timelighting: guided exploration of 2D temporal network projections

velitchko filipov[1], davide ceneda[1], daniel archambault[2], and alessio arleo[1]

time

time-sliced

time
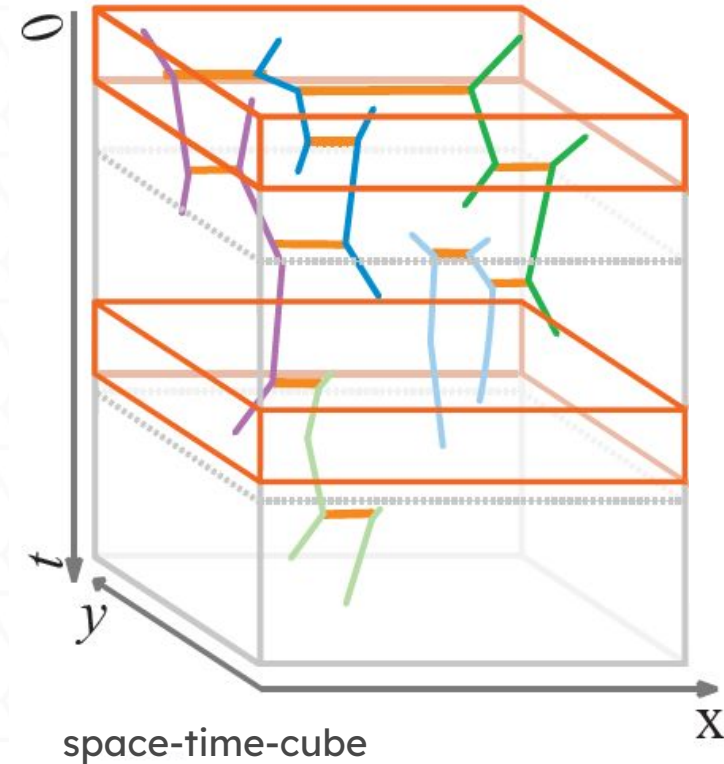
time-sliced

event-based

event-based network visualization

space-time-cube

node & edge additions & removals

time-dependent attributes

nodes form *trajectories*

edges form *ruled surfaces*

space-time-cube

why event-based networks?

no need to choose suitable time slices

better quality drawings compared to time-sliced networks [1, 2]

