

# Time-Series Data

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# Referred Papers



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

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- ★ 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.

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- ★ 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).

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- ★ 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

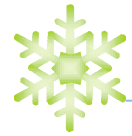
## ★ Why do that?

- ★ 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

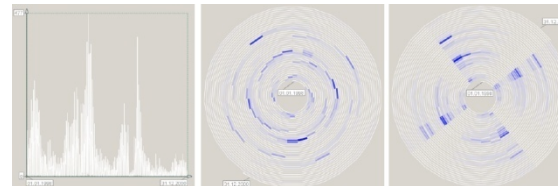


# Types to visualize



## Linear vs. cyclic

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

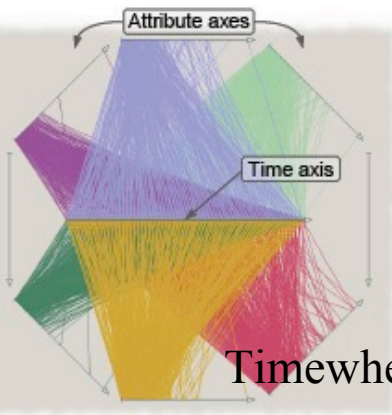


## Points vs. intervals

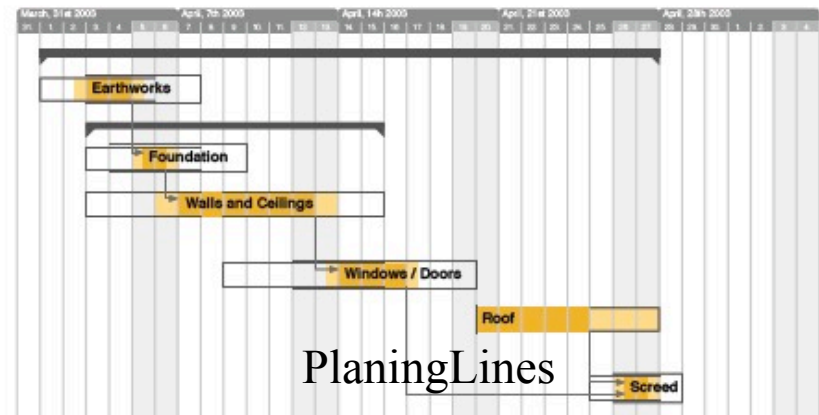
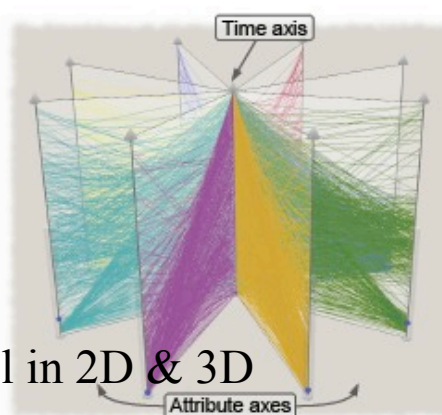
Linear display

