Why do we need visualizations?

Isabel Meirelles

NetSci High Workshop & Conference | July 19, 2014

1. External aids enhance our **cognitive abilities**
2. **Context** is key to understanding
3. There is **not a single answer** to a given problem
4. Solving a design problem requires finding the **right representation**
5. **Human-centered design**: understanding our constraints and capabilities

information design
infographics

communicate information with the purpose to reveal patterns and relationships not known or not easily deduced without the aid of visual representations

information visualization
data visualization

the use of computer-supported, interactive, visual representations of abstract data to amplify cognition
Card et al. : *Readings in Information Visualization*

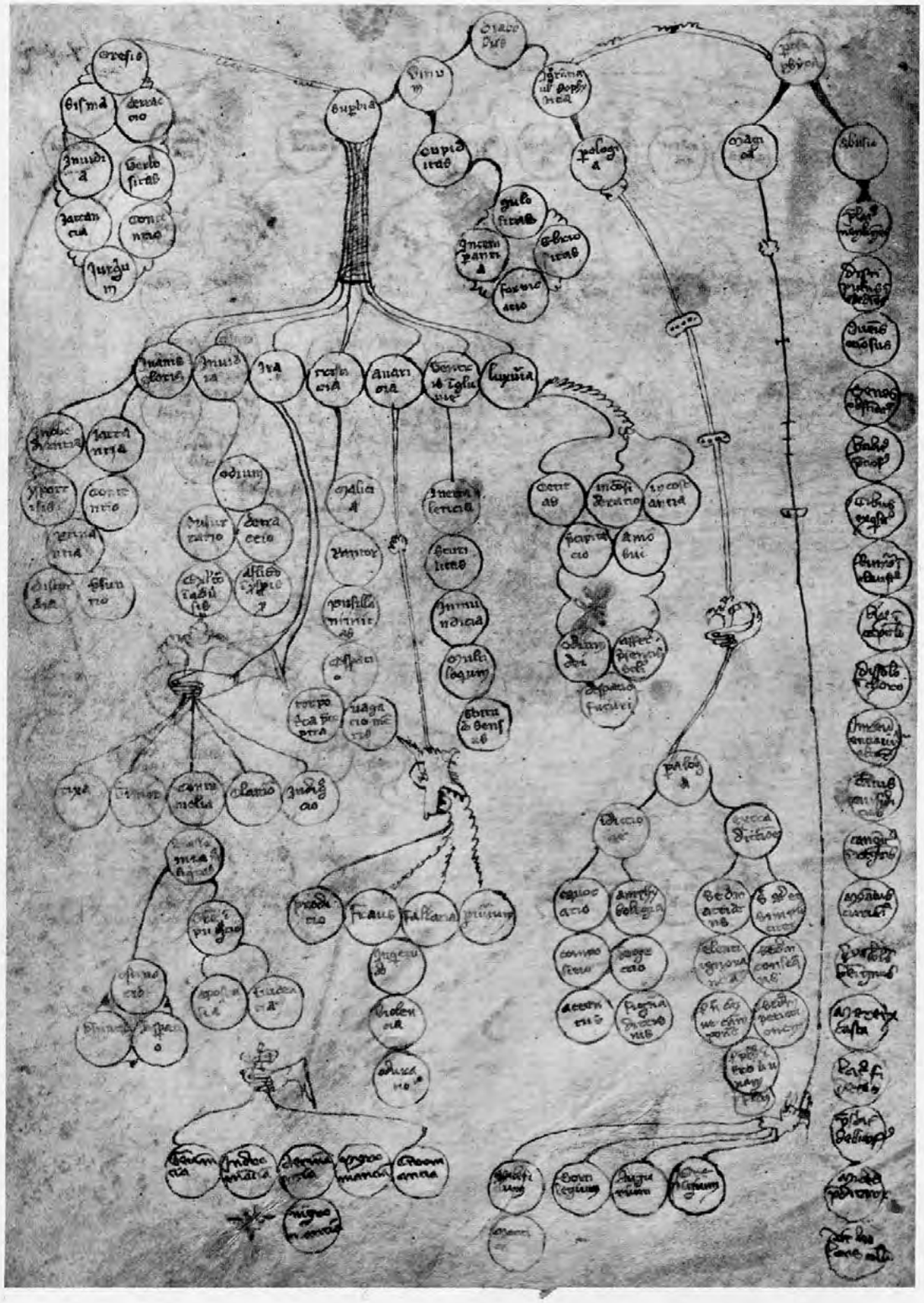
1

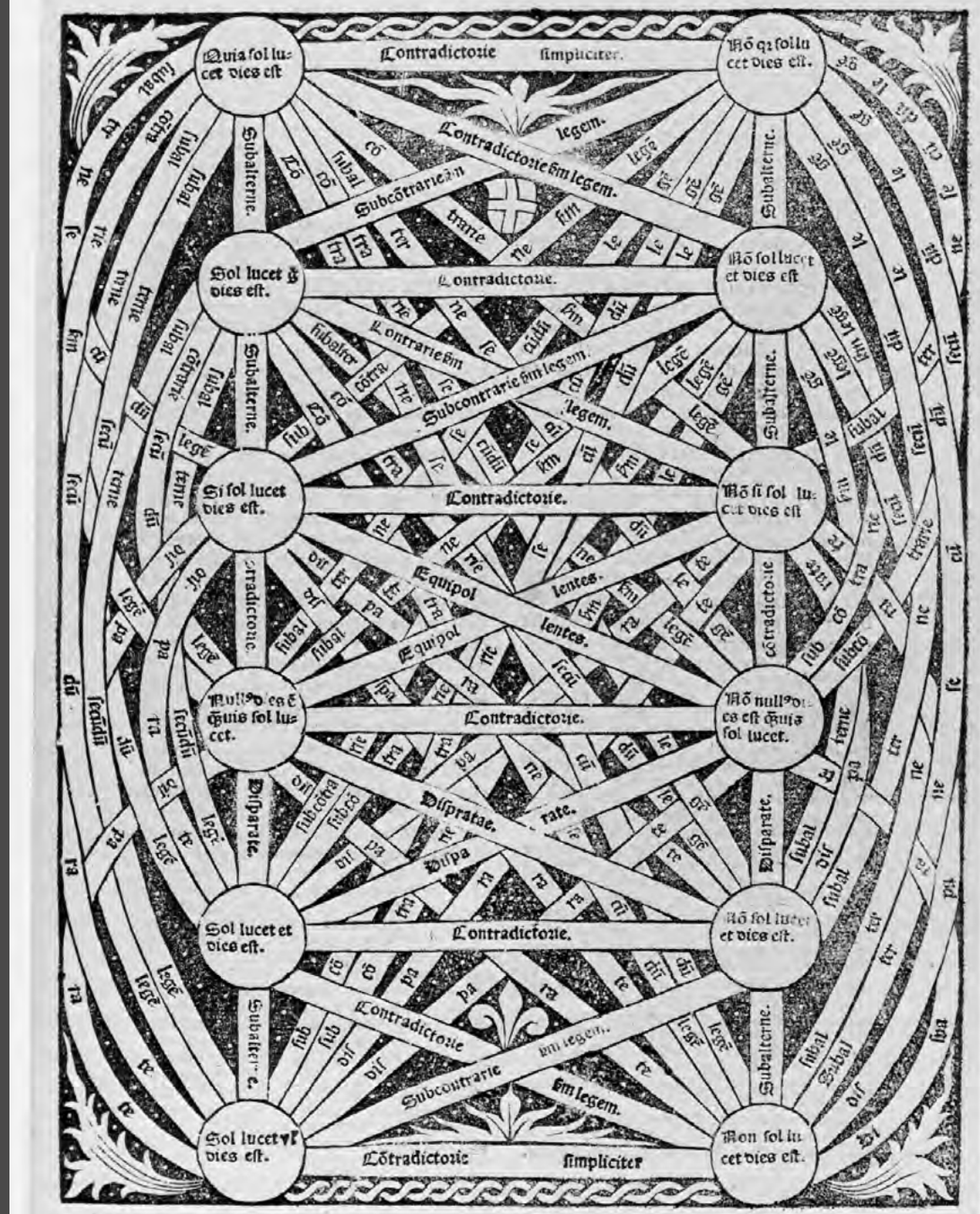
The real powers come from devising external aids that enhance cognitive abilities. How we increase memory, thought, and reasoning?
By the invention of external aids:
It is things that make us smart.

Donald A. Norman
Things that Makes Us Smart (1993), 43

Cognitive principles behind information visualization:

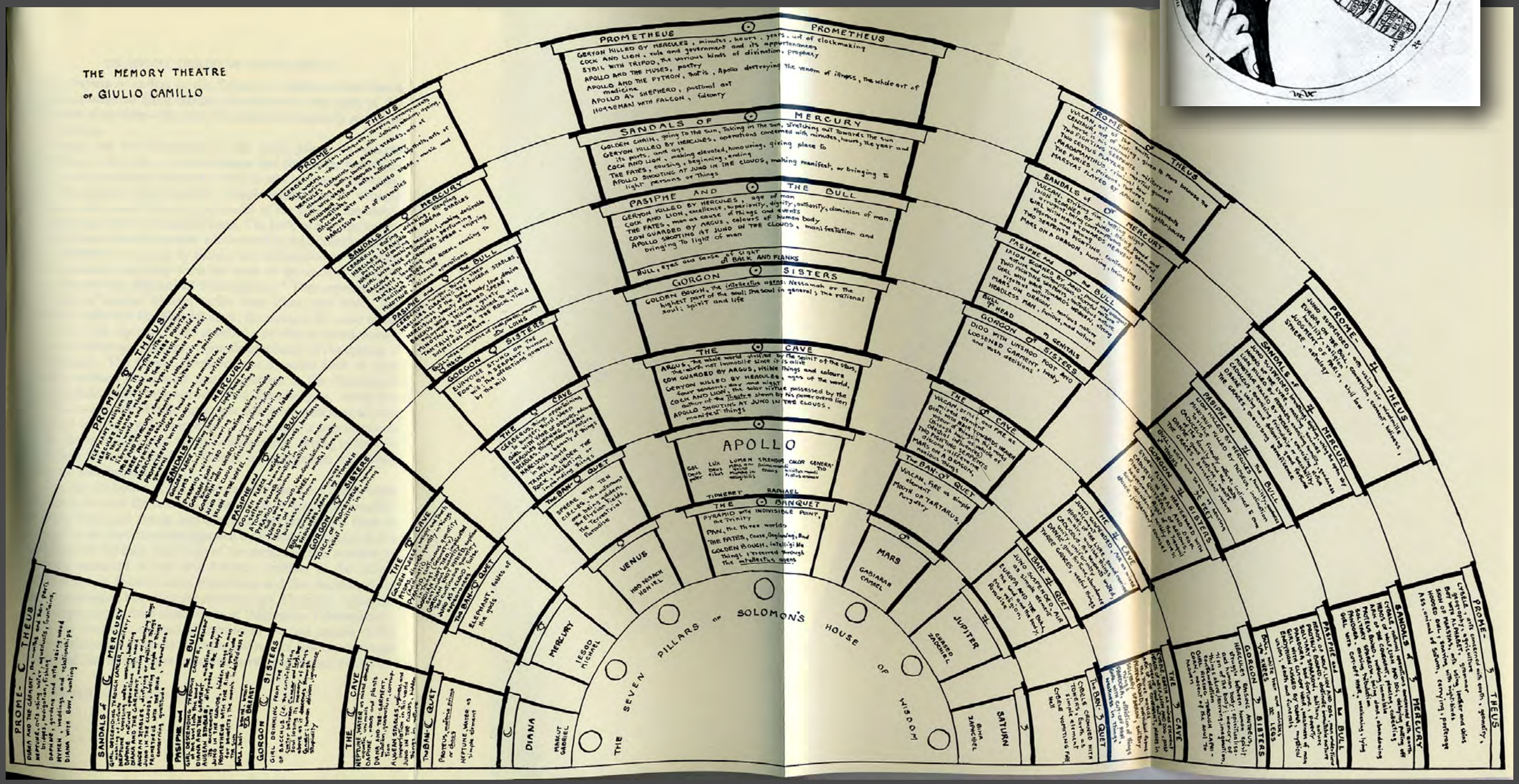
- to convey meaning
- to increase working memory
- to facilitate search & discovery
- to support perceptual inference
- to enhance detection & recognition
- to provide models of actual & theoretical worlds
- to provide manipulation of data





