Inferring **Road Networks** from **GPS Trajectories**

Radu Mariescu Istodor

19.12.2018
GPS Trajectory

Latitude: 62.2351
Longitude: 29.4123
Timestamp: 10.10.2018 19:05
Satellite Images ➔ GPS Trajectories

Chicago

Joensuu

MOPSI
Proposed Method

Mariescu-Istodor, Radu, and Pasi Fränti.
"Cellnet: Inferring road networks from gps trajectories."

Step 1
Detecting Intersections

Step 2
Creating Road segments

In the next slides I will:
1. Teach the background
2. Show how we did it*
3. Give you a challenge 😊

*most important steps only
Detecting Intersections

Detecting Intersections

Detecting Intersections


Turning patterns
Detecting Intersections

PROPOSED
Mariescu-Istodor, Radu, and Pasi Fränti.
"Cellnet: Inferring road networks from gps trajectories."
Detecting Intersections

**PROPOSED**

Mariescu-Istodor, Radu, and Pasi Fränti.
"Cellnet: Inferring road networks from gps trajectories."

Still works...

**Random Swap**

Fränti, Pasi, and Juha Kivijärvi.
"Randomised local search algorithm for the clustering problem."
Pattern Analysis & Applications (2000).
Sum of squared errors

Validity Index

SSE

No. Clusters

5 10 15 20

Validity Indices

WB
Rate
Silhouette
Dav
Bayesian
Minimum

S2 (synthetic) dataset

cs.uef.fi/sipu/datasets
Creating Road segments
Creating Road segments

Creating Road segments

Cao, Lili, and John Krumm.
"From GPS traces to a routable road map."
Advances in geographic information systems (2009).

Merging
Creating Road segments

Edelkamp, Stefan, and Stefan Schrödl.
"Route planning and map inference with global positioning traces."
*Computer Science in Perspective* (2003).
Creating Road segments

**PROPOSED**
Mariescu-Istodor, Radu, and Pasi Fränti.
"Cellnet: Inferring road networks from gps trajectories."
*ACM TSAS (2018).*

Hautamäki, Ville, Pekka Nykänen, and Pasi Fränti.
"Time-series clustering by approximate prototypes."
*ICPR pp. 1-4. (2008).*
Accepted connections

\[ \text{length} (\alpha) \approx \text{length} (\alpha) \]
Accepted connections

Mariescu-Istodor, Radu, and Pasi Fränti.
"Grid-based method for GPS route analysis for retrieval."
ACM TSAS (2017).

\[ \text{length} (\alpha) \approx \text{length} (\alpha) \]
**Evaluation**

<table>
<thead>
<tr>
<th>City</th>
<th>Precision</th>
<th>Recall</th>
<th>F-Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicago</td>
<td>42%</td>
<td>28%</td>
<td>10%</td>
</tr>
<tr>
<td>Joensuu</td>
<td>46%</td>
<td>58%</td>
<td>87%</td>
</tr>
</tbody>
</table>

**Precision**

\[
\text{precision} = \frac{\text{correct}}{\text{correct} + \text{false detected}}
\]

**Recall**

\[
\text{recall} = \frac{\text{correct}}{\text{correct} + \text{missed}}
\]

**F-Score**

\[
f - \text{score} = 2 \cdot \frac{\text{precision} \cdot \text{recall}}{\text{precision} + \text{recall}}
\]
Challenge:

**Average GPS segments**

http://cs.uef.fi/sipu/segments

Other useful links:

http://cs.uef.fi/mopsi/routes/network
http://cs.uef.fi/mopsi/routes/dataset

Thank You.

Radu Mariescu-Istodor

radum@cs.uef.fi
Choosing the test locations
Choosing the test locations

Mean shifting
Too many detections!
Non-intersections

Roundabout
Silhouette Coefficient:
Silhouette coefficient  
[Kaufman & Rousseeuw, 1990]

- Cohesion: measures how closely related are objects in a cluster
- Separation: measure how distinct or well-separated a cluster is from other clusters
Silhouette coefficient

- **Cohesion** $a(x)$: average distance of $x$ to all other vectors in the same cluster.
- **Separation** $b(x)$: average distance of $x$ to the vectors in other clusters. Find the minimum among the clusters.
- **silhouette** $s(x)$:
  
  $$s(x) = \frac{b(x) - a(x)}{\max\{a(x), b(x)\}}$$

- $s(x) = [-1, +1]$: -1=bad, 0=indifferent, 1=good
- **Silhouette coefficient (SC)**:
  
  $$SC = \frac{1}{N} \sum_{i=1}^{N} s(x)$$
Silhouette coefficient

\[ a(x): \text{average distance in the cluster} \]

\[ b(x): \text{average distances to others clusters, find minimal} \]
Detecting Intersections
- no intersection case -