Spiral 27days

Spiral 28days



Timewheel in 2D & 3D



PlaningLines

# Analyzing methods



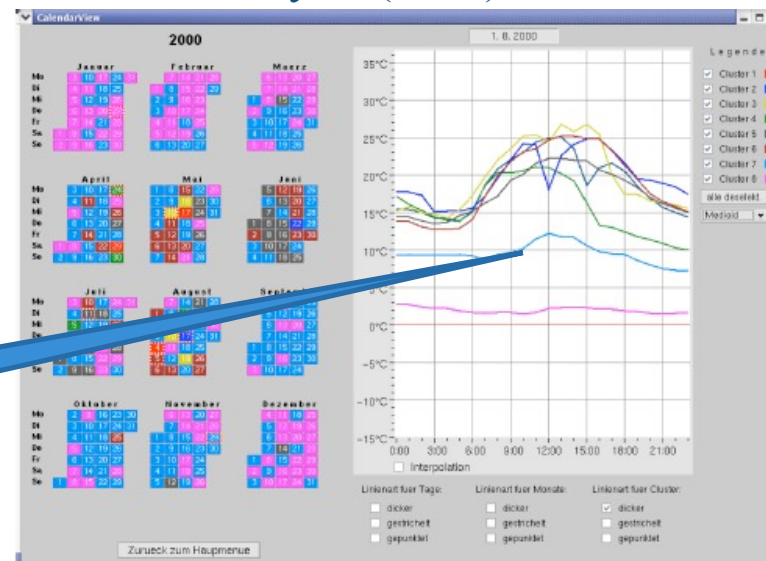
## Challenges

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

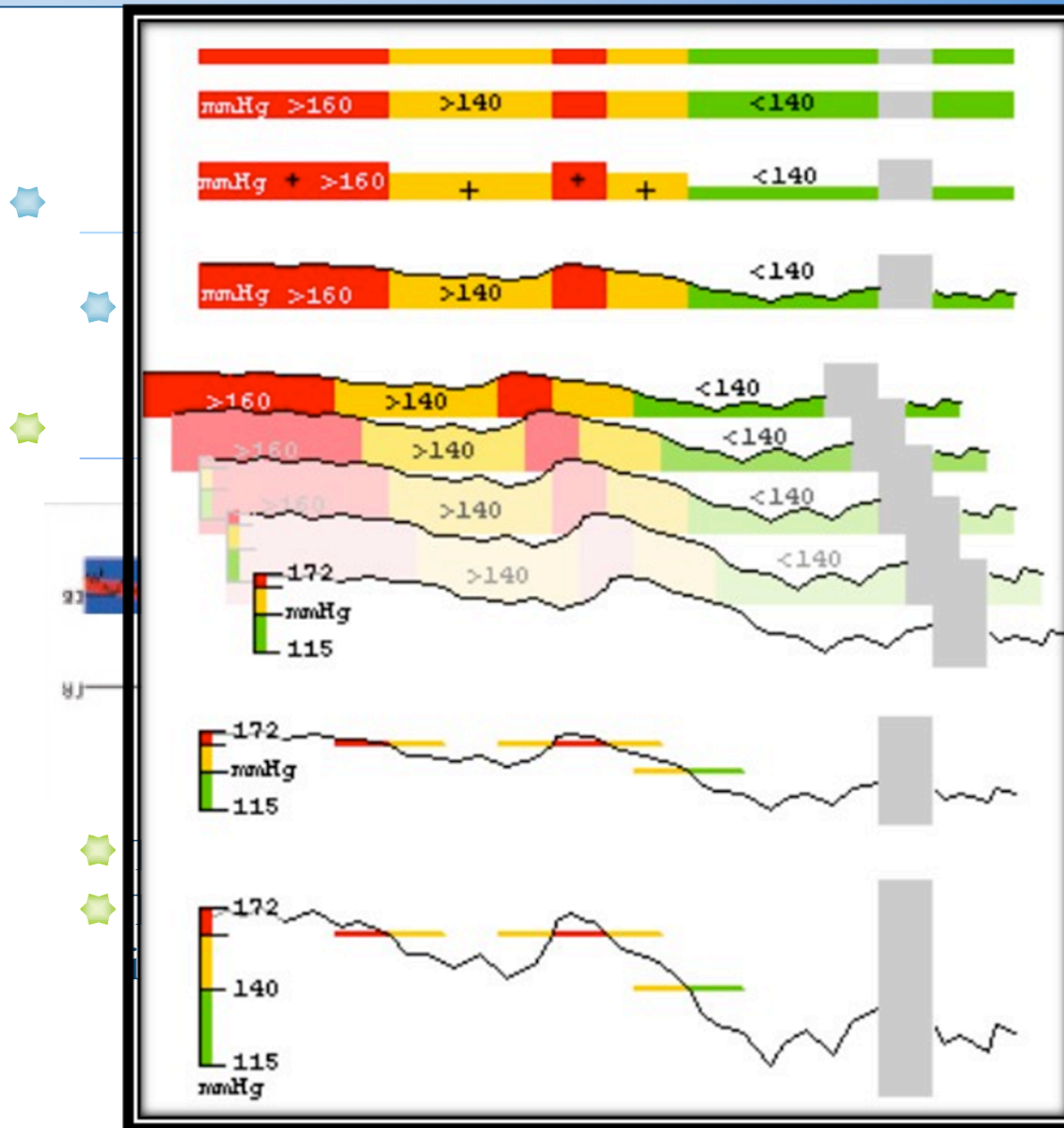
## Methods

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

Temperature trends



