Information Visualization
Visualization Motivation, What: Data Abstraction

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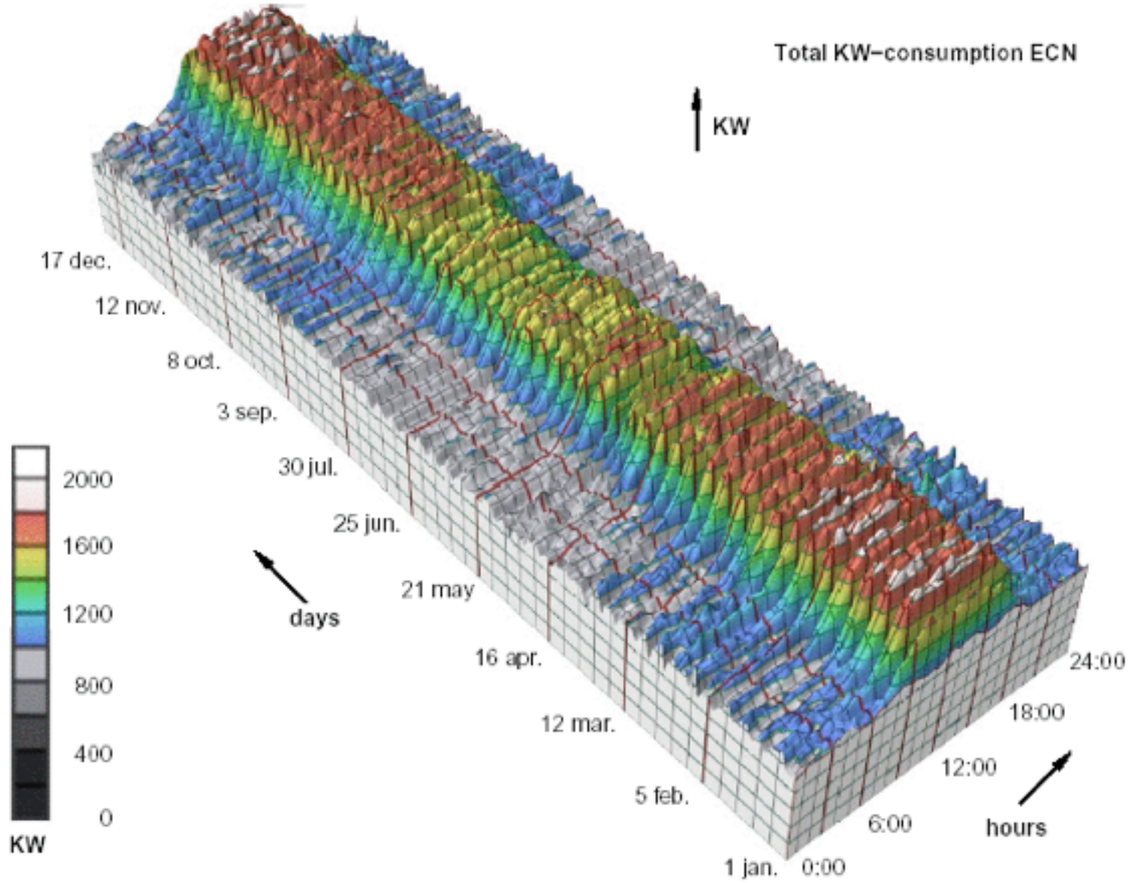
http://www.cs.ubc.ca/~tmm/courses/547-17

Before: In-class design exercise, in small groups

- Five time-series scenarios
  - A: every 5 min, duration 1 year, 1 thing: building occupancy rates
  - B: every 5 min, 1 year, 2 things: currency values (exchange rate)
  - C: several years and several things: 5 years, 10 currencies
  - D: 1 year, many things: CPU load across 1000 machines
  - E: 1 year, several parameters, many things: 10 params on each of 1000 machines
- Small-group exercise: 15-20 min
  - one group per table (3-4 people/group, 10 groups)
  - discuss/sketch possible visual encodings appropriate for your assigned scenario
- Reportback: 20-30 min
  - 3 min from each group
- Design space examples/discussion: 15-20 min

Case A: 3D Approach (Not Recommended)

