Universität Konstanz

JOHANNES GUTENBERG UNIVERSITÄT MAINZ

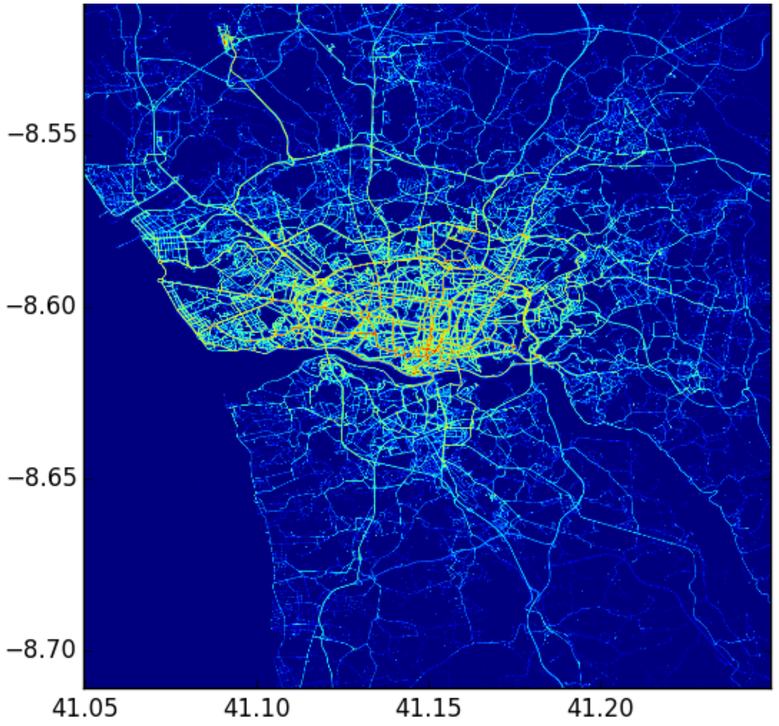
History Oblivious Route Recovery on Road Networks

Theodoros Chondrogiannis, University of Konstanz
Johann Bornholdt, University of Konstanz
Panagiotis Bouros, Johannes Gutenberg University Mainz
Michael Grossniklaus, University of Konstanz

ACM SIGSPATIAL GIS 2022

Mobility Analysis

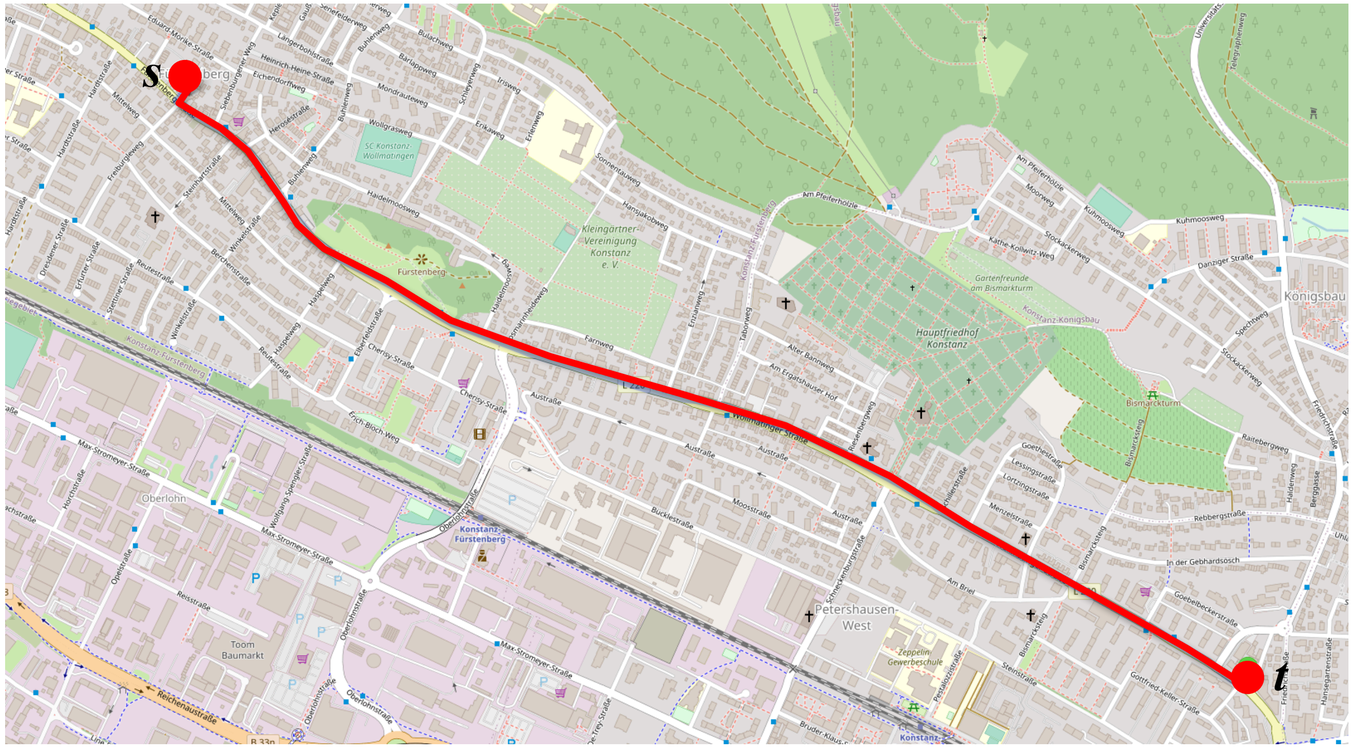
- Vehicle trajectory data
- Many tasks rely on trajectory analysis
  - ETA
  - Traffic forecasting
  - Vehicle routing
  - and more



