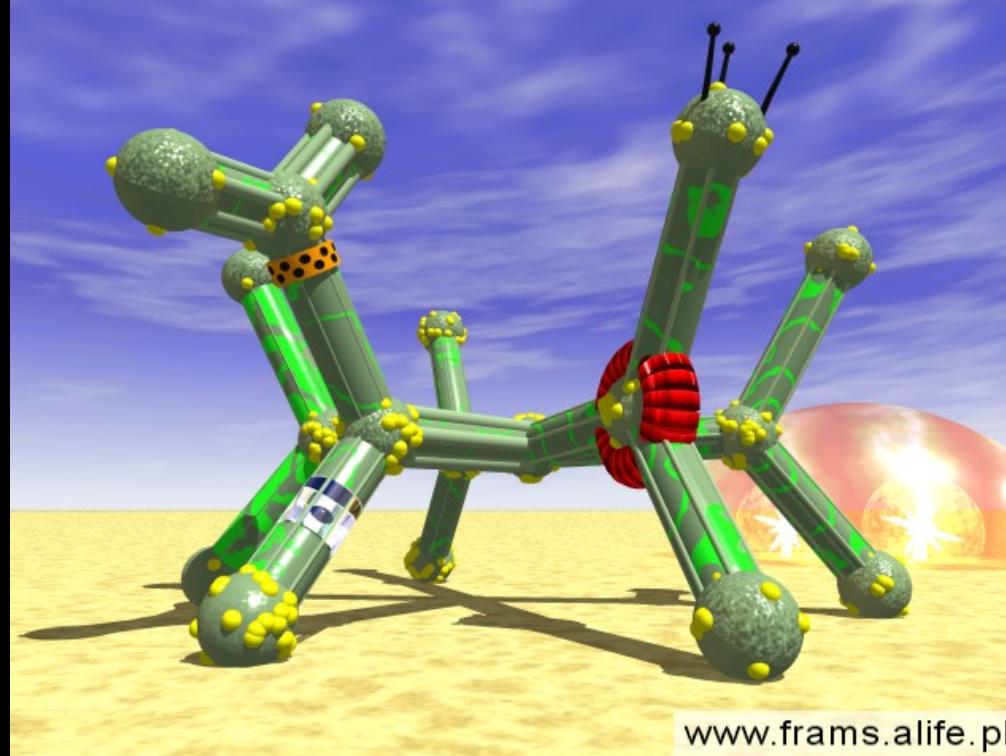
Methods

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



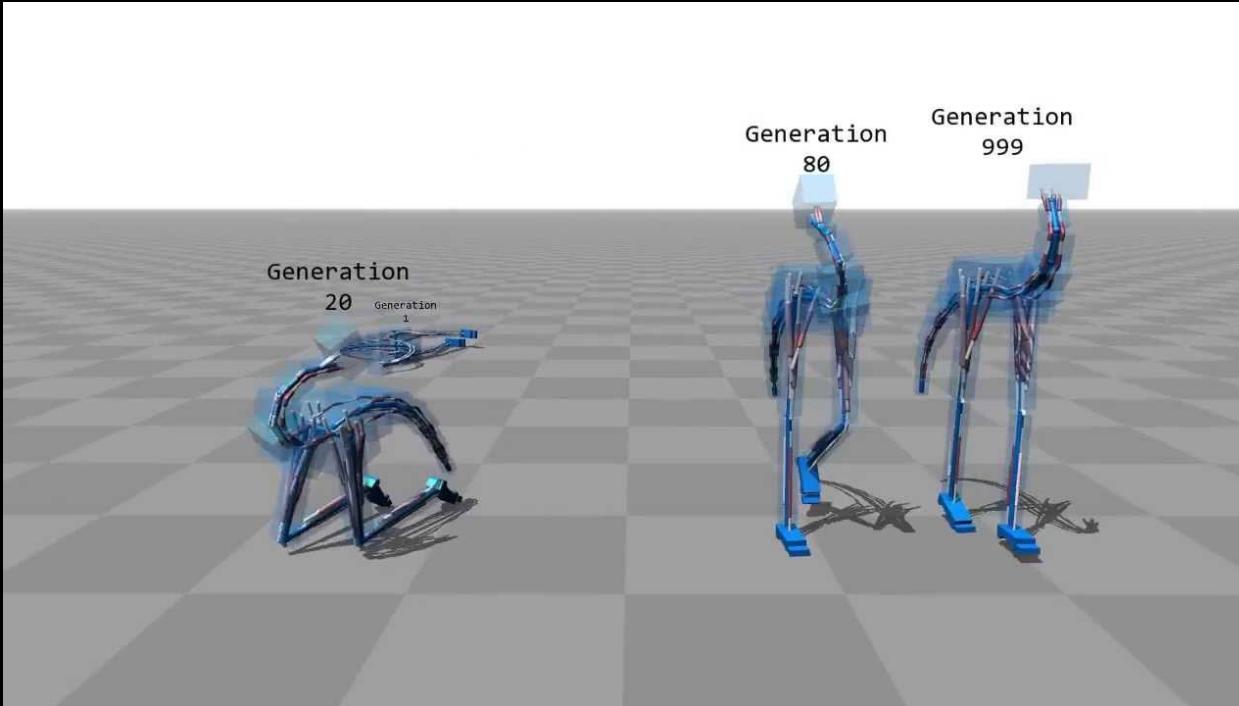
[youtube.com/watch?v=RZtZia4ZkX8](https://www.youtube.com/watch?v=RZtZia4ZkX8)

