



Institute of Cartography and Geoinformatics | Leibniz Universität Hannover

Finding interesting places and characteristic patterns in spatio-temporal trajectories

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Outline

- ▶ Problem definition
- ▶ A Three-Step-Approach
- ▶ Examples for results
- ▶ Summary and outlook

Problem definition

► Problem context: Project 'qTrajectories'

'Observation of human beings or animals in complex areas using limited resources (cameras)'

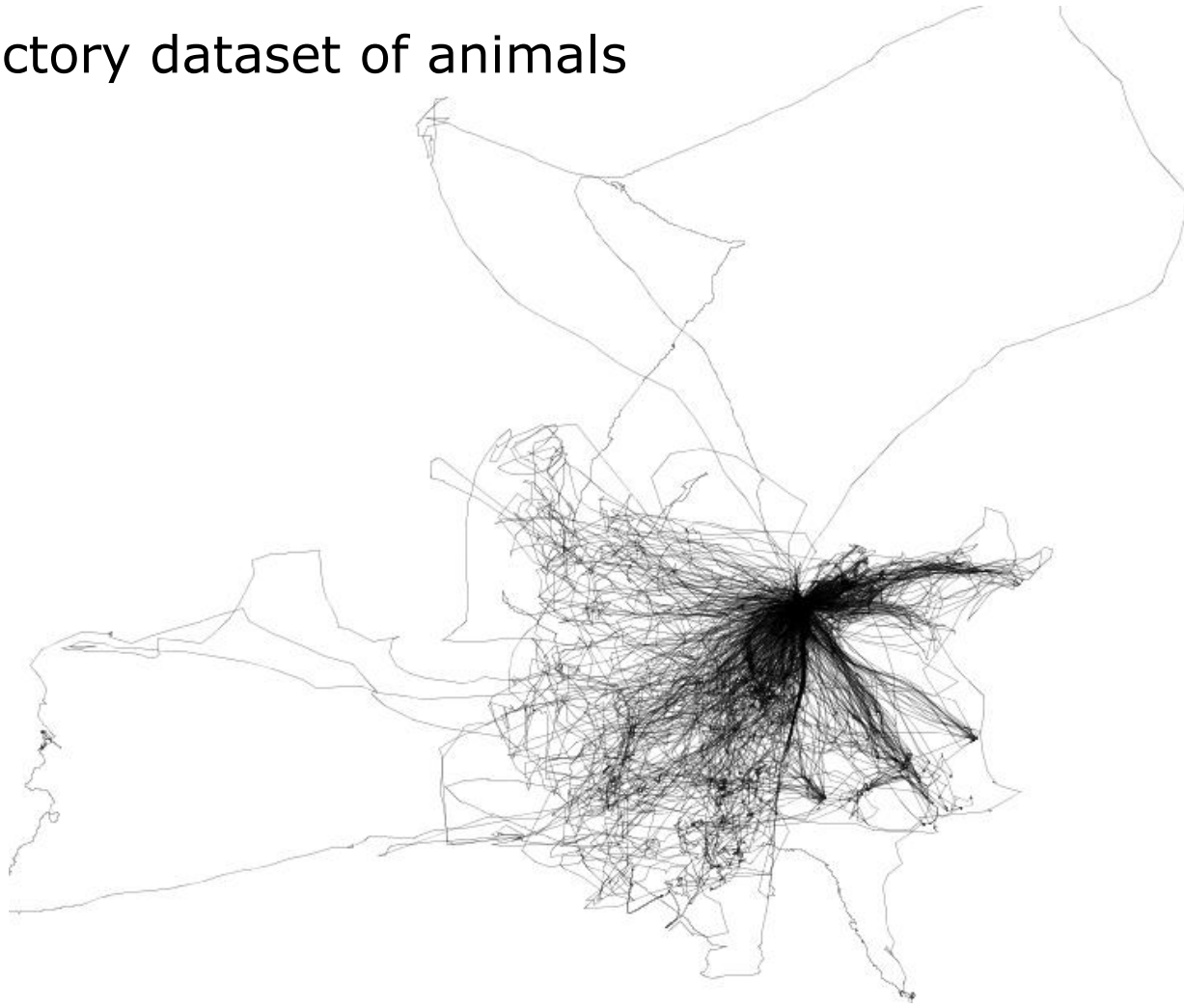
- Interpretation und classification of trajectory data
 - Recognition of movement patterns
 - Prediction of movement
 - Identification of critical behavior
- Use of decentralized algorithms (more than one camera)

