Time-Series Data

JINGXIAN LI
## Referred Papers

1. **Visual Methods for Analyzing Time-Oriented Data**  
   - 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**  
   - Search similar patterns with a certain pattern indicated

3. **Exploratory Analysis of Time-series with ChronoLenses**  
   - More complicated time-series processing method with lens and pipeline.
**Paper: Time-oriented**

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**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

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**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**
- Points: discrete, have no duration
- Intervals: defined for a duration, delimited by 2 points
  example: days, months or years

**Branch time:**
- Multiple strands branch out facilitates description and comparison
- Support decision making process

**Visualizations:**
- 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

The red area depicts the spread. The blue rectangles represent the derived temporal intervals of steady qualitative values.
PCA -- Principal Component-based Analysis

**Advantage**

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

**An example**

- NUM\_warm
- NUM\_sumdays
- NUM\_hotdays
- MEAN\_T\_avg
- MEAN\_T\_max
- 1893~1997

Global Warming!?
User-centered analysis via events

- **Event specify**
  - Event formula
    - Direct specification
  - Event type template
    - Parametrization
  - Event type collection
    - 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?

Where to pay attention
- Visualization
  - Linear/cyclic
  - Points/intervals
  - Ordered/branched
    - Abstraction
    - PCA
    - Clustering
    - 3 steps

2 Applications for time-series data processing
Application 1: pattern search

Paper reference

Interactive Pattern Search in Time Series

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

Too naive?

Options for constrains

Offset translation
Magnitude scaling
Linear trend removal
Noise reduction

\[ D(Q, C) = \sum_{i=1}^{n} (Q_i - C_i)^2 \]
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 streams
Application 2: ChronoLenses

Paper reference

Exploratory Analysis of Time-series with ChronoLenses

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
2 Applications for time-series data processing

- Linear/cyclic
- Points/intervals
- Ordered/branched

Similar Pattern Search

Pipeline lens for complex stream processing

Visualization

Analysis

User concern

Where to pay attention

3 steps

PCA

Abstraction

Clustering
Thank You!