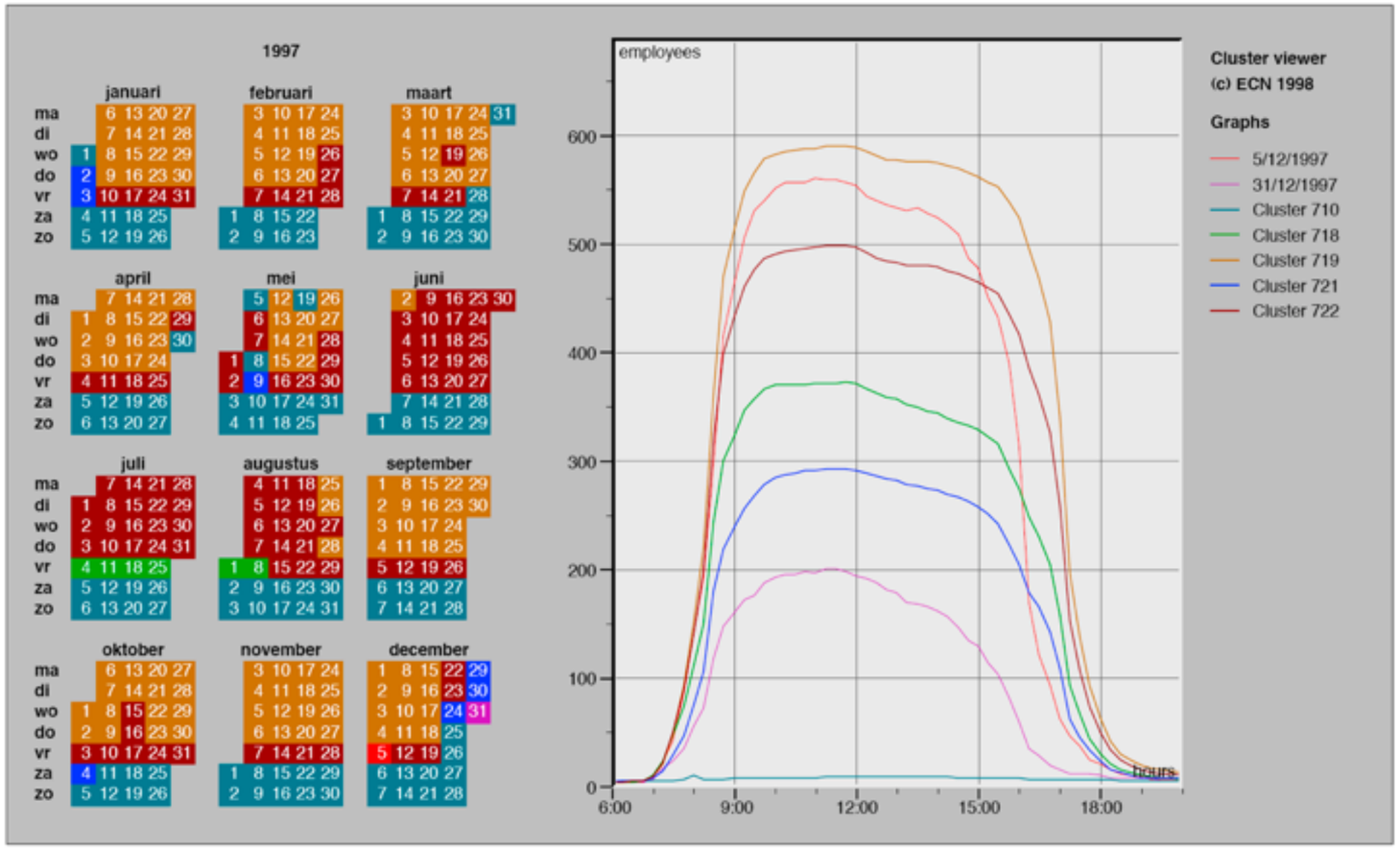
- extruded curves: detailed comparisons impossible



[Cluster and Calendar based Visualization of Time Series Data. van Wijk and van Selow, Proc. InfoVis 99.]

