

Spatial Analysis and Visualization

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Spatial Analysis

Most human activities and interests are related to locations.

Areas and buildings have specific purposes.

So, most created data are related to location in some way.

Location-related data is also called spatial data or geospatial data.

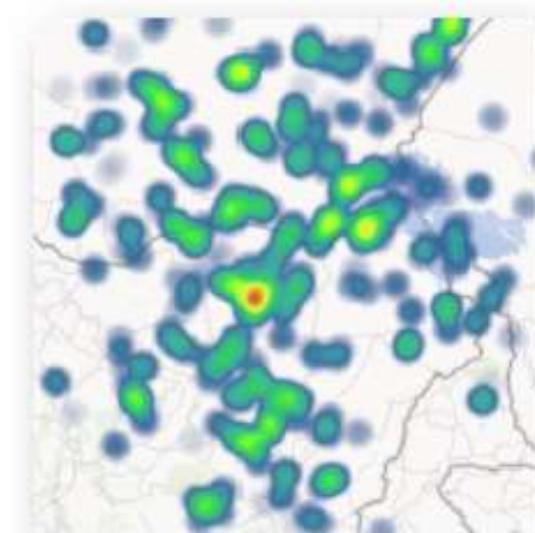
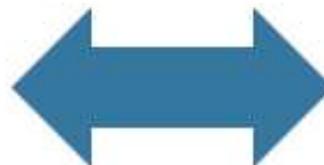
Spatial analysis is a process to gain insight from location-related data and solve location-related problems.

*“Everything is related to everything else, but near things are more related than distant things.”
The first law of geography, Waldo Tobler, 1970.*

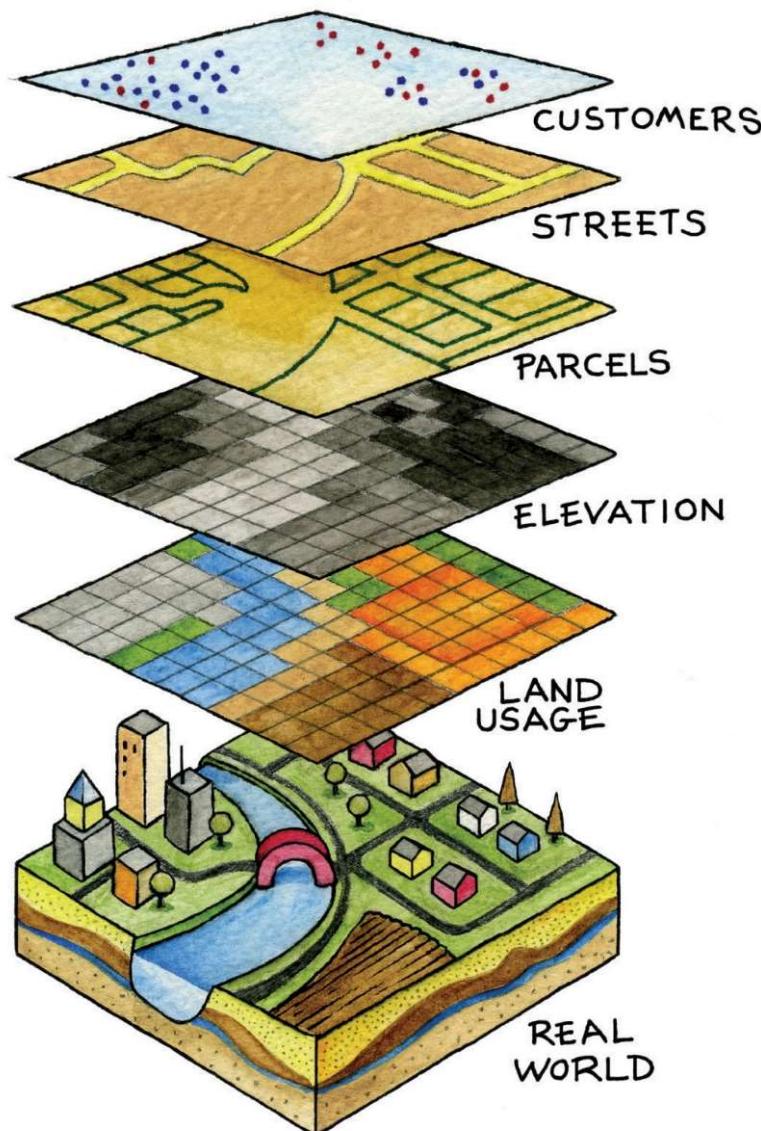
Map

Map is the primary visualization method for spatial data and an effective tool for spatial analysis.

Latitude	Longitude	PlaceName	Death
13.58801	11.0956	P1	0
9.878124	12.55918	P2	4
14.65398	10.18044	P3	0
15.22057	9.993003	P4	5
13.16265	12.96319	P5	4
13.80617	8.889046	P6	2
13.10214	10.56081	P7	4
11.00403	11.86713	P8	2



Geospatial Data Layers



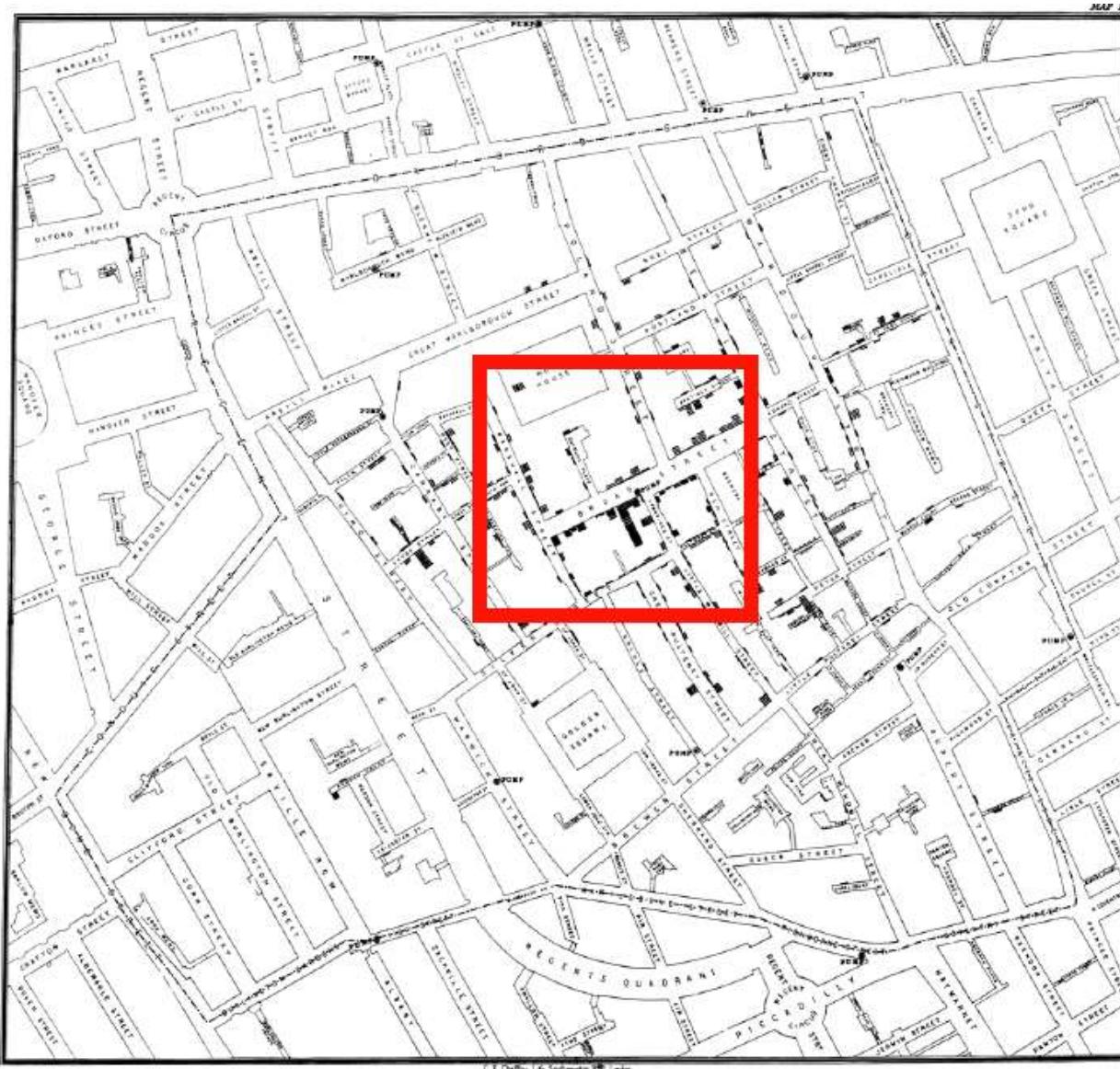
All geospatial datasets refer to locations on Earth.

So, they can be overlaid.

Basic Types of Spatial Data

- Points
- Lines
- Polygons
- Raster (image)

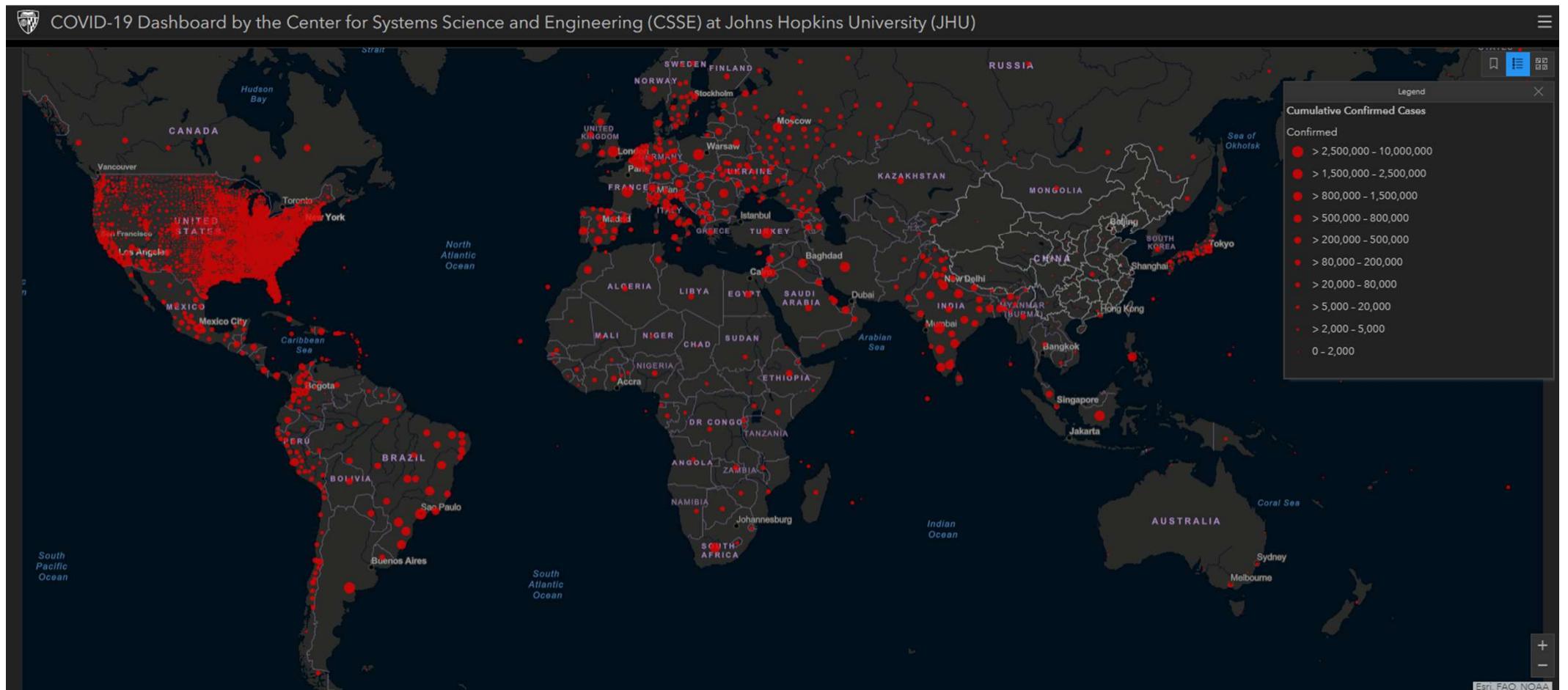
Classic Example: Dr.John Snow's Cholera Map (1855)



