

# Visual Traffic Jam Analysis Based on Trajectory Data

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VisOPKU

## Introduction

- Many cities are suffering from traffic jams



Beijing



Melbourne



Atlanta

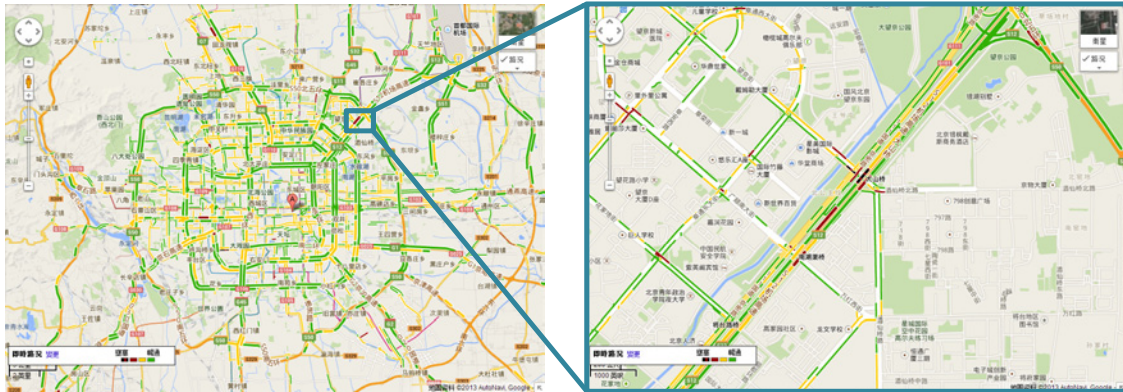
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TU/e

# Introduction

Real time road condition  
from Google Map

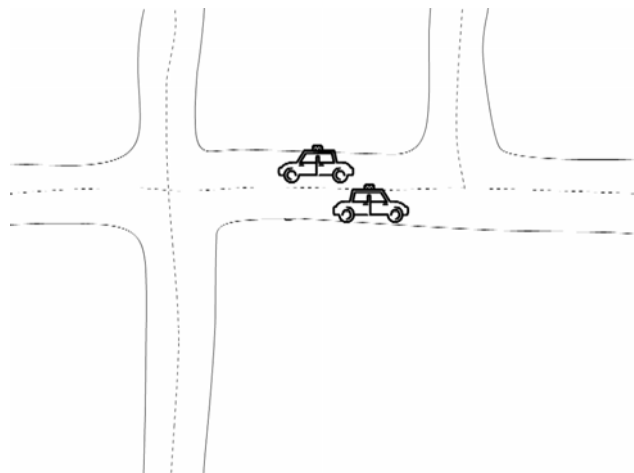
- Current traffic jam monitoring technologies



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# Introduction

- Complexities of traffic jams
  - Road conditions change with time
  - Different roads have different congestion patterns
  - Congestions propagate along the road network

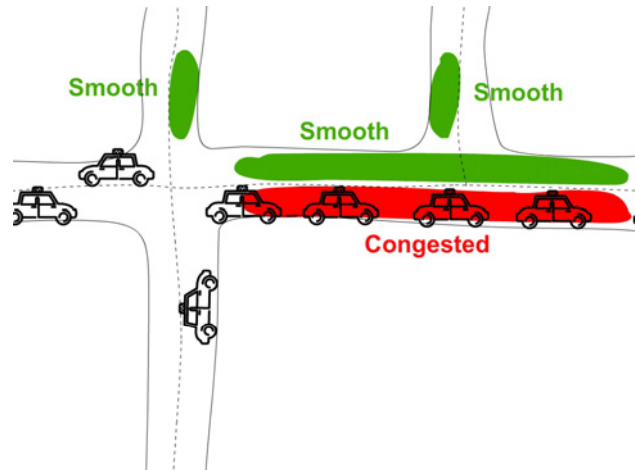


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## Introduction

- Complexities of traffic jams

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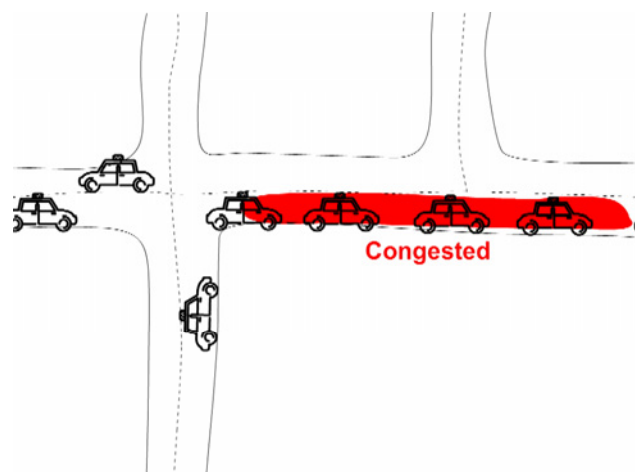


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## Introduction

- Complexities of traffic jams

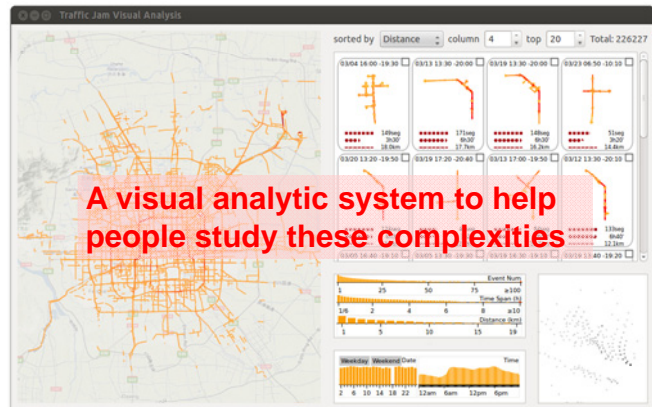
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# Introduction