Problem:

Critical behavior is not defined a priori

Problem definition – Example dataset

- ▶ One trajectory dataset of animals

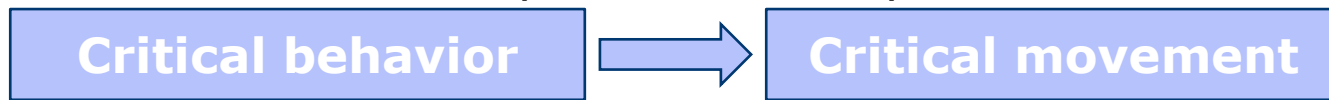


Problem definition – Critical/unusual behavior

- ▶ Evaluation is based on movement/trajectory data

- ↳ Behavior derives from movements

- ↳ Critical movement patterns correspond to critical behavior

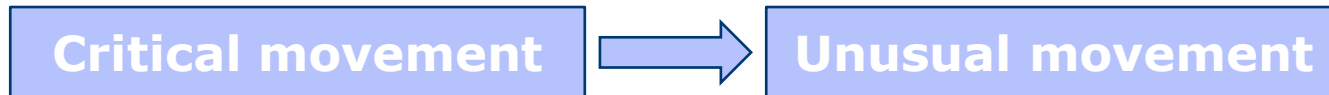


- ▶ Assumption: In general, individuals do not behave critically

- ↳ Critical movements correspond to unusual movements

- ↳ Search for unusual movements

- (later: further classification in critical or not critical)*



- ▶ Criteria for unusual movements depend on spatio-temporal context

A Three-Step-Approach

- ▶ Unusualness depends on spatio-temporal context

- ↳ Spatio-temporal structuring of data

Step 1: Extraction of interesting places

- ▶ Creation of comparability

- ↳ Detection of comparable trajectories / trajectory segments

Step 2: Segmentation of trajectories based on places

- ▶ Critical behavior corresponds to unusual movements

- ↳ Identification of unusual movements

Step 3: Evaluation of comparable segments

Requirements, assumptions and definitions

▶ Requirements

- Large amount of data with a high density and sampling rate

▶ Definitions

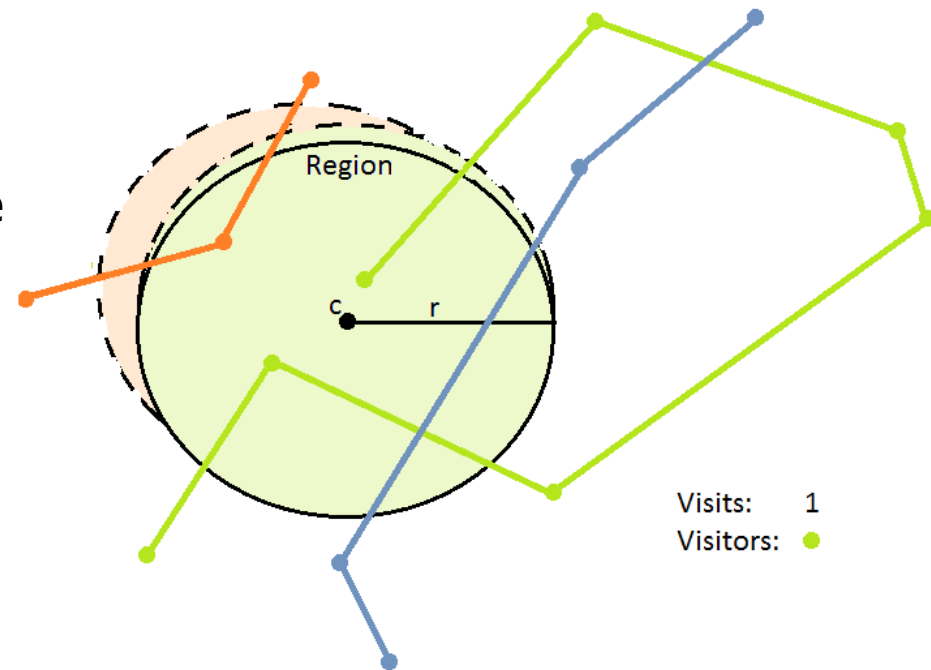
- Attractive place counts at least **N visits**
- Place has certain **geometry and expansion**

