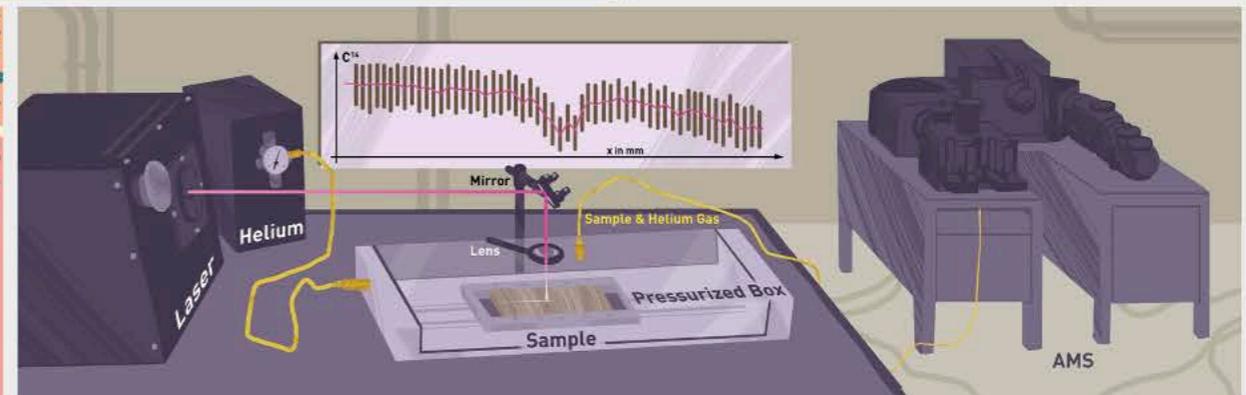
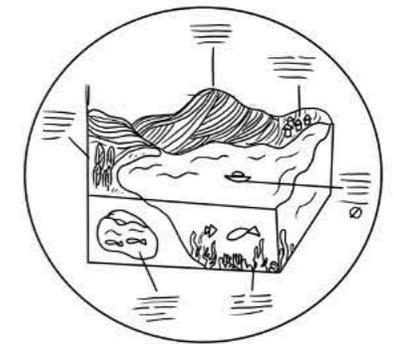


visualizing science

ETH

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich



23.3.2023

Dr. Jeanine Reutemann
Lead LET EduMedia ETH

today

MORNING

09:00 – 09:20 Introduction

09:20 – 10:30 Input 1 with exercises

10:30 – 10:50 Break

10:50 – 12:00 Input 2 & focus work

Lunchbreak

AFTERNOON

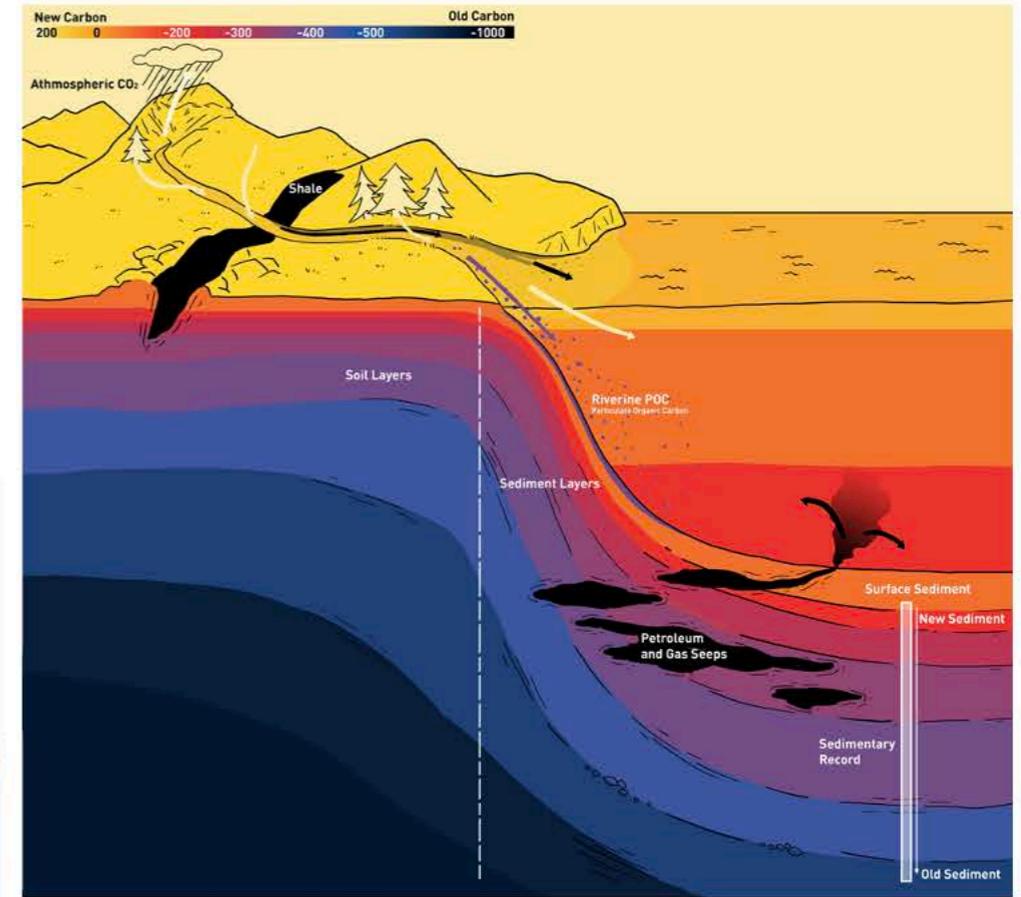
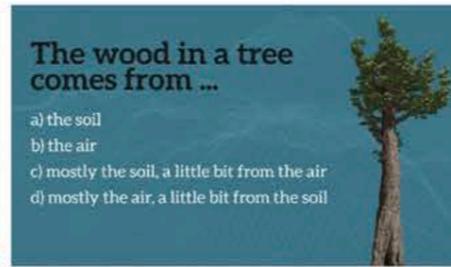
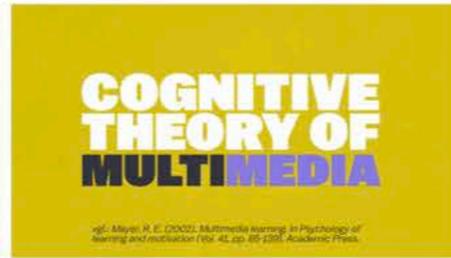
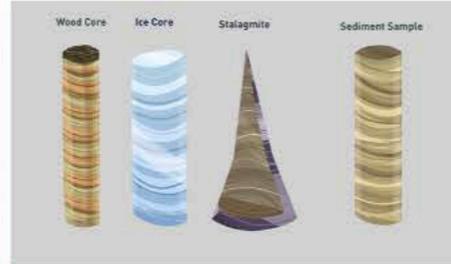
13:00 – 13:30 Reflections & Questions

13:30 – 15:00 Case Studies

15:00 – 15:15 Break

15:15 – 16:00 Final Round

EduMedia Team





FREELANCERS

MEDIA DESIGNERS
videographer
animation expert
interaction designe
graphic designer
game designer
illustrator
...

CONTENT EXPERTS
teachers
scientists
professors
professionals
...

CO-DESIGN

LEARNING EXPERIENCE DESIGNERS
script editor
didactic expert
production designer
learning psychologist
media theory expert
...

TECHNICAL SUPPORT

STUDENT SUPPORT



You and your ETH team



Introduction round

**Describe an image that had
an lasting effect on you.**

words and images

academic culture and the digital world

L S O 1:0P 0 S 1 0 0B00

[Kein Titel]

S 1LQ1101 I O A1 H0 09 S 1 R

D?G?T?L?S??R?NG

H Q 1:0Q 0 S 1 0 0B0L

S 1MD1101 I O 81 B0 01R1 R



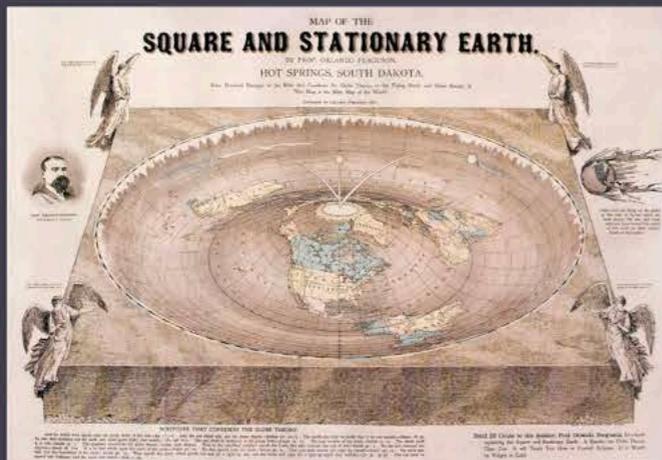
Scientist: My discoveries are useless if taken out of context



Media:

Scientist claim their discoveries are useless

thatcucmberguy | 29 minutes ago



"A not thankless task would be, for example, to record the shooting up of a forest mushroom or the turning of a sunflower during a day in a series of such photographs. The growth, etc., could be studied very nicely in this way."

TRANSLATED INTO ENGLISH, ORIGINAL IN GERMAN:
LUDWIG MACH: UEBER DAS PRINCIP DER
ZEITVERKÜRZUNG IN DER SERIENPHOTOGRAPHIE.

1893

«You had to be able to describe your science in words, or tables, or in plots, in two-dimensions on a piece of paper. [...] With videos, you can now describe dynamic phenomena which are simply too complicated, too complex, too unusual, too full of information to do in words and two-dimensional pictures'.»

GEORGE WHITESIDES IN BERKOWITZ, JACOB. VIDEO
ABSTRACTS, THE LATEST TREND IN SCIENTIFIC
PUBLISHING. UNIVERSITY AFFAIRS.

2013

iconic or pictorial turn

what do images do?

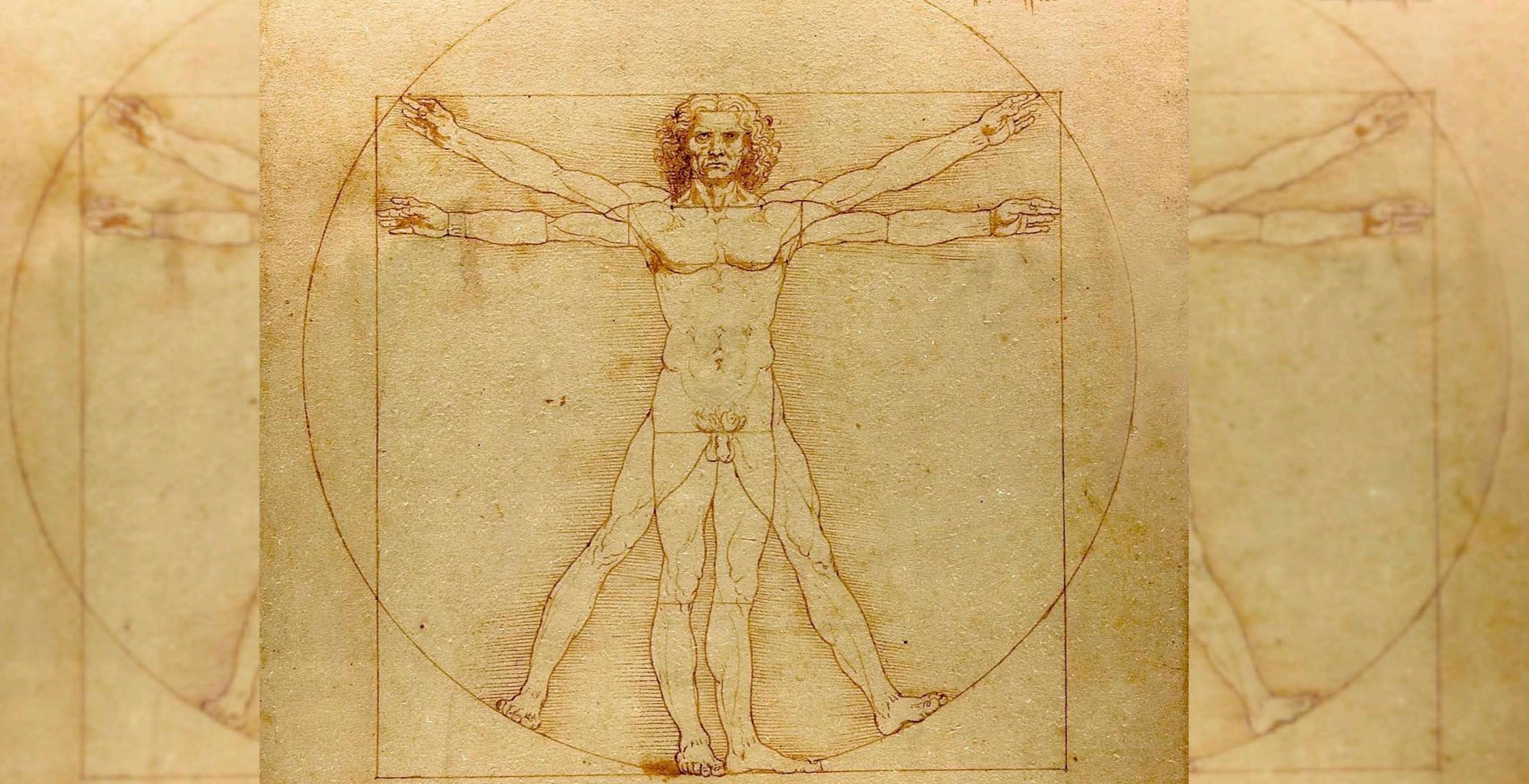
**Fotografie, das
ist die Wahrheit.
Und Kino, das ist
die Wahrheit 24
Mal pro Sekunde.**

Jean-Luc Godard, Der kleine Soldat, 1960.

