

Dynamic and Interactive GeoTime Visualization

Vast Challenge 2021, MC 2

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Introduction

Background Information

The 2021 annual Visual Analytics Science and Technology (VAST) Challenge brought back a classic three mini-challenges to see how approaches and techniques of visual analytics have developed since the inception of the classic scenario in 2014. GASTech has been operating a natural gas production site in the island country of Kronos. In January, 2014, several employees of GASTech go missing.

Motivation

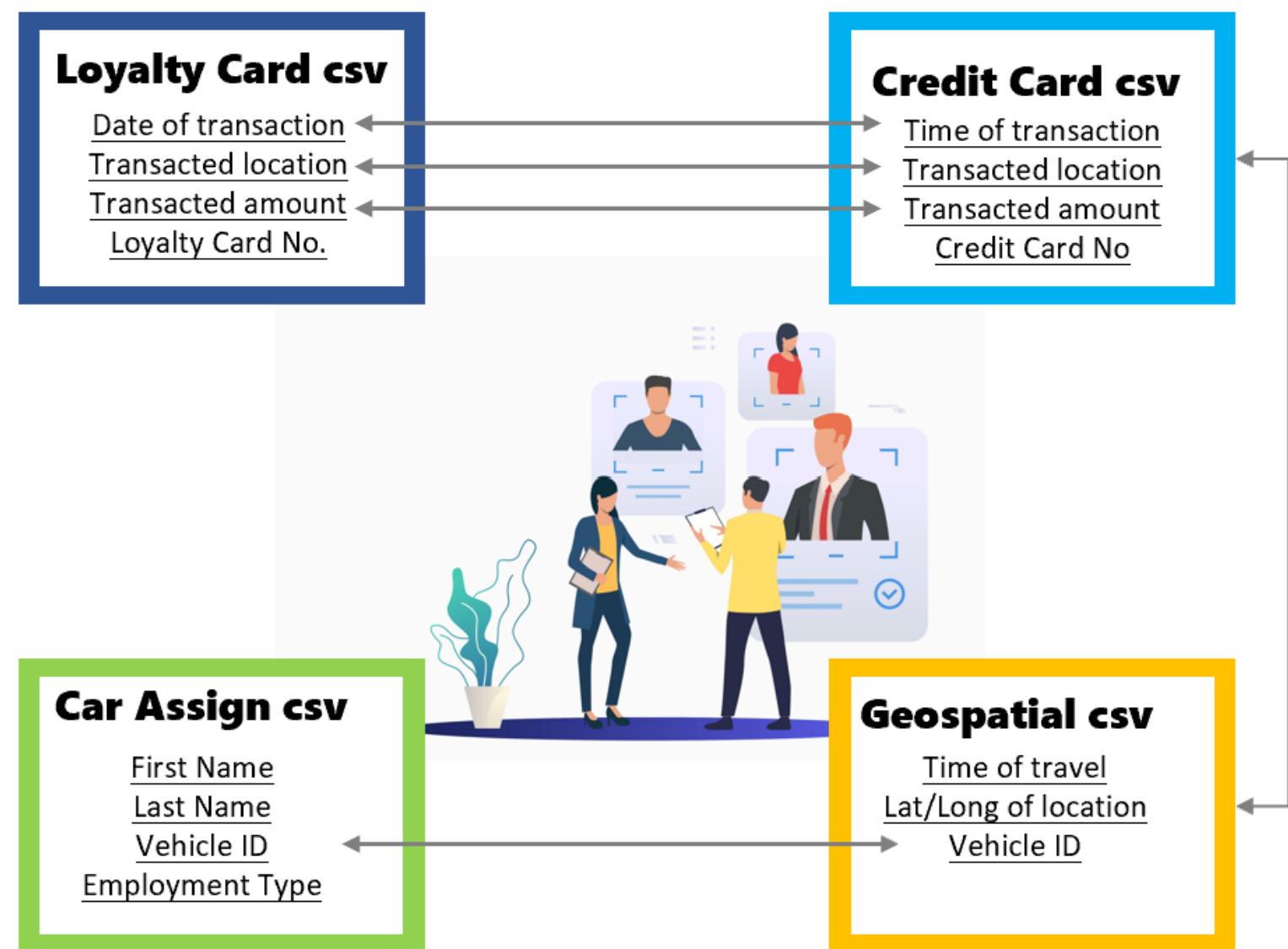


Figure 1: Data File Introduction

Each csv file was like a puzzle piece and solving the puzzle would be dependent on the ability to establish the links between the common metadata within the files (loyalty card, credit card, car assignment, gps). We aim to provide an effective and high usability web-enabled client-based shiny visualisation dashboard to support the investigation efforts on geographical.