research on improving scalability of temporal graph layouts

[1] Arleo et al. "Event-based Dynamic Graph Drawing without the Agonizing Pain" CGF (2022)
[2] Simonetto et al. "Event-based Dynamic Graph Visualisation" IEEE TVCG (2018)
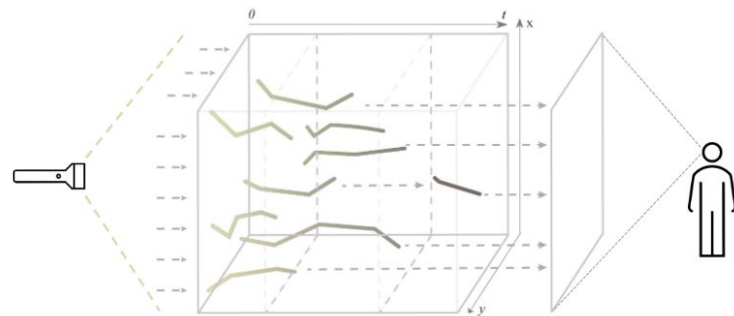
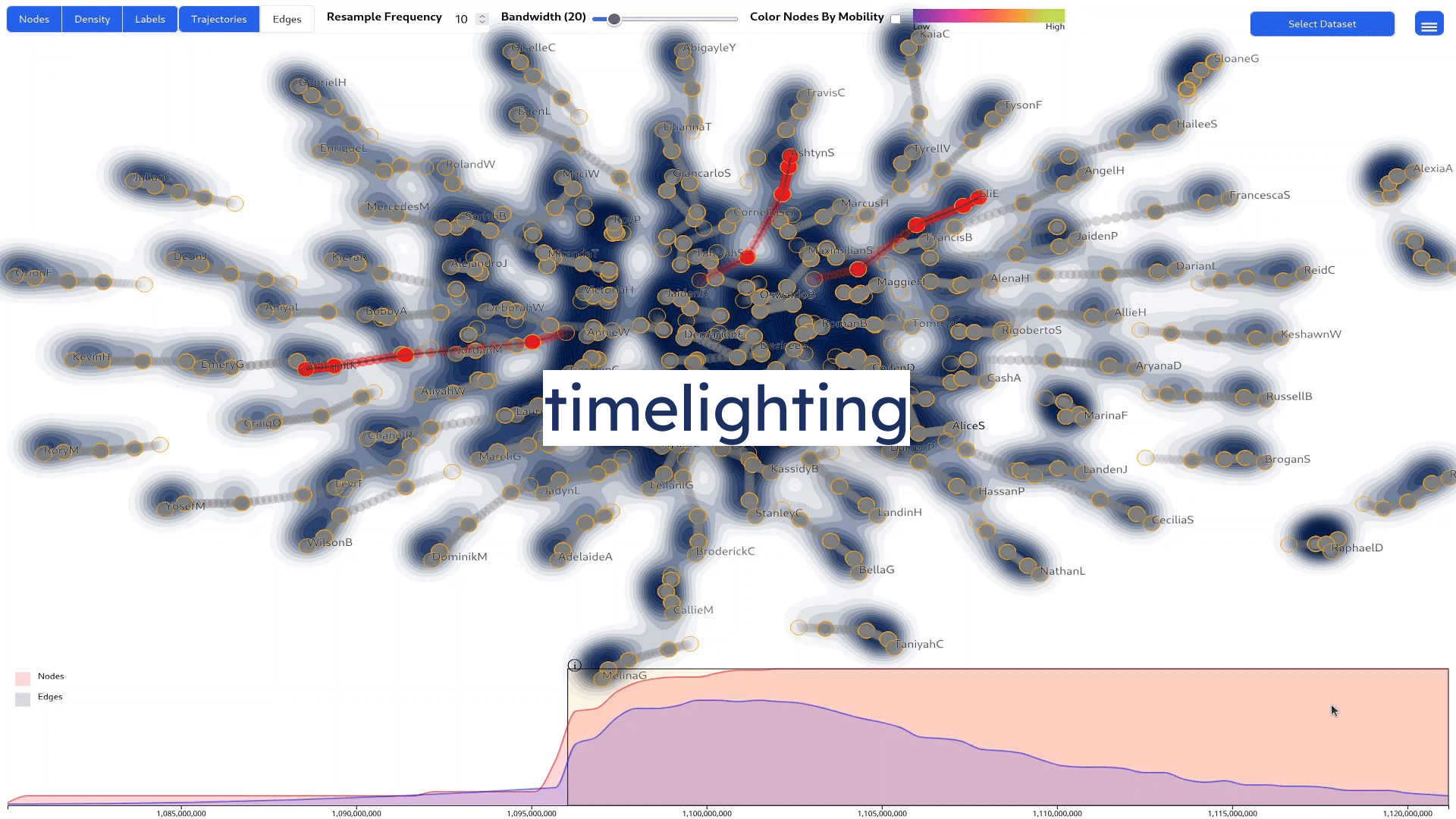VIS 2025

why 2D projections of event-based networks?

