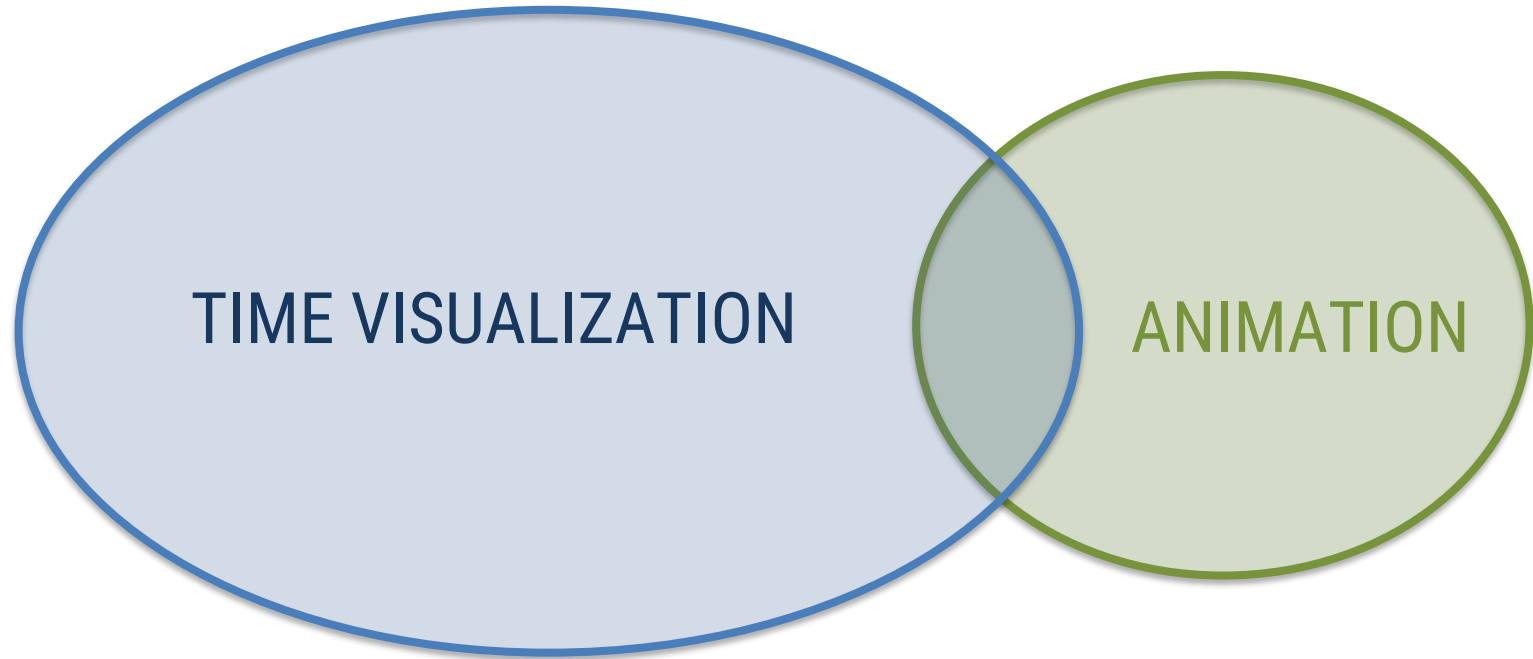
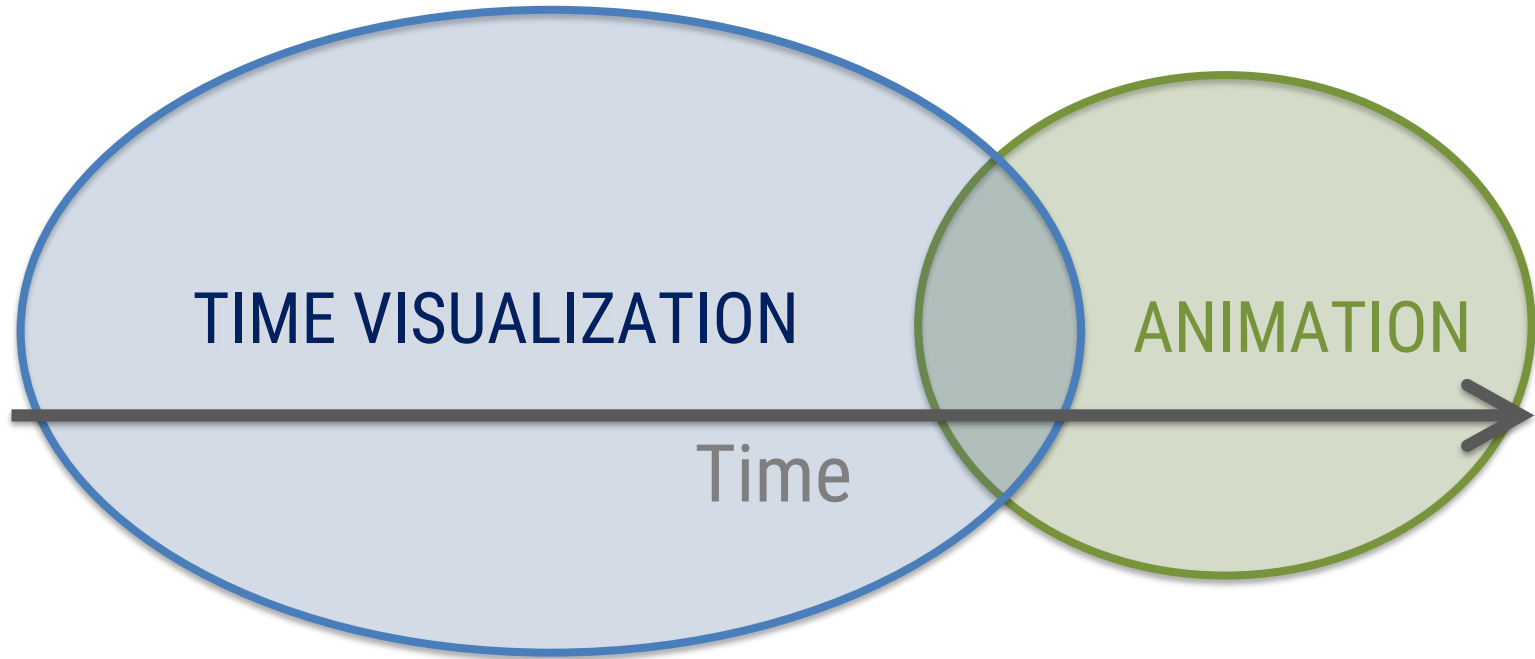


TIME AND ANIMATION

Petra Isenberg (&Pierre Dragicevic)





VISUALIZATION OF TIME

TIME

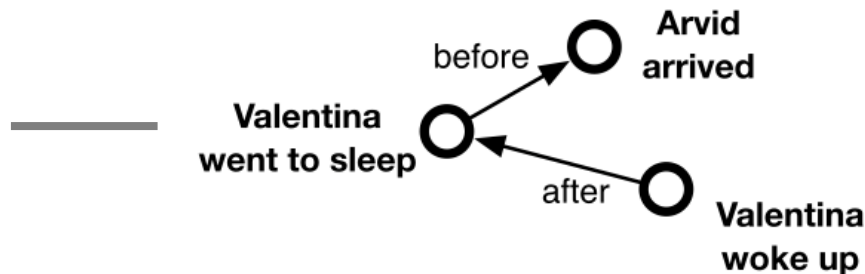
- Is just another data dimension
- Why bother?

TIME

- Is just another data dimension
- Why bother?
- What data type is it?
 - Nominal?
 - Ordinal?
 - Quantitative?

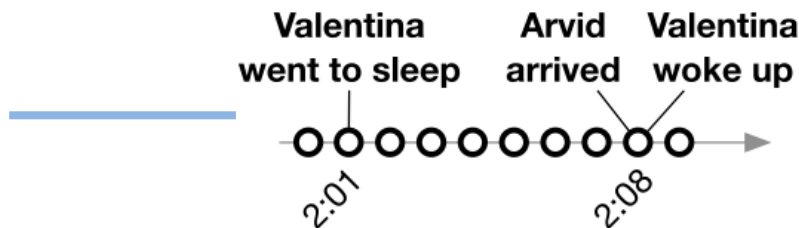
TIME

- **Ordinal**

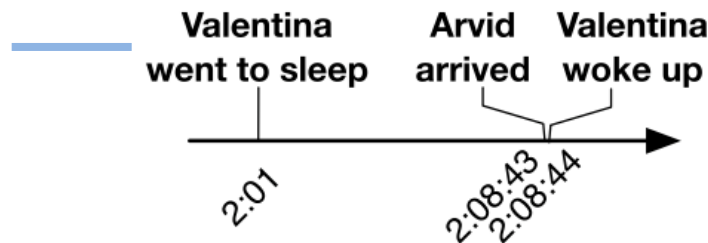


- **Quantitative**

- Discrete



- Continuous



TIME

	Quantitative		Ordinal		Nominal
More Accurate	Position 		Position 		Position 
	Length 		Density 		Hue 
	Angle 		Saturation 		Density 
	Slope 		Hue 		Saturation 
	Area 		Length 		Shape 
	Density 		Angle 		Length 
	Saturation 		Slope 		Angle 
	Hue 		Area 		Slope 
Less Accurate	Shape 		Shape 		Area 

TIME

- Periodicity
 - Natural: days, seasons
 - Social: working hours, holidays
 - Biological: circadian, etc.
- Has many subdivisions (units)
 - Years, months, days, weeks, H, M, S
- Has a specific meaning
 - Not captured by data type
 - Associations, conventions
 - Pervasive in the real-world
 - Time visualizations often considered as a separate type

TIME

Shneiderman:

- 1-dimensional data
- 2-dimensional data
- 3-dimensional data
- **temporal data**
- multi-dimensional data
- tree data
- network data

VISUALIZING TIME

as a time point



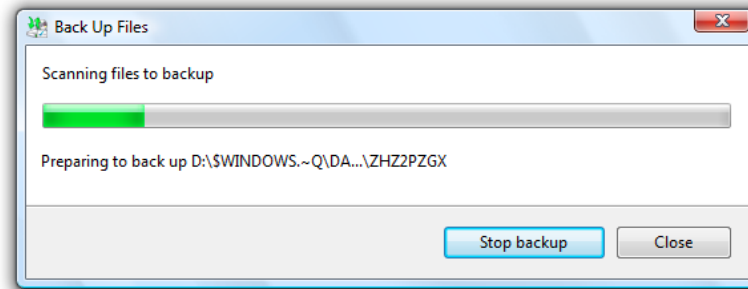
VISUALIZING TIME



as a time period

VISUALIZING TIME

as a duration

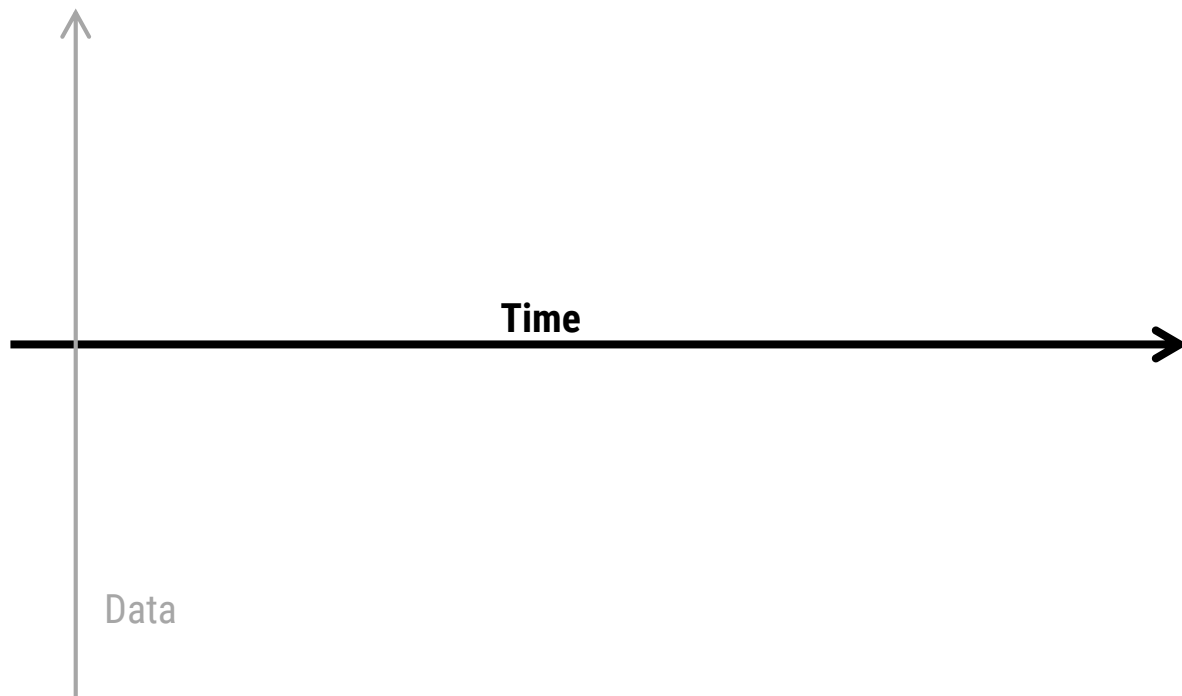


VISUALIZING TIME

PLUS DATA

MAPPING TIME TO SPACE

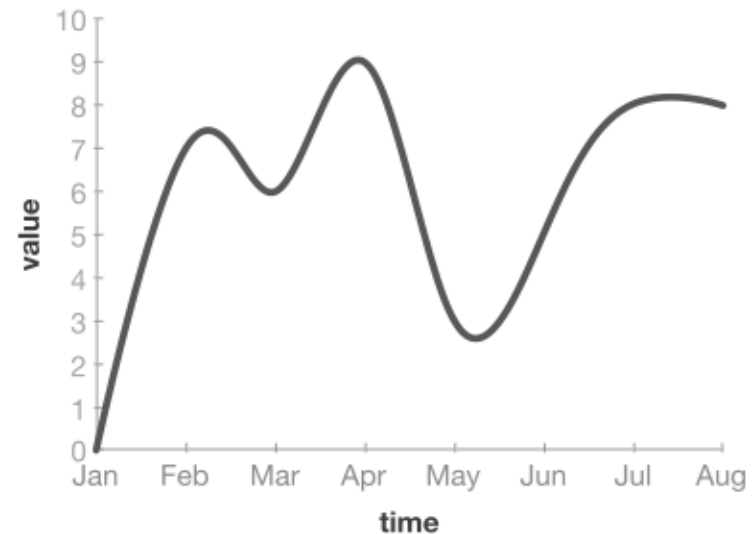
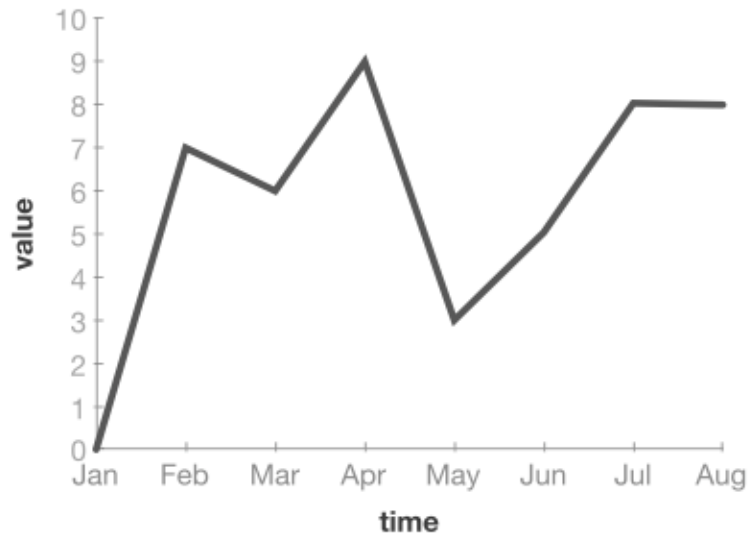
MAPPING TIME TO AN AXIS



TIME-SERIES DATA

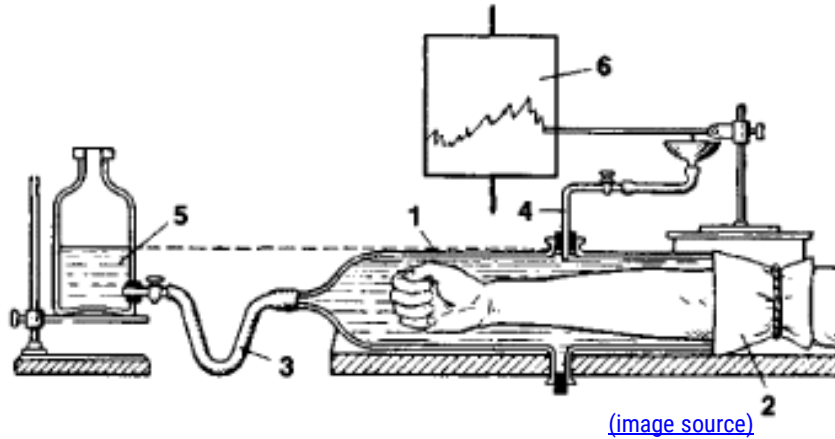
- From a Statistics Book:
 - A set of observations x_t , each one being recorded at a specific time t
- From Wikipedia:
 - A sequence of data points, measured typically at successive time instants spaced at uniform time intervals

LINE CHARTS

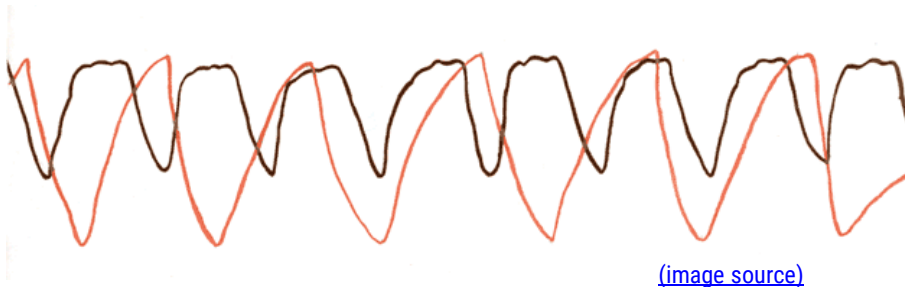


LINE CHARTS

Marey's Physiological Recordings



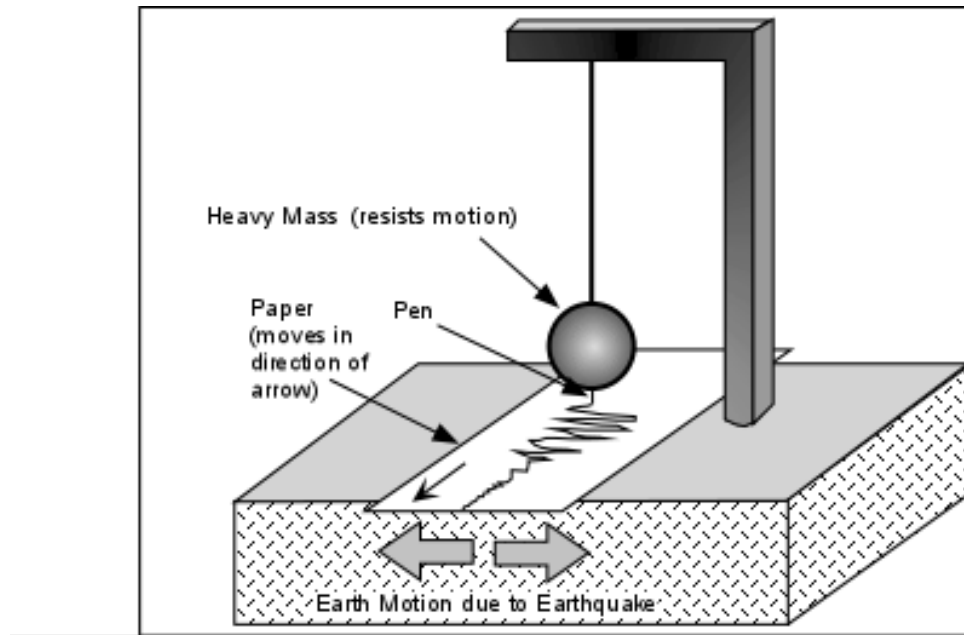
Plethysmograph
Étienne-Jules Marey, 1876



Pneumogram
Étienne-Jules Marey, 1876

LINE CHARTS

Pendulum Seismometer

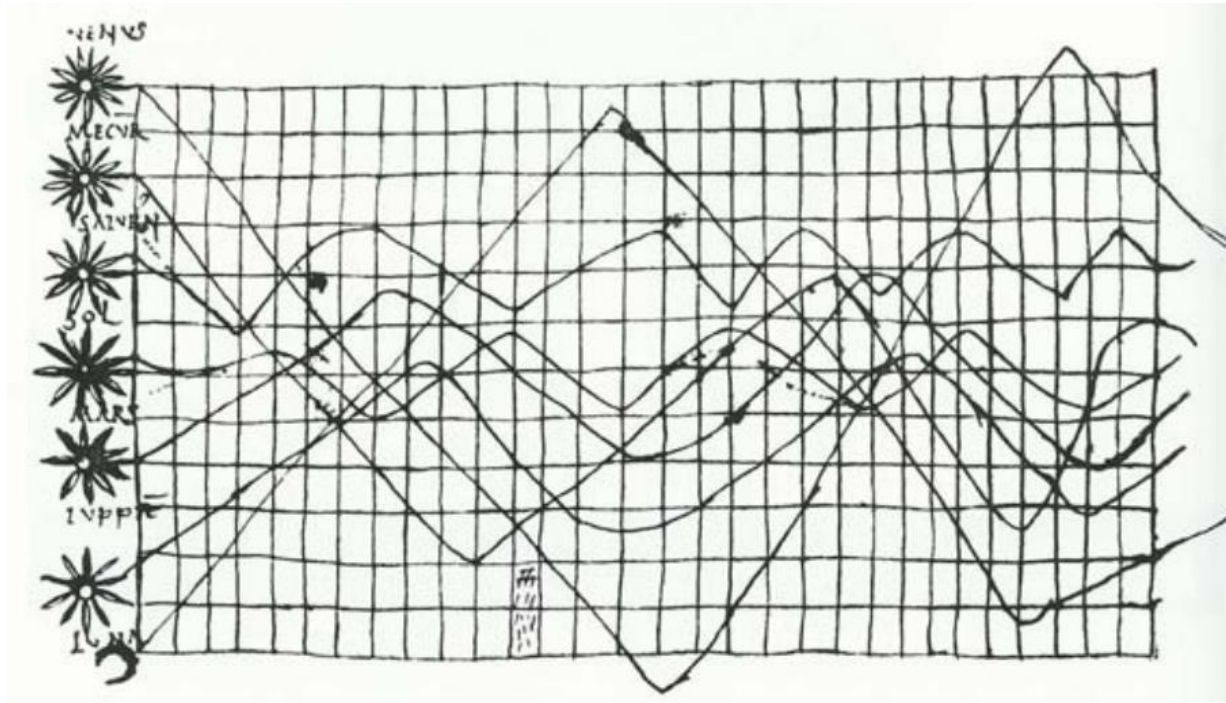


[\(image source\)](#)

Andrea Bina, 1751
Possibly also 17th century [\(source\)](#)

LINE CHARTS

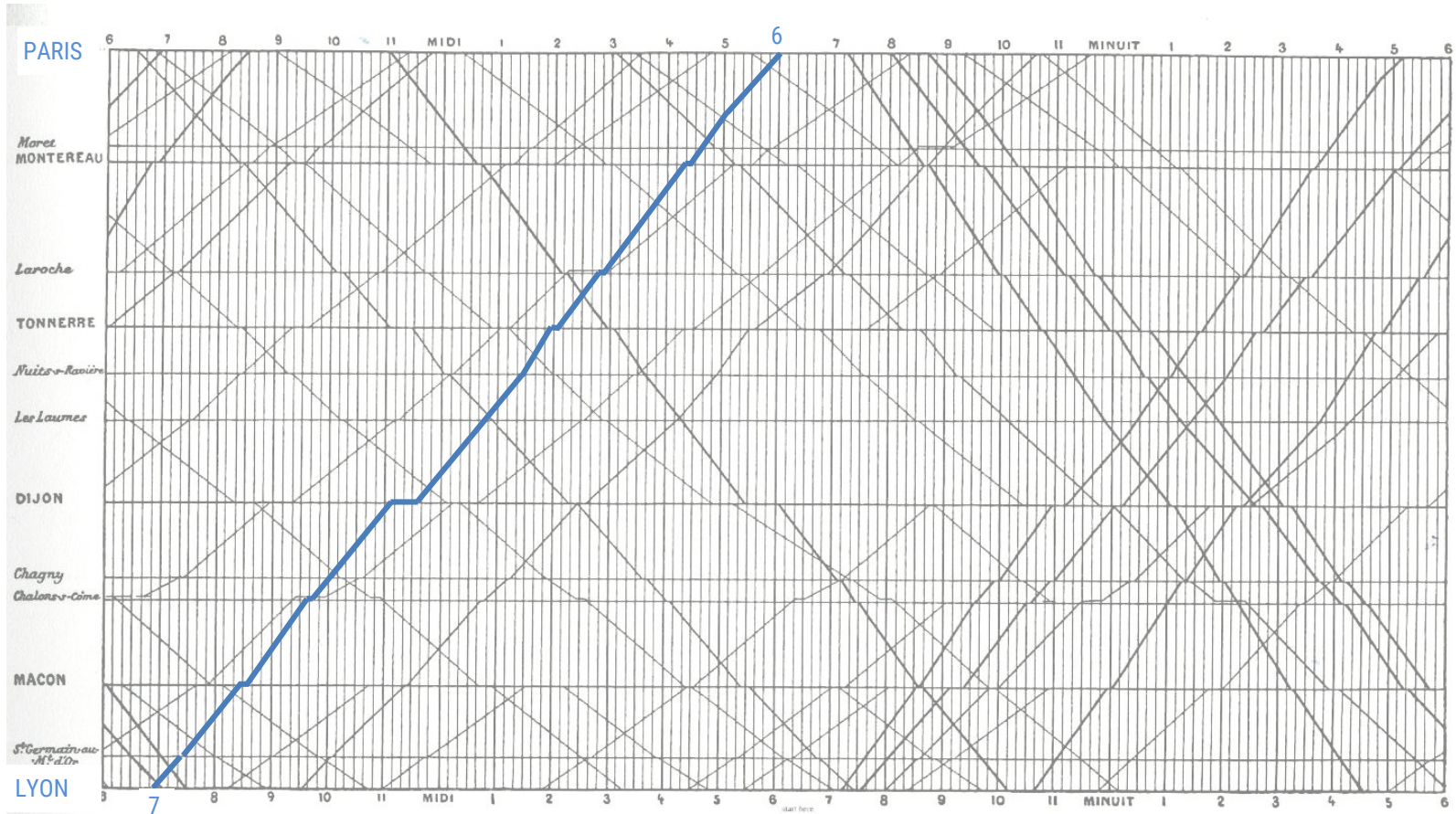
Inclinations of planetary orbits



Macrobius, 10th or 11th century
cited in [Kendall, 1990](#)

LINE CHARTS

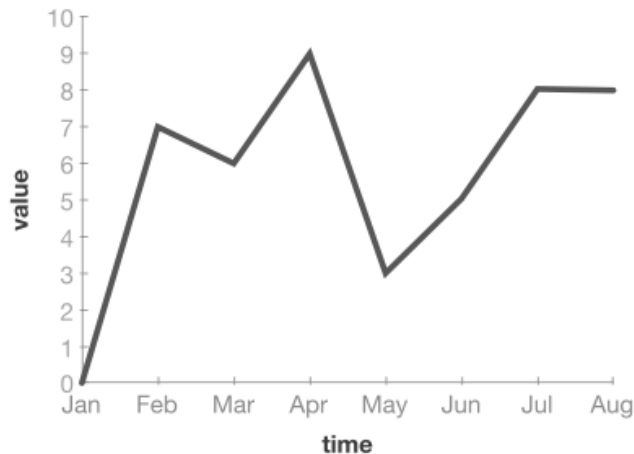
Marey's Train Schedule



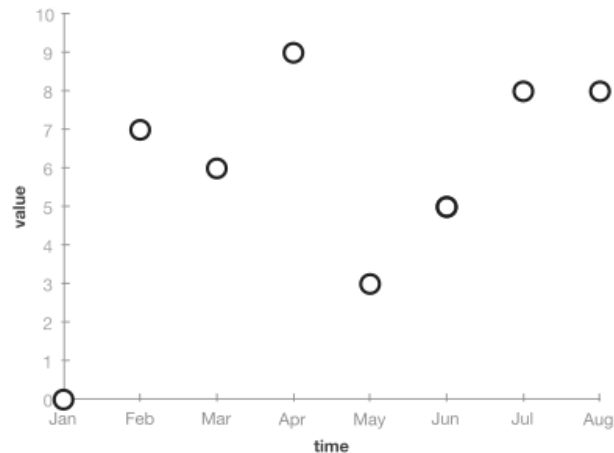
Étienne-Jules Marey, 1885, cited in [Tufte, 1983](#)

OTHER CHARTS

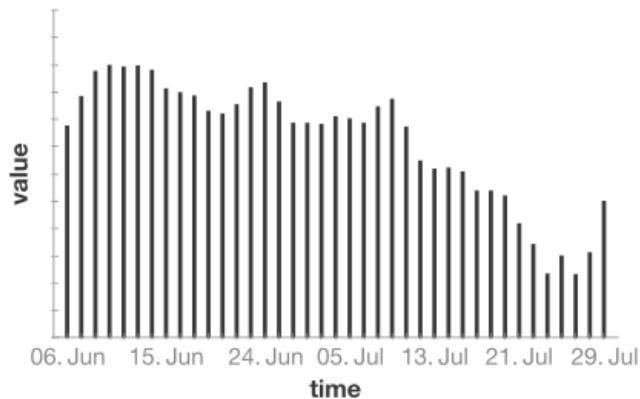
Line Plots



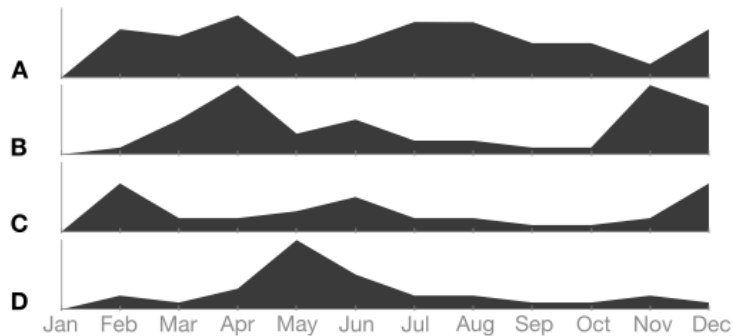
Point Plots



Bar Charts

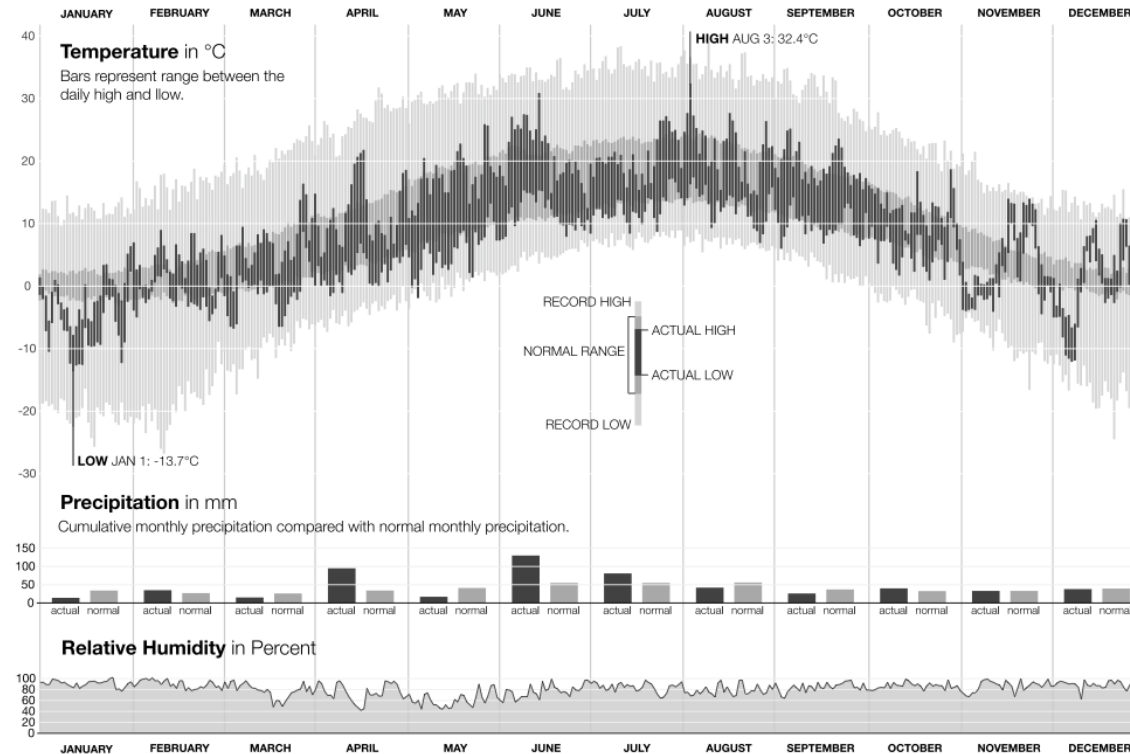


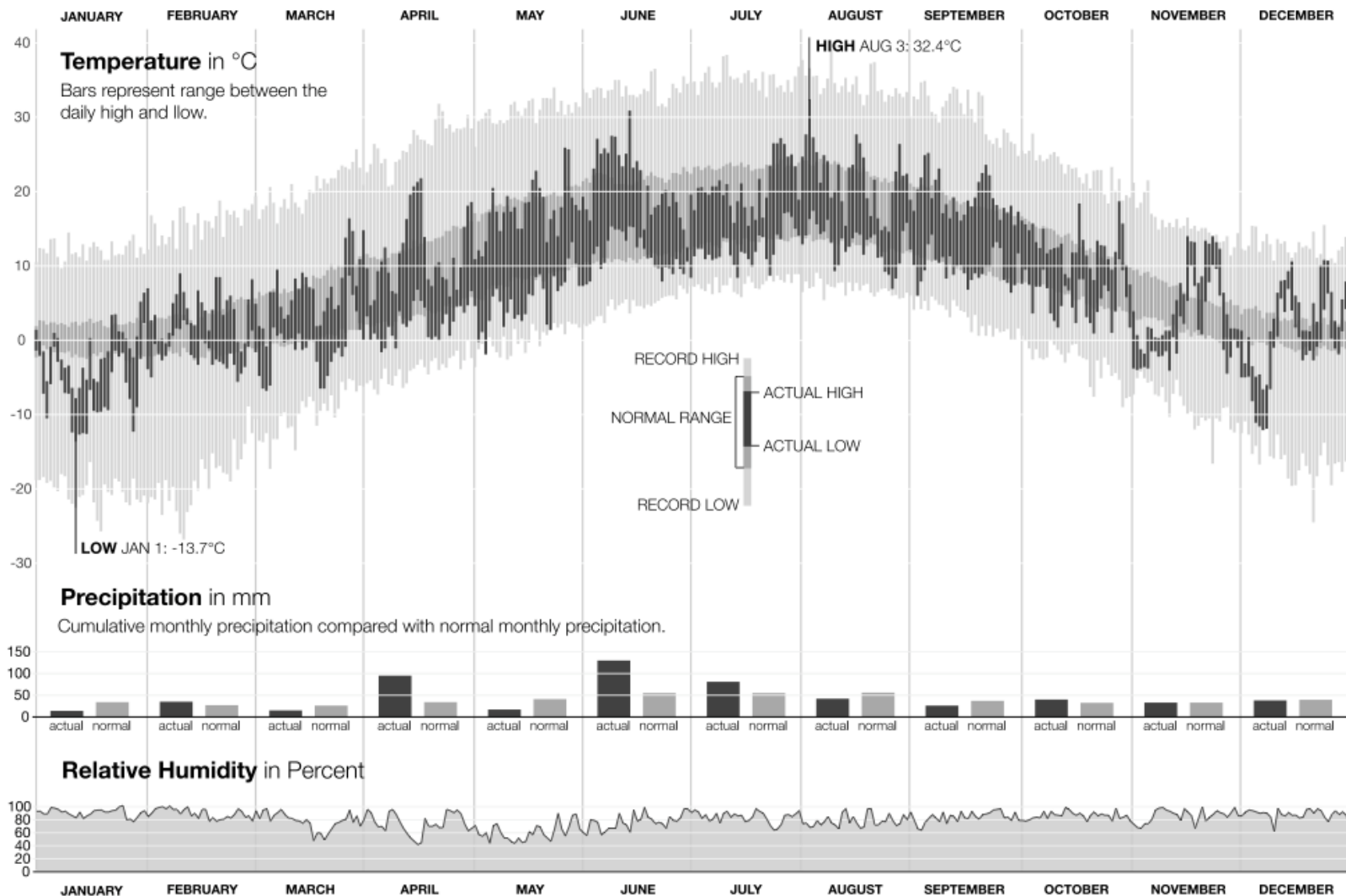
Silhouette Graphs



OTHER CHARTS

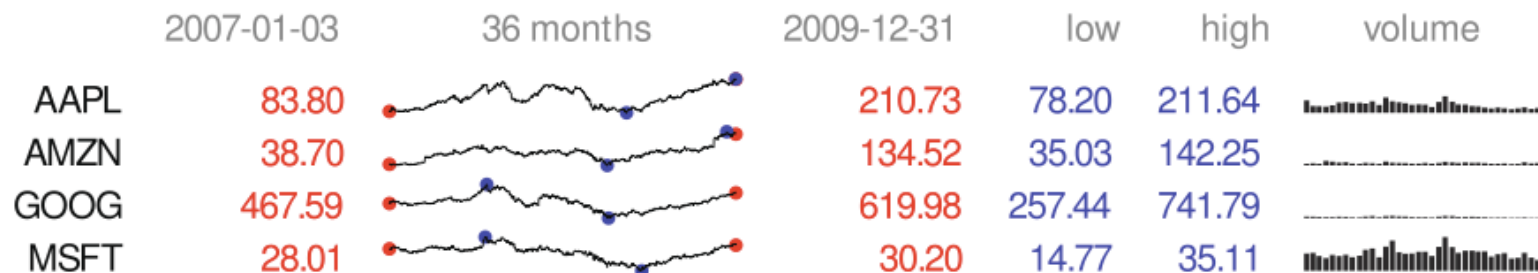
Combination - New York Times Weather Chart

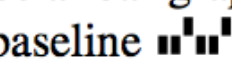




OTHER CHARTS

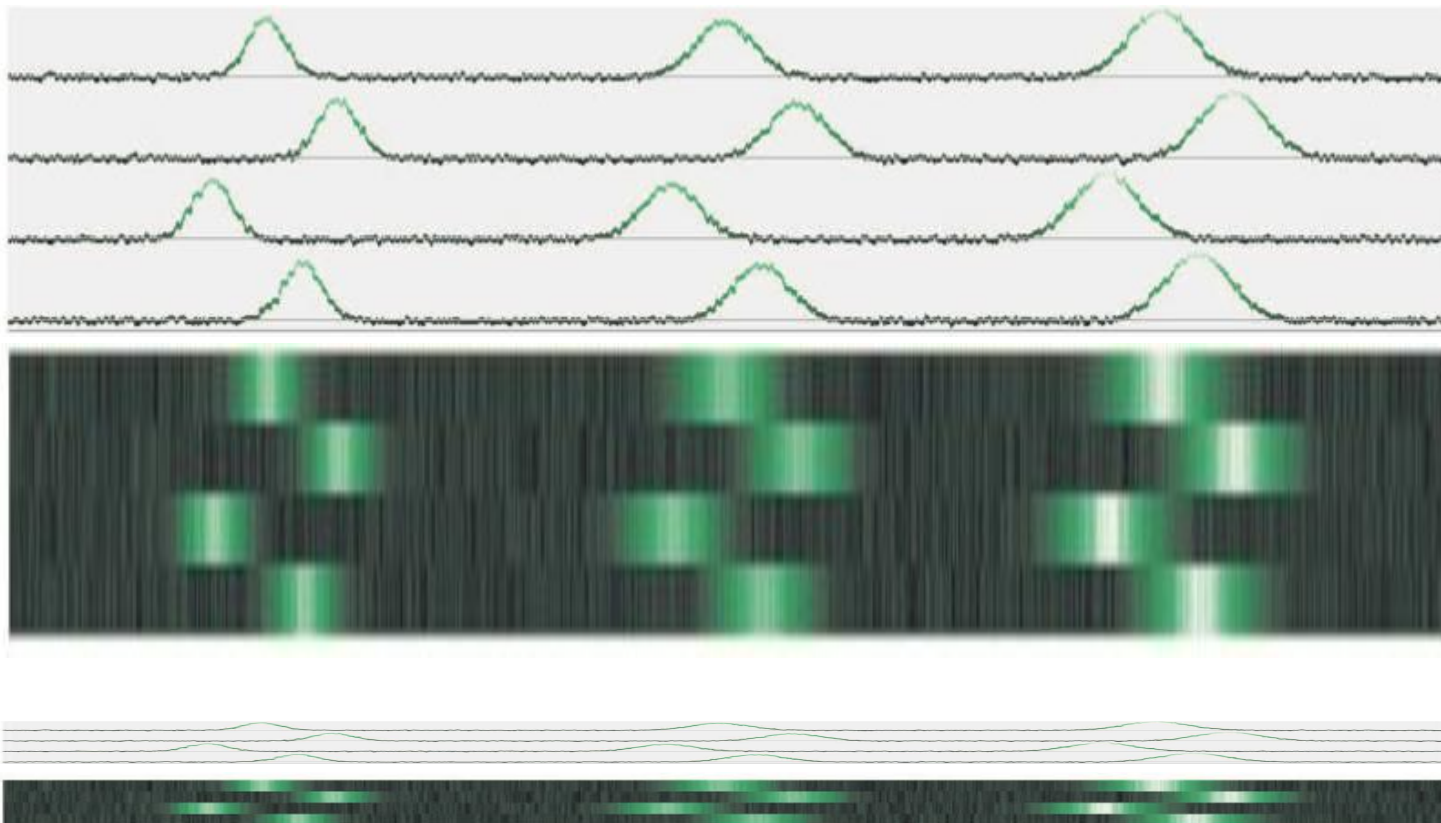
Sparklines



Usually, miniaturized versions of line plots  (↪ p. 153) and bar graphs  (↪ p. 154) are employed to represent data. For the special case of binary or three-valued data, special bar graphs can be applied that use ticks extending up and down a horizontal baseline . One use for this kind of data are wins and losses of sports teams where the history of a whole season can be presented using very little space. For line plots, the first and last value can be emphasized by colored dots (•) and printing the values themselves textually

