Analyzing Delays in Trajectories

Maximilian Konzack, Thomas McKetterick, Georgina Wilcox, Maike Buchin, Luca Giuggioli, Joachim Gudmundsson, Michel Westenberg, Kevin Buchin

University of BRISTOL

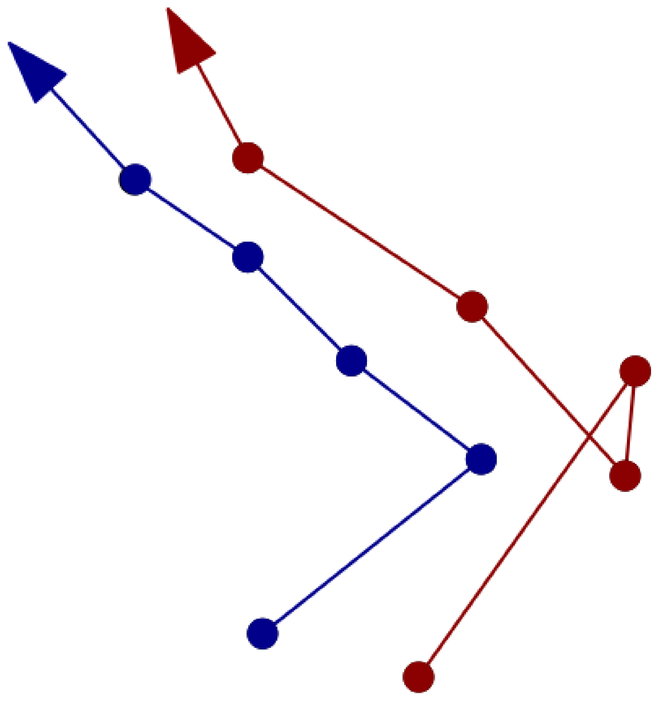
THE UNIVERSITY OF SYDNEY

RUB

TU/e Technische Universiteit Eindhoven University of Technology

Where innovation starts

Action-reaction in a pair of moving animals

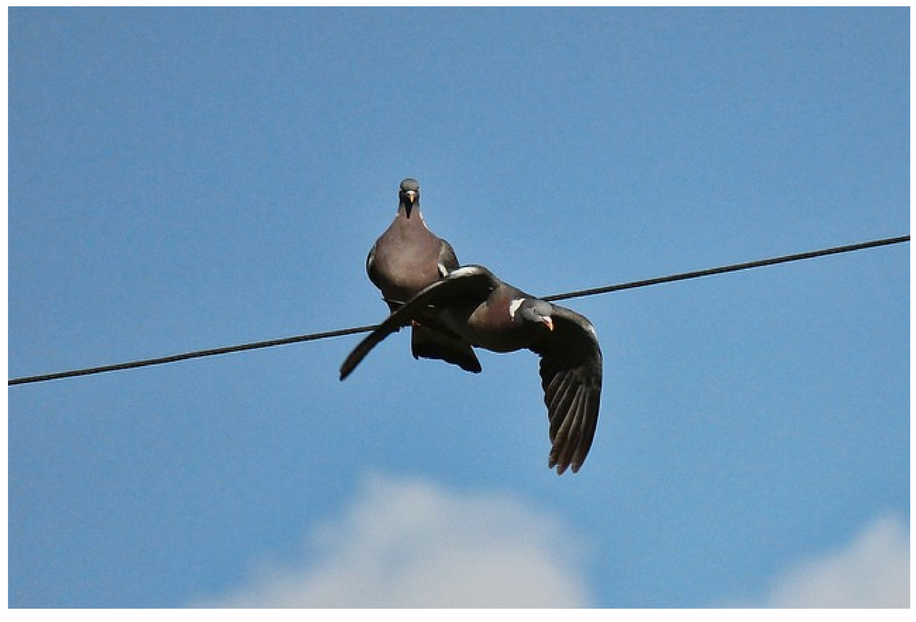


What is interaction?

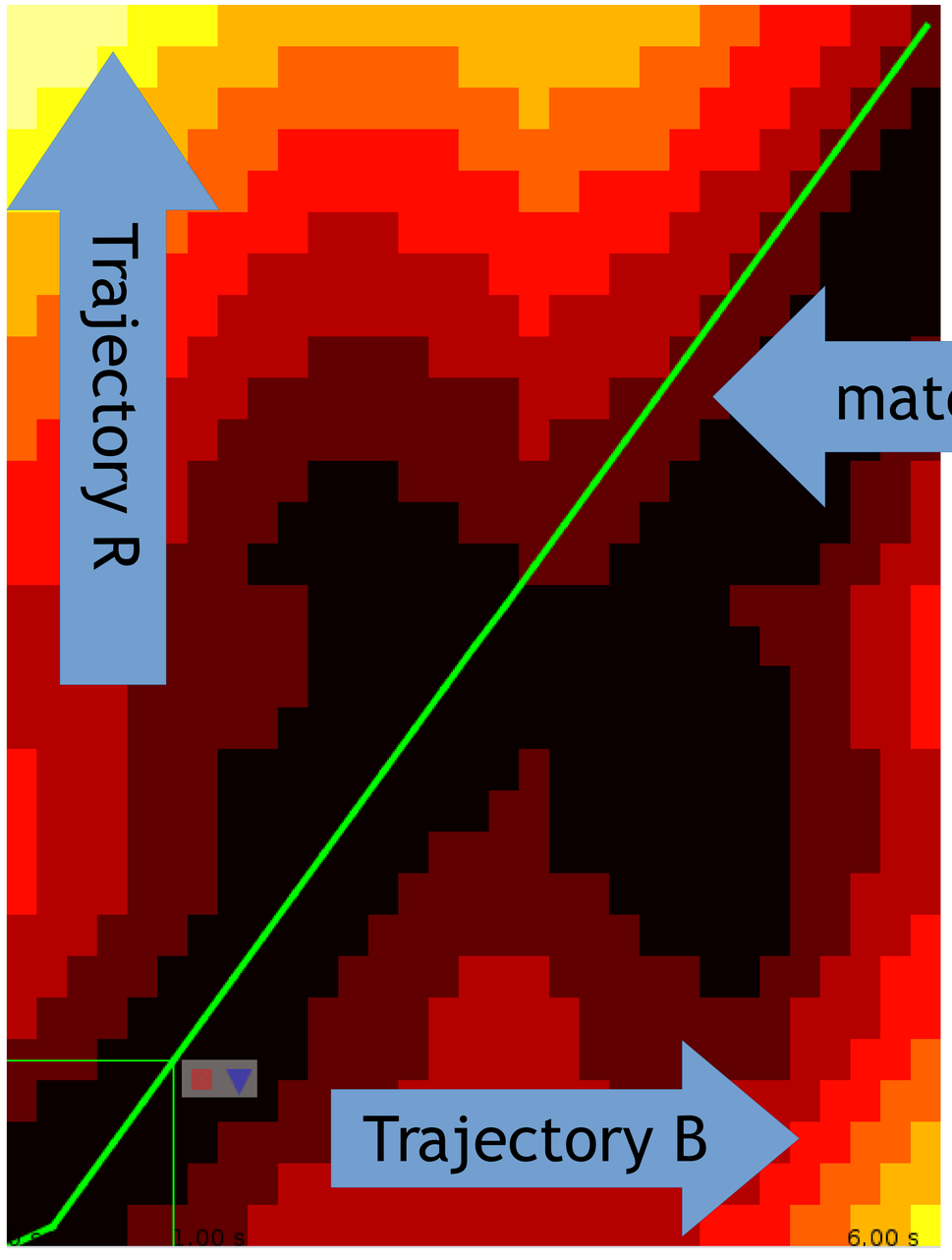
- Movement by **one trajectory**
- Response by **another trajectory**