Case A: Cluster-Calendar Solution

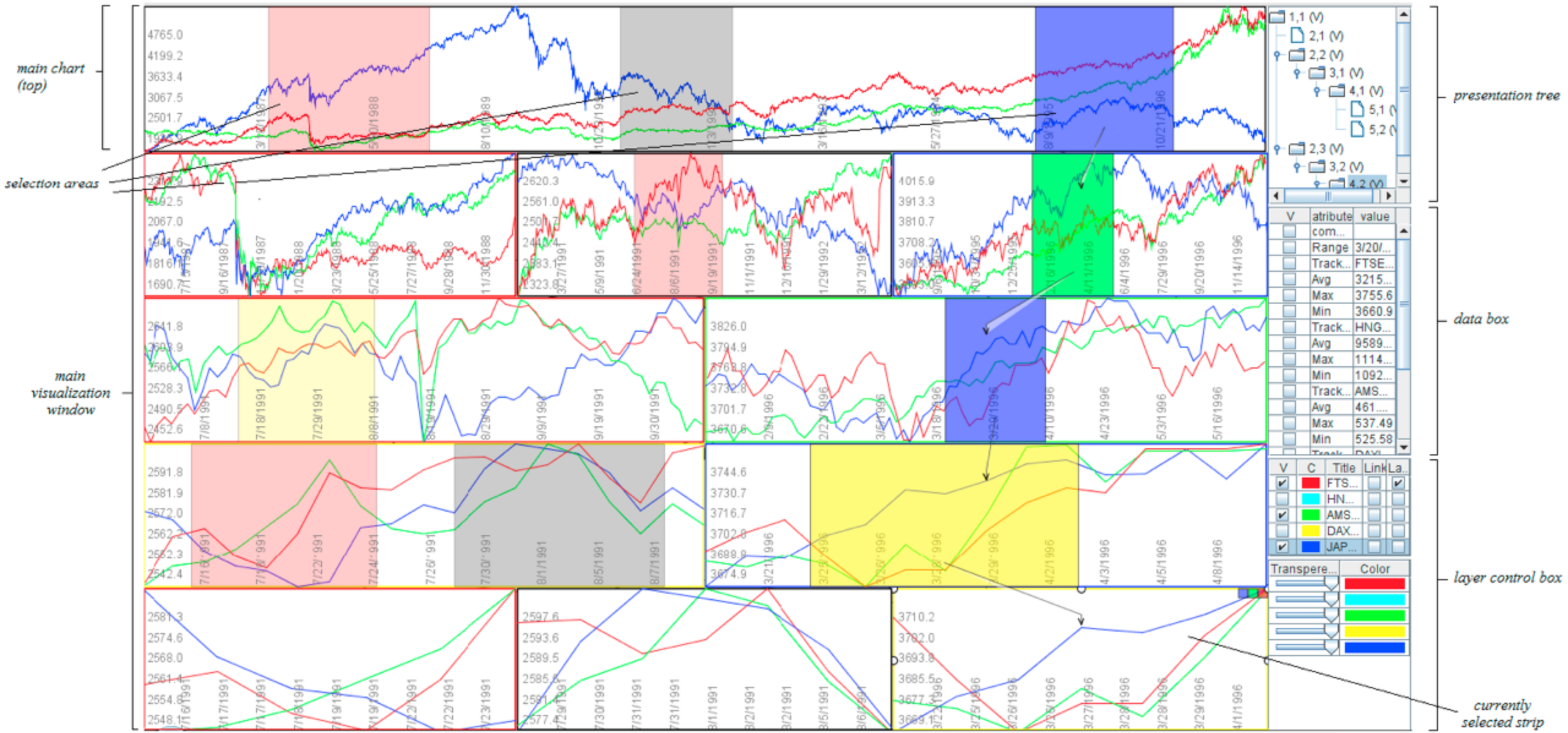
- derived data: cluster hierarchy
- juxtapose multiple views: calendar, superimposed 2D curves



[Cluster and Calendar based Visualization of Time Series Data. van Wijk and van Selow, Proc. InfoVis 99.]