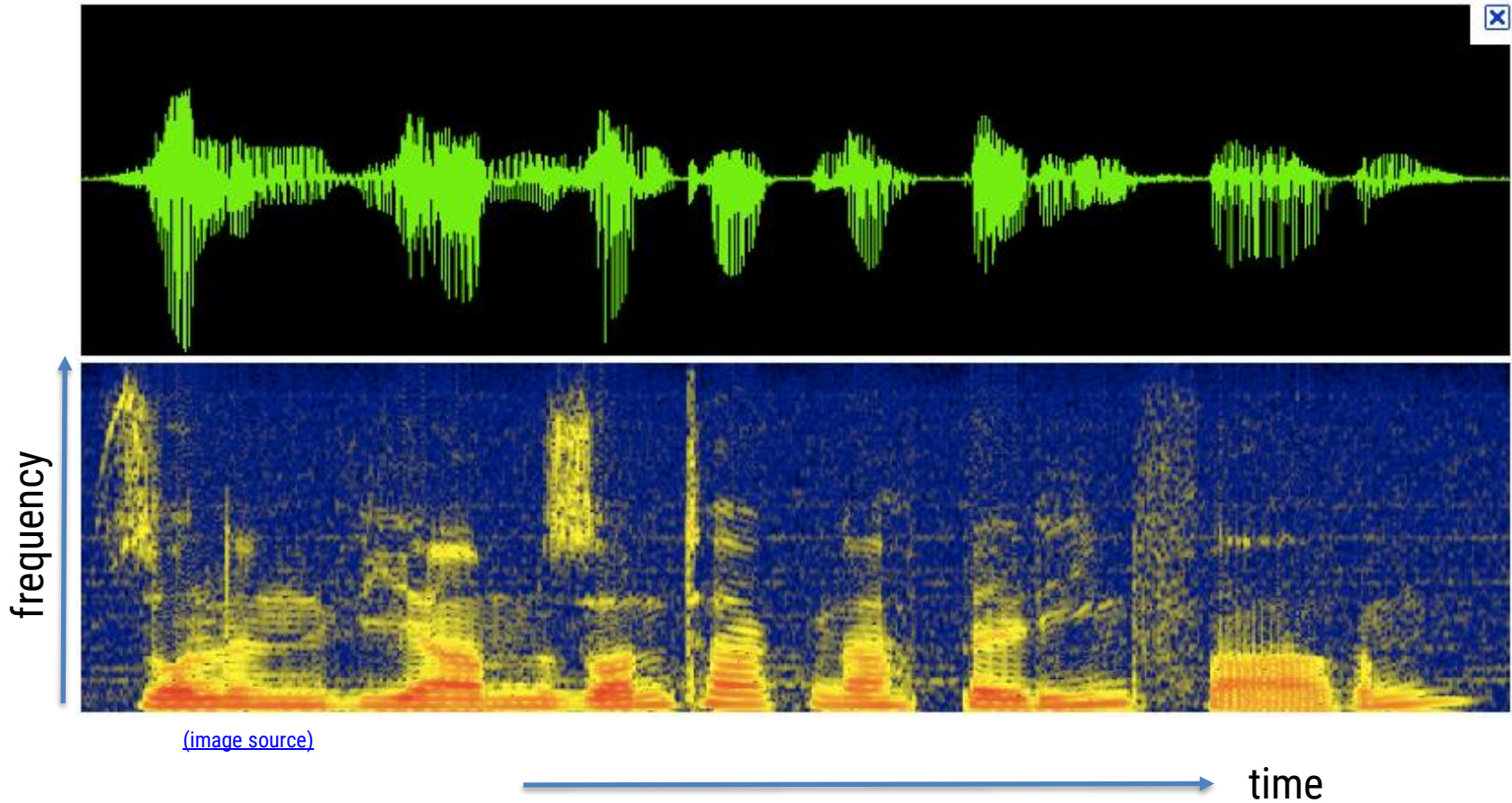
OTHER CHARTS

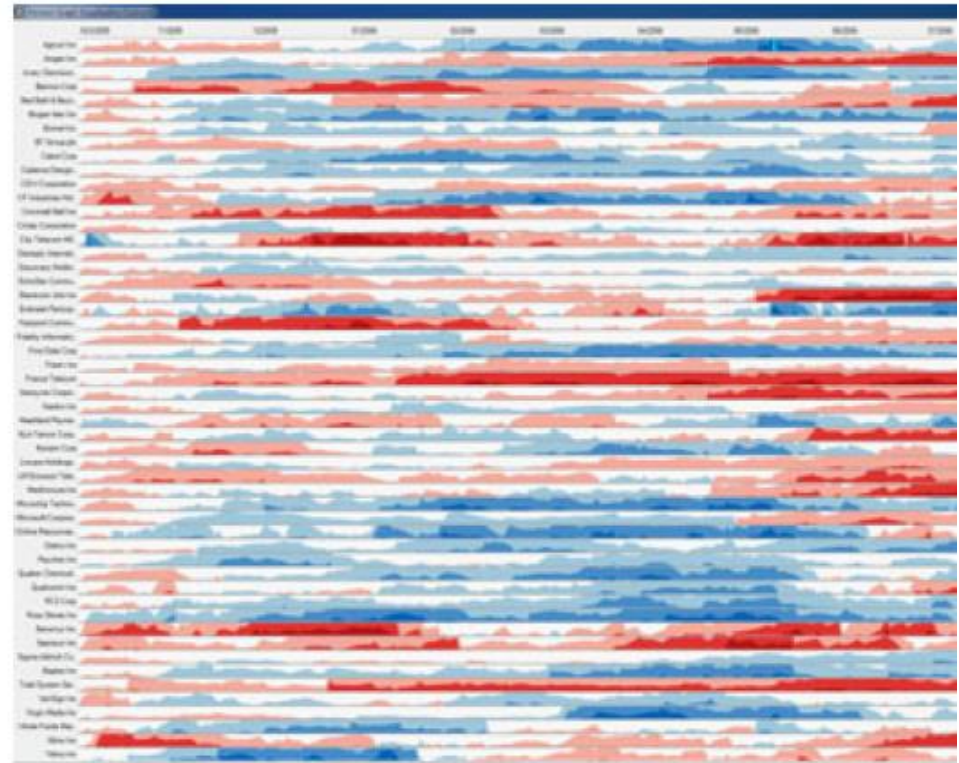
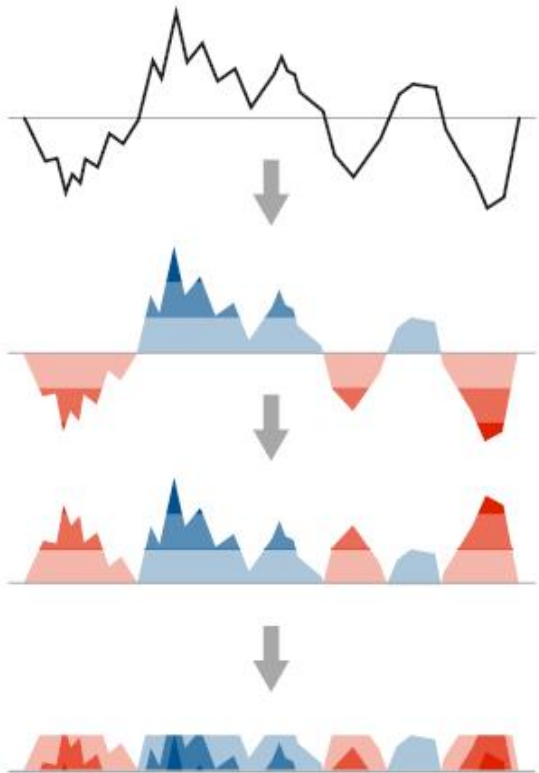
Color Encoding



OTHER CHARTS

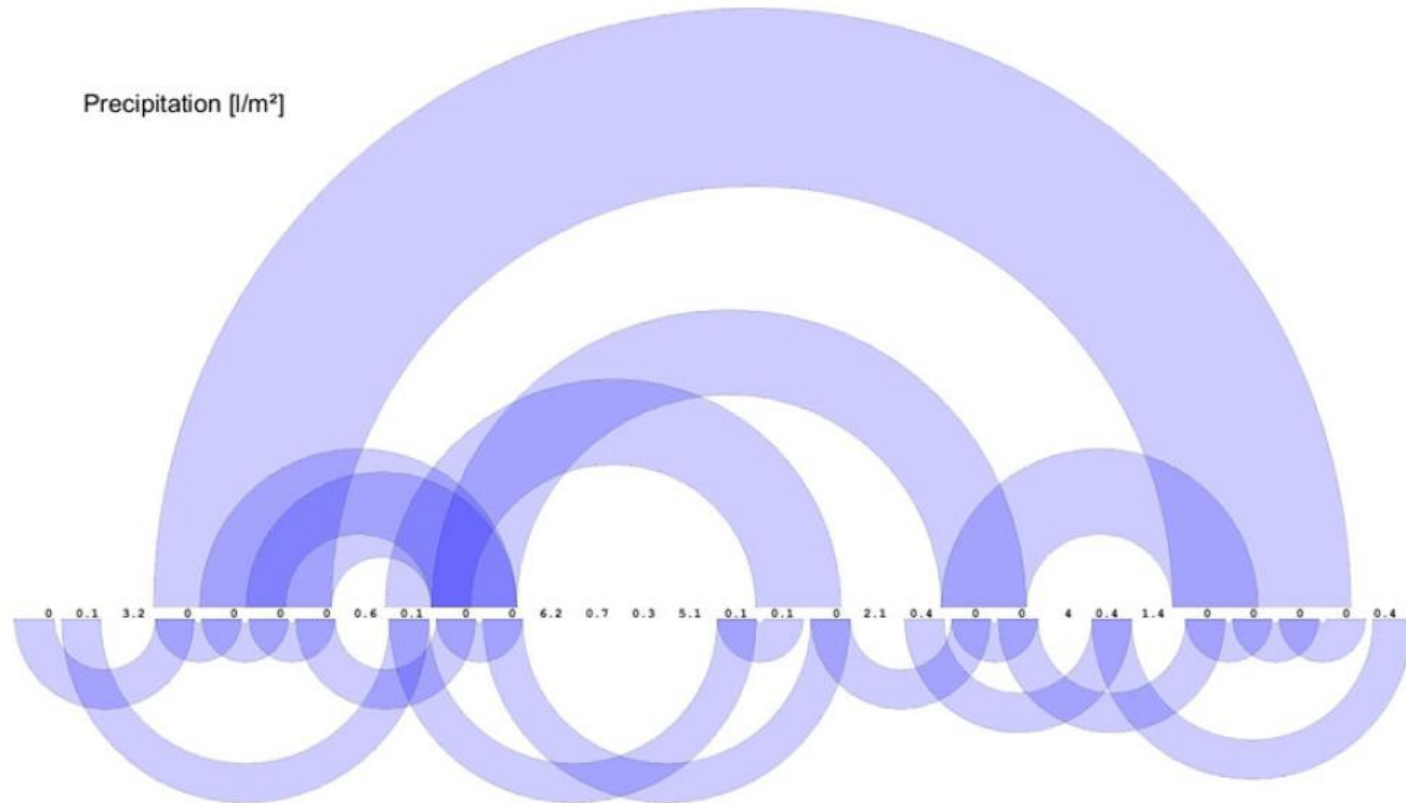
Color Encoding - FFT Spectrum



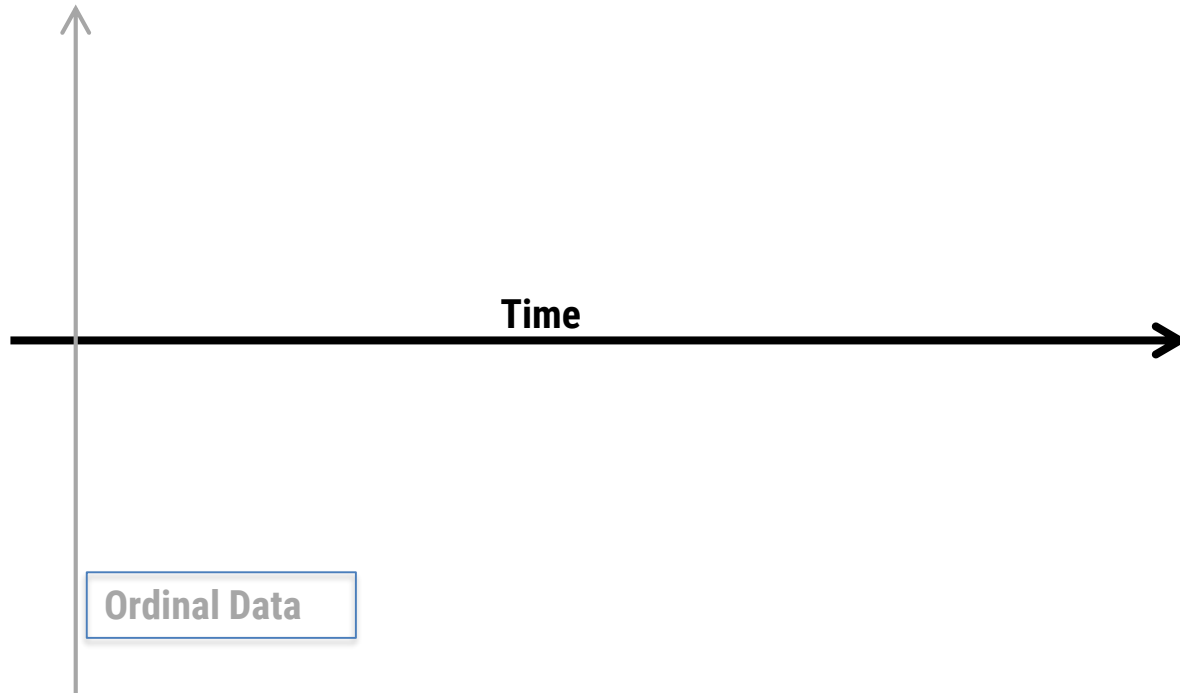


OTHER CHARTS

Arc Diagrams

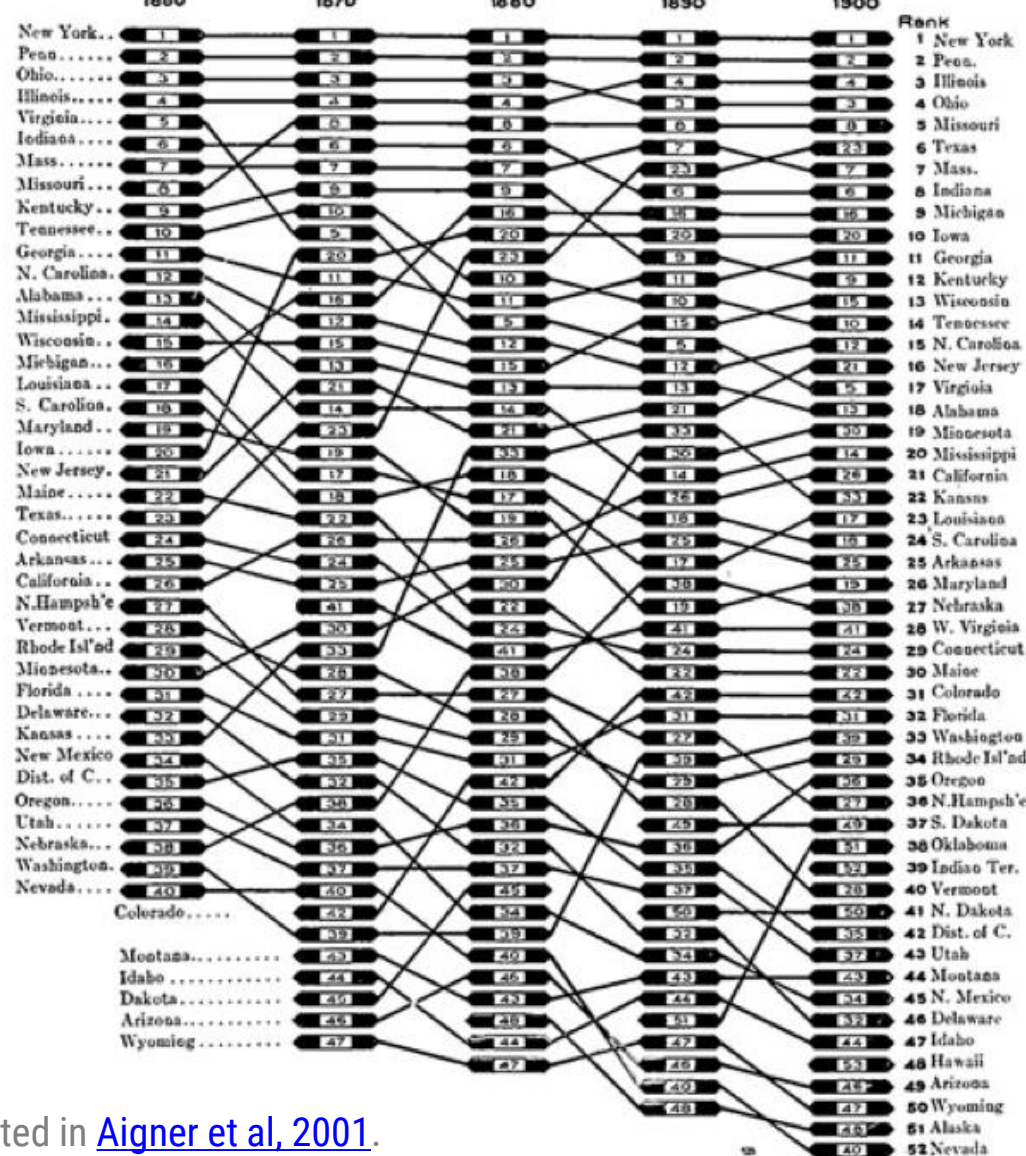


OTHER DATA TYPES



OTHER

Rank Chart



Adapted from the United States Statistical Atlas

OTHER

Rank Chart

MOST HIGHLY-REGARDED BRANDS BY UK'S PROMINENT LEADERS

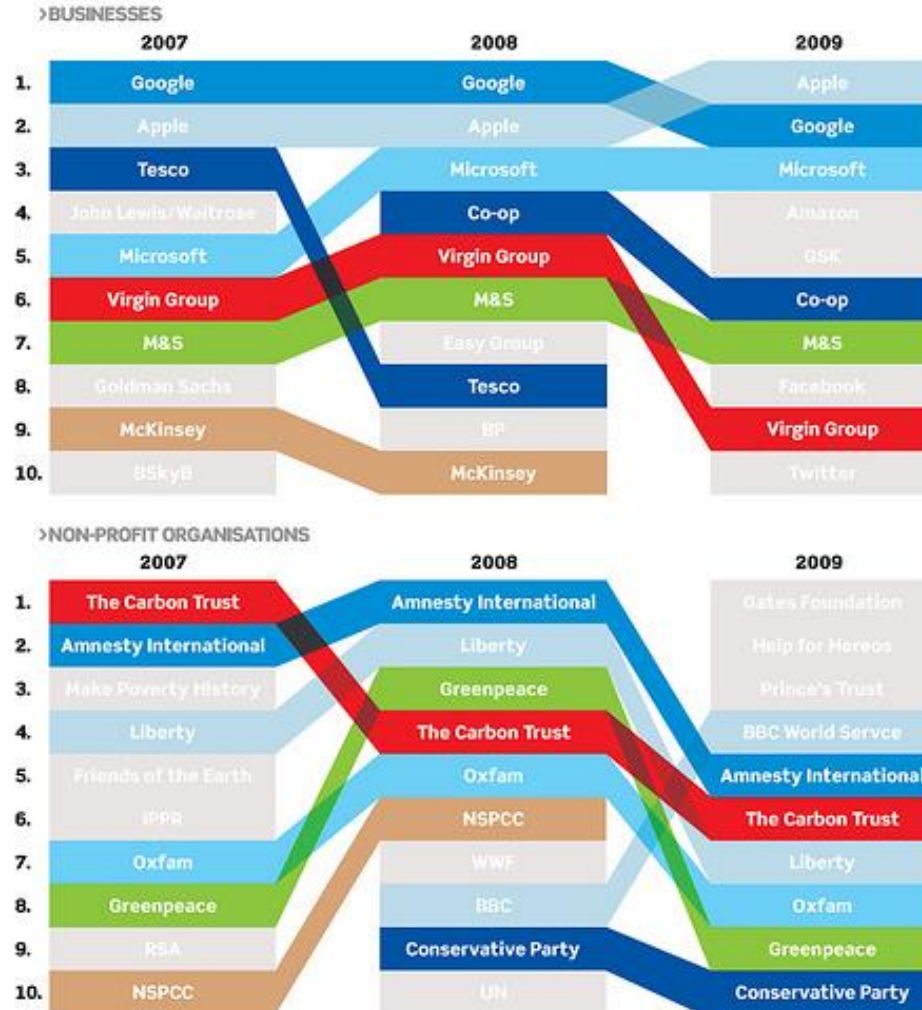
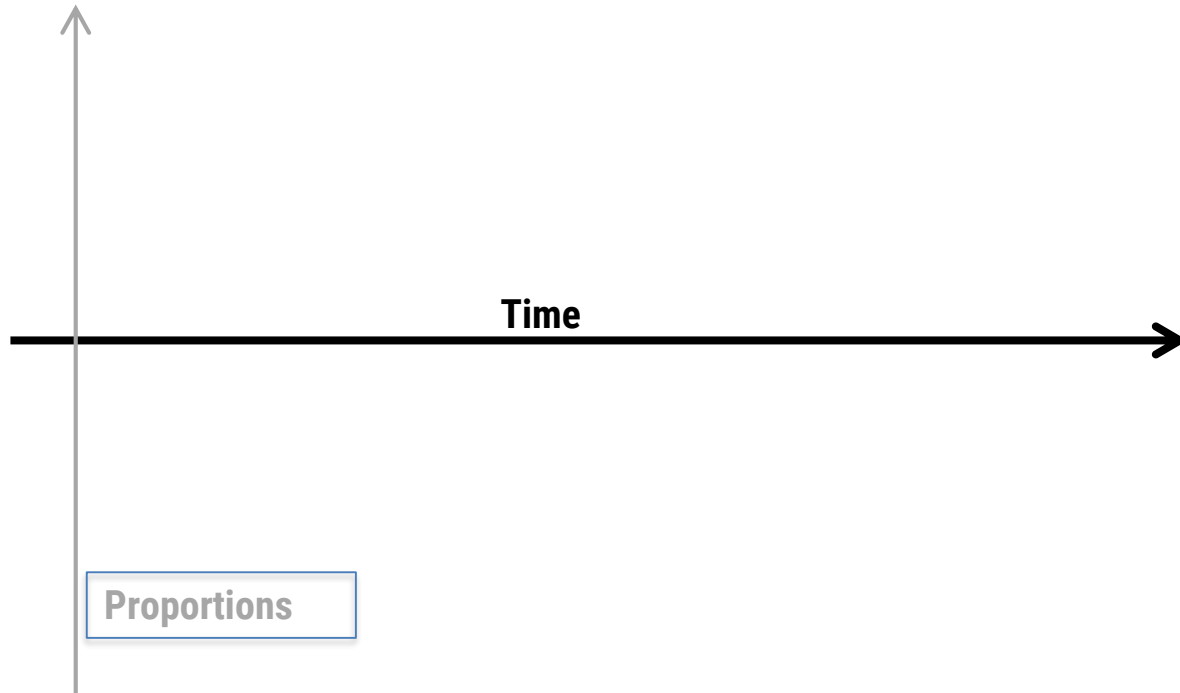


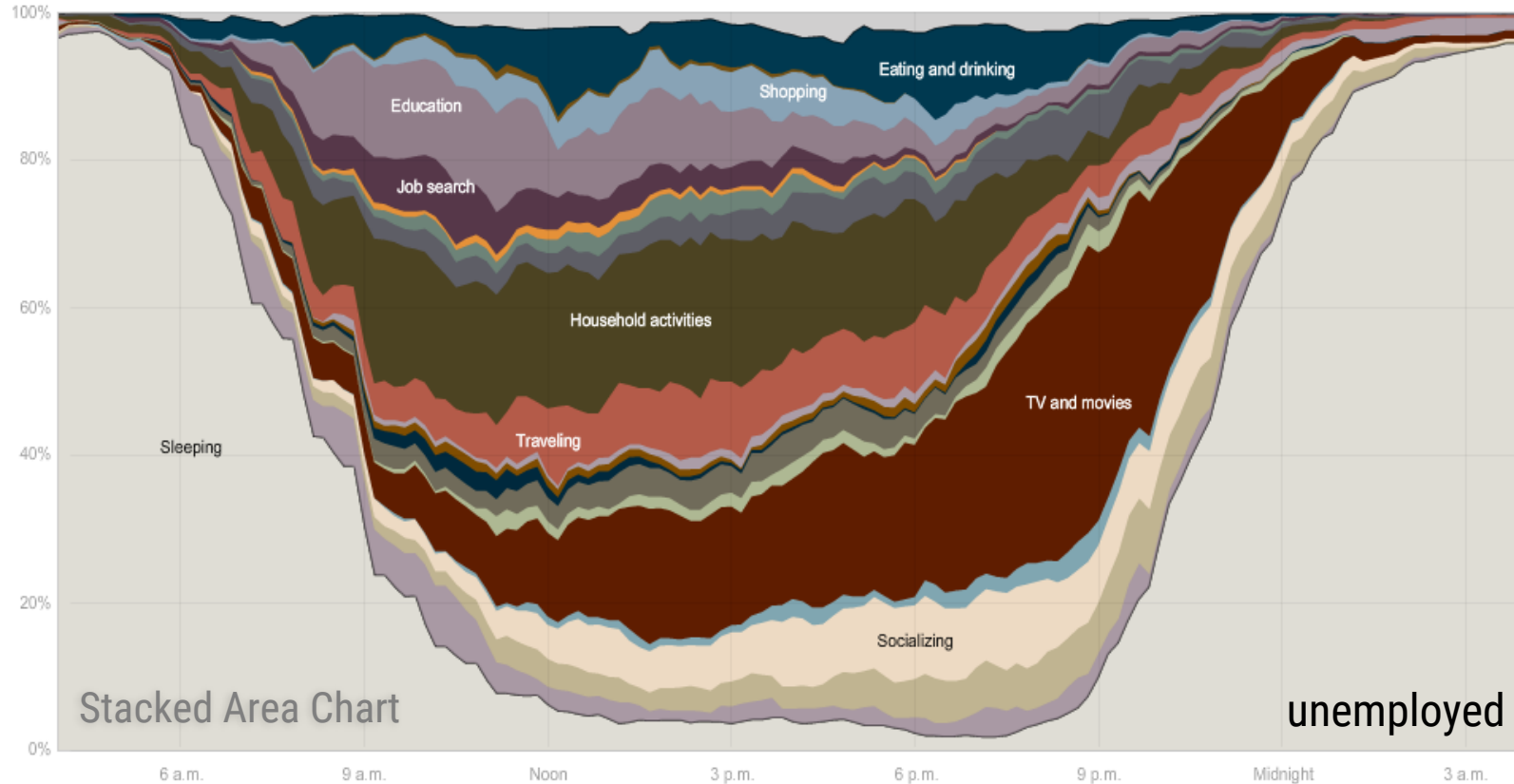
Chart showing the top ten brands' standing over the last three years

OTHER DATA TYPES



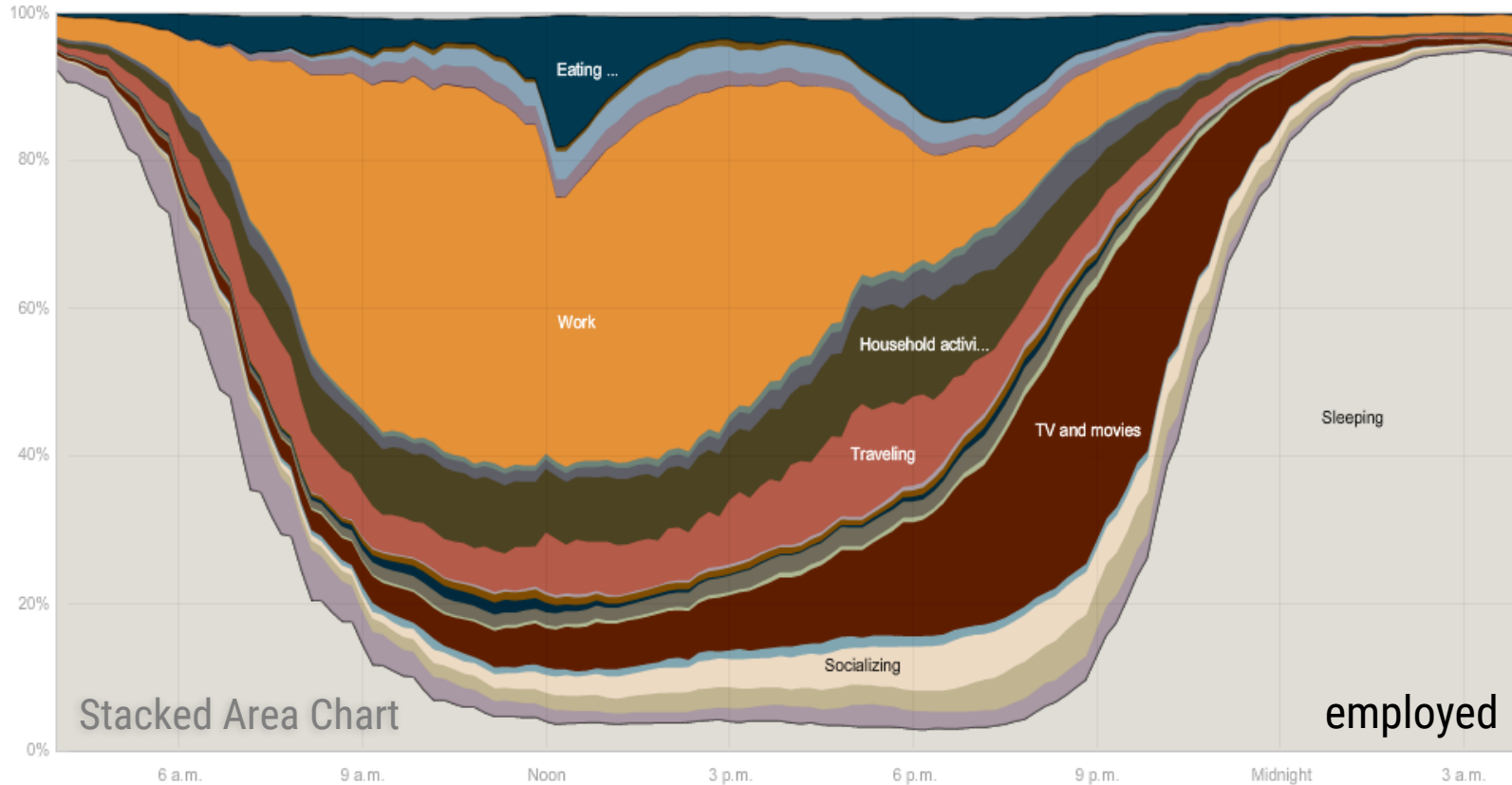
OTHER CHARTS

Stacked Graph
Area Chart
ThemeRiver
StreamGraph



OTHER CHARTS

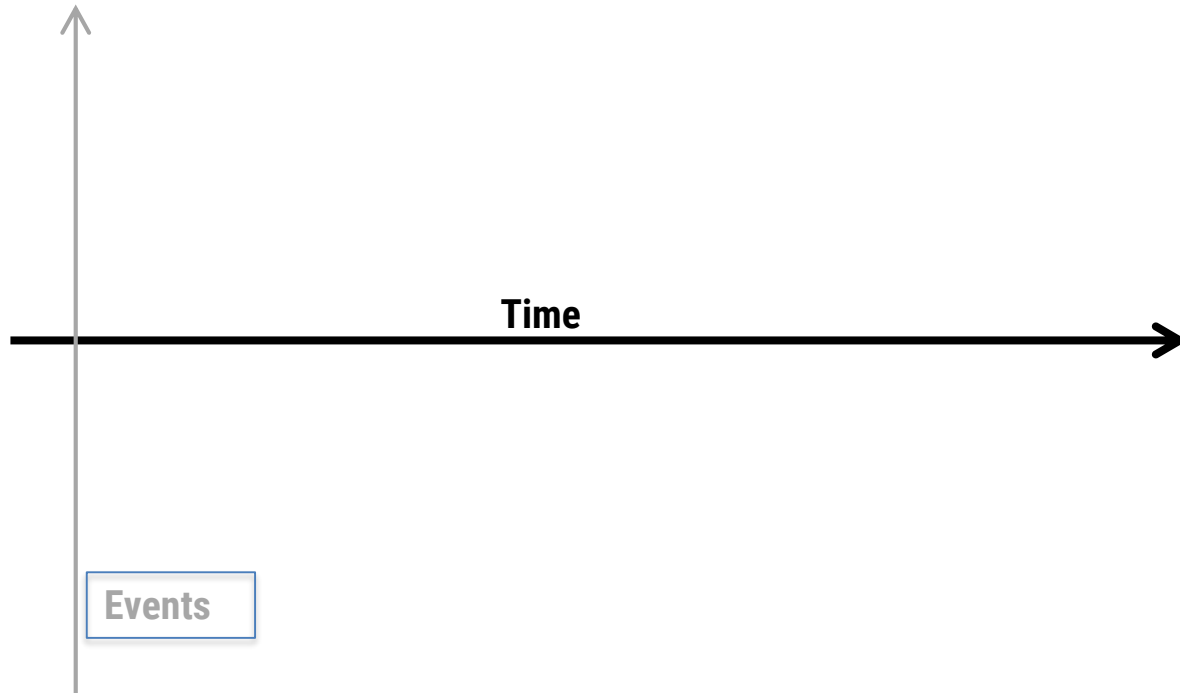
Stacked Graph
Area Chart
ThemeRiver
StreamGraph



Stacked Area Chart



OTHER DATA TYPES

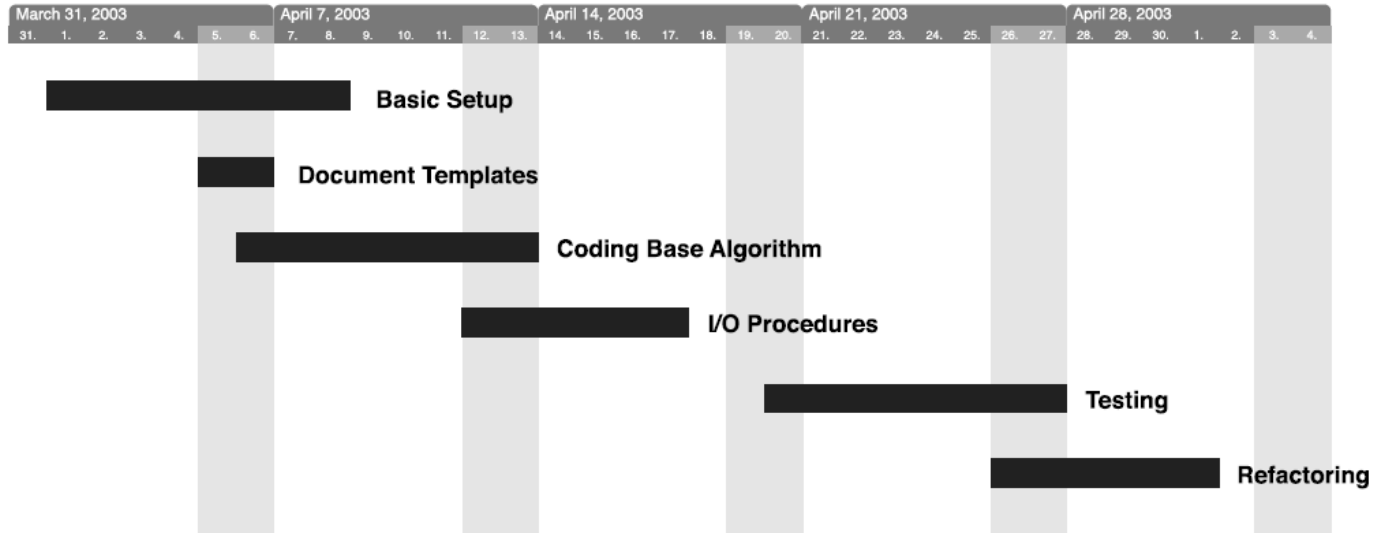


EVENTS

- Like *observations* in time-series:
 - Data points with a time stamp
- But:
 - Most often sparse and irregular
 - Data is mostly nominal
 - Can have a duration (start + end)
- Often, subjective / social data rather than physical measures