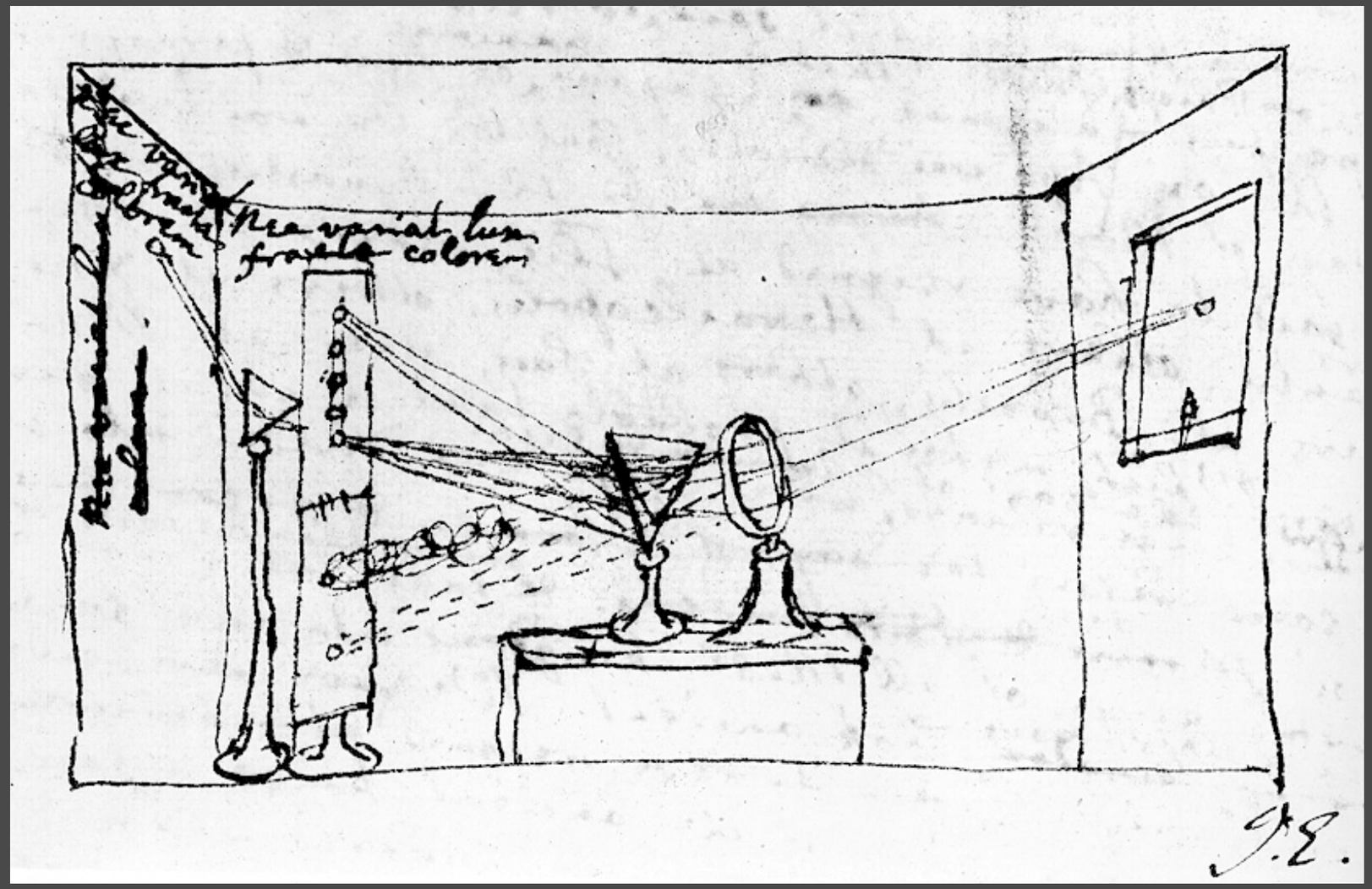
14th century Virtues, Vices, and the Sciences Dichotomy.

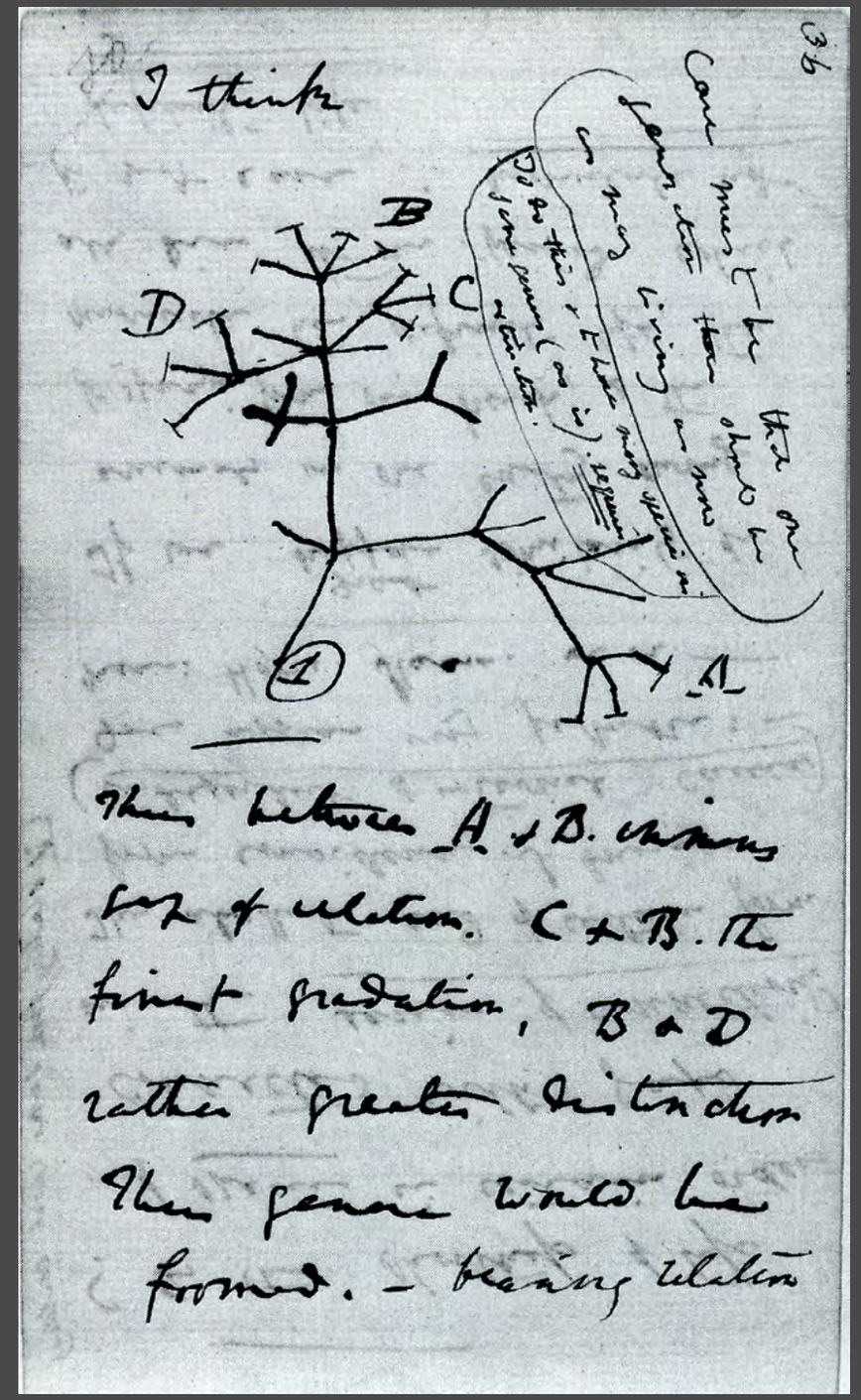
16th ct. printed work by the Spanish scholar Juan de Celaya



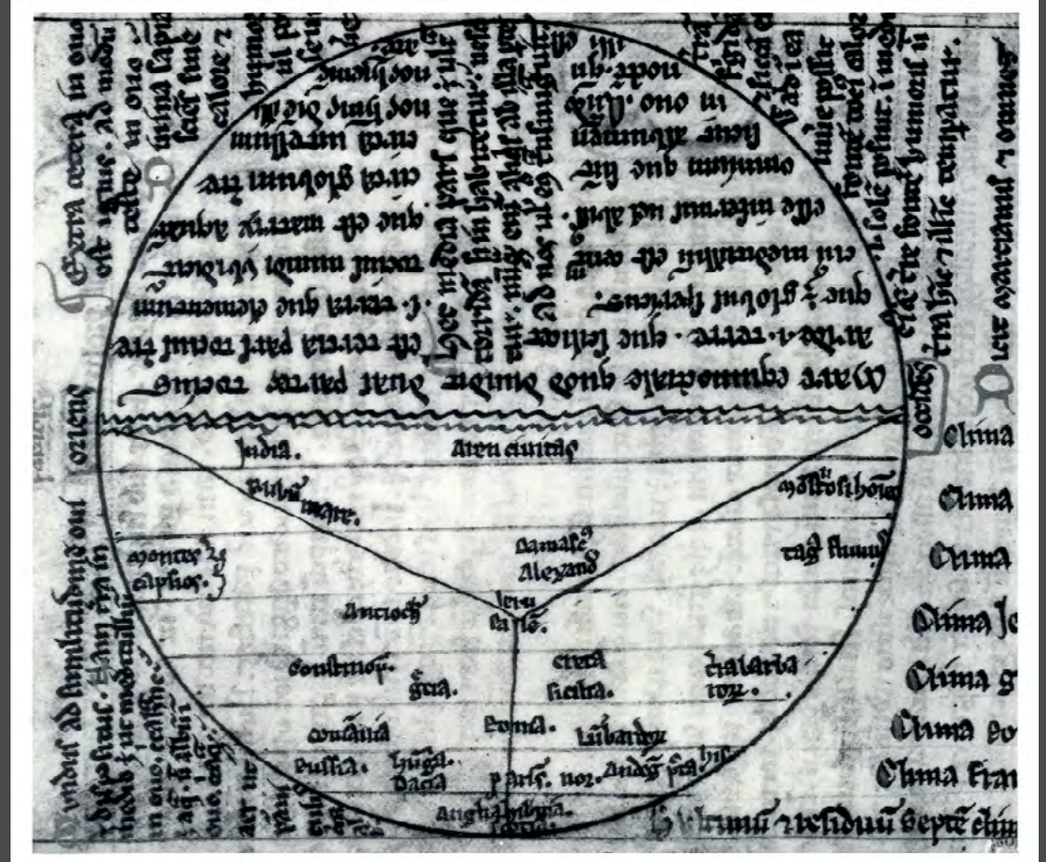
1274 Hand of Guido: utilization of mnemonic hands as part of medieval musical theory.

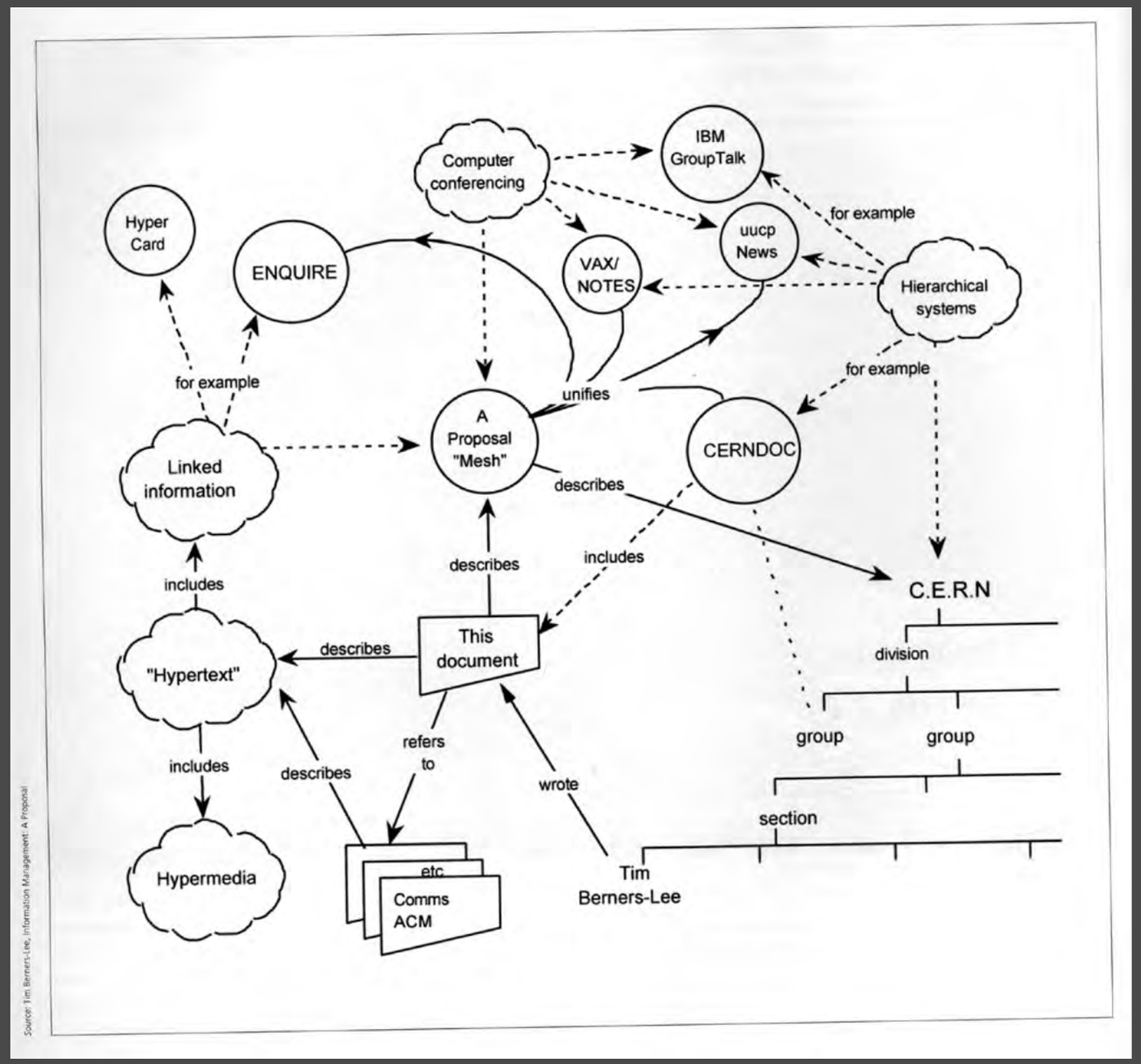
1550 Giulio Camillo: THe memory Theater.





Isaac Newton's 1665 sketch of experiment on light and color prism to generate color spectrum.
Charles Darwin's 1870 sketch for an Evolutionary Tree.





