

Eye Tracking and Visual Analytics

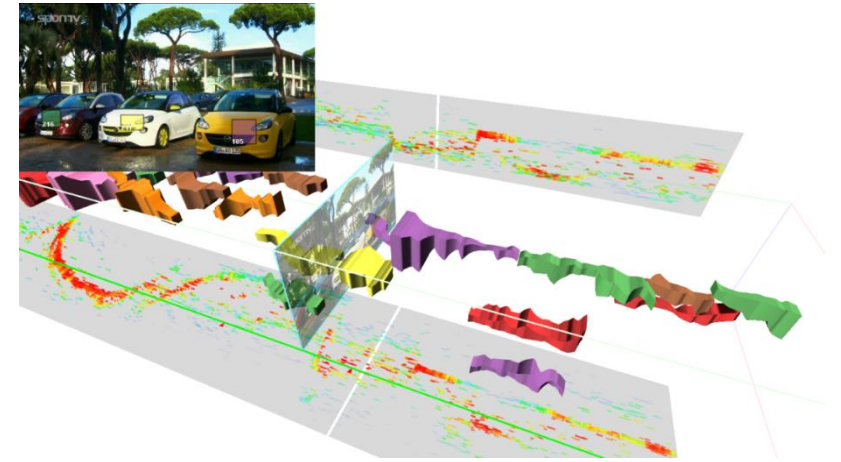
Visual Analytics Tools

Tanja Blascheck, Michael Burch, Michael Raschke

ETRA | Warsaw, Poland | 14.06.2018

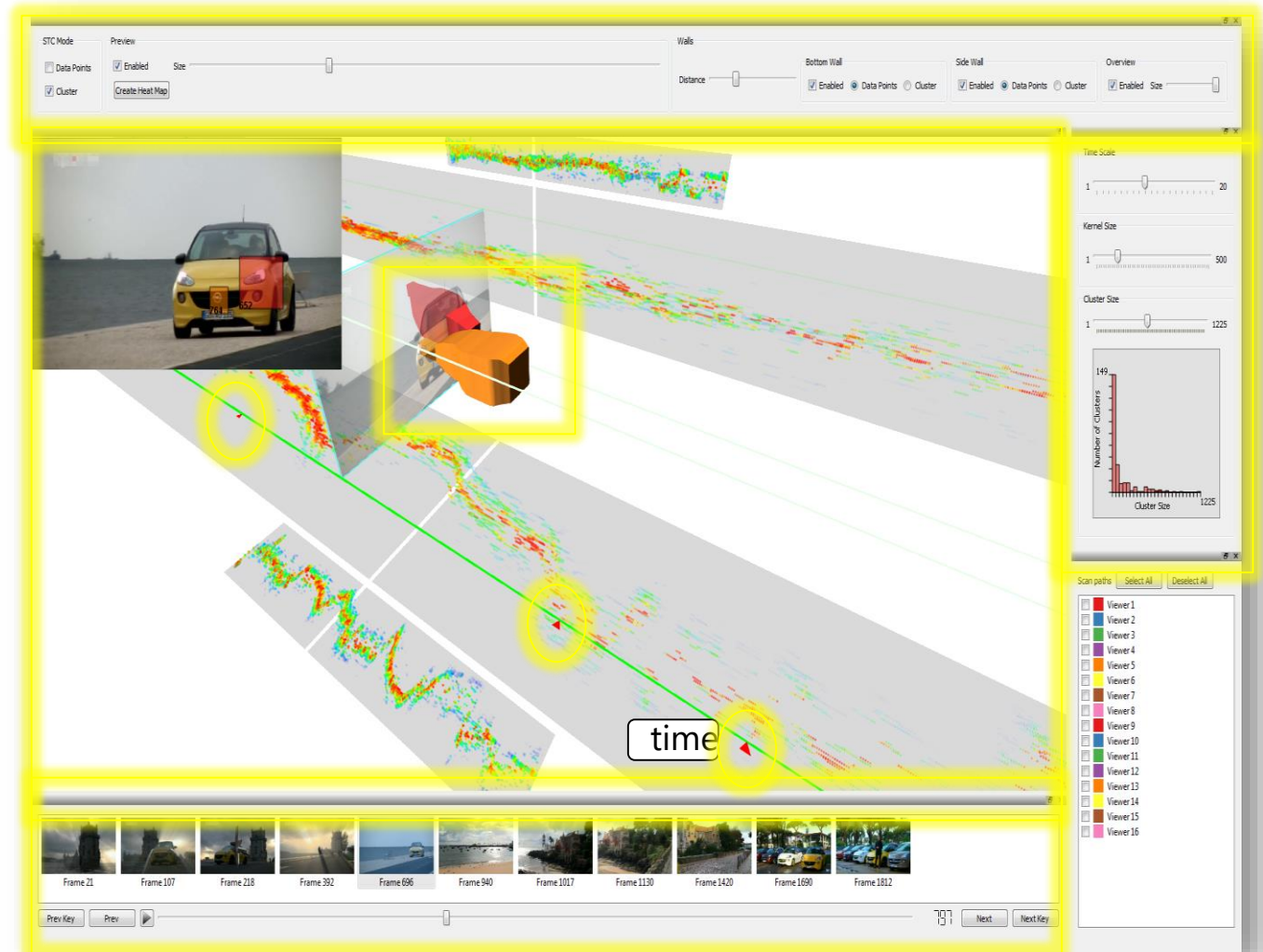
ISeeCube

- Authors: Kuno Kurzhals and Daniel Weiskopf
- Publication: Kurzhals and Weiskopf. (2013) Space-Time Visual Analytics of Eye-Tracking Data for Dynamic Stimuli. *IEEE Transactions on Visualization and Computer Graphics*, 19(12): 2129-2138



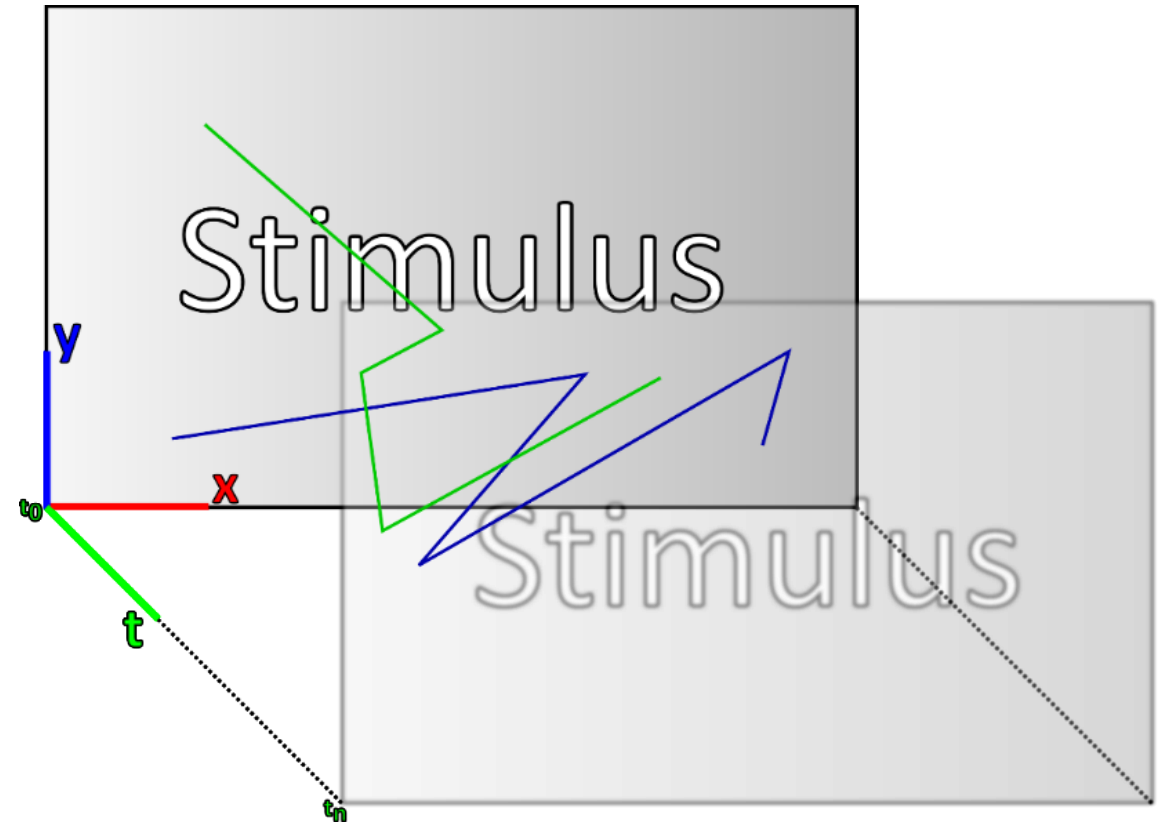
ISeeCube

- Static overview
- Data mining and computer vision
 - Shot detection
 - Gaze clustering
- Interaction
 - Density filter
 - Cluster size filter
- Multiple coordinated views



