

VISUALIZATION OF TEMPORAL DATA

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UNIVERSITY
DEPARTMENT OF COMPUTER SCIENCE

TIME VISUALIZATION
DATAVIS FALL 2025

HANS-JÖRG SCHULZ
ASSOCIATE PROFESSOR



1. INTRODUCTION

2. VISUAL ENCODING

3. BASIC CHART TYPES

4. INTERACTION

5. VISUALIZATION DESIGN

6. DATA PREPROCESSING

7. RECAP 1st Half

8. MULTIVARIATE DATAVIS

9. TEMPORAL DATAVIS

10. GEOSPATIAL DATAVIS

11. GRAPH DATAVIS

12. 3D DATAVIS

13. VISUAL ANALYTICS

14. RECAP 2nd Half

Basics

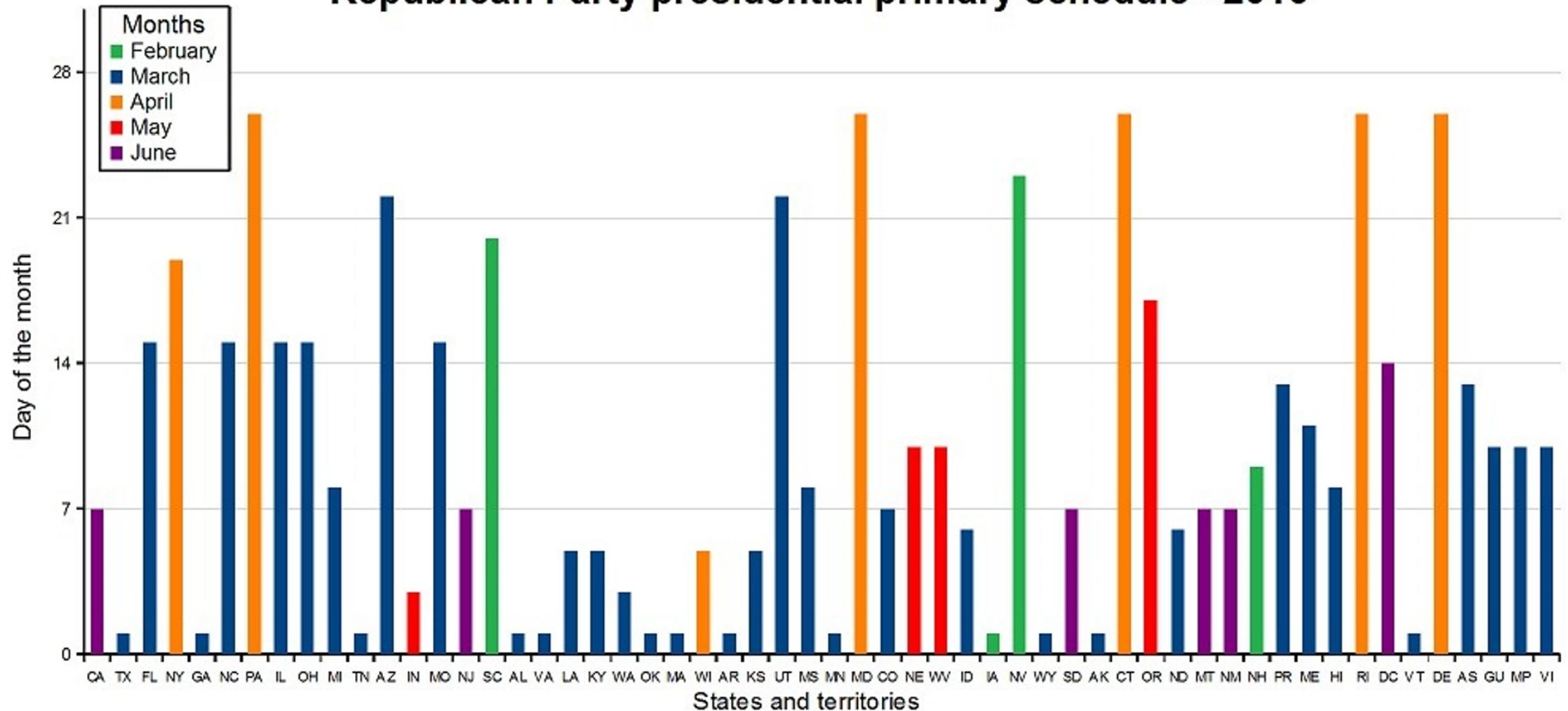
Visualization
Building Blocks
& Processes

Visualization
Techniques

Visualization
Applications



Republican Party presidential primary schedule - 2016



OVERVIEW

1. Principles of Time Vis

- Data & Task Characterization
- Principle Mapping Possibilities
- Horizon Graphs

2. Visualizing Time Intervals

- Triangular Model

3. Visualizing Event-based Data

- Outflow
- Time Maps

4. Interaction Techniques

- Stack Zooming
- ChronoLenses



PRINCIPLES OF TIME VIS



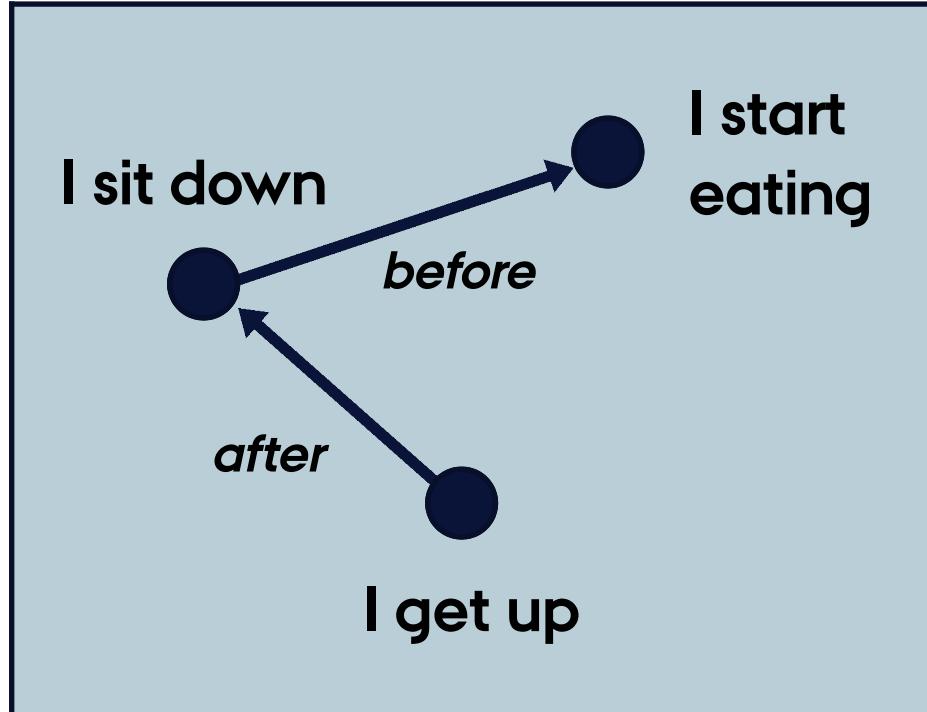
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WHAT IS TIME? - TIME SCALES