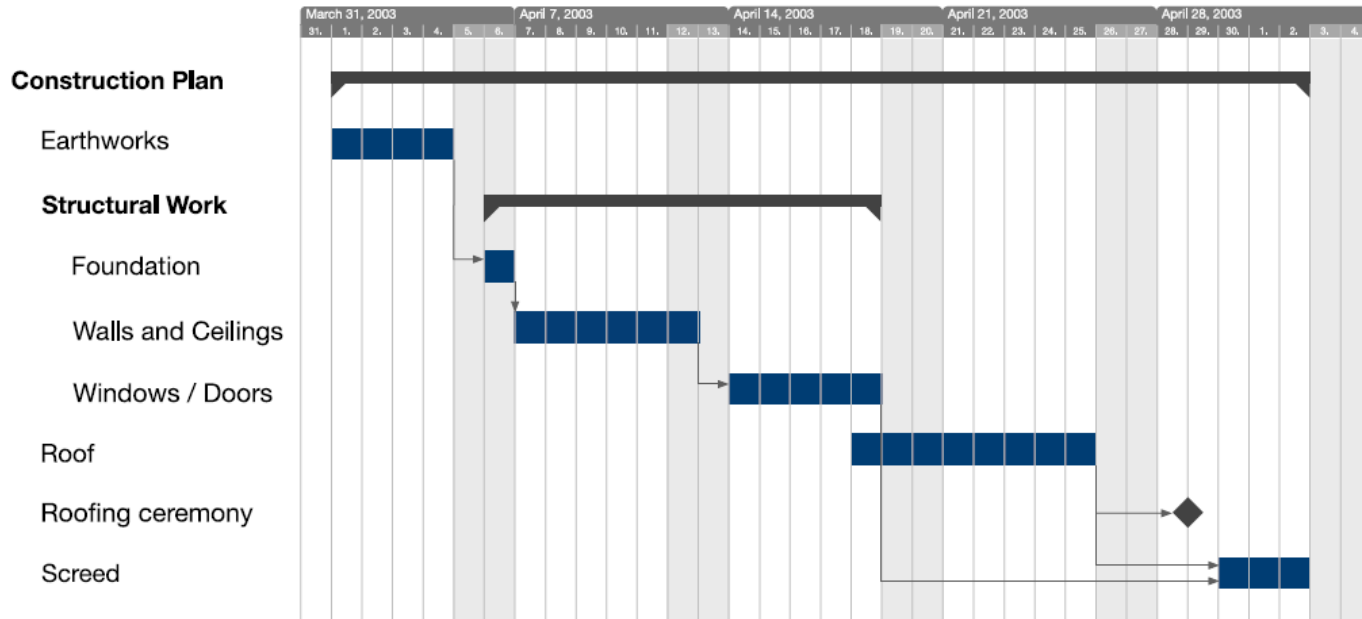
TIMELINES

Project Timeline



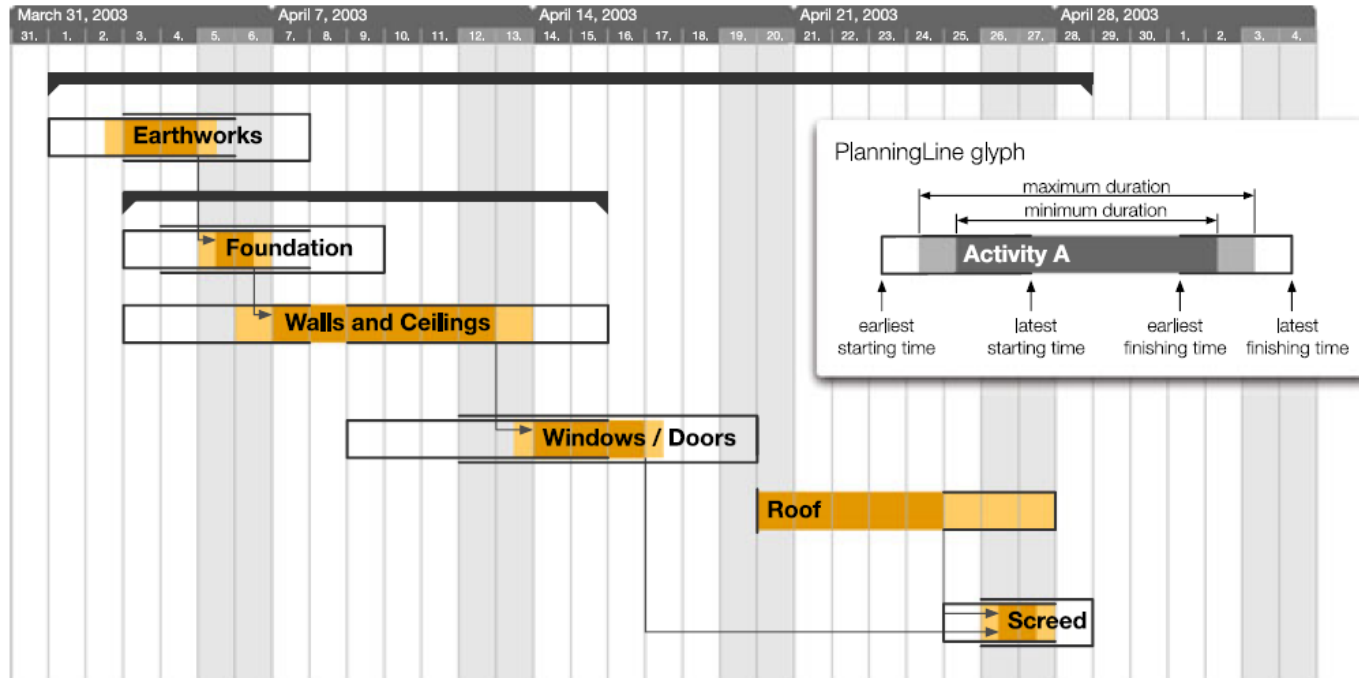
TIMELINES

Gantt Chart



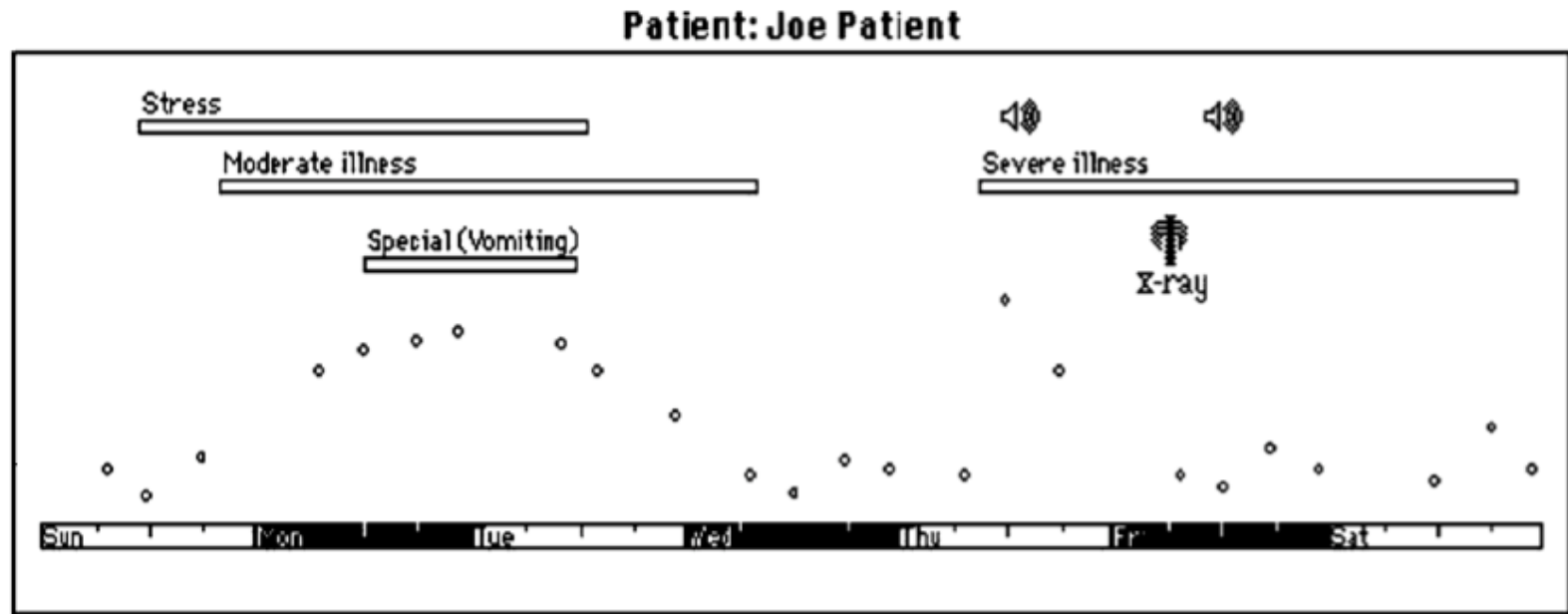
TIMELINES

Planning Lines



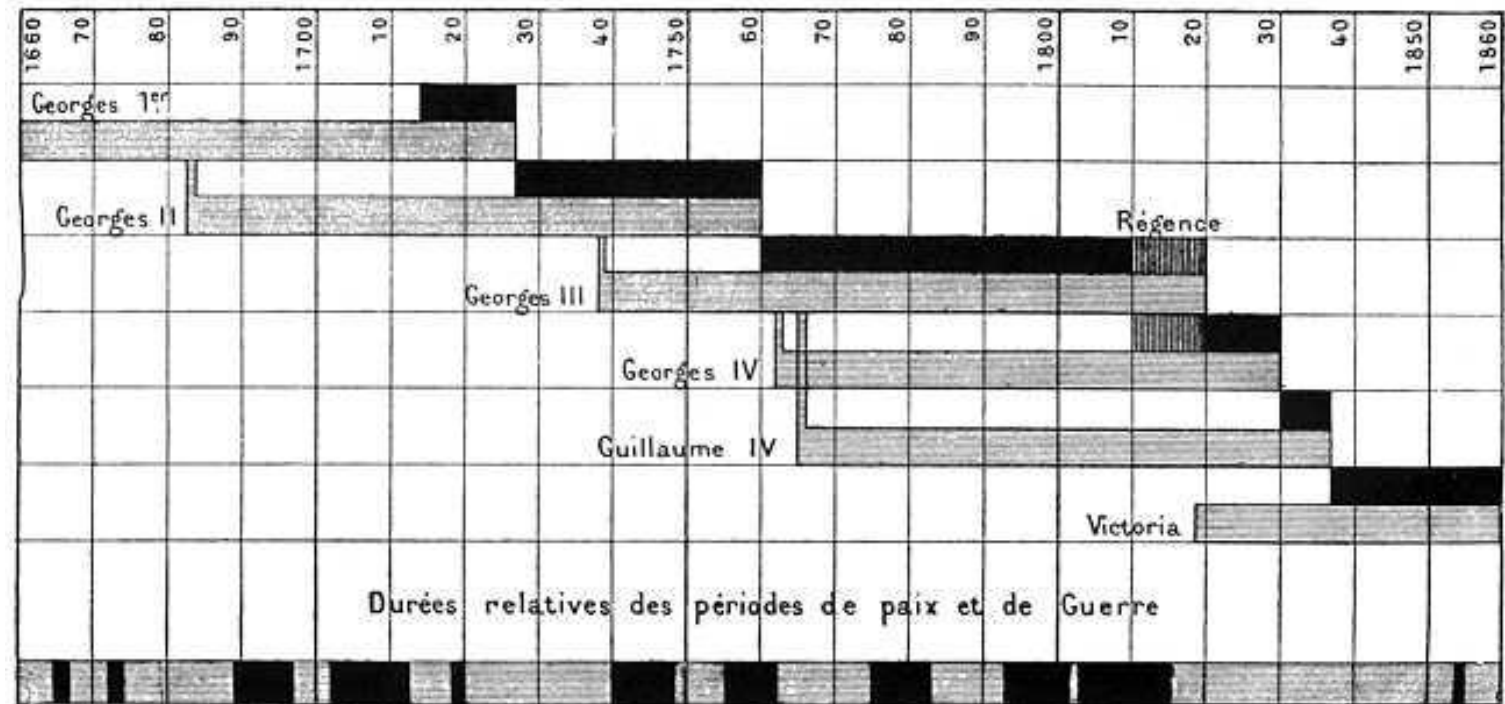
TIMELINES

Patient Data



TIMELINES

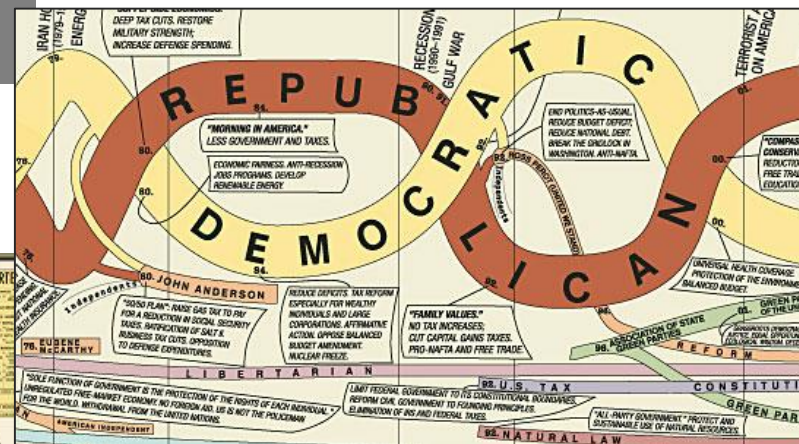
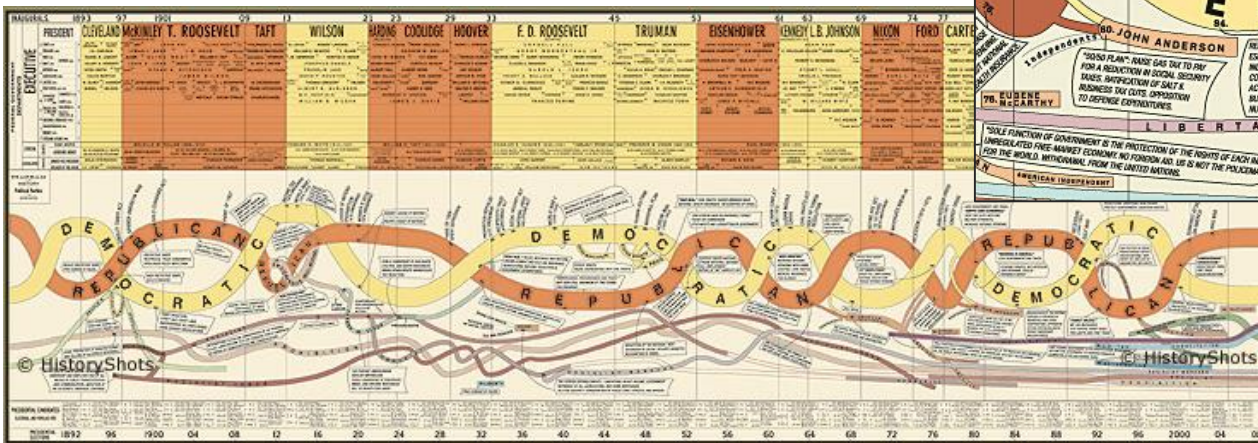
Reigns of English Monarchs



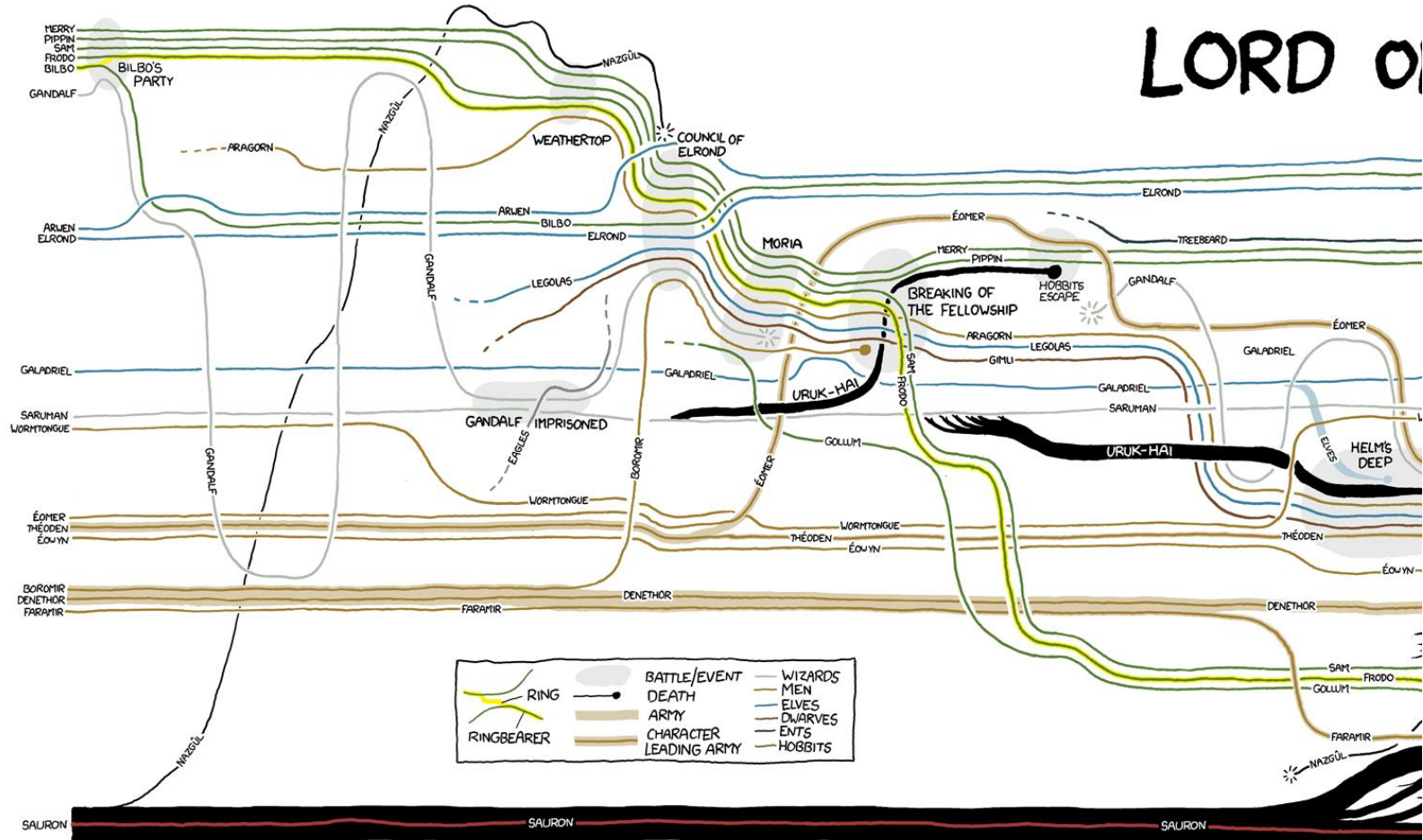
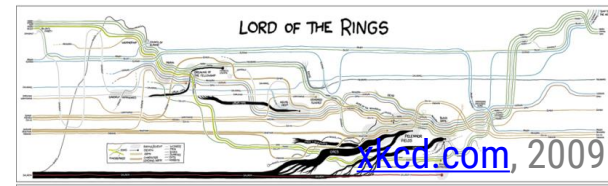
Joseph Priestley, 1769 ([source](#))



TIMELINES

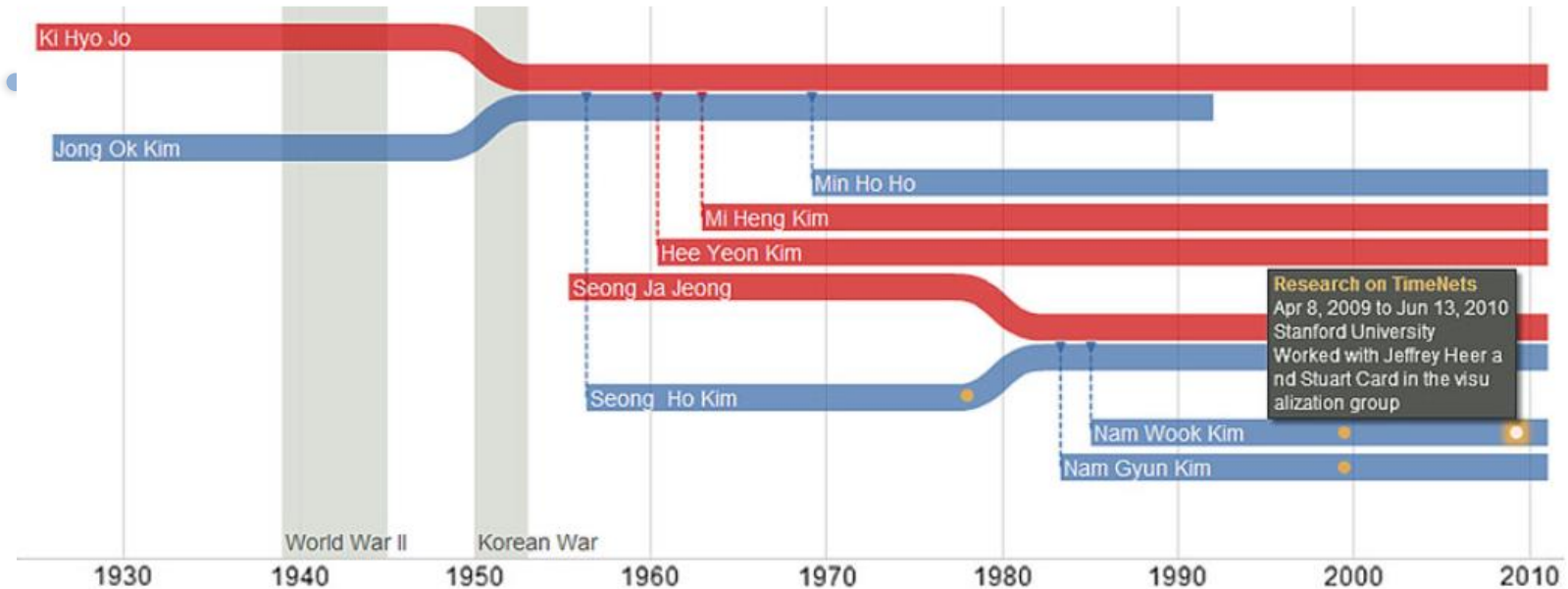


TIMELINES

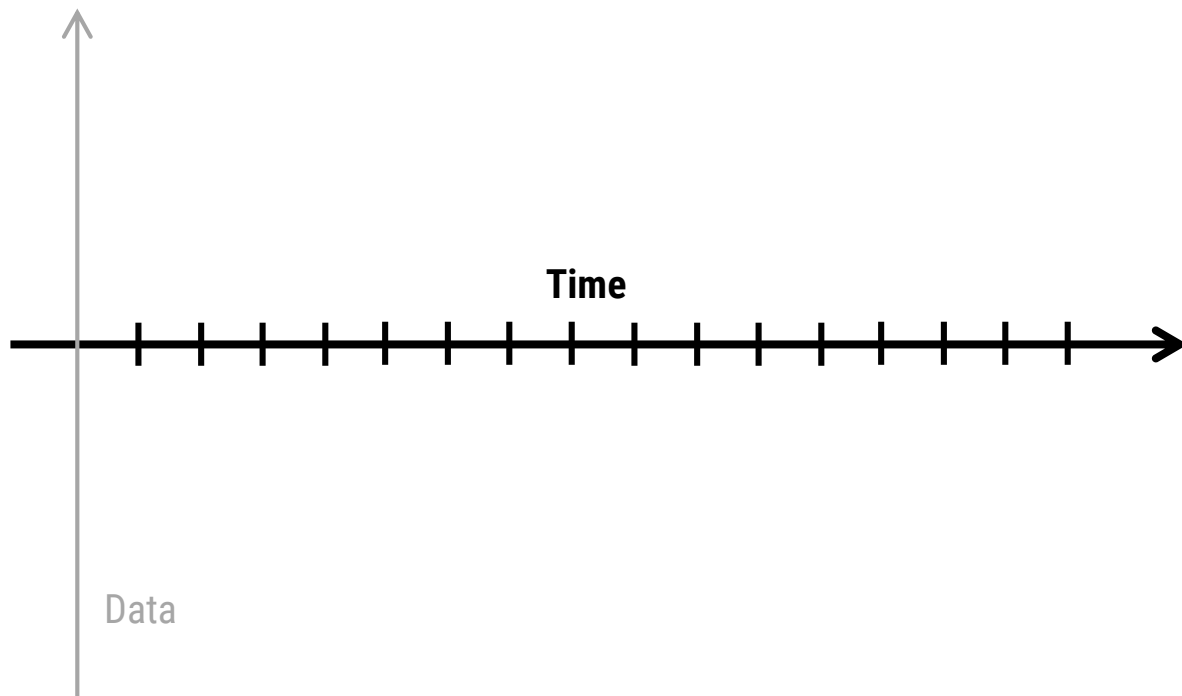


TIMELINES

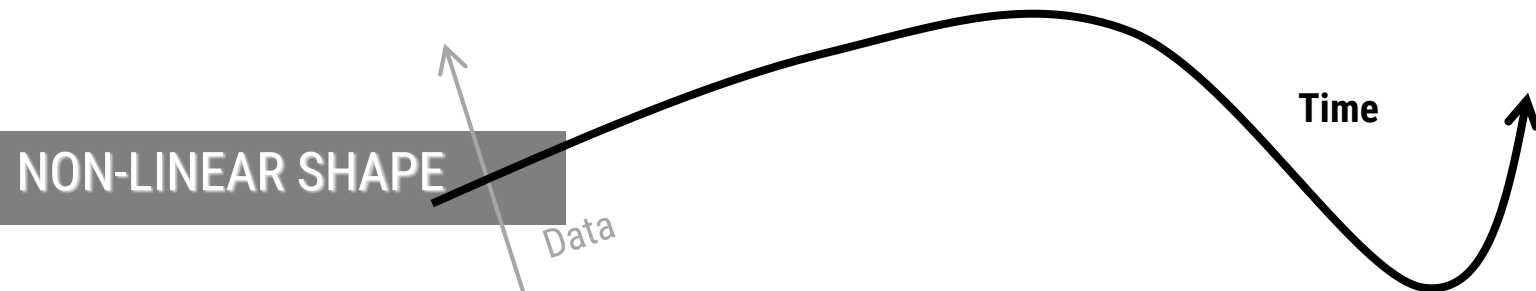
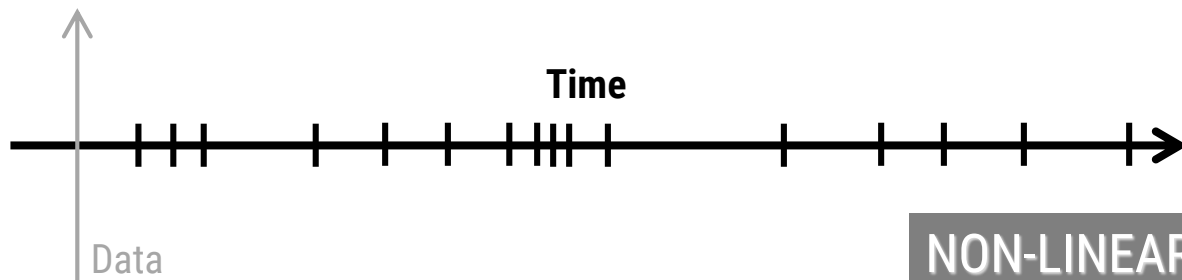
TimeNets



MAPPING TIME TO AN AXIS

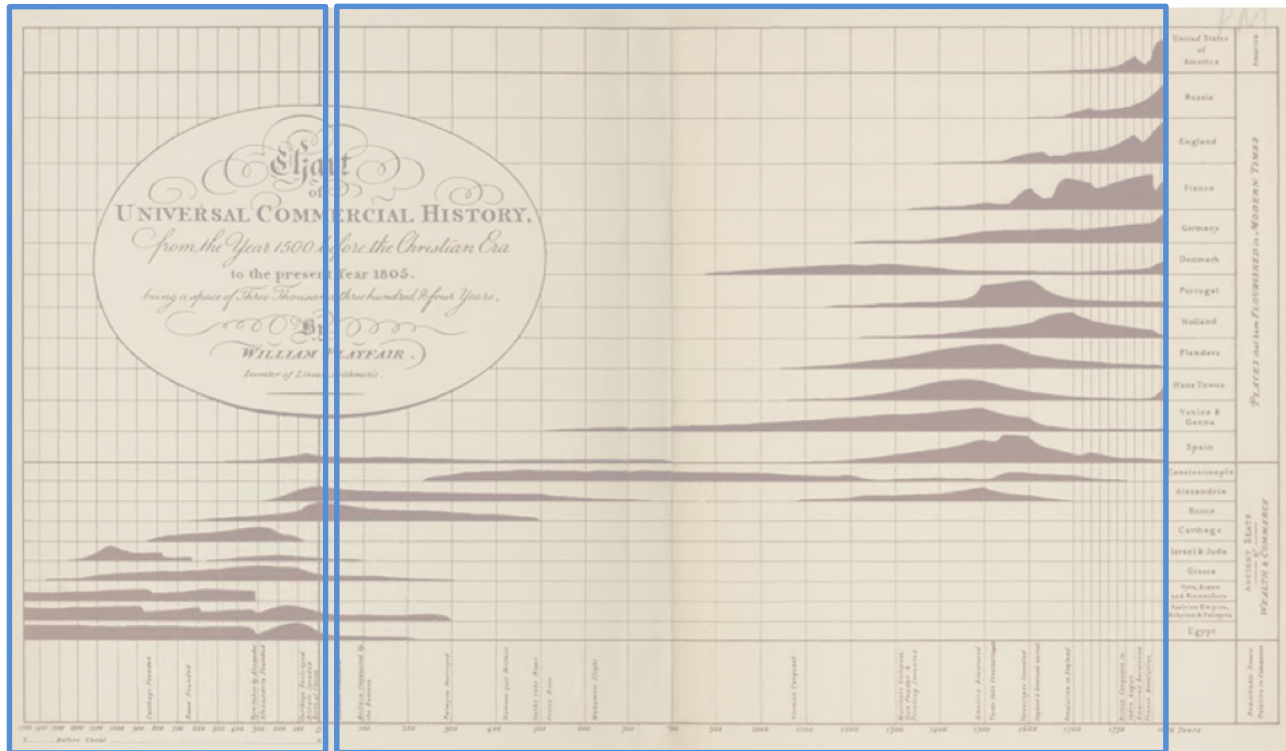


NON-LINEAR TIME AXES



NON-LINEAR TIME AXES

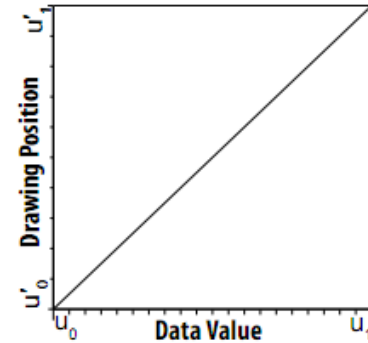
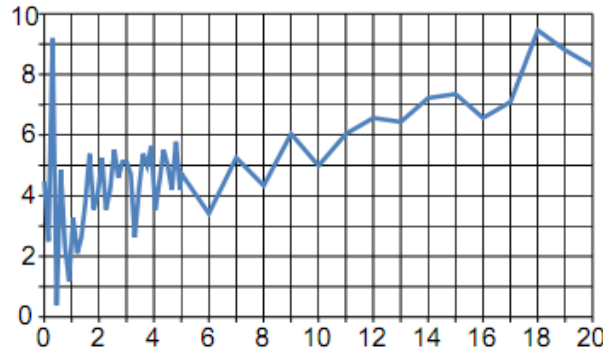
Dual-Scale Charts



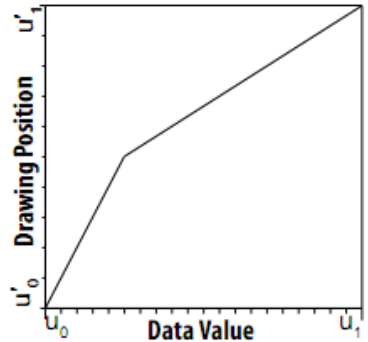
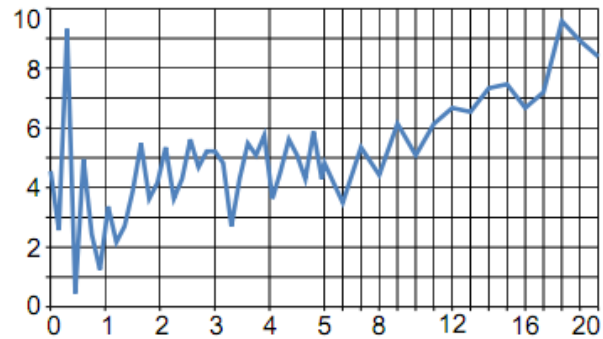
William Playfair, 1805. Cited in [Aigner et al, 2011](#).

NON-LINEAR TIME AXES

Dual-Scale Charts



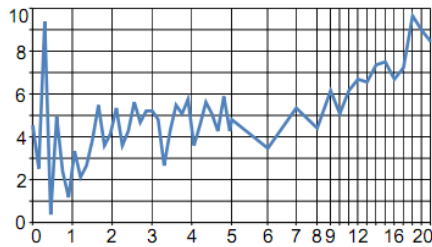
Regular Chart



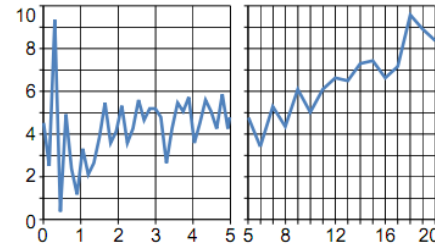
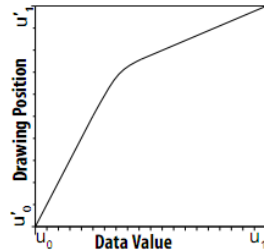
Bifocal Chart

NON-LINEAR TIME AXES

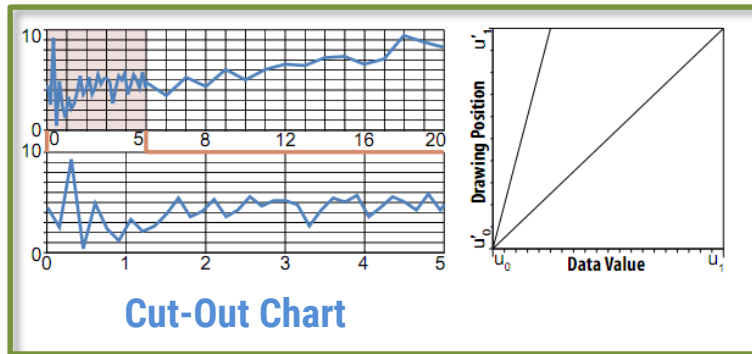
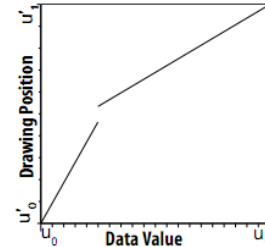
Other Types of Dual-Scale Charts



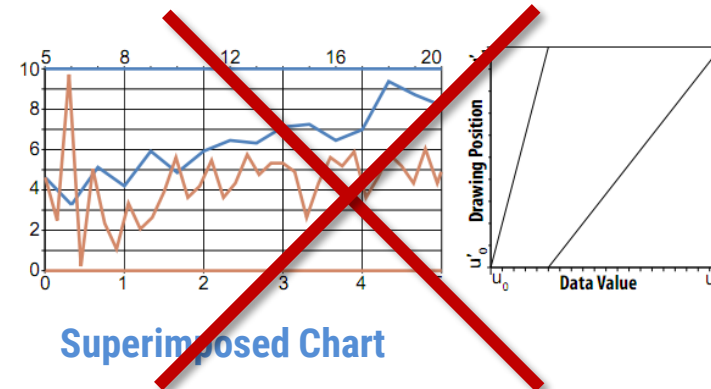
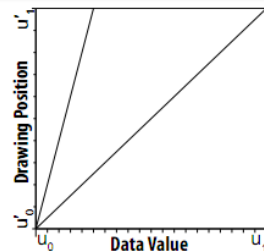
Lens Chart



Broken Chart



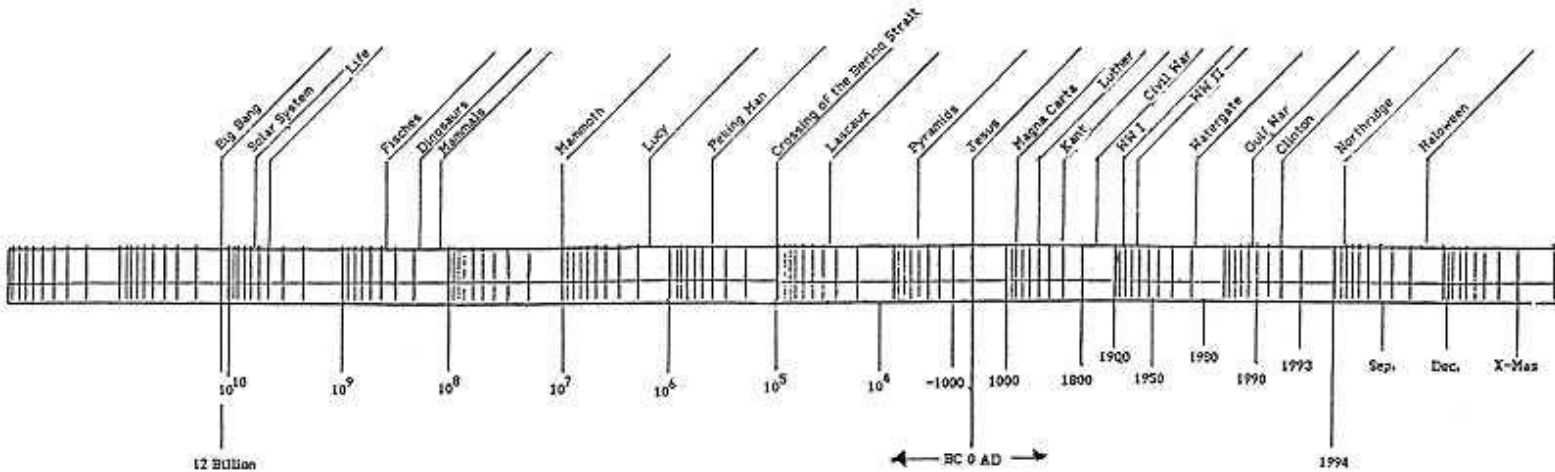
Cut-Out Chart



Superimposed Chart

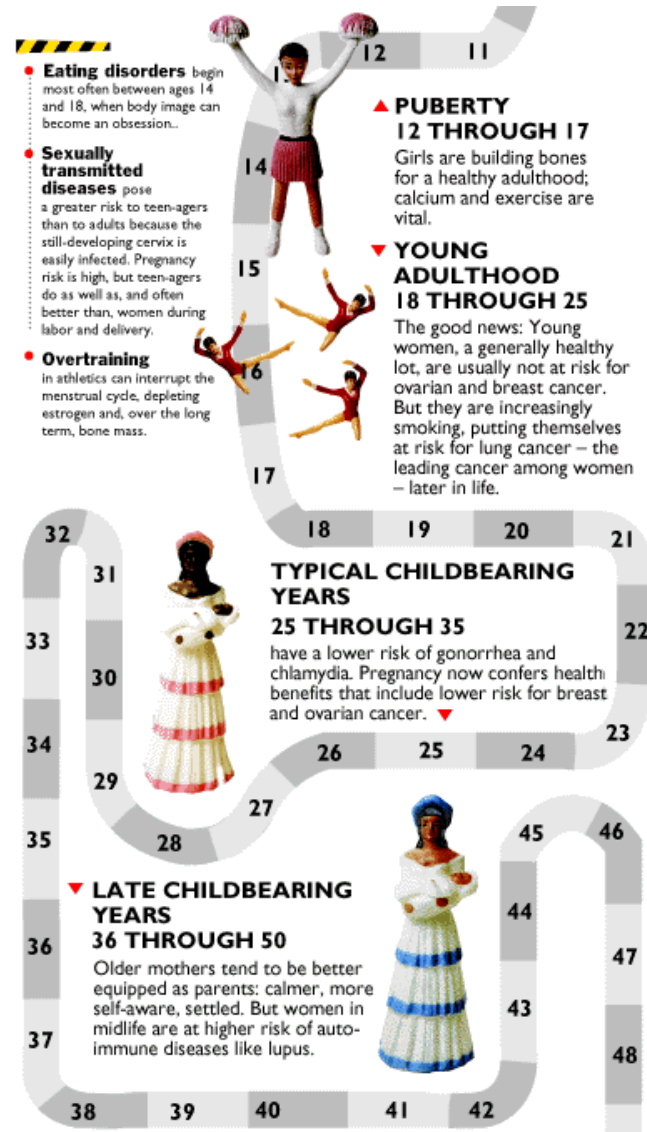
NON-LINEAR TIME AXES

Logarithmic scale



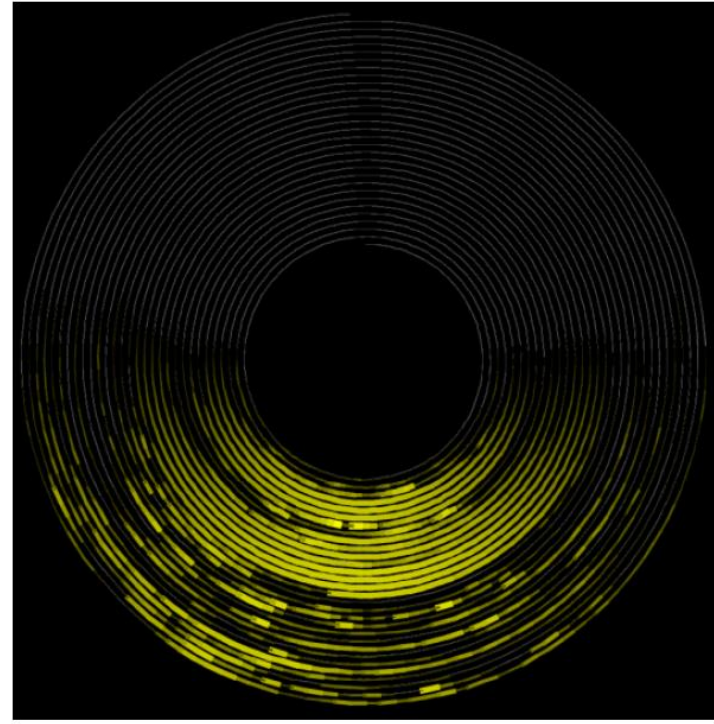
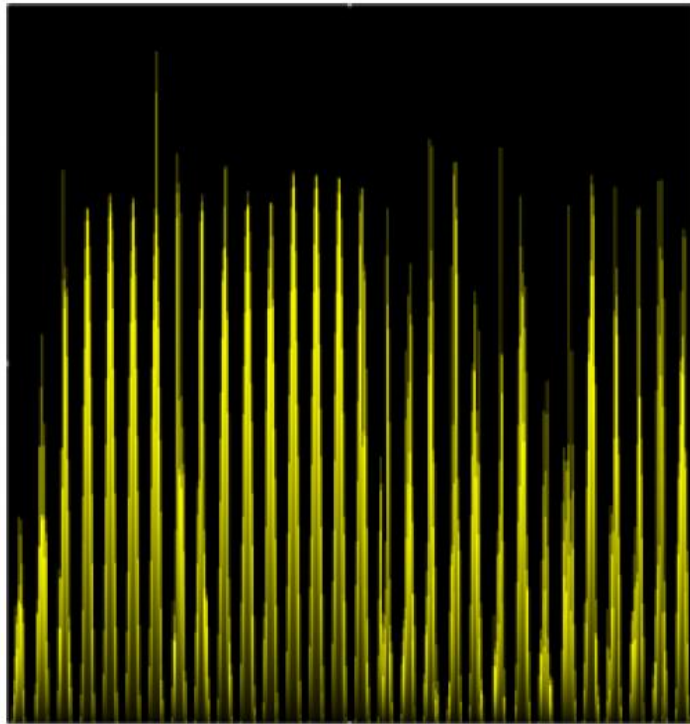
NON-LINEAR

Curved



[Megan Jaegerman, 1997](#)

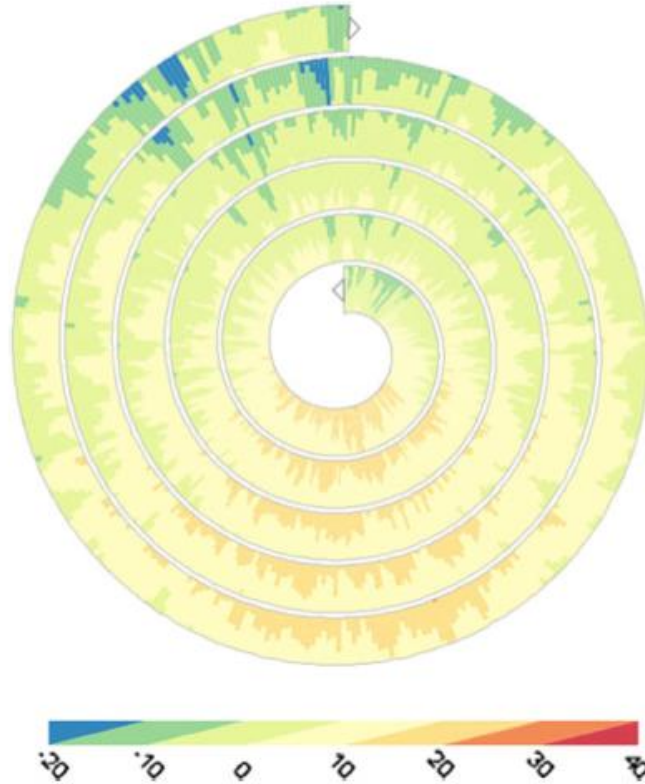
NON-LINEAR TIME AXES



[Webel et al, 2001](#)