Example: **Framsticks** experiment with genetic algorithms

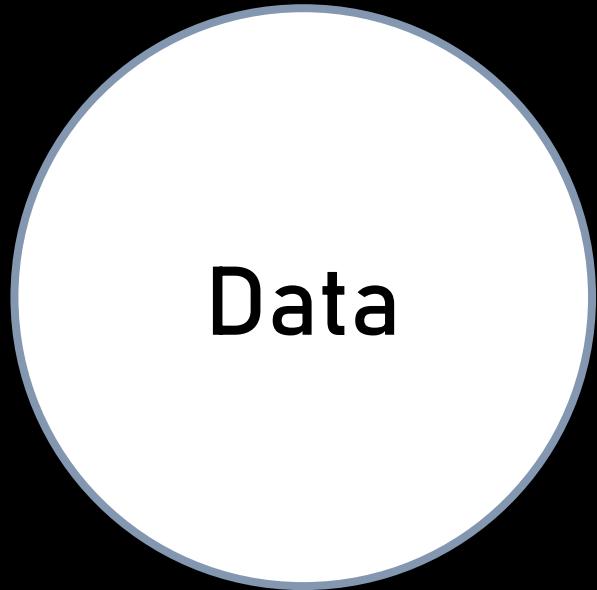


[youtube.com/watch?v=SoZguPlXGPA](https://www.youtube.com/watch?v=SoZguPlXGPA)

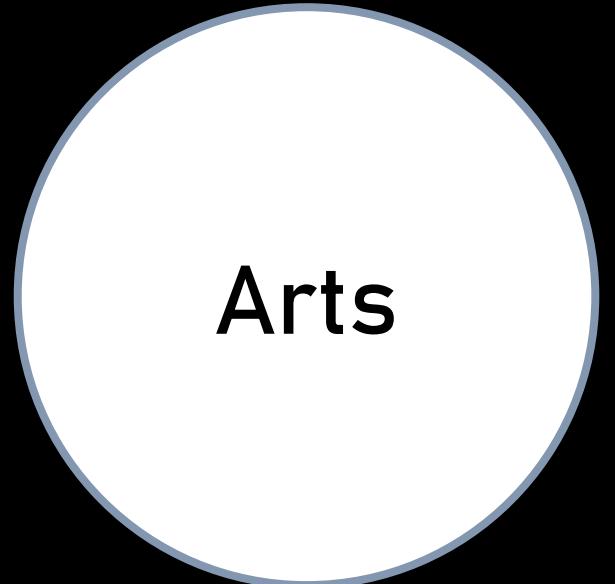
Example: Flexible Muscle-Based Locomotion for Bipedal Creatures



