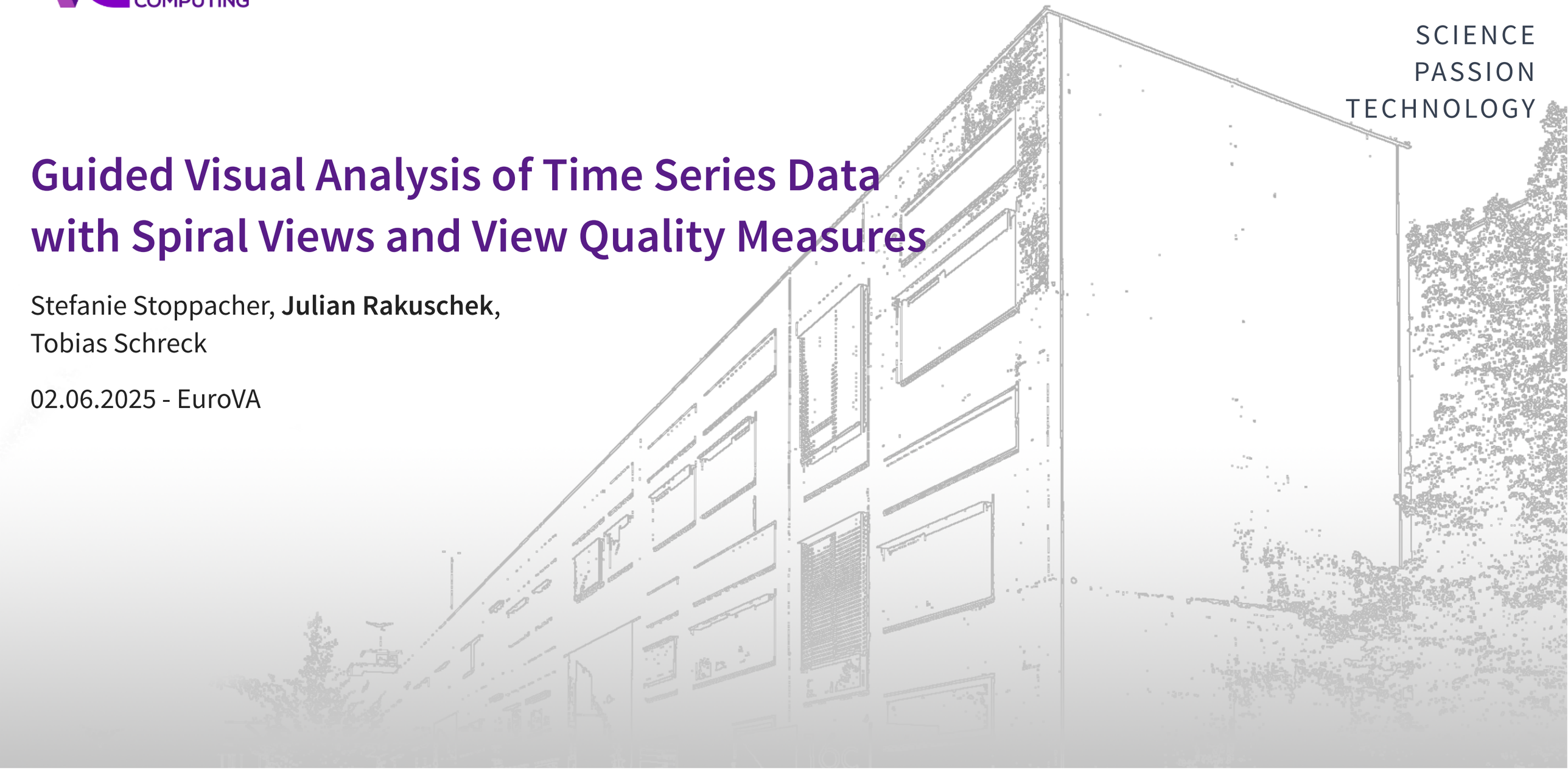
INSTITUTE OF VISUAL COMPUTING

TU Graz

SCIENCE
PASSION
TECHNOLOGY

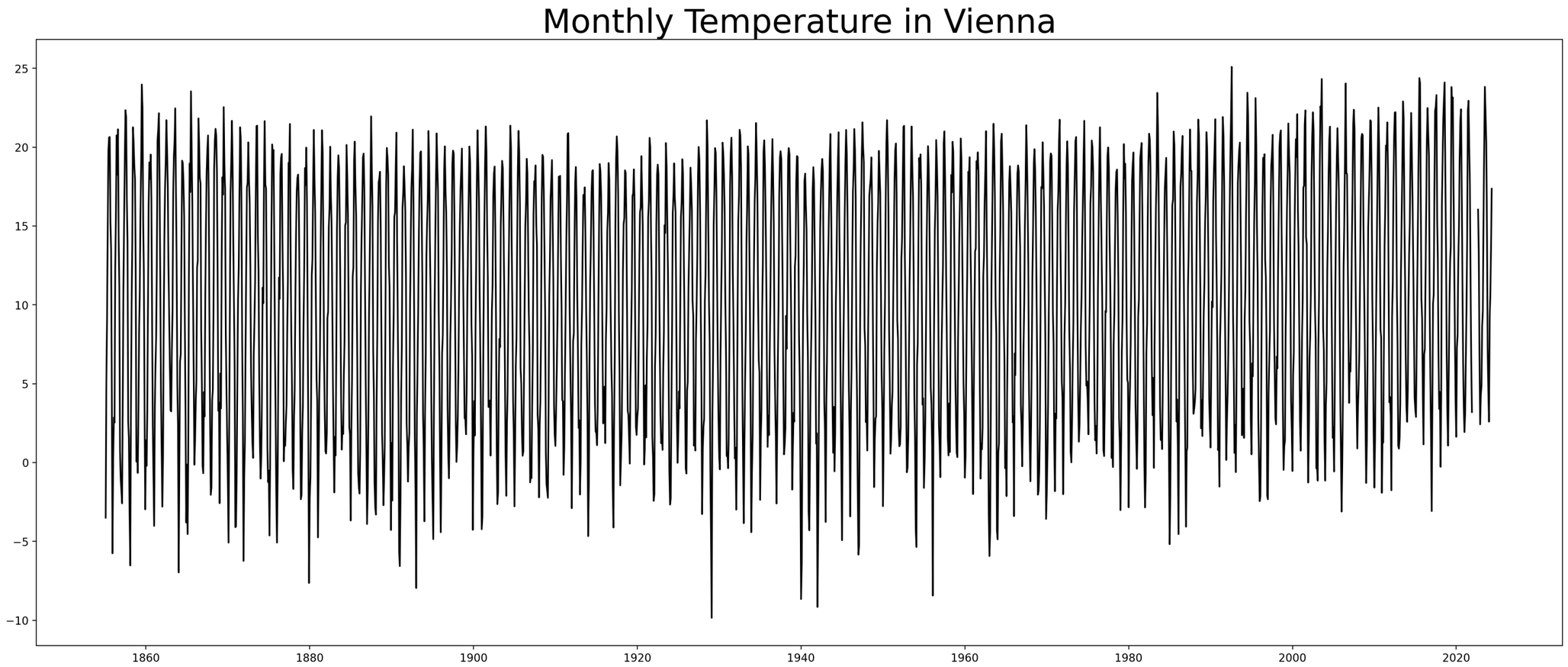


Guided Visual Analysis of Time Series Data with Spiral Views and View Quality Measures