Approach

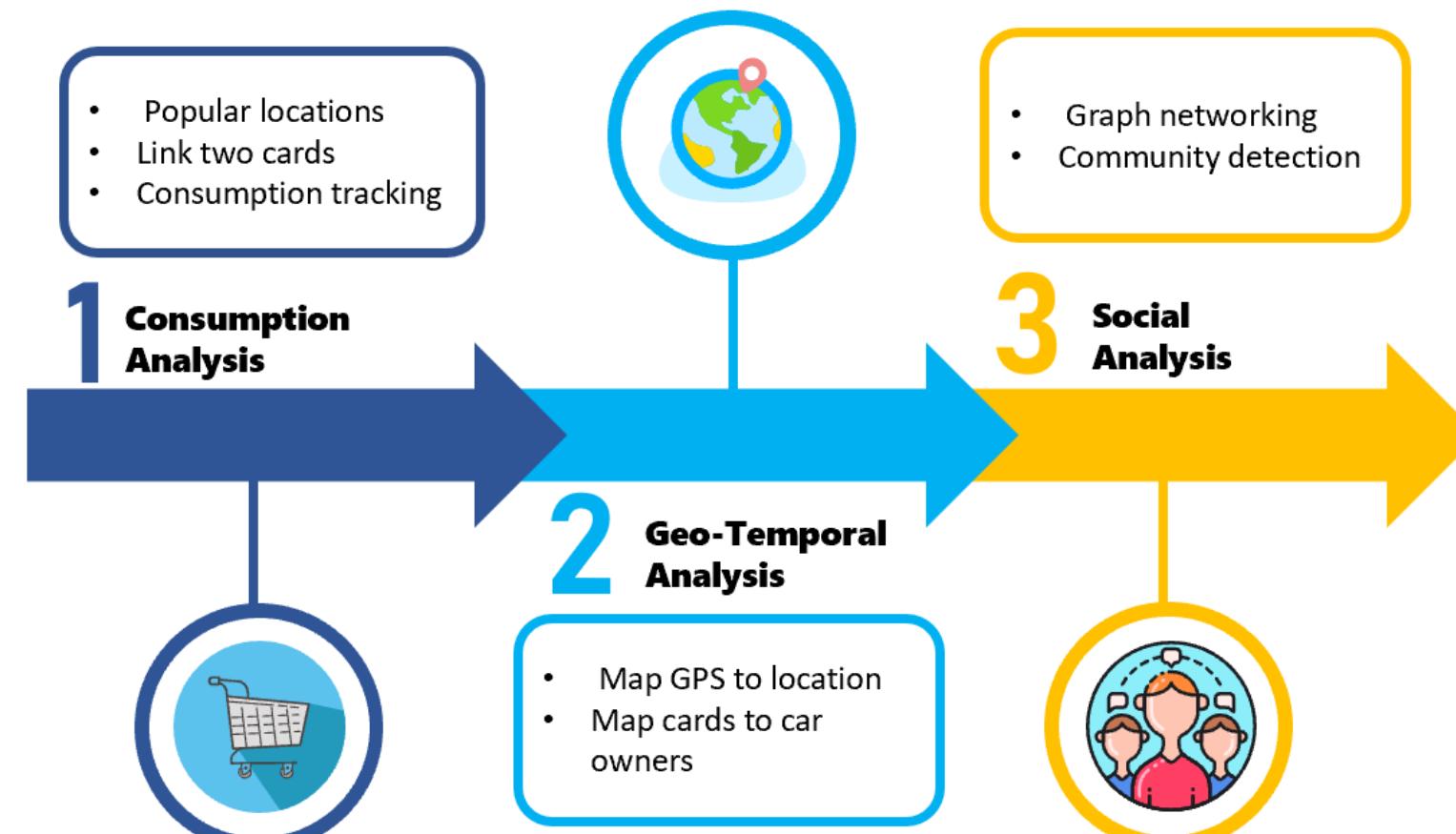


Figure 2: Approach overview

- Consumption Analysis* conduct exploratory data analysis based on aspatial data i.e. transaction records with temporal information
- Geo-temporal Analysis* determine the credit card owner through geospatial temporal analysis and assist the investigator to discover insights
- Social Analysis* discover formal or informal relationship or activities based a network structure build from geospatial tracking data