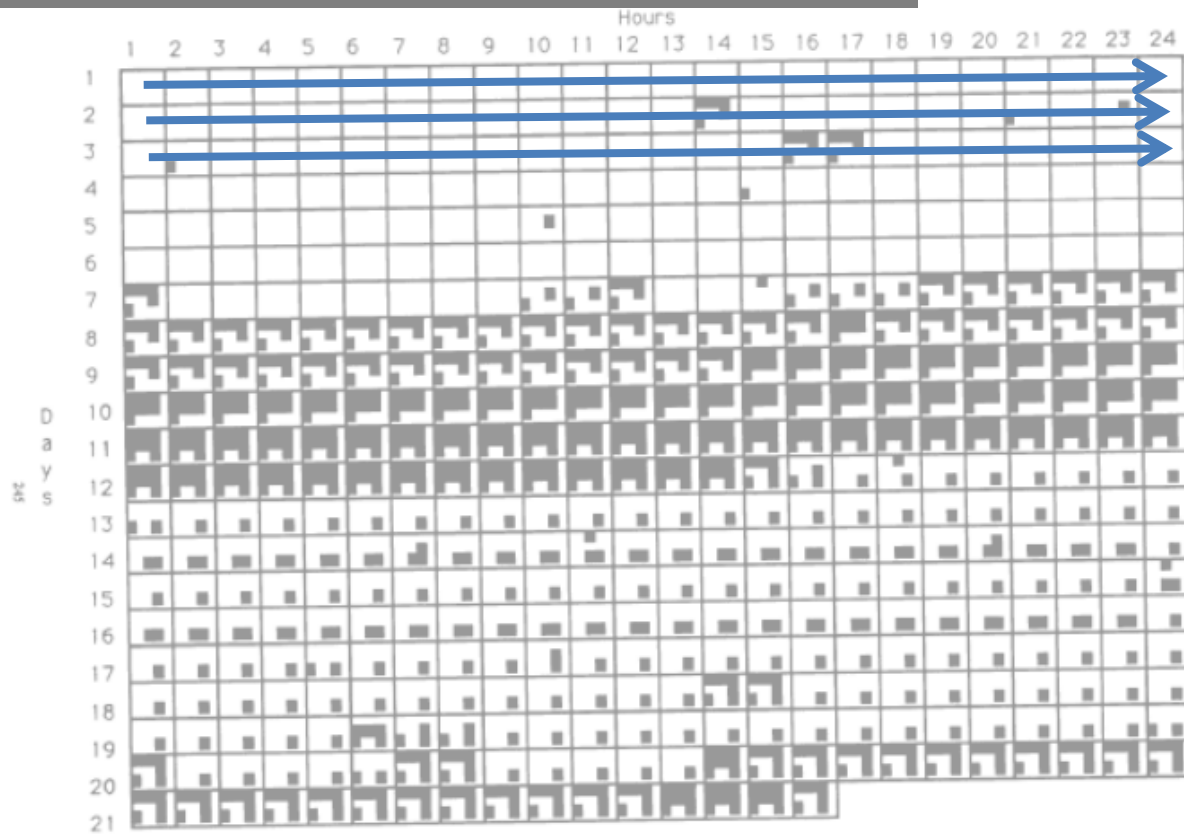
NON-LINEAR TIME AXES

Spiral



NON-LINEAR TIME AXES

Grid



Day by Hour: Thirteen Parameters of Magnetosphere and Solar Wind Data

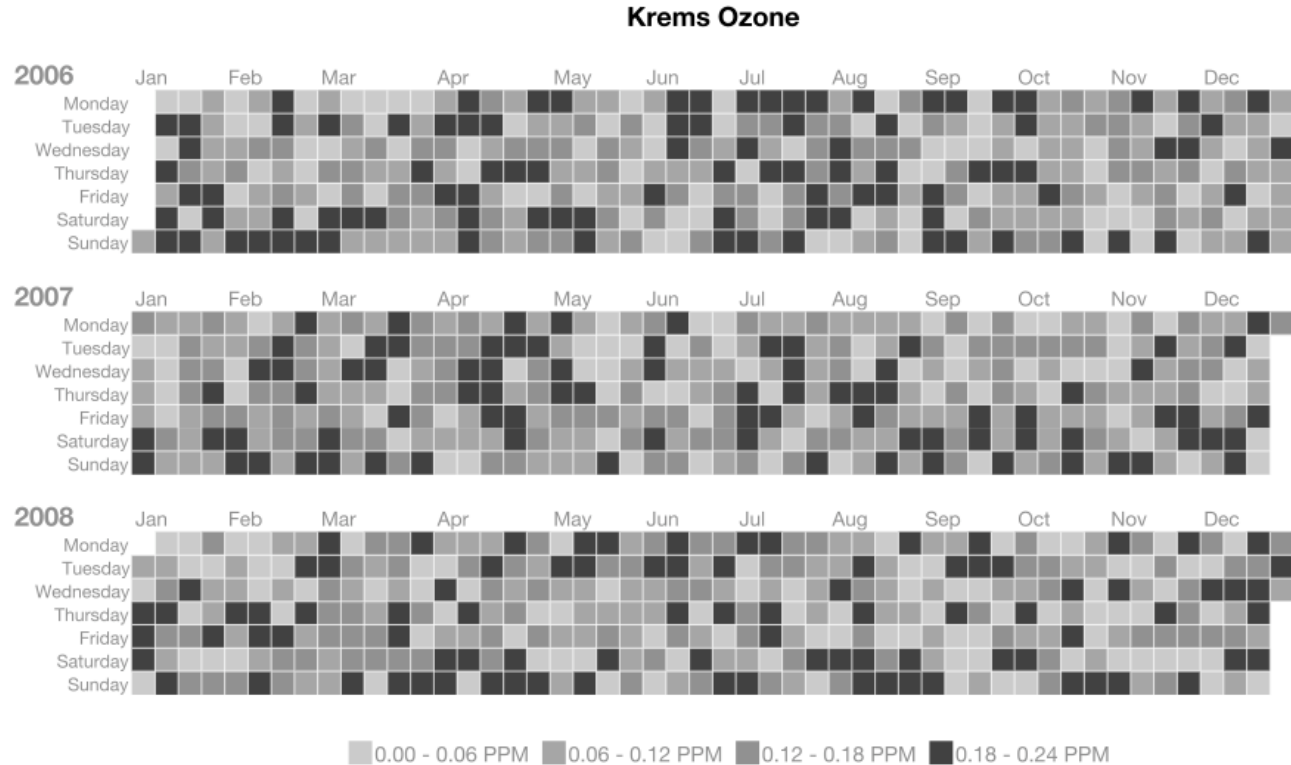
NON-LINEAR TIME AXES

Grid - Calendar



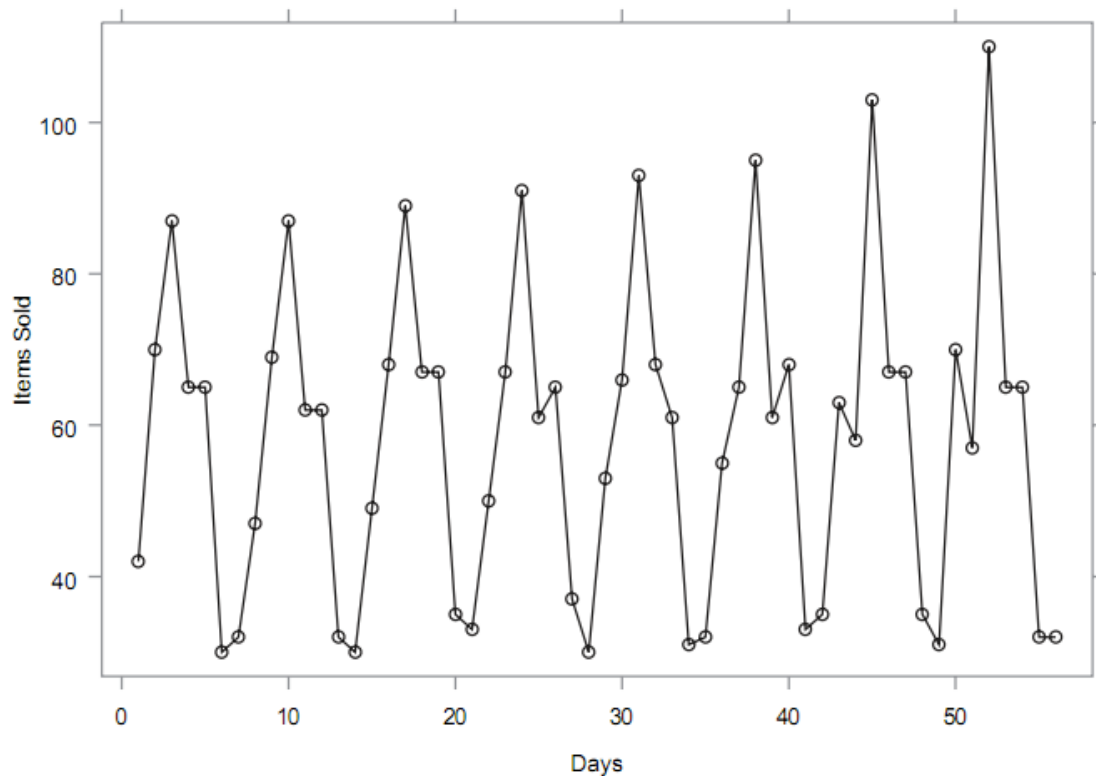
NON-LINEAR TIME AXES

Grid - Tile Map



NON-LINEAR TIME AXES

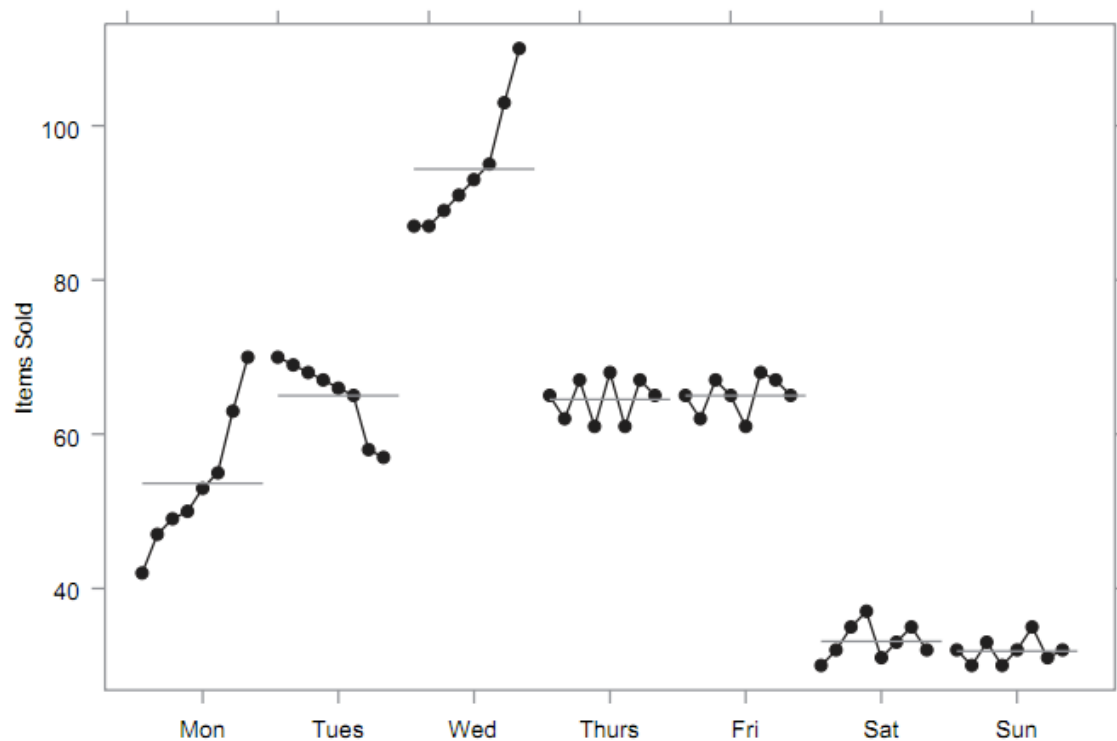
Cycle Plots



[Cleveland et al, 1978](#)

NON-LINEAR TIME AXES

Cycle Plots



[Cleveland et al, 1978](#)

HES REICH

634-642: Byzanz verlor Syrien u Mesopotamien an die Araber

687-1025: Makedon. Dynastie: Hochblau von Byzanz unter **Basilios I. II.**

Mohammed [570-632] begründet um 600 den Islam (Muslim. Religion - Moslems)

622: Mohammed flüchtet von Mekka (Fidesch) **Beginn der islamischen Zeitrechnung** von Mecca aus formt er ein politisch und religiös geeinigtes Arabien

632-750: Hochblüte **Kalifen** sind die Nachfolger Mohammeds u. vereinen d. gesamte u. weltl. Macht, auf vielen Gebieten d. Kultur, Wissenschaft sind d. Araber, die das Wissen d. Griechen, Perser u. Byzantiner übernehmen, dem Europäern überlegen. Ihr Reich erstreckte sich bis **Spanien**, über N-Afrika bis Indien. Weltmacht des Gewürz- u. Sklavenshandels bis ins 18. Jh.

Splung des Islam in Südwest-Europa u. Süftein (iberische Schwäche d. Reich)

7.Jh.: Zerfall des islamischen Reiches durch machungsreiche Genährke: Rivalisierende Kalifen u. Stämme. Daher für ein Jh. machtlos gg. sein Rekonquiste des im eindringenden Kreuzritzer.

1281-1328: Osman I. begründet Osmanisches Reich (Türk) u. SO-Naher Osten, M.

1453-75: Venedig Peloponnes u. Albanien

1430: Siedlung verrückter Balkenbau

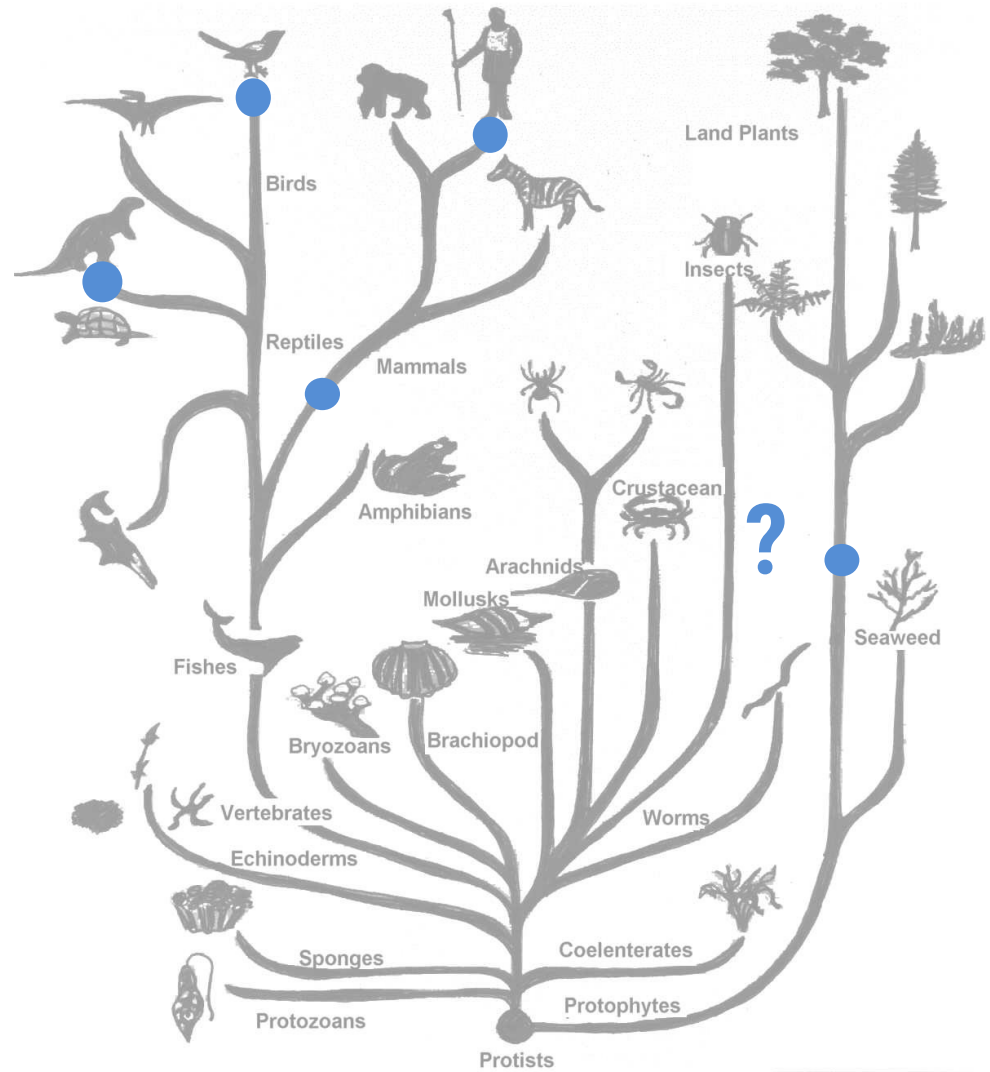
500 **1000**

K. E. ROMANIK GOTIK R.

a. Chl. 950-1250 1130-1500

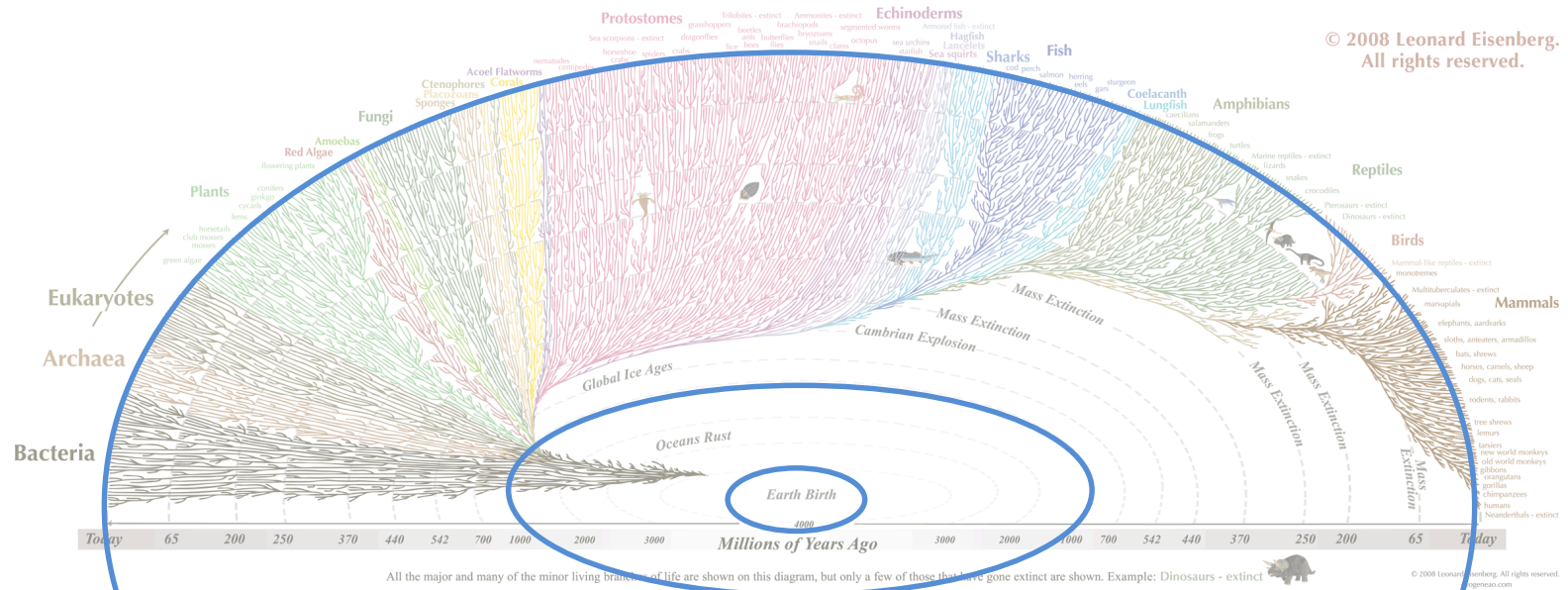
KAROLINGISCHE KUNST 750-1000

Phylogenetic Tree



NON-LINEAR TIME AXES

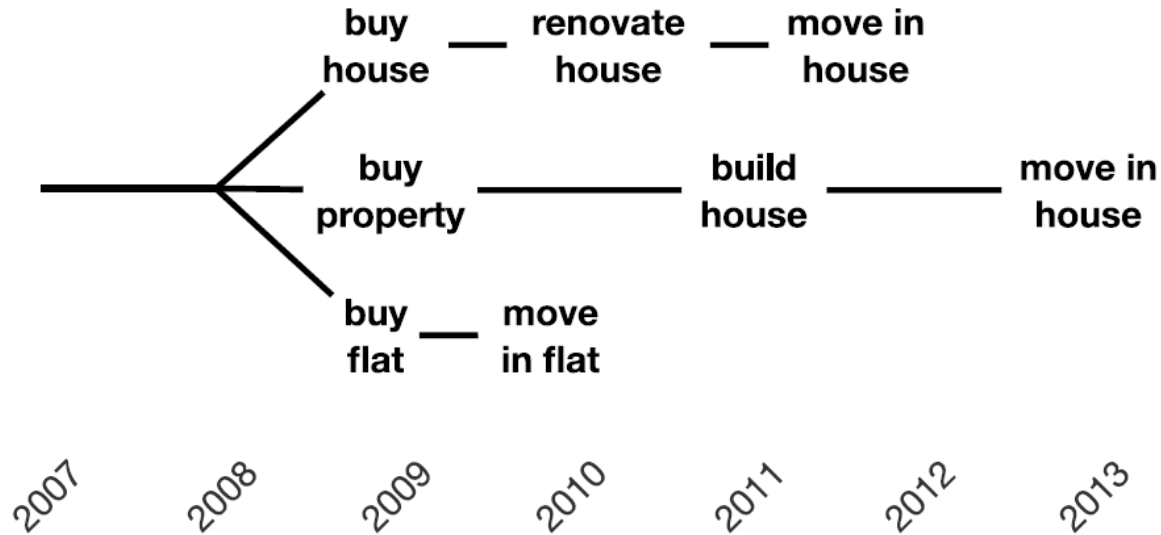
Phylogenetic Tree



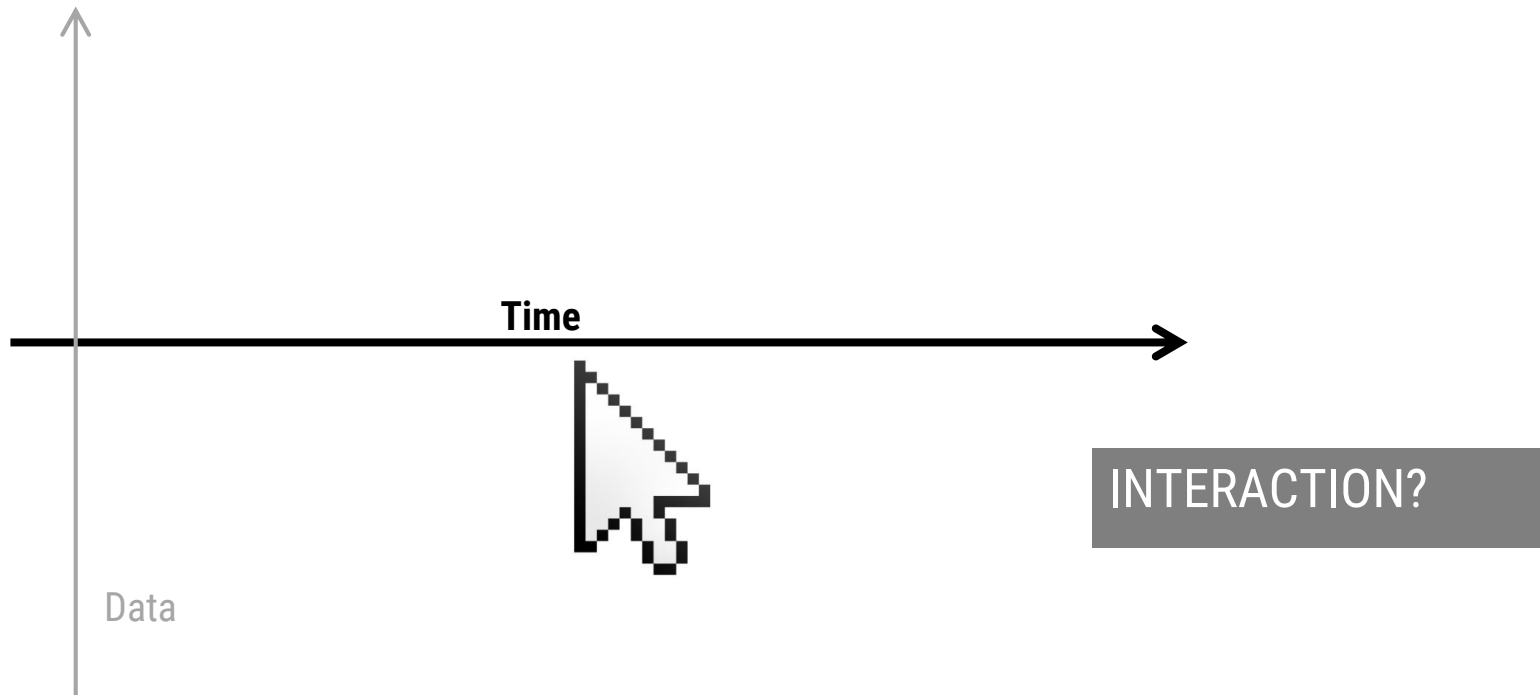
evogeneao.com – based on Dawkins, The Ancestor's Tale

NON-LINEAR TIME AXES

Trees – Branching time

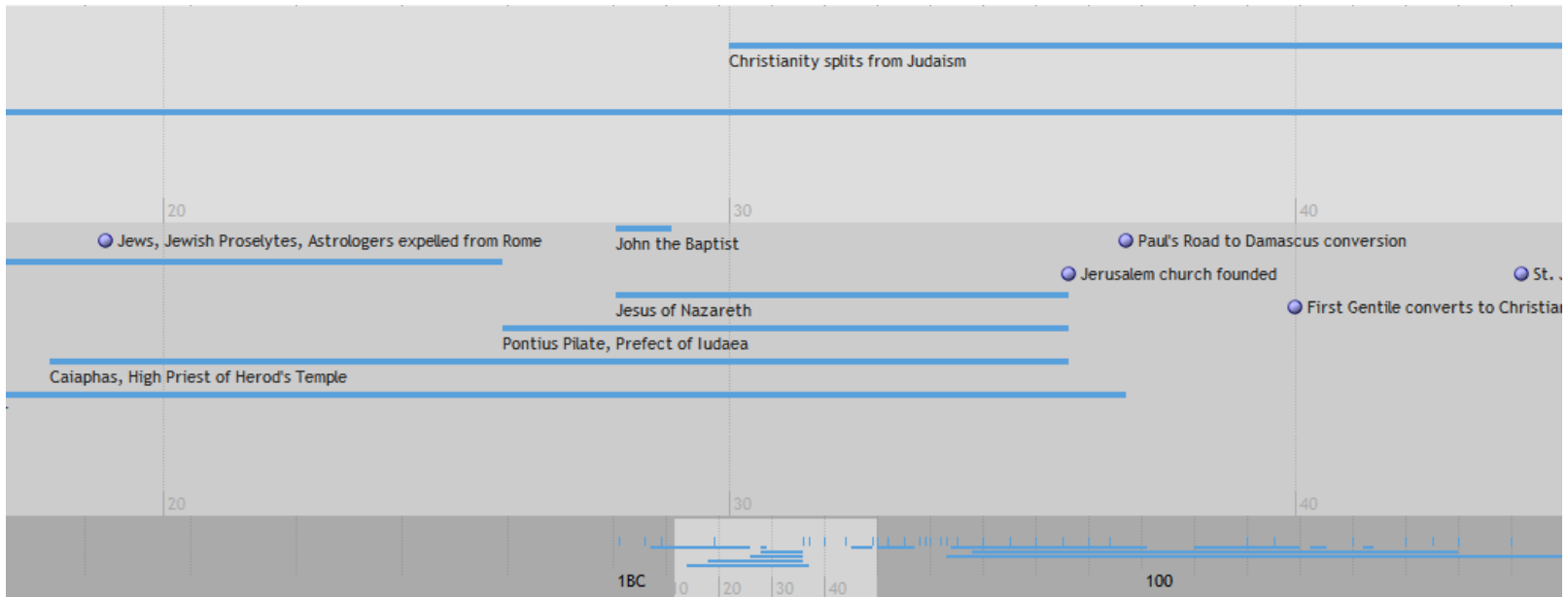


MAPPING TIME TO AN AXIS



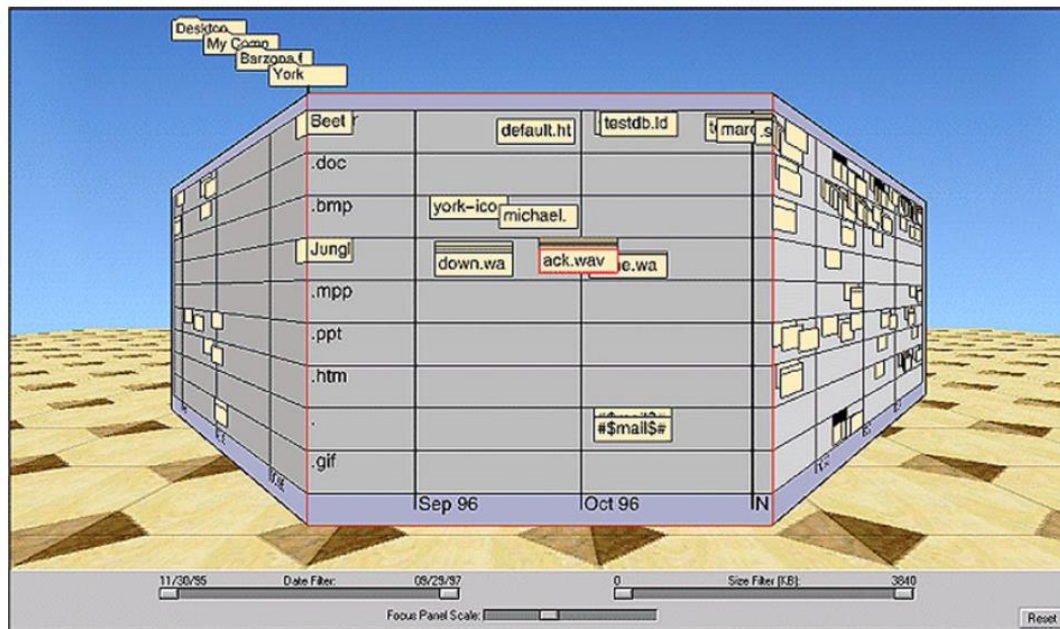
INTERACTION

Focus+Context - Simile Timeline



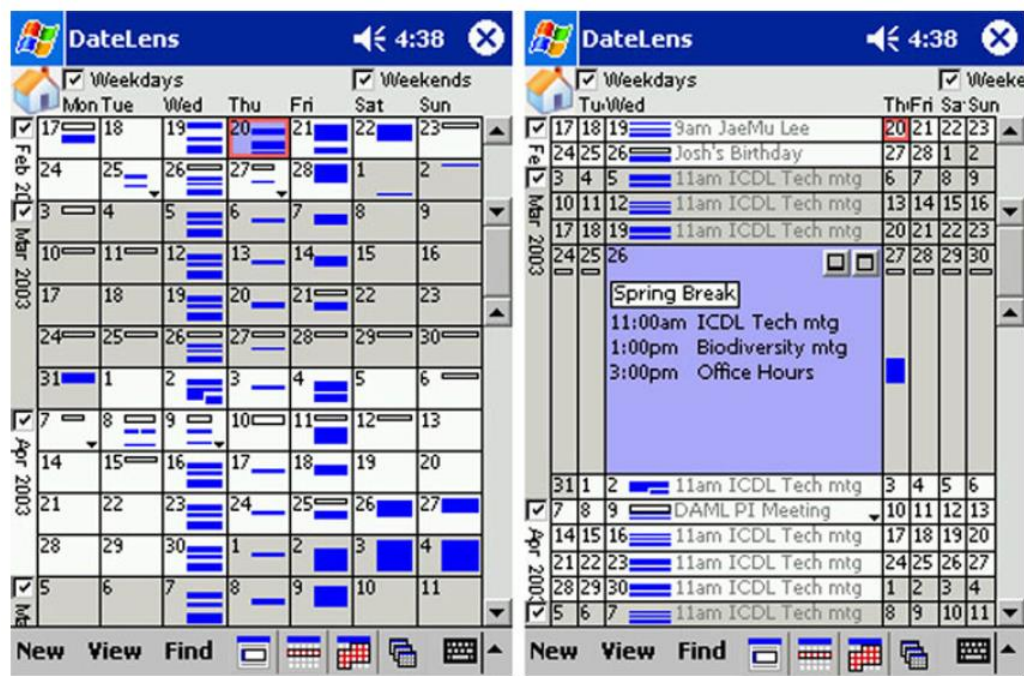
INTERACTION

Focus+Context - Perspective Wall



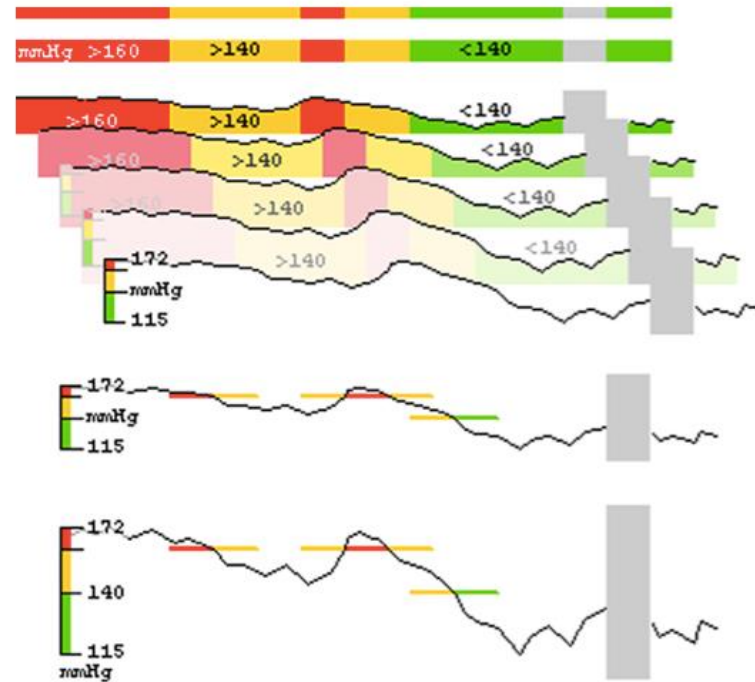
INTERACTION

Focus+Context - DateLens



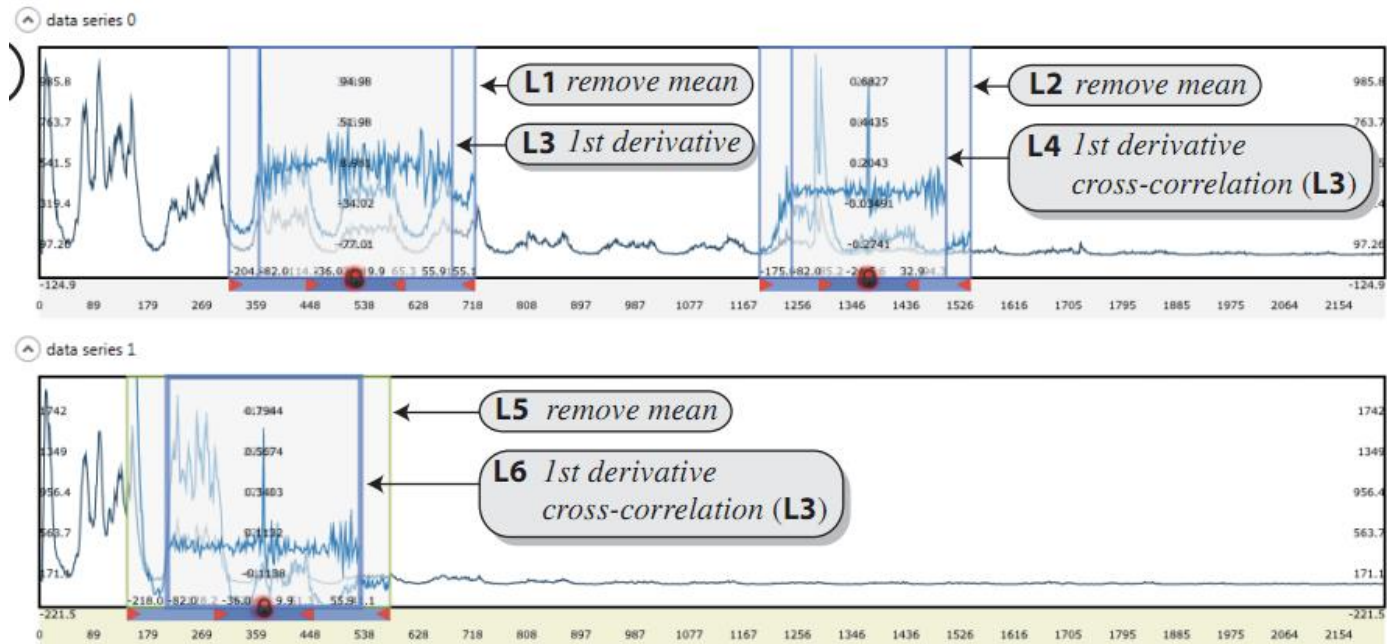
INTERACTION

Semantic Zooming - Midgaard



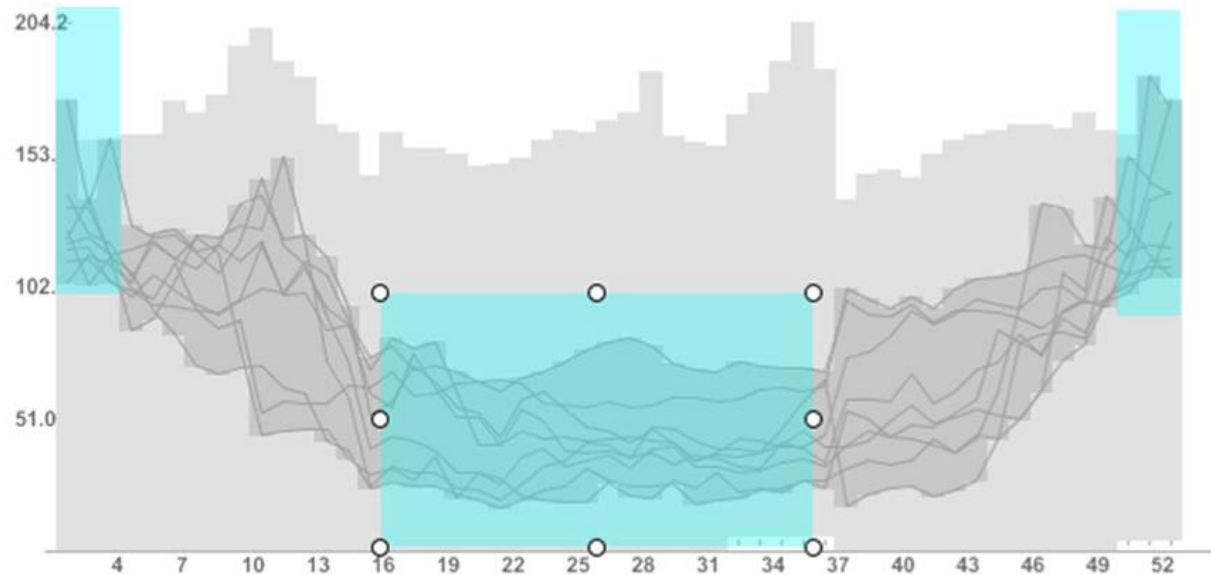
INTERACTION

Magic Lenses - ChronoLenses



INTERACTION

Dynamic queries - Time Searcher



TimeSearcher...13 Months of High and Low prices

File Edit View Transform Help



Search:

Search

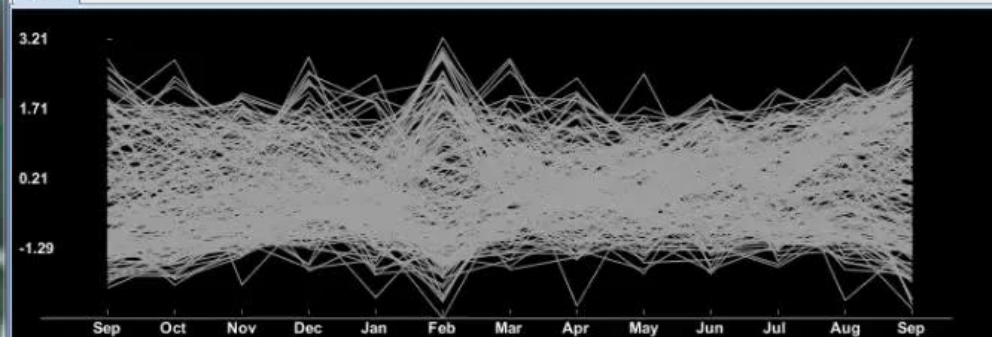
Clear

Query Variable

Low



Low



Name: AVIRON

Low High

September: 21.63 24.25

October: 23.75 24.38

November: 16.0 16.5

December: 15.5 16.06

January: 19.5 21.44

February: 37.88 43.0

March: 27.25 28.88

April: 23.0 24.88

May: 23.63 25.38

June: 29.13 31.25

July: 27.56 31.06

August: 41.63 45.63

September: 52.5 59.0

AVIS GROUP HOLDINGS CL A

AVIRON

AVANT CORP

AVON PRODUCTS INC

AVNET INC

AVX CORP

AVERY DENHISON CORP

AMVESCO PLC

ALLIED WASTE INDUSTRIES

AMERICAN WATER WORKS INC

AVARE INC

AXA ADS

ANIXTER INTERNATIONAL

AXA FINANCIAL INC

AMERICAN AXLE & MANUFACT

AXENT TECHNOLOGIES INC

AMERICAN EXPRESS CO

AXT INC

ALLEGHENY ENERGY INC

ALZA CORPORATION

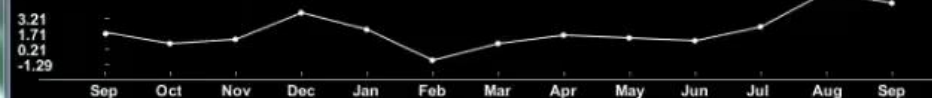
ASTRAZENECA PLC

AUTOZONE INC

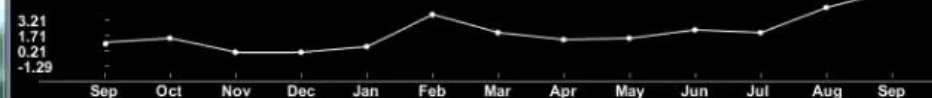
ASPEN TECHNOLOGY INC

AZTAR CORP

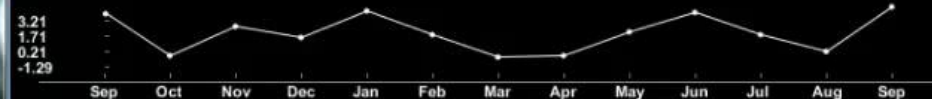
AVIS GROUP HOLDINGS CL A



AVIRON

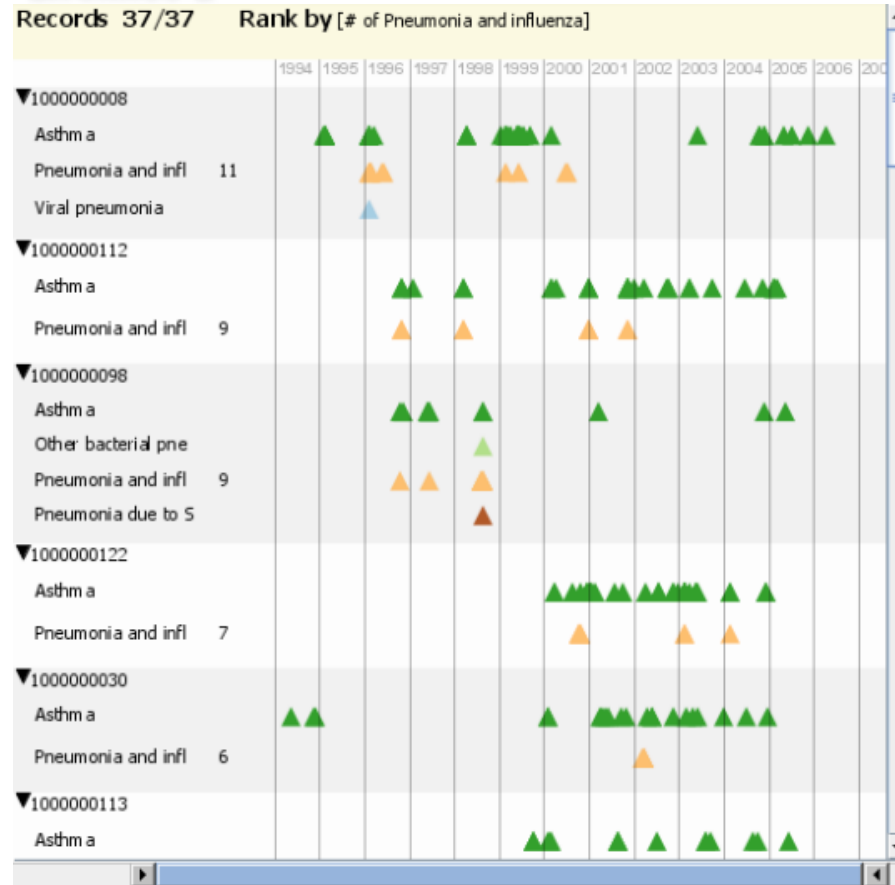


AVANT CORP



INTERACTION

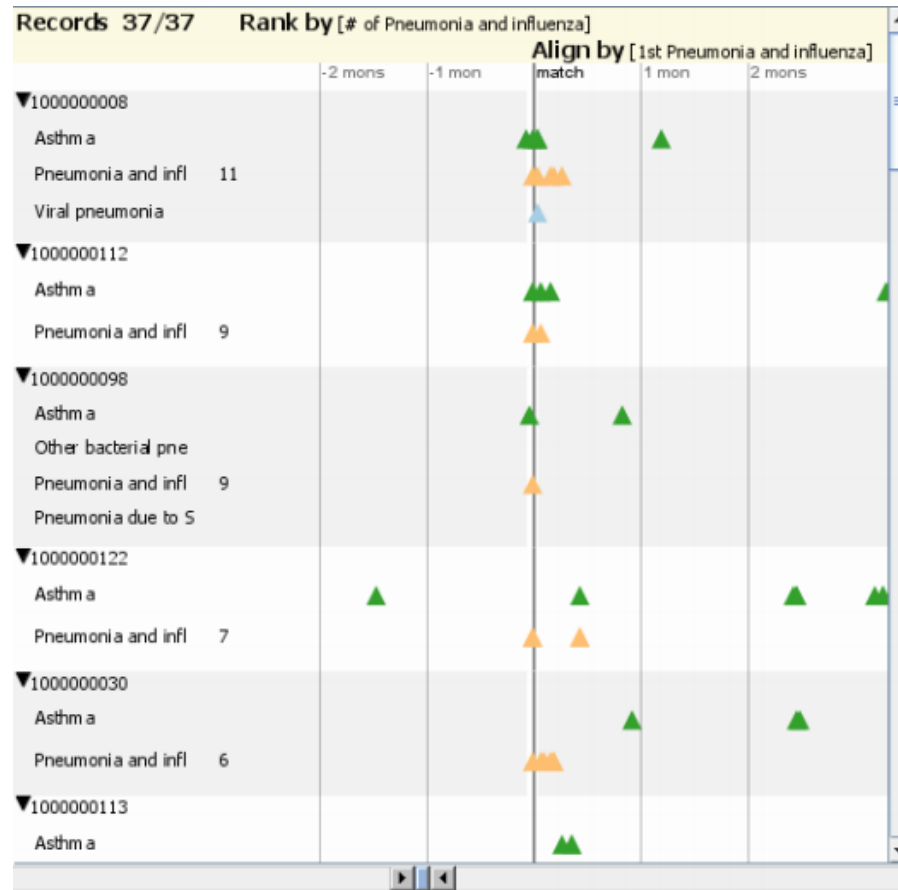
Temporal alignment – Lifelines 2



[Wang et al, 2008](#)