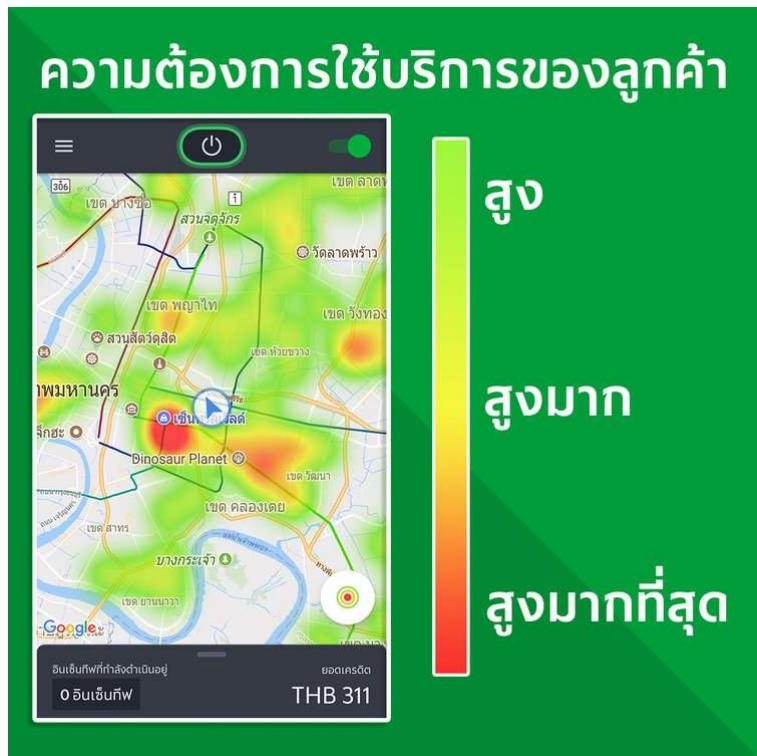
To stop the outbreak of cholera in London in 1854, **Dr. John Snow marked the cholera deaths on a map**. This map visualization indicated that the water from a pump on **Broad Street** was to blame as a large number of deaths were marked close to that pump. Snow's visualization is one of the most important early examples of epidemiology, that **clearly linked cholera's spread to water and not air**.

Snow, 1855 in
*On the Mode of
Communication of Cholera*

COVID-19 Map (2021)



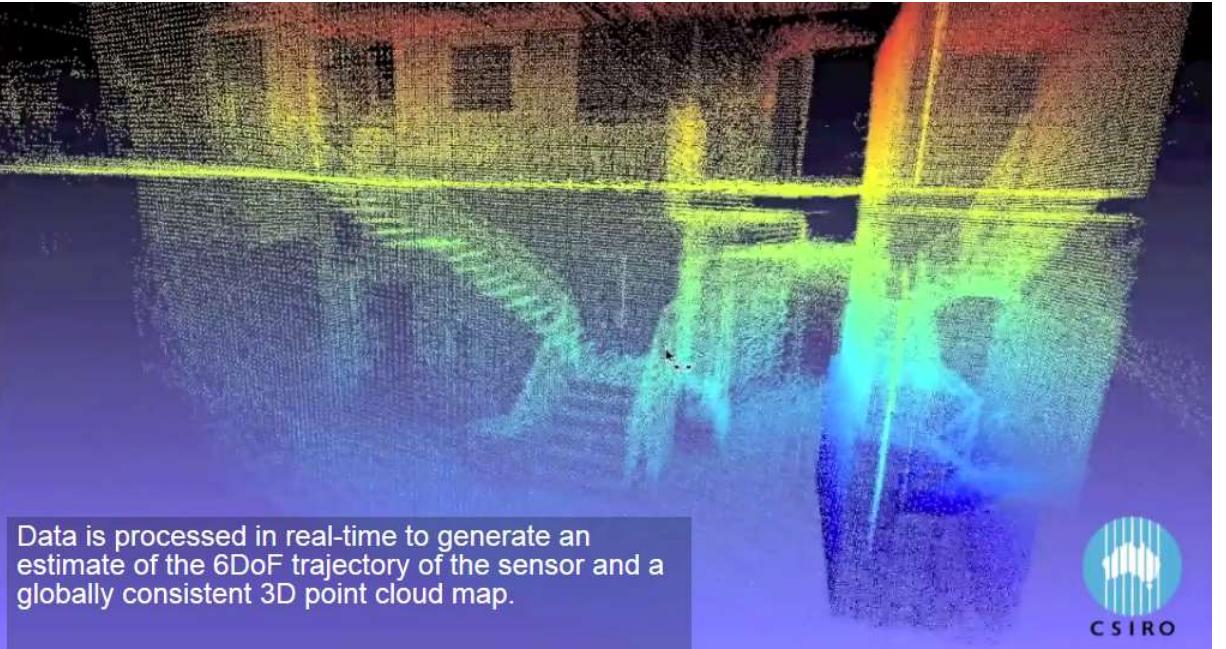
HeatMap of service demands for Grab drivers



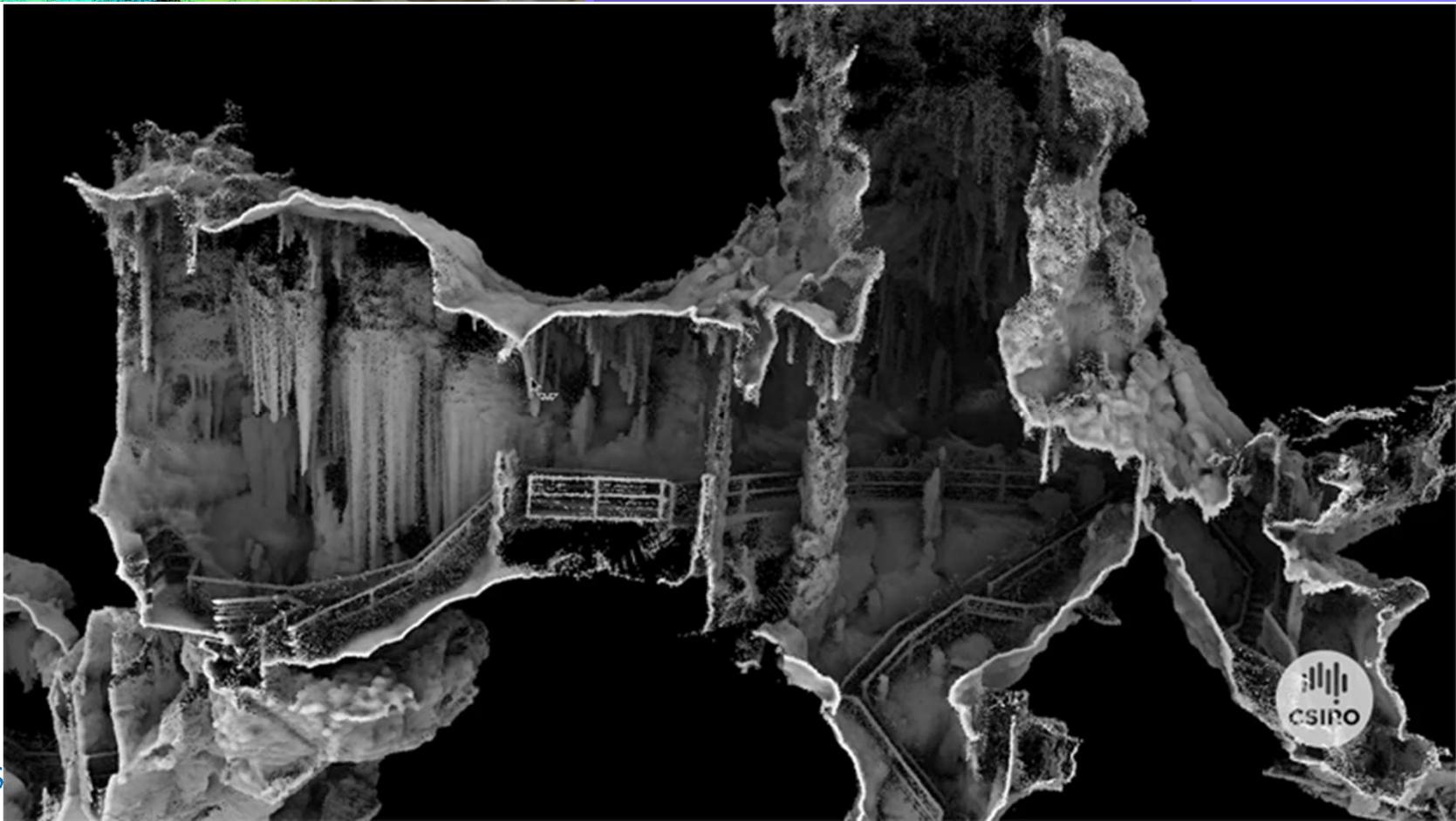
- 1
- 2
- 3
- 4

With modern mapping techniques,
everywhere, out-door and in-door,
will be on high-resolution map.