- However
  - The availability of fine-grained trajectory data is limited

Problem Definition

- Route Recovery from Trip Data (without using any historical information)
  - Given a trip $T = (src, trg, \tau_s, dur)$, find the exact route that the moving object followed during T



Single Route Recovery

- Compute a path that optimizes some objective criterion/driver preference
  - Fastest path
    - Minimizes travel time
  - Shortest simple path
    - Minimizes travel time and limits turns [Sacharidis et al.]
  - Minimum road hierarchy peaks
    - Minimizes switches between road types

Single Route Recovery

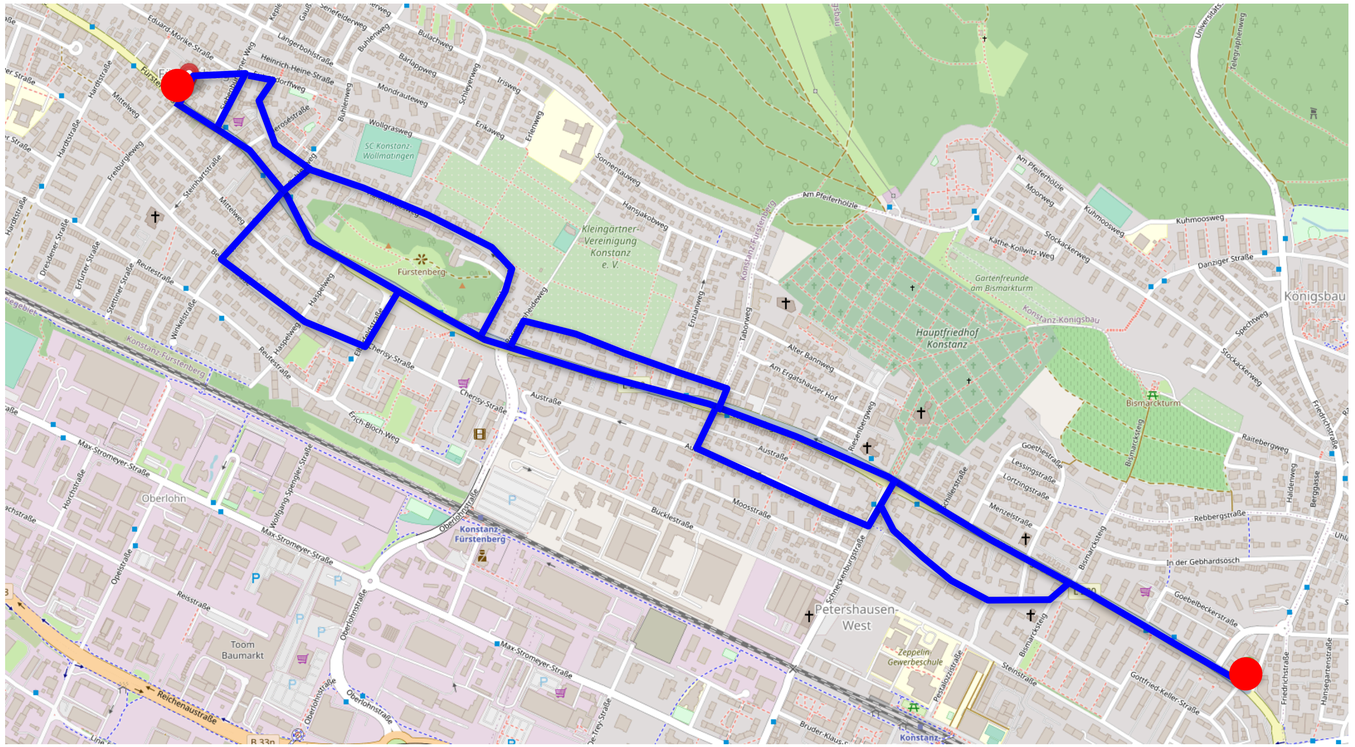
- Experimental evaluation
  - Road network of Porto (78,080 nodes, 183,404 edges)
  - 101,705 taxi trajectories used as ground truth