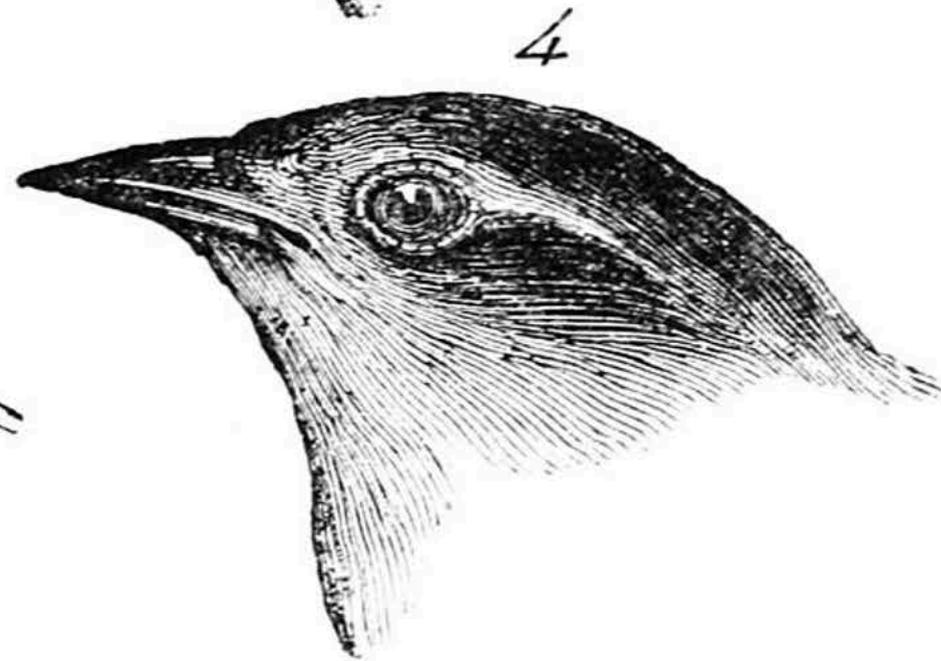
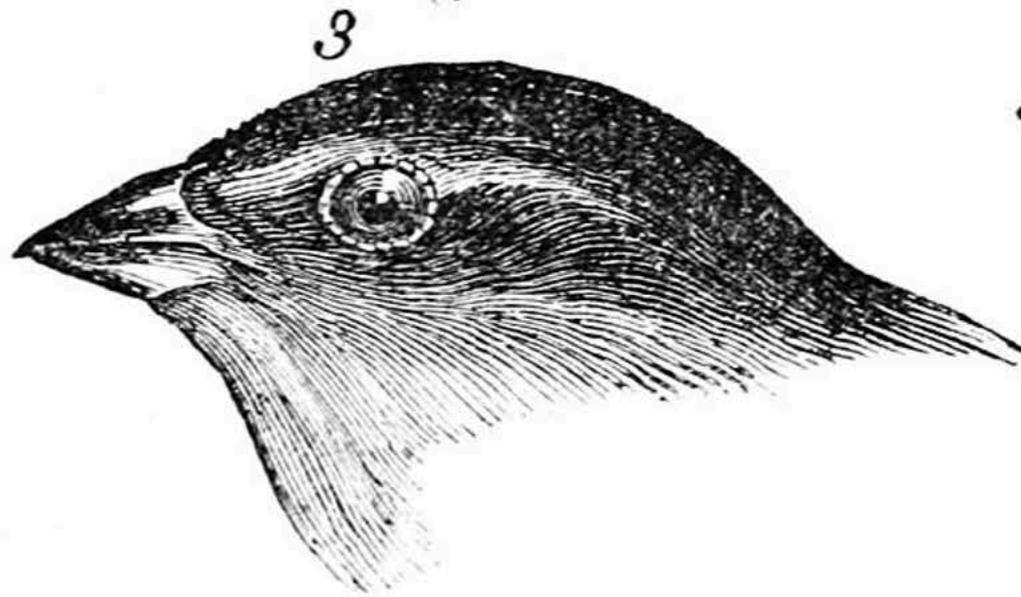
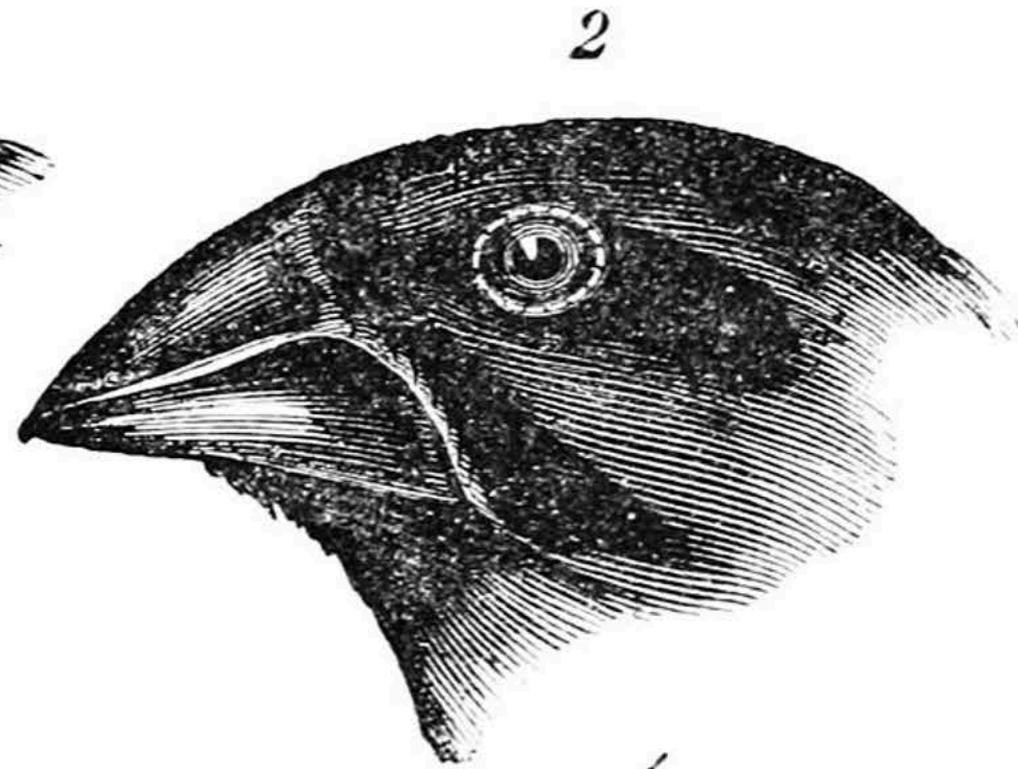
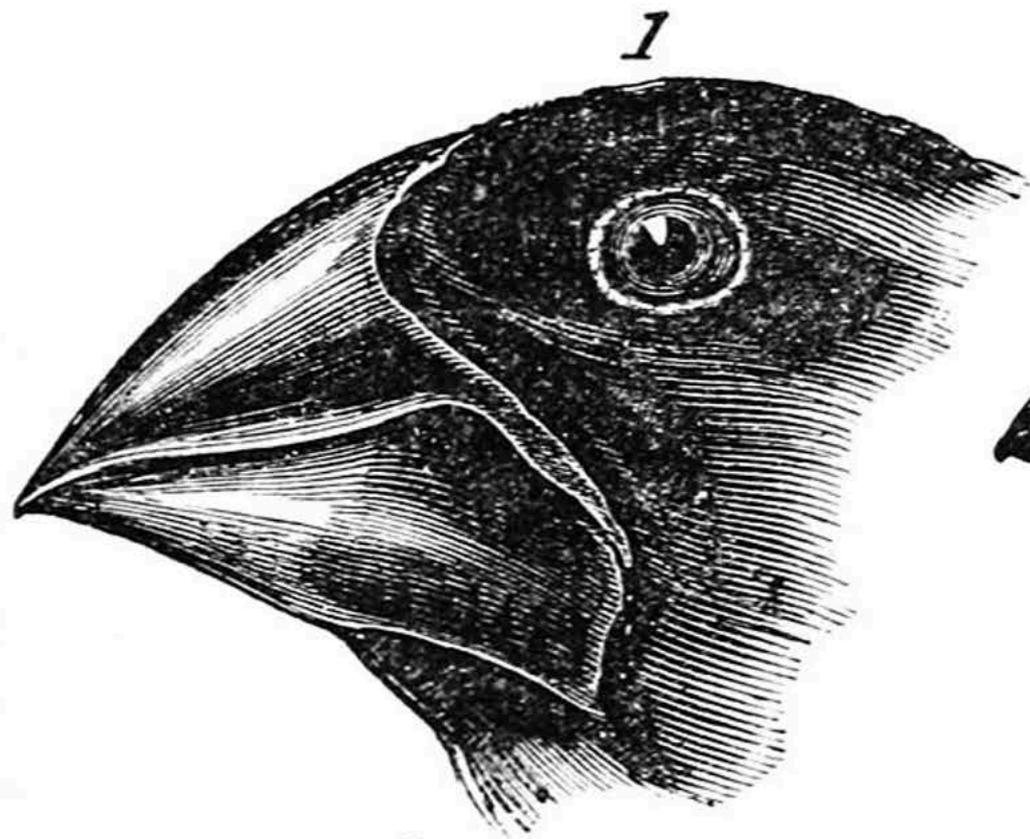


Buster Keaton, The Goat, 1921.

Handwritten text in a cursive script, likely a Greek or Latin manuscript, located at the top of the page. The text is partially obscured by the top edge of the central drawing.



Handwritten text at the bottom of the page, including a series of vertical tick marks and a small signature or mark on the right side.



1. *Geospiza magnirostris*.
3. *Geospiza parvula*.

2. *Geospiza fortis*.
4. *Certhidea olivacea*.

Carte Figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812-1813.

Dressée par M. Minard, Inspecteur Général des Ponts et Chaussées en retraite. Paris, le 20 Novembre 1869.

Les nombres d'hommes présents sont représentés par les largeurs des zones colorées à raison d'un millimètre pour dix mille hommes; ils sont de plus écrits en travers des zones. Le rouge désigne les hommes qui entrent en Russie, le noir ceux qui en sortent. — Les renseignements qui ont servi à dresser la carte ont été puisés dans les ouvrages de M.M. Chiers, de Léger, de Fezensac, de Chambray et le journal inédit de Jacob, pharmacien de l'Armée depuis le 28 Octobre. Pour mieux faire juger à l'œil la diminution de l'armée, j'ai supposé que les corps du Prince Jérôme et du Maréchal Davout qui avaient été détachés sur Minsk et Mohilow et ont rejoint vers Orscha et Witebsk, avaient toujours marché avec l'armée.