ORDINAL SCALE

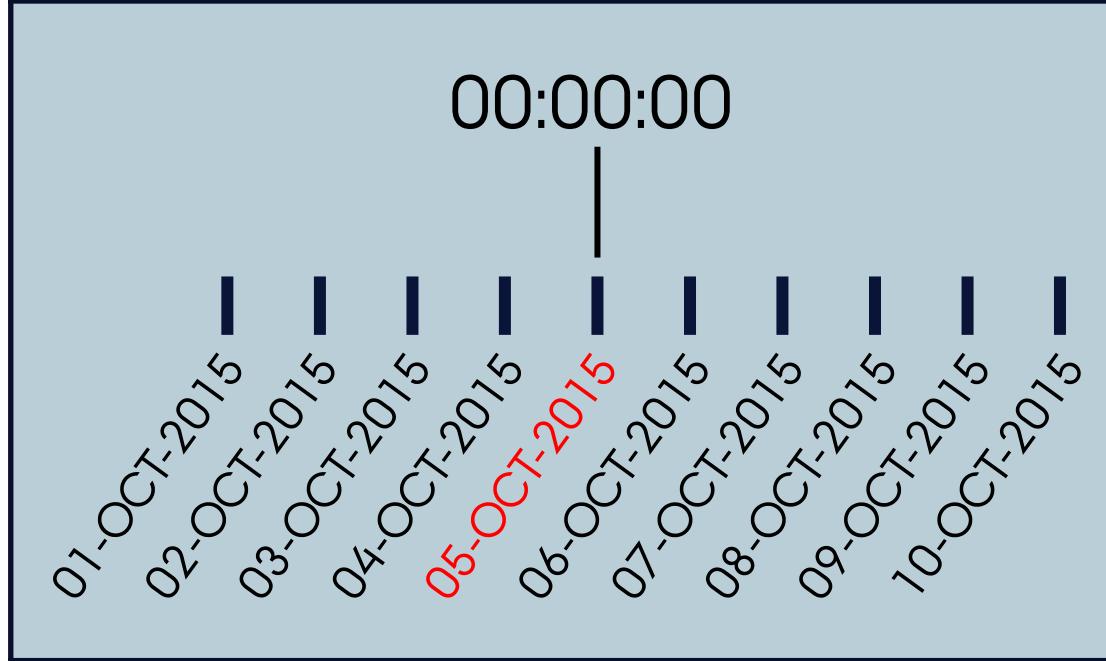


DISCRETE SCALE

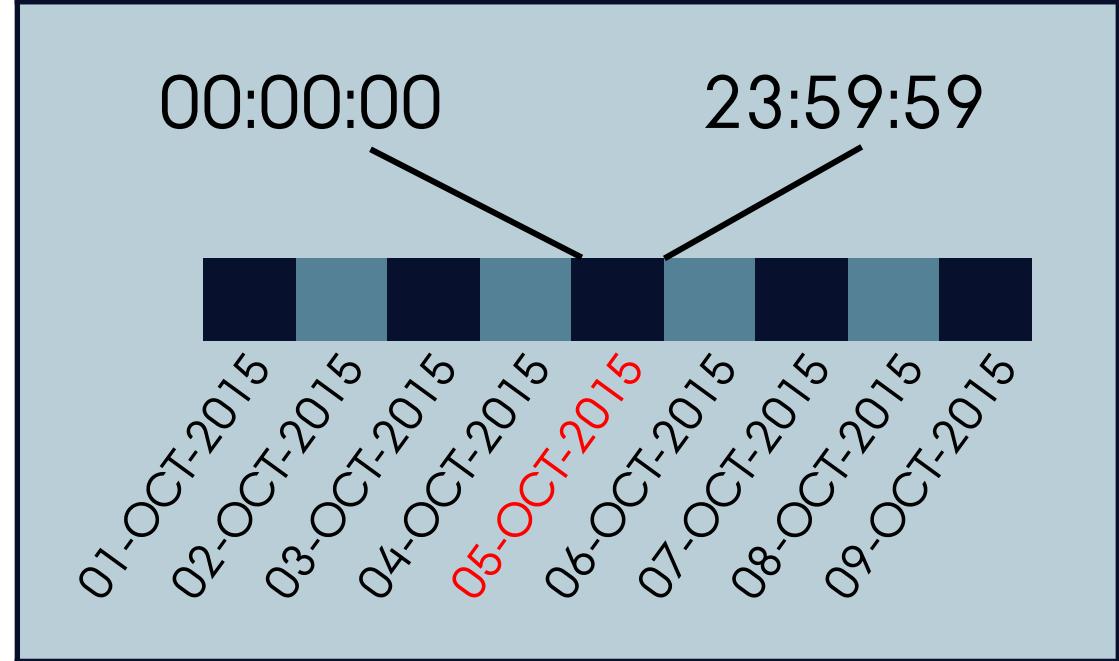


CONTINUOUS SCALE

WHAT IS TIME? - TIME SCOPE

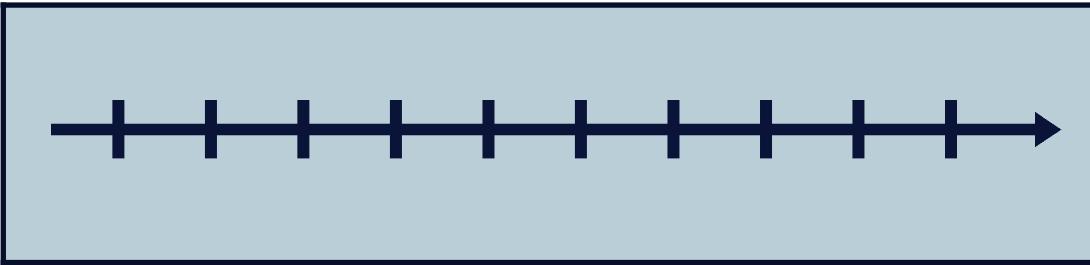


TIME POINT

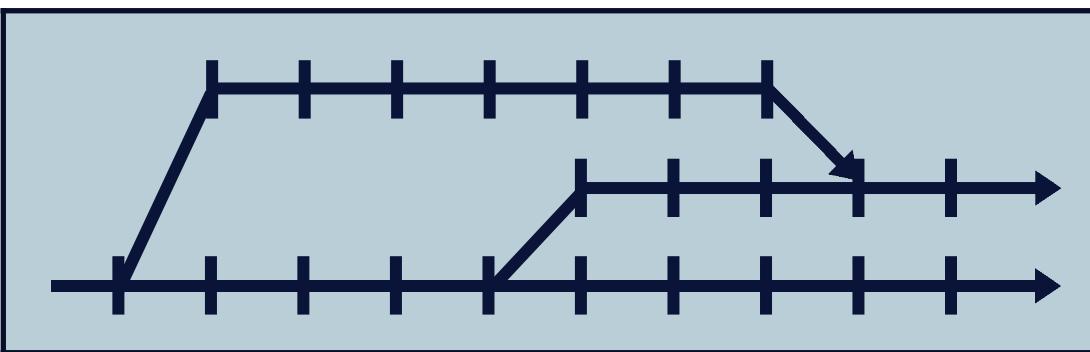


TIME INTERVAL

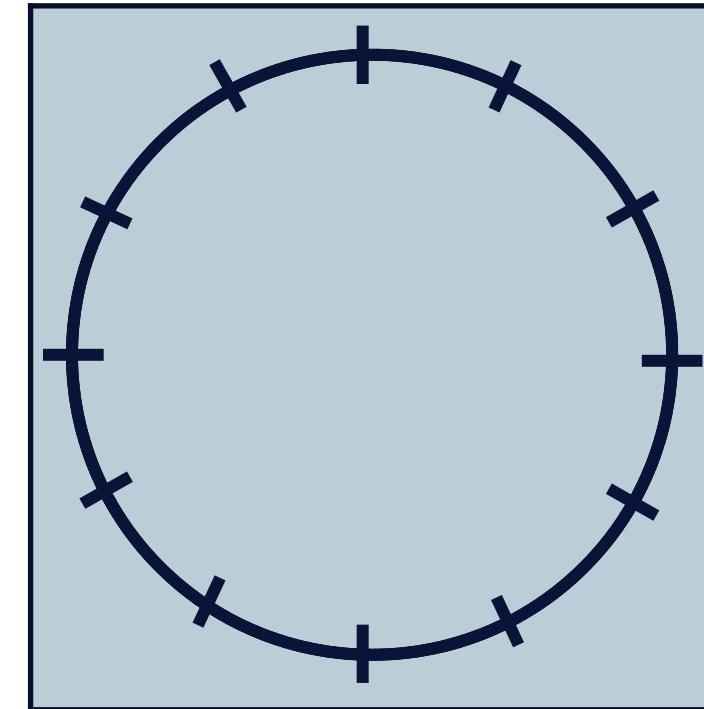
WHAT IS TIME? - TIME ARRANGEMENT



LINEAR TIME



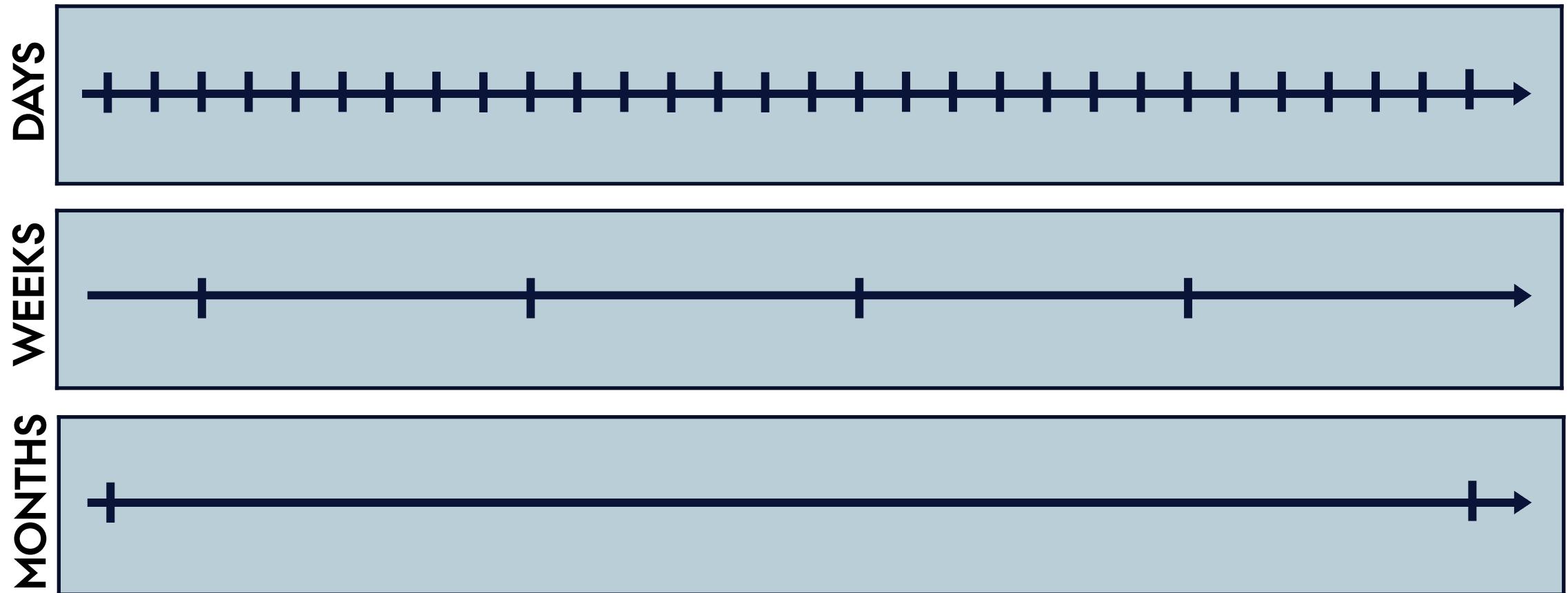
BRANCHING TIME



CYCLIC TIME

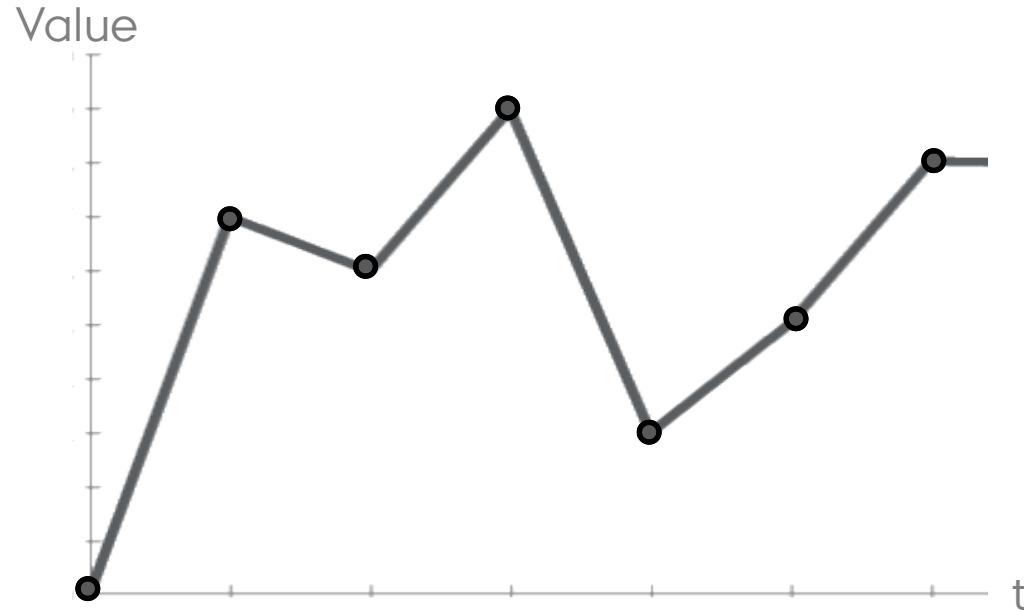


WHAT IS TIME? - TIME GRANULARITIES

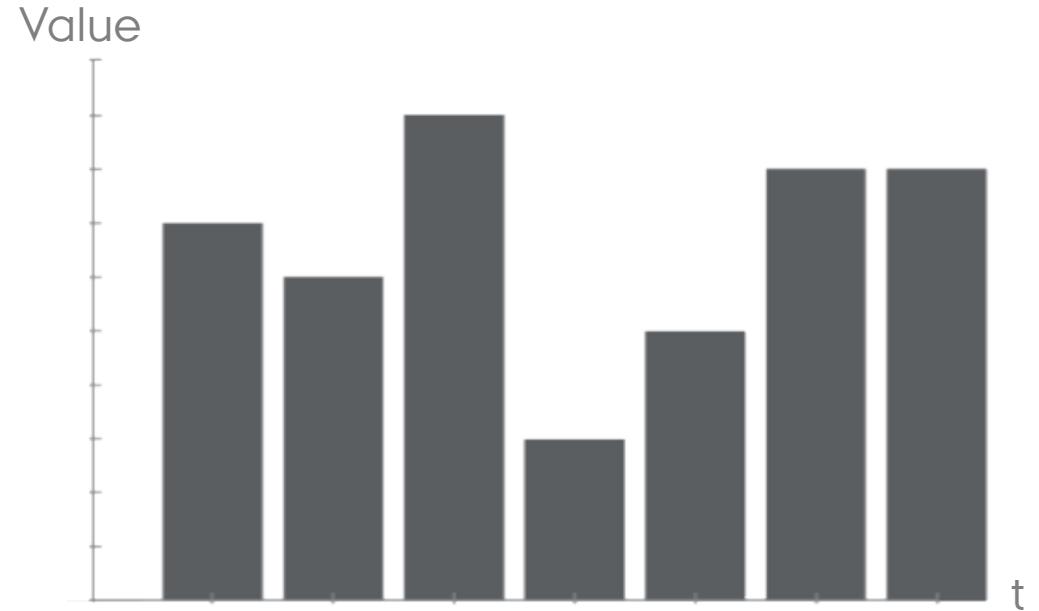


→ Multiple Granularities: Calendar

TIME'S IMPACT ON VISUALIZATION

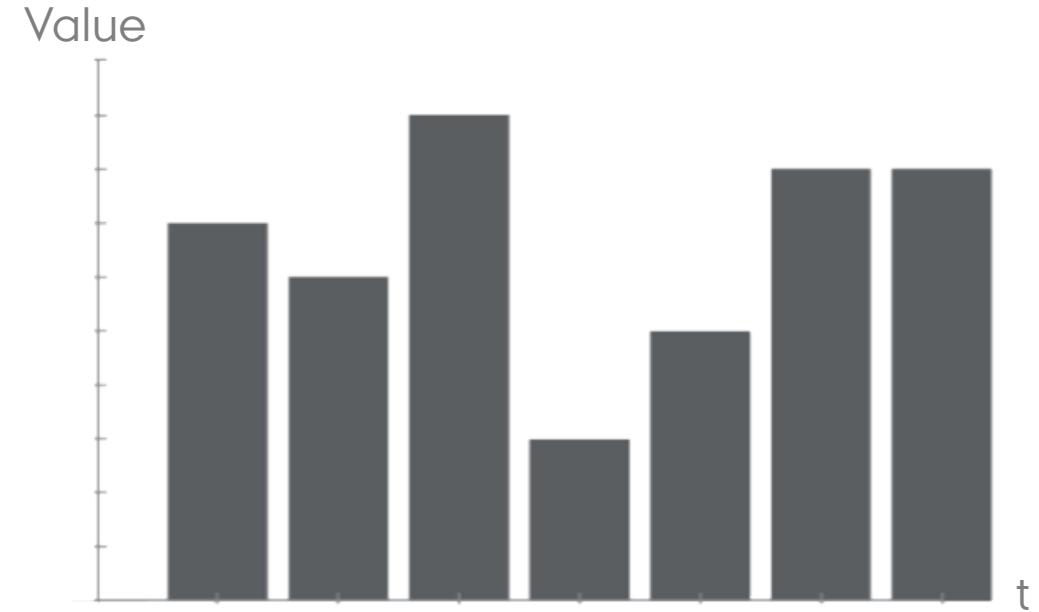
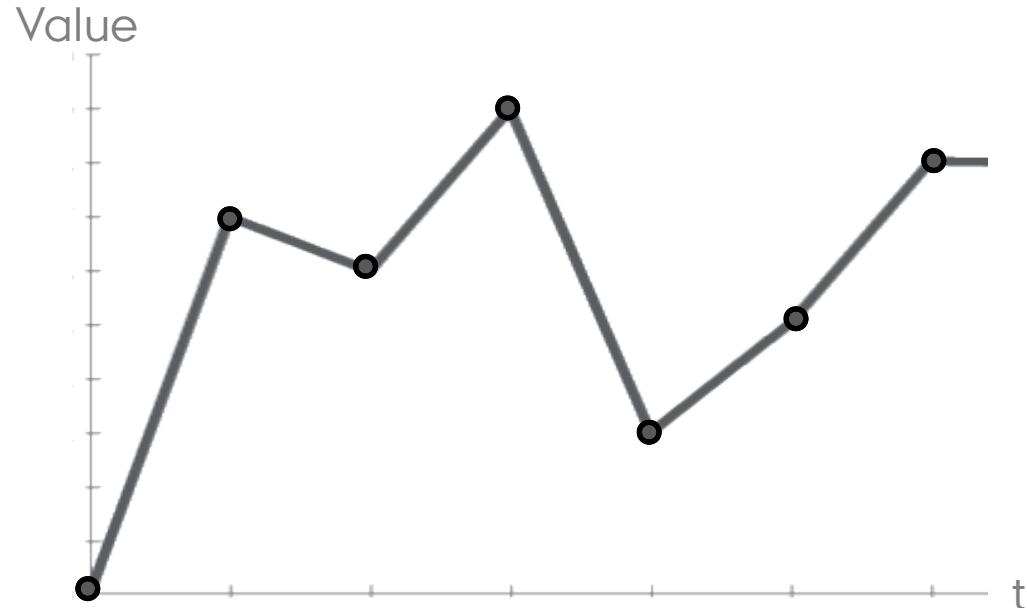


Time Scale: continuous
Time Scope: time points
Time Arrangement: linear



Time Scale: discrete
Time Scope: time intervals
Time Arrangement: linear

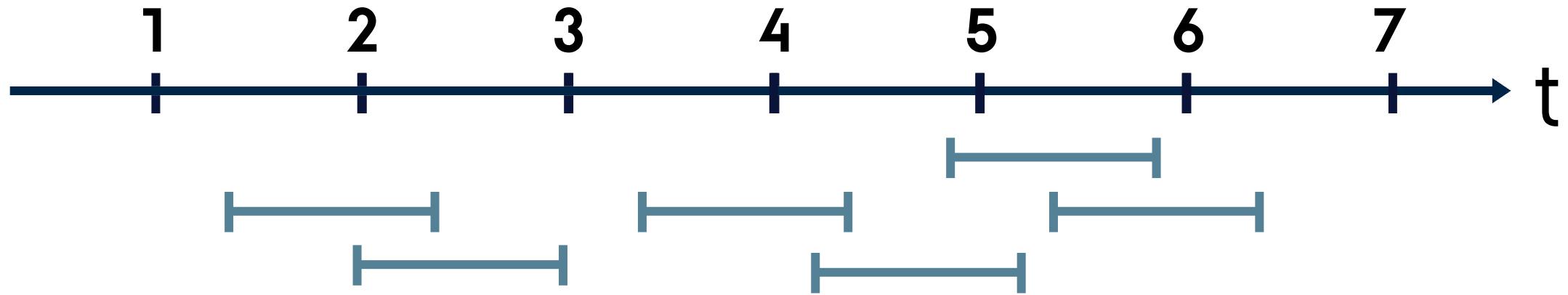
TIME'S IMPACT ON VISUALIZATION



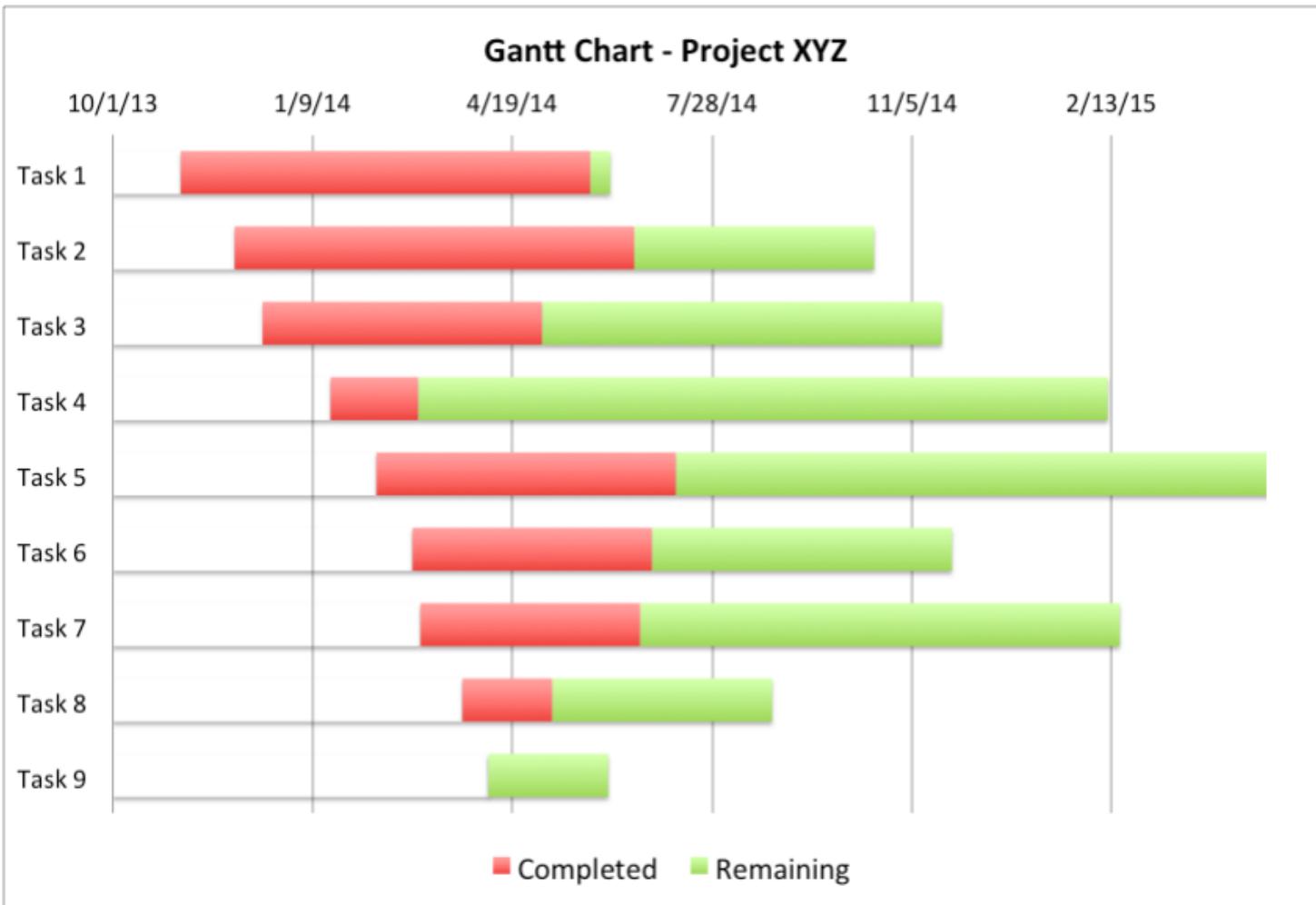
Can a continuous time scale (as on the left) and interval time scopes (as on the right) ever co-occur? If not, why?
If so, how could a visualization for them look like?