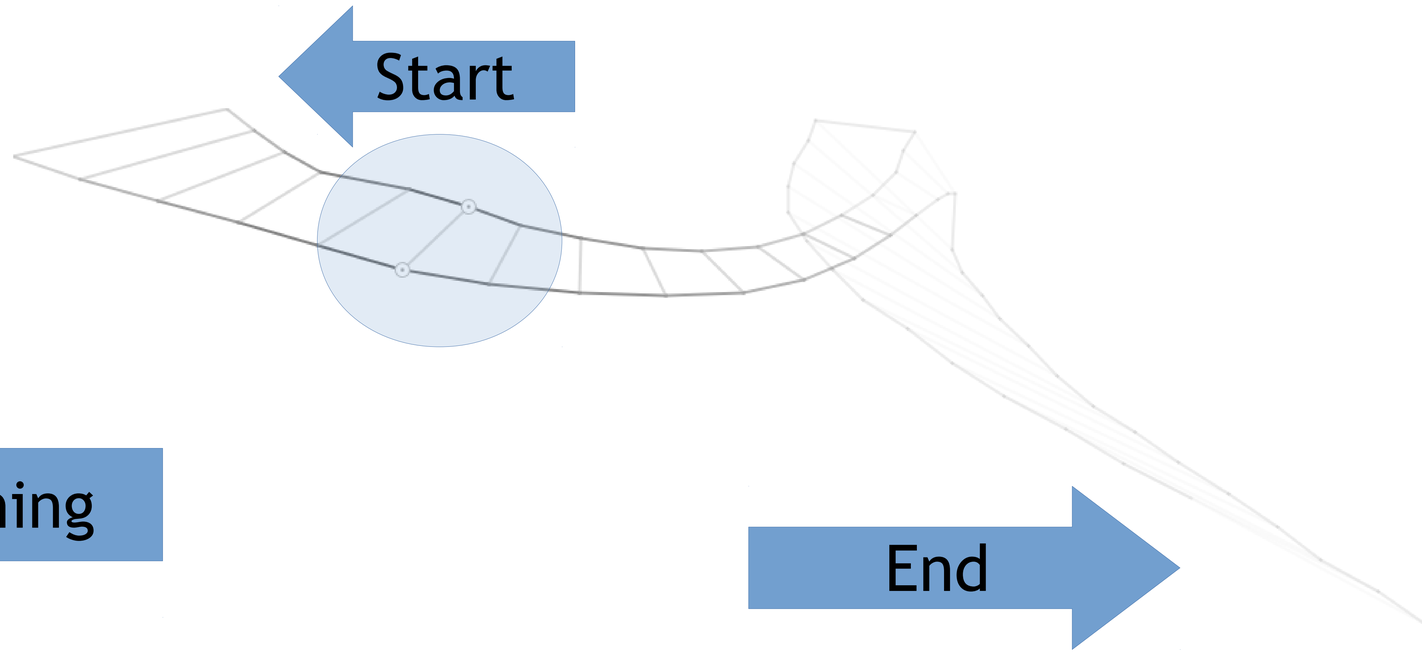
How to compute interaction?

Use a matching between the trajectories



1 to 1 mapping: index-based matching of trajectories





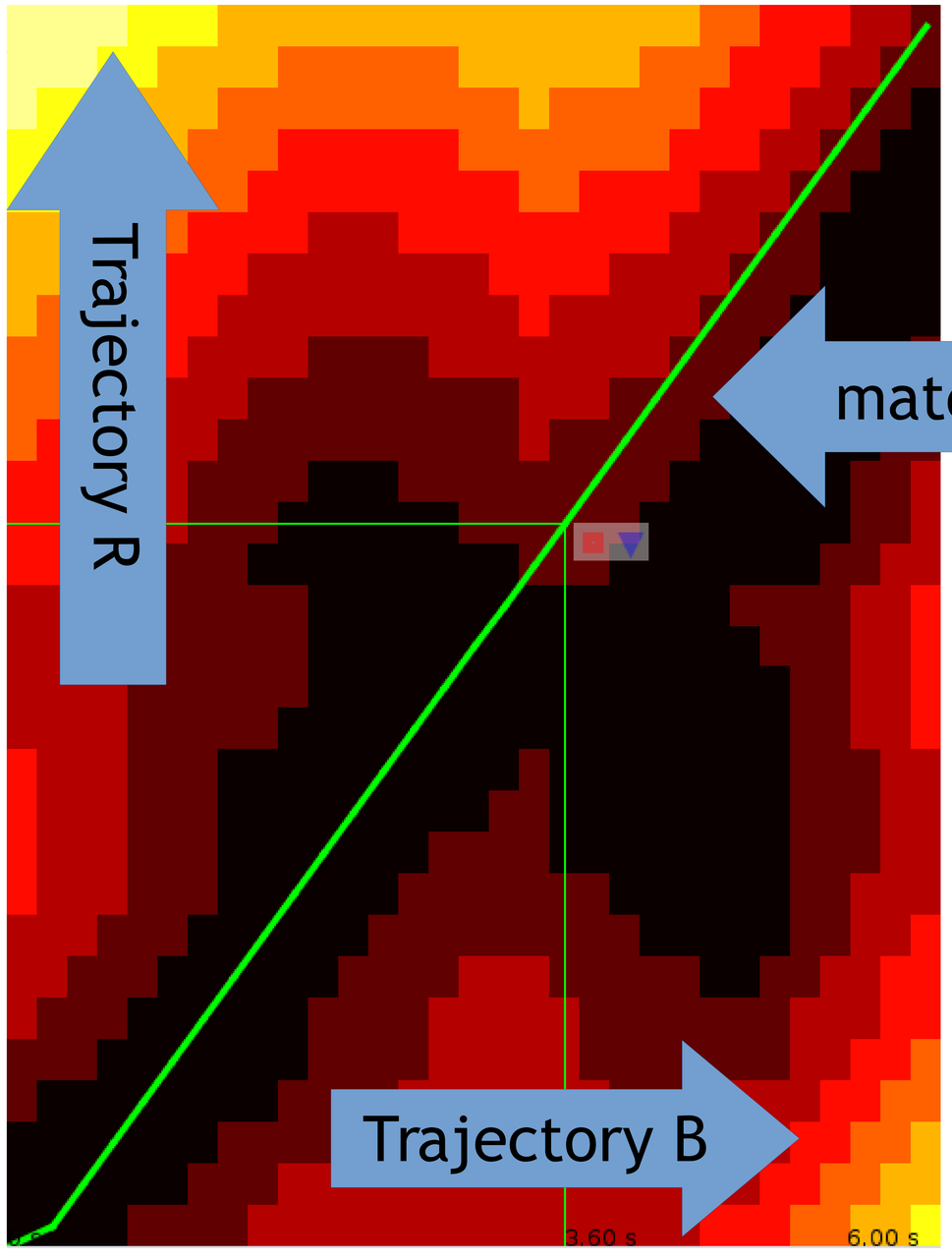
Idea: map points with same time-stamps

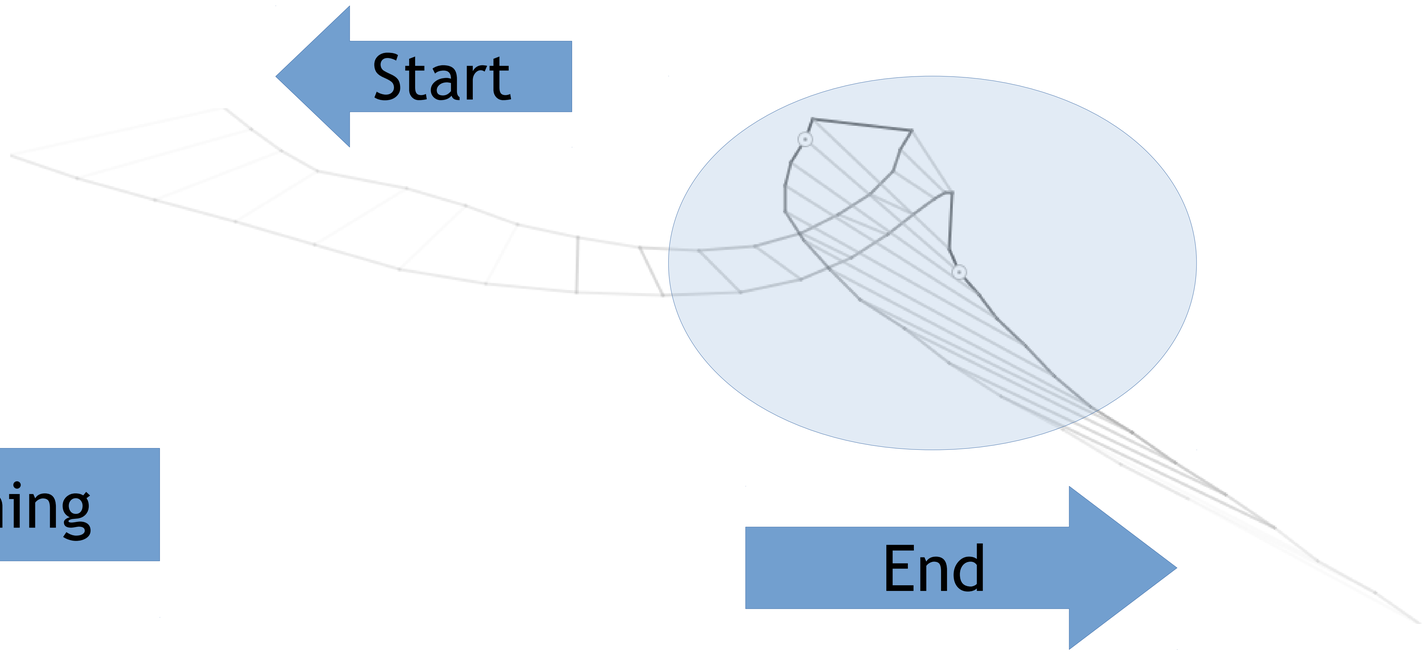
Delay space

- All distances of pairs of points
- Encoded as a heated color body map

Data set: Ultimate Frisbee from [Long and Nelson, 2013]