13th century World Map

1989 original concept of the World Wide Web by Tim Berners-Lee (while at CERN, Switzerland)

lesson 1

External aids enhance our cognitive abilities

2

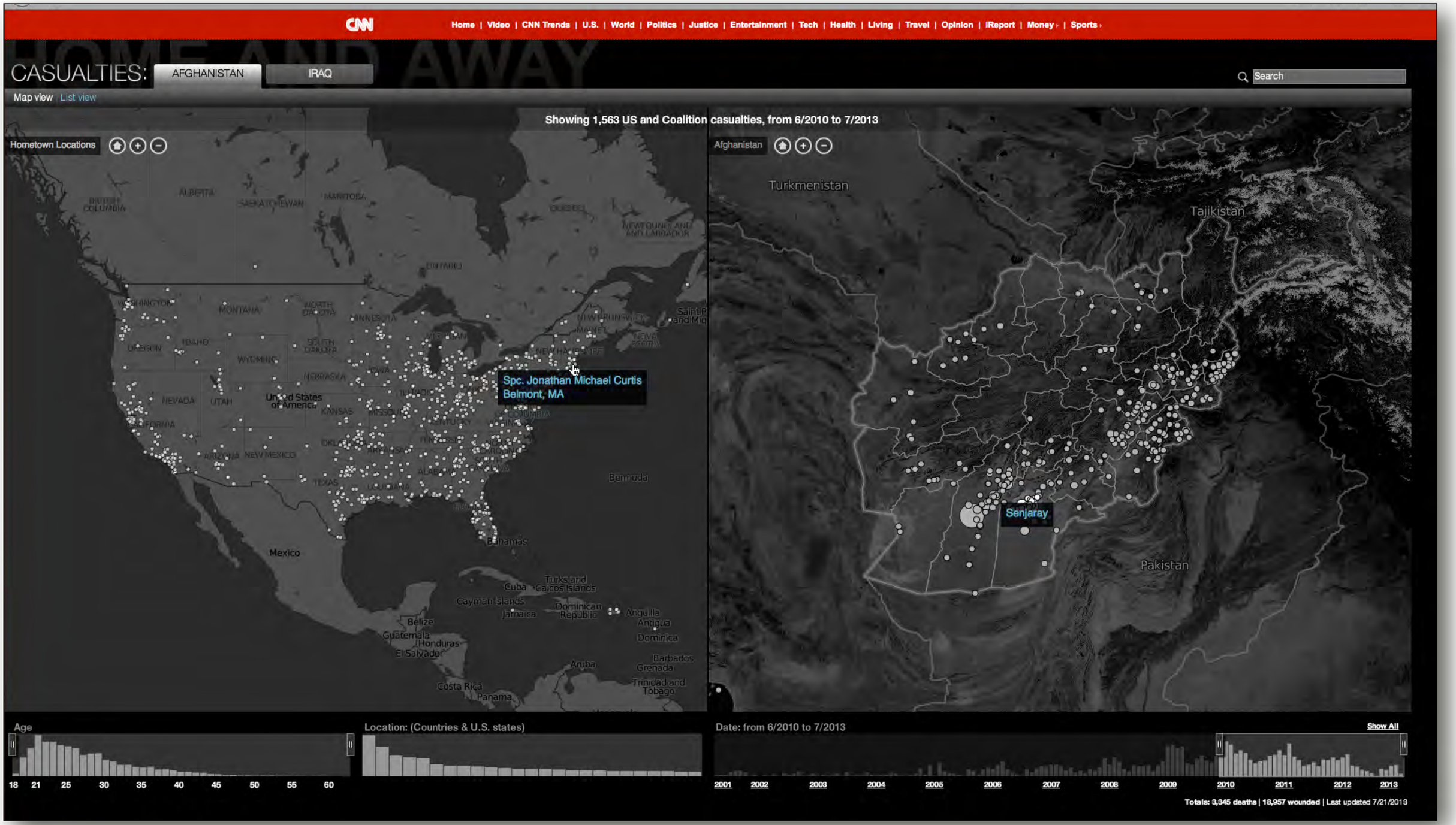
Always design a thing by considering
it in the next larger context:

***a chair in a room**,*
*a room **in a house**,*
*a house **in an environment**,*
*an environment **in a city plan**.*

Eliel Saarinen

2

Context is key to understanding



Stamen Design & CNN : Home and Away > www.cnn.com/SPECIALS/war.casualties

USA

Canada

Brazil

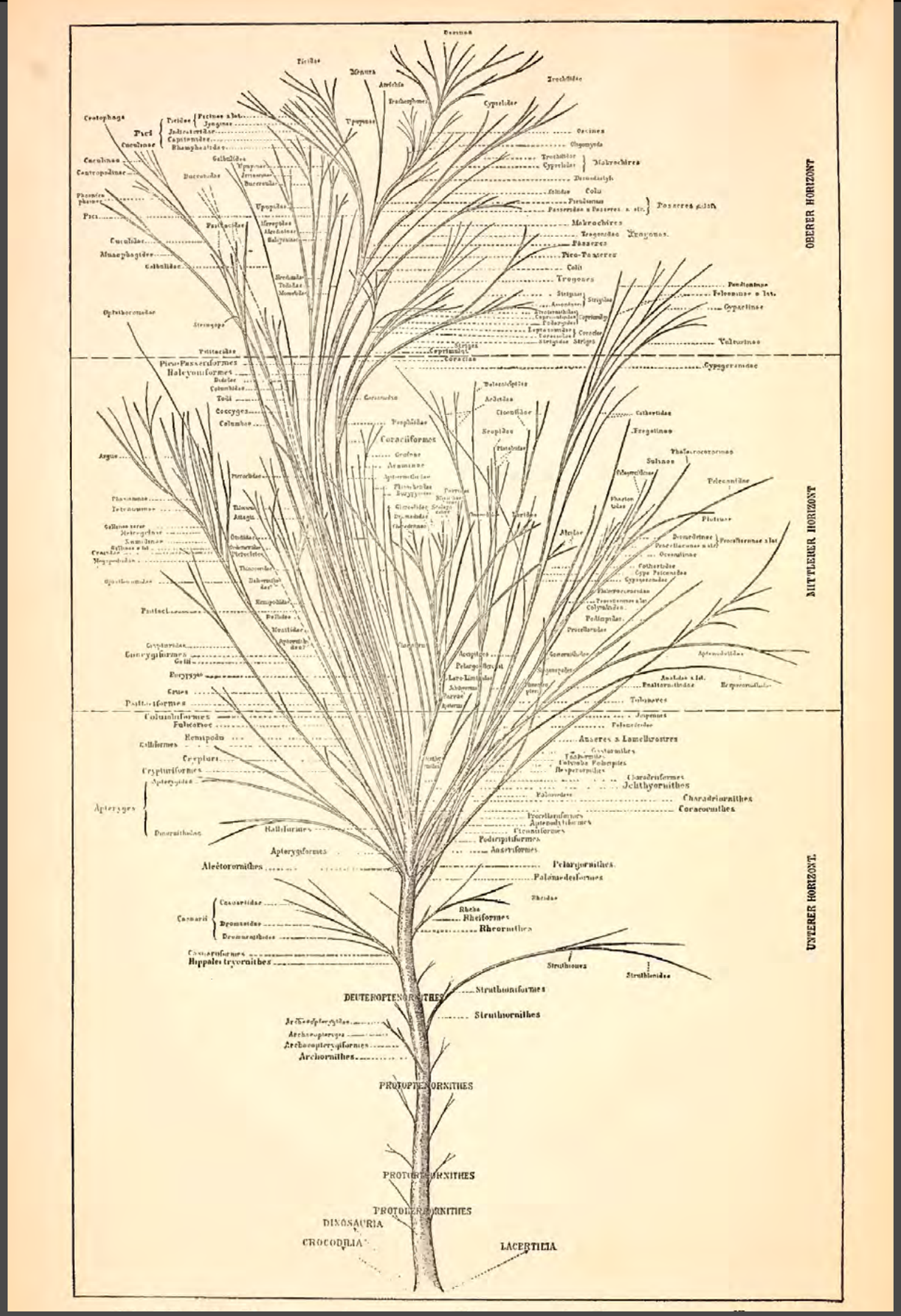
UK

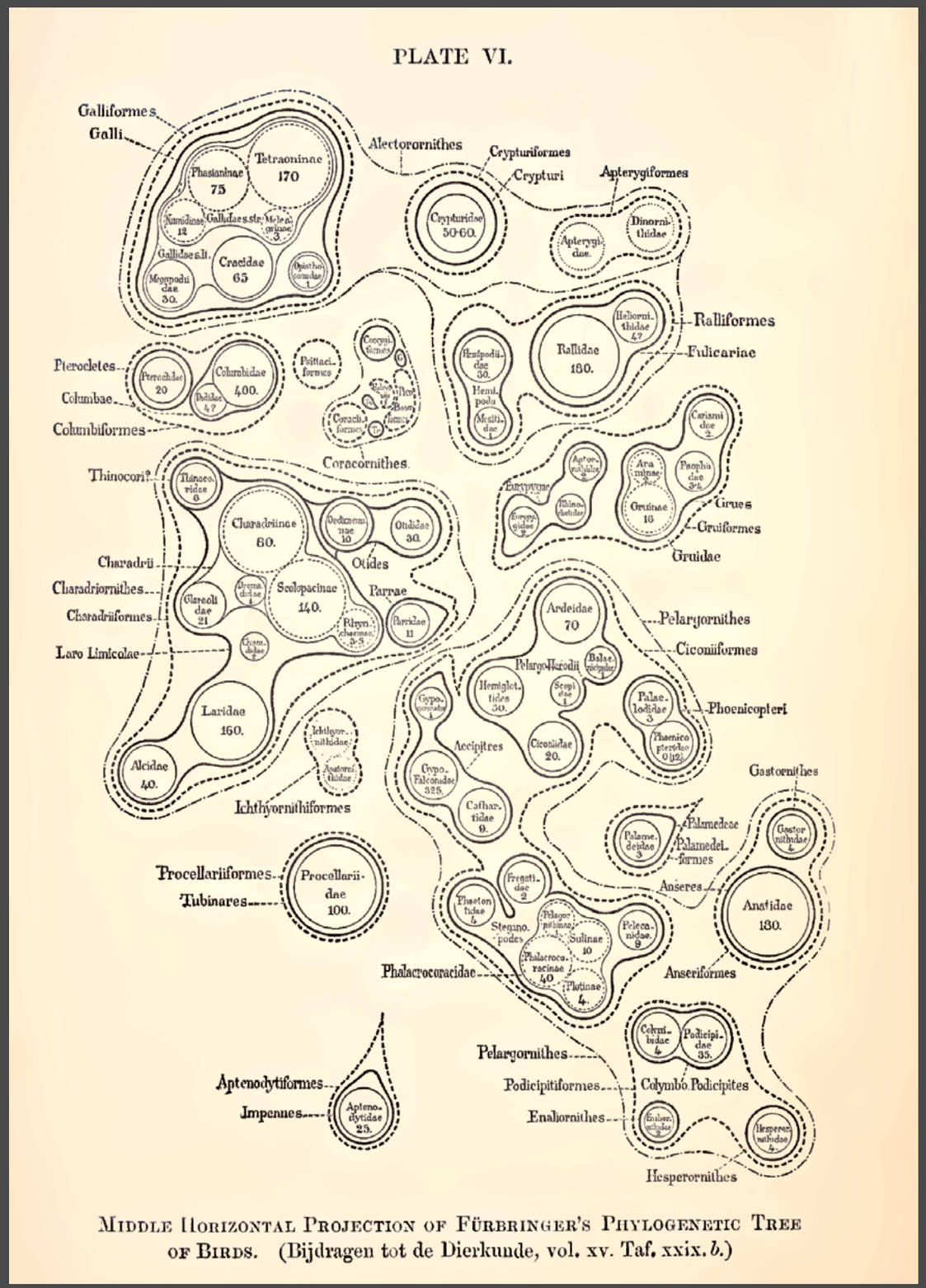
Marcos Weskamp (2004): NewsMap > http://newsmap.jp | July 19, 2014

lesson 2

Information visualizations are good at **providing context** and uncovering patterns that can **facilitate decision-making**

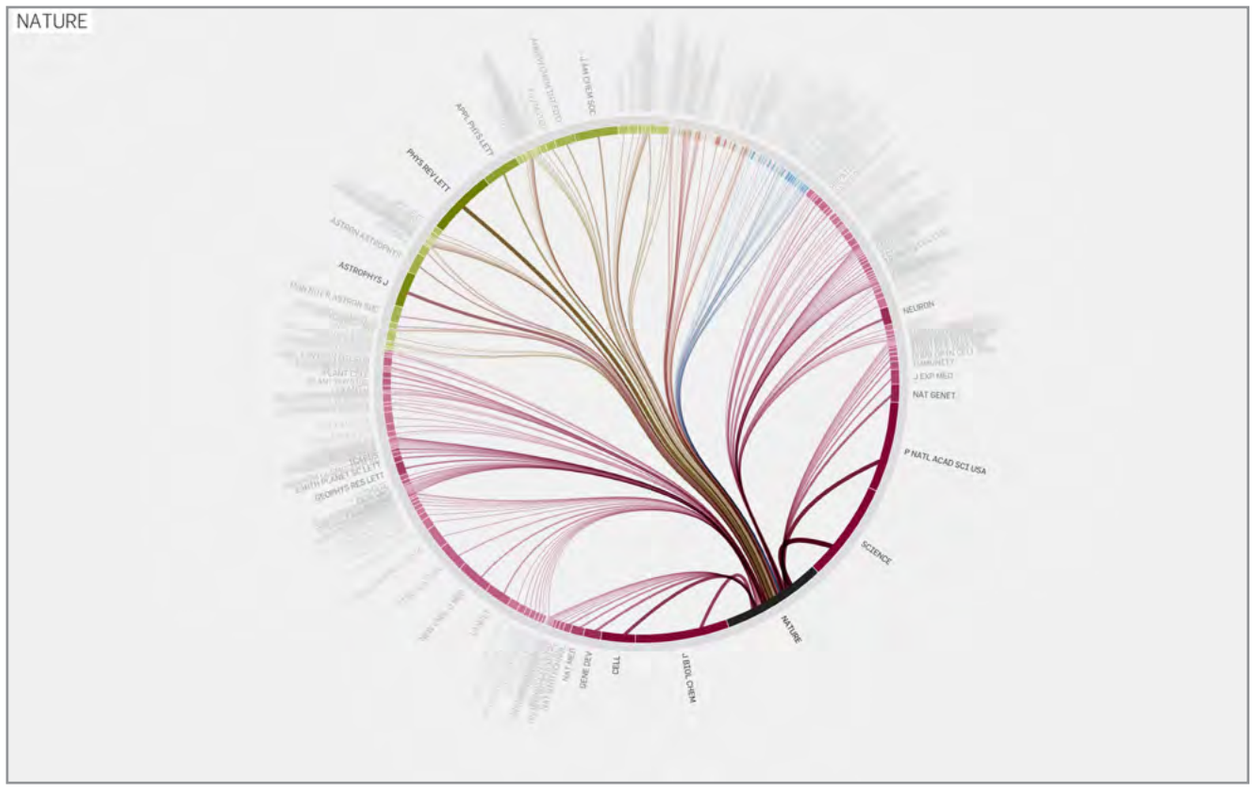
3 **There is not a single answer to a given problem**