Case B: Stack Zooming

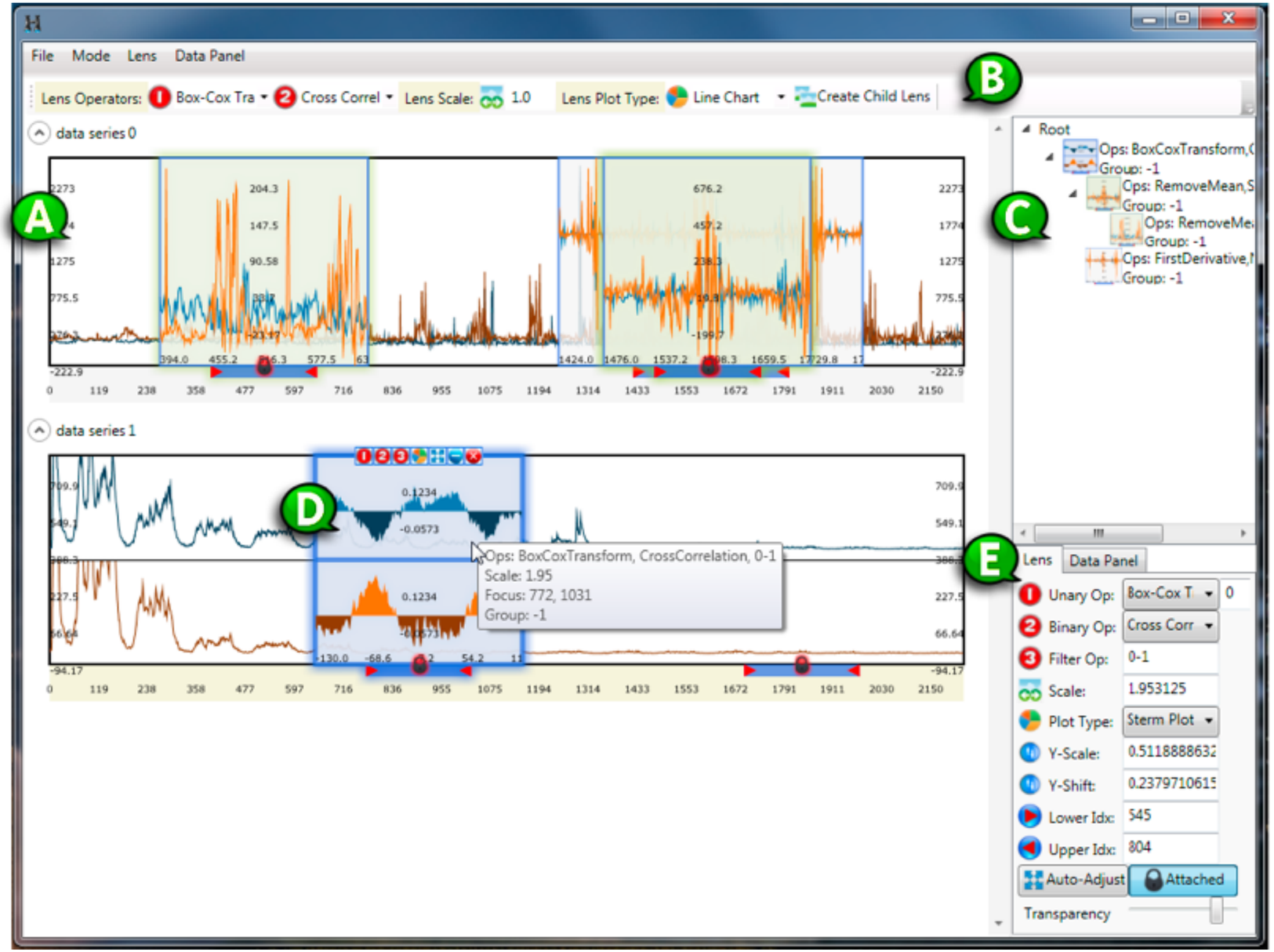
https://youtu.be/dK0De4XPm5Y

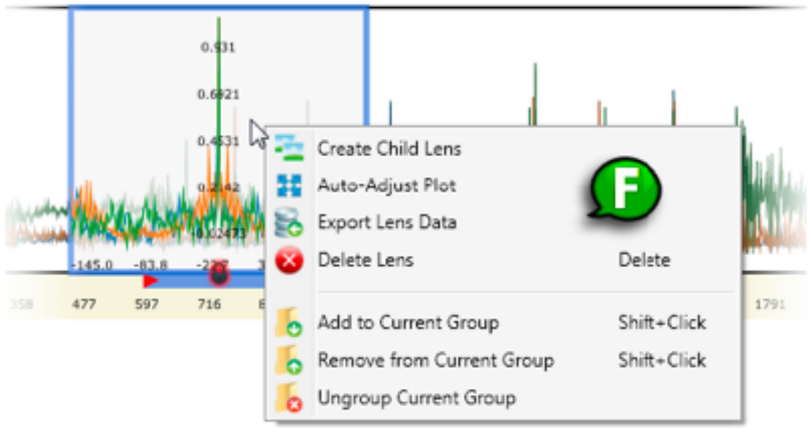


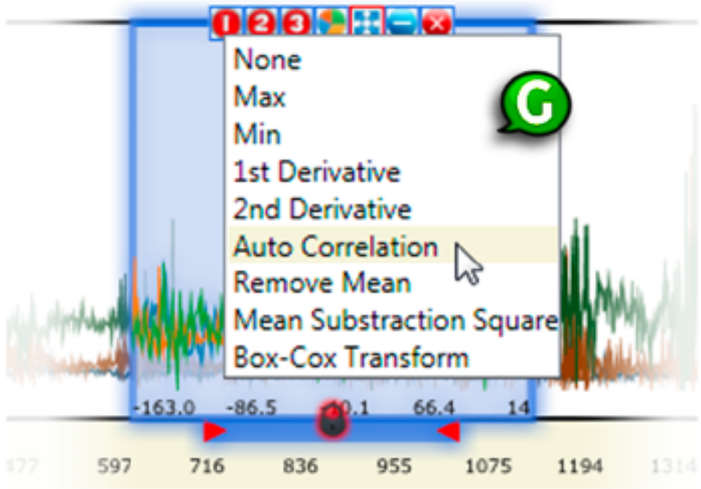
[Stack Zooming for Multi-Focus Interaction in Time-Series Data Visualization. Javed and Elmqvist. Proc PacificVis 2010, p 33-40.]

