ts2g²

time-series to graph and back

Jože M. Rožanec, Ivana Ristovska.
JOŽEF STEFAN INSTITUTE - SLOVENIA

Objective

Developing and implementing various techniques to convert time series data into networks and generative processes that leverage such graphs to generate novel sequences and time series with similar topological properties to those found in the original time series.

Why use ts2g²?

Accessibility

The library makes advanced techniques for converting time series to graphs and generating new sequences accessible to a wider audience, including researchers and practitioners.

Versatility

It supports a wide range of conversion techniques and parameters, allowing users to customize their analyses and generative processes.

Insight Generation

By making non-trivial relationships in time series data visible through graph representations, the library helps users uncover new insights and patterns

Innovative Analysis

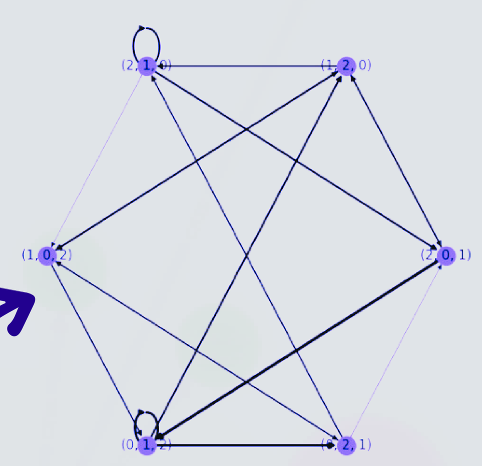
Users can apply graph-based analysis techniques to time series data, opening up new avenues for research and practical applications.

The project aims to:

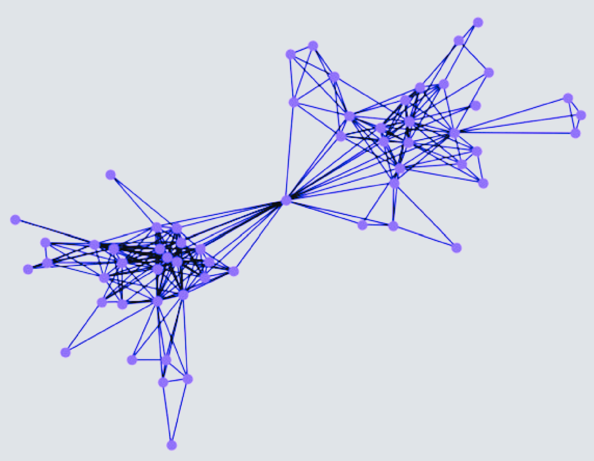
- provide techniques in a Python library that will be widely accessible
- offer different perspectives on time series data
- develop comprehensive tutorials and apply such techniques to various use cases

Project Solutions

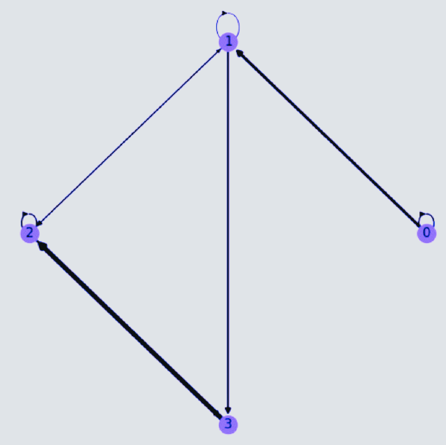
Converting time series into network graphs enhances analysis by revealing hidden patterns and relationships through graph theory. This approach allows for identifying clusters of similar behaviors over time, examining connectivity and influence among time series, and discovering causality and leading indicators.



