

# Visualization as a design process

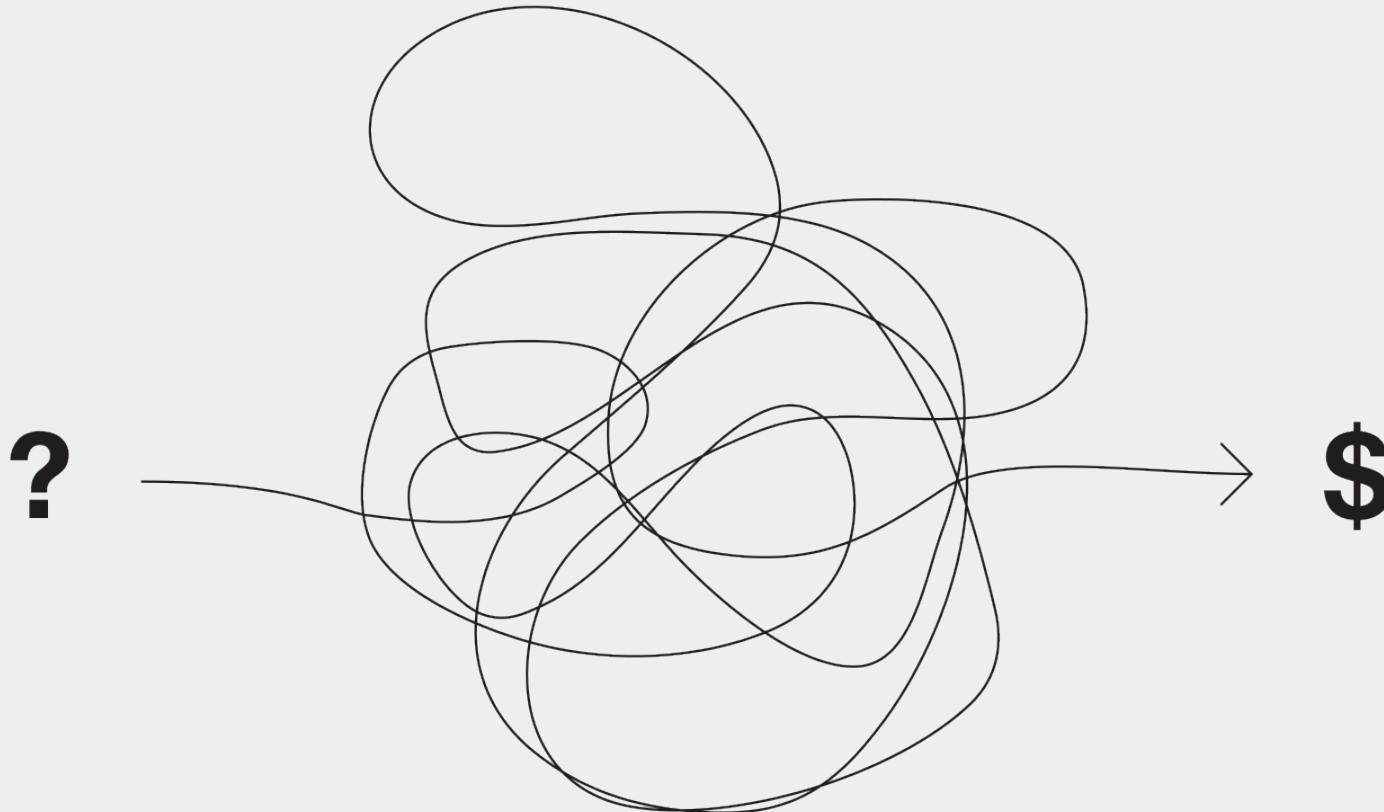
Jonas Schöley

[jschoeley@health.sdu.dk](mailto:jschoeley@health.sdu.dk)



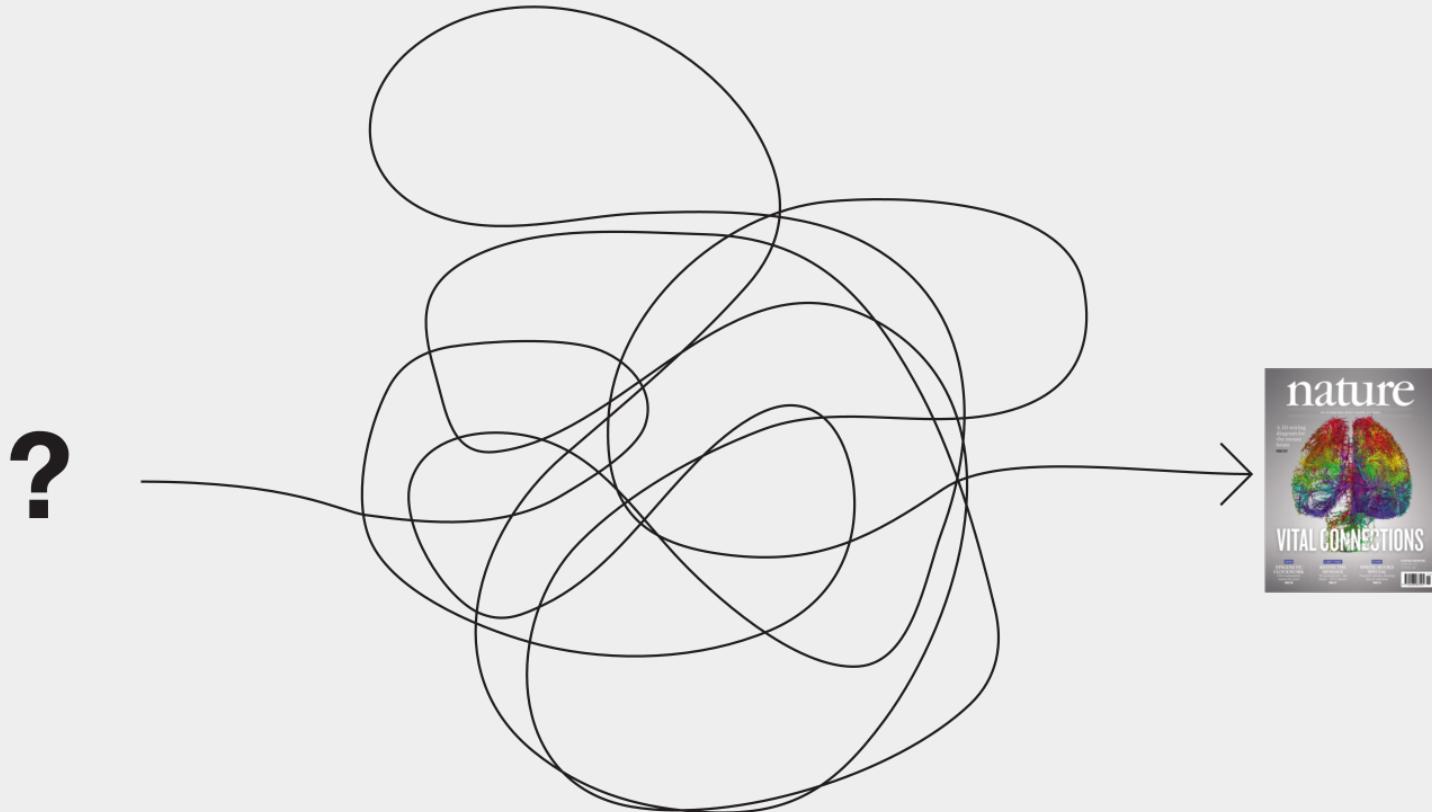
Department of Public Health  
University of Southern Denmark

# What is a design process?



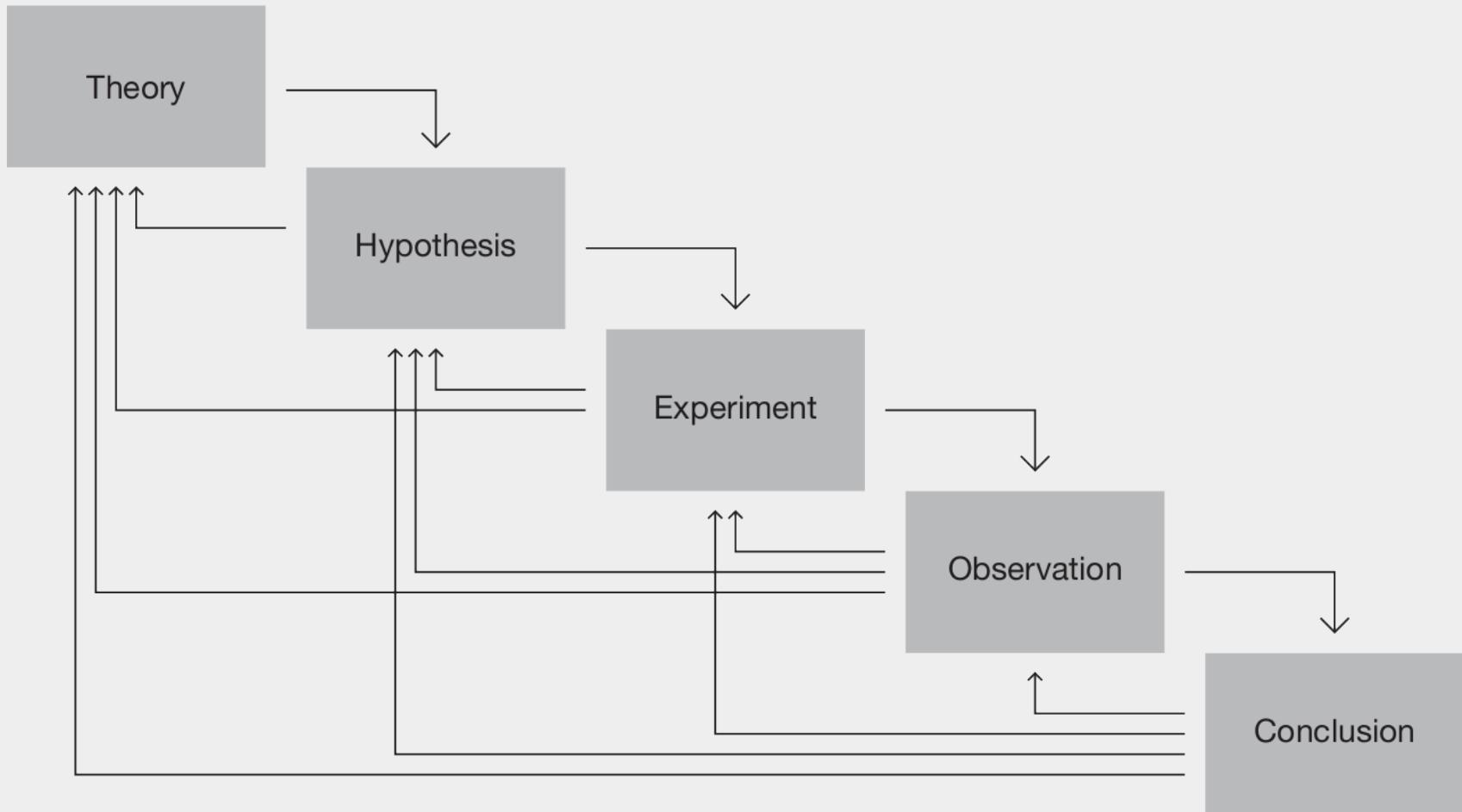
Tim Brennan (~1990) via Dubberly (2008). How do you design? A Compendium of Models.

# What is a design process?



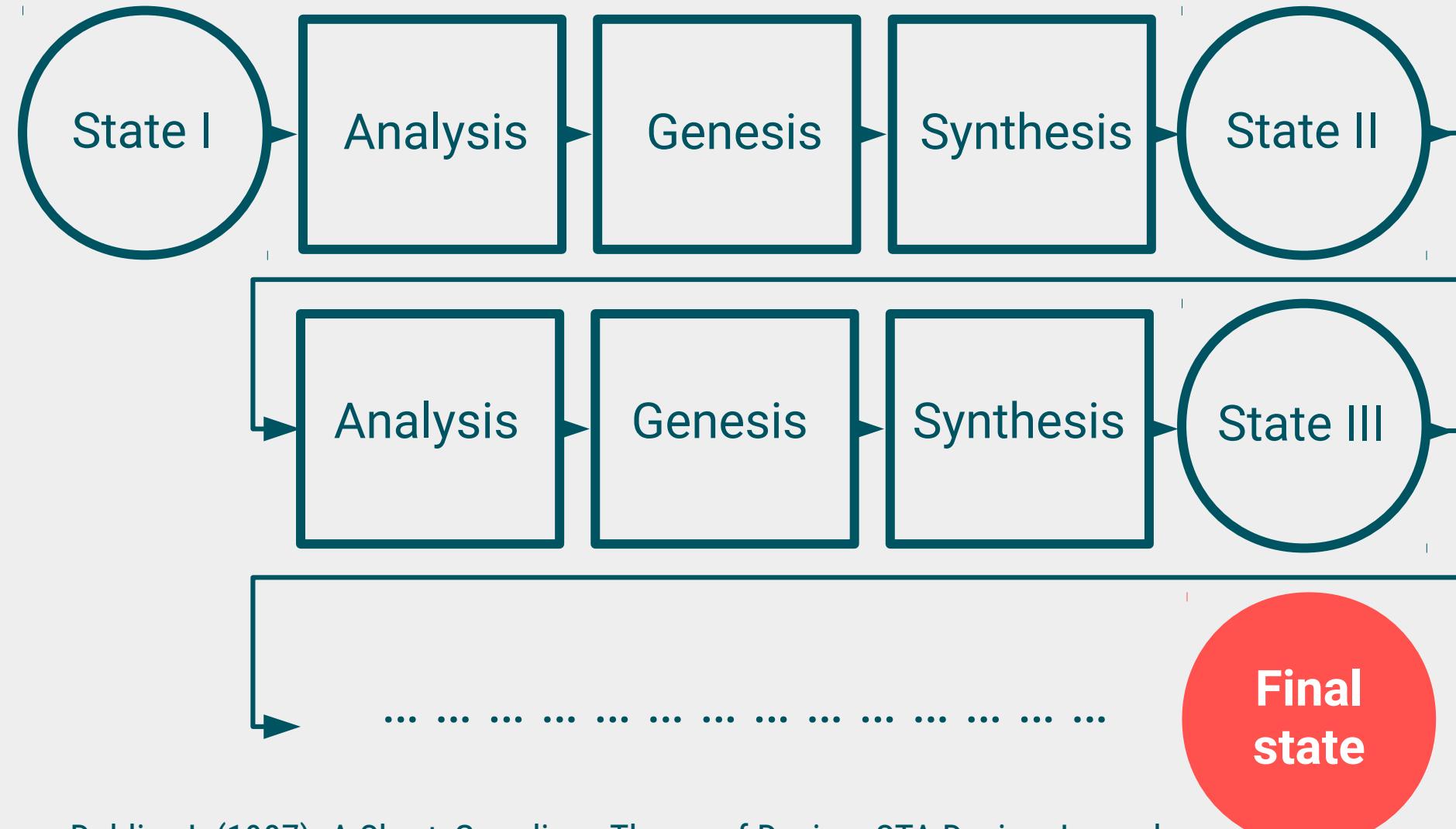
Tim Brennan (~1990) [adapted for the academic design process].

# The scientific (design) process



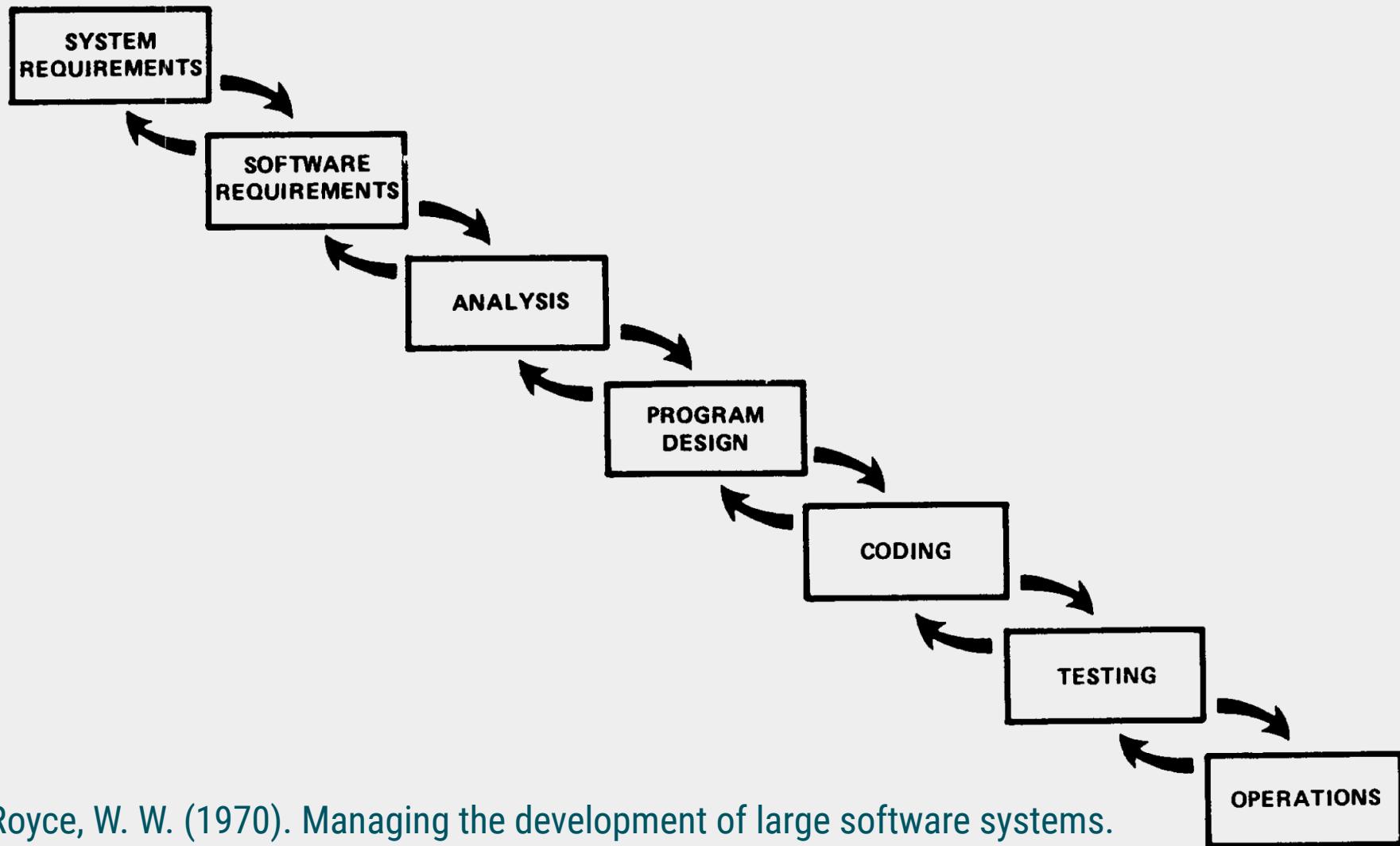
Dubberly (2008). How do you design? A Compendium of Models.

# Analysis, genesis, synthesis



Doblin, J. (1987). A Short, Grandiose Theory of Design. STA Design Journal.

# The “Waterfall” life-cycle



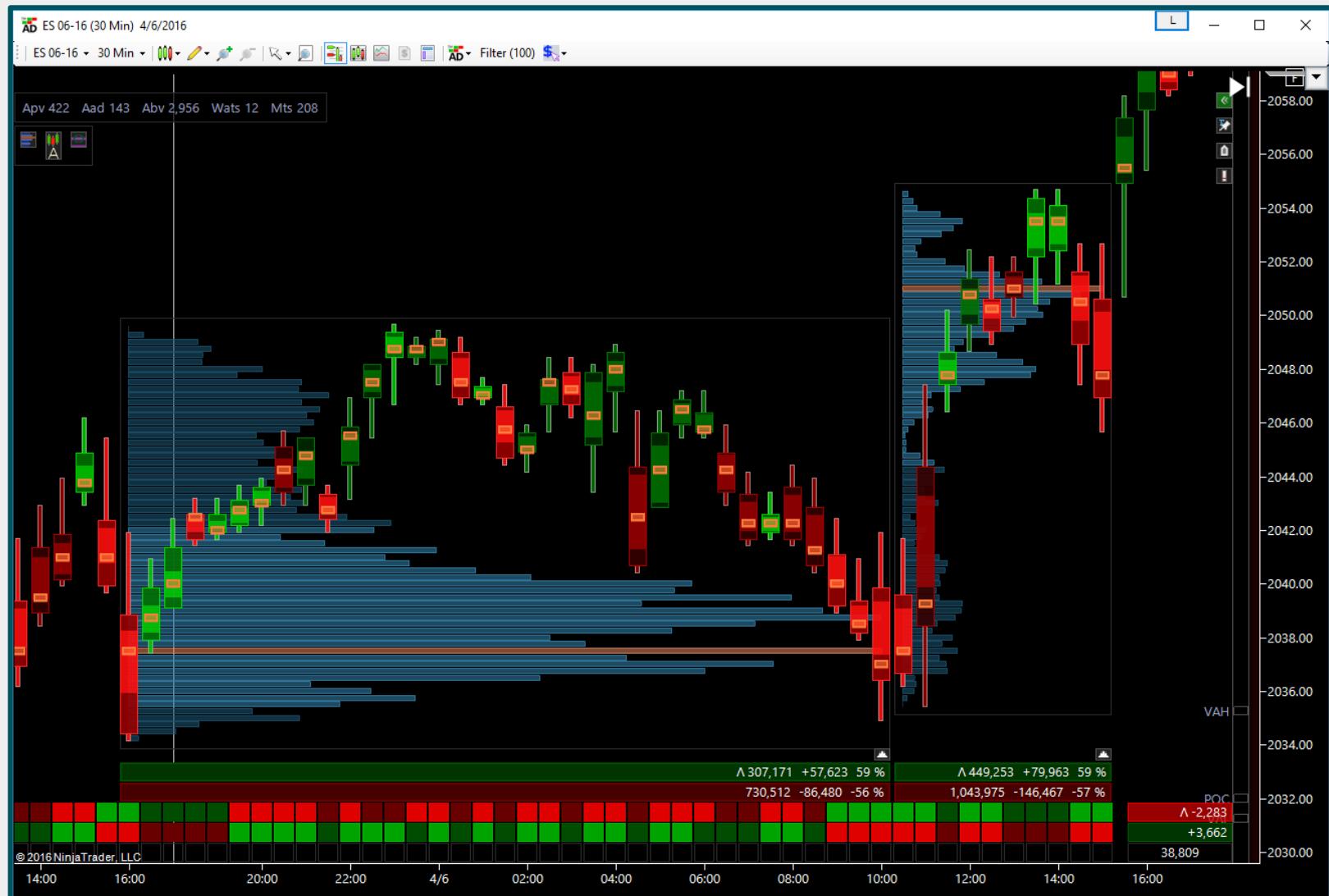
Royce, W. W. (1970). Managing the development of large software systems. Electronics, 26 (August), 1–9.

