



Multigranular spatio-temporal exploration: An Application to On-Street Parking Data

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Academic Year 2017/2018

Overview

1. State of the art
2. Design of the application
3. Dataset, Data Model and Architecture
4. Front-end Visualisation
5. Conclusion & Future Works

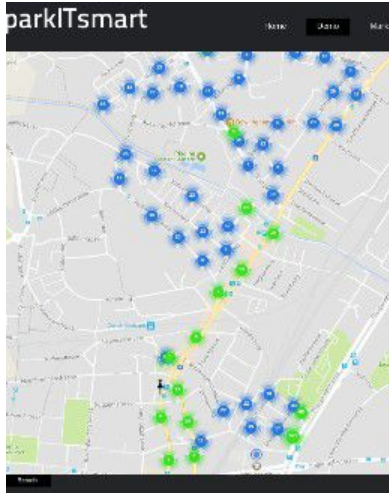




1. State of the Art

Parking Applications

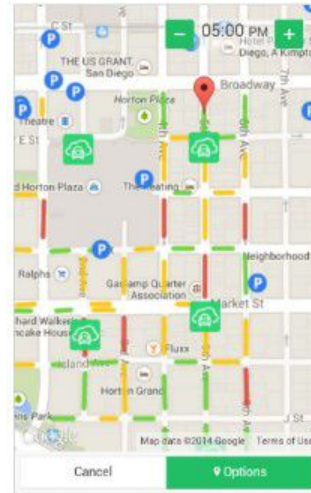
ParkItSmart



Web/Mobile Application

- Decision Maker & Final User
- Availability by clusters
- No colour scale

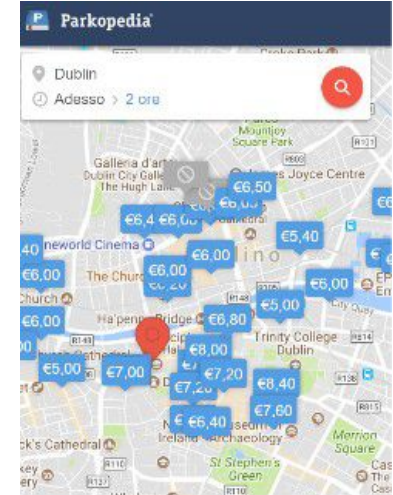
ParknCloud



Mobile Application

- Final User
- Availability by colors
- Traffic light scale

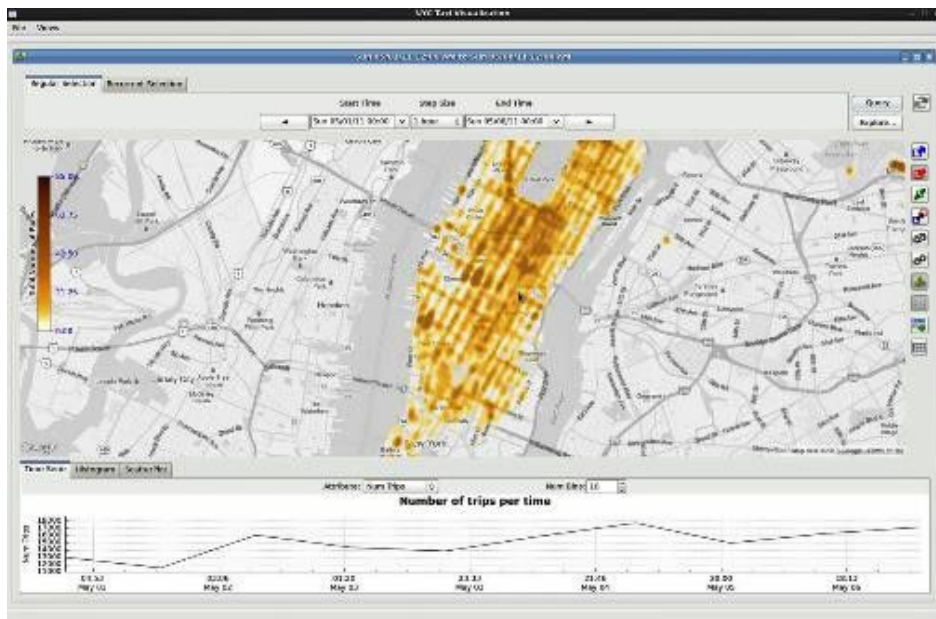
Parkopedia



- Web/Mobile Application
- Final User
- No availability
- No colour scale



Spatio-Temporal Visualisation of Taxi Routes



Target: Decision Maker

Topic: Taxi Routes

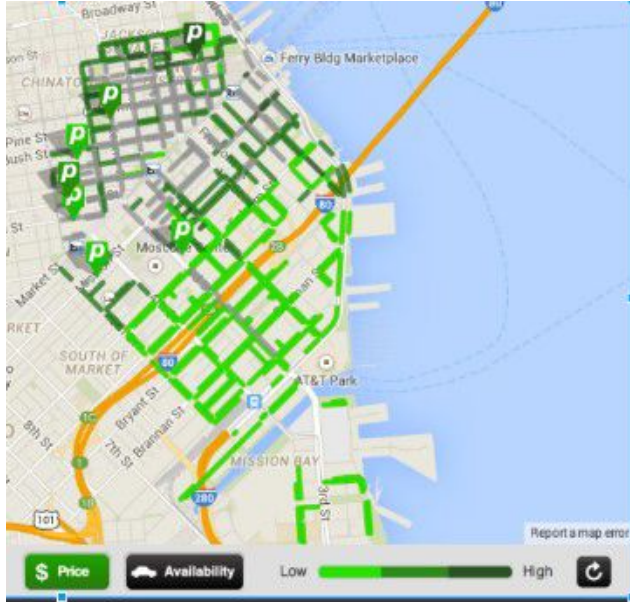
Characteristics:

- Zoom in / Zoom out
- Heat Map / Point Visualisation
- Temporal Granularity
- Trend about behaviour
- Comparison
- Others

Nivan Ferreira, Jorge Poco, Huy T Vo, Juliana Freire, and Cláudio T Silva. Visual exploration of big spatio-temporal urban data: A study of new york city taxi trips. IEEE Transactions on Visualization and Computer Graphics, 19(12):2149–2158, 2013.



Parking Applications: SFPark



Target: Decision Maker

Topic: On-Street Parking

Characteristics:

- Zoom in/ Zoom out
- Visualisation of availability
- Real Time Visualisation





2. Design of the application

The Application Design

- Availability of Parking
$$\text{availability} = \frac{(\# \text{parking amount} - \# \text{occupied parking})}{\# \text{parking amount}}$$
- Target: Decision Maker
- Spatial Data
 - Heat Map
 - Colouring each segment
- Temporal Granularities
 - Real Time
 - Past Behaviour
- Behaviour Trends
- Correlations with availability of parking



Rules for temporal sliders Enabling/Disabling (E/D)

Enable/Disable	Month	DayOfMonth	DayOfWeek	Hour
Month		E/D	D/E	E
DayOfMonth	E		D	E
DayOfWeek	E	D		E
Hour	E	E/D	D/E	



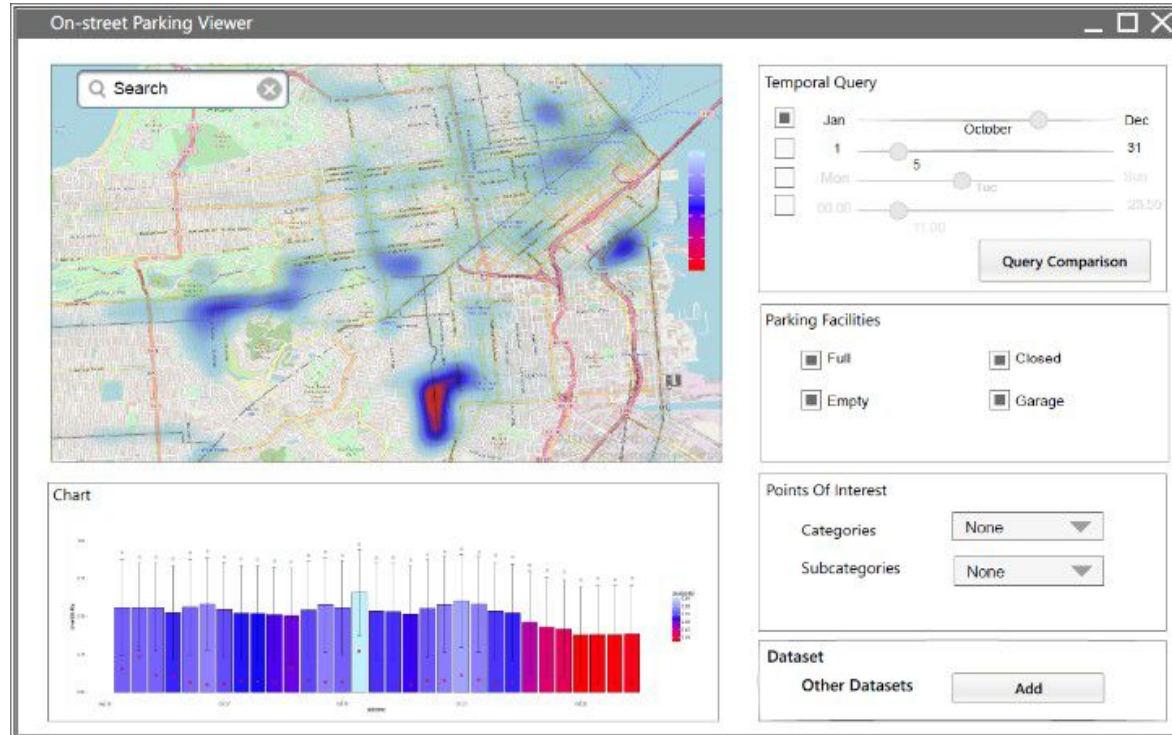
Aggregation method depending on a query

Selected Temporal Query	Aggregation Query
M-D*-H	Availability WHERE M=m AND D*=d* AND H=h
M-D*	avg(Availability), sd(Availability) WHERE M=m AND D*=d* GROUP BY H
M-H	Availability WHERE M=m AND H=h
M	avg(Availability), sd(Availability) WHERE M=m GROUP BY Dm
D*-H	Availability WHERE D*=d* AND H=h
D*	avg(Availability), sd(Availability) WHERE D*=d* GROUP BY H
H	Availability WHERE H=h
-	avg(Availability), sd(Availability) GROUP BY M