INTERACTION

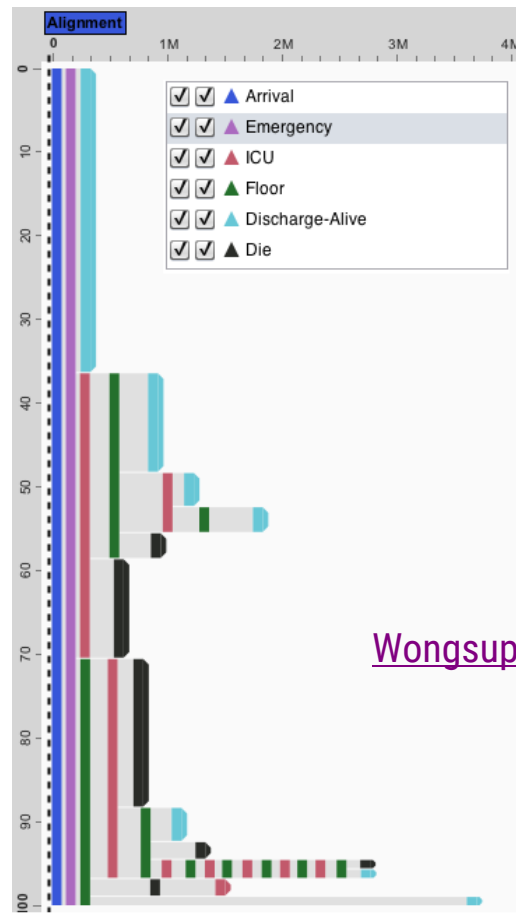
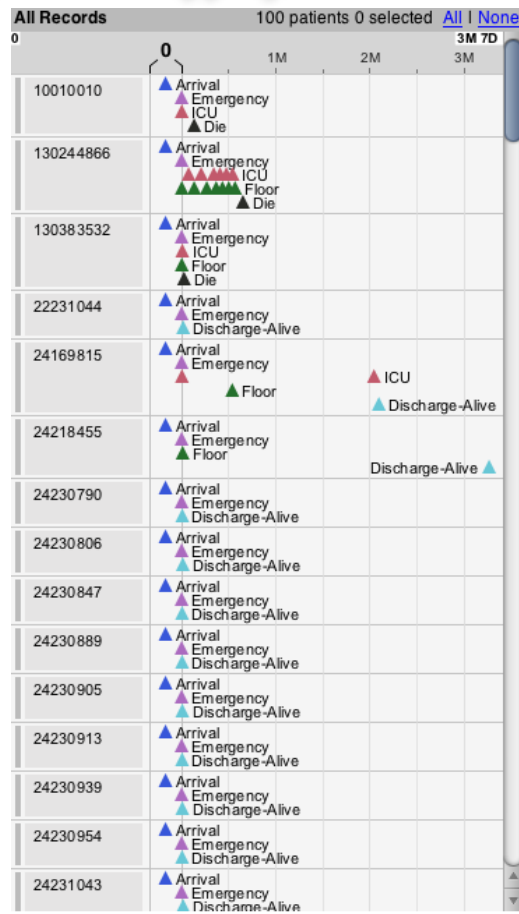
Temporal alignment – Lifelines 2



[Wang et al, 2008](#)

INTERACTION

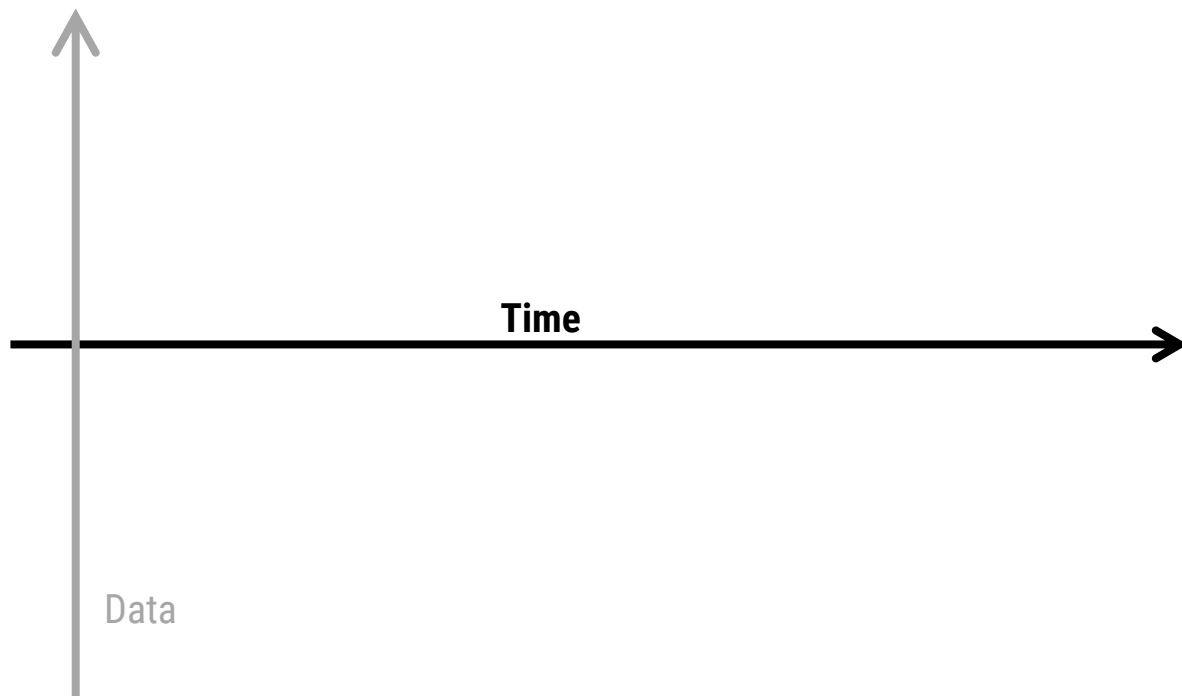
Temporal alignment + Aggregation – LifeFlow



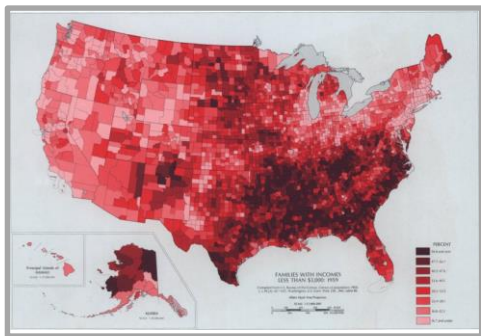
Wongsuphasawat et al.
2011

MAPPING TIME TO SPACE

MAPPING TIME TO AN AXIS



MAPPING TIME TO AN AXIS

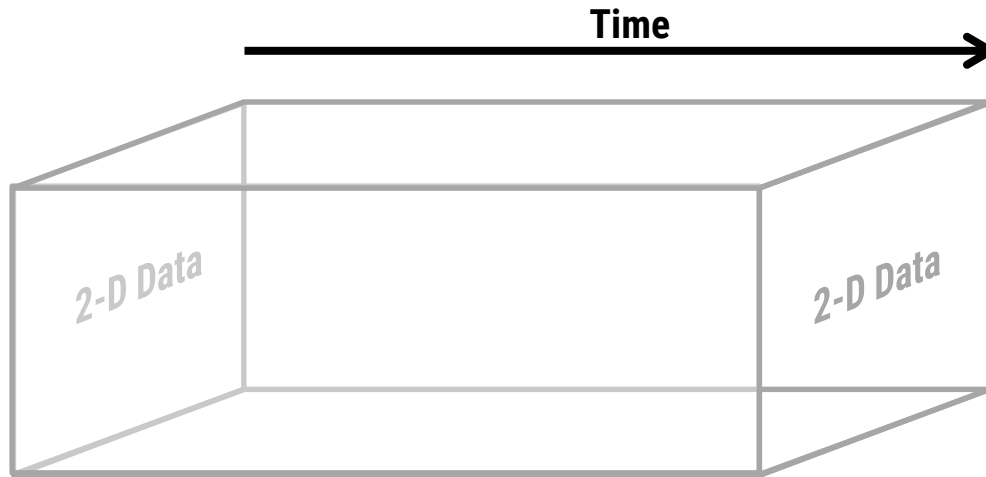


Data

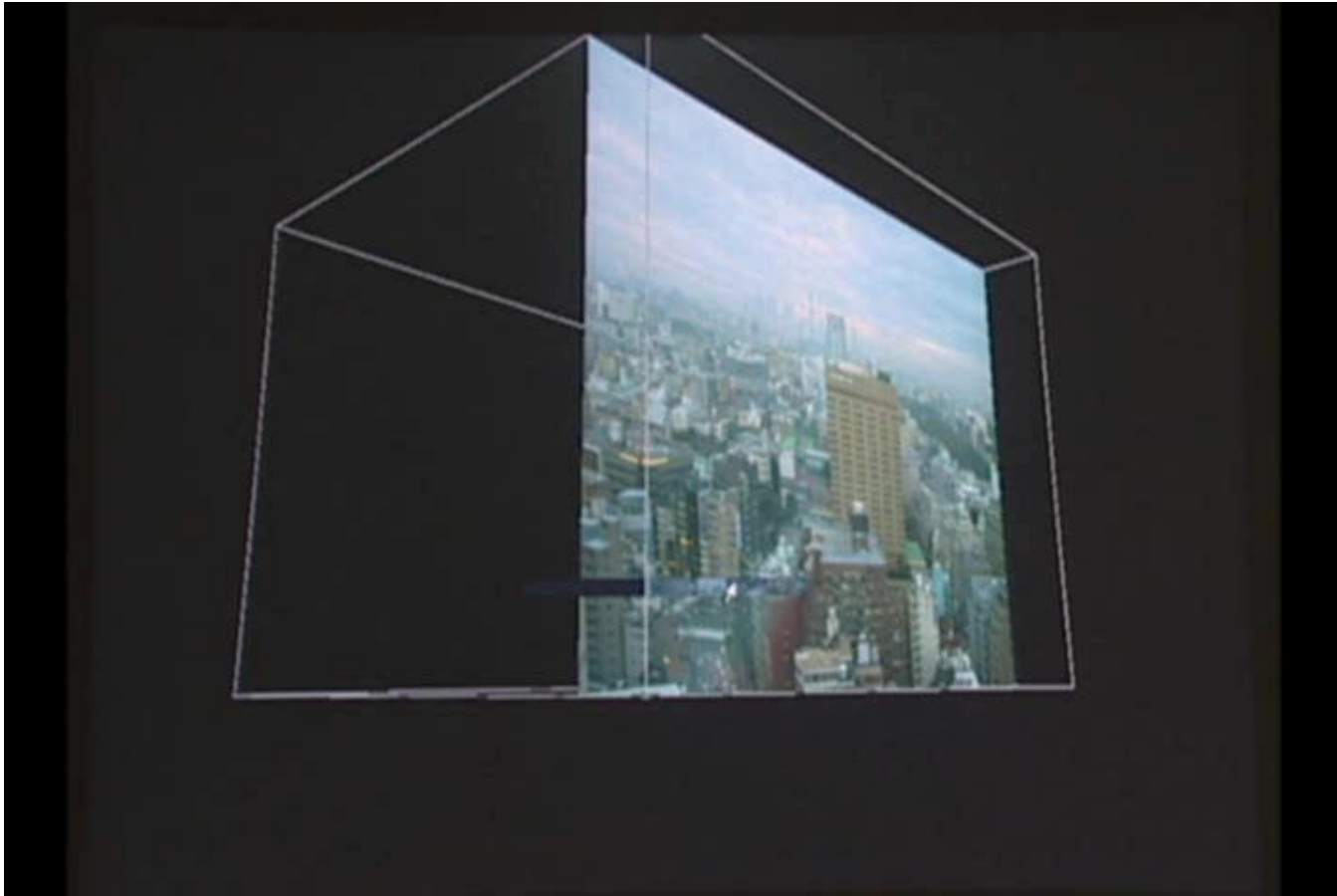
Time

2D + TIME

Space-Time Cube Model



2D + TIME

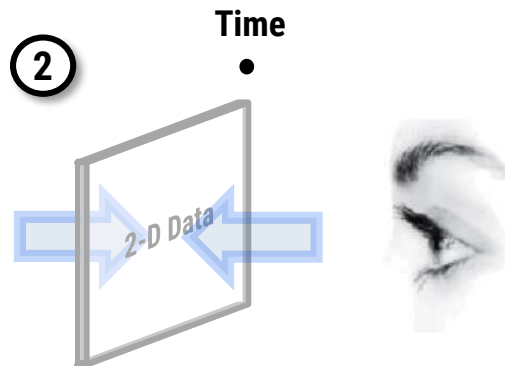
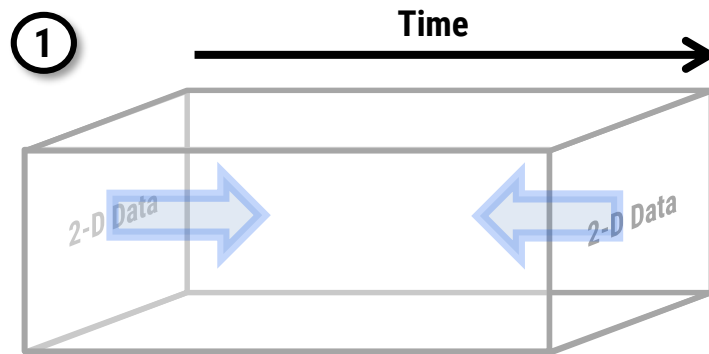


2D + TIME



2D + TIME

Time Flattening



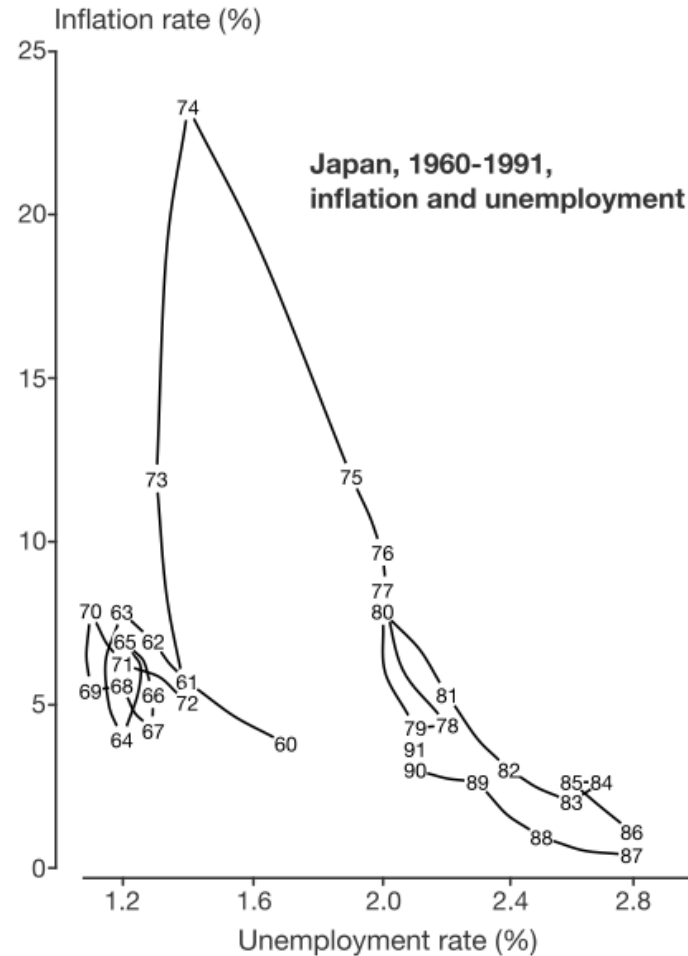
2D + TIME

Long exposure photography



2D + TIME

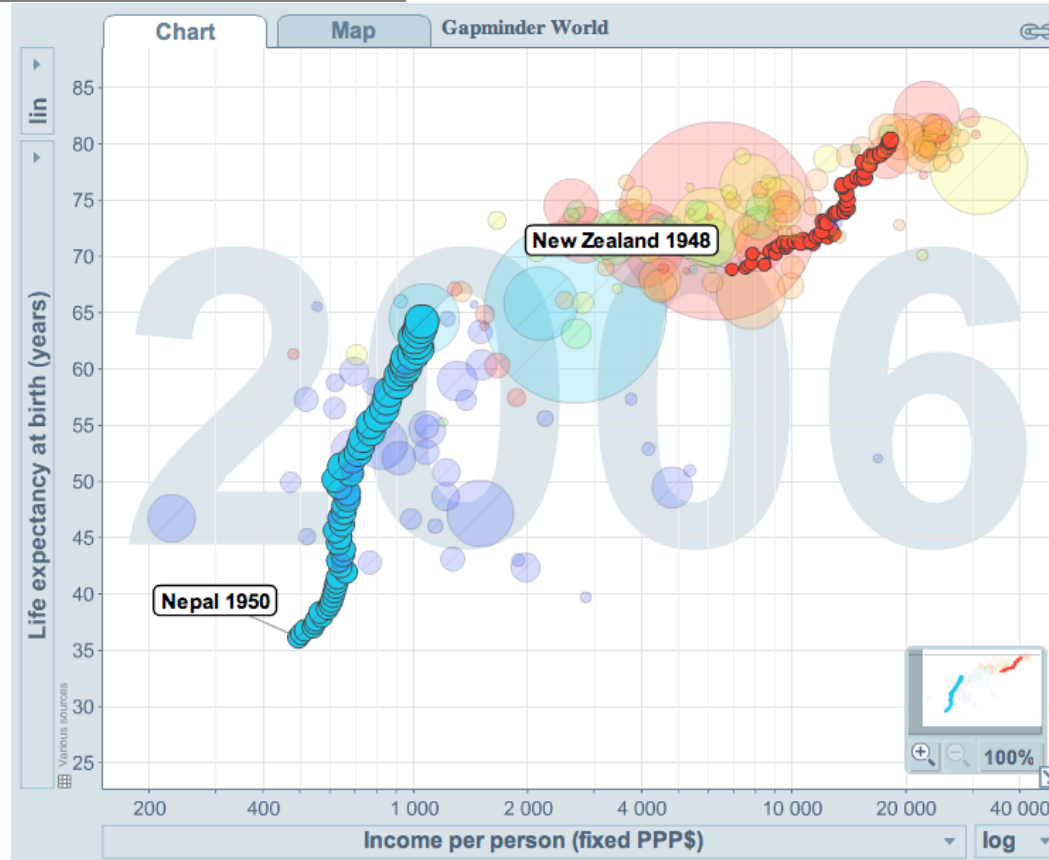
Phillips Curve



Tufte, 1997. Cited in [Aigner et al, 2001](#)

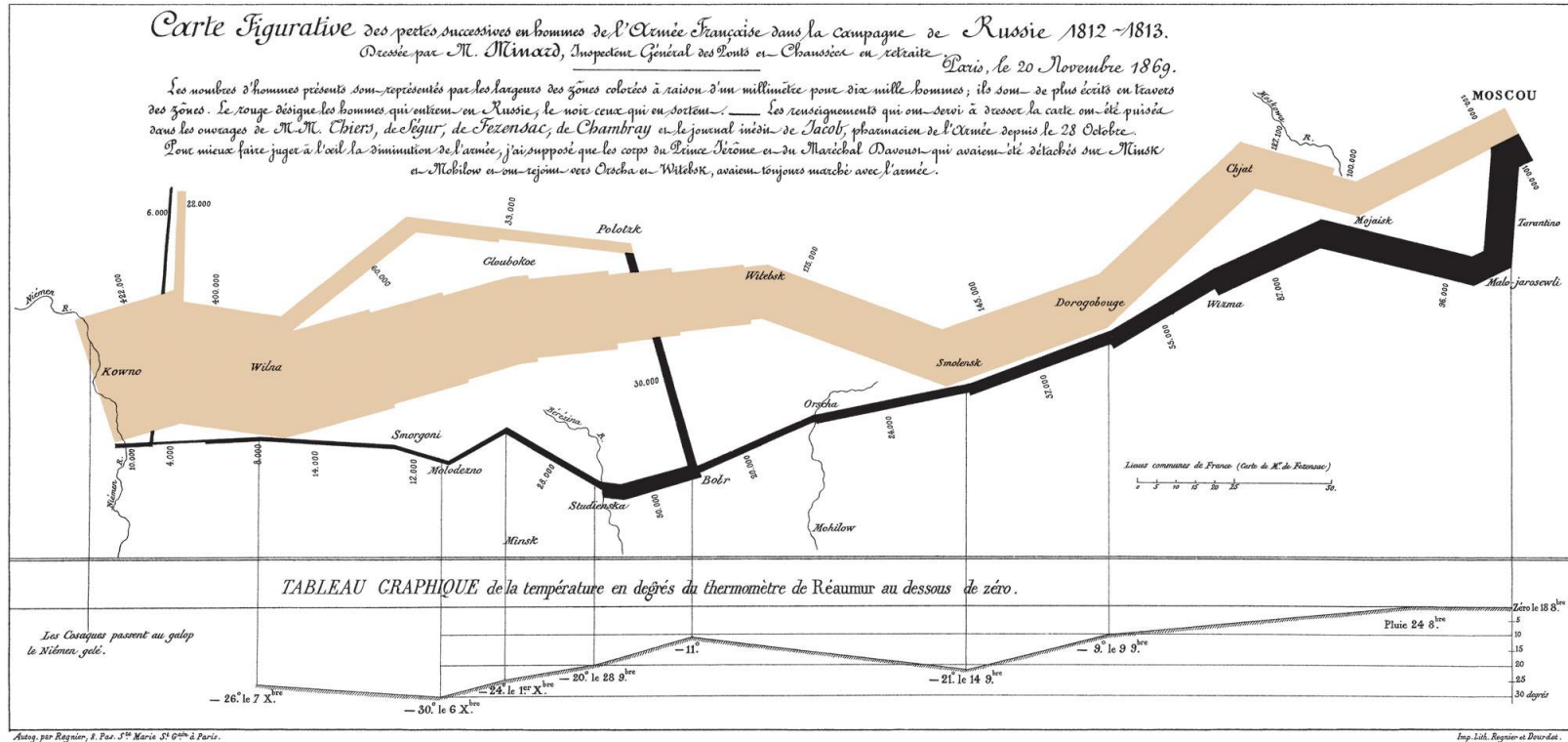
2D + TIME

Trails



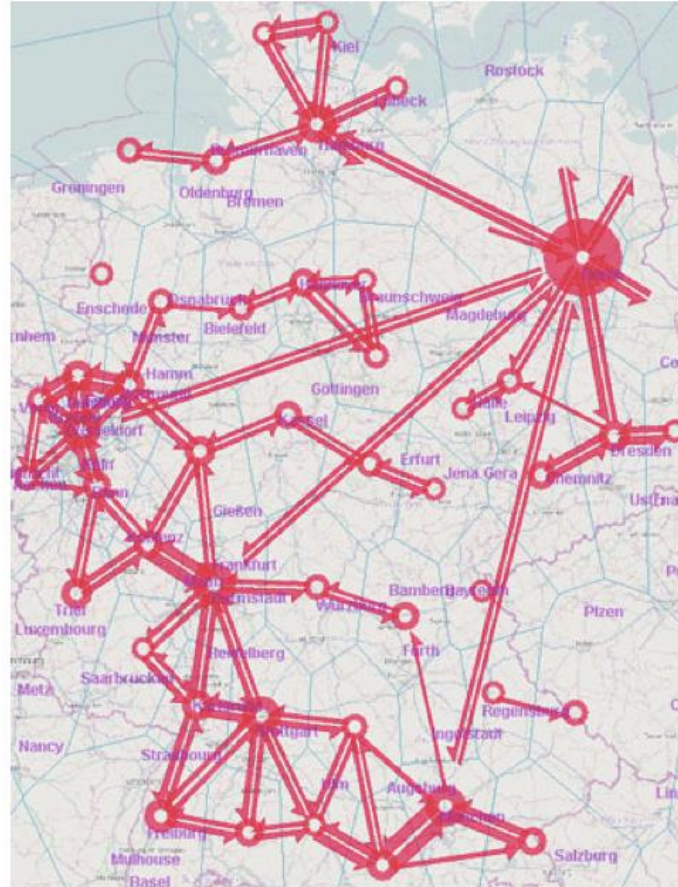
2D + TIME

Napoleon's Russian Campaign of 1812



2D + TIME

Flow Maps

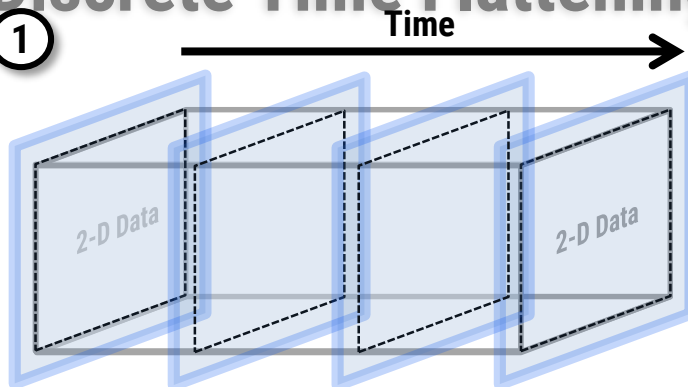


[Tobler, 1987](#)
[Adrienko, 2011](#)

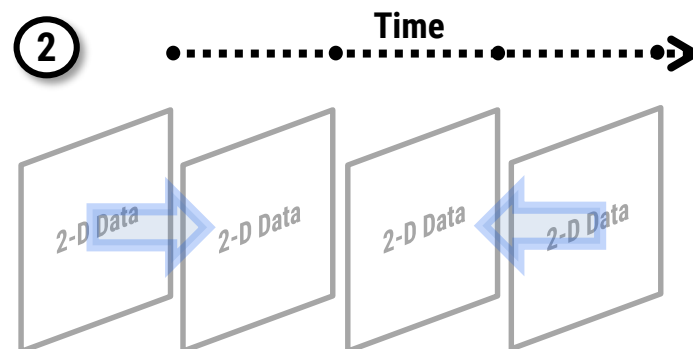
2D + TIME

Discrete Time Flattening

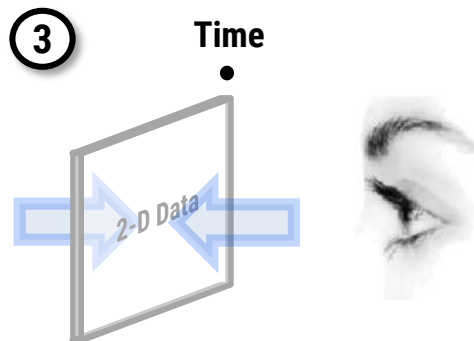
①



②

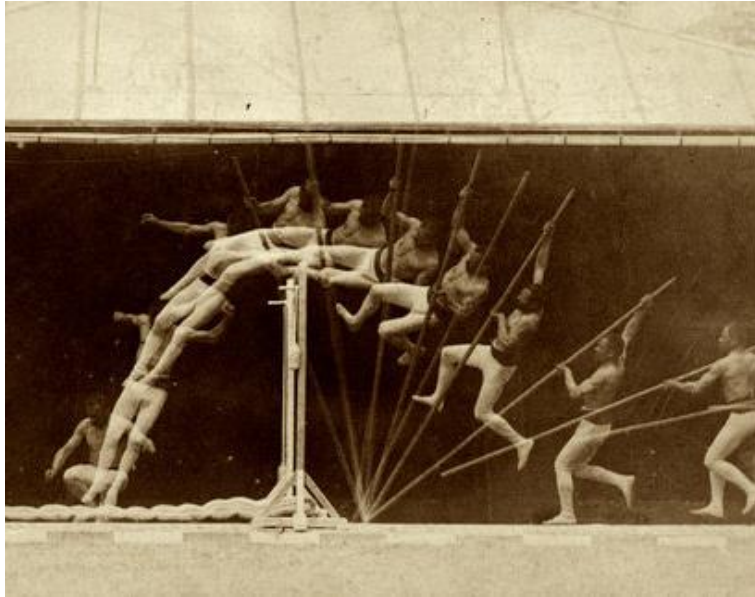


③



2D + TIME

Marey's Chronophotography Technique



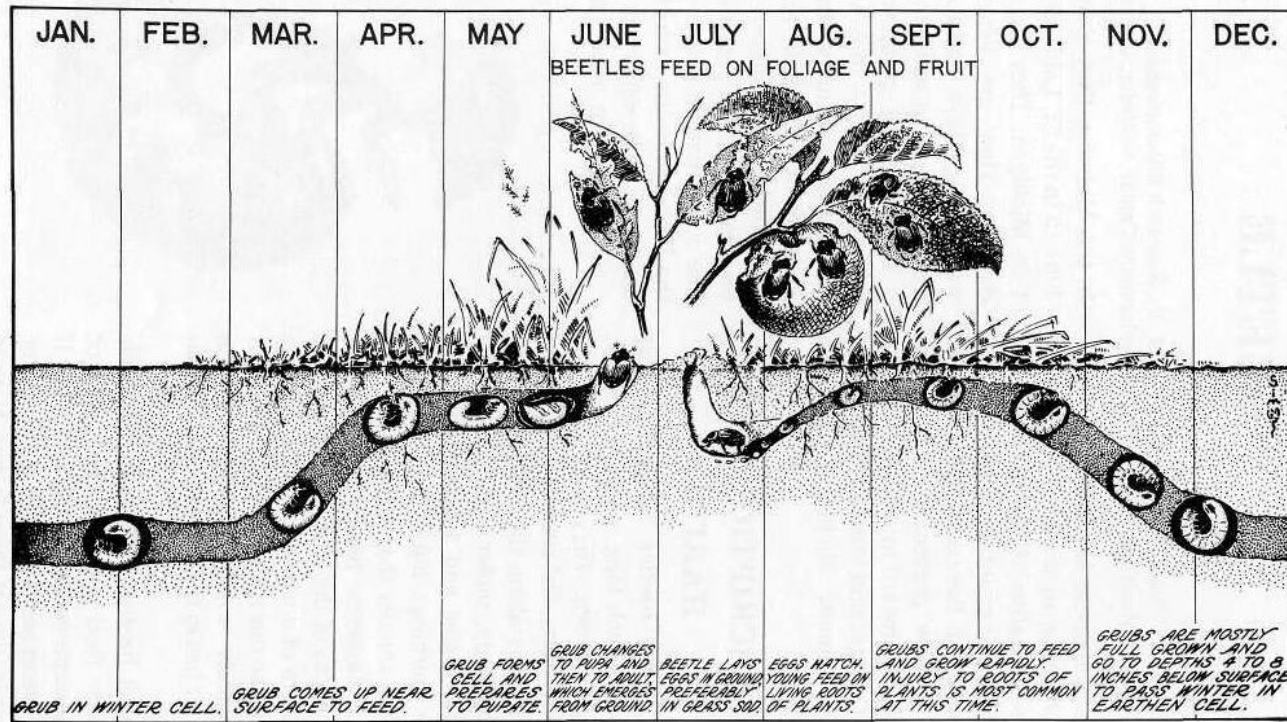
Étienne-Jules Marey, 1880s ([source](#))



([image source](#))

2D + TIME

Sequences



Seasonal life cycle of the Japanese beetle in the vicinity of Philadelphia.

FR.1.2789

2D + TIME

Sequences

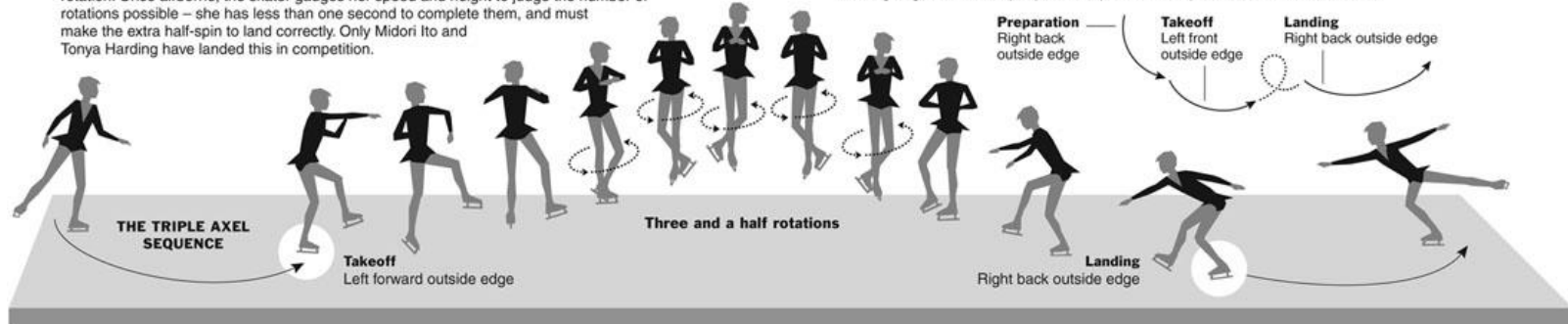
The Jumping Off Points: Moves That Will Be Made in the Free Skating Programs

TRIPLE AXEL: Add an extra half-spin

The axel's forward takeoff and backward landing positions add an extra half-rotation to the jump, so skaters need maximum power on takeoff, and precise upper body control during rotation. Once airborne, the skater gauges her speed and height to judge the number of rotations possible – she has less than one second to complete them, and must make the extra half-spin to land correctly. Only Midori Ito and Tonya Harding have landed this in competition.

SKATING THE EDGES: An overhead view of the axel

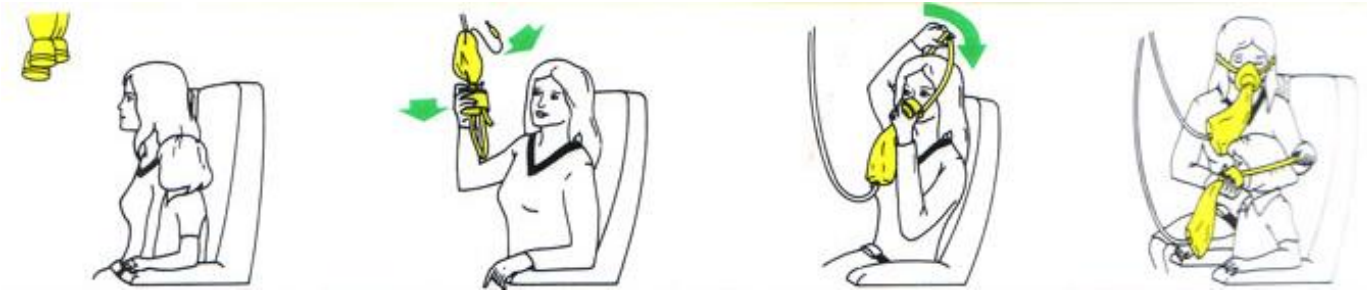
In skating terminology, the path of a jump is described as a series of edges – semicircular arcs that follow the path of the skate blade. The diagram shows the preparatory, takeoff and landing edges of an axel jump. The loop at center represents one midair rotation.



Megan Jaegerman. Cited in [Tufte, 2007](#)

2D + TIME

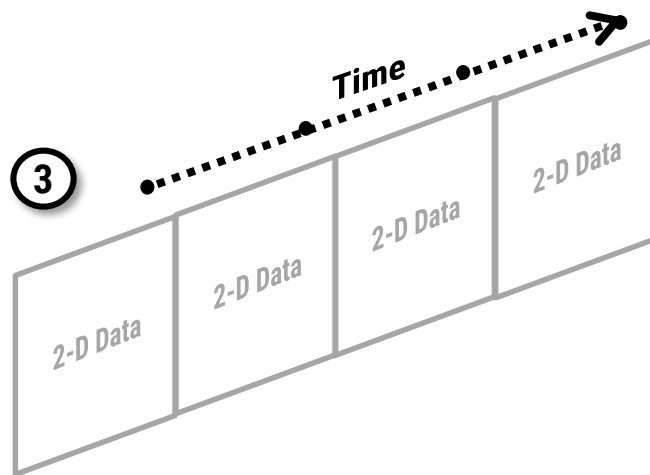
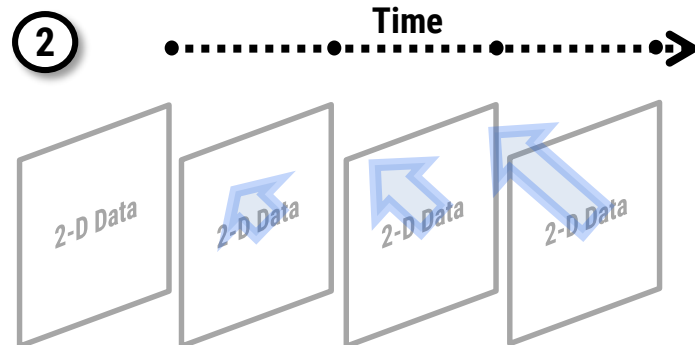
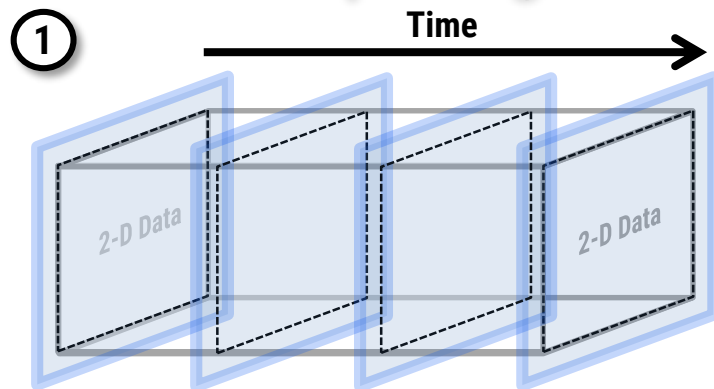
What about this?



[\(image source\)](#)

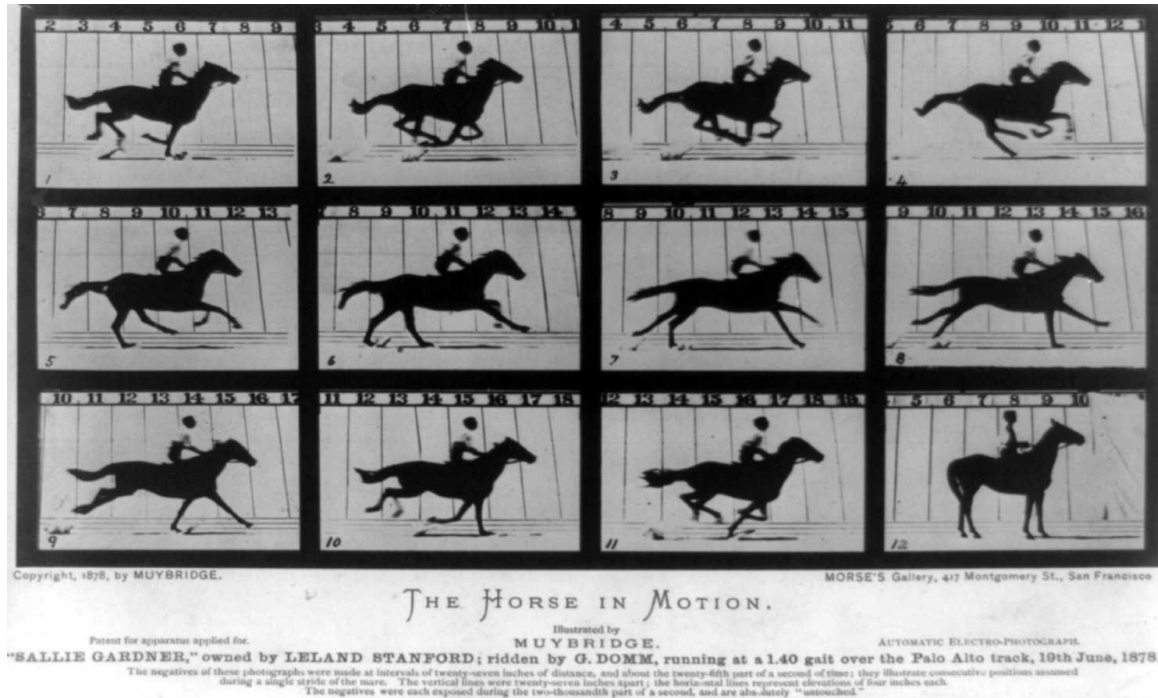
2D + TIME

Time Juxtaposing



2D + TIME

Muybridge's Chronophotography Technique



Eadweard J. Muybridge, 1878 ([source](#))

2D + TIME

Comics



Understanding Comics: The invisible Art

[Scott McCloud, 1993](#)

2D + TIME

Comics

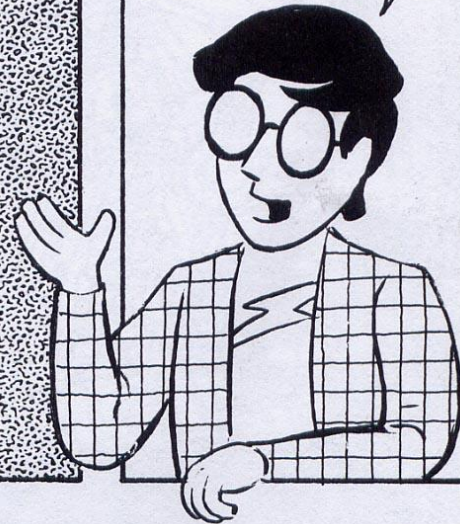
adv.

com.ics (kom'iks) **n.** plural in form, used with a singular verb. **1.** Juxtaposed pictorial and other images in deliberate sequence, intended to convey information and/or to produce an aesthetic response in the viewer.