Case C: ChronoLenses

https://youtu.be/k7pI8ikczqk



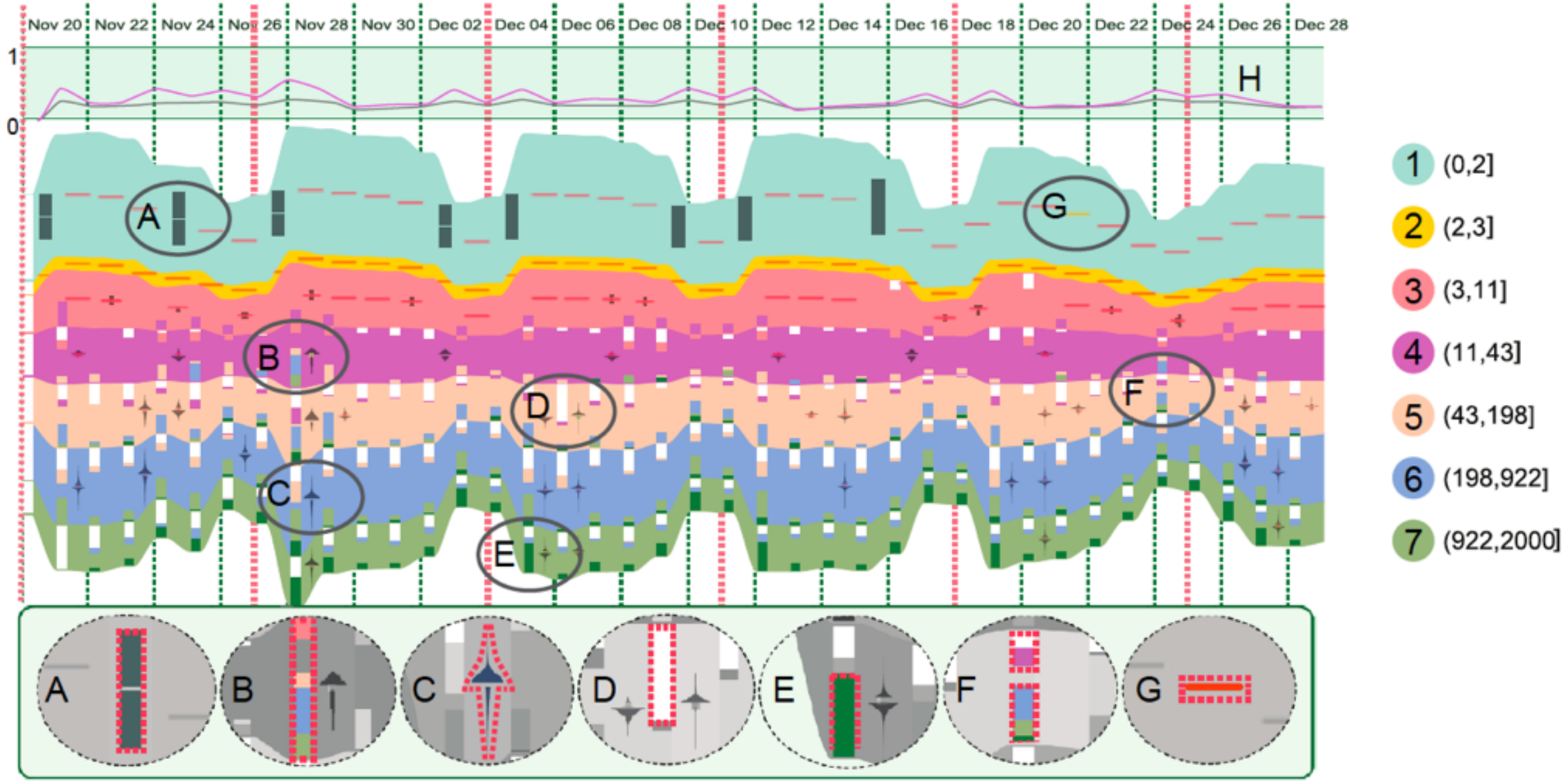




[Exploratory Analysis of Time-Series with ChronoLenses. Zhao, Chevalier, Pietriga, and Balakrishnan. IEEE TVCG 17(12):2422-2431 (Proc. InfoVis 2011).]