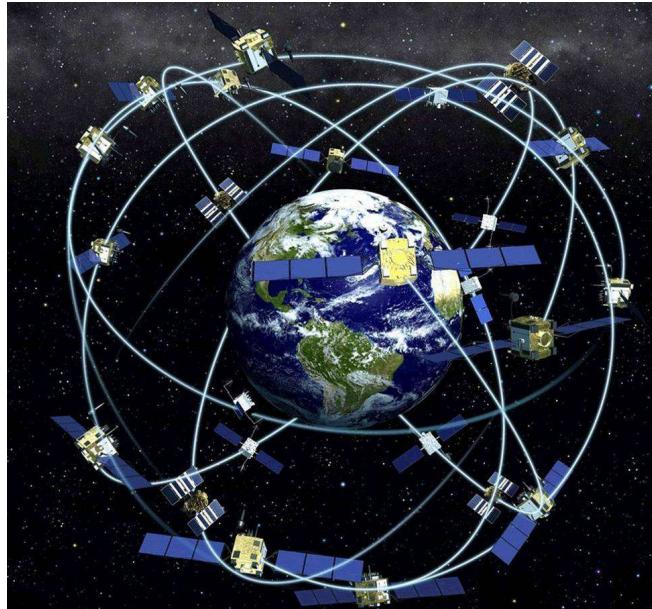
Data is processed in real-time to generate an estimate of the 6DoF trajectory of the sensor and a globally consistent 3D point cloud map.



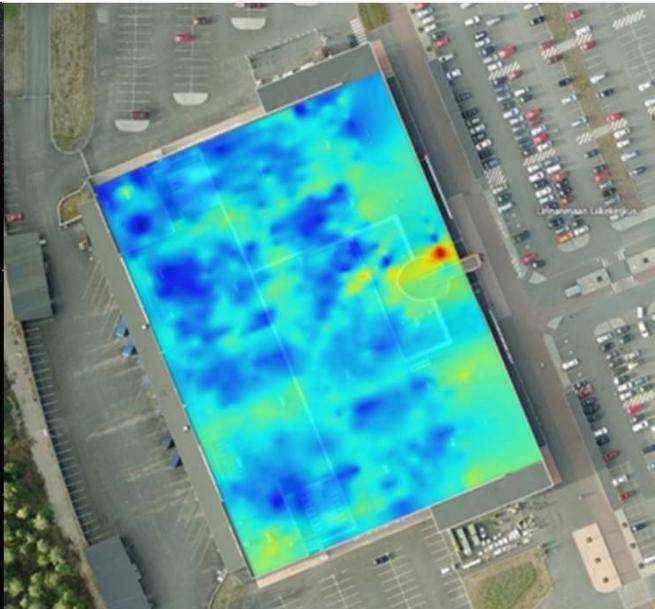
With modern positioning techniques,
everything can be located.

Location Technologies

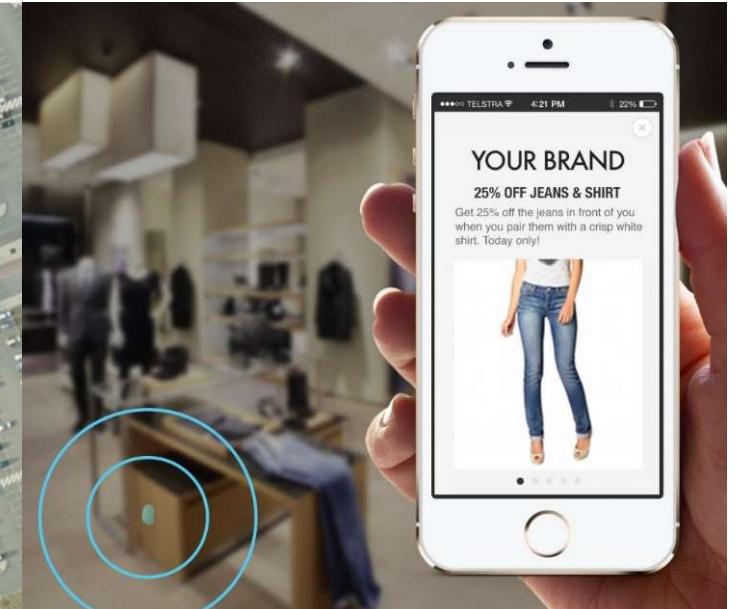
GPS



WiFi



Bluetooth/Beacon



Types of Location Data

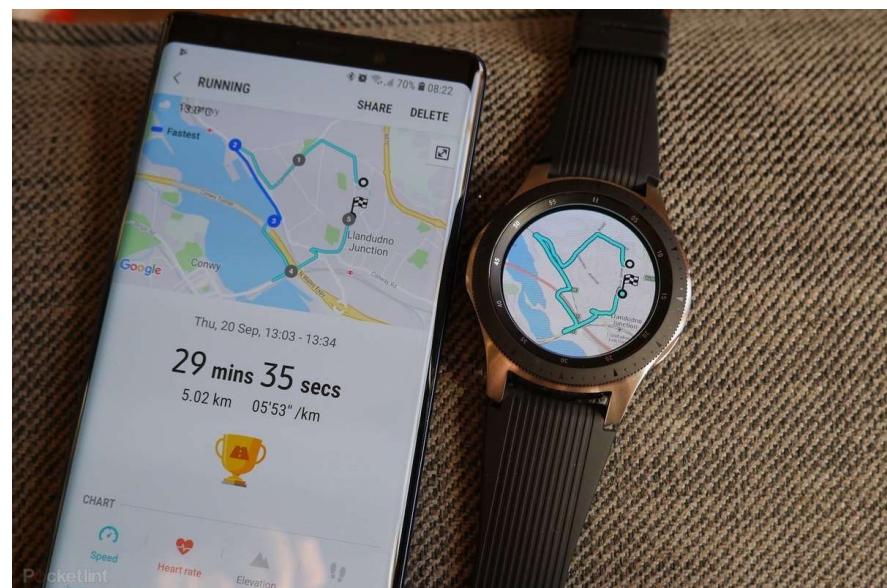
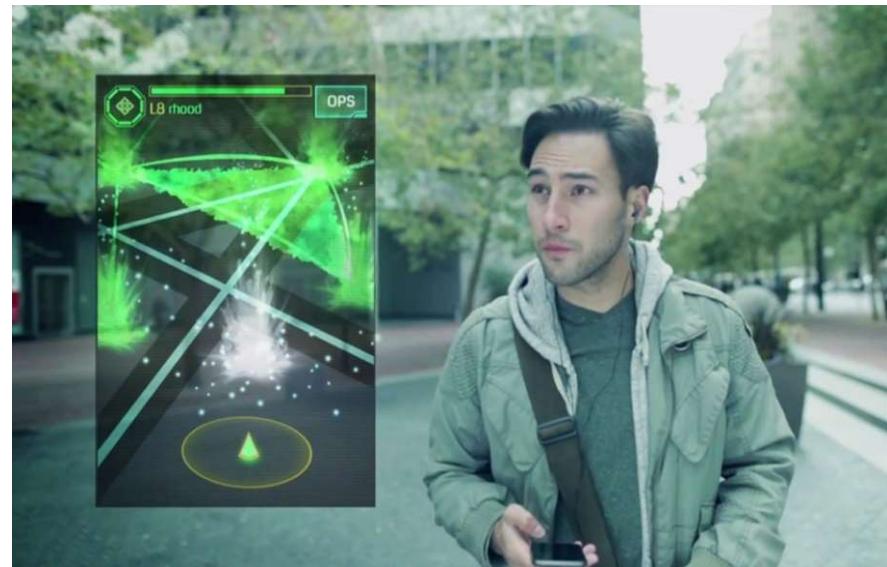
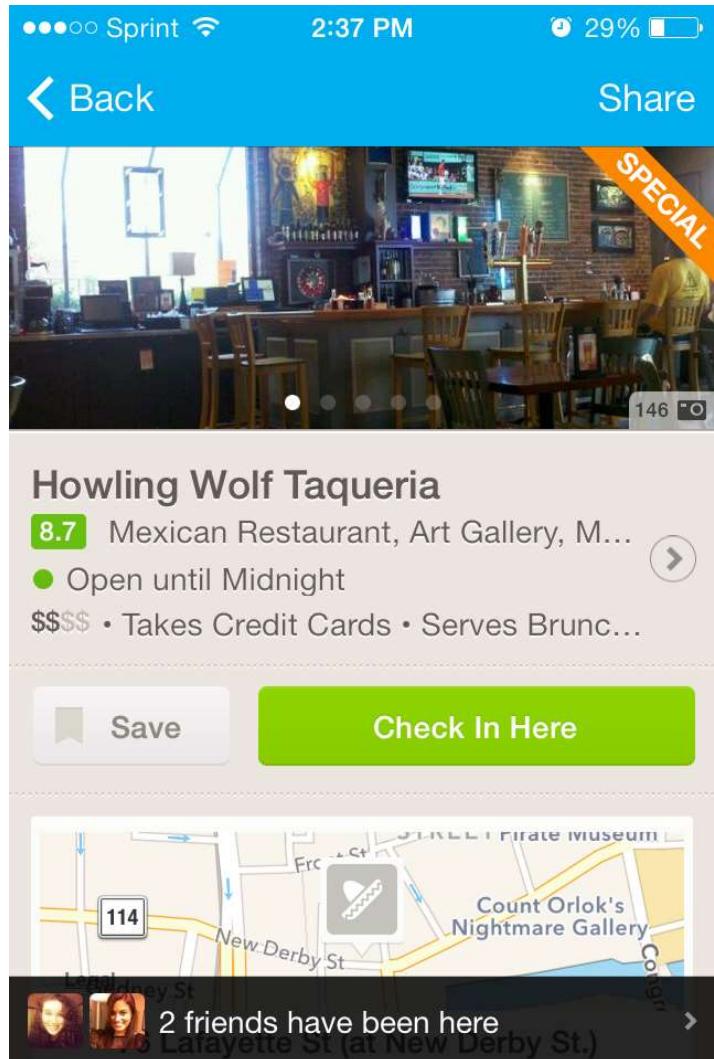
- Coordinates (latitude, longitude)
- Place name, street address
- Proximity of reference point (WiFi access point id, cell tower id)
- Location + Time → changes, movement

Sources of Location Data

- Moving sources
 - People (carry-on and wearable devices)
 - Vehicle
 - Robot
- Stationary sources
 - Sensor
 - Network Access Point
 - Point of Sale

Any kind of smart devices with known locations can be used as sensors that collect geospatial data.