# The essence of every design process

**Iteration until converging  
on a predefined goal**

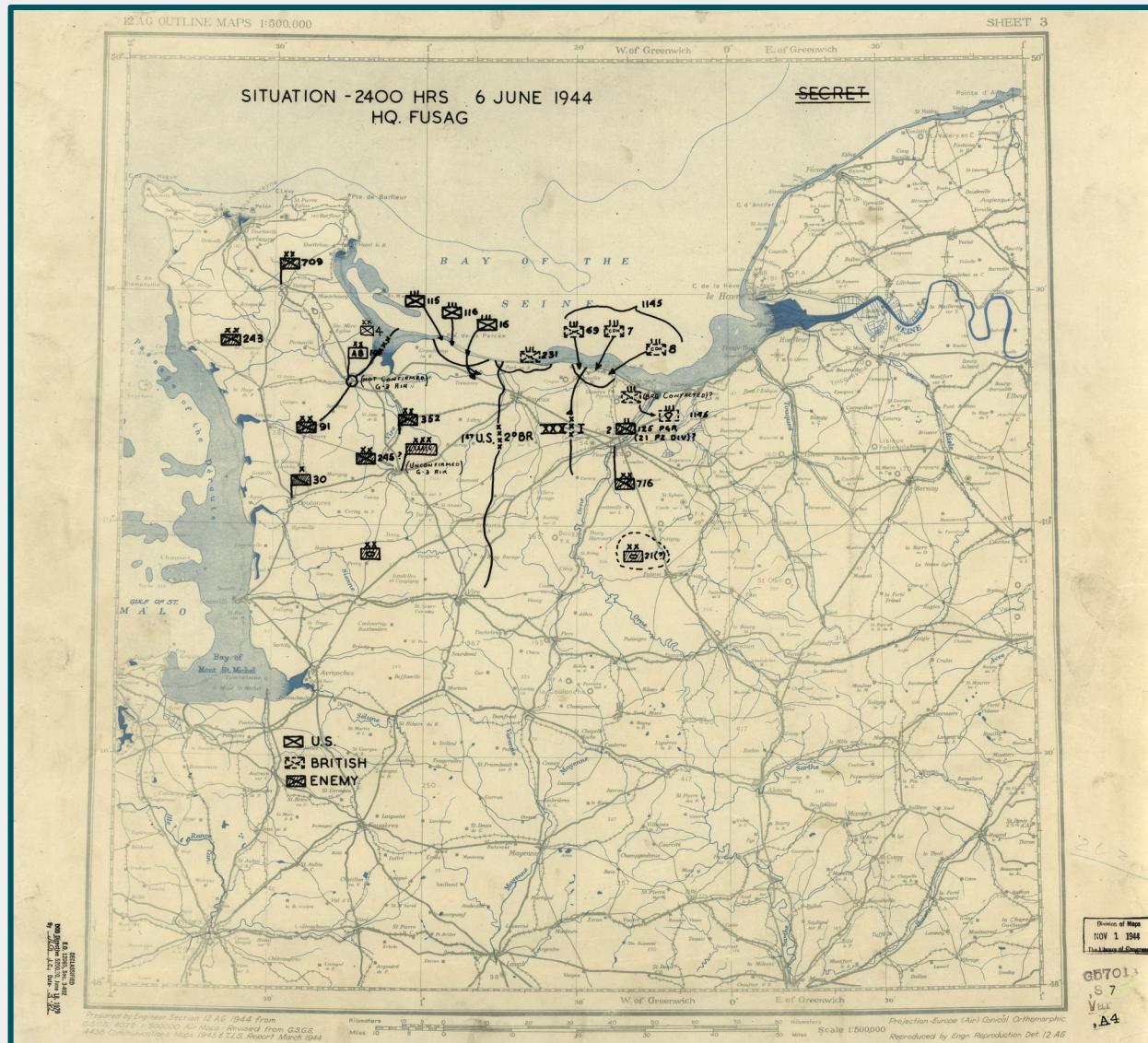
**Different domains,  
different design goals**

# Trader terminal



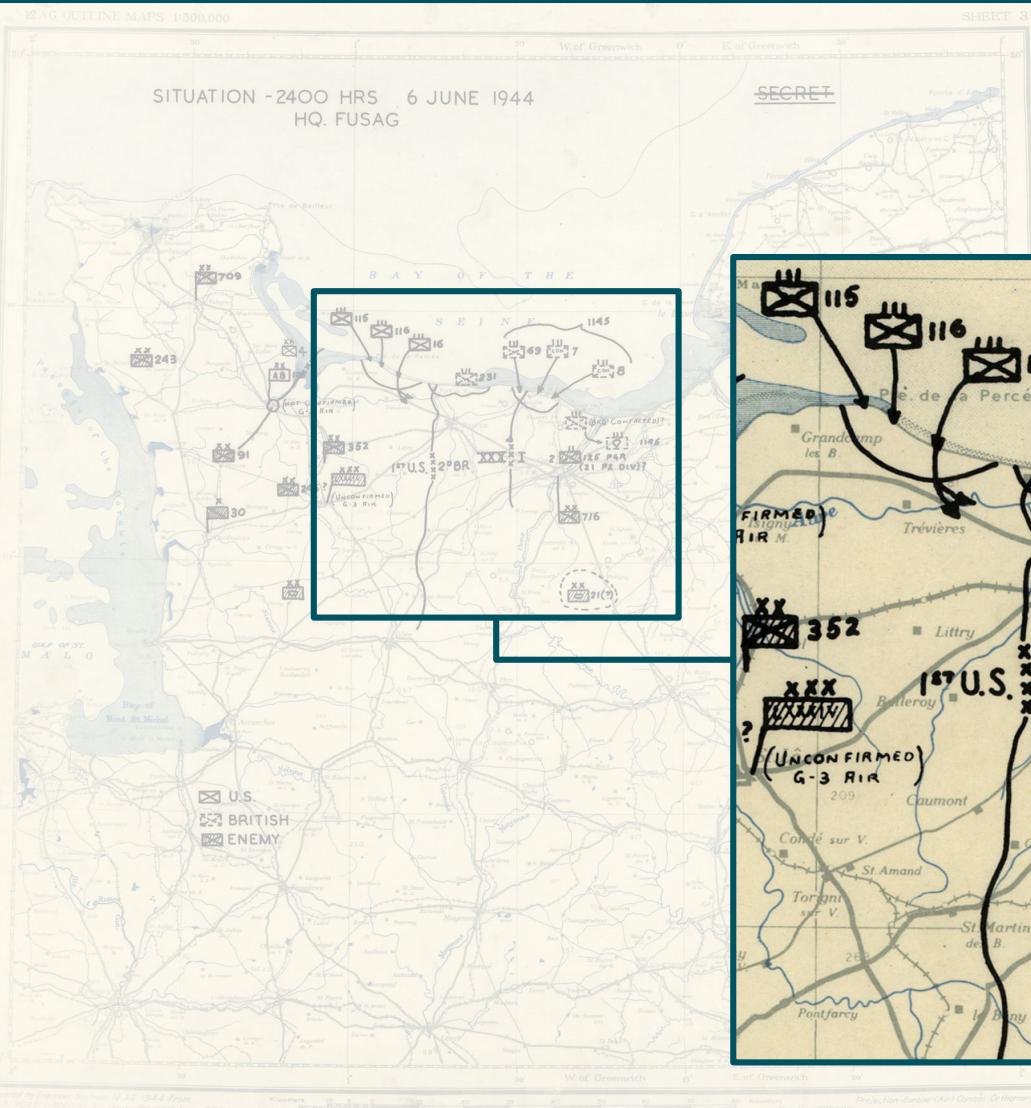
Auction Dashboard™ composite volume profile view.

# Situation room

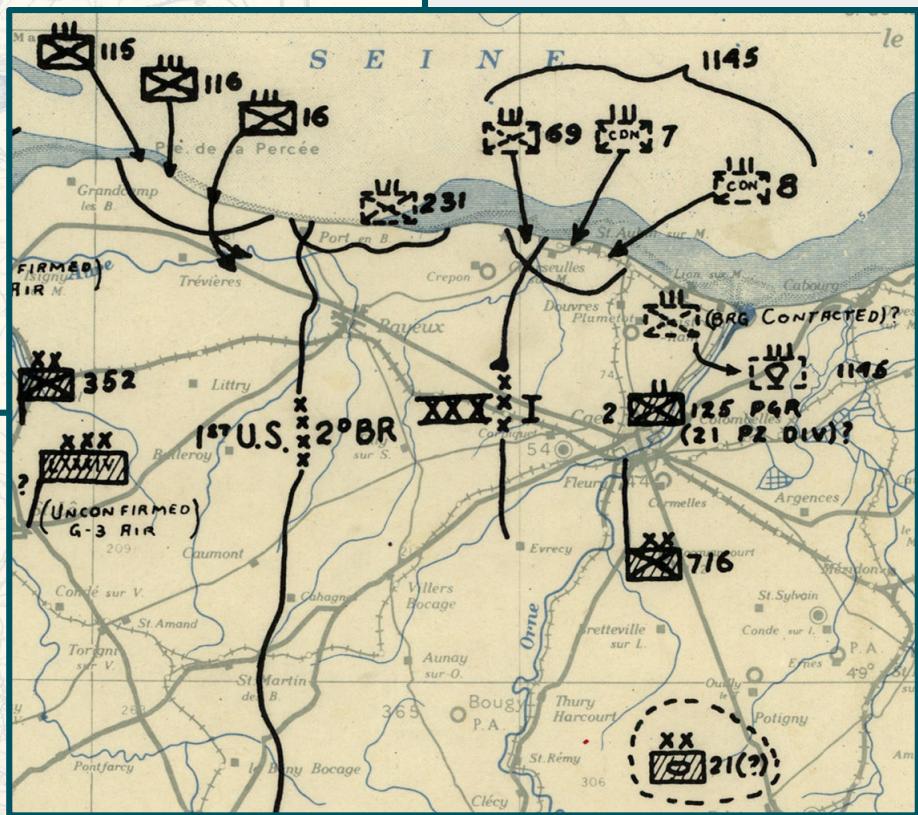


# Official U.S. 12th army position map at 2400 hours on D-Day.

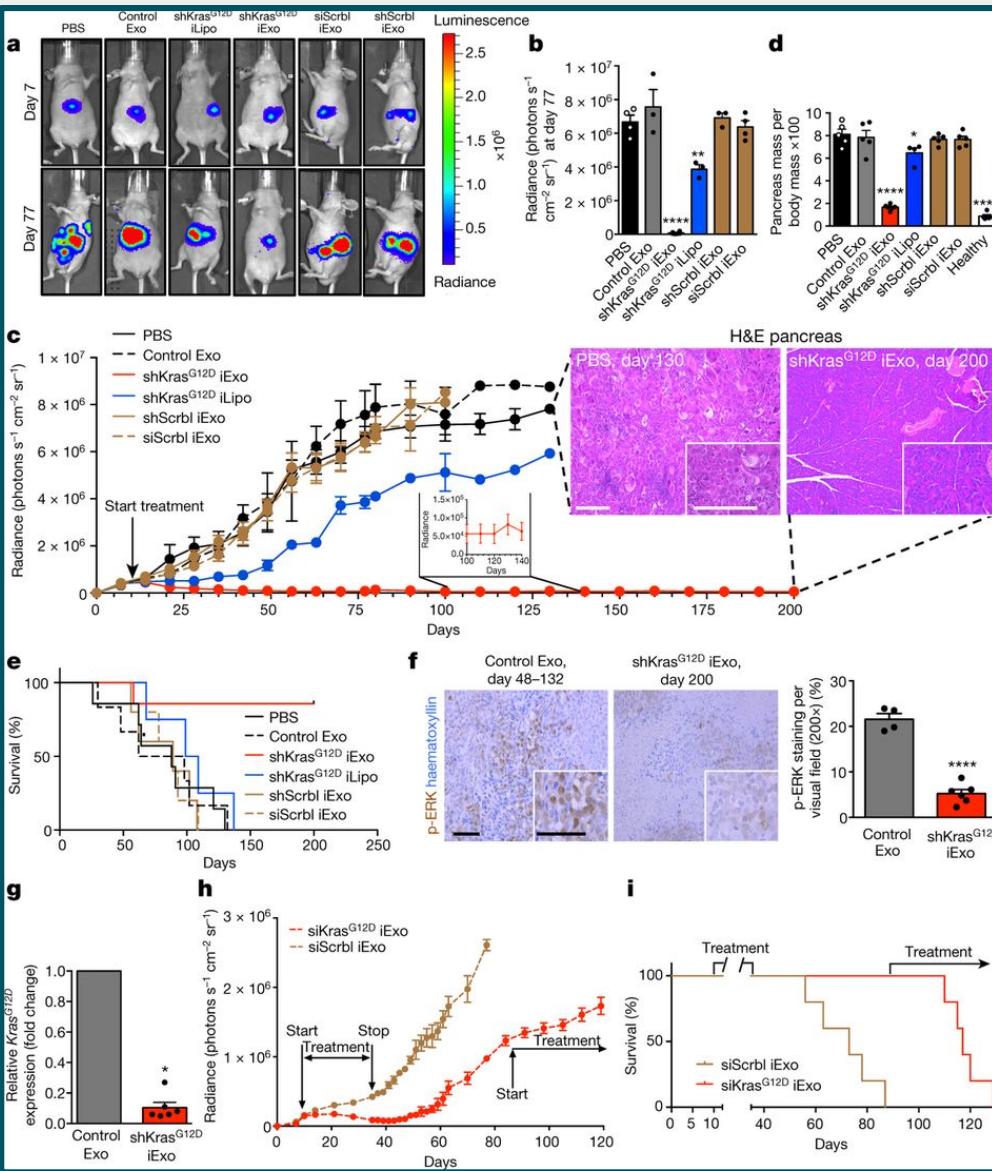
# Situation room



Official U.S. 12th army position map at 2400 hours on D-Day.

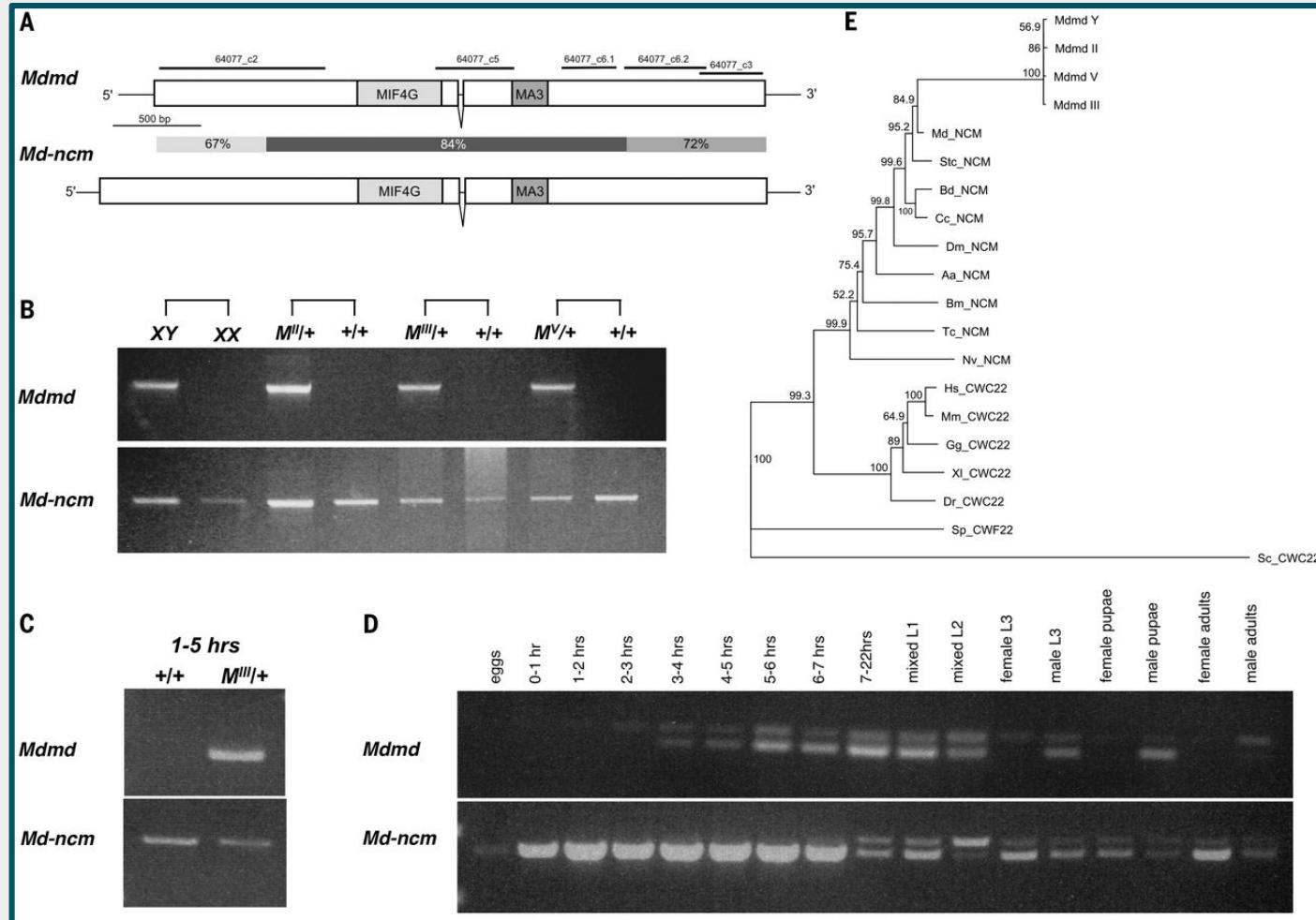


# High-gloss science



Kamerkar (2017). Exosomes facilitate therapeutic targeting of oncogenic KRAS in pancreatic cancer. Nature.

# Molecular biology

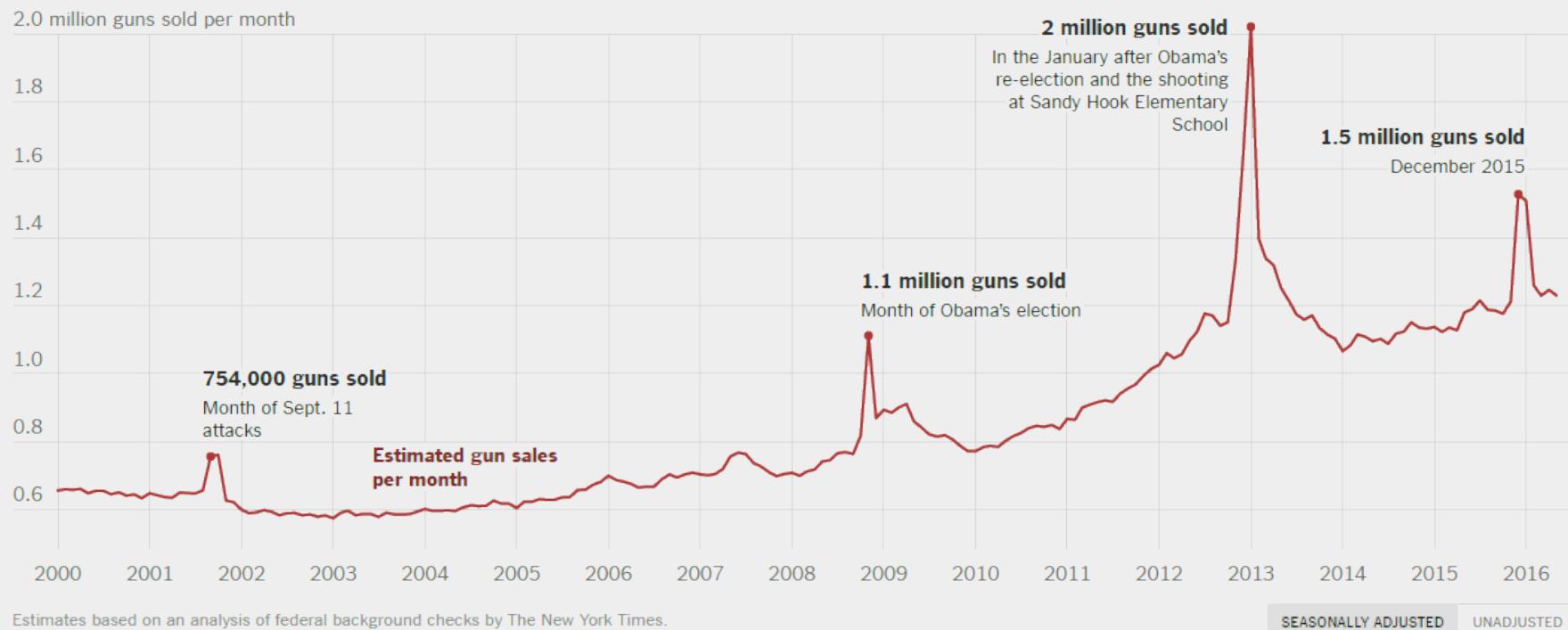


Sharma et al. (2017). Male sex in houseflies is determined by *Mdmd*, a paralog of the generic splice factor gene *CWC22*. Science, 356(6338), pp. 642-645.

# News graphics

## What Happens After Calls for New Gun Restrictions? Sales Go Up

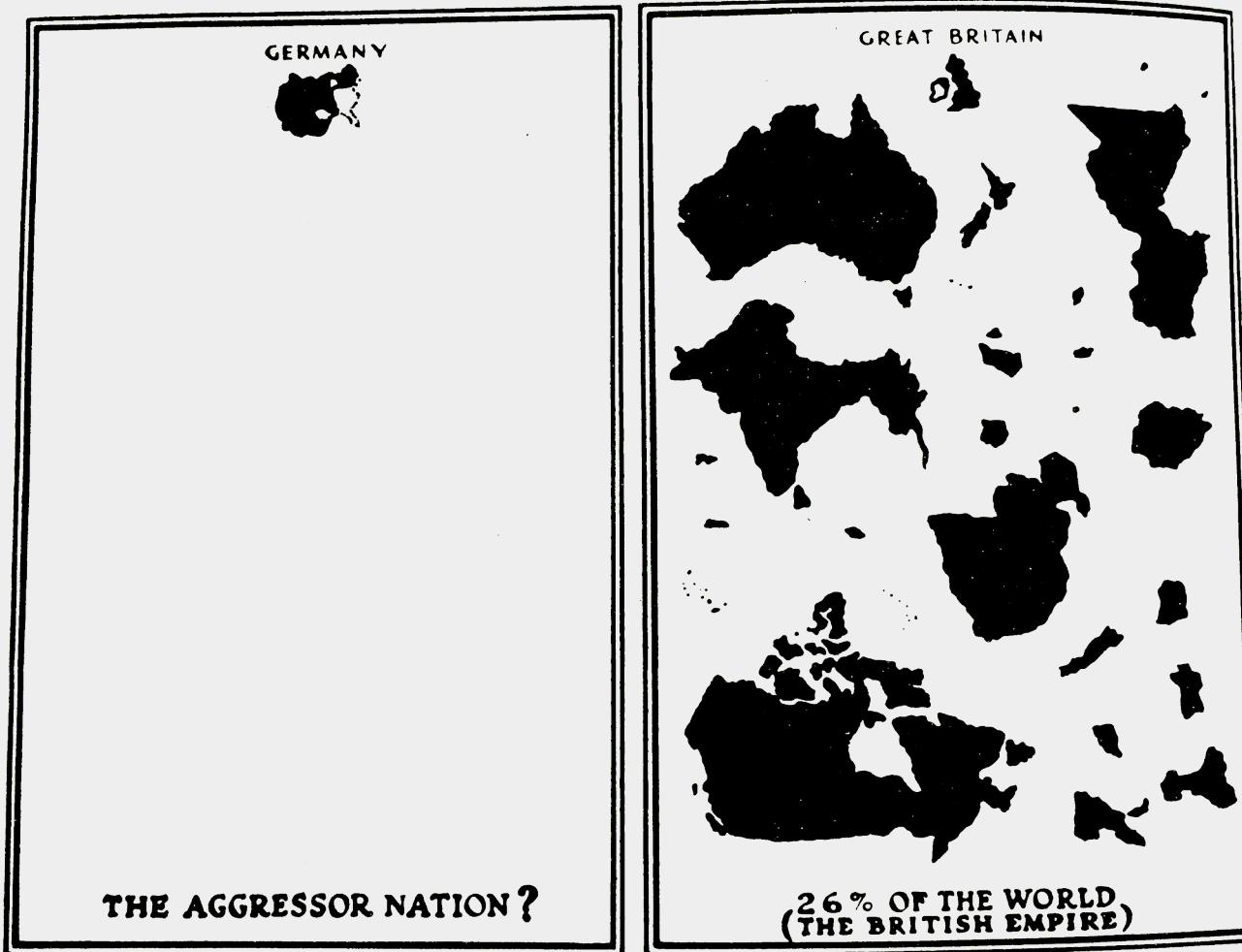
By GREGOR AISCH and JOSH KELLER UPDATED June 13, 2016



Gregor Aisch and Josh Keller (2016). What Happens After Calls for New Gun Restrictions? Sales Go Up. New York Times.