youtube.com/watch?v=pgaEE27nsQw



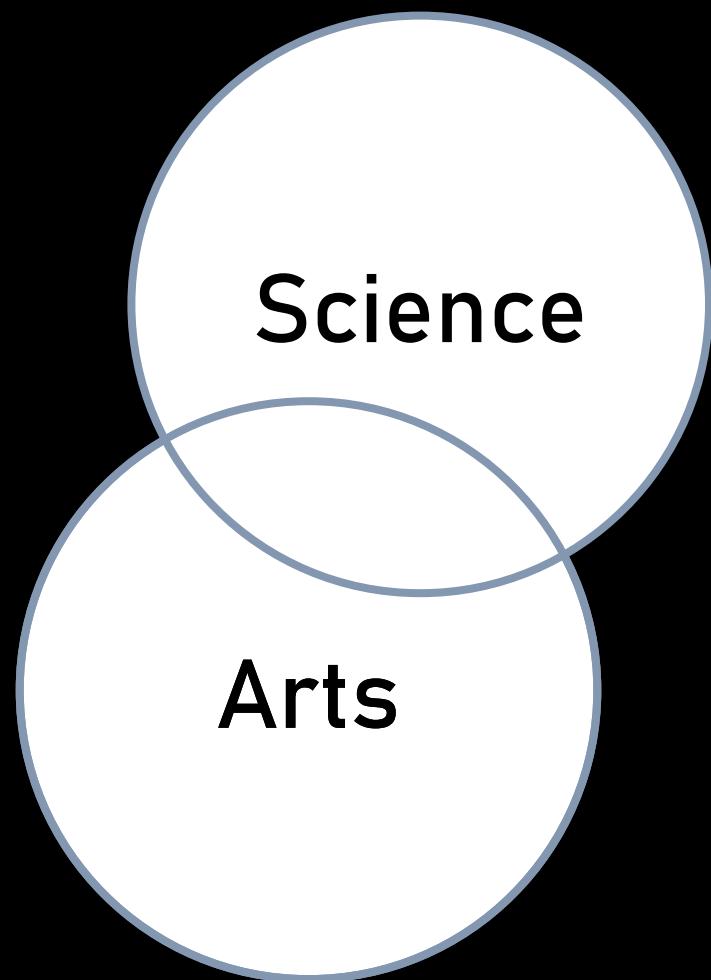
- Information (theoretically absolutely anything more *interesting* than noise)
- Why would we care? (Fair question, *data is just data!*)
 - Large quantities (“Big Data”) and smart methods and algorithms (Machine Learning ;-))
- Visualization
- Modelling, learning to understand, generate



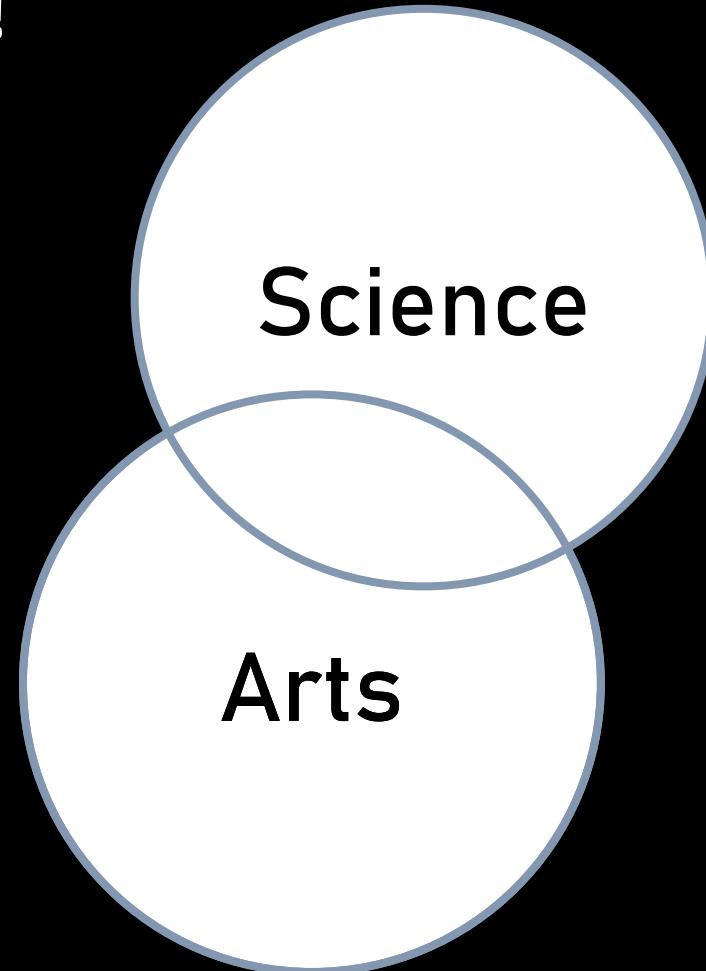
Arts

- 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!