YES, THEY CAN!



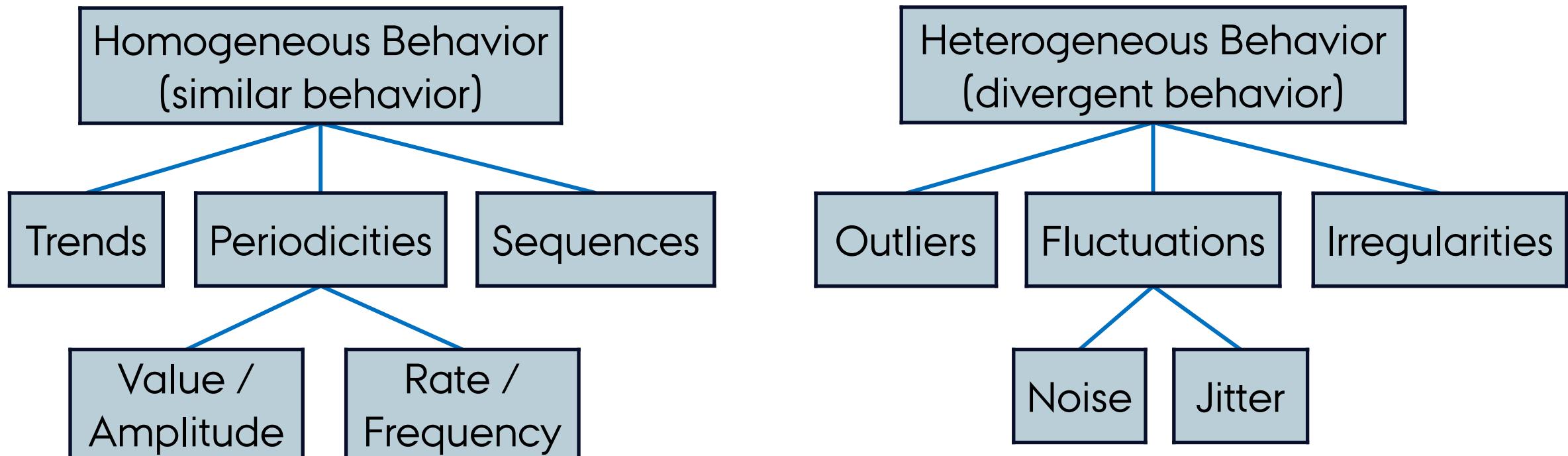
EXAMPLE: GANTT CHART



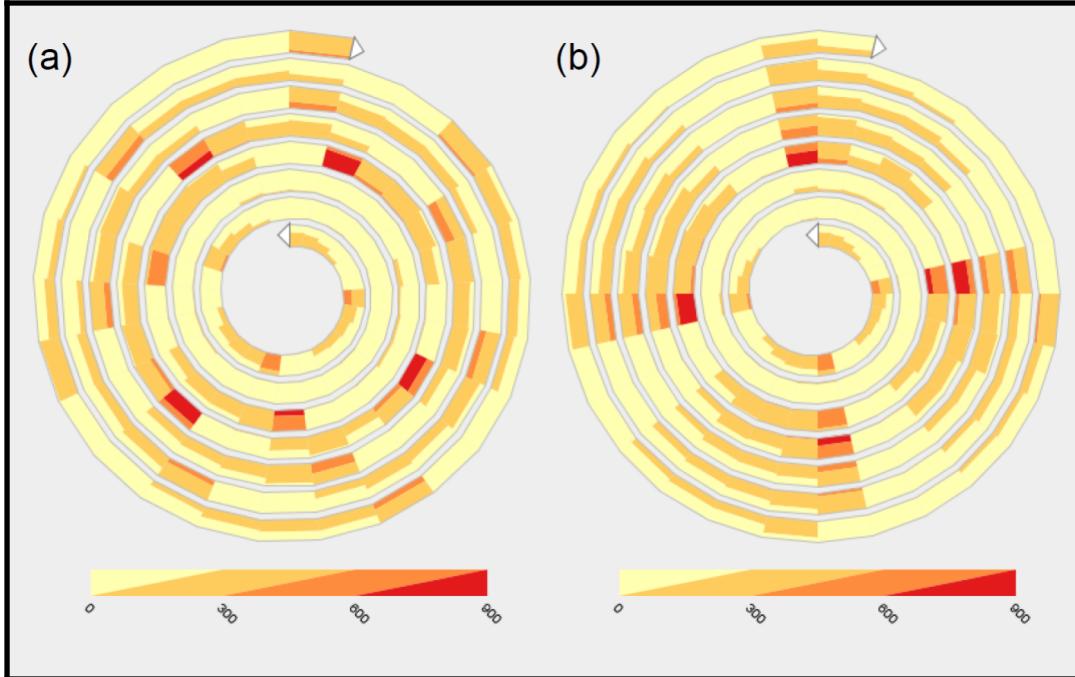
TASKS ON TIME-ORIENTED DATA

Generic tasks: values, extremes, groups / clusters, distributions,...

Time-specific tasks: behavior of the data over time

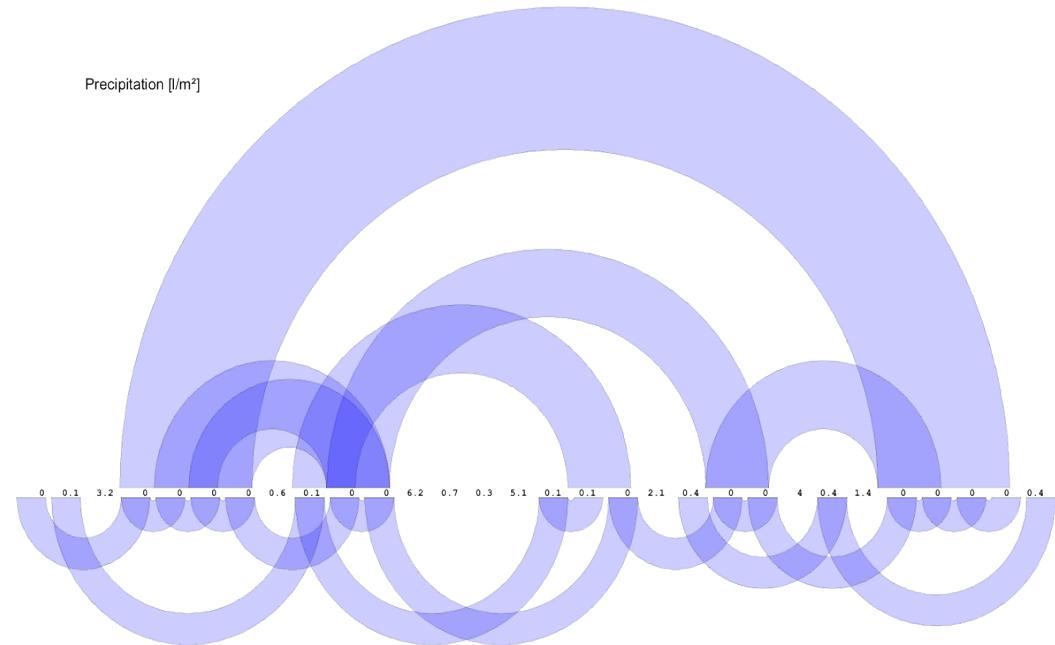


TASK'S IMPACT ON TIME VISUALIZATION



Periodicities

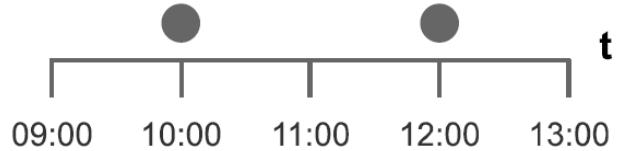
[https://vca.informatik.uni-rostock.de/~ct/
software/EnhancedSpiral.js/index.html](https://vca.informatik.uni-rostock.de/~ct/software/EnhancedSpiral.js/index.html)



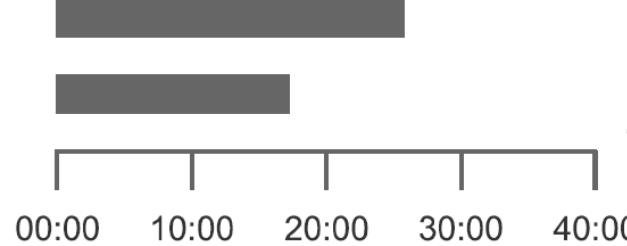
Sequences

Arc Diagram [Nagel + Duval 2013]

