

# Time-Series Data

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## Referred Papers

- 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
- Interactive Pattern Search in Time Series**  
Buono, P., C., Khella, A. Proc. VDA 2005.
  - Search similar patterns with a certain pattern indicated
- Exploratory Analysis of Time-series with ChronoLenses**  
Jan Zhao. IEEE TVCG 17(12):2422-2431 2011 (Proc. InfoVis 2011).
  - More complicated time-series processing method with lens and pipeline.

## Paper: Time-oriented

- 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 (basic)
- Analysis (Current, result)
- User side (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
- Timestep in 2D & 3D**
- PlanningLines**

## 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

## Temporal data abstraction

## PCA-- Principal Component-based Analysis

- Advantage**
  - Compressed description of correlations for better understanding of underlying features and trends
- An example**
  - NUMsum
  - NUMsundays
  - NUMsaturdays
  - MEANTemp
  - MEANmax
  - 1893-1997

## User-centered analysis via events

- Event specify**
  - Event formula
  - Event type template
  - Event terms
  - Event type collection
  - Direct specification
  - Parameterization
  - Selection
- 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

## Application1: pattern search

- Interface for multi-variable view**

## Application1: 3 steps for pattern search

- Reduce the scope of query
- Search and highlight
- Filtering by  $\tau$

## Application1: pattern search algorithm

- Algorithm**

$$D(Q, C) = \sum_i (Q_i - C_i)^2$$
- 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 streams

## Application2: ChronoLenses

- Paper reference**  
Exploratory Analysis of Time-series with ChronoLenses  
Jan 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

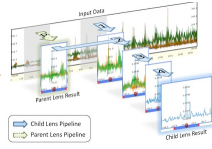
### 2 main tasks

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

### Lens & parameters

- $f_{hide}(\cdot, \theta)$  : Hide some streams according to the parameter
- $f_{scale}(\cdot, s)$  : Scale some streams according to the parameter
- $f_{sim}(\cdot)$  : Similar to (T1)
- $f_{sim}(\cdot, -)$  : Similar to (T2)

### Pipeline



## Application2: ChronoLenses-Critiques

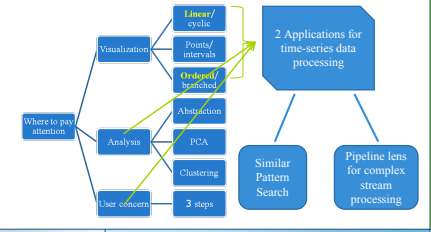
### Strength

- 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 !