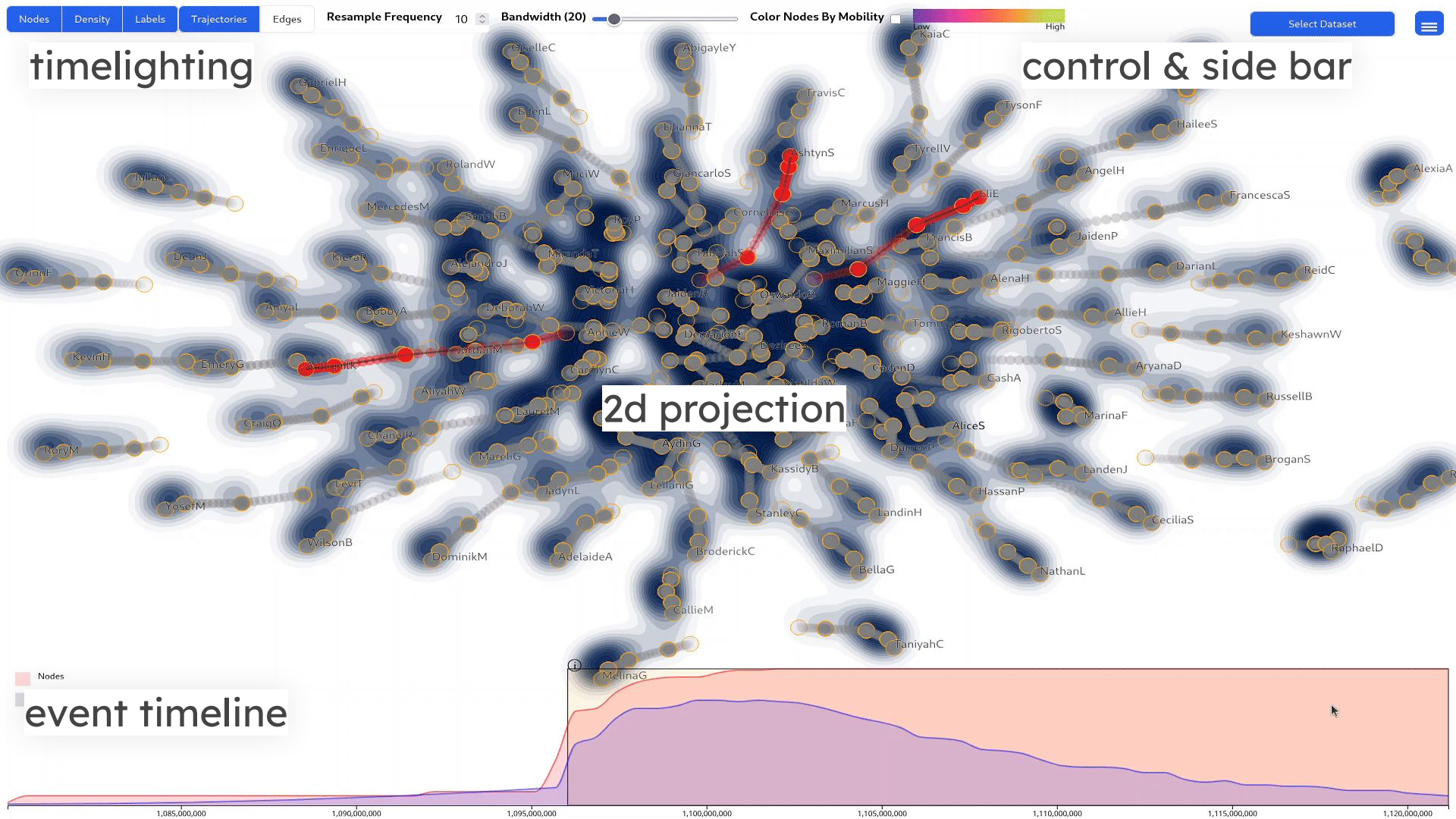usually 3D representations (can be difficult to explore)

2D approaches: juxtaposition and animation do not scale well [3]

other 2D representations less explored

timelighting metaphor 👉

[3] Filipov et al. "On Network Structural and Temporal Encodings: A Space and Time Odyssey"
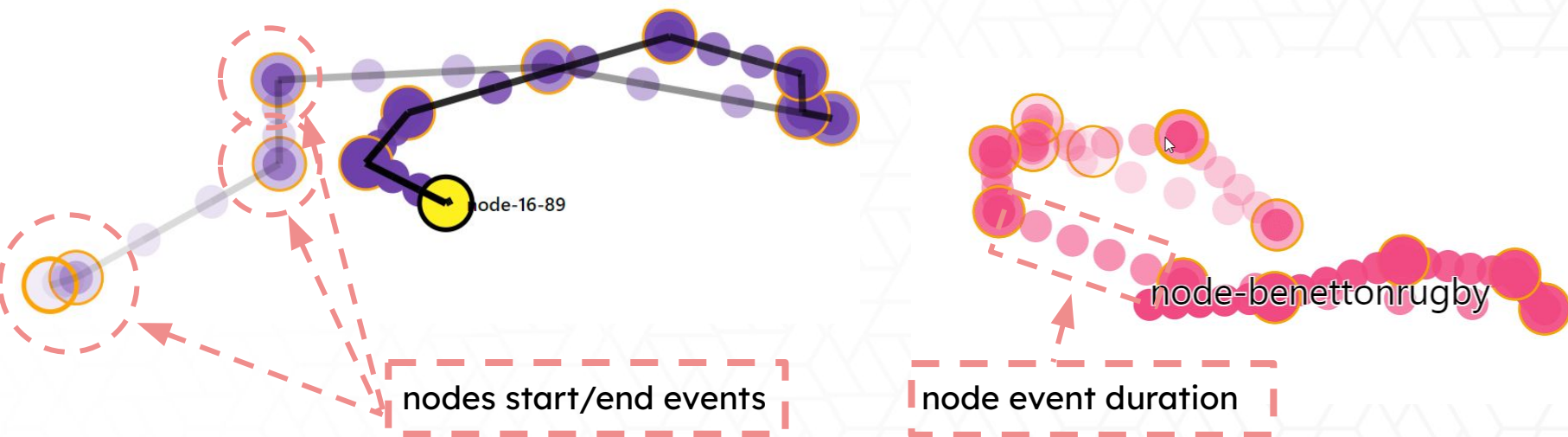IEEE TVCG (2024)