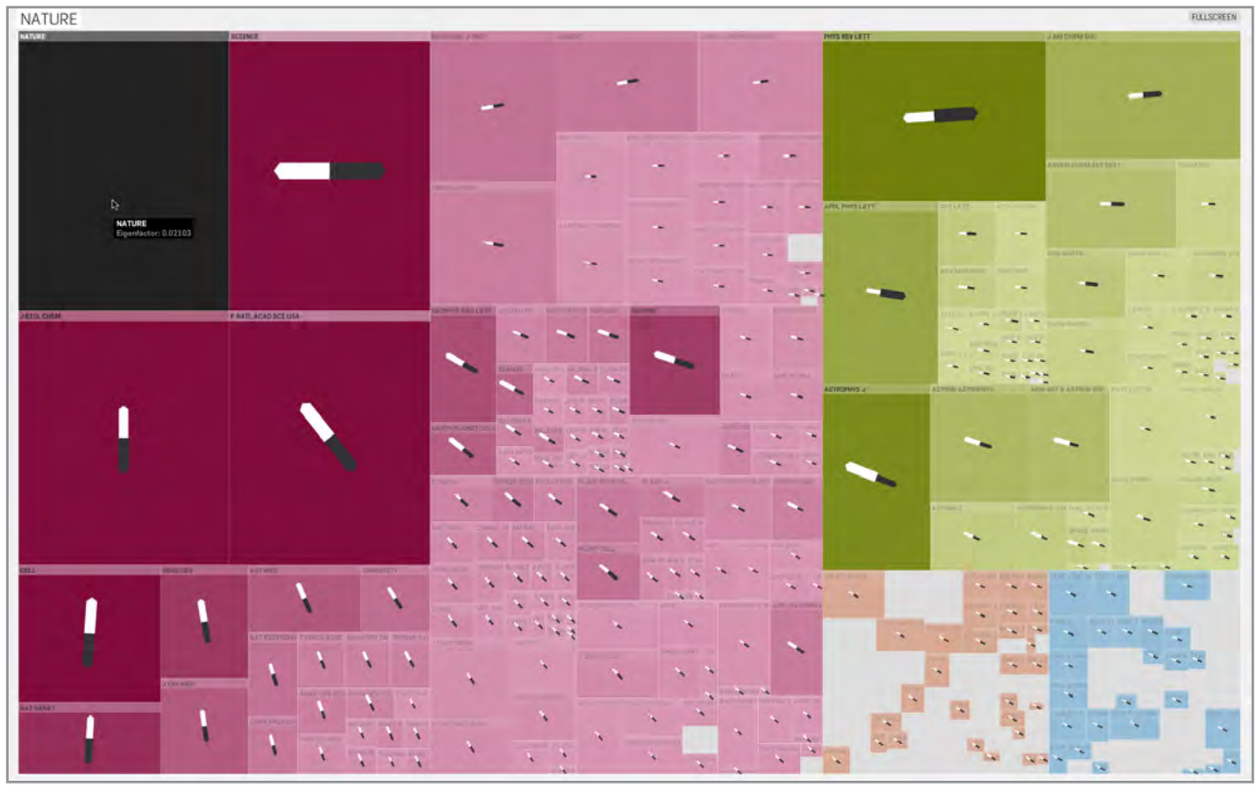


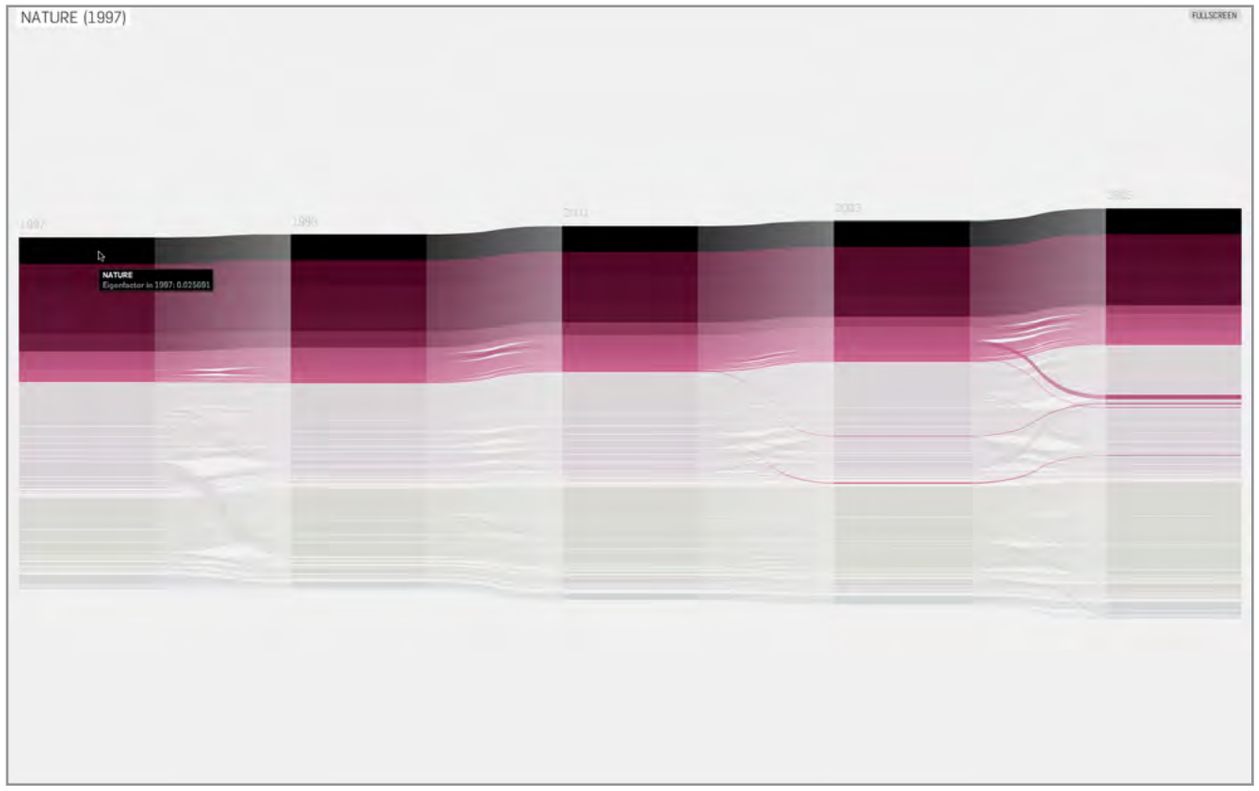


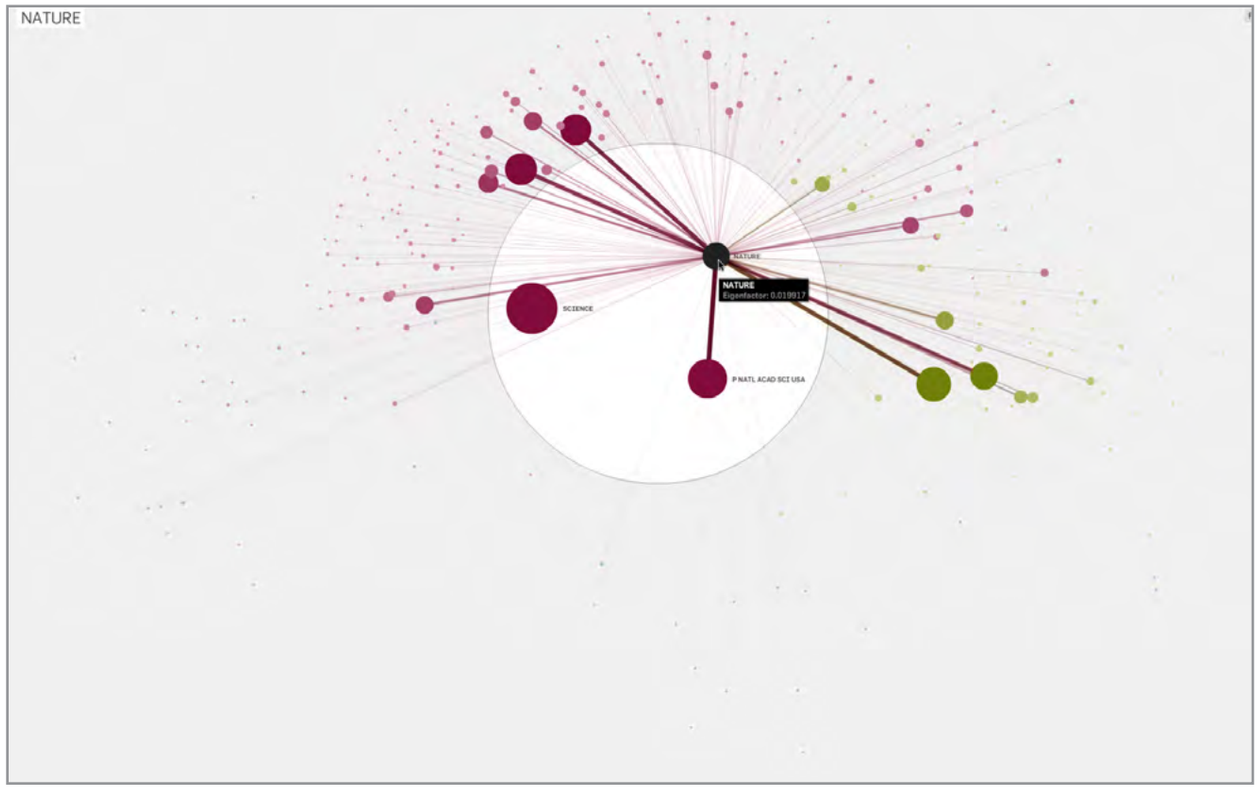
MIDDLE HORIZONTAL PROJECTION OF FÜRBRINGER'S PHYLOGENETIC TREE OF BIRDS. (Bijdragen tot de Dierkunde, vol. xv. Taf. xxix. *b*.)

Max Fürbringer (1888): Diagrams representing the “Phylogenetic Tree of Birds”