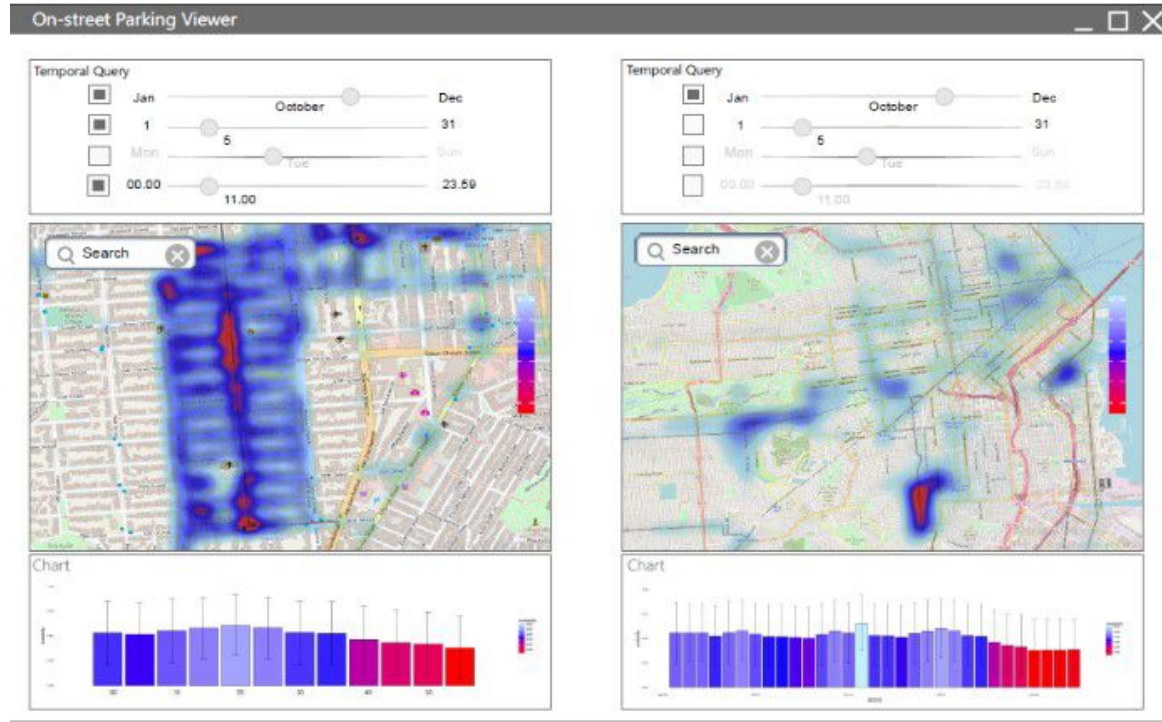
D* represent either DayOfMonth or DayOfWeek.
These two granularities have the same behavior