▶ Assumptions

- Individuals get slower at attractive places
- Stays can be identified by low **velocity** (threshold)

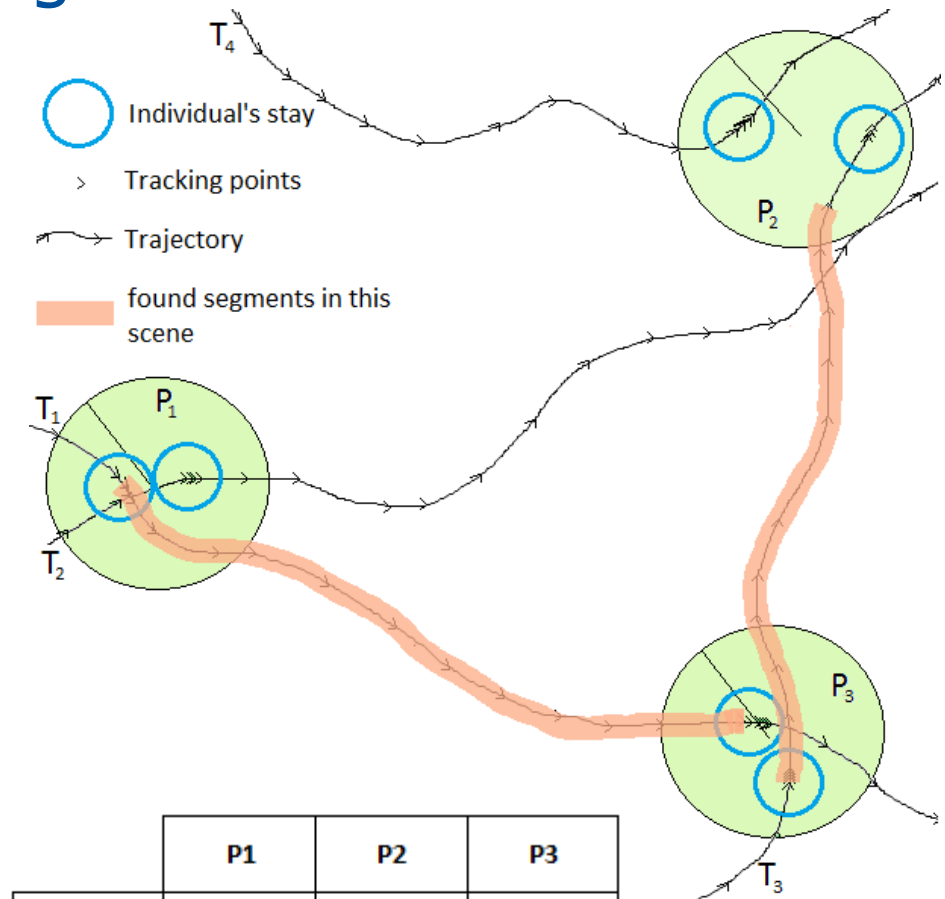
Approach – Step 1 – Extraction

- ▶ Test of 'stay criteria' on every movement
- ▶ Creation of candidate places
 - Condition: first visit
- ▶ Upgrade to attractive places
 - Condition: N visits of candidate
- ▶ While visiting:
 - Counts of entries and exits of each individual
 - Total visit count
 - Correction of place's center coordinates



