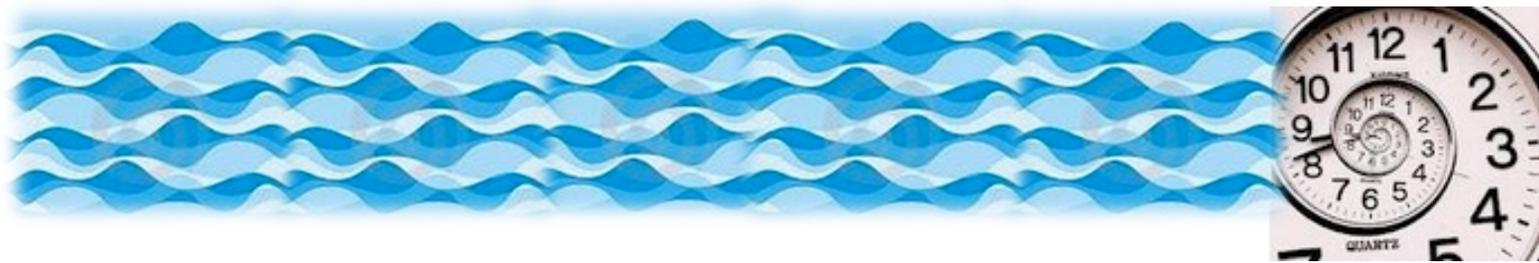


Time-Series Data

JINGXIAN LI



Referred Papers



★ **1 Visual Methods for Analyzing Time-Oriented Data**
Wolfgang Aigner. IEEE TVCG 14(1): 47-60 (2008).

- ★ Evaluation/summary on how to deal with time-oriented data
- ★ Three aspects to concern from: visualization, analyze, user

★ **2 Interactive Pattern Search in Time Series**
Buono, P., C., Khella, A. Proc. VDA 2005.

- ★ Search similar patterns with a certain pattern indicated

★ **3 Exploratory Analysis of Time-series with ChronoLenses**
Jian Zhao. IEEE TVCG 17(12):2422-2431 2011 (Proc. InfoVis 2011).

- ★ More complicated time-series processing method with lens and pipeline.



★ Time-oriented vs. time-series



- ★ Time-oriented: the data is somehow connected to time
examples: interval, time points
- ★ Time-series: linear sequential record with same sampling step
examples: sound, seismographs, history

★ Why do that?

- ★ Ubiquitous in many application domains
- ★ Reveal trend for better understanding and prediction
- ★ Visualizing derived values, identifying correlations, Identifying anomalies beyond obvious outliers

Entry points to start with



Visualization



Analysis



User side

basic



Current

result



Interact

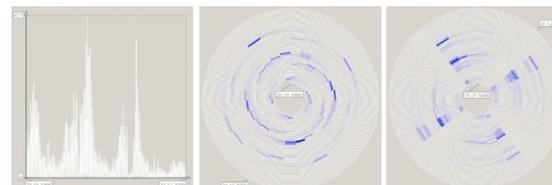


Types to visualize



Linear vs. cyclic

- Linear: go from past (with a start point) to future
- Cyclic: points are ordered in cyclic time domain
example: seasons

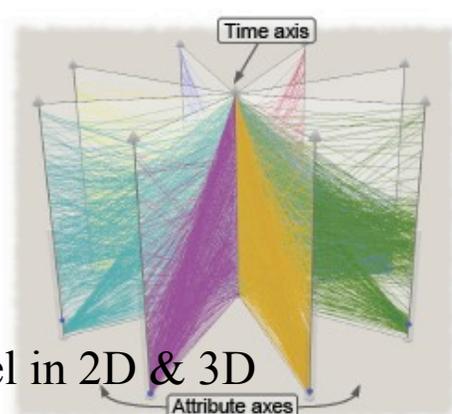
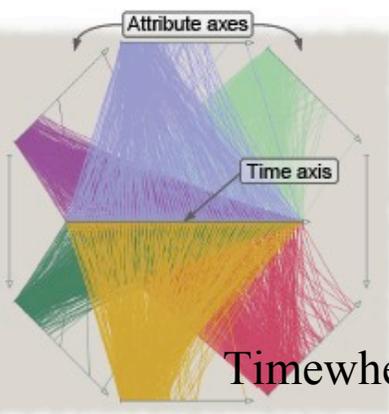