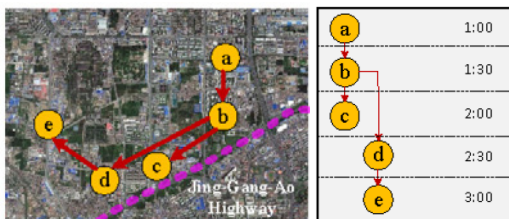
- Complexities of traffic jams
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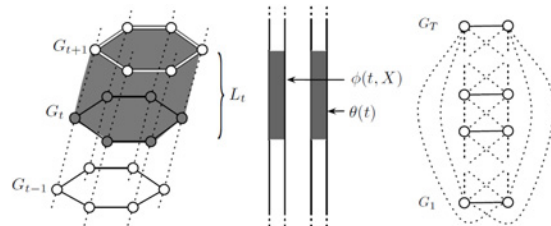
# Related Work

- Traffic Modeling



Outlier tree  
[Liu et al. 2011]

Study the propagation of traffic outlier events between regions



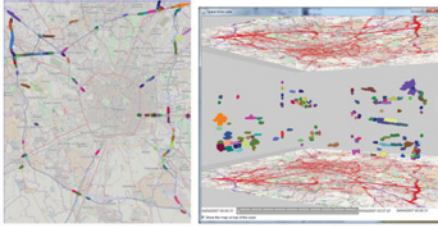
Probabilistic Graph Model  
[Piatkowski et al. 2012]

powerful but complex

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## Related Work

- Traffic Event Visualization



[Andrienko et al. 2011]

**Individual events extraction**



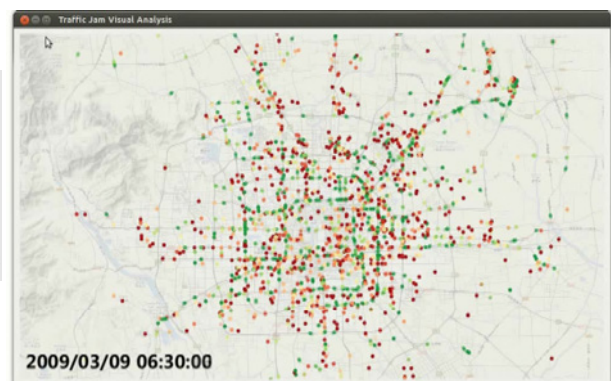
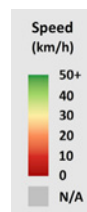
Incident Cluster Explorer  
[Pack et al. 2011]

**Individual events filtering**

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## Data Description

- Beijing taxi GPS data (from DataTang.com)
  - Size: 34.5 GB
  - #Taxi: 28,519  
(7% of total traffic flow volume)
  - #Sampling point: 379,107,927
  - Time range: 24 days  
(Mar.2<sup>nd</sup>~25<sup>th</sup>, 2009, missing 18<sup>th</sup>)
  - Sampling interval: 30 seconds  
(60% data missing)

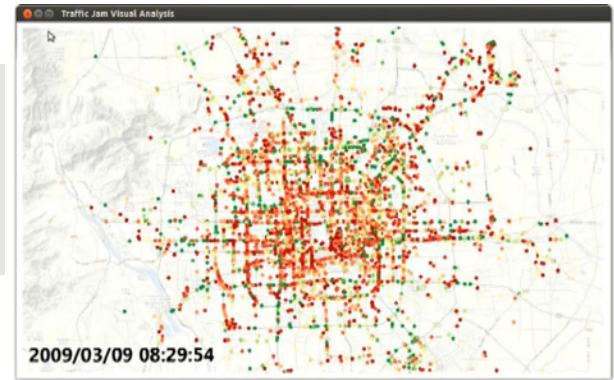
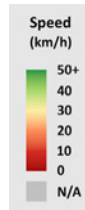


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  - Sampling interval: 30 seconds  
(60% data missing)
- Beijing road network (from OpenStreetMap)
  - Size: 40.9 MB
  - 169,171 nodes and 35,422 ways



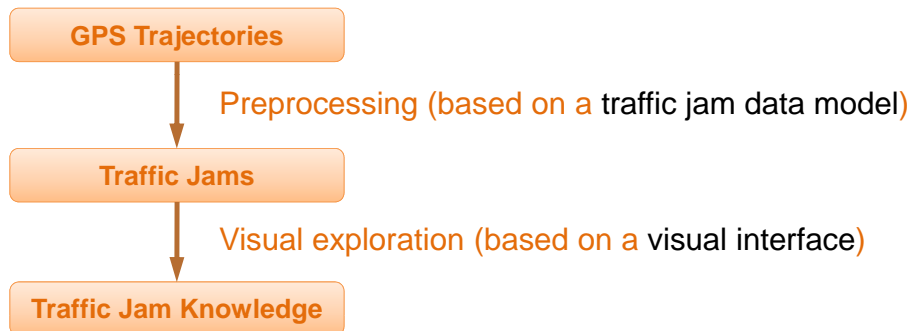
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## Overview



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## Overview



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## Design Requirements

- Traffic jam data model

### Complete

- Include location, time, speed

### Structured

- Study propagations of traffic jams

### Road Bound

- Traffic jams happen on roads

- Visual interface

### Informative

- Show location, time, speed, propagation path

### Multilevel

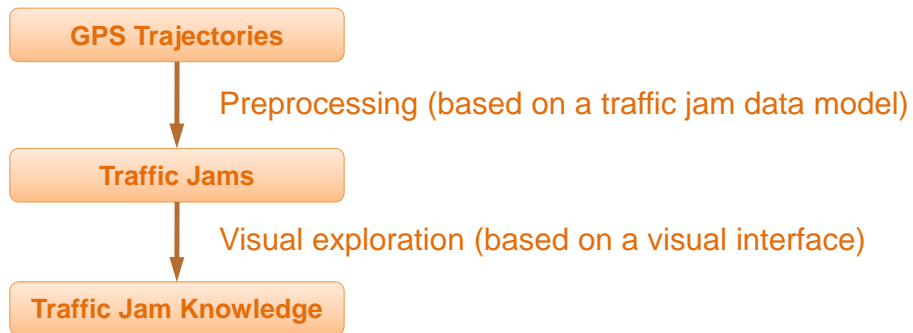
- Explore from city level to road segment level