	shortest	fastest	MinHP	MinTurns
precision	0.559	**0.613**	0.611	0.575
recall	0.485	0.525	**0.531**	0.469
f1 score	0.519	0.566	**0.568**	0.527
recall@n	0.429	0.482	**0.490**	0.443
accuracy	0.429	0.482	**0.487**	0.439

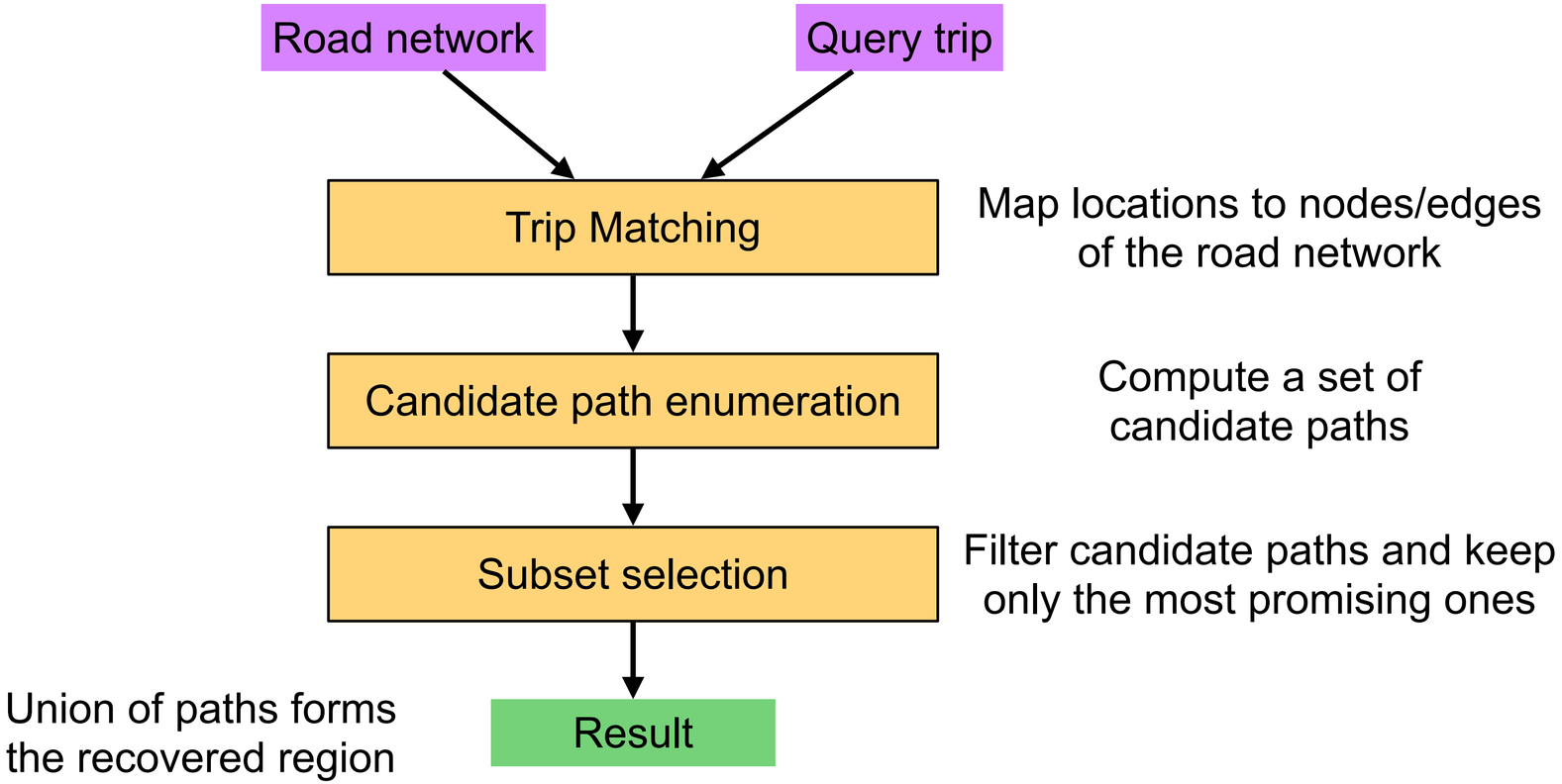
- Conclusion
  - Results are good given the circumstances but we rarely get the actual route or the largest part of it