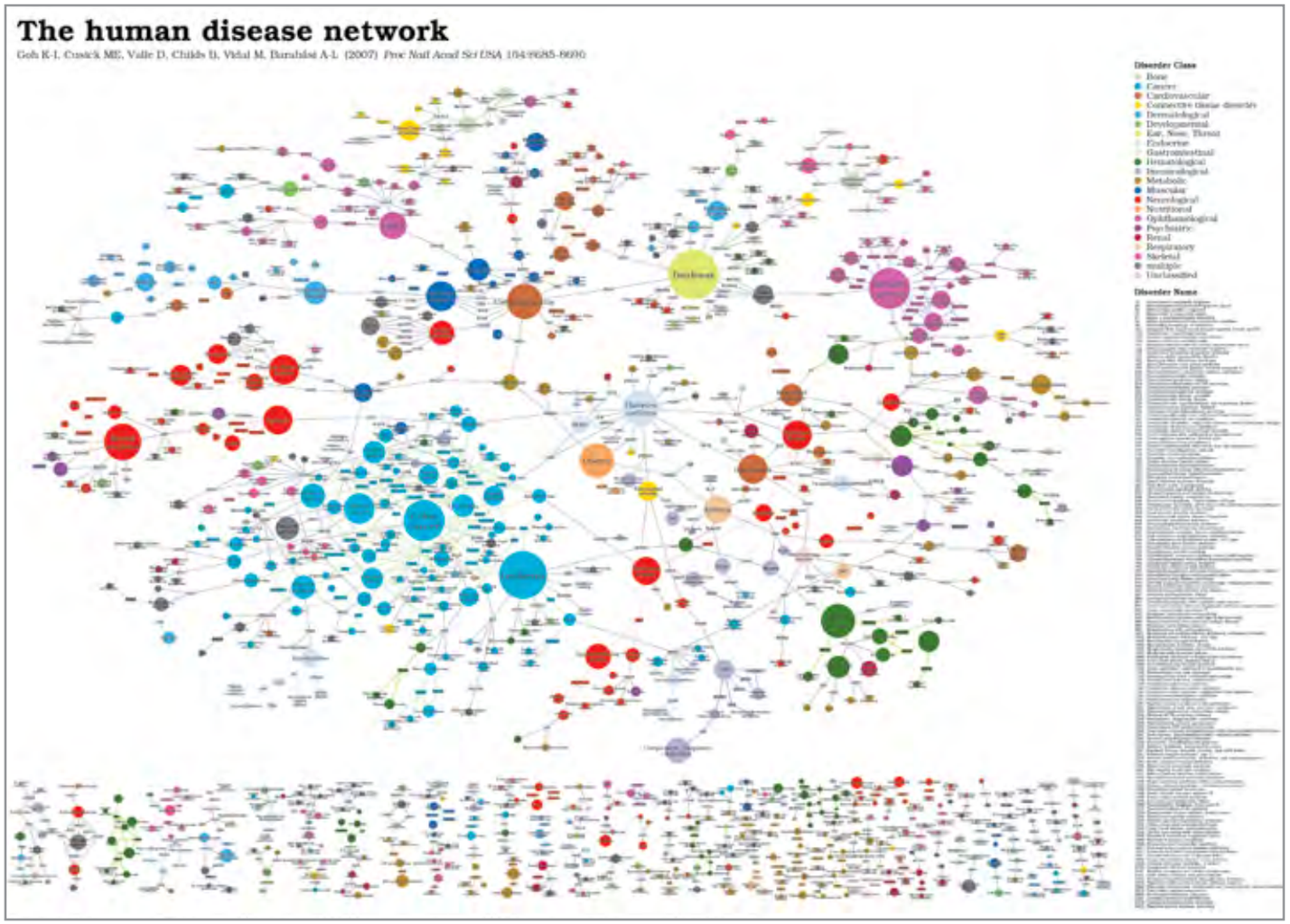


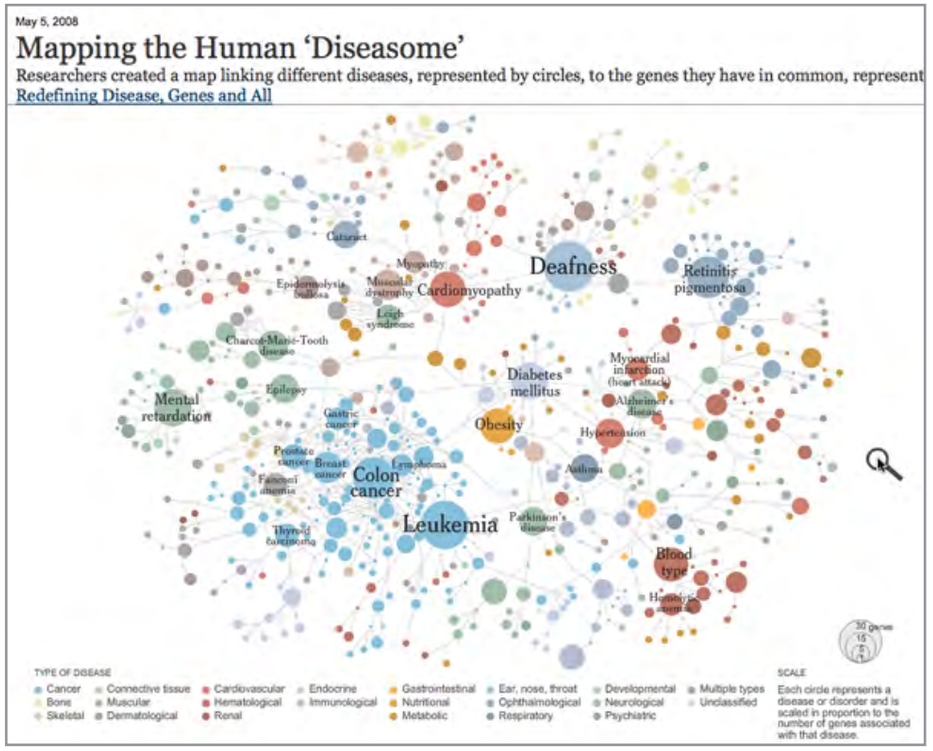


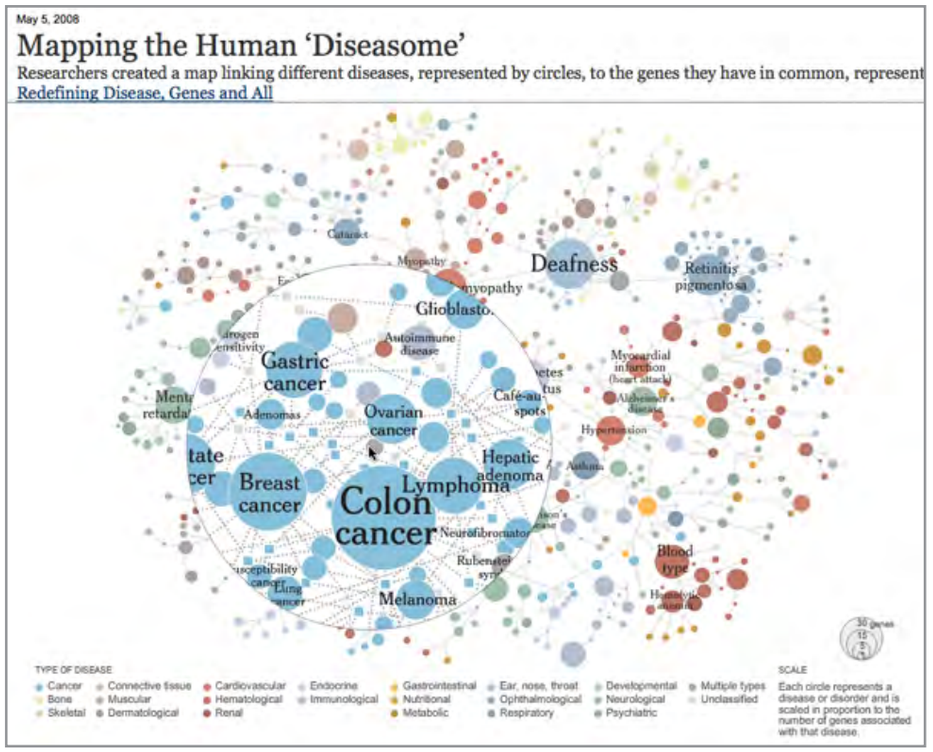




M. Stefaner et al. (2009): http://well-formed.eigenfactor.org







Vidal et al.: The Human Disease Network

Poster :The PNAS in 2007

Online tool: The New York Times in 2008 > http://nyti.ms/1aMWXgz

lesson 3

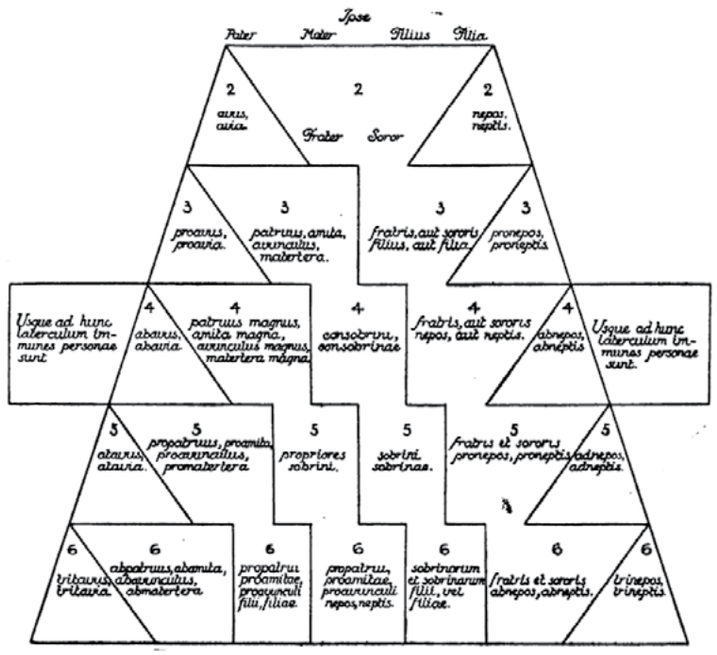
Design entails compromise and depends largely on the task and target audience

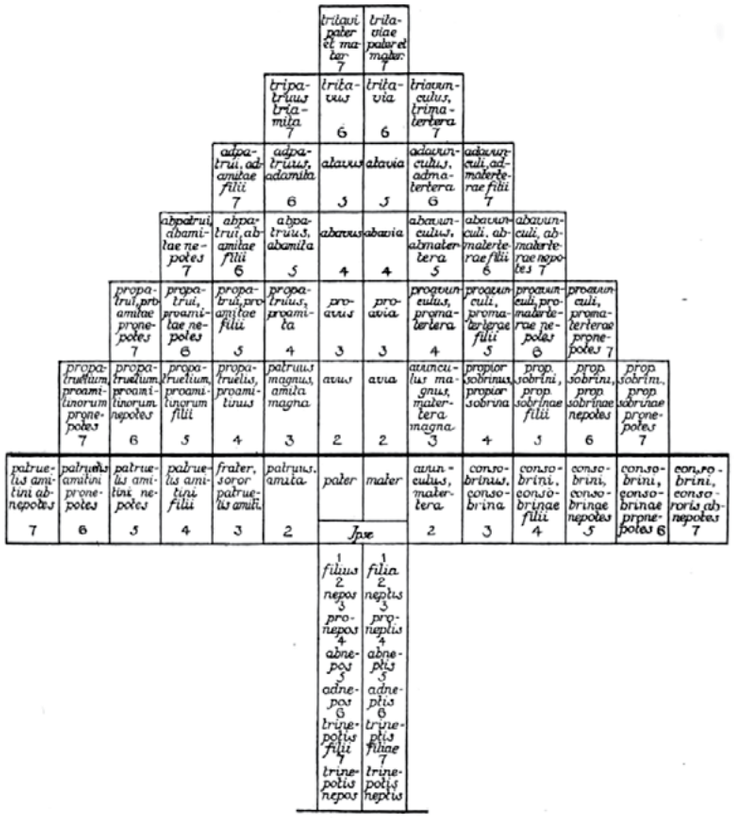
4

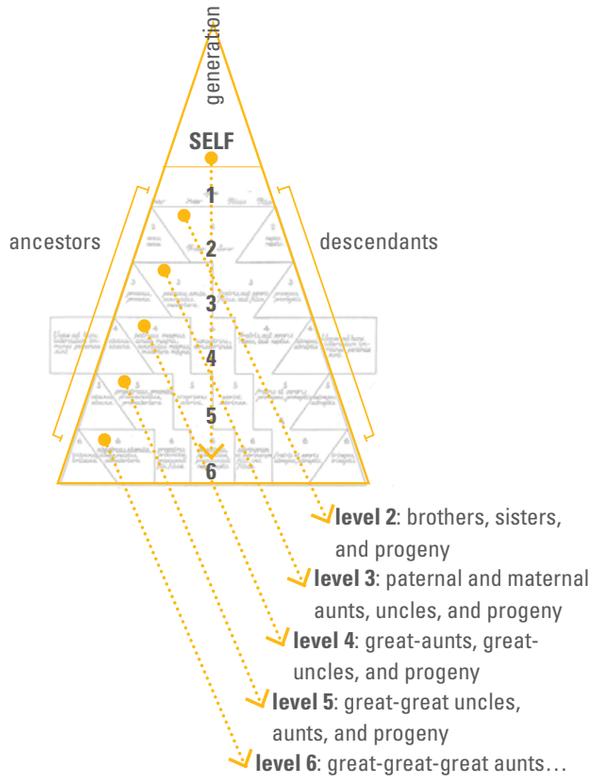
The brain is a powerful pattern-finding engine… If we can transform data into the appropriate visual representation, its structure may be revealed.

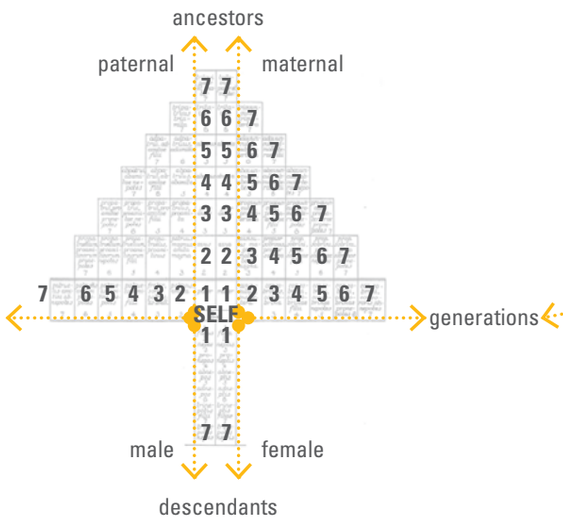
Colin Ware

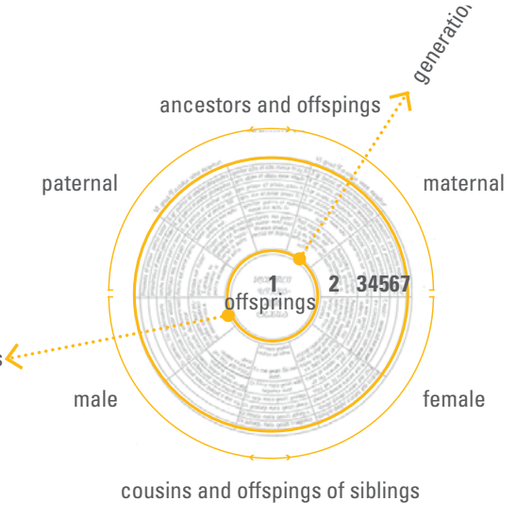
Information Visualization, Second Edition: Perception for Design (2004), 239



