Visual Data Quality Analysis for Taxi GPS Data

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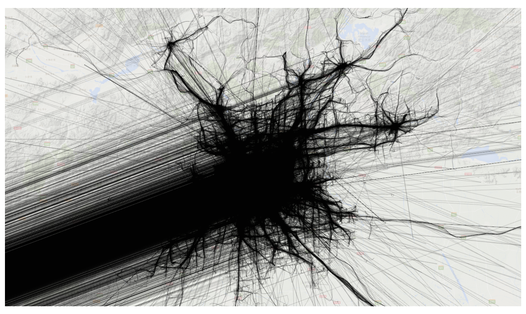
What Quality Problems in This Data?



- Any systematic way to detect quality problems?
- Any way to detect unknown problems?
- Any way to discover strange shapes?

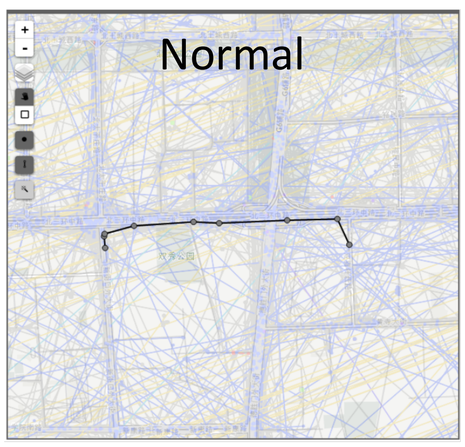
See What We Discovered in a Sample!

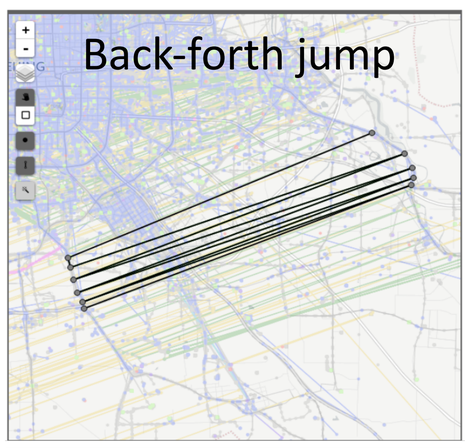
Beijing taxi GPS data

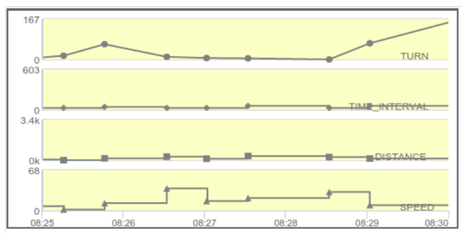
- Time: Mar 4th, 2009, 7-9 am (2 hours)
- Taxis: 13,080 (50% random sample)
- Points: 747,431
- Data size: 74.2 MB
- Sampling: 30 secs/point
- **Partition: 5 min pieces**

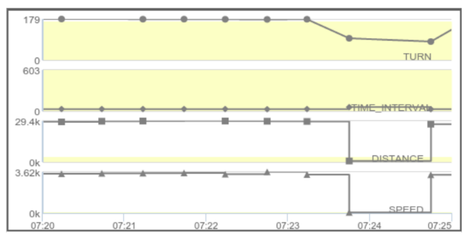
Find 8 quality problems

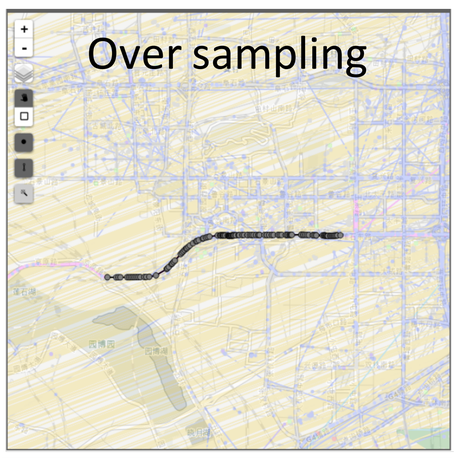
- **Over sampling**
- Data missing
- Duplication
- Stopage
- Long jump
- V-shape jump
- **Back-forth jump**
- **Random movement**