Tools



Figure 3: Tools used

Visual Analytics

Consumption Analysis

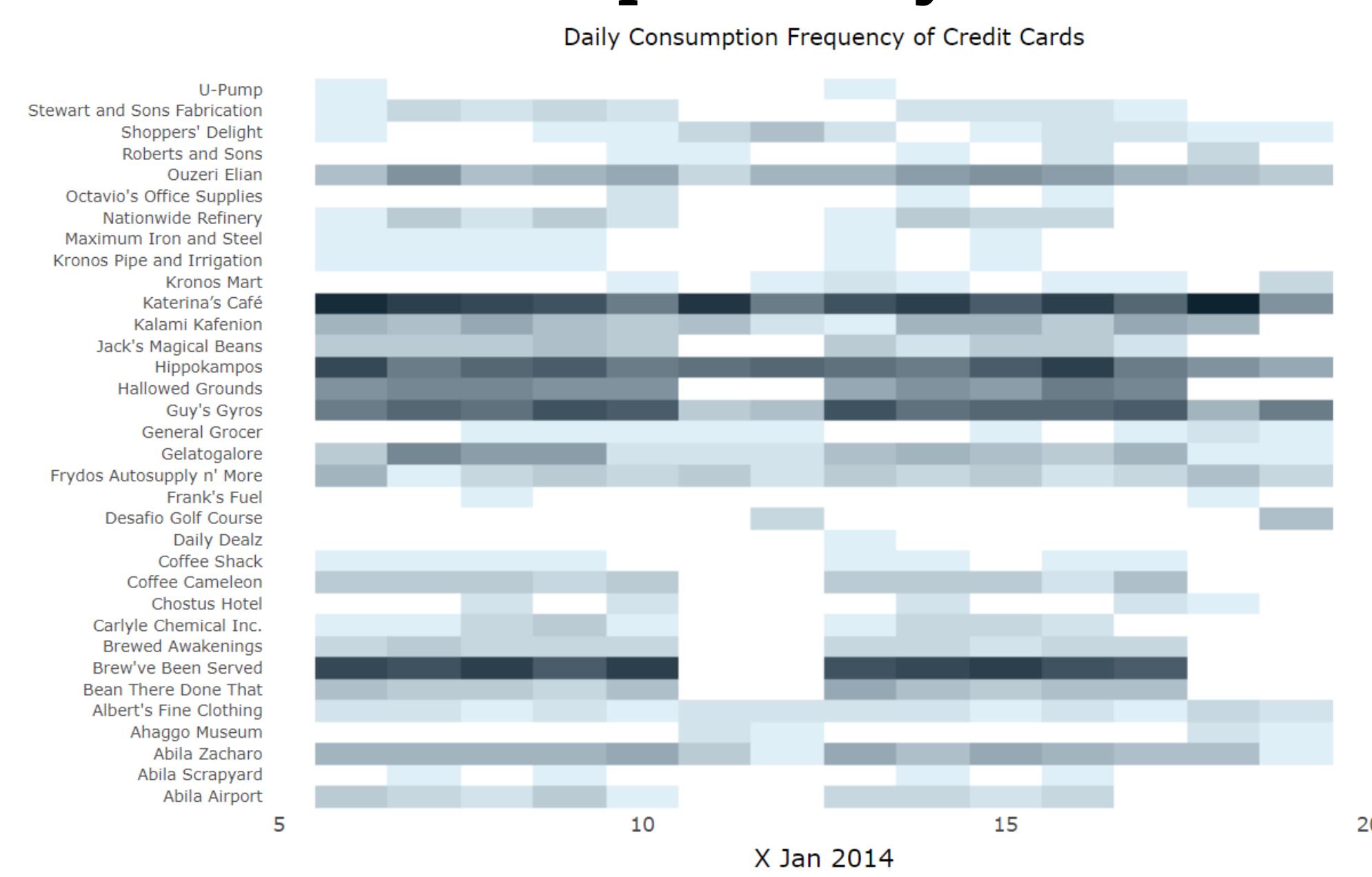


Figure 4: Heatmap

Heatmap is a data visualization technique that shows magnitude of a phenomenon as color in two dimensions. The DiGTvis provides two heatmap, one for credit card, another for loyalty card under the same tab with fixed locations variable in the Y axis. Another dimension