# Temporal data abstraction





# PCA-- Principal Component-based Analysis

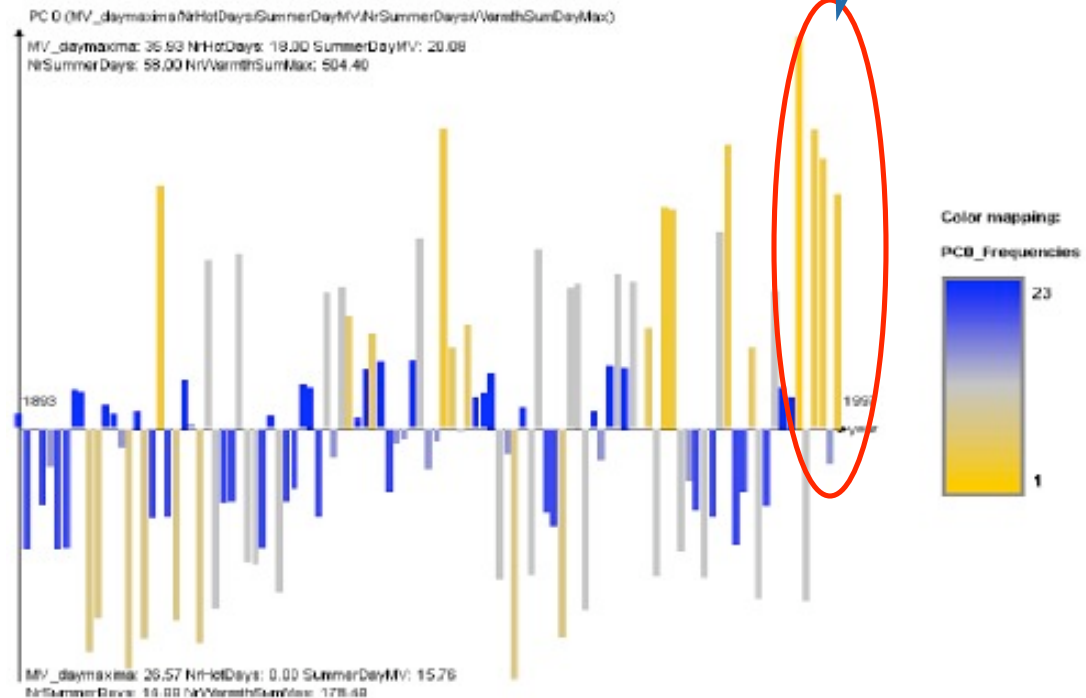


## ★ Advantage

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

## ★ An example

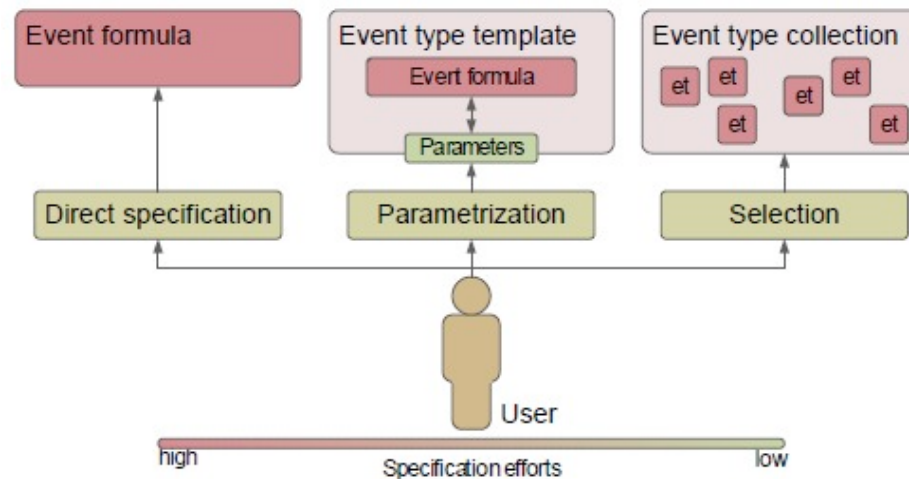
- ★ NUMwarm
- ★ NUMsumdays
- ★ NUMhotdays
- ★ MEANTavg
- ★ MEANTmax
- ★ 1893~1997