2. Superheroes in bright colorful costumes, fighting dastardly villains who want to conquer the world, in violent sensational pulse-pounding action sequences! **3.** Cute, cuddly bunnies, mice and roly-poly bears, dancing to and fro Hippy-Hop, Hippy-Hop. **4.** Corruptor of our Nation's Youth.

com-ing (kum'ing) **adv.**

I ADMIT, THIS
ISN'T THE SORT
OF THING THAT
COMES UP A LOT
IN *CASUAL*
CONVERSATION--

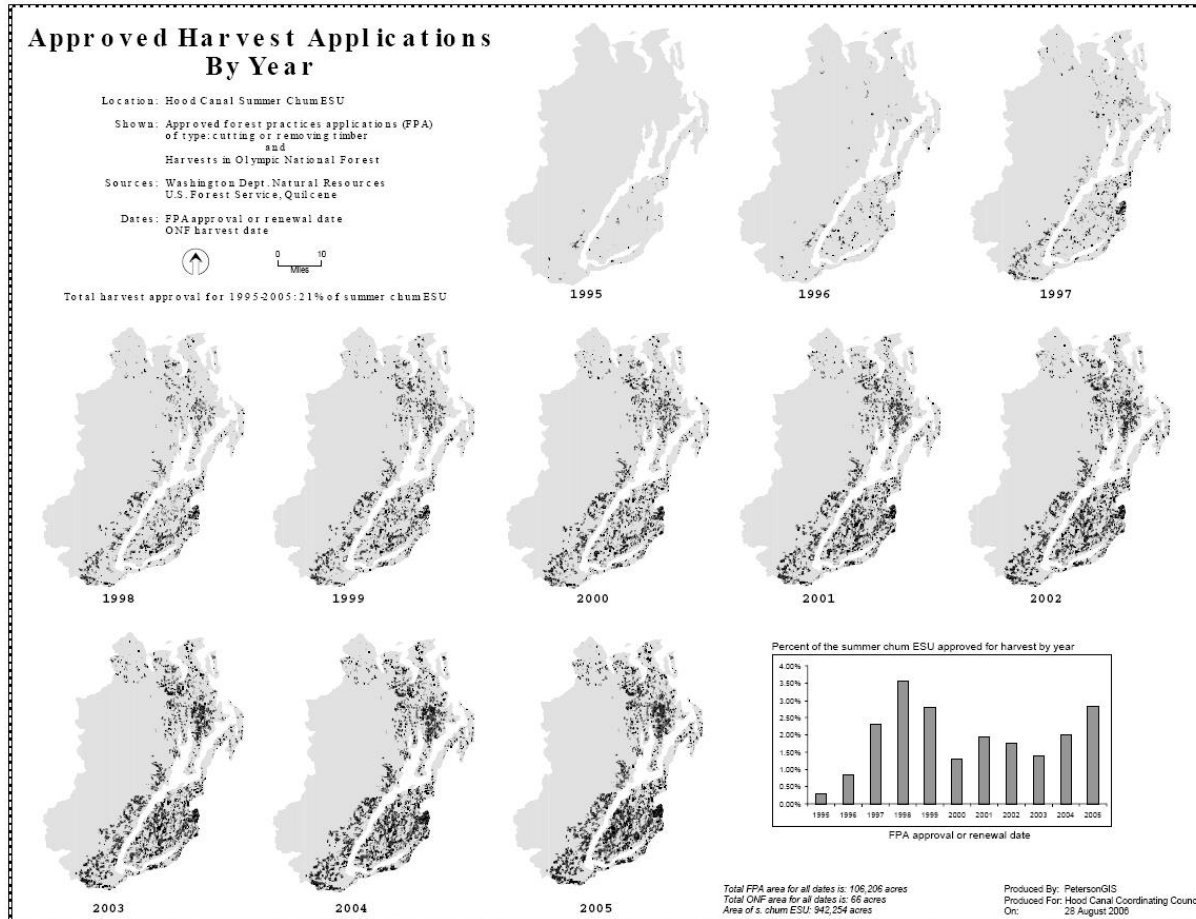


Understanding Comics: The invisible Art

[Scott McCloud, 1993](#)

2D + TIME

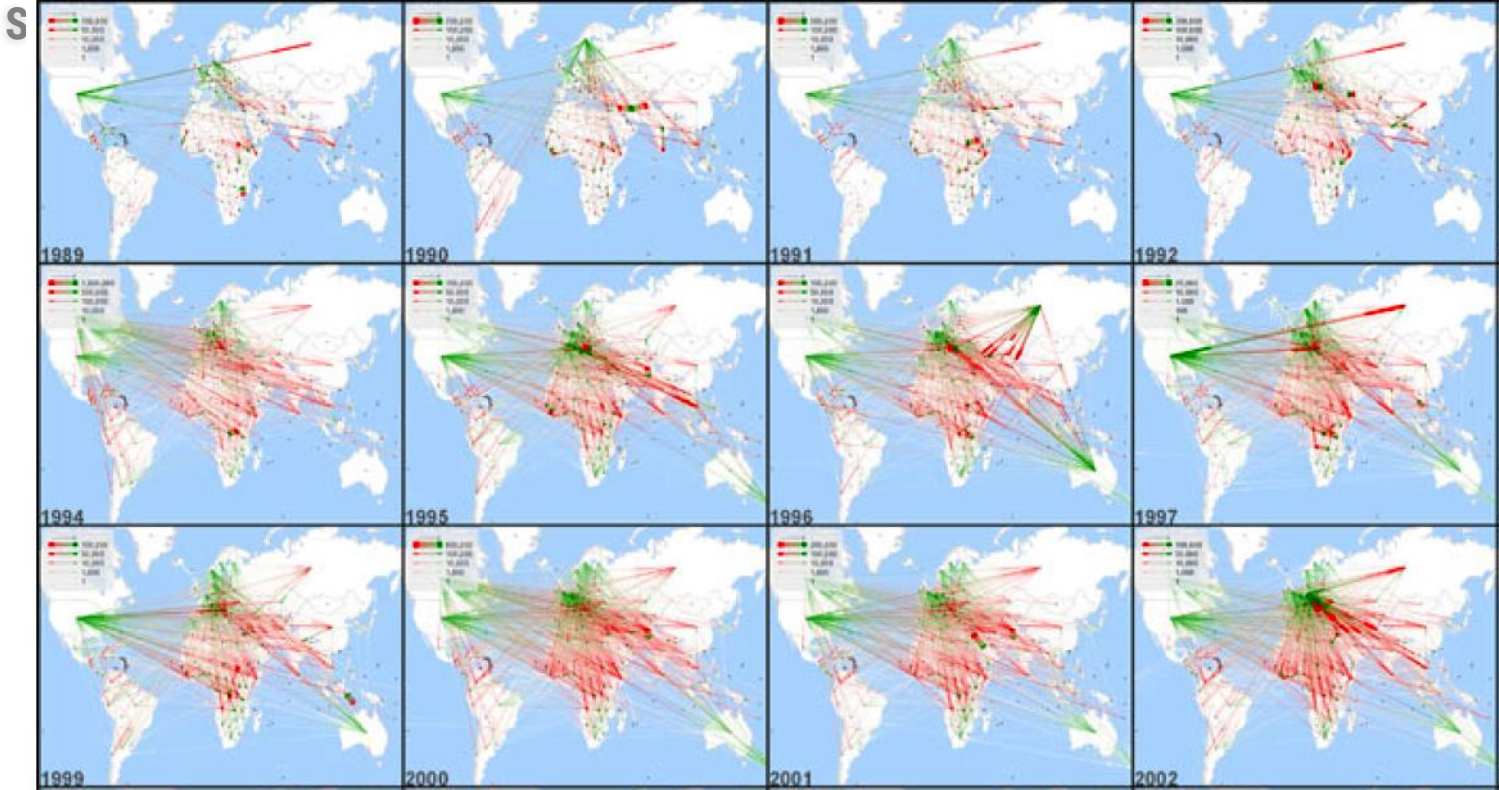
Small Multiples



Tufte,
1983

(image source)

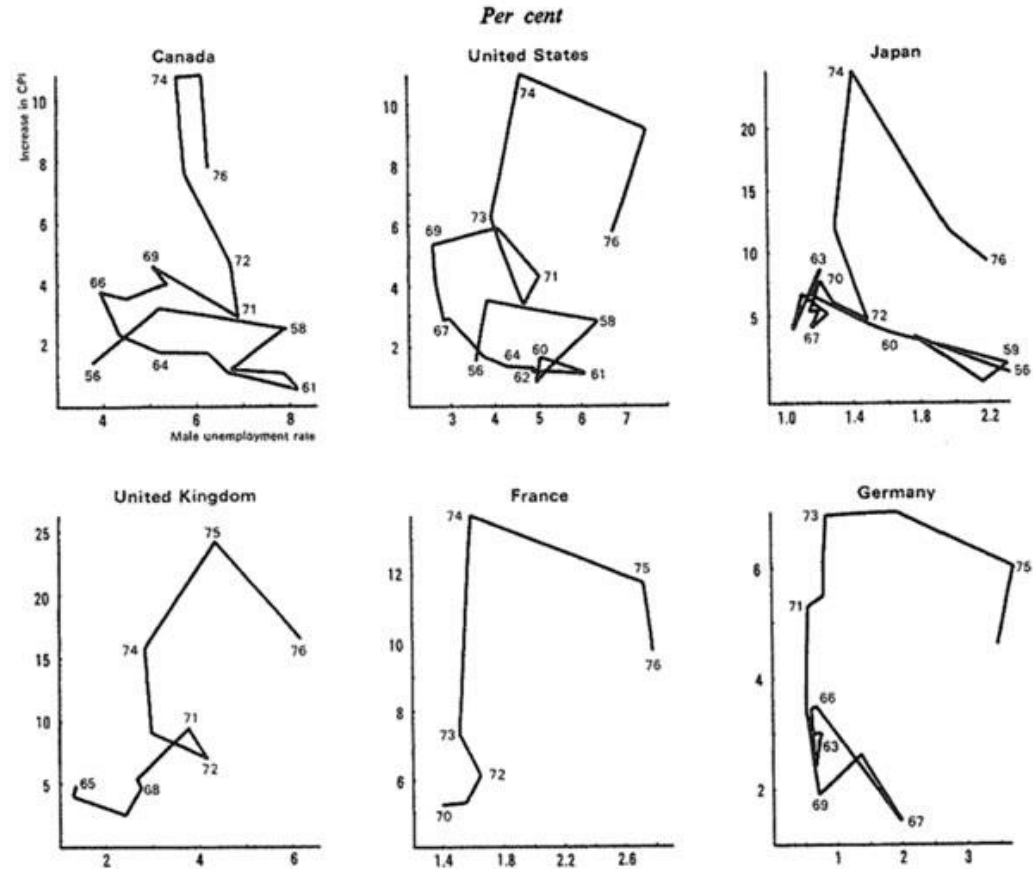
2D + TIME



2D + TIME

What about this?

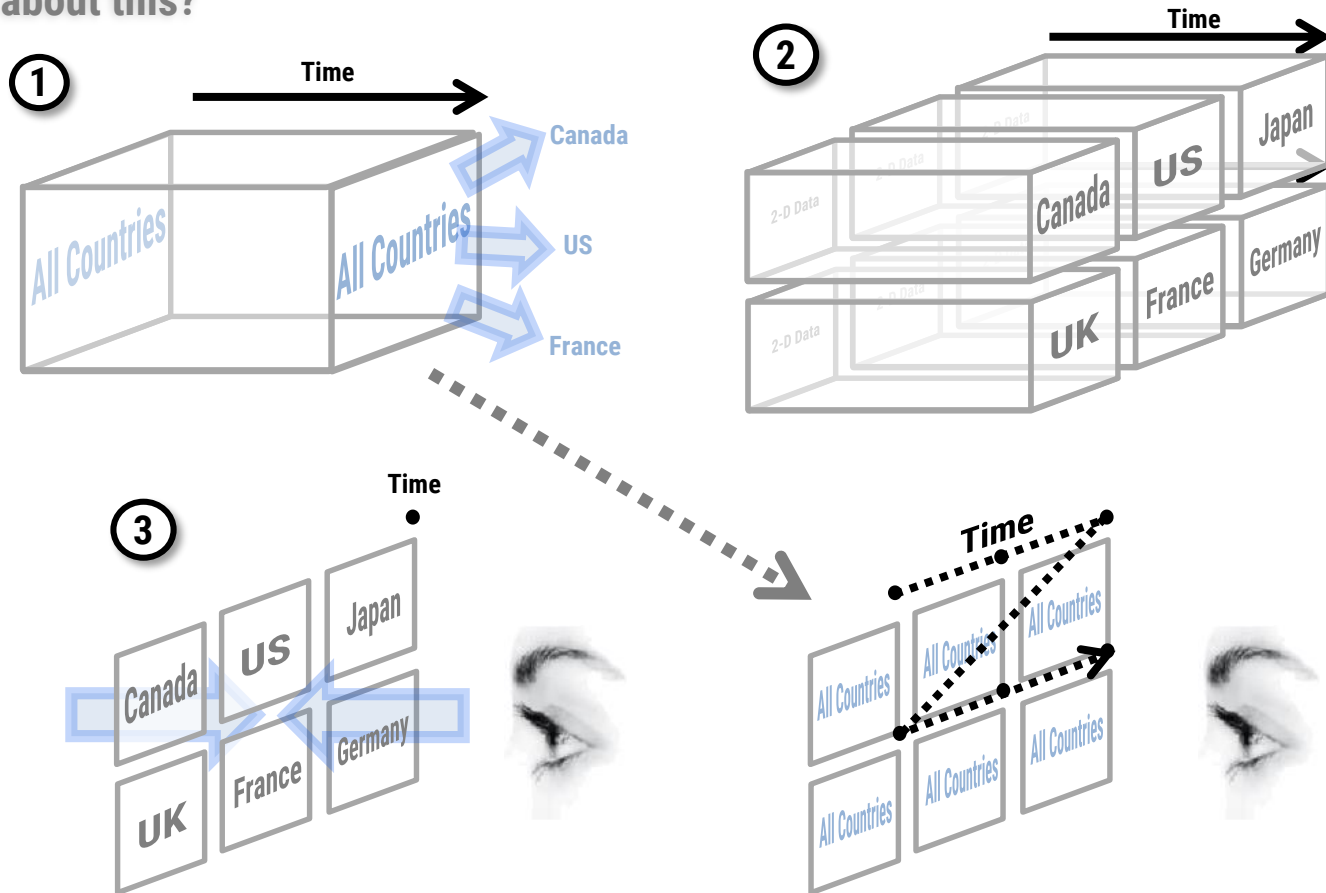
Inflation and Unemployment Rates



([image source](#))

2D + TIME

What about this?



2D + TIME

Side-By-Side Views

FE / trunk
build.xml

Activity Revisions Users Reports Source

107905 107905 Changeset Raw Annotation Highlighting Columns Reviews

```
<import file="eclipse/build.xml"/>
<import file="idea4/build.xml"/>
<import file="idea5/build.xml"/>
<import file="jbuilder/build.xml"/>
<import file="jdeveloper/build.xml"/>

<macrodef name="subtarget">
  <attribute name="module"/>
  <attribute name="target"/>
  <sequential>
    <subant target="@{module}.@{target}">
      <dirset dir="." file="@{module}"/>
    </subant>
  </sequential>
</macrodef>

<macrodef name="doall">
  <attribute name="target"/>
  <sequential>
    <subtarget module="buildutil" target="@{target}"/>
    <subtarget module="cloverantlr" target="@{target}"/>
    <subtarget module="core" target="@{target}"/>
    <subtarget module="viewer" target="@{target}"/>
    <subtarget module="clover-ant" target="@{target}"/>
    <subtarget module="plugincore" target="@{target}"/>
    <subtarget module="eclipse" target="@{target}"/>
    <subtarget module="idea4" target="@{target}"/>
    <subtarget module="idea5" target="@{target}"/>
    <subtarget module="jbuilder" target="@{target}"/>
    <subtarget module="jdeveloper" target="@{target}"/>
  </sequential>
</macrodef>
```

```
4 <import file="eclipse/build.xml"/>
5 <import file="idea7/build.xml"/>
6 <import file="perfmon/build.xml"/>
7
8 <property name="test.results.dir" value="${build.dir}/test/ht
9
10 <macrodef name="subtarget">
11   <attribute name="module"/>
12   <attribute name="target"/>
13   <sequential>
14     <subant target="@{module}.@{target}" inheritrefs="true"
15       <dirset dir="." file="@{module}"/>
16   </subant>
17   </sequential>
18 </macrodef>
19
20 <macrodef name="doall">
21   <attribute name="target"/>
22   <sequential>
23     <subtarget module="buildutil" target="@{target}"/>
24     <subtarget module="cloverantlr" target="@{target}"/>
25     <subtarget module="core" target="@{target}"/>
26     <subtarget module="clover-ant" target="@{target}"/>
27     <subtarget module="eclipse" target="@{target}"/>
28     <subtarget module="idea7" target="@{target}"/>
29     <subtarget module="perfmon" target="@{target}"/>
30   </sequential>
31 </macrodef>
32
33 <target name="global.build">
34   <doall target="build"/>
```

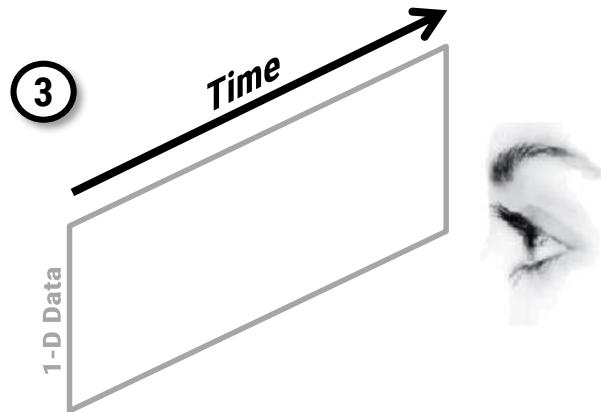
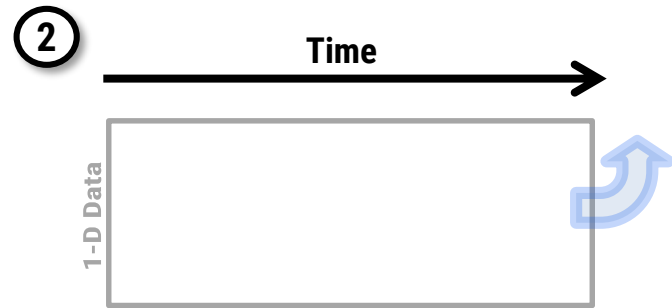
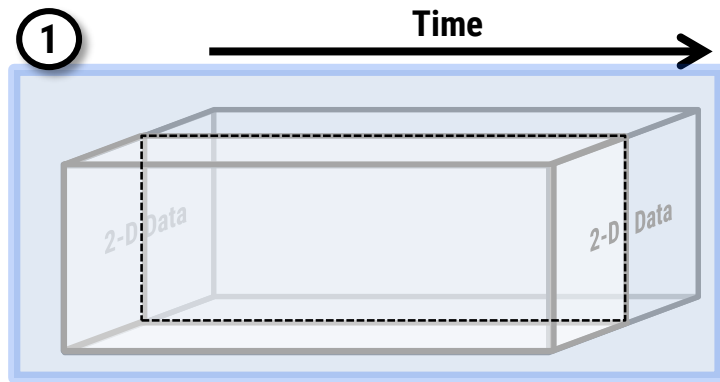
2D + TIME

Side-By-Side Views



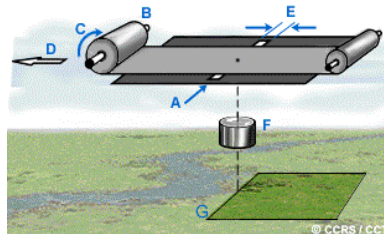
2D + TIME

Space Cutting



2D + TIME

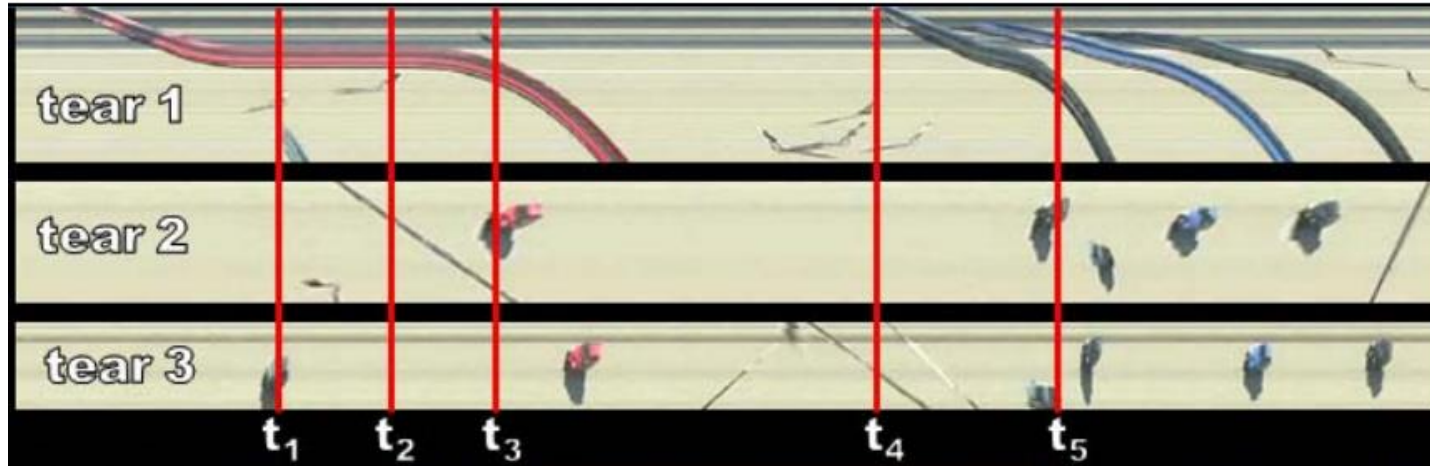
Slit-Scan Photography



[\(images source\)](#)

2D + TIME

Slit-Tear Exploration of Videos



Exploring Video Streams using Slit-Tear Visualizations

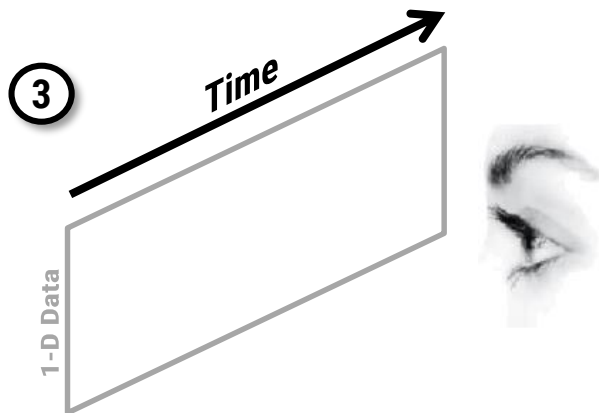
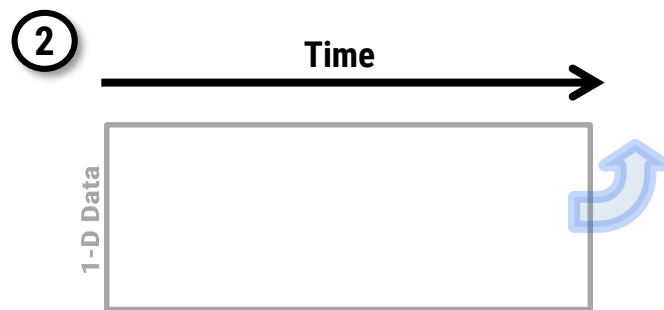
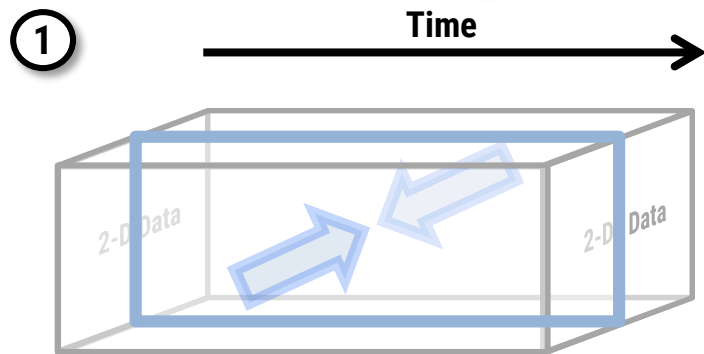
Anthony Tang, *University of British Columbia*

Saul Greenberg, *University of Calgary*

Sidney Fels, *University of British Columbia*

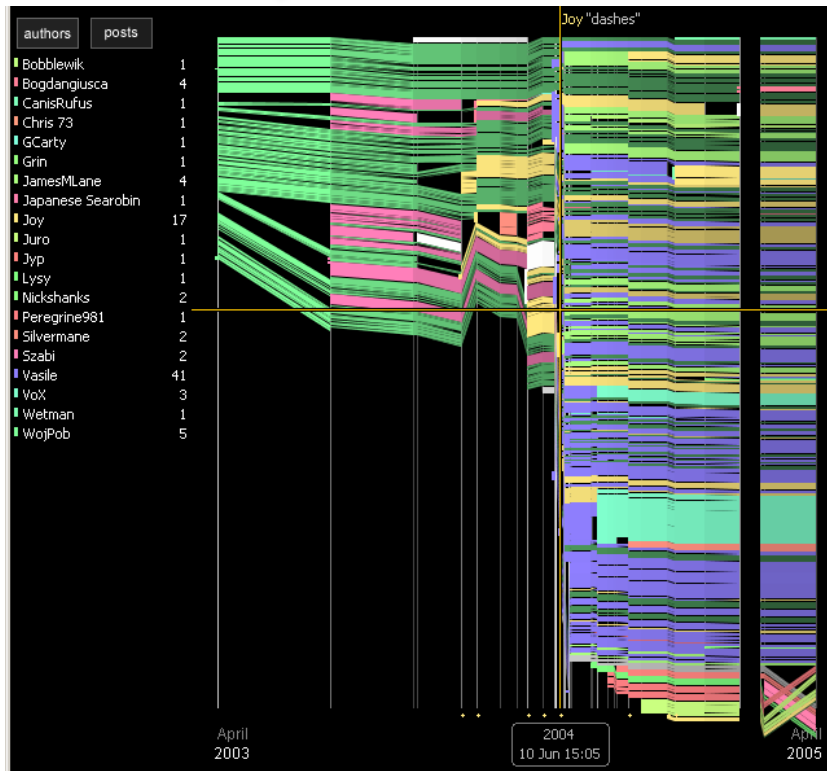
2D + TIME

Space Flattening



2D + TIME

History Flow



of Hungary was about 45% of the entire population. The provinces Hungary lost in the treaty had significant population of non-Magyars, but also a significant Magyar minority, which can still be found in these countries.

The number of Hungarians in the provinces started decreasing after the treaty. Comparing the Magyar population based on census data before and after the treaty:

* In Slovakia:

** 1910: 884,000 - 30%

** 1930: 592,000 - 18%

* In Transylvania (now in Romania):

** 1910: 1,662,000 - 32%

** 1930: 1,353,000 - 24%

* In Voivodina (now in Serbia and Montenegro):

** 1910: 420,000 - 28%

** 1931: 376,000 - 23%

* In Transcarpathia (now in Ukraine):

** 1910: 183,000 - 30%

** 1930: 123,000 - 17%

* In Croatia:

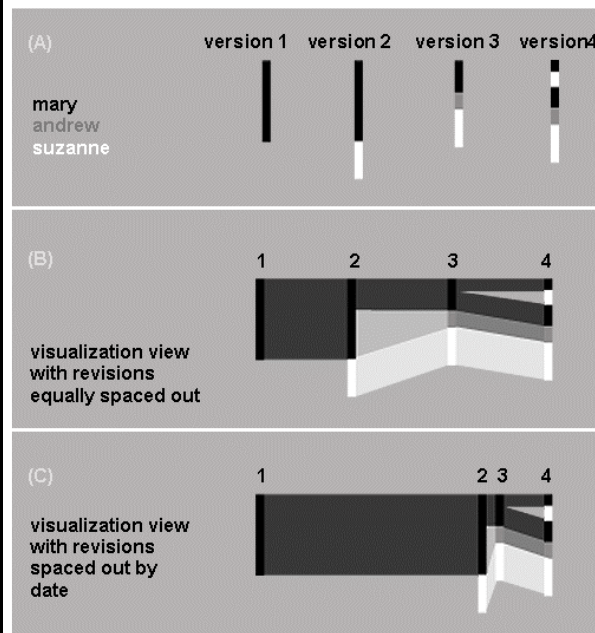
** 1910: 121,000 - 3.5%

** 1921: 76,000 - 2.2%

* In Slovenia:

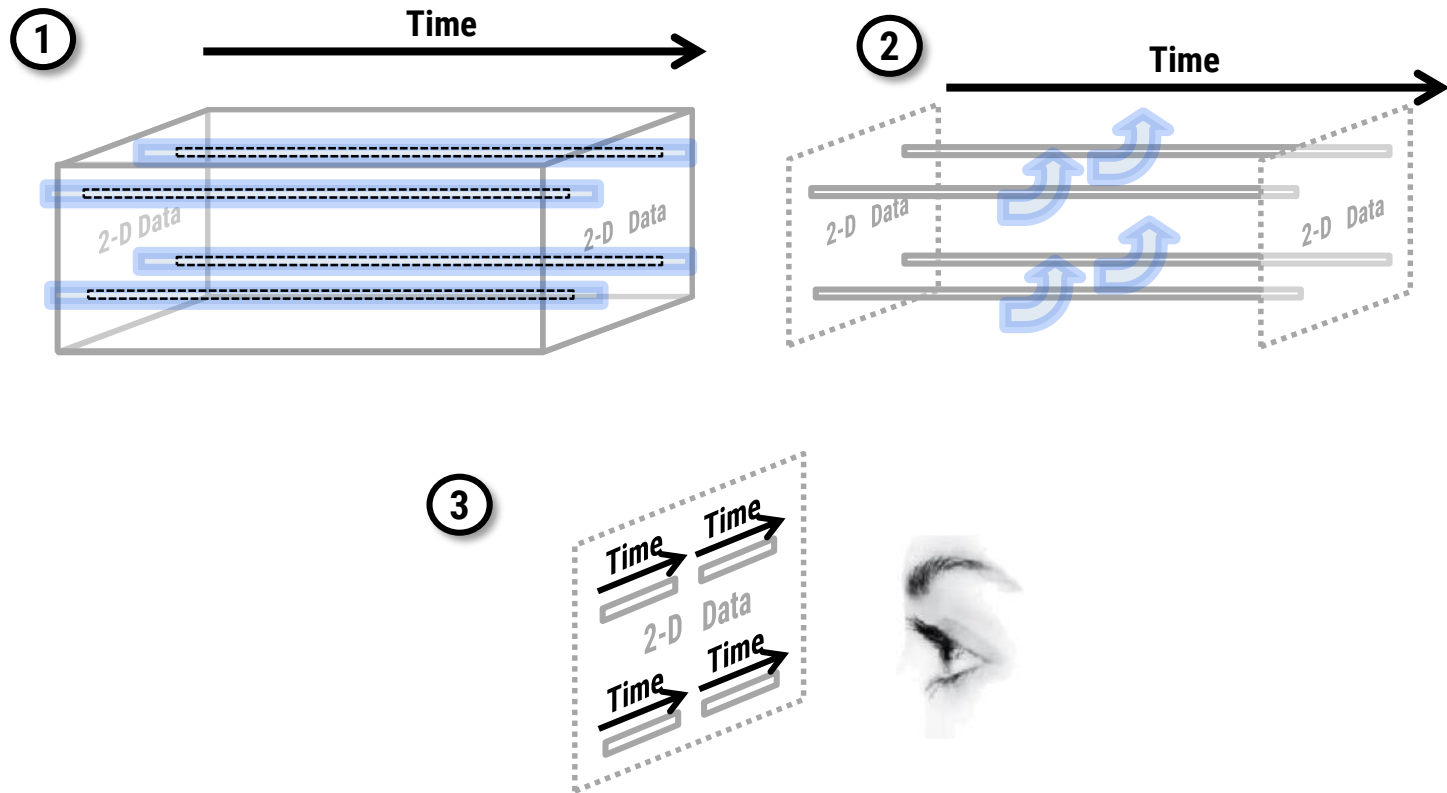
** 1910: 20,800 - 1.6%

** 1921: 15,000 - 1.1%



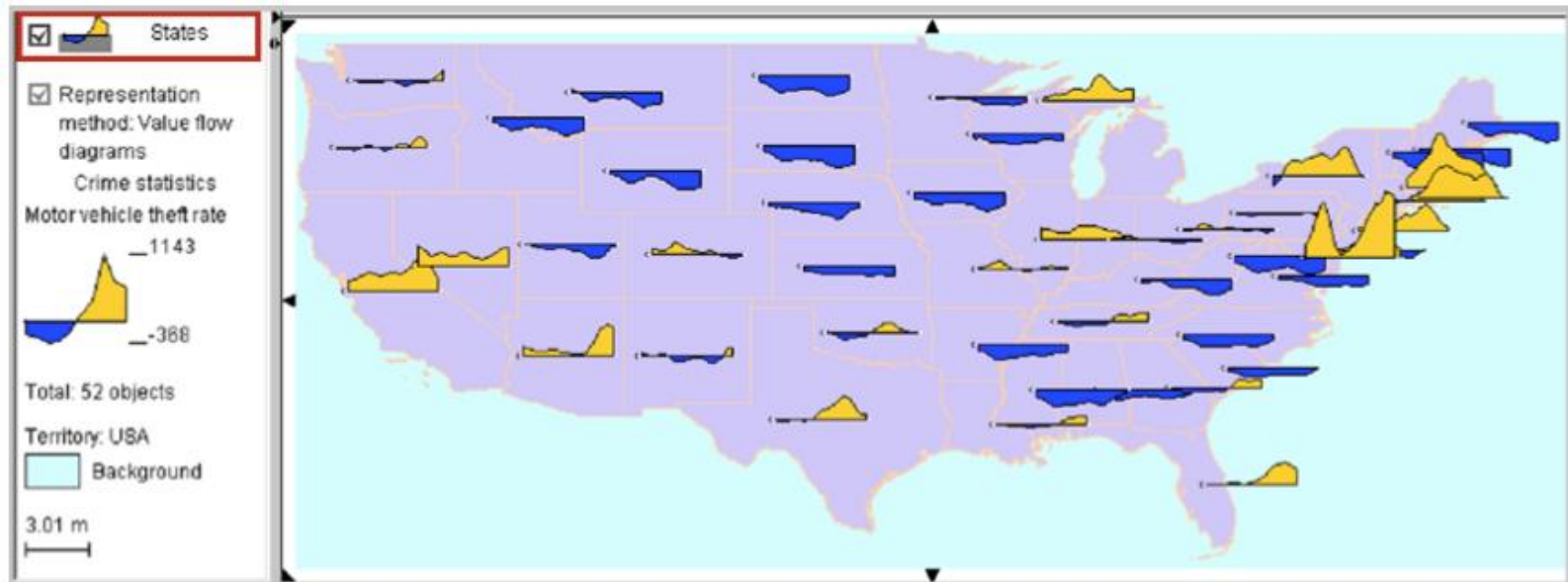
2D + TIME

Sampling



2D + TIME

Multiple Silhouette Graphs



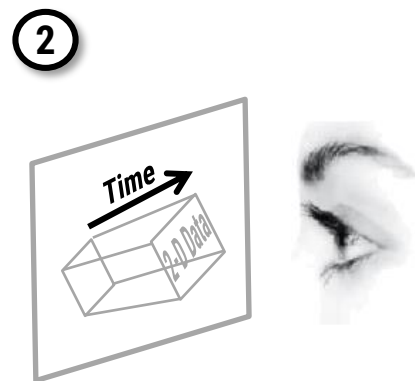
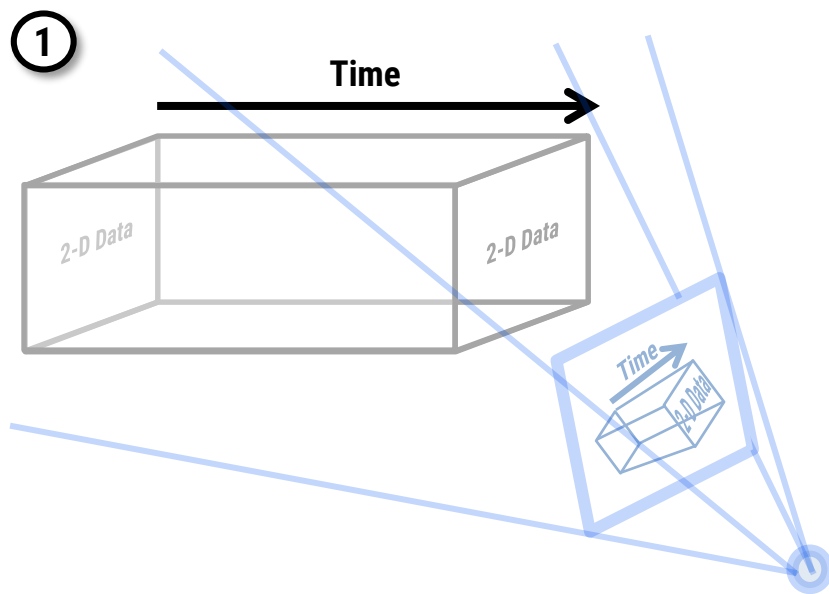
2D + TIME