Points vs. intervals

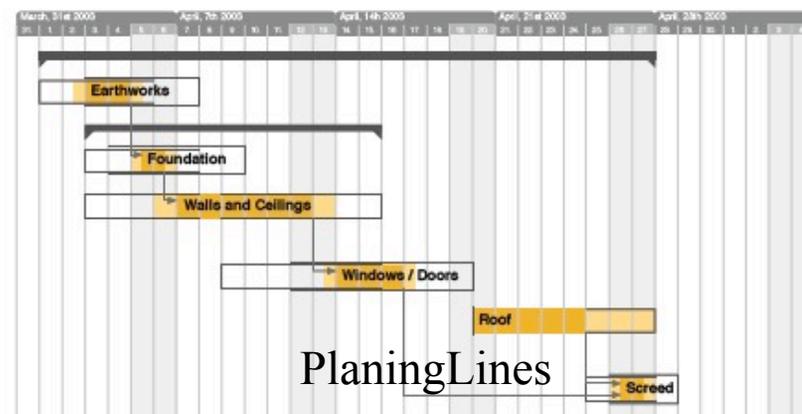
Linear display

Spiral 27days

Spiral 28days



Timewheel in 2D & 3D



PlaningLines

Analyzing methods



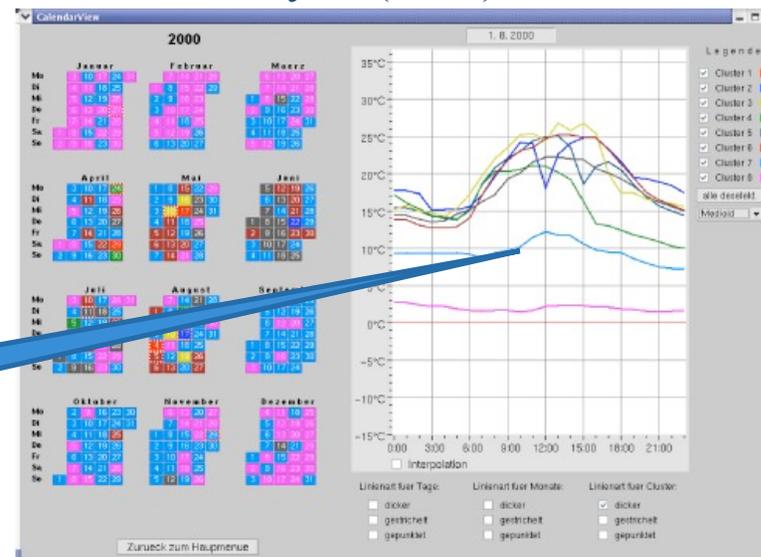
Challenges

- Large amount of data
- High frequency time-series
- Too many attributes to concern