## ★ Event specify



## ★ Event detect

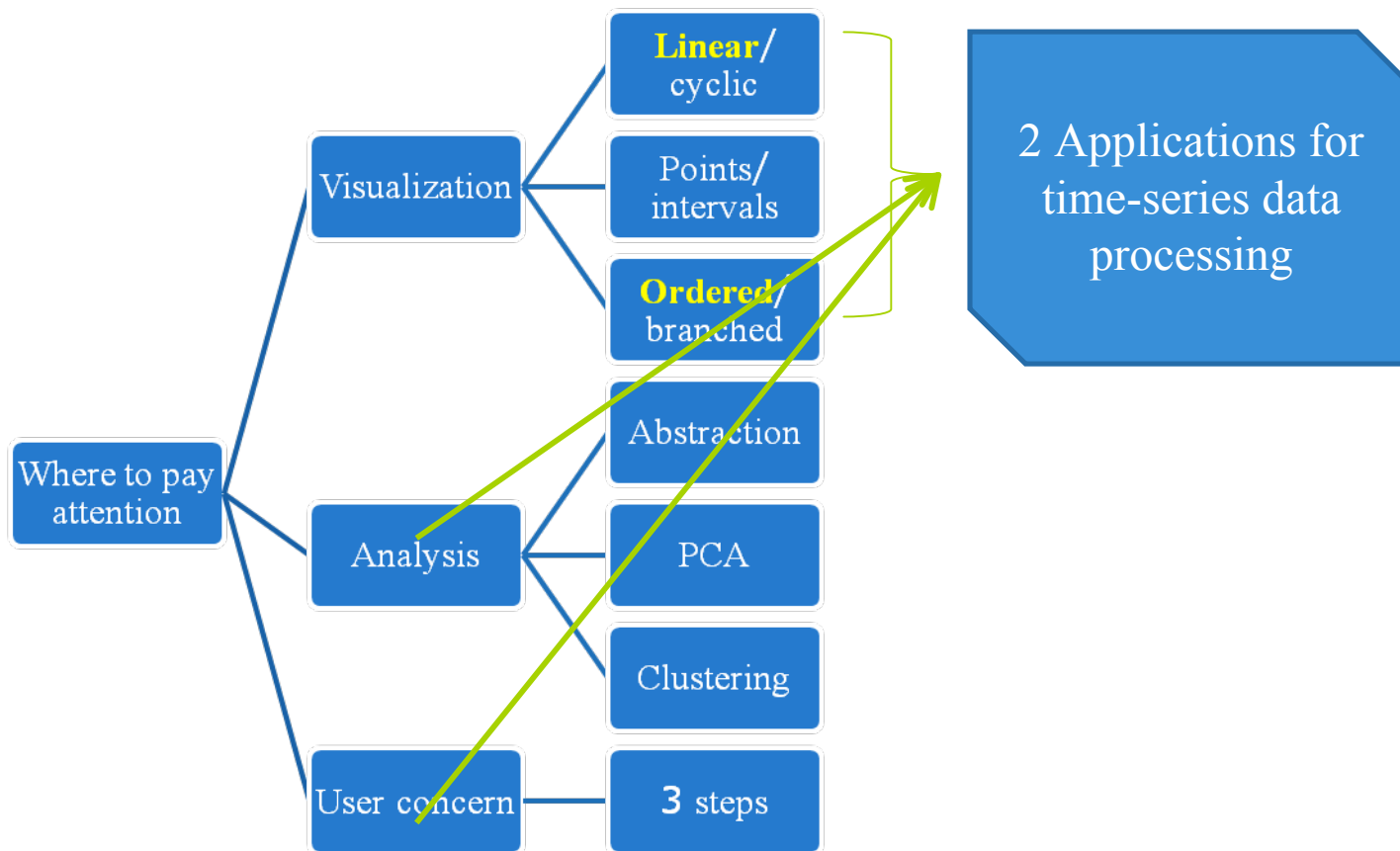
## ★ Event representation

# 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.

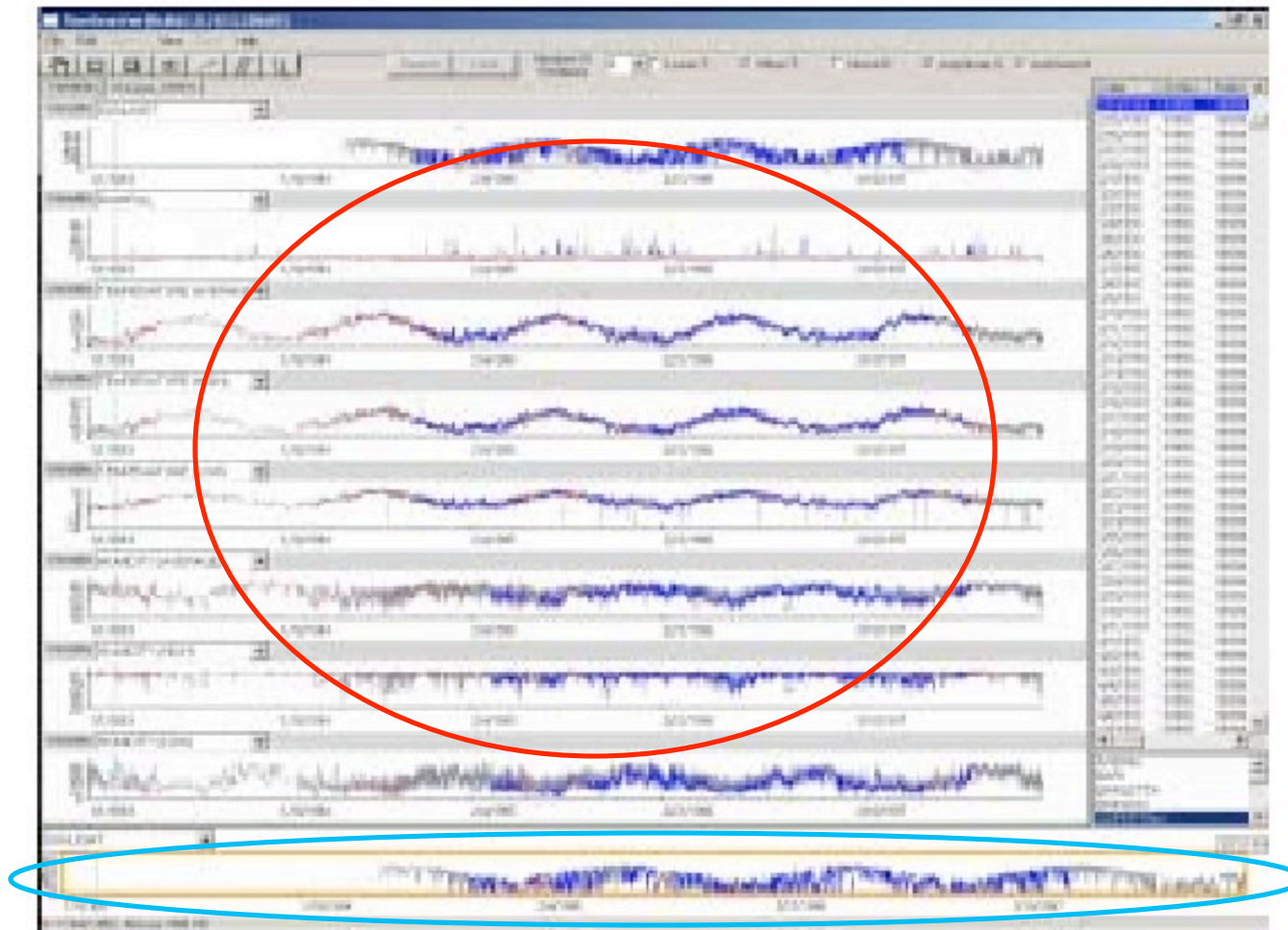
## ★ Functions

- ★ 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

