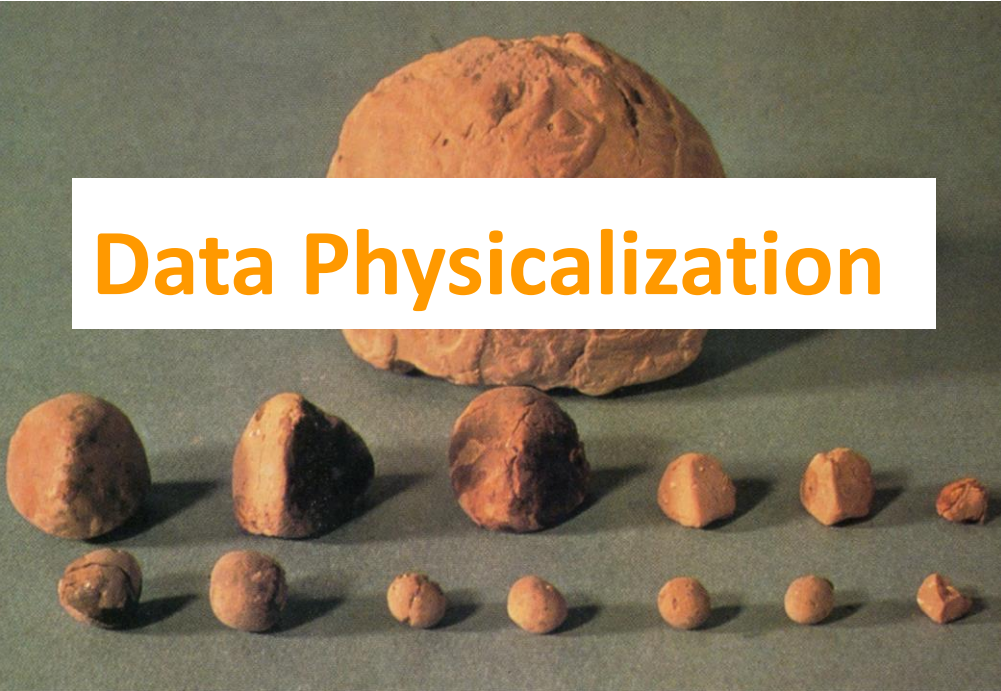


Session 4.1

Applications I

Data Physicalization



Online Course
**Data Visualization
for Professionals**



THE UNIVERSITY
of EDINBURGH

Uta Hinrichs
June 2020

<https://sachi.cs.st-andrews.ac.uk/people/faculty/>

<https://datavis-online.github.io>

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data physicalization: what & why?

what is data physicalization?

A data physicalization (or simply physicalization) is a physical artifact whose geometry or material properties encode data.

Jansen et al. 2015

Jansen et al. Opportunities and Challenges for Data Physicalization. CHI 2015
<https://hal.inria.fr/hal-01120152/document>

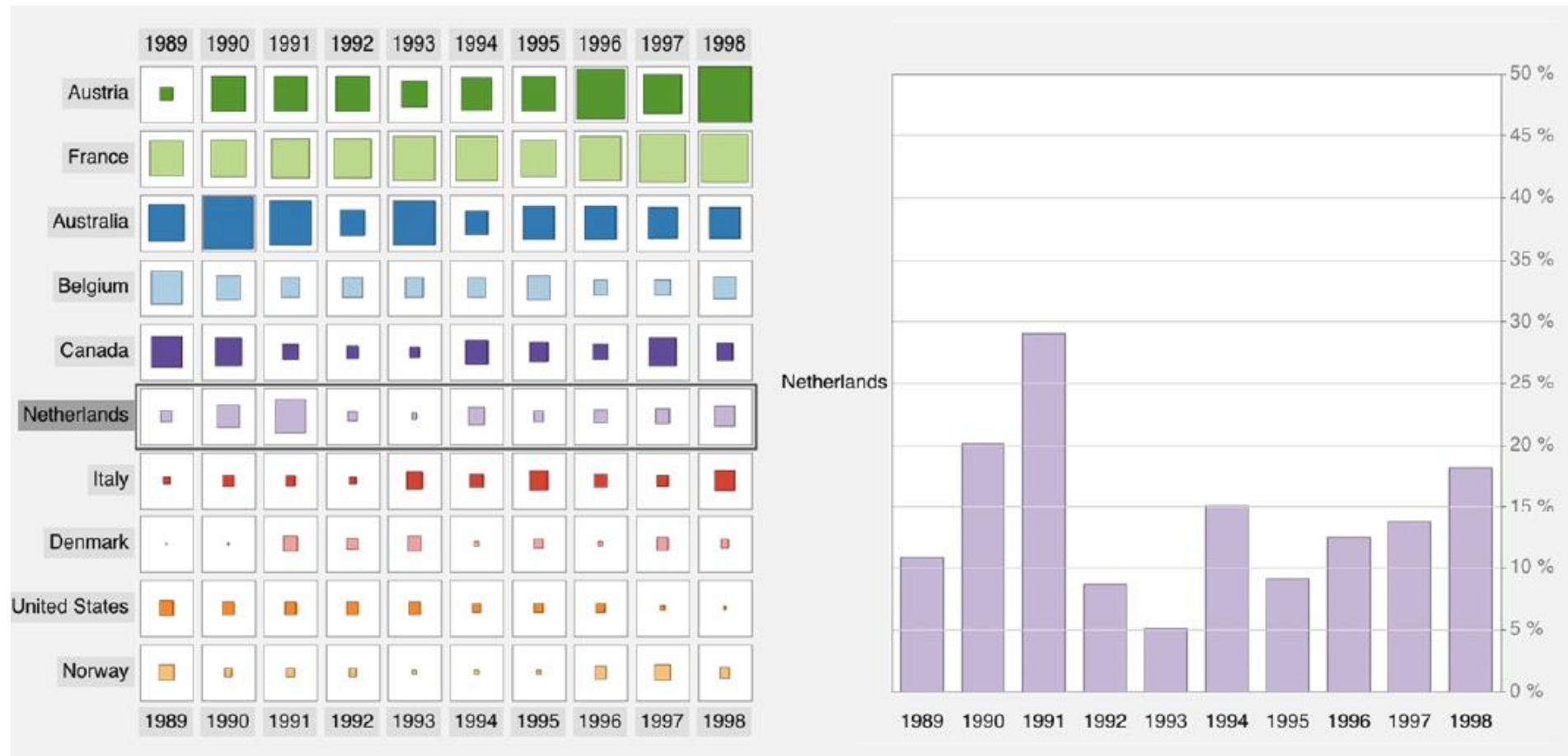
what is data physicalization?

- A way to represent data through physical & tangible artefacts
 - visual appearance
 - physical form

	1990	1995	1996	1997	1998	1999
Australia	13,200,000,000	17,344,724,795	20,072,000,000	20,443,479,000	18,320,872,400	18,003,519,200
Austria	7,682,000,000	12,240,000,000	11,613,000,000	11,219,611,976	12,303,561,168	12,454,800,000
Belgium	8,901,000,000	8,584,000,000	8,640,000,000	7,927,859,601	8,110,109,247	10,355,269,873
Canada	33,176,000,000	39,061,000,000	41,993,965,984	43,720,691,559	33,470,286,481	35,959,627,519
France	55,040,000,000	87,480,000,000	88,020,000,000	79,333,009,800	77,456,373,964	77,265,000,000