1 to 1 mapping: index-based matching of trajectories



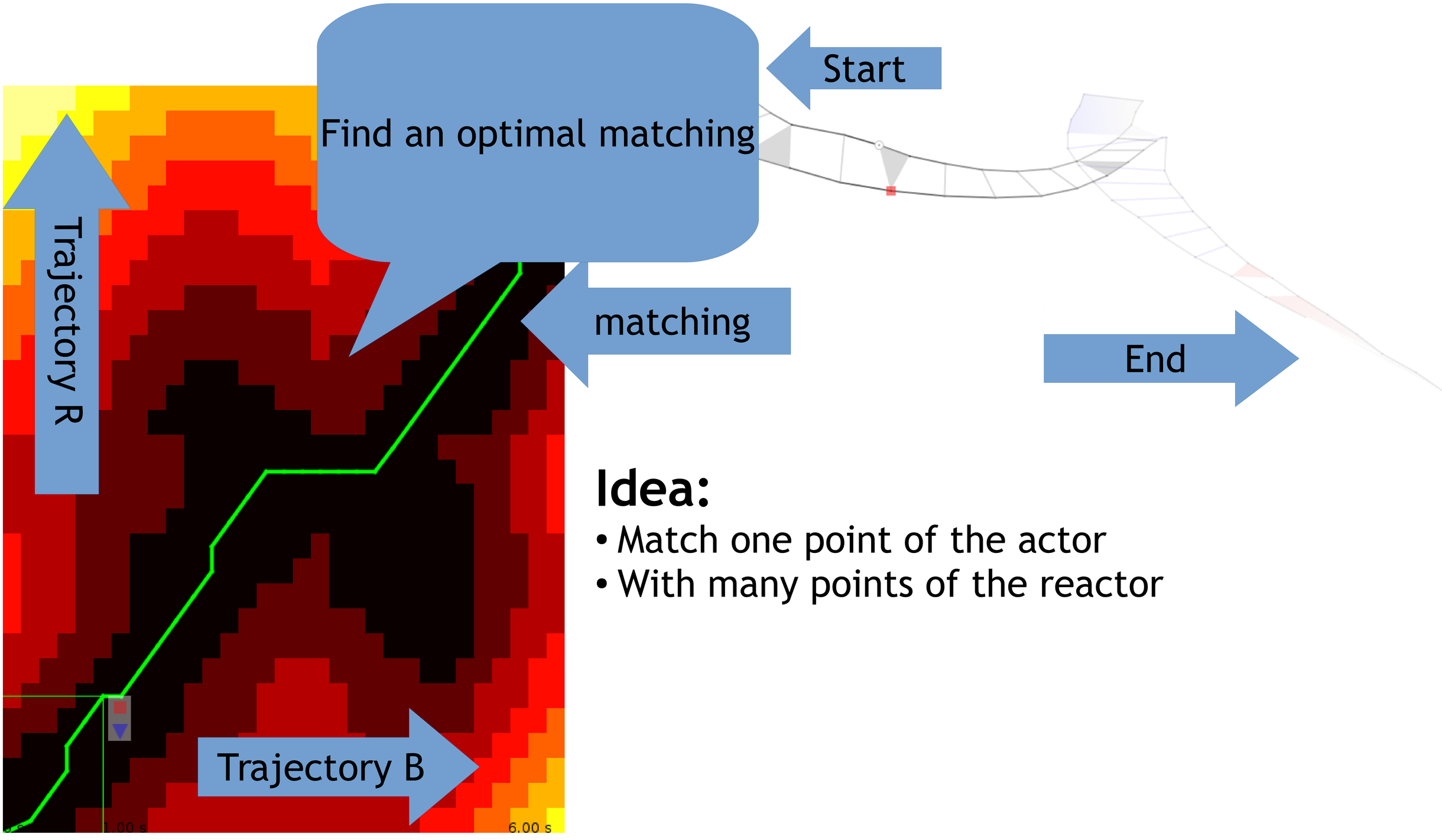


Issues:

- Visual clutter in the matching
- Non optimal pairs for an index-based matching

Data set: Ultimate Frisbee from [Long and Nelson, 2013]

1 to many matching of trajectories



Idea:

- Match one point of the actor
- With many points of the reactor

Data set: Ultimate Frisbee from [Long and Nelson, 2013]

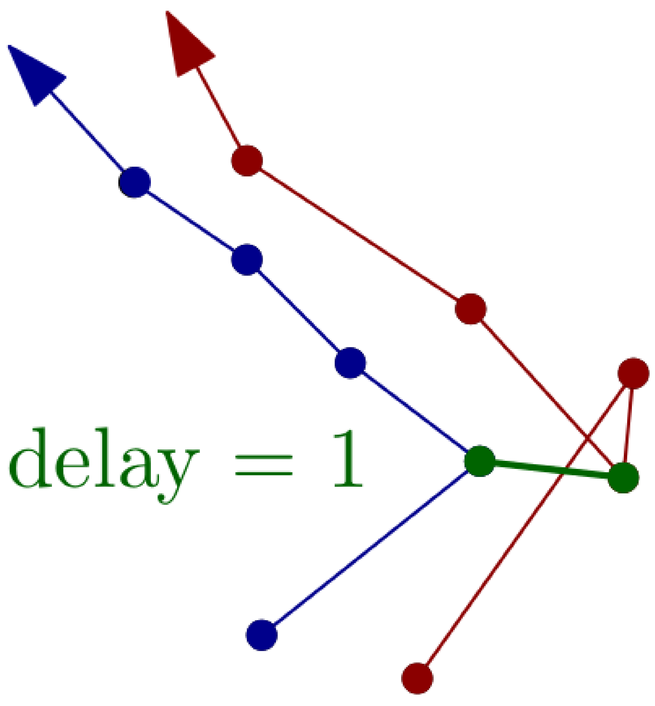
Action-reaction in a pair of moving animals

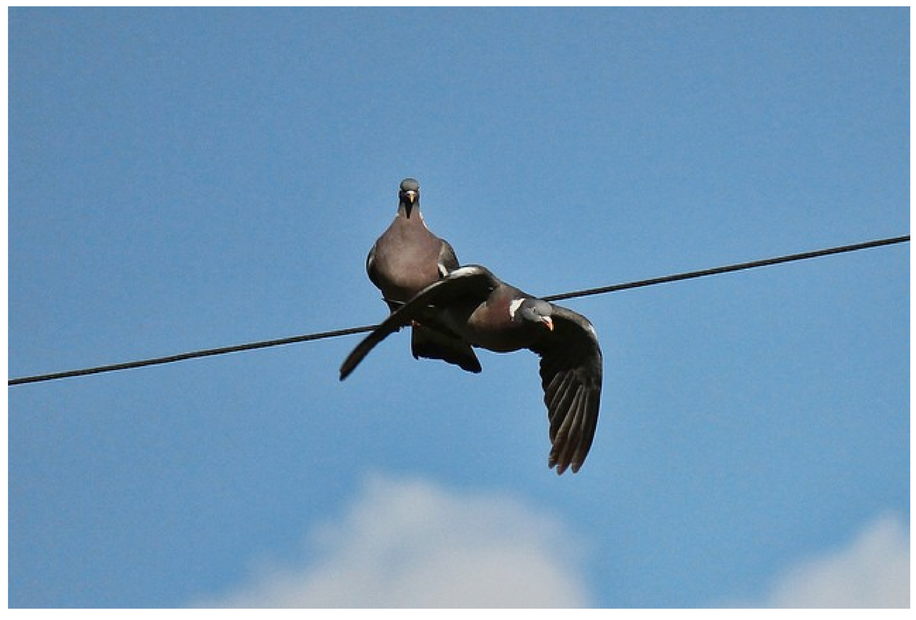
What is interaction?