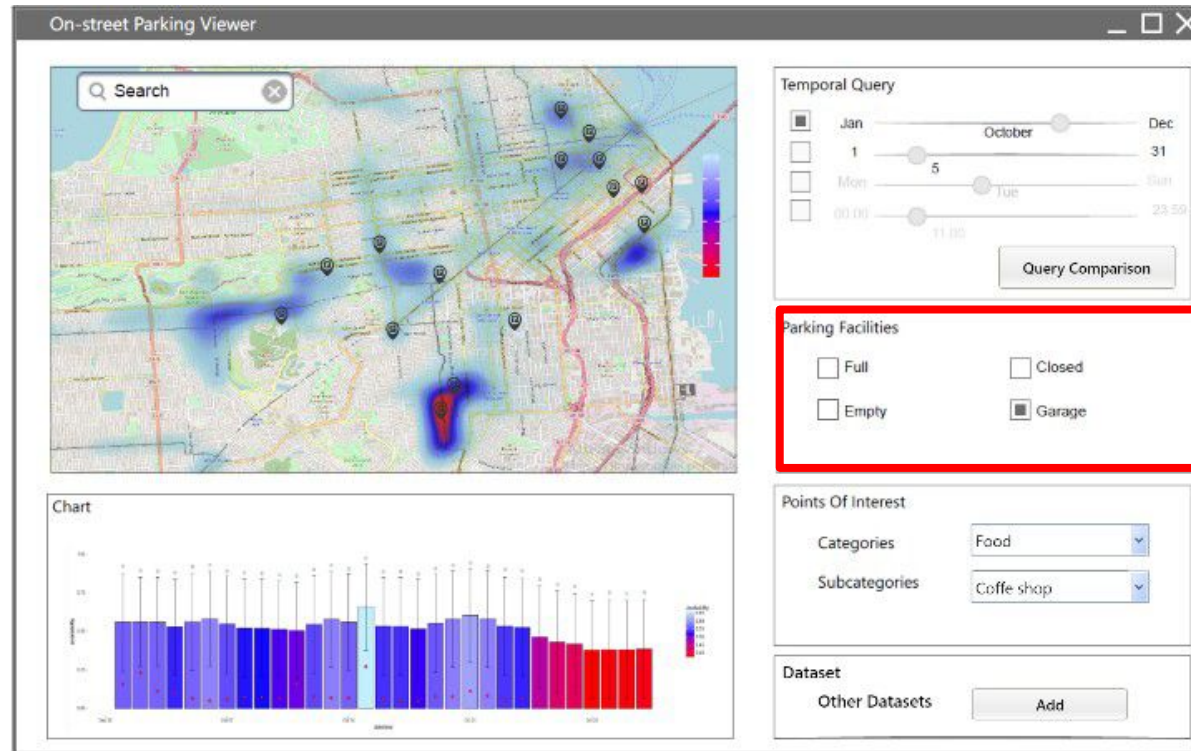
Homepage



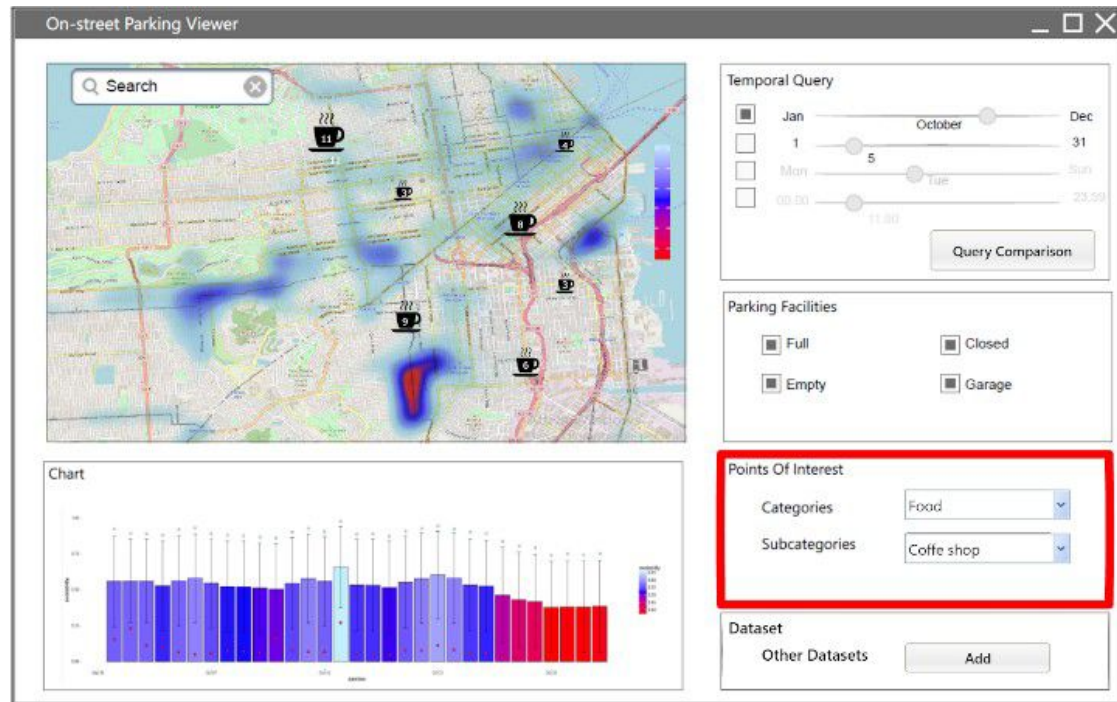
Comparison



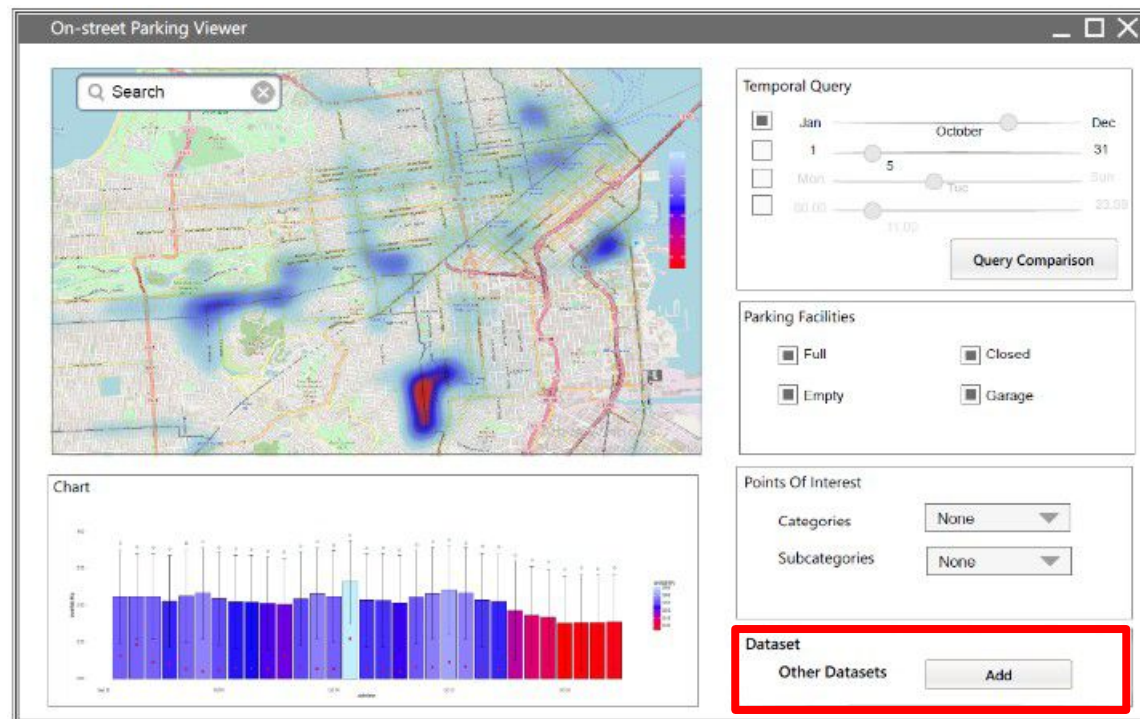
Parking Facilities



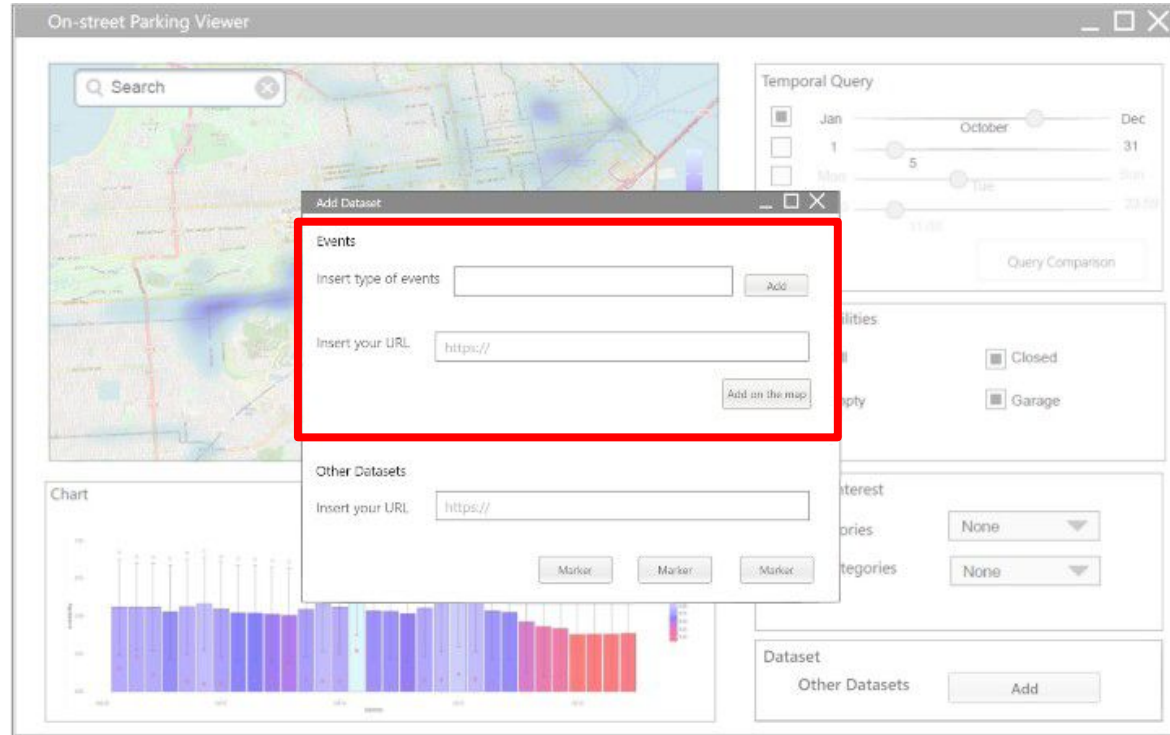
Points of Interest