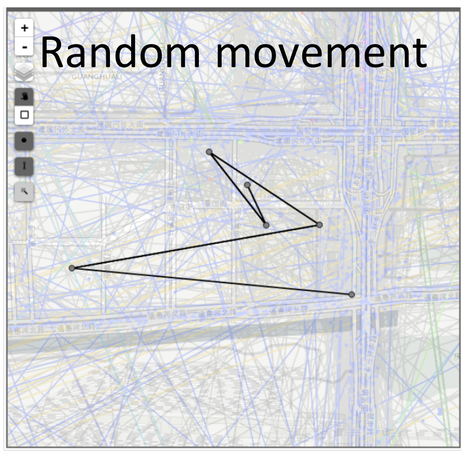


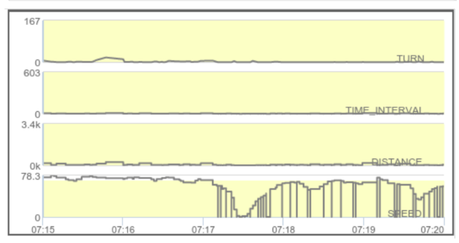


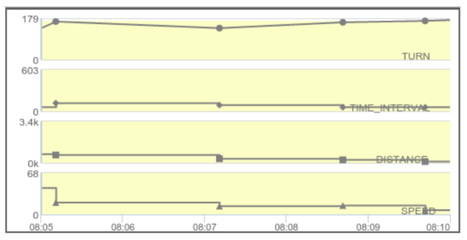












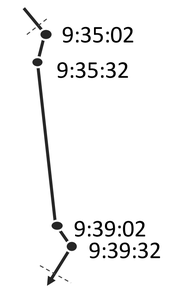
How Do We Discovered Them?

Interactive discovery of potential problems

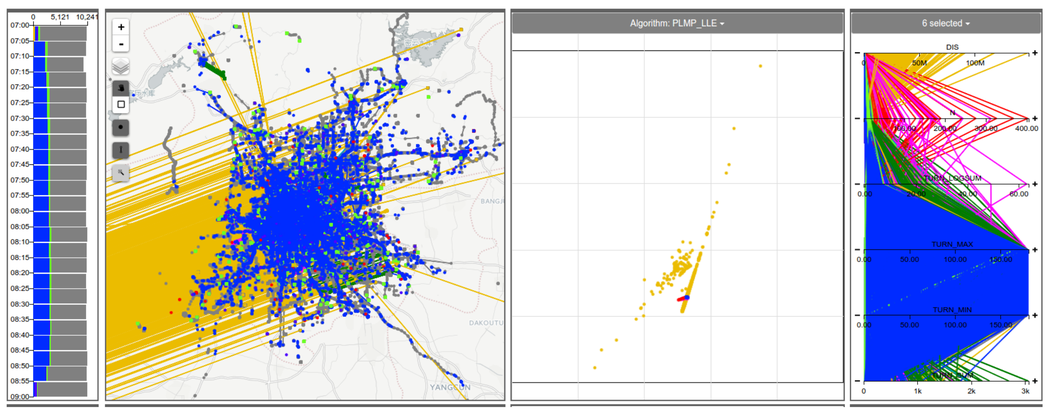
- Project trajectory pieces into spatial, temporal & **feature** spaces
- Detect data **outliers and clusters** (potentially problematic)

Feature space definition (19 features)

- #sampling points, distance, sum(turning angles)
- min/max/recsum/logsum of turning angle
- min/max/recsum/logsum of segment distance
- min/max/recsum/logsum of segment time interval
- min/max/recsum/logsum of segment average speed



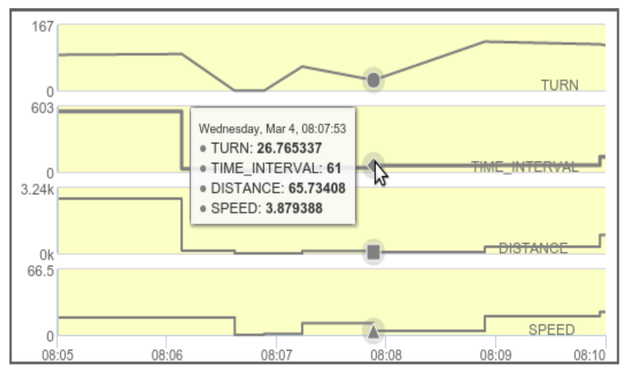
Showing data distribution from different aspects



Temporal Spatial Feature Feature

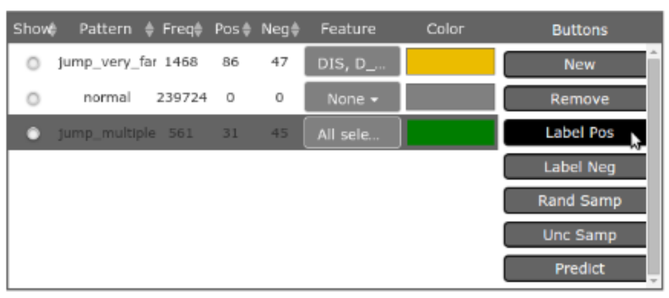
Visual confirmation of suspected data

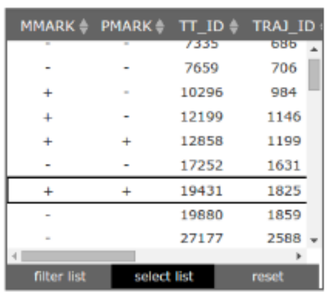
- Show the spatial shape and point/segment attribute change
- Help expert users confirm whether there's a problem



Automatic extraction of data with confirmed problems

- Binary SVM classifiers to extract problematic data
- Classifier training with interactive labeling
  - Active learning: label data that best optimize classifiers
  - Similarity search: label data similar to problematic ones





Next Step ?

- Improve scalability
- Select features systematically
- Consider interactions among different quality problems

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