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mainview: nodes (& trajectories)

nodes are represented as a trail of circles

trajectories are visualized using a polyline connecting of the nodes

node-16-89

node-benettonrugby

nodes start/end events

node event duration

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mainview: edges

edges are represented as solid straight lines
connect nodes belonging to two distinct trajectories

G-Glasgow

node-zebrerugby

Z-Zebre

M-Munster

*not strongly connected
drifting apart*

*well-connected
stays central*

node-benettonrugby-111

B-Benetton
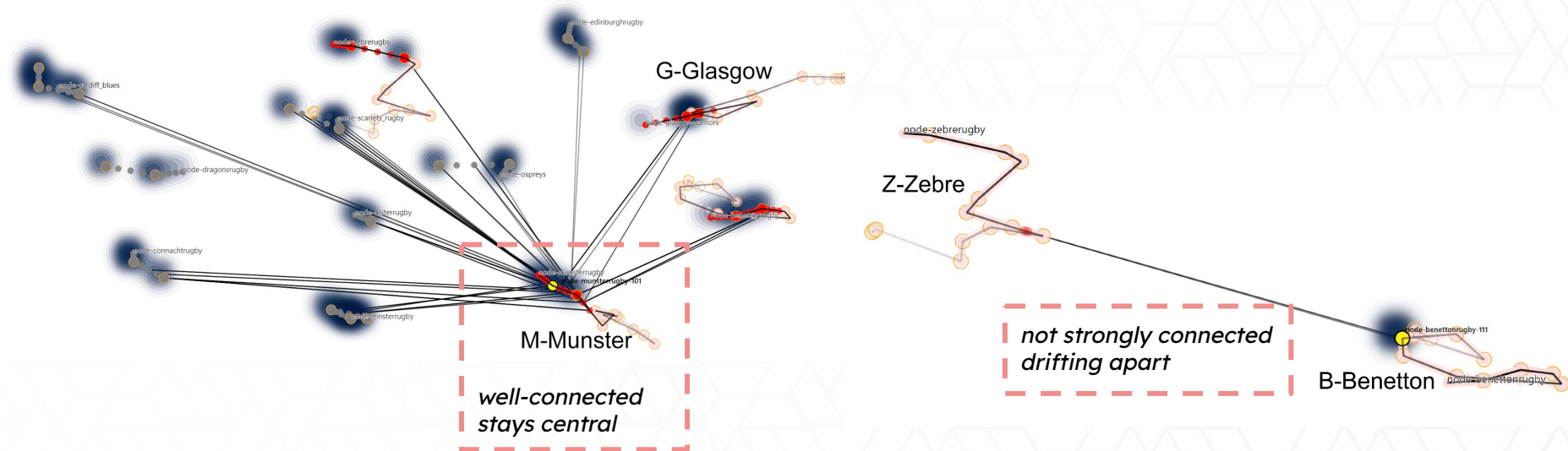
event timeline

overview + explore specific intervals
shows node & edge events
guidance regions

time = milliseconds

edge events

node events

guidance intervals

click to snap

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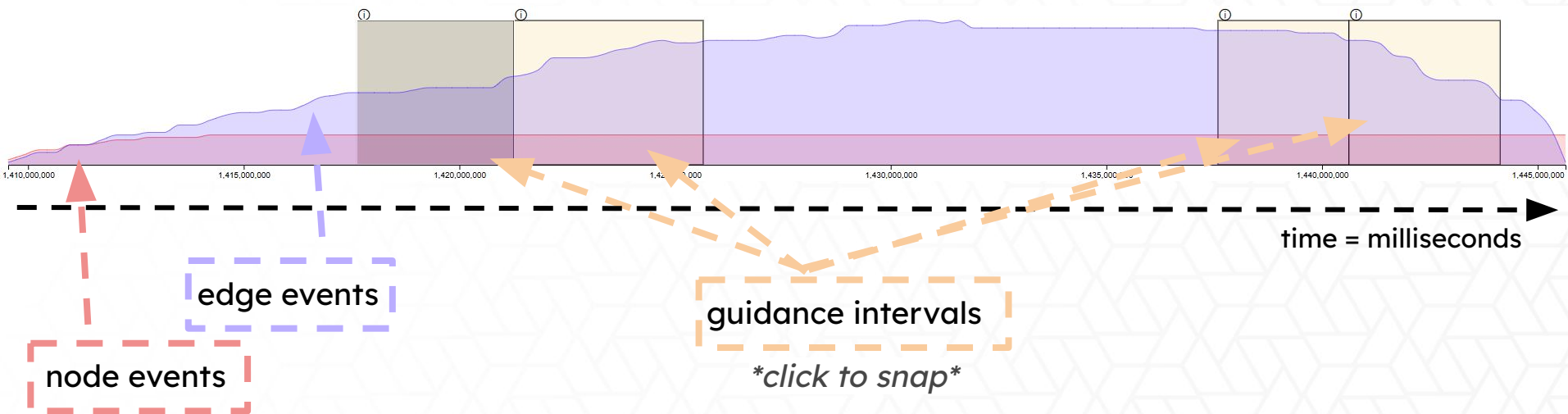
evaluation (👍)