# Propaganda

## A STUDY IN EMPIRES



German Library of Information (1940). A study in empires. Facts in Review 2 (5).

Reprinted in Monmonier (1996). How to Lie with Maps.

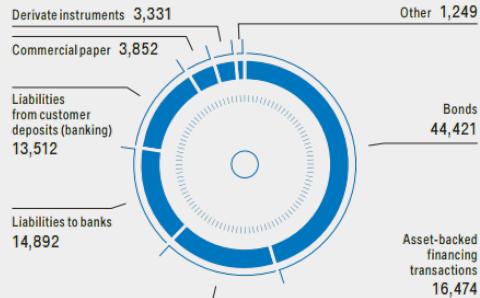
# The executive report

## BMW Group (2016). Annual report 2016. [excerpt].

### BMW Group financial liabilities

→ 45

in € million



### Steel price trend

→ 18

Index: January 2012 = 100



### Proportion of female executives within management / function levels I and II at BMW AG

→ 65

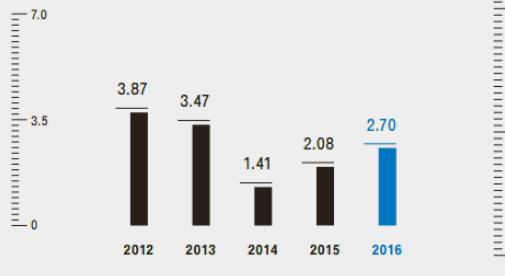
in %



### Employee attrition rate at BMW AG\*

→ 36

as a percentage of workforce



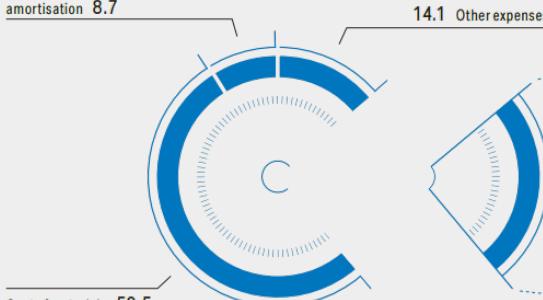
### BMW Group value added 2016

→ 51

in %

### Depreciation and amortisation 8.7

Cost of materials 52.5



48.8 % Employees

8.3 % Providers of finance

13.7 % Government/public sector

9.7 % Shareholders

19.3 % Group

0.2 % Minority interest

# Visualization design goals

# General goals

@lisacrost

Attention  
& Beauty

Under-  
standing

Implication

## Goals of Data Vis

- |  |   |   |
|--|---|---|
| <ul style="list-style-type: none"><li>1. Get them to read</li><li>2. Attract different learning types</li><li>3. Go with the hype</li><li>4. Create beauty</li></ul> | <ul style="list-style-type: none"><li>1. Understand</li><li>2. Explain</li><li>3. Get people to explore</li></ul> | <ul style="list-style-type: none"><li>1. Prove</li><li>2. Correct views</li><li>3. Evoke feelings</li><li>4. Evoke actions</li><li>5. Go meta</li></ul> |
|--|---|---|

Rost (2017). Why do we visualize data? INCH conference presentation.

# Specific goals

**Table 1: Evaluation of different visualization techniques for compositional data on the Lexis surface**

	Ternary- balance scheme	Qualitative- sequential scheme	Agewise- area plot	Small multiples
Completeness	yes	no	yes	yes
Continuity	yes	yes	no	yes
Category limit	3	≈ 5–6	≈ 8	unlimited
Pattern perception	good	good	limited	good
Table lookup	limited	limited	limited	limited
Colour-accessible	no	no	yes	yes
Footprint	small	small	small	large

Schöley & Willekens (2017). Visualizing compositional data on the Lexis surface.

# **Clarity & effectiveness**

# Testable hypothesis in viz research

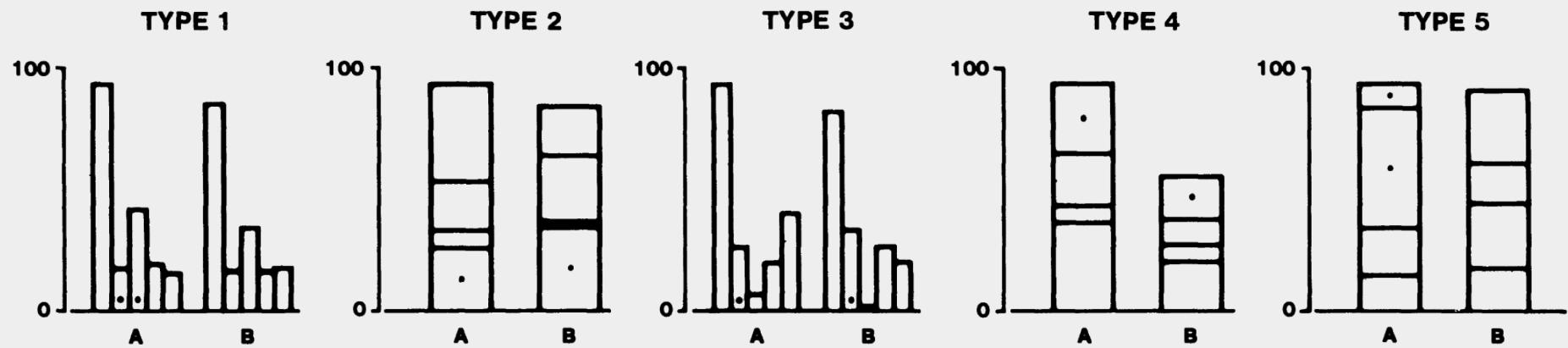


Figure 4. Graphs from position-length experiment.

Cleveland, W. S., & McGill, R. (1984). Graphical Perception: Theory, Experimentation, and Application to the Development of Graphical Methods. *Journal of the American Statistical Association*, 79(387), 531.

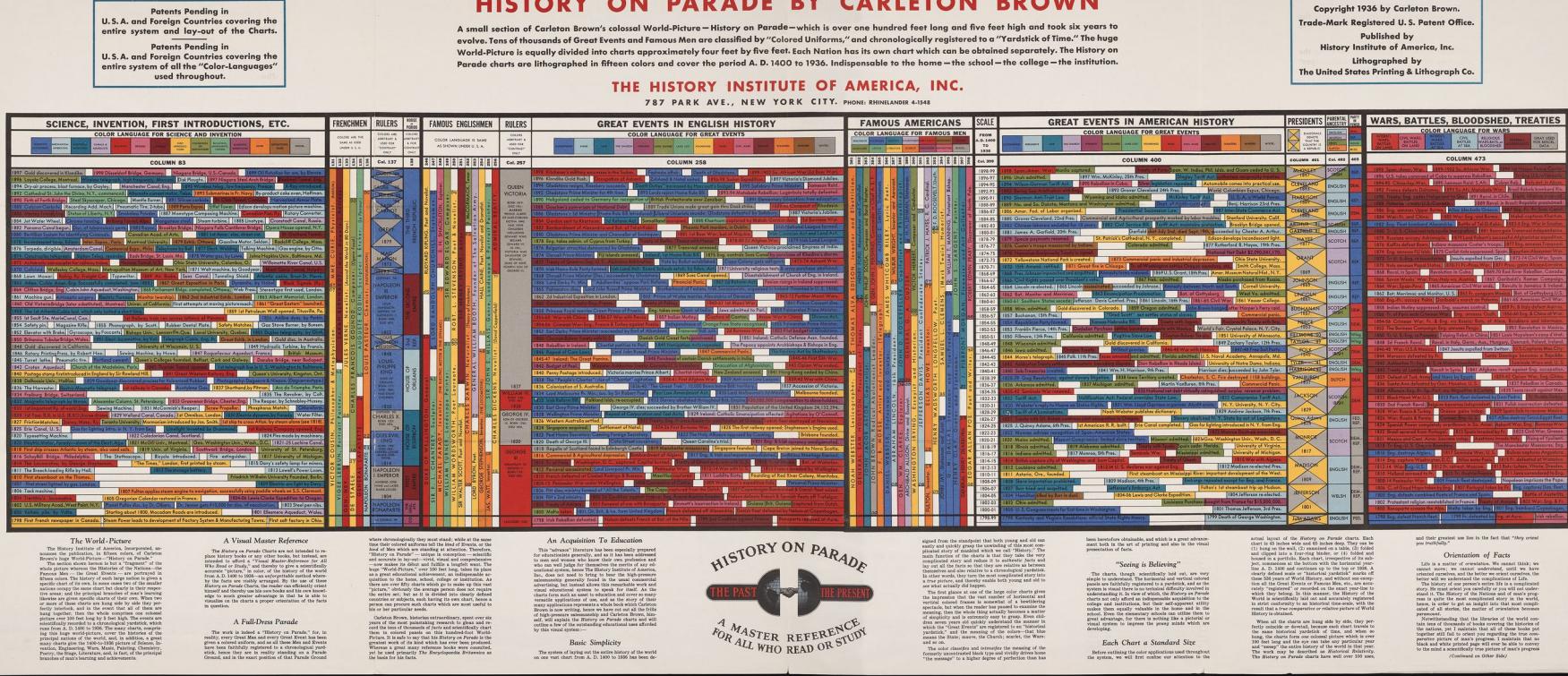
# **Attention & Engagement**

# “Wimmelbilder”



Markus Wende (2016). Wimmelbild “Recht auf Stadt” [cutout].

# Macro view



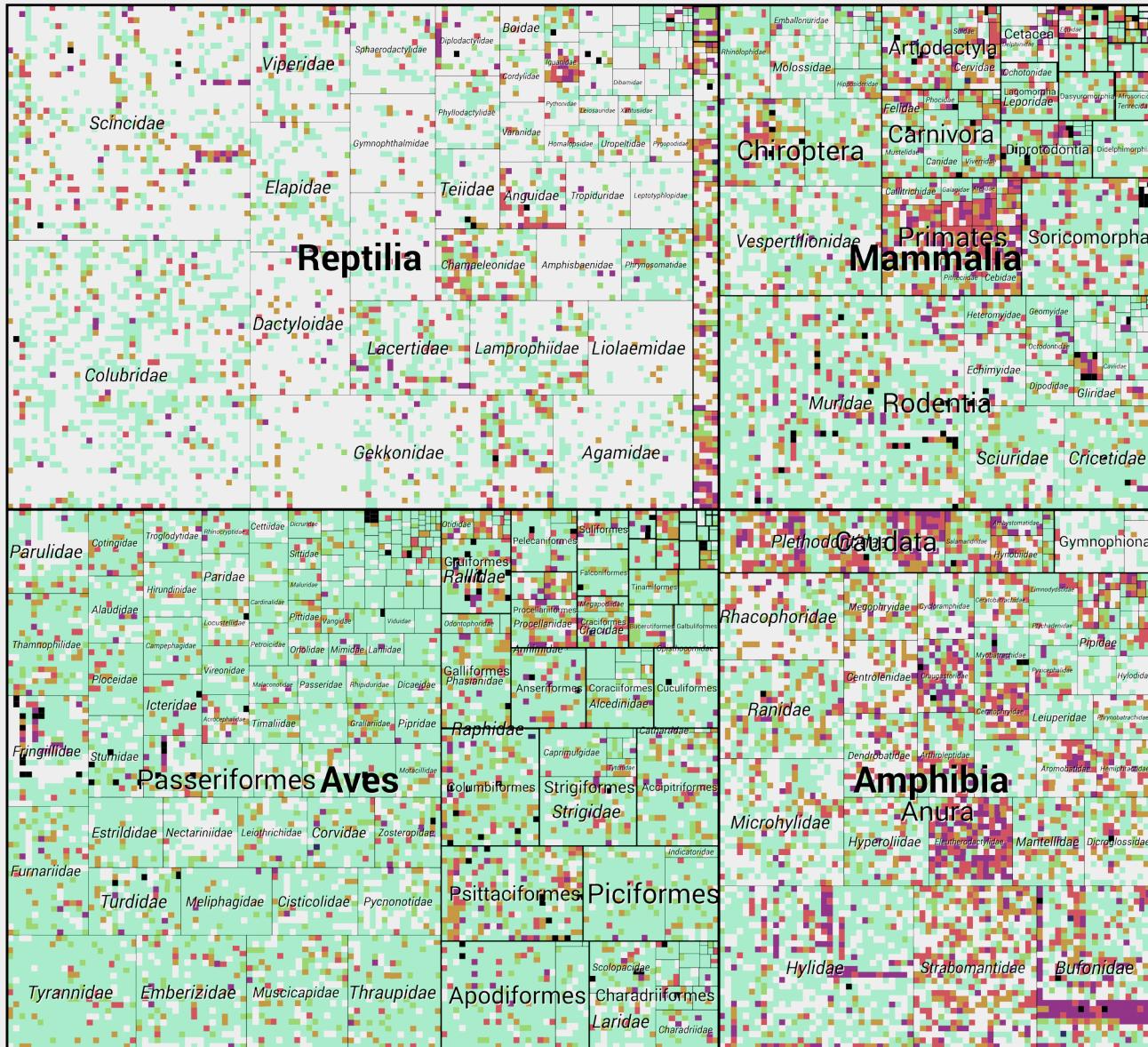
Carleton Brown (1936). History on parade by Carleton Brown. History Institute of America, Inc.

## Micro view



Carleton Brown (1936). History on parade by Carleton Brown. History Institute of America, Inc.

# Macro view



# The State of Vertebrate Conservation

## IUCN Red List conservation status for each species

IUCN Conservation Status

- Extinct
- Extinct in the Wild
- Critically Endangered
- Endangered
- Vulnerable
- Near Threatened
- Least Concern
- Unknown

**Taxonomic Rank**

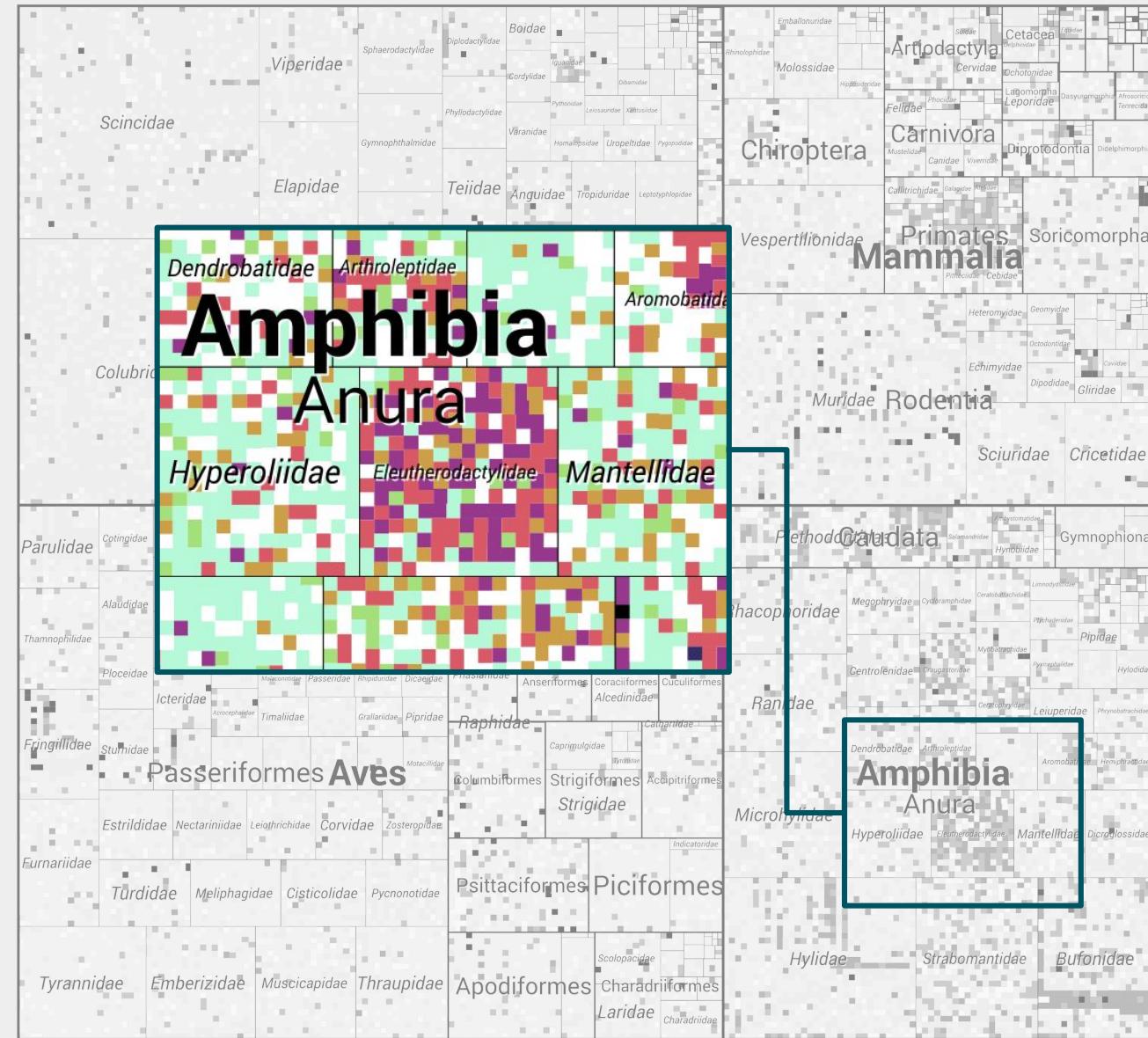
**Class** —

Order —

Family —

by DISKo  
Demographic Index  
of Species Knowledge

# Micro view



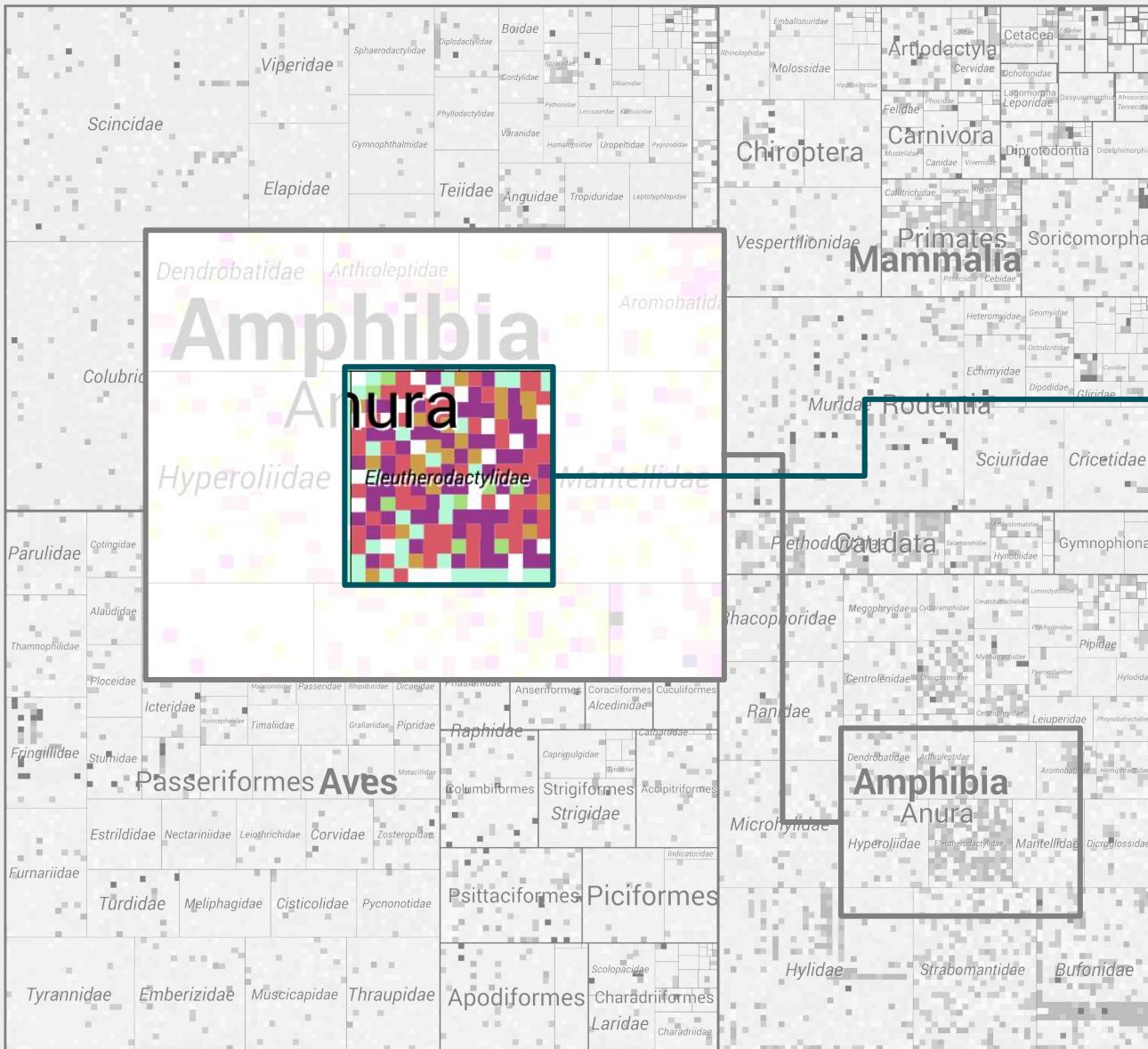
# The State of Vertebrate Conservation

IUCN Red List conservation status  
for each species



by DISKo  
Demographic Index  
of Species Knowledge

# Micro-micro view (drill down)



*Eleutherodactylus danae*

## Scientific classification

Kingdom: Animalia  
 Phylum: Chordata  
 Class: Amphibia  
 Order: Anura  
 Family: **Eleutherodactylidae**  
 Lutz, 1954