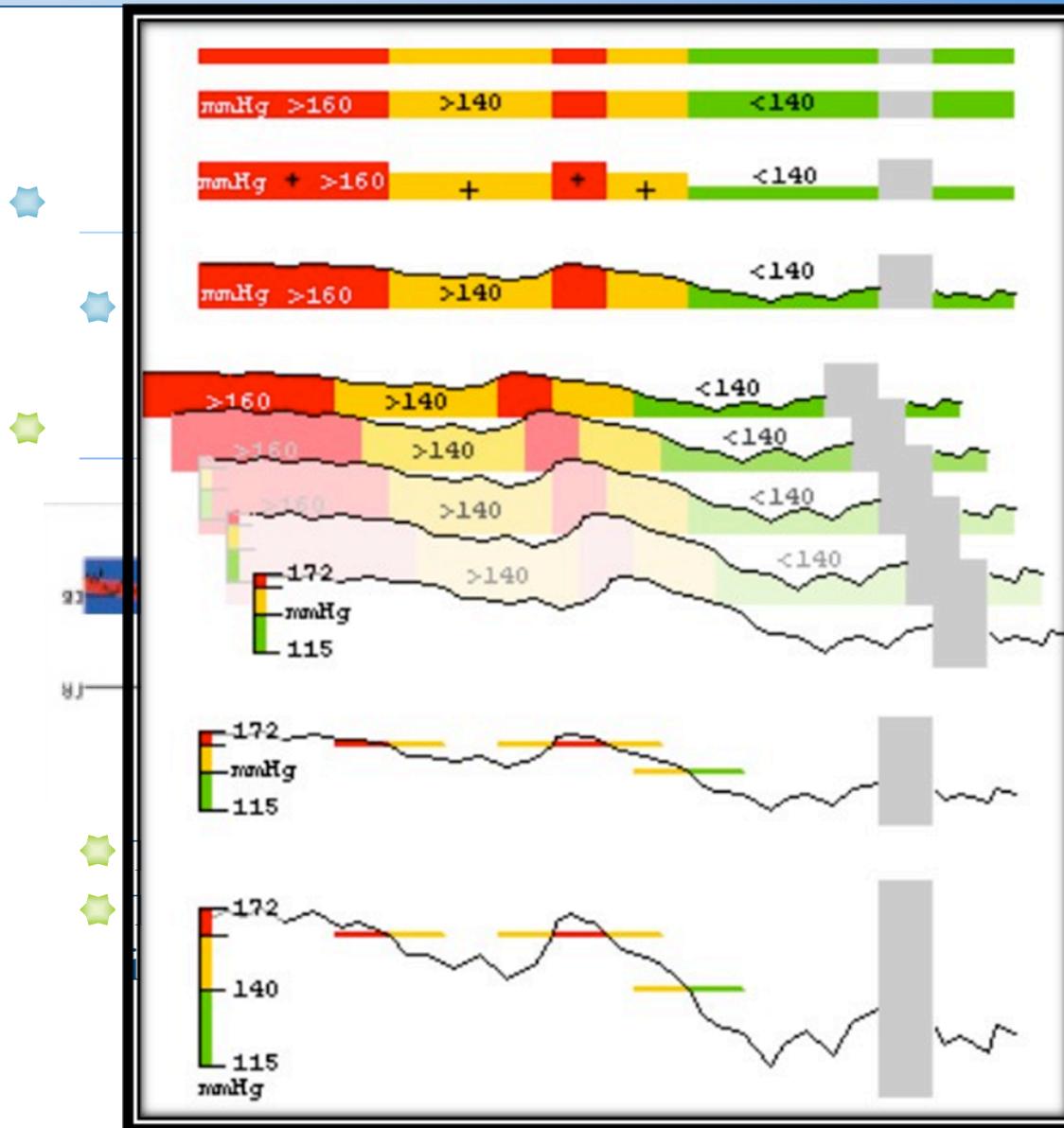
Methods

- Temporal data abstraction
- Principal Component-based Analysis (PCA)
- Clustering

Temperature trends



Temporal data abstraction



PCA-- Principal Component-based Analysis

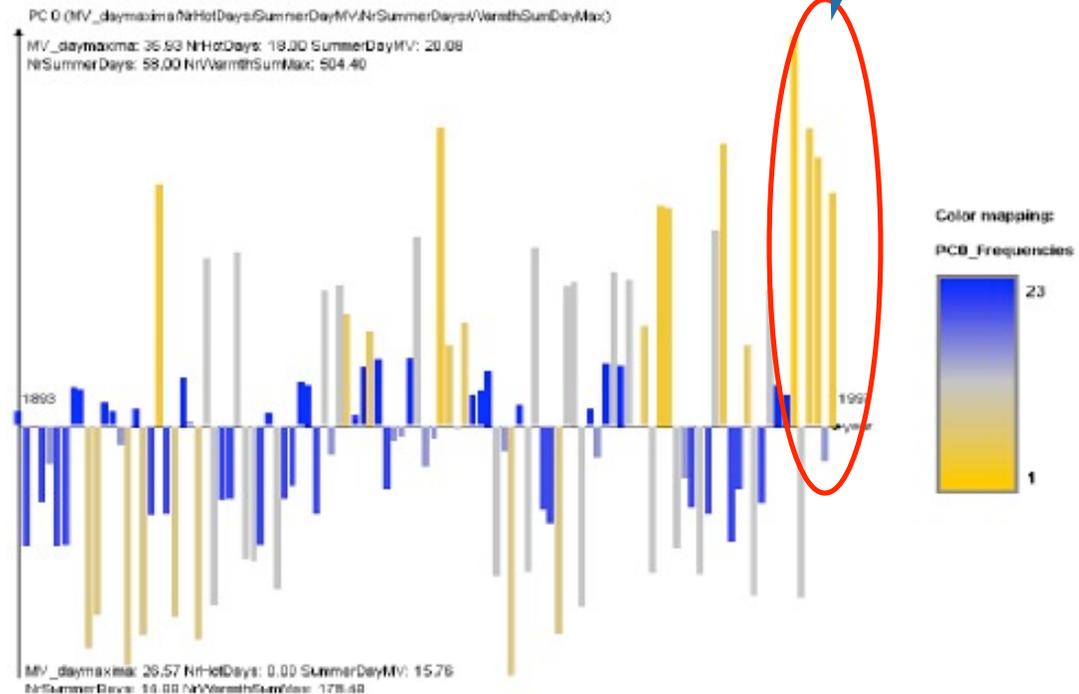


★ Advantage

- ★ Compressed description of correlations for better understanding of underlying features and trends