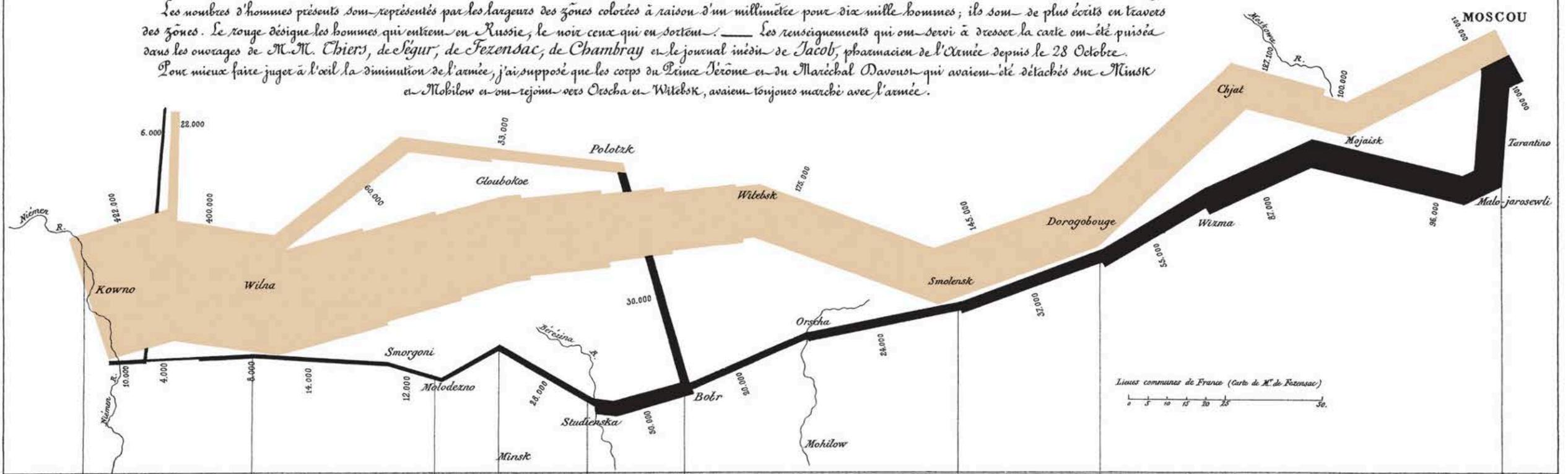
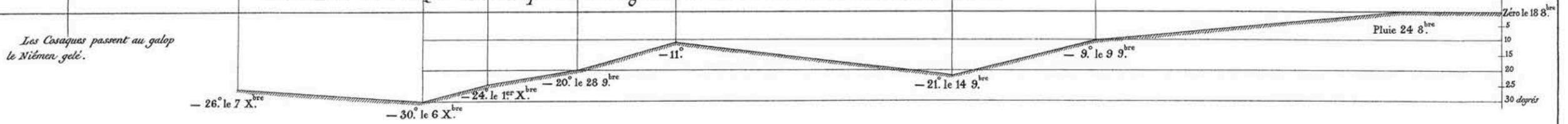


TABLEAU GRAPHIQUE de la température en degrés du thermomètre de Réaumur au dessous de zéro.



Les Cosaques passent au galop le Niémen gelé.

Autog. par Regnier, 8. Par. S^{te} Marie S^{te} G^{er}m à Paris.

Imp. Lit. Regnier et Dourdet.

Minard's 1869 diagram of Napoleonic France's invasion of Russia, early example of an information graphic

ANIMAL LOCOMOTION.

AN ELECTRO-PHOTOGRAPHIC INVESTIGATION OF CONSECUTIVE PHASES OF ANIMAL MOVEMENTS.

1872—1885.

BY
EADWEARD MUYBRIDGE.

PUBLISHED UNDER THE AUSPICES OF THE

UNIVERSITY OF PENNSYLVANIA.

PLATES.—VOL. I.

MALES (NUDE).

THE PLATES PRINTED BY THE PHOTO-GRAVURE COMPANY.

PHILADELPHIA:

1887.

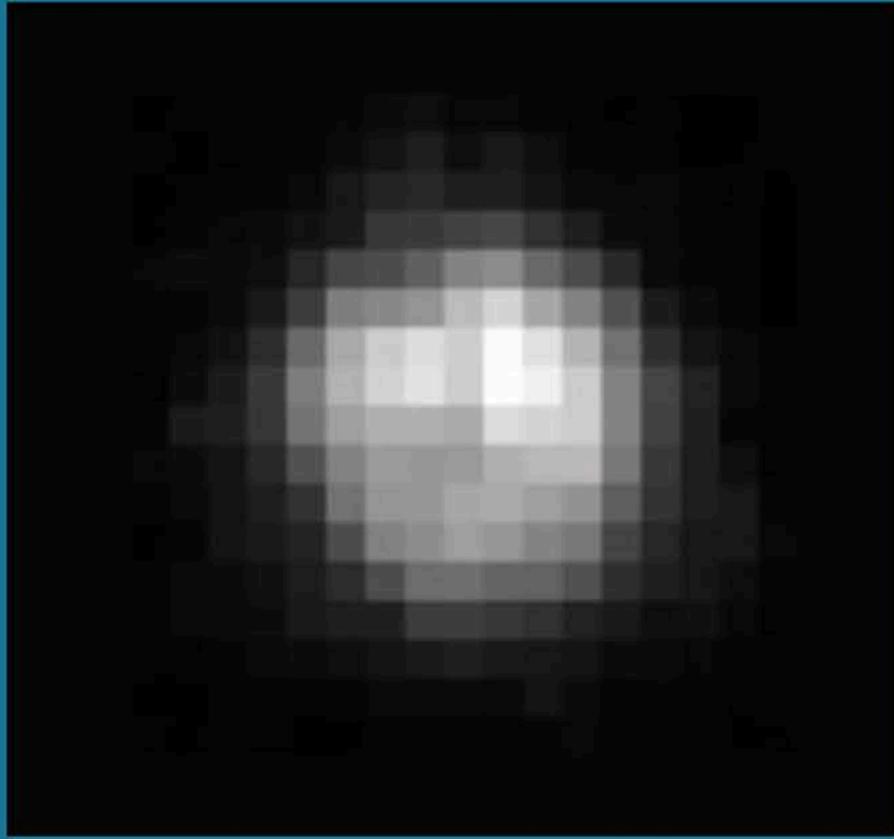
116. 15. 10. 11.



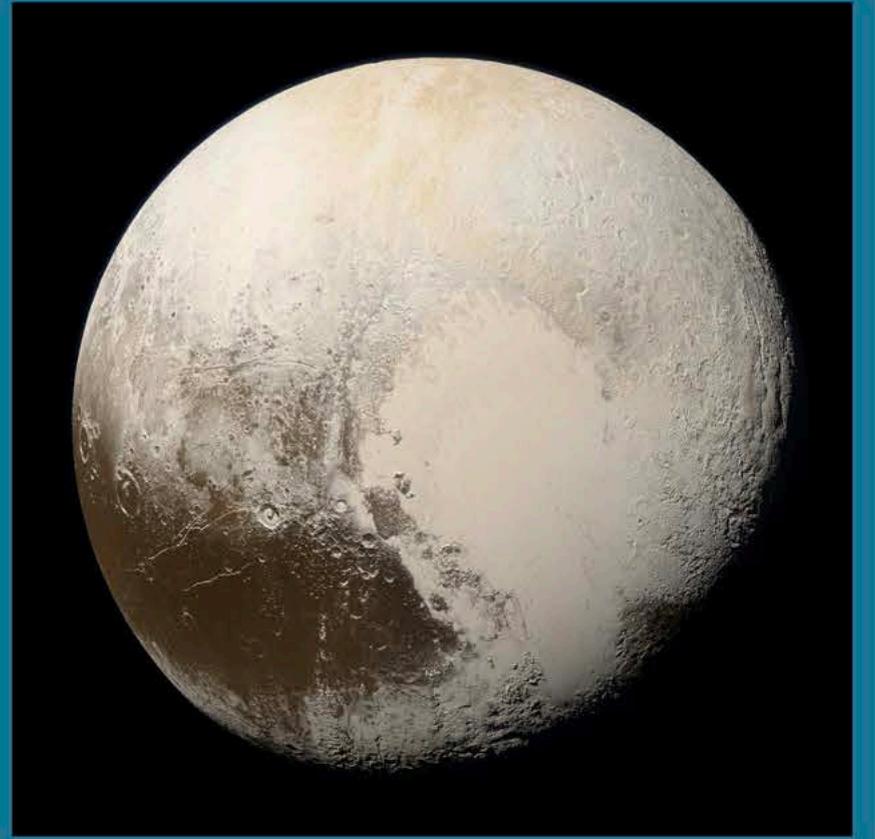
Muybridge's electro-photographic investigation of consecutive phases of animal movements, 1872-1885.



1930

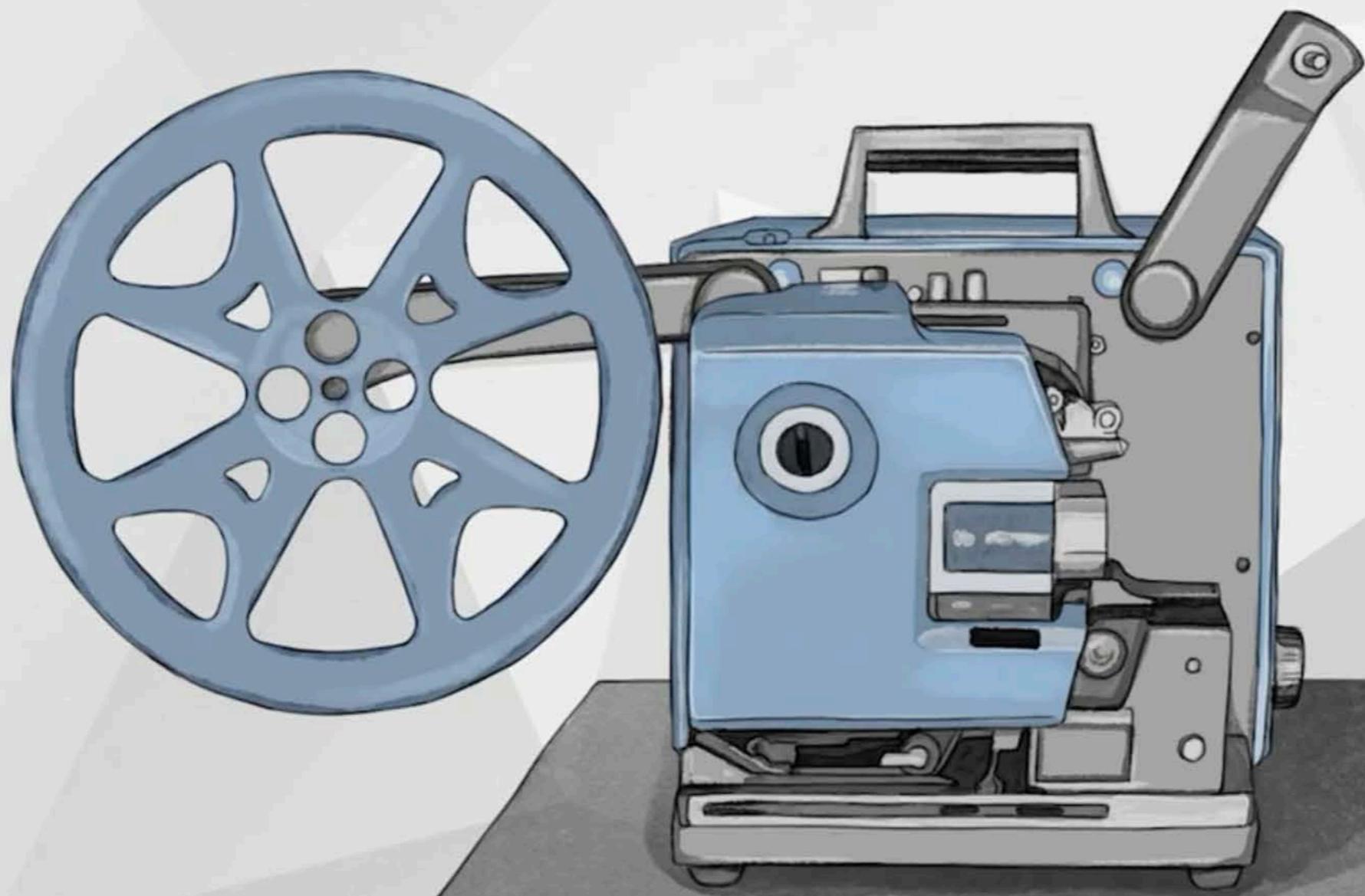


1994



2015

Left: Discovery of Pluto, 1930. Lowell Observatory Archives; Middle: Faint Object Camera, Hubble Space Telescope, 1994. Nasa/ESA/A. Stern and M. Buie. Right: New Horizons, 2015. NASA/Johns Hopkins University Applied Physics Laboratory/Southwest Research Institute/Alex Parker.



media formats

the subtle pain of choosing the right one

- Videos (concept videos, Expert Interviews, Documentary, Observations, Tutorial, Introduction Videos, tiktok, etc)
- Animations (2D, 3D, Stop-Motion, Pixilation, Animated Documentaries, Character Portraits etc.)
- Illustrations, Scientific Illustrations
- Comics, Graphic Novel
- Interactive Poster Design
- Icons and Symbols
- Graphics
- Graphic Design / Typography
- Gifs, memes, animated graphics
- Diagrams
- Drawings, Paintings
- Photography Series
- Interactive Media
- UI/UX Design
- Mixed media (VR, AR, 360-Videos)
- Hybrid media
- Transmedial storytelling formats
- Audio Podcasts
- Soundscapes, Sonifications

cold data, warm data

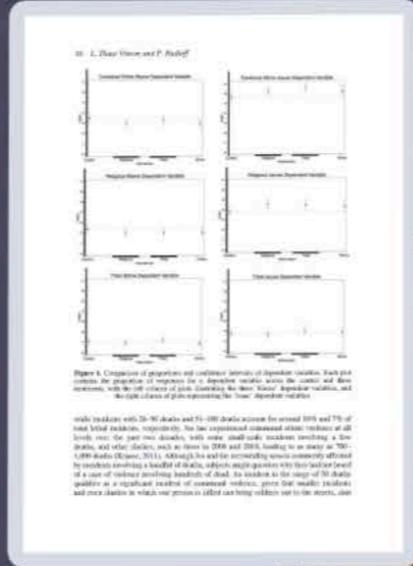
Further Recommendations

The ODIHR

The ODIHR continued to be the coordination center, providing the level of data gathering and reporting that is needed to build a common and consistent database and platform for the rights defenders. It is important that national authorities and university or other research bodies continue to work together to ensure the ODIHR remains an effective platform for the rights defenders to report on the situation in their country.

