USER ORIENTED TRAJECTORY SEARCH FOR TRIP RECOMMENDATION

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TO BE SHORT...

- How can I go from Park Inn Berlin to Humboldt University?
- We recommend a trajectory that is spatially closest.
- I prefer public transportation.
- We recommend a trajectory that is not-so-close via S-Bahn.
OUTLINE

- Introduction
- Methods
  - Preliminaries
  - Baseline: Spatial-First
  - UOTS Query Processing
- Experiments
- Summary
TRAJECTORY SEARCH

- Given: a set of trajectories and a set of query locations
- Task: finding trajectories connecting/close to the query locations
HOWEVER. . .

- Spatial domain is not sufficient!
  - Recommending the trajectory of a train passenger to a car driver
  - Recommending the trajectory of an office lady to a computer scientist
TEXTUAL ATTRIBUTES

- Features of trajectories
- Preference of travelers

<table>
<thead>
<tr>
<th></th>
<th>tollway</th>
<th>highway</th>
<th>off road</th>
<th>travel style</th>
<th>transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>$K_q$</td>
<td>0%</td>
<td>&gt;70%</td>
<td>&lt;10%</td>
<td>independent</td>
<td>by private vehicle</td>
</tr>
<tr>
<td>$K_{\tau 1}$</td>
<td>20%</td>
<td>60%</td>
<td>20%</td>
<td>grouped</td>
<td>by bus</td>
</tr>
<tr>
<td>$K_{\tau 2}$</td>
<td>0%</td>
<td>80%</td>
<td>0%</td>
<td>independent</td>
<td>by private vehicle</td>
</tr>
<tr>
<td>$K_{\tau 3}$</td>
<td>0%</td>
<td>70%</td>
<td>20%</td>
<td>grouped</td>
<td>by bus</td>
</tr>
</tbody>
</table>
WHY DIFFICULT?

- High dimensionality in textual domain
- . . and therefore high computational complexity
- Baseline: Spatial-First Trajectory Search
DIFFERENT IN. . .

- Trajectory Similarity Search
  - distance between (trajectory, trajectory)
  - spatial only
  - free space

- Spatial Keyword Search
  - simple keyword matching
  - invalid optimization in spatial networks
  - single query location
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ROAD NETWORKS AND TRAJECTORIES

Road Networks
- Model: connected and undirected planar graphs $G(V, E)$
- $E$: weighted, spatial distance
- $V$: mapped objects, even if there is no "branch"

Trajectories
- Model: $\tau = \{ p_1, p_2, ..., p_n \}$
- Aligned to the vertexes by map-matching algorithms
**Spatial-Textual Distance Function**

- **Spatial distance**
  - Sigmoid function $S_{\text{dist}}(O_q, \tau)$

- **Textual distance**
  - Jaccard distance $T_{\text{dist}}(K_q, K_\tau)$

- **Spatial-textual distance**
  - $ST_{\text{dist}}(q, \tau) = \lambda \times S_{\text{dist}}(O_q, \tau) + (1 - \lambda) \times T_{\text{dist}}(K_q, K_\tau)$
PROBLEM DEFINITION

- Given a trajectory set $T_r$, a query input $q$, including a location set $O_q$ and a textual attribute set $K_q$ . . .
- User Oriented Trajectory Search (UOTS) finds the trajectory $\tau \in T_r$ with the minimum value of $ST_{\text{dist}}(q, \tau)$
- . . . such that $ST_{\text{dist}}(q, \tau) \leq ST_{\text{dist}}(q, \tau_0), \forall \tau_0 \in T_r \setminus T$
SPATIAL-FIRST

1. Spatial Domain

2. Textual Domain

\(o_1, o_2, o_3, o_4\)

\(K_q\)
SPATIAL-FIRST

1. Spatial Domain

2. Textual Domain

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**SPATIAL-FIRST**

1. **Spatial Domain**

   - $r_1$, $r_2$, $r_3$, $r_4$
   - $r_1$: $O_1$
   - $r_2$: $O_2$
   - $r_3$: $O_3$
   - $r_4$: $O_4$

2. **Textual Domain**

   - $K_a$
SPATIAL-FIRST

1. Spatial Domain

2. Textual Domain

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1. Spatial Domain

2. Textual Domain

\( K_a \)
SPATIAL-FIRST

1. Spatial Domain

2. Textual Domain
Spatial-First

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Spatial-First

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SPATIAL-FIRST

1. Spatial Domain

2. Textual Domain
UOTS QUERY PROCESSING

1. Spatial Domain

2. Textual Domain
EXPERIMENTS
EXPERIMENTS
SUMMARY

- Trajectory search taking **user preferences** into consideration
- Collaborative search with . . .
  - A pair of **bounds**
  - A **heuristic** strategy
  - Extension to **ordered** query locations
SUMMARY

- Trajectory search taking user preferences into consideration
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- Outlook
  - Low sample rate trajectories...
  - Combining trajectories?
Q&A

- Thank you!