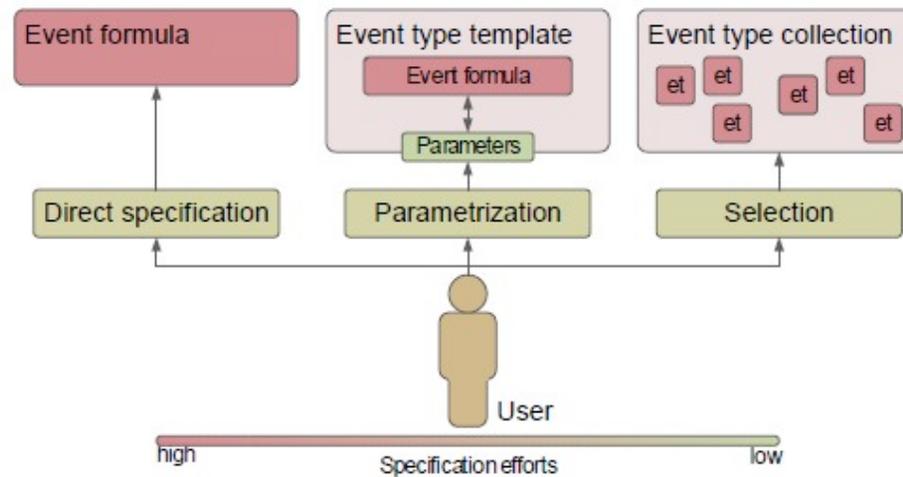
★ An example

- ★ NUMwarm
- ★ NUMsumdays
- ★ NUMhotdays
- ★ MEANTavg
- ★ MEANTmax
- ★ 1893~1997