can be defined by users. Users can also check the discrepancy between two heatmaps.

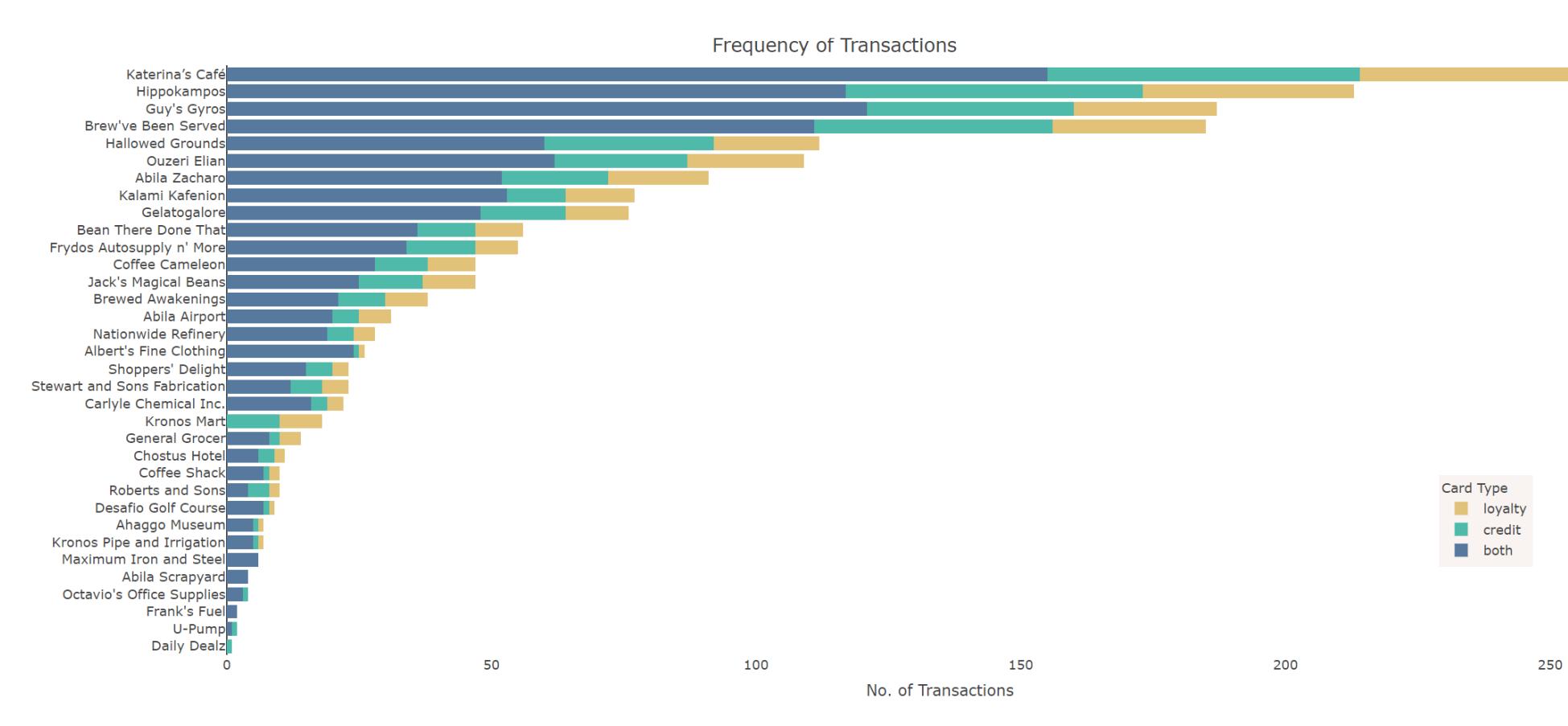


Figure 5: Barplot

In this panel, users can view the frequency of transactions with the kind of transaction ways, namely employees used credit card, loyalty card or both cards. This graph is in descending order. Hence, users can compare the popularity of locations easily.