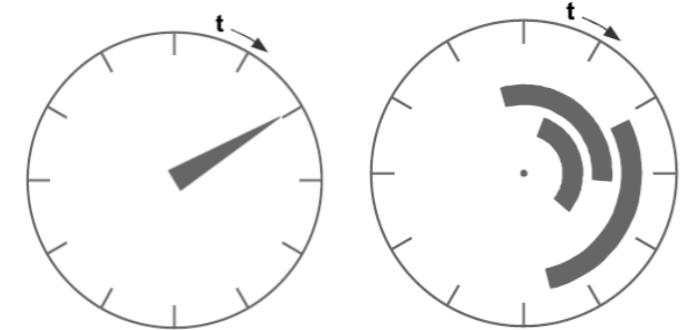
MAPPING TIME TO VISUAL CHANNELS



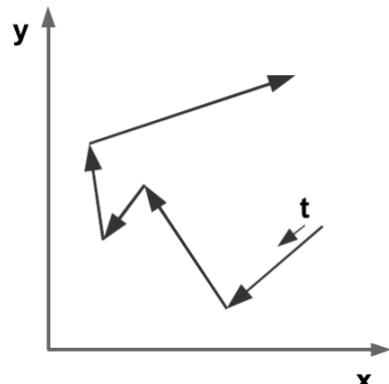
Position



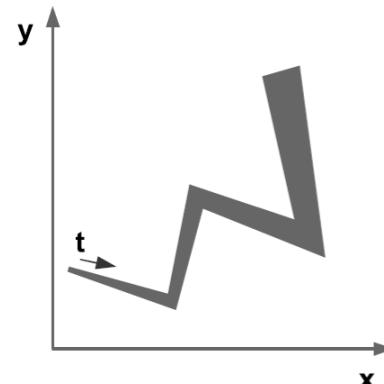
Length



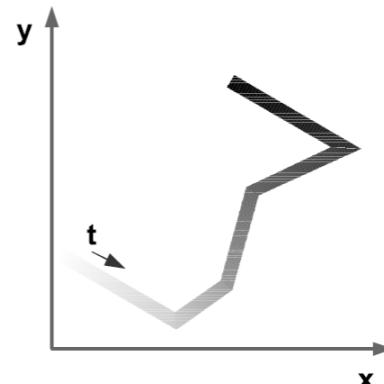
Angle



Connection



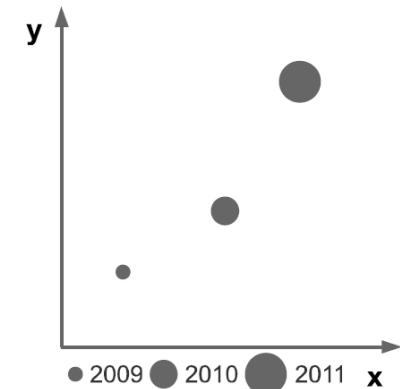
Line width



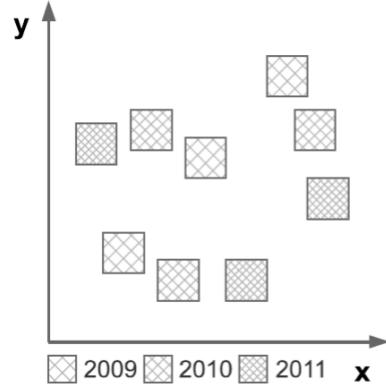
Brightness



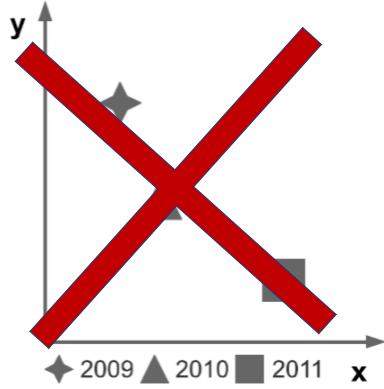
MAPPING TIME TO VISUAL CHANNELS



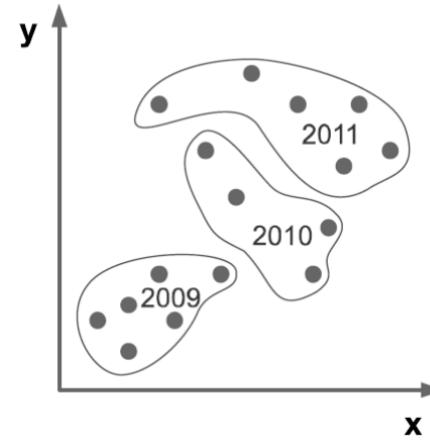
Size



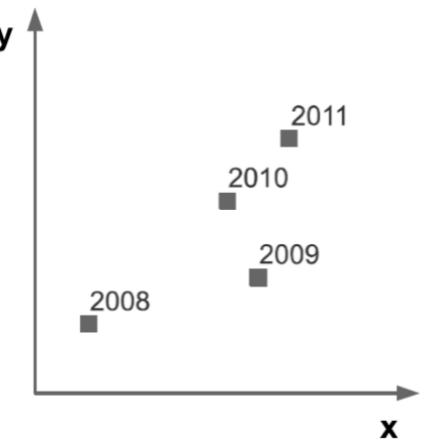
Texture



Shape

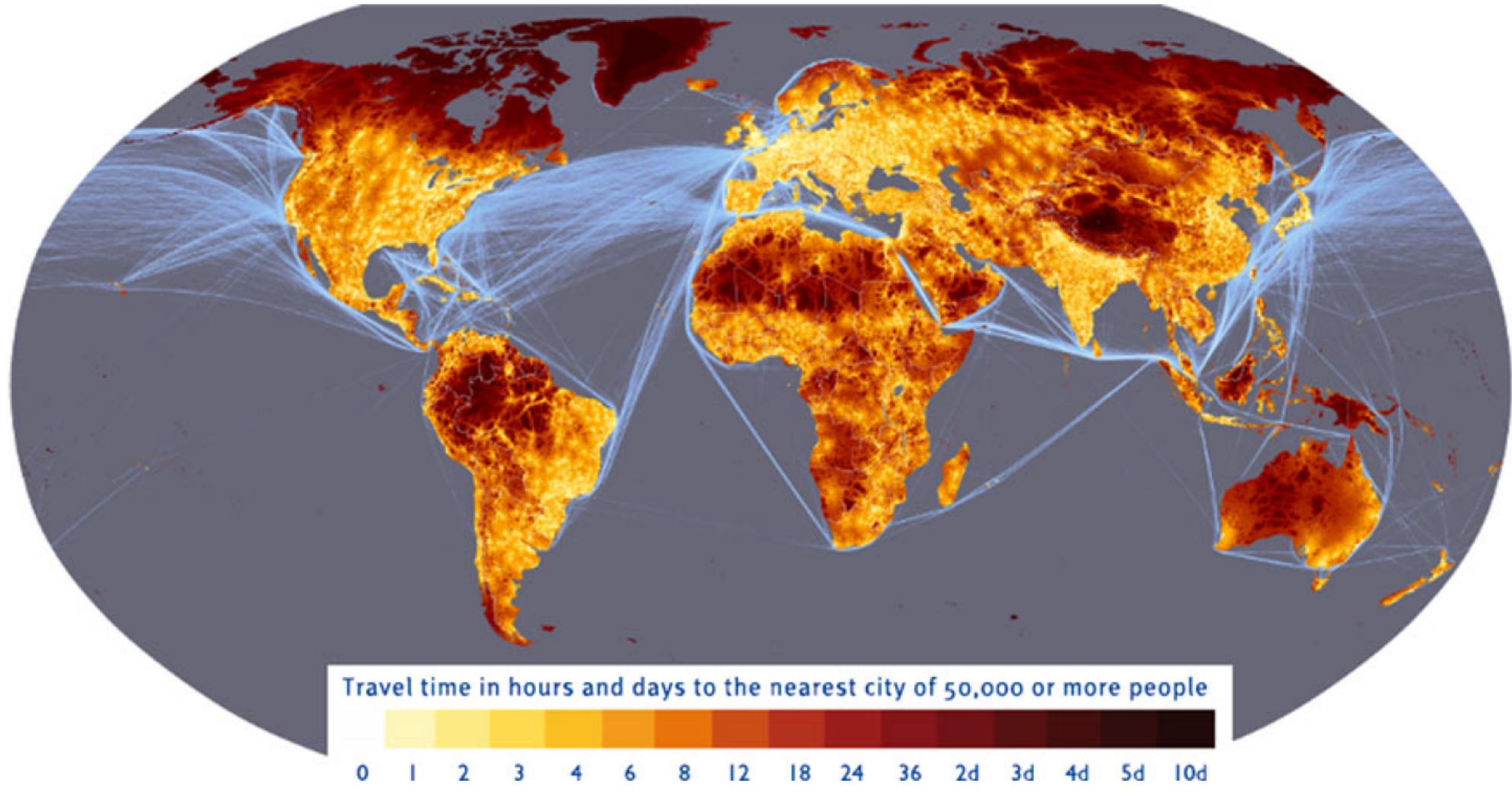


Containment



Text

MAPPING TIME TO COLOR



LET'S REVISIT MACKINLAY'S SCHEMA

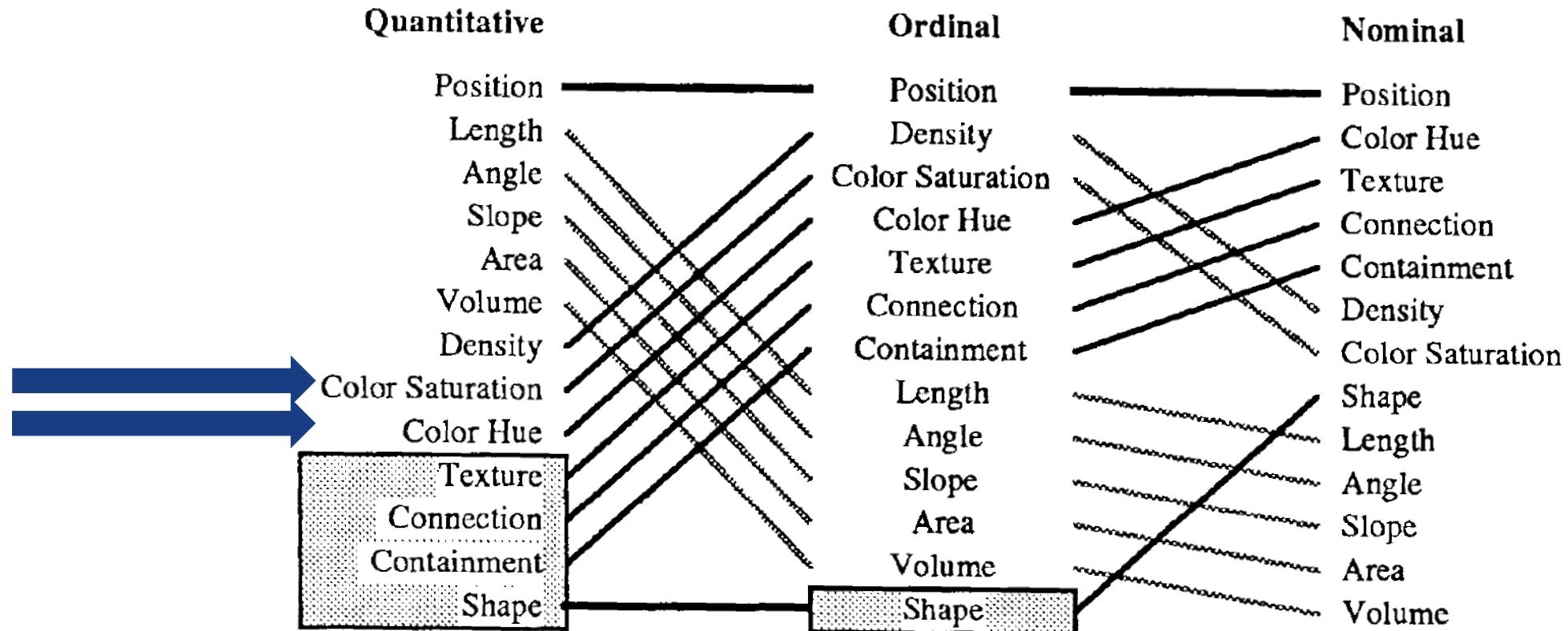


Fig. 15. Ranking of perceptual tasks. The tasks shown in the gray boxes are not relevant to these types of data.

The TimeViz Browser

A Visual Survey of Visualization Techniques for Time-Oriented Data
by Christian Tominski and Wolfgang Aigner

of Techniques: 115

Search:

How to use filters:

- Want:** Show me!
- Indifferent:** I don't care.
- Hide:** I'm not interested!

Data

Frame of Reference

- Abstract
- Spatial

Number of Variables

- Univariate
- Multivariate

Time

Arrangement

- Linear
- Cyclic

Time Primitives

- Instant
- Interval

Visualization

Mapping

- Static
- Dynamic

Dimensionality

- 2D
- 3D

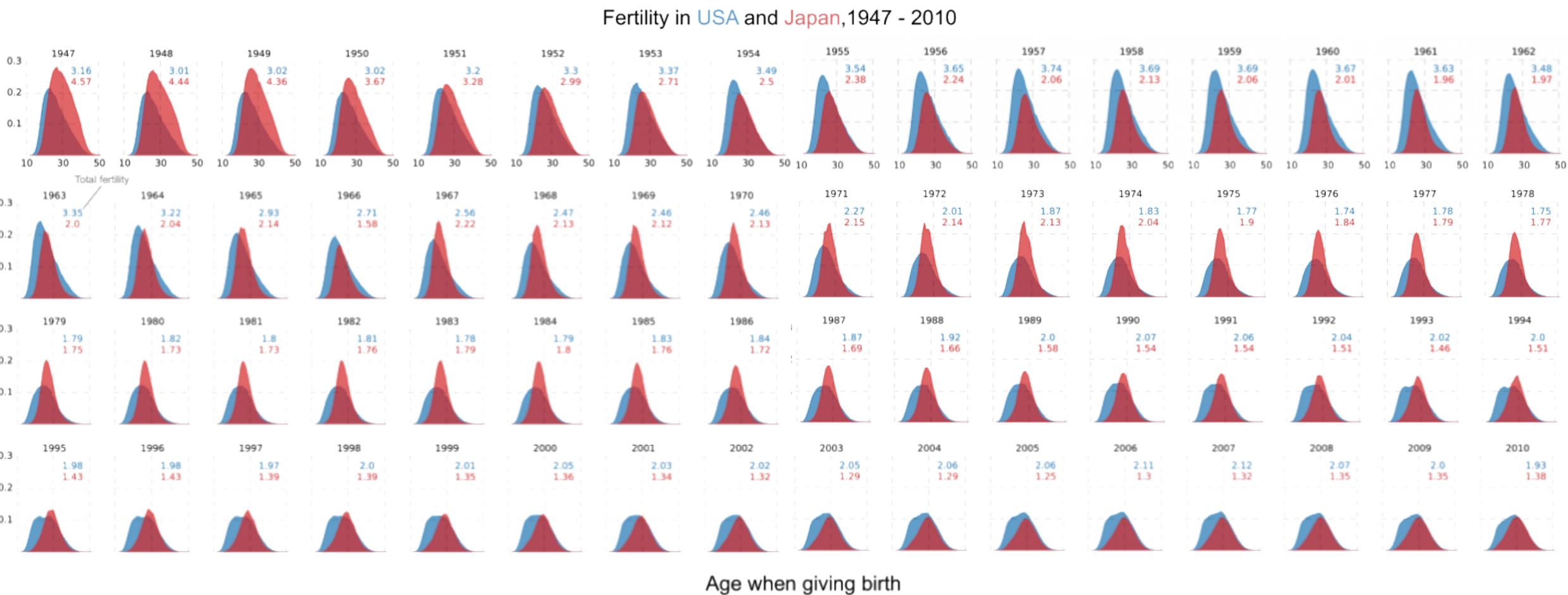
Our book:



<http://timeviz.net> -> click "Browser"