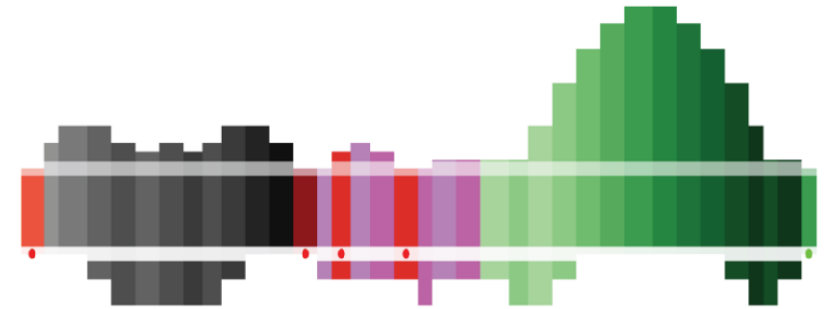
ISeeCube

- Extends spatial dimension by a temporal dimension
- Spatio-temporal overview
- Visualize gaze points, scanpaths, and cluster



Alpscarf

- Authors: Chia-Kai Yang and Chat Wacharamanotham
- Publication: Yang and Wacharamanotham (2018) Alpscarf: Augmenting Scarf Plots for Exploring Temporal Gaze Patterns. *In Proceedings of the 2018 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, ACM
- Tool: <https://www.zpac.ch/alpscarf/>
<https://github.com/chia-kaiyang/alpscarf>



Alpscarf

- Finding temporal patterns of AOI visits
 - What are the reading strategies?
 - Do study participants read the text sequentially or jump to different sections out of sequence?
 - How do participants read and re-read individual sections?
- With more than 10 AOIs, visualizations become ineffective

Alpscarf

Mountains

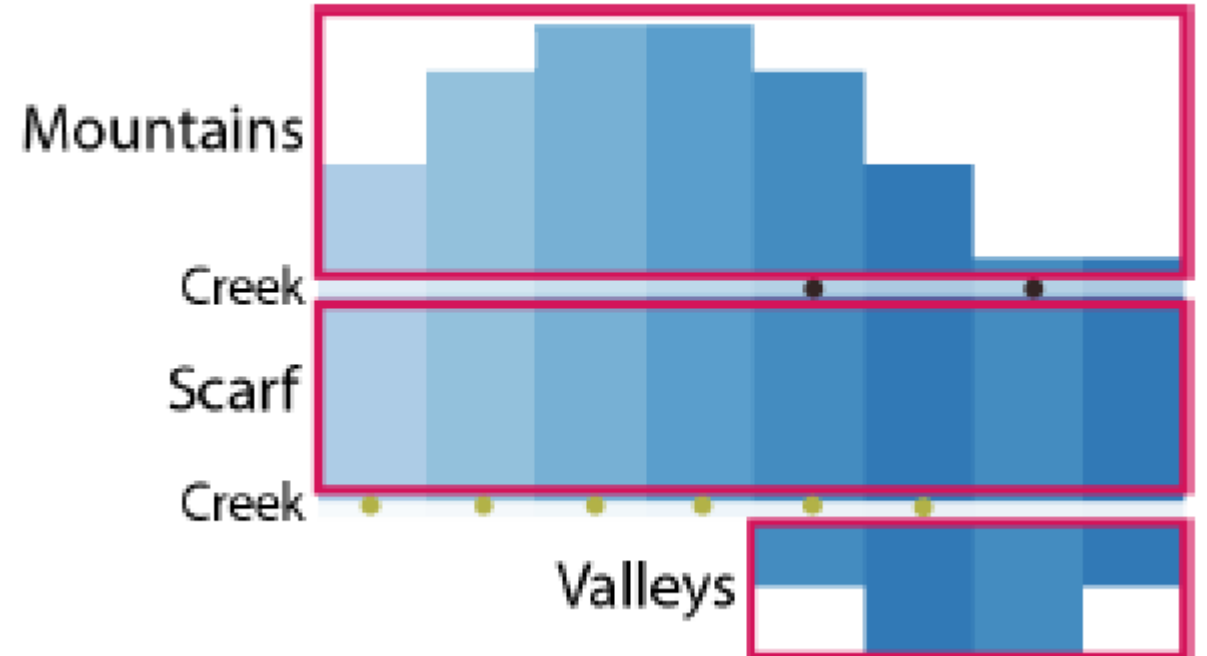
- Conformity of AOI visits to an expected order
- Symmetrical
- Peak indicates the middle of such sequence-conformity behavior

Valleys

- Indicate the occurrence of visiting patterns
- Horizontal length of the valley corresponds to the duration of such re-visiting behavior