Case D: RankExplorer

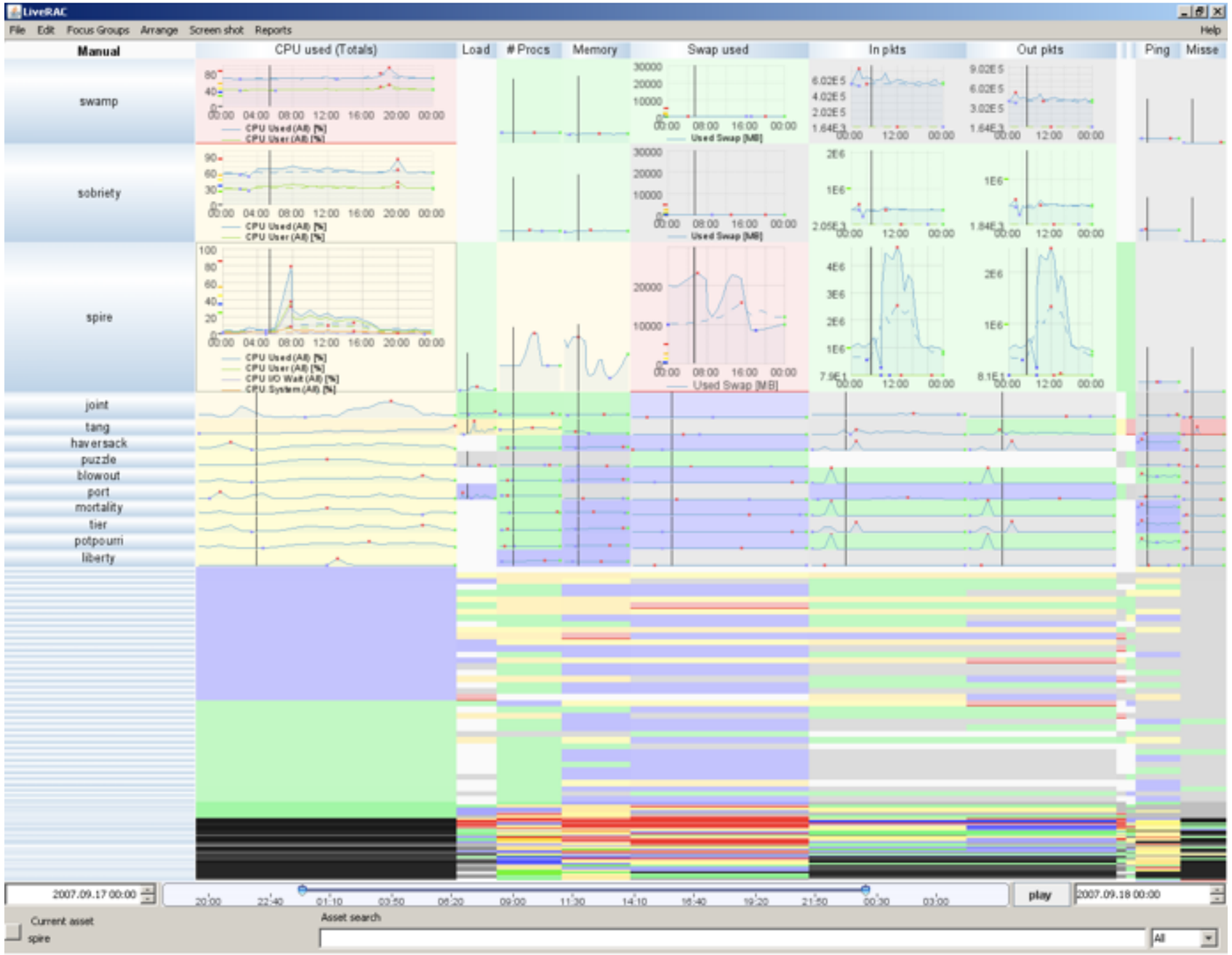
https://youtu.be/rdgn1qcZ2A4



[RankExplorer:Visualization of Ranking Changes in Large Time Series Data. Shi, Cui, Liu, Xu, Chen and Qu. IEEE TVCG 12(18):2669-2678 (Proc. InfoVis 2012)]

Case E: LiveRAC video

http://youtu.be/ld0c3H0VSkw



[LiveRAC - Interactive Visual Exploration of System Management Time-Series Data. McLachlan, Munzner, Koutsofios, and North. Proc. Conf. on Human Factors in Computing Systems (CHI) 2008, pp 1483-1492.]