### Filter Enabled

- Select and study a subset of propagations

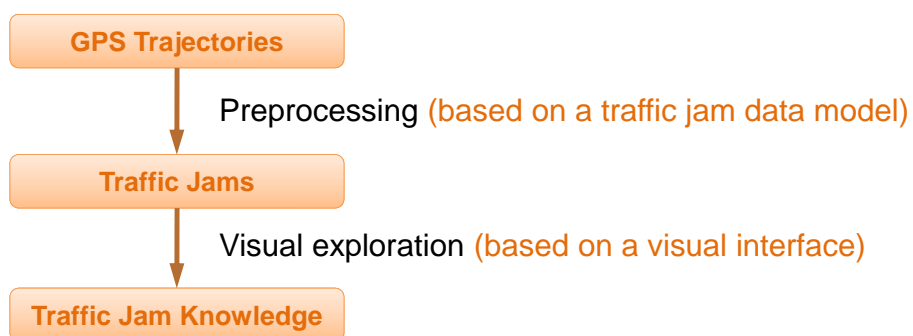
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## Overview



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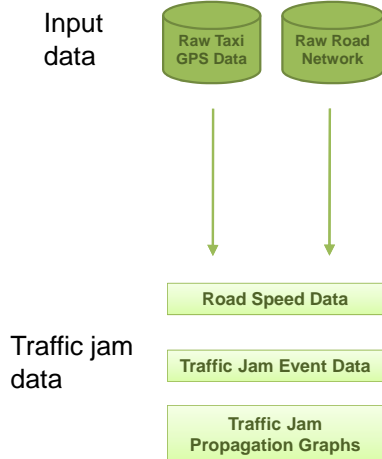
## Overview



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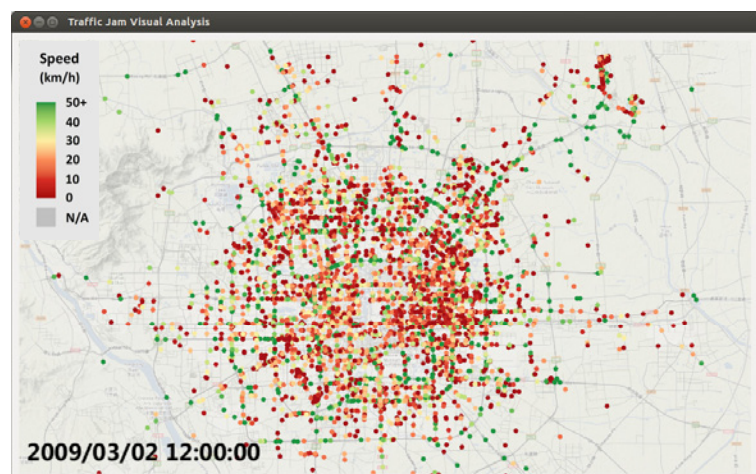


# Preprocessing



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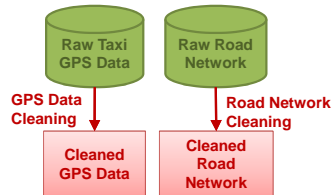
# Preprocessing



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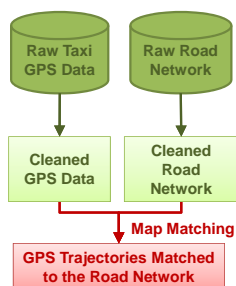
Input  
data



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# Preprocessing

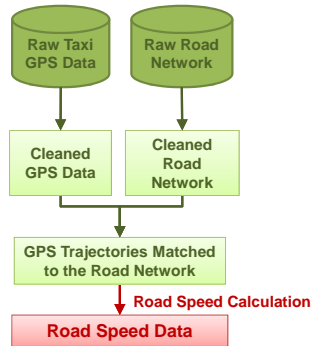
Input  
data



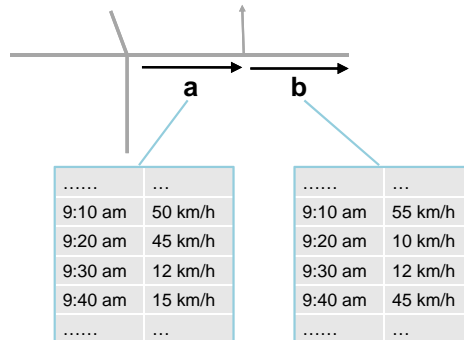
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# Preprocessing

Input data



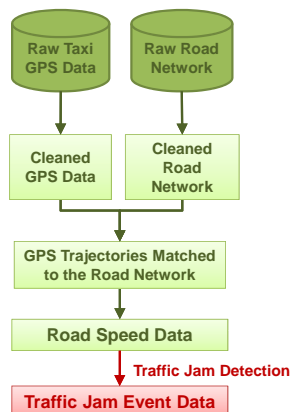
Road speed: for each road at each time bin (10 min)



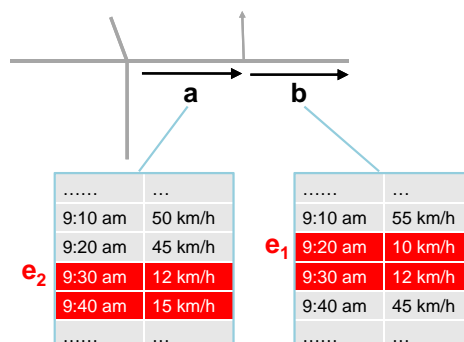
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# Preprocessing