Creeks

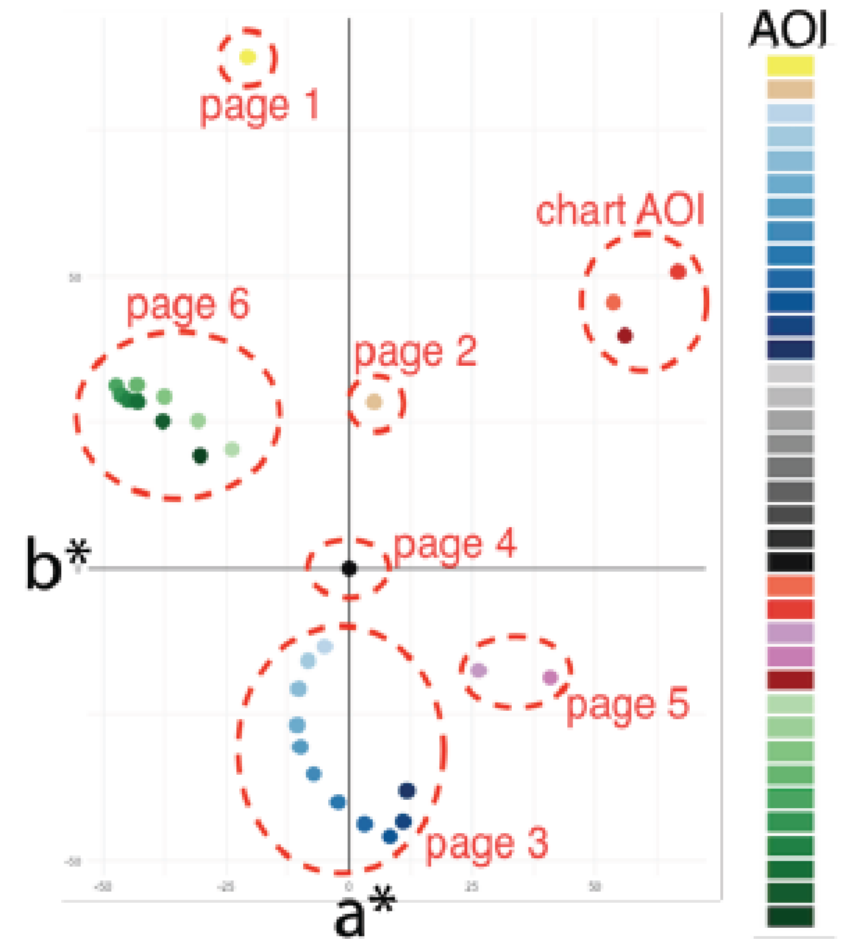
- Additional annotations



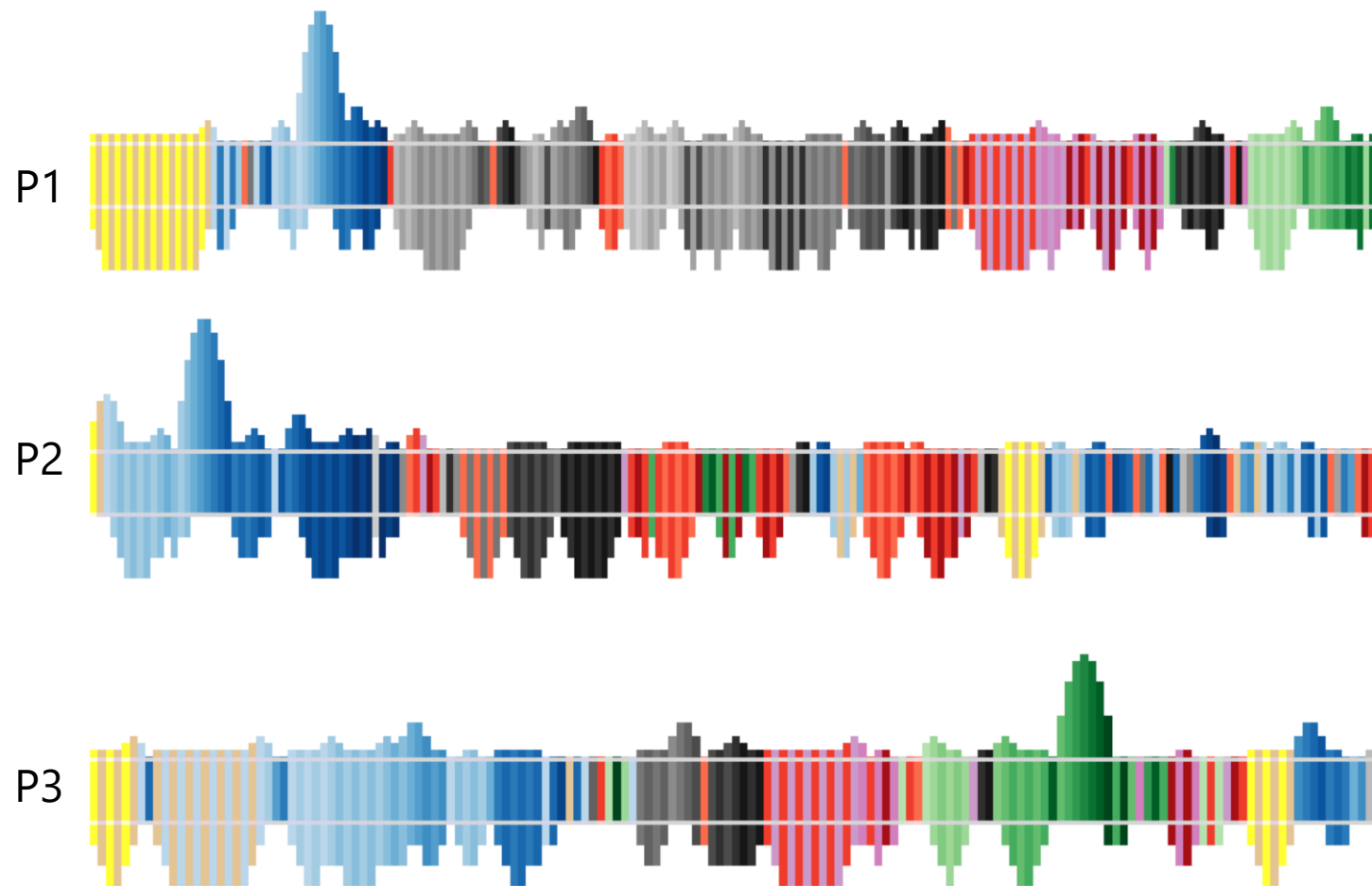
Alpscarf

Color scheme

- Indicates hierarchical structures of the AOIs
- Paragraph AOIs of the same section
 - Shown as shades of same color
 - Luminance ordered by paragraph appearance



Alpscarf



Radial Transition Graph

- Authors: Tanja Blascheck, Markus Schweizer, Fabian Beck, and Thomas Ertl
- Publication: Blascheck et al. (2017) Visual comparison of eye movement patterns. *Computer Graphics Forum*, 36(3):87–97
- Tool: <http://www.rtgct.fbeck.com/>



Radial Transition Graph

- Compare data from different eye tracking recordings
 - Find common eye movement patterns
 - Identify groups of participants sharing the same strategy
 - Detect outliers

Radial Transition Graph

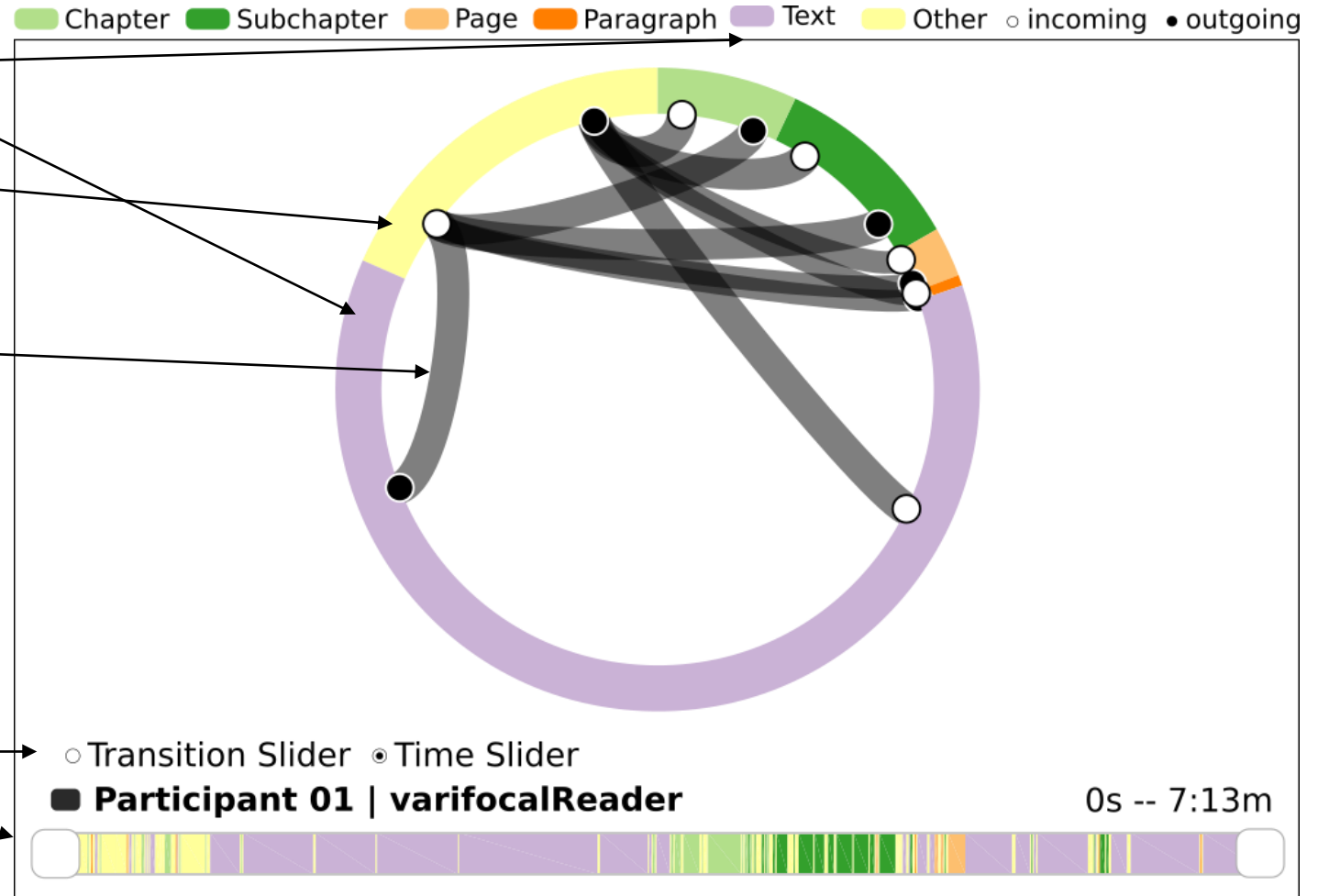
Sectors: AOIs depicted with unique color

Sector size: dwell time

Transition arcs: thickness represents transition count

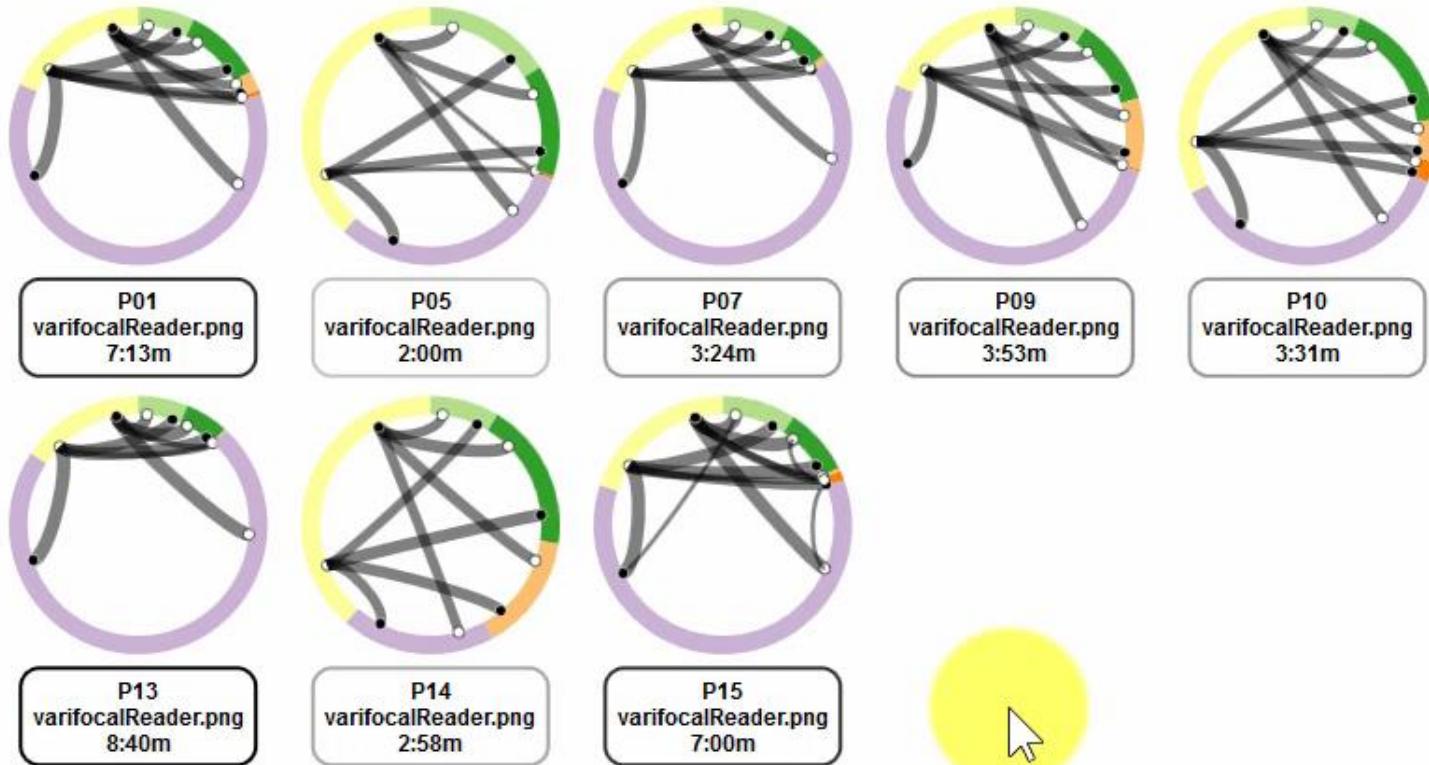
Scarf plots: show the temporal order of transitions