Stefanie Stoppacher, **Julian Rakuschek**,
Tobias Schreck

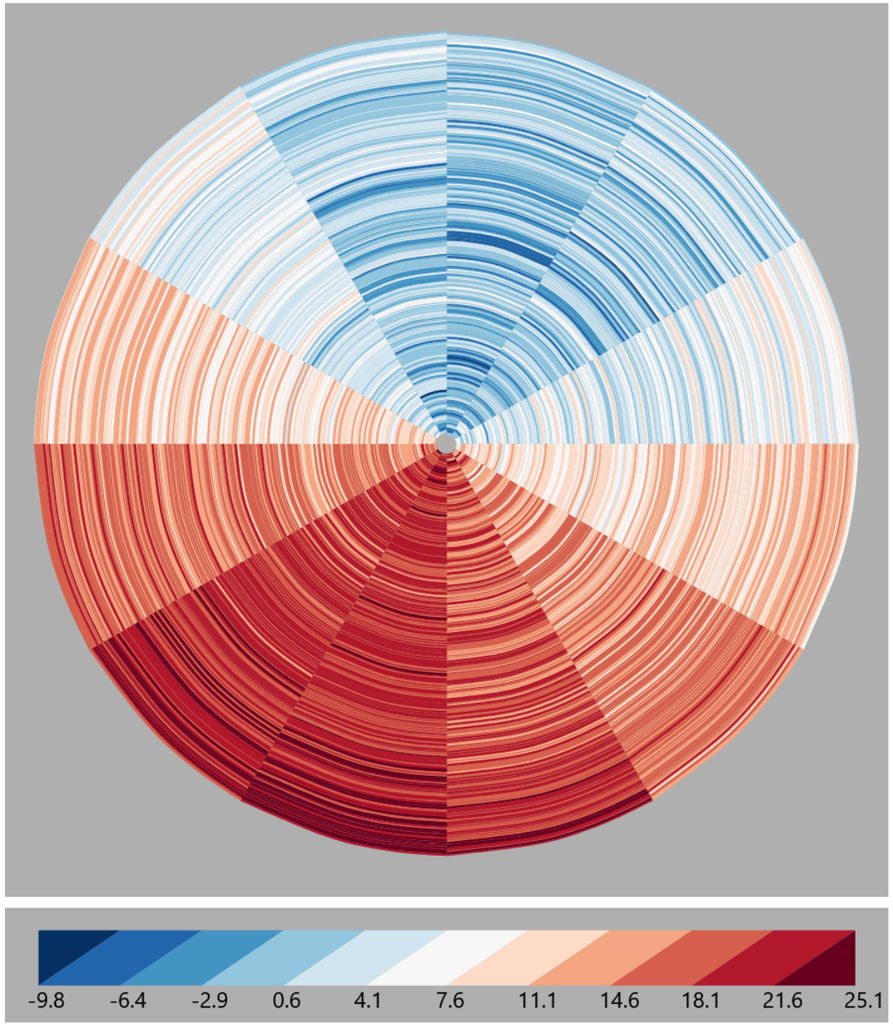
02.06.2025 - EuroVA

Given a long time series



Hard to spot repeating patterns through a line chart.

Alternative Visualization: Spirals



Visualizing Time-Series on Spirals

Marc Weber
crcp

Marc Alexa
Technische Universität Darmstadt

Wolfgang Müller
e4ib.com

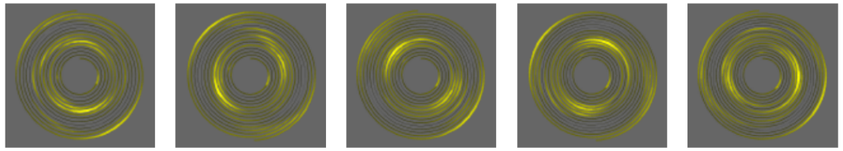


Figure 3: Visualizations of the same data with continously changing cycle length. The period in the data can be found visually, i.e. the visual system is used to detect periodic patterns in the data exploiting the spatial layout on the spiral. In this example, the visual system detects a significant structure in the middle image, which unveils the corresponding periodicity in the data.

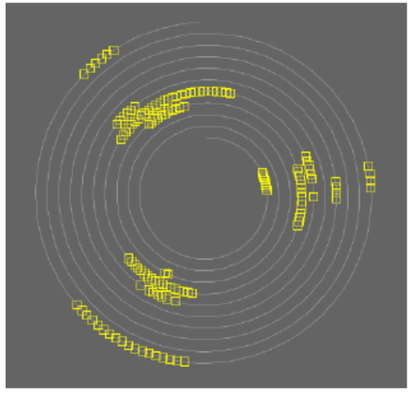


Figure 2: Nominal time-series data presented on a Spiral. The periodic behaviour of the underlying process is revealed.

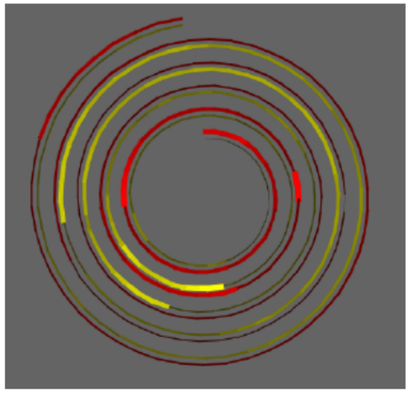
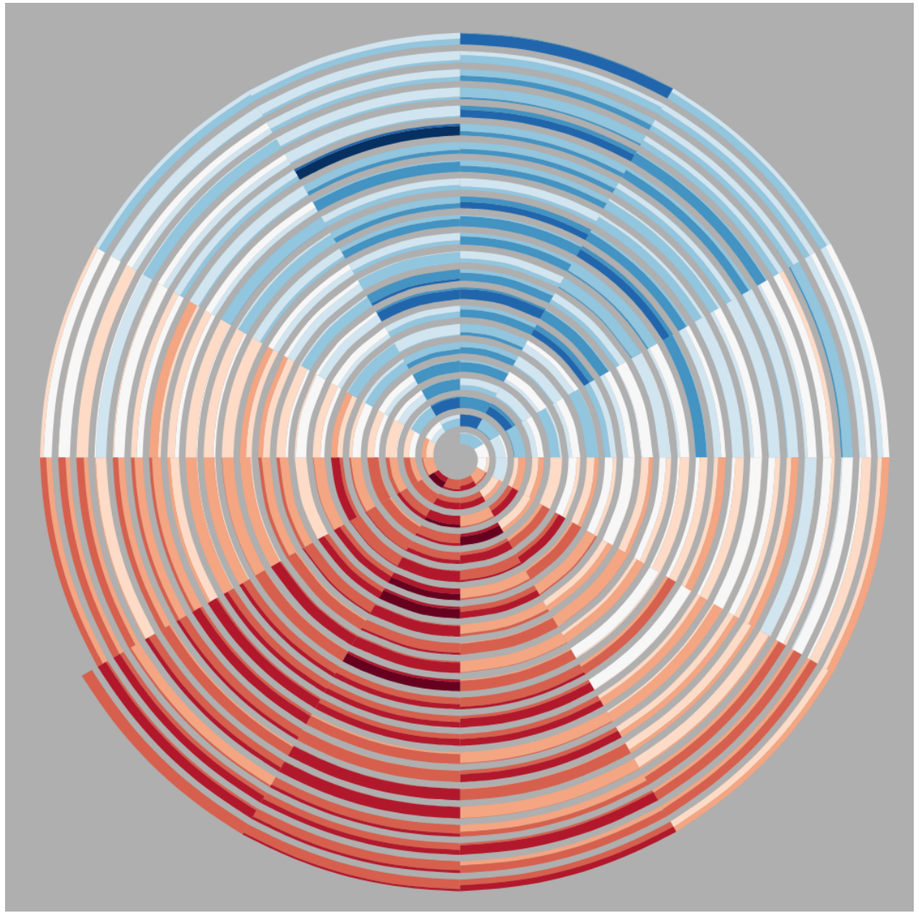