Input data

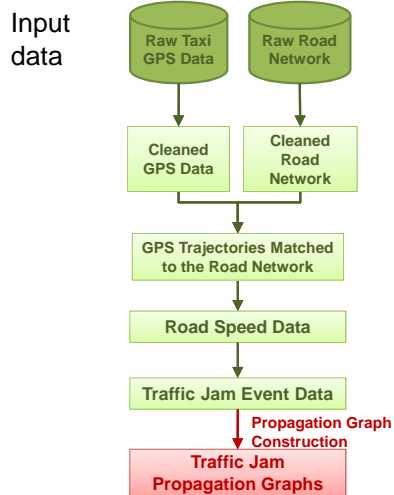


Traffic jam events: road, start/end time bin

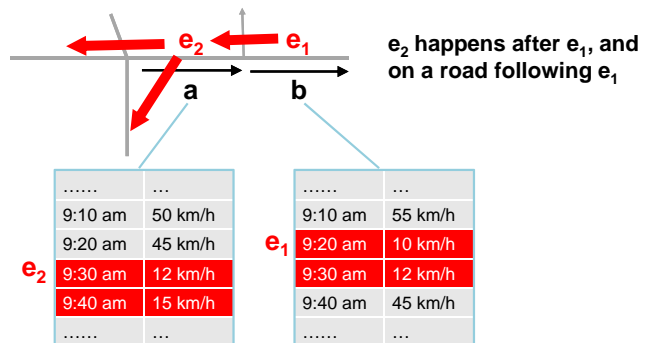


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# Preprocessing

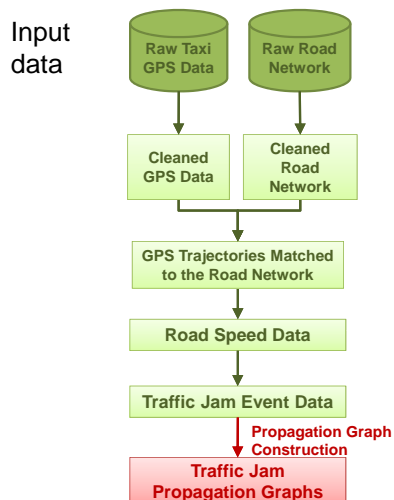


Defining propagation based on spatial/temporal relationship:

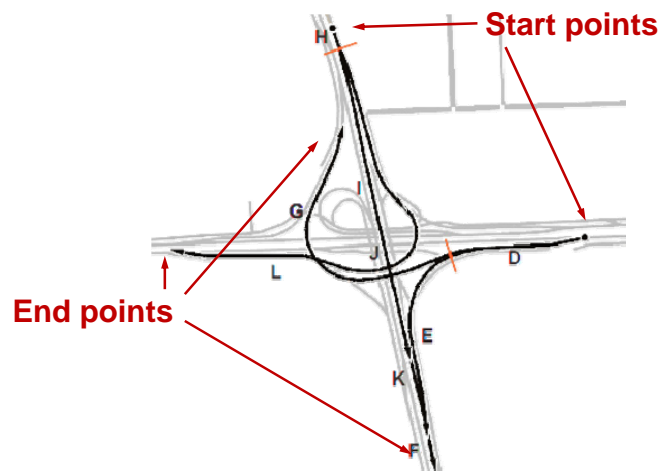


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# Preprocessing

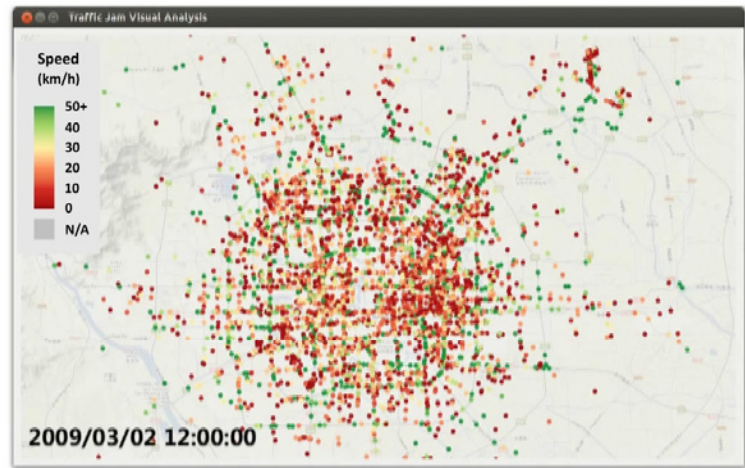
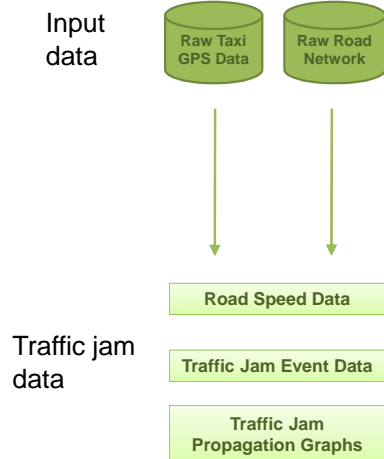


A real propagation graph:



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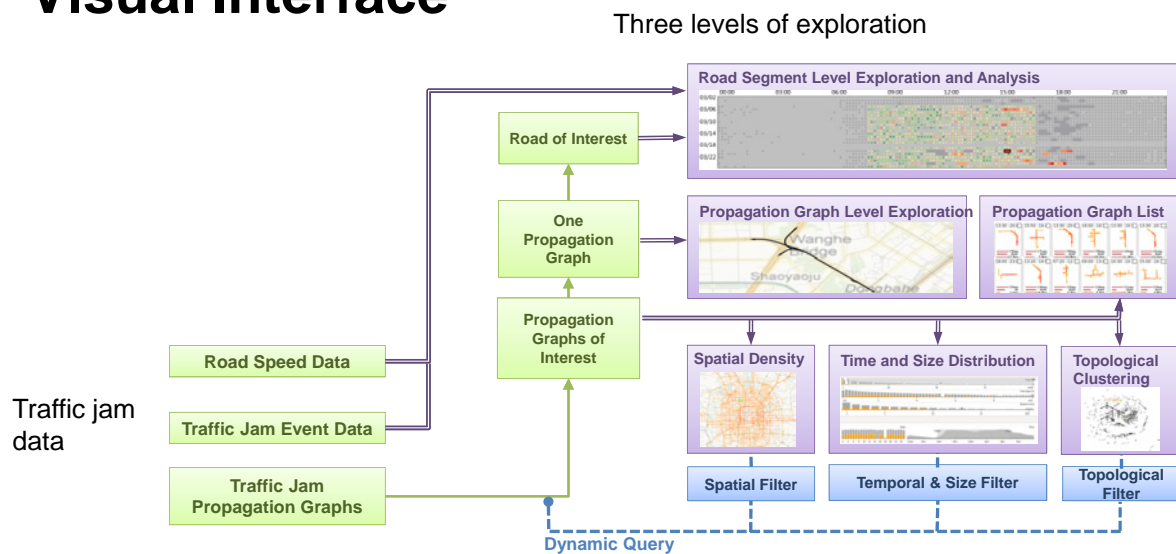
# Preprocessing



Input Taxi GPS Trajectories

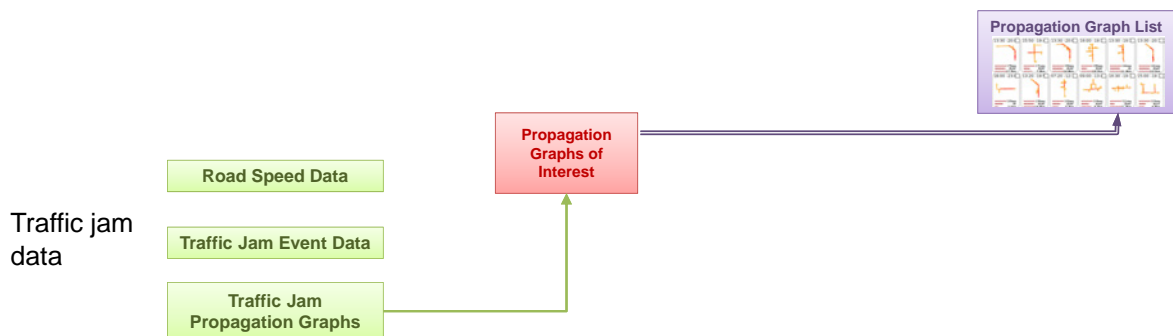
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# Visual Interface



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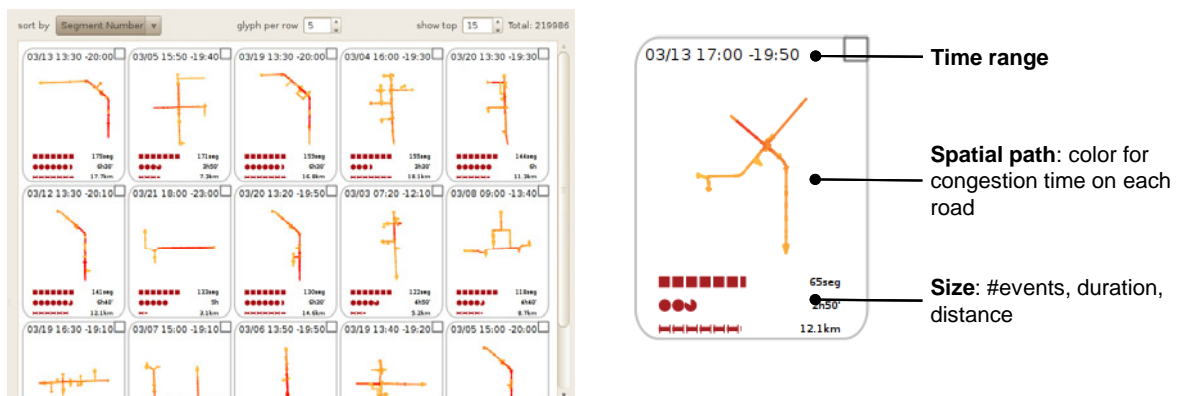
## Visual Interface: City Level



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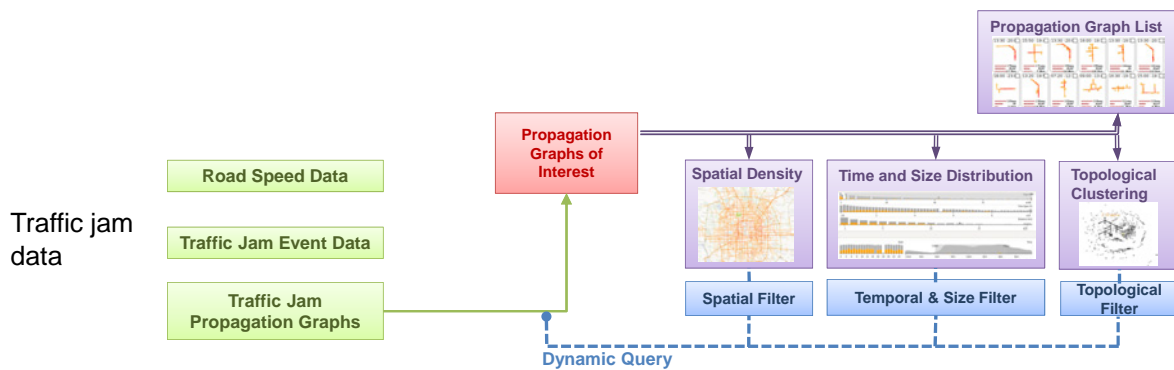
## Visual Interface: City Level