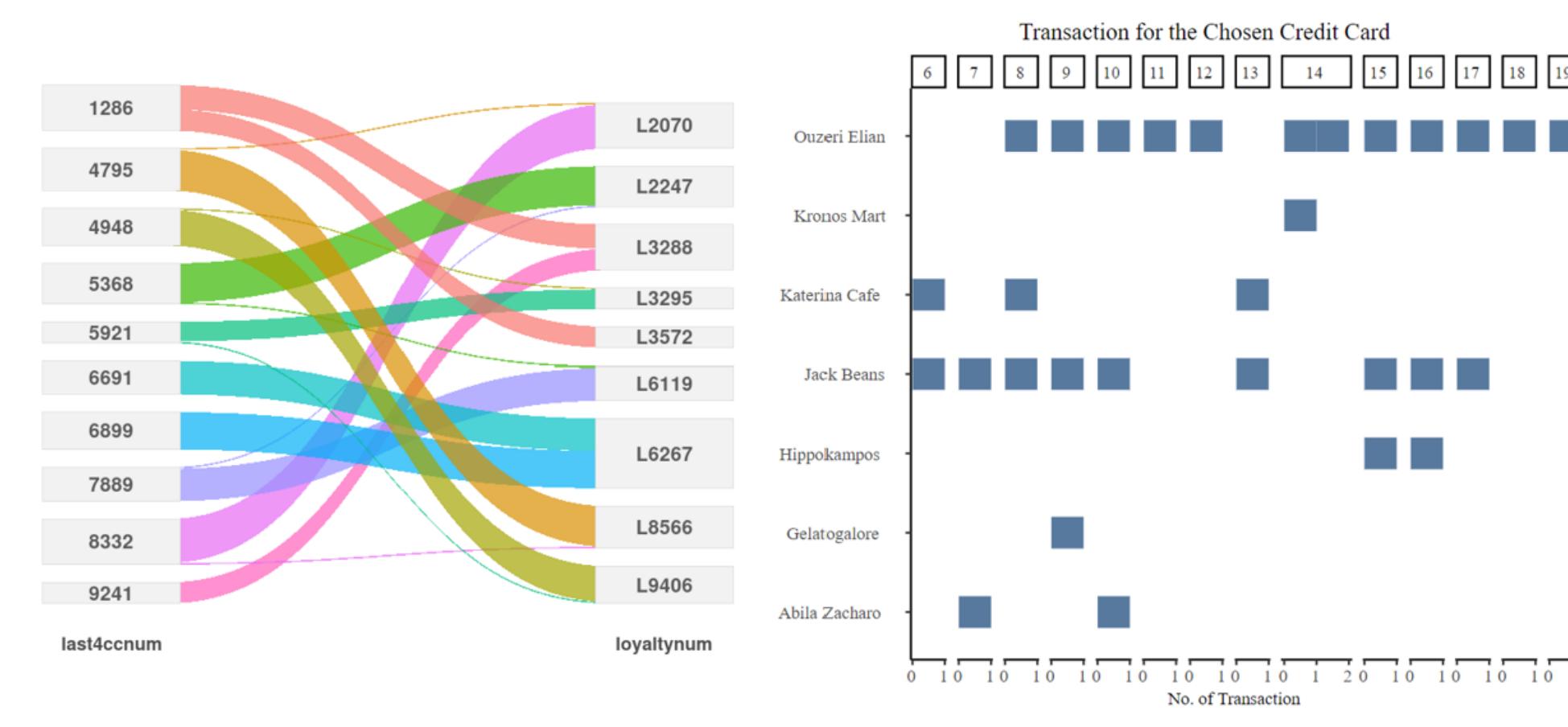


Figure 6: Parallel & Facet plot

The parallel sets plot on the right show connections between cards. The width of lines represents the number of matched consumption records between this credit card and this loyalty card. It can be regarded as the confidence level of this mapping pair. Users can identify the most possible card pairs as well as anomalies behind.