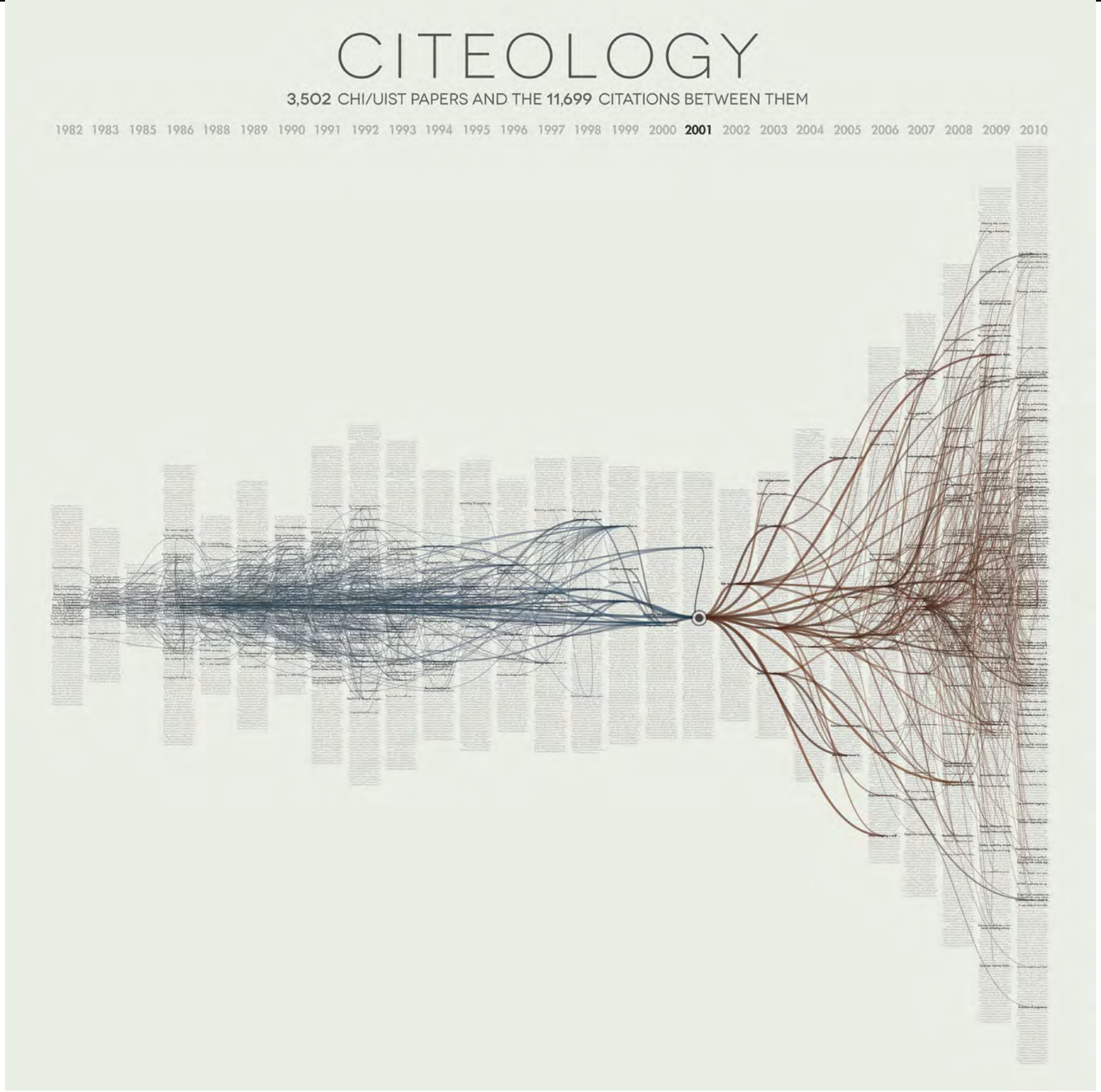




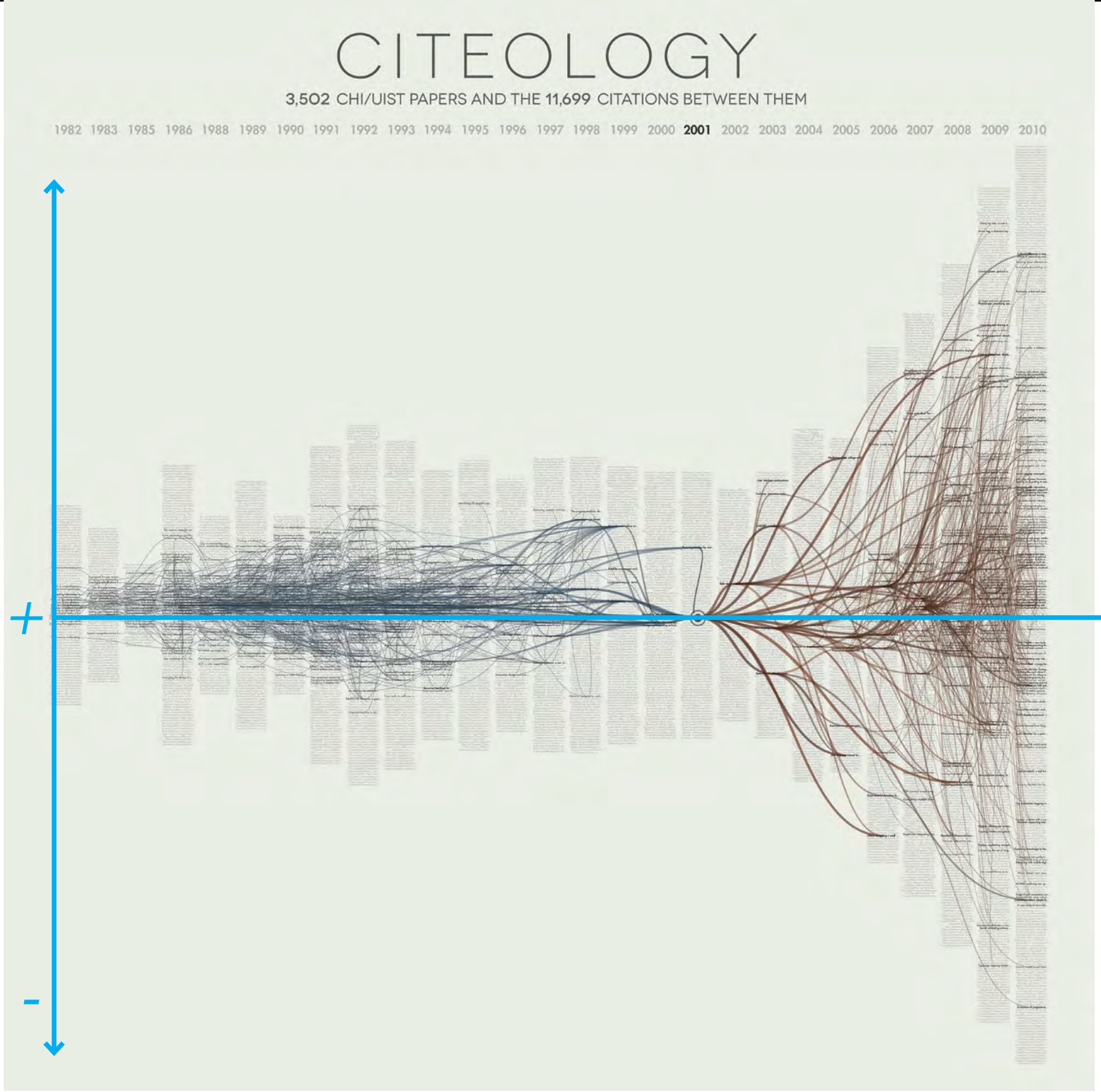




Bishop Isidore of Seville: “Consanguinity Trees,” I, II, III, Seventh century.



Justin Matejka et al. (Autodesk), 2011 > www.autodeskresearch.com/projects/citeology

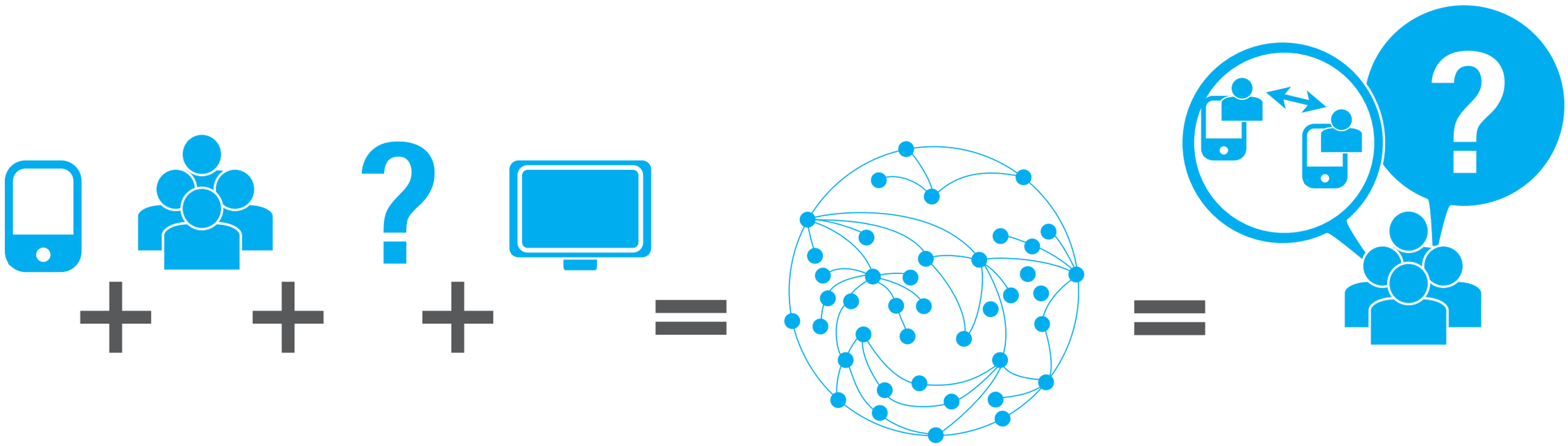


Justin Matejka et al. (Autodesk), 2011 > www.autodeskresearch.com/projects/citeology

lesson 4

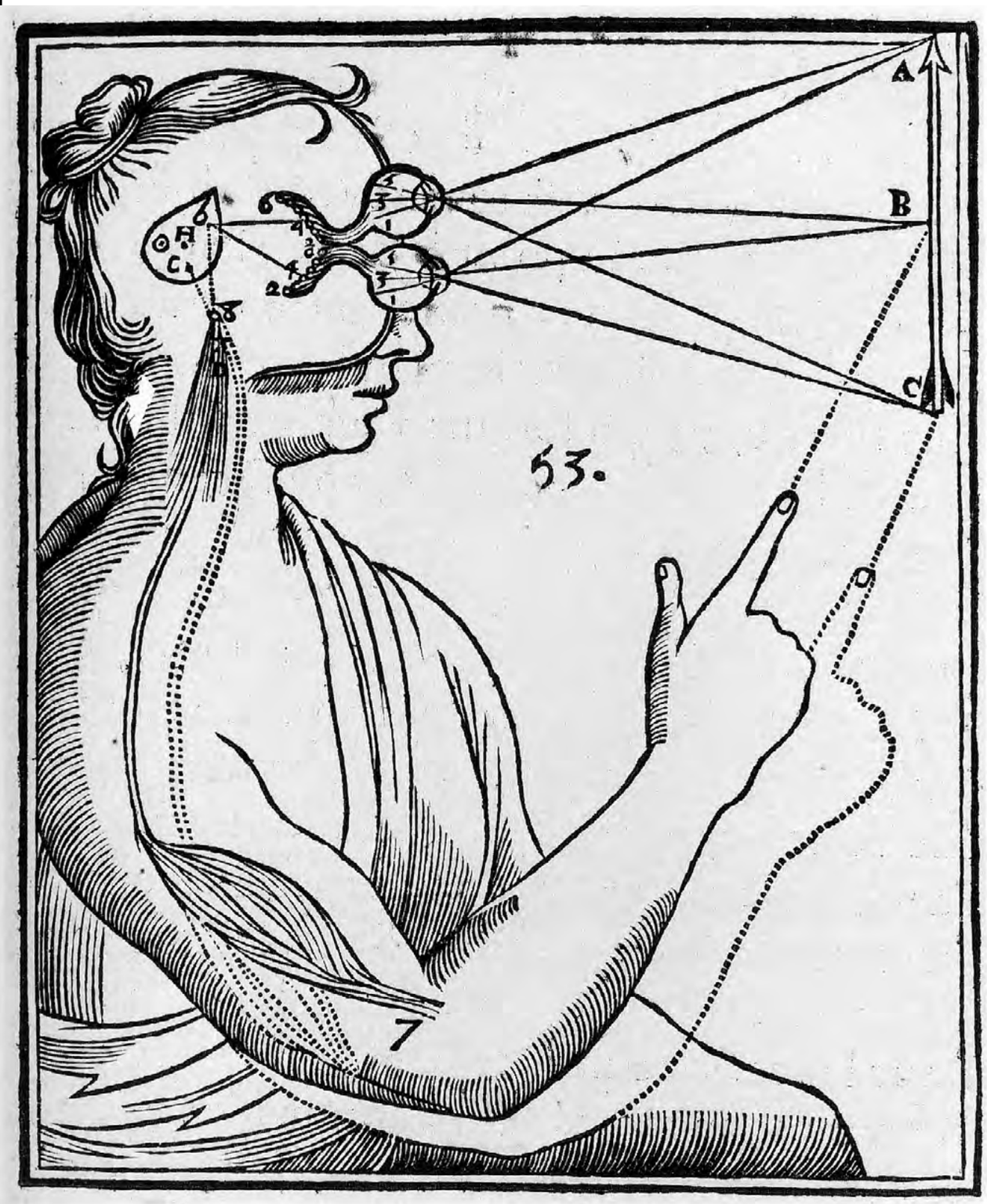
Solving a problem requires finding the **right representation**

5 Perceptual and Cognitive capabilities and constraints



information designer *target audiences*

encode **de**code



René Descartes (1664):
The Process of Visual Perception

Constraints:

Perceptual systems

Cognitive processes

Data types

Dimensions of medium

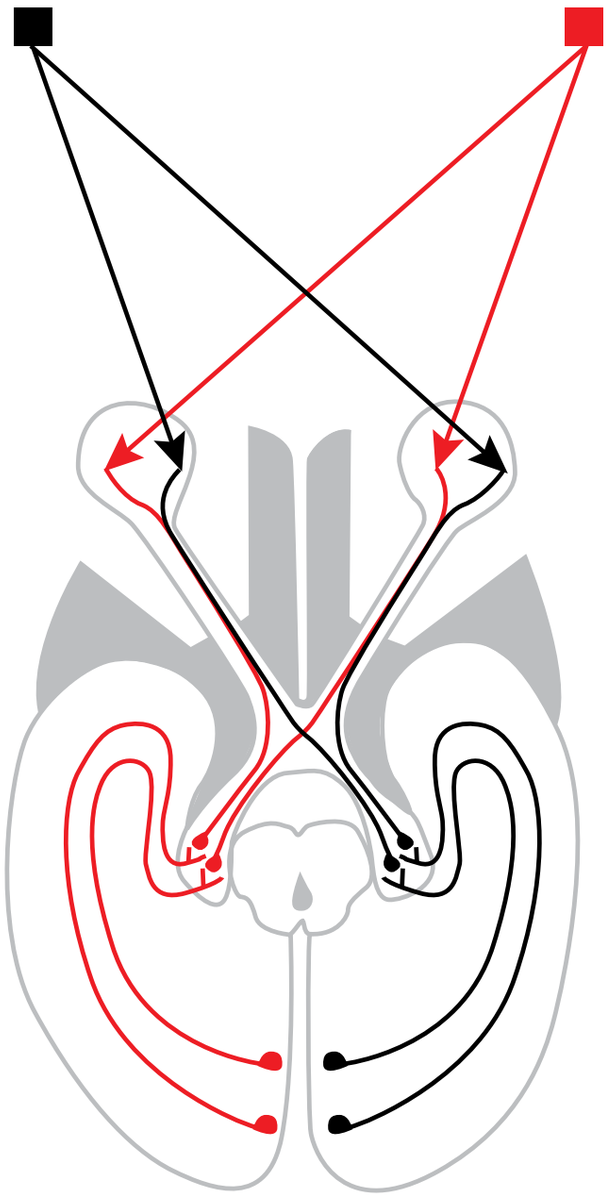
Representation types

Prior knowledge

Believes

...