Planning Polygons



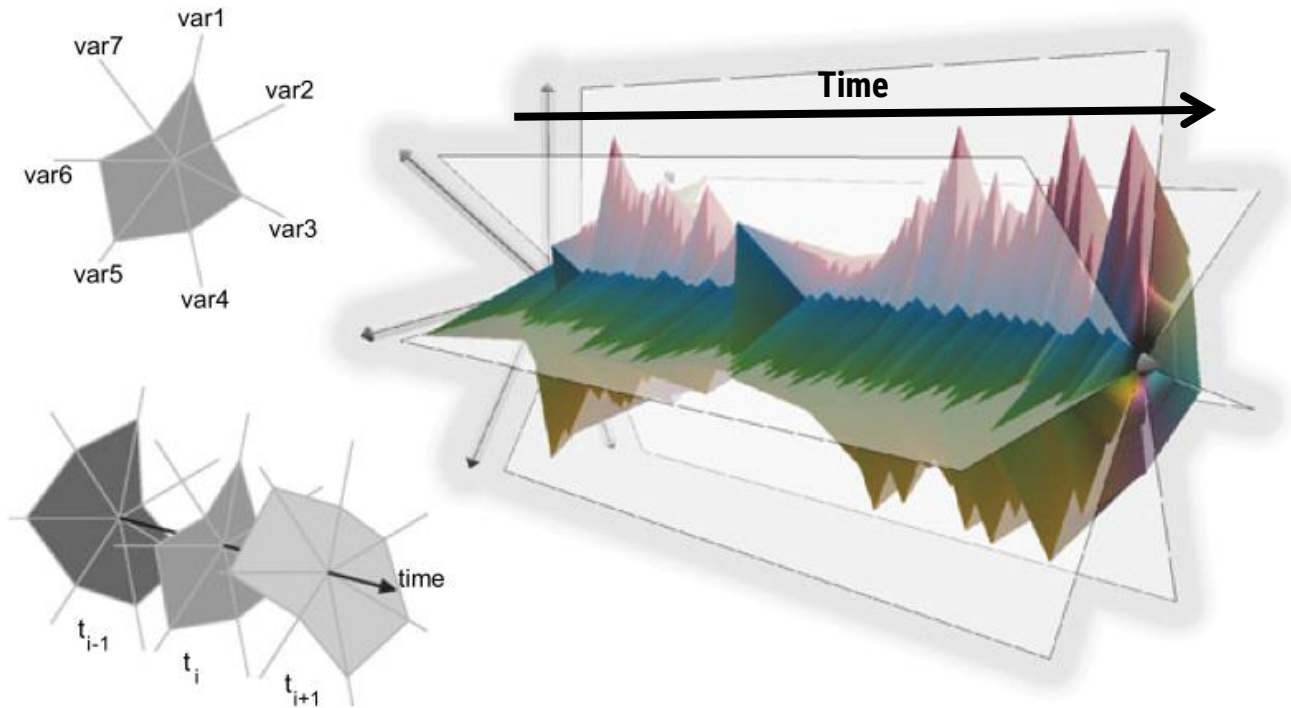
2D + TIME

3D Rendering



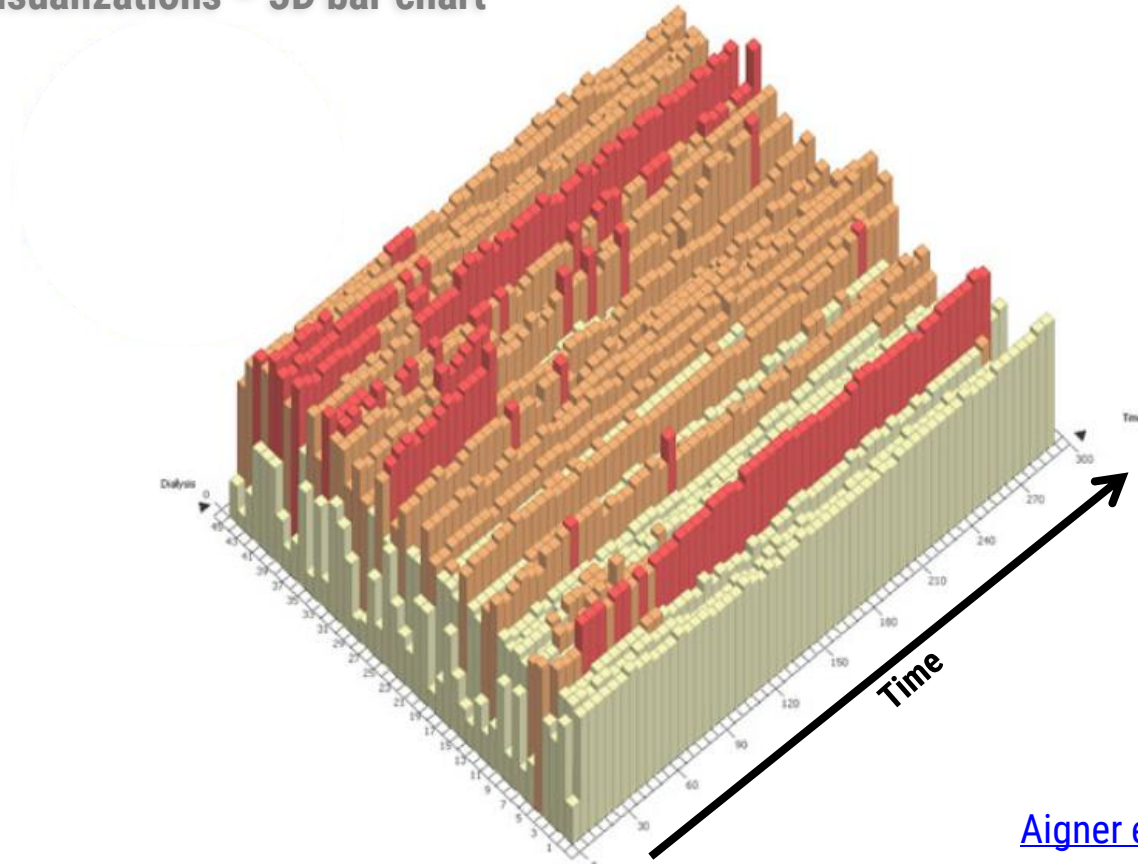
2D + TIME

3D visualizations - Kiviat Tube



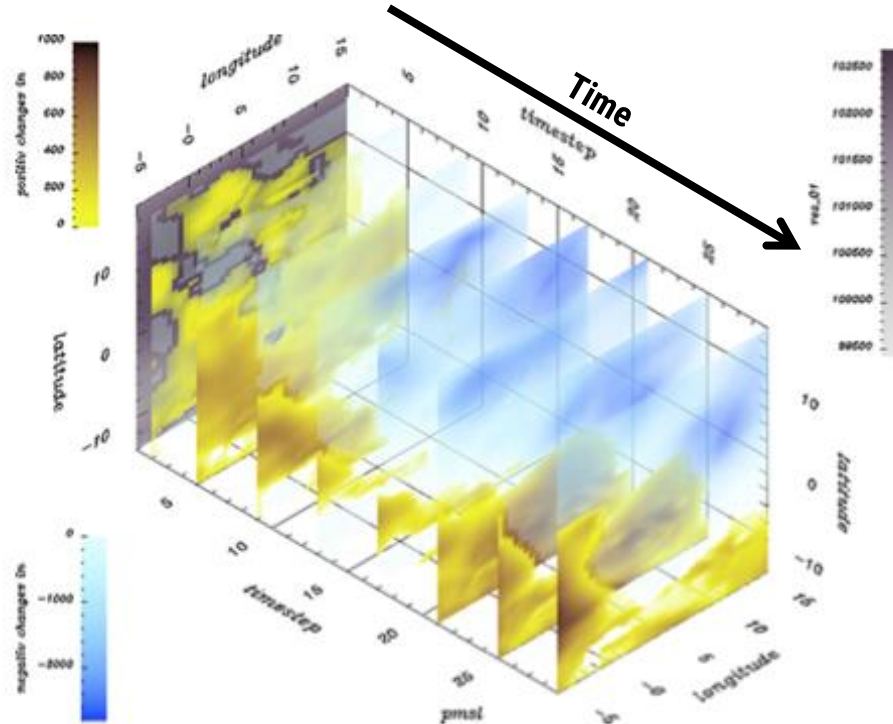
2D + TIME

3D visualizations – 3D bar chart



2D + TIME

3D visualizations – Climate data

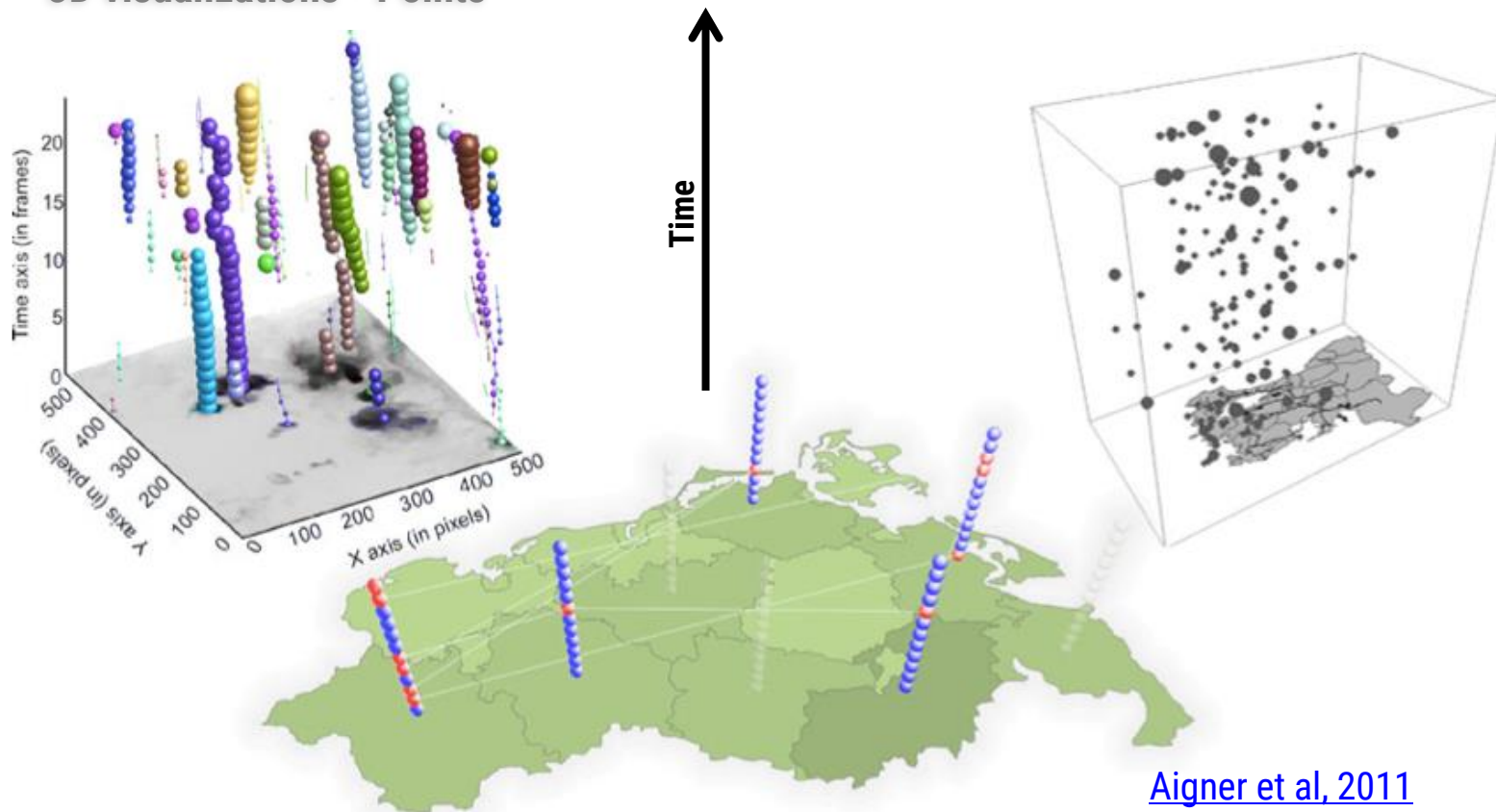


3D visualizations – Time-evolving graphs



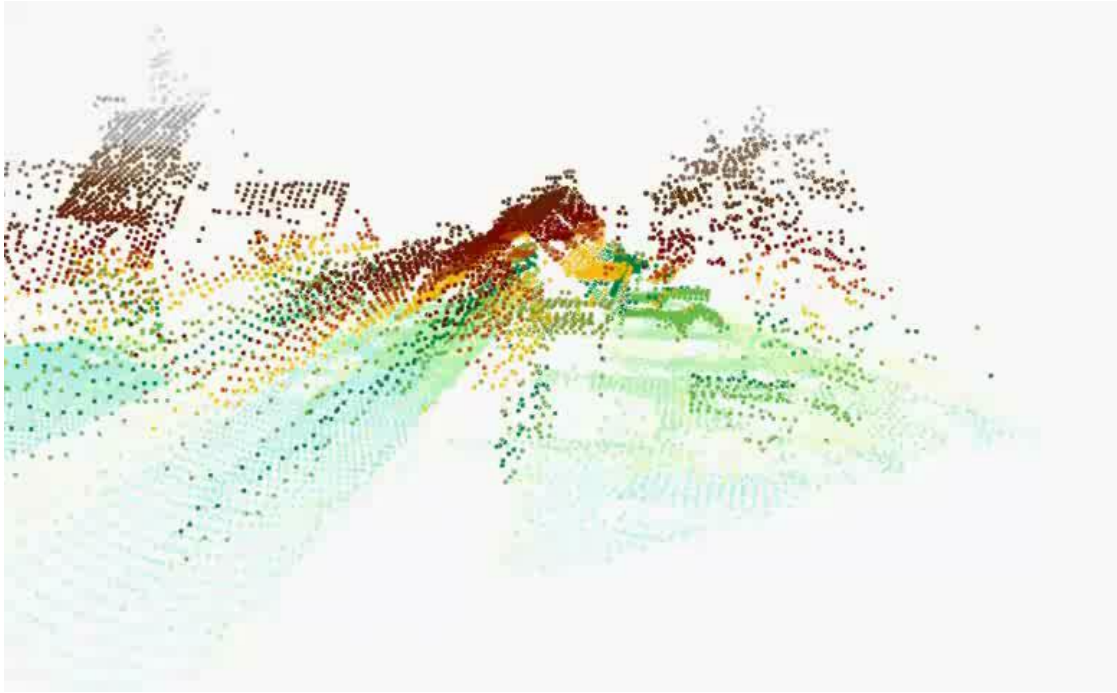
2D + TIME

3D visualizations - Points



2D + TIME

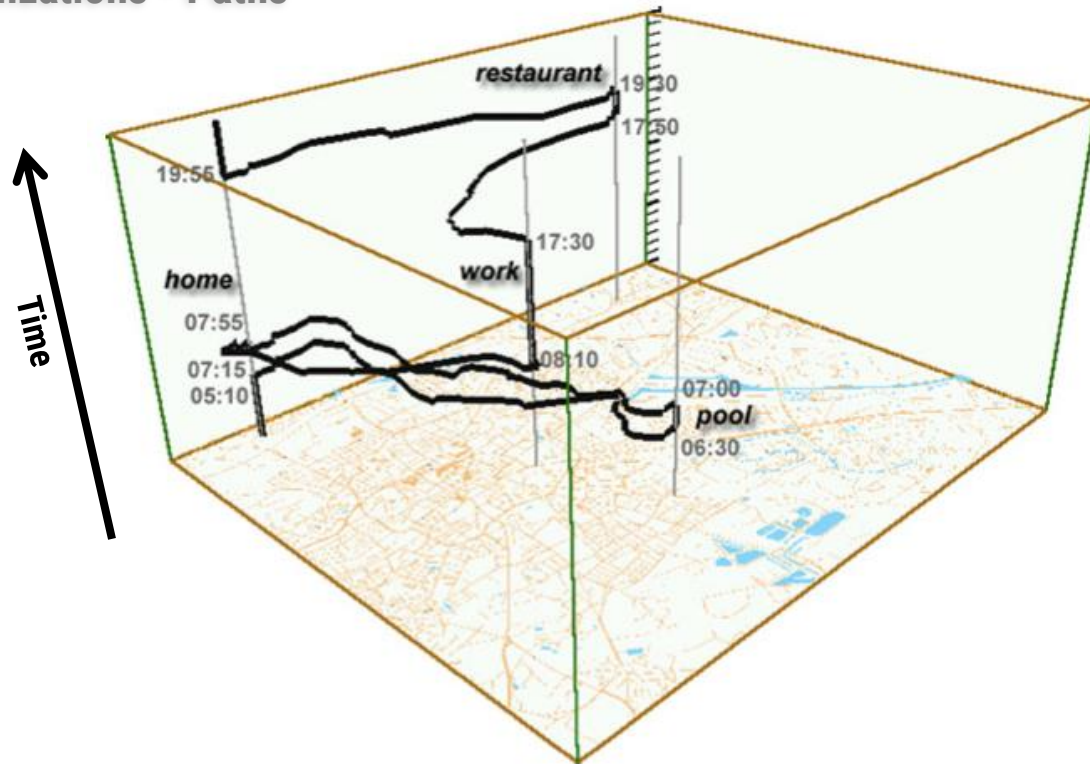
3D visualizations - Points



[\(video source\)](#)

2D + TIME

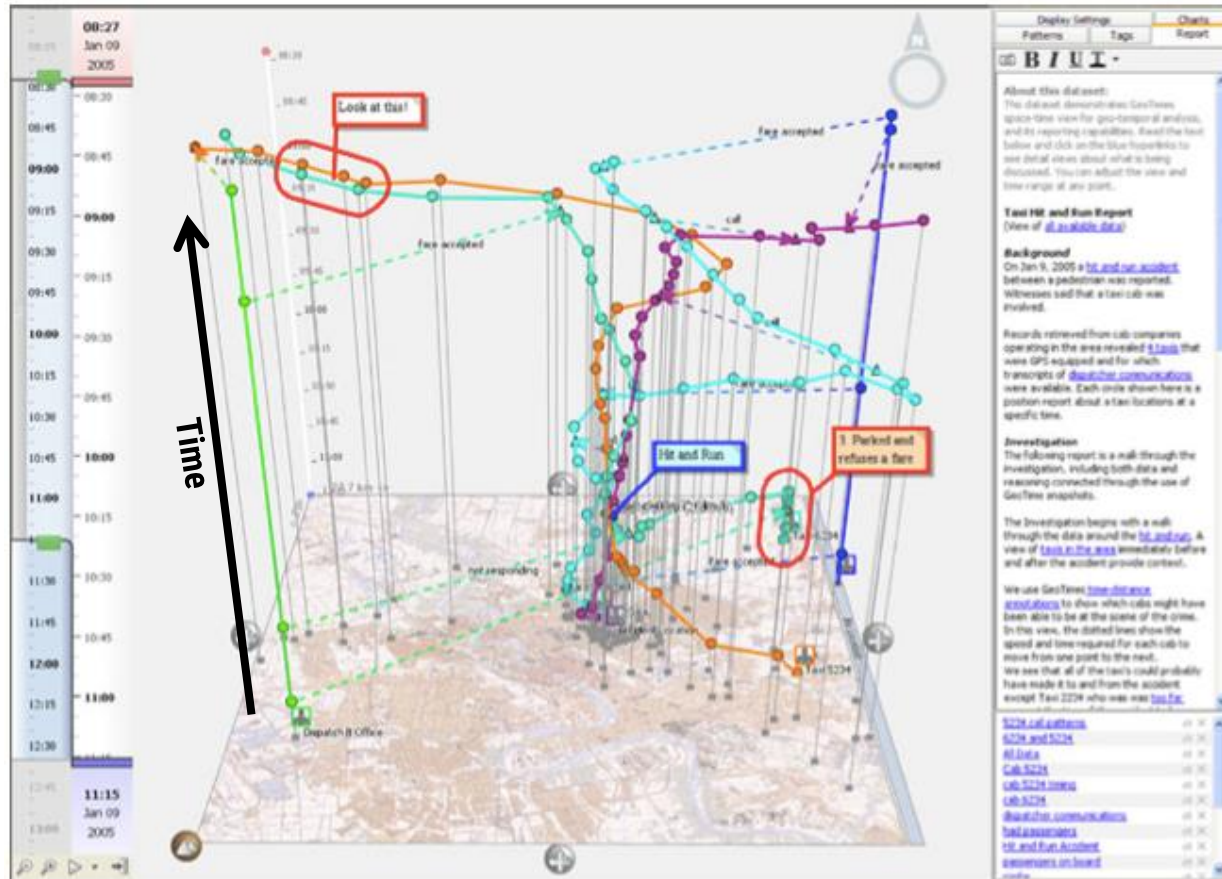
3D visualizations - Paths



2D + TIME

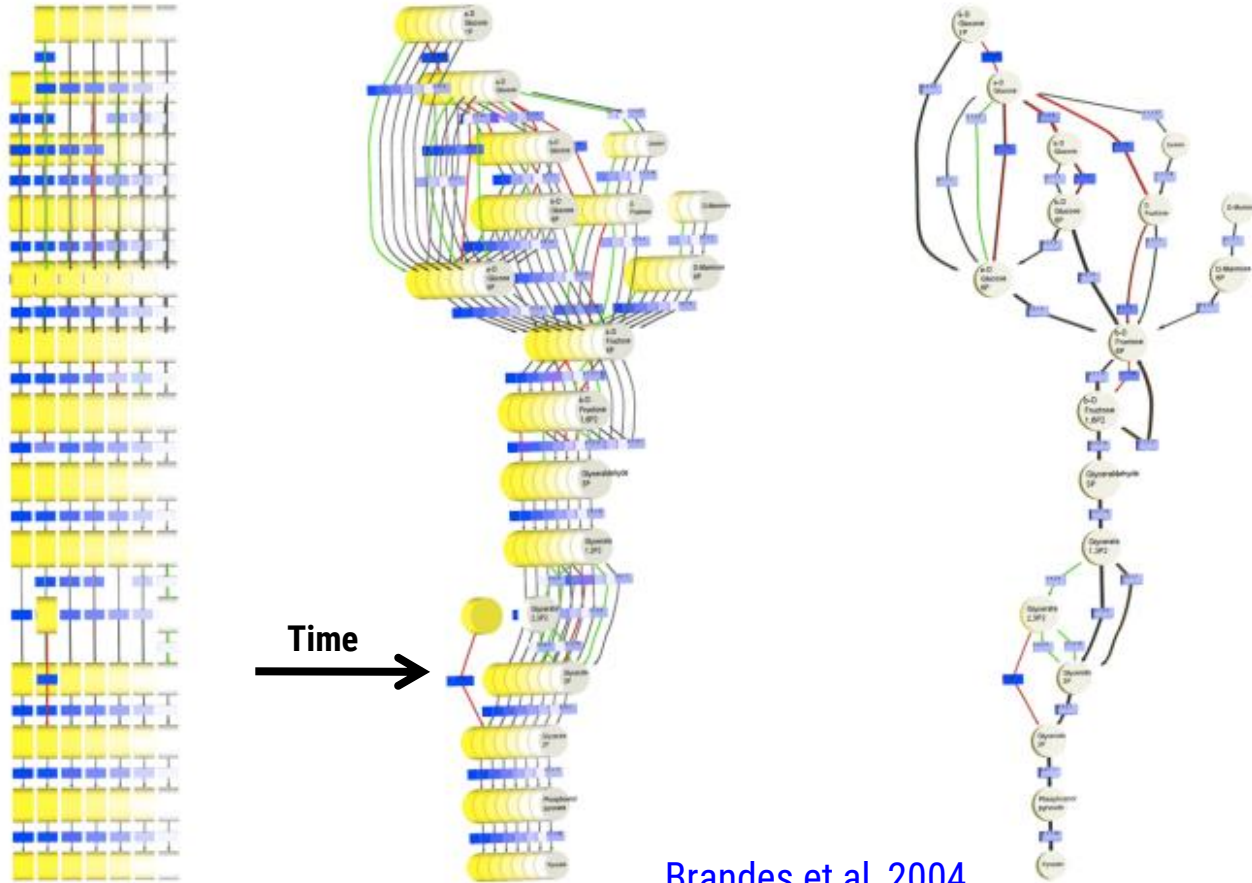
3D visualizations - GeoTime

geotime.com



2D + TIME

3D visualizations – Time-evolving graphs

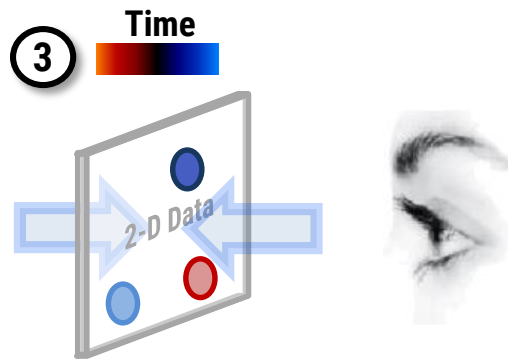
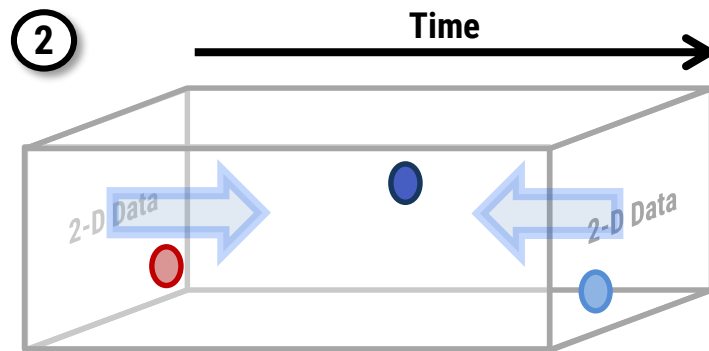
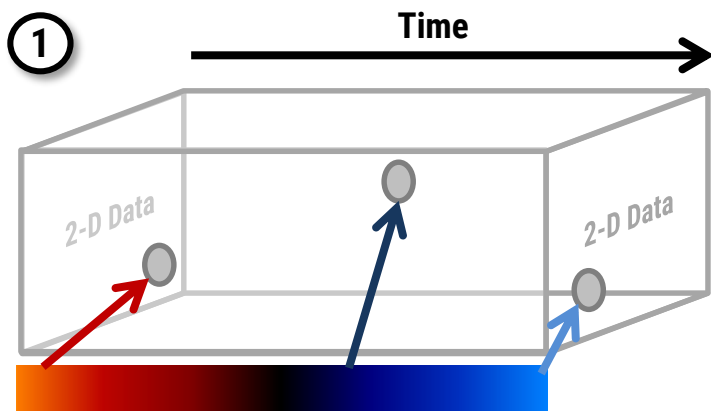


Brandes et al, 2004

MAPPING TIME TO SPACE

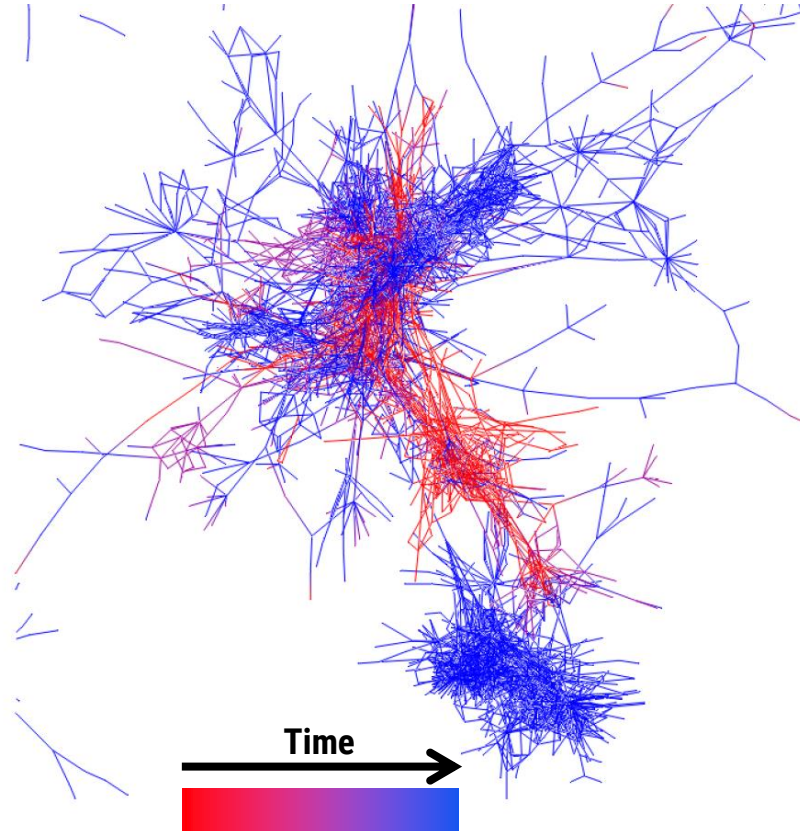
2D + TIME

Colored Time Flattening



2D + TIME

Using Color – GEOVOL

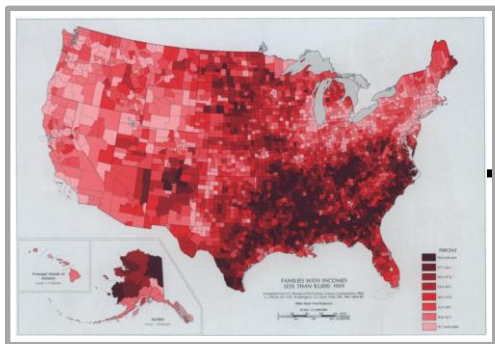


2D + TIME

Using Color – Stroke Order



MAPPING TIME TO AN AXIS

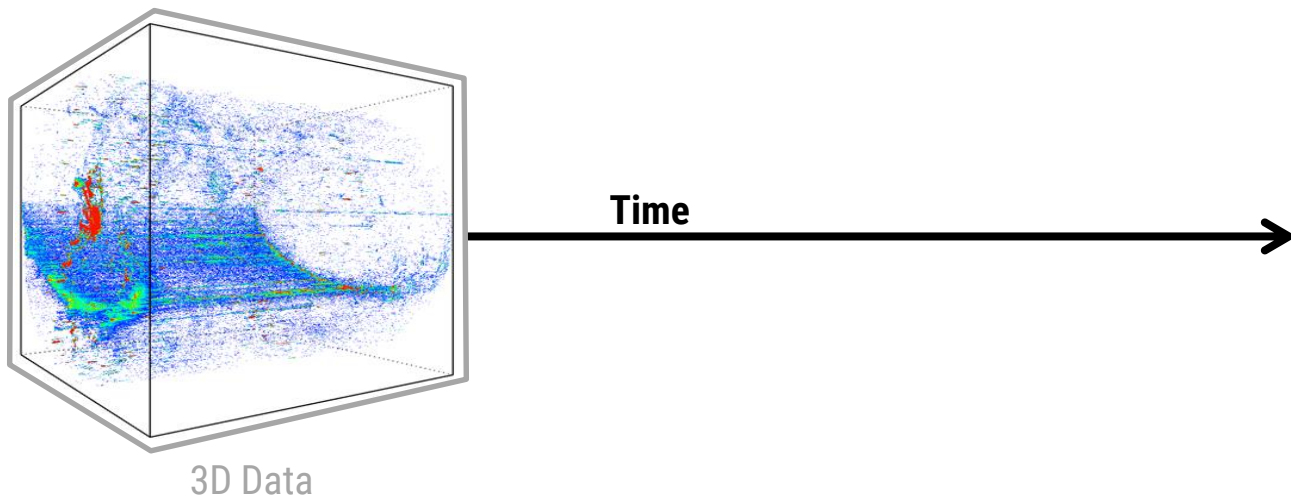


2D Data

Time

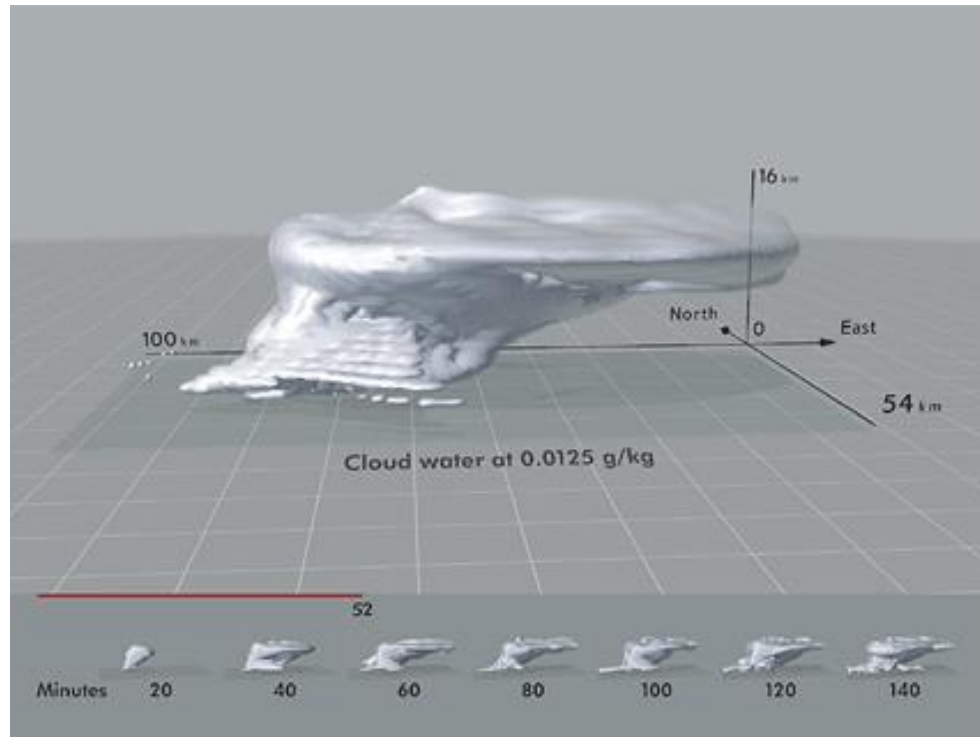


MAPPING TIME TO AN AXIS



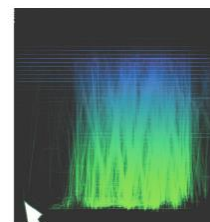
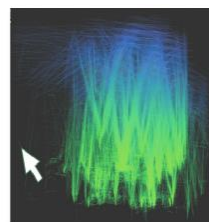
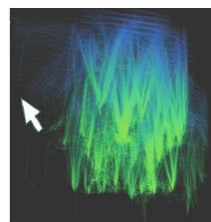
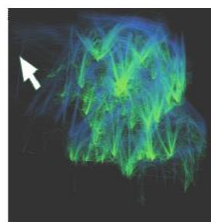
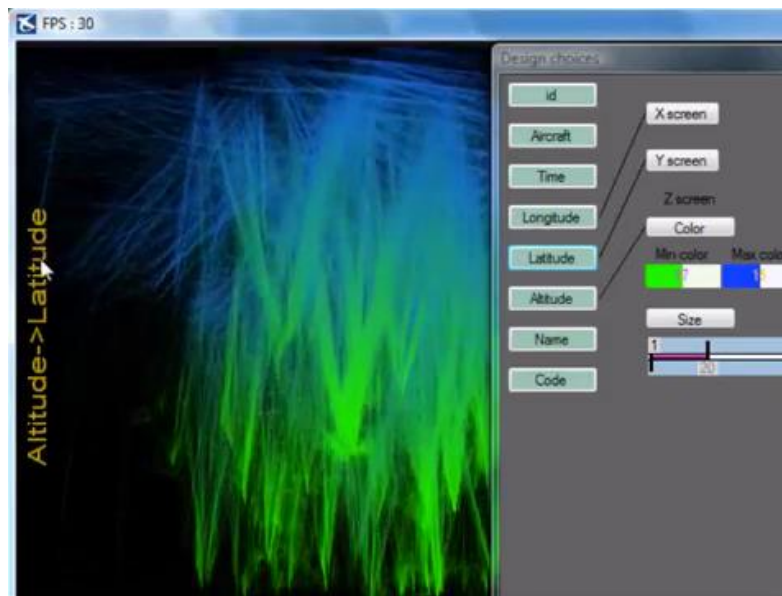
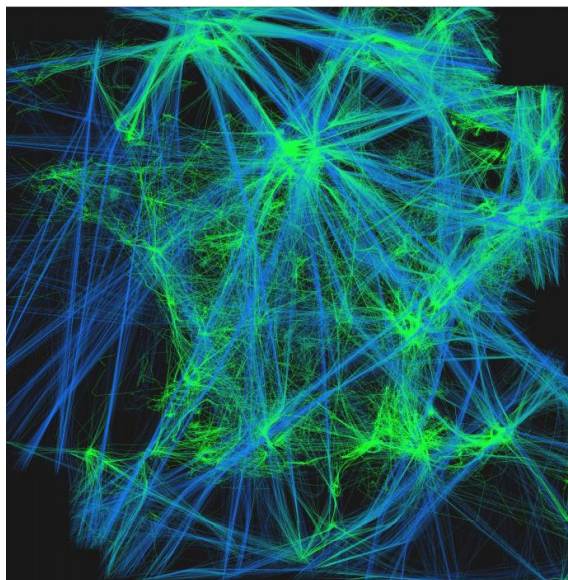
3D + TIME

Slicing + Juxtaposing – 3D Small Multiples



3D + TIME

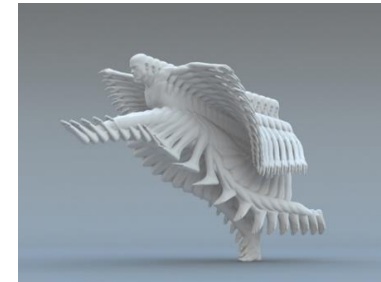
Flattening - FromDaDy



[Hurter et al, 2009](#)

3D + TIME

Slicing & Flattening - Peter Jansen's Sculptures



TIME VISUALIZATION

What's Missing?

Animations

ANIMATION

ANIMATION

- **Static Visual Content**
 - **Visual content that is fixed over time**

ANIMATION

- **Static Visual Content**
 - Visual content that is fixed over time
- **Dynamic Visual Content**
 - Visual content that changes over time

ANIMATION

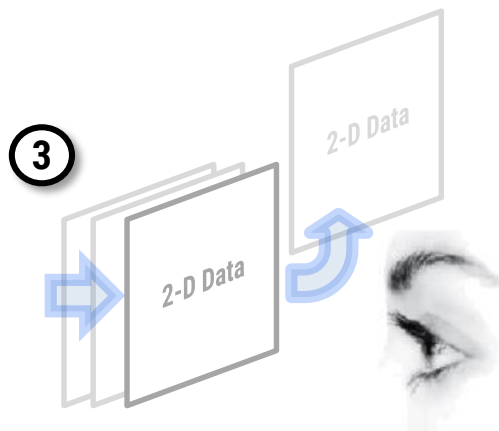
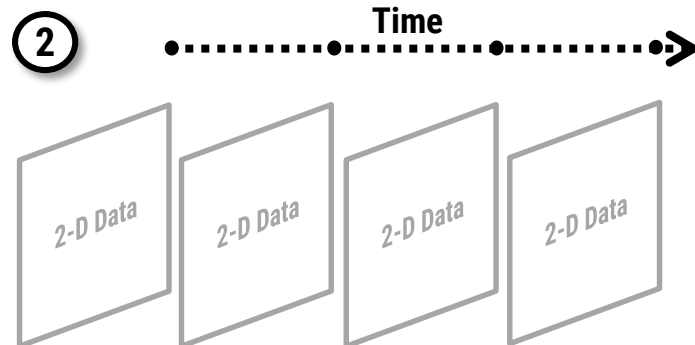
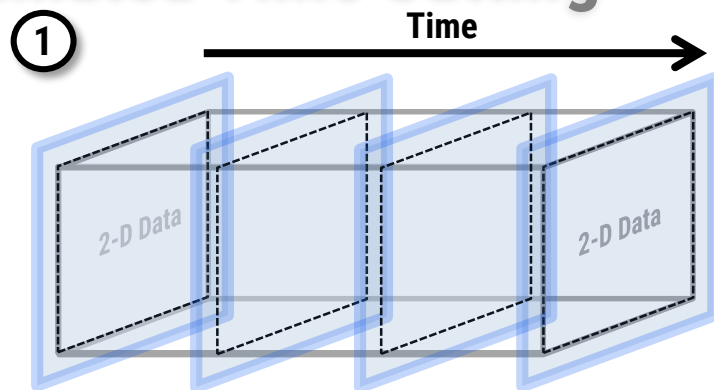
- **Static Visual Content**
 - Visual content that is fixed over time
- **Dynamic Visual Content**
 - Visual content that changes over time
- **Interactive Visual Content**
 - Visual content that changes over time
 - Under the user's influence

ANIMATION

- Static Visual Content
 - Visual content that is fixed over time
- Dynamic Visual Content
 - Visual content that changes over time
- Interactive Visual Content
 - Visual content that changes over time
 - Under the user's influence
- Animation
 - Visual content that changes over time
 - Outside the user's influence

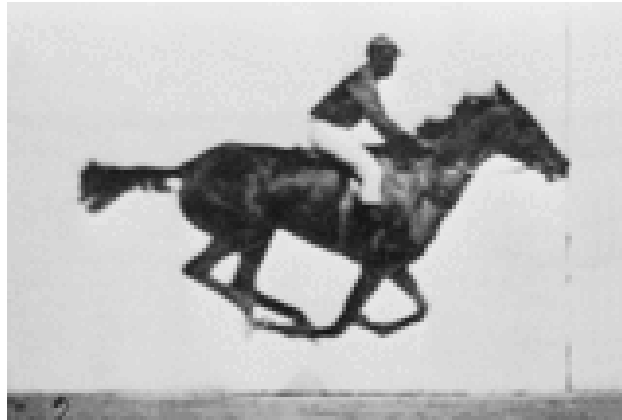
2D + TIME

Animated Time Cutting



2D + TIME

Movies and Cartoons



Eadweard J. Muybridge, 1879

2D + TIME

Zoopraxiscope



[\(image source\)](#)

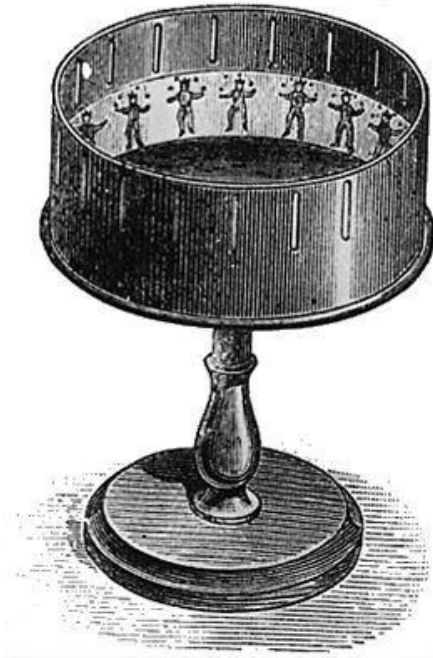


[\(image source\)](#)

Eadweard J. Muybridge, 1879

2D + TIME

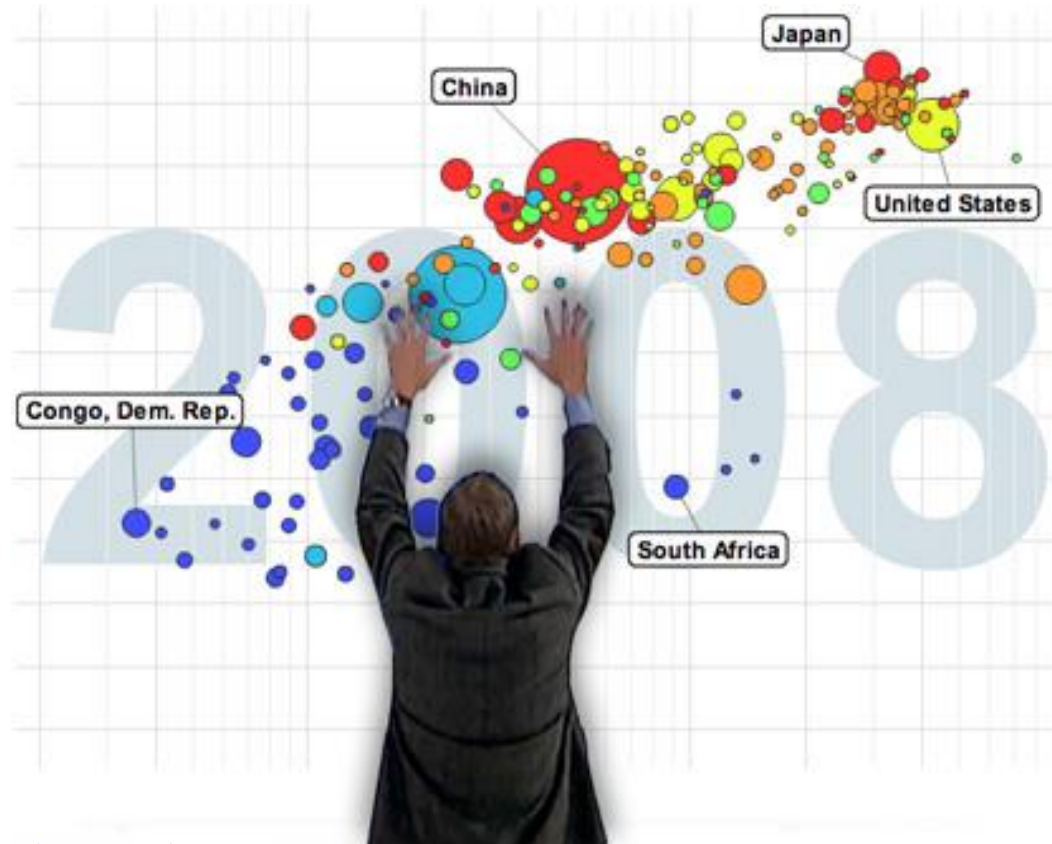
Zoetrope



William G. Horner, 1833
also Ting Huan, 180 AD
([source](#))

2D + TIME

Animation – Gap Minder



[\(image source\)](#)

gapminder.org

2D + TIME

Animation – Gap Minder



[\(video source\)](#)

2D + TIME

Animation vs. Other Approaches



[\(image source\)](#)

2D + TIME

Animation vs. Other Approaches



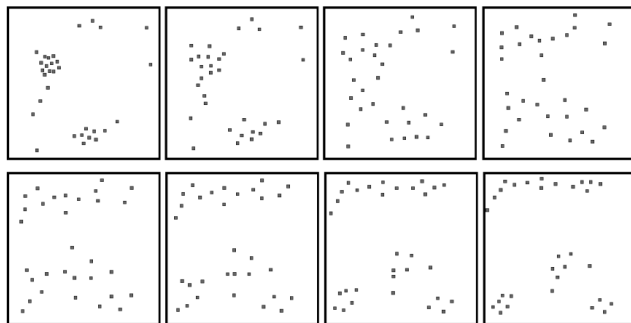
[\(image source\)](#)



2D + TIME

Animation vs. Other Approaches

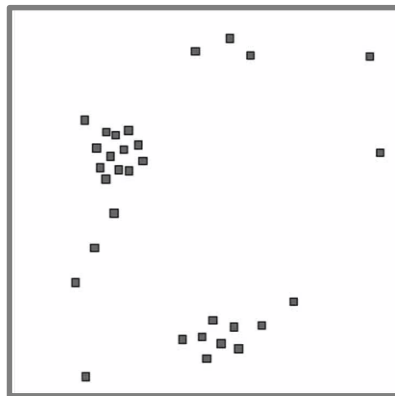
Small Multiples



Trails (Coloring + Flattening)