- Graph list view: show propagation graphs as icons



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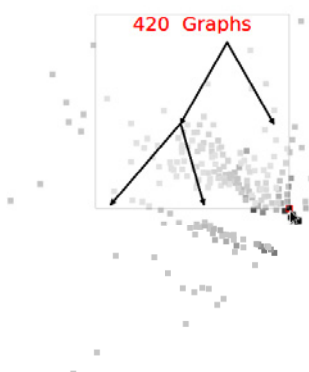
## Visual Interface: City Level



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## Visual Interface: City Level

- Graph projection view: topological aggregation



All propagation graphs are grouped

Each group is represented by a point

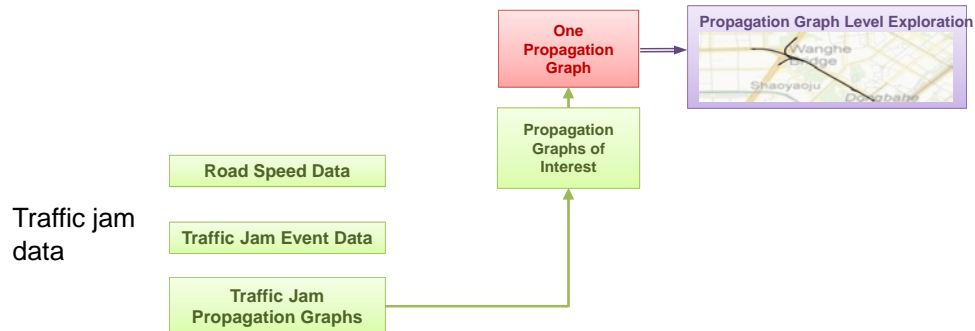
Graphs in the same group have similar topologies

Distance between points represent the topological distance between graph groups

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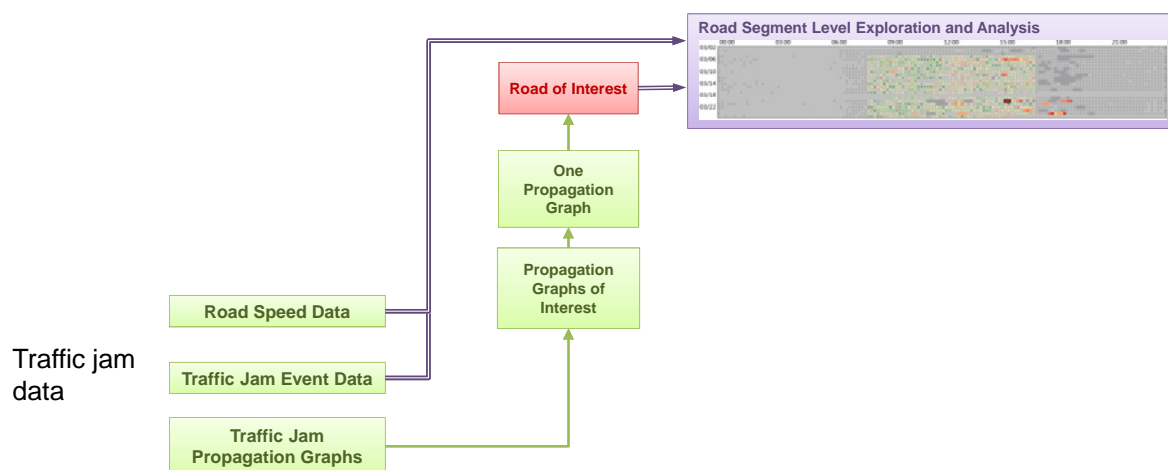


## Visual Interface: Single Propagation Level



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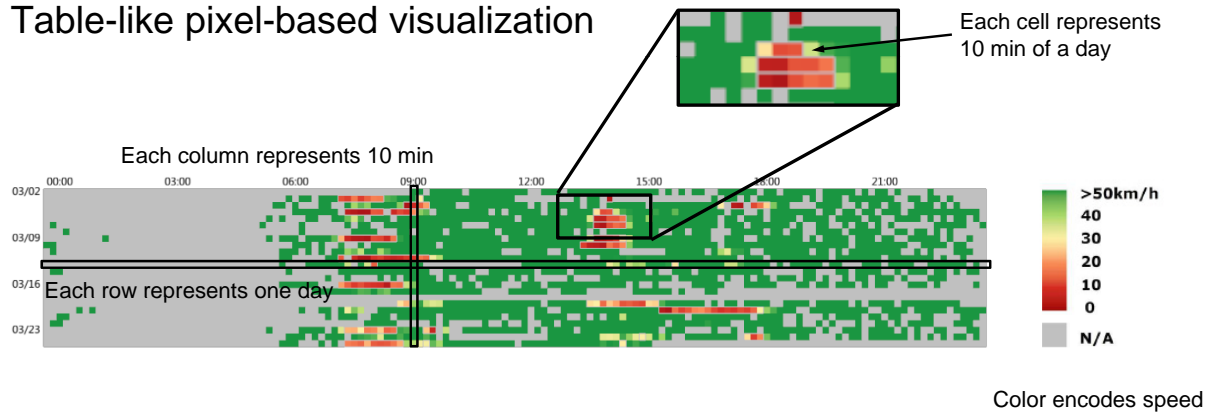
## Visual Interface: Single Road Level



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## Visual Interface: Single Road Level