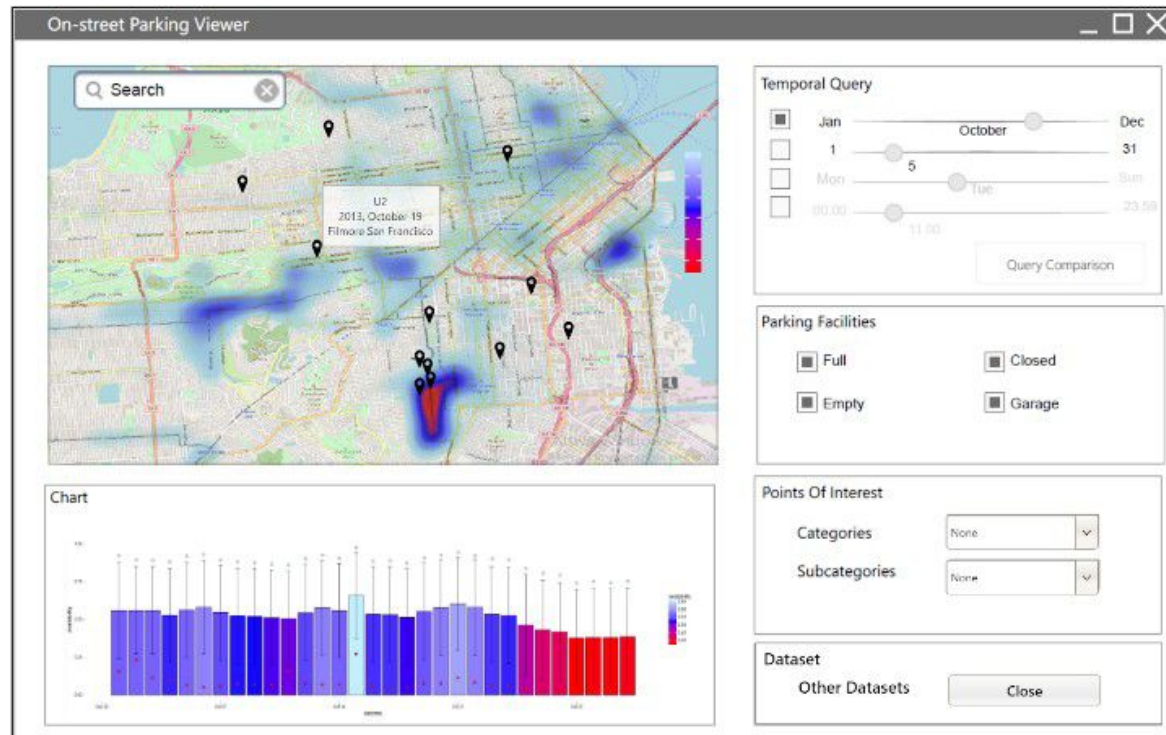
Other Datasets



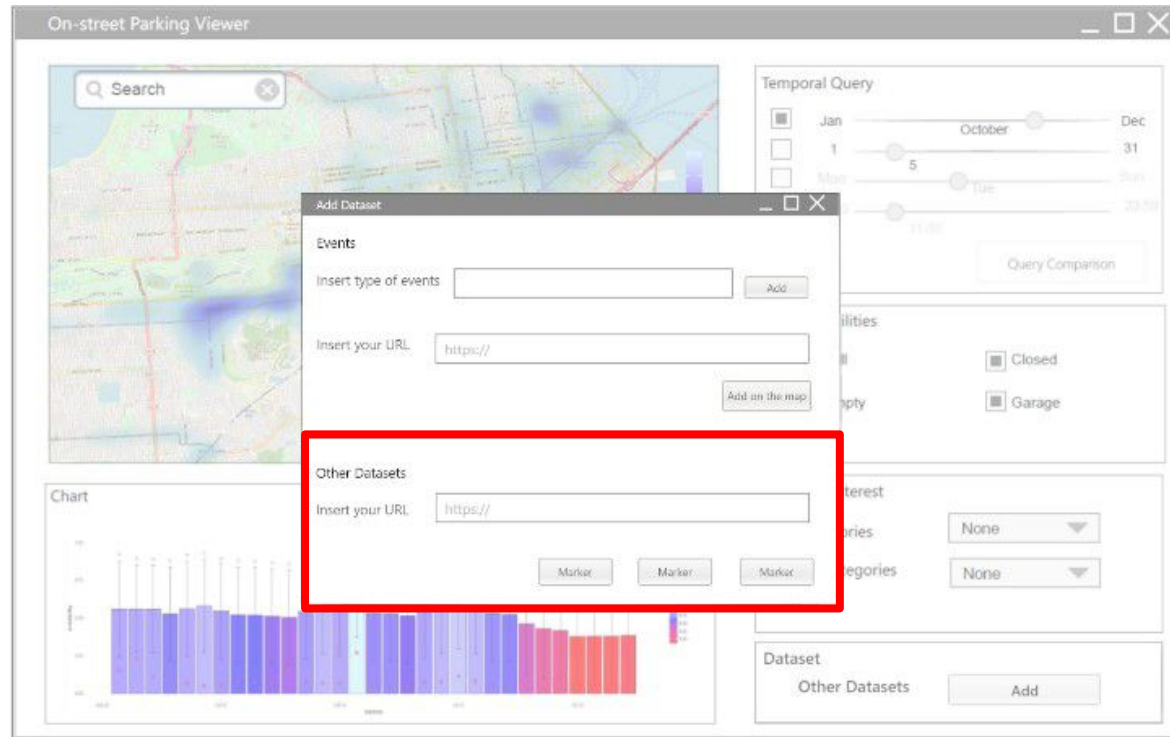
Events



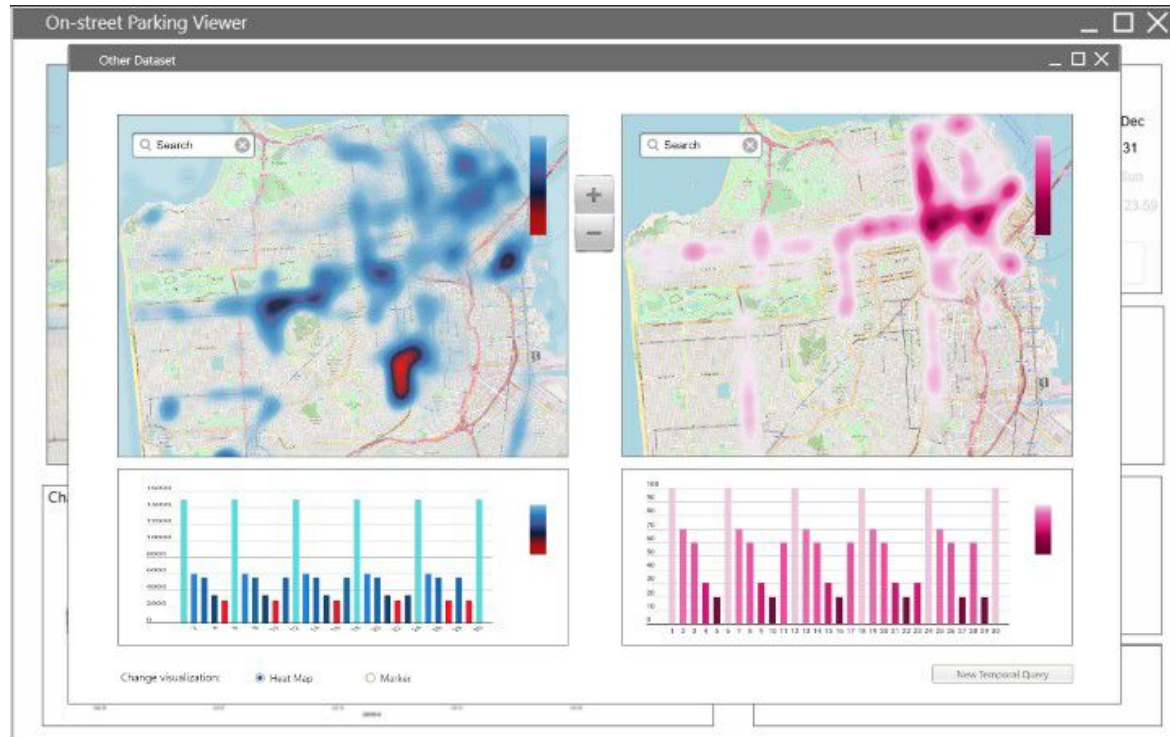
Events Visualisation



Other Datasets



Other Datasets Visualisation





