CrowdAtlas: Self-Updating Maps for Cloud and Personal Use

Yin Wang, Xuemei Liu, Hong Wei, George Forman, Chao Chen, Yanmin Zhu

Presenter: Yongbo Chen
Motivation

- Digital road maps remain inaccurate and incomplete
  - 26% of drivers had been misdirected by their GPS

- Updating existing maps promptly and consistently can be challenging
  - 15% of roads change each year (TomTom’s estimation)
  - The map situation is worse in developing countries

- Growing needs for additional types of maps for non-motorist traffic and personalized maps
  - Cycling, hiking, off-road driving
Motivation (cont.)

- Existing commercial and public maps are created manually
  - NAVTEQ (now Nokia)
    - 7,000 employees in location content team
  - Google, TomTom, Waze
    - Encourage users submit map edits online
    - Pending manual review
  - OpenStreetMap (OSM)
    - 600,000+ registered contributors
    - Limited in detail, freshness and accuracy
CrowdAtlas Architecture

(a) CrowdAtlas system and the overall context

(b) CrowdAtlas navigation app
Stream Processing Flow (1/4)
Stream Processing Flow (2/4)
Stream Processing Flow (3/4)
Stream Processing Flow (4/4)
Map Matching

- **GPS samples:** $z_0, z_1, z_2$
- **Candidate sets:** 
  - $\{x_0^0, x_0^1\}$, $\{x_1^0, x_1^1\}$, $\{x_2^0\}$
- $z_0, z_1 \Rightarrow \text{ABD}$
- $z_0, z_1, z_2 \Rightarrow \text{ABC}$

*Figure 3: Map matching illustration*
New Road Inference

- Trace clustering
  - Hausdorff distance
- Centerline fitting
  - a threshold for the number of elements in a cluster
  - generate a polyline to minimize its mean square error to the samples
- Connection
  - connect with intersections
- Iteration
  - Re-match and re-cluster
Challenges and Limitations

- The base map must have a reasonably accurate skeleton of arterial roads.
- Tunnels and plane separated roads are limitations for map inference using only latitude and longitude.
- Road names and address numbers cannot be added automatically.
- Existing map inference work always makes a single representation choice for all roads.
Evaluation: Standalone Map Update
Evaluation-Server Map Update

- 70 taxis in Beijing for 8 days in December 2008
- Sampled at 10 second intervals
- Evaluated by OSM map of 10/31/2012

(a) New roads inferred vs. different support thresholds
Evaluation-Server Map Update

![Bar chart showing length of inferred roads over 8 days: Correctly inferred vs. Incorrectly inferred.](chart.png)
Evaluation-Server Map Update

(c) Using sub-sampled data (support = 3)
Questions?