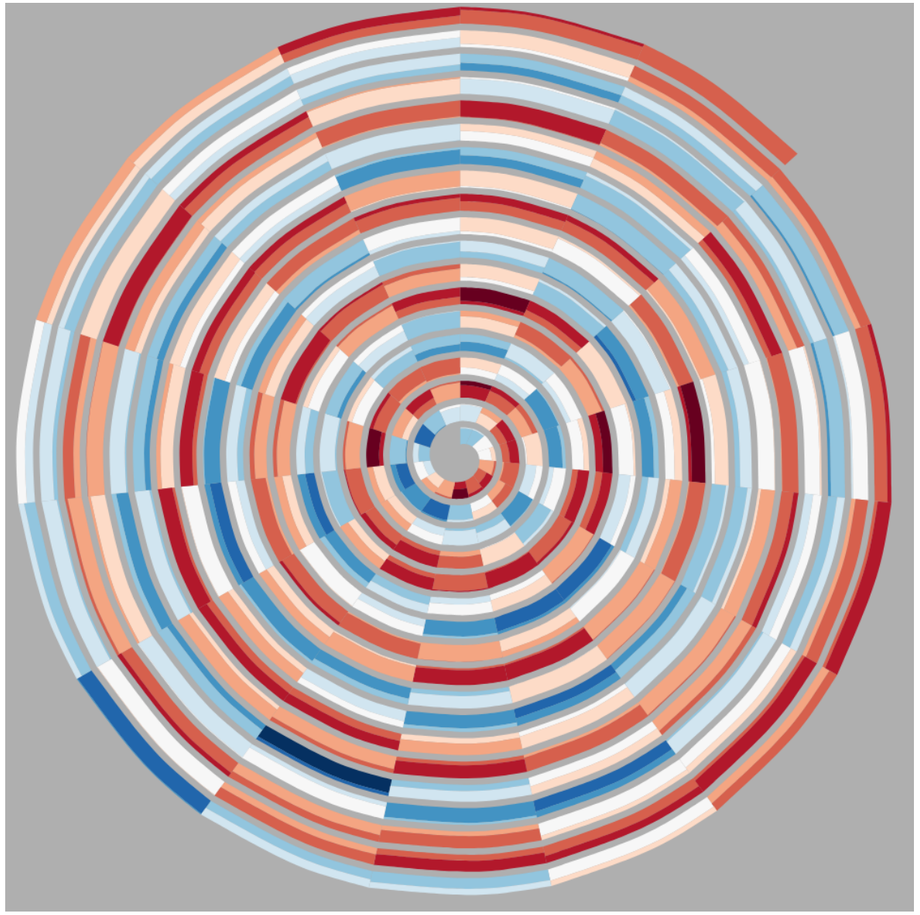
Figure 4: Comparing different data sets on a multi-spiral. Here, comparative reading can be combined with matching the peri-

Weber et al. "Visualizing Time-Series on Spirals" (2001)

Not every number of segments per cycle is meaningful



12 segments per cycle



15 segments per cycle

How to find a good alignment? Guidance!

Guided Visual Exploration of Cyclical Patterns in Time-series

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Theresia Gschwandtner
TU Wien, Austria

