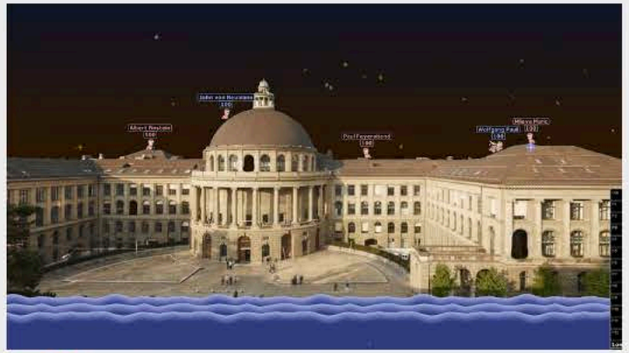
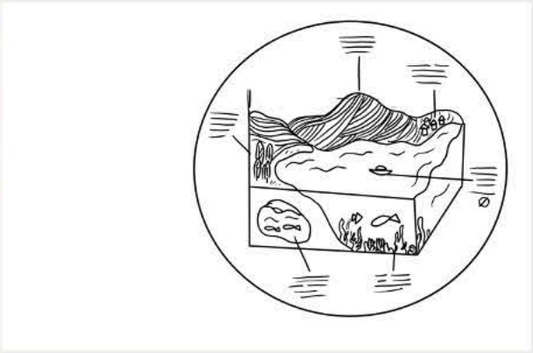
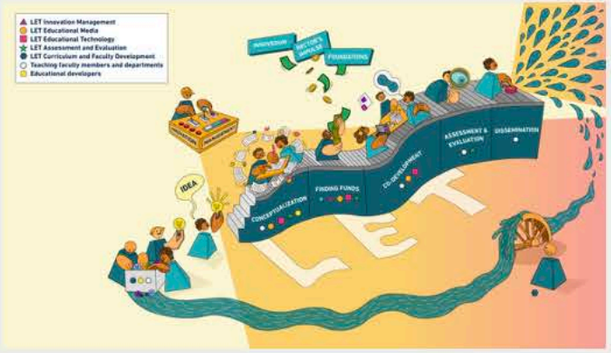
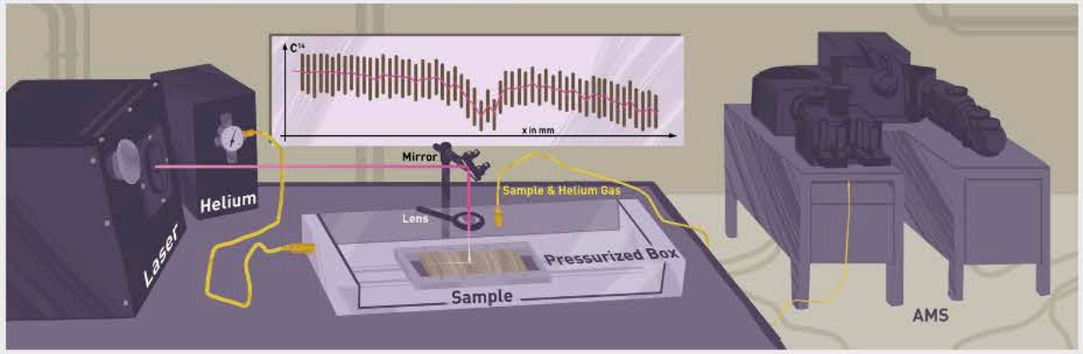
visualizing *science*

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

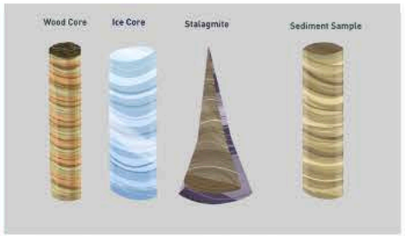
15:00 – 15:15 Break

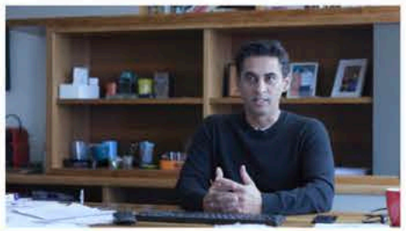
15:15 – 16:00 Final Round

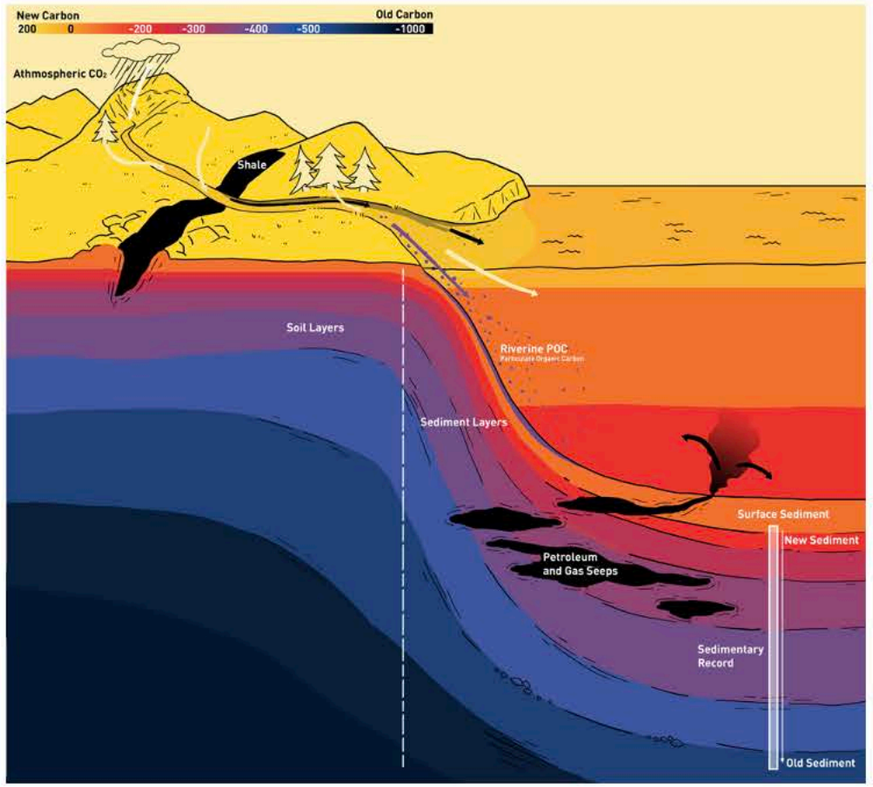
ETH

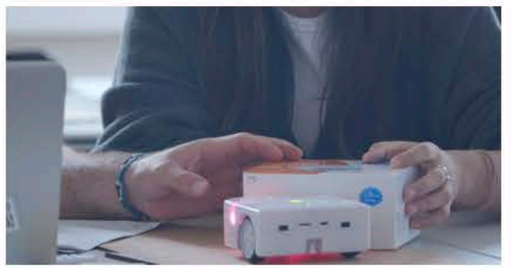
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

EduMedia Team









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

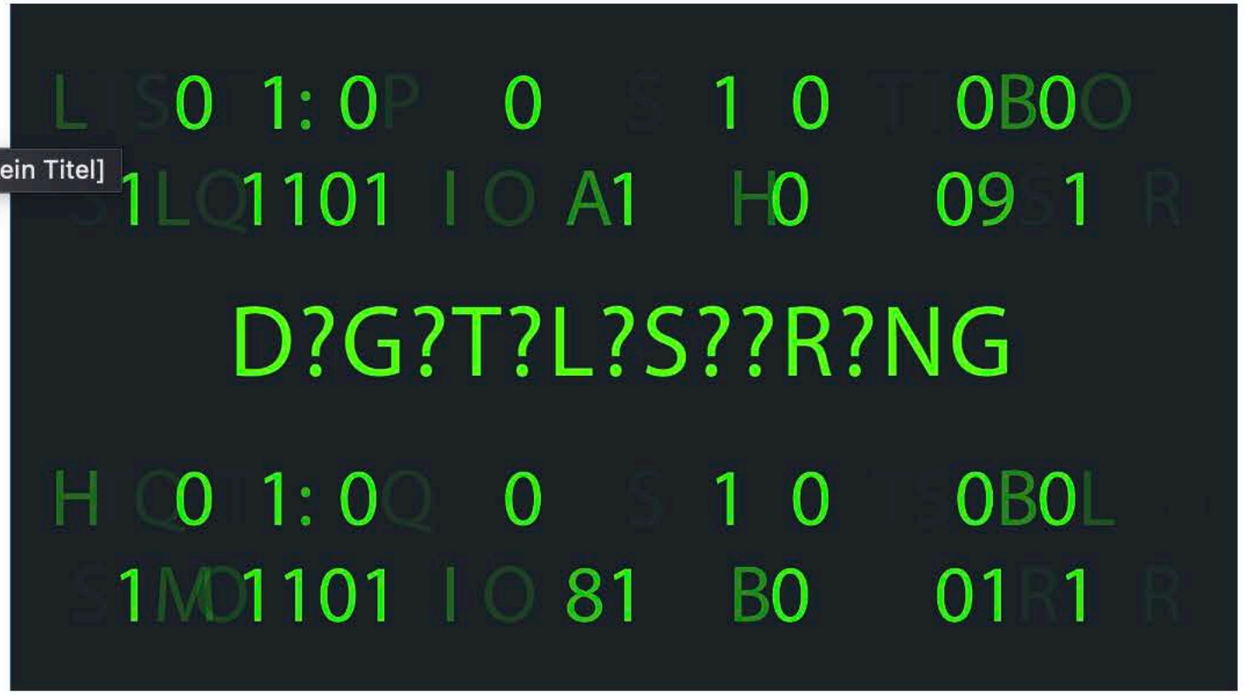
Introduction round

Describe an image that had an lasting effect on you.

words and images

academic culture and the digital world

[Kein Titel]



Scientist: My discoveries are useless if taken out of context

Media:

"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

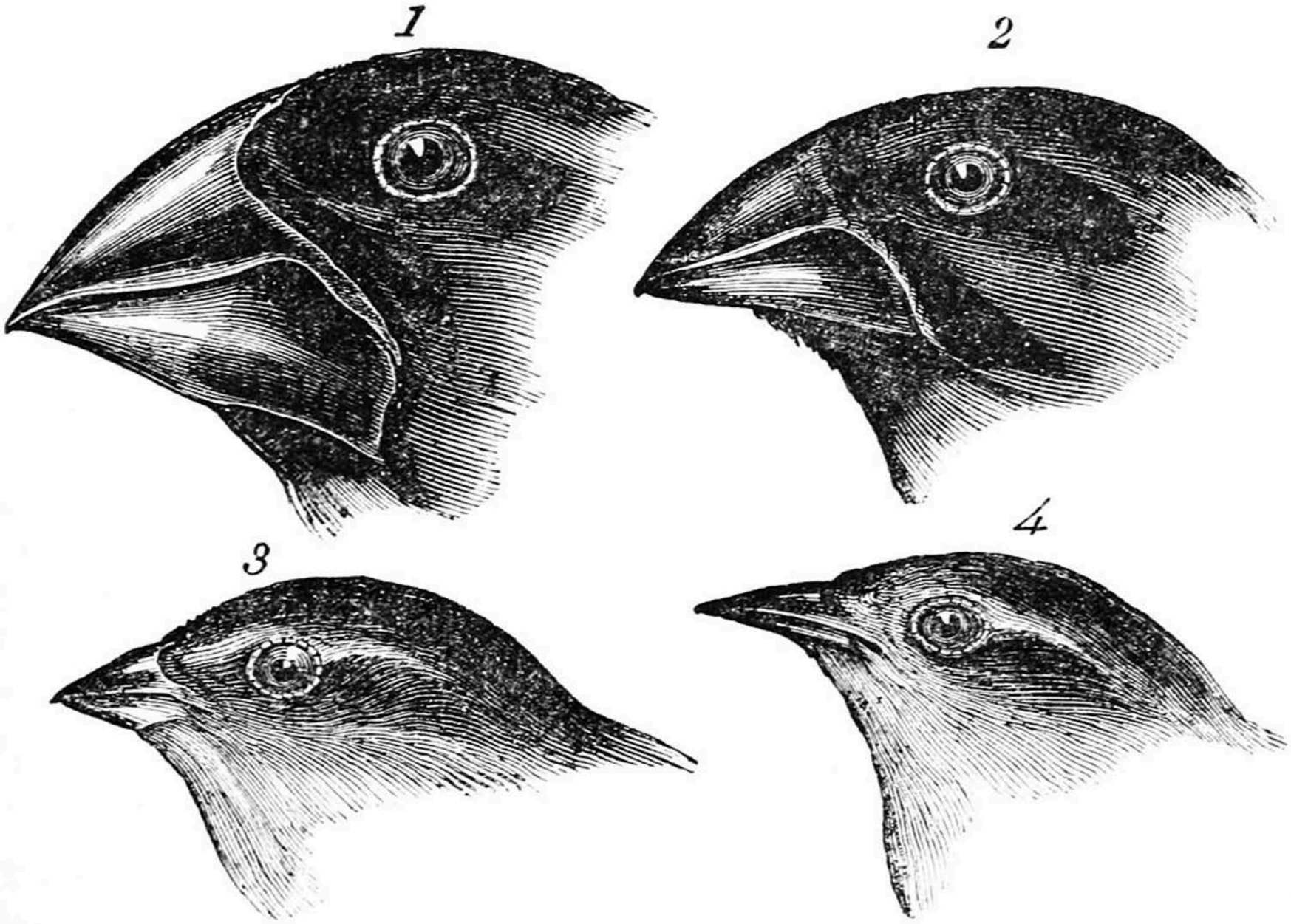
iconic or pictorial turn

what do images do?

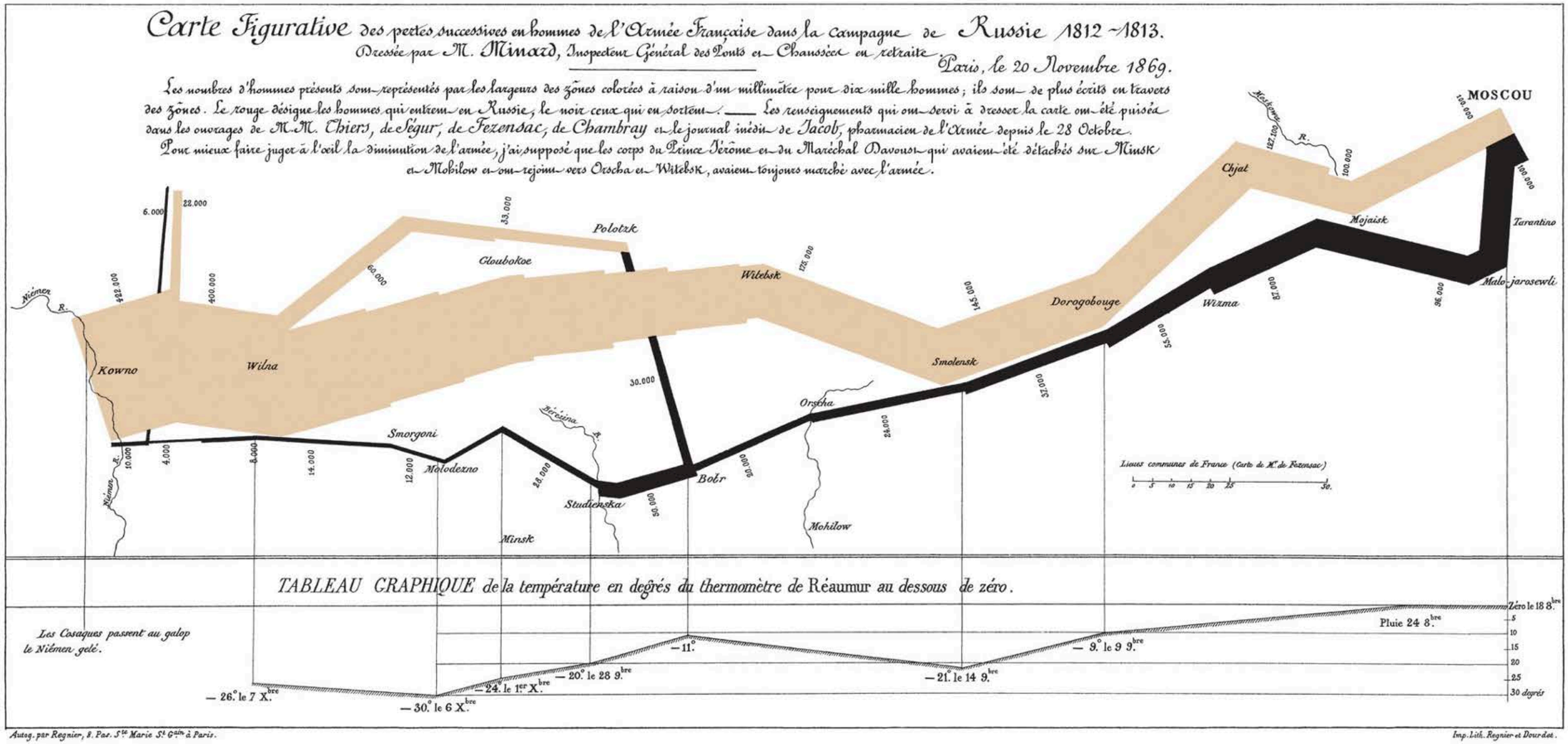
Fotografie, das ist die Wahrheit. Und Kino, das ist die Wahrheit 24 Mal pro Sekunde.

Jean-Luc Godard, Der kleine Soldat, 1960.

Buster Keaton, The Goat, 1921.



1. Geospiza magnirostris.
2. Geospiza fortis.
3. Geospiza parvula.
4. Certhidea olivasea.



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.

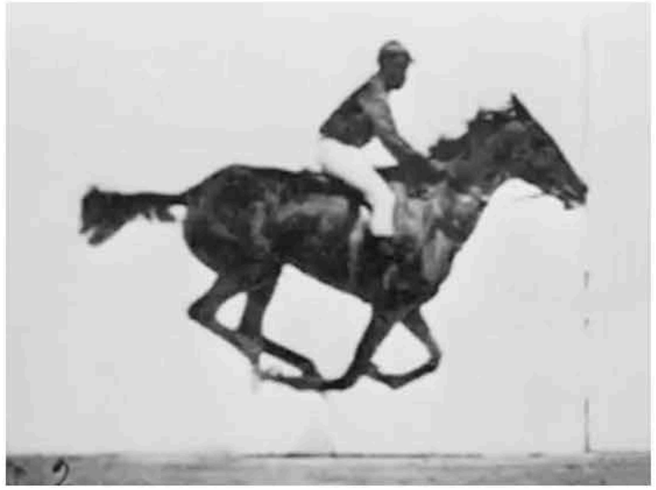
PLATES.—VOL. I.

MALES (NUDE).

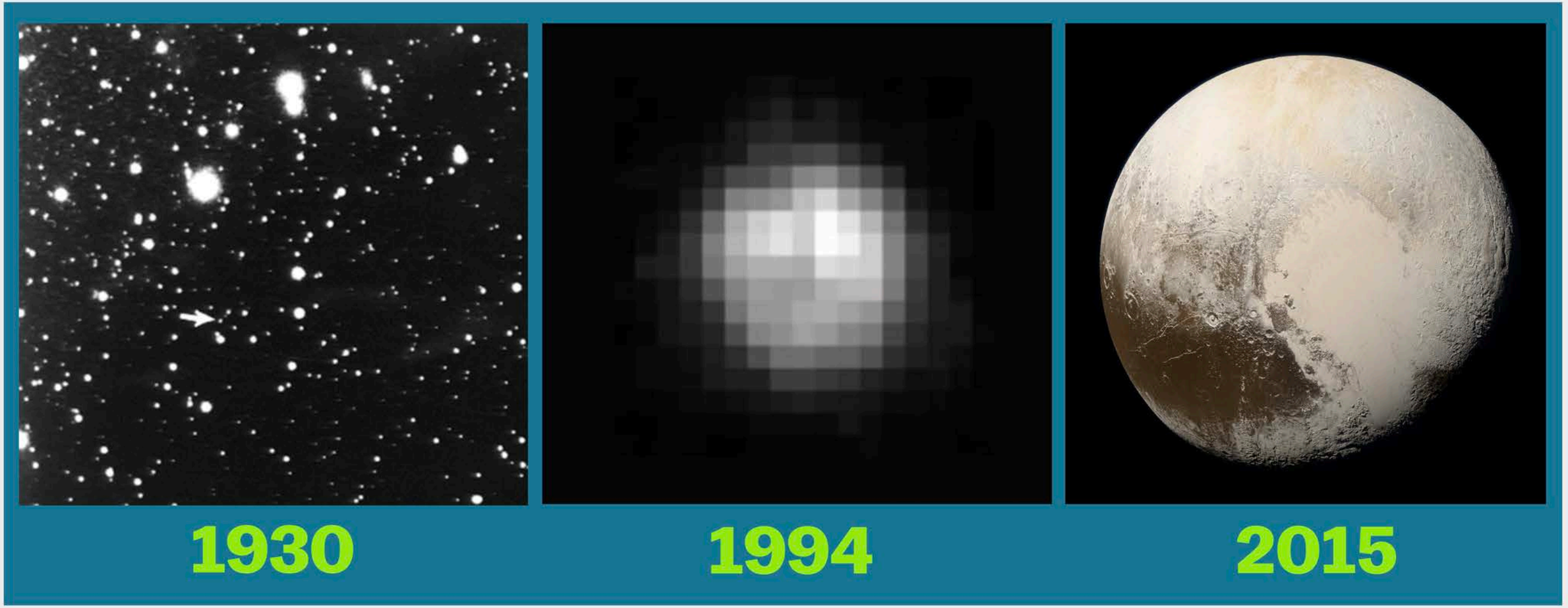
THE PLATES PRINTED BY THE PHOTO-GRAVURE COMPANY.