transition and time



Radial Transition Graph

Chapter Subchapter Page Paragraph Text Other ◯ incoming • outgoing



Radial Transition Graph

Participant 01 | inner
Participant 15 | outer

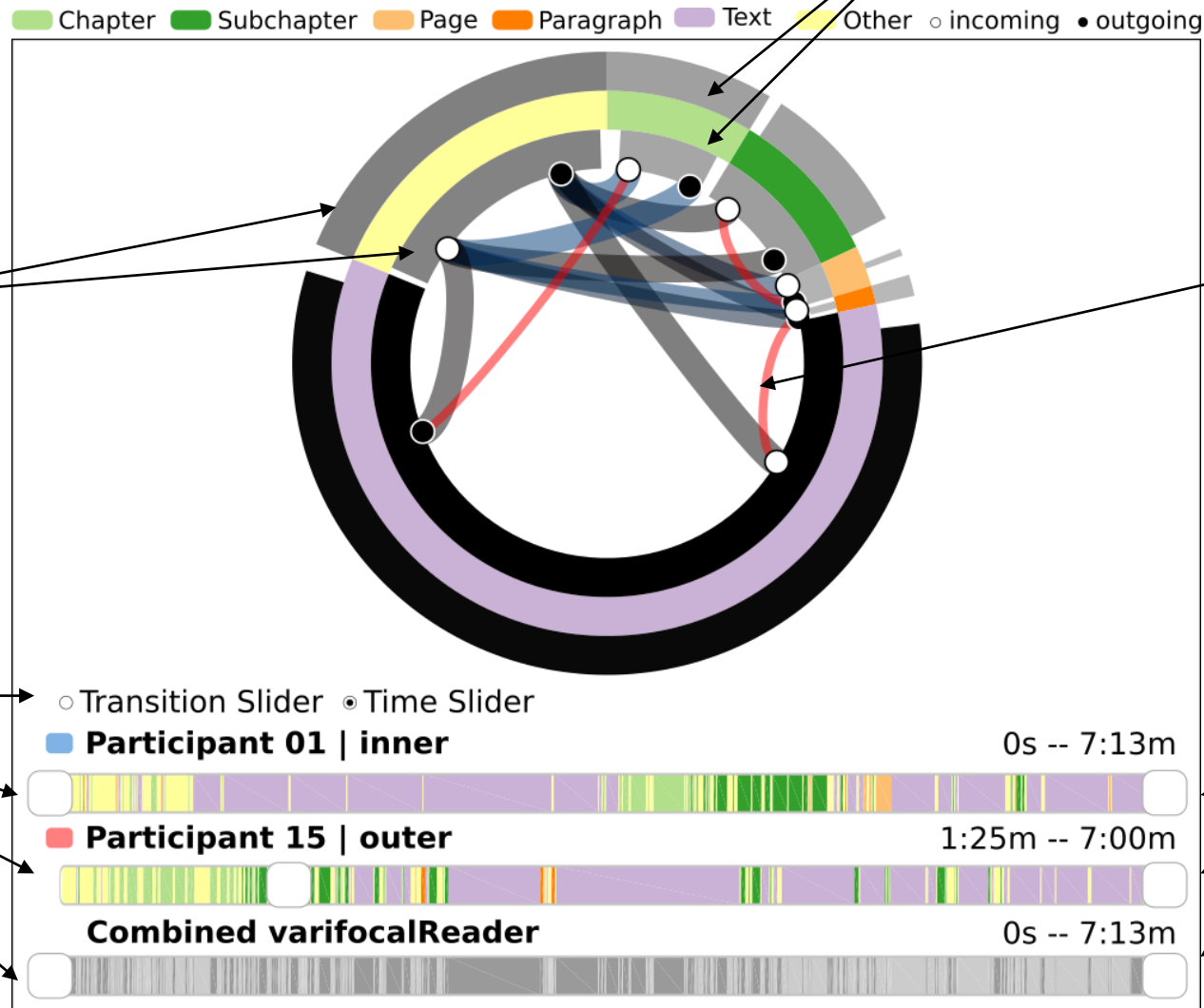
Inner and outer sectors: one for each participant

Sliders: one for each participant and combined

Sector size: maximum dwell time of both participants

Transition arcs: color depicts which participant has more transitions

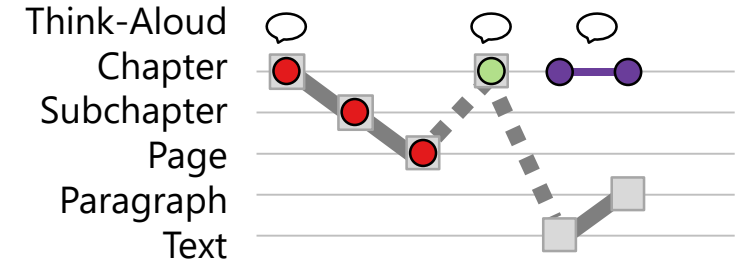
Scarf plots: one for each participant and combined



AOI Sequence Charts

- Authors: Tanja Blascheck, Markus John, Kuno Kurzhals, Steffen Koch, Thomas Ertl
- Publication: T. Blascheck et al. (2016) VA2: A visual analytics approach for evaluating visual analytics applications. *IEEE Transactions on Visualization and Computer Graphics*, 22(1): 61–70