Silvia Miksch
TU Wien, Austria

Christian Tominski
University of Rostock, Germany

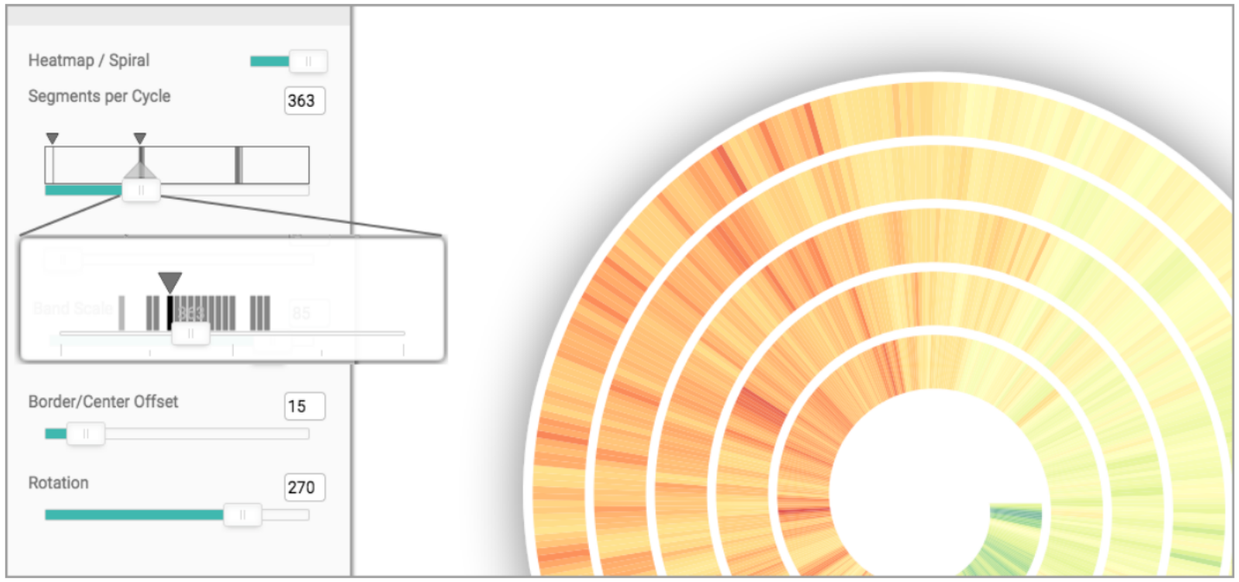


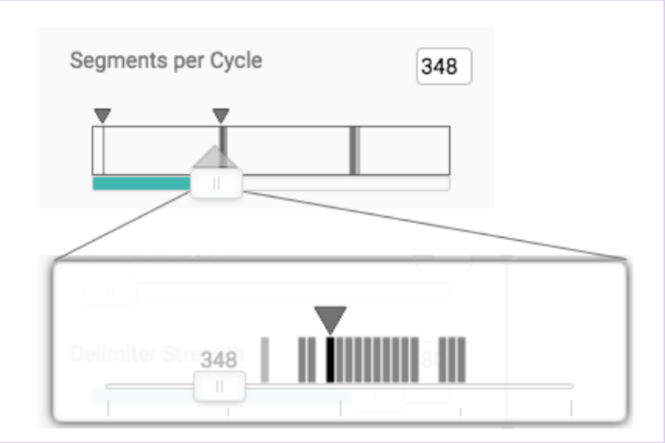
Figure 1: Our guided solution for the exploration of cyclical patterns in time-series. A classical spiral plot is enhanced with data-driven guidance mechanisms to support the identification of patterns. This figure is cropped to see the slider which is used to modify the cycle length displayed in the spiral plot. We statistically determine cycle lengths that reveal strong patterns and visually indicate these interesting cycle lengths while the user interacts with the slider.

How does it work?

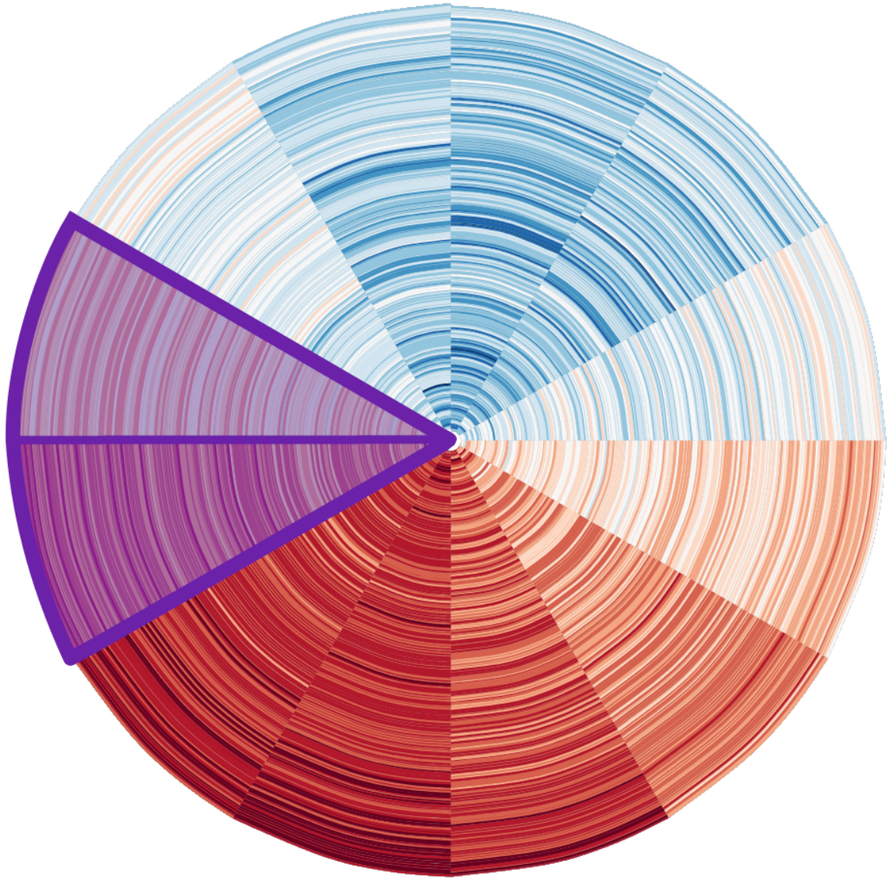
1. Algorithmically determine cyclical phenomena

- Discrete Fourier Transform (DFT)
- Chi Square Periodogram (CSP)

2. Provide Visual Cues



Once aligned, we can compare cycles within a sector

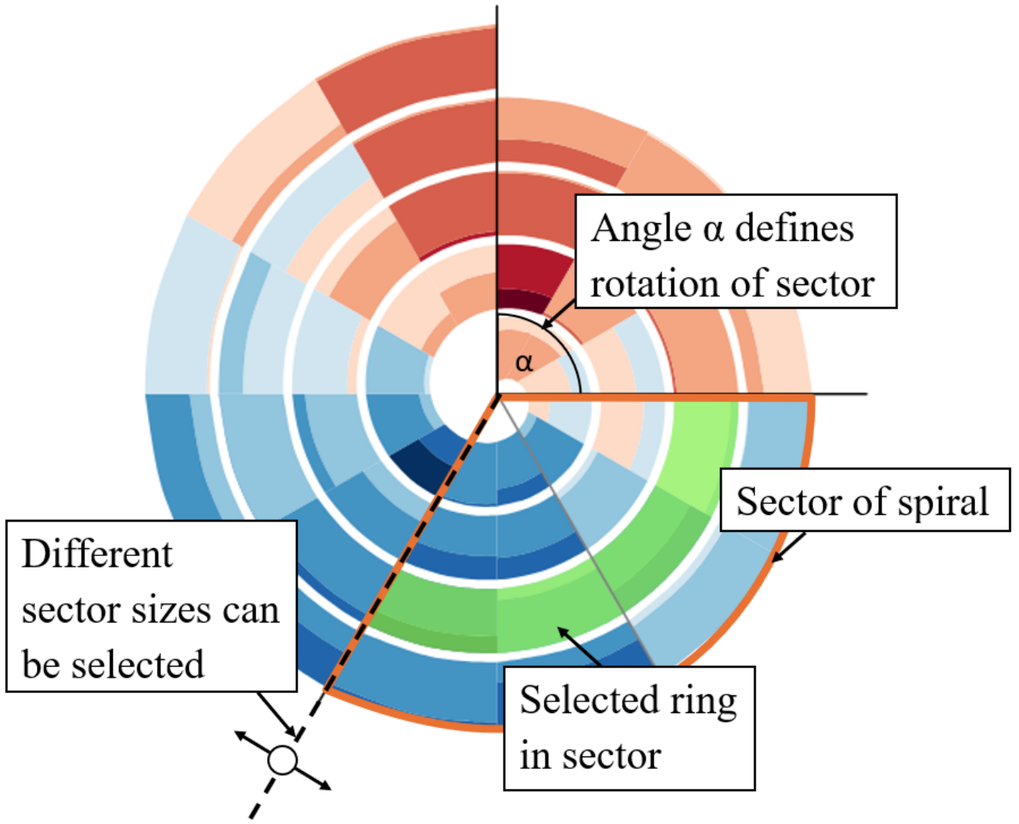


Do segments within a sector change over time?