See & Understand

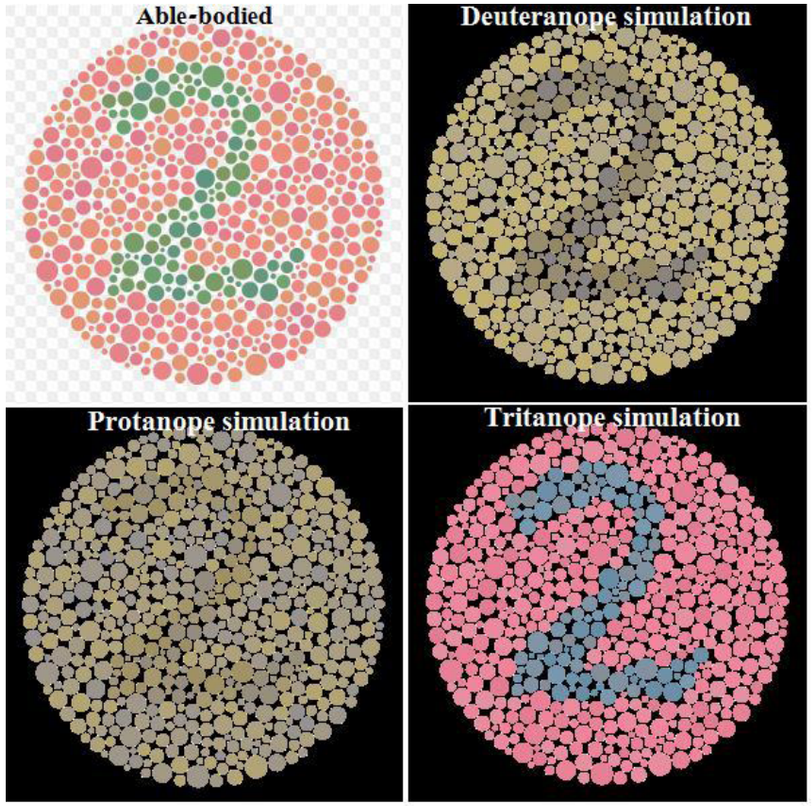


see *verb 1. I can see the house make out, catch sight of, glimpse, spot, notice, observe, view,* **perceive**, **discern**, *espy, descry, distinguish, identify,* **recognize**. *2. see that man over there look at, regard, note, observe, heed, mark, behold, watch; inf. get a load of. 3. saw a movie last night watch, look at, view. 4. see what they mean* **understand**, **grasp**, *get,* **comprehend**, *follow, take in,* **know**, *realize, get the drift of, make out, fathom; inf. latch on to. 5. go and see what he wants find out, discover,* **learn**, *ascertain, determine, ask, inquire, make inquiries into/about, investigate. 6. we will have to see* **think**, *consider, reflect, deliberate, give thought, have a think.*

understand *verb 1. understand his meaning | understand what he says* **comprehend**, *apprehend,* **grasp**, **see**, *take in,* **perceive**, **discern**, *make out, glean,* **recognize**, *appreciate, get to* **know**, *follow, fathom, get to the bottom of, penetrate, interpret; inf. get the hang/drift of, catch on, latch on to, figure out. 2 . I understand your feelings/position appreciate, accept, commiserate with, feel compassionate toward, sympathize with, empathize with. 3. I understand that he has left gather, hear, be informed,* **learn**, *believe,* **think**, *conclude.*

Perceptual constraints

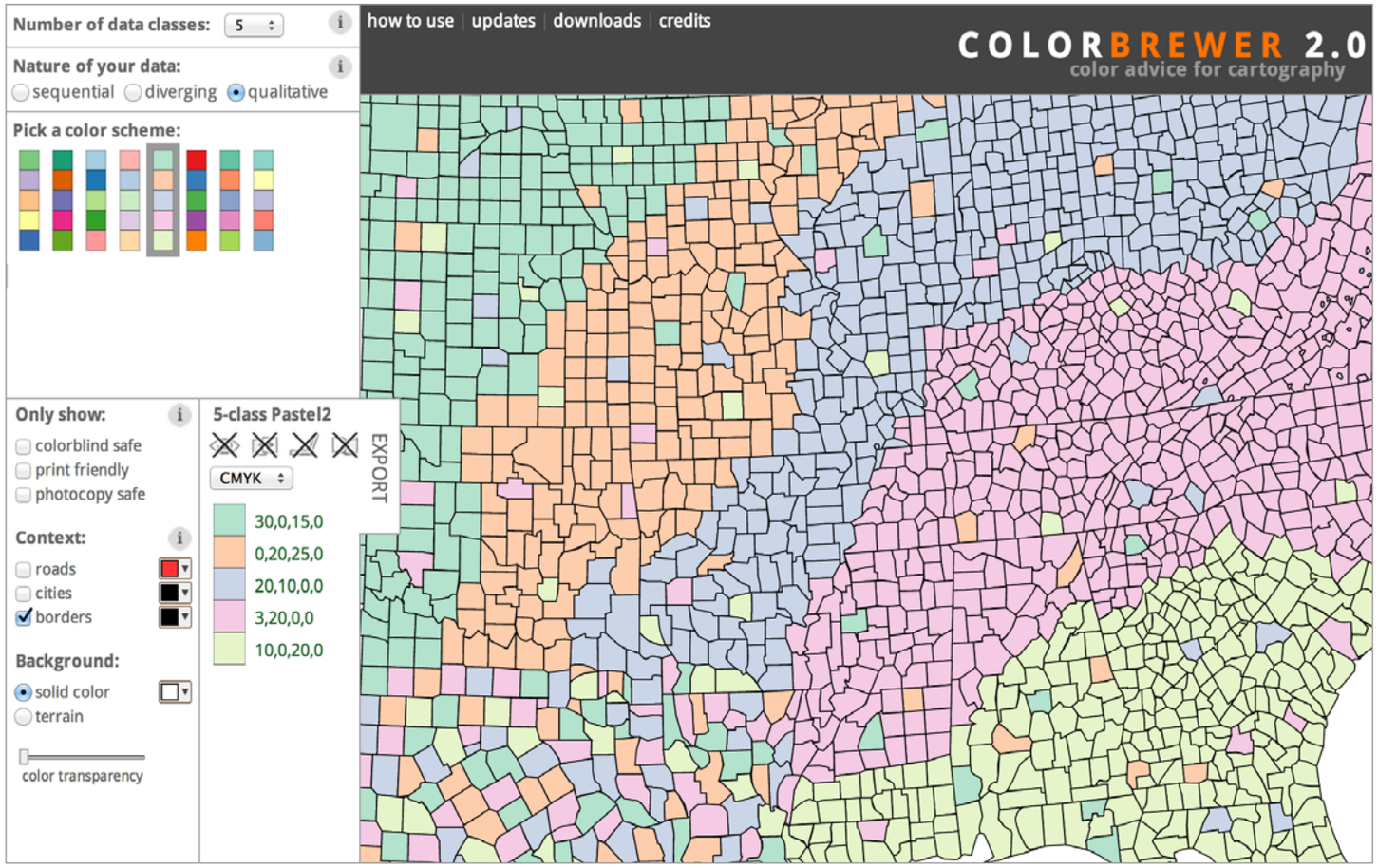
green deficient



red deficient

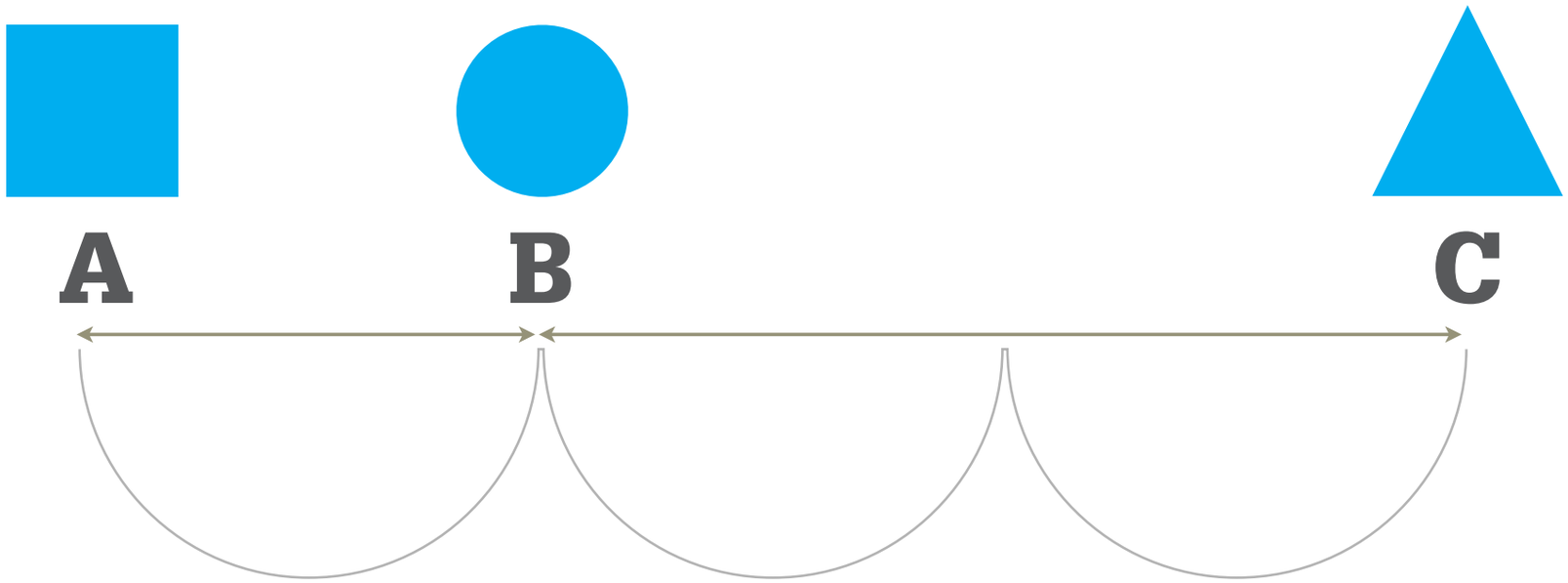
blue deficient

Ishihara test image



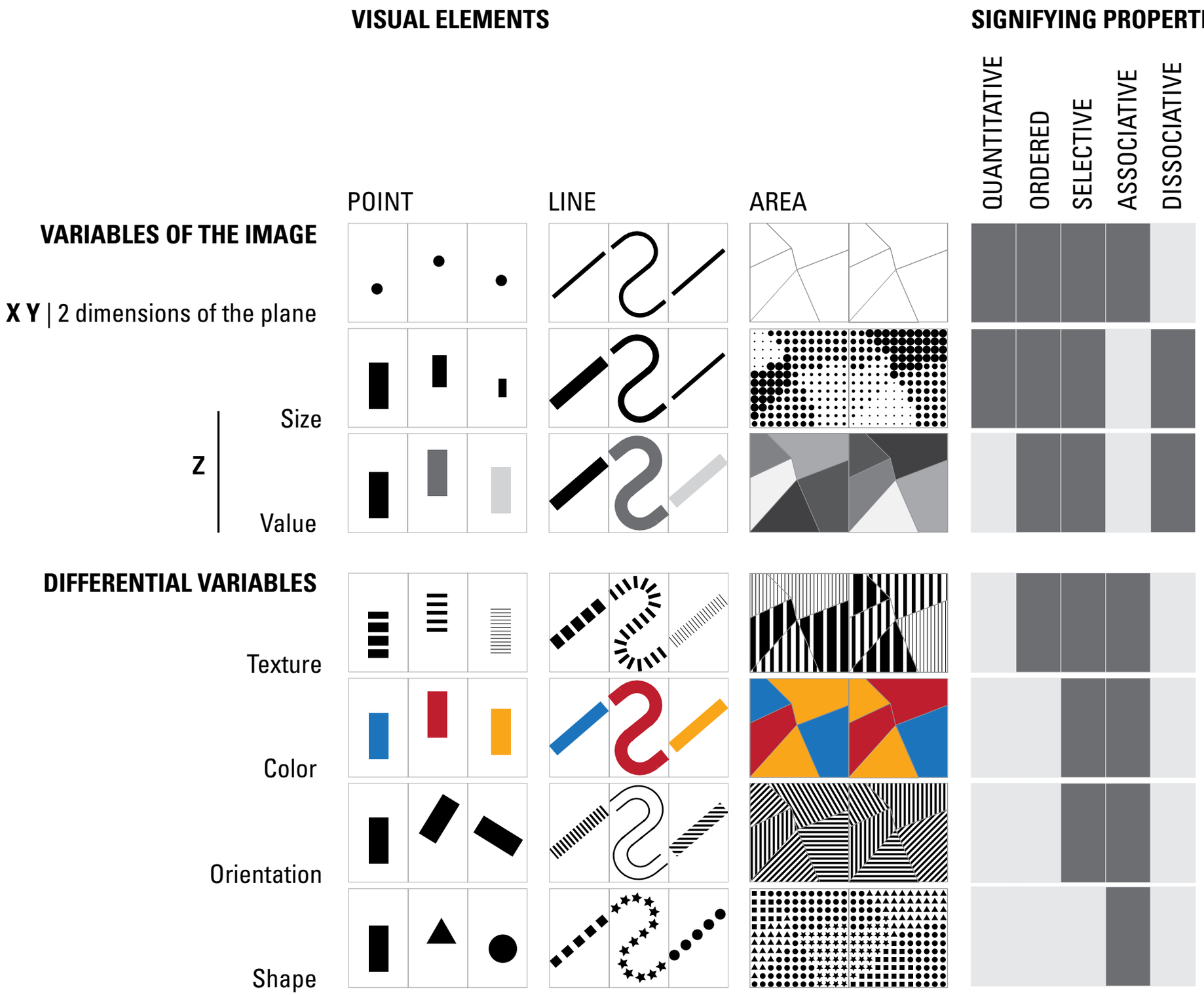
Chyntia Brewer color tool > http://colorbrewer2.org/

