



**VIS**  
**2018**

**Tutorial: Urban Trajectory Visualization**

# **Case Studies**

**Ye Zhao**



# Use Cases

- We show examples of the web-based visual analytics system TrajAnalytics
  - The case study information and videos are available at  
<http://vis.cs.kent.edu/TrajAnalytics/>
  - Porto taxi and New York datasets are used

# Different Cases

- **TrajAnalytics** can handle **taxi trajectory data** in different cases.
  - **Case 1: Visualize Trajectory Data**
  - **Case 2: Visualize Trajectory Data Matched to Road Network**
  - **Case 3: Visualize Trajectory Data Matched to Zip Code Regions**
  - **Case 4: Visualize Trajectory Data Matched to Grid Regions**

# Case 1: Visualize Trajectory Data

- Query and visualize taxi trajectories

tripid	latitude	longitude	pdatetime	speed
282	41.152	-8.60586	7/1/2013 2:58	2.92838384
282	41.1521	-8.60592	7/1/2013 2:58	21.26700265
282	41.1522	-8.60697	7/1/2013 2:58	36.35014457
282	41.1509	-8.60751	7/1/2013 2:58	22.9627538
282	41.1504	-8.60844	7/1/2013 2:59	30.46576288
282	41.1508	-8.60986	7/1/2013 2:59	0.40189208
282	41.1508	-8.60988	7/1/2013 2:59	17.65402867
282	41.1514	-8.60951	7/1/2013 2:59	38.63710629
282	41.1528	-8.61	7/1/2013 3:00	43.52484407
282	41.1544	-8.60958	7/1/2013 3:00	35.65751611
282	41.1557	-8.60917	7/1/2013 3:00	56.21626115
282	41.1578	-8.60895	7/1/2013 3:00	51.04945668
282	41.1596	-8.60809	7/1/2013 3:01	98.20711144
282	41.1631	-8.60658	7/1/2013 3:01	58.94278596
282	41.1653	-8.60632	7/1/2013 3:01	58.760349
282	41.1675	-8.60644	7/1/2013 3:01	56.93524034
282	41.1696	-8.60594	7/1/2013 3:02	59.02982574
282	41.1713	-8.60406	7/1/2013 3:02	65.50494422
282	41.1711	-8.60081	7/1/2013 3:02	67.14541109

# Case 1: Visualize Trajectory Data

- **System functions**
  - Account management
  - Data uploading
- **Map Based Visualization**
  - Taxi Trajectories and Pick-Up and Drop-Off locations
- **Information Visualization:**
  - Distributions over days and times
  - Ranking lists
  - Interactions

# Case 1: Demo

*Data Loading*



# Case 2: Visualize Trajectories Matched to Road Network

- Taxi trajectory data with **road map matching** with street ID and geometry

tripid	RoadID	latitude	longitude	pdatetime	speed
282	1535	41.152	-8.60586	7/1/2013 2:58	2.92838384
282	1535	41.1521	-8.60592	7/1/2013 2:58	21.26700265
282	1535	41.1522	-8.60697	7/1/2013 2:58	36.35014457
282	1535	41.1509	-8.60751	7/1/2013 2:58	22.9627538
282	1535	41.1504	-8.60844	7/1/2013 2:59	30.46576288
282	1535	41.1508	-8.60986	7/1/2013 2:59	0.40189208
282	1535	41.1508	-8.60988	7/1/2013 2:59	17.65402867
282	1535	41.1514	-8.60951	7/1/2013 2:59	38.63710629
282	1535	41.1528	-8.61	7/1/2013 3:00	43.52484407
282	1521	41.1544	-8.60958	7/1/2013 3:00	35.65751611
282	1521	41.1557	-8.60917	7/1/2013 3:00	56.21626115
282	1521	41.1578	-8.60895	7/1/2013 3:00	51.04945668
282	1521	41.1596	-8.60809	7/1/2013 3:01	98.20711144
282	1511	41.1631	-8.60658	7/1/2013 3:01	58.94278596
282	1511	41.1653	-8.60632	7/1/2013 3:01	58.760349
282	1511	41.1675	-8.60644	7/1/2013 3:01	56.93524034
282	1511	41.1696	-8.60594	7/1/2013 3:02	59.02982574
282	1511	41.1713	-8.60406	7/1/2013 3:02	65.50494422
282	1511	41.1711	-8.60081	7/1/2013 3:02	67.14541109

# Case 2: Visualize Trajectories Matched to Road Network

- **Web-based functions of map-matching**
  - Road network downloading
  - Map-matching
- **Map Based Visualization**
- **Information Visualization**



# Case 2: Demo

*Data Loading*

# Case 3: Visualize Trajectory Matched to Zip code Regions

- Not all data can be mapped to the road network
  - Such kind of data can be mapped to zip code regions through **region map matching**.
- **Zip code regions** consists of a group of **polygons** with its geometry.