## Subfamilia

Eleutherodactylinae  
 Phyzelaphryinae

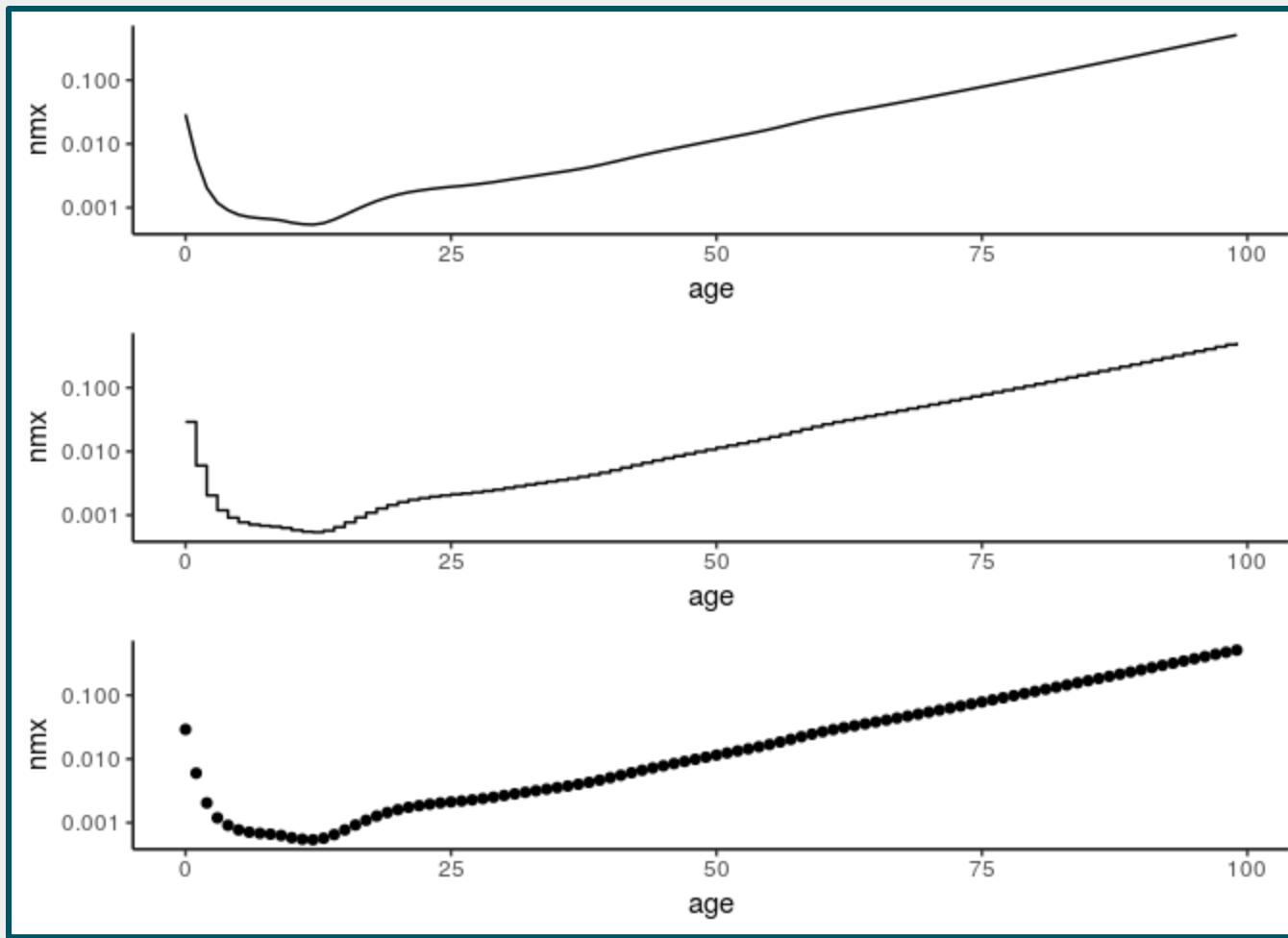
## Synonyms

Eleutherodactylinae Lutz, 1954

[en.wikipedia.org/wiki/Eleutherodactylidae](https://en.wikipedia.org/wiki/Eleutherodactylidae)

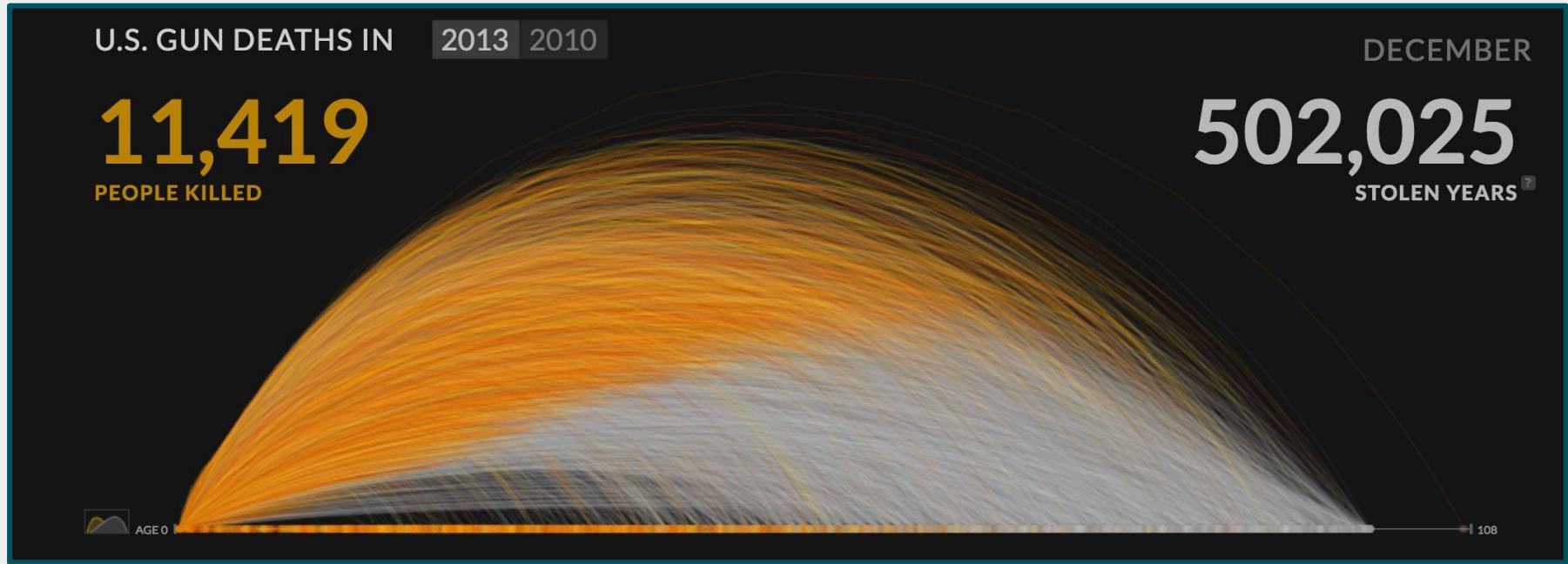
# Precision

# Are those the same?



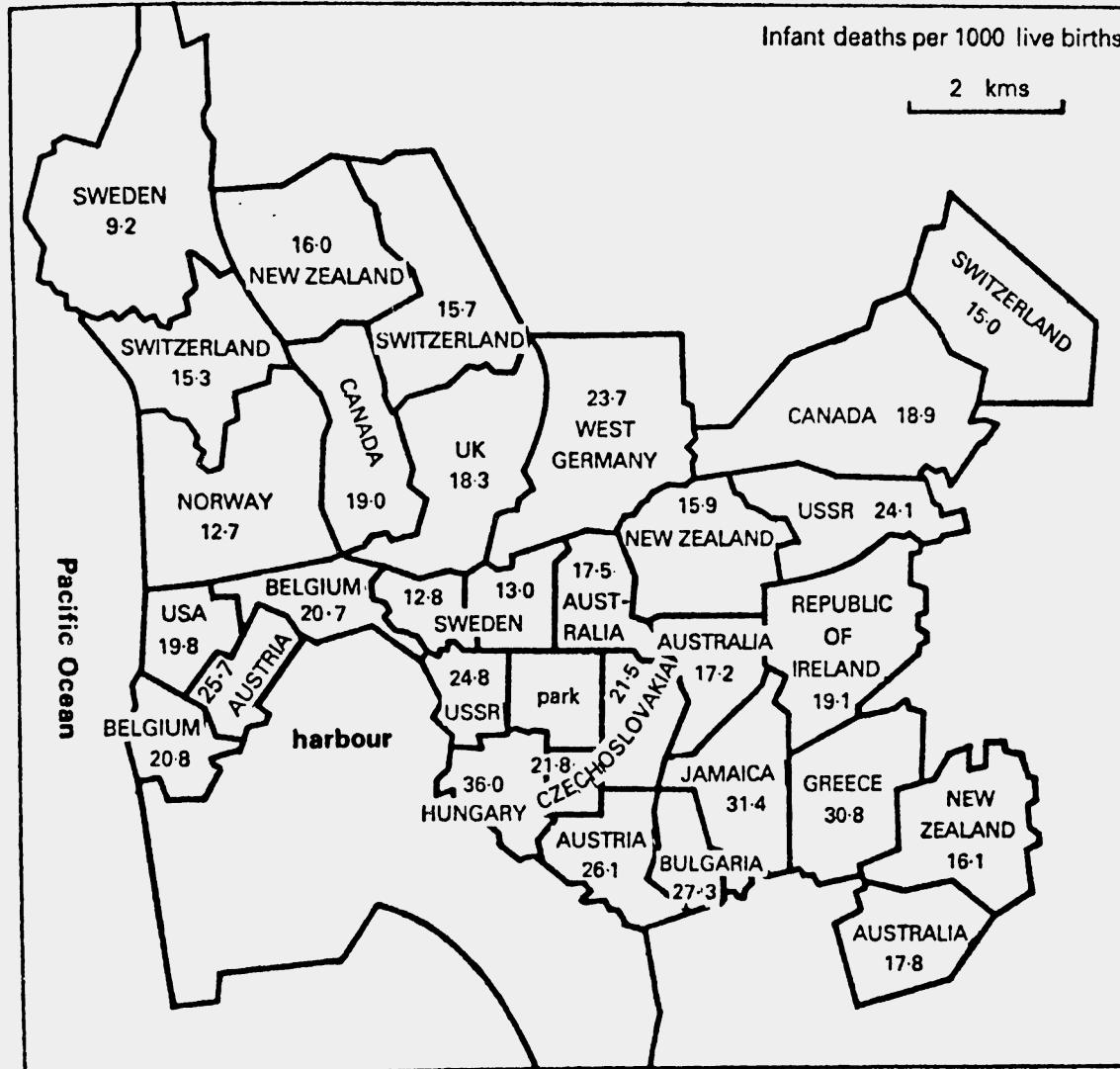
Truthfulness, persuasion  
*Truthful persuasion?*

# Micro data, intuitive units



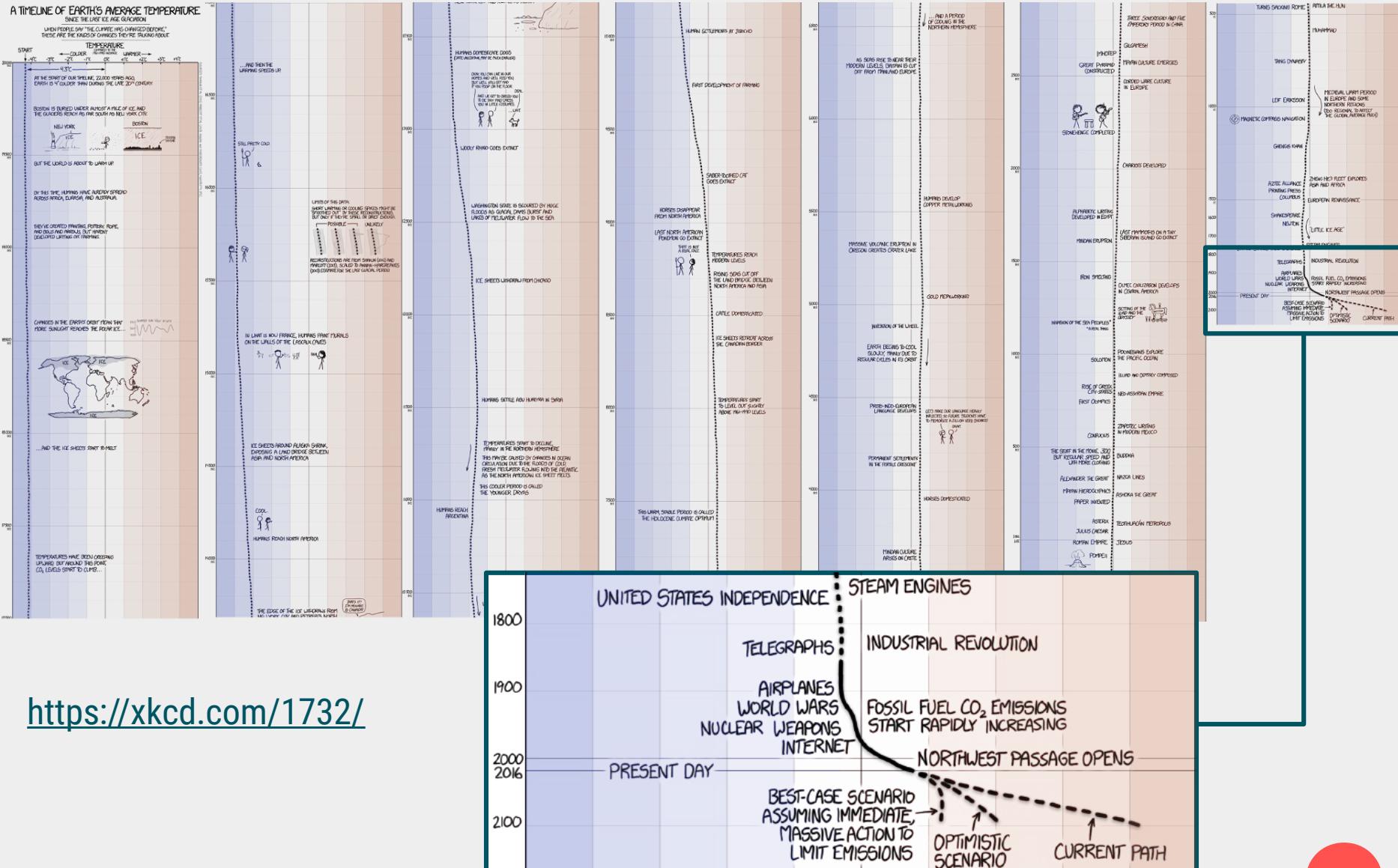
<http://guns.periscopic.com/>

# Intuitive comparisons



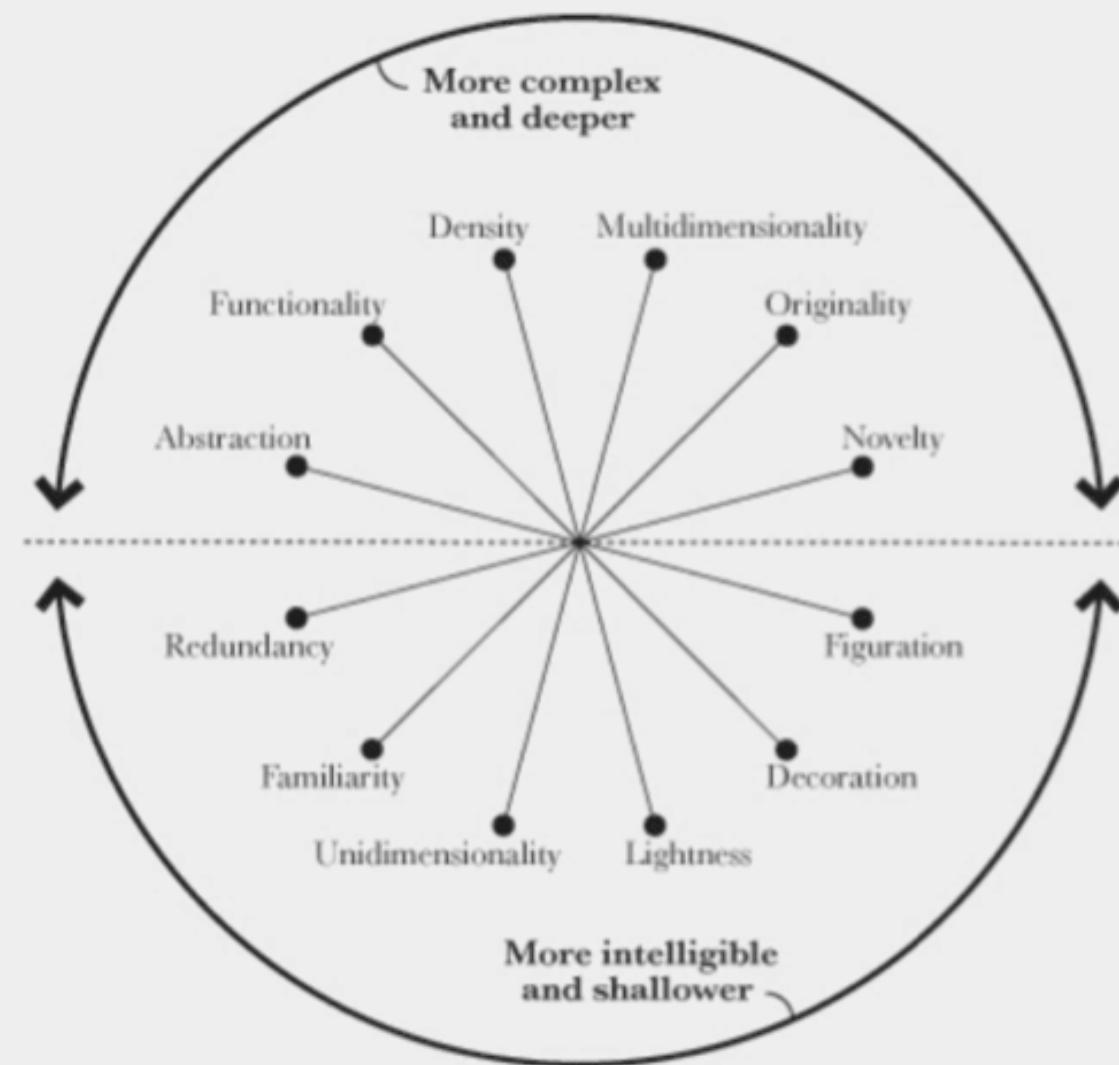
Infant mortality rates for parts of San Diego, California expressed in national rates of comparable nations. Monmonier (1996). How to lie with maps.

# Overwhelm with data, make relevant comparisons



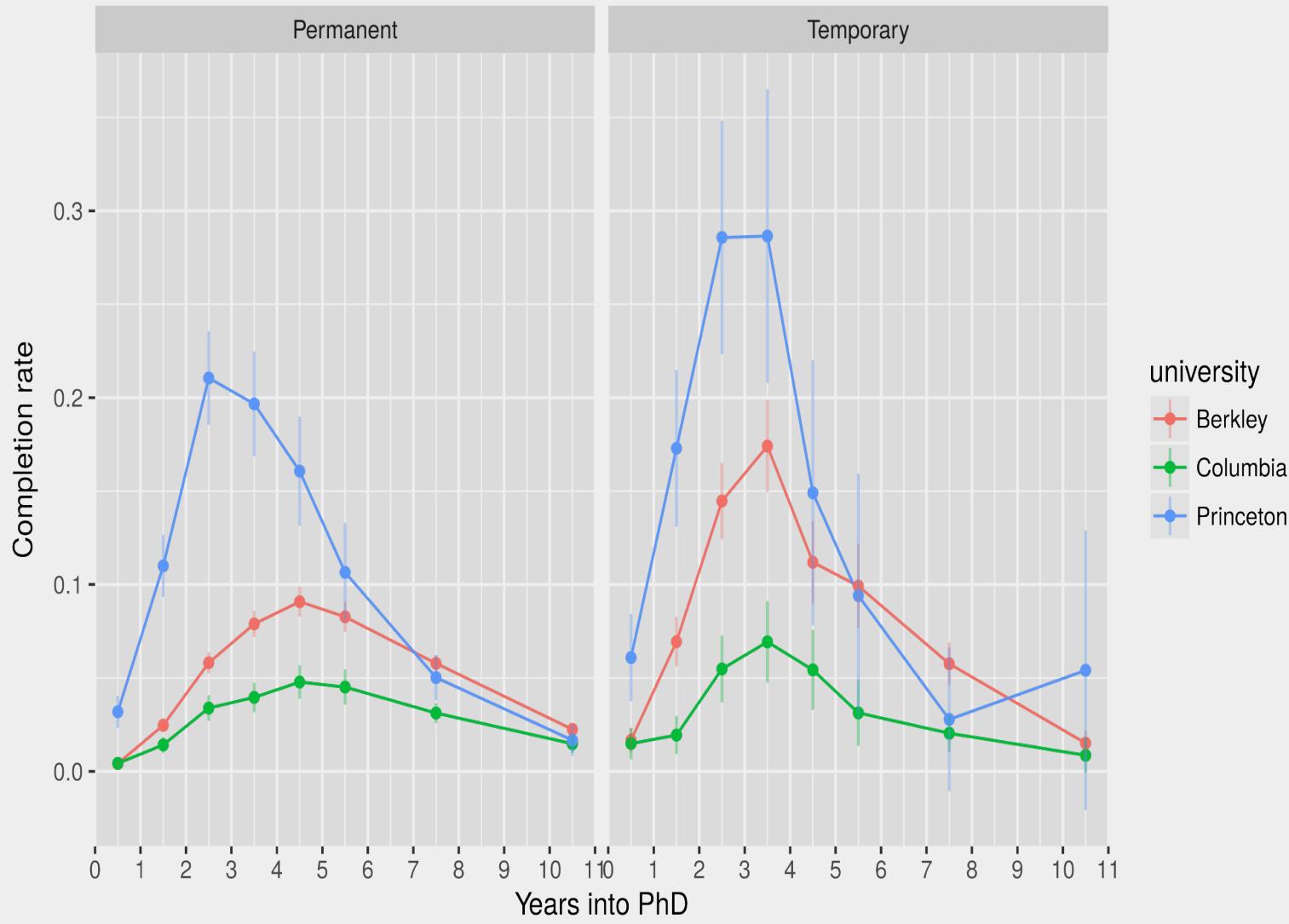
# Competing design goals

# Trade-off in viz design

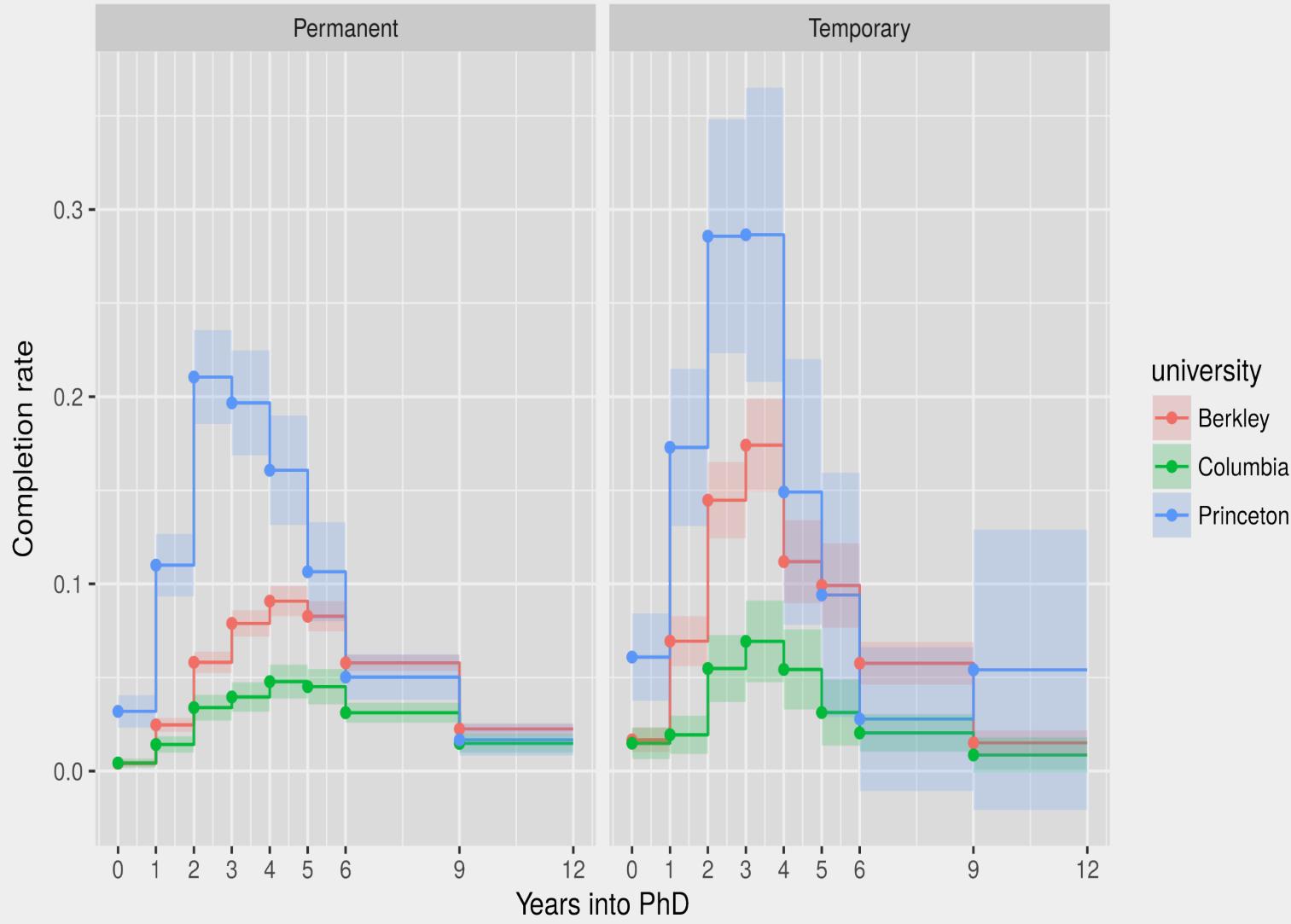


Cairo, A. (2012). The Functional Art.