Geotemporal Analysis

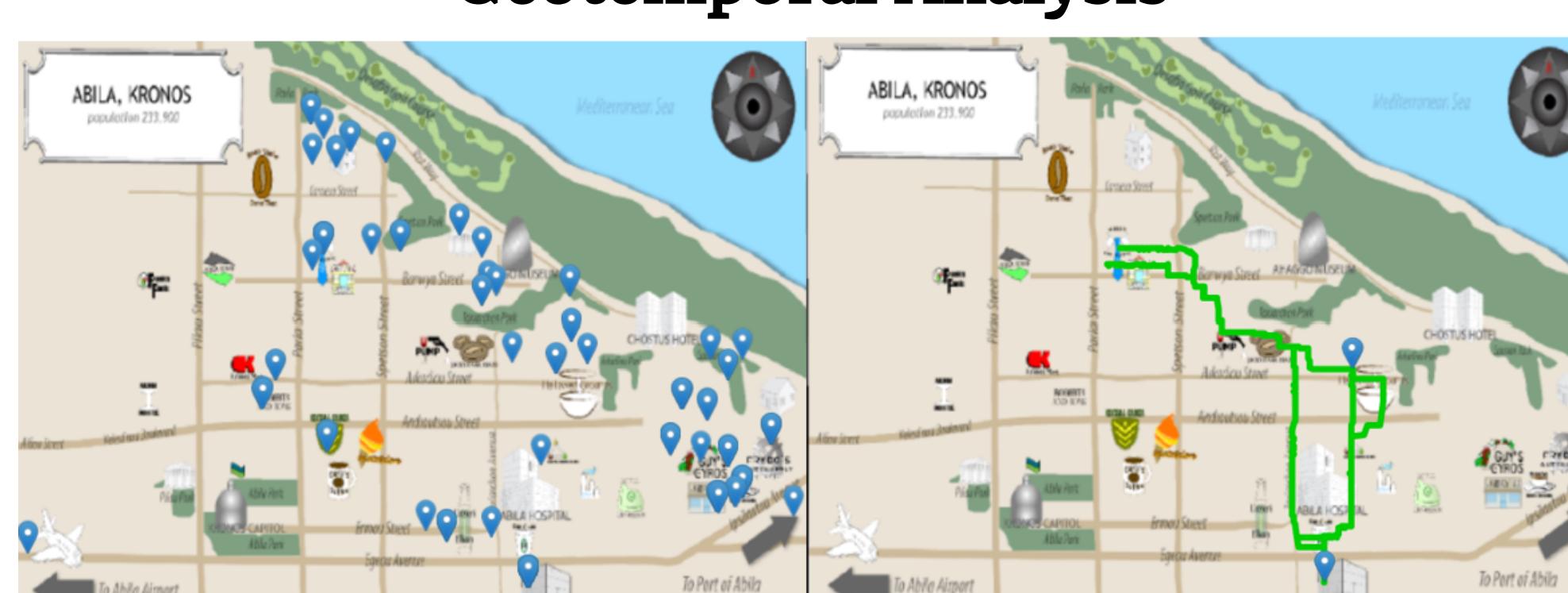


Figure 7: Parking Spots & Route Tracking Map

Maps provide two ways to visual suspicious activities. Parking spots are to show the staytime in one position compared with other cars' spots. Route tracking can track the travel route of specific cars by date to find out the discrepancies from daily routes.