Education expenditure by country and year (US \$)

data visualization

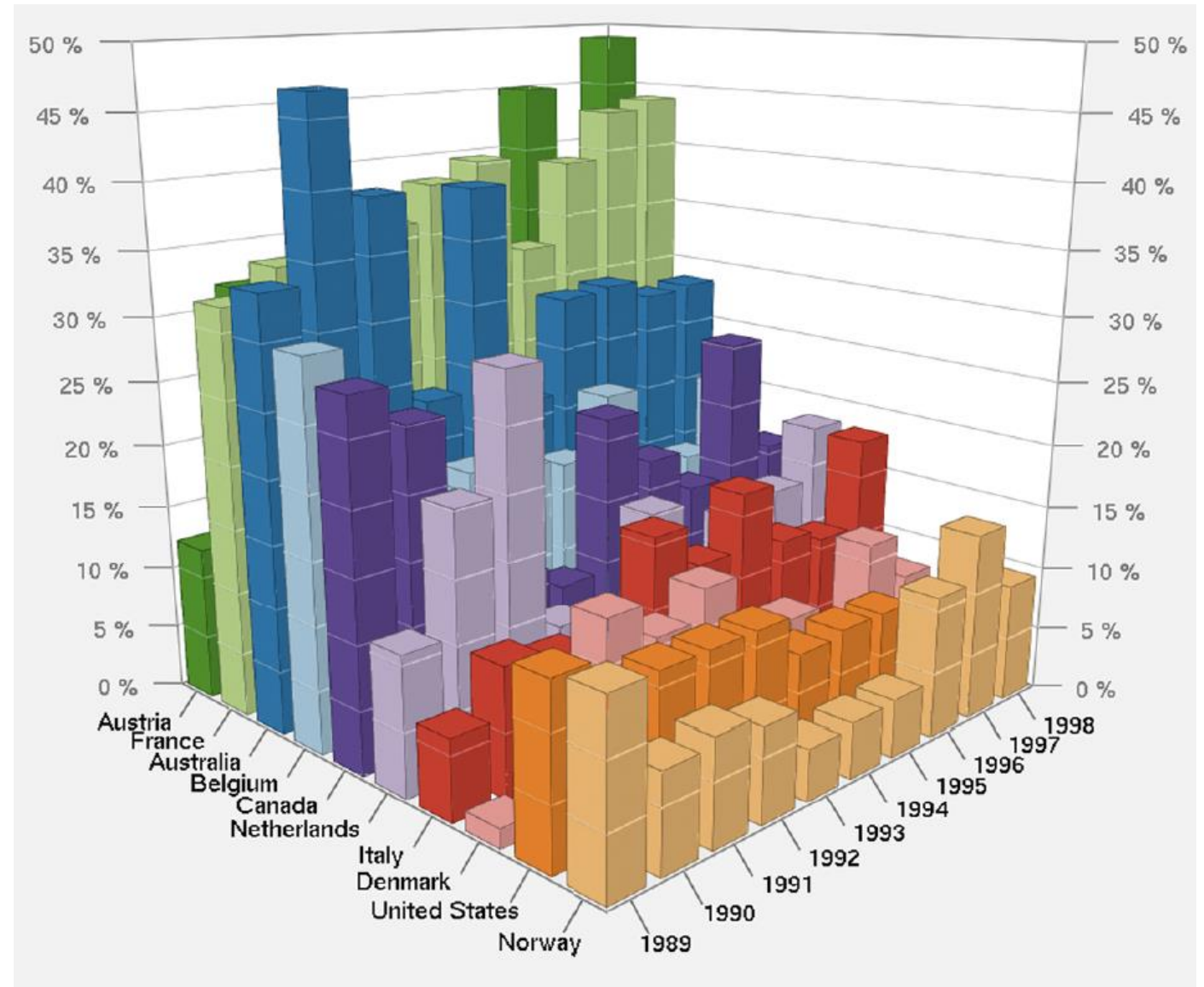


Jansen et al. Evaluating the Effectiveness of Physical Visualizations. CHI 2013

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<https://hal.inria.fr/hal-00781831>

data visualization

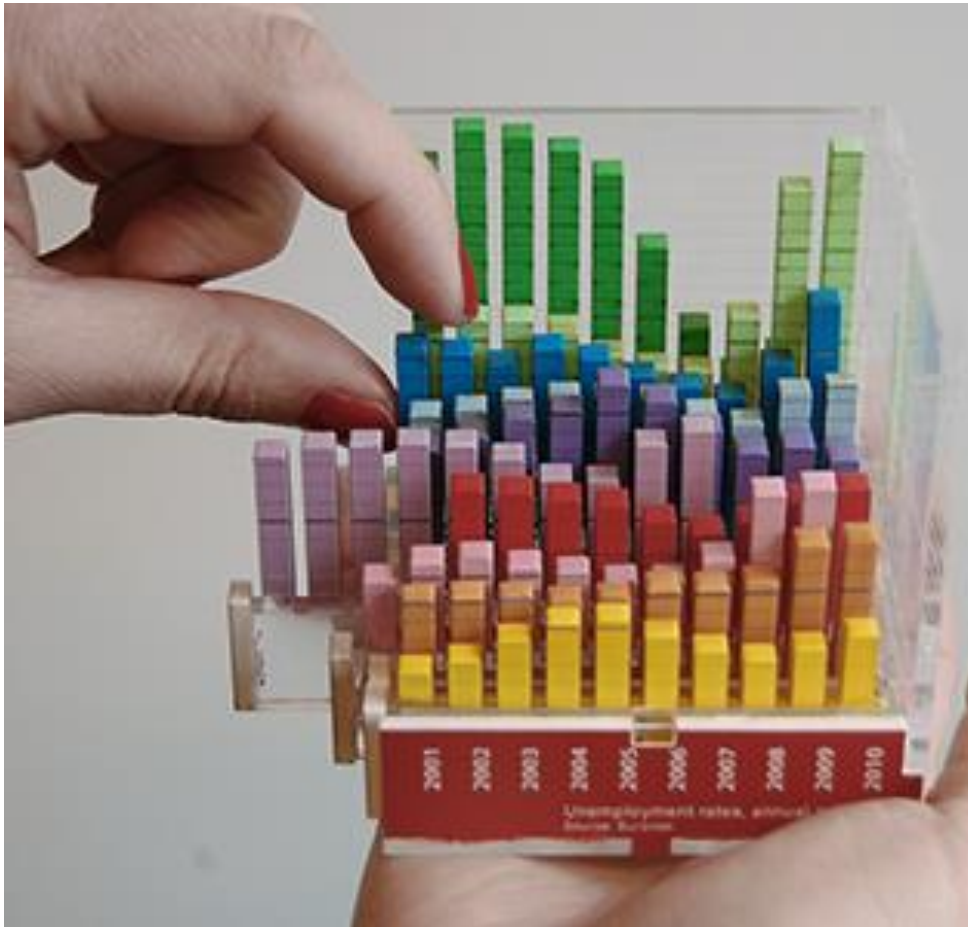


Jansen et al. Evaluating the Effectiveness of Physical Visualizations. CHI 2013

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<https://hal.inria.fr/hal-00781831>

data physicalization



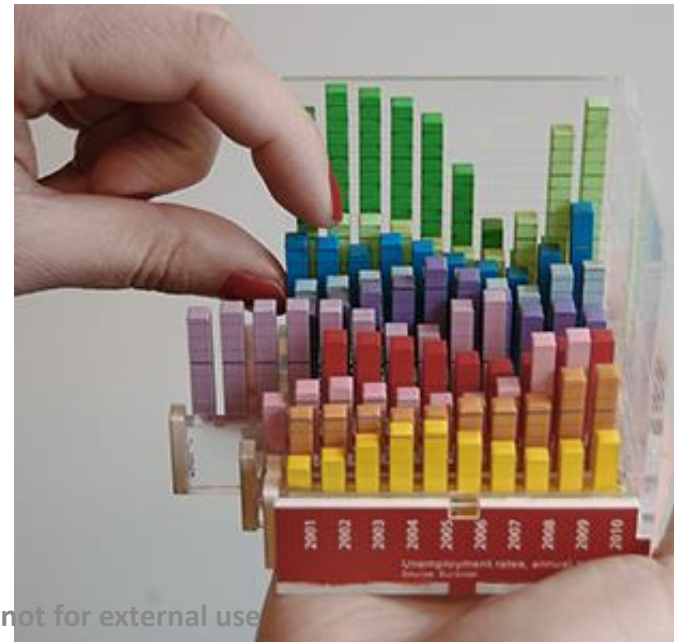
Jansen et al. Evaluating the Effectiveness of Physical Visualizations. CHI 2013

not for external use

<https://hal.inria.fr/hal-00781831>

physicalization goes beyond the visual

- It is an opportunity to
 - Make data tangible
 - Enable the exploration of data with hands or the full body
 - Embed data into the physical environment