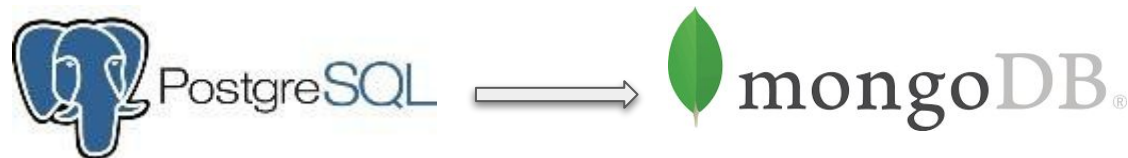
3. Dataset, Data Model and Architecture

San Francisco Dataset

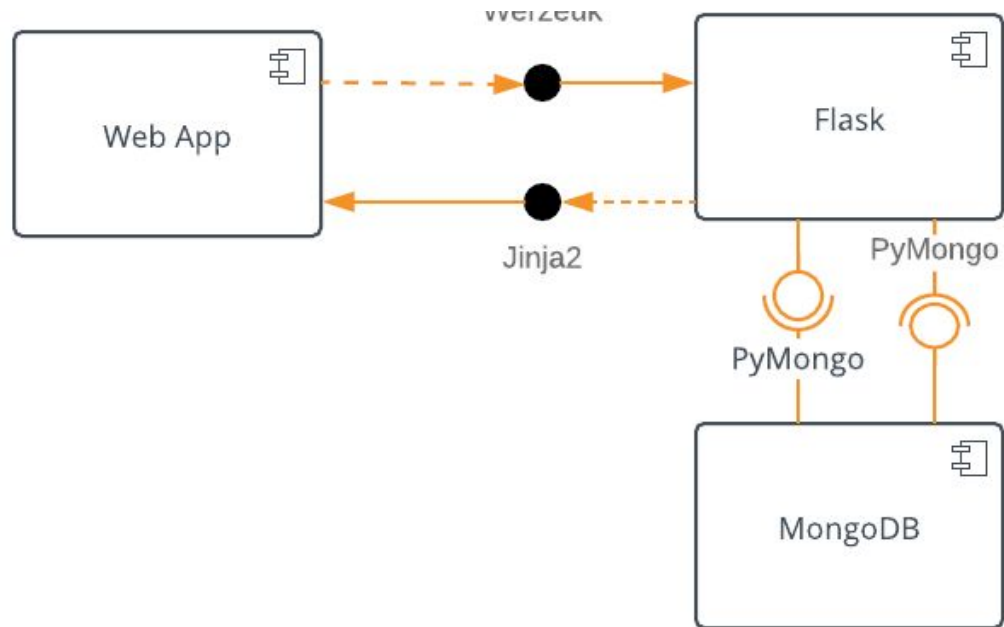
Timestamp	Street ID	Street Name	Parking Space Number	Occupied Parking Space	On Street	Latitude	Longitude