expert interviews & heuristic evaluation [4, 5]

flattening makes dynamics a easier to understand

new & different perspectives

single view integration is great

serendipitous discoveries & quick information seeking

[4] Wall et al. "Heuristic Approach to Value-Driven Evaluation of Visualizations," IEEE TVCG (2019)
[5] Ceneda et al. "A Heuristic Approach for Dual Expert/End-User Evaluation of Guidance in Visual Analytics", IEEE TVCG (2023)

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evaluation (👎)

expert interviews & heuristic evaluation [4, 5]

data & layout quality could be better

limited "steering" of guidance

interpretability of movement scores

improvements

    👉 *more algorithms and configuration options*

       (and explanations)

[4] Wall et al. "Heuristic Approach to Value-Driven Evaluation of Visualizations," IEEE TVCG (2019)
[5] Ceneda et al. "A Heuristic Approach for Dual Expert/End-User Evaluation of Guidance in Visual Analytics", IEEE TVCG (2023)
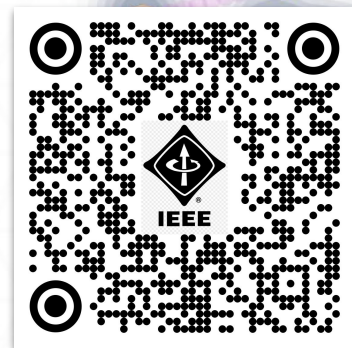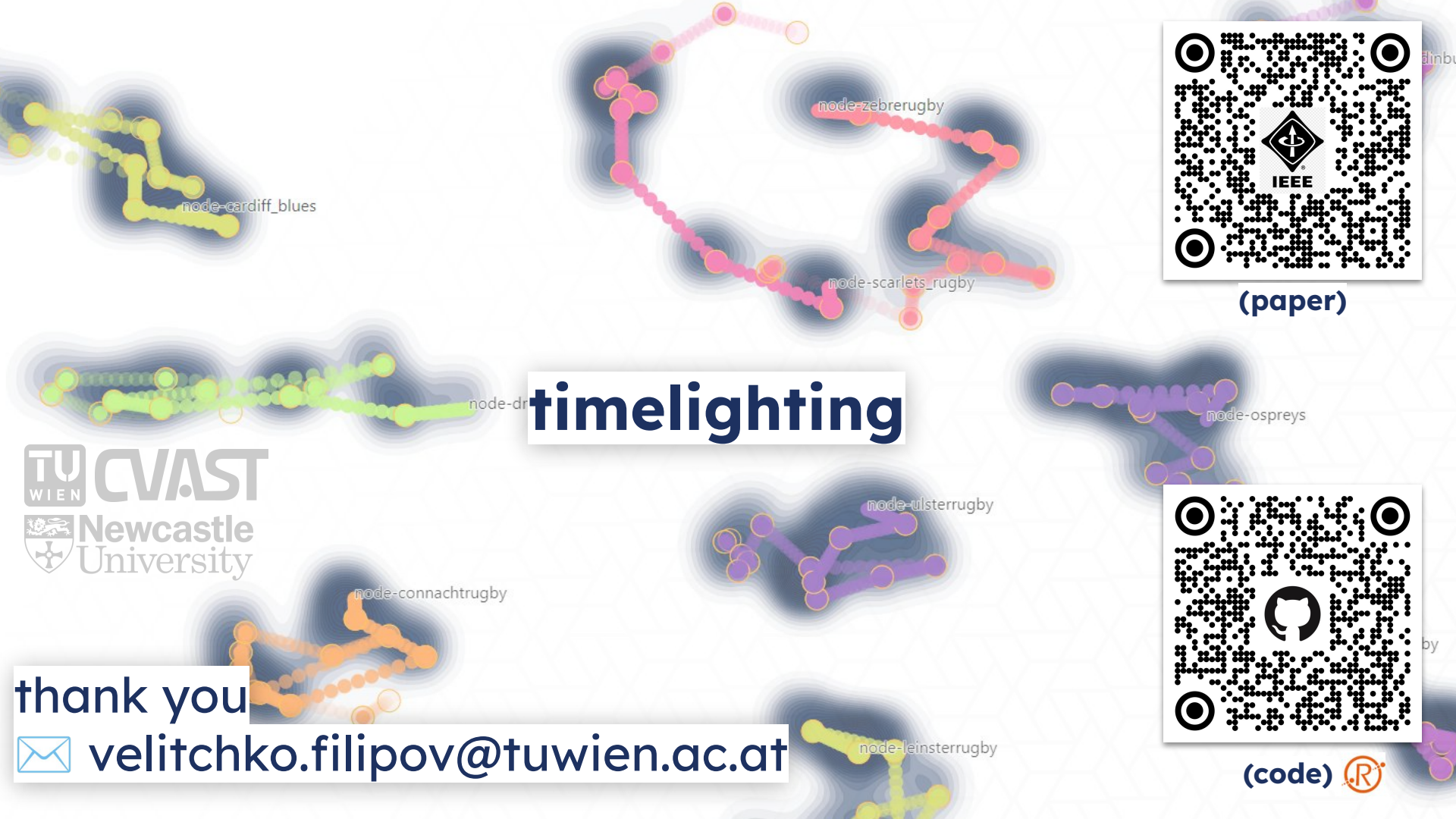
future work