PHILADELPHIA:

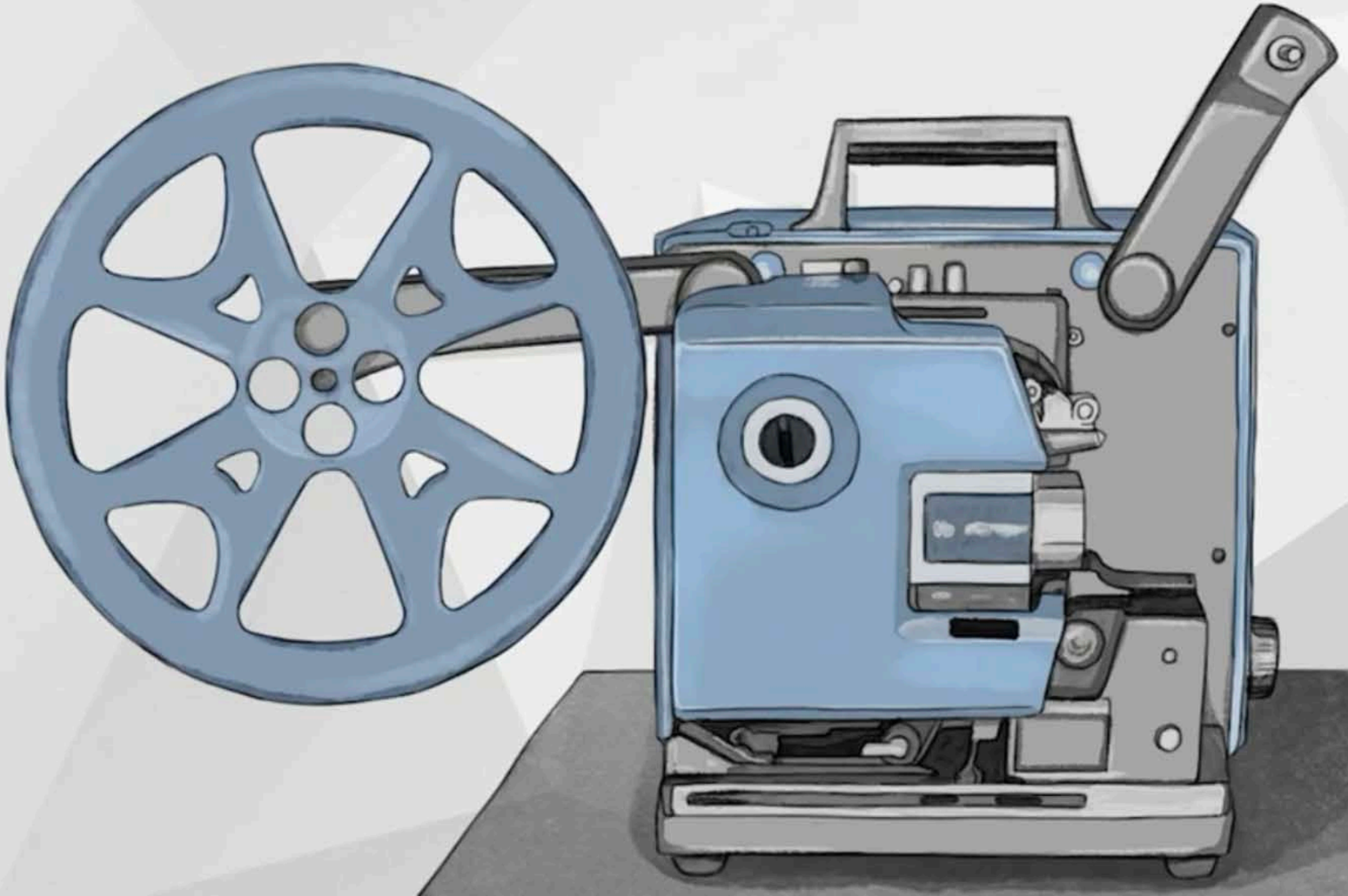
1887.



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



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

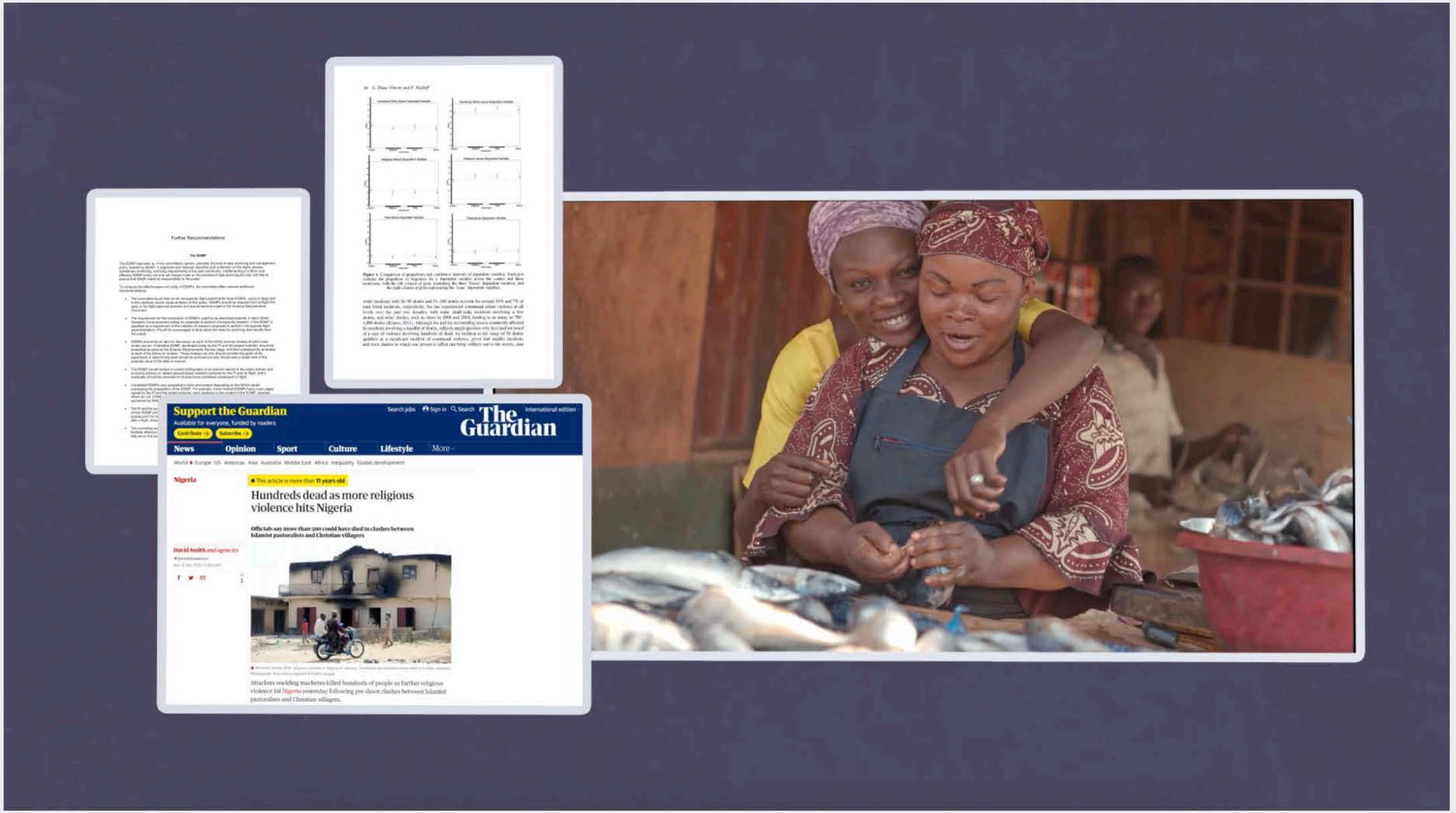


media formats

the subtle pain of choosing the right one

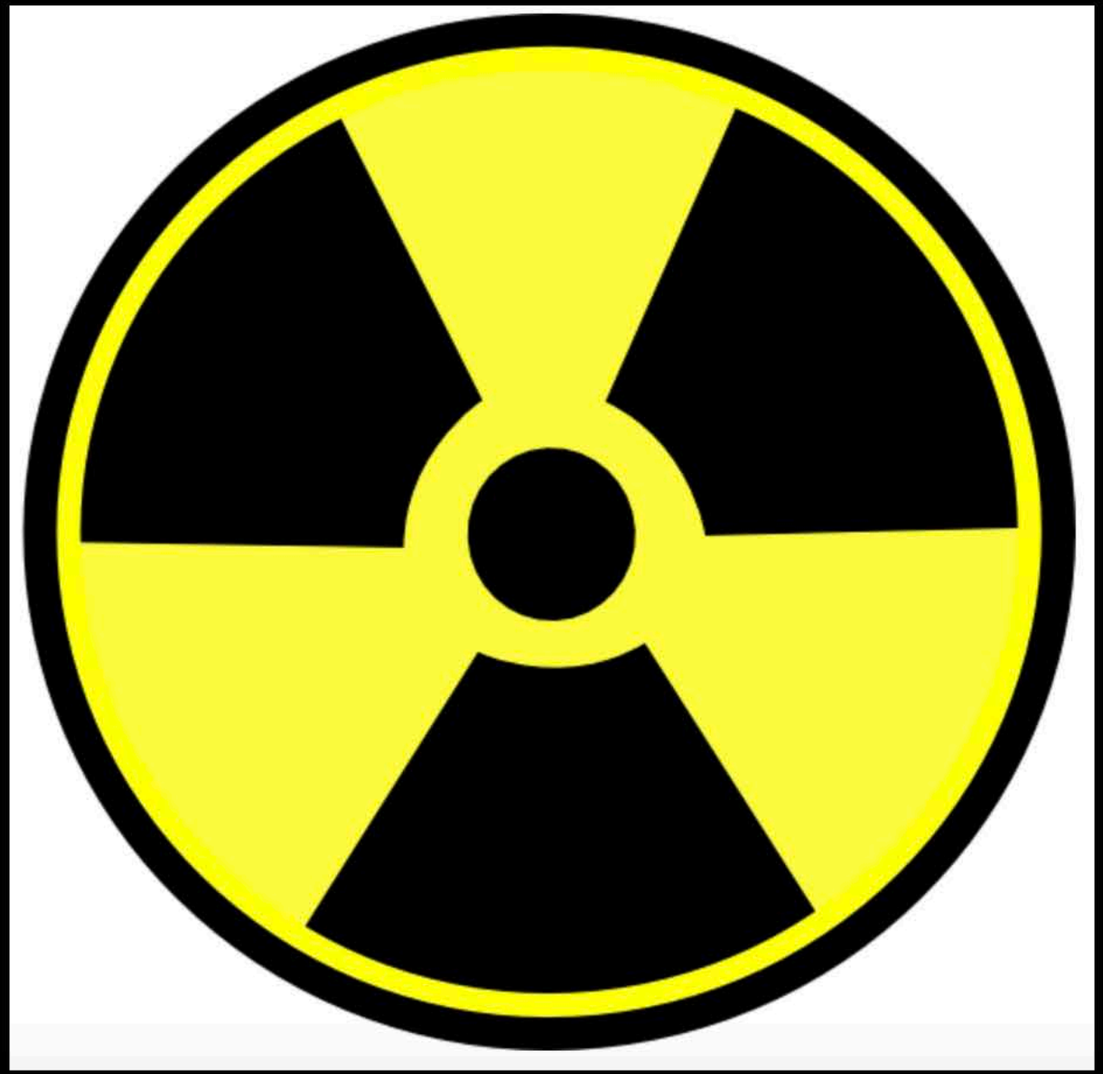
- Videos (concept videos, Expert Interviews, Documentary, Observations, Tutorial, Introduction Videos, tiktok, etc)
- Animations (2D, 3D, Stop-Motion, Pixilation, Animated Documentaries, Character Portraits etc.)
- Illustrations, Scientific Illustrations
- Comics, Graphic Novel
- Interactive Poster Design
- 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