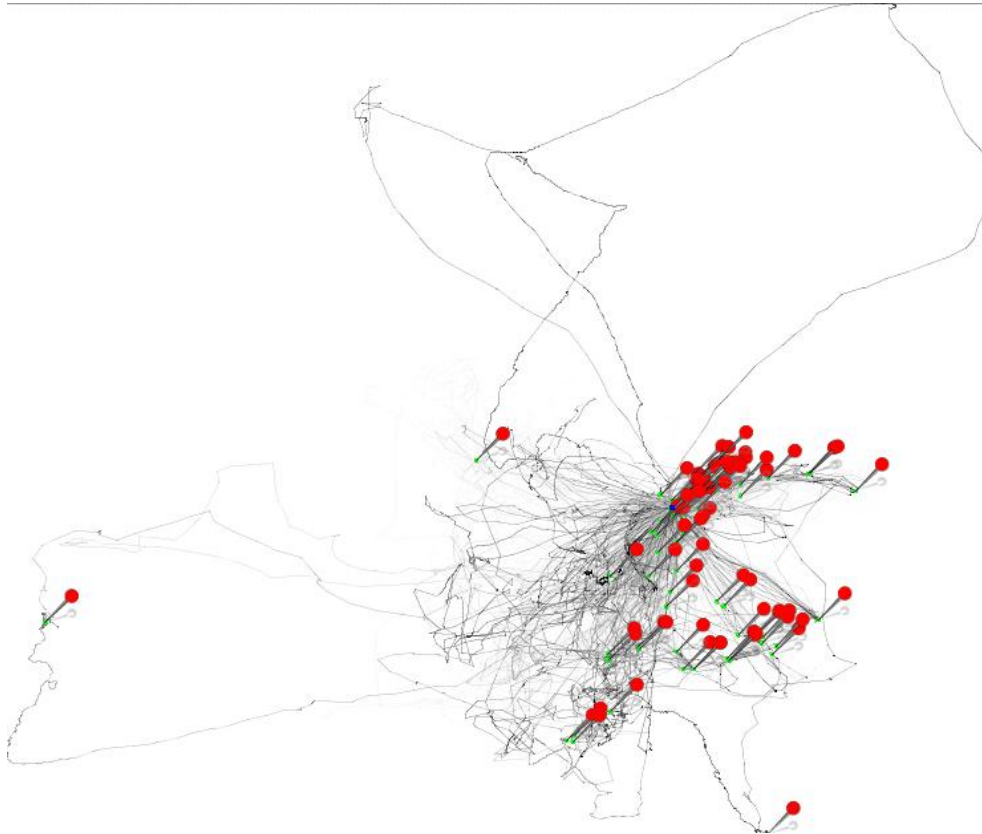
Approach – Step 2 – Segmentation

- ▶ 'Cutting' trajectories into segments between places
- ▶ Collect/Cluster segments in segment clusters
- ▶ Segments without second place are discarded
- ▶ Result:
Matrix of segment clusters