Region Recovery

- Instead of returning a single route that (potentially) matches the actual route, we return a subnetwork that (potentially) contains the actual route



Region Recovery

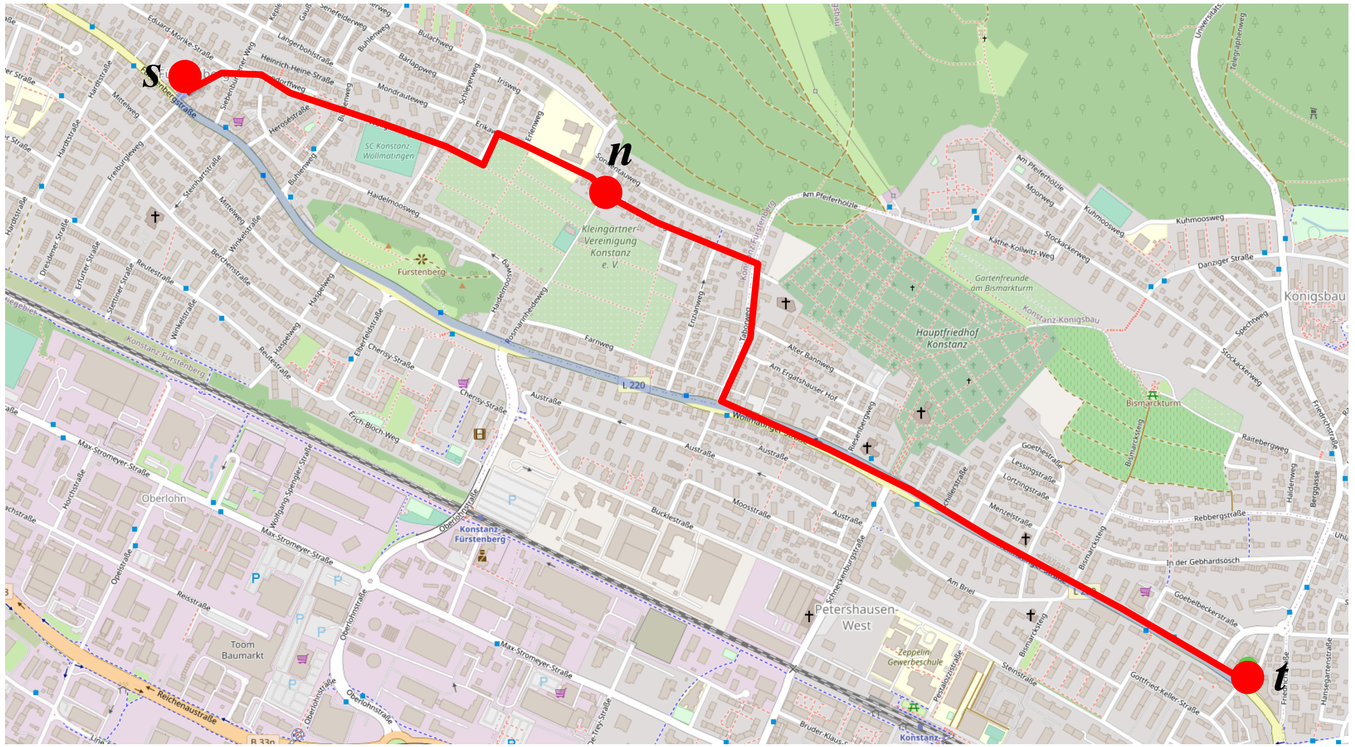


Region Recovery

- Candidate Path Enumeration
  - Single-via paths
  - Penalty-based path enumeration