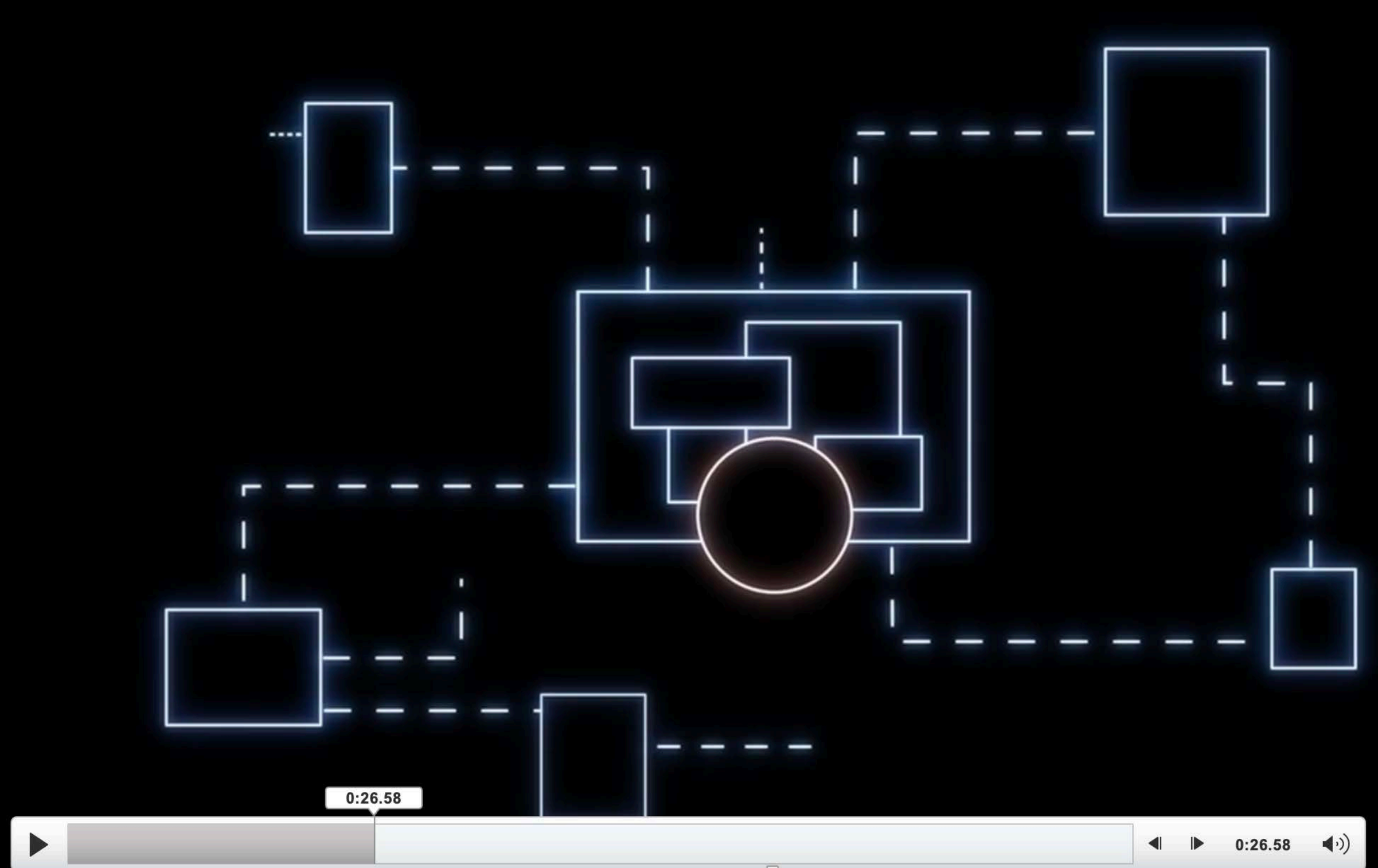
cold data, warm data



why use more visuals?

... knowledge dissemination
... knowledge communication
... knowledge transfer
... knowledge translation
... knowledge transformation ...




0:26.58
0:26.58

Math. Z. 127, 10–16 (1972)

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:

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

Nun sei der Operator T,

$$T\colon X \to X^*,$$

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

$$\forall x_1, x_2 \in X\colon \quad \langle T(x_1) - T(x_2), x_1 - x_2 \rangle \geqq 0.$$

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

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

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

$$\exists \alpha > 0 \; \forall x_1, x_2 \in X\colon \quad \langle T(x_1) - T(x_2), x_1 - x_2 \rangle$$

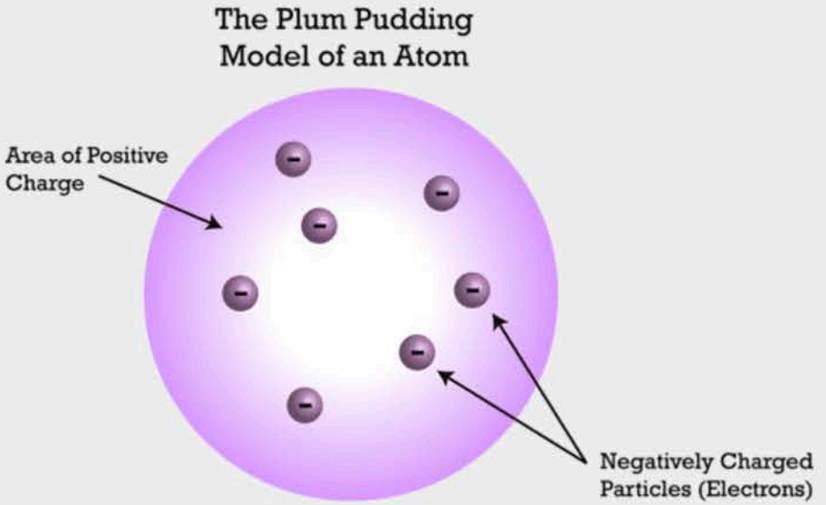
Media-specific transformation processes

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

science translation issues

Plum pudding

Raisin cake

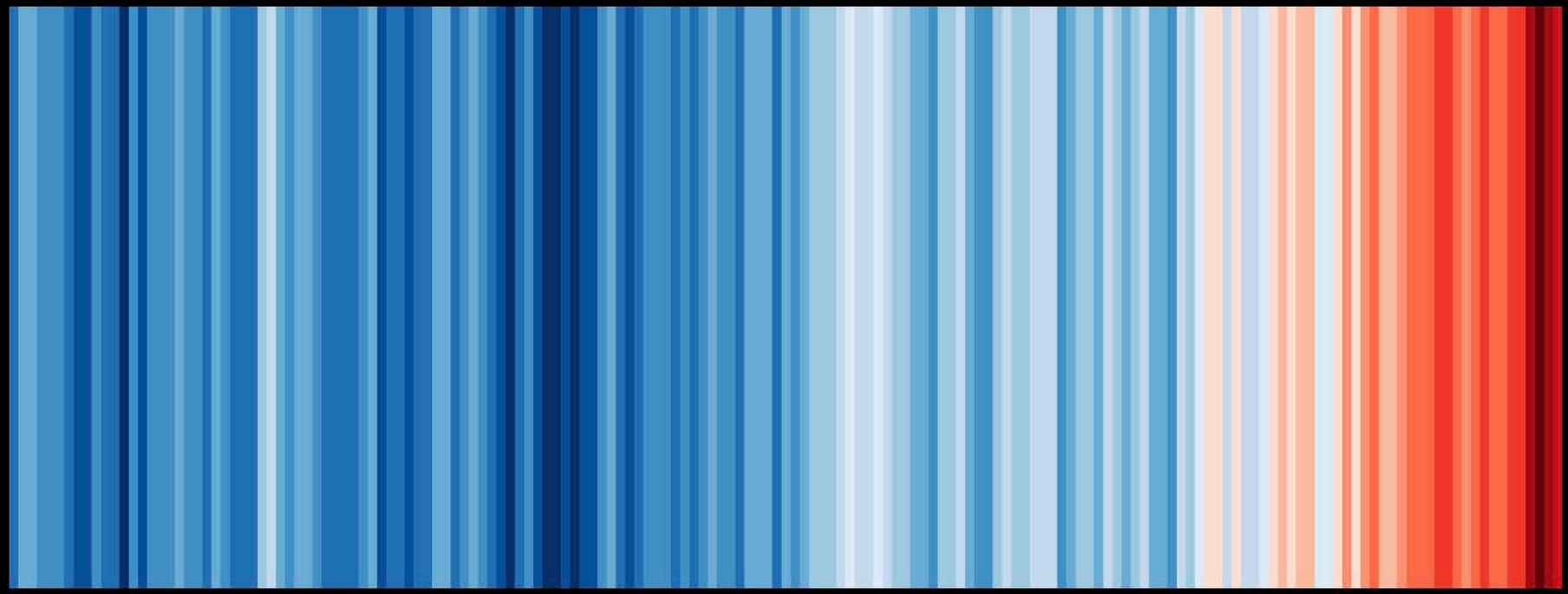


Translation issues not only from words and images, but also sometimes in language translation (e.g. wrong metaphors).

«This graphic explains everything in the blink of an eye [...] 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 — #fb6a4a
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**