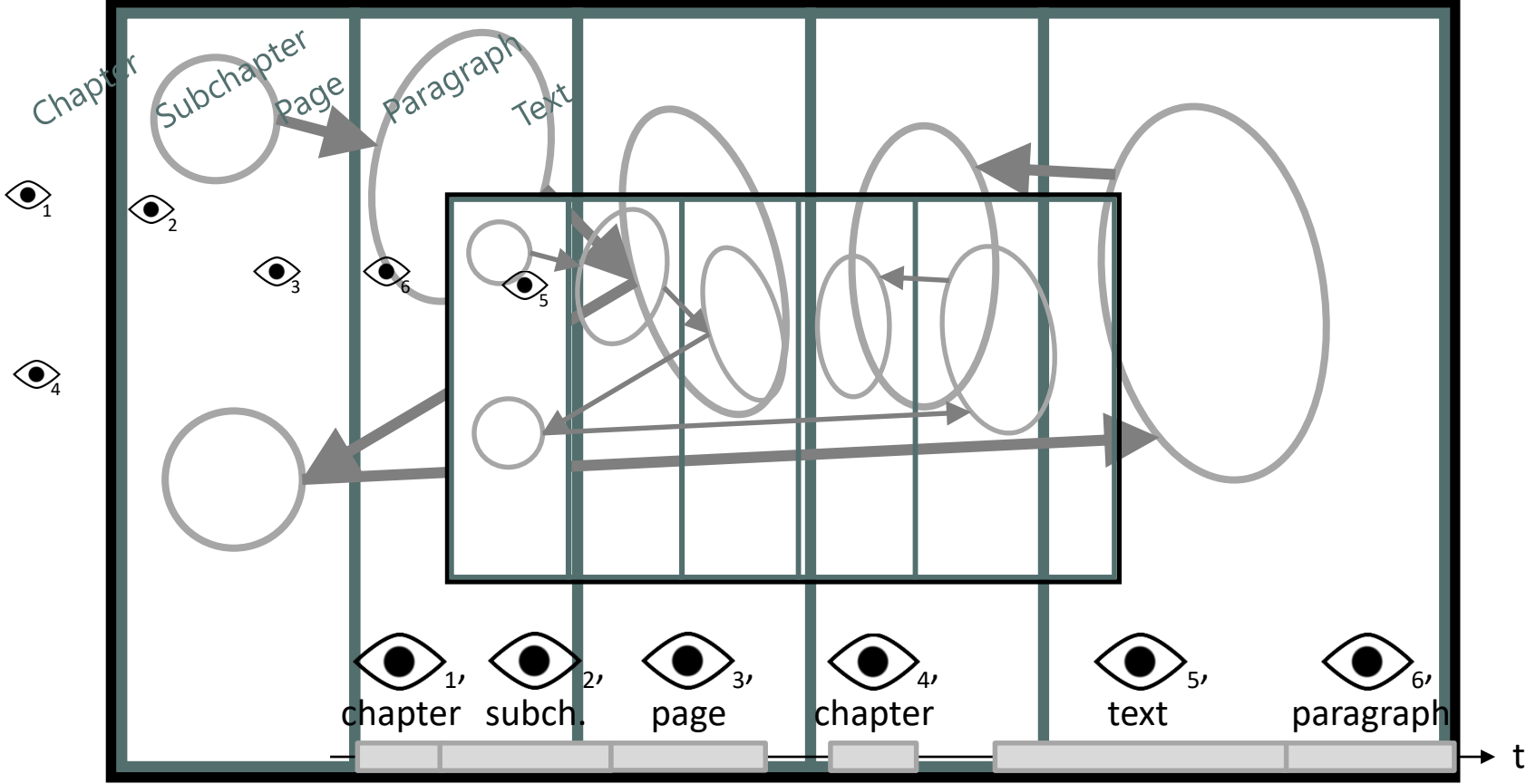
Participant P01



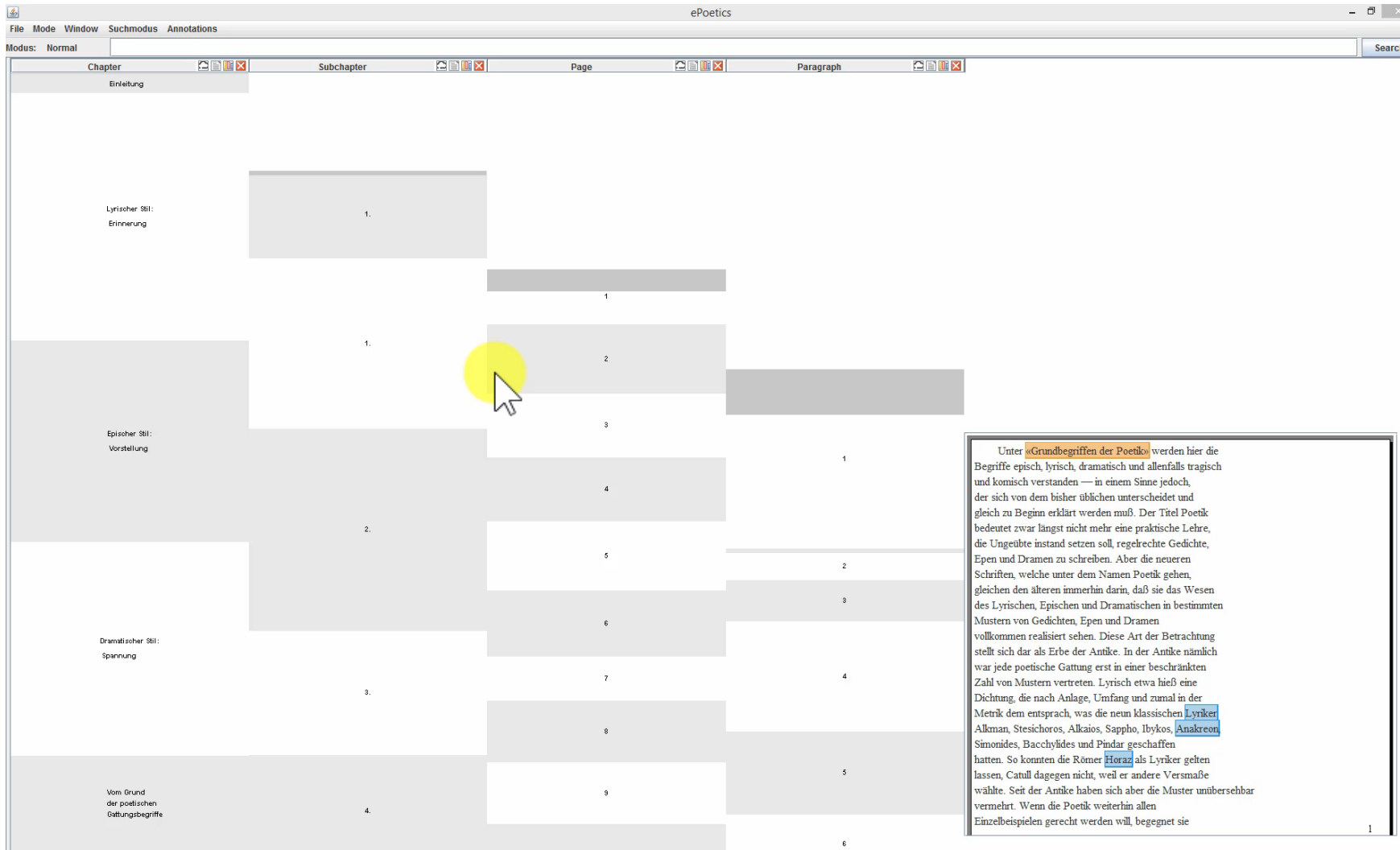
AOI Sequence Charts

- Extraction of patterns
- Discovery of common strategies
- Generate and test hypothesis
- Multimodal data
 - Eye movements
 - Interaction logs
 - Think-aloud protocols