★ Event specify



★ Event detect

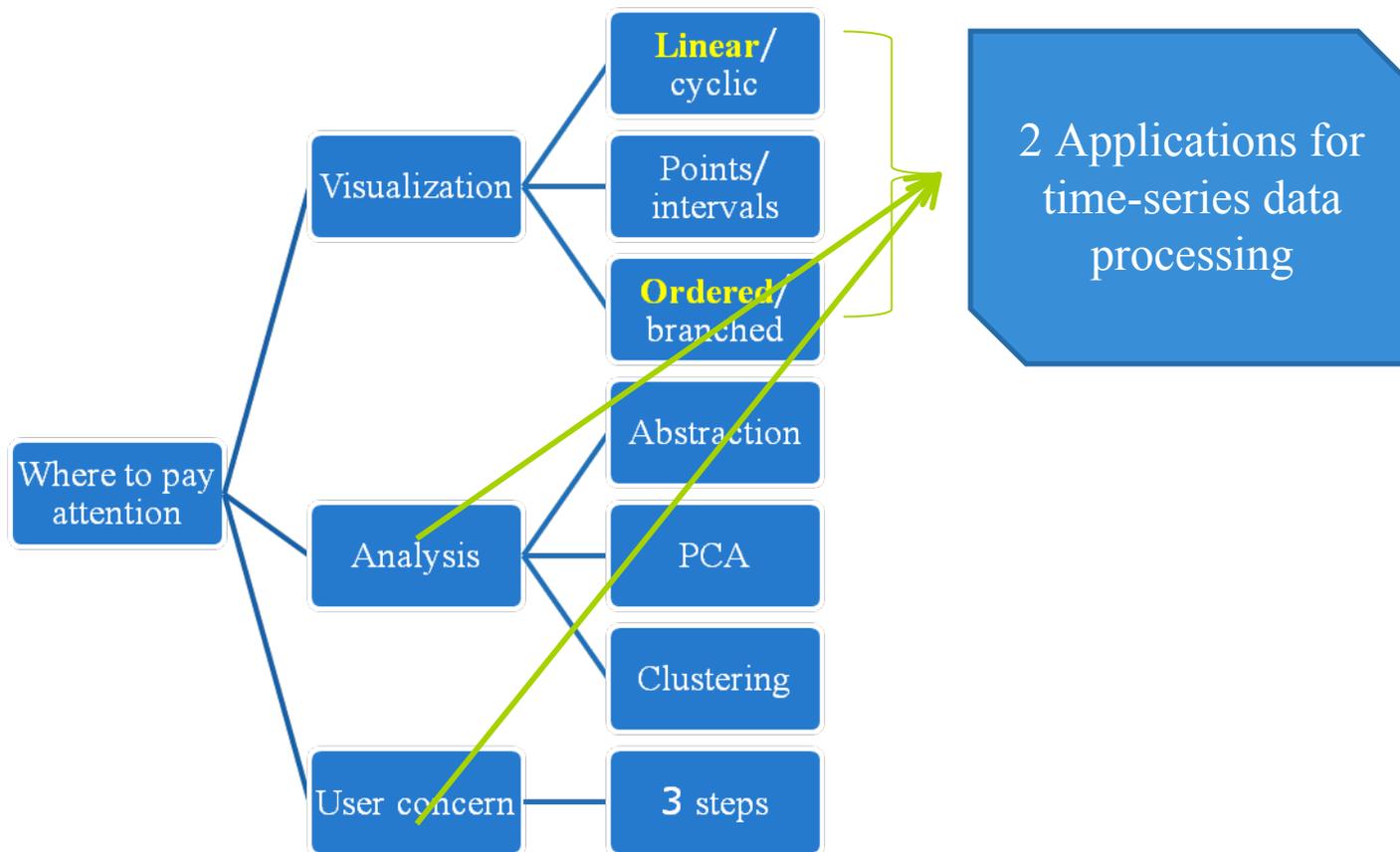
★ Event representation

Summary for "Method" paper



★ Critiques

- ★ Strength: clear structure for designer to start
- ★ Unmentioned: how to process the raw data? Which method to choose?



Application1: pattern search



★ Paper reference

Interactive Pattern Search in Time Series

Buono, P., C., Khella, A. Proc. VDA 2005.

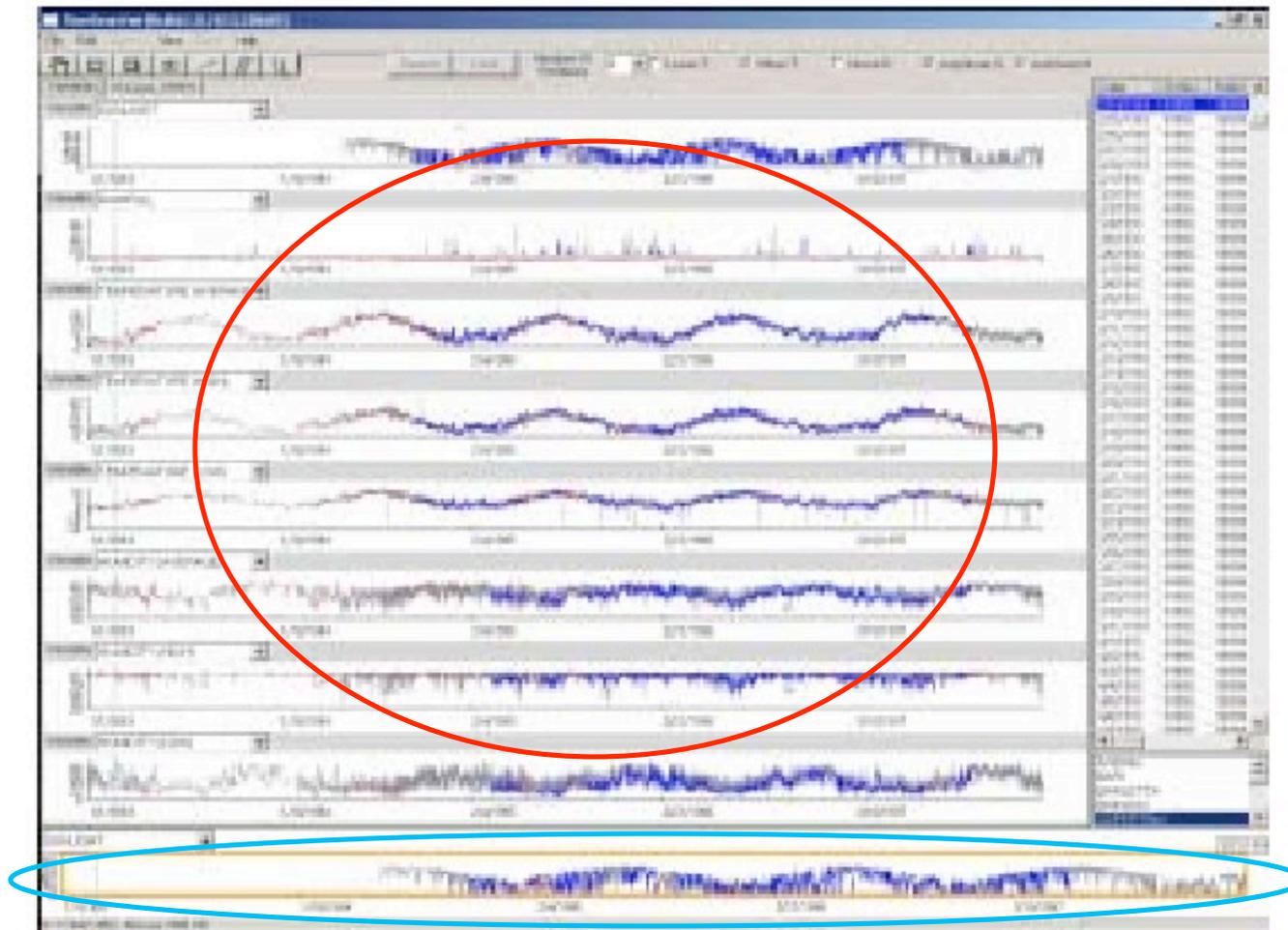
★ Functions

- ★ Deal with long time series of multiple heterogeneous variables
- ★ Filter the data and reduce the scope of the search
- ★ Perform a specific pattern search