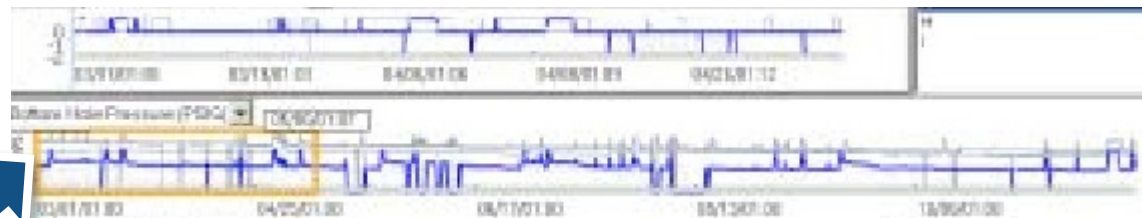


## ★ Interface for multi-variable view

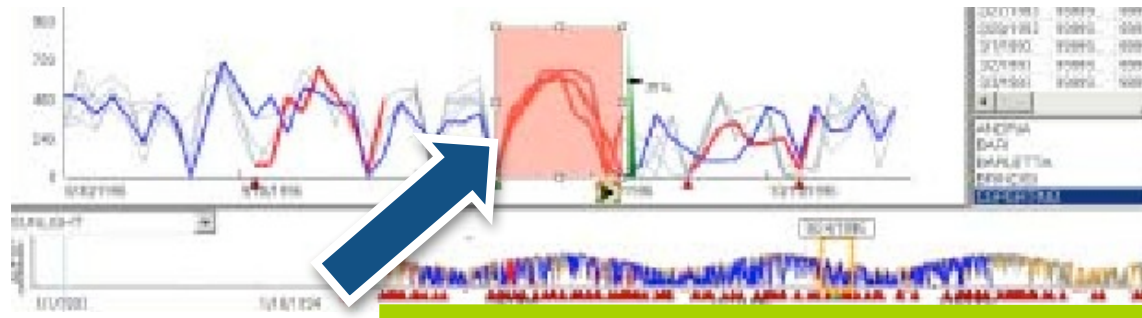


# Application 1: 3 steps for pattern search

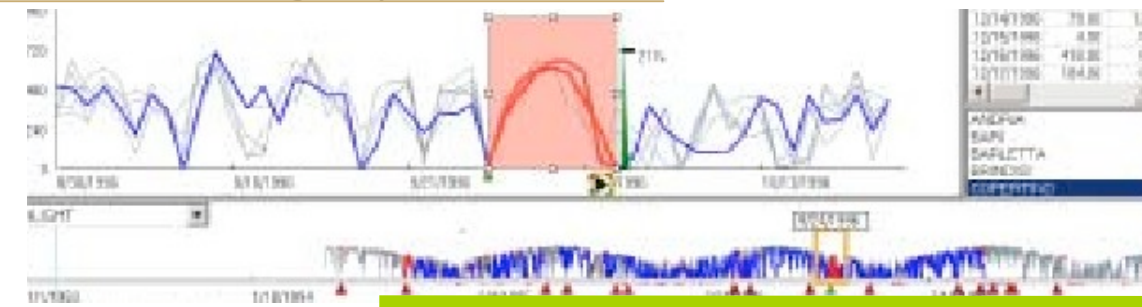
- ★ Reduce the scope of query