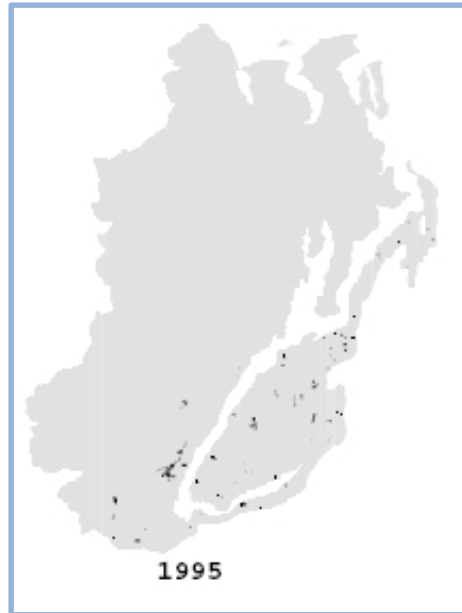


Animation



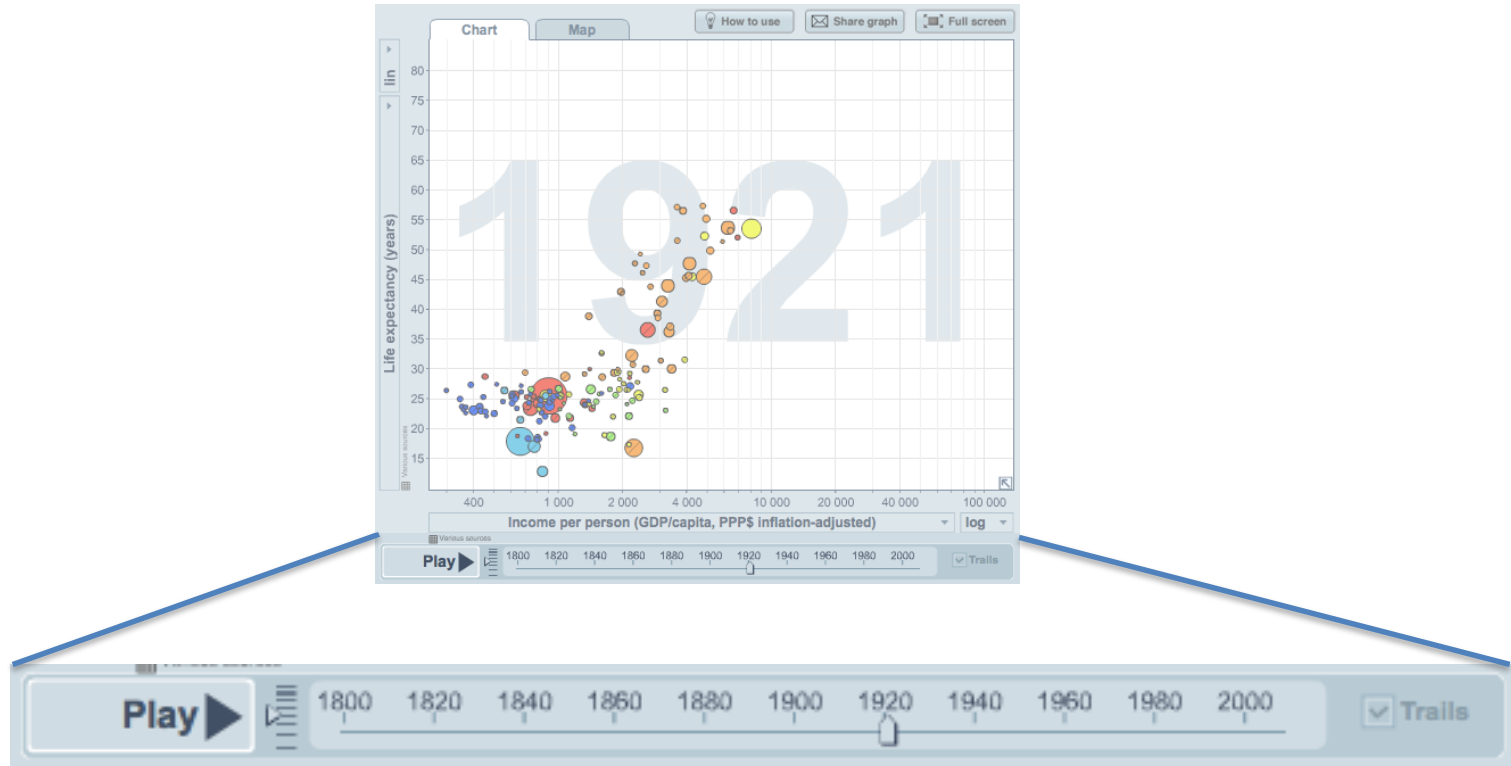
2D + TIME

Animation vs. Other Approaches

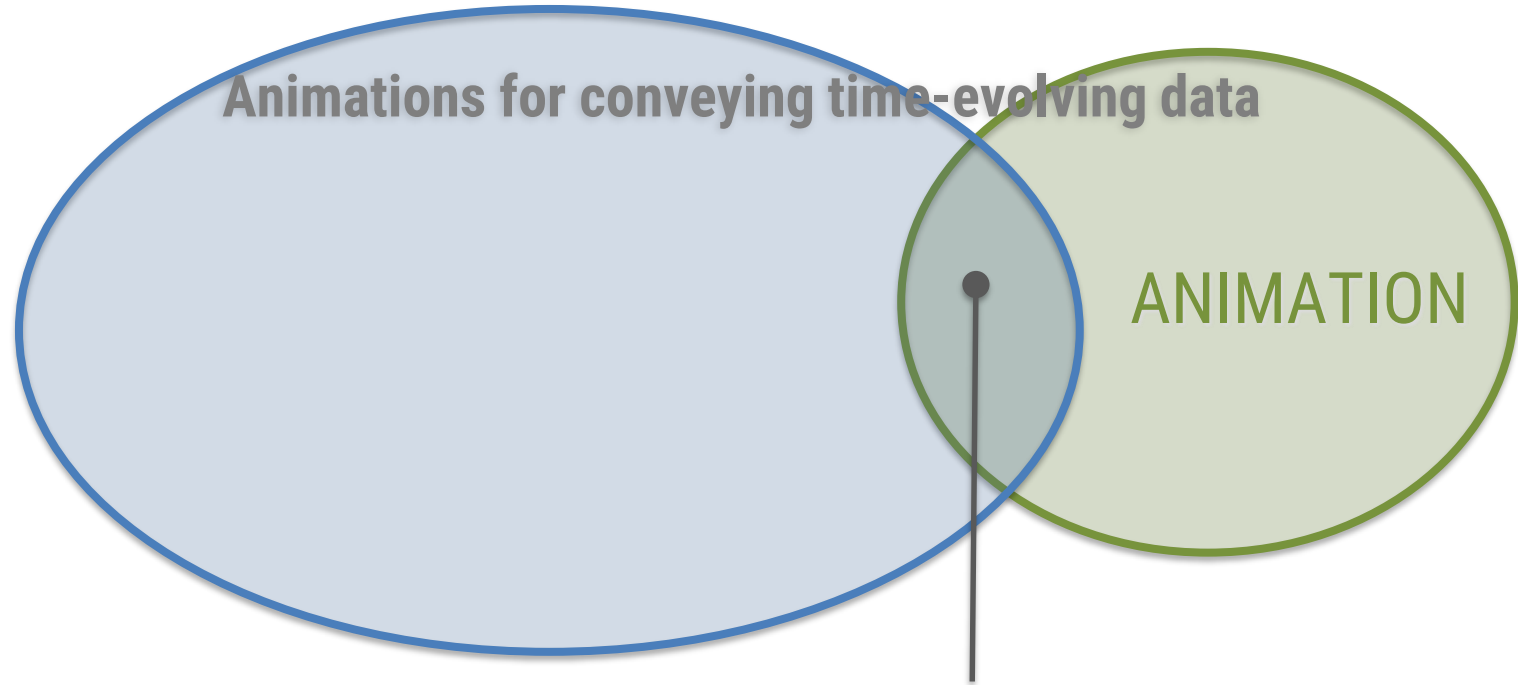


2D + TIME

Time Slider – GapMinder



TIME VISUALIZATION



ANIMATIONS

- **For conveying time-evolving data**

ANIMATIONS

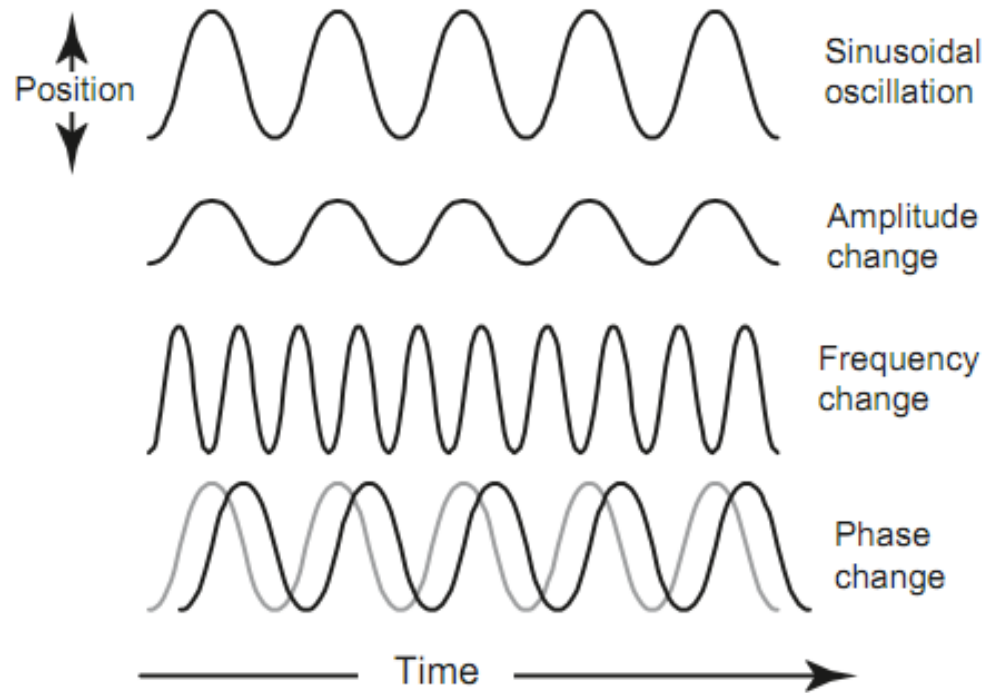
- **For conveying time-evolving data**
- **For capturing users' attention**
- **As an information channel**
- **For explaining transitions**

ANIMATIONS

- For conveying time-evolving data
- For capturing users' attention
- As an information channel
- For explaining transitions

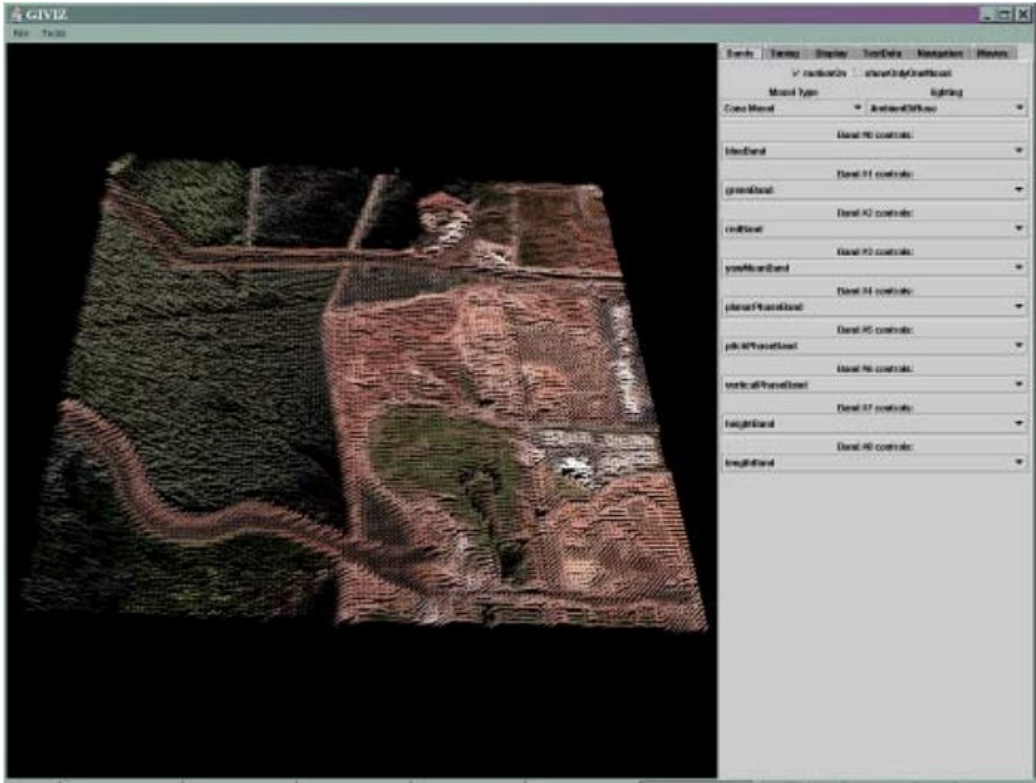
ANIMATIONS

Motion primitives as visual variables



ANIMATIONS

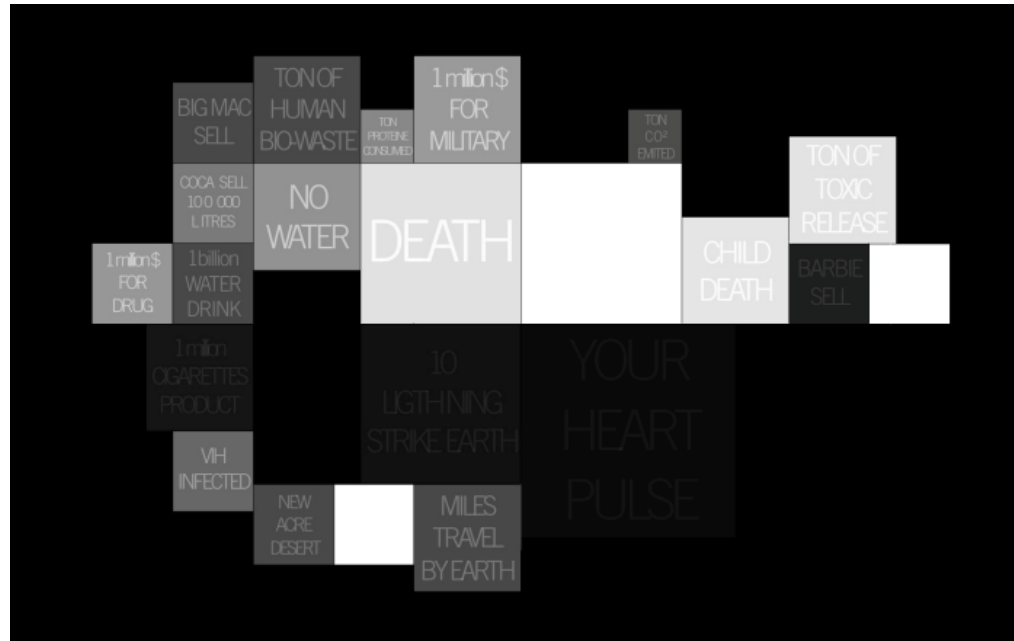
Motion primitives as visual variables



Ware and Bobrow, 2006. Also see Bartram.

ANIMATIONS

Rhythm as a visual variable



[LINK](#)

ANIMATIONS

- For conveying time-evolving data
- For capturing users' attention
- As an information channel
- For explaining transitions

ANIMATED TRANSITIONS

Change Blindness Demo



ANIMATED TRANSITIONS

Change Blindness Demo



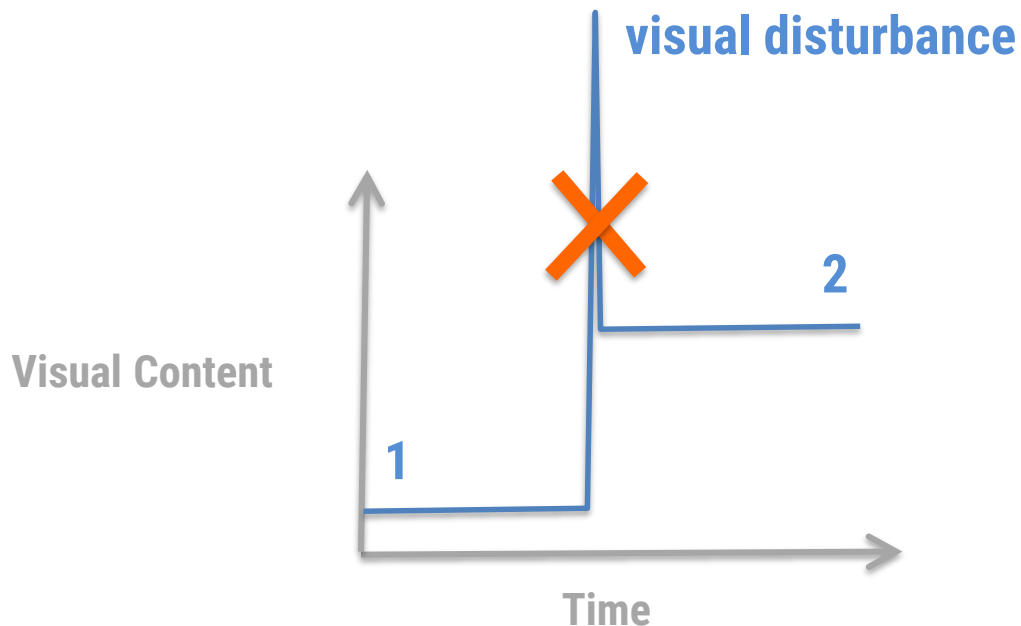
ANIMATED TRANSITIONS

Change Blindness Demo – Try again



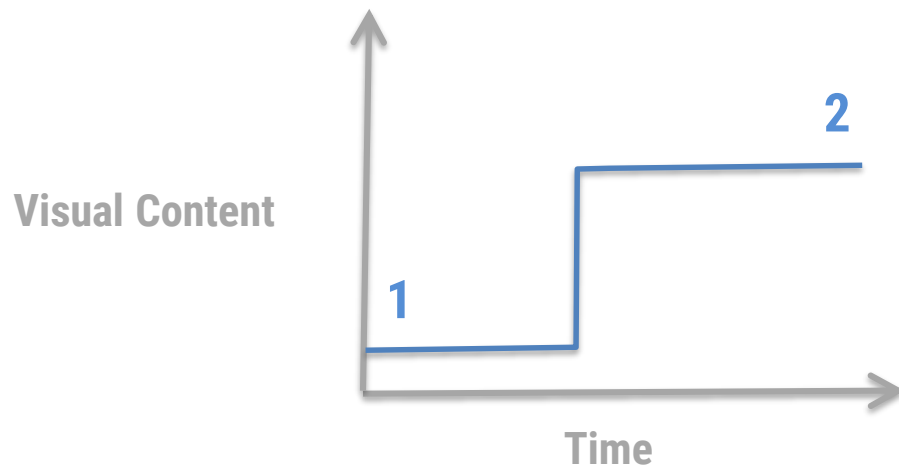
ANIMATED TRANSITIONS

Understanding Visual Transitions



ANIMATED TRANSITIONS

Understanding Visual Transitions



ANIMATED TRANSITIONS

How many words were inserted?

Hervey de Saint Denys has recently started to be known for his introspective studies on dreams. He wrote down his dreams on a daily basis from the age of 13. In 1867, he anonymously published *Les rêves et les moyens de les diriger* (Dreams and the Ways to Direct Them). In this book, he proposed techniques to control dreams, and he described dreams in which the "dreamer is perfectly aware he is dreaming". This particular state of consciousness later came to be called lucid dreaming.

ANIMATED TRANSITIONS

How many words were inserted? Try Again

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ANIMATED TRANSITIONS

What has changed?

Hervey de Saint Denys devoted himself to the study of Chinese, and in 1851 published his *Recherches sur l'agriculture et l'horticulture des Chinois*, in which he dealt with the plants and animals that might be acclimatized in the West. He translated Chinese texts as well as some Chinese stories not of classical interest but valuable for the light they throw on oriental custom. He also translated some works from the Spanish, and wrote a history of the Spanish drama.

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ANIMATED TRANSITIONS

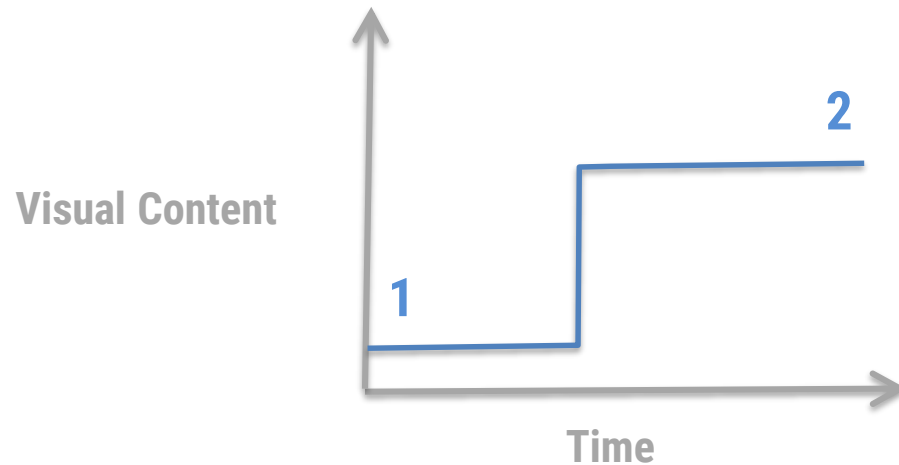
What has changed? Try Again

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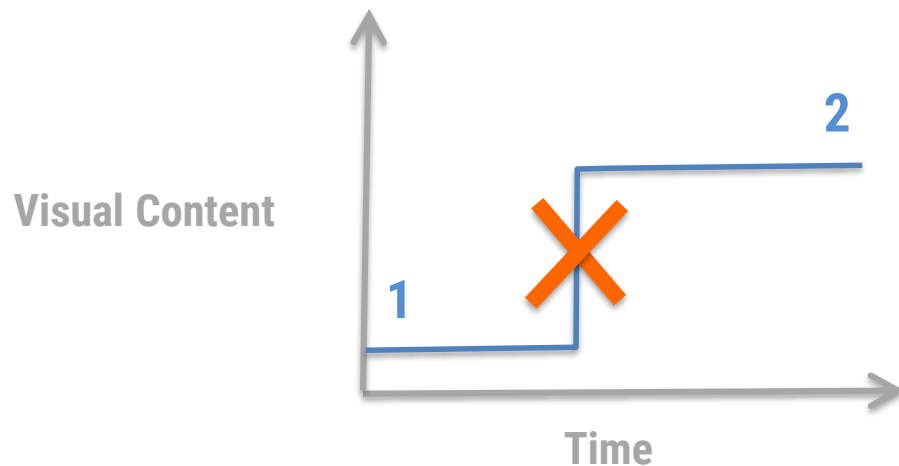
ANIMATED TRANSITIONS

Understanding Visual Transitions



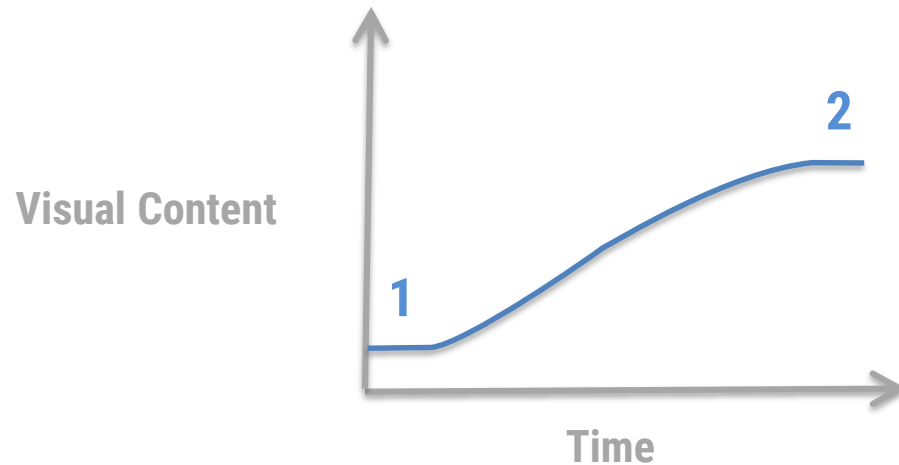
ANIMATED TRANSITIONS

Understanding Visual Transitions



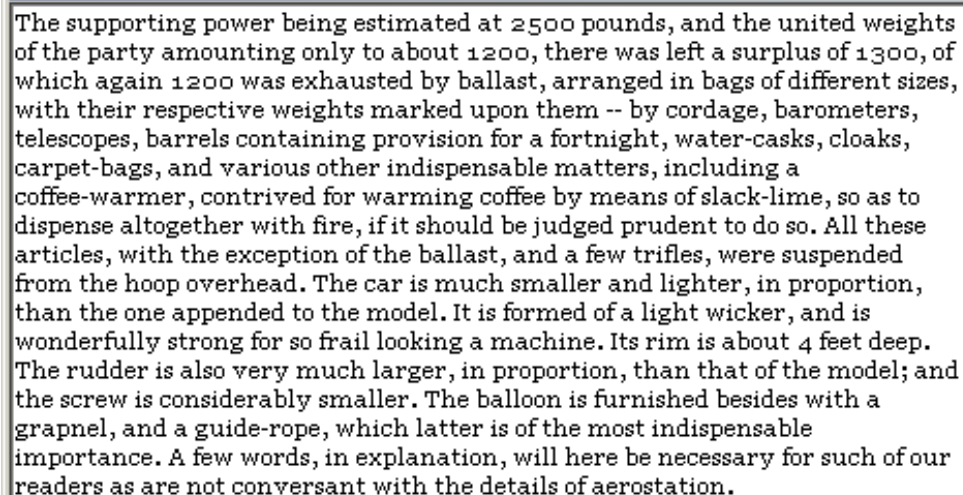
ANIMATED TRANSITIONS

Understanding Visual Transitions



ANIMATED TRANSITIONS

Help when scrolling documents



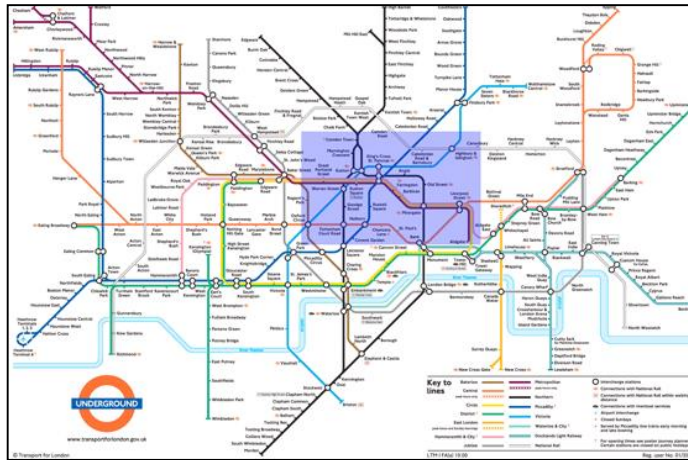
The supporting power being estimated at 2500 pounds, and the united weights of the party amounting only to about 1200, there was left a surplus of 1300, of which again 1200 was exhausted by ballast, arranged in bags of different sizes, with their respective weights marked upon them -- by cordage, barometers, telescopes, barrels containing provision for a fortnight, water-casks, cloaks, carpet-bags, and various other indispensable matters, including a coffee-warmer, contrived for warming coffee by means of slack-lime, so as to dispense altogether with fire, if it should be judged prudent to do so. All these articles, with the exception of the ballast, and a few trifles, were suspended from the hoop overhead. The car is much smaller and lighter, in proportion, than the one appended to the model. It is formed of a light wicker, and is wonderfully strong for so frail looking a machine. Its rim is about 4 feet deep. The rudder is also very much larger, in proportion, than that of the model; and the screw is considerably smaller. The balloon is furnished besides with a grapnel, and a guide-rope, which latter is of the most indispensable importance. A few words, in explanation, will here be necessary for such of our readers as are not conversant with the details of aerostation.

As soon as the balloon quits the earth, it is subjected to the influence of many circumstances tending to create a difference in its weight; augmenting or diminishing its ascending power. For example, there may be a deposition of dew upon the silk, to the extent, even, of several hundred pounds; ballast has

[Klein & Bederson, 2005](#)

ANIMATED TRANSITIONS

Help when panning and zooming



[Shanmugasundaram & Irani, 2008](#)

ANIMATED TRANSITIONS

Help when navigating document revisions

Revision history of User interface

From Wikipedia, the free encyclopedia

[View logs for this page](#)

Browse history

From year (and earlier): From month (and earlier): Tag filter:

For any version listed below, click on its date to view it. For more help, see [Help:Page history](#) and [Help:Edit summary](#).

External tools: [Revision history statistics](#) • [Revision history search](#) • [Number of watchers](#) • [Page view statistics](#)

(cur) = difference from current version, (prev) = difference from preceding version,

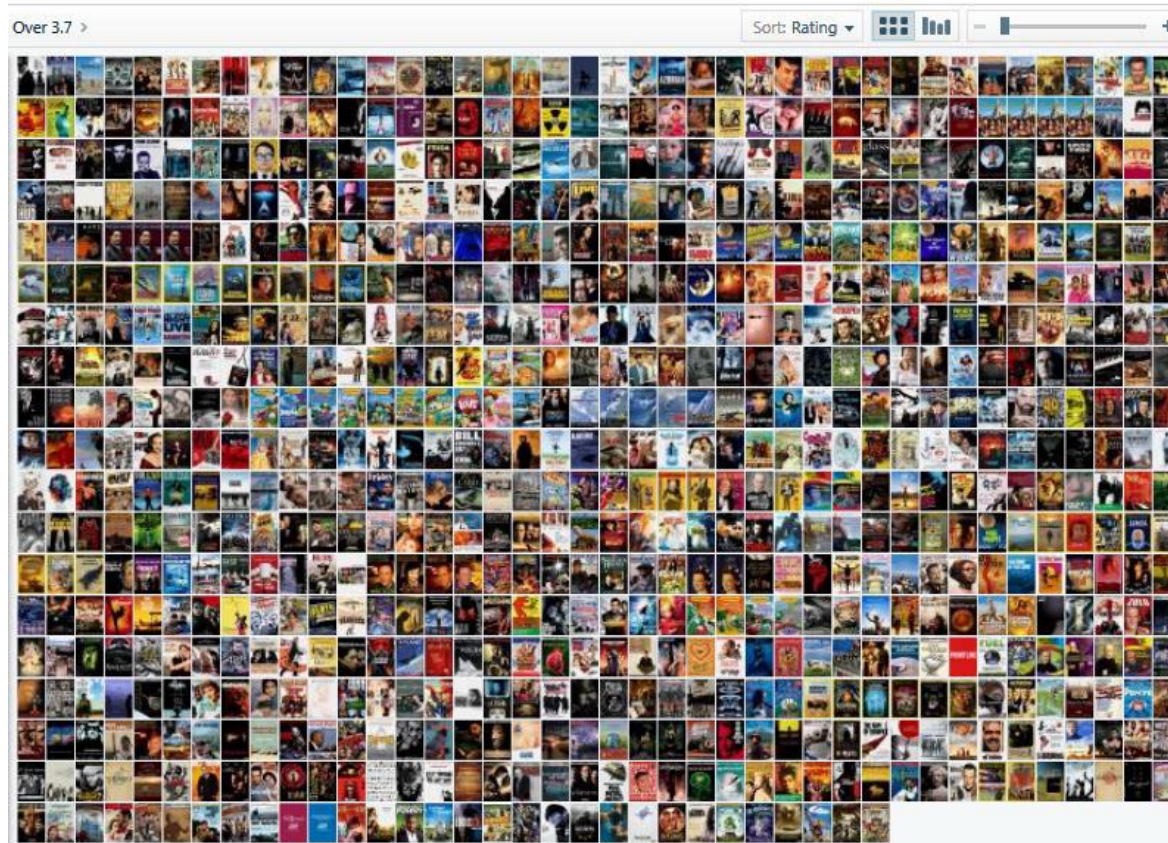
m = [minor edit](#), **→** = [section edit](#), **←** = [automatic edit summary](#)

(latest | [earliest](#)) View (newer 50 | older 50) (20 | 50 | 100 | 250 | 500)

- (cur) (prev)  21:05, 6 December 2009 94.74.138.66 (talk) (16,058 bytes) (undo)
- (cur) (prev)  19:15, 17 November 2009 72.48.156.2 (talk) (16,056 bytes) (→Introduction) (undo)
- (cur) (prev)  11:33, 17 November 2009 192.248.16.90 (talk) (15,551 bytes) (→See also) (undo)
- (cur) (prev)  22:06, 9 November 2009 The Thing That Should Not Be (talk | contribs) **m** (15,522 bytes) (Reverted edits by 189.72.213.11 (talk) to last revision by ClueBot (Report Mistake) (HG)) (undo)
- (cur) (prev)  22:06, 9 November 2009 189.72.213.11 (talk) (15,764 bytes) (→Usability) (undo)
- (cur) (prev)  11:24, 9 November 2009 ClueBot (talk | contribs) **m** (15,522 bytes) (Reverting possible vandalism by 41.220.224.134 to version by Lester. False positive? Report it. Thanks, ClueBot. (819644) (Bot)) (undo)
- (cur) (prev)  11:24, 9 November 2009 41.220.224.134 (talk) (15,405 bytes) (→Literature) (undo)

ANIMATED TRANSITIONS

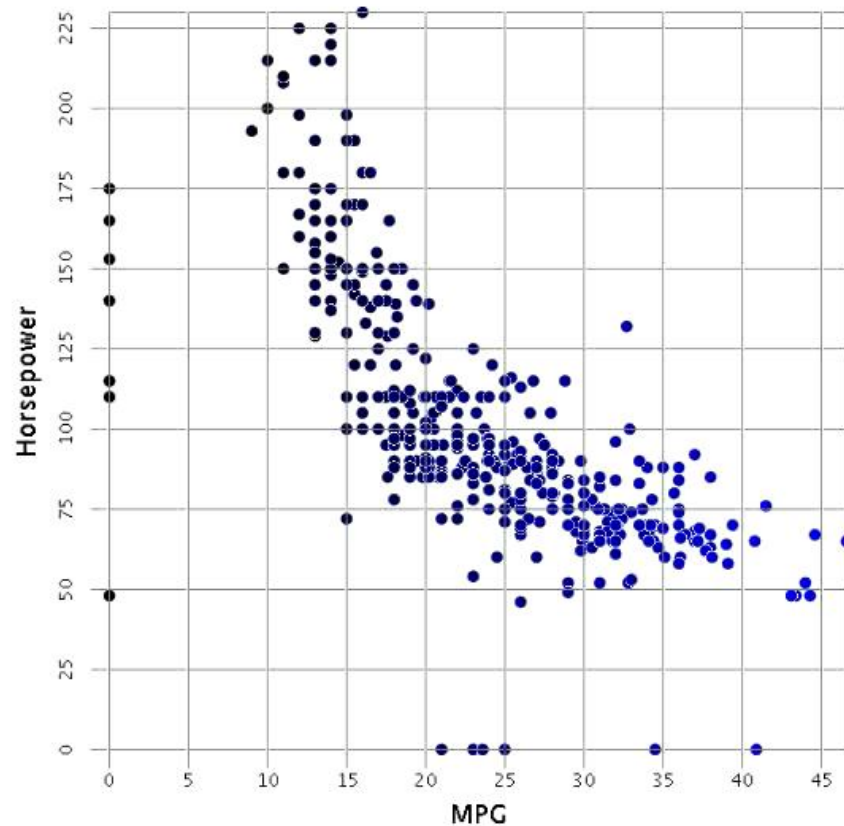
In faceted browsing - Pivot



[Microsoft
Pivot](#)

ANIMATED TRANSITIONS

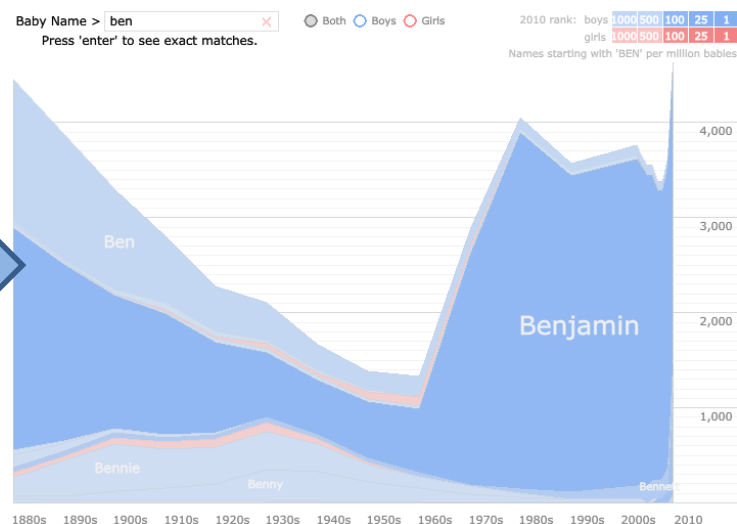
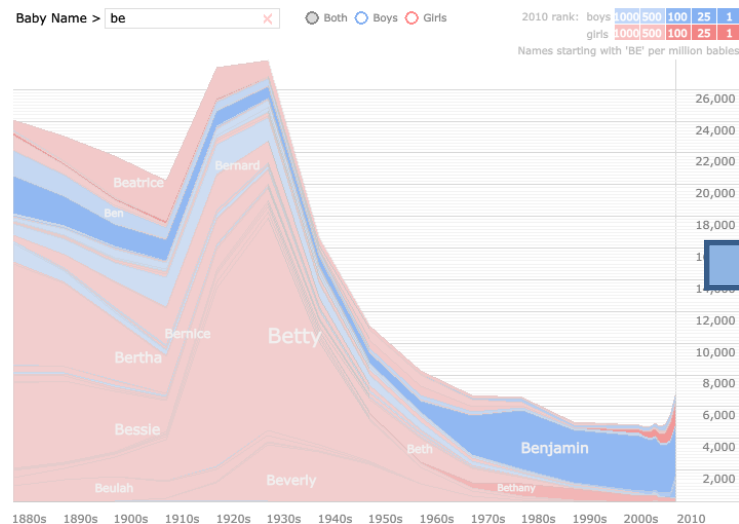
In multidimensional exploration - ScatterDice



[Elmqvist et al, 2009](#)

ANIMATED TRANSITIONS

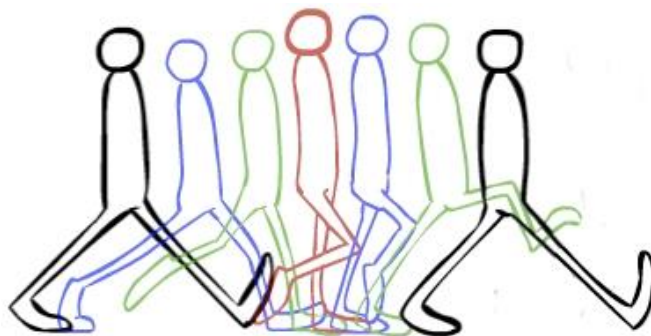
In charts – Baby Name Voyager



ANIMATED TRANSITIONS

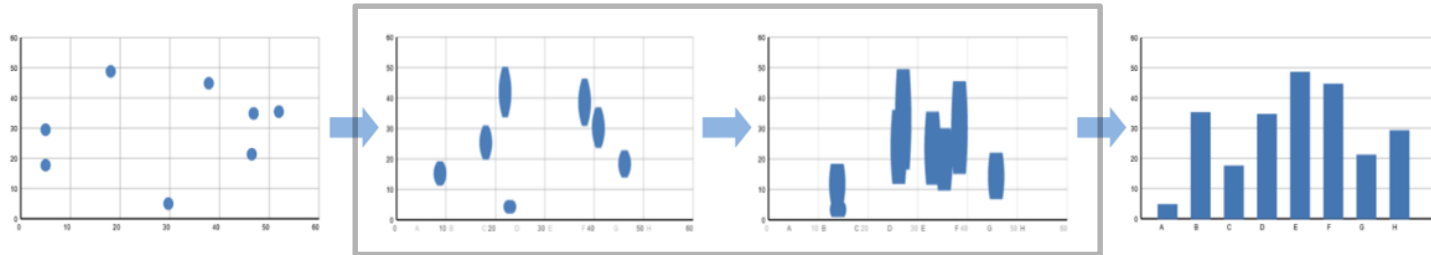
How to design them?

1. **Interpolation problem:** what to show in-between
2. **Pacing problem:** when to show it

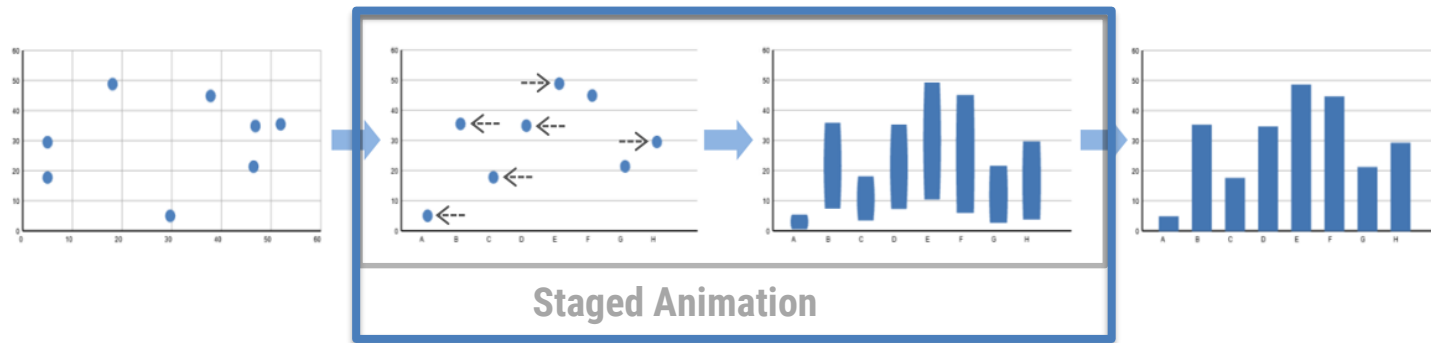


ANIMATED TRANSITIONS

Designing Animated Transitions



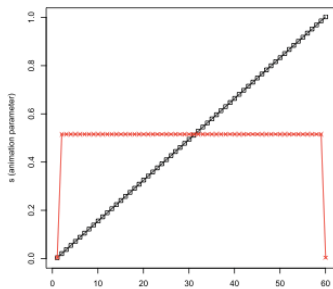
Direct Interpolation



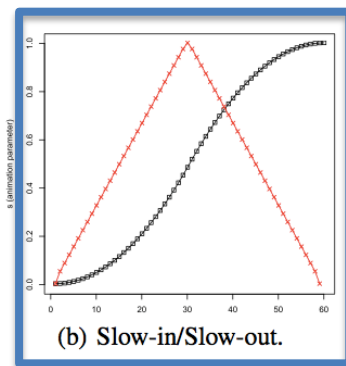
Staged Animation

ANIMATED TRANSITIONS

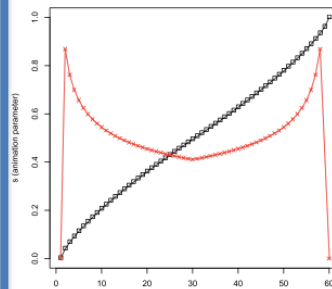
Designing Animated Transitions



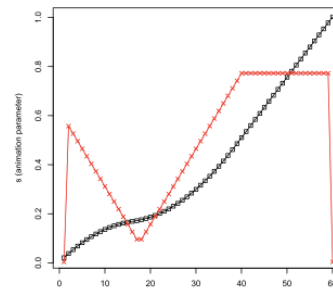
(a) Constant rate.



(b) Slow-in/Slow-out.



(c) Fast-in/Fast-out.

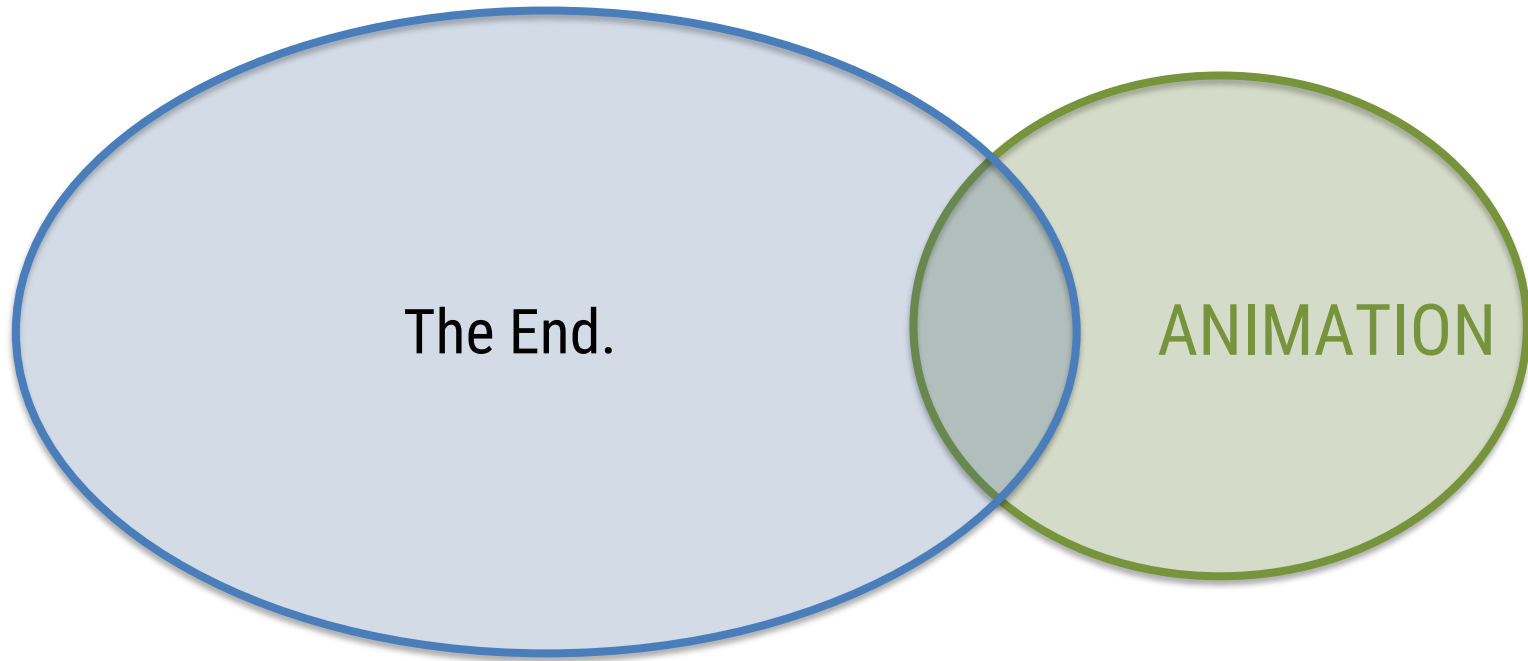


(d) Adaptive rate (frame 18).

ANIMATED TRANSITIONS

Use them!

TIME VISUALIZATION



ACKNOWLED

Slides in were inspired and adapted from slides by

- Pierre Dragicevic (Inria)