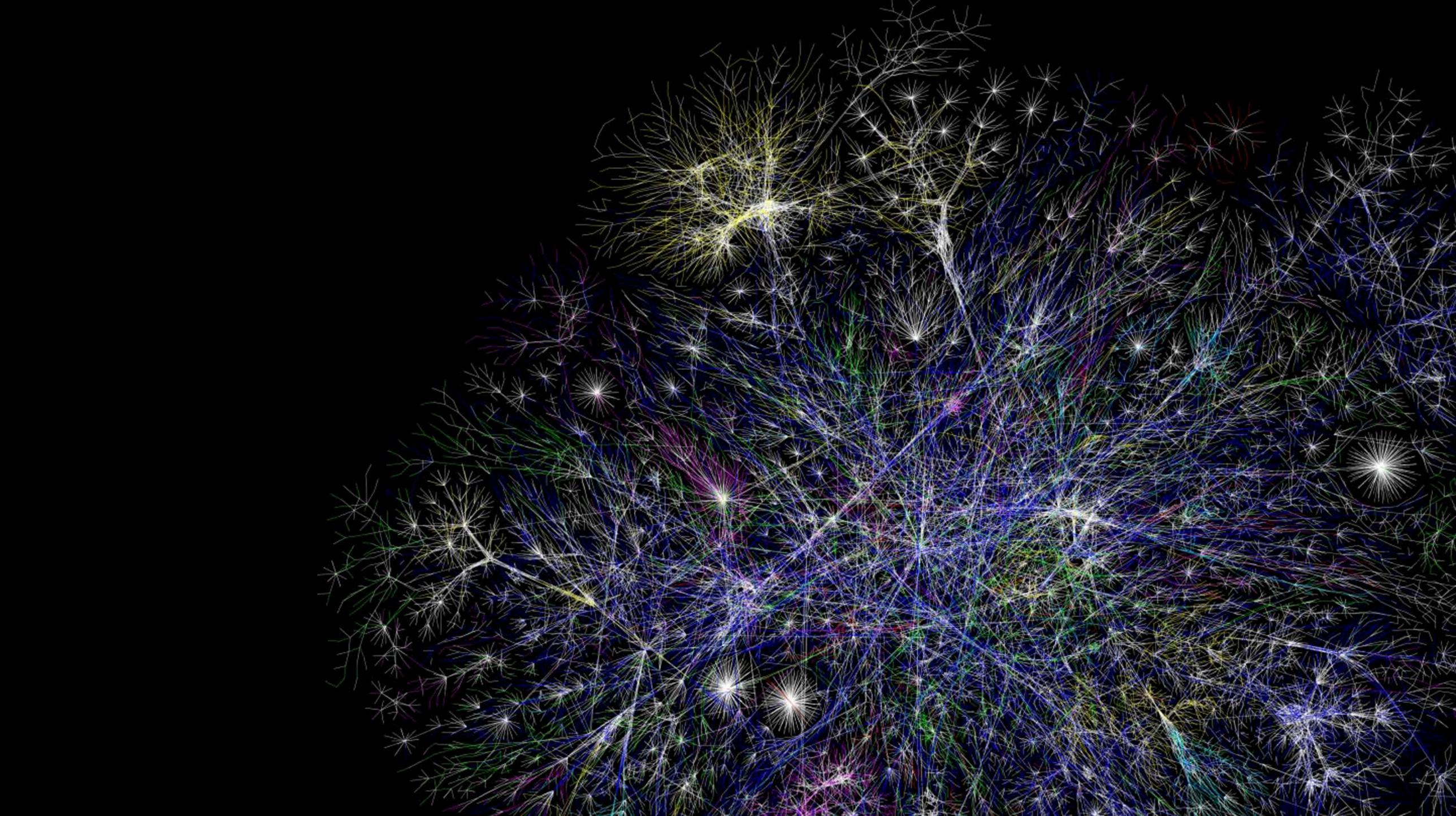
data storytelling

- 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


BBC
BBC
NEWS
lifespan
50
years
25
years

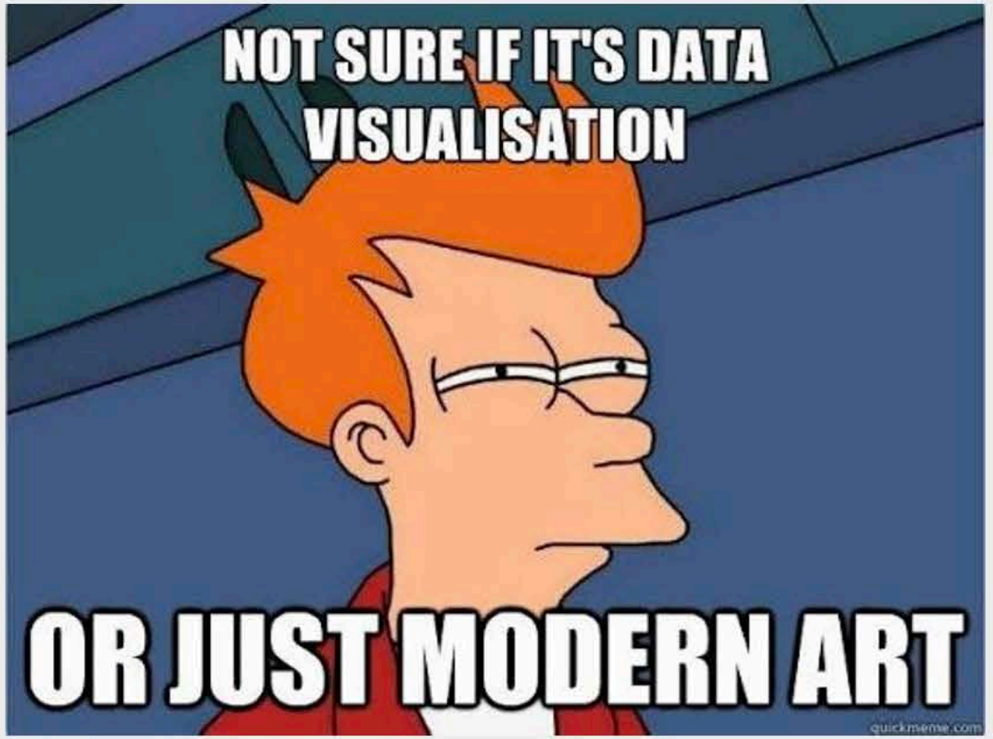
Difference between data storytelling and data visualization:

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*

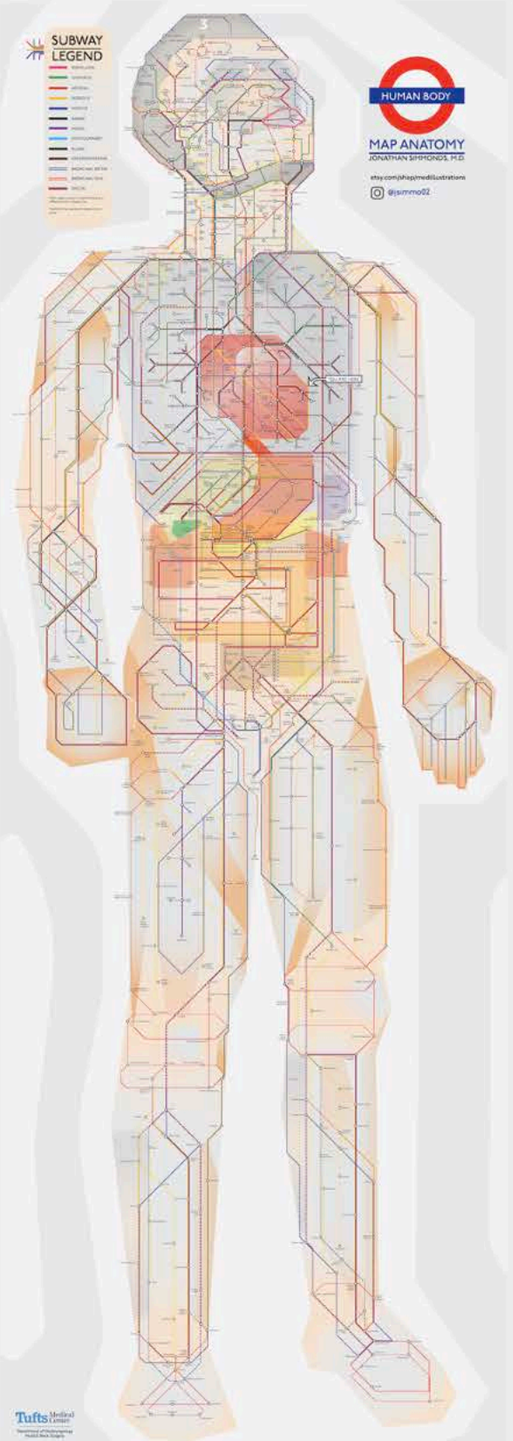
What are important or famous visuals in your scientific disciplines? (also e.g. gifs, diagrams, memes, pictures)

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)

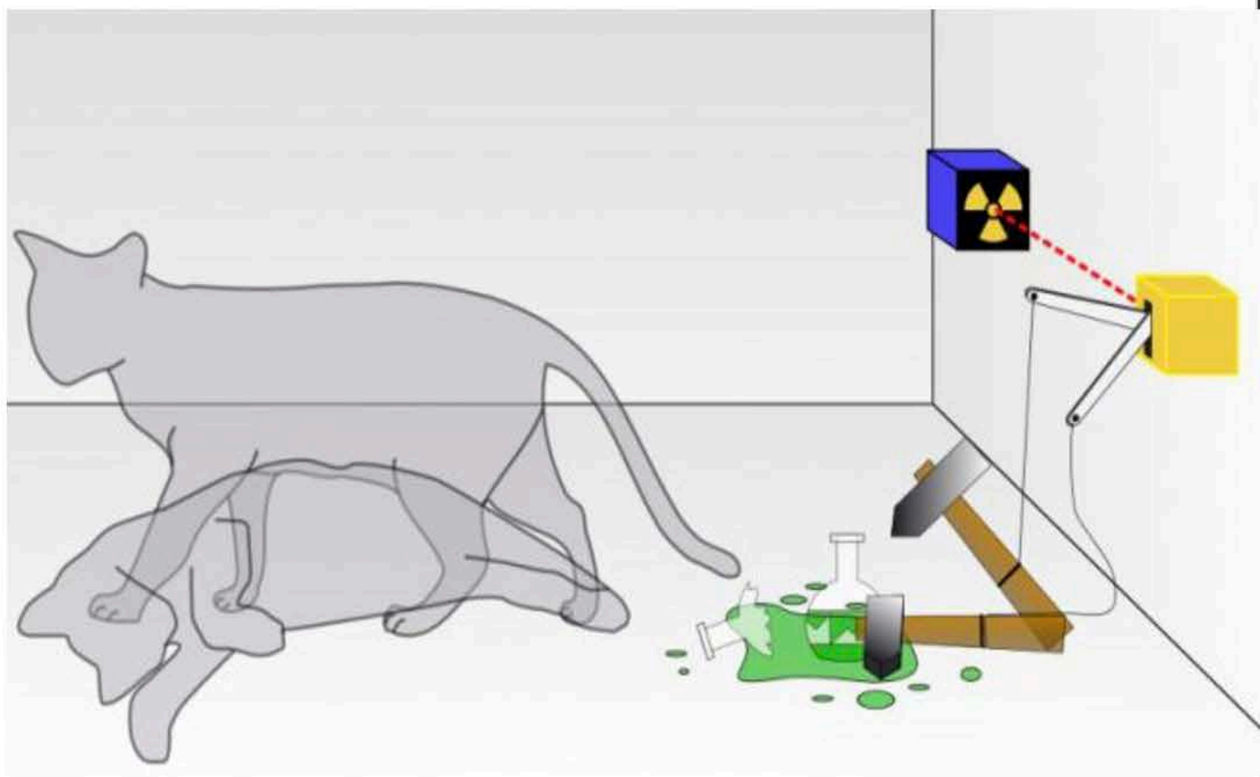
metaphors & analogies

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




Ceci n'est pas une pipe.

+

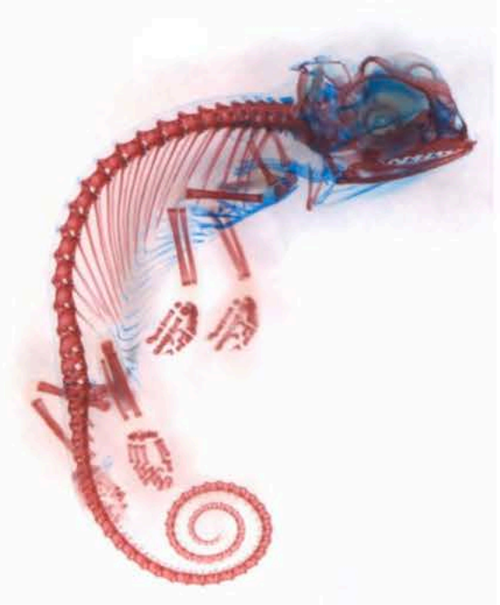



Ceci nest pas un photon.