Search and highlight

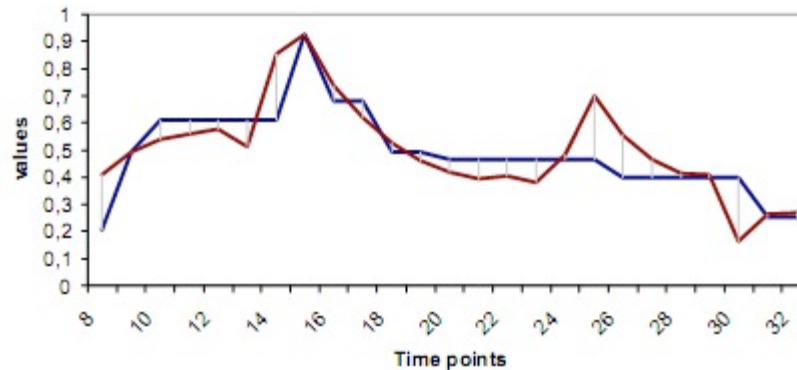


- ★ Filtering by  $\tau$



# Application 1: pattern search algorithm

## Algorithm



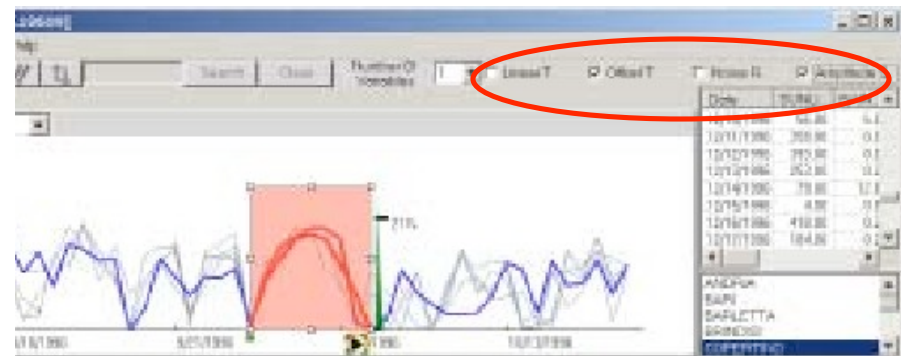
$$D(Q, C) = \sum_{i=1}^n (Q_i - C_i)^2$$

## Too naive?

Offset? Similar?