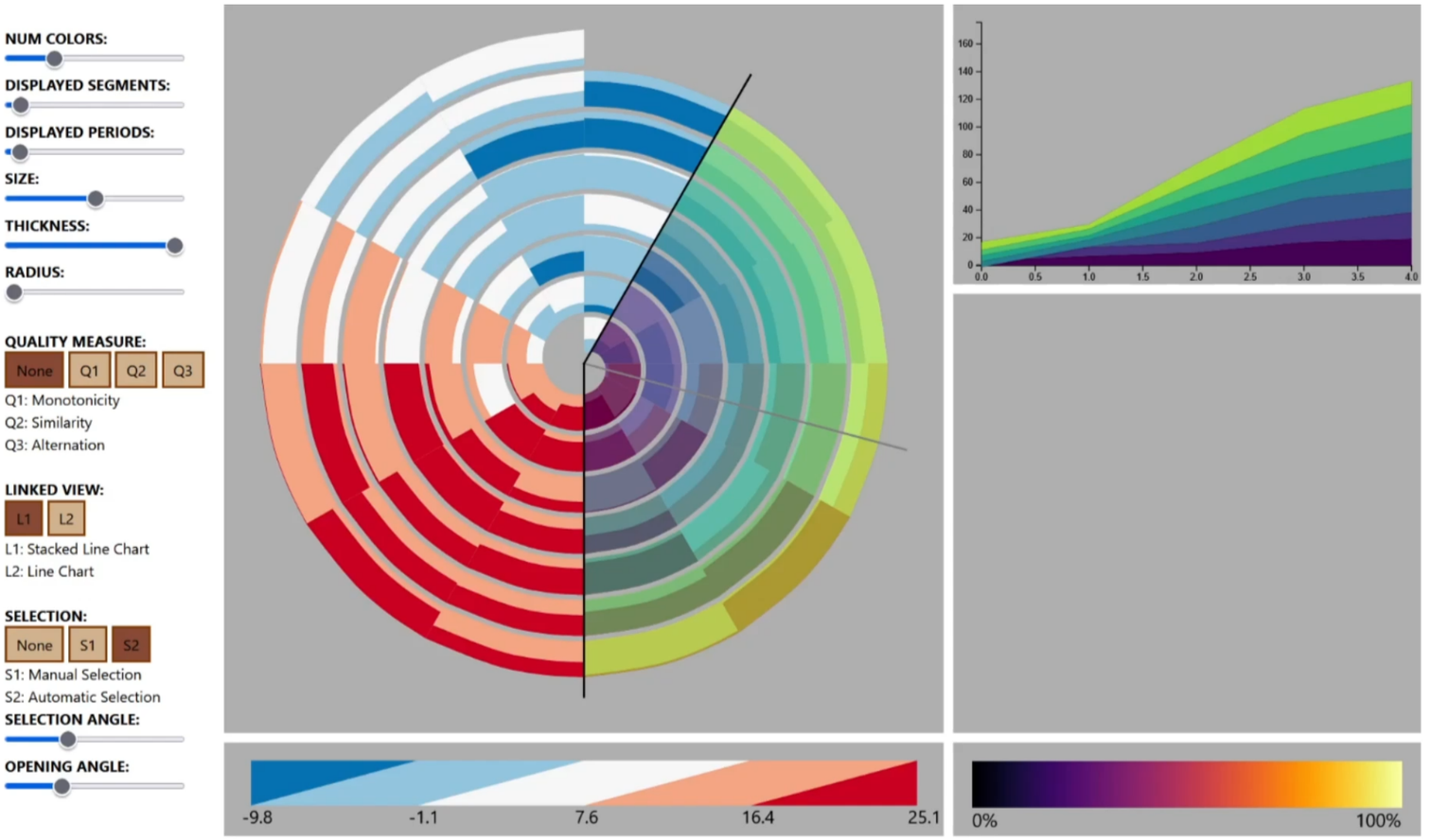
How do segments compare with neighboring segments?

Can we effectively guide users towards interesting sectors?

Selecting Sectors of the Spiral



Interactive Sector Selection



What makes a sector interesting?

- Similarity between cycles
- Monotonicity behavior
- Change of values of over time

Quantifying these properties through quality measures

Monotonicity

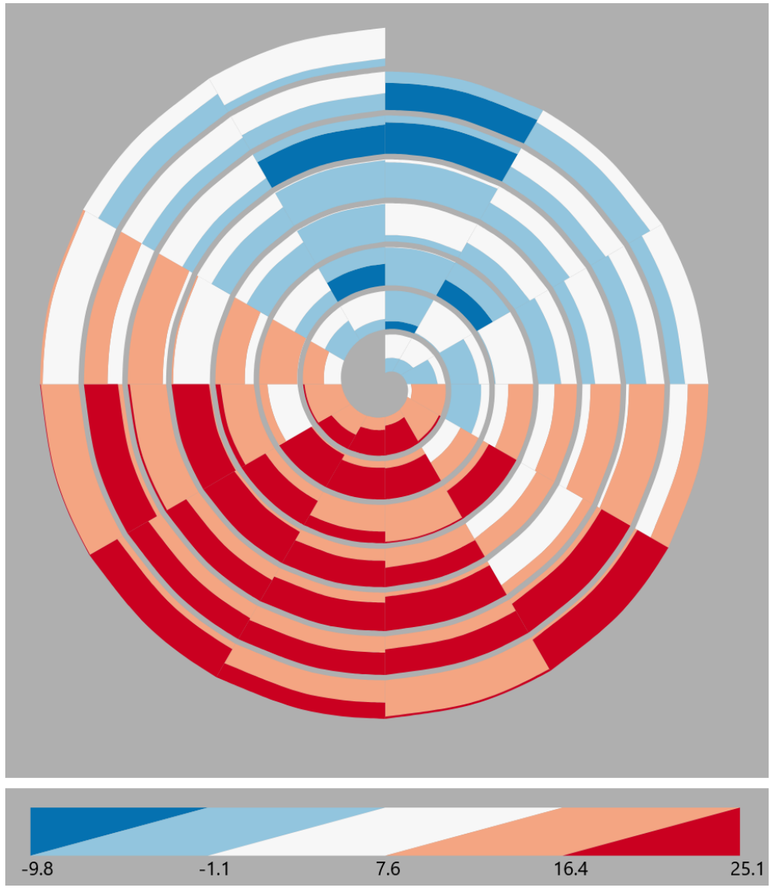
- Select a sector
- For each cycle in the sector:
  - Count number of consecutively increasing elements
  - Normalize by cycle length
- Average all cycle monotonicity scores to attain sector score