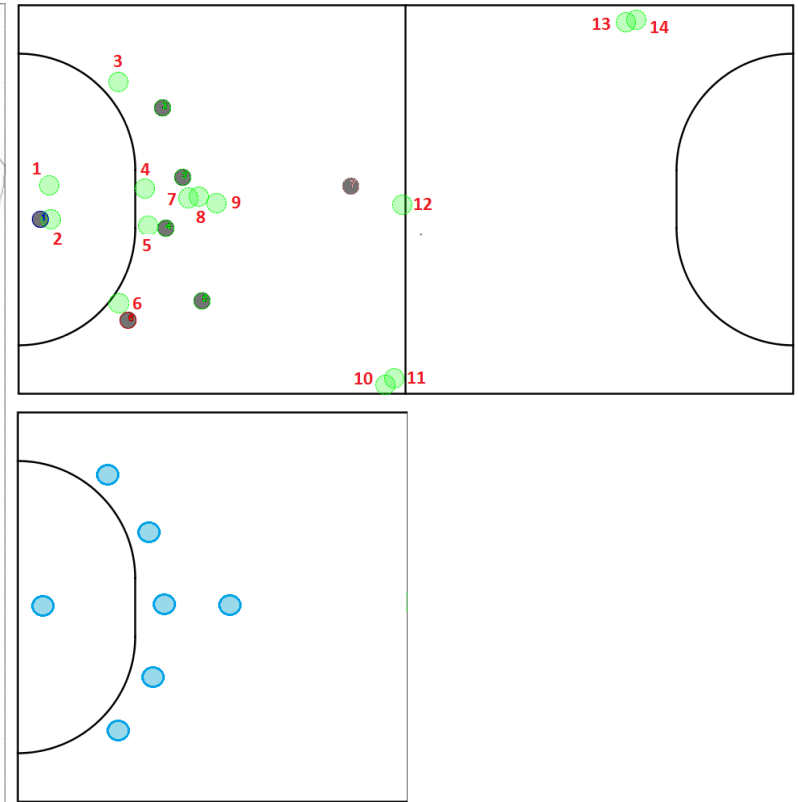


	P1	P2	P3
P1	0	0	1
P2	0	0	0
P3	0	1	0

Results of Step 1 – Examples



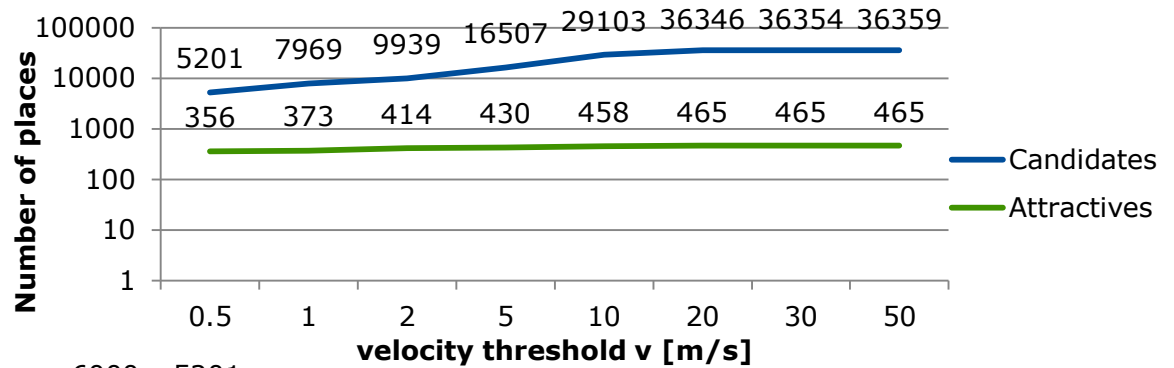
Birds (GPS)



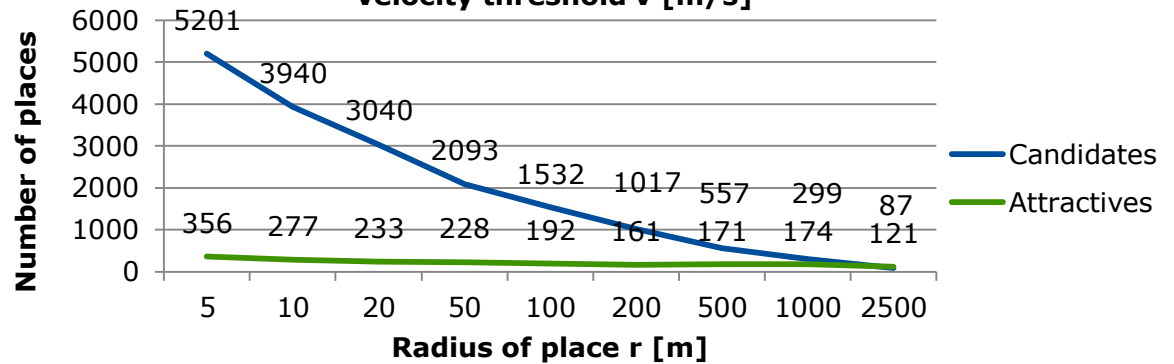
One team during handball match (video)