tripid	Zip Code	latitude	longitude	pdatetime	speed
282	44241	41.152	-8.60586	7/1/2013 2:58	2.92838384
282	44241	41.1521	-8.60592	7/1/2013 2:58	21.26700265
282	44241	41.1522	-8.60697	7/1/2013 2:58	36.35014457
282	44241	41.1509	-8.60751	7/1/2013 2:58	22.9627538
282	44241	41.1504	-8.60844	7/1/2013 2:59	30.46576288
282	44241	41.1508	-8.60986	7/1/2013 2:59	0.40189208
282	44241	41.1508	-8.60988	7/1/2013 2:59	17.65402867
282	44241	41.1514	-8.60951	7/1/2013 2:59	38.63710629
282	44241	41.1528	-8.61	7/1/2013 3:00	43.52484407
282	44241	41.1544	-8.60958	7/1/2013 3:00	35.65751611
282	44241	41.1557	-8.60917	7/1/2013 3:00	56.21626115
282	44241	41.1578	-8.60895	7/1/2013 3:00	51.04945668
282	44241	41.1596	-8.60809	7/1/2013 3:01	98.20711144
282	44241	41.1631	-8.60658	7/1/2013 3:01	58.94278596
282	44241	41.1653	-8.60632	7/1/2013 3:01	58.760349
282	44242	41.1675	-8.60644	7/1/2013 3:01	56.93524034
282	44242	41.1696	-8.60594	7/1/2013 3:02	59.02982574
282	44242	41.1713	-8.60406	7/1/2013 3:02	65.50494422
282	44242	41.1711	-8.60081	7/1/2013 3:02	67.14541109

# Case 3: Visualize Trajectory Mapped to Zip code Regions

- **Web-based functions of map-matching**
  - Zipcode region data selection
  - Map-matching
- **Map Based Visualization**
- **Information Visualization**

# Case 3: Demo

*Data Loading*

# Case 4: Visualize Trajectory Data Matched to Grid Regions

- Sometimes there is lack of available road network and zip code regions in the trajectory area.
  - Divide the field to a **grid of cells**.
  - Each cell is a region and the data can be mapped to these regions through a process of **region map matching**.

tripid	Cell ID	latitude	longitude	pdatetime	speed
282	10	41.152	-8.60586	7/1/2013 2:58	2.92838384
282	10	41.1521	-8.60592	7/1/2013 2:58	21.26700265
282	10	41.1522	-8.60697	7/1/2013 2:58	36.35014457
282	10	41.1509	-8.60751	7/1/2013 2:58	22.9627538
282	10	41.1504	-8.60844	7/1/2013 2:59	30.46576288
282	10	41.1508	-8.60986	7/1/2013 2:59	0.40189208
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282	10	41.1528	-8.61	7/1/2013 3:00	43.52484407
282	10	41.1544	-8.60958	7/1/2013 3:00	35.65751611
282	11	41.1557	-8.60917	7/1/2013 3:00	56.21626115
282	11	41.1578	-8.60895	7/1/2013 3:00	51.04945668
282	11	41.1596	-8.60809	7/1/2013 3:01	98.20711144
282	11	41.1631	-8.60658	7/1/2013 3:01	58.94278596
282	11	41.1653	-8.60632	7/1/2013 3:01	58.760349
282	11	41.1675	-8.60644	7/1/2013 3:01	56.93524034
282	11	41.1696	-8.60594	7/1/2013 3:02	59.02982574
282	11	41.1713	-8.60406	7/1/2013 3:02	65.50494422
282	12	41.1711	-8.60081	7/1/2013 3:02	67.14541109



# Case 4: Visualize Trajectory Data Mapped to Grid Regions

- **Web-based functions of map-matching**
  - Grid based spatial division
  - Map-matching
- **Map Based Visualization**
- **Information Visualization**

# Case 4: Demo

*Data Loading*



## Tutorial: Urban Trajectory Visualization

# Conclusion

Ye Zhao

# Urban Trajectory Visualization

- An important topic in many domain fields
  - Visualization tools and systems are direly needed
  - Traditional GIS tools mostly focus on point based data
  - Trajectory is more general and need to be easily integrated

# Visualization Design Challenges

- Visualization design need to combine visualization techniques with
  - User friendly interface for data processing including
    - Database management
    - Map-matching
- Allow users to attend the design
  - Visualization should be understandable for general users
  - Visualization should be implemented for real tasks



# Big Data Challenge

- Database design
  - Distributed system
  - Caching technologies
  - Query performance optimization
- Data transfer: Internet speed, pre-aggregation
- Visualization:
  - E.g., drawing a large amount of points is slow
  - Visual metaphors should be designed adaptively according to
    - data constrains
    - Platform conditions
    - Interaction conditions such as zoom levels, etc.



## **Tutorial: Urban Trajectory Visualization**

**Thank You!**