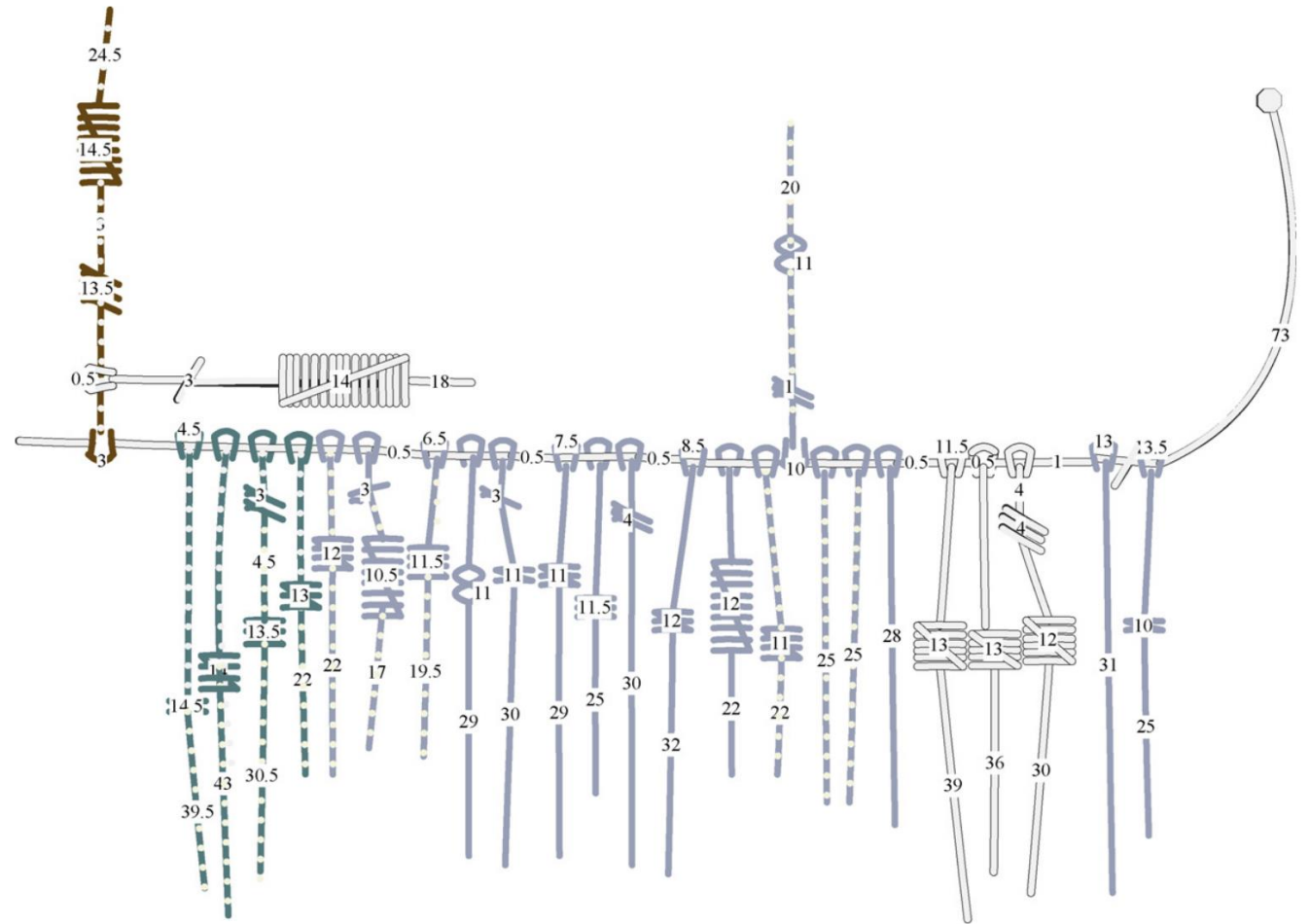
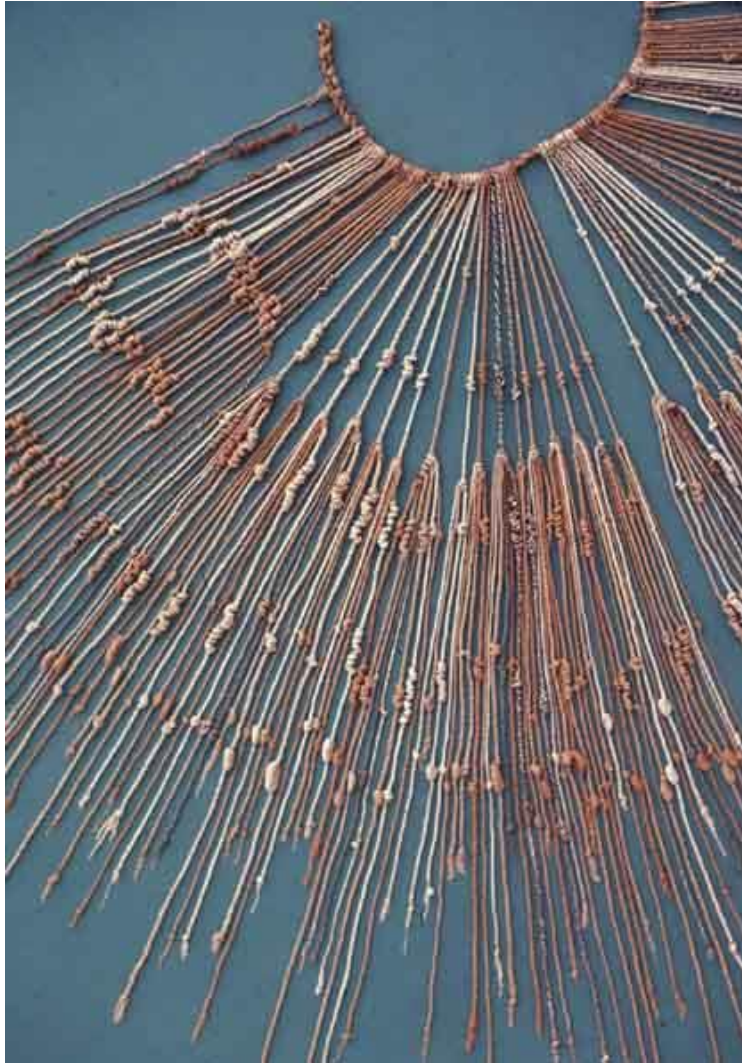