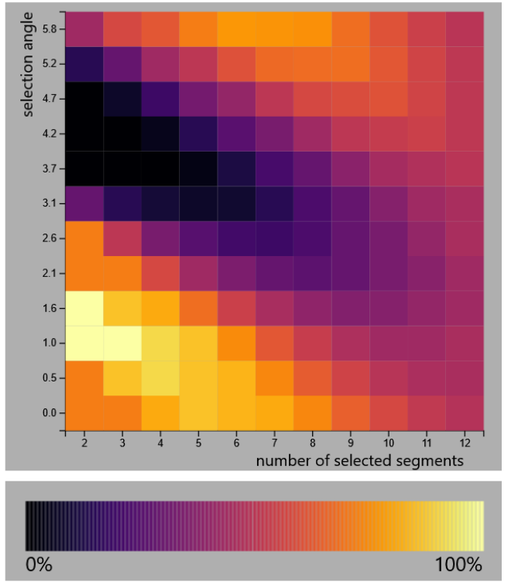
Dissimilarity

- Select a sector
- Compute pairwise Euclidean distance / DTW between all cycles (excluding self similarity)
- Compute average distance

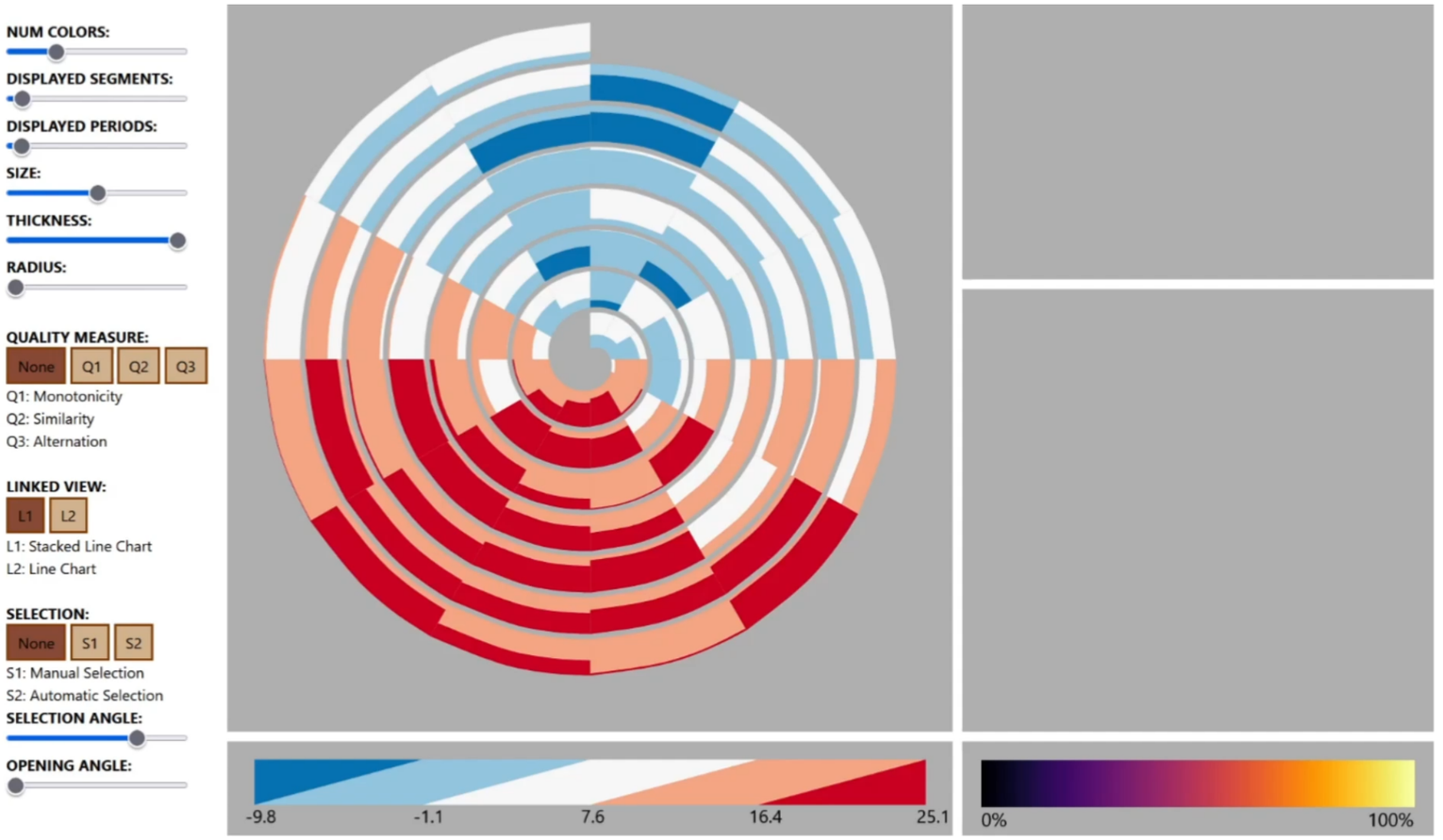
Visualization via heatmaps

We compute these quality measures for each sector configuration



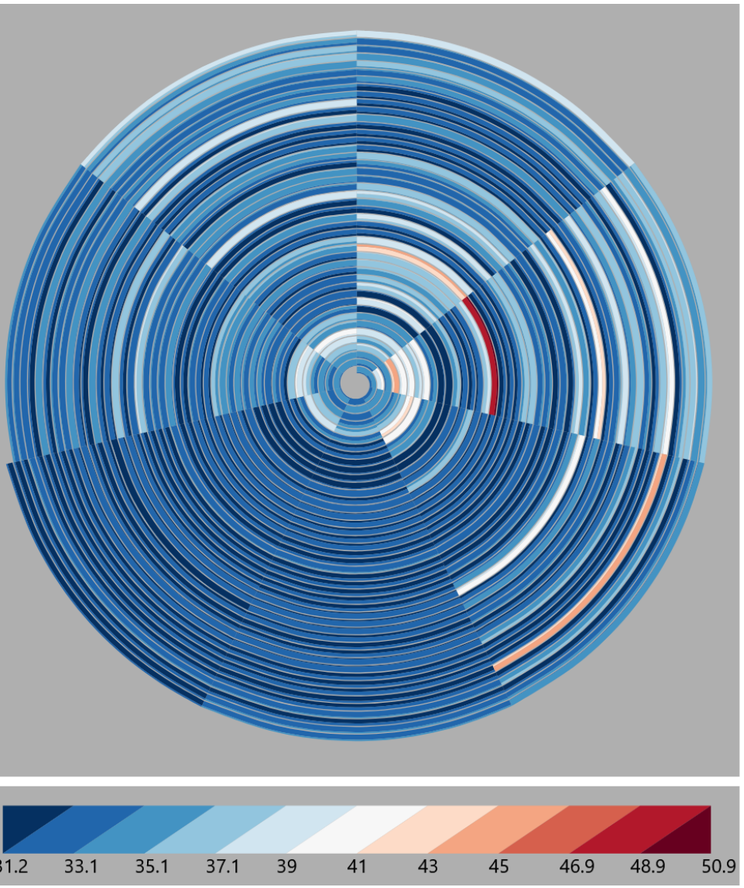


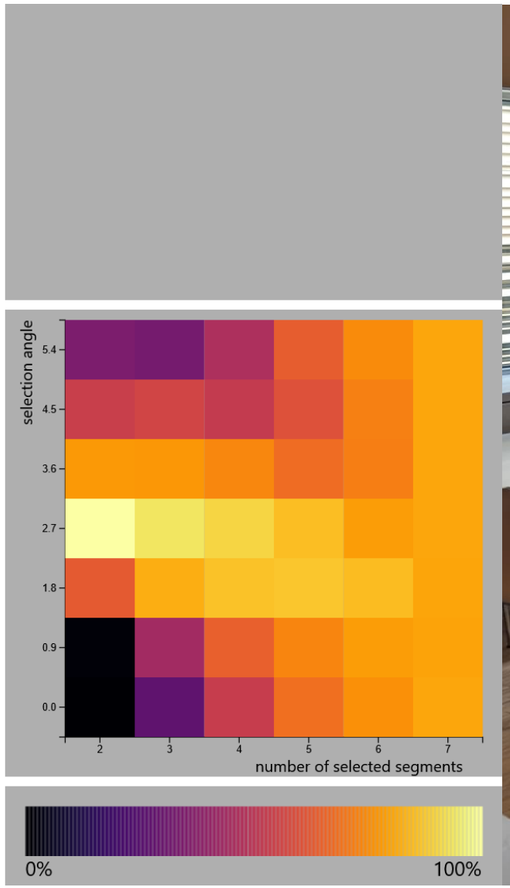
The heatmaps are fully interactive



What are the benefits of this guidance approach?