- Movement by **one trajectory**
- Response by **another trajectory**

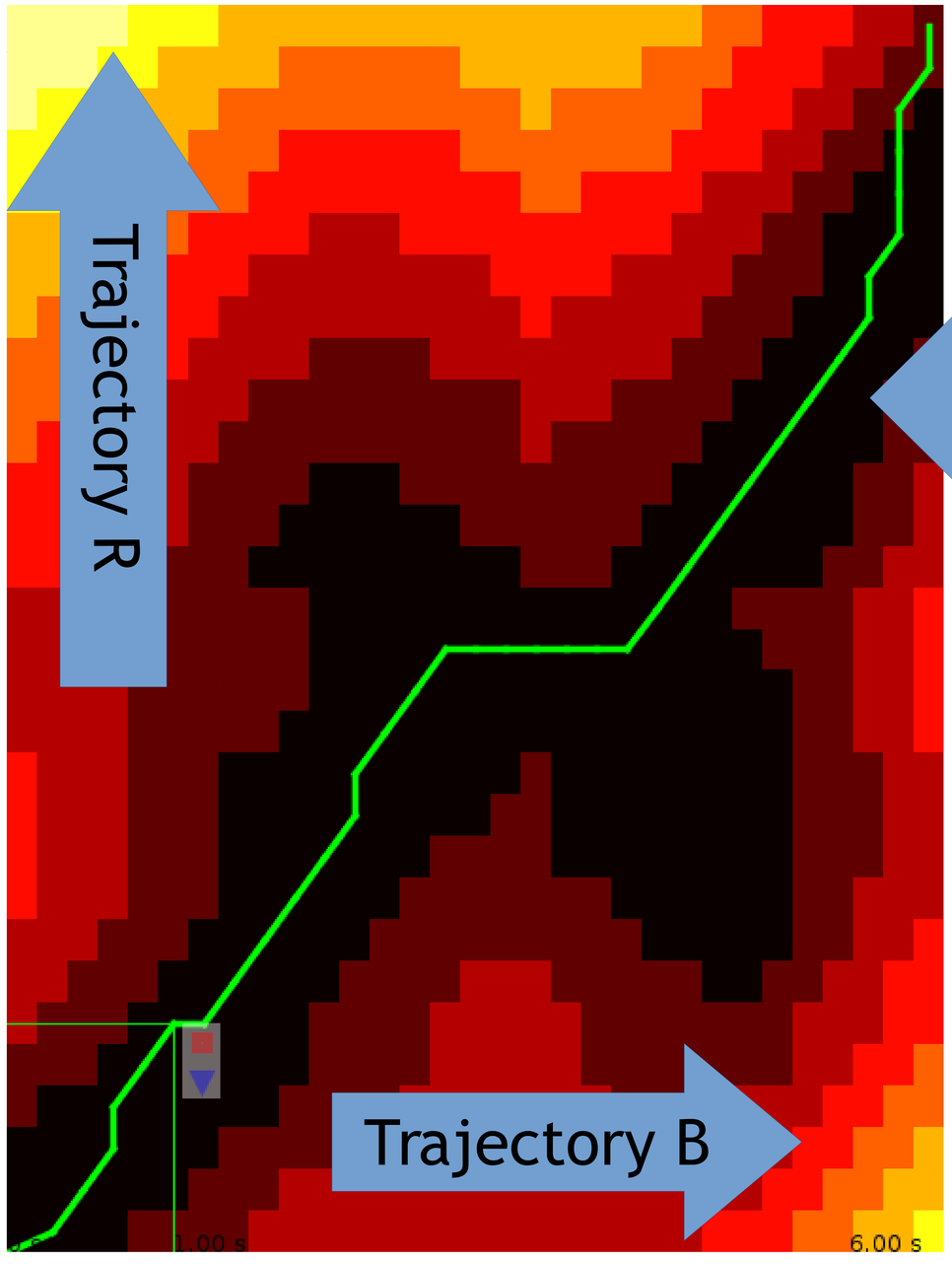
What is a delay?

- **Delay**: difference of time stamps for a pair of points
- Occurs often in action-reaction interactions