To continue to be the platform for the ODIHR, the coordination office should continue to:

- 1. The ODIHR should continue to be the coordination center for the ODIHR, working in close cooperation with the national and international partners of the ODIHR. The ODIHR should be required to continue to be the platform for the rights defenders to report on the situation in their country.
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World Europe US Americas Asia Australia Middle East Africa Inequality Global development

Nigeria This article is more than 11 years old

Hundreds dead as more religious violence hits Nigeria

Officials say more than 500 could have died in clashes between Islamist pastoralists and Christian villagers

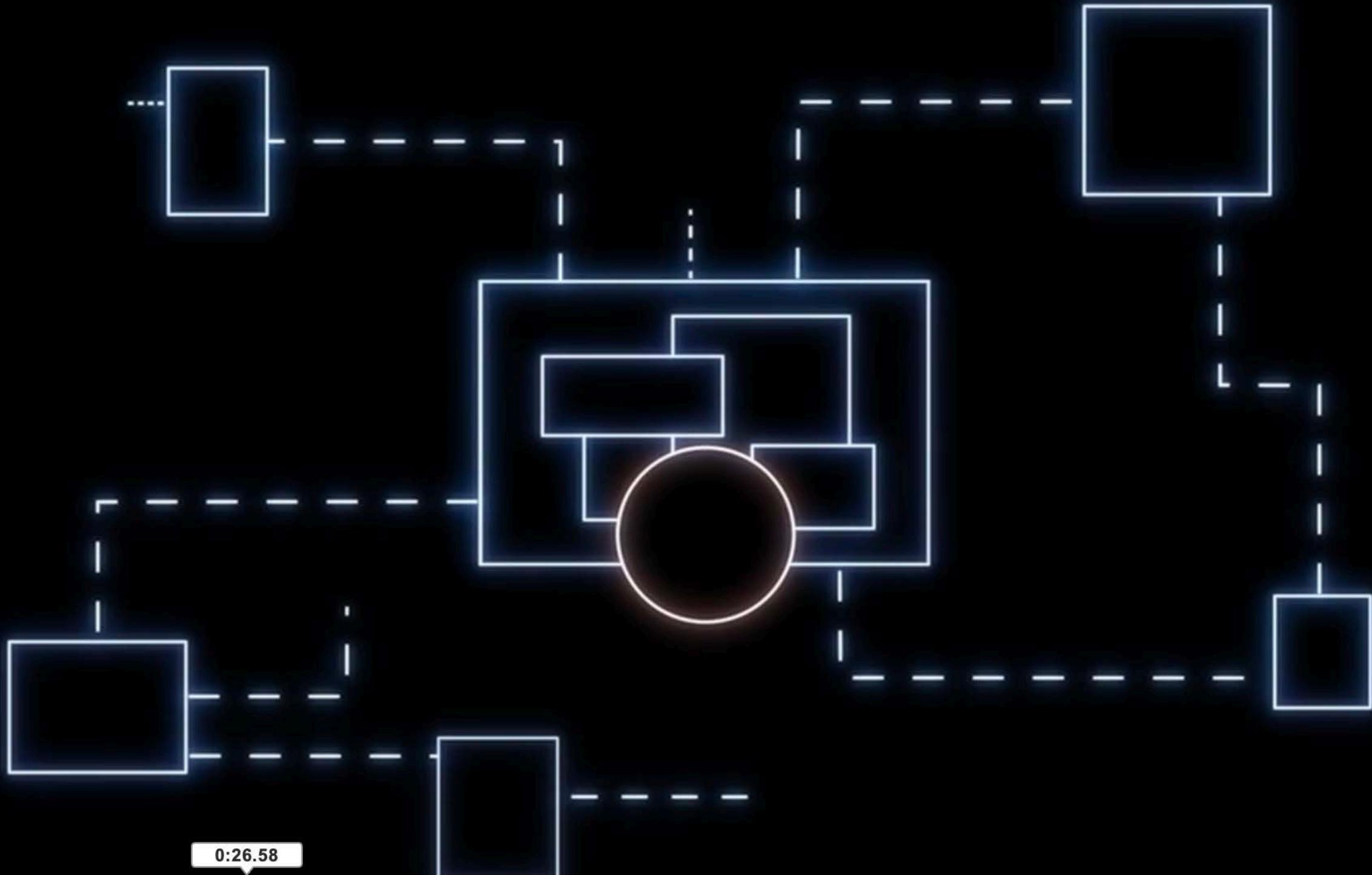
David Smith and agencies
@guardiannews
View 8 Nov 2011 11:00 GMT

Attacks wielding machetes killed hundreds of people as further religious violence hit Nigeria yesterday following pre-dawn clashes between Islamist pastoralists and Christian villagers.

why use more visuals?

- ... knowledge dissemination**
- ... knowledge communication**
- ... knowledge transfer**
- ... knowledge translation**
- ... knowledge transformation ...**





0:26.58

A video player control bar with a play button on the left, a progress slider, and playback controls on the right including a play/pause button, a volume icon, and a timestamp of 0:26.58.

Galerkins Lösungs­näherungen bei monotonen Abbildungen

Friedrich Wille

§ 1. Approximation bei stark monotonen Operatoren

Gar mancher hatte Mühe schon
mit seiner Lösungskonstruktion.
Drum haben wir uns ausgedacht
wie man es mit Galerkin macht.

X sei reeller Banachraum,
der außerdem, sonst klappt es

kaum,

in uns'rer mathemat'schen Fabel
ist reflexiv und separabel.

Die Dimension ist endlich nicht,
sonst wär' zu einfach dies Gedicht.
Mit X^* wird, wie wohlbekannt,
der konjugierte Raum benannt.

Aus diesem folgern wir nun schon:
Zu jedem n als Dimension
gibt's einen Raum E_n in X
mit folgenden erlaubten Tricks:

$$E_1 \subset E_2 \subset E_3 \subset \dots, \quad \overline{\bigcup_{n=1}^{\infty} E_n} = X.$$

Nun sei der Operator T ,

$$T: X \rightarrow X^*,$$

den ich als stetigen versteh',
im Folgenden stets monoton,
das heißt (wir kennen dieses schon):

$$\forall x_1, x_2 \in X:$$

$$\langle T(x_1) - T(x_2), x_1 - x_2 \rangle \geq 0.$$

Wir wissen dabei aus Erfahrung:
die Winkelklammern sind die
Paarung:

$$\forall y \in X^* \forall x \in X: \langle y, x \rangle = y(x).$$

Stark monoton ist unser T ,
wenn Folgendes erfüllt ich seh':

$$\exists \alpha > 0 \forall x_1, x_2 \in X:$$

$$\langle T(x_1) - T(x_2), x_1 - x_2 \rangle$$

Media-specific transformation processes

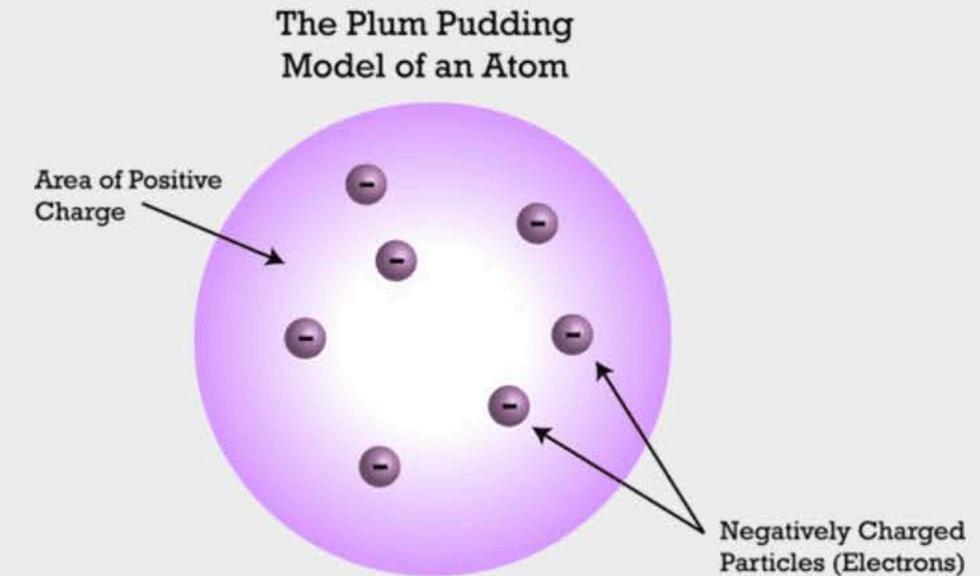
*Imagine this paper
As a comic, as an
animation, as a podcast.*

science translation issues

Plum pudding



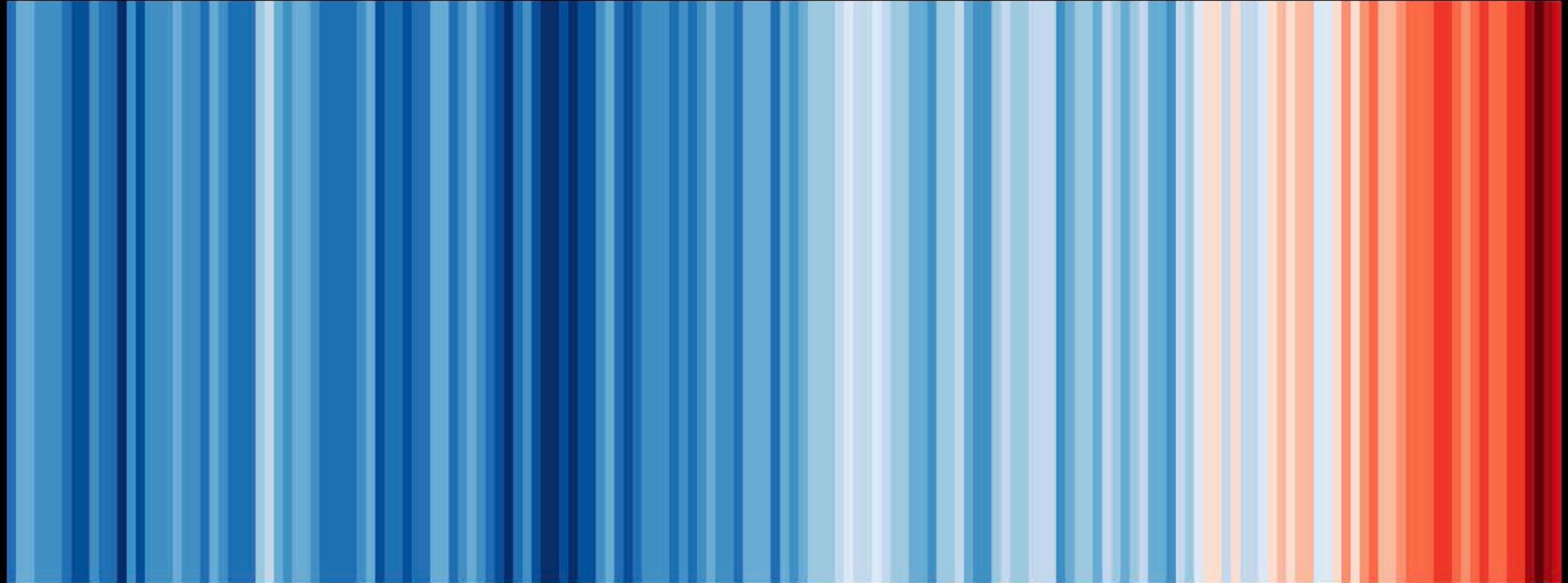
Raisin cake



Translation issues not only from words and images, but also sometimes in language translation (e.g. wrong metaphors).

«This graphic explains everything in the blink of an eye. We have a magic effect on our (letting) us recognize connections before we have even actively thought about them», Schmid, Simon (2019).