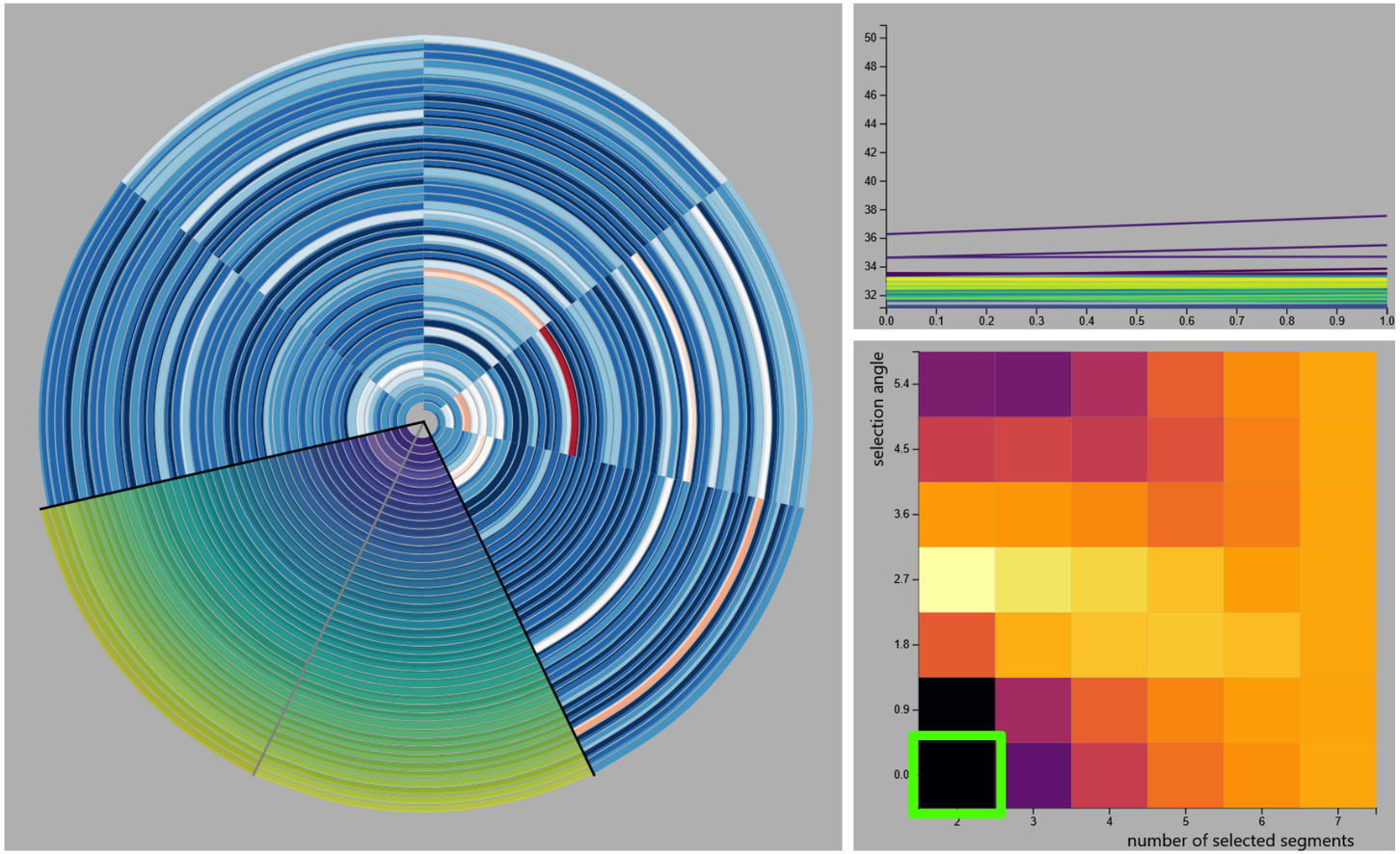
Outliers may distort the color mapping





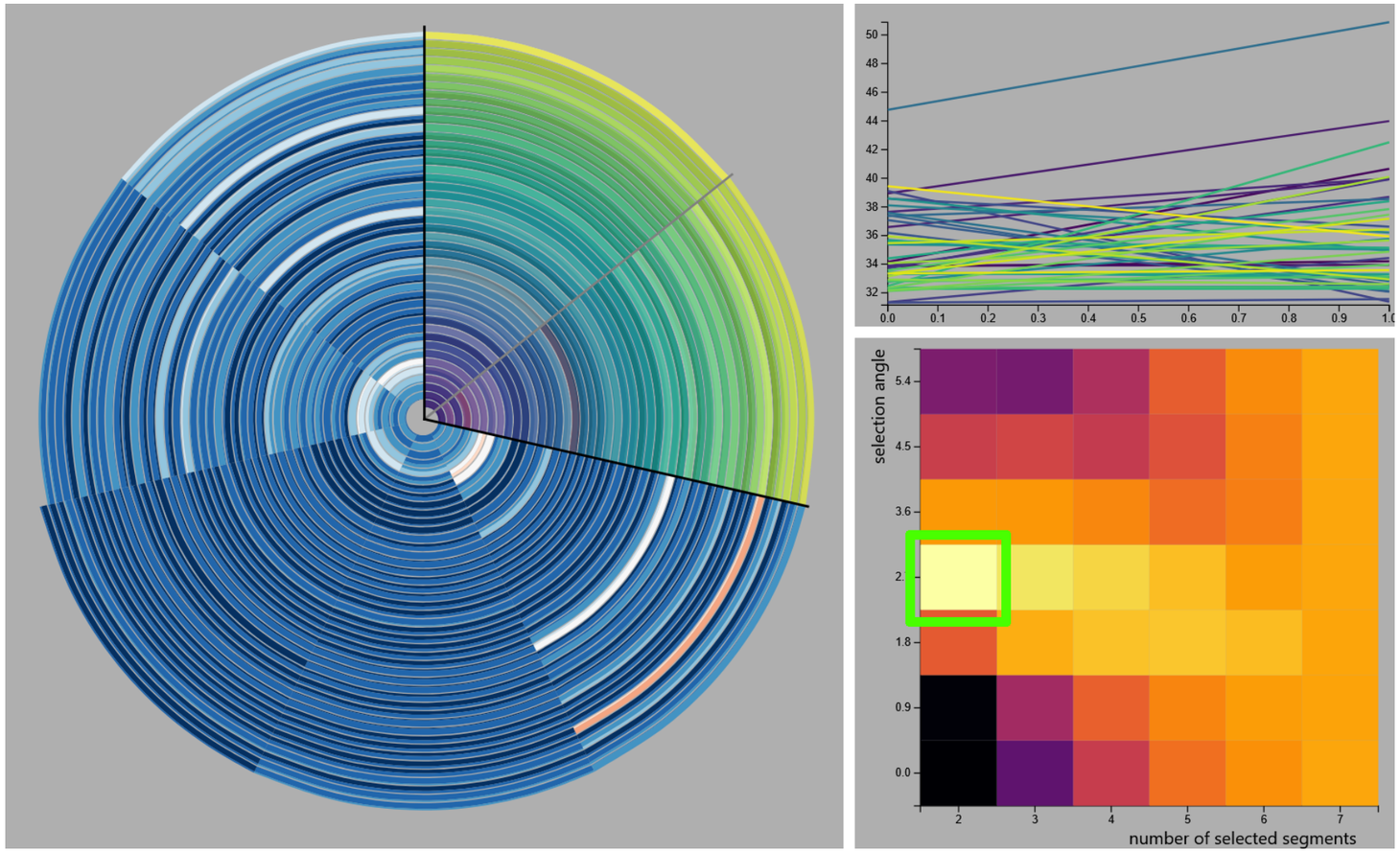
We recorded the sound level in our seminar room

Guidance unaffected



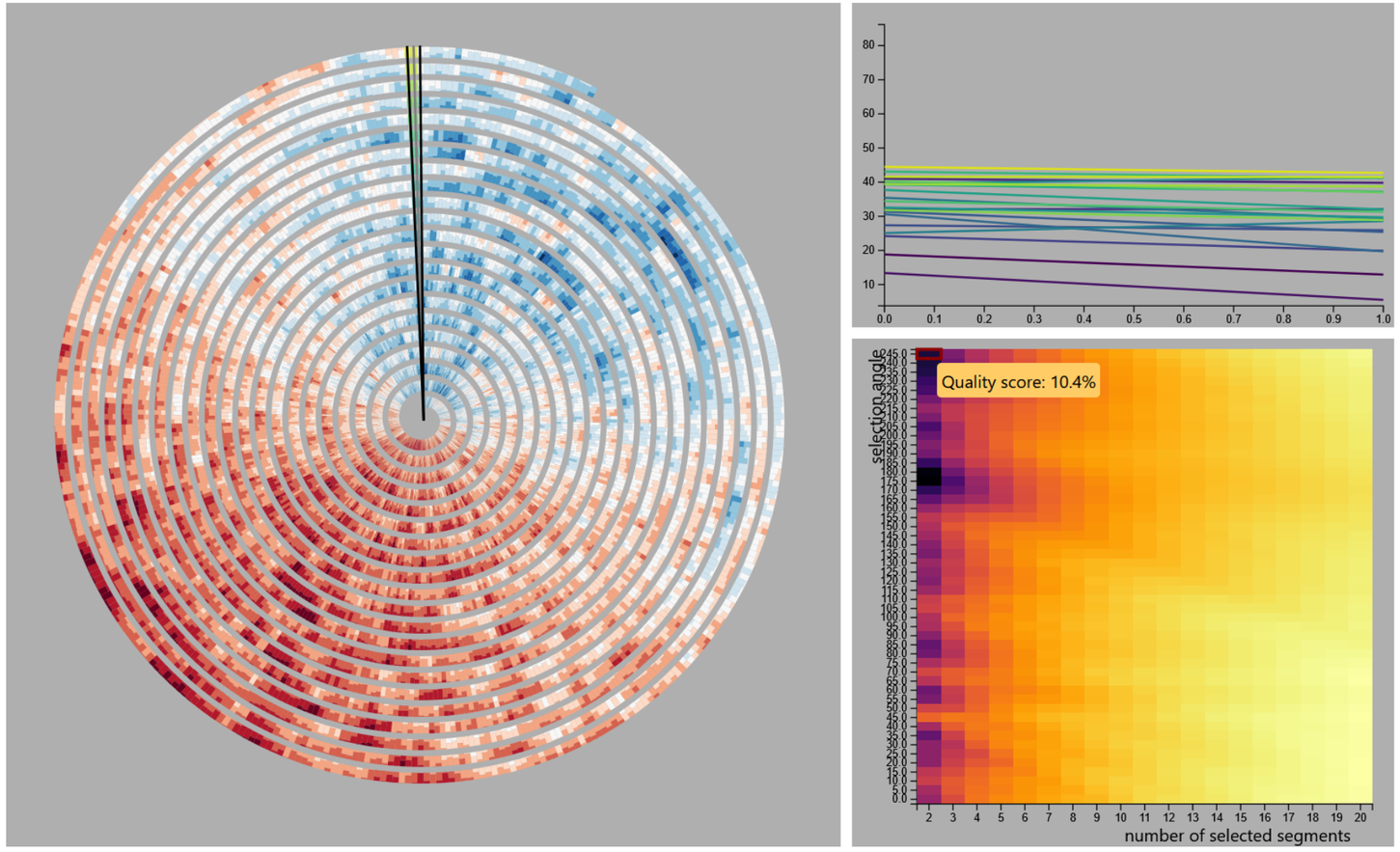
Euclidean Distance - Weekends rather quiet

Guidance unaffected



Euclidean Distance - During week rather busy

Guidance on large spirals



Daily temperature in Vienna over 20 years

Conclusion

Providing guidance on time series spirals may provide additional value

Our interface provides a framework for future extensions

Future Works

- Additional quality measures
- Multivariate time series
- Searching for further use cases

Questions?

Slides:

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