more parameters & configuration options

generalization beyond networks

visual scalability

   👉 *graph simplification, semantic zoom, hybrid techniques?*
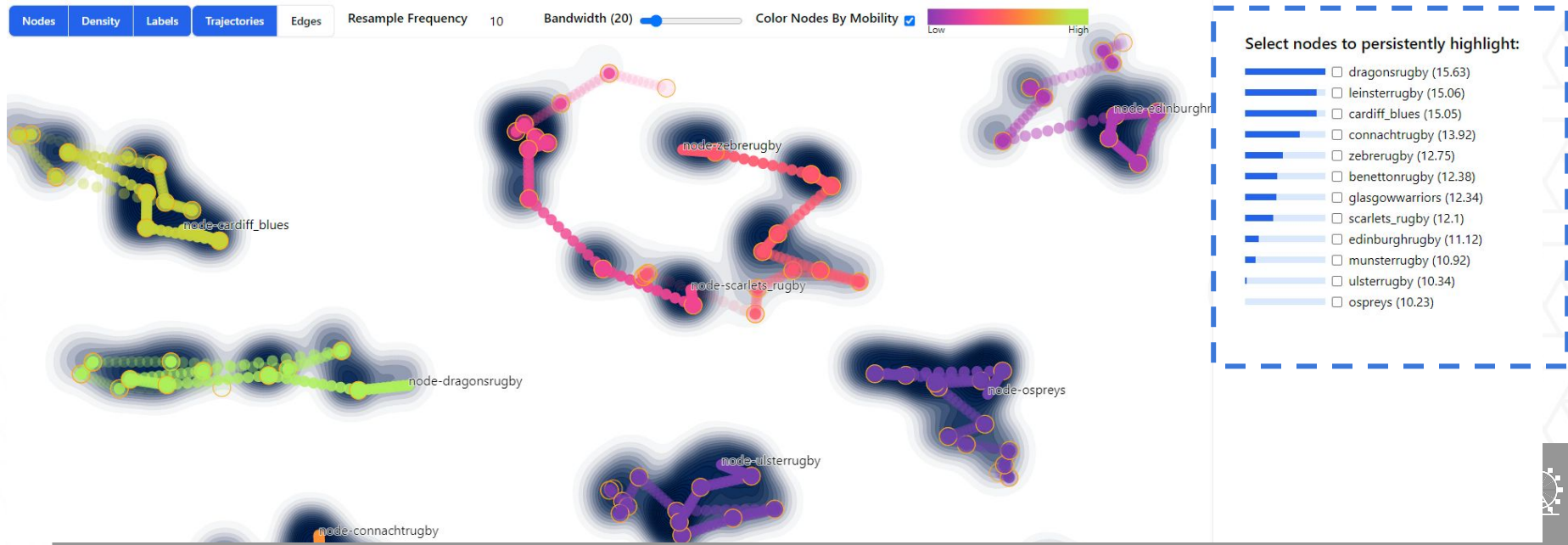
timelighting

CVAST

Newcastle University

thank you

✉ velitchko.filipov@tuwien.ac.at

(paper)