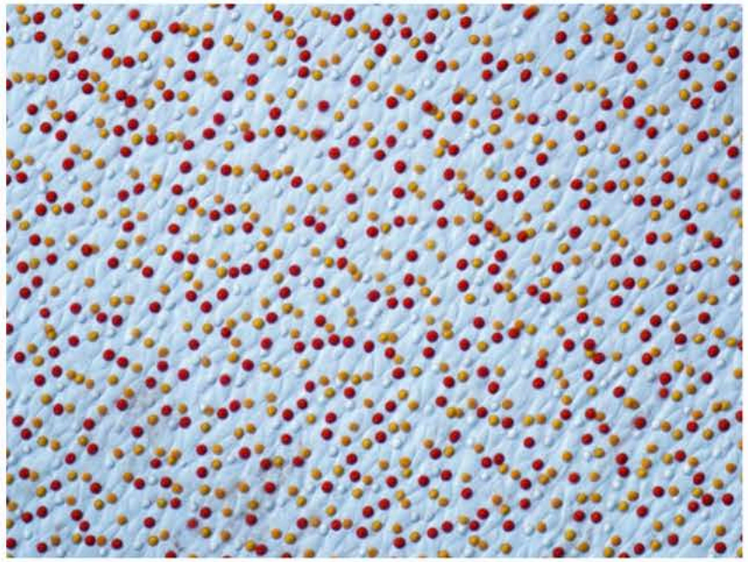
epistemic images

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

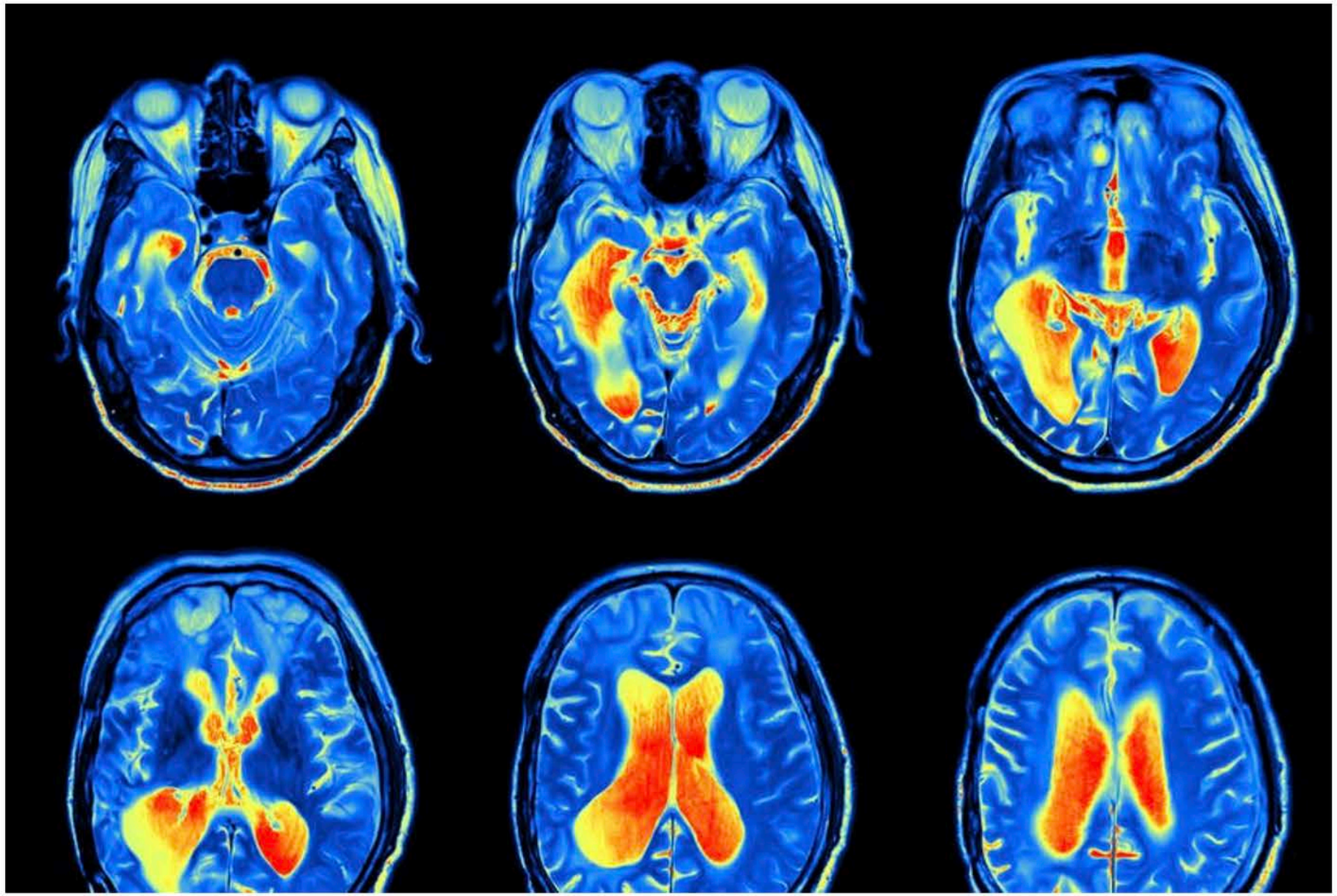


2. Platz: Die Netzhaut einer Zierschildkröte, in 400-facher Vergrösserung.
Bild: Dr. Joseph Corbo/Washington University School of M

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.

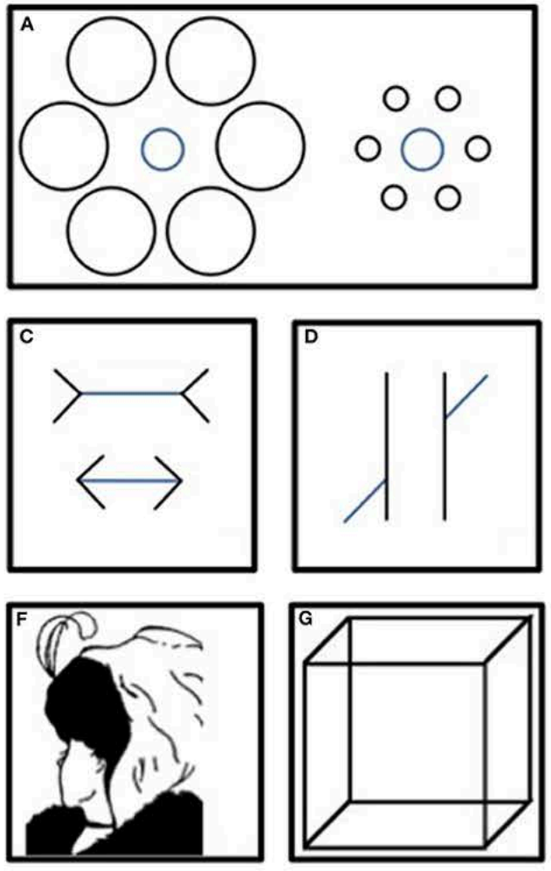
designing

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.


Memory of a Voyage, 1952 - Magritte


A
C
D
F
G

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

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 emptyness)
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?

[Kein Titel]

everyday visuals

process documentation, sketches, notes ...

The renowned mathematician Benoît 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

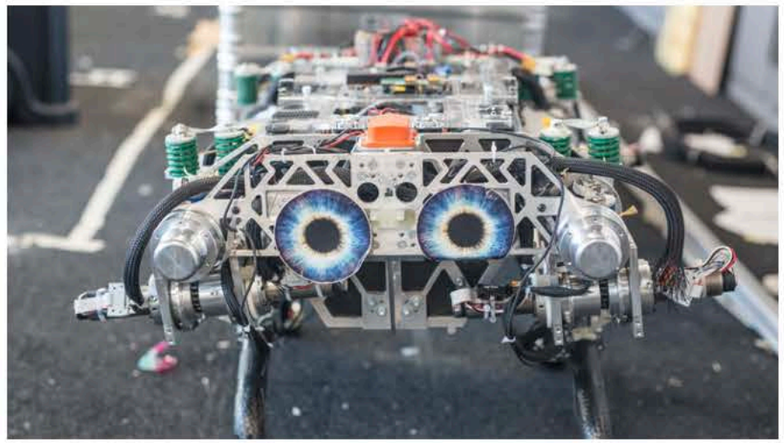
1. start to look closely

data collection, idea and note taking, literature …

2. practice visual documentation

observations; prototypes, thought experiments

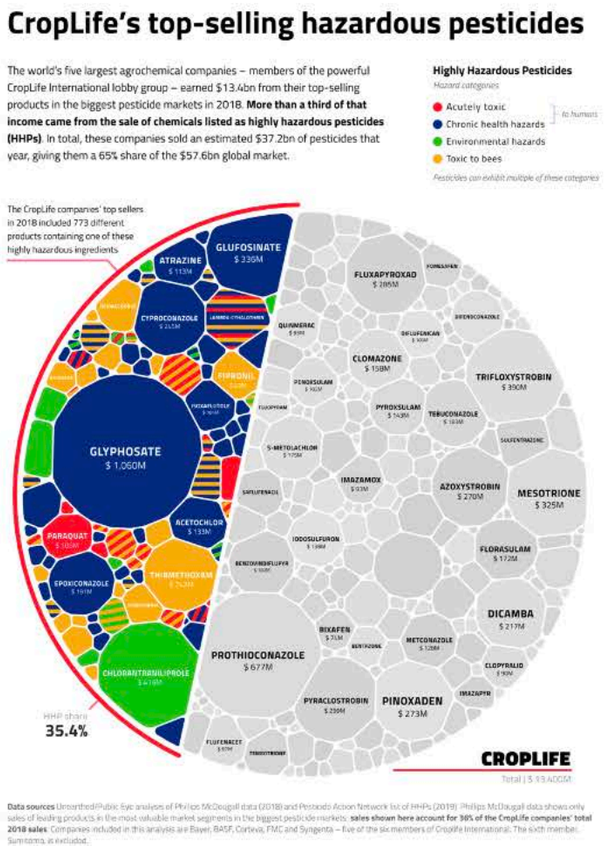
laboratory shots, moodboards, field notes ...

