

# RAJ Group Presentation

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TNM098 ADVANCE VISUAL DATA ANALYTICS



# VAST Challenge 2021 - Mini Challenge 2

**A company, GASTech International wants to investigate their employees in case of suspicious behaviour.**

**The employees have access to company cars fitted with gps tracking.**

**The employees can get discounts when registering a purchase with loyalty cards.**



**GASTech**  
INTERNATIONAL

# Available Data

- Periodic GPS tracking data of company cars as they move around.
  - **Timestamp**, latitude, longitude, **ID**
- Assignment records, to whom each car has been assigned.
  - Employee Name, title, department and **CarID**.
- Credit card purchase history.
  - C-Card number, **location**, **Timestamp**, **price**.
- Loyalty card purchase history
  - L-Card number, **location**, **Date**, **price**.

# Available Data



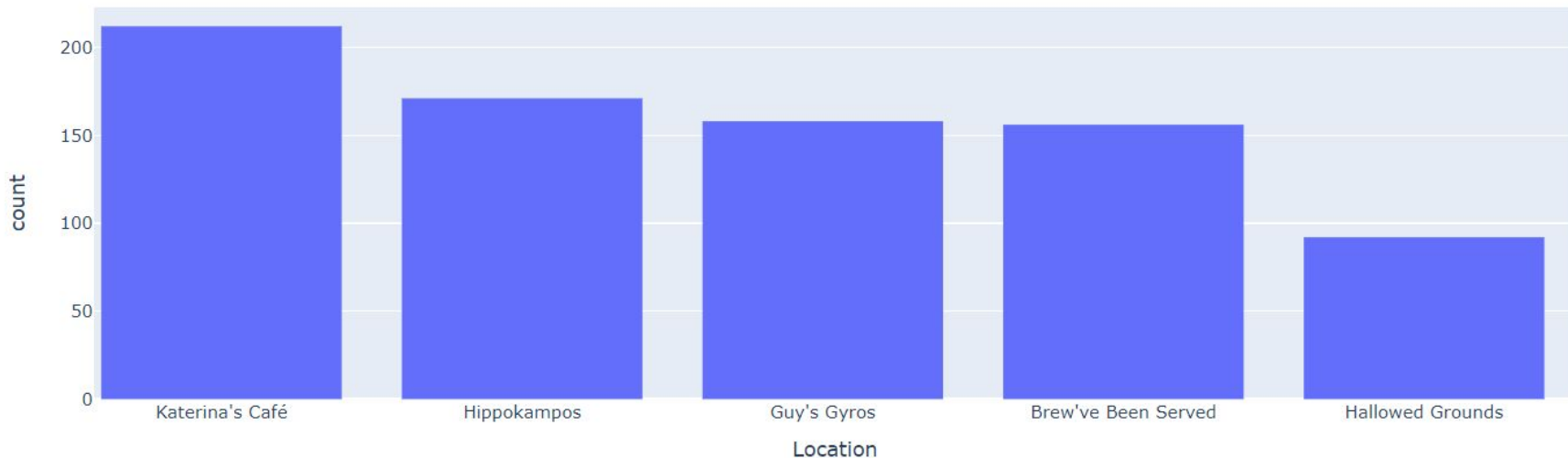
# Task 1

- Most Popular Places
- When they are popular
- Anomalies
- Recommended corrections

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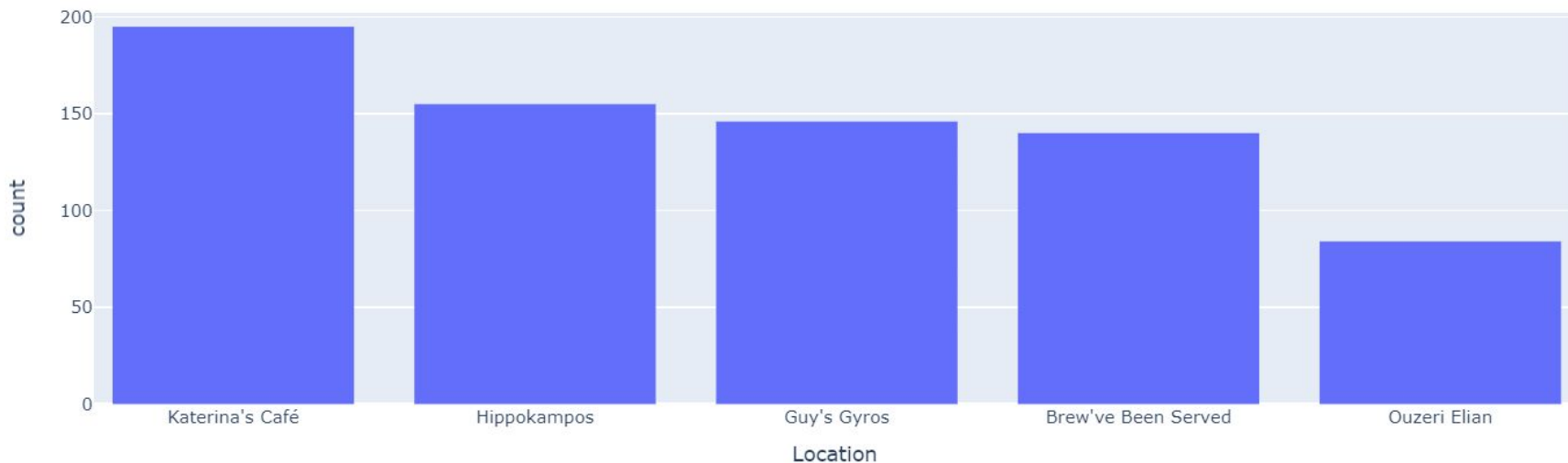
# Most Popular locations by Credit Card

Credit Card: Number of Transactions by Location