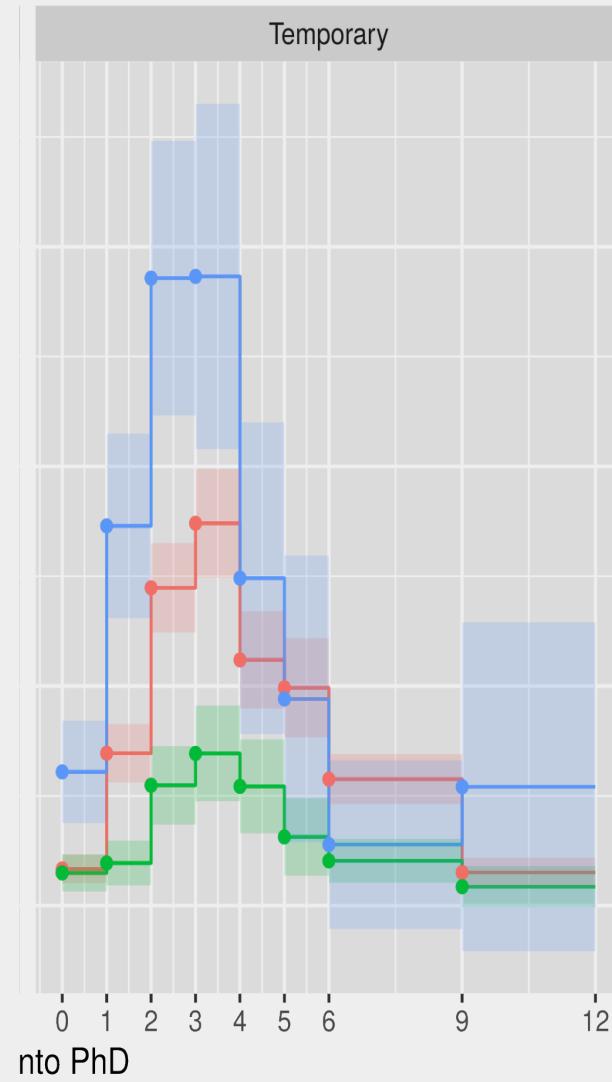
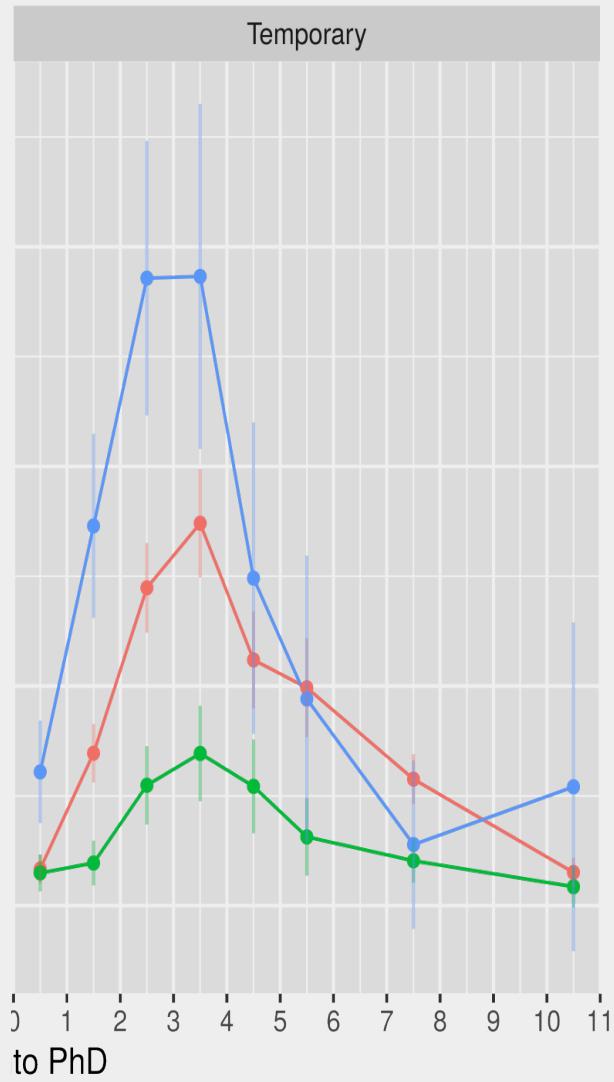
# Precision versus clarity



# Precision versus clarity



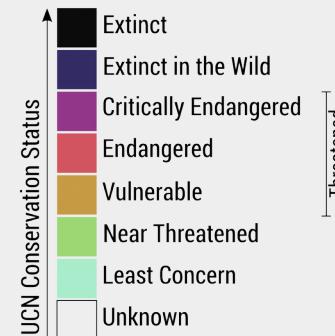
# Precision versus clarity



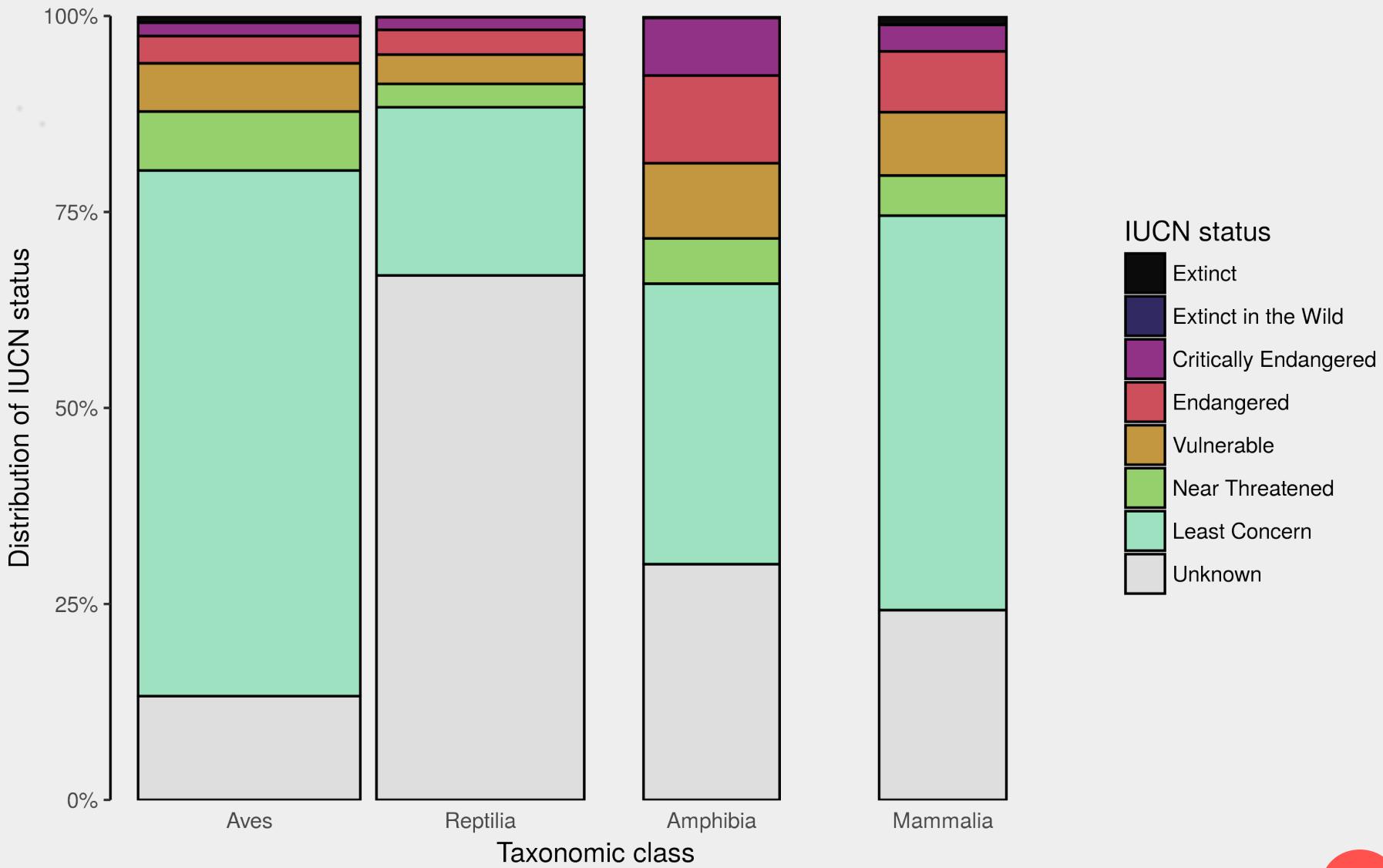
# Engagement & density versus effectiveness

## The State of Vertebrate Conservation

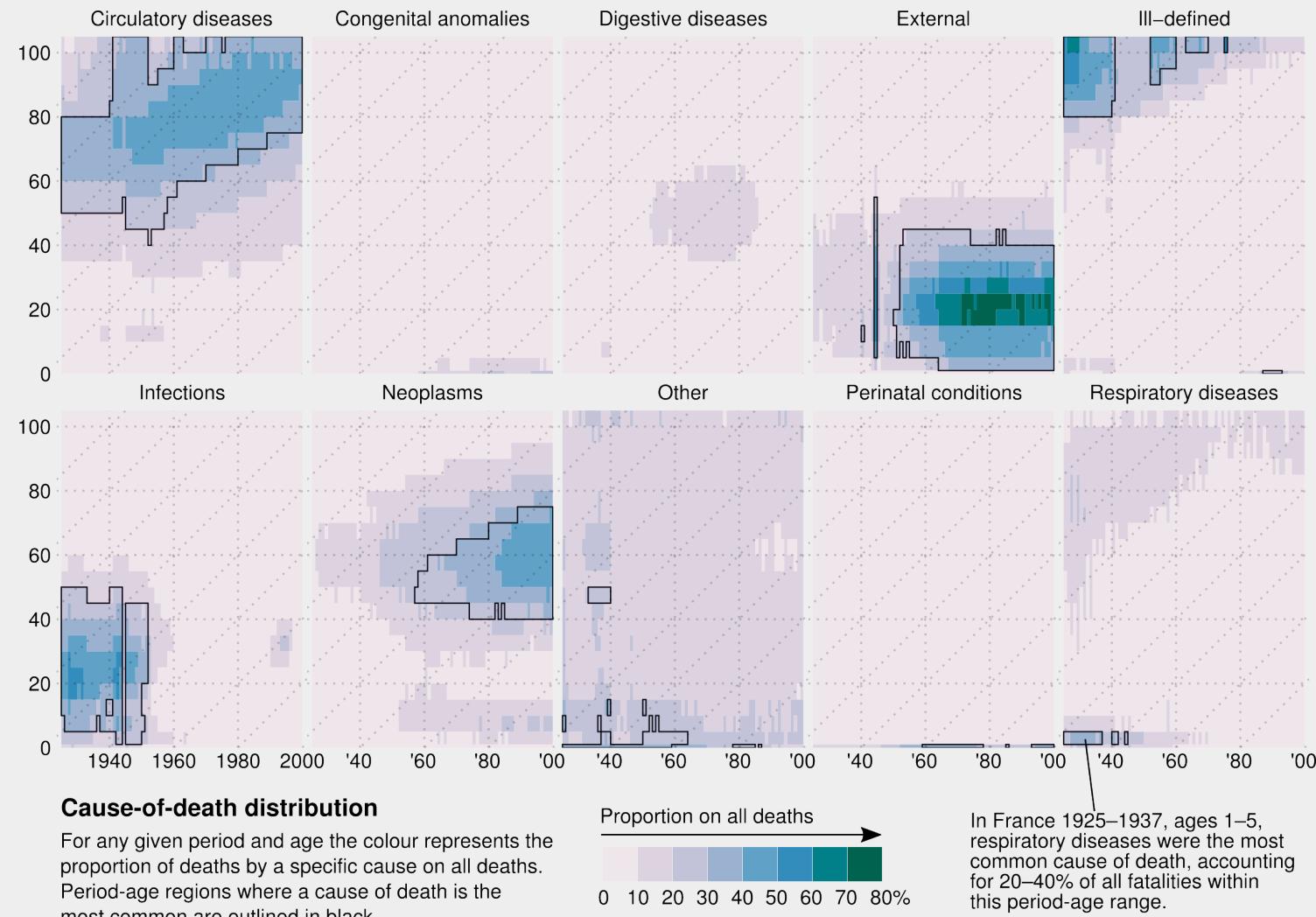
IUCN Red List conservation status for each species



# Engagement & density versus effectiveness

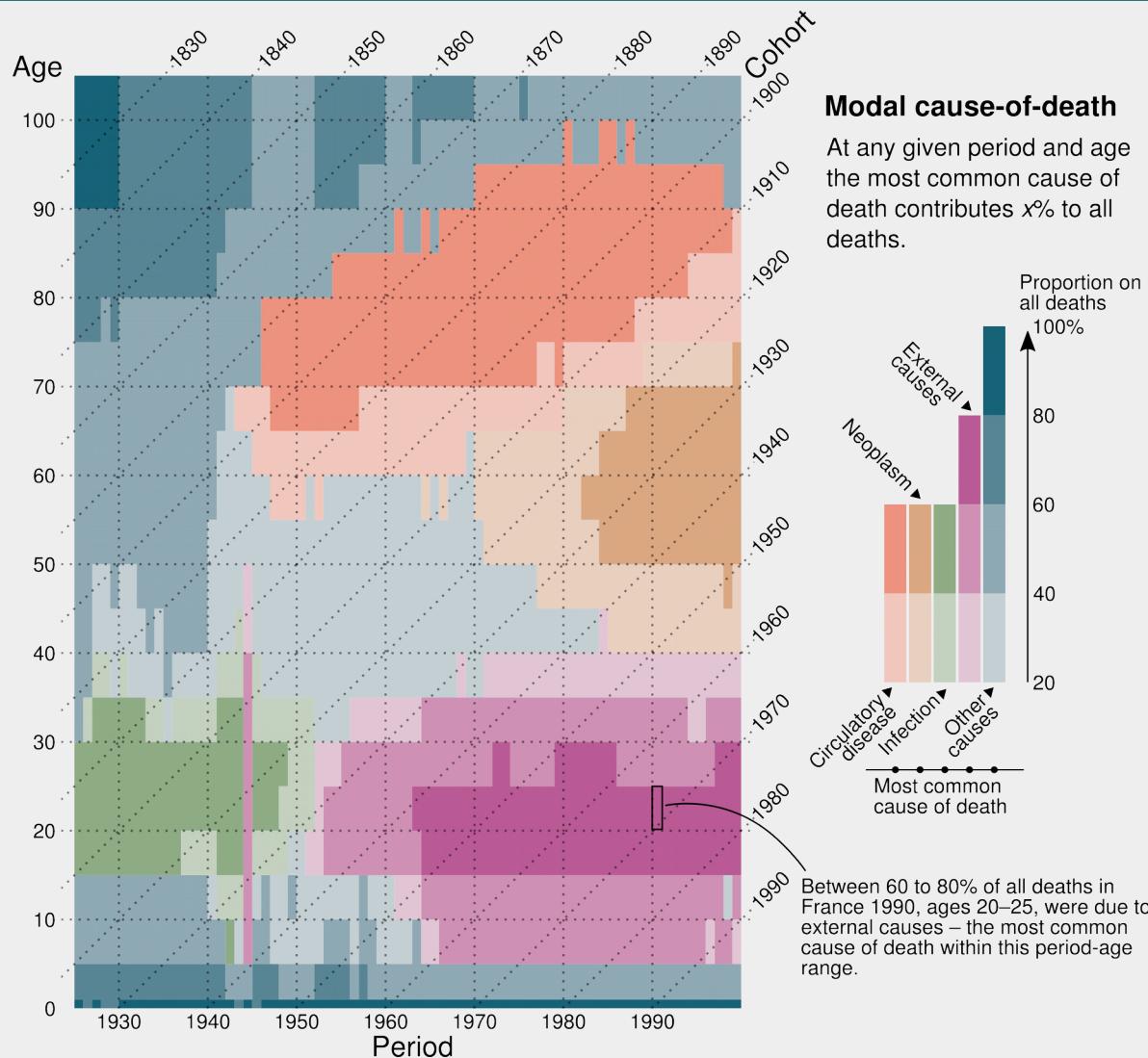


# 4 plots of the same data



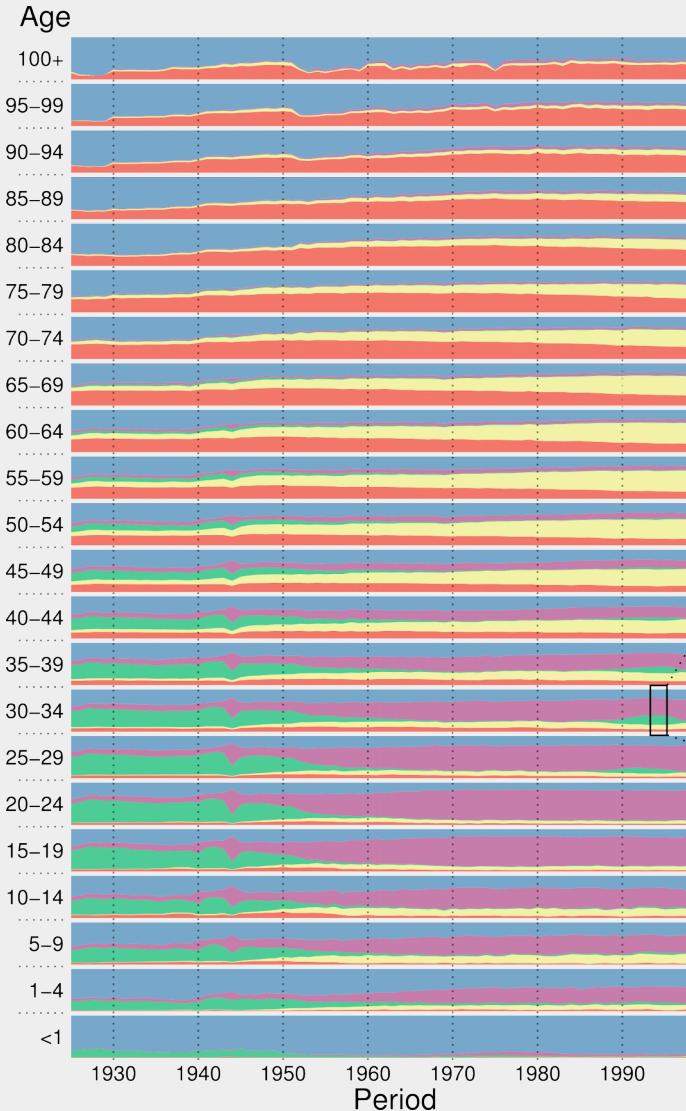
Schöley & Willekens (2017). Visualizing compositional data on the Lexis surface.

# 4 plots of the same data



Schöley & Willekens (2017). Visualizing compositional data on the Lexis surface.