Application 1: pattern search

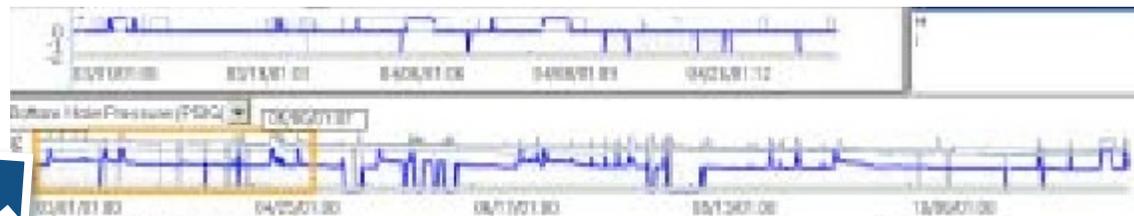


★ Interface for multi-variable view

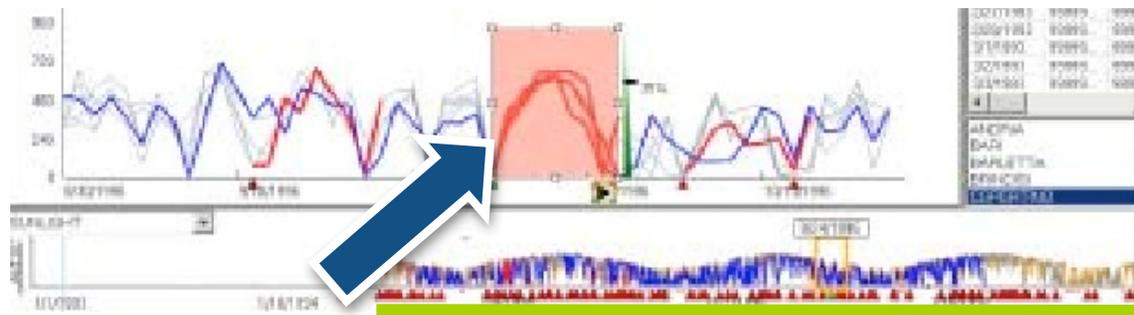


Application 1: 3 steps for pattern search

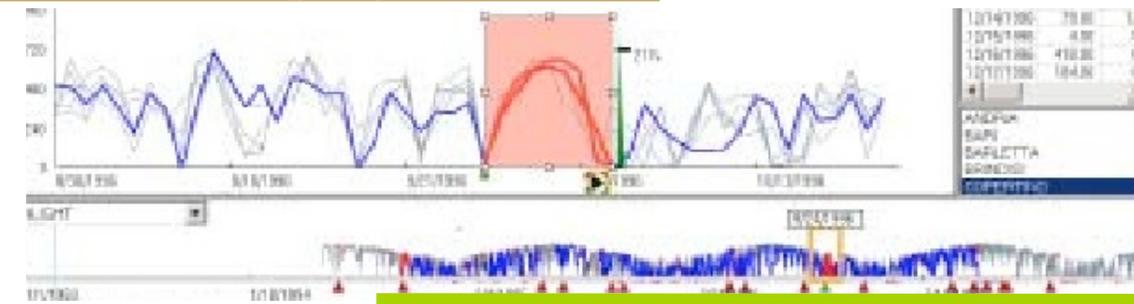
- ★ Reduce the scope of query



Search and highlight

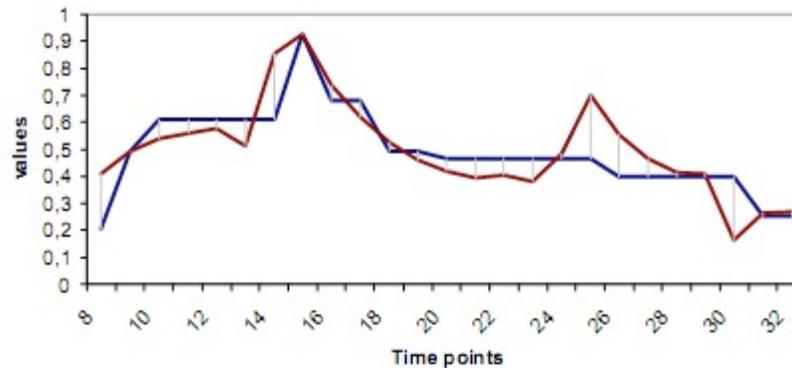


- ★ Filtering by τ



Application 1: pattern search algorithm

Algorithm



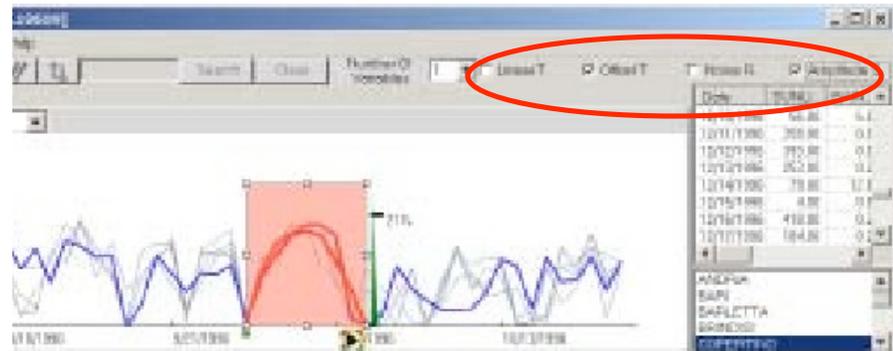
$$D(Q, C) = \sum_{i=1}^n (Q_i - C_i)^2$$

Too naive?

Offset? Similar?

Options for constrains

- Offset translation
- Magnitude scaling
- Linear trend removal
- Noise reduction



Application 1: pattern search—Critiques

★ Strength

- ★ Successful to improve the flexibility of pattern search
 - Scale and offset options
- ★ Easy and clear interface to handle

★ Weakness

- ★ Not in interactive level when dealing with larger dataset
- ★ Not able to deal with complex operation among data steams