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Ch 1. What's Vis, and Why Do It?

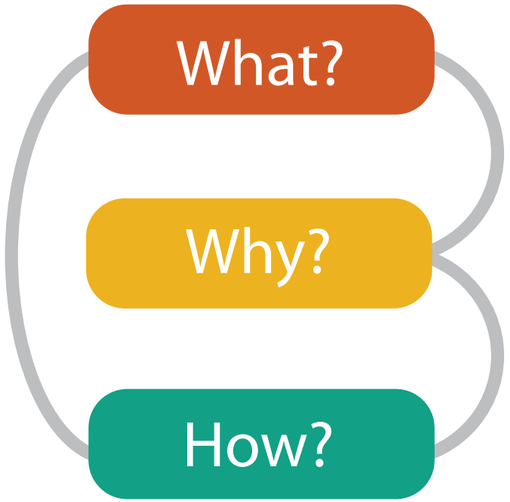
VAD Ch 1: What's vis, and why do it?

Computer-based visualization systems provide visual representations of datasets designed to help people carry out tasks more effectively.

Visualization is suitable when there is a need to augment human capabilities rather than replace people with computational decision-making methods.

- human in the loop needs the details
  - doesn't know exactly what questions to ask in advance
  - longterm exploratory analysis
  - presentation of known results
  - stepping stone towards automation: refining, trustbuilding
- external representation: perception vs cognition
- intended task, measurable definitions of effectiveness

Analysis: What, why, and how



- what is shown?
  - **data** abstraction
- why is the user looking at it?
  - **task** abstraction
- how is it shown?
  - **idiom**: visual encoding and interaction

- abstract vocabulary avoids domain-specific terms
  - translation process iterative, tricky
- what-why-how analysis framework as scaffold to think systematically about design space

How?

Encode

Arrange

- Express
- Separate
- Order
- Align
- Use

Map

from categorical and ordered attributes

- Color
  - *Hue*
  - *Saturation*
  - *Luminance*
- Size, Angle, Curvature, ...
- Shape
- Motion

Direction, Rate, Frequency, ...

Manipulate

- Change
- Select
- Navigate

Facet

- Juxtapose
- Partition
- Superimpose

Reduce

- Filter
- Aggregate
- Embed

What?

Why?

How?

VAD Ch 2: Data Abstraction

What?

Datasets

Data Types

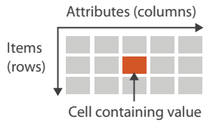
- Items
- Attributes
- Links
- Positions
- Grids

Data and Dataset Types

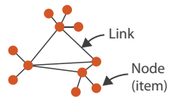
Tables	Networks & Trees	Fields	Geometry	Clusters, Sets, Lists
Items	Items (nodes)	Grids	Items	Items
Attributes	Links	Positions	Positions	
	Attributes	Attributes		

Dataset Types

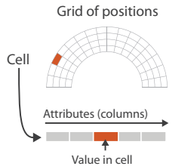
- Tables



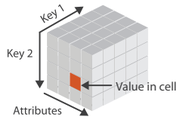
- Networks



- Fields (Continuous)



- *Multidimensional Table*



- *Trees*

- Geometry (Spatial)

Attributes

Attribute Types

- Categorical

- Ordered
  - *Ordinal*

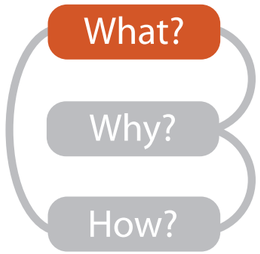
  - *Quantitative*

Ordering Direction

- Sequential

- Diverging

- Cyclic



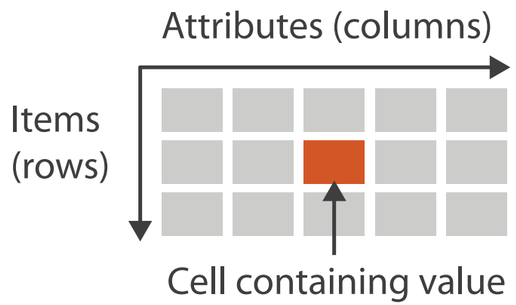
[VAD Fig 2.1]