Data types constraints



Nominal: A, **B**, **C** *are distinguishable*
Ordinal: B *is between* **A** *and* **C**
Quantitative: BC *is twice as long as* **AB**

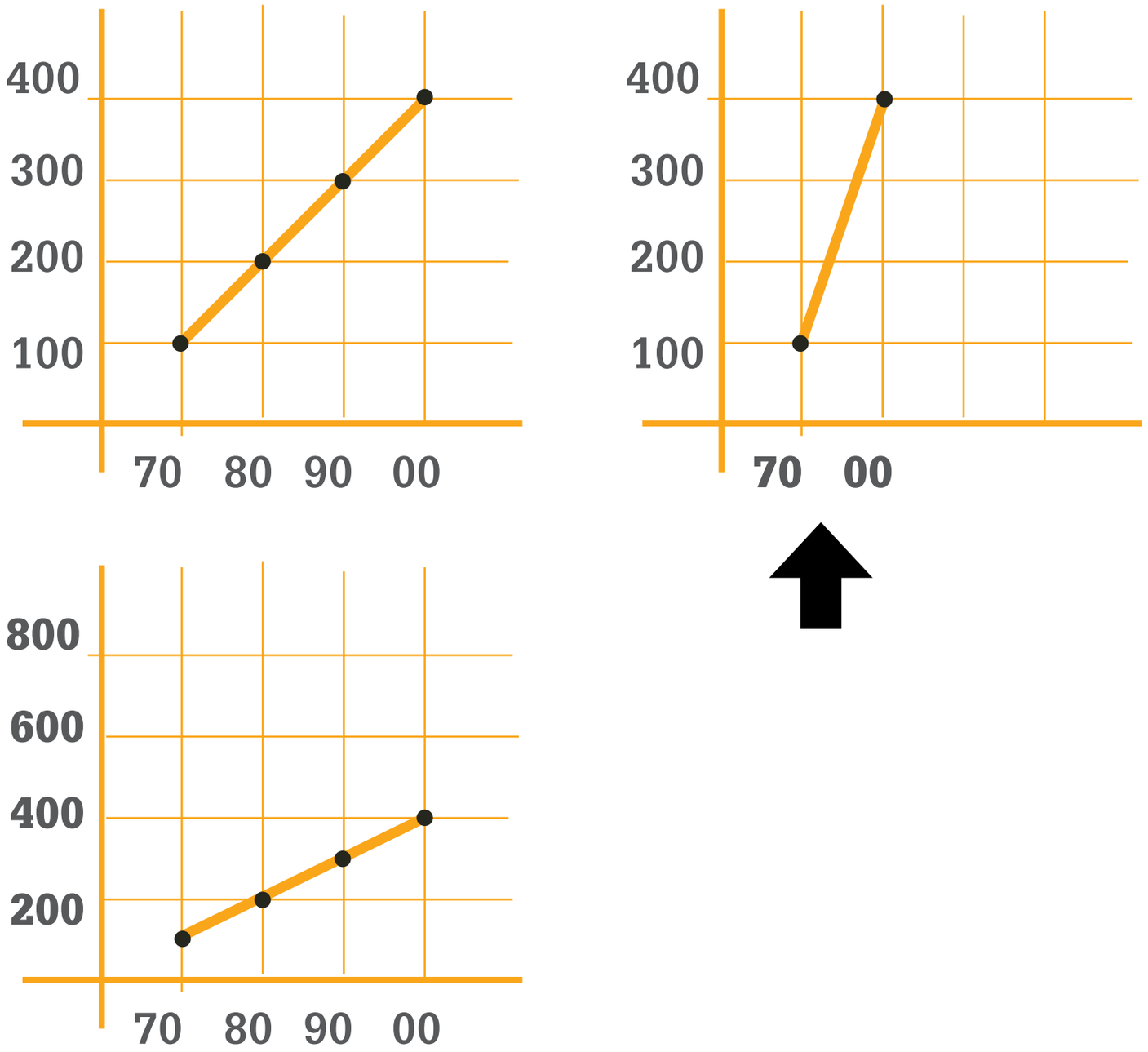
Bertin's system: perceptual variables



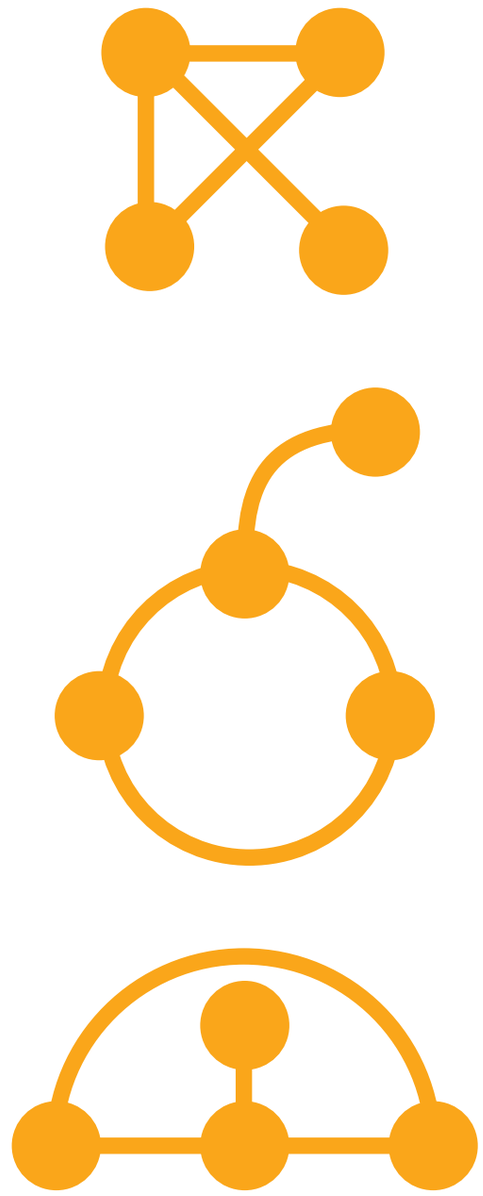
J. Bertin (1967): *Semiologie Graphique*

Graphics can mislead

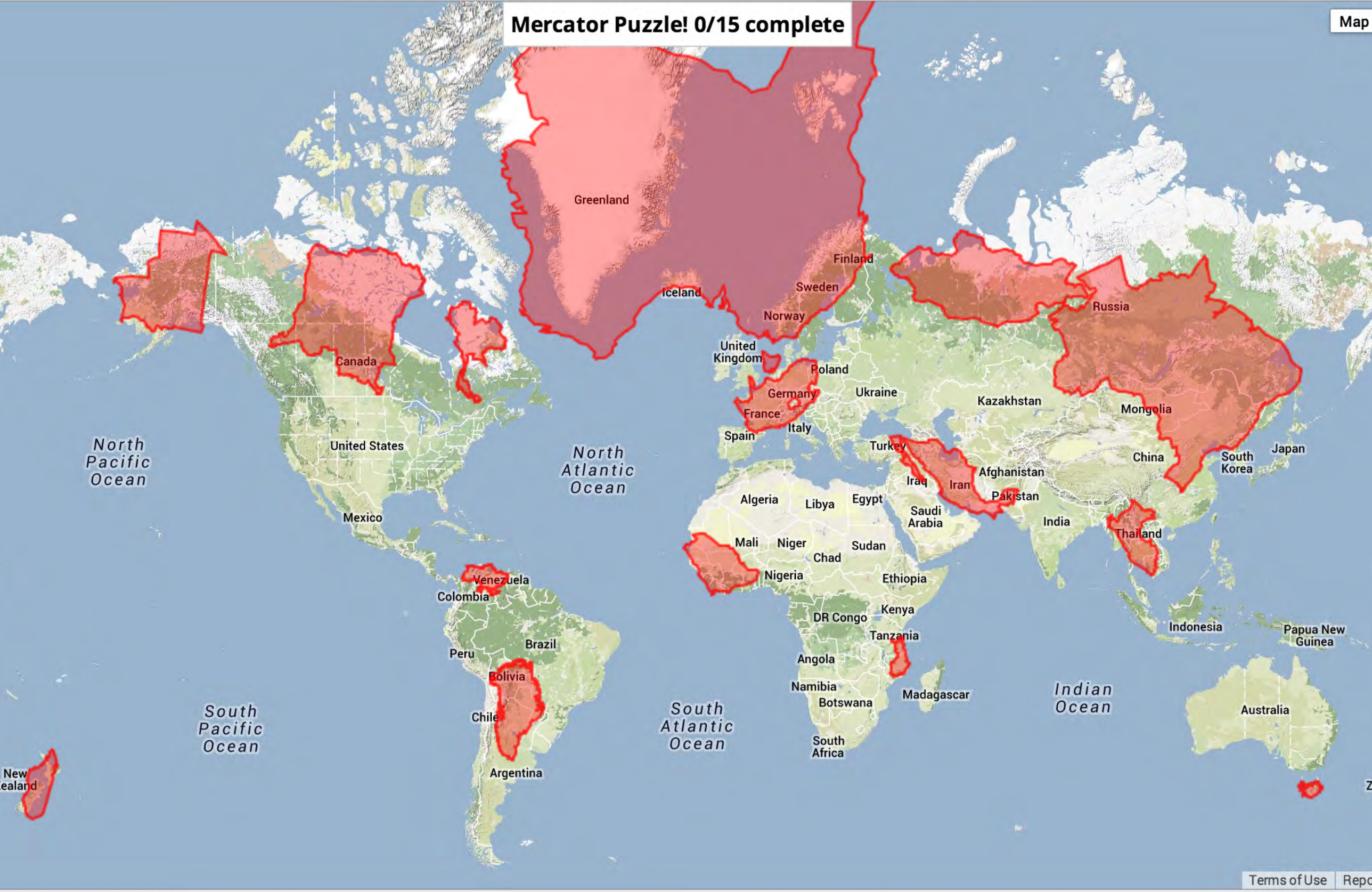
Axes / ratios:



Topologies:



Paul Butler (Facebook), 2010: Map visualizing friendships in Facebook around the globe

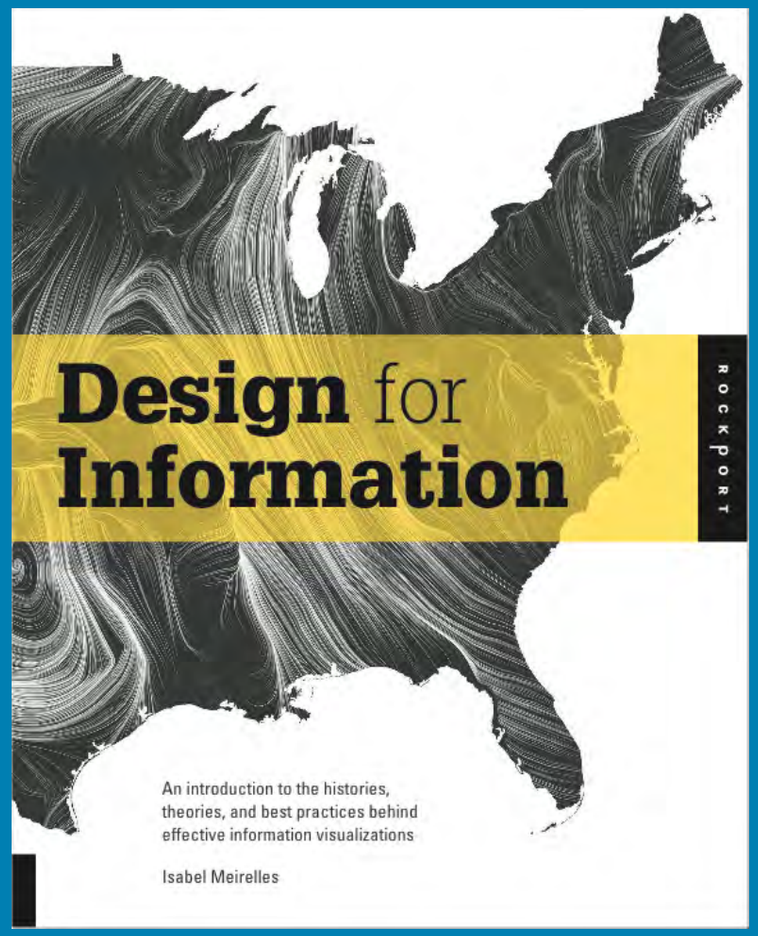


http://gmaps-samples.googlecode.com/svn/trunk/poly/puzzledrag.html

lesson 5

Visualizations are **human-centered** artefacts

thanks!



meirelles.isabel@gmail.com