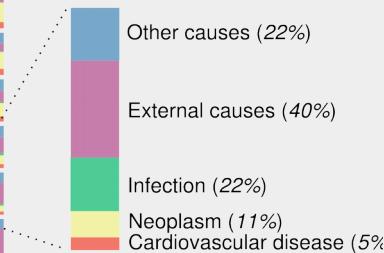
# 4 plots of the same data



## Cause-of-death distribution

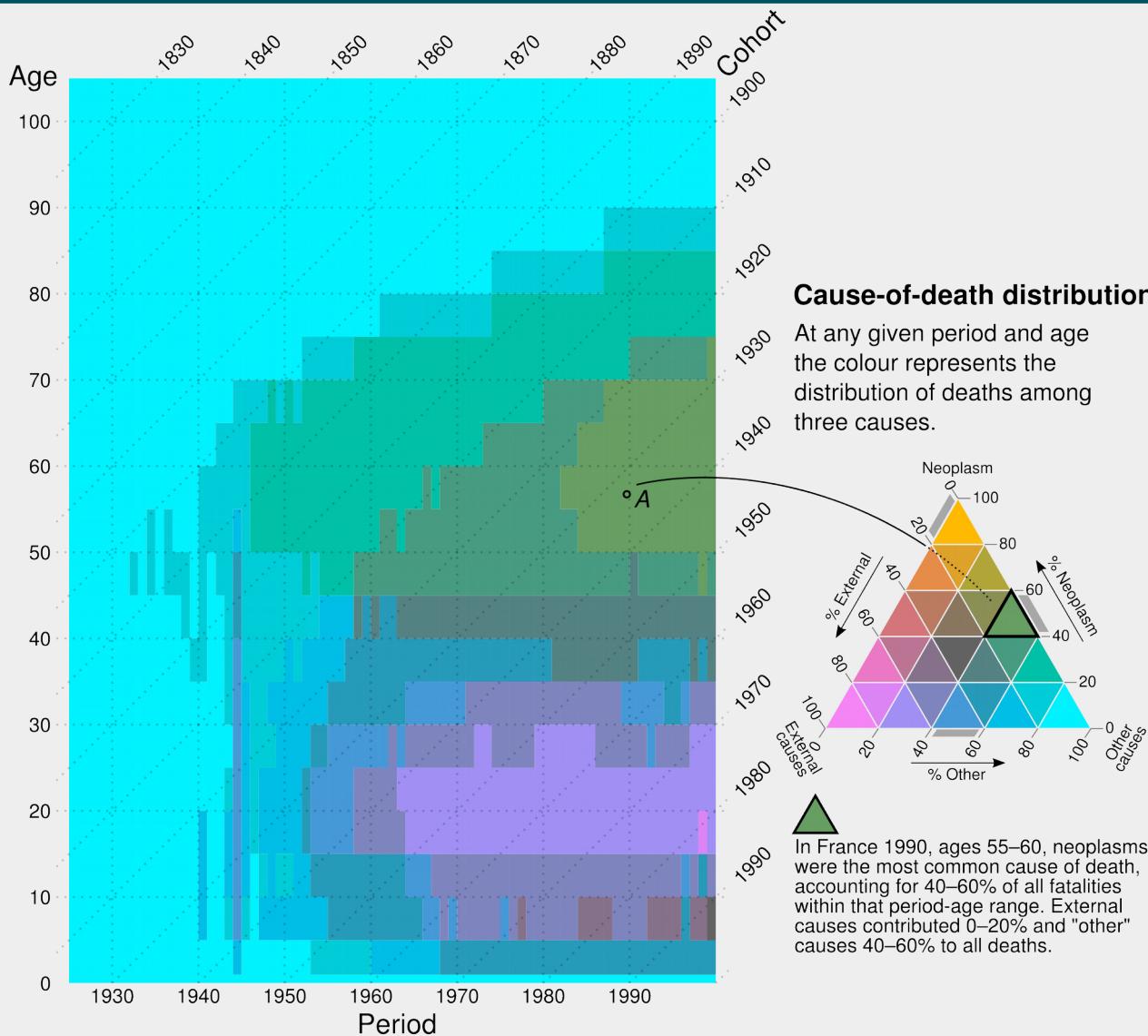
At any given period and age the distribution of colours represents the distribution of deaths by cause.

In France 1995, ages 30–34, causes of death were distributed as:



Schöley & Willekens (2017). Visualizing compositional data on the Lexis surface.

# 4 plots of the same data

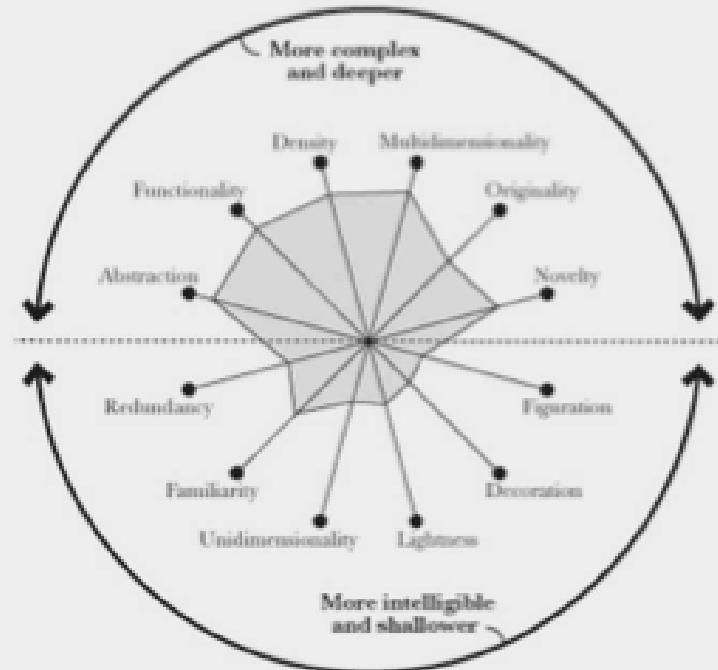


Schöley & Willekens (2017). Visualizing compositional data on the Lexis surface.

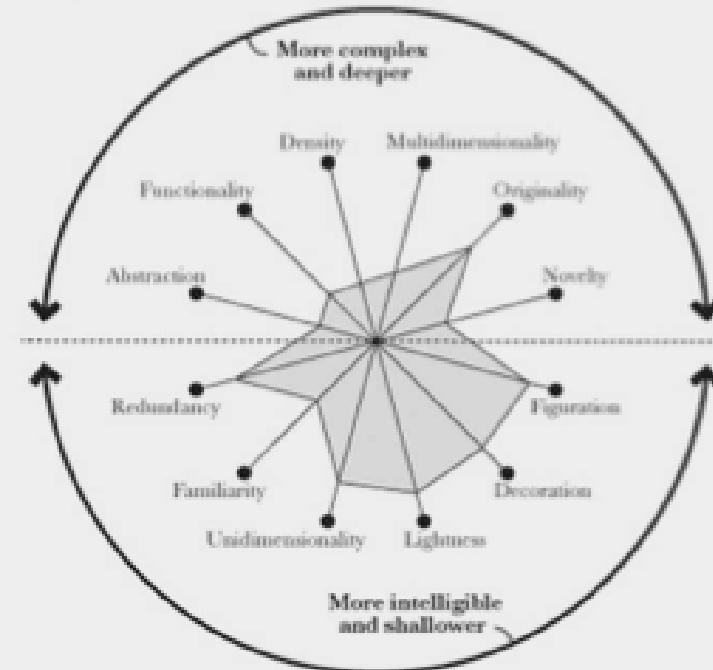
**Design for your audience**

# Different audience, different priorities

**The wheel preferred by scientists and engineers**



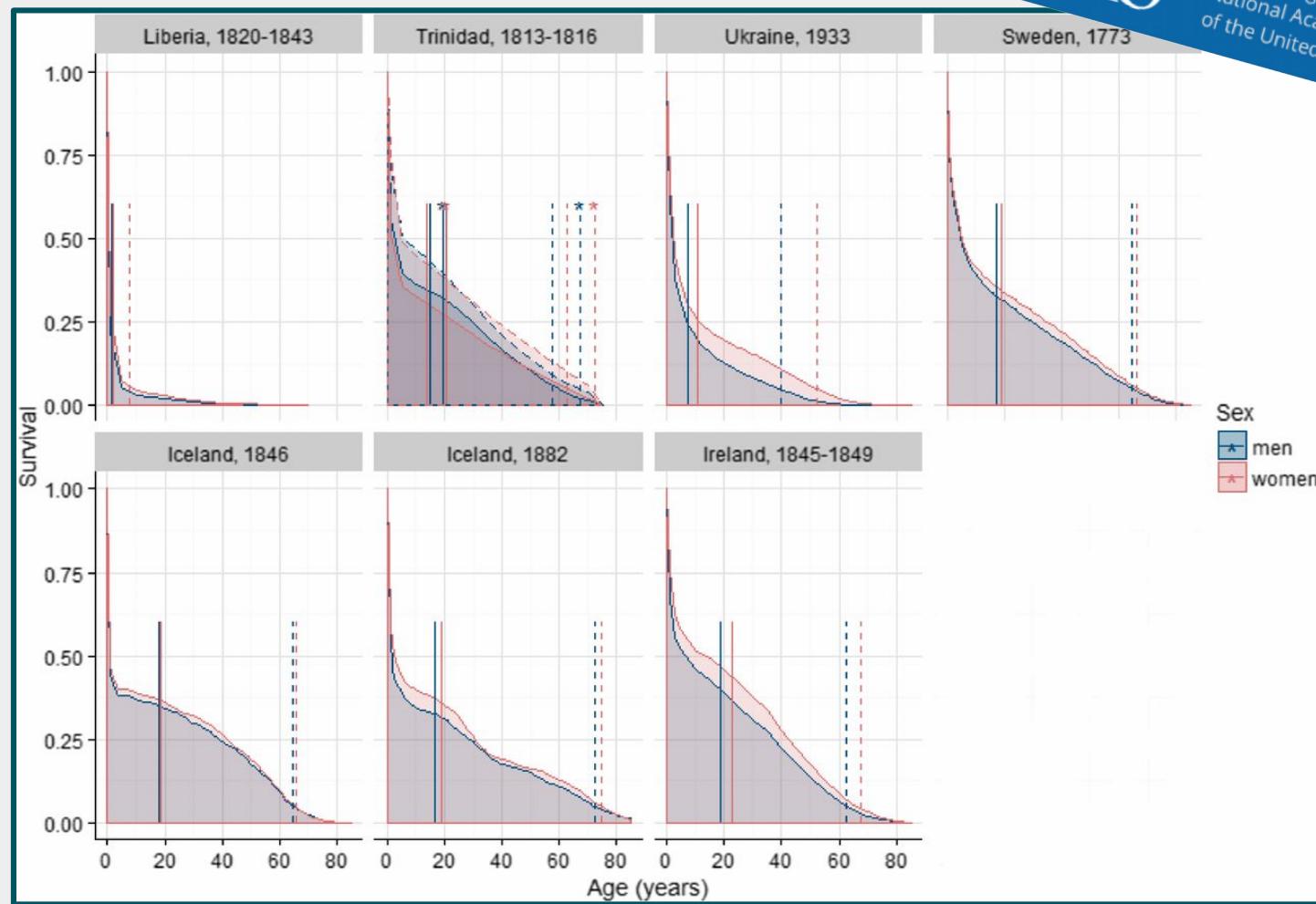
**The wheel favored by artists, graphic designers, and journalists**



Cairo, A. (2012). *The Functional Art*.

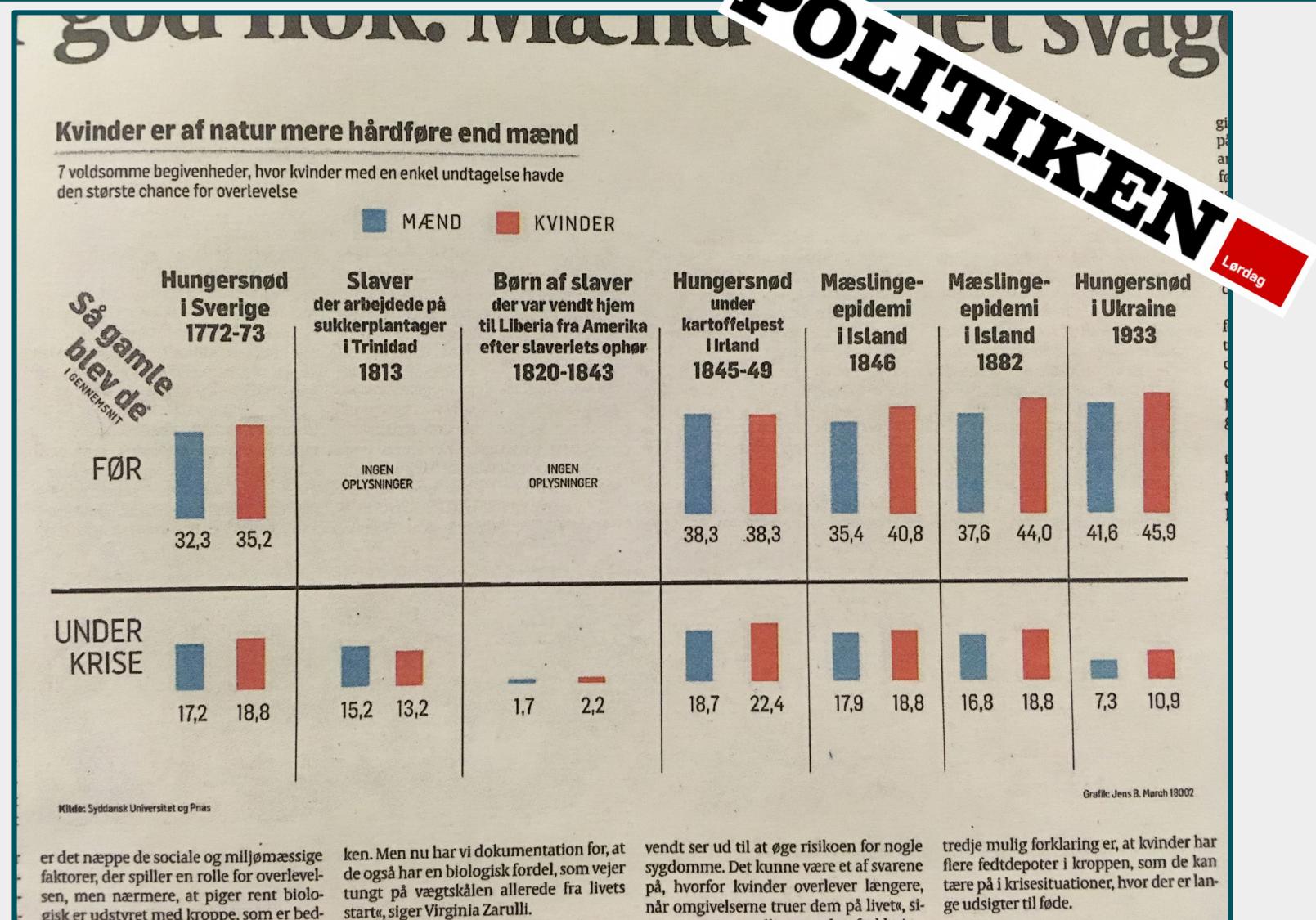
# Different audience, different priorities

PNAS  
Proceedings of the  
National Academy of Sciences  
of the United States of America



Zarulli et al. (2017). Women live longer than men even during severe famines and epidemics.

# Different audience, different priorities



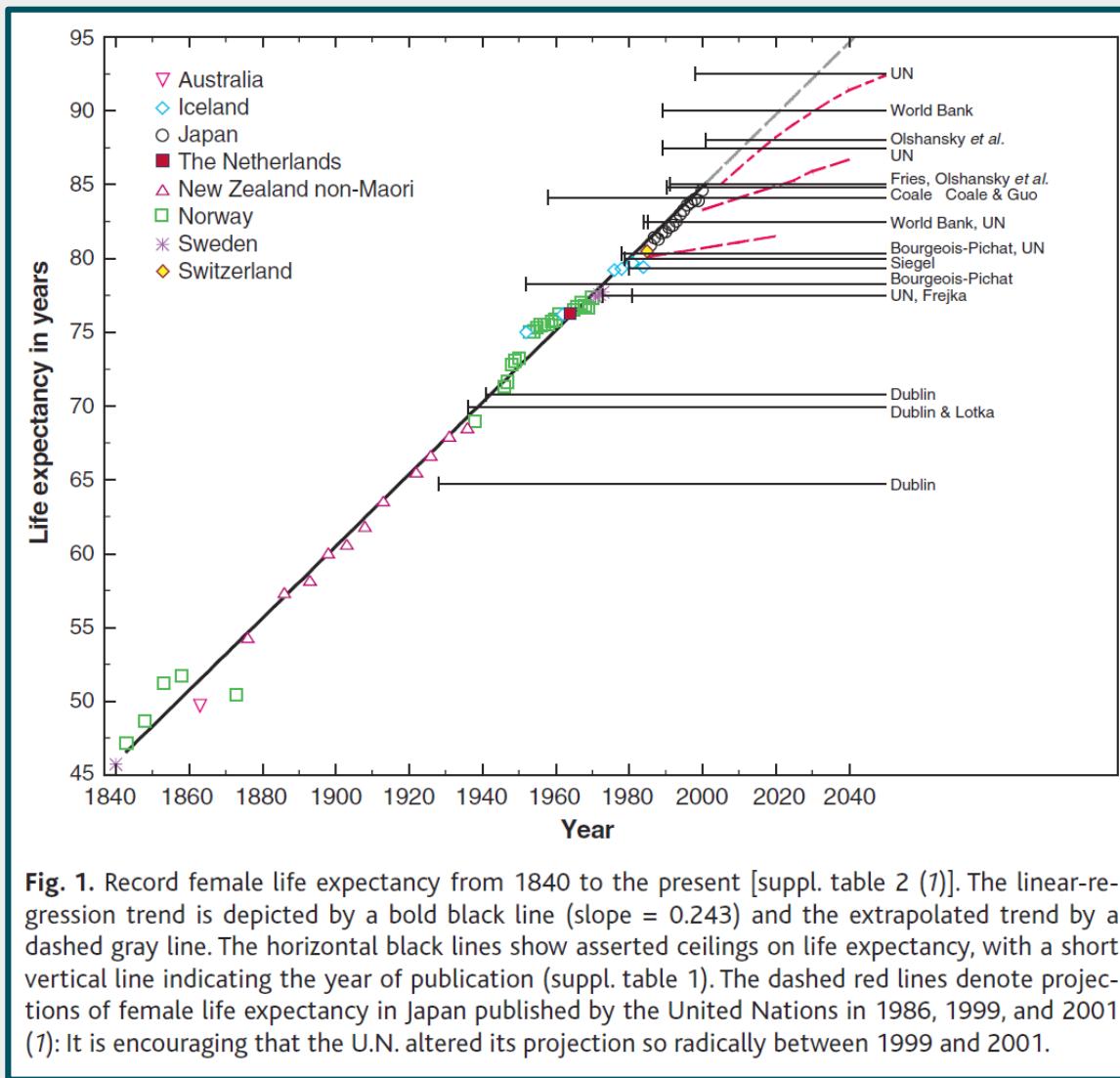
Politiken (2018). Den er god nok: Mænd er det svage køn.