Ch 2. What: Data Abstraction

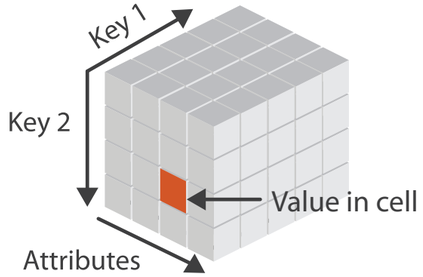
Three major datatypes

Dataset Types

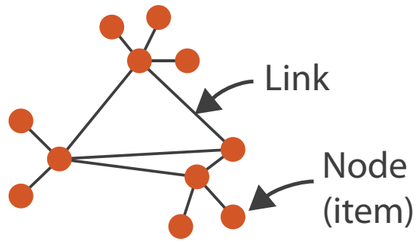
Tables



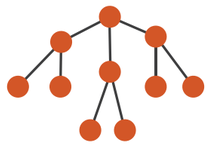
Multidimensional Table



Networks

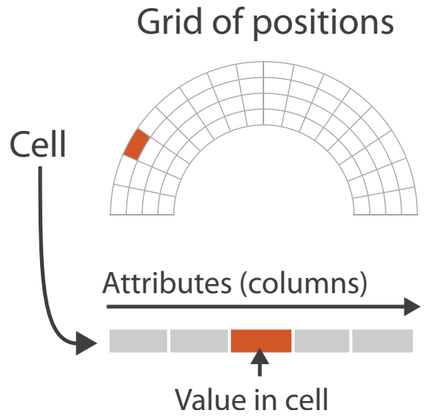


Trees

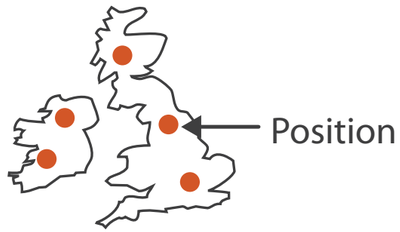


Spatial

Fields (Continuous)



Geometry (Spatial)



- visualization vs computer graphics
  - –geometry is design decision

Attribute types

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- Ordered
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  - *Quantitative*

Ordering Direction

- Sequential

- Diverging

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Dataset and data types

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	Attributes	Attributes		

Data Types

- Items
- Attributes
- Links
- Positions
- Grids

Dataset Availability

- Static

- Dynamic

Further reading: Articles

- Mathematics and the Internet: A Source of Enormous Confusion and Great Potential. Walter Willinger, David Alderson, and John C. Doyle. Notices of the AMS 56(5):586-599, 2009.
- Rethinking Visualization: A High-Level Taxonomy. InfoVis 2004, p 151-158, 2004.
- The Eyes Have It: A Task by Data Type Taxonomy for Information Visualizations Ben Shneiderman, Proc. 1996 IEEE Visual Languages
- The Structure of the Information Visualization Design Space. Stuart Card and Jock Mackinlay, Proc. InfoVis 97.
- Polaris: A System for Query, Analysis and Visualization of Multi-dimensional Relational Databases. Chris Stolte, Diane Tang and Pat Hanrahan, IEEE TVCG 8(1): 52-65 2002.

Further reading: Books

- Visualization Analysis and Design. Munzner. CRC Press, 2014.
  - Chap 2: Data Abstraction
- Information Visualization: Using Vision to Think. Stuart Card, Jock Mackinlay, and Ben Shneiderman.
  - Chap 1
- Data Visualization: Principles and Practice, 2nd ed. Alexandru Telea, CRC Press, 2014.
- Interactive Data Visualization: Foundations, Techniques, and Applications, 2nd ed. Matthew O. Ward, Georges Grinstein, Daniel Keim. CRC Press, 2015.
- The Visualization Handbook. Charles Hansen and Chris Johnson, eds. Academic Press, 2004.
- Visualization Toolkit: An Object-Oriented Approach to 3D Graphics, 4th ed. Will Schroeder, Ken Martin, and Bill Lorensen. Kitware 2006.
- Visualization of Time-Oriented Data. Wolfgang Aigner, Silvia Miksch, Heidrun Schumann, Chris Tominski. Springer 2011.

Next Time

- to read
  - VAD book, Ch 3: Why: Task Abstraction
  - paper: Design Study Methodology