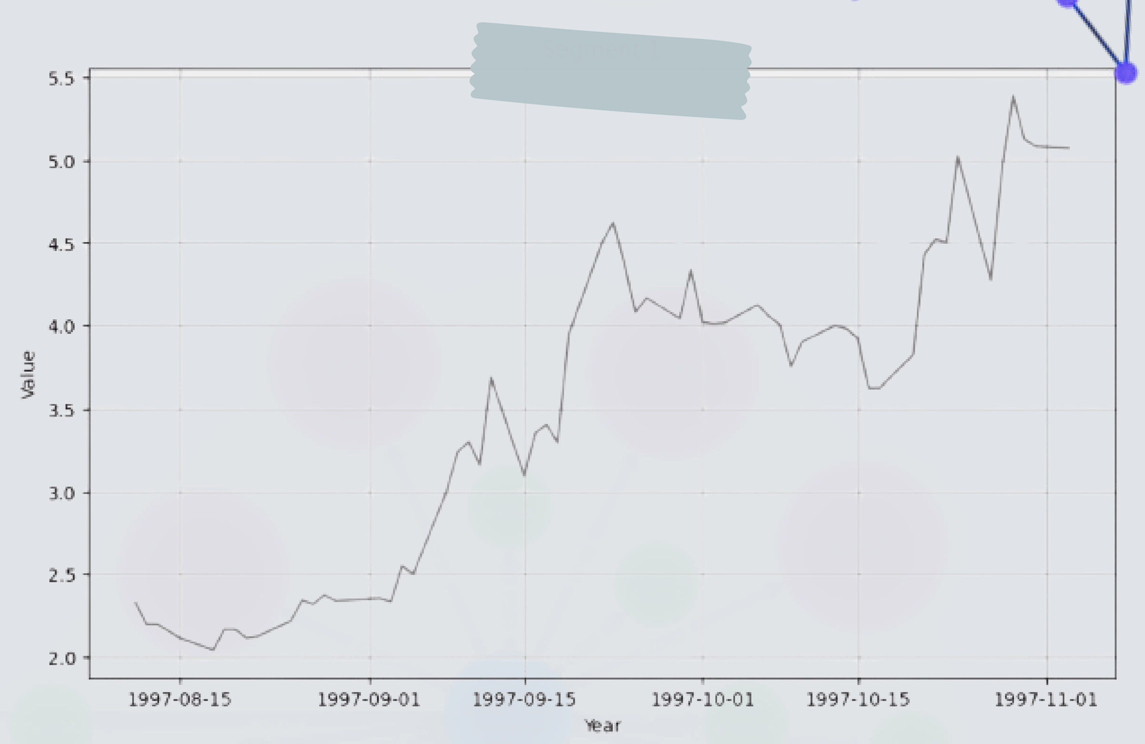
OrdinalPatternGraph



NaturalVisibilityGraph



QuantileGraph

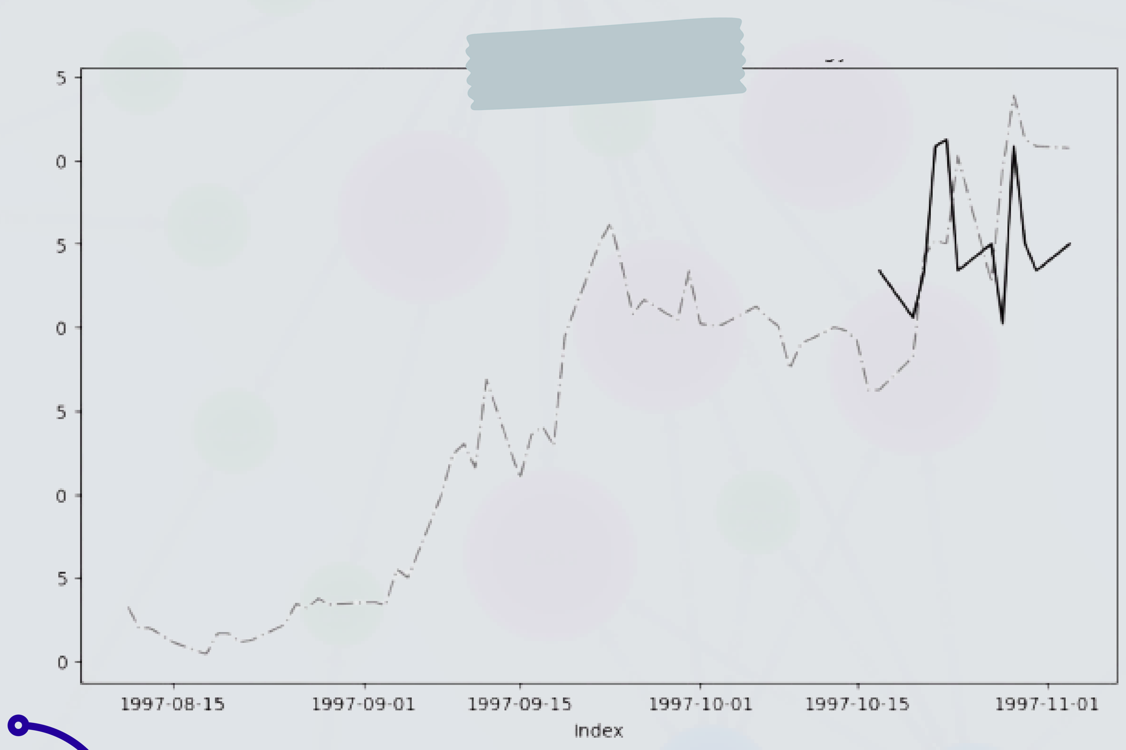


Time series to graph strategies

One set of such techniques is known as visibility graphs. They represent the data points in the time series as nodes in the graph and link them based on some visibility criteria: if we stand at a certain point, which other data points can we see?
The strategies consider natural visibility, horizontal visibility, and a wide range of parameters (e.g., constraints regarding the angle of vision or how far the sight may penetrate).

Right next to it, we have quantile graphs that divide a time series into different size groups - quantiles, where each group becomes a node. Nodes are connected with edges when values move between these groups. Frequent movements between groups result in thicker edges, helping to visualize the patterns and transitions within the time series. We can adjust the number of quantile groups and step size used when connecting these groups.

Ordinal pattern strategy turns a time series into sequences based on the order of values. Each sequence is ranked by value, creating patterns that represent how the data changes over time. These patterns are mapped to points in a network, where edge width shows how often one pattern follows another. We can customize our graph by applying the length of sequences extracted from the time series and step size between consecutive elements.



Graph to time series strategies

Once the visibility graphs are formed, they can be traversed to generate new sequences and time series, which retain the topological properties of the original time series, even when such sequences and time series are no longer the same as the original one. Therefore, multiple traversal strategies can be implemented to realize a generative component that creates time series from such visibility graphs.

Jožef Stefan Institute | UNIVERSITY OF TWENTE. | ALMA MATER STUDIORUM | VU UNIVERSITY AMSTERDAM | UNIVERSITÄT KLAGENFURT | GRAPH MASSIVIZER

KDD2024 BARCELONA, SPAIN
European Data Science Day

ts2g²
https://timeseriestographs.com

https://graph-massivizer.eu
in/graph-massivizer-project
@graphmassivizer
@graph-massivizer

This project has received funding from the European Union's Horizon Research and Innovation Actions under Grant Agreement N 101093202.