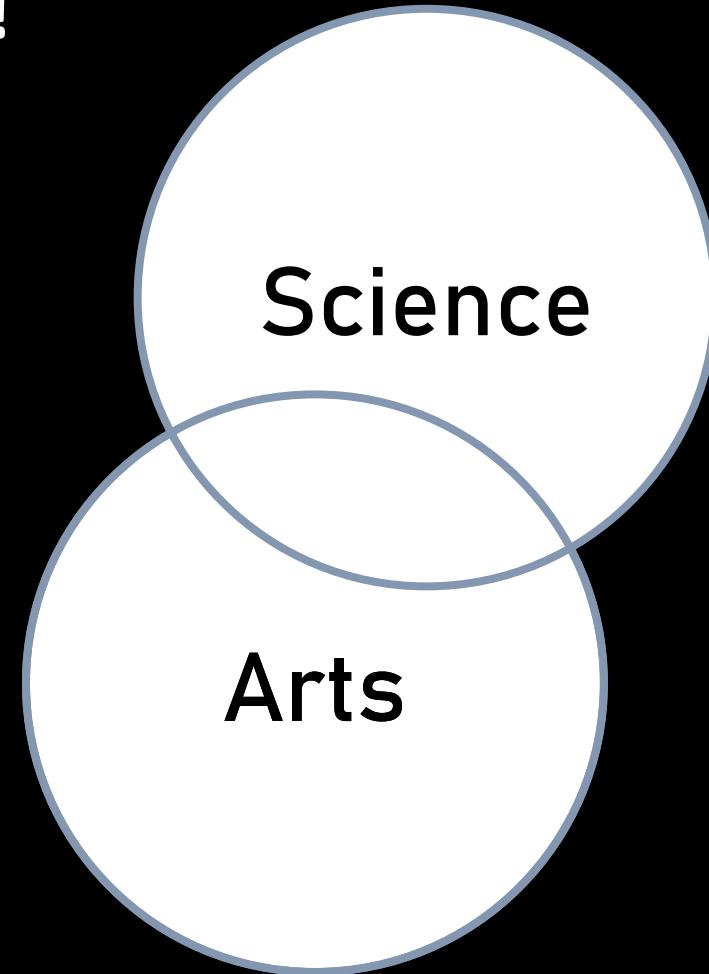
- Exploration of the unknown!

- Science -> Arts:

- Modernism
- Abstraction
- (via theories of Systems)

- Art -> Sciences:

- Complicatedness?