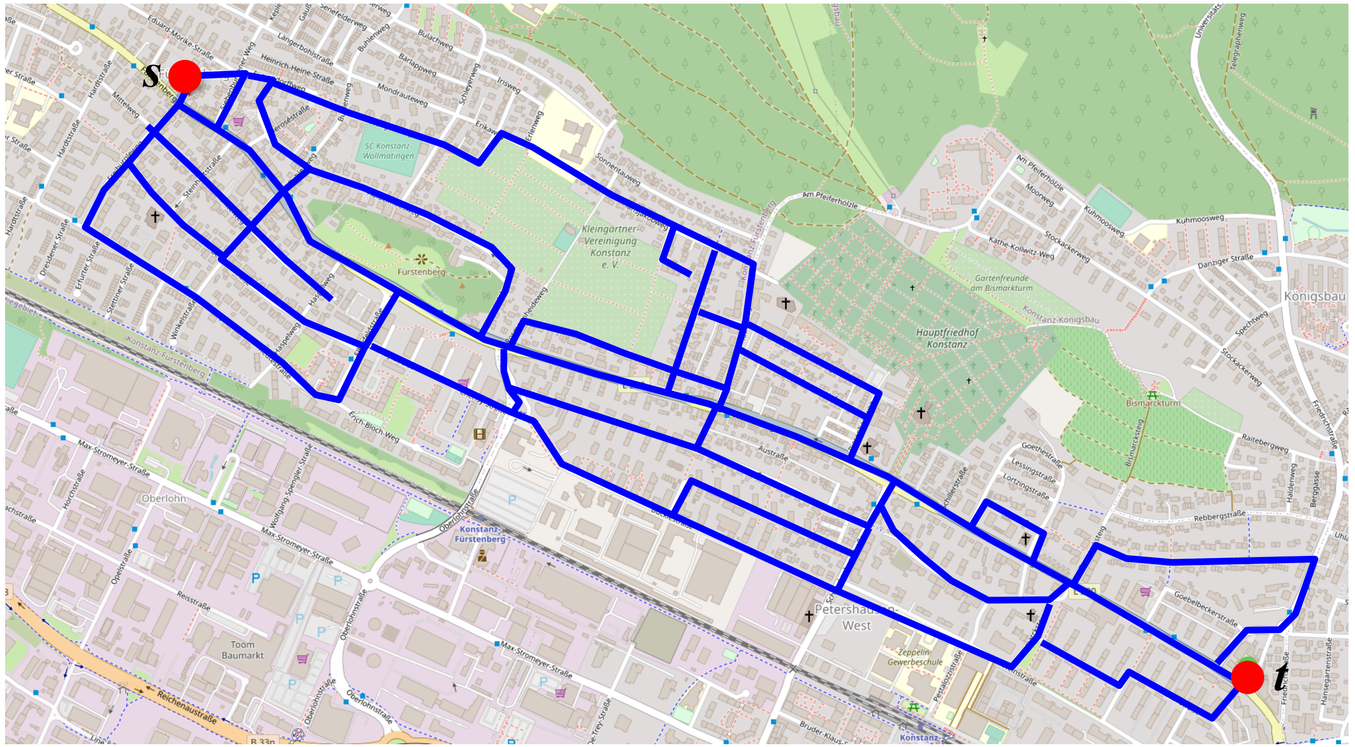
Single-via Paths

- Given $s - t$ and $n \in N : p_{sp}(s \rightarrow n) \circ p_{sp}(n \rightarrow t)$
  - Shortest possible path from s to t that also contains n