2014-03-01 01:53:11.695	930	16th and Hoff Garage	70	7	1	37°45'52.7"N	122°25'14.7"W

10 Months of Data, each item every 5 minute

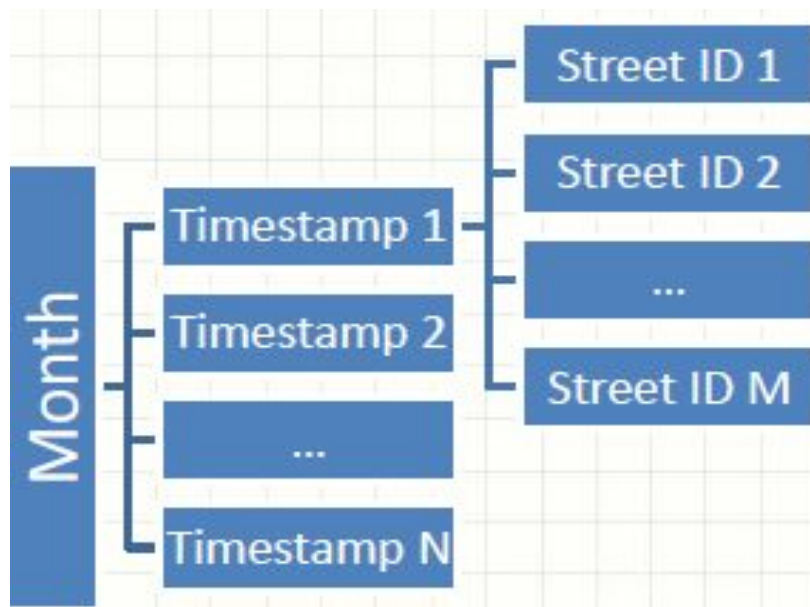
Aggregation in different time granularities