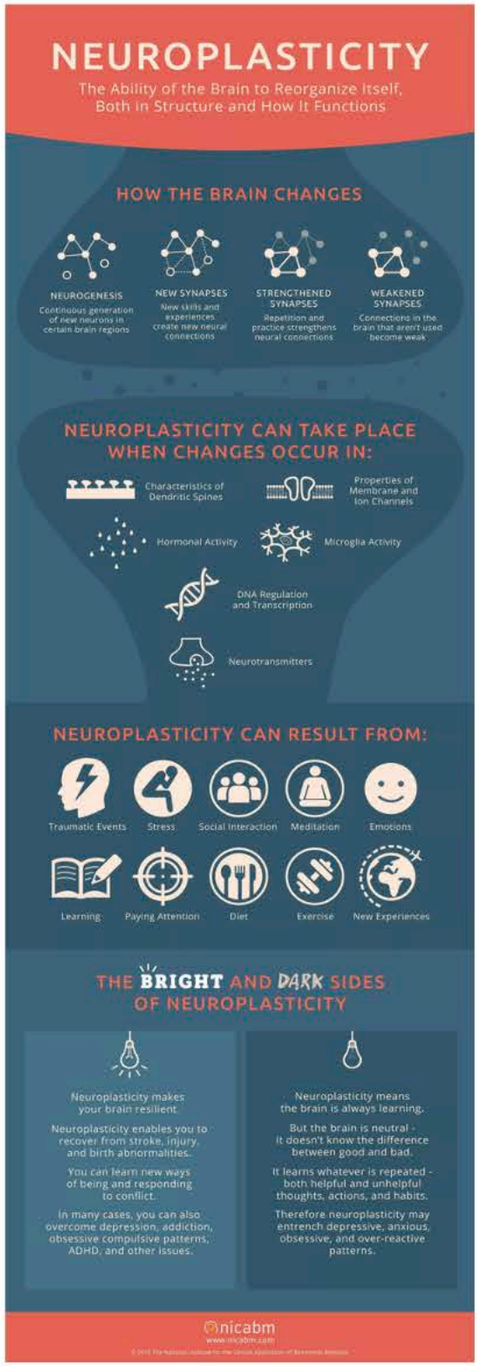


3. tell more stories – storytelling

4. inquire “the visual“

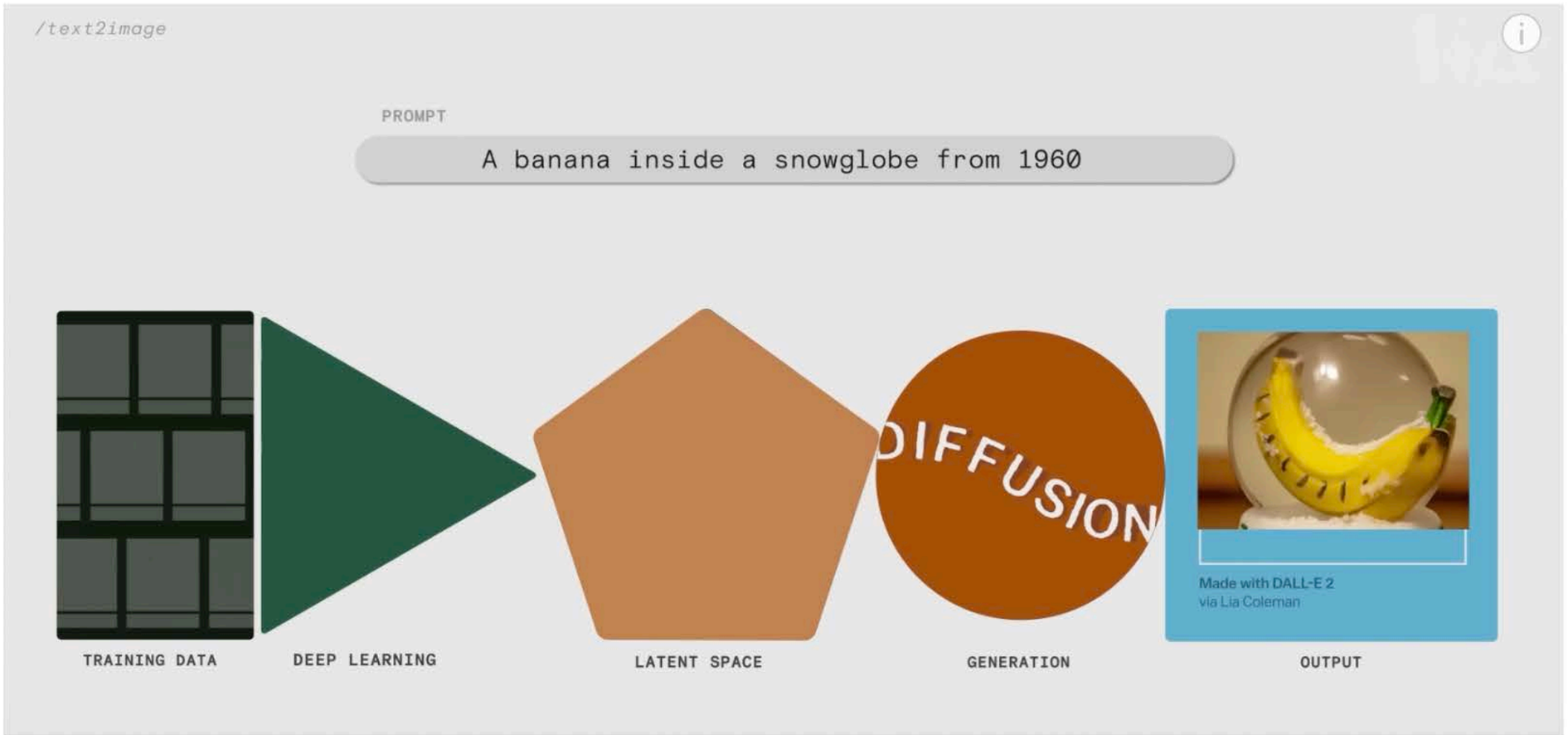
compare visuals you like with others





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*

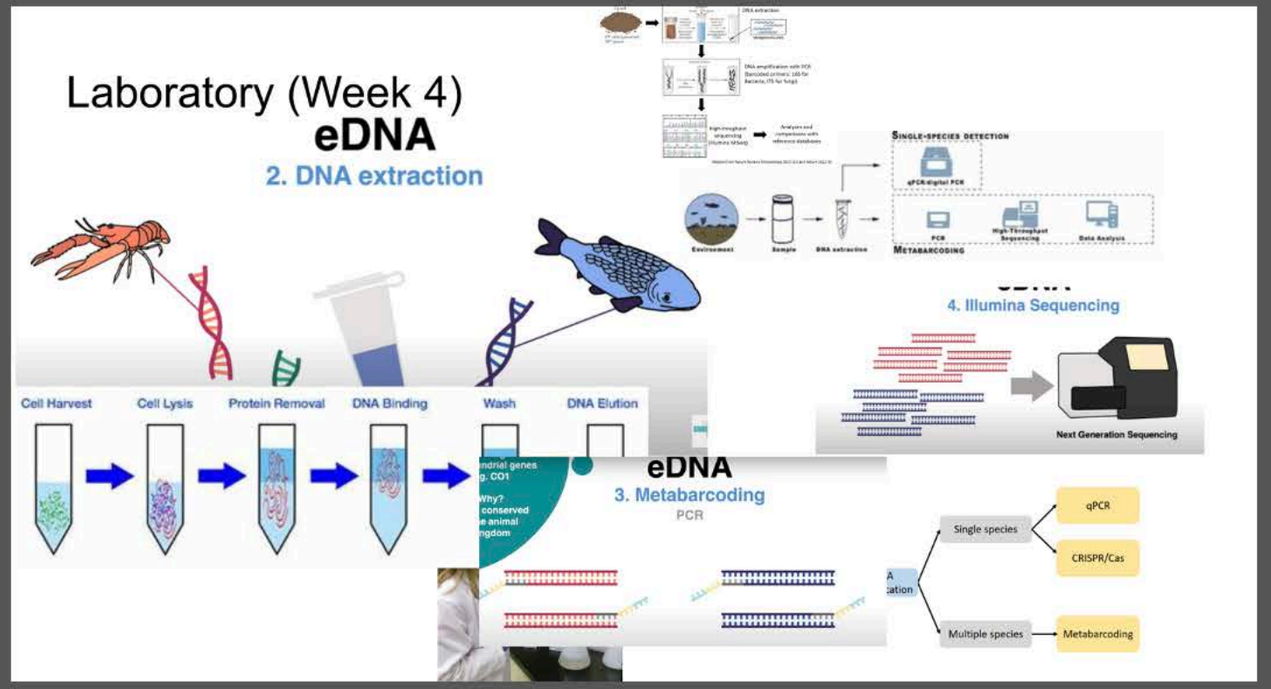
Compare the different data visualizations and data storytelling examples.

eDNA illustrations

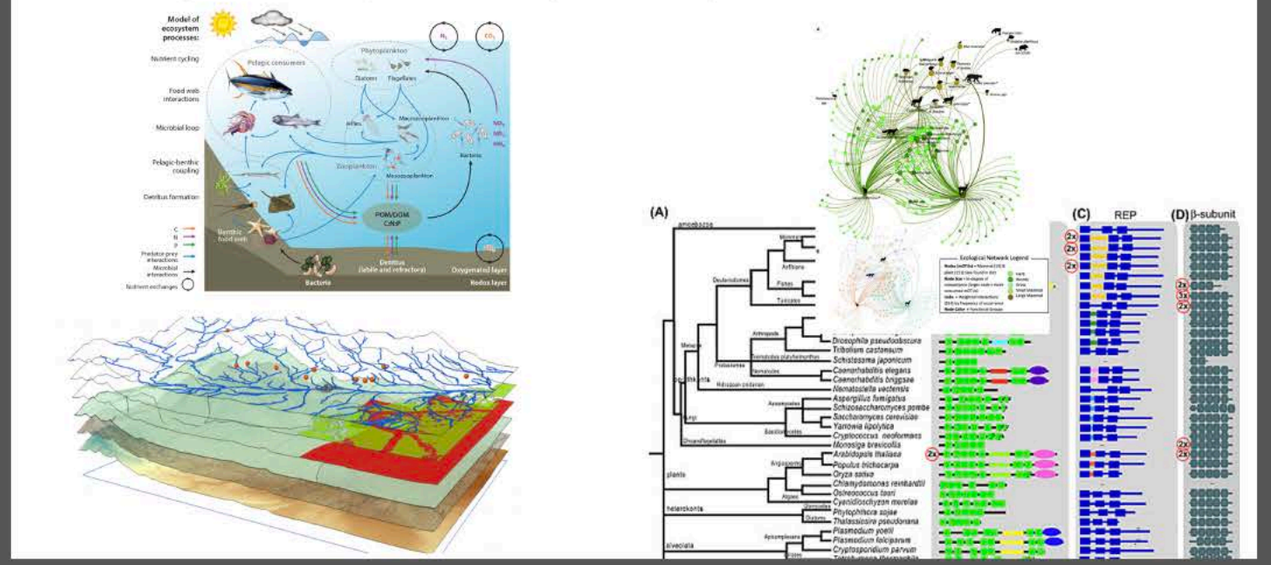
co-design with D-USYS

Sampling (Week 3)

Laboratory (Week 4)



Ecological interpretation (Week 6)



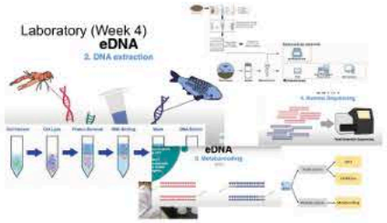
Environmental DNA visualizations

First Input:

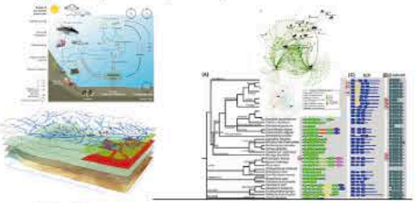
Study design (Week 2)

Sampling (Week 3)

Laboratory (Week 4)



Ecological interpretation (Week 6)



First round of sketches:

Writing feedback:

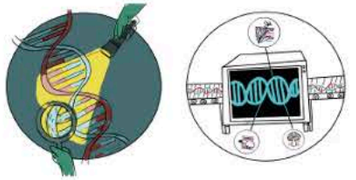
Study design: the one with the drops converging onto the paper works well. I was thinking whether the droplets could be replaced by (interlocking) cogwheels (that make up a DNA helix shape for instance). Instead of the one-way flow from people to paper, it could be two-directional between people and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

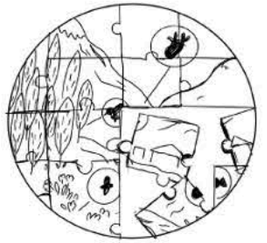
It might be better to visually show the act of a person dipping a test tube into a soil/water surface, or holding it up in front of him/her with the species balloons coming out of it.

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.

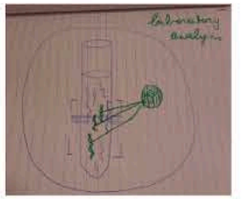
Ecological interpretation: Perhaps a different way to show this could be to have the different species as puzzle pieces or building blocks that we need to fit together as parts of a landscape in order to make sense of how ecosystems work.

Second round of sketch:

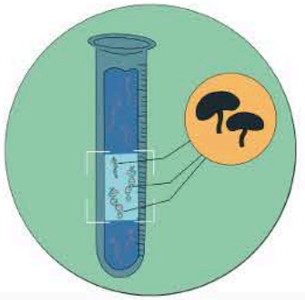




Sketch :



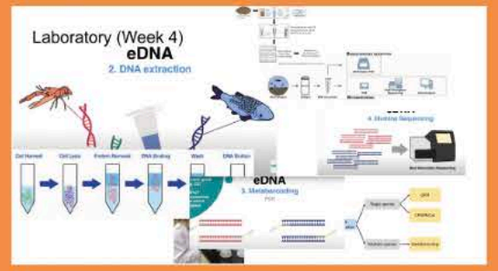
Final visualization:



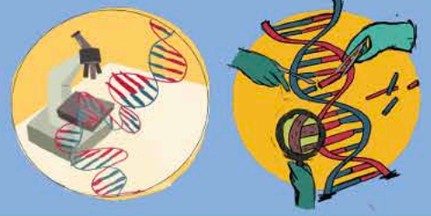
Environmental DNA visualizations: co-design working process

el]

First Input:



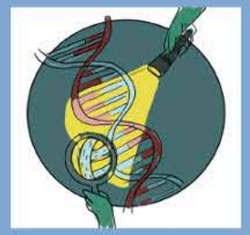
First round of sketches:

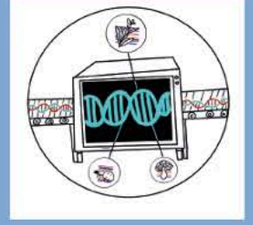


Writing feedback:

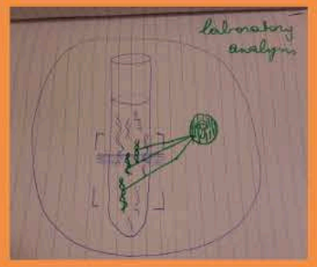
analysis: This one might be a little bit too distant from eDNA work.
- What could work is having 2-3 DNA strands (each different colour) that enter a scan-machine type device (much like a luggage scan in the airport) where a segment of only one strand is seen as a barcode or lights up differently (maybe 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.