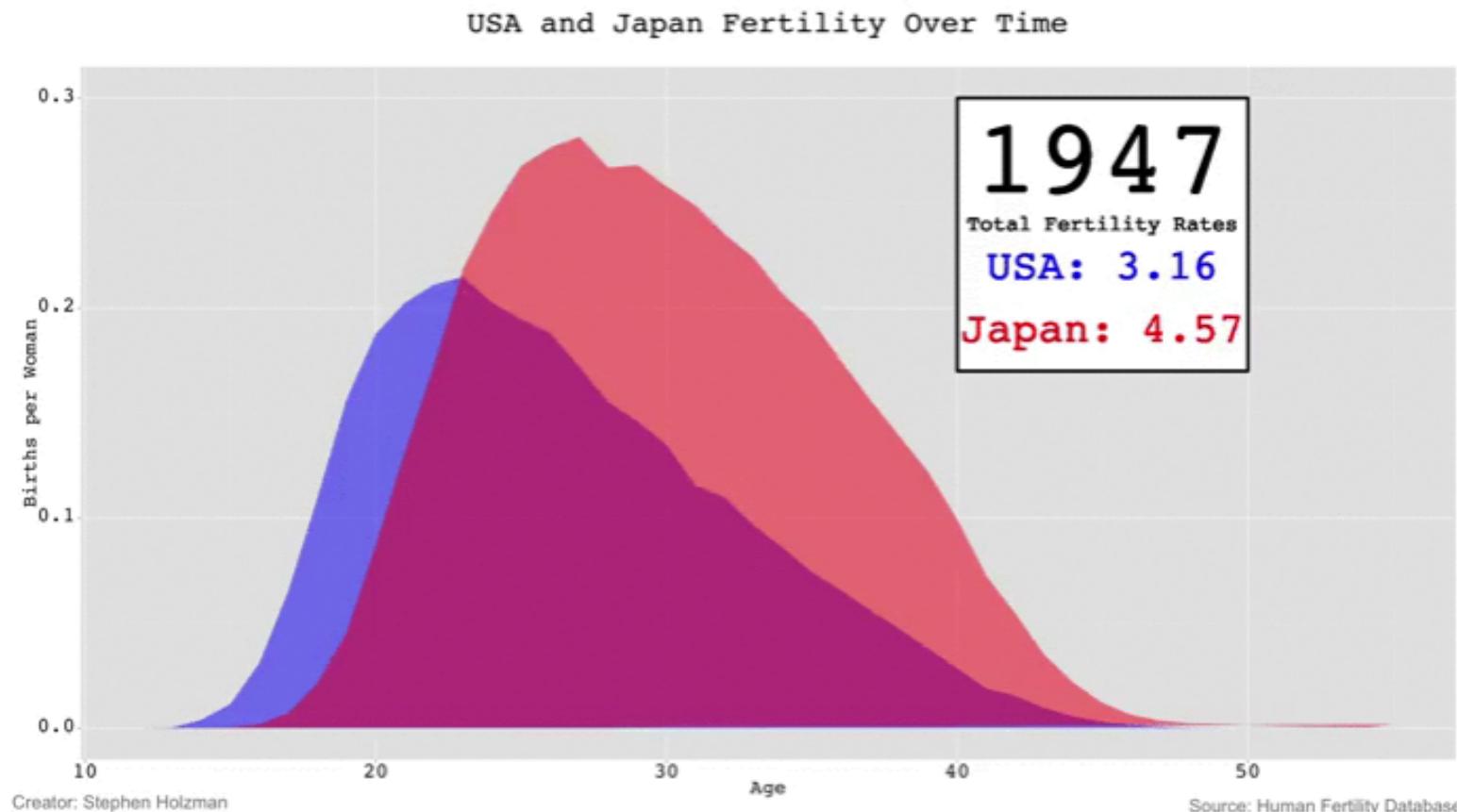
VISUALIZATIONS FOR TIME-ORIENTED DATA

Mapping Time to Space -> Small Multiples



VISUALIZATIONS FOR TIME-ORIENTED DATA

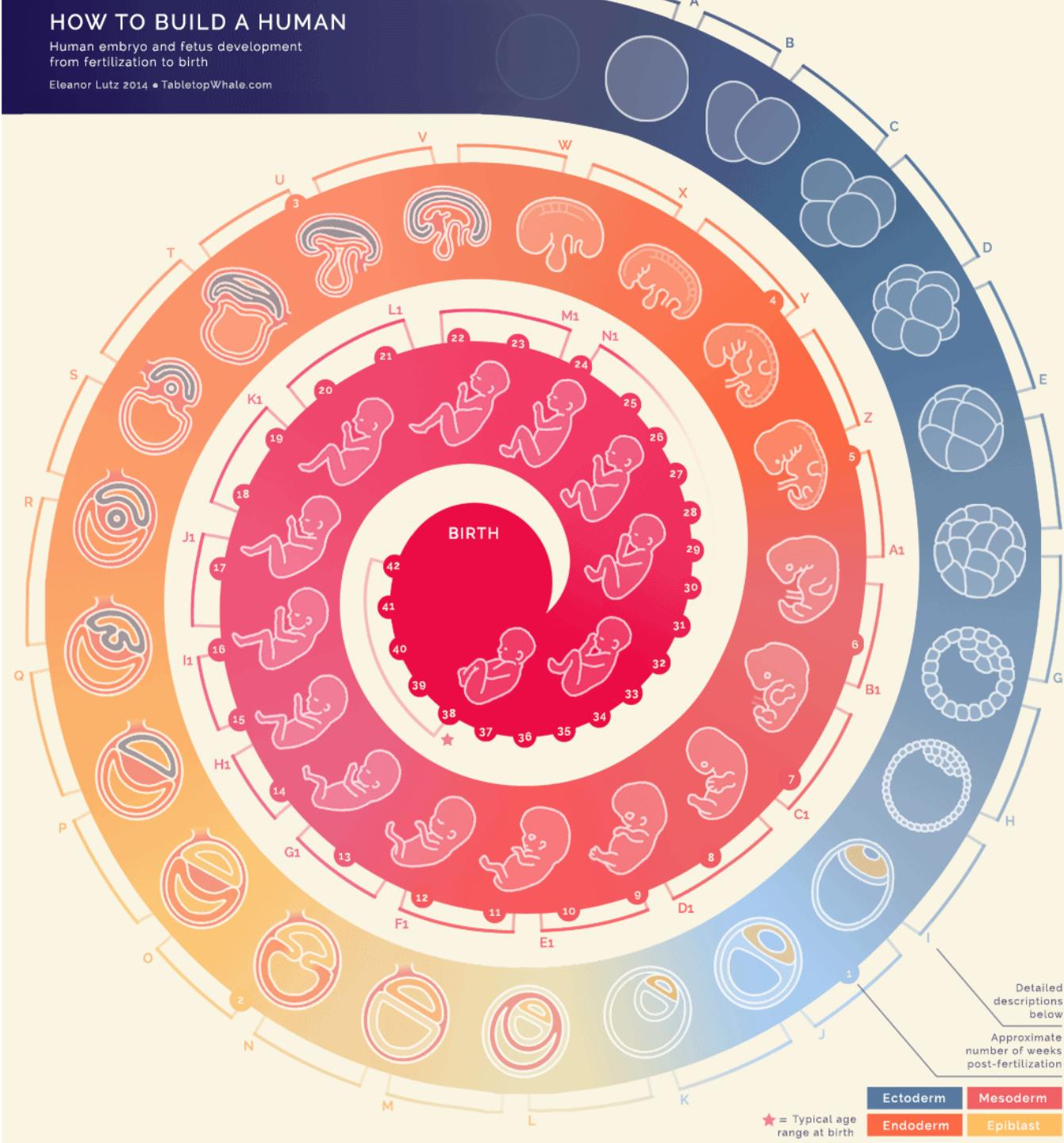
Mapping Time to Time -> Animation

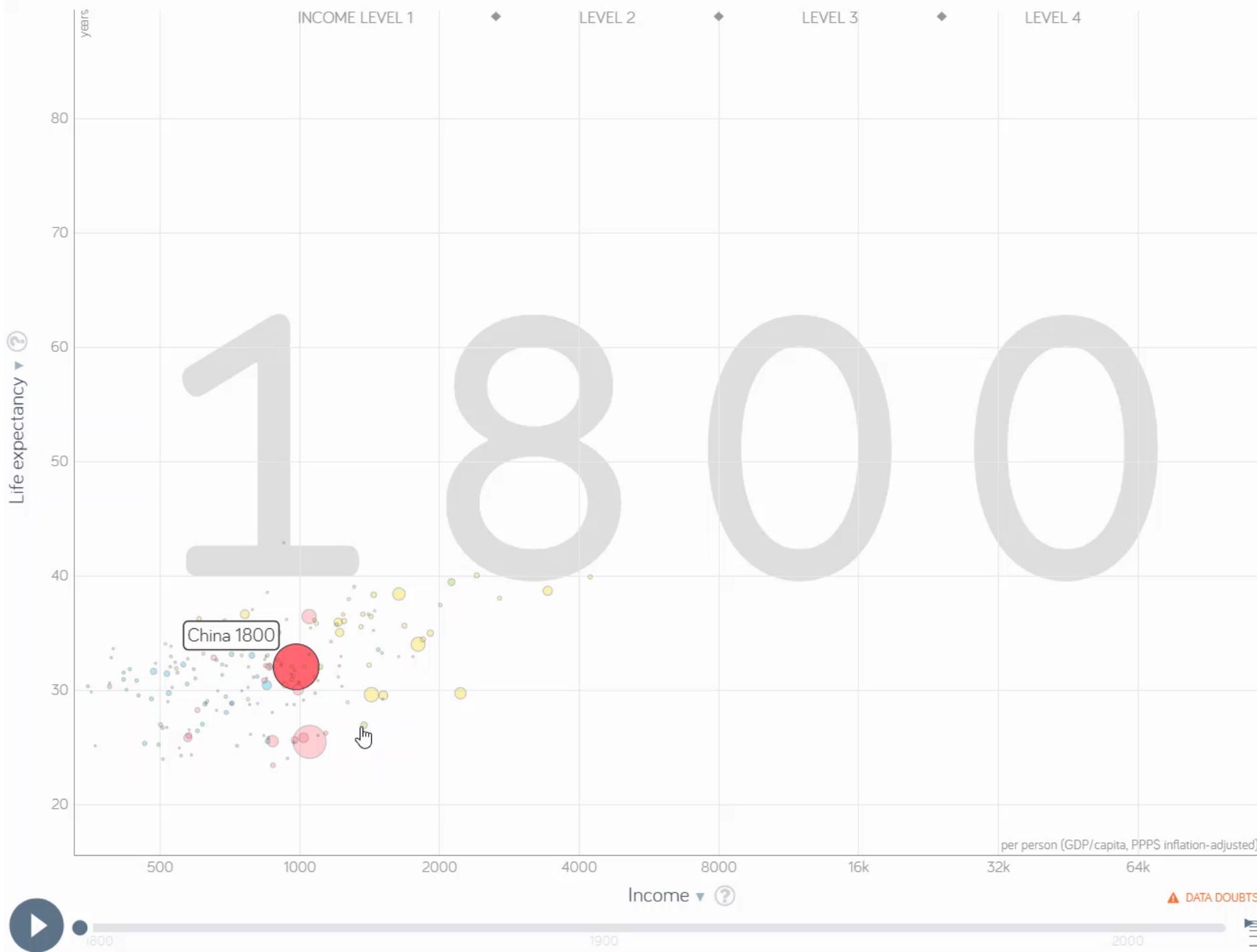


HOW TO BUILD A HUMAN

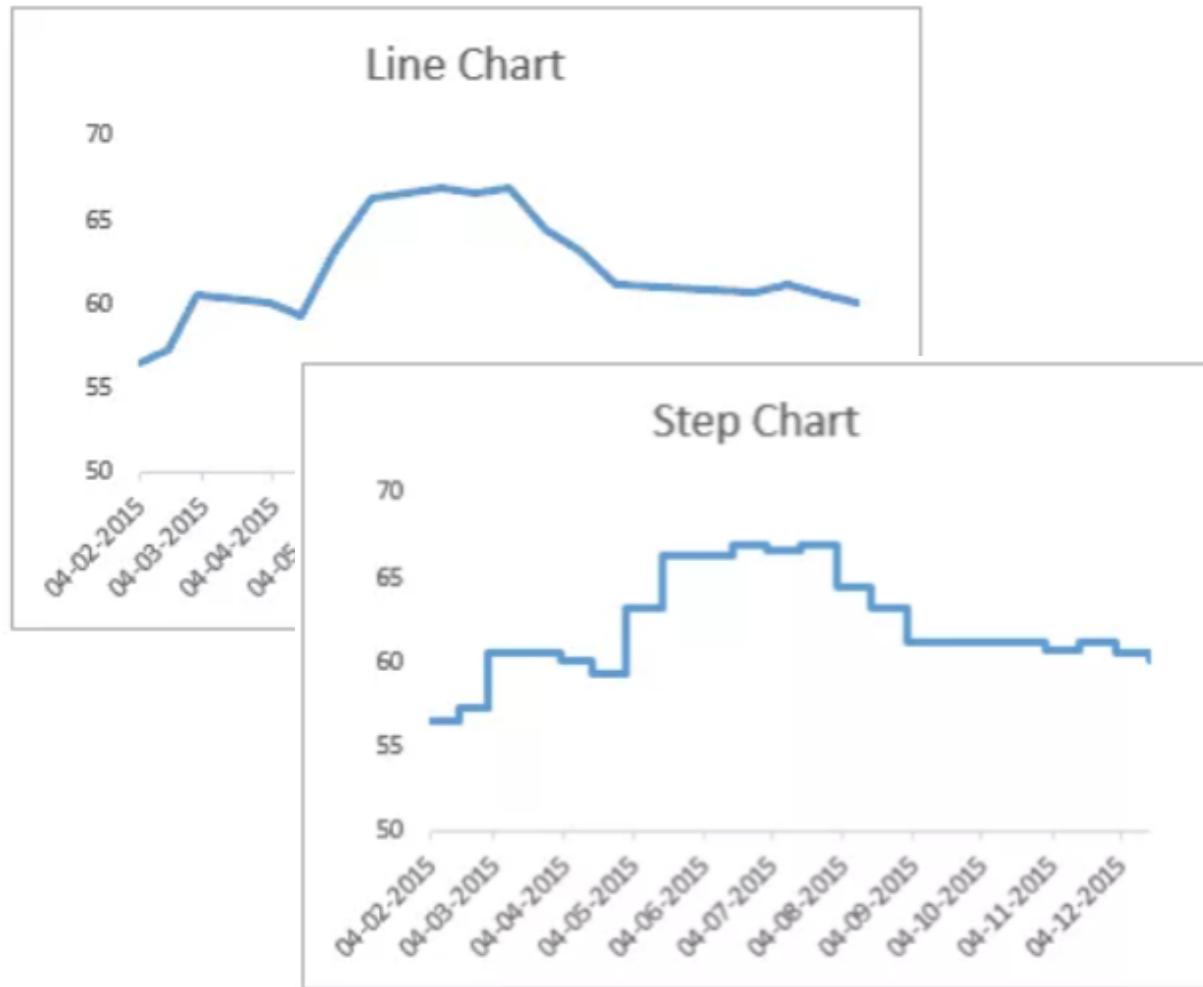
Human embryo and fetus development
from fertilization to birth

Eleanor Lutz 2014 • TabletopWhale.com





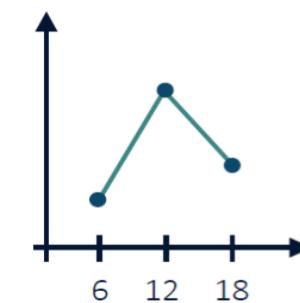
THE LINE CHART (LECTURE 02)



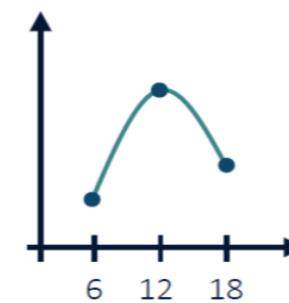
Considerations:

- Does it make sense?
- How to scale it?
- Should I use grid lines?
- Which line style to use?

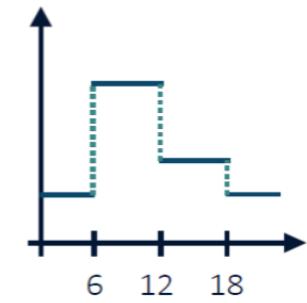
Straight Line



Curved Line

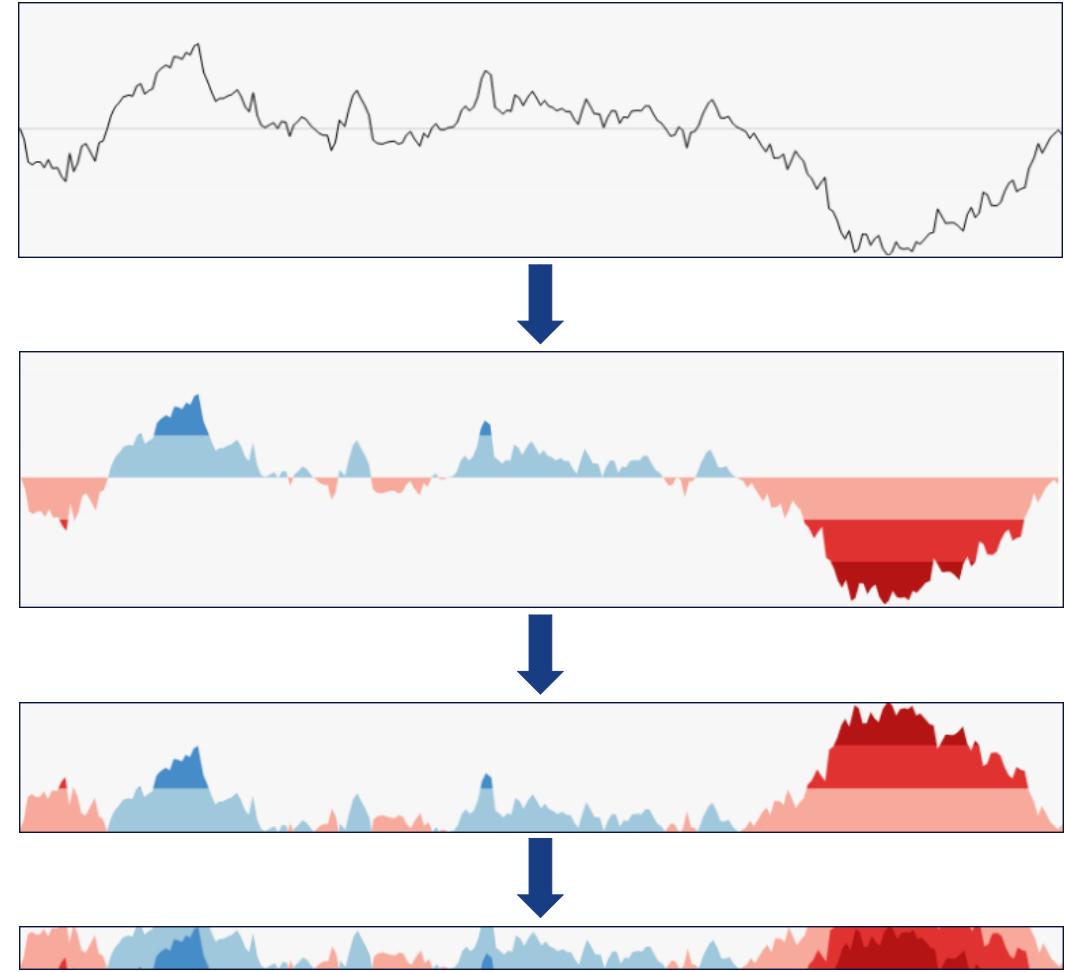
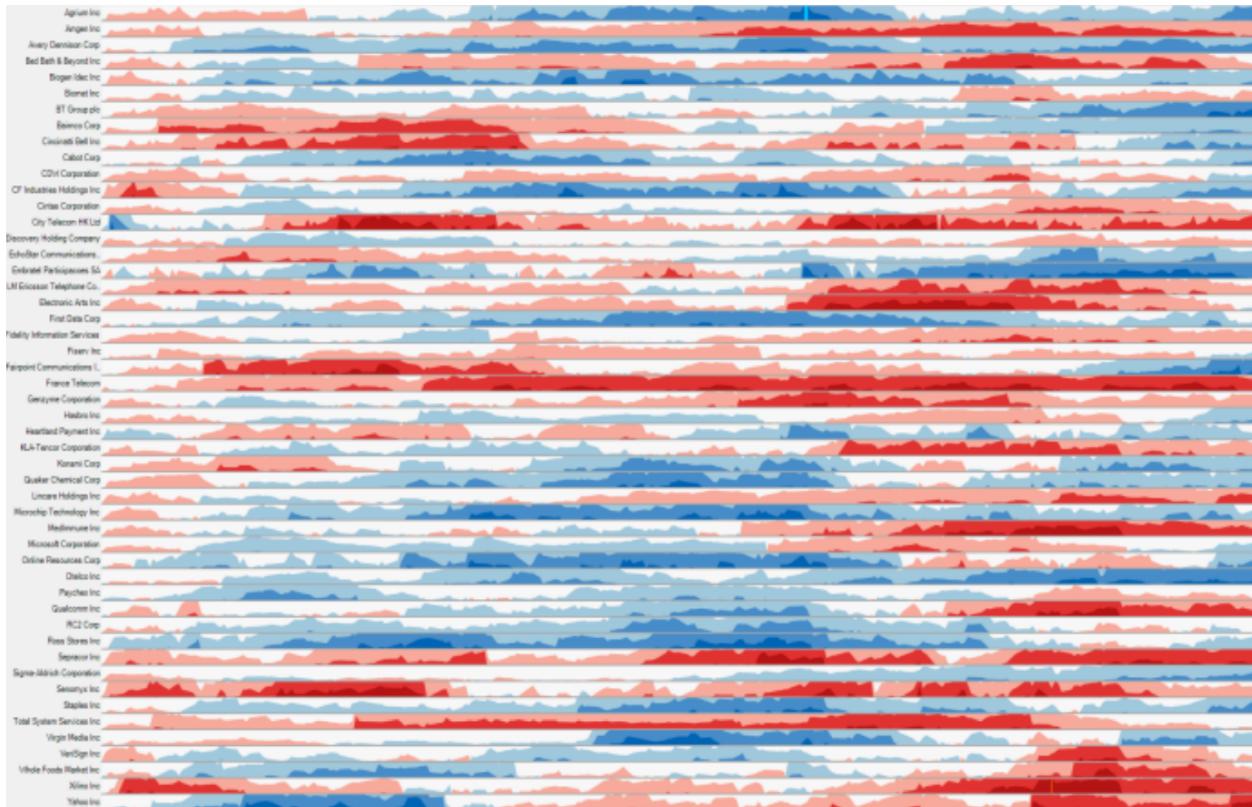