AOI Sequence Chart

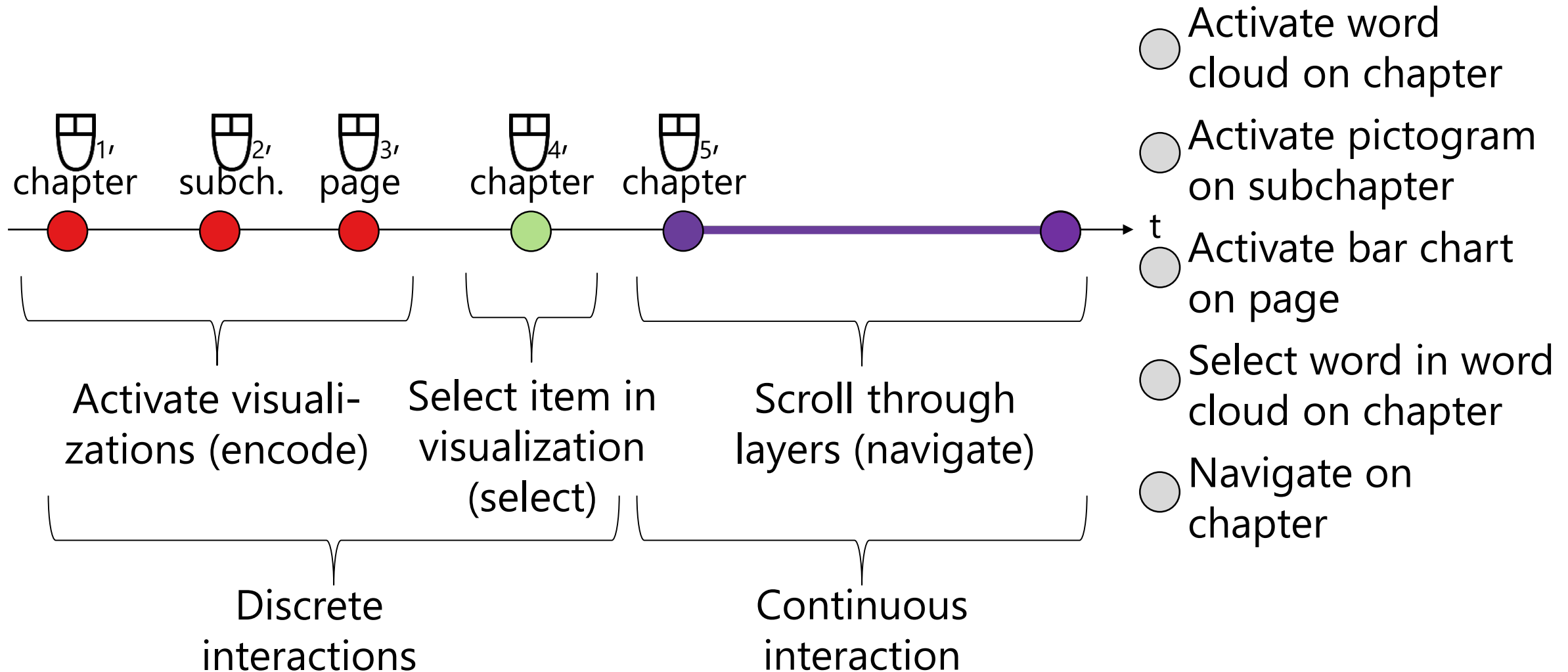


AOI Sequence Chart

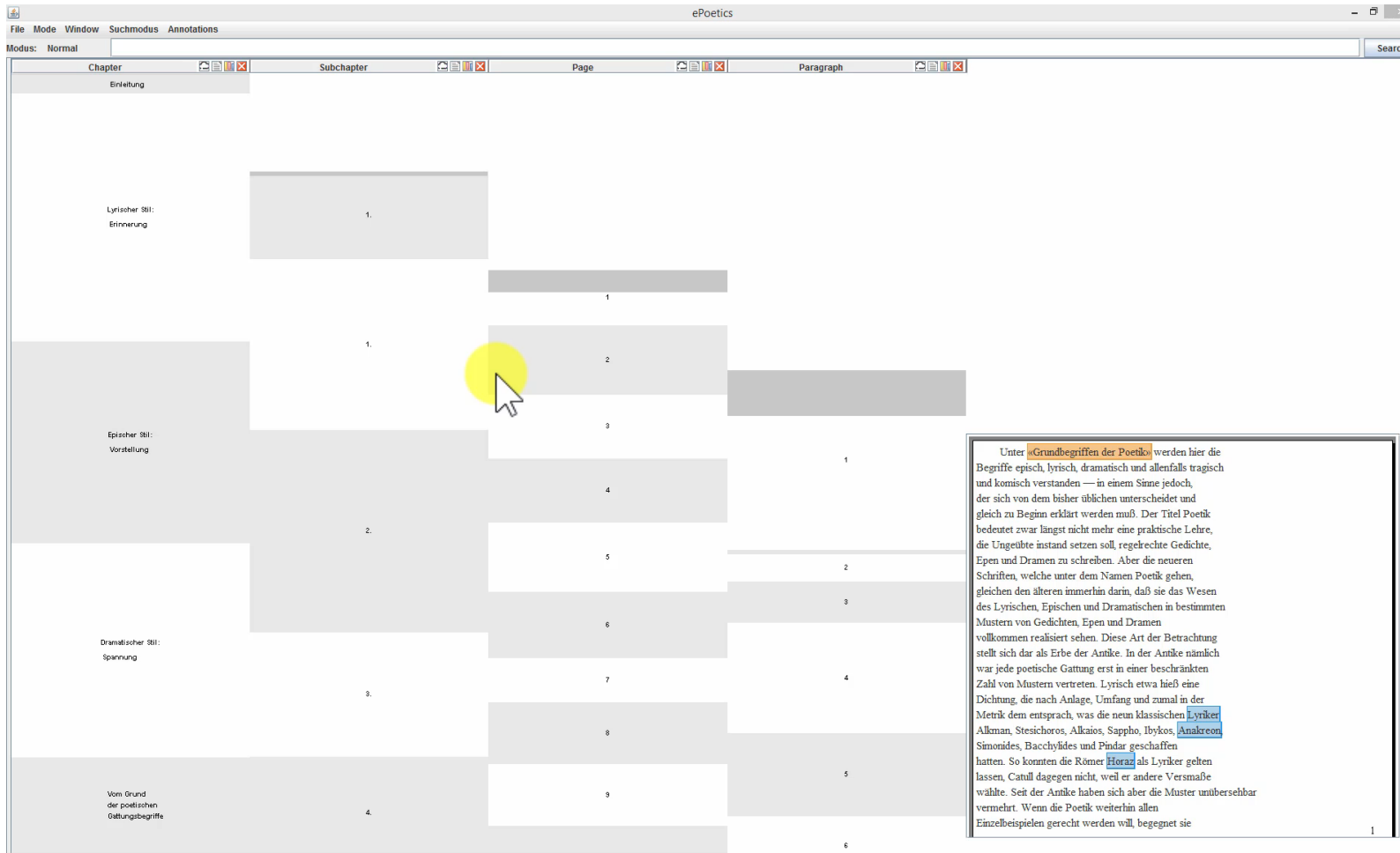
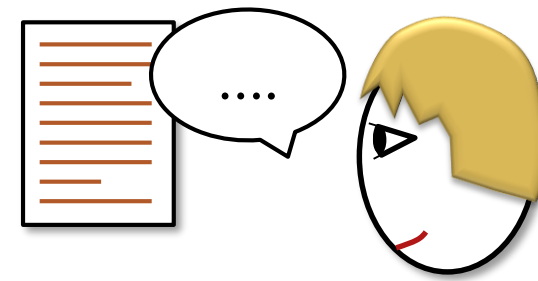


- Activate word cloud on chapter
- Activate pictogram on subchapter
- Activate bar chart on page
- Select word in word cloud on chapter
- Navigate on chapter

AOI Sequence Chart



AOI Sequence Chart

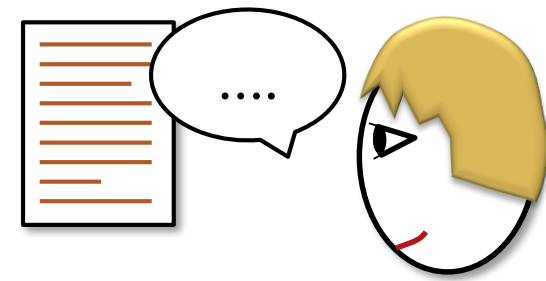


00:00:00 – First, I will activate all the visualizations.

00:00:10 – Now, I will select the term Wallenstein in the word cloud.

00:00:15 – Next, I will navigate through the text until I find the term. Ah, there the book is referring to Wallenstein.

AOI Sequence Chart



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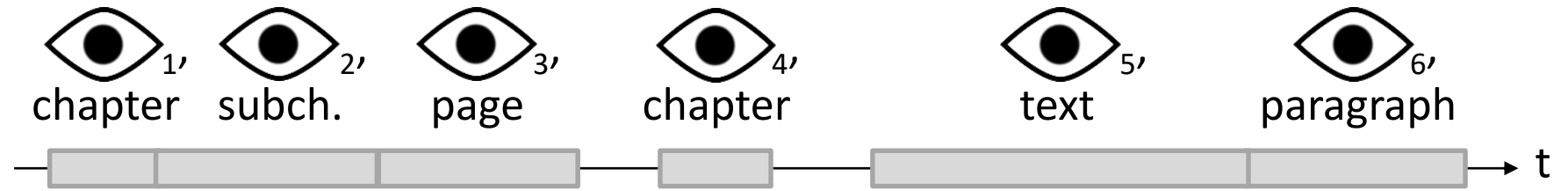
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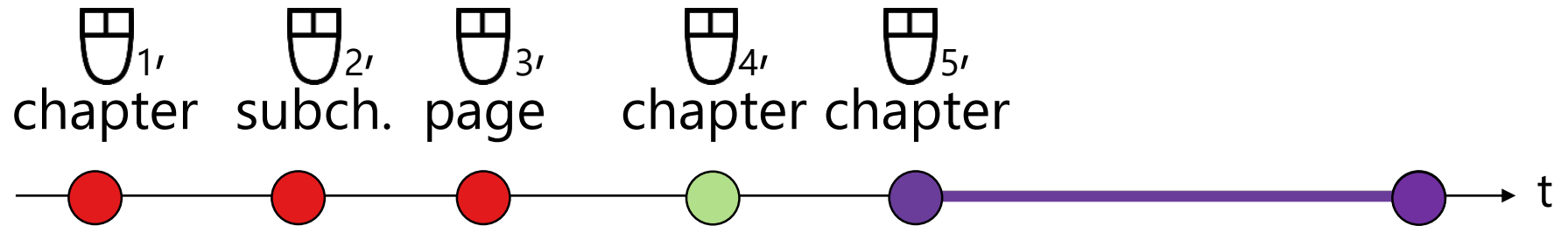
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AOI Sequence Chart

Eye tracking



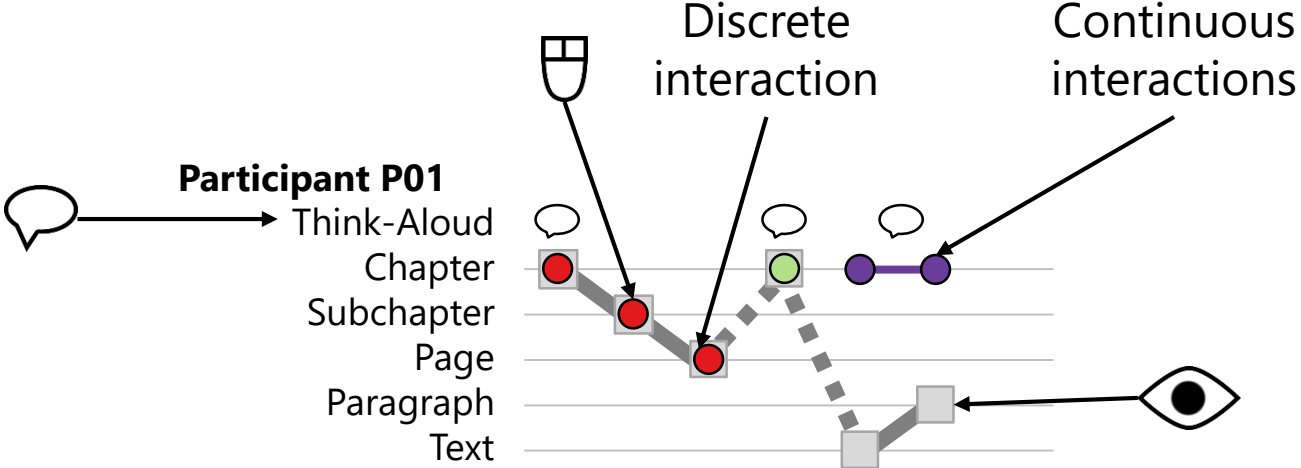
Log files



Think-aloud



AOI Sequence Chart



AOI Sequence Chart

Results – Bottom-up

- Explorative approach
- Find out which patterns are used

- Common strategy
 - Navigate on higher layer
 - Switch focus between sub-chapter and lines of text