(code) ®

control & sidebar: guidance (1/2)

mobility - progress bars
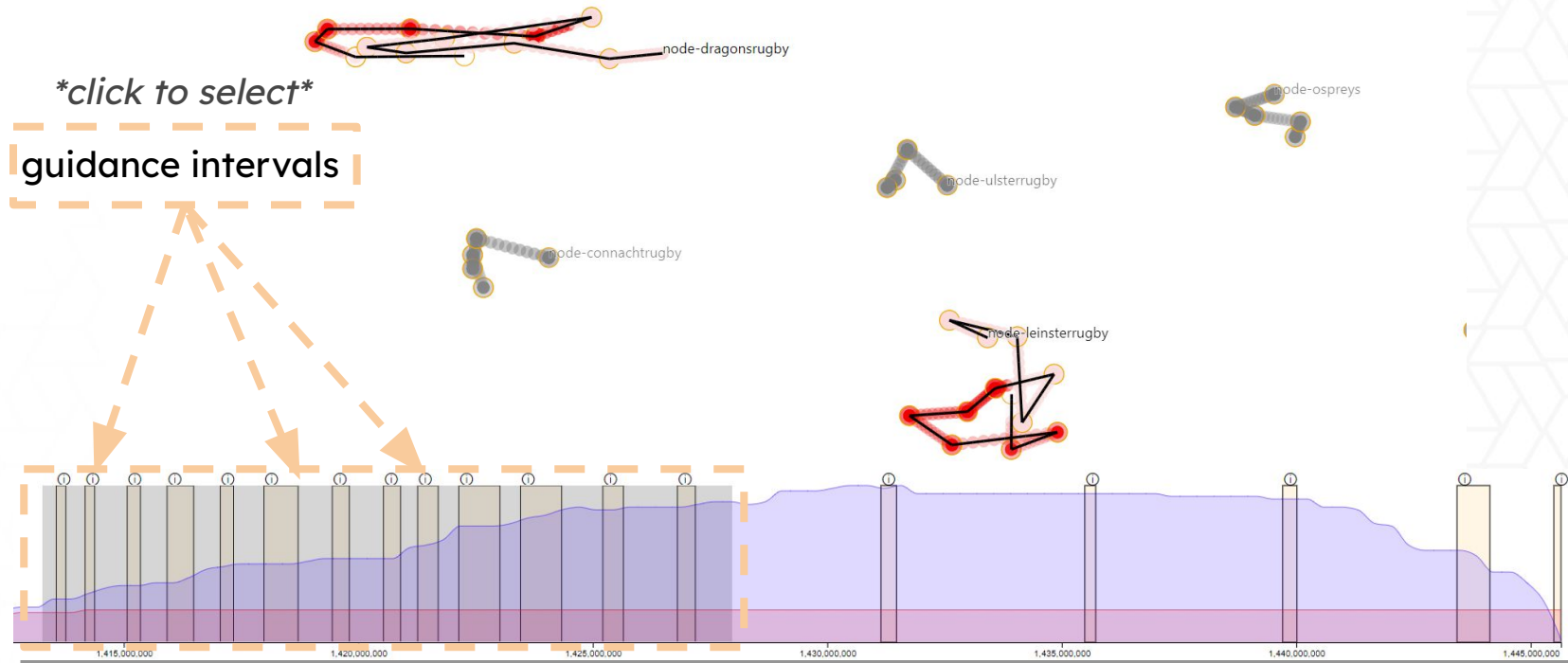
nodes that frequently change connections are higher

event timeline: guidance (2/2)

timeline suggests specific time intervals for further inspection based on user defined set of nodes (interests)

click to select

guidance intervals

2025

contribution

a guidance-enhanced [4] visual analytics solution

2D approach displaying full temporal resolution

understand temporal patterns/behaviors
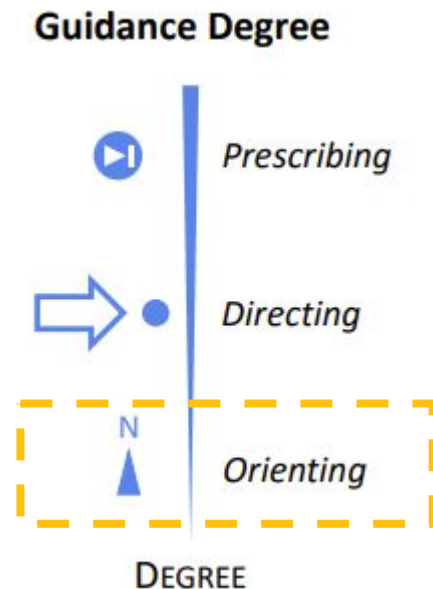
extract insights from complex temporal dynamics

[4] Ceneda et al. "Characterizing guidance in visual analytics" IEEE TVCG (2016), 10.1109/TVCG.2016.2598468

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guidance slide

prescribing:

    prescribe a series of actions / steps to take

    to conclude the current analysis task

directing:

orienting:

    helps to maintain an overview of the problem

    and the alternative analytical paths that can be

    taken to progress towards the analytical goal.