Application2: ChronoLenses



★ Paper reference

Exploratory Analysis of Time-series with ChronoLenses

Jian Zhao, Fanny Chevalier. IEEE TVCG 17(12):2422-2431 2011 (Proc. InfoVis 2011).

★ Background

- ★ Support more elaborate task
- ★ Deriving new time-series from the original data
- ★ An iterative manner to process data in pipeline

Application2: ChronoLenses



★ User interface



Application2: ChronoLenses



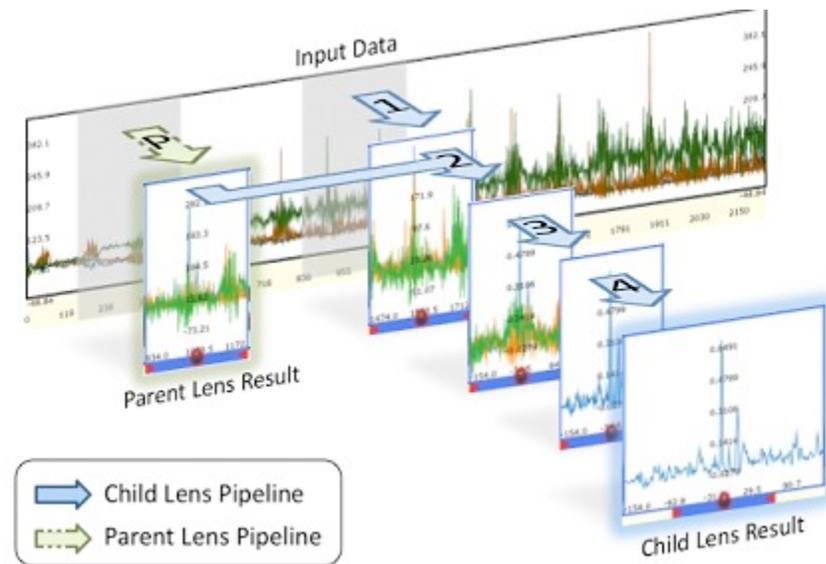
★ 2 main tasks

- ★ (T1) Single-data stream transformation (e.g. Fourier Trans, remove means)
- ★ (T2) Cross-data stream analysis (e.g. Subtraction, inner product)

★ Lens & parameters

- ★ $\ell_{filter}(\cdot, \theta)$: Hide some streams according to the parameter
- ★ $\ell_{scale}(\cdot, s)$: Scale some streams according to the parameter
- ★ $\ell_{unary}(\cdot)$: Similar to (T1)
- ★ $\ell_{binary}(\cdot, \cdot)$: Similar to (T2)