AOI Sequence Chart

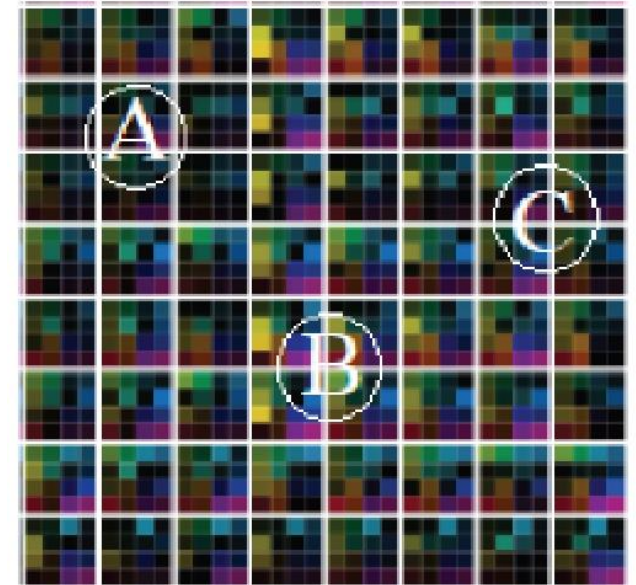
Results – Top-down

- Targeted approach
- Find out if VarifocalReader is used as intended

- Behavior pattern
 - Encode followed by select interaction at the beginning

Visual Multi-Metric Grouping of Eye-Tracking Data

- Authors: Ayush Kumar, Rudol Netzel, Michael Burch, Daniel Weiskopf, Klaus Mueller
- Publication: Kumar et al. (2018). Visual Multi-Metric Grouping of Eye-Tracking Data. Journal on Eye Movement Research, 10(5)10:1-17
- Tool: <http://www3.cs.stonybrook.edu/~aykumar/JEMR2017>



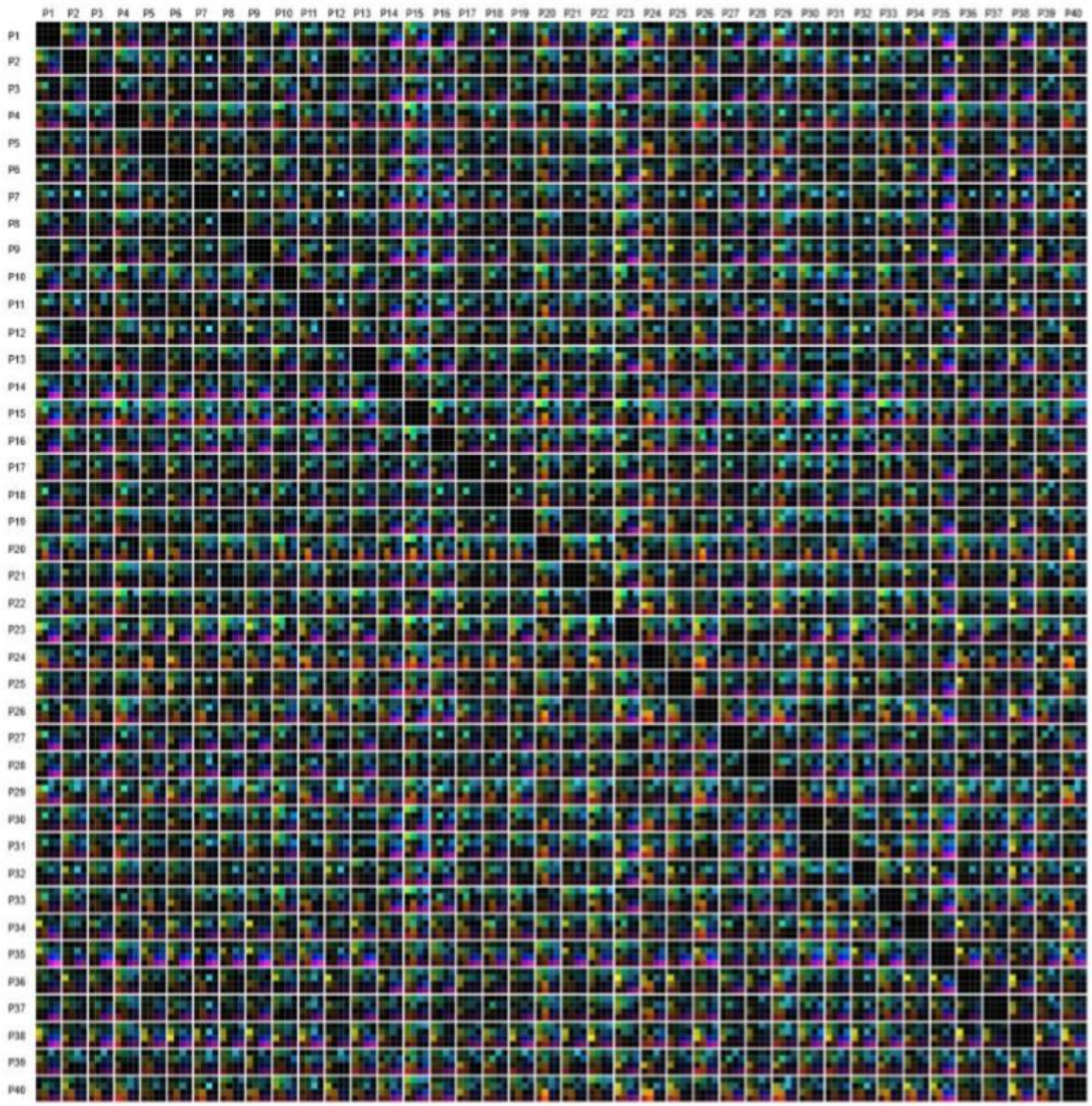
Visual Multi-Metric Grouping of Eye-Tracking Data

- Algorithmic and visual grouping of participants and eye-tracking metrics
- Well-established visualization concepts
 - Adjacency matrices
 - Parallel coordinates
- Interactions for
 - Different groupings
 - Filtering
- Application to metro map eye tracking data

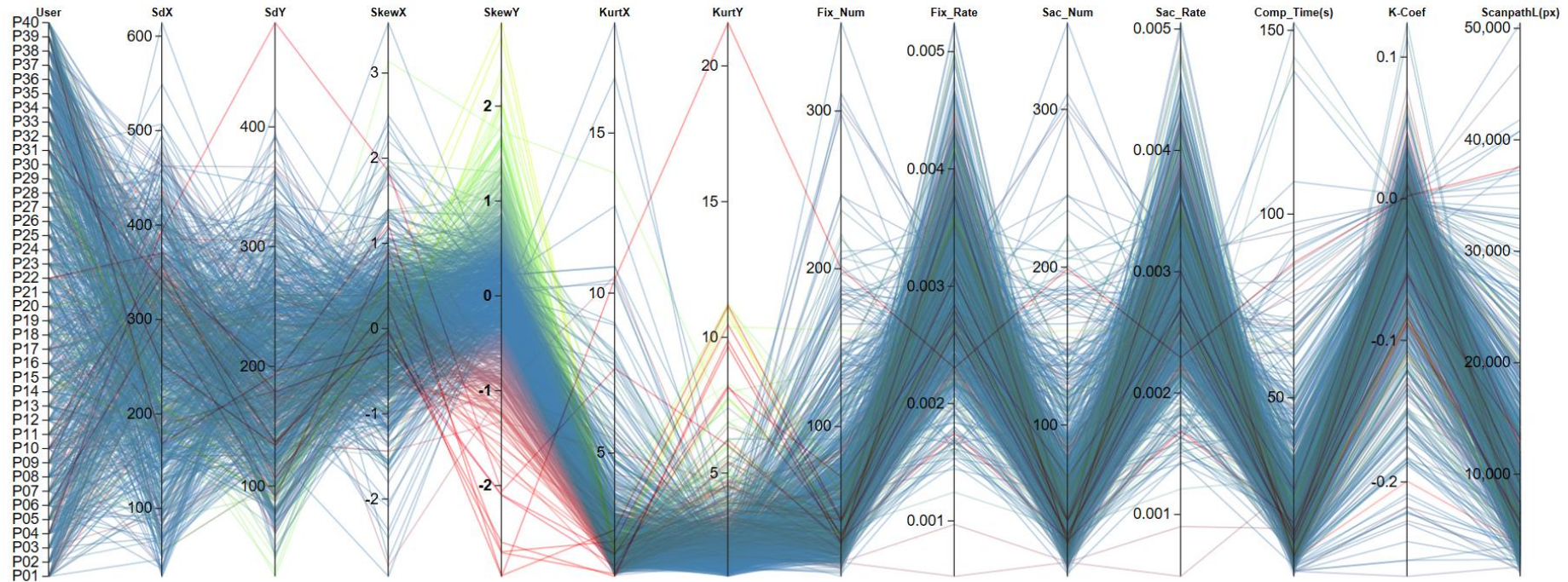
Visual Multi-Metric Grouping of Eye-Tracking Data

General Idea

Color coded adjacency matrix with multiple cell entries



Visual Multi-Metric Grouping of Eye-Tracking Data



Dissolving Matrices with their Weights (0 - 1)