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

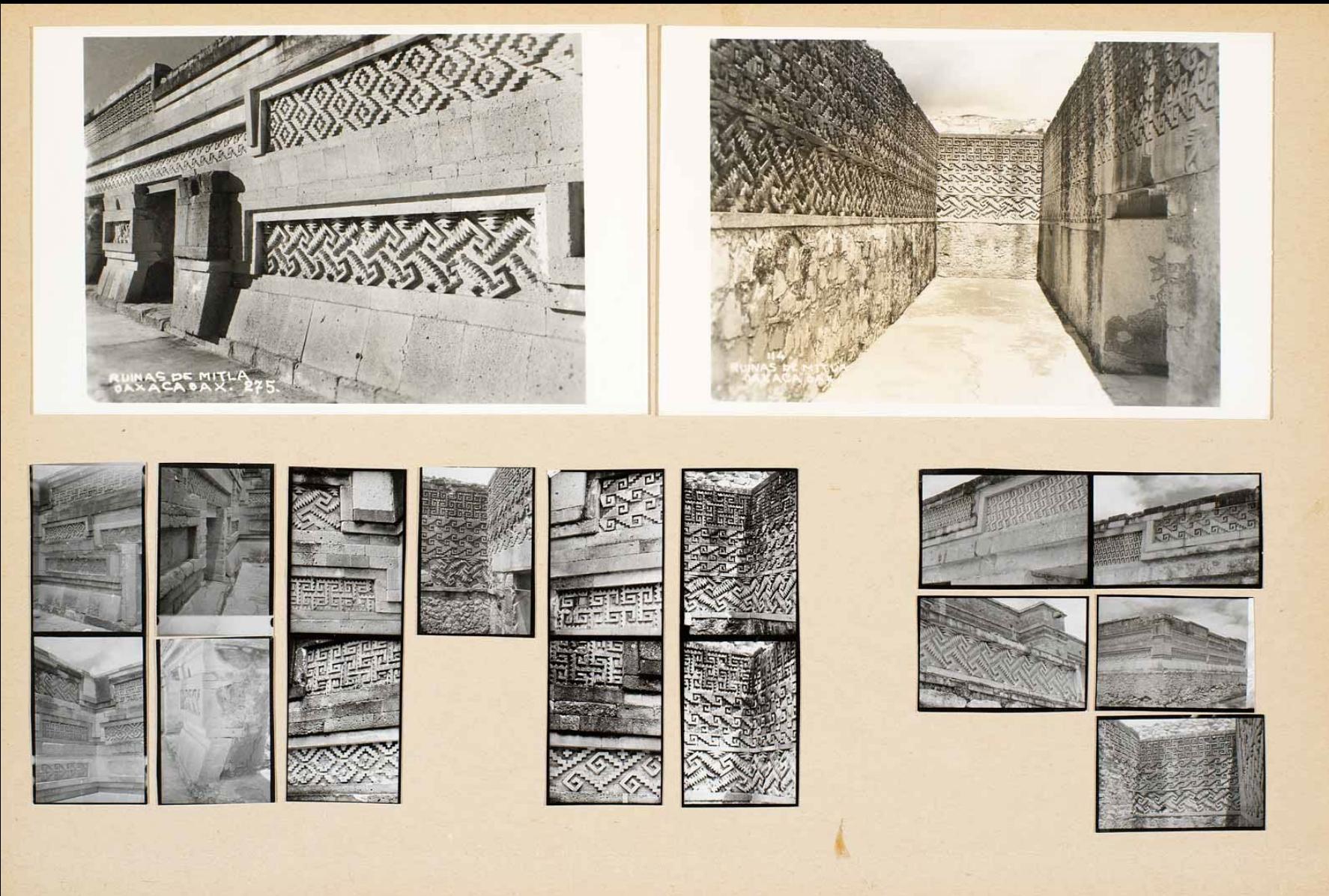




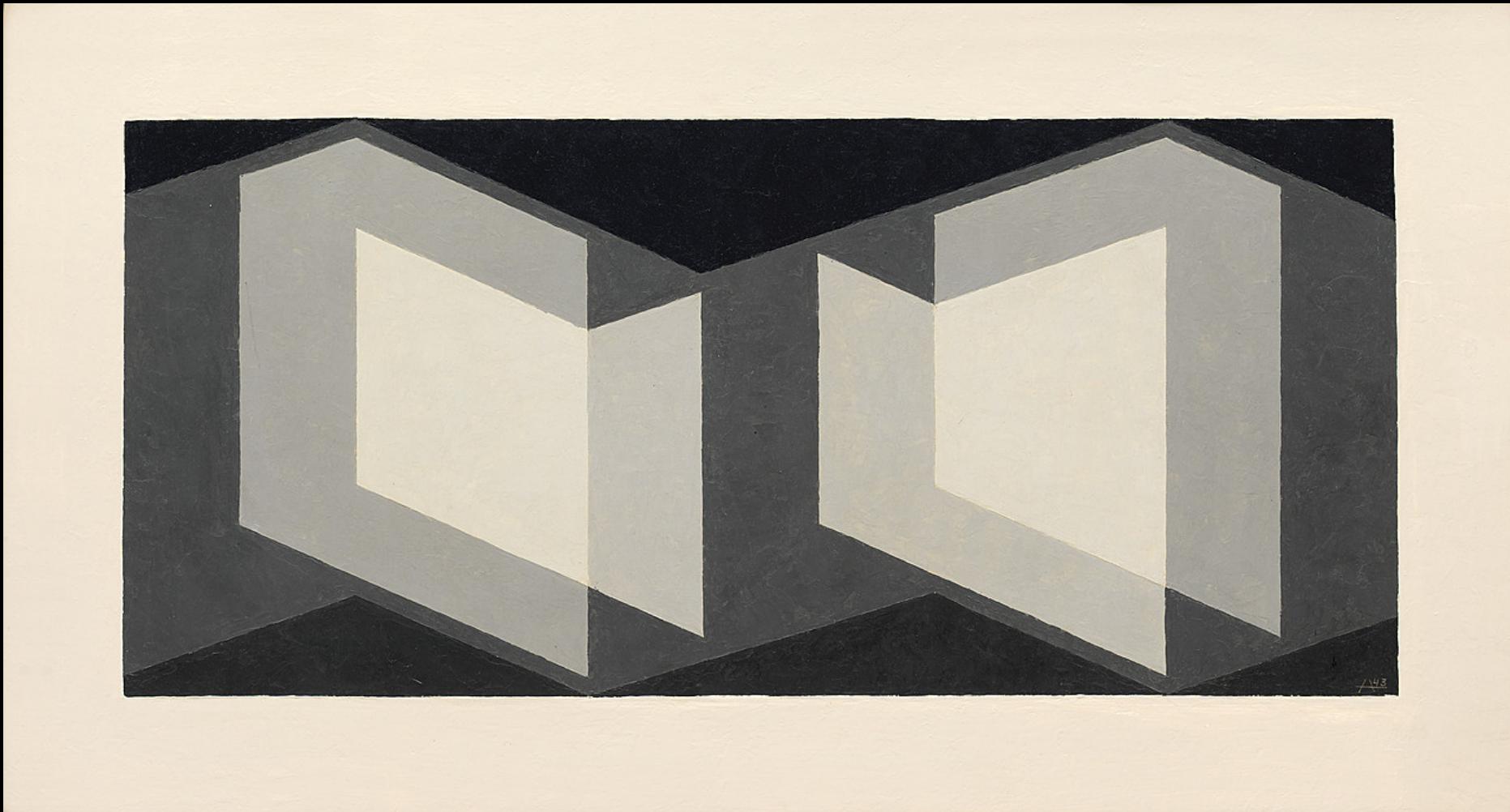
Example: Georges Seurat - A Sunday on La Grande Jatte (1884)