Results of Step 1 – Influence of parameters

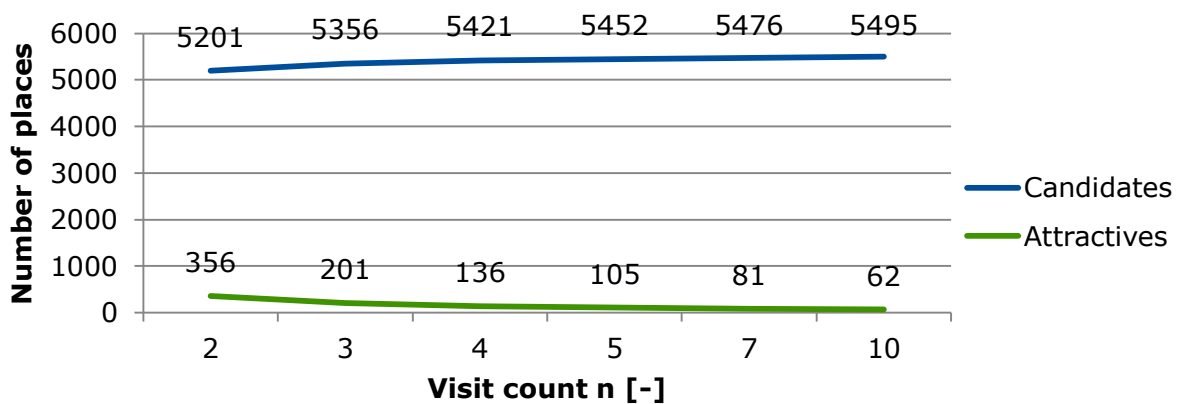
Velocity



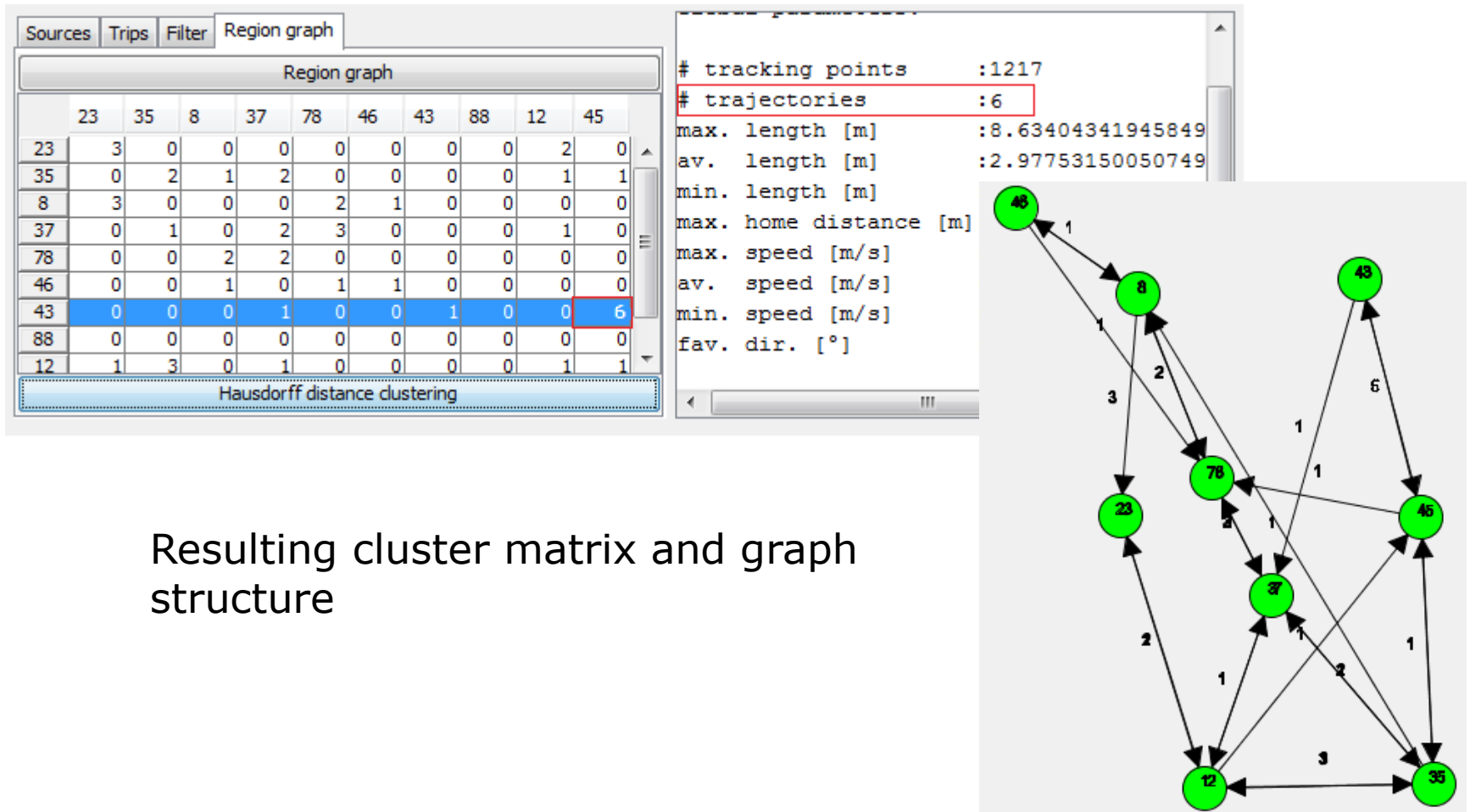
Expansion of place



Visit count



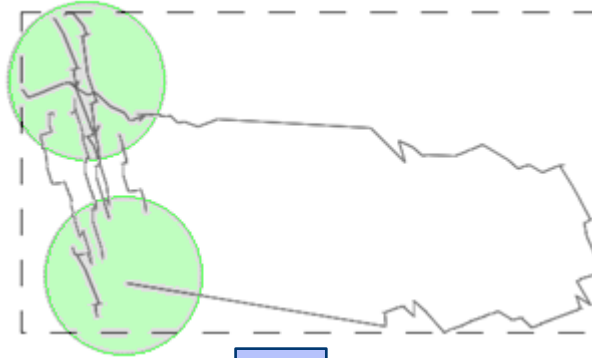
Results of Step 2 – Segmentation



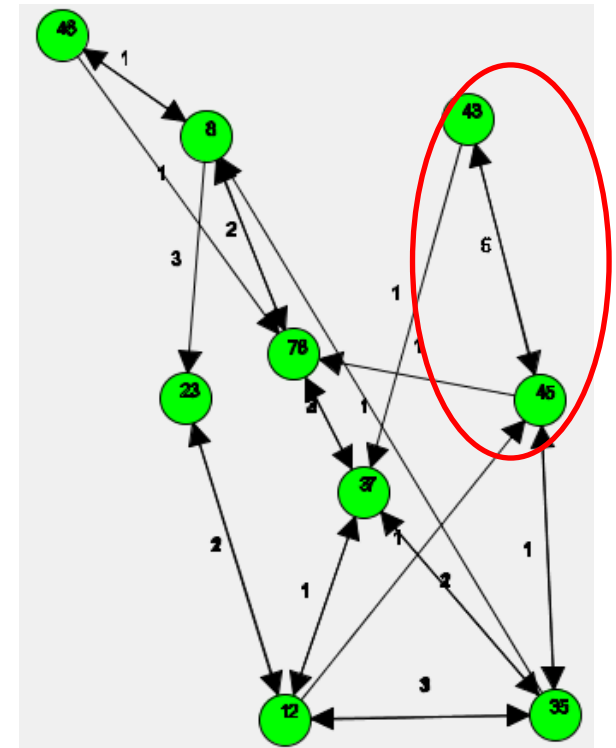
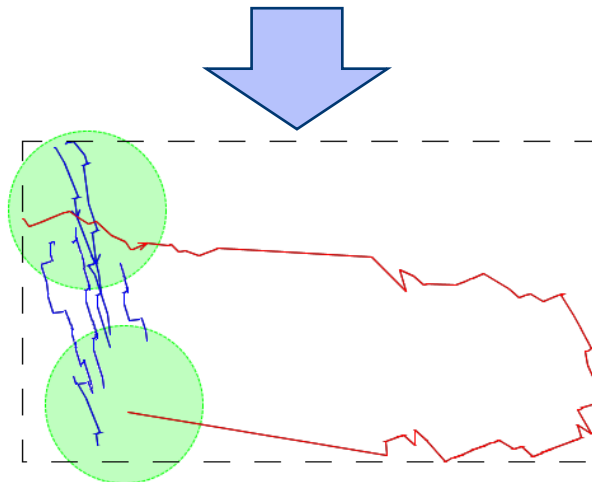
Resulting cluster matrix and graph structure

Results of Step 3 – Evaluation

- ▶ Evaluation example for one segment cluster



Clustering based on Hausdorff distances between segments



Summary

- ▶ A three step approach to detect unusual behavior
 - Extraction of attractive places
 - Segmentation of trajectories
 - Evaluation of segments within each segment cluster

- ▶ Applicable for trajectory data of
 - different sources (human beings, animals,...)
 - different tracking devices (GPS, video,...)

- ▶ Algorithm is suitable for real-time applications

Outlook

- ▶ Use of graph structure (nodes → places, edges → segment) clusters for movement prediction
- ▶ Decentralized version of algorithm
- ▶ Learning or automatic adjustment of required parameters
- ▶ Using more temporal components (e.g. typical times of day)

Thank you for your attention!
Are there any questions?