8	—	#67000
7	—	#a50f15
6	—	#cb181d
5	—	#ef3b2c
4	—	#f97070
3	—	#fc9272
2	—	#fcbba1
1	—	#fee0d2
1	—	#deebf7
2	—	#c6dbef
3	—	#9ecae1
4	—	#6baed6
5	—	#4292c6
6	—	#2171b5
7	—	#08519c
8	—	#08306b



«Warming stripes», Professor Ed Hawkins, 2016.

data visualization

can be used for:

- **making data engaging and easily digestible**
- **identifying trends and outliers within a set of data**
- **telling a story found within the data**
- **reinforcing an argument or opinion**
- **highlighting the important parts of a set of data**

data storytelling

- **create knowledge, new decisions, actions**
- **story is meant to explain the data and WHY it matters (to the audience)**
- **relevance (to the audience), what is the preknowledge of the target audience?**
- **what matters to them? the best stories speak to people**
- **needs to include “good” data**

lifespan

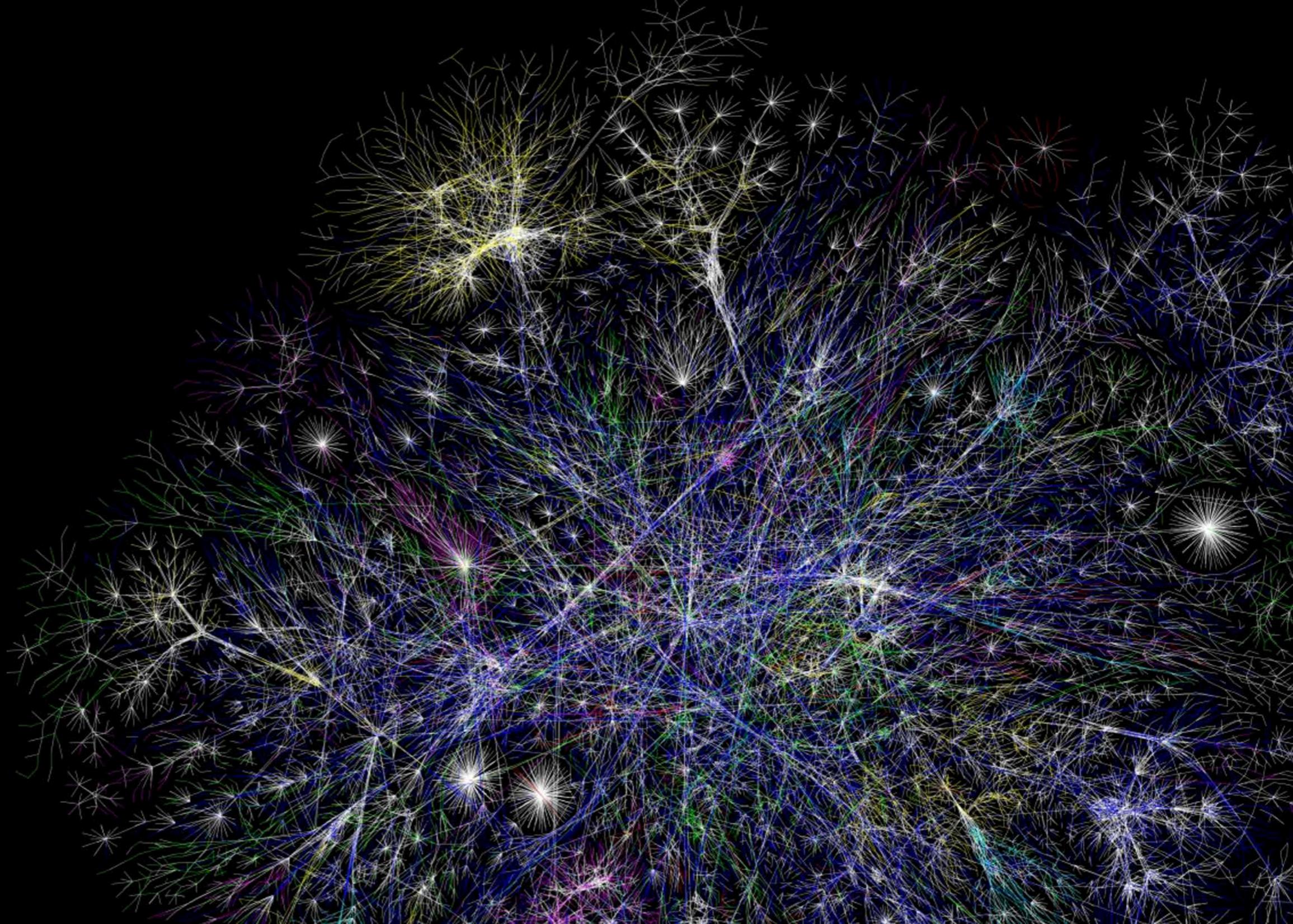
50
years

25
years



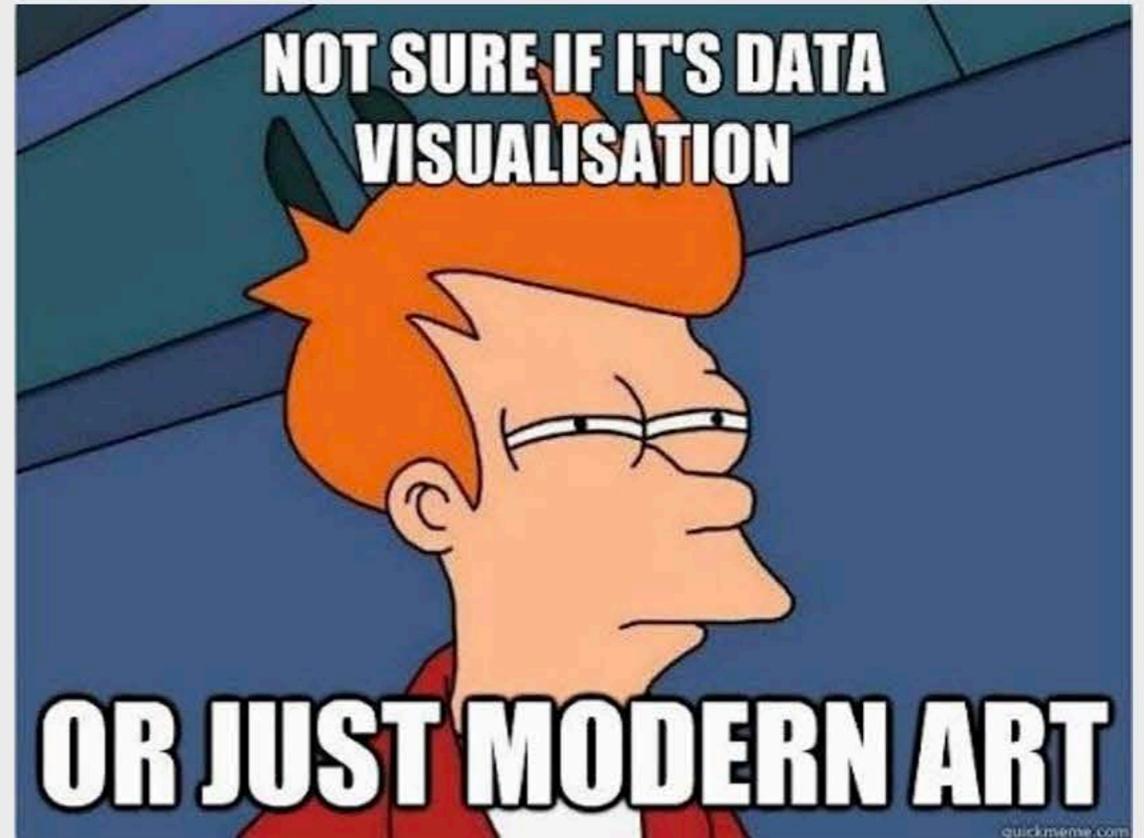
Difference between data storytelling and data visualization:

In general, data visualization highlights key takeaways while data storytelling will help understand, why those takeaways matter.