## Options for constrains

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



# Application1: 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



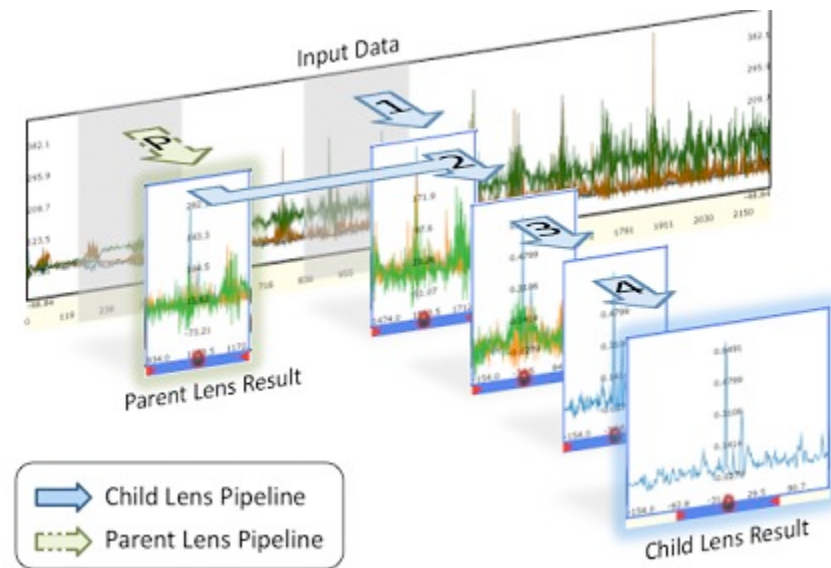
## ★ 2 main tasks

- ★ (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

