

# Interactive Visual Analysis of Temporal Cluster Structures

Turkay et al. (2011)

Paper Analysis

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## Abstract

Cluster analysis is a useful method which reveals underlying structures and relations of items after grouping them into clusters. **In the case of temporal data, clusters are defined over time intervals where they usually exhibit structural changes. Conventional cluster analysis does not provide sufficient methods to analyze these structural changes, which are, however, crucial in the interpretation and evaluation of temporal clusters.** In this paper, we present two novel and interactive visualization techniques that enable users to explore and interpret the structural changes of temporal clusters. We introduce the temporal cluster view, which visualizes the structural quality of a number of temporal clusters, and temporal signatures, which represents the structure of clusters over time. We discuss how these views are utilized to understand the temporal evolution of clusters. We evaluate the proposed techniques in the cluster analysis of mixed lipid bilayers.

Categories and Subject Descriptors (according to ACM CCS):  
Computing Methodologies [I.3.m]: Computer Graphics—Miscellaneous

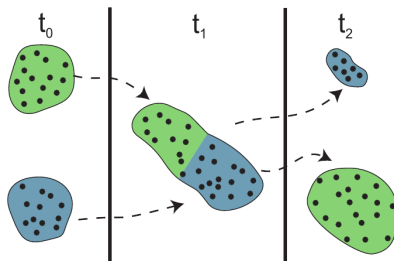
- 1 Introduction
- 2 Related Work
- 3 The Framework
- 4 Experiments and Results
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- Visualizing of dynamic data is more complex than visualizing static data
  - It occurs on a series of time intervals
  - Multiple visualizations
  - Unstable structures
- Lack of works in the field of time varying clusters
  - Lack of specific visualizing metaphors

Figure: Time varying cluster



Source: Turkay et al. (2011)

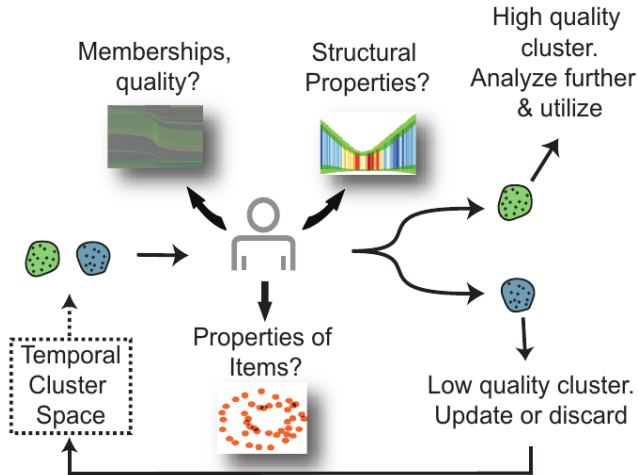
# Problem

- "How does the quality of clusters vary over time?"
- "What type of structural changes do clusters exhibit?"

- Two novel interactive visualization techniques to analyze time varying cluster
- Temporal Cluster View
  - Structural quality
  - Silhouette coefficients
- Temporal Signatures
  - Visual summaries of temporal clusters structures
  - Cluster cohesion
  - Cluster homogeneity



Figure: Overview



Source: Turkay et al. (2011)

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- Analysing cluster
- Cluster analysis of temporal data
- Visual representation of temporal data

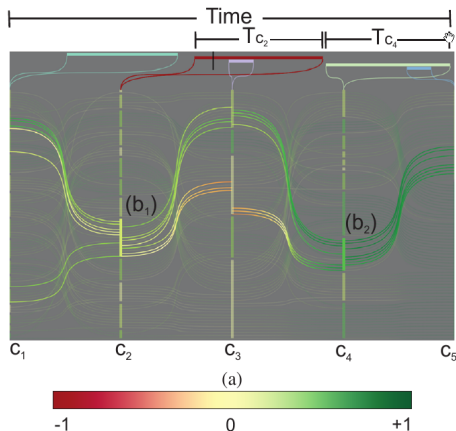
- Major reference:  
**LIAO W.: Clustering of time series data– a survey. Pattern Recognition 38, 11 (2005), 1857–1874.**

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- **Cluster View:** Visualizes the quality of clusters together with structural changes that are related to item-cluster and cluster-cluster relationships
- **Temporal Signatures:** Visual summaries of the statistical properties of clusters over time. The variations of these statistical properties reveals structural changes in groups of items.

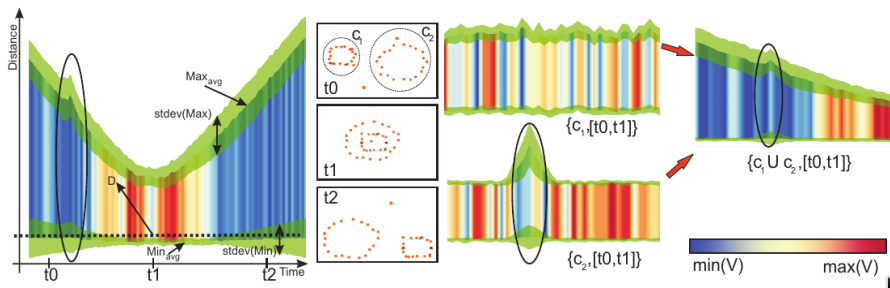
Figure: Cluster View



Source: Turkay et al. (2011)

# Temporal Signatures

Figure: Cluster View



Source: Turkay et al. (2011)



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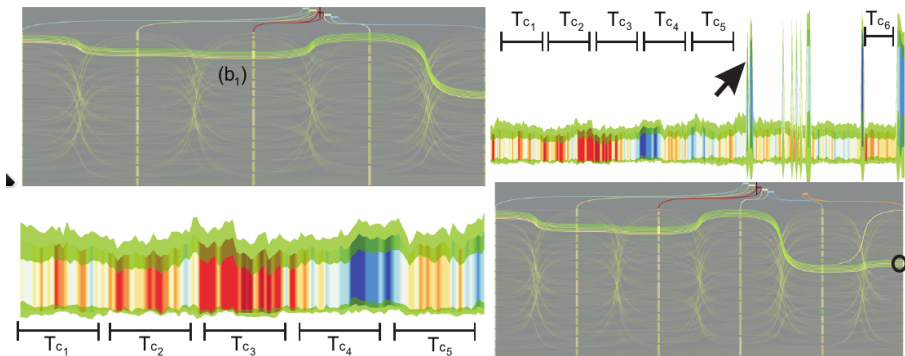
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- Case study: Modeling of Biological Membranes

- Molecular dynamics
- Evaluate the cluster by its stability over time.

# Case study

Figure: Case study



Source: Turkay et al. (2011)

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# Conclusions

- Novel visualizations of time varying clusters
- Is the first interactive visual approach to analyze the structural changes in cluster-cluster and item-cluster relations of temporal datasets.

- Extend temporal signatures
- Create an abstract representation of structural changes
  - Event based

- C. Turkay, J. Parulek, N. Reuter, and H. Hauser, “Interactive visual analysis of temporal cluster structures,” *Computer Graphics Forum*, vol. 30, no. 3, pp. 711–720, 2011.