memes

why they are important for all of us



1. *Discuss in pairs*
2. *Note it down on post-its*
3. *7-minutes*

**What are important or famous
visuals in your scientific
disciplines? (also e.g. gifs,
diagrams, memes, pictures)**

1. *Discuss in pairs*
2. *Note it down on post-its*
3. *10-minutes*

**What are important or famous
visuals in your scientific
disciplines? (also e.g. gifs,
diagrams, memes, pictures)**

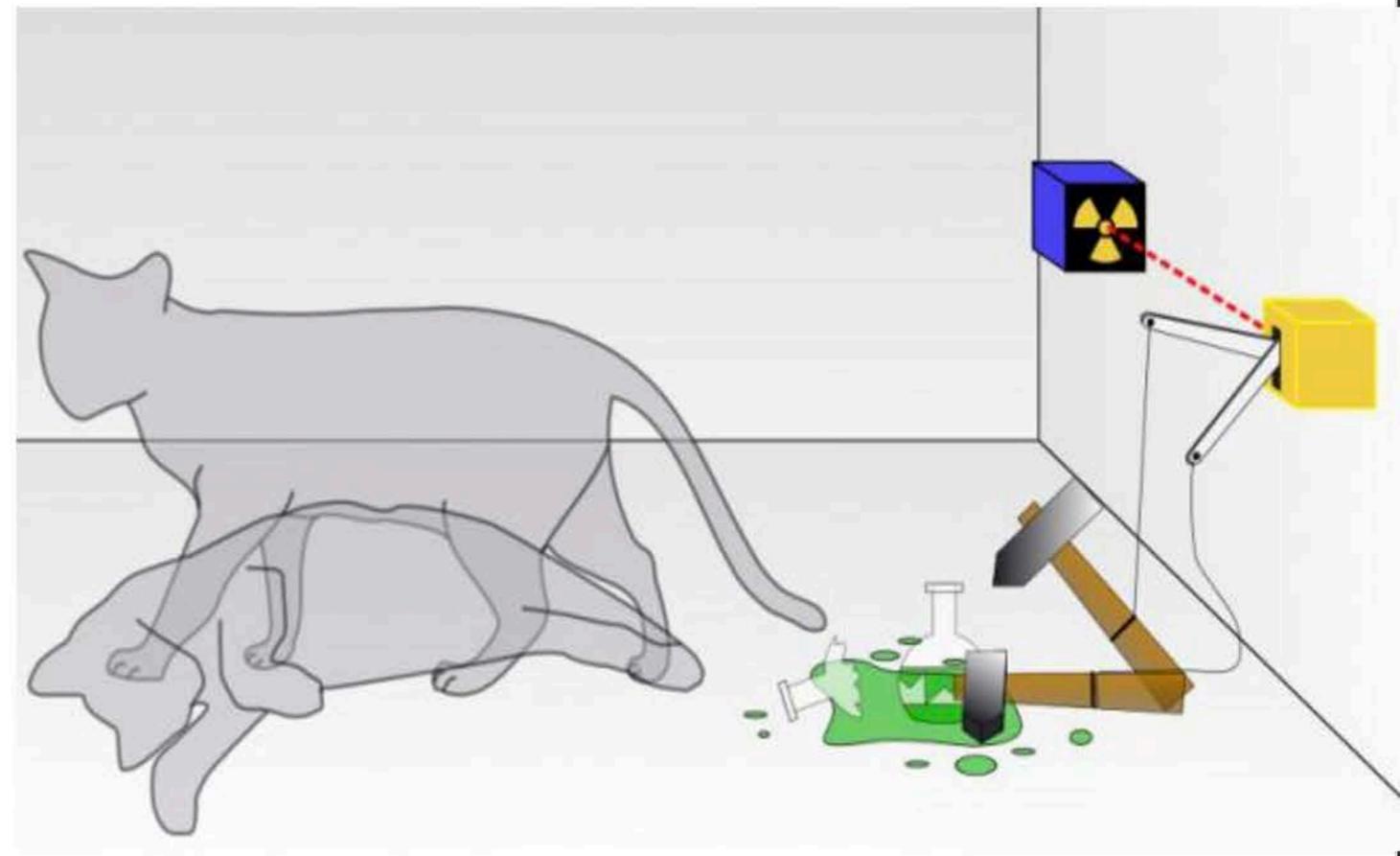
metaphors & analogies

*for storytelling of scientific concepts,
topic, phenomena's etc.*

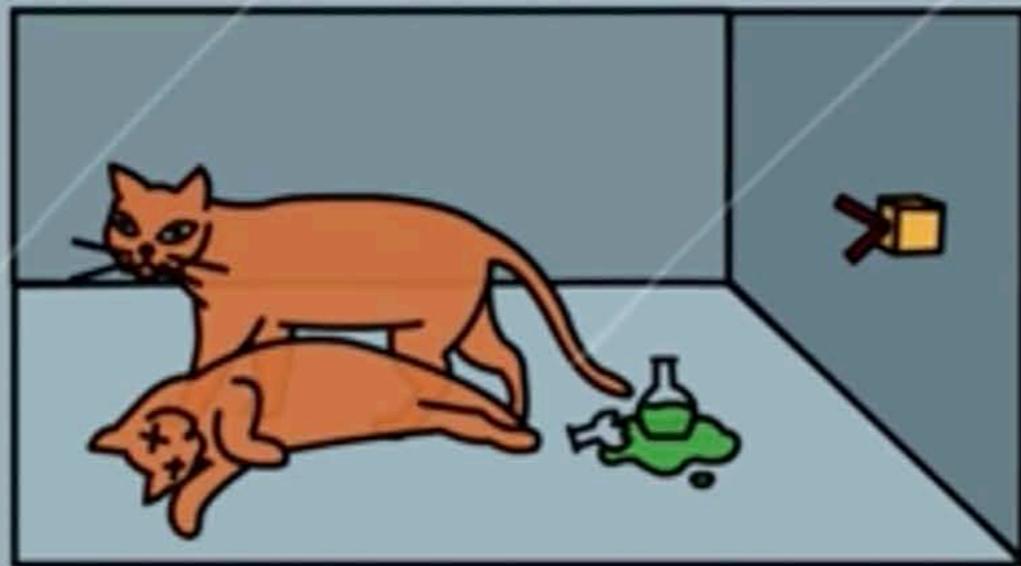




+



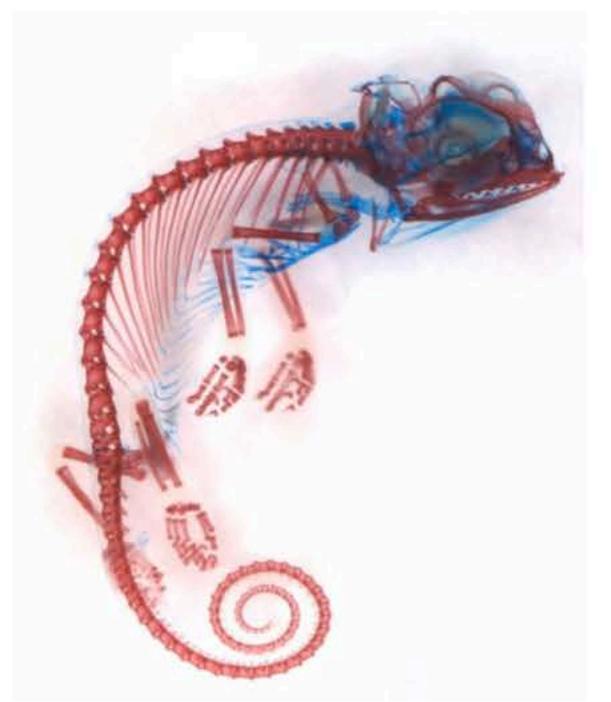
Ceci n'est pas un photon.



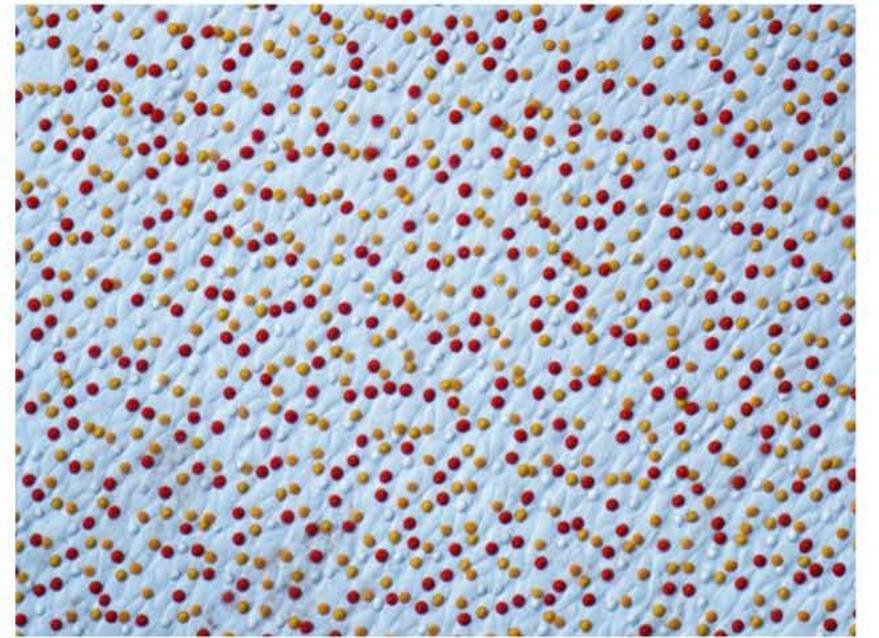
epistemic images

signs arguments document visual proof demonstrate

Not «only» visualization,
but epistemic qualities of visuals



6. Platz: Der Embryo eines Chamäleons.
Bild: Dorit Hockman/University of Cambridge



2. Platz: Die Netzhaut einer Zierschildkröte, in 400-facher Vergrößerung.
Bild: Dr. Joseph Corbo/Washington University School of M





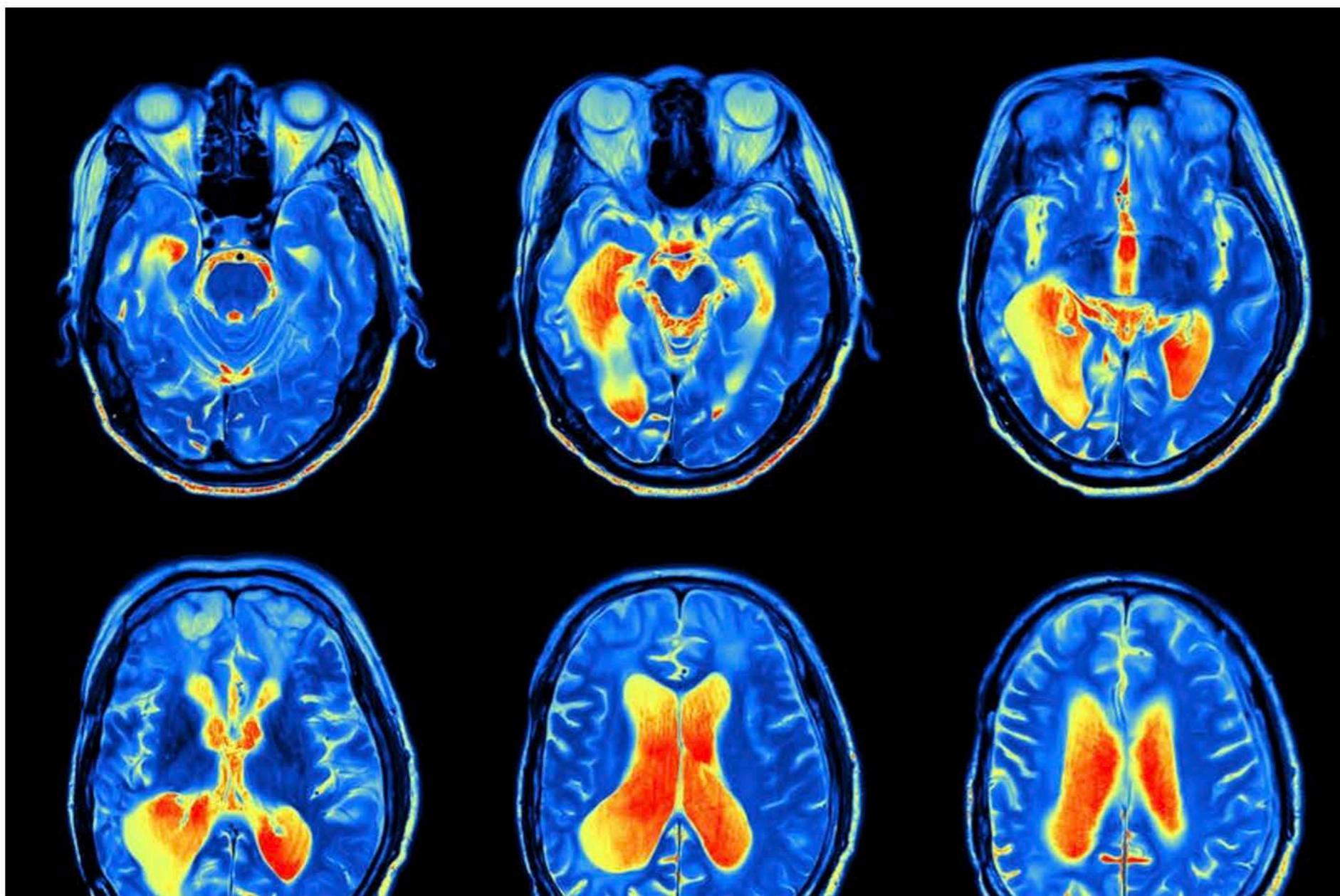
*Co-design with D-USYS «Conservation Management
in the Scottish Highlands», 2015.*



Leiden University VR-360 project «The method of remote sensing», 2015.



r4d programme SNF, research documentary
«Inequality and Conflict – beyond us and them, 2019.»

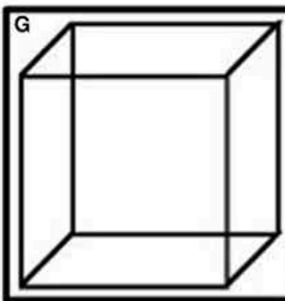
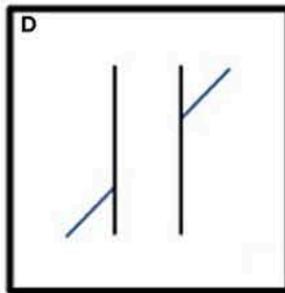
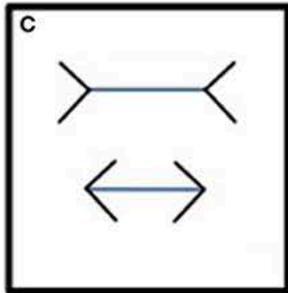
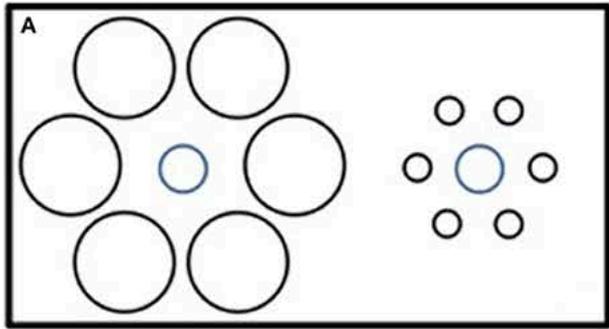


Random image from the www.

designing *for human perception*

Human visual processing is efficient in detecting changes and making comparisons between quantities, sizes, shapes and variations in lightness.

It is estimated that 2/3 of the brain's neurons can be involved in visual processing. Proper visualization provides a different approach to show potential connections, relationships, etc. which are not as obvious in non-visualized quantitative data.



the good design

aka swiss design

- **modernity, highlighting clarity**
- **Ernst Keller, the father of Swiss design, believed that design should adapt to the content and not the other way around**
- **the use of simple geometric shapes and sans serif typography with very unusual placements**

75 Helvetica Bold 65 Helvetica Medium 55 Helvetica Roman 45 Helvetica Light

The 1234
The ABC 567890
DEFGHI abcdefhij
JKLMNO klmnopq
PQRSTU stuvwxyz
VWXYZ of Mate
rialist Dia
lectics.

"I will here attempt to sketch the substance of the problem in a very concise form. The Aristotelian logic of the simple syllogism starts from the proposition that 'A' is equal to 'A'. This postulate is accepted as an axiom for a multitude of practical human actions and elementary generalizations. But in reality, 'A' is not equal to 'A'. This is easy to prove if we observe these two letters under a lens - they are quite different from each other. But, one can object, the question is not of the size or the form of the letters, since they are only symbols for equal quantities, for instance, a pound of sugar. The objection is beside the point; in reality a pound of sugar is never equal to a pound of sugar - a more delicate scale always discloses a difference. Again one can object: but a pound of sugar is equal to itself. Neither is this true - all bodies change unerringly in size, weight, colour, etc. They are never equal to themselves."
- From 'The ABC of Materialist Dialectics' (1939), Leon Trotsky.

Helvetica
A documentary film by Gary Huxford

the good design

where do my eyes go first?

The „International Typographic Design“ is based on **mathematical grids**. These grids are considered to be the “most legible and harmonious means for structuring information.” Using a grid for design makes creating a hierarchy for the content much easier.

Akzidenz-Grotesk	Folio	Helvetica	Univers 55
C	C	C	C
G	G	G	G
J	J	J	J
Q	Q	Q	Q

the good design

aka swiss design

- The style favoured cleanliness, legibility. The design should be as invisible as possible and the designer's subjectivity should be pushed aside in order to create graphic work that would shine on its own.
- Swiss Design eventually became the International Typographic Style as it expanded around the world in the 1950s.

the white space

core rule for every media format

- 1. Less is more (white space leads our eyes, creating emptiness)**
- 2. Give room to breath (leave space empty - but where?, it's not that simple)**
- 3. White space separates and groups elements**
- 4. White space helps build hierarchy (like text hierarchies)**
- 5. White space helps build a certain look**
- 6. Reduces cognitive overload**

hands-on practical advice

where to start?

everyday visuals

process documentation, sketches, notes ...