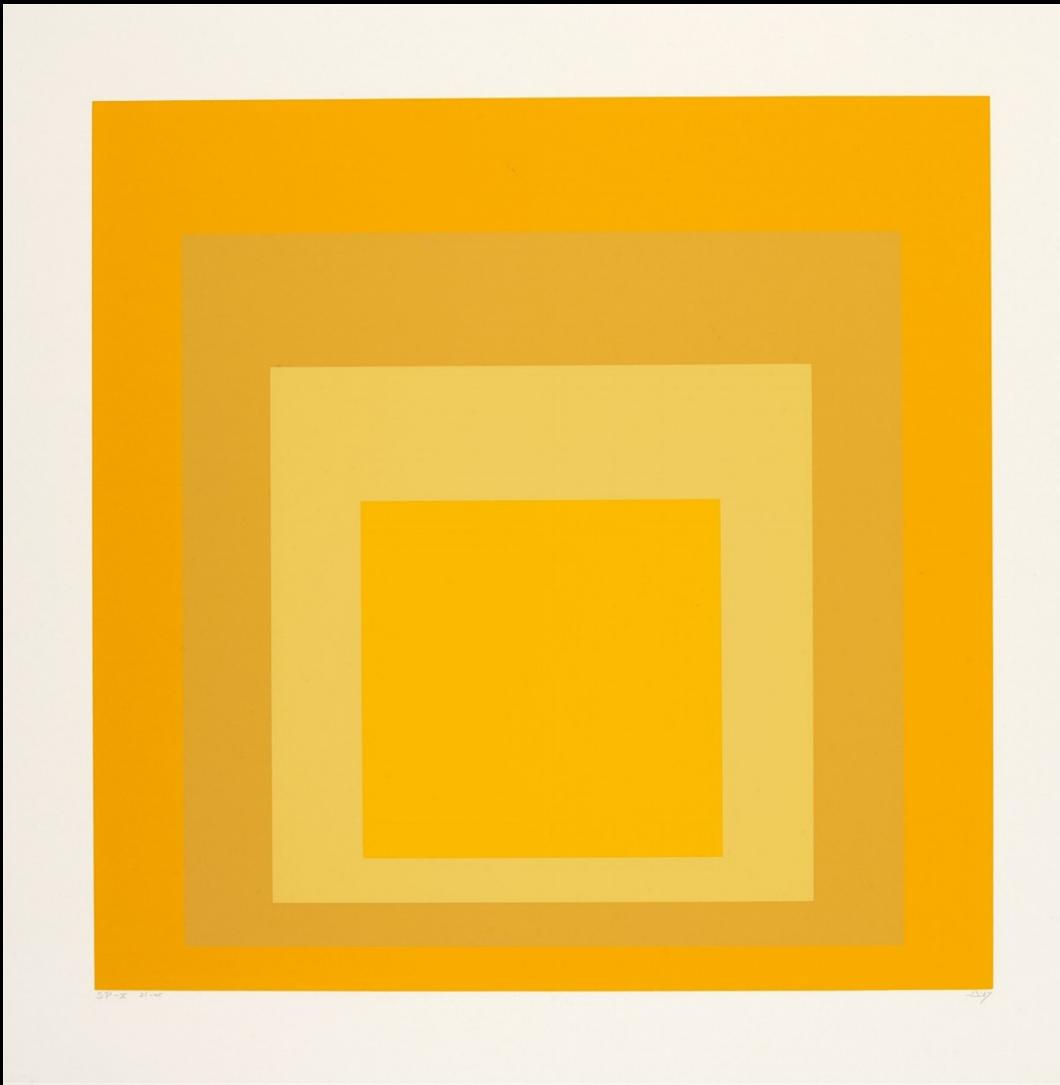
Example: Josef Albers – journals from Mexico