Architecture



MongoDB Dataset Model



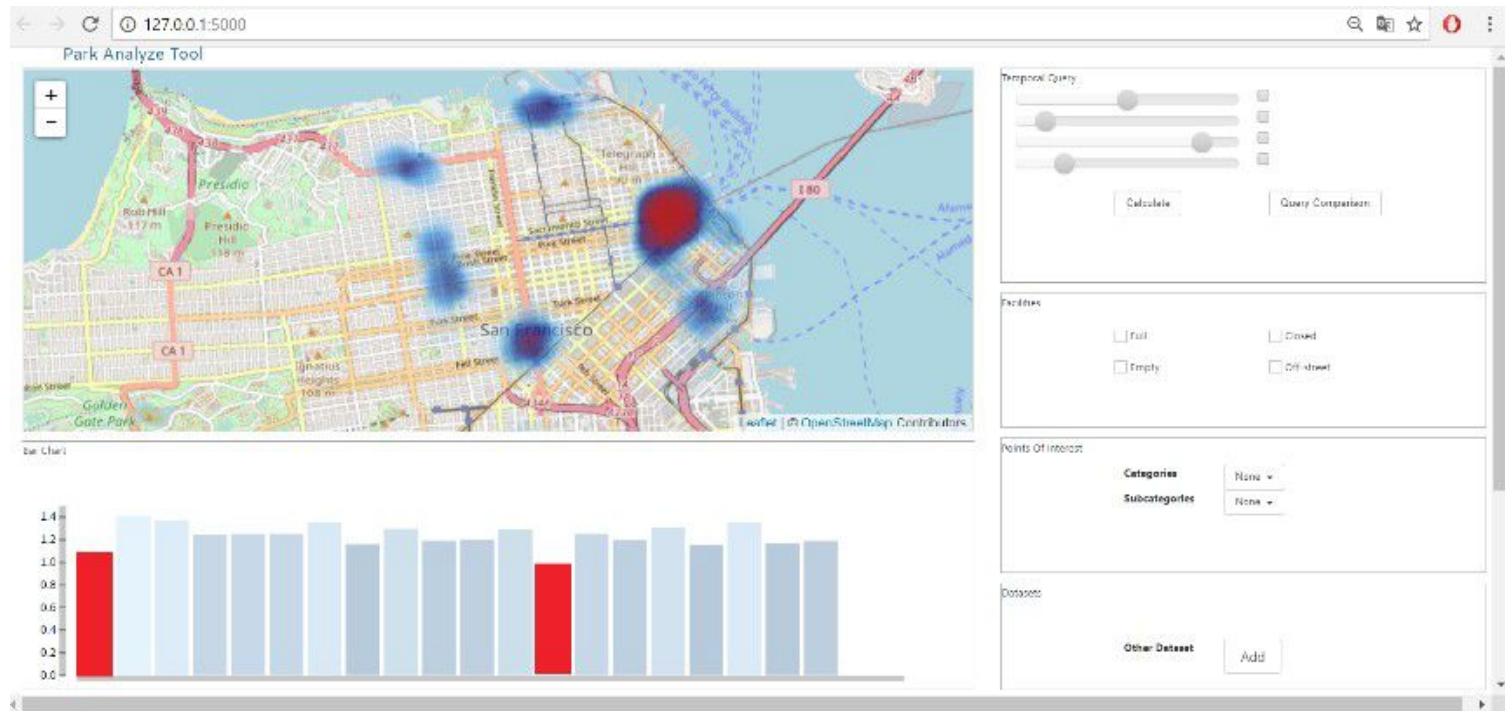
```
{
  "timestamp ": " 2014 -03 -01 01:53:11.695 ",
  "value ":
  [{
    "streetid_int ": "930 ",
    "streetname ": "16th and Hoff Garage ",
    "parkingspacenumber ": "70",
    "occupiedparkingspaces ": "7",
    "availability ": "0.9 "
    "geometries ":
    {
      " type ": " LineString ",
      " coordinates ":
      [[37.7691151689 , -122.38634671] ,
      [37.7707731833 , -122.3865237358]]
    }.....]
  },....
```





4. Front End Visualisation

Front-End Visualisation





6. Conclusion and Future Works

Conclusion

- Developed a multigranular spatial temporal system aiming at visualizing car parking data
- Target: decision makers
 - Analyze data according to both spatial and temporal dimensions at different granularities
 - Explore combined visualizations of data on a map
 - Visualize aggregated data on a bar chart
- Lack in literature about this topic
- Main Contributions:
 - Generic logic for the development of the system
 - Design and development of a GUI for on-street parking data
 - Suitable architecture
- Collaboration with University College Dublin and Università degli Studi di Napoli Federico II
 - Publication at W2GIS, A Coruna, Spain, May 2018
 - Publication at International Conference Information Visualisation, Salerno, Italy, July 2018



Future Works

- Functionality Extensions
 - Parking Facilities, Point Of Interest, Dataset panels
 - Link with other car parking application
 - Link with dynamic dataset
 - Load data in different formats without pre-processing by the user
 - Predict the availability in the future
- Use different dataset
- Evaluation
 - Usability, by getting feedback on the usability and usefulness
 - Efficiency: use of NodeJS or different NoSQL databases
- Mobile Application
 - Extend the application also for the end-user
 - Visualization real-time
 - Back-end suitable for the most used mobile platform