Avg Fix No Fix

Avg Sac Fix Rate

Polyline Smoothness & Bundling

Smoothness. The current value is 0

Hiding Selected Axis from Parallel Coordinate

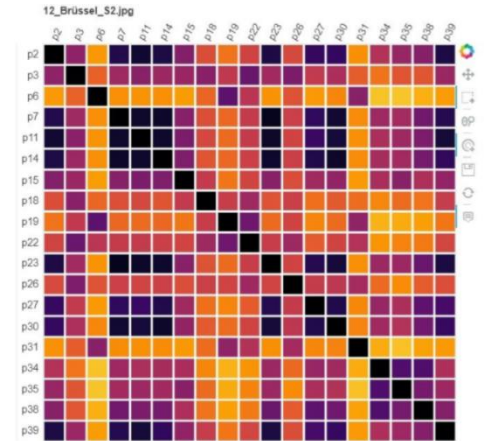
User Scanpath No. of Fix KurtX

Avg Fix L Fix Rate KurtY

Avg Sac SdX No. of Comp

Comparing Scanpaths by Ordered Adjacency Matrices

- Authors: Student project at Eindhoven University of Technology
- Publication: not yet published



Comparing Scanpaths by Ordered Adjacency Matrices

Task

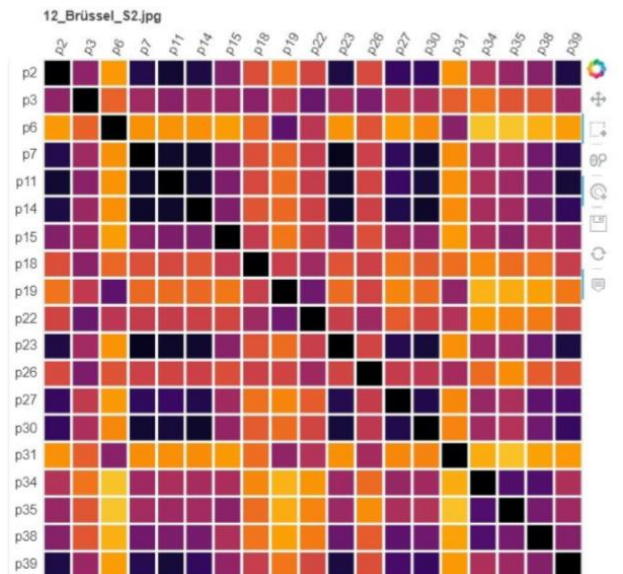
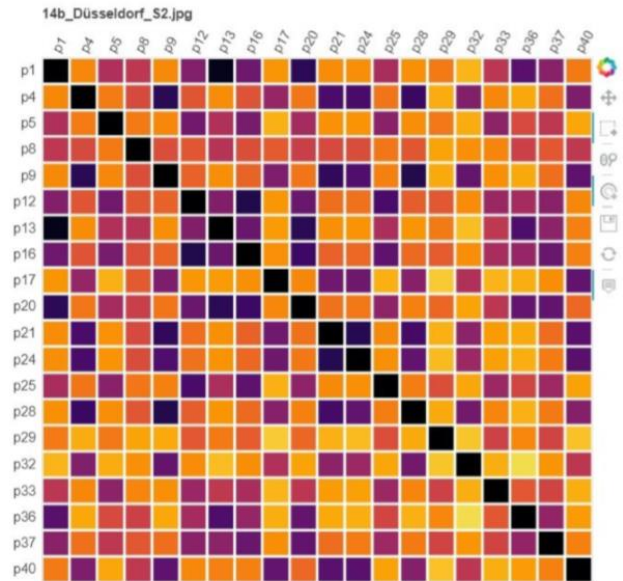
- Develop an interactive visualization tool that is able to
 - Load scanpath data
 - Compare the scanpaths using similarity measures
 - Visualize the result using adjacency matrices
 - Reorder scanpaths
 - Allow interactions

Comparing Scanpaths by Ordered Adjacency Matrices

Scanpath Similarity Measures

- Splitting of scanpaths
- Several similarity measures
- Results in a 2D array of real-valued numbers

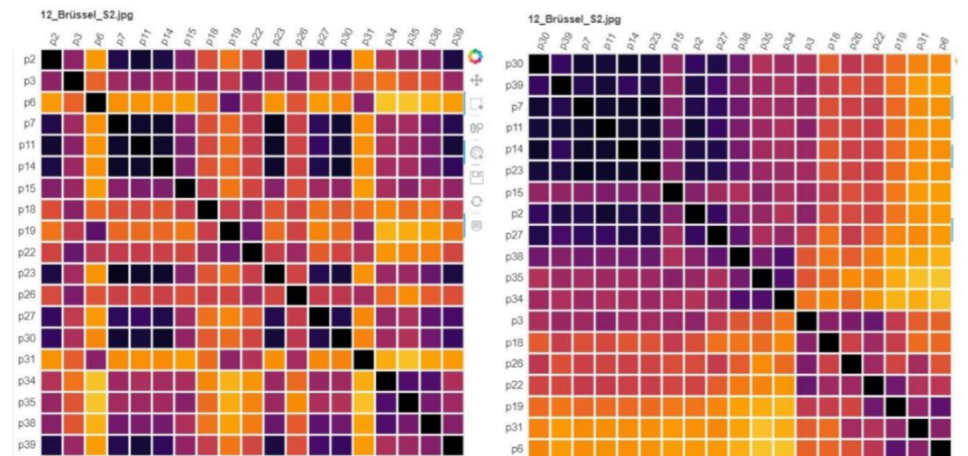
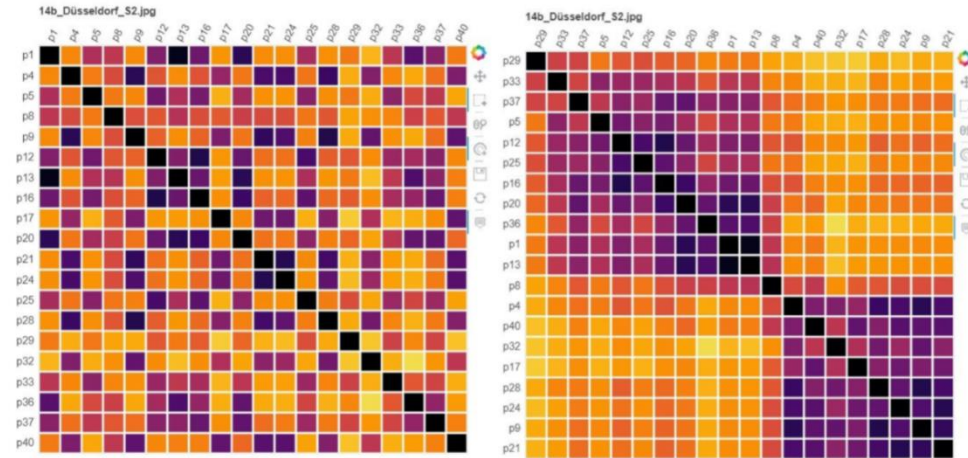
➔ Visualized as color coded adjacency matrix



Comparing Scanpaths by Ordered Adjacency Matrices

Matrix Reordering Techniques

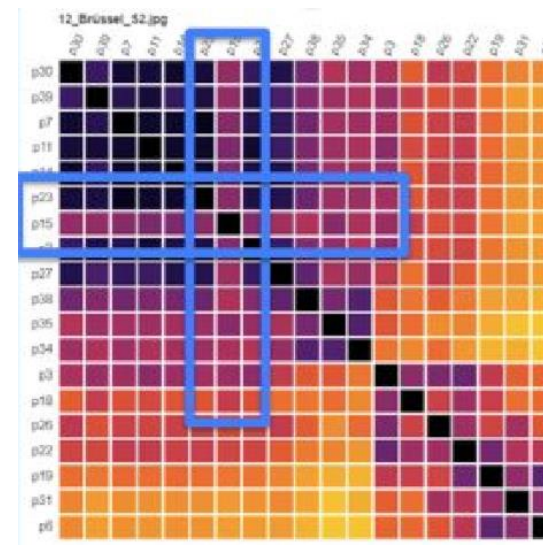
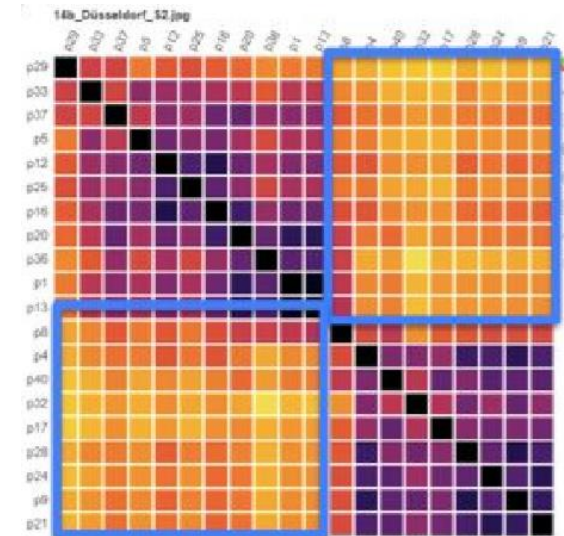
- Spectral method
- Hierarchical clustering
- Robinsonian method
- Dimensionality reduction
- ...



Comparing Scanpaths by Ordered Adjacency Matrices

Similarity Patterns

- Block pattern
- Off-diagonal block pattern
- Line/Star pattern
- ...



Comparing Scanpaths by Ordered Adjacency Matrices

Interaction Techniques

- Select
- Explore
- Reconfigure
- Encode
- Abstract/Elaborate
- Filter
- Connect