People as Sensors



Sensors in Transportation



Financial Activity Sensors



GZPDA07

- 1. Wifi
- 2. Bluetooth
- 3. 3G/4G
- 4. Printer
- 5. NFC
- 6. GPS
- 7. Camera

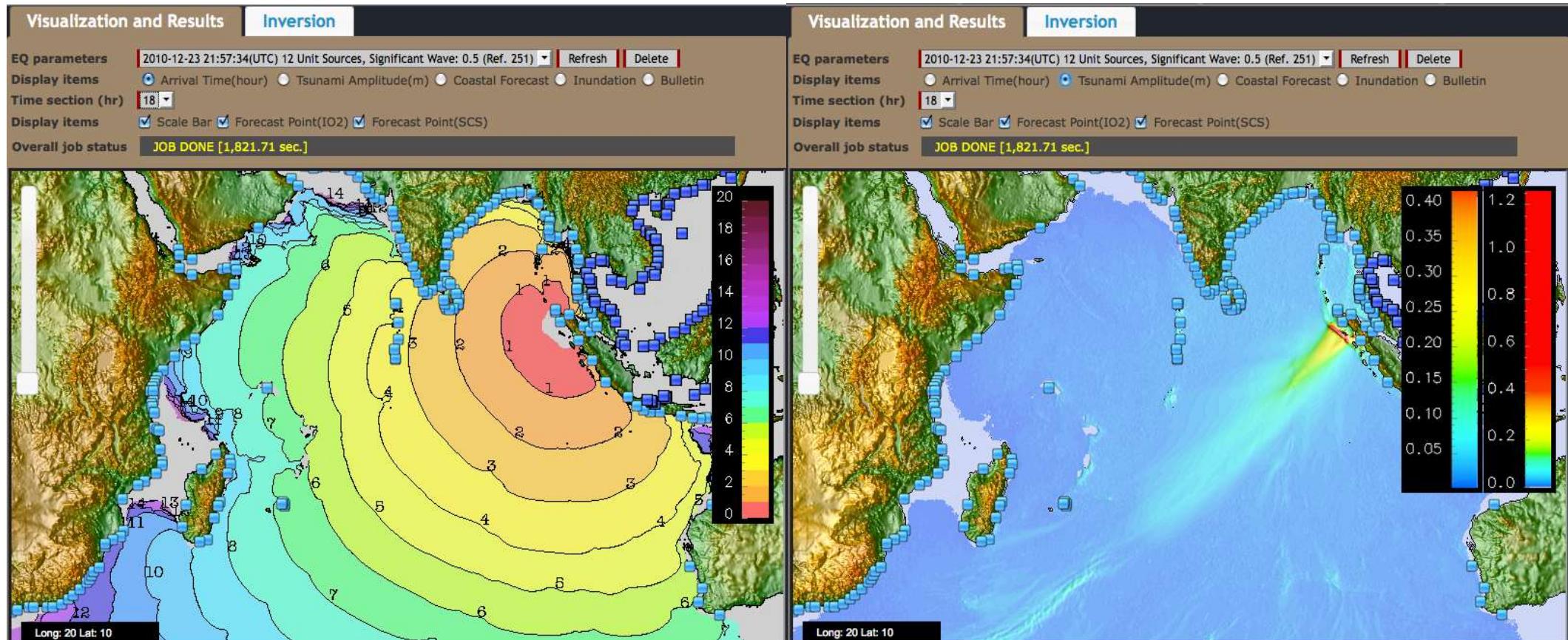
Geospatial Applications

- Navigation, route planning
- Customer geodemographic segmentation
- Targeted marketing
- Branch/facility location selection
- Real estate valuation / risk assessment
- ...

Examples

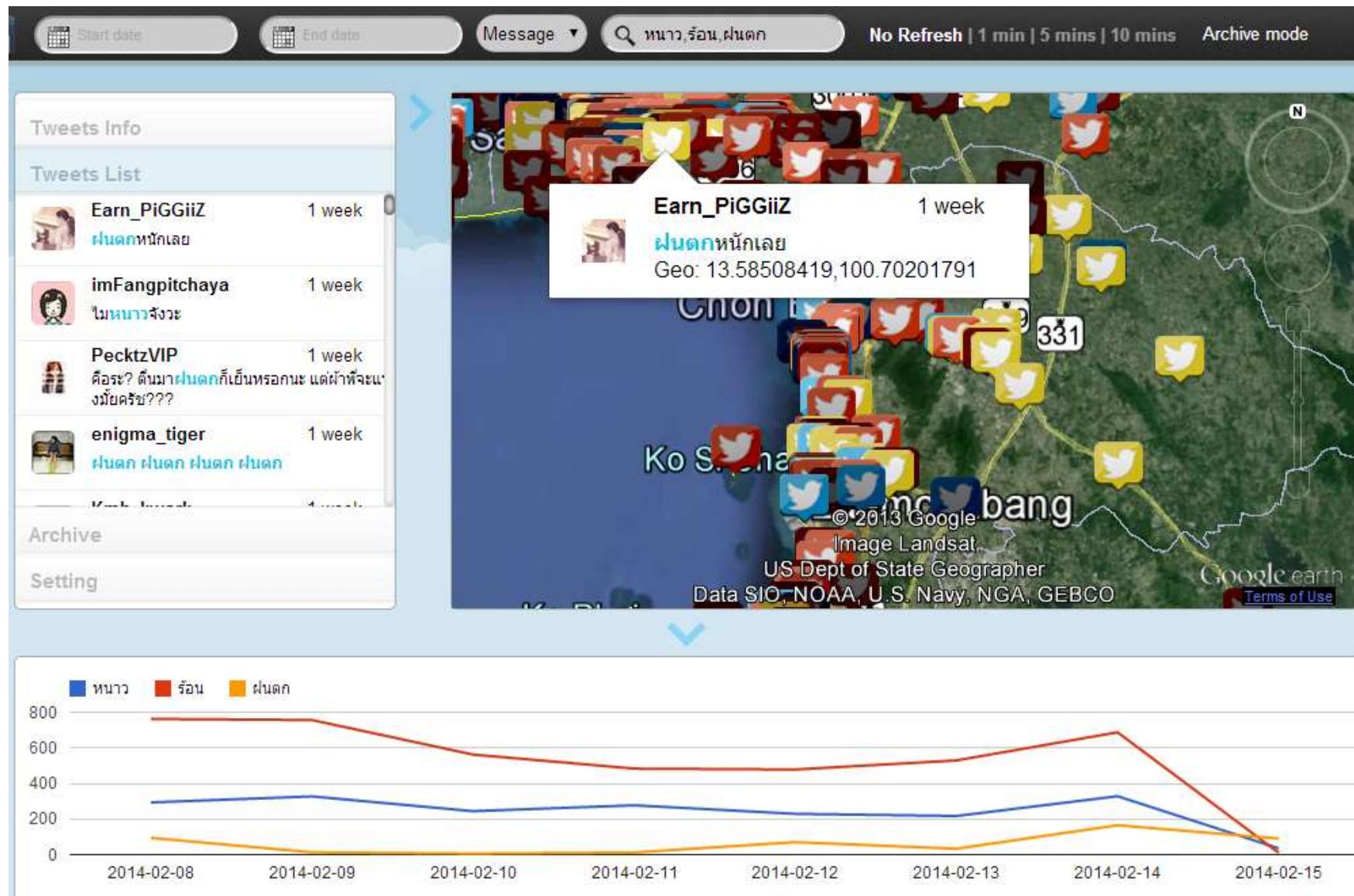
Tsunami Arrival Time & Wave Height

- Raster data is generated from wave simulation.



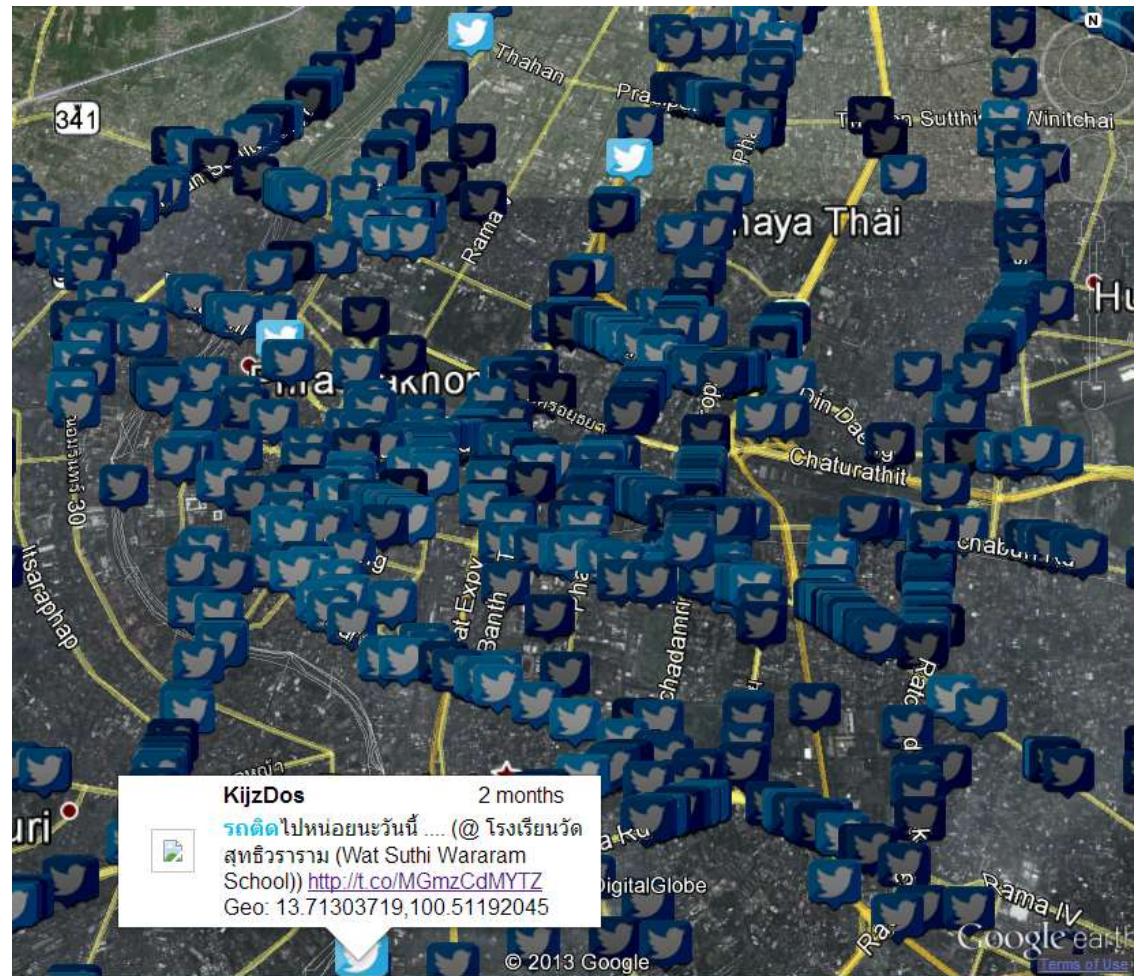
Twitter Map

- Some tweets contain location data.