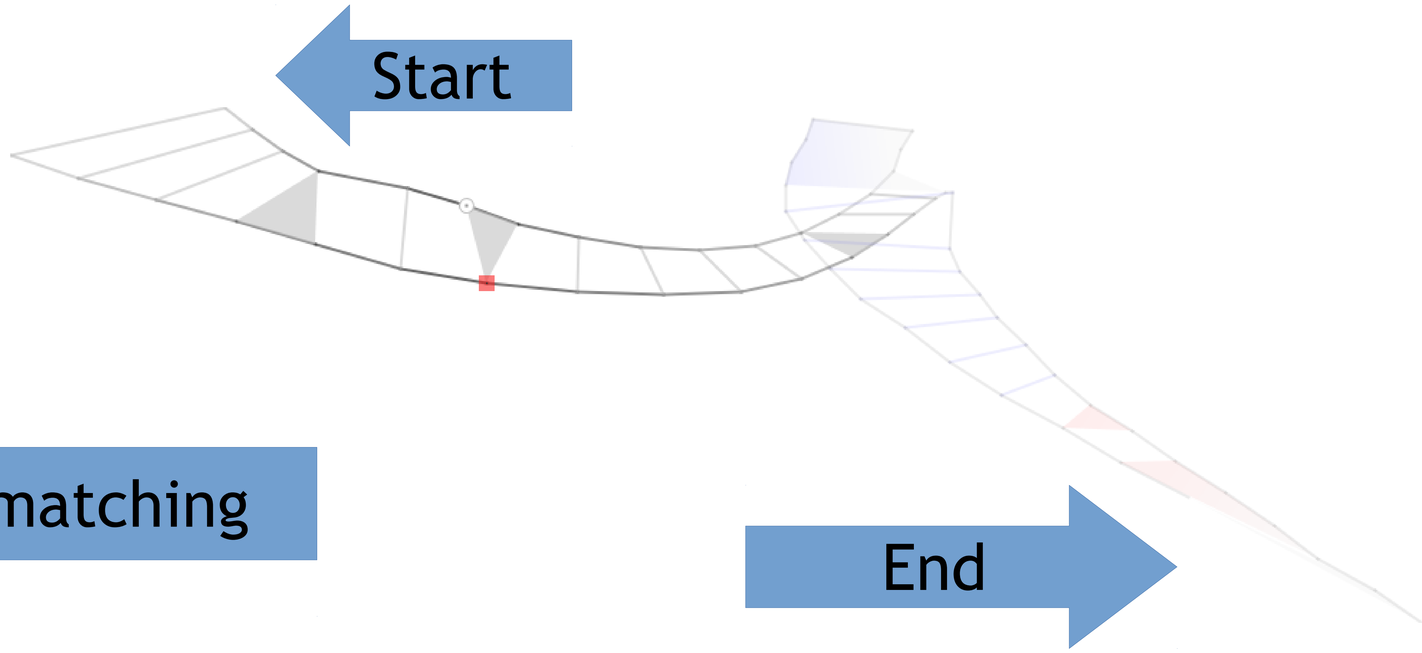




1 to many matching of trajectories



matching

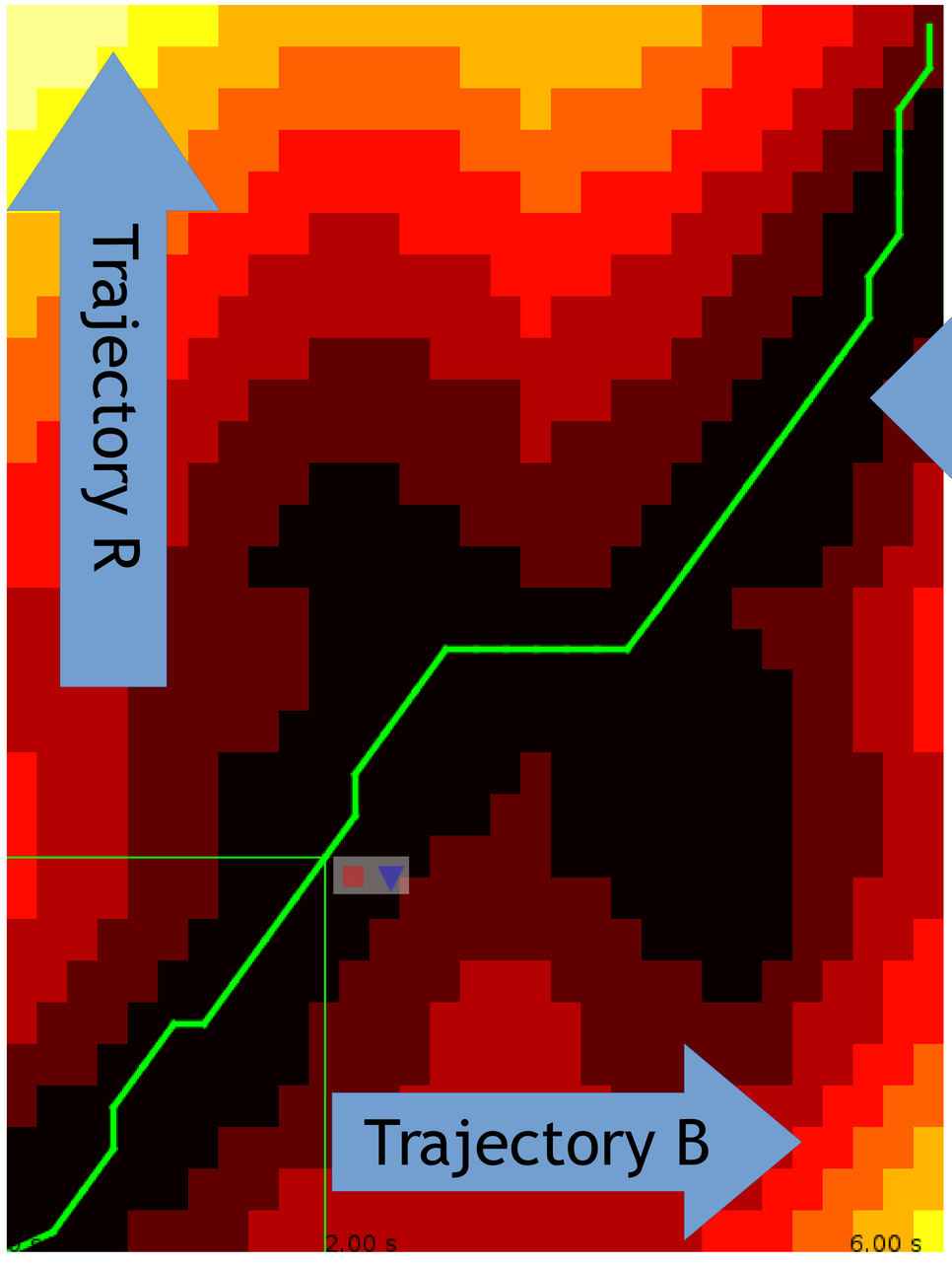


Technique:

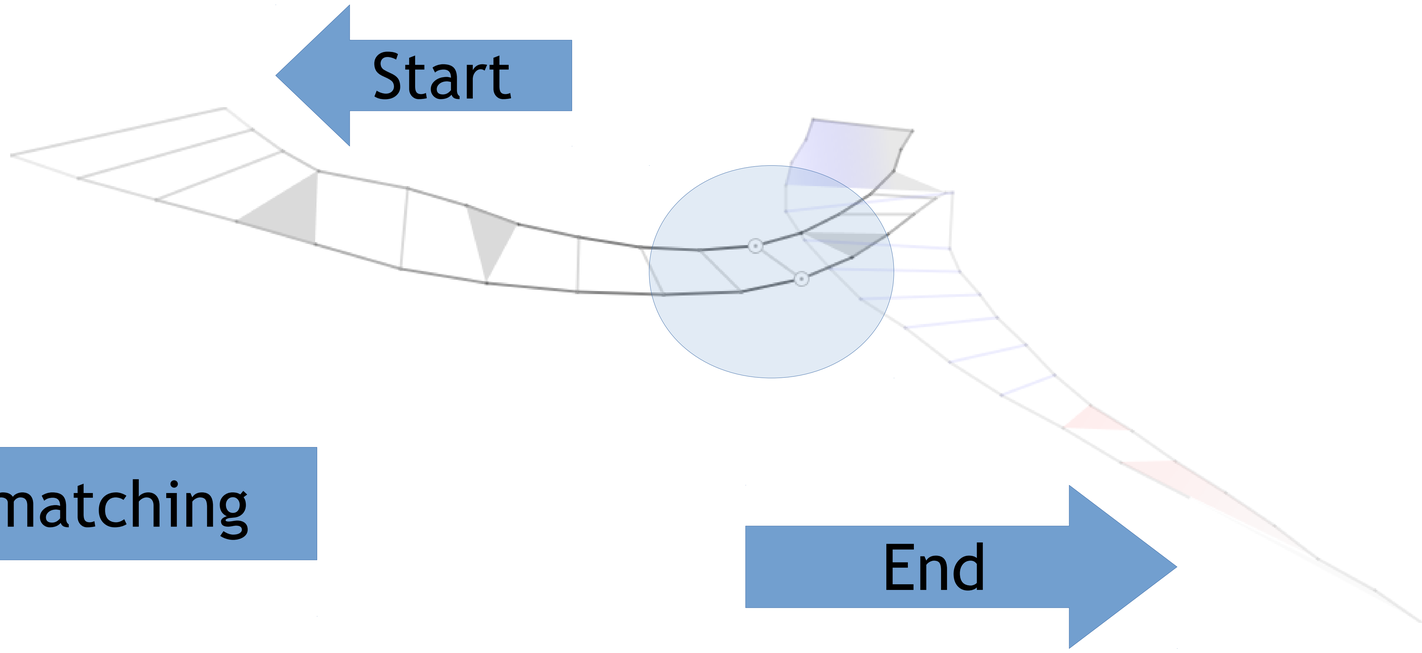
- Horizontal or vertical movements in the delay space
- Bundle those edges into a patch to avoid visual clutter
- A patch captures changes in the delay

Data set: Ultimate Frisbee from [Long and Nelson, 2013]

1 to many matching of trajectories



matching

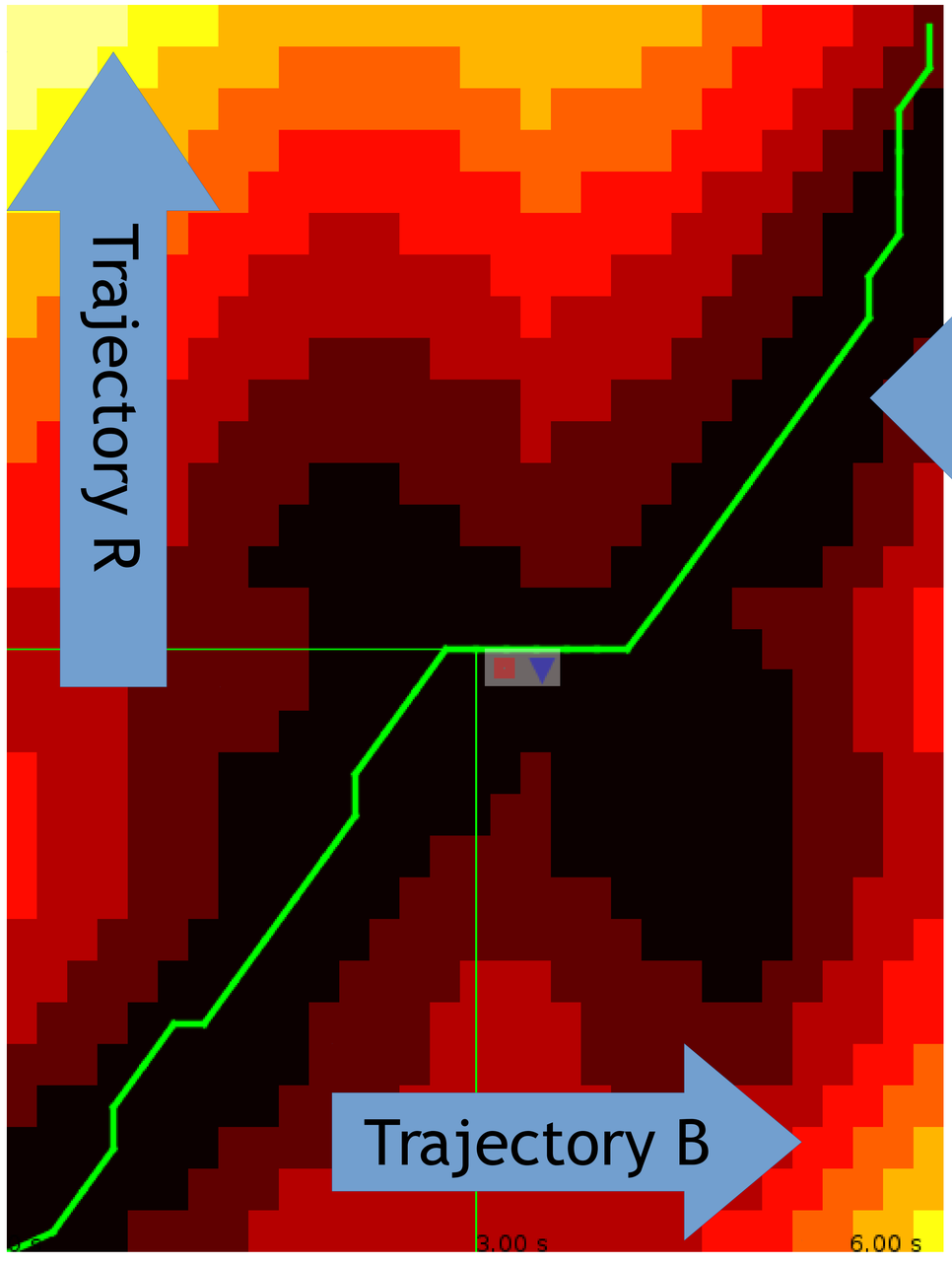


Delay:

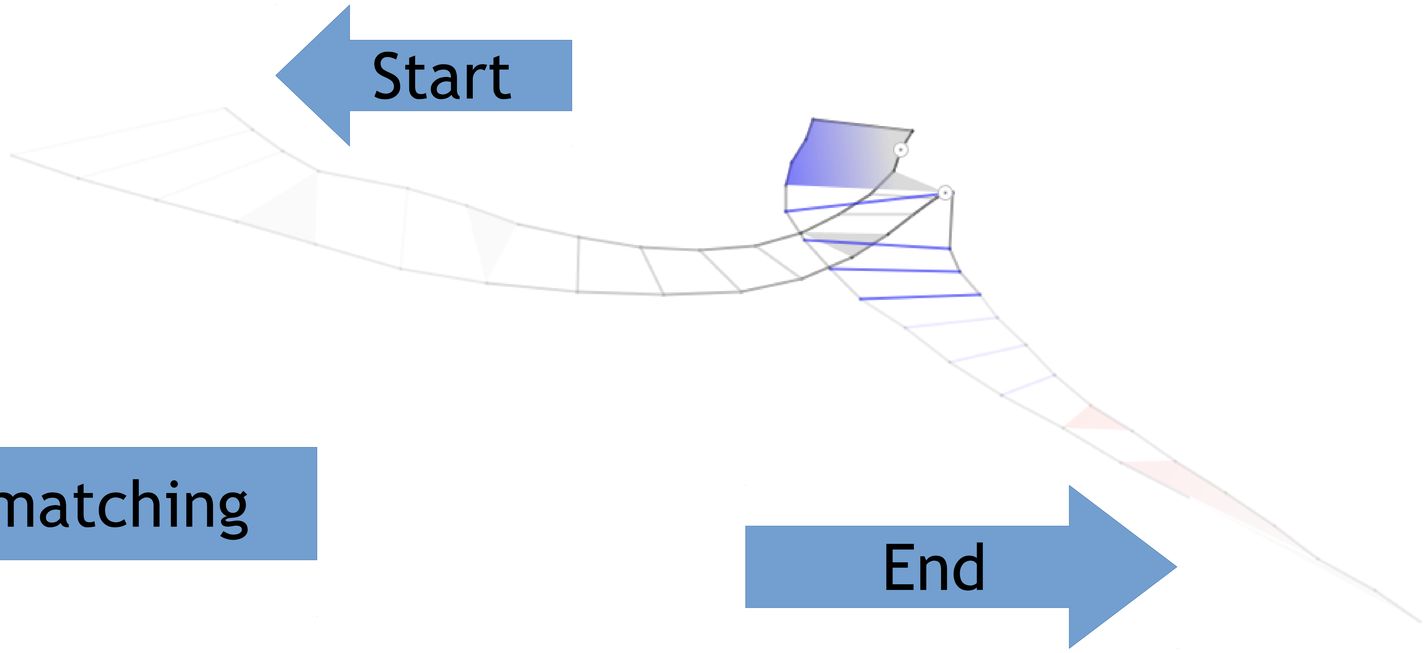
- Diagonal movement in the delay space is a single edge
- No change in the delay

Data set: Ultimate Frisbee from [Long and Nelson, 2013]

1 to many matching of trajectories



matching

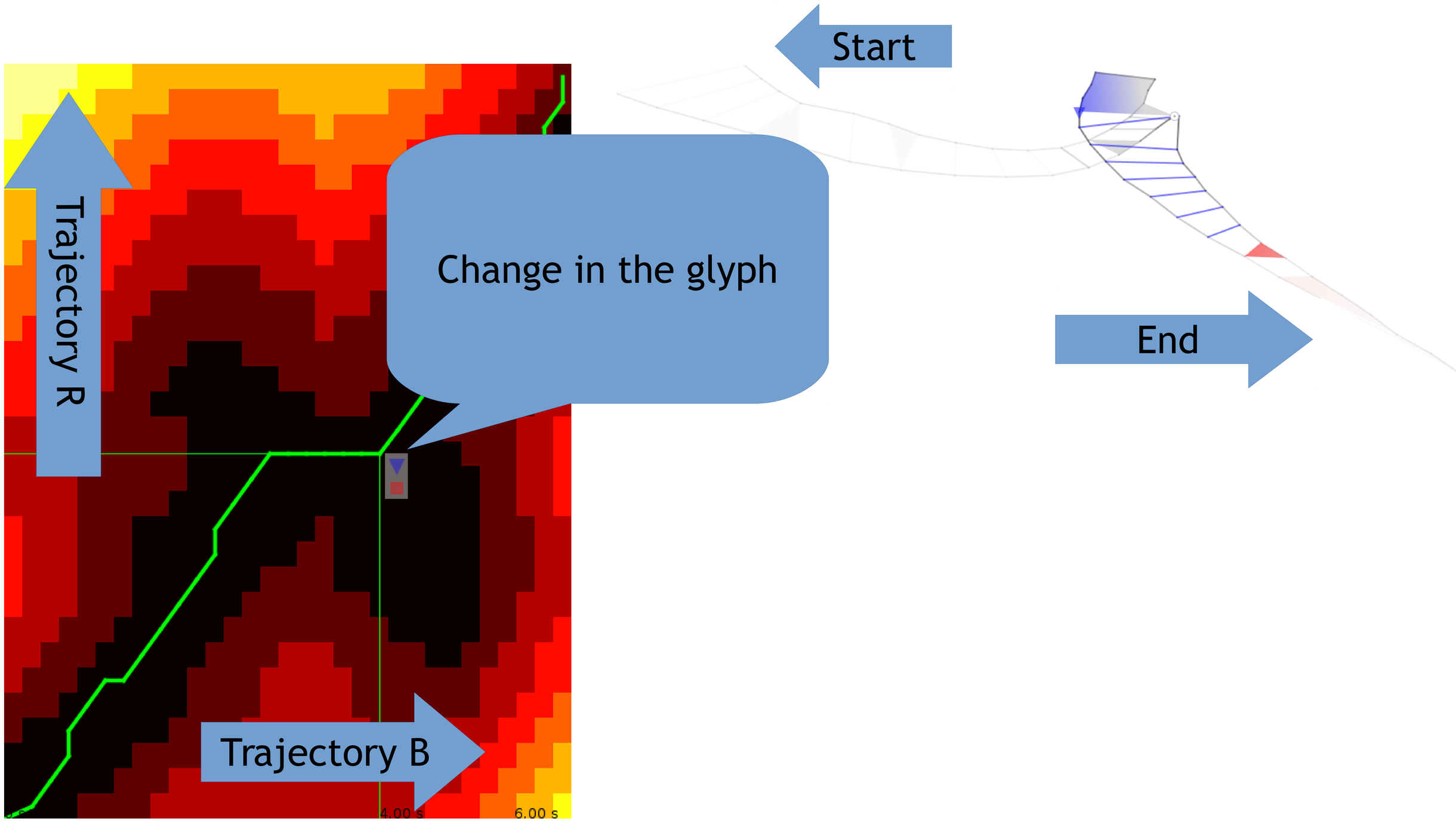


Structure of a patch:

- Patch points to the source of the interaction
- Color of the patch indicates the relevance of the interaction event