★ Pipeline



Application2: ChronoLenses-Critiques

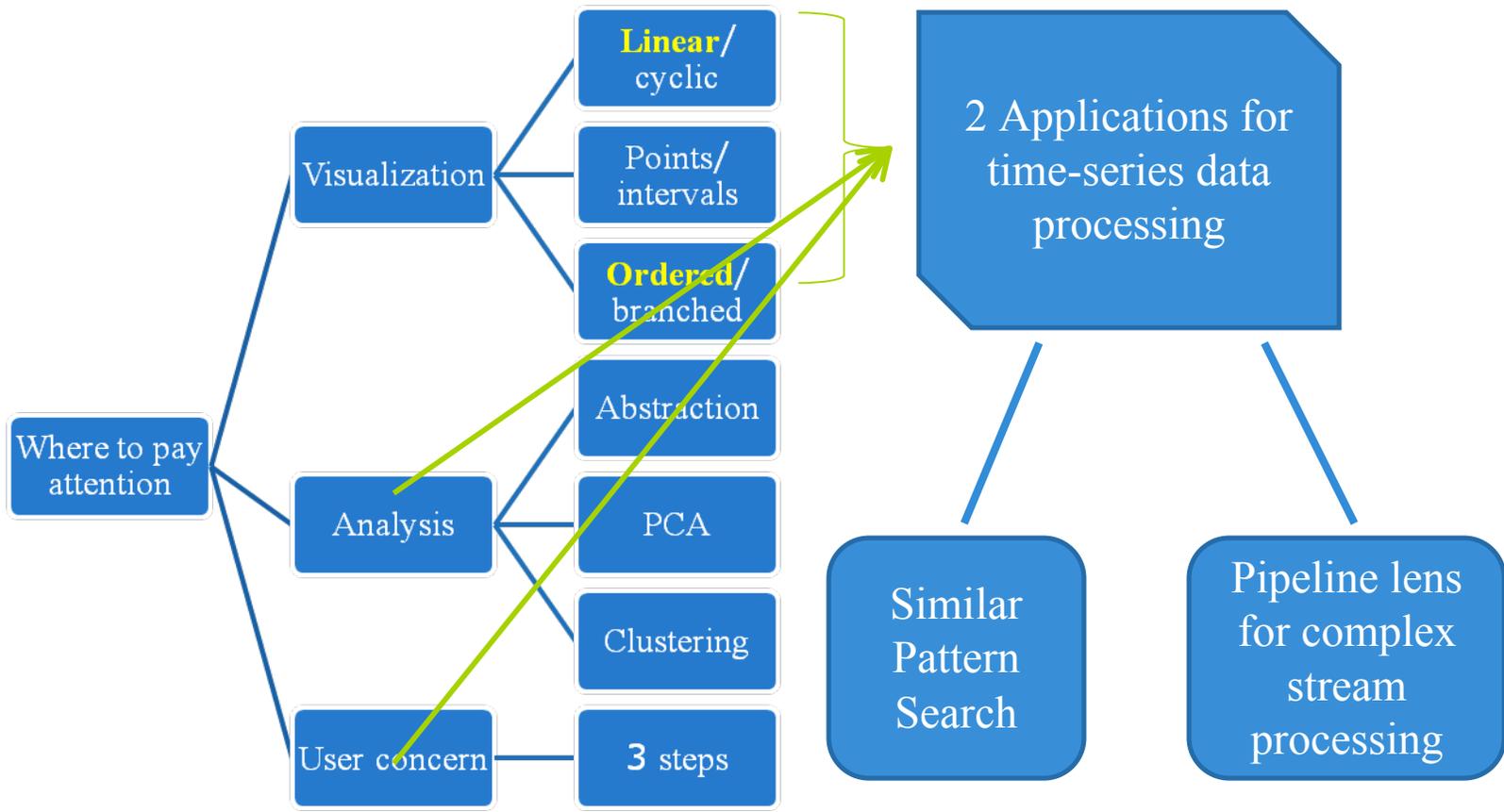
★ Strength

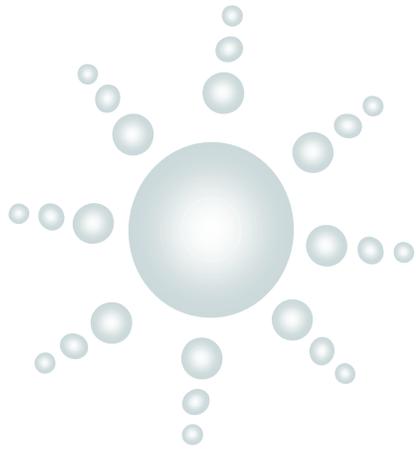
- Flexible interface
- Strong process ability for complex tasks
- Immediate response when moving the lens
- Domain independent

★ Weakness

- Layering and Tree-view limitation
- Large jump might occur when lens highly integrated
- Similar to microscope

Q & A





Thank You !