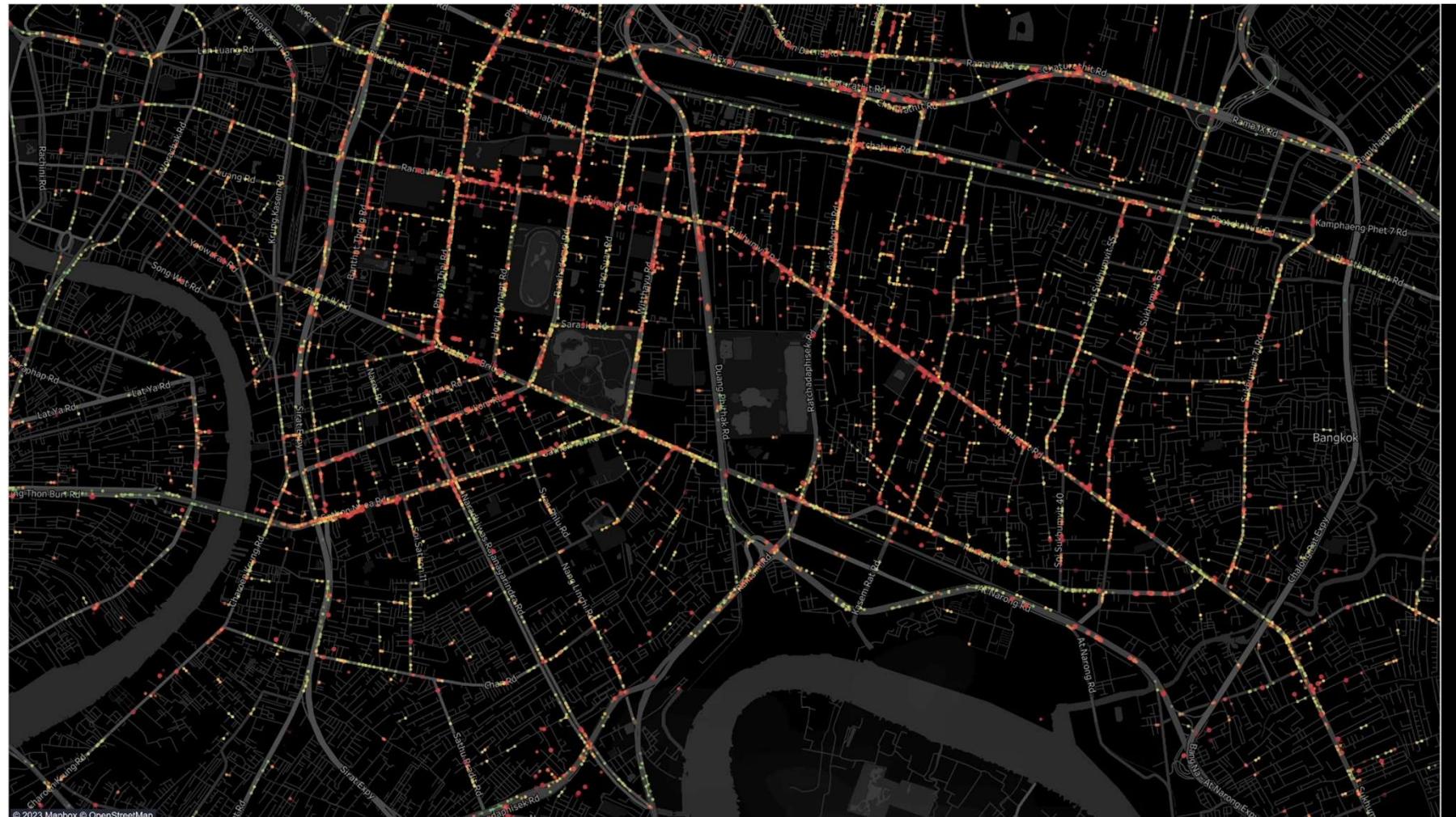


Traffic Data Analysis from Twitter

- GPS + Social Network



Taxi GPS Data



Density map of taxis over time

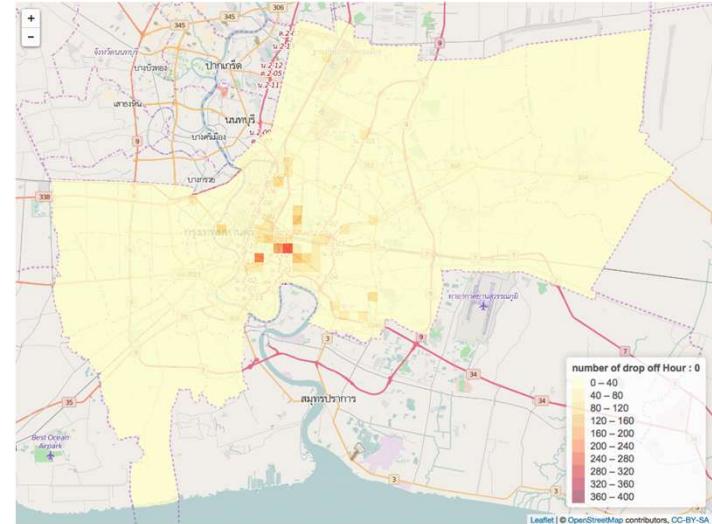
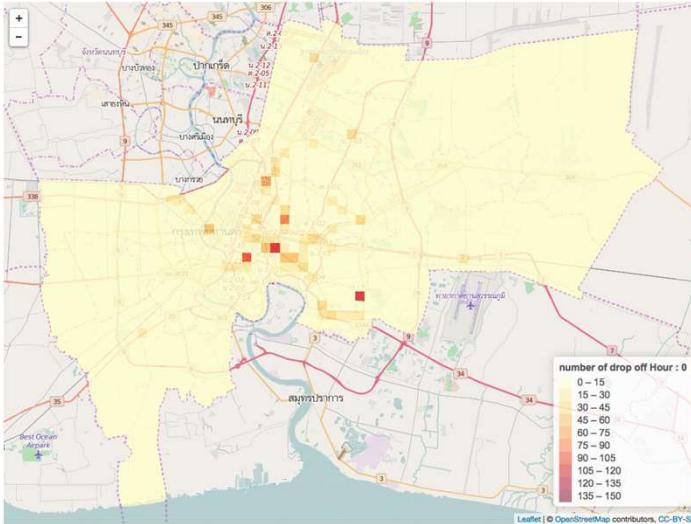


Traffic Analysis using Taxi GPS Traces

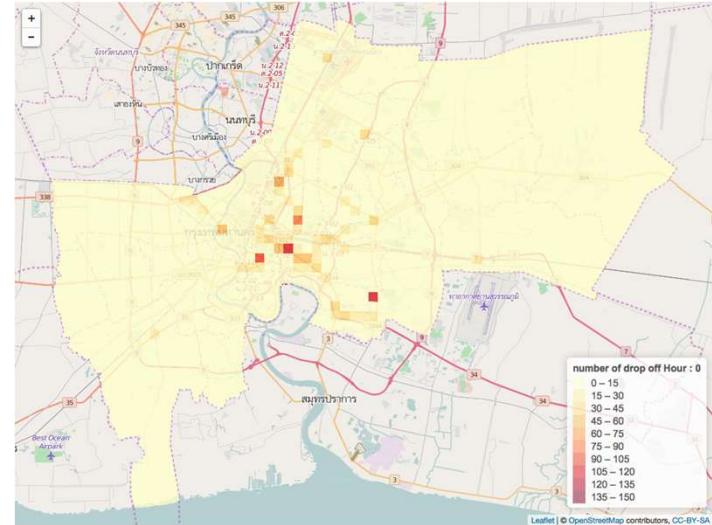
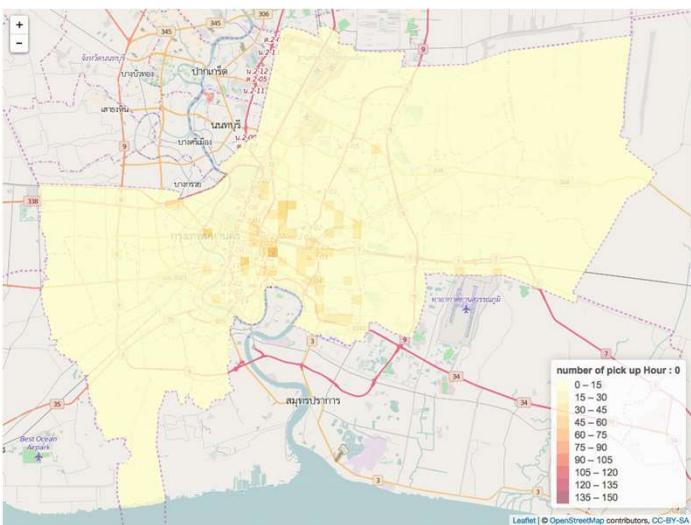