Guidance Degree

Prescribing

Directing

N

Orienting

DEGREE

[4] Ceneda et al. "Characterizing guidance in visual analytics" IEEE TVCG (2016), 10.1109/TVCG.2016.2598468

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tasks

taxonomies for dynamic network visualization [5,6]

T1: overview.

  provide an overview of the temporal information

T2: event tracking.

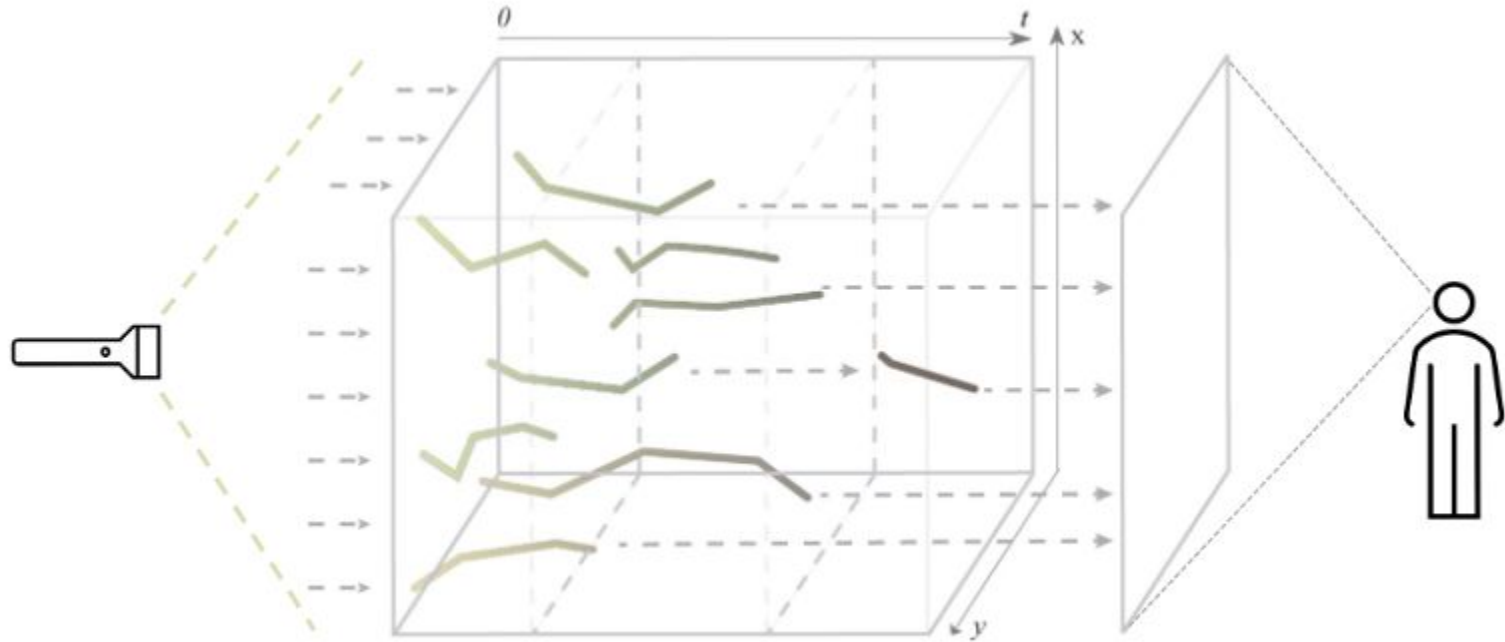 understanding the dynamics and events' frequency

  understand the node movement over time (e.g., speed, repetition, etc.)

T3: investigate relationships.

  edge events perturb the trajectories

  identify relationships which have an impact or how often they occur

[5] Ahn et al. "A Task Taxonomy for Network Evolution Analysis" IEEE TVCG (2019),
[6] Bach et al. "GraphDiaries: Animated Transitions and Temporal Navigation for Dynamic Networks" IEEE TVCG (2014)

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timelighting

data slide because silvia asked

event-based networks
timesliced networks

layout precomputed using DynoSlice [2]