historical examples

5500 BC: Mesopotamian clay tokens



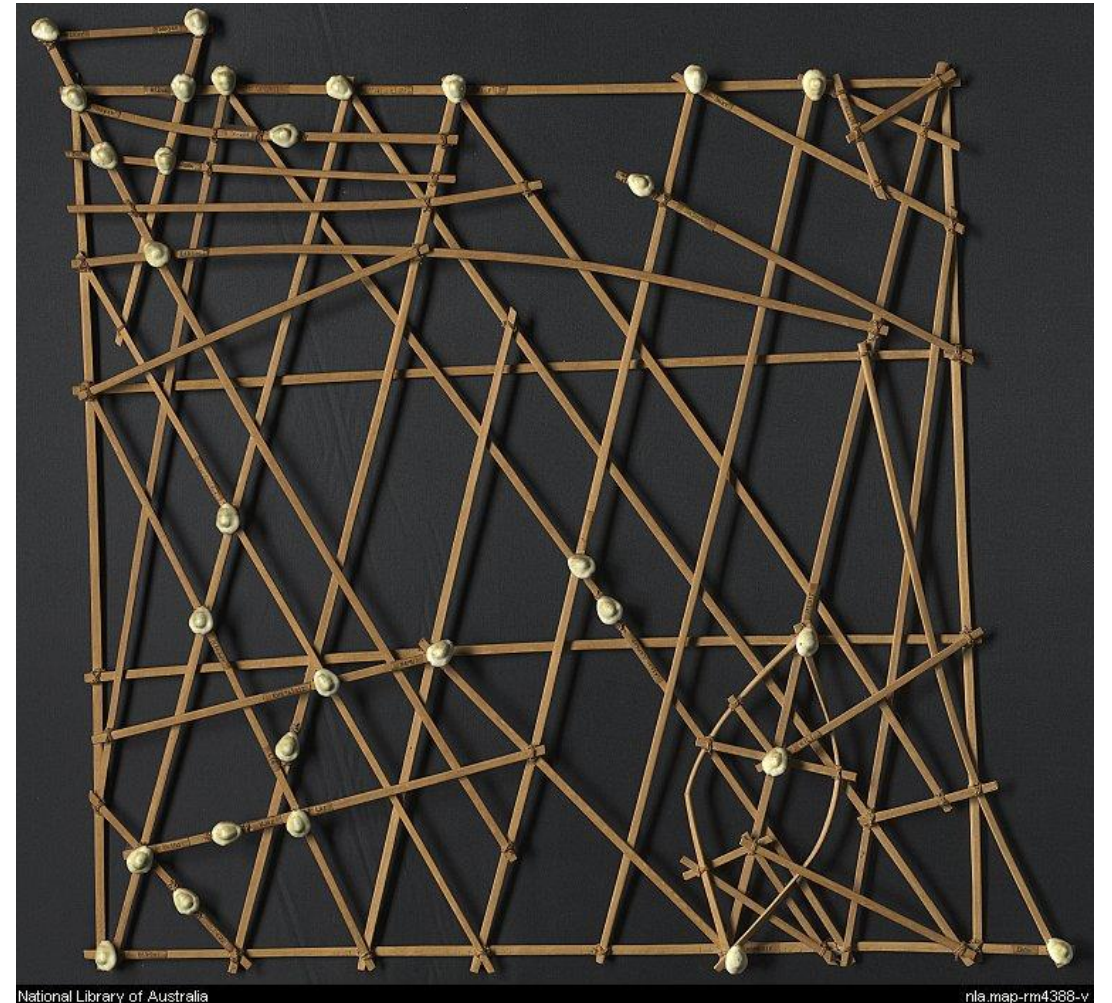
2600 BC: Inca Quipus



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<http://dataphys.org/list/peruvian-quipus/>