The renowned mathematician Benoit Mandelbrot was once asked what had led to his great success. Mandelbrot responded: “When I seek, I look, look, look, and play with pictures. One look at a picture is like one reading on a scientific instrument. One is never enough.”

Mandelbrot, *The Fractalist*, 2014

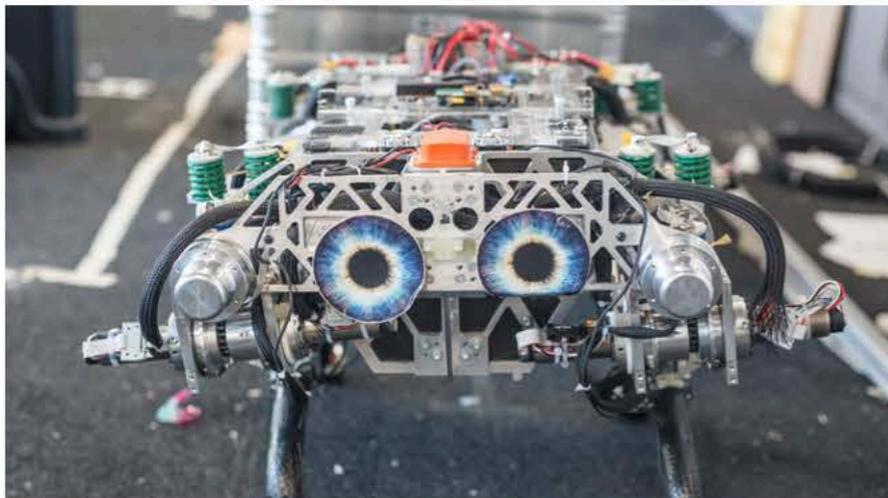
1. start to look closely

data collection, idea and note taking, literature ...



2. practice visual documentation

observations; prototypes, thought experiments
laboratory shots, moodboards, field notes ...

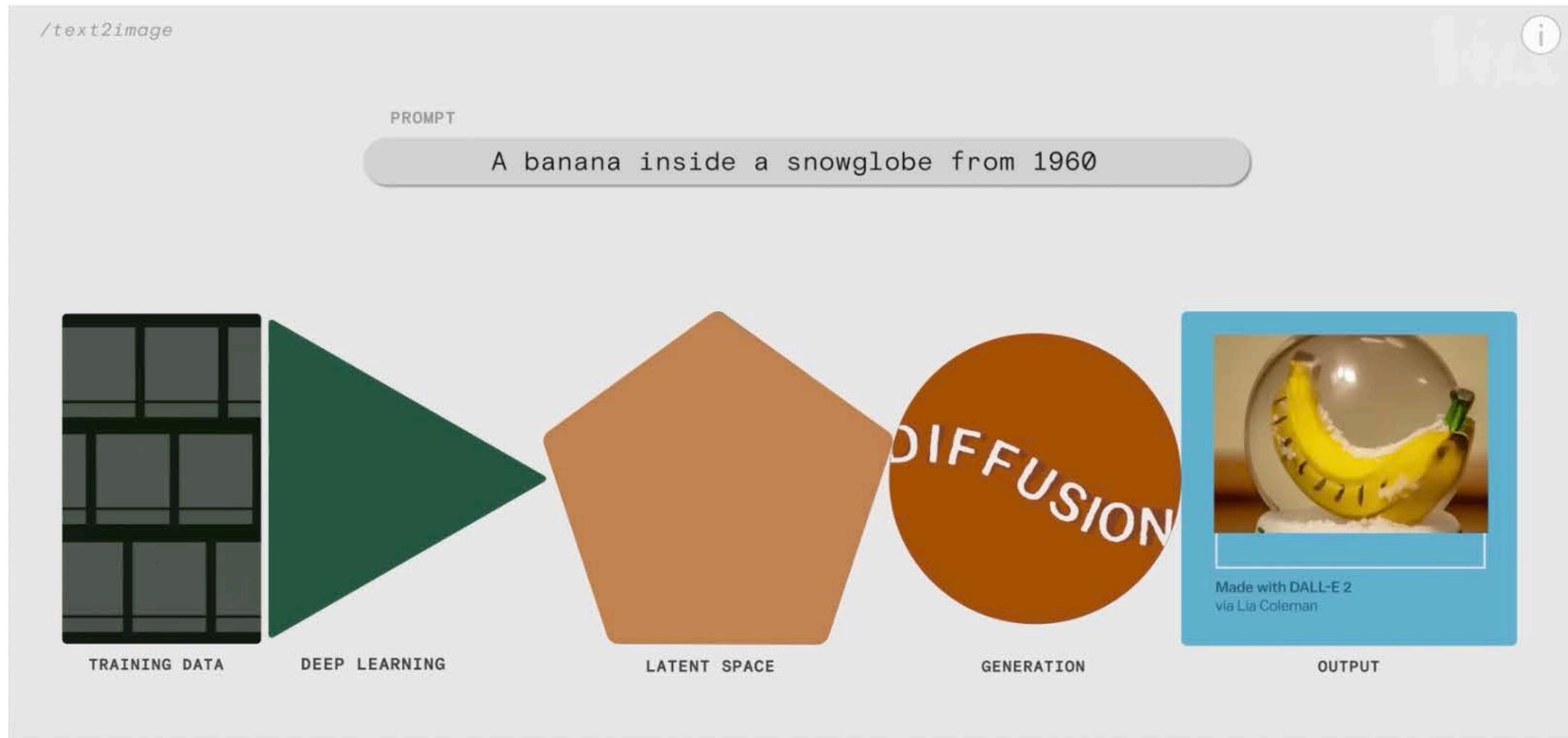


3. tell more stories – storytelling



5. Start to use text to image models

the time is here and now!



1. *Groups of 3 or 4*
2. *Discuss about the data visualization and storytelling examples*
3. *20min*

Compare the different data visualizations and data storytelling examples.

eDNA illustrations

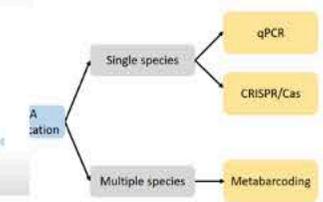
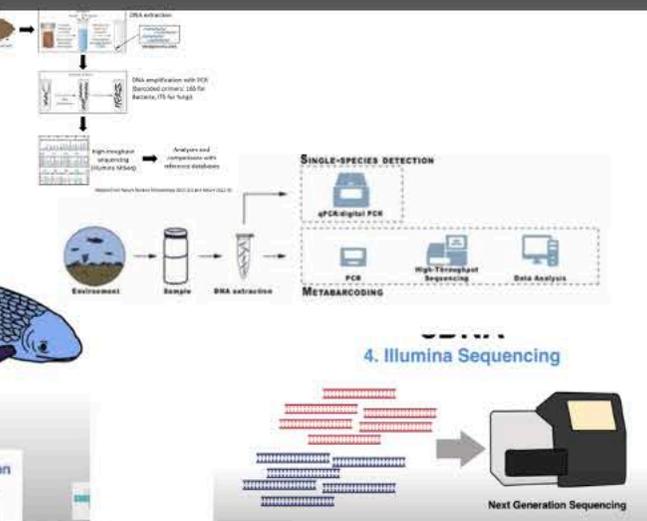
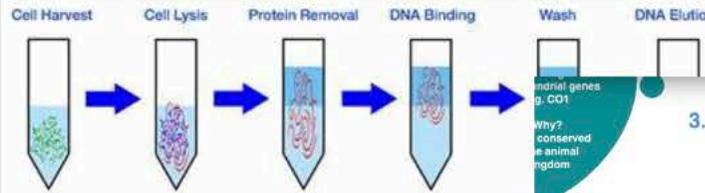
co-design with D-USYS

Sampling (Week 3)

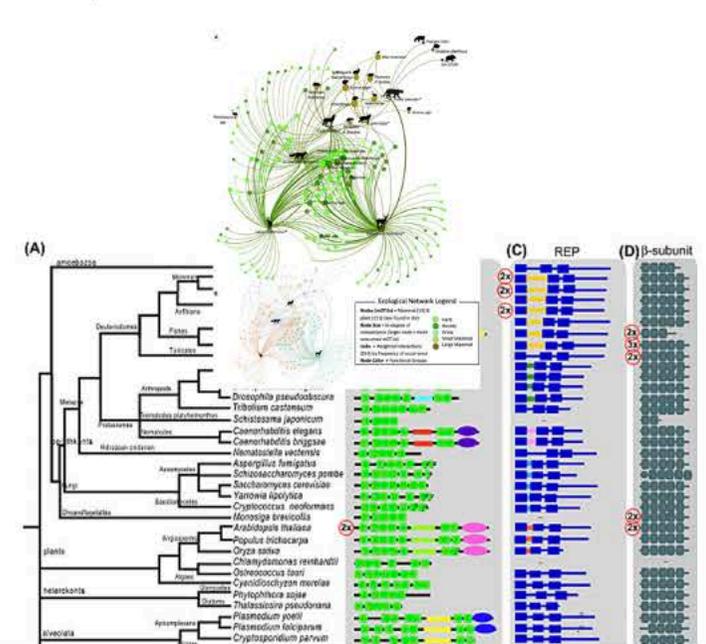
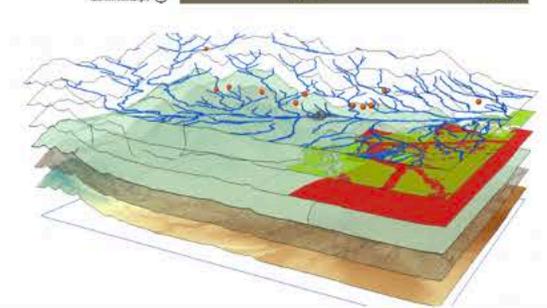
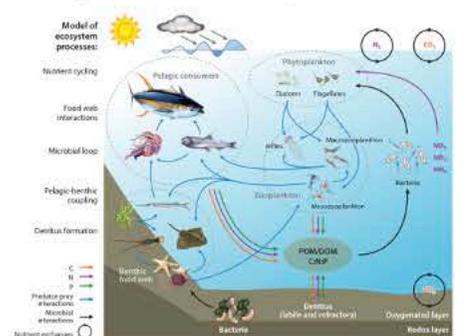


Laboratory (Week 4) eDNA

2. DNA extraction



Ecological interpretation (Week 6)



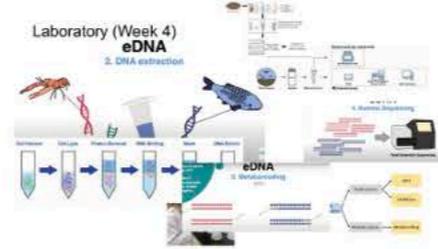
Environmental DNA visualizations

First Input:

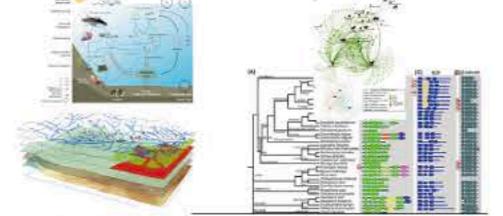
Study design (Week 2)



Sampling (Week 3)



Ecological interpretation (Week 6)



First round of sketches:



Writing feedback:

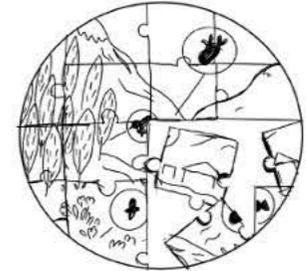
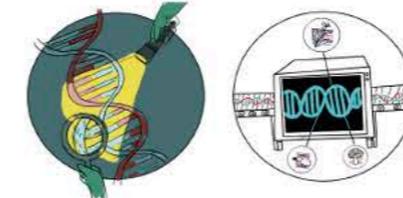
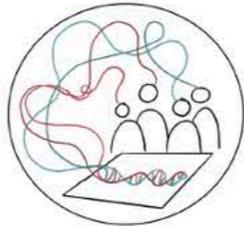
Study design: the one with the drops converging onto the paper works well. I was thinking whether the droplets could be replaced by (interlocking) cogwheels (that make up a DNA helix shape for instance). Instead of the one-way flow from people to paper, it could be two-directional between people and a simplified representation of nature/landscape/ecosystem.

It might be better to visually show the act of a person dipping a test tube into a soil/water surface, or holding it up in front of him/her with the species balloons coming out of it.

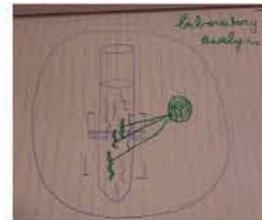
This one might be a little bit too distant from eDNA work.
- What could work is having 2-3 DNA strands (each different colour) that enter a scan-machine type device (much like a luggage scan in the airport) where a segment of only one strand is seen as a barcode or lights up differently (maybe with a reference to a species balloon). Then, only this strand comes out of the machine again along with several of its same-coloured copies. The other strands don't come out.