# Different audience, different priorities

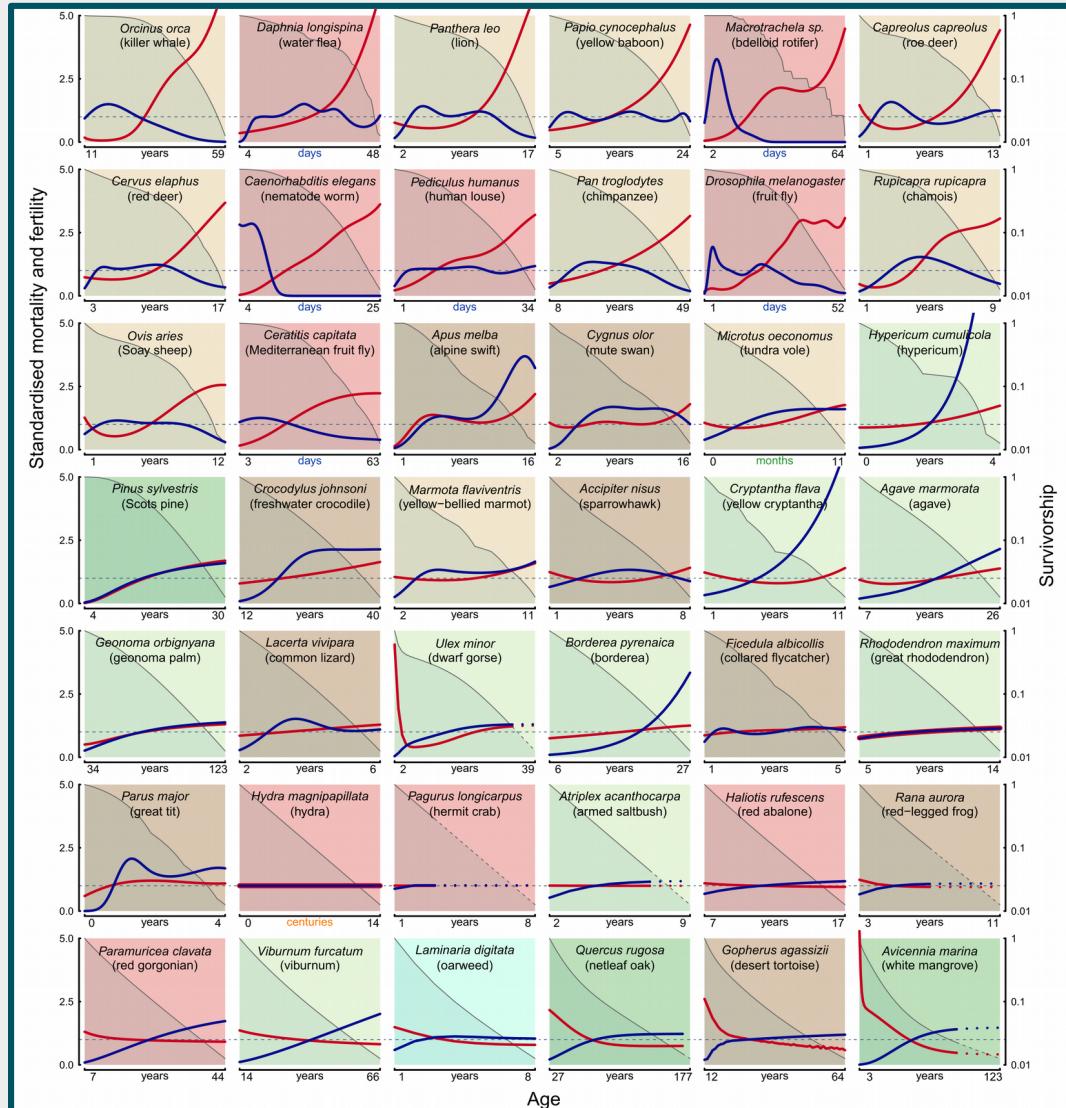


**Design for the medium**

# Articles, Presentations, Posters, Tweets...

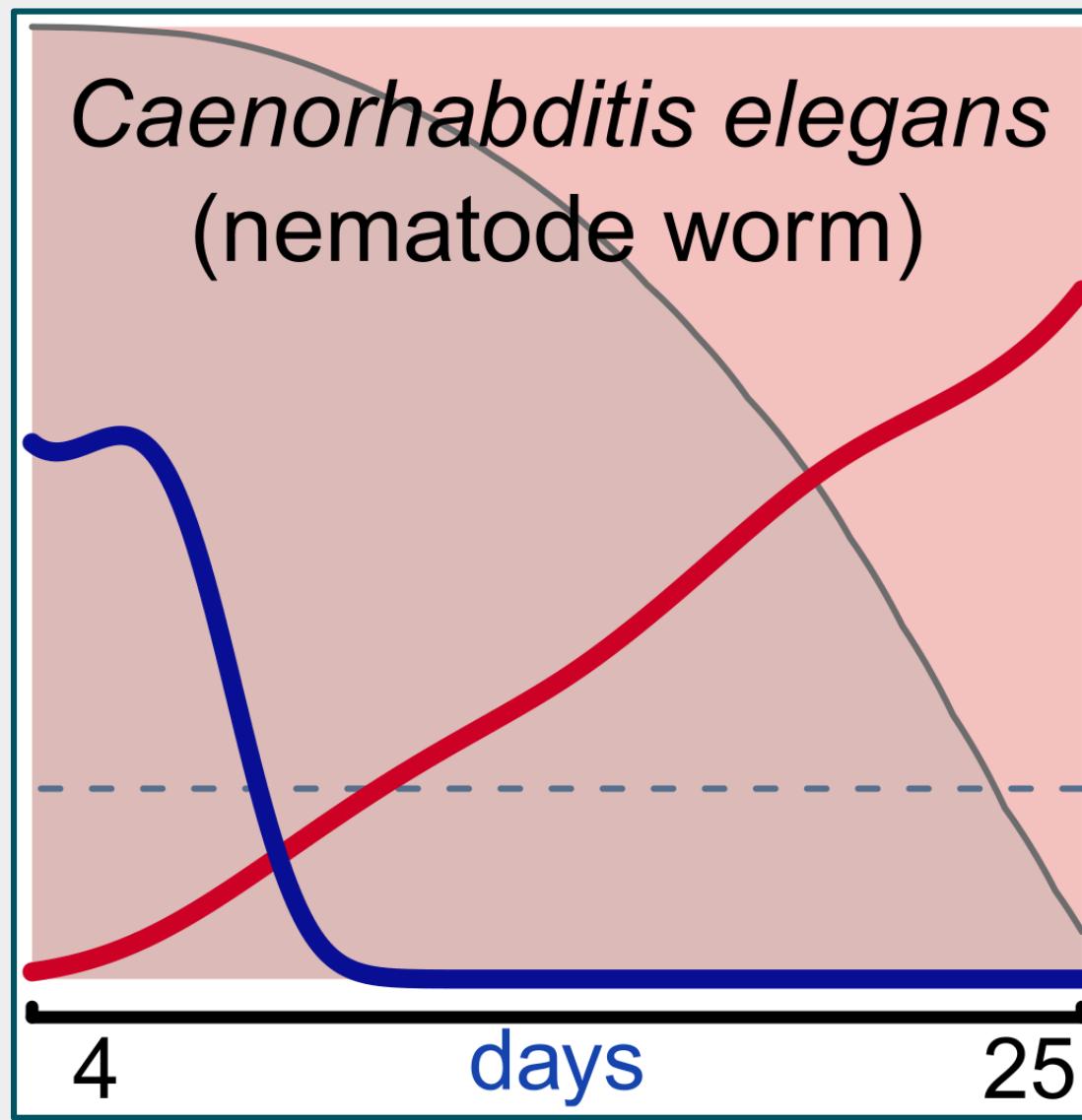


# Articles, Presentations, Posters, Tweets...

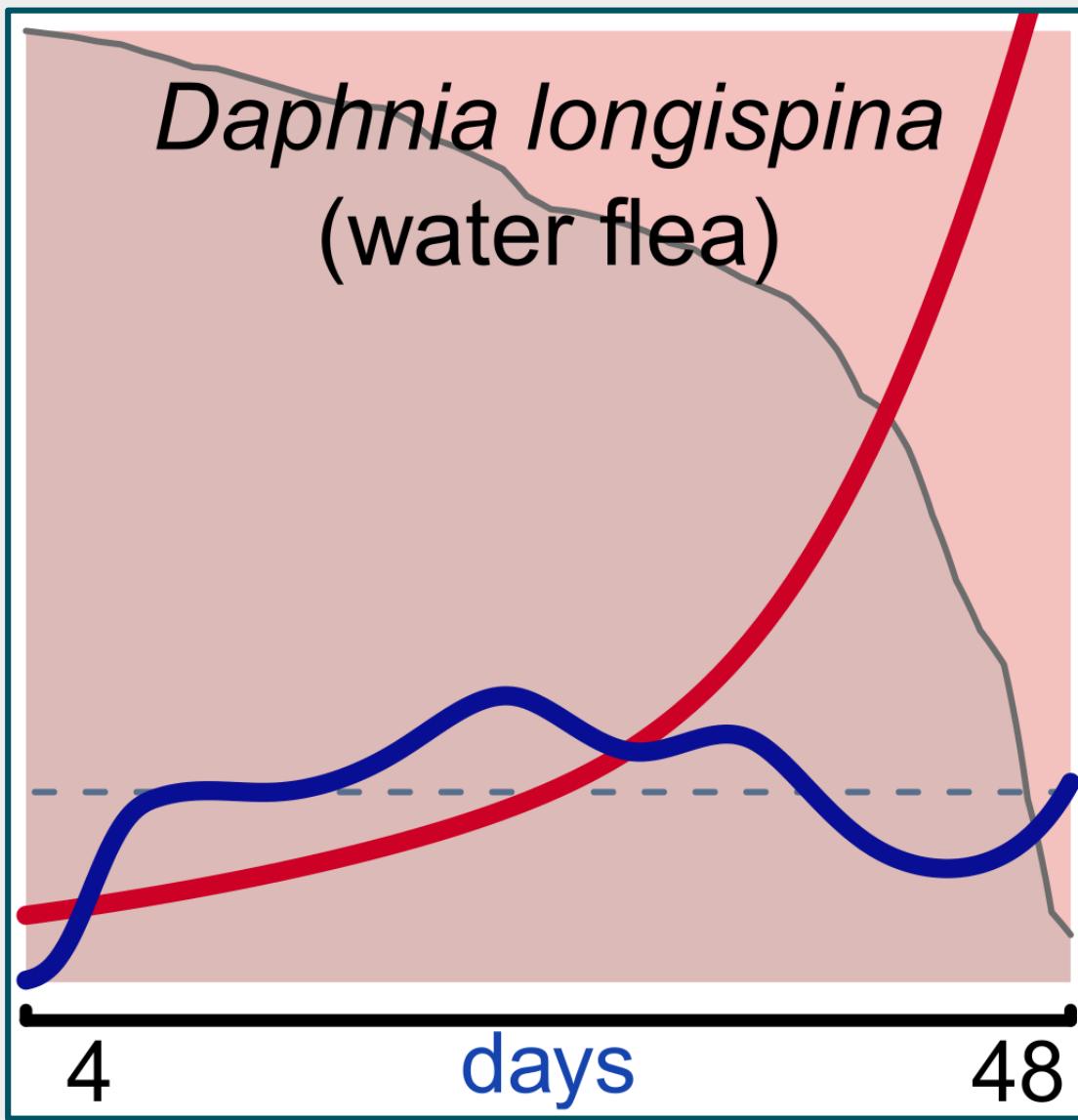


Jones et al. (2014). Diversity of ageing across the tree of life. [excerpt]

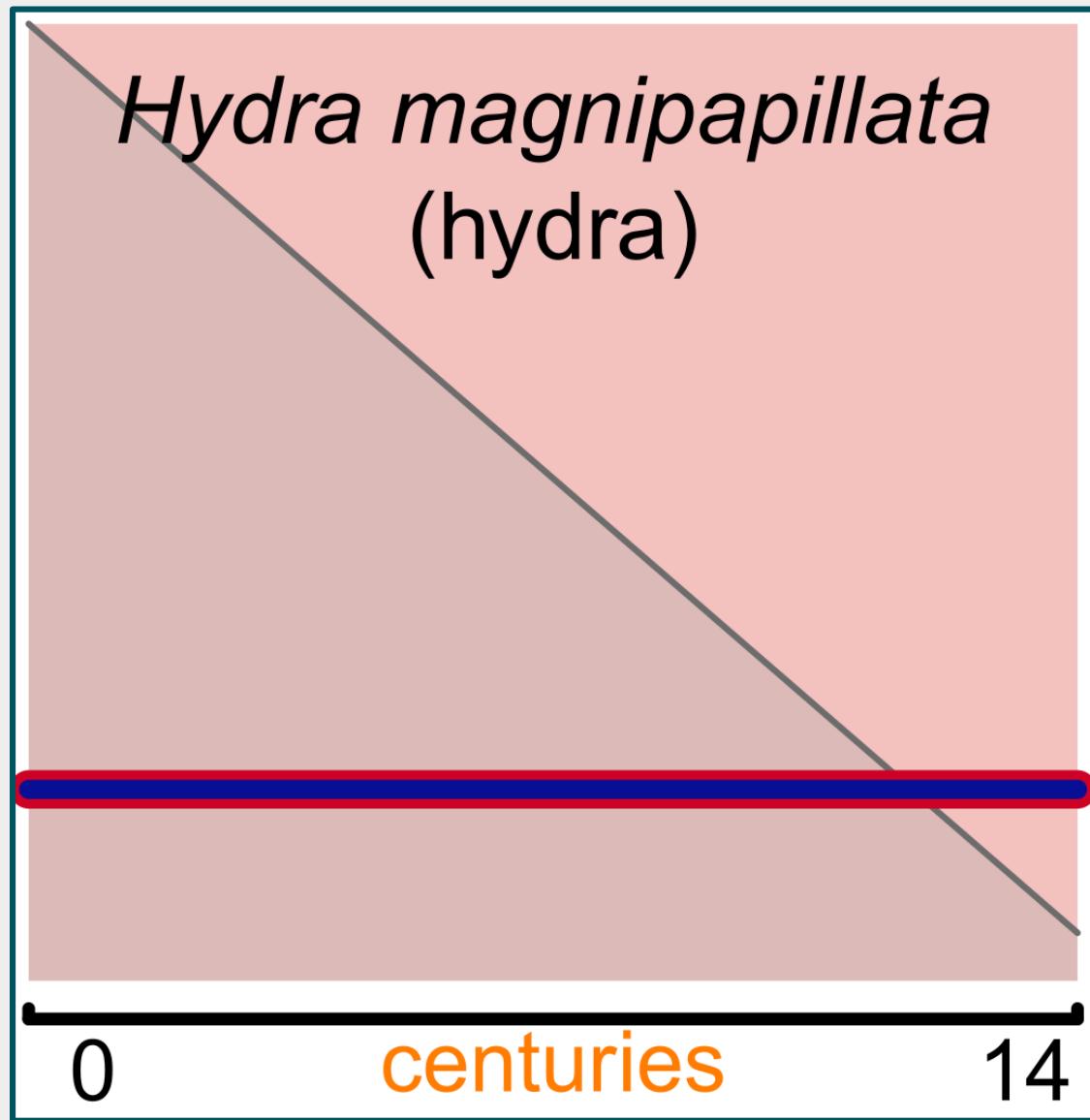
# Articles, Presentations, Posters, Tweets...



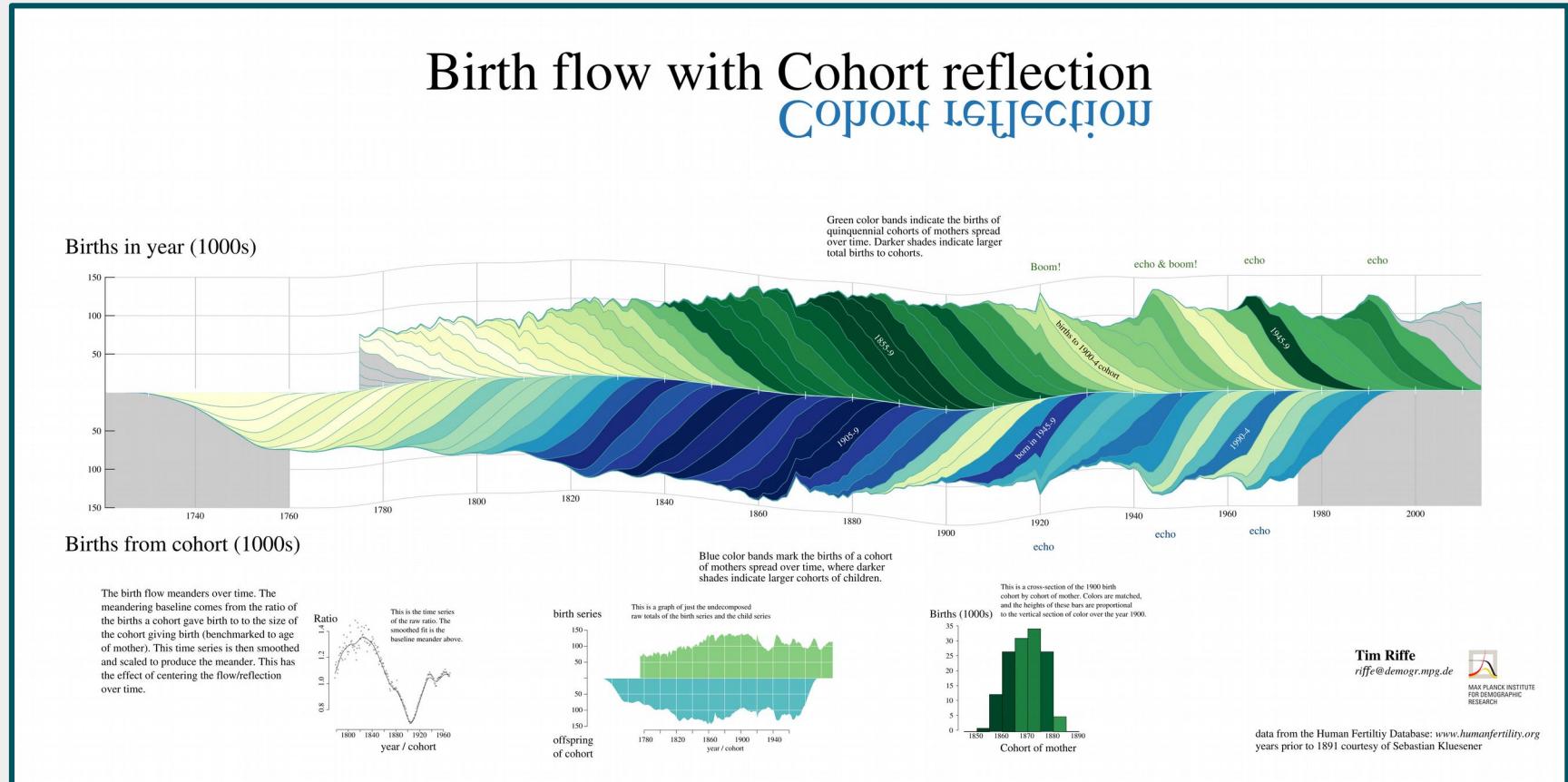
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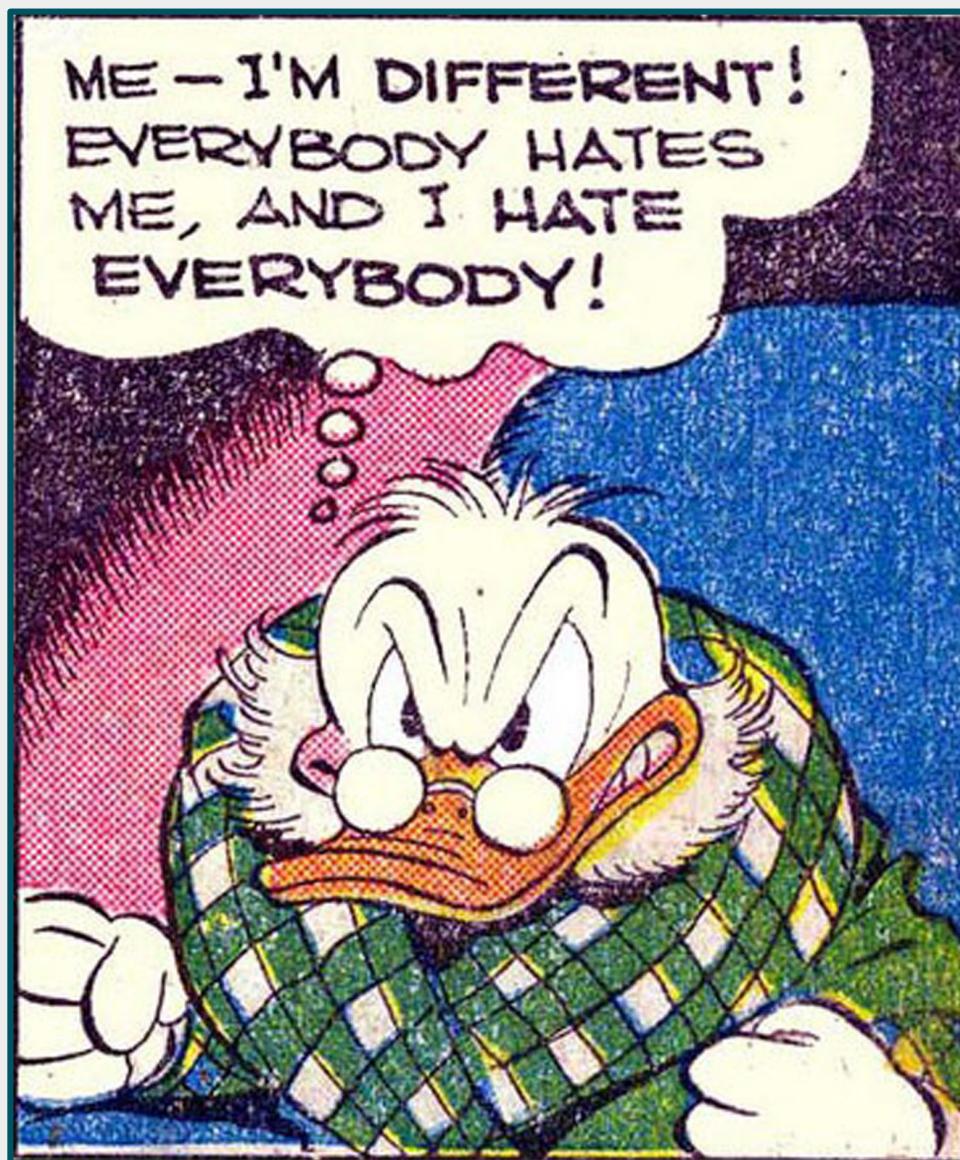
# Articles, Presentations, Posters, Tweets...



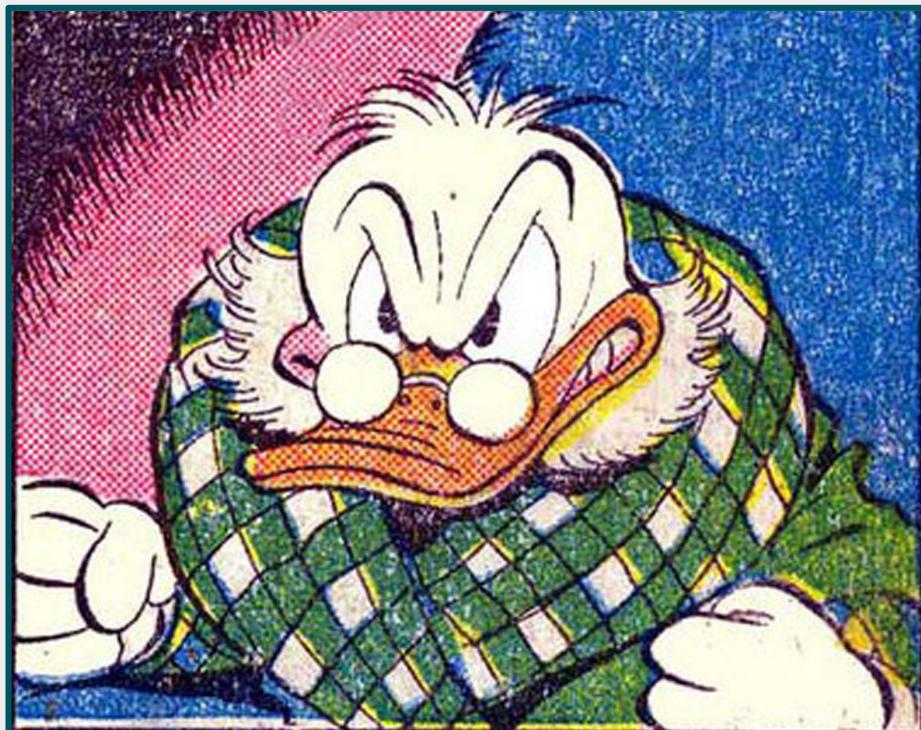
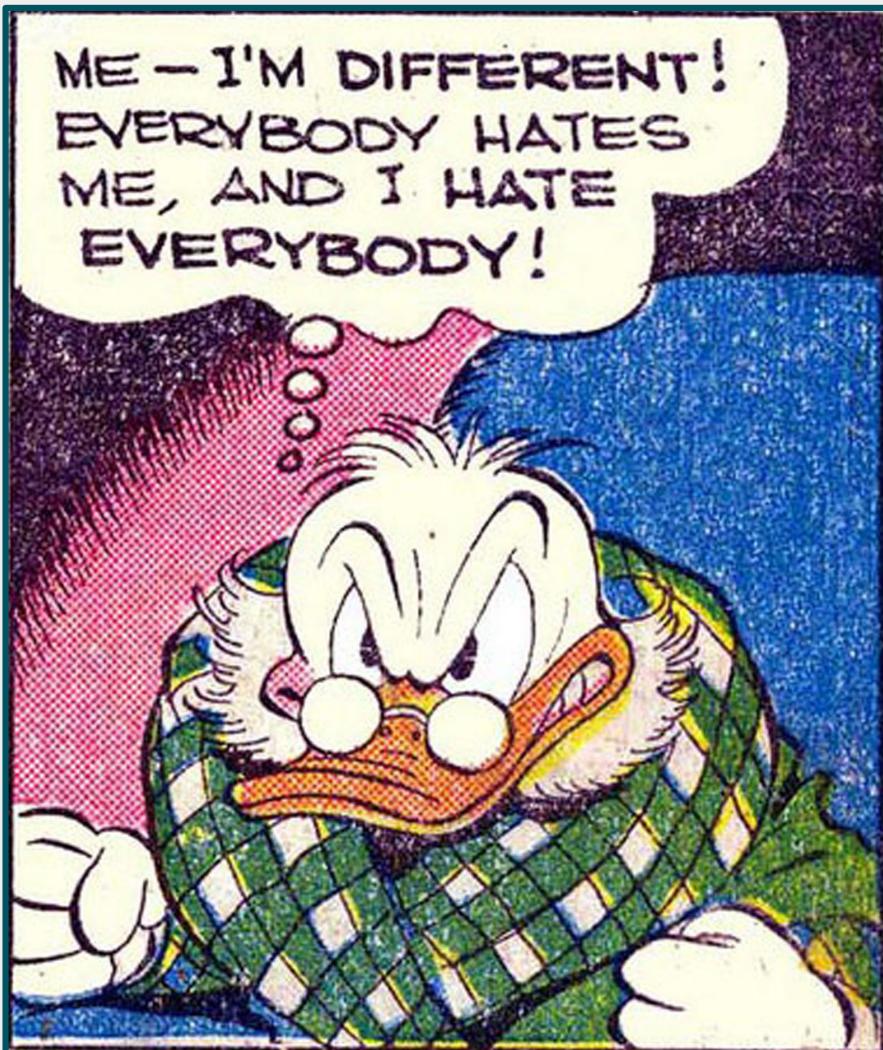
Tim Riffe (2017). Birth flow with Cohort reflection.