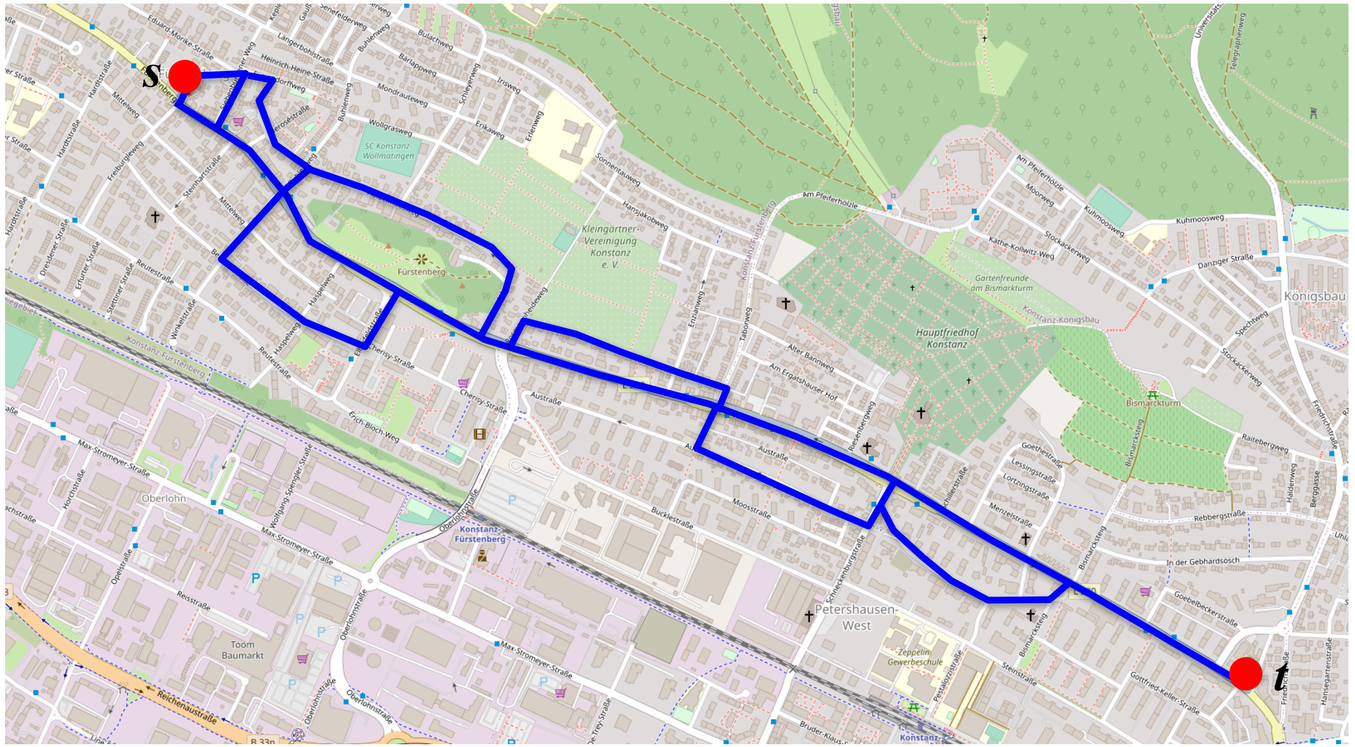
Single-via Paths

- Route containment region
  - Union of all single-via paths of travel time up to the recorded duration of the given trip



Penalty-based Path Enumeration

- Compute paths iteratively with travel time up to the recorded duration



Region Recovery

- Candidate Path Enumeration
  - Single-via paths
  - Penalty-based path enumeration
- Subset Selection
  - Local optimality
  - Bi-criteria skyline (travel time + road hierarchy peaks)

Group-based Region Recovery

- Penalty-based
  - Apply penalty by taking into account the recorded duration of trips that happened at the same time

Experimental Evaluation

- Region recovery methods

	SvPE	SvPE-LOpt	SvPE-Sky	PenPE	PenPE-LOpt	PenPE-Sky
precision	0.015	0.053	0.553	0.181	0.239	0.567
recall	1.0	0.953	0.606	0.901	0.816	0.596
f1 score	0.029	0.100	0.579	0.301	0.370	0.581
recall@n	1.0	0.908	0.565	0.857	0.769	0.555
accuracy	0.012	0.041	0.466	0.174	0.230	0.469

Experimental Evaluation

- Group-based region recovery

	SvPE	PenPE	GrPE-30
precision	0.015	0.181	0.351
recall	1.0	0.901	0.693
f1 score	0.029	0.301	0.466
recall@n	1.0	0.857	0.641
accuracy	0.012	0.174	0.331

Conclusions & Future Work

- Conclusions
  - Among single route recovery methods, MinHP is the most effective one but it's accuracy is low
  - Region recovery methods offer various trade-offs between precision and recall
- Future work
  - Improve the efficacy of our approaches
  - Measure the effect that our route recovery methods have on real world tasks

Thank you!