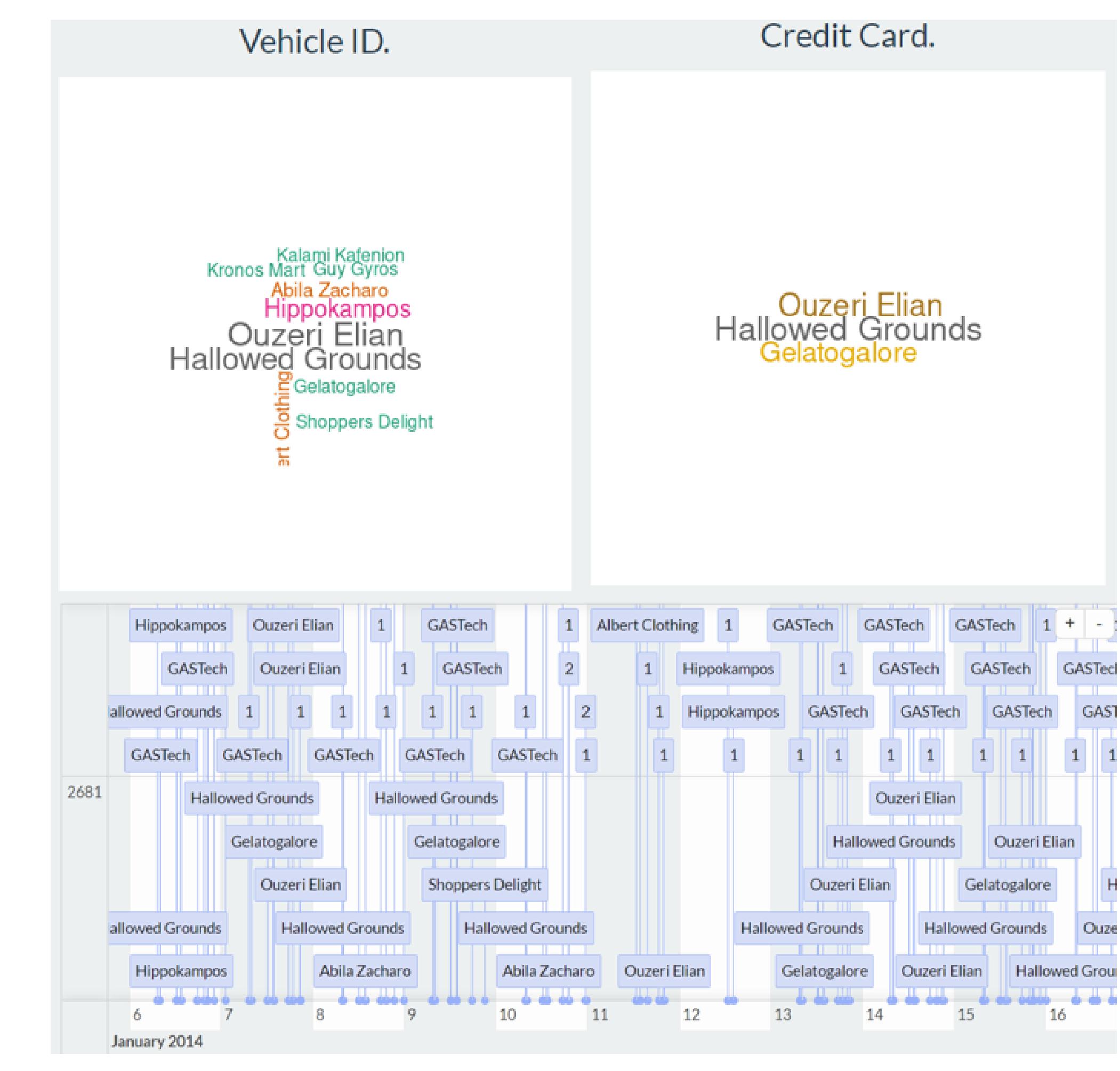


Figure 8: Wordcloud & Timeviz

Wordcloud could effectively act as a first layer filtering to expedite the search for match prior timevis validation. Timevis interaction was smooth and dynamic where one could zoom in and out at ease. Dynamic UI rendering allowed one to disable the automated filter to handle scenario where id and credit card do not have good match at top visited location such as truck vehicle where it was company vehicle used by few truck drivers or credit card owners.