Taxi Heatmap

Weekdays



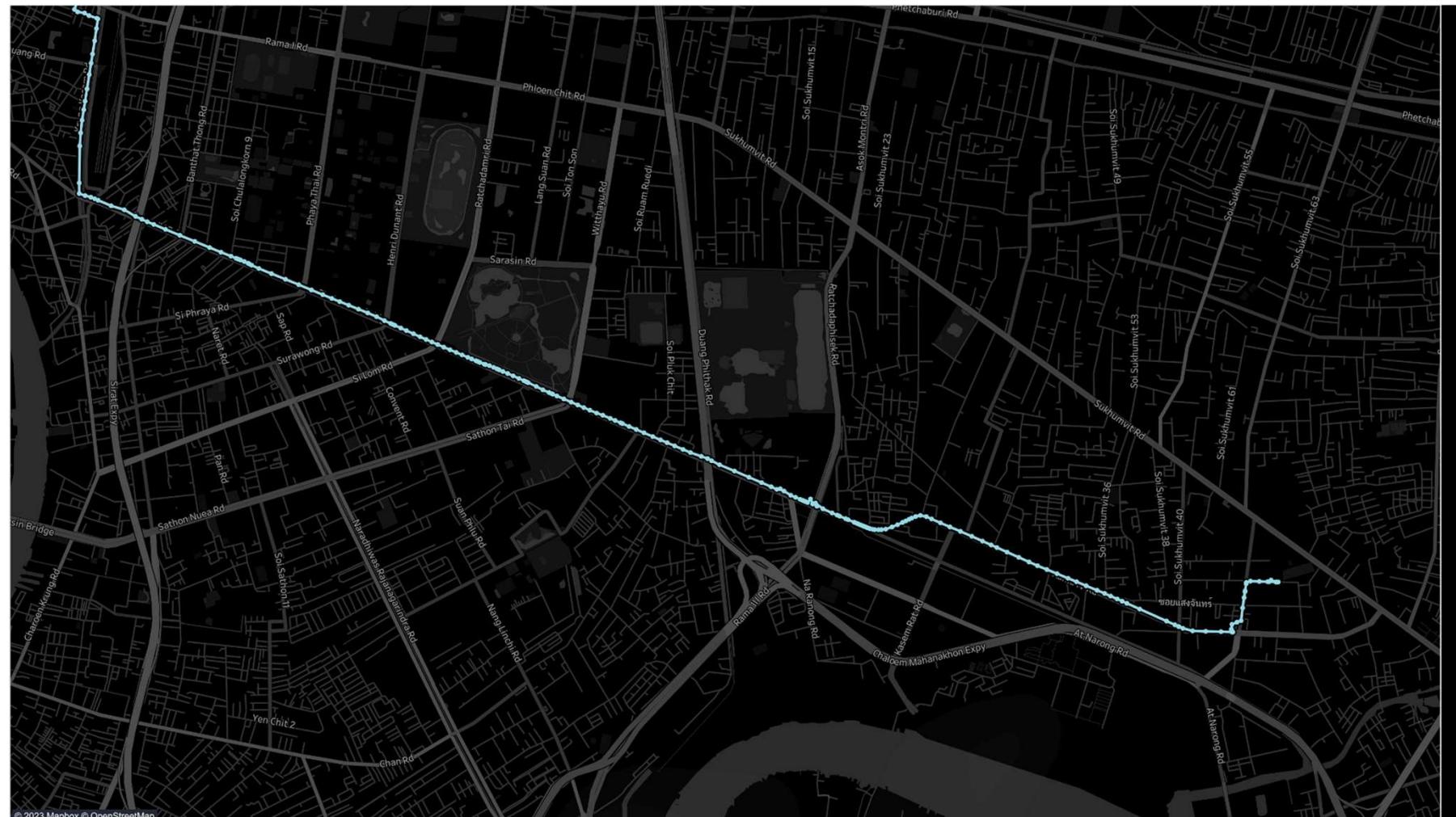
Weekends



Pick-up

Drop-off

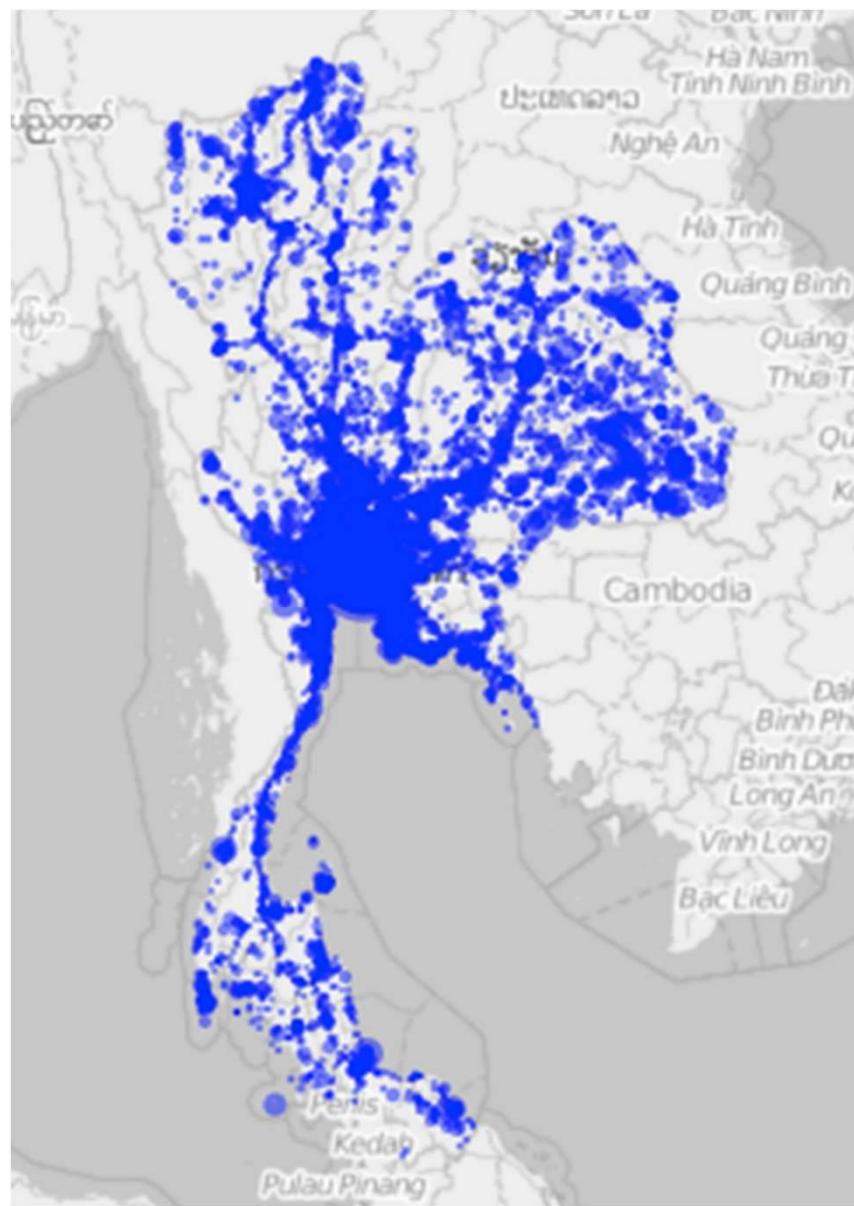
Route Analysis



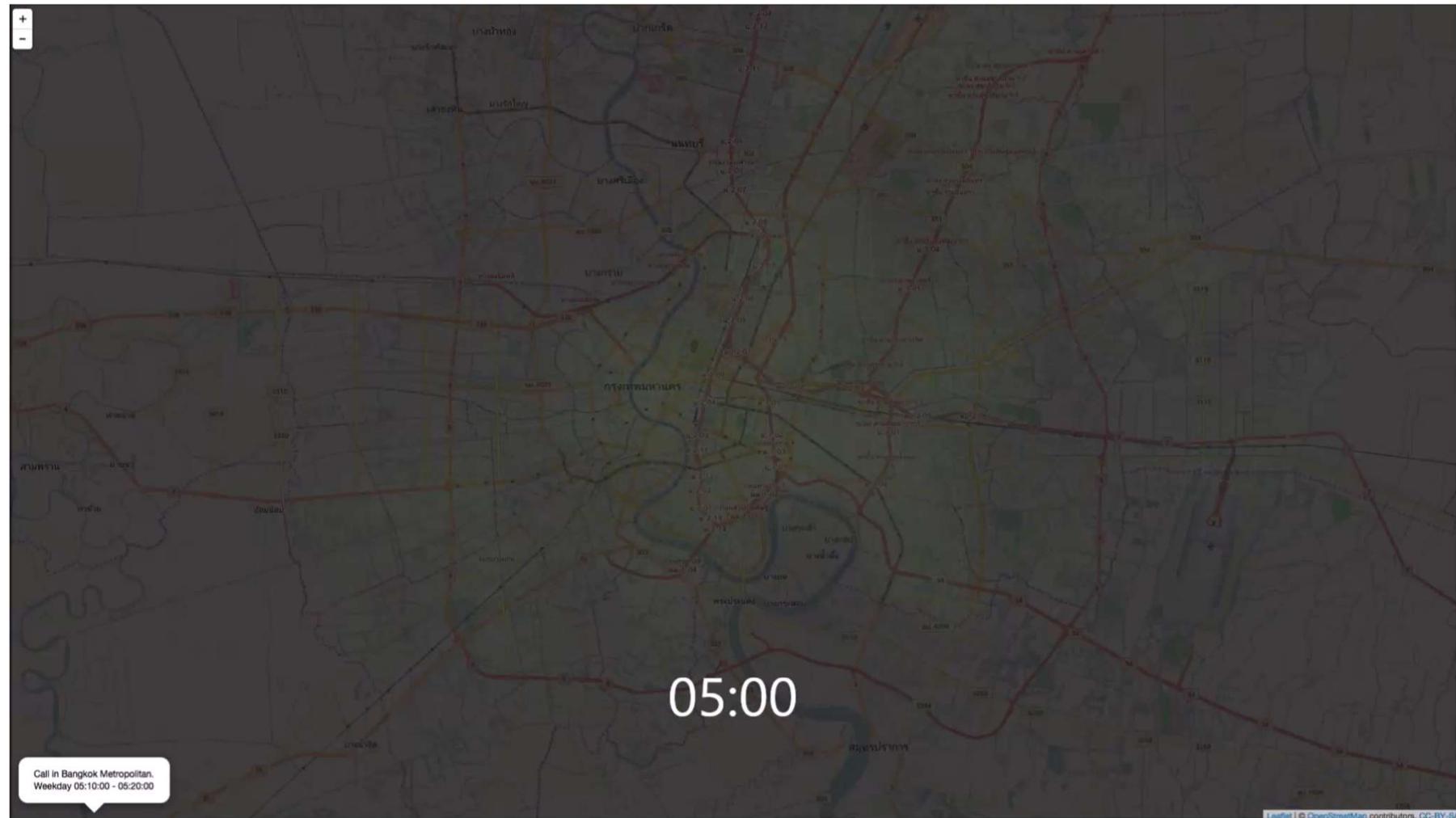
Route Analysis



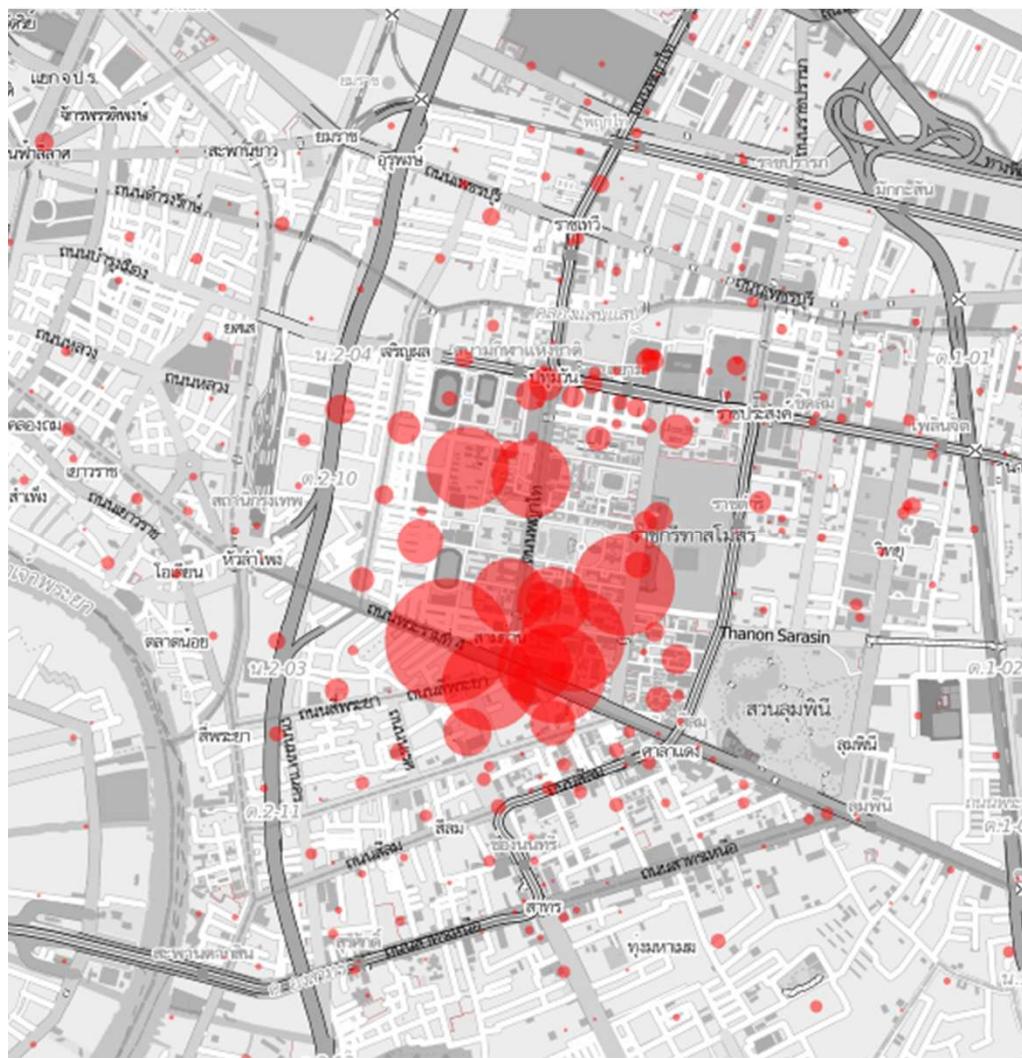