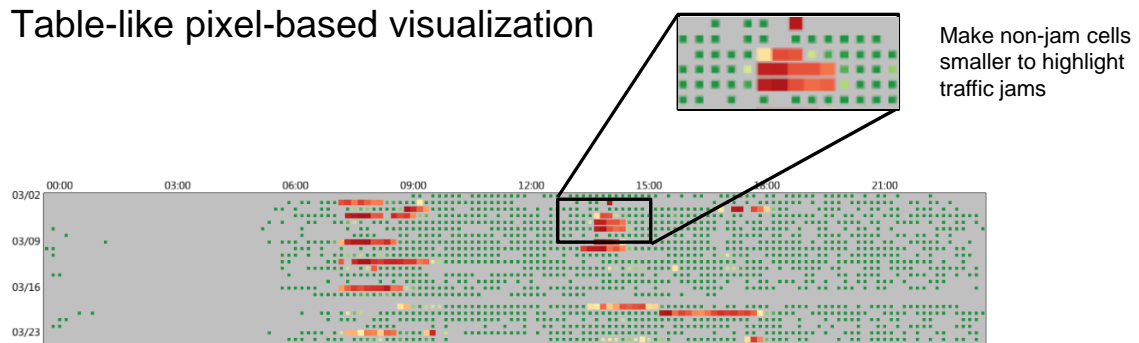
- Table-like pixel-based visualization



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## Visual Interface: Single Road Level

- Table-like pixel-based visualization



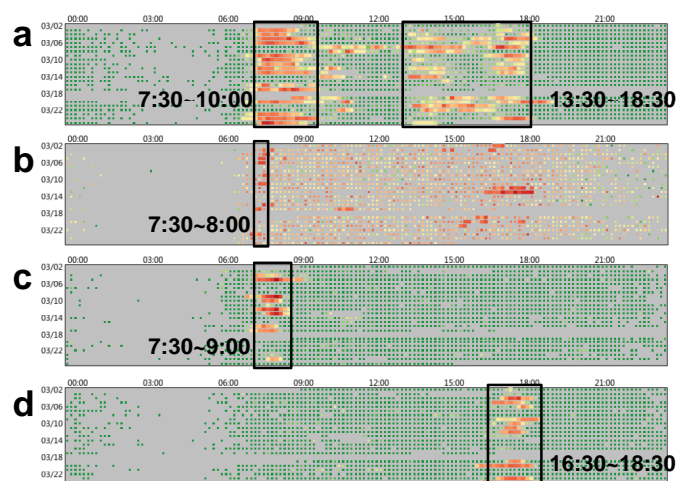
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## Case Studies

- Road level exploration
- Propagation graph exploration
- Propagation trend exploration

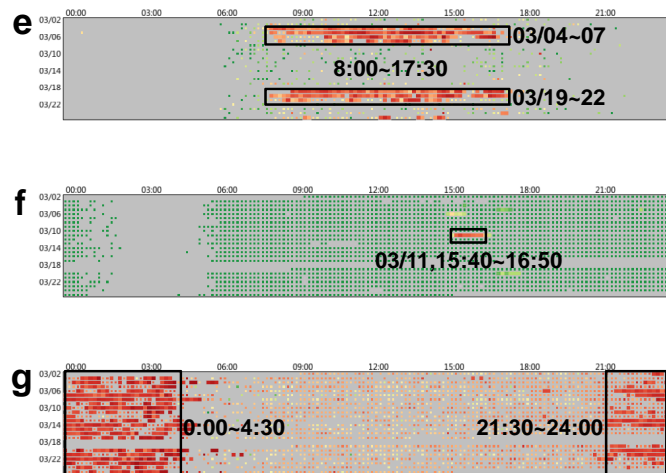
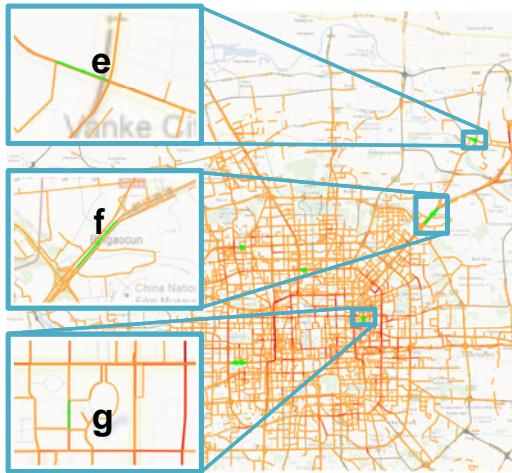
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## Case Study: Road Level Exploration



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## Case Study: Road Level Exploration



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## Case Study: Propagation Graph Exploration

- Filter propagation graphs
- Observe propagation path
- Check road speed
- Check propagation time
- Watch animation

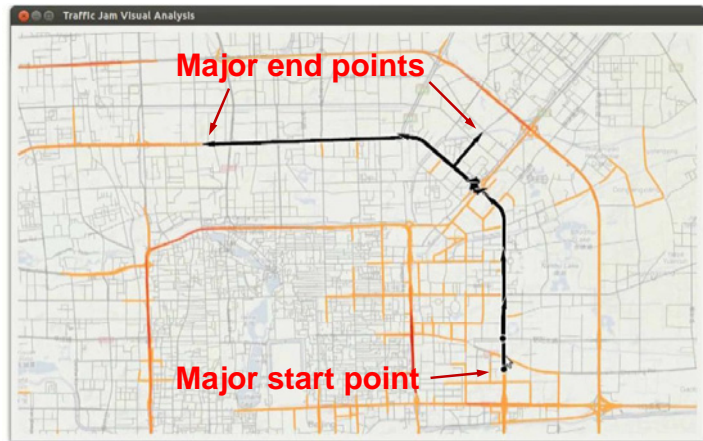


Temporal Filtering

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## Case Study: Propagation Graph Exploration