1882 – Marshall Island Stick Charts



National Library of Australia

nla.map-rm4388-v

1890 – Polynesian Genealogical Instrument

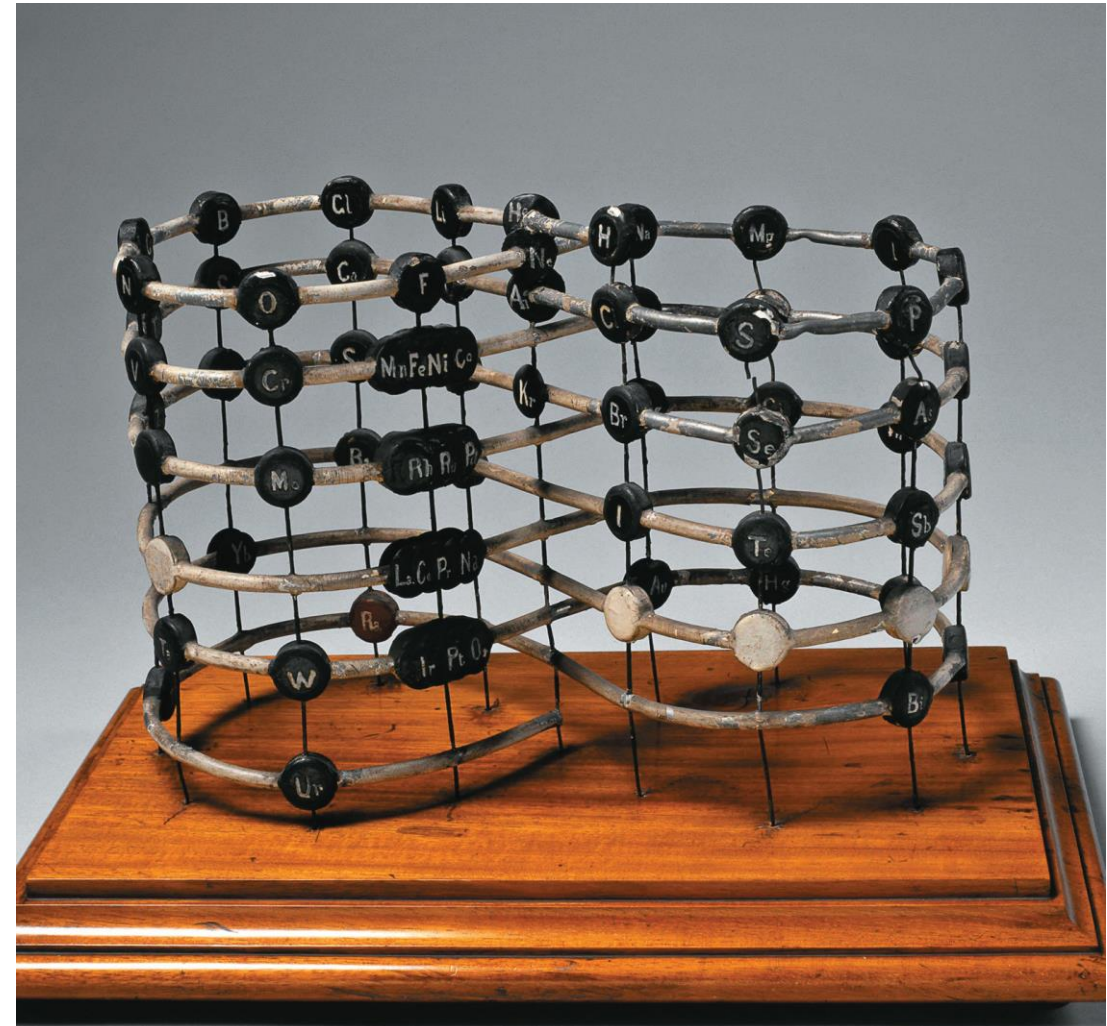


<http://dataphys.org/list/polynesian-genealogical-instrument/>

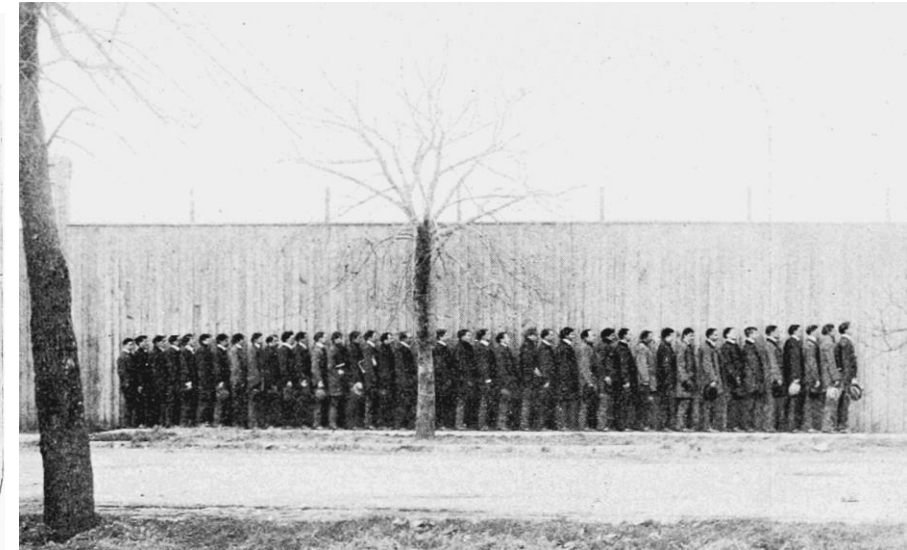
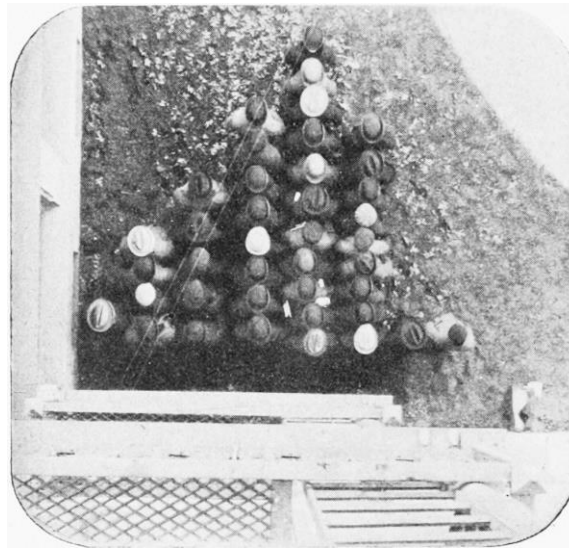
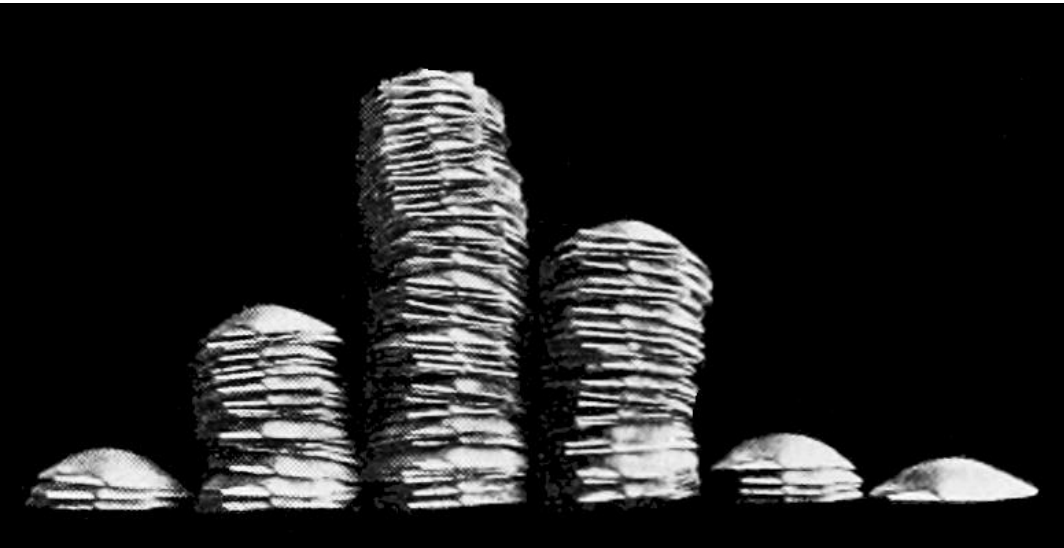
1920 – Yakama Time Ball



1898 – Crookes' Vis Generatrix



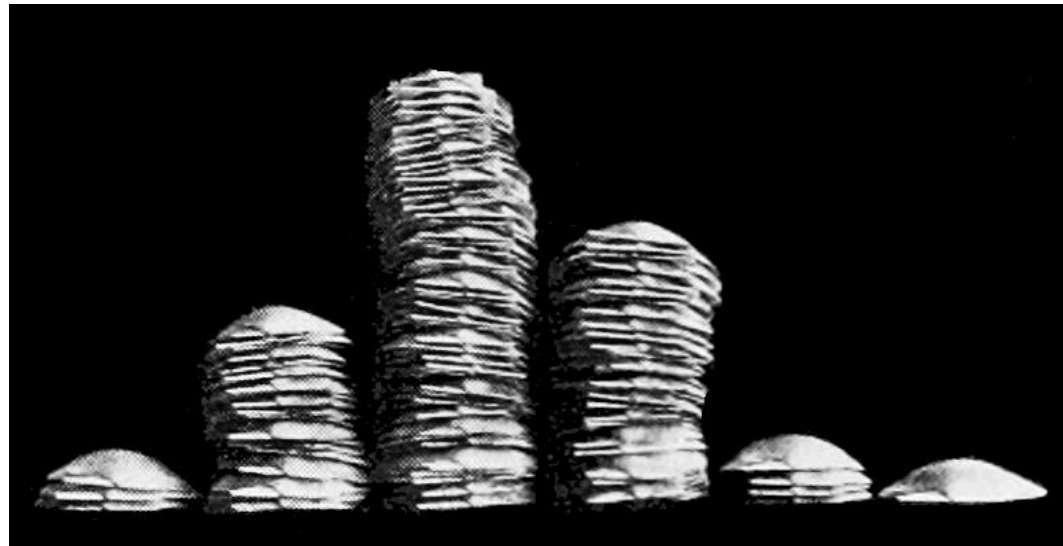
1901 – Davenport's Physical Distributions



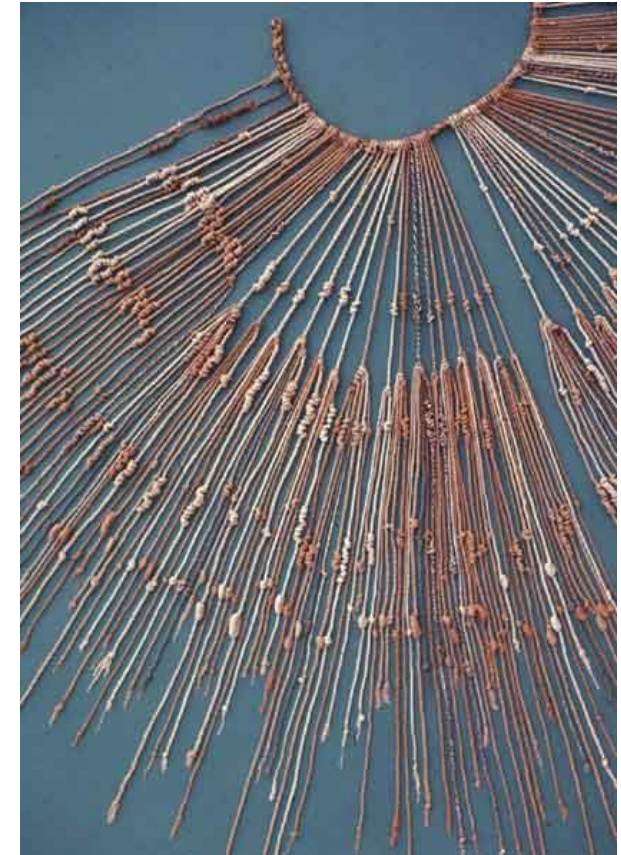
<http://dataphys.org/list/davenports-physical-distributions/>

historical examples of data physicalization

- Variations in material
 - String, clay, sticks
 - Objects of focus in the data

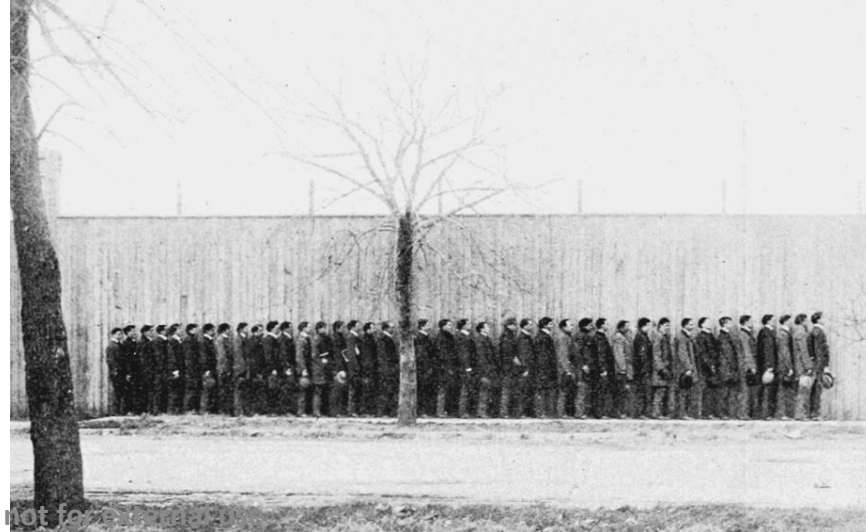
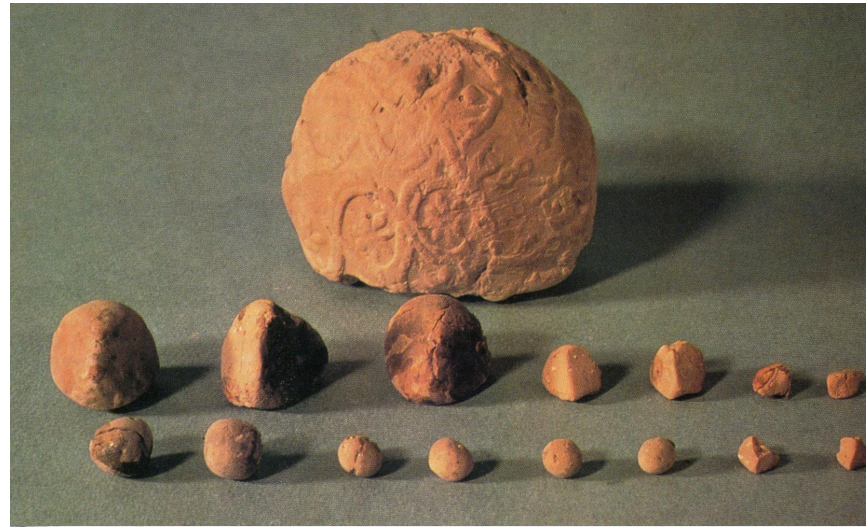