Mobile Cell Tower Usage



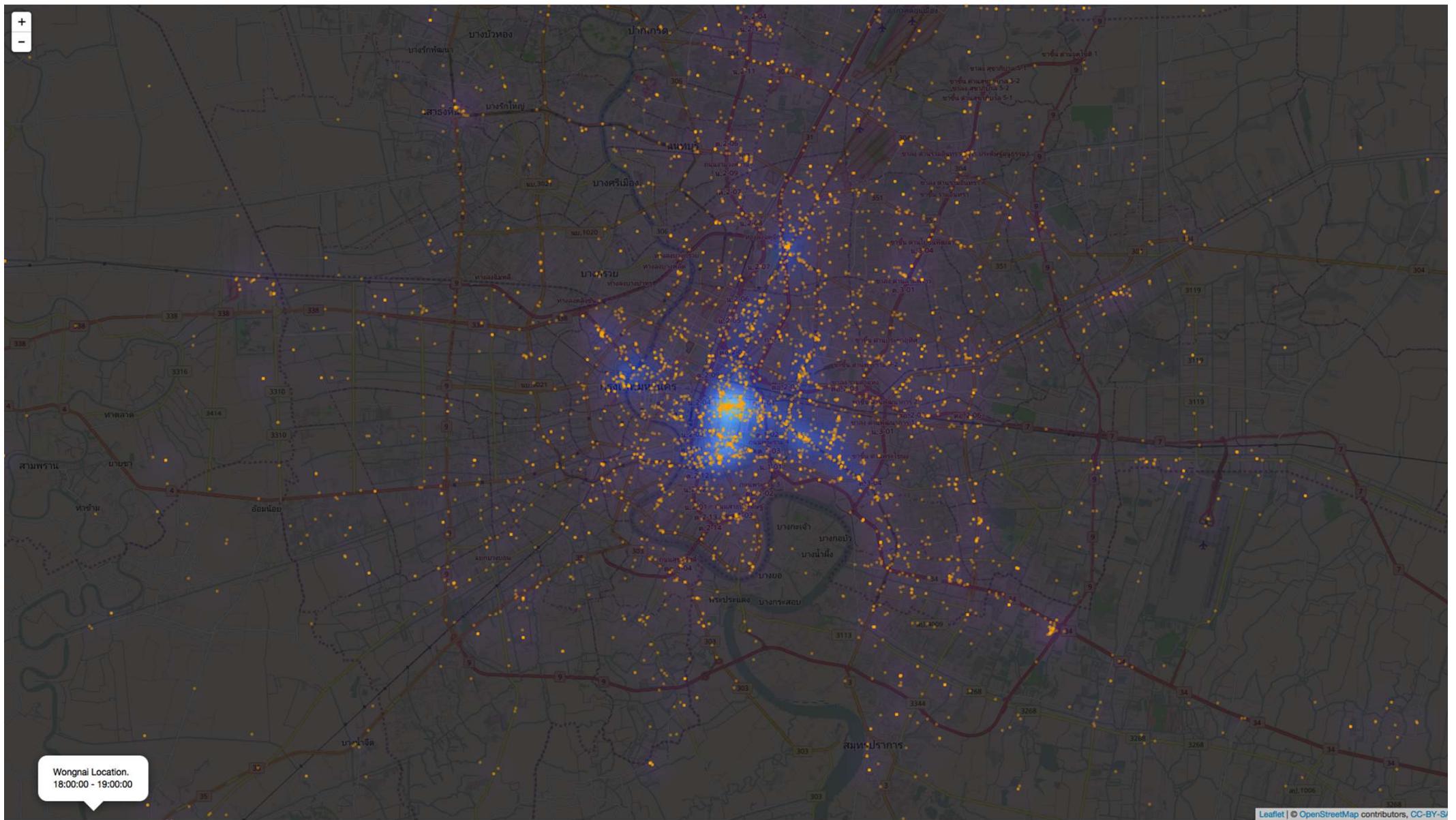
Density map of mobile phone usage over time



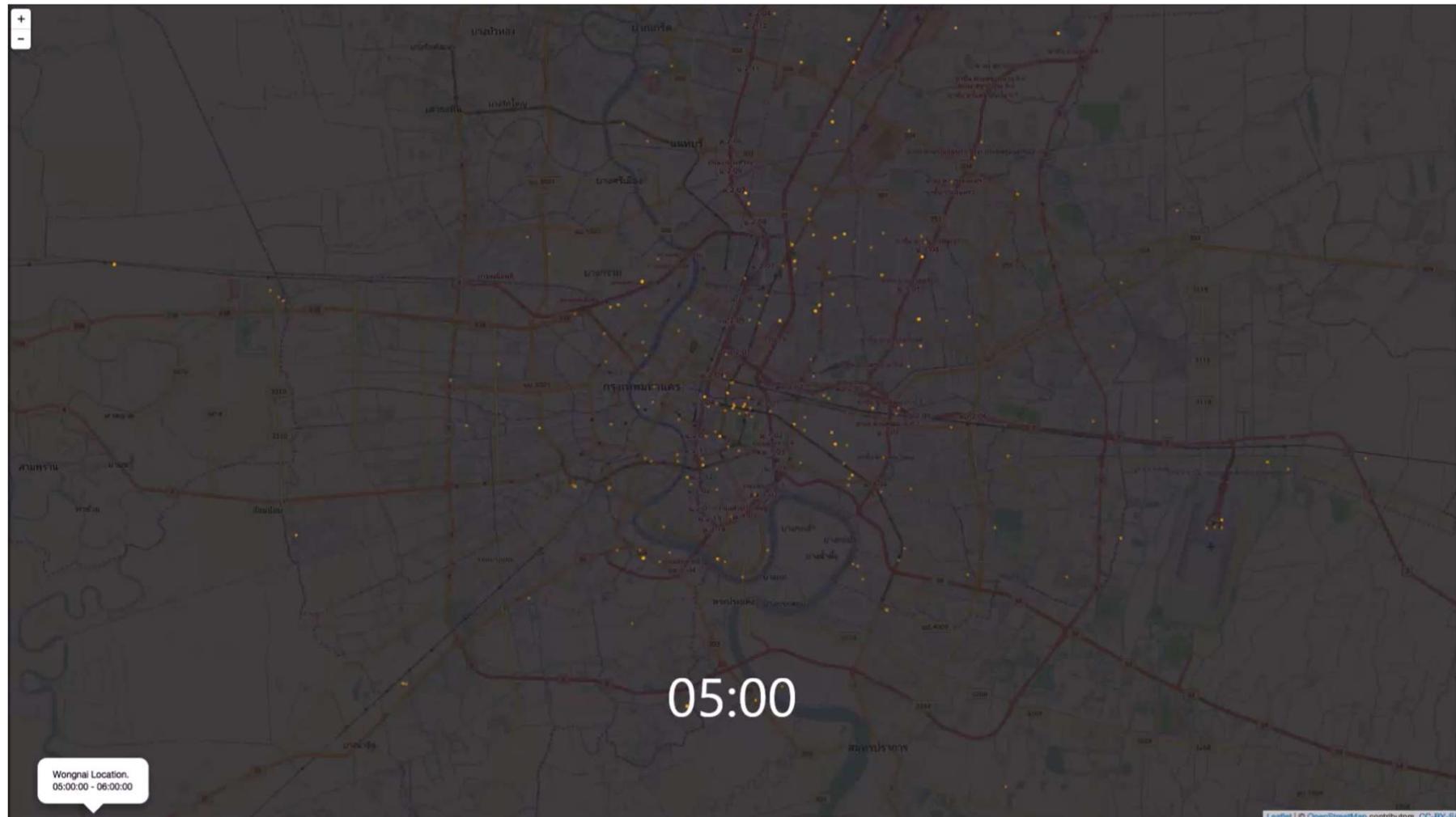
Mobile Cell Tower Usage around CU, Monday vs. Sunday 1-2 pm