Second round of sketch:

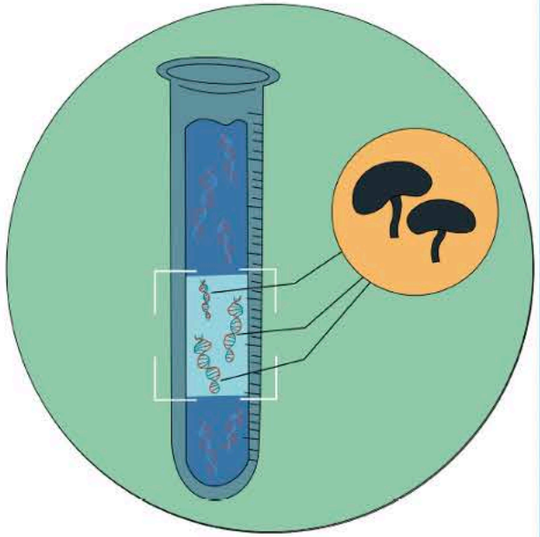




Sketch :



Final visualization:



= EDNA Team

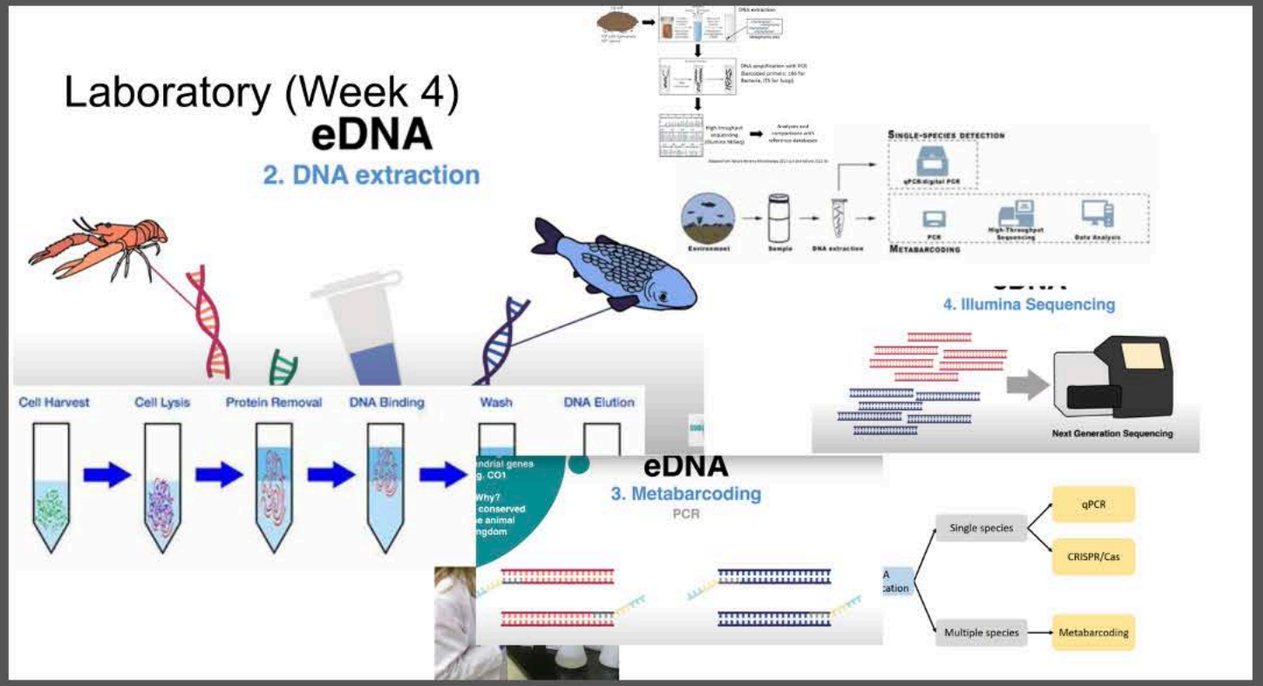
= Media Design Team

radionucleids animations

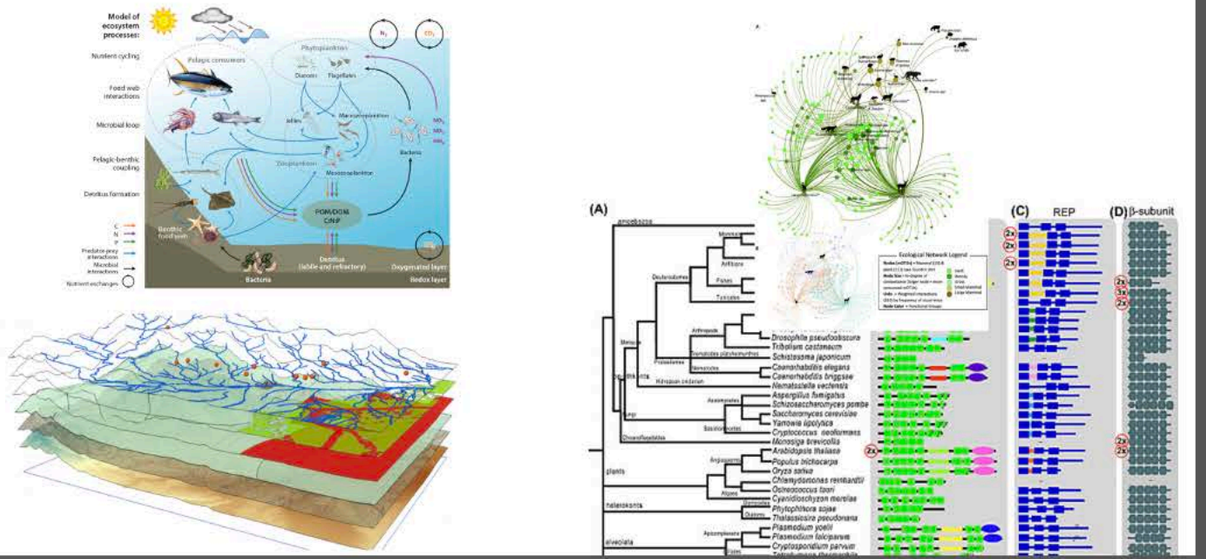
Co-design with D-PHYS, D-ERDW, D-USYS

Sampling (Week 3)

Laboratory (Week 4)

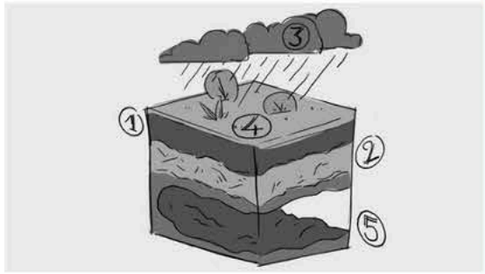
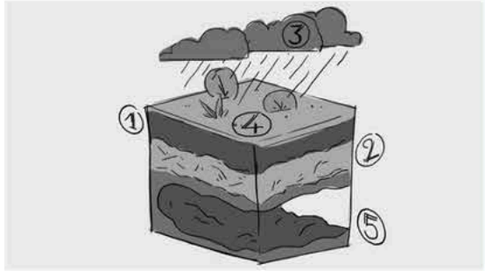
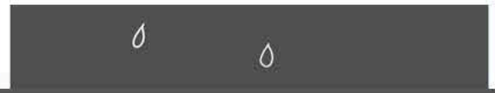


Ecological interpretation (Week 6)



radionucleids animations

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

Panel n°	Szene n°	Picture	Voice-over	Action	Done
07	030		For a stalagmite to from, generally three things are needed: soil, a limestone 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

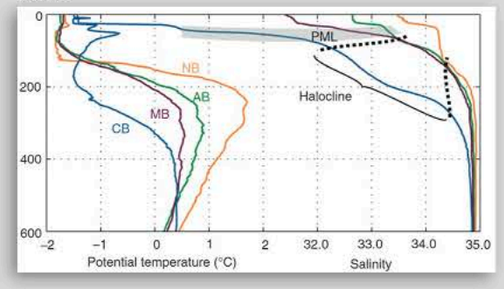
Content Meeting → Visual Kickoff Meeting → First Sketch → Choosing Option → Style Proposal → Expert Feedback → Finishing Graphic → Final/Peer Review → Final Product

Starting Point

Script

To collect seawater samples a device called a CTD
s needed. CTD stands for Conductivity, Temperatu
Depth, and the rosette is a frame which typically h
so-called Niskin bottles attached to it. These bottl
open on both sides when the device is lowered int
water. While the CTD is lowered down the water c
different parameters of the surrounding water ar

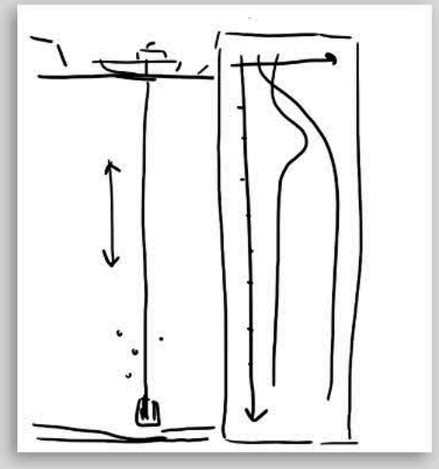
Data



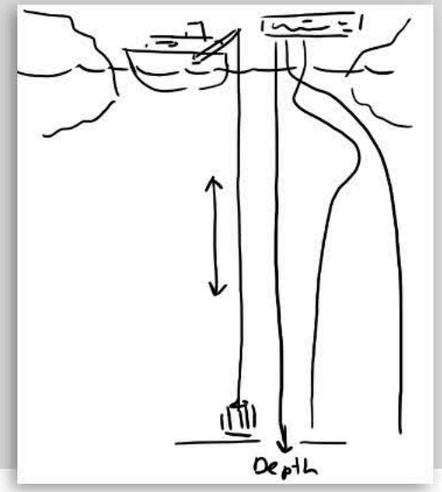
Reference Images

Sketch

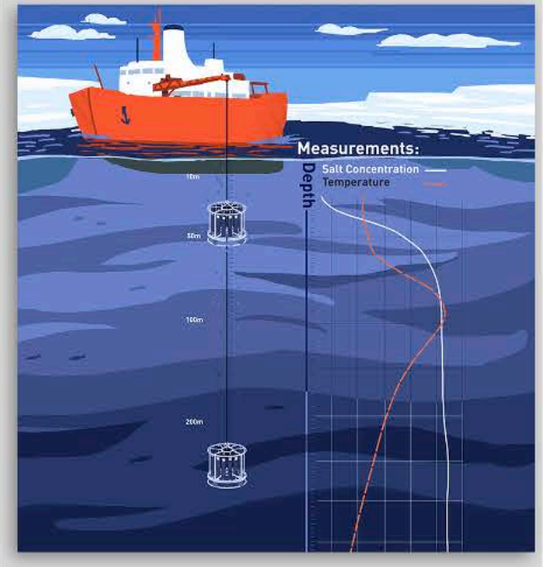
Option 1



Option 2



Styleframe



Final Version