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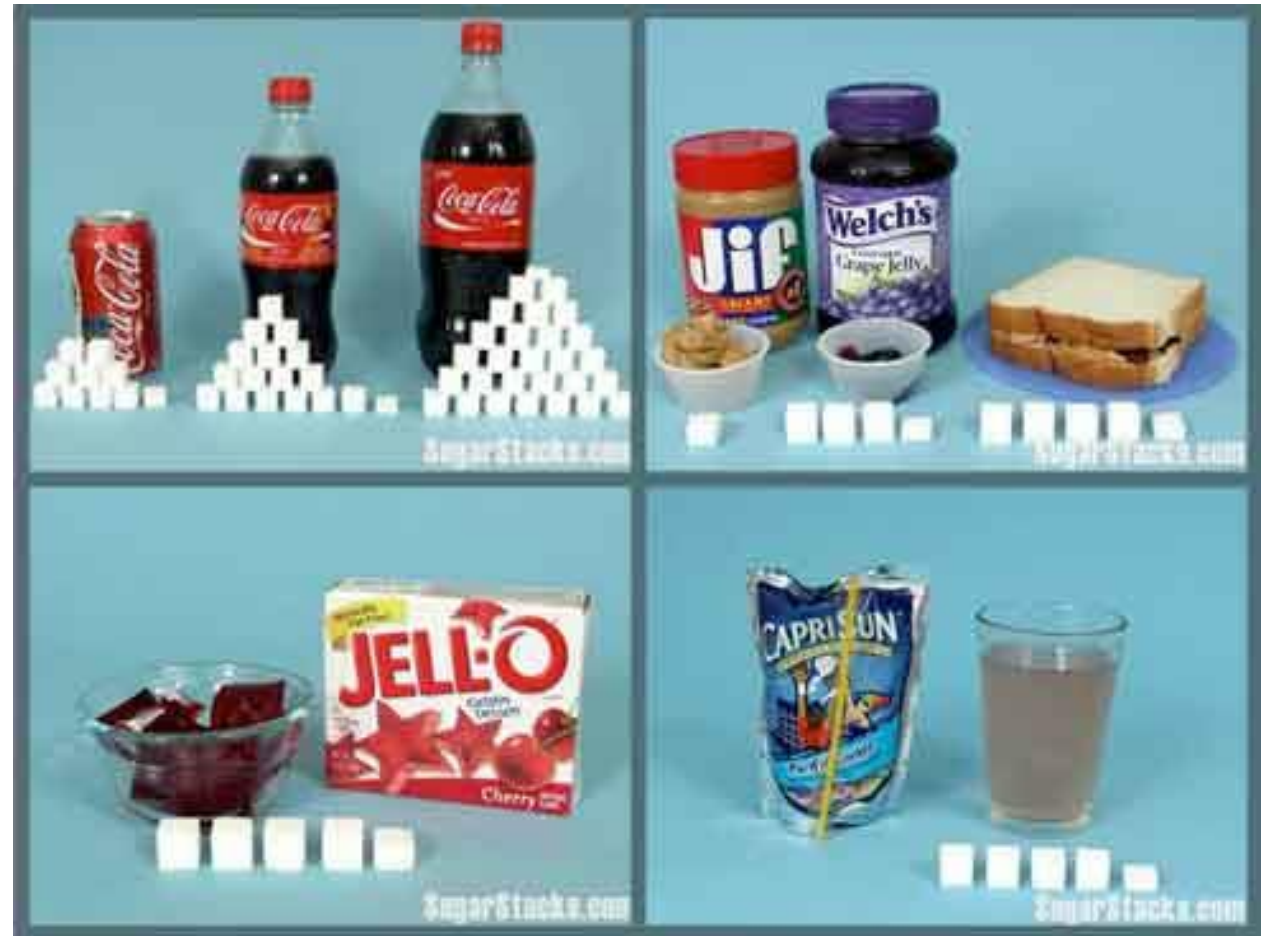
historical examples of data physicalization

- Variations in scale
 - Small tokens
 - Human size and beyond



data physicalization today

sugar stacks: how much sugar do you consume?



form follows data: tableware



Iohanna Pani

<http://dataphys.org/list/iohanna-panis-tableware/>

touching air



Stefanie Prosavec and Miriam Quick

<http://dataphys.org/list/touching-air-necklace-shows-air-pollution/>

CO2 emission shown with balloons



Mario Klemm and José Ernesto Rodriguez

<http://dataphys.org/list/co2-emissions-shown-with-balloons>

walkable age pyramid

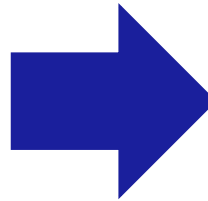
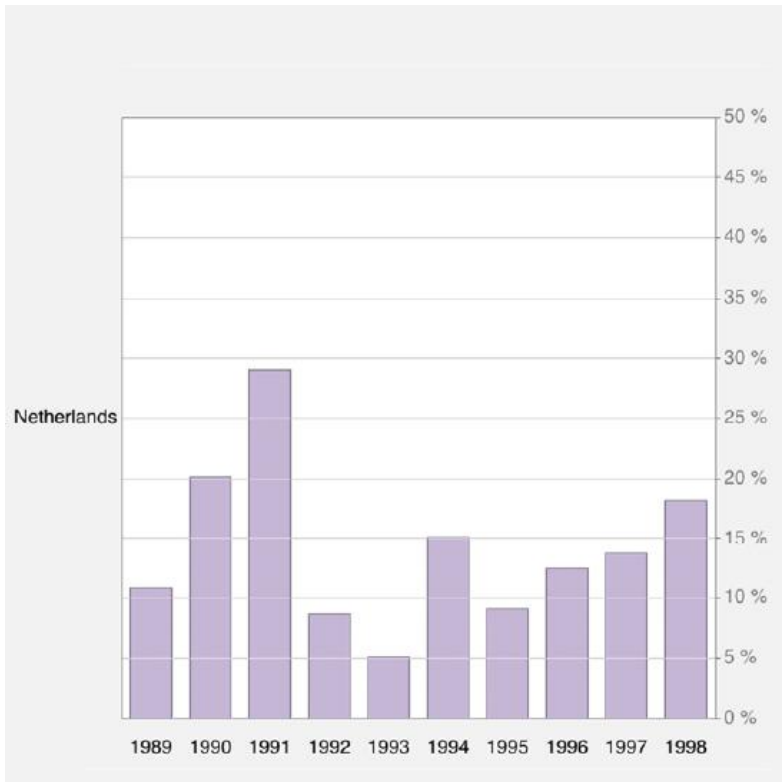