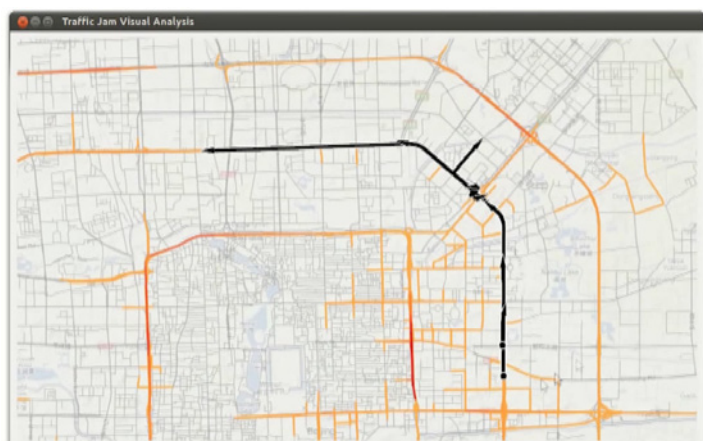
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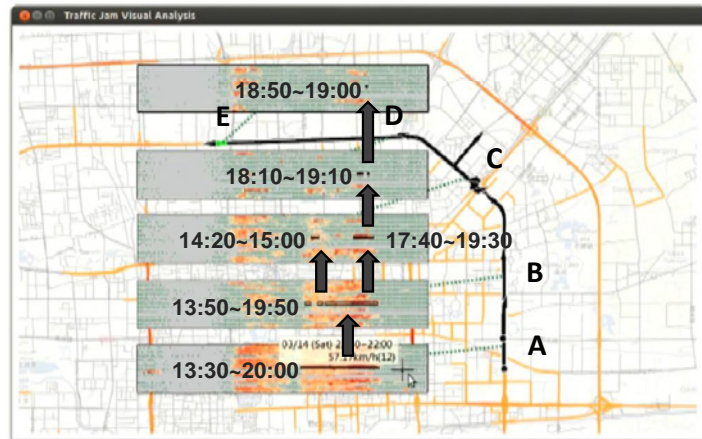


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## Case Study: Propagation Graph Exploration

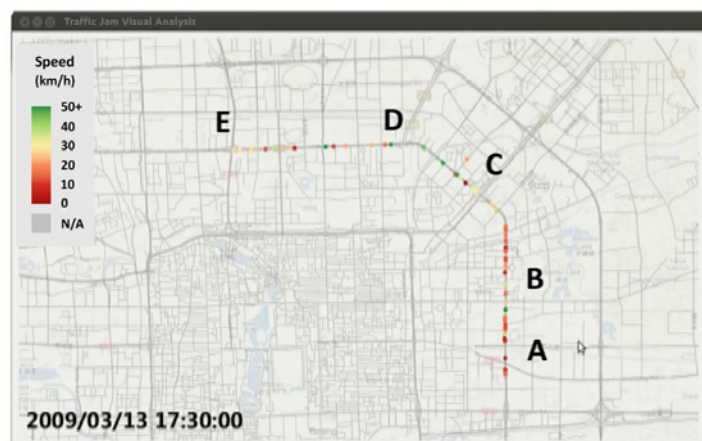
- Filter propagation graphs
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## Case Study: Propagation Graph Exploration

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Watching Taxi Trajectory Animation

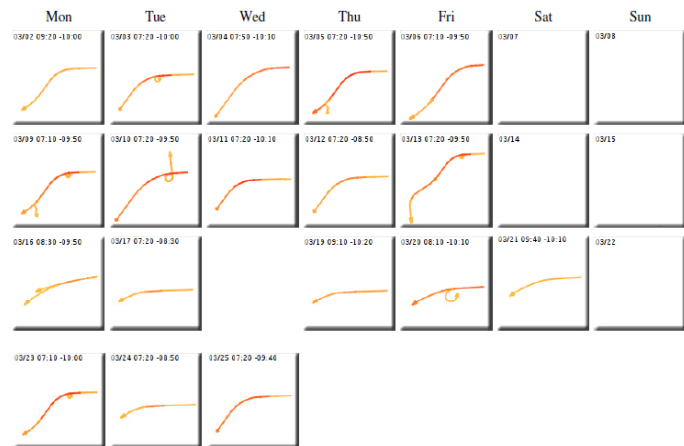
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## Case Study: Propagation Trend Exploration

One fixed region



Different mornings



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## Showing to the public



北京国际  
设计周  
BEIJING  
DESIGN  
WEEK

International Information  
Design Exhibition  
09/26/2013~10/13/2013

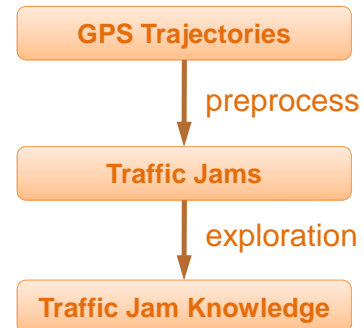
Simplified version  
Only road level exploration

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## Conclusion

- A visual analytic system to study traffic jams
  - An automatic process to extract traffic jams from GPS trajectories
  - A visual interface to support multilevel exploration of traffic jams



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## Future Work

- Improve the traffic jam data model (e.g. add prediction functions)
- Support more analysis task (e.g. spatial/temporal clustering)
- Try better visual design of propagation graphs
- Collaboration with the domain experts

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# Acknowledgement

- Funding:
  - NSFC Project No. 61170204
  - NSFC Key Project No. 61232012
- Data:
  - Datatang.com
  - OpenStreetMap
- Anonymous reviewers for valuable comments

Our website:  
<http://vis.pku.edu.cn/trajectoryvis>