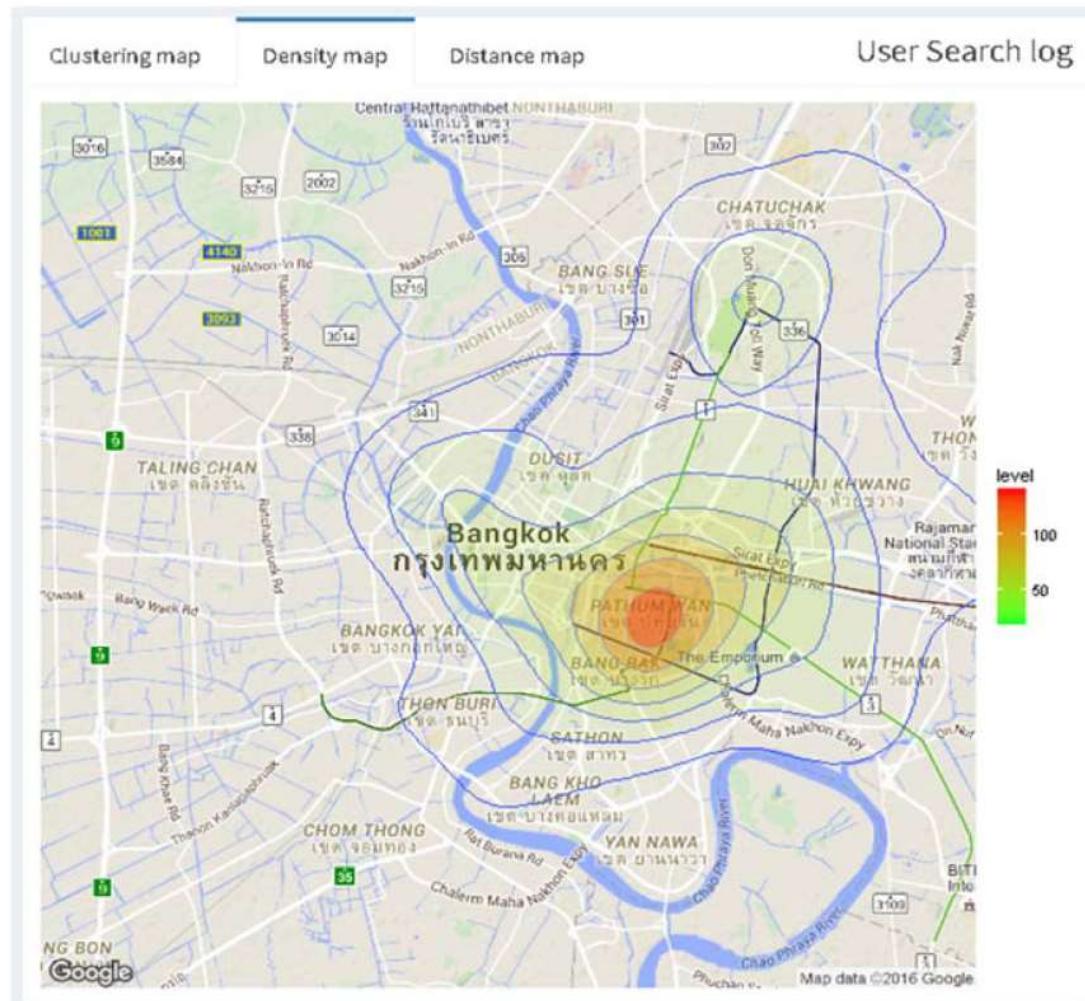
Density of Wongnai Apps Usage



Density of Wongnai usage over time

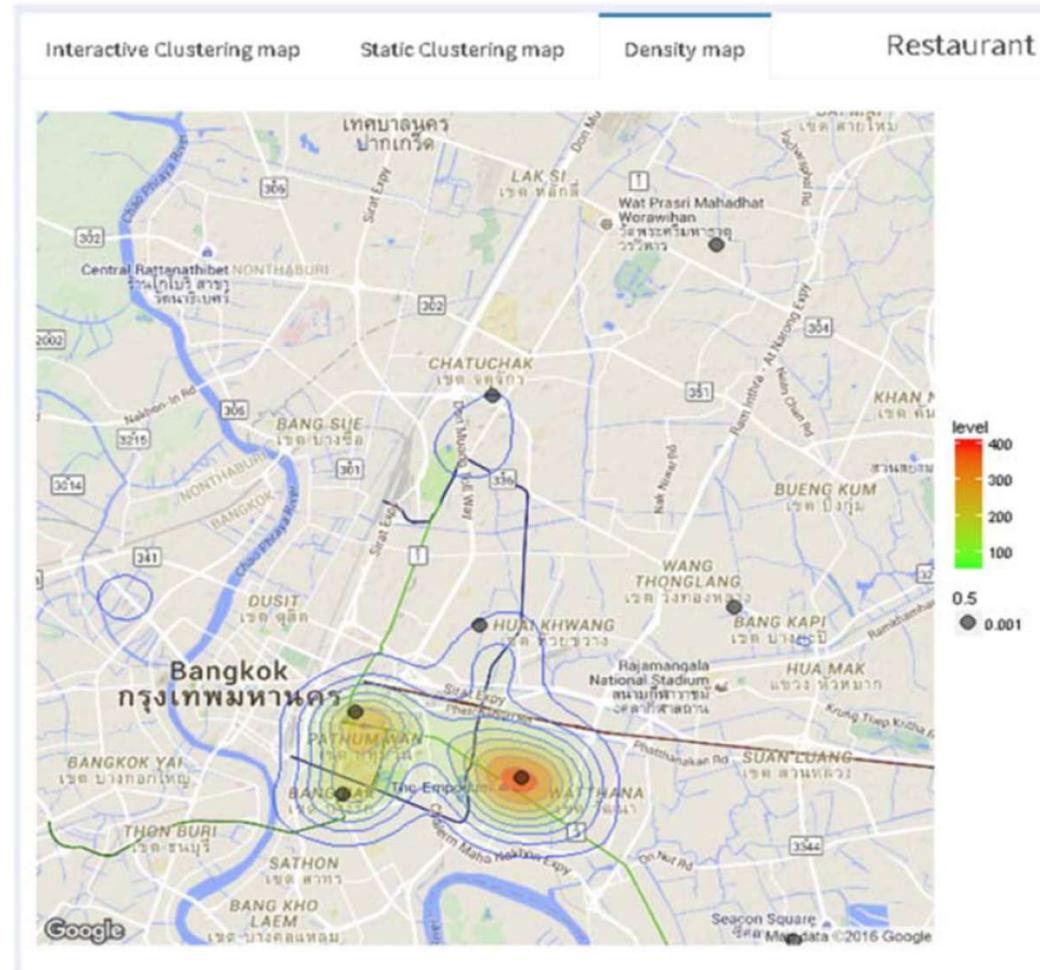


Density Map of Wongnai Users

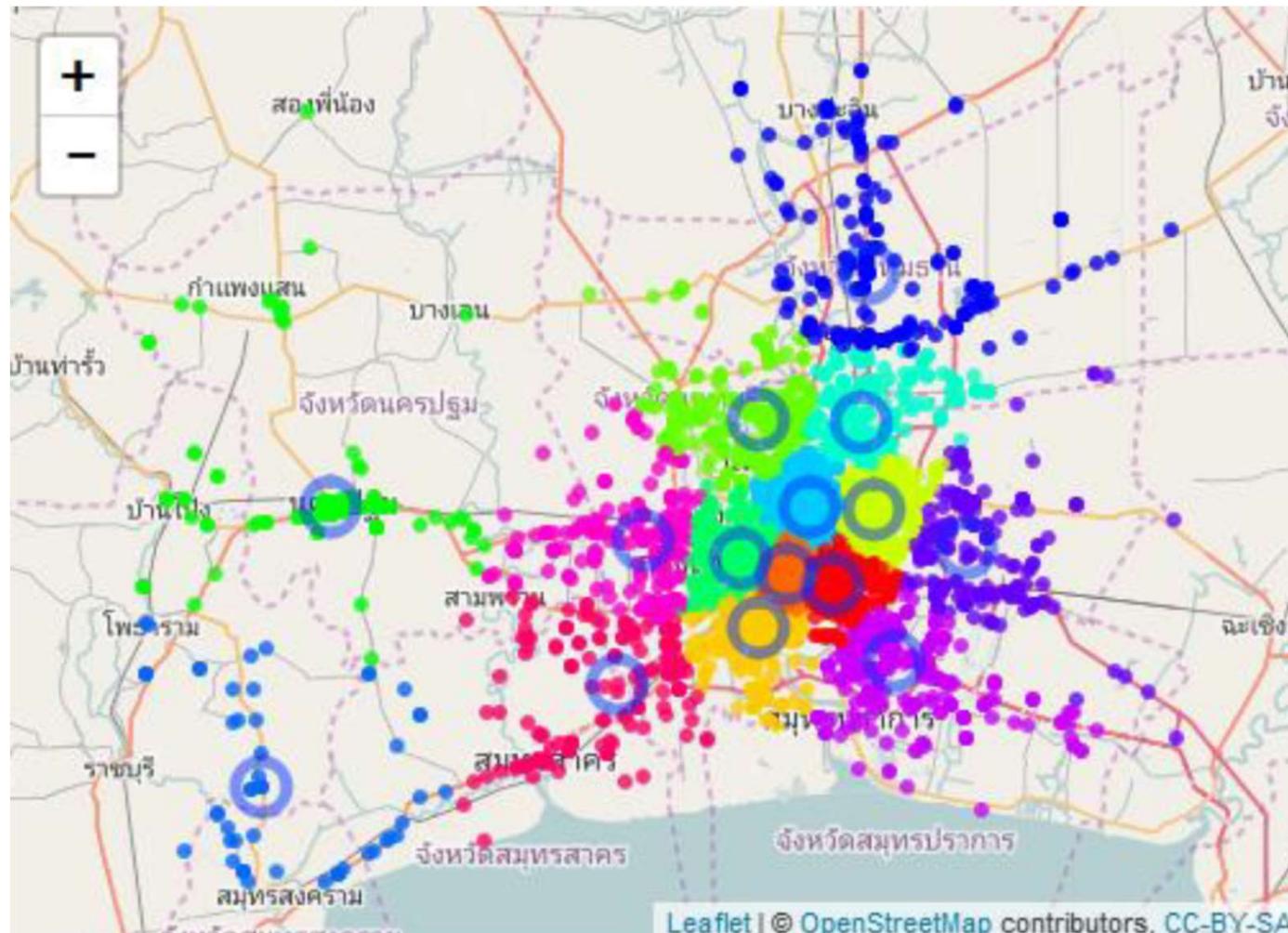


ภาพที่ 36 แสดงผลการวิเคราะห์ข้อมูลความหนาแน่นของข้อมูลผู้ใช้งานแอปพลิเคชั่นใน

Density Map of Japanese Restaurants



Clustering



Where do hungry people go?

Spatial Analysis & Viz Tools

- GIS software
 - QGIS
 - ESRI ArcGIS
- Business Intelligence
 - PowerBI
 - Tableau
- Python Libraries
 - Geopandas
 - Folium
 - Plotly