Networking Analysis

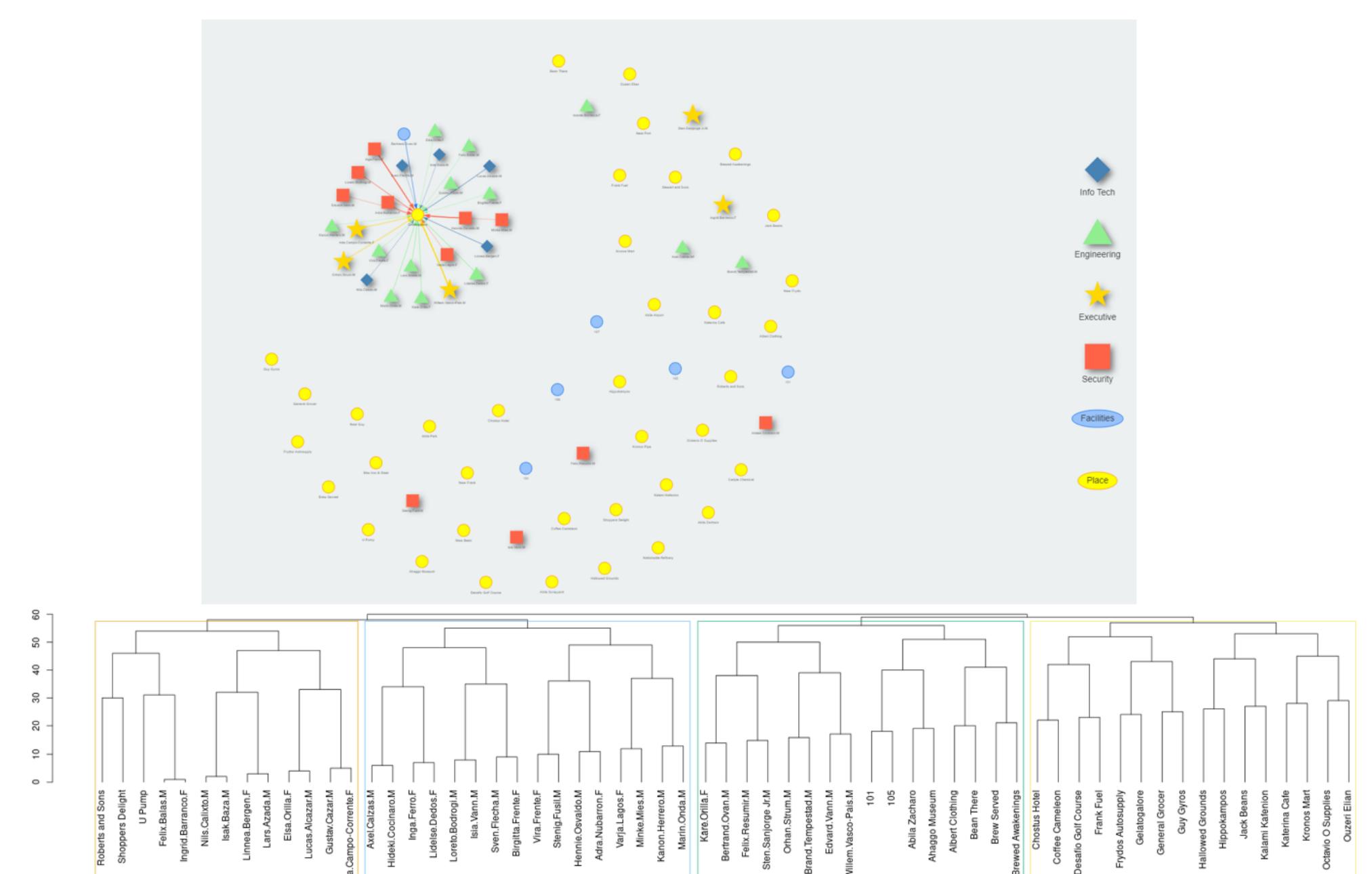


Figure 9: Community Detection

Users could determine the common visited locations by individual and departments, and the department outliers who do not visit those locations. Users could also observed that underlying communities formed for different time of visitation (i.e. morning, afternoon and night) to amenities verse a general community detection for visitation to all amenities were slightly different.

Future Work

- Enhance interactive and connectivity:* heatmap interactive selecting, multiple filtering between deferent graphs
- Build Transaction:* identify similarity and association from transaction and geographical tracking data
- Potential information gaps:* detect anomaly base on duration that an individual stayed in a specific location