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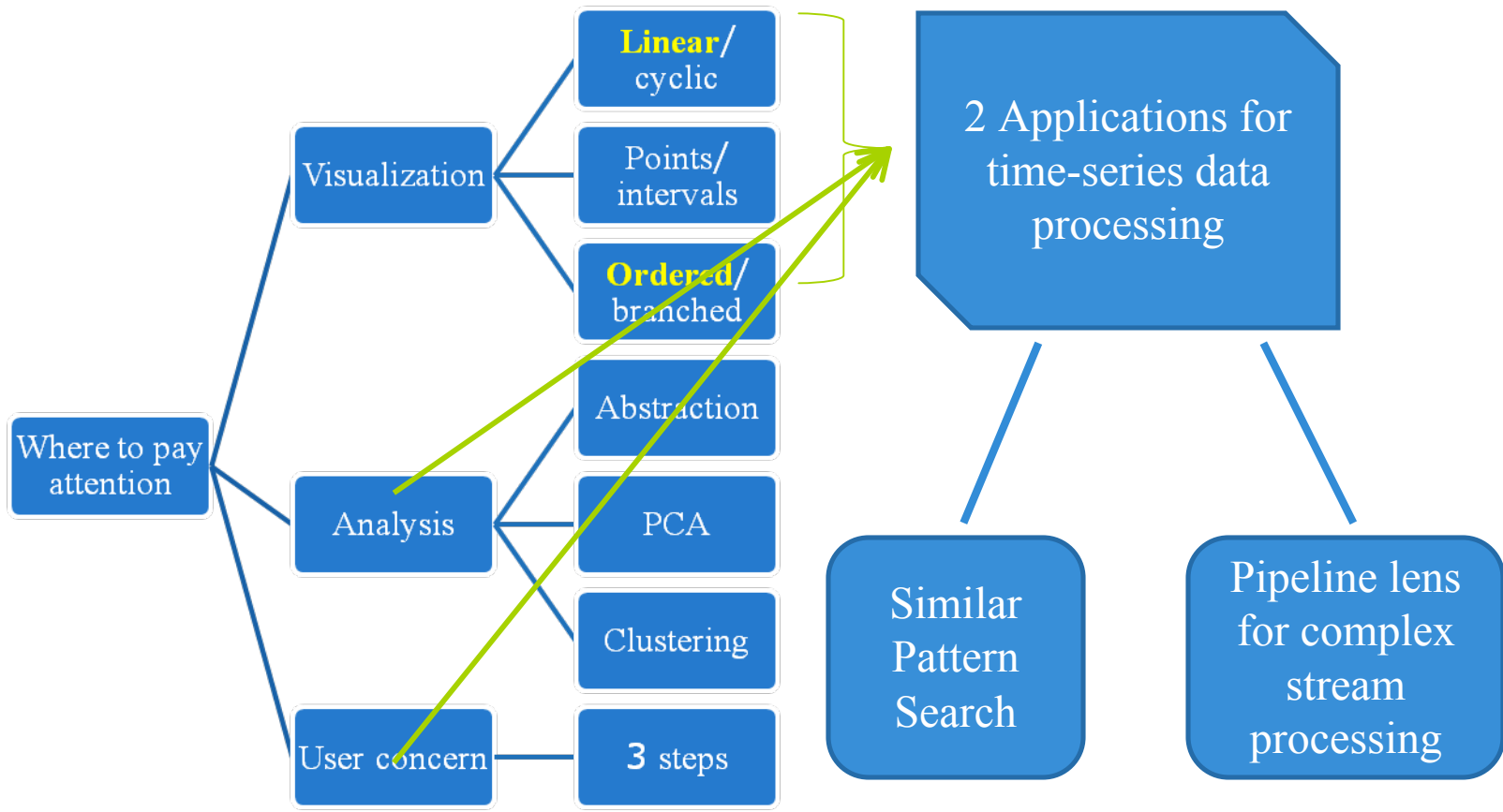
- Flexible interface
- Strong process ability for complex tasks
- Immediate response when moving the lens
- Domain independent

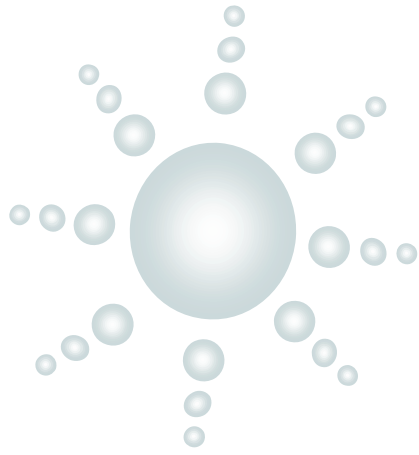
## ★ Weakness

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

# Q & A





**Thank You !**