Example: Josef Albers - Biconjugate (1943)



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





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



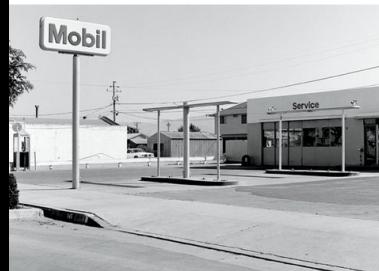


Example: D.J. Ruzicka - Penn Station (1920)





Example: Ed Ruscha - Twentysix Gasoline Stations (1963)

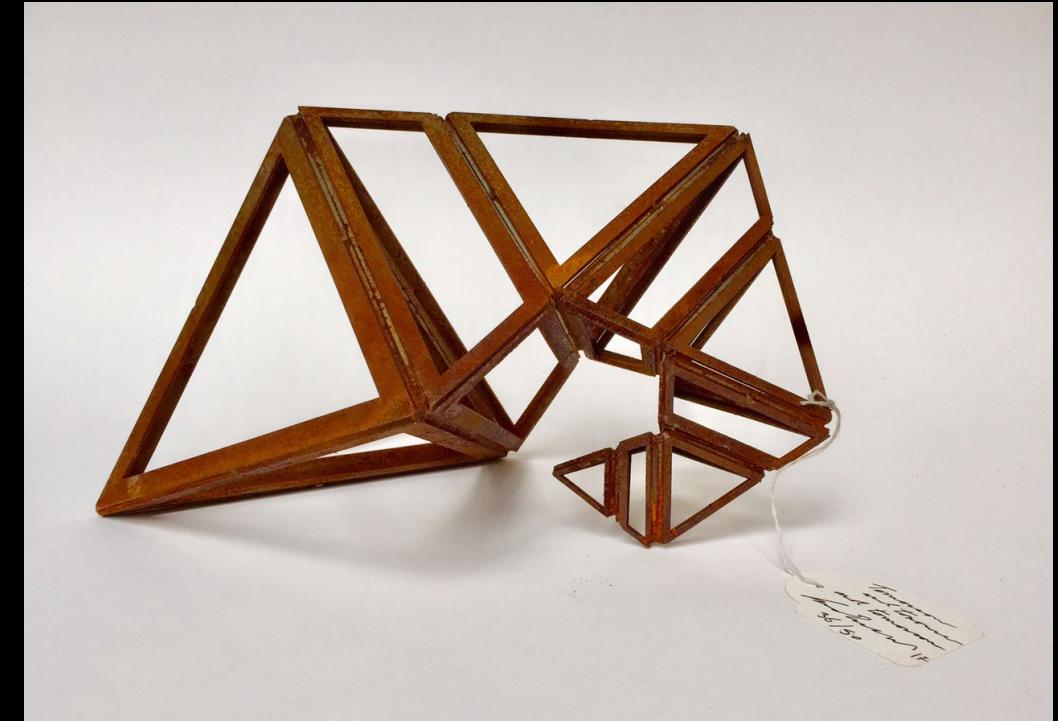


Pause 1



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 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>
- John Conway on Conway’s Game of Life:
 - <https://www.youtube.com/watch?v=E8kJL04ELA>
 - (pretty amazing to watch!)