Ecological interpretation: Perhaps a different way to show this could be to have the different species as puzzle pieces or building blocks that we need to fit together as parts of a landscape in order to make sense of how ecosystems work.

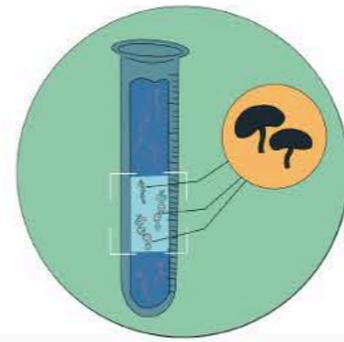
Second round of sketch:



Sketch :



Final visualization:



Environmental DNA visualizations: co-design working process

el]

First Input:

First round of sketches:

Writing feedback:

analysis: This one might be a little bit too distant from eDNA work.

- What could work is having 2-3 DNA strands (each different colour) that enter a scan-machine type device (much like a luggage scan in the airport) where a segment of only one strand is seen as a barcode or lights up differently (maybe with a reference to a species balloon). Then, only this strand comes out of the machine again along with several of its same-coloured copies. The other strands don't come out.
- Another option is to use the idea of your first laboratory sketch but replace the surgical intervention with a highlighting simile such as searchlights or flashlights shining on one short segment of a long DNA strand that is surrounded by many DNA strands. The highlighted segment could then look like a barcode or could light up unless that is too much detail for the icon.

Sketch :

Second round of sketch:

Final visualization:

= EDNA Team
 = Media Design Team

radionuclides animations

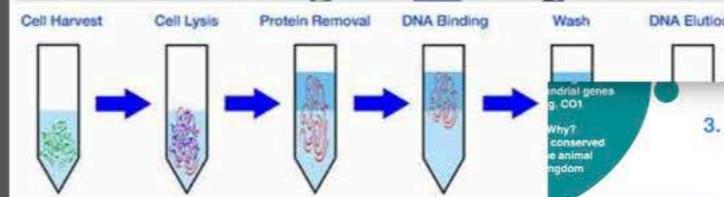
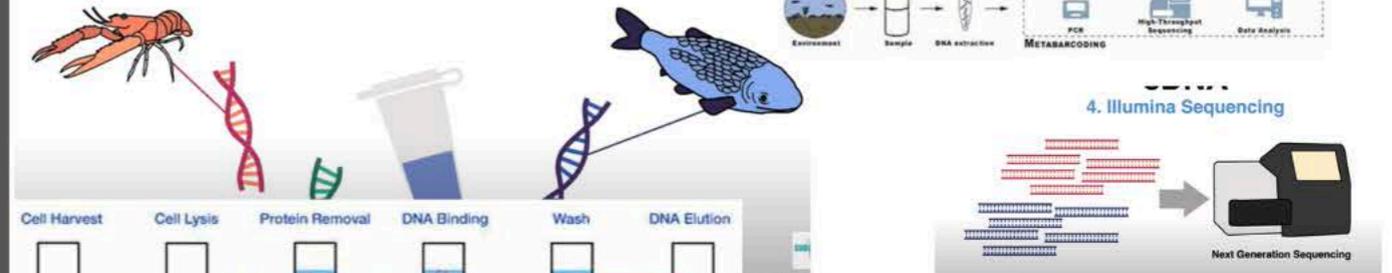
Co-design with *D-PHYS*, *D-ERDW*, *D-USYS*

Sampling (Week 3)

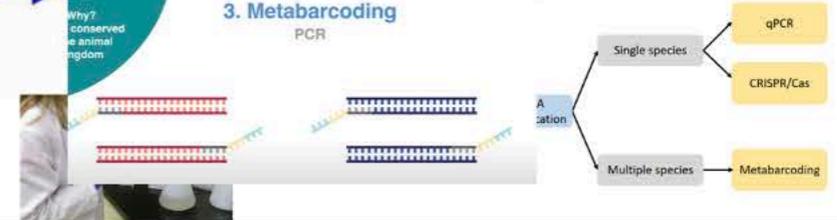


Laboratory (Week 4) eDNA

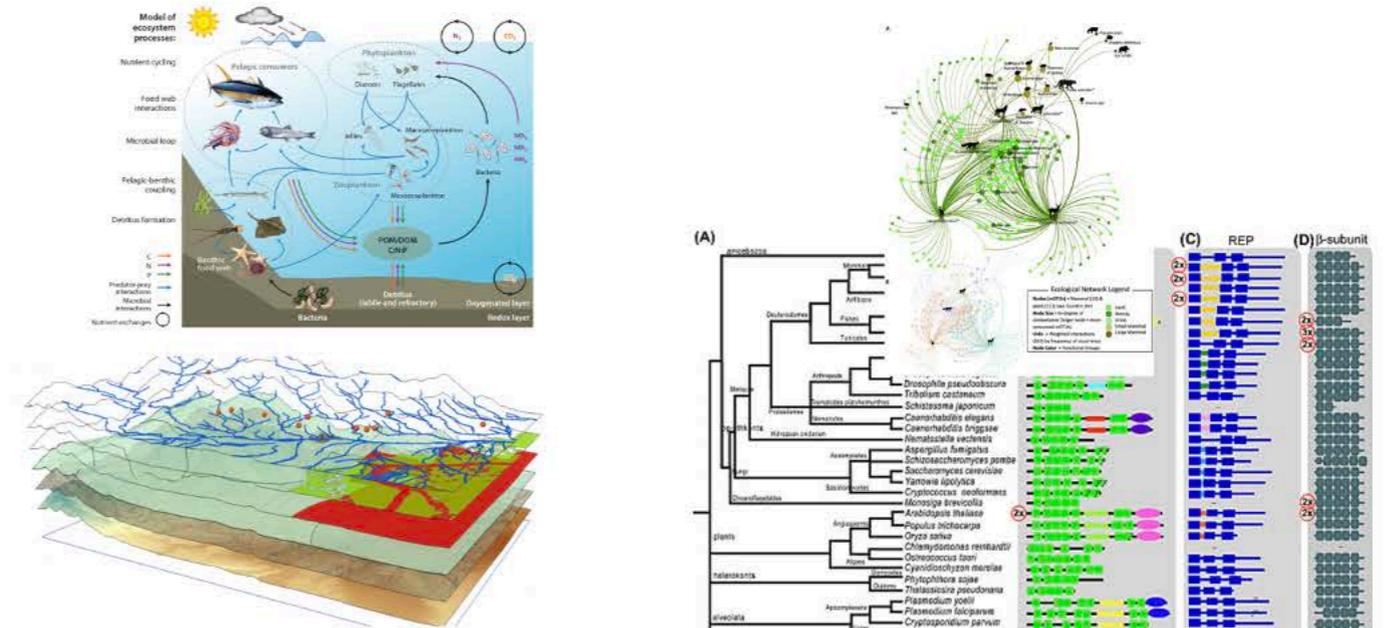
2. DNA extraction



3. Metabarcoding PCR



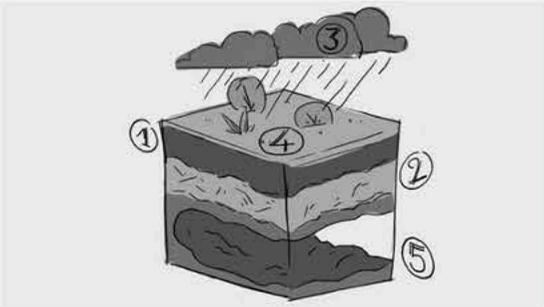
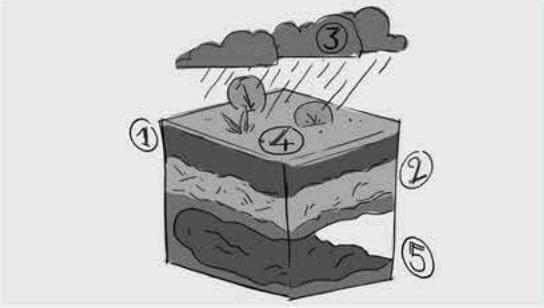
Ecological interpretation (Week 6)



radionucléides

animations

Co-design *with* D-PHYS,
D-ERDW, D-USYS

Panel n°	Scene n°	Picture	Voice-over	Action	Done
07	030		For a stalagmite to <u>from</u> , generally three things are needed: soil, <u>a limestone</u> bedrock and rainwater.	This part will be in Color. It is only for the storyboard that it is in black and white, for efficiency reasons. :)	X
08			Oh, and a cave beneath the limestone bedrock and typically also vegetation growing on the soil. So, if those five conditions are provided, a stalagmite can form.		
09	040		This is how it works: Rain falls on the surface above a cave, and the rainwater penetrates the soil.		
10	050		This rainwater is in chemical equilibrium with		

Radionuclides Project: Ocean Water Samples

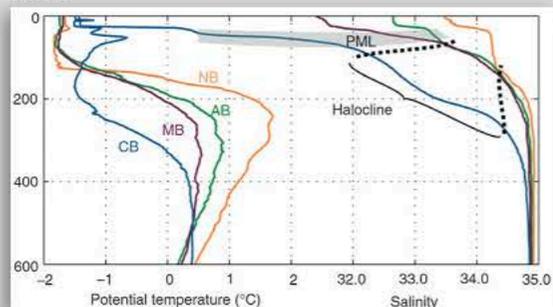


Starting Point

Script

To collect seawater samples a device called a CTD is needed. CTD stands for Conductivity, Temperature, and Depth, and the rosette is a frame which typically has so-called Niskin bottles attached to it. These bottles open on both sides when the device is lowered into water. While the CTD is lowered down the water, different parameters of the surrounding water are

Data

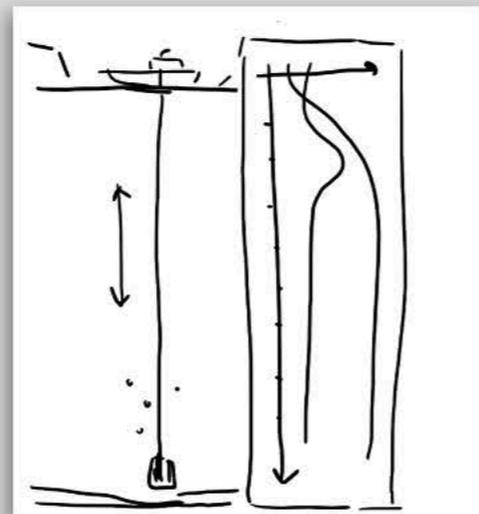


Reference Images

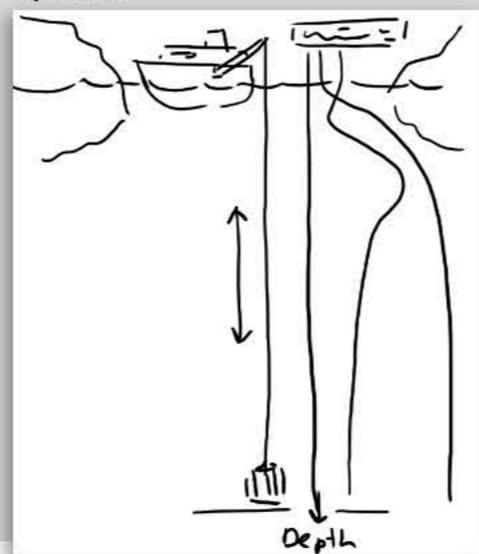


Sketch

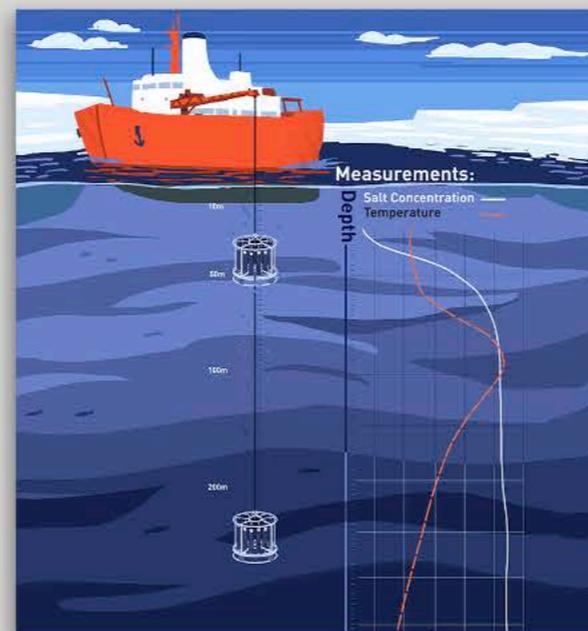
Option 1



Option 2



Styleframe



Final Version