Flat Line



MANY TIME SERIES

Horizon Graphs



[Perin et al. 2013]



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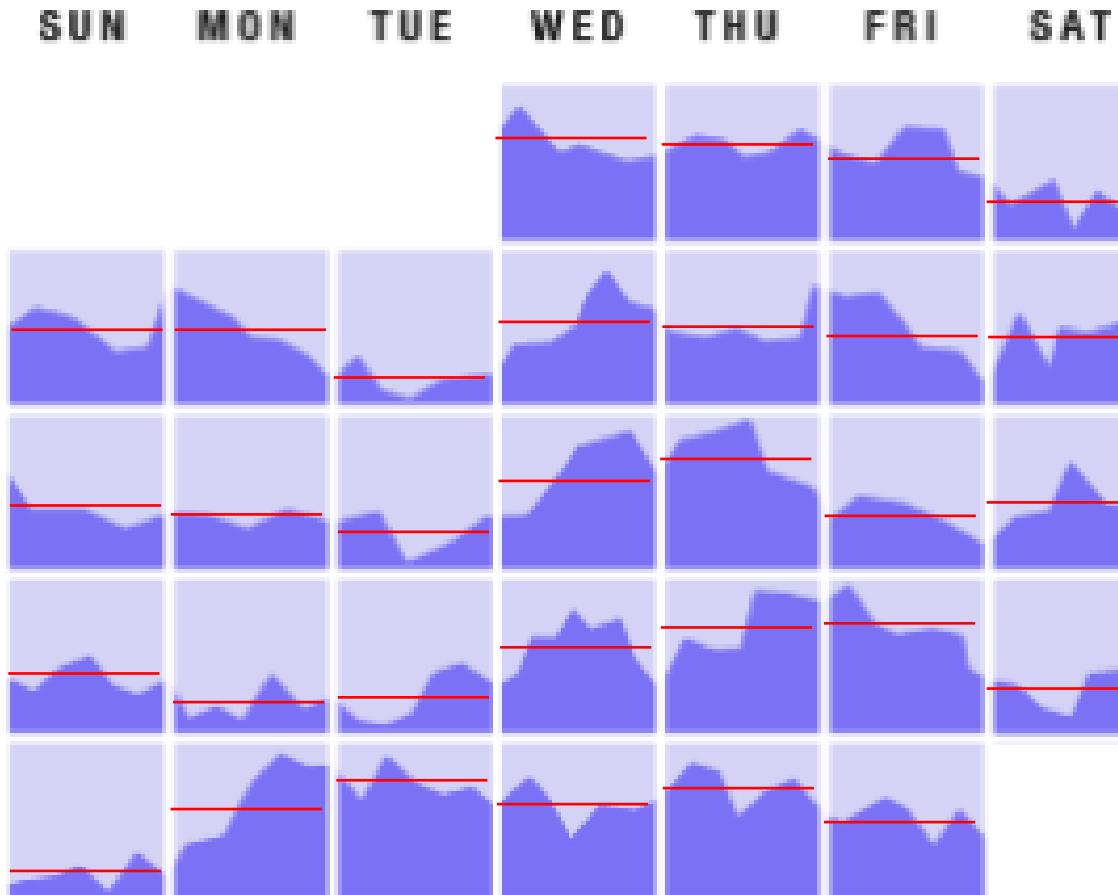
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TIME ON DIFFERENT GRANULARITIES

APRIL



VISUALIZING TIME INTERVALS



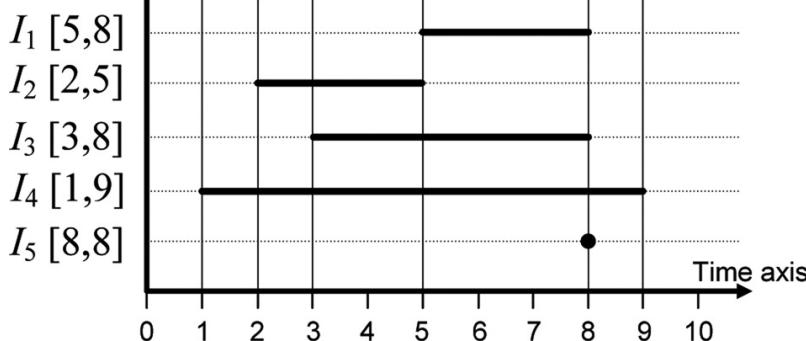
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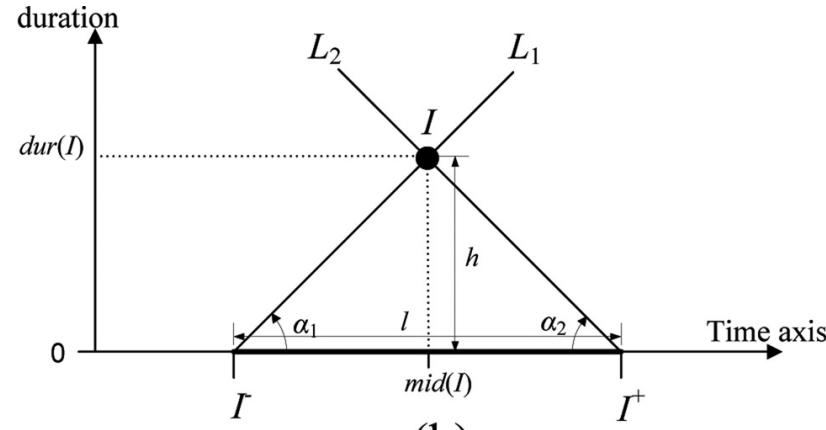
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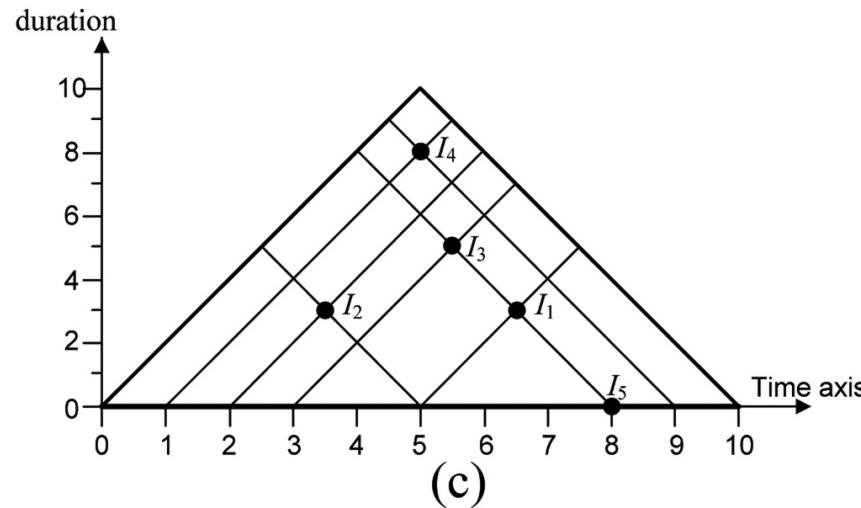
SHOWING TIME INTERVALS



(a)



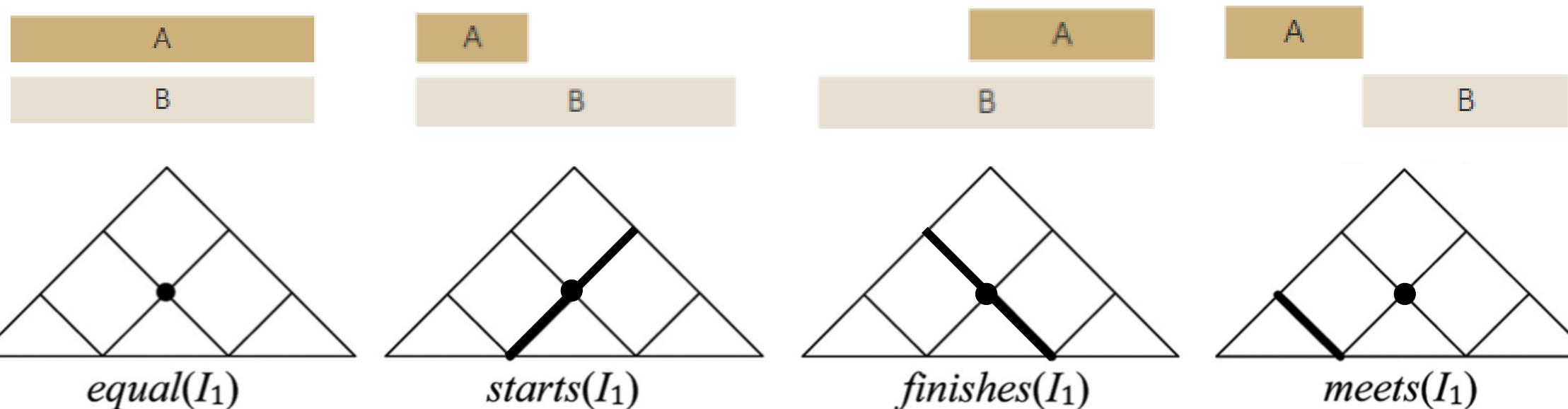
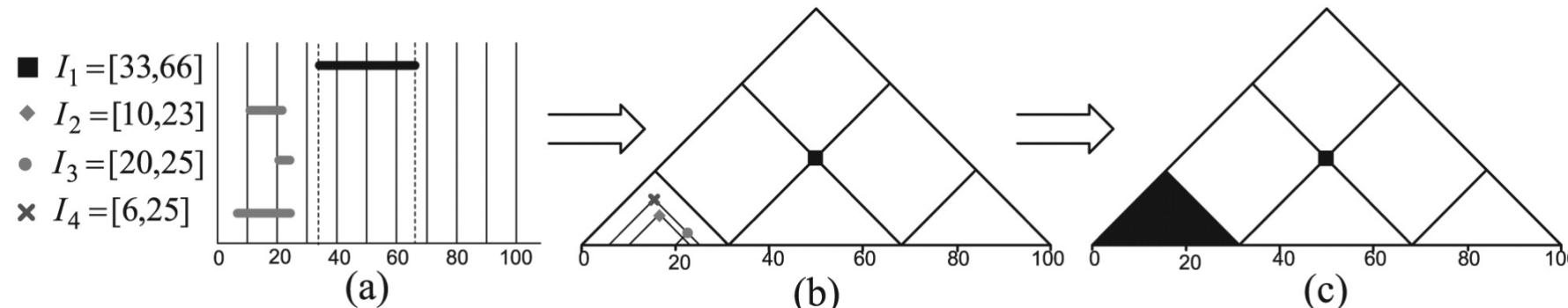
(b)



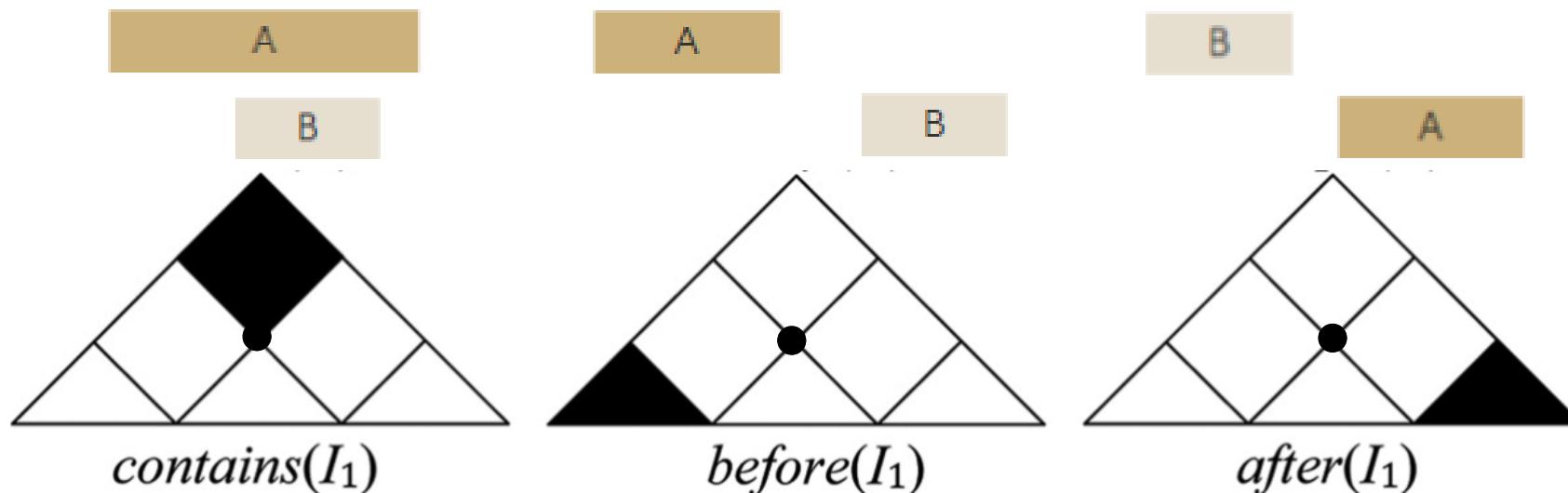
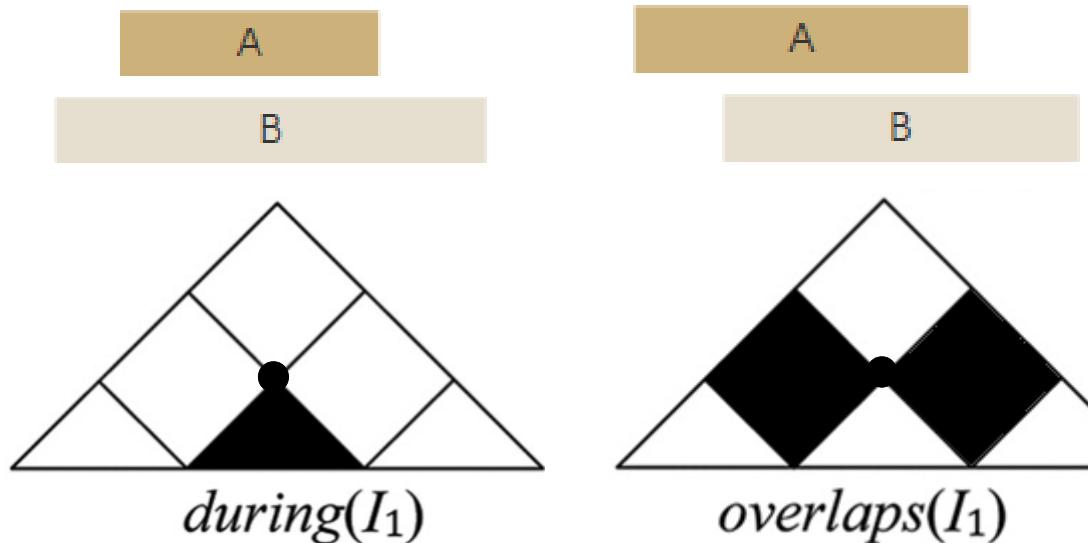
Triangular Model