Atelier Brückner

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<http://dataphys.org/list/walkable-age-pyramid/>

translating visualization to physicalization

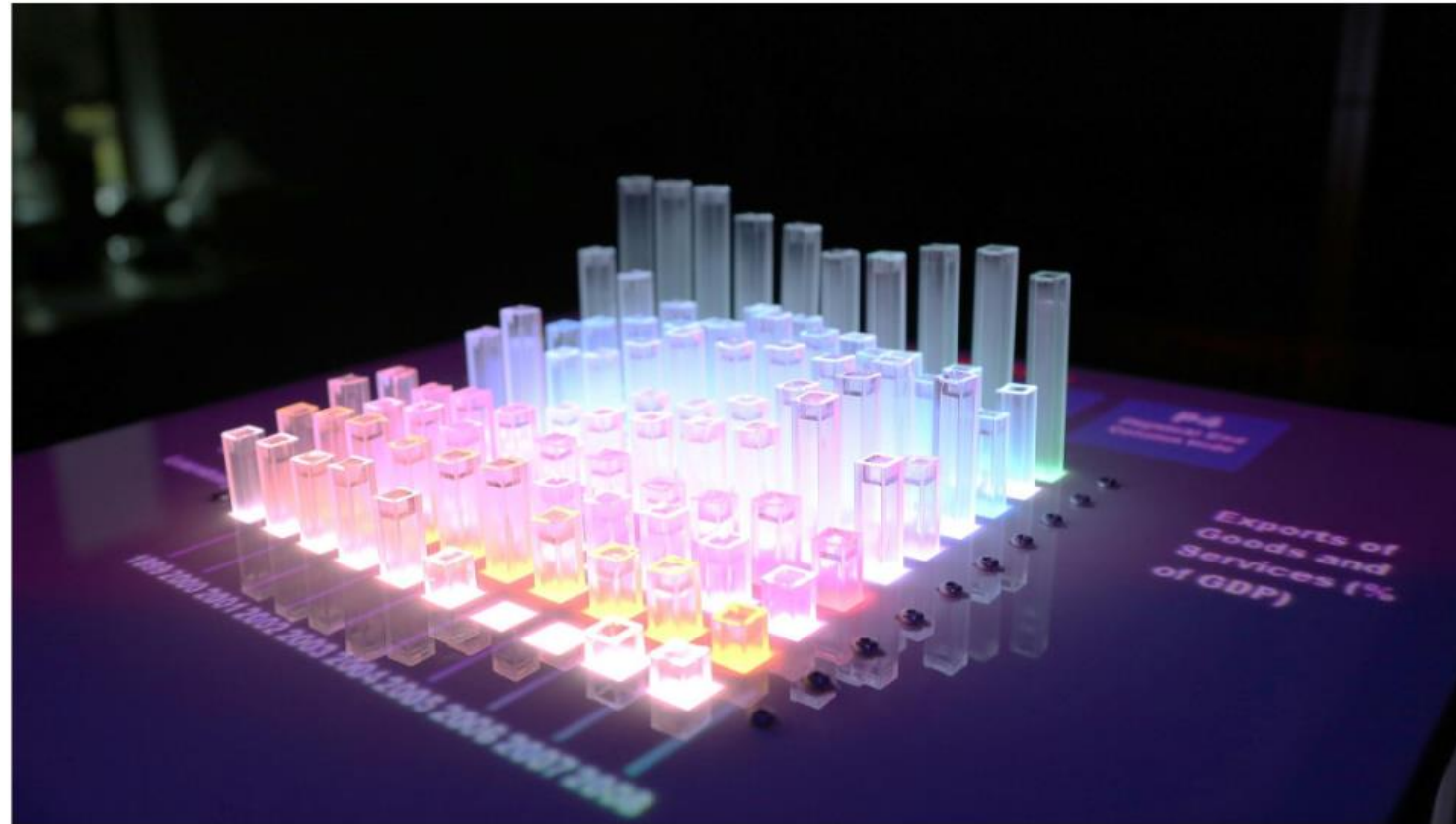
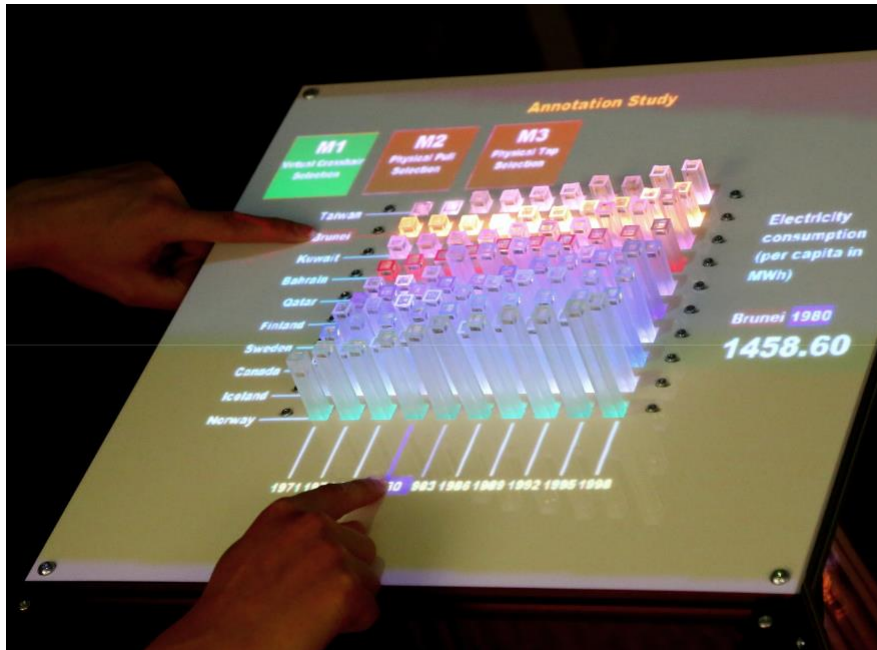


Jansen et al., Evaluating the Efficiency of Physical Visualizations; CHI 2013

<https://dl.acm.org/citation.cfm?id=2481359>

not for external use

translating visualization to physicalization



Taher et al., Exploring Interactions with Physically Dynamic Bar Charts; CHI 2015

http://www.jasonalexander.kiwi/pdf/CHI15_EMERGE.pdf

<https://www.youtube.com/watch?v=UC6l6dy04zI>

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physicalization goes beyond the visual

- It is an opportunity to
 - Make data tangible
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 - Embed data into the physical environment
 - Engage with data in a playful way