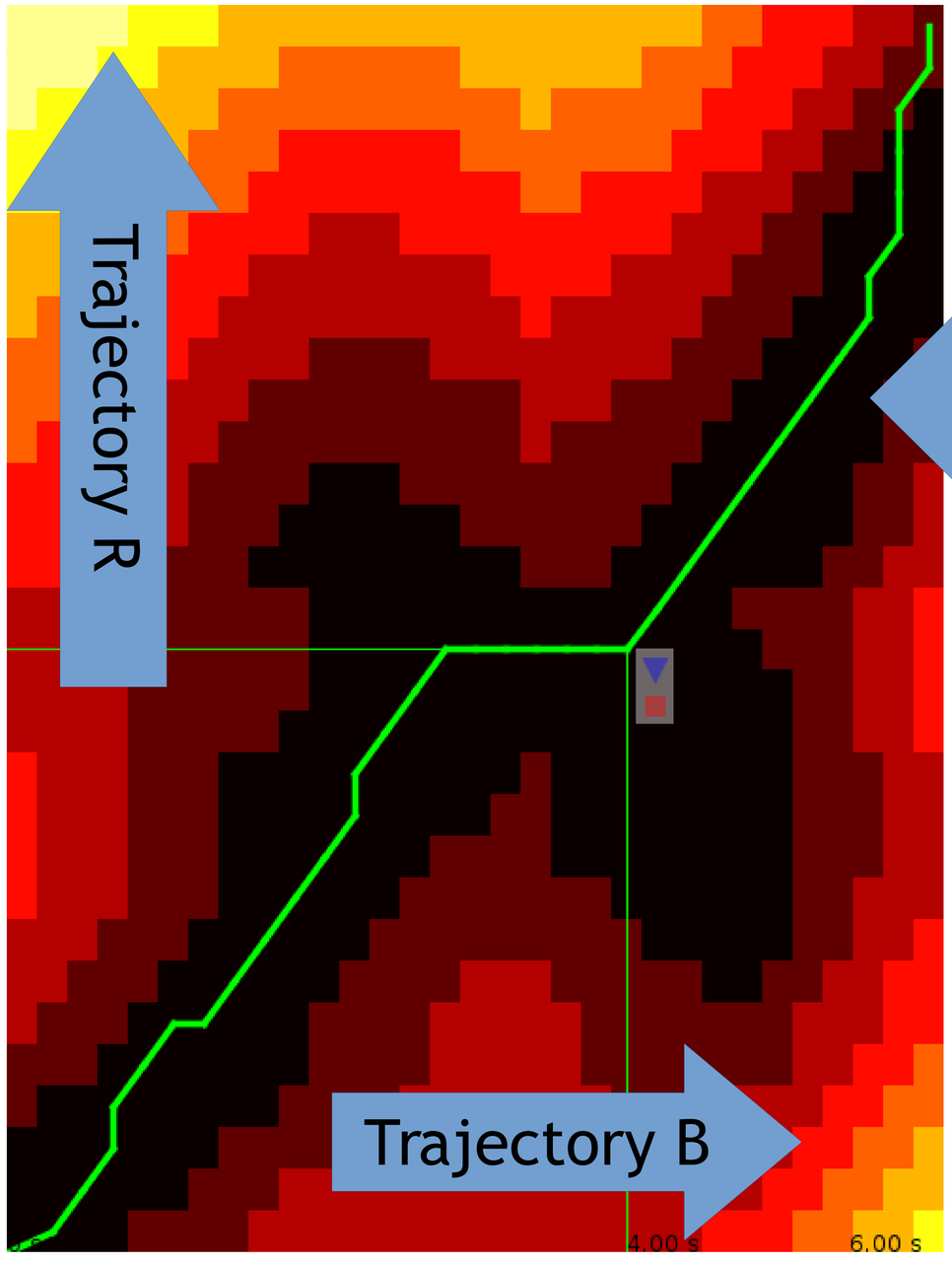
Data set: Ultimate Frisbee from [Long and Nelson, 2013]

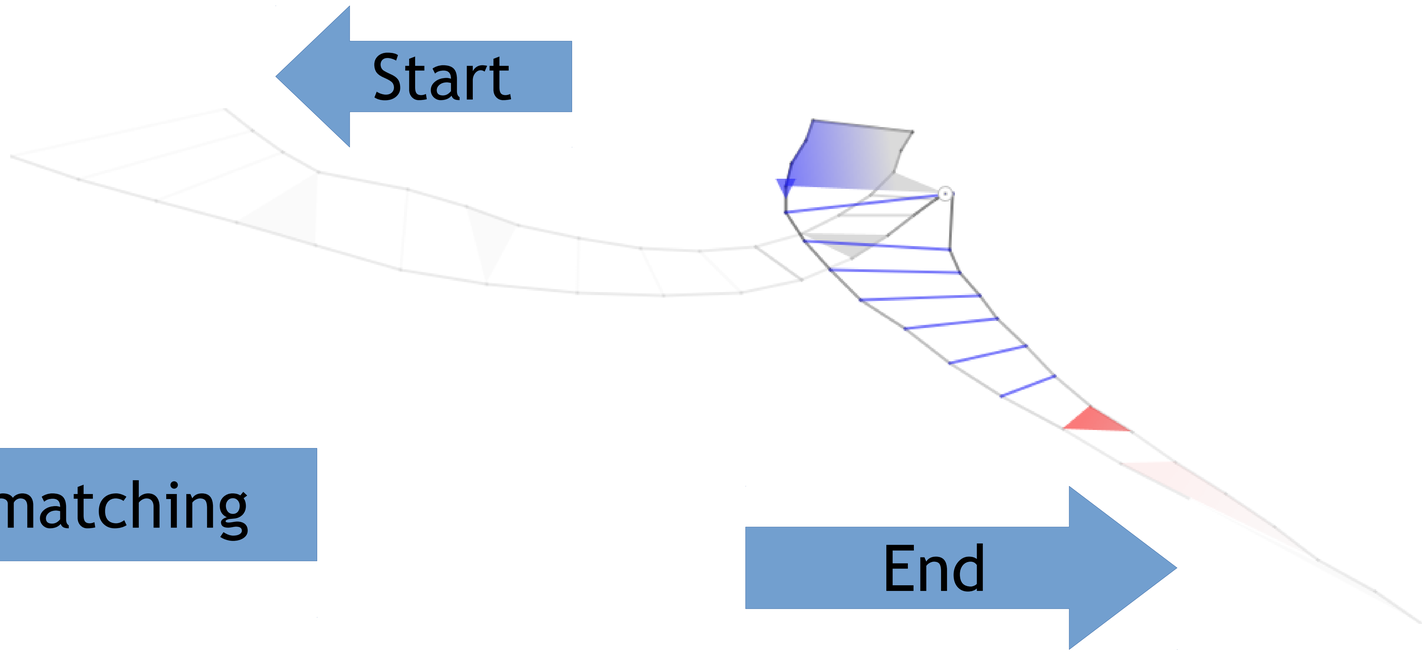
1 to many matching of trajectories



Data set: Ultimate Frisbee from [Long and Nelson, 2013]

1 to many matching of trajectories



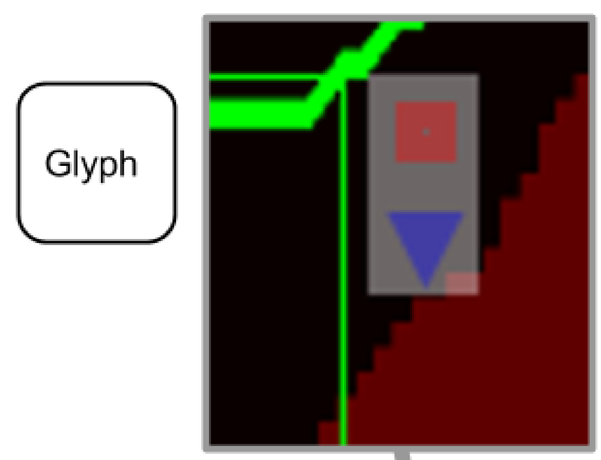


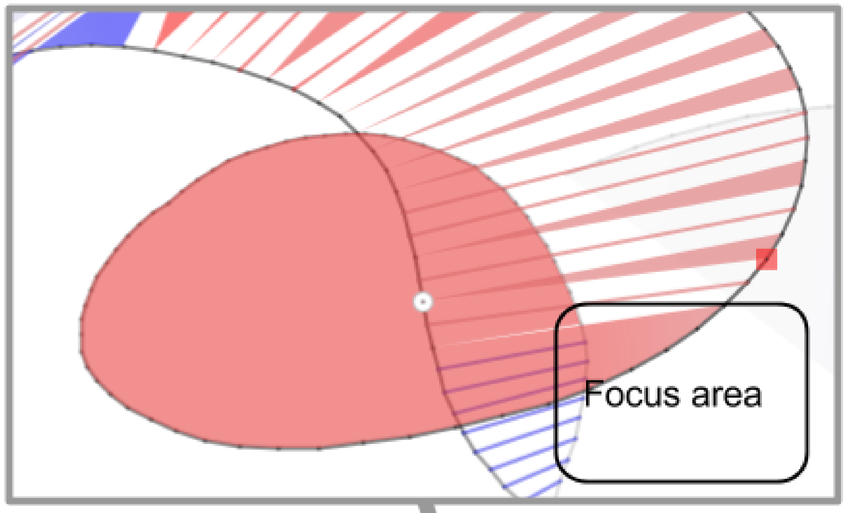
Detecting a loop:

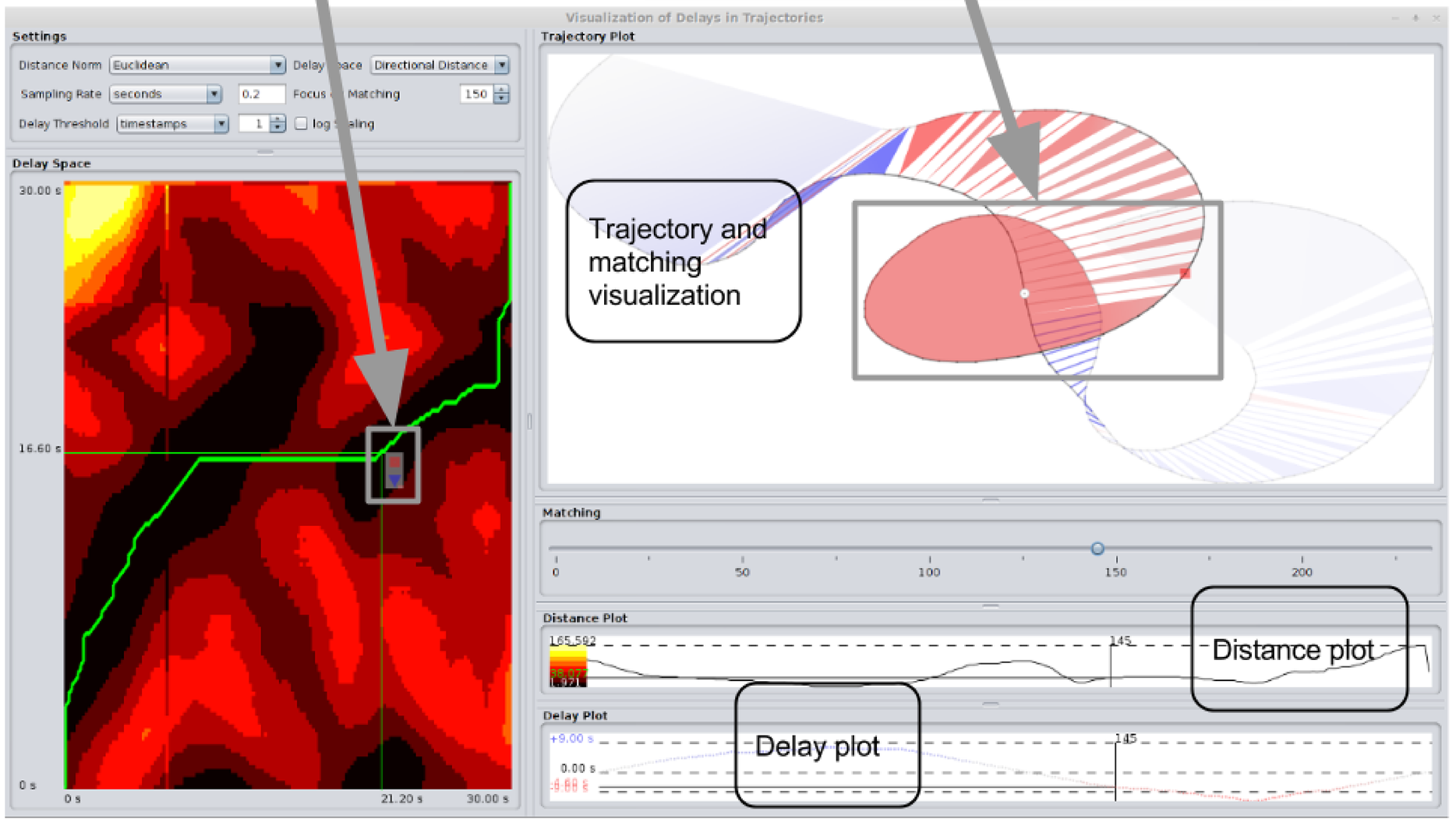
- Reaction by trajectory B
- Trajectory B increases delay to trajectory R

Data set: Ultimate Frisbee from [Long and Nelson, 2013]

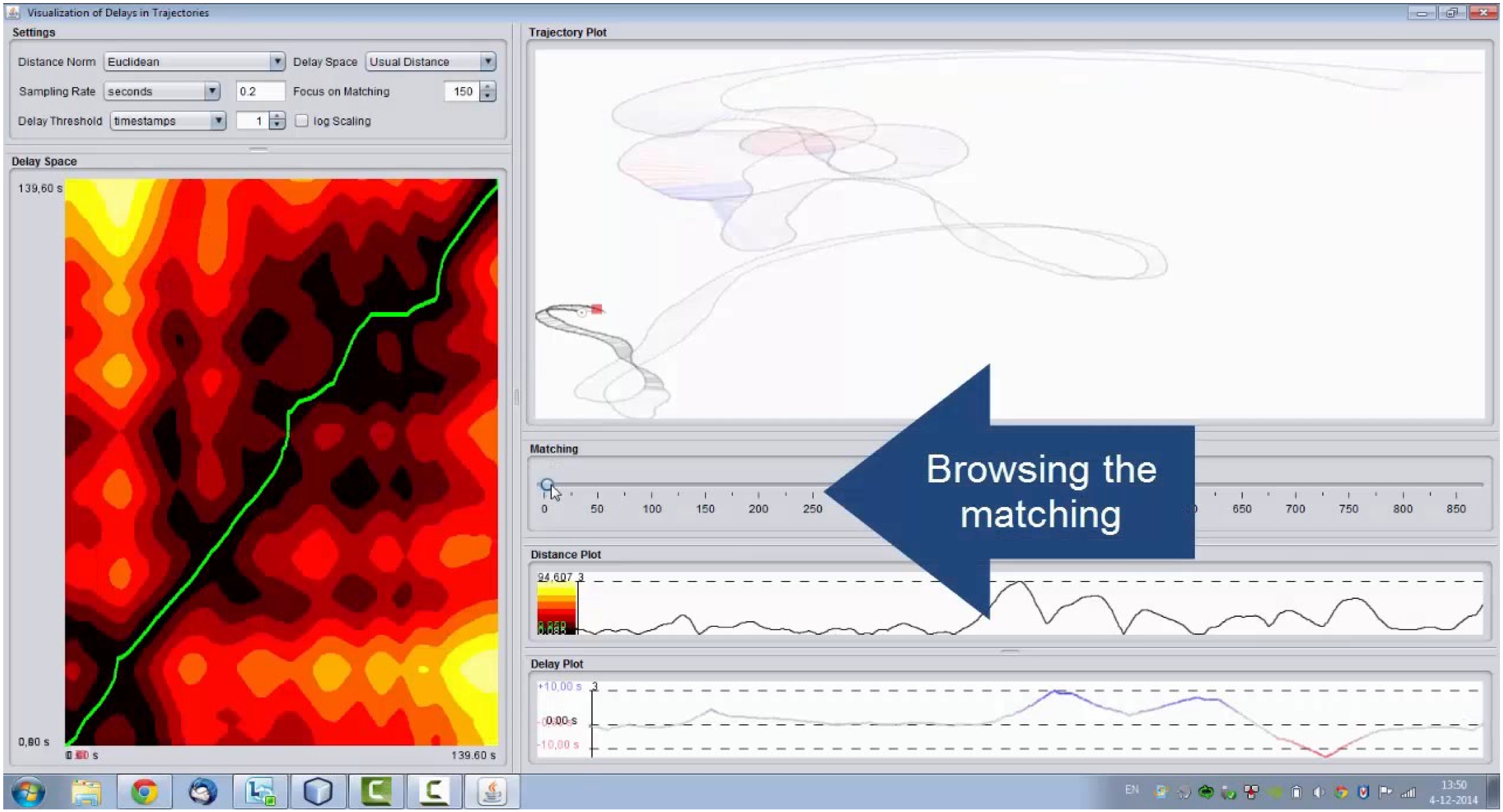
Overview of the visual analytics tool







Demonstration of the visual analytics tool



Data set: homing pigeons from [Pettit et al., 2013]

Conclusions

Summary

- Prototype visual analytics tool for analyzing delays in trajectories
- Visual exploration as interconnected views
  - matching including the trajectories
  - delay space
  - delay plot
  - distance plot

Future work

- Apply our approach in more scenarios
- Evaluate feedback from domain experts
- Generalize the concepts of interaction and delay to multiple trajectories

Thank you for your attention

Netherlands Organisation for Scientific Research