# **Two useful techniques**

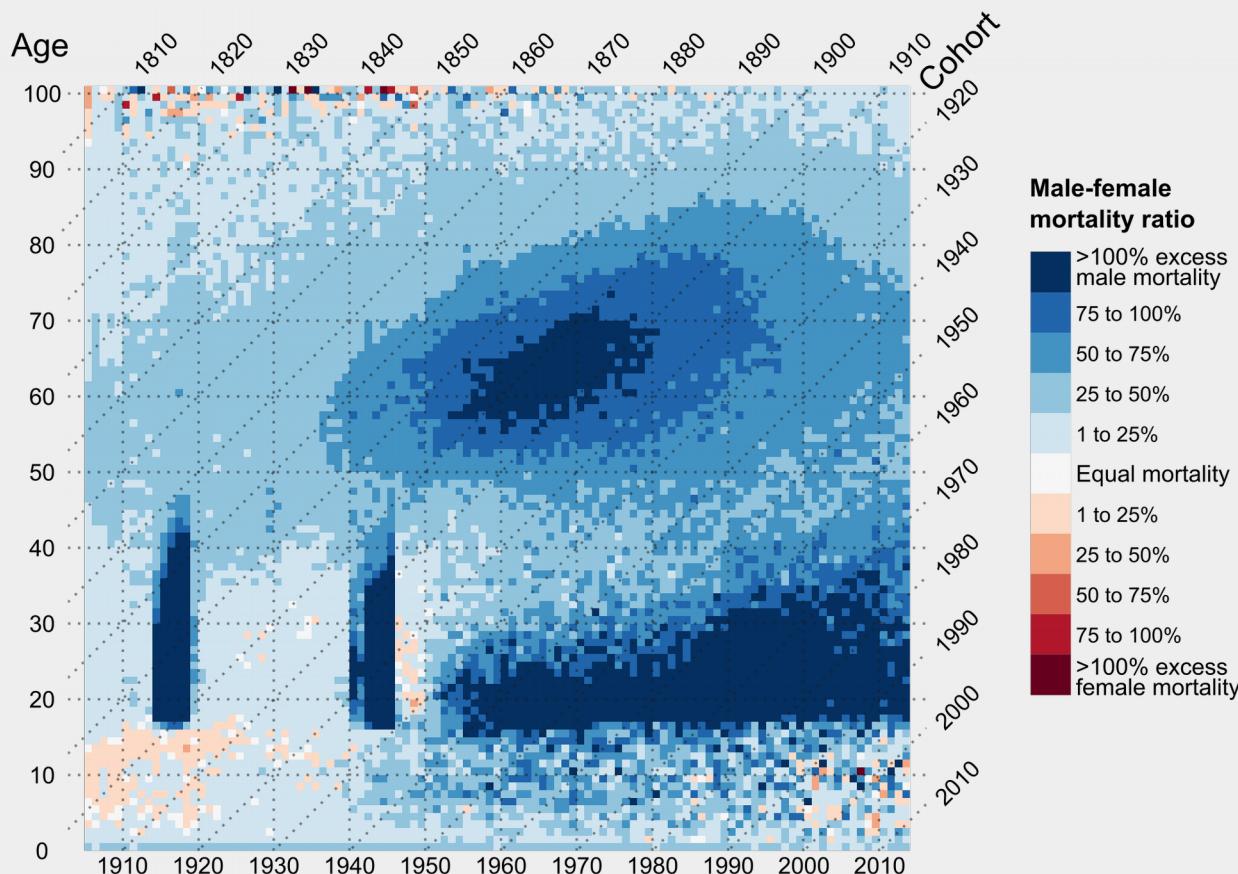
# Indirect versus direct annotation



# Indirect versus direct annotation



# Indirect versus direct annotation



**Figure 1: Age-specific excess-male mortality in England & Wales 1905 to 2013.** Clearly visible is the male mortality related to World War I (1914–1918) and World War II (1939–1945). Conscription was introduced in March 1916 and applied to men aged 18–40. Smoking-related excess mortality among male cohorts born prior to World War II shows as a elliptical region above age 50. In later cohorts women's smoking habits caught up with those of men, counterbalancing the male deaths. Great successes in combating infectious diseases reduce early adult mortality for both sexes. Young men remain at a higher risk for accidents, which contributes to their excess mortality since the mid 1950s.

# Indirect versus direct annotation

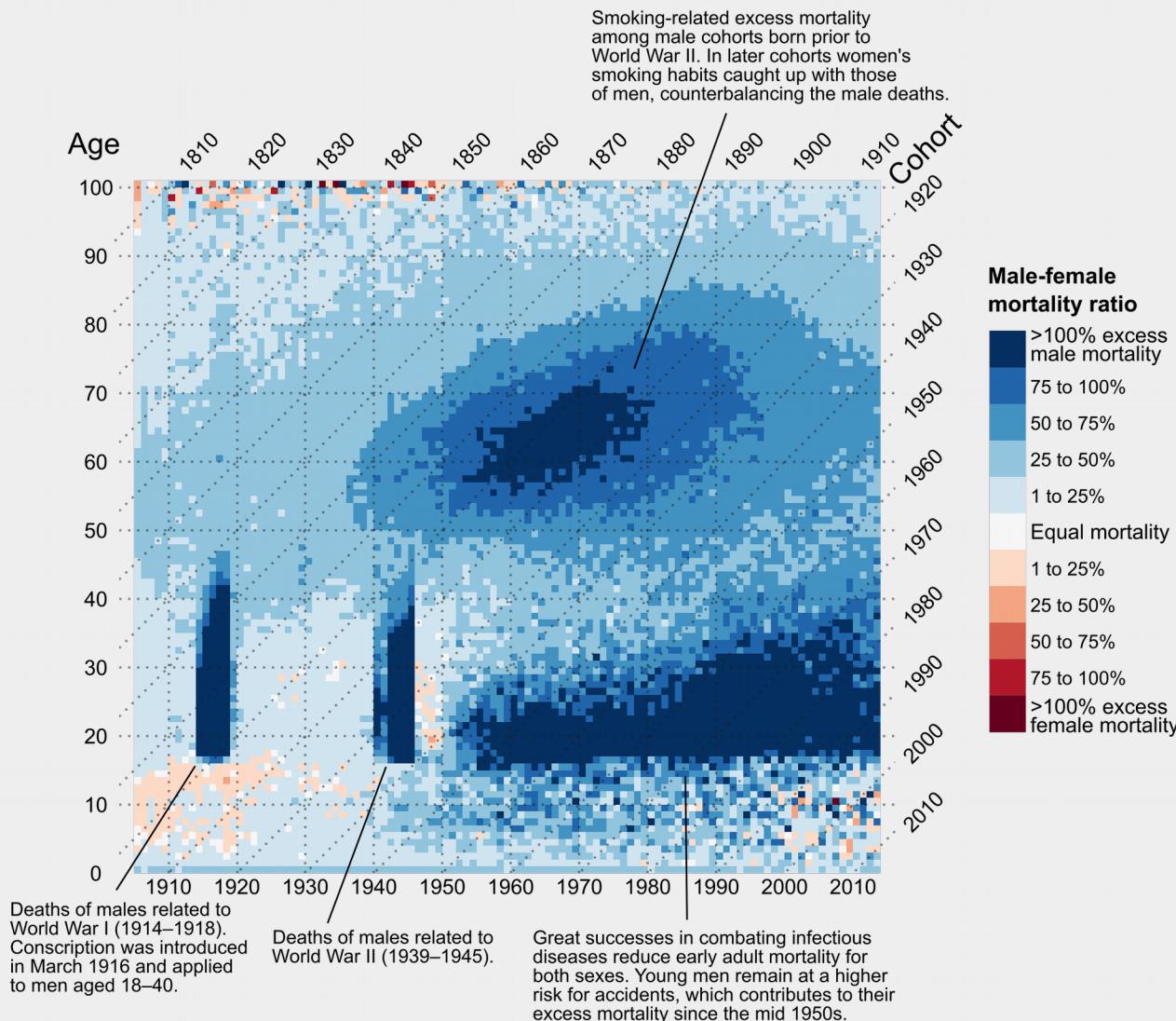
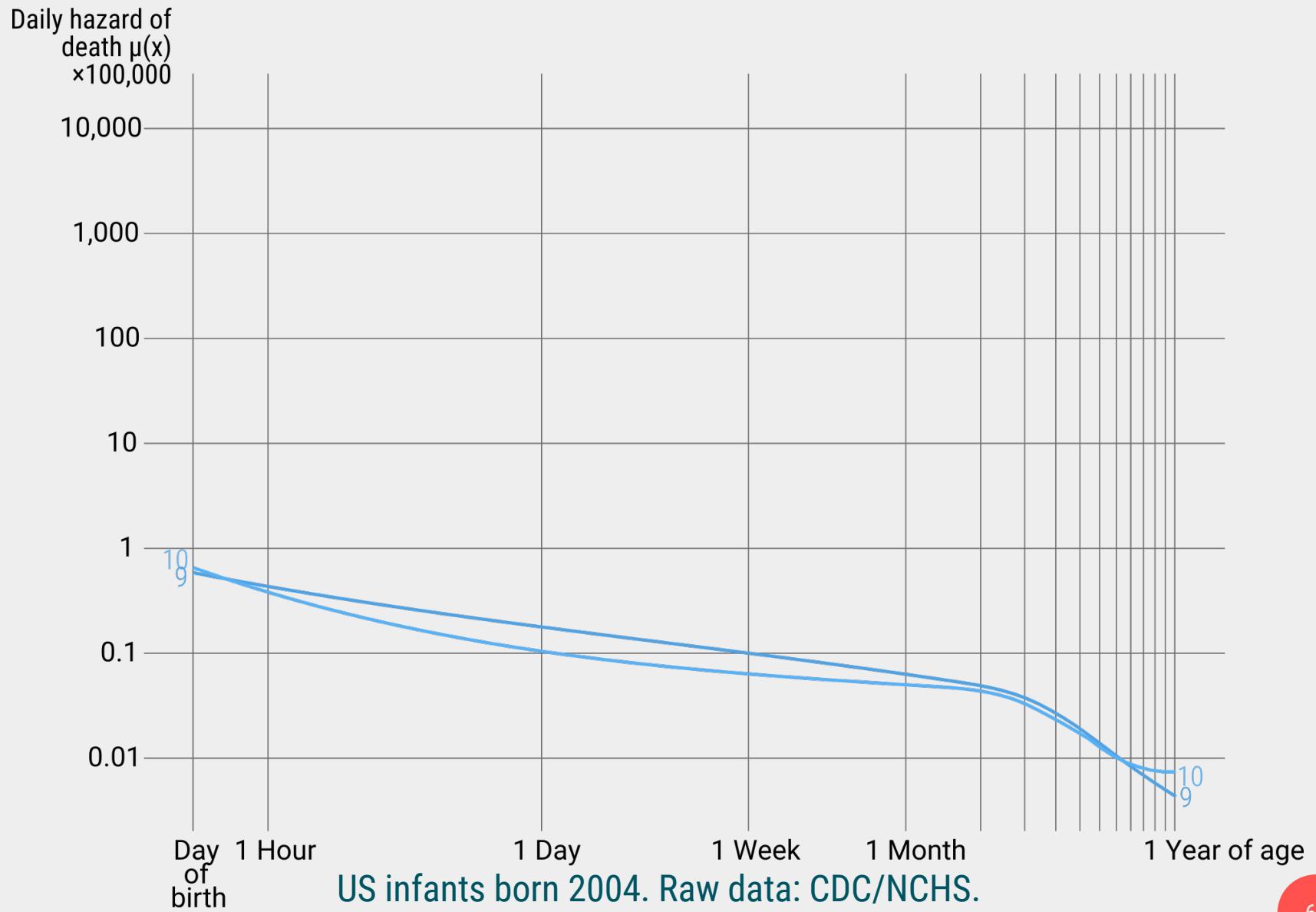
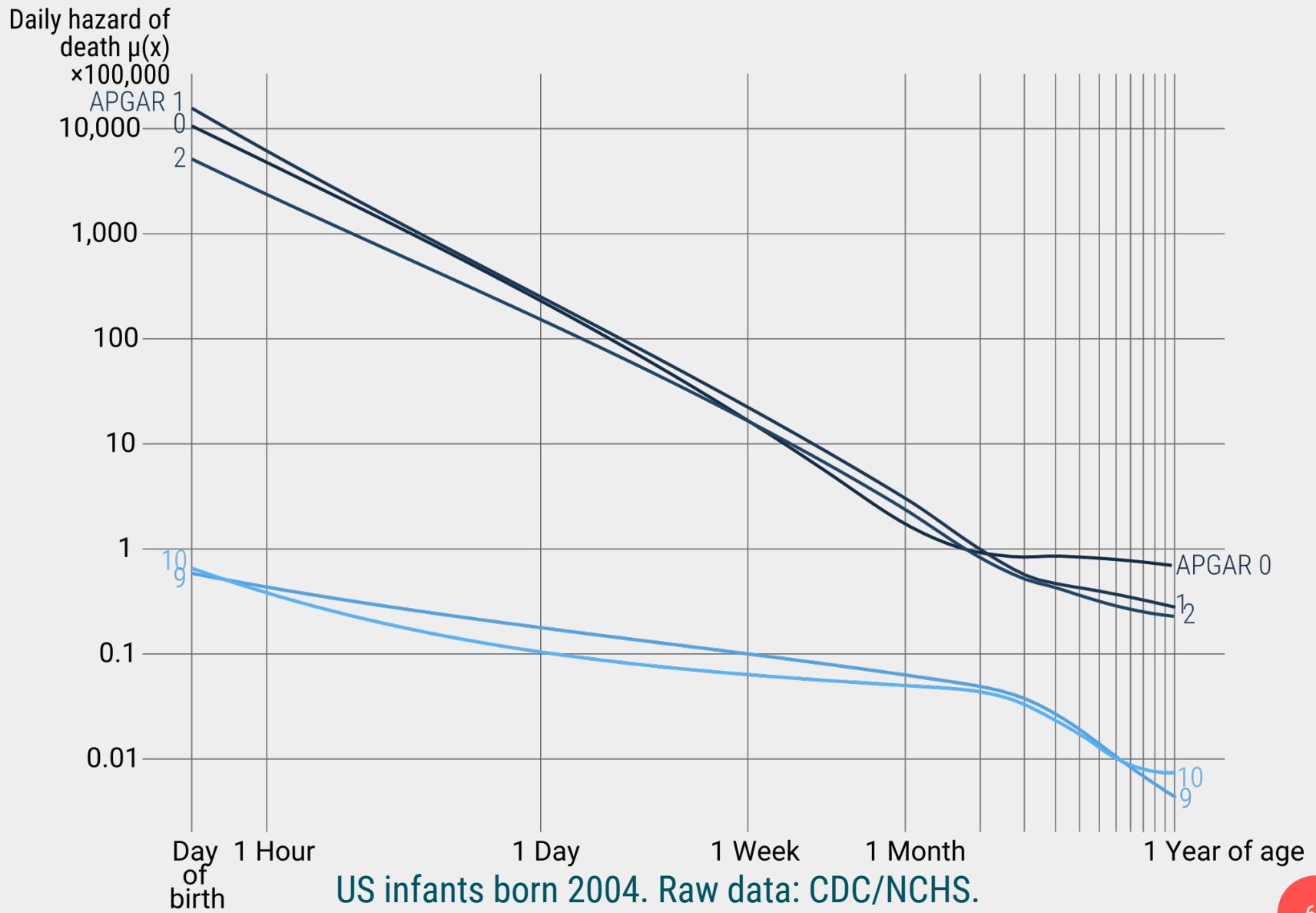


Figure 1: Age-specific excess-male mortality in England & Wales 1905 to 2013.

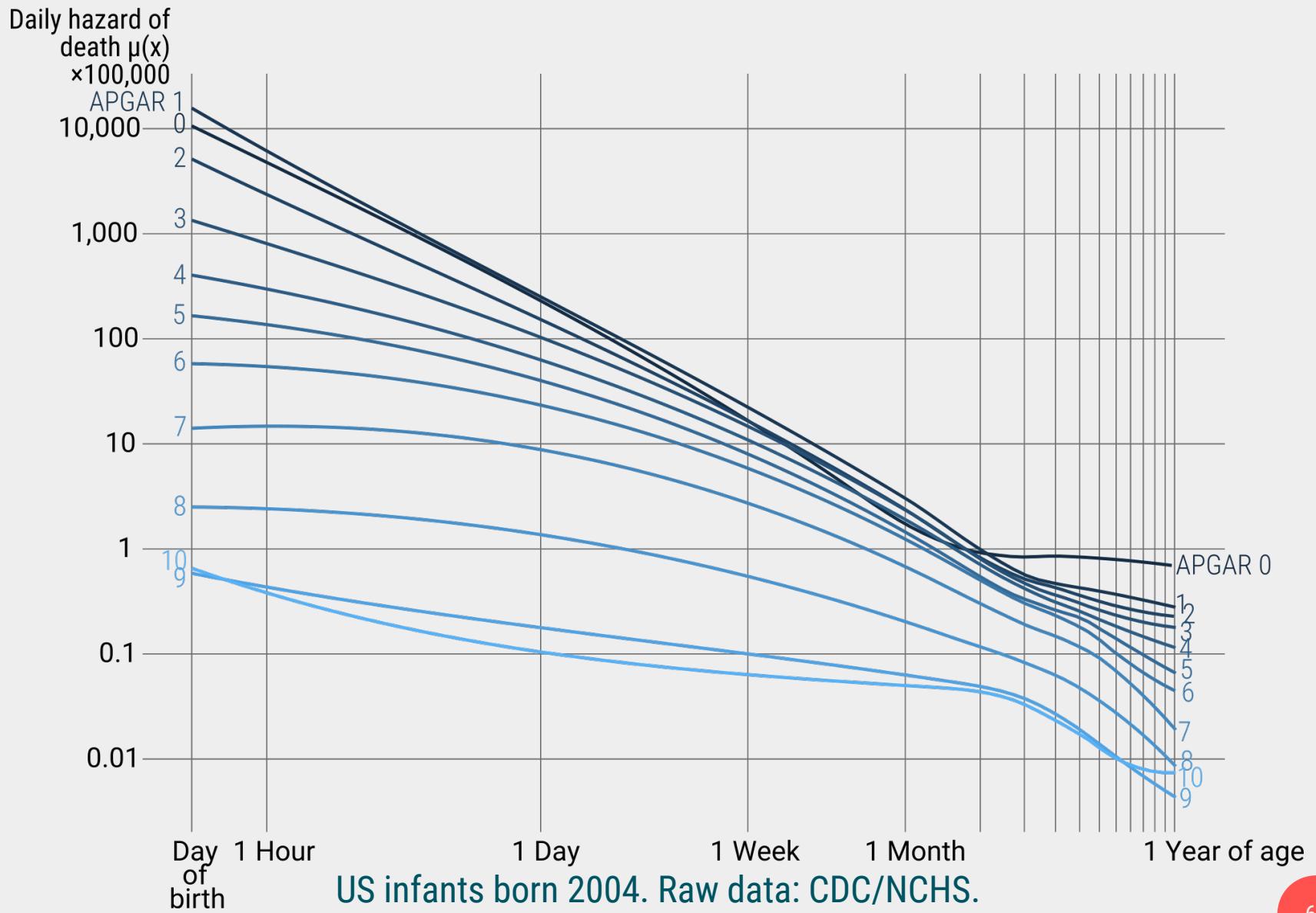
# Visual storytelling via cumulative plot building



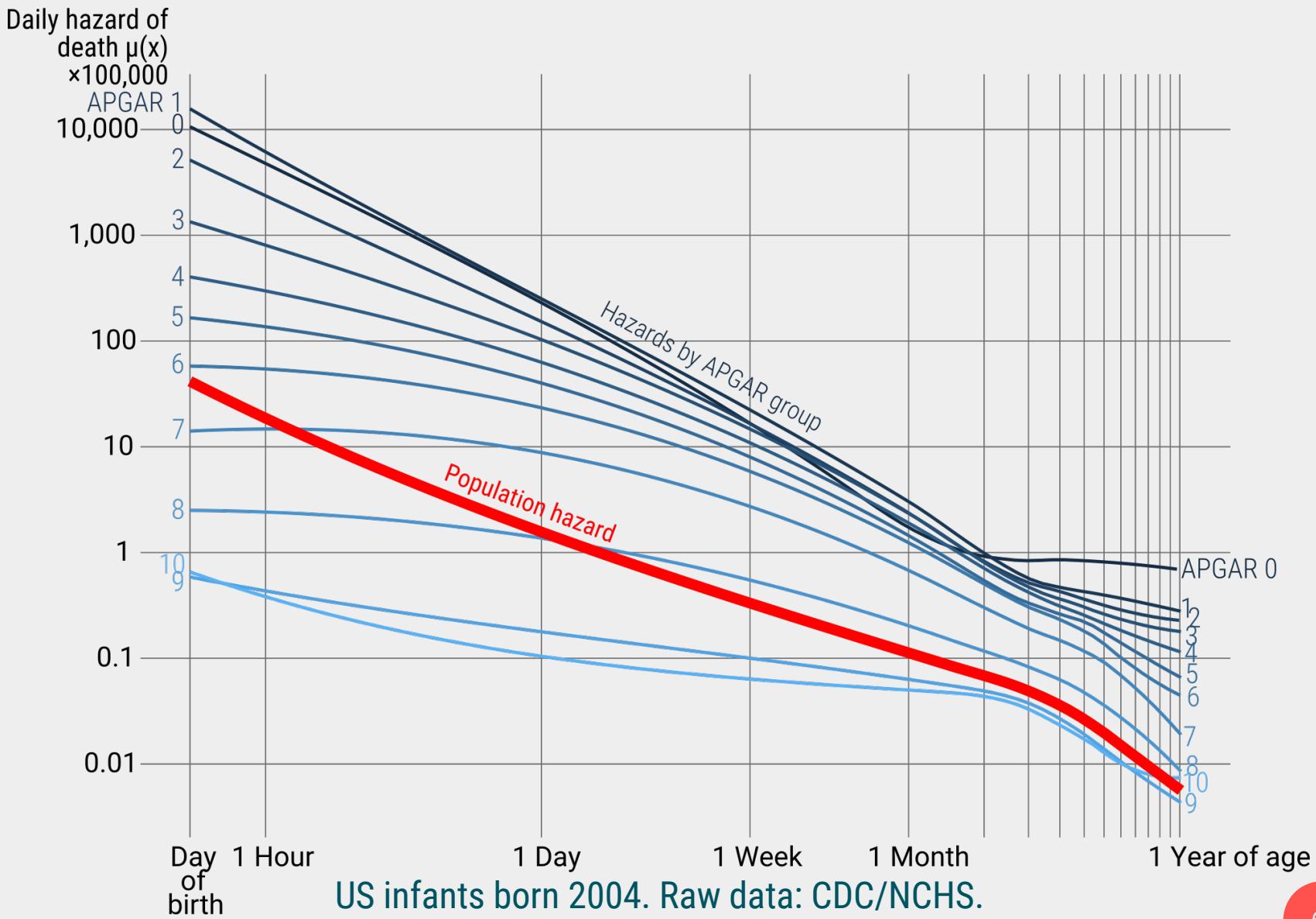
# Visual storytelling via cumulative plot building



# Visual storytelling via cumulative plot building



# Visual storytelling via cumulative plot building



**Good Visualizations are  
designed  
with a clear purpose, for a  
specific audience and for a  
specific medium**

**Slides available at**  
[github.com/jschoeley/edsd1718-dataviz](https://github.com/jschoeley/edsd1718-dataviz)

Jonas Schöley

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Twitter: [@jschoeley](https://twitter.com/jschoeley)