[Qiang et al. 2012]

TEMPORAL QUERIES DONE VISUALLY (1/2)



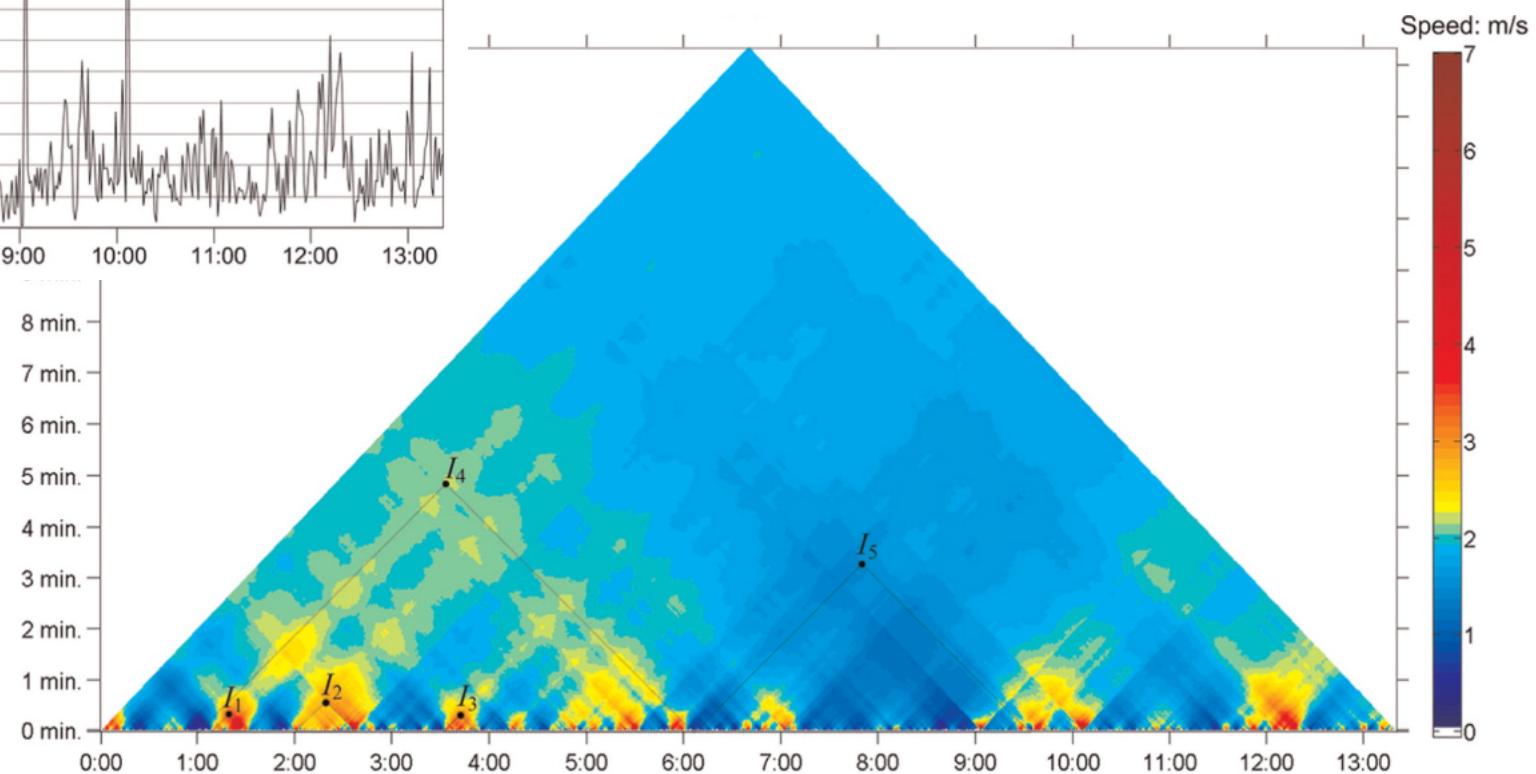
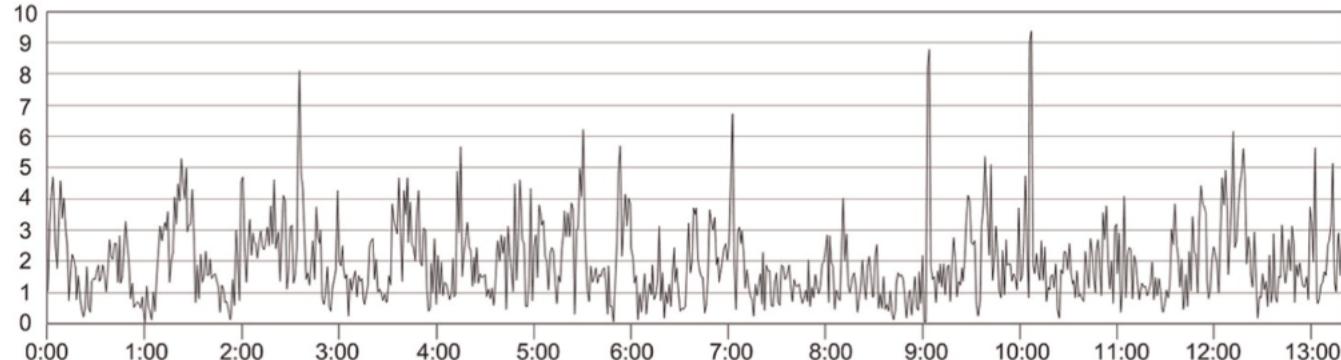
TEMPORAL QUERIES DONE VISUALLY (2/2)



THE CONTINUOUS TRIANGULAR MODEL

[Qiang et al. 2013]

Speed: m/s



VISUALIZING EVENT-BASED DATA



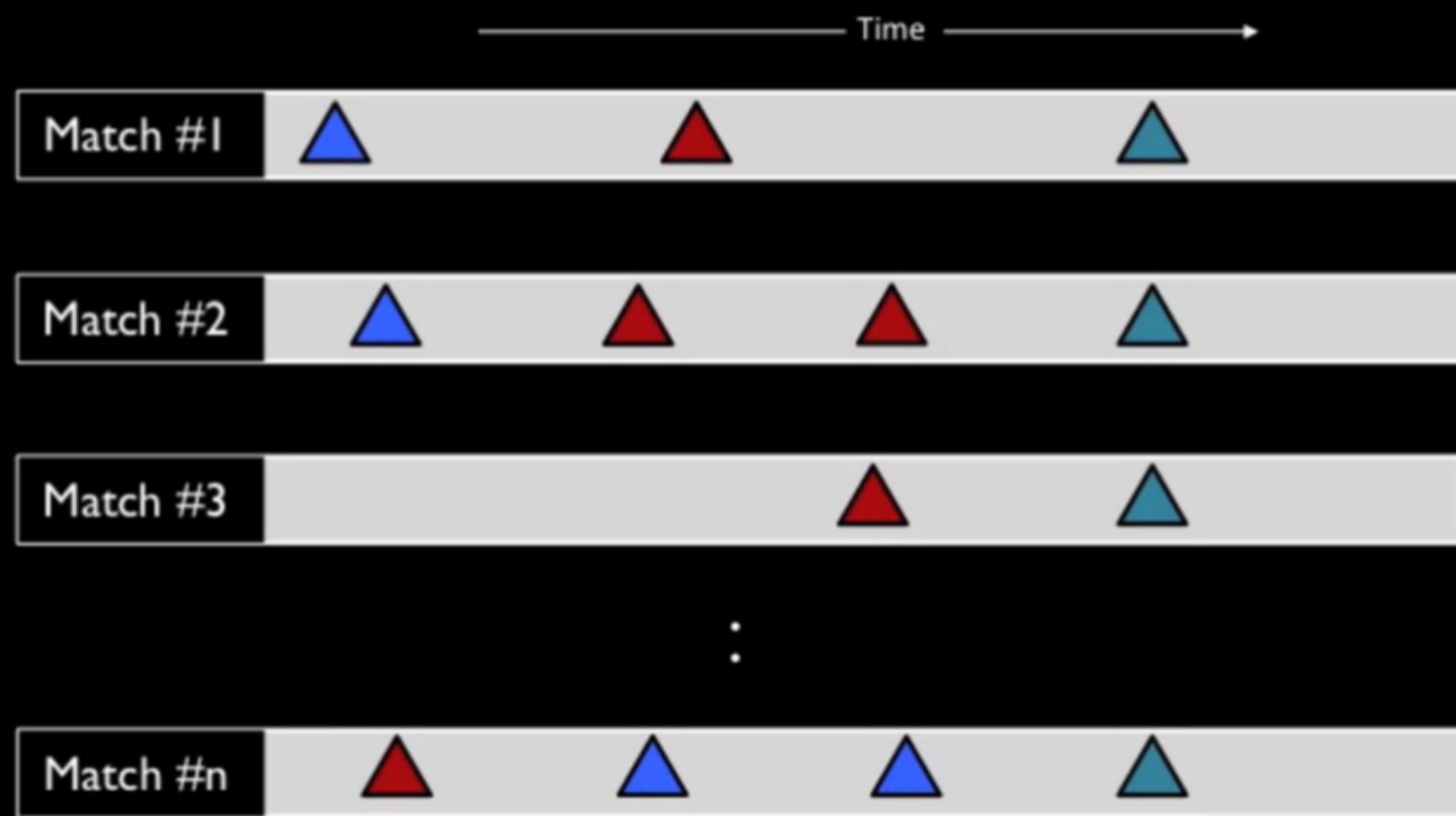
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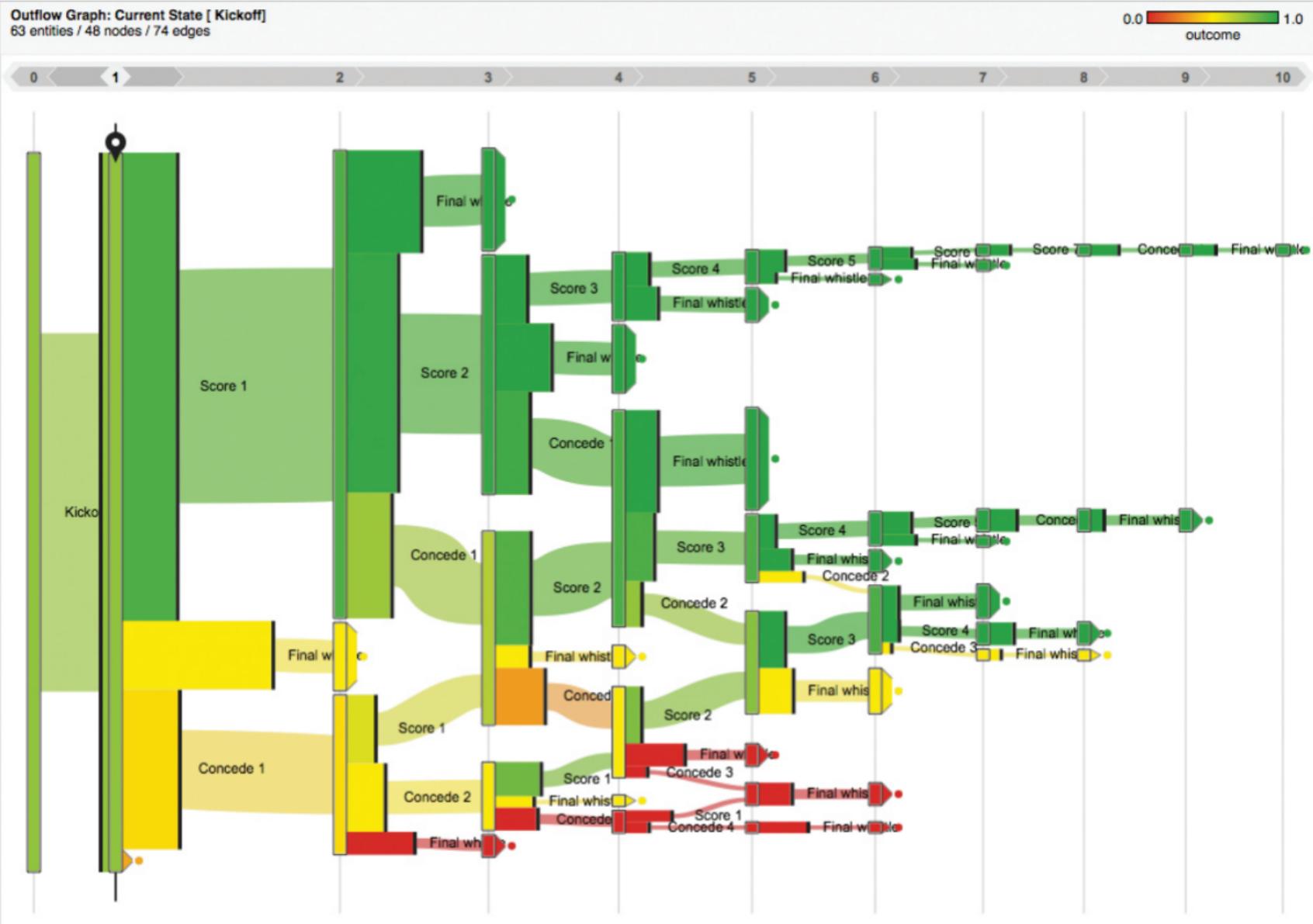
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Many soccer matches