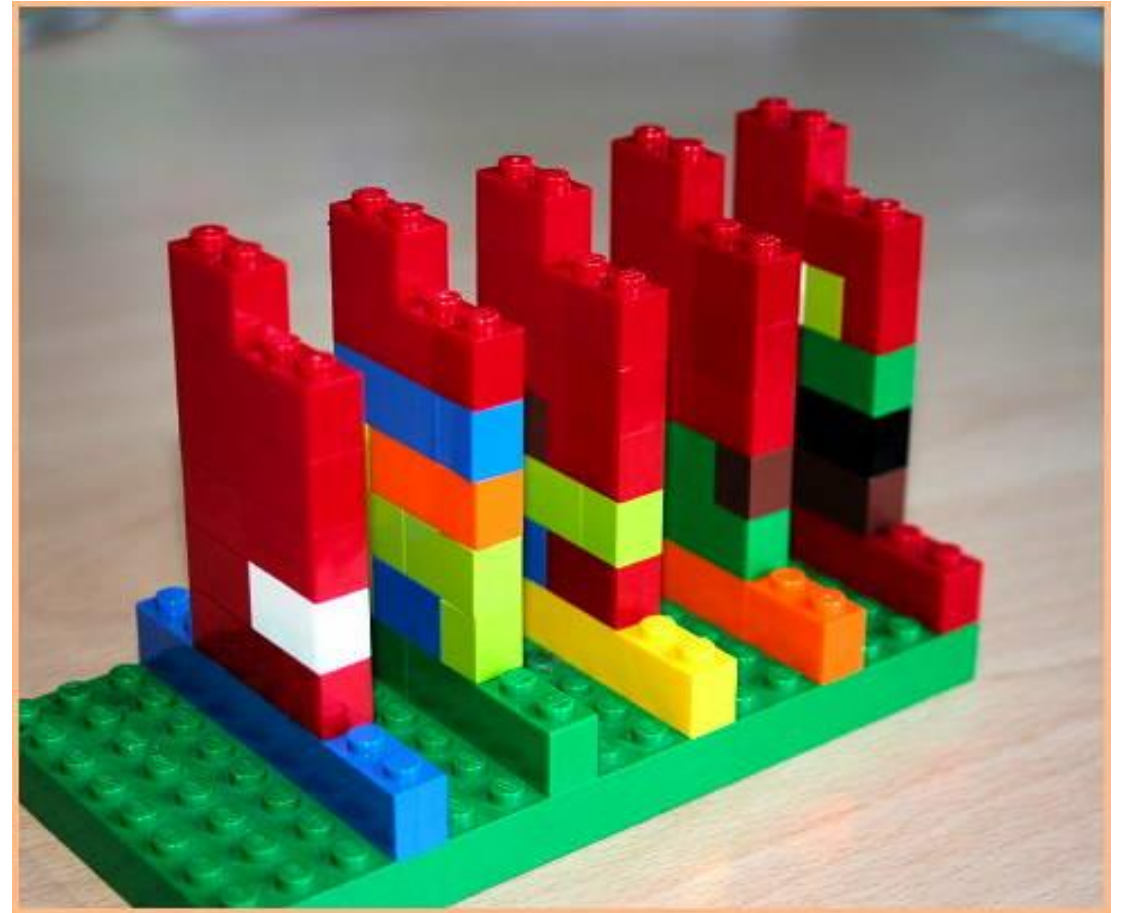
data physicalization as a process

activity logging with LEGO bricks



General Motors, 2012

<http://dataphys.org/list/activity-logging-with-lego-bricks/>



Michael Hunger, 2008

<http://dataphys.org/list/activity-logging-with-lego-bricks/>

constructive visualization paradigm

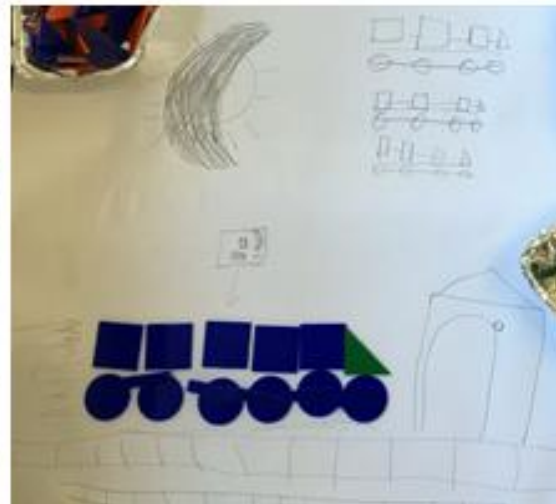
- Simple
 - No prior skills or knowledge required
- Expressive
 - A variety of visualization can be created
- Dynamic
 - Visualizations can be easily adjusted



Huron et al.; Constructive Visualization

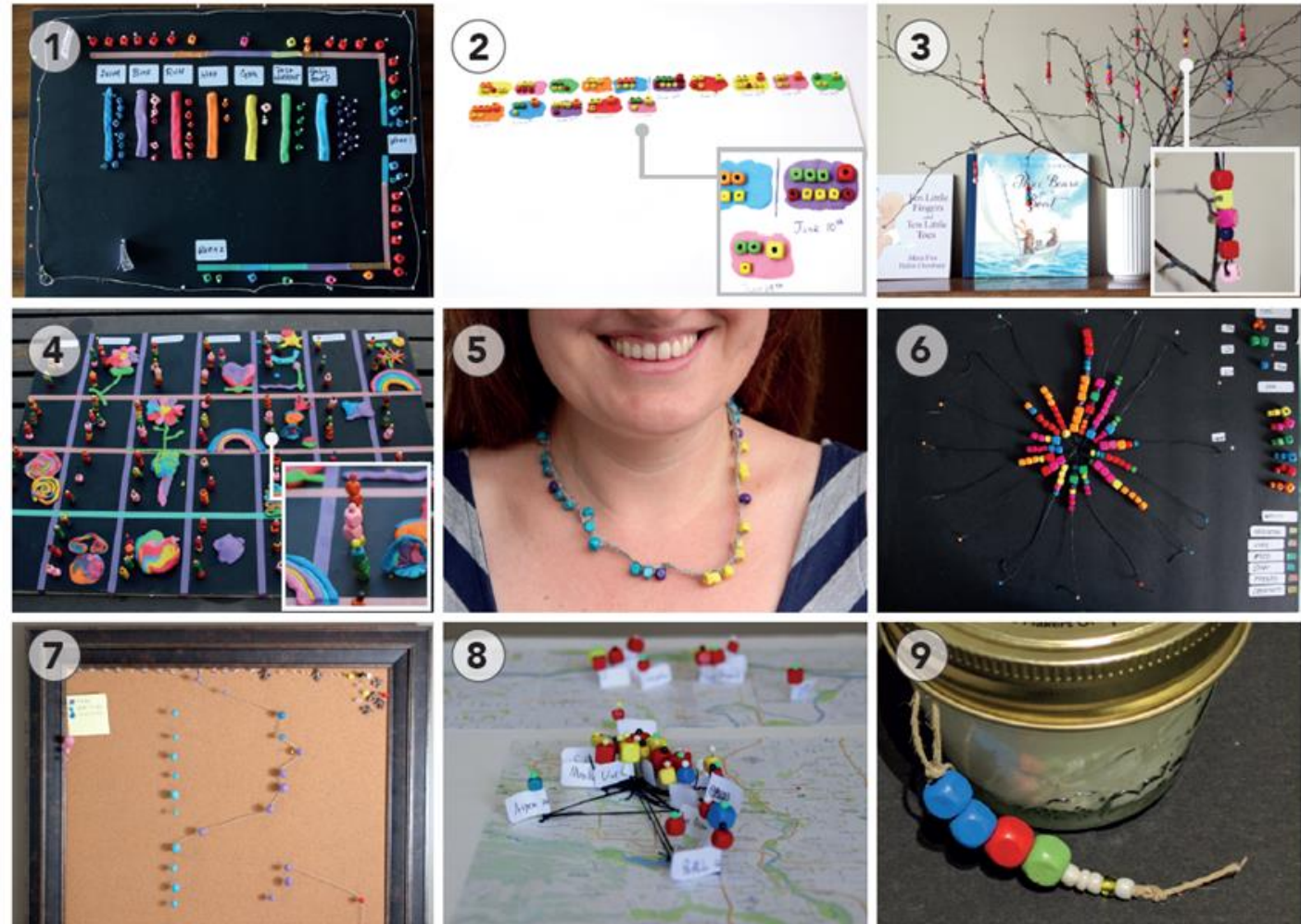
<https://innovis.cpsc.ucalgary.ca/innovis/uploads/Publications/Publications/huron2014.pdf>

data physicalization with children



Bishop & Hinrichs; Challenges of Running Constructive Visualization Studies with Children.
http://www.utahinrichs.de/uta/uploads/Publications/Publications/Bishop_DIS2017.pdf

data physicalization for personal reflection

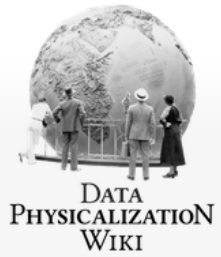


Thudt et al. Self-Reflection and Personal Physicalization Construction, 2018

https://research-repository.st-andrews.ac.uk/bitstream/handle/10023/13267/CPV_CameraReady.pdf

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Data Physicalization

Physical representations of data have existed for thousands of years. Now, with advances in digital fabrication, actuated tangible interfaces, and shape-changing displays, a new area of research is emerging: **data physicalization**.

Data physicalization aims to help people explore, understand, and communicate data using computer-supported physical data representations. These representations are called **physicalizations**, analogously to visualizations – their purely visual counterpart. This wiki provides reading material and a forum for all interested in this topic.

Content of this Wiki

- [Terminology](#) – Terminology related to data physicalization
- [People](#) – List of people involved in data physicalization
- [Bibliography](#) – List of research papers on data physicalization
- [Technologies](#) – Papers on enabling technologies for data physicalization
- [Workshops](#) – Past and future workshops on data physicalization
- [Contribute](#) – How to contribute to this wiki

External Links



- [Gallery of physical visualizations](#)



A video featuring examples of data physicalizations.

<http://dataphys.org/>