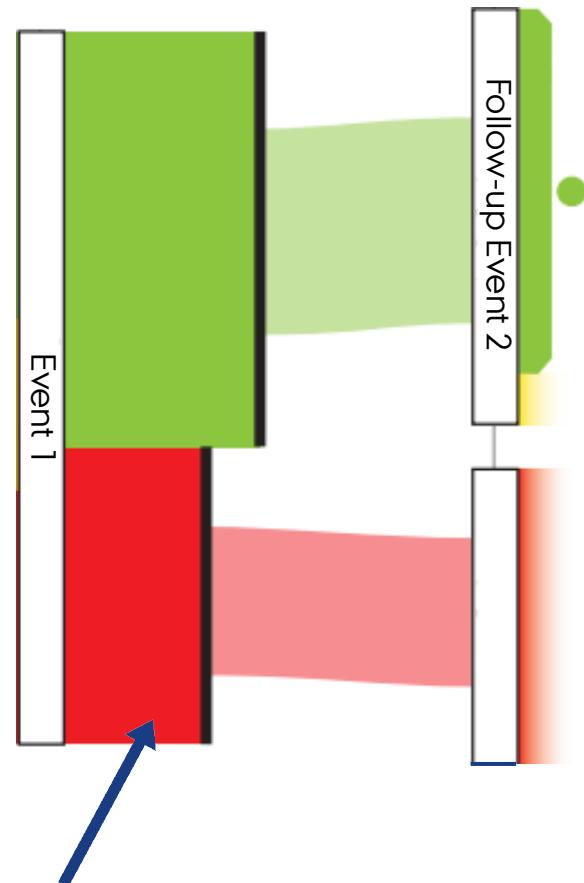


RELATING EVENTS TO EACH OTHER



Outflow

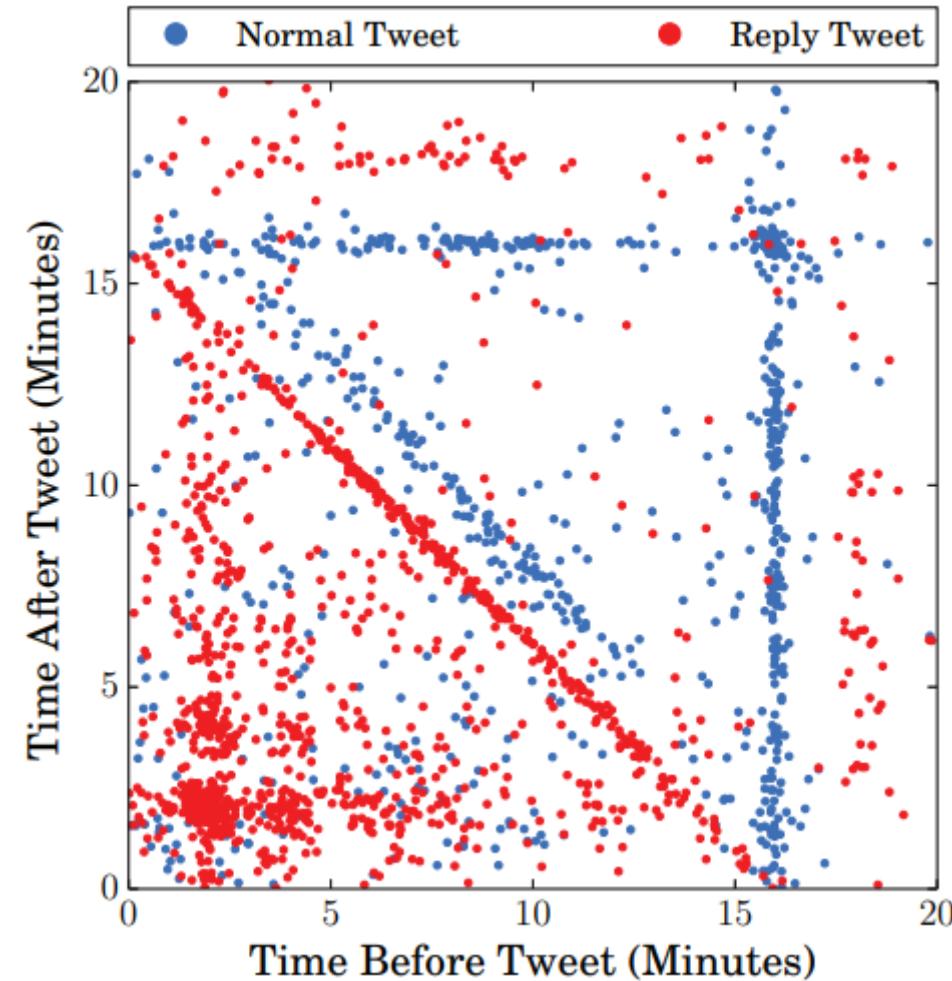
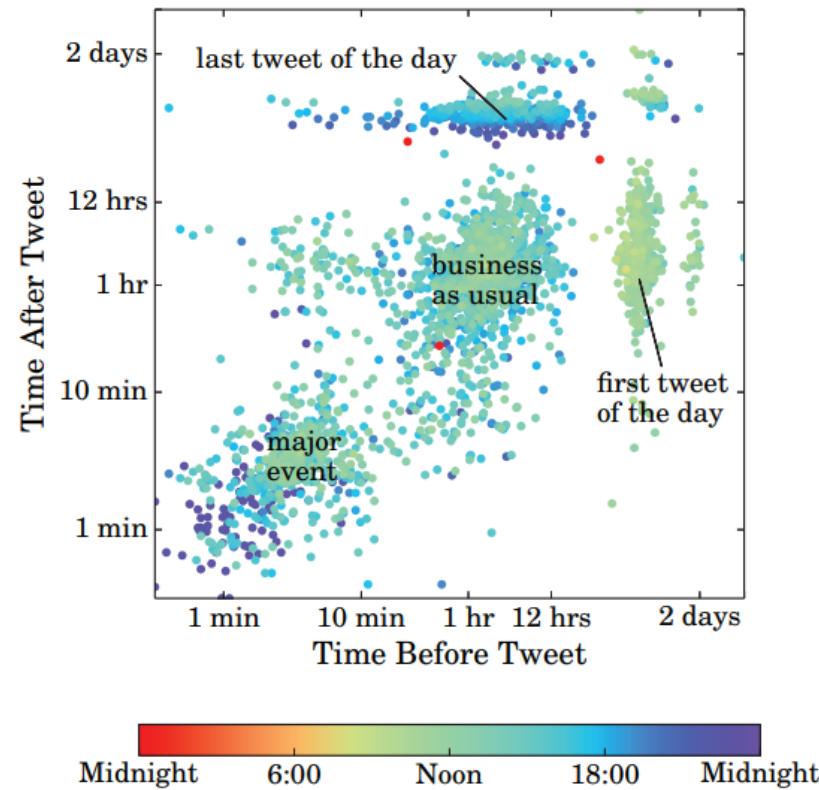
[Wongsuphasawat + Gotz 2012]



Width = time
Height = # occurrences

RELATING EVENTS TO EACH OTHER

Time Map [Watson 2015]



INTERACTION TECHNIQUES



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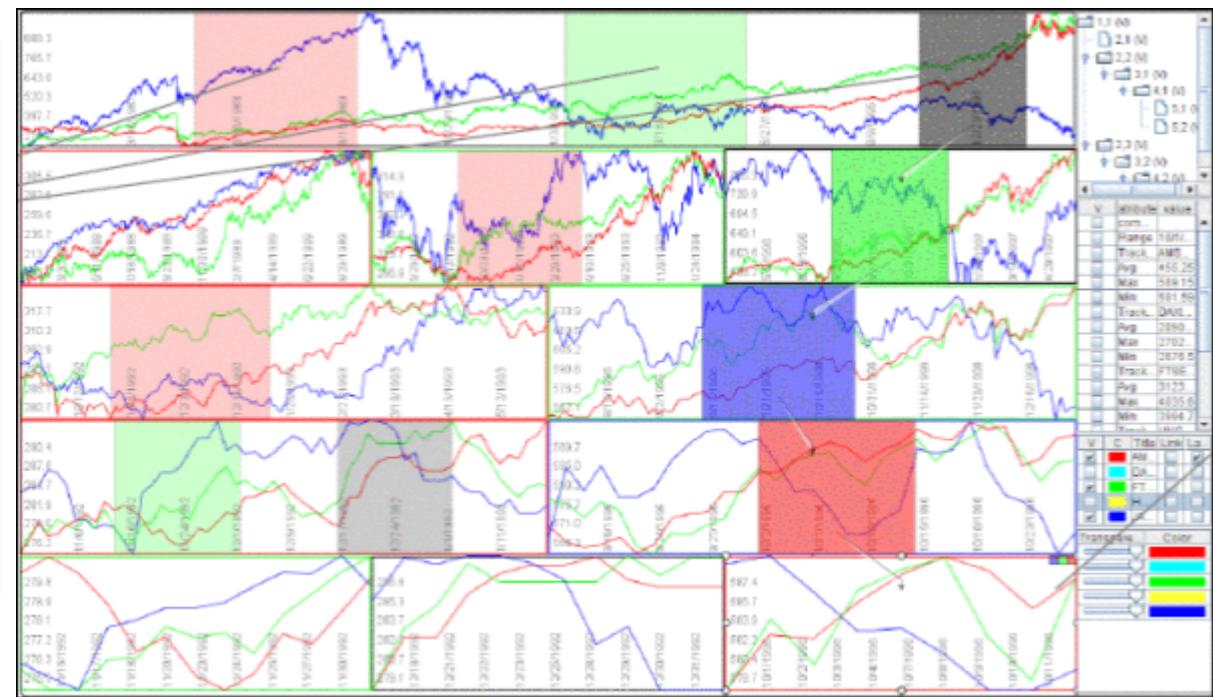
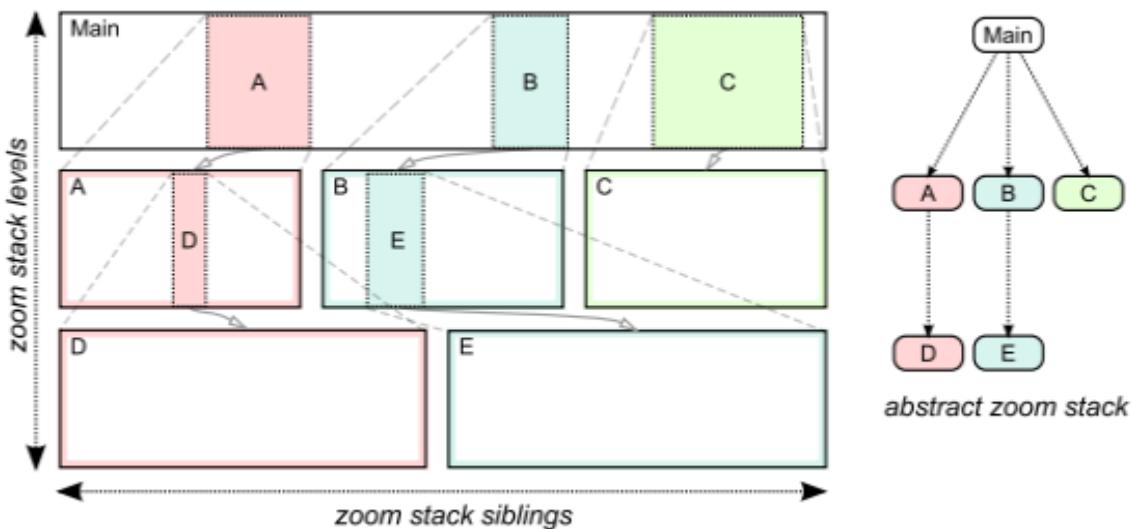
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INTERACTION: STACK ZOOMING

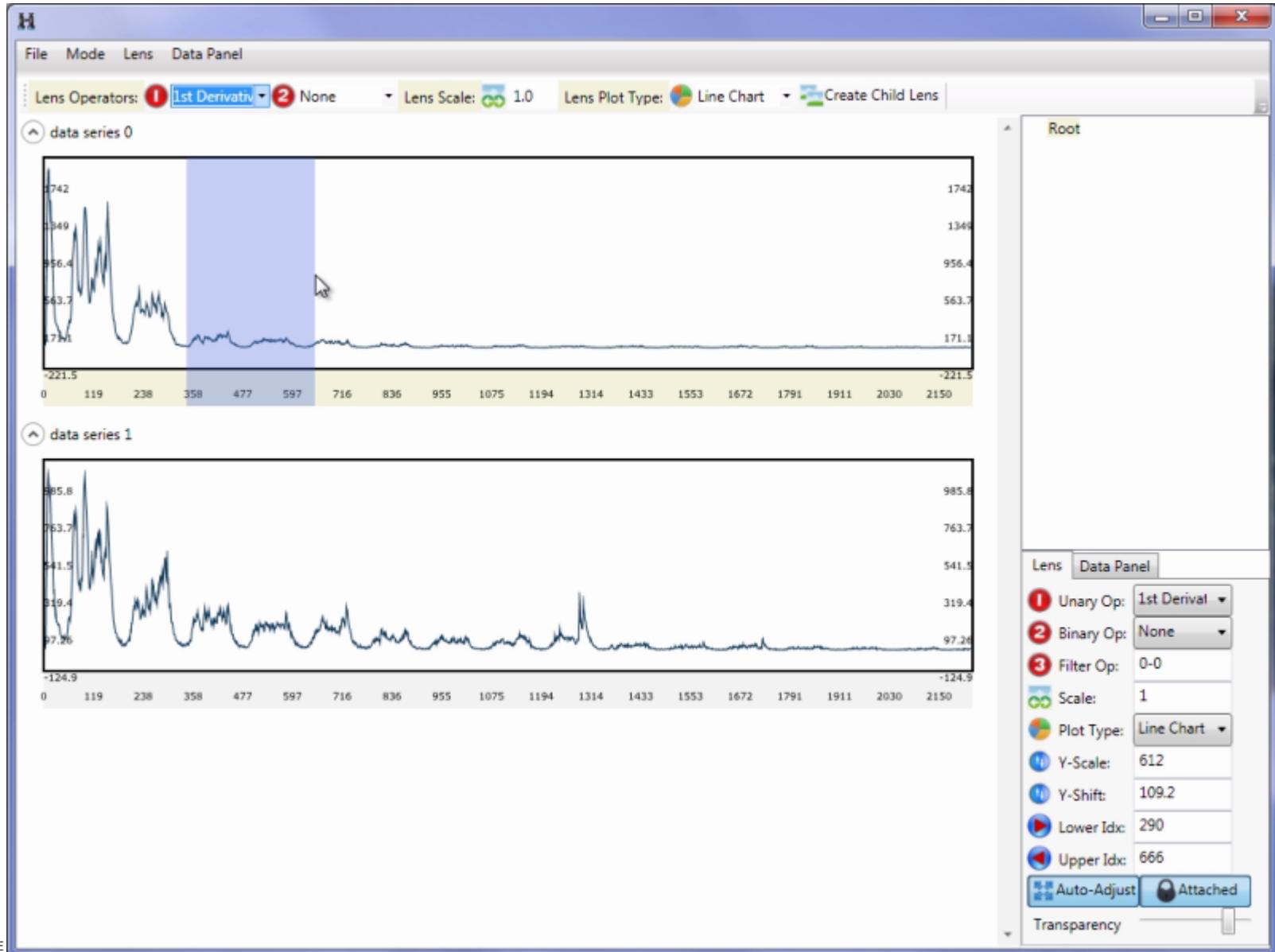
[Javed + Elmquist 2010]





INTERACTION: CHRONO LENSES

[Zhao et al. 2011]



LIST OF LITERATURE SOURCES

- Time Visualization Book (Aigner et al. 2019): <https://doi.org/10.1007/978-0-85729-079-3>
- SpiralVis (Tominski & Schumann 2008): <https://vcg.informatik.uni-rostock.de/~ct/publications/Tominski08EnhancedSpiral.pdf>
- Arc Diagram [Nagel + Duval 2013]: <https://uclab.fh-potsdam.de/wp/wp-content/uploads/2013-a-visual-survey-of-arc-diagrams.pdf>
- Horizon Graphs (Perin et al. 2013): <https://doi.org/10.1145/2470654.2466441>
- Triangular Model (Qiang et al. 2012): <https://doi.org/10.1177/1473871612436775>
- Outflow (Wongsuphasawat + Gotz 2012): <http://dx.doi.org/10.1109/TVCG.2012.225>
- Time Map [Watson 2015]: <https://doi.org/10.1109/BigData.2015.7363824>
- Stack Zooming [Javed + Elmquist 2010]: <https://doi.org/10.1109/PACIFICVIS.2010.5429613>
- ChronoLenses [Zhao et al. 2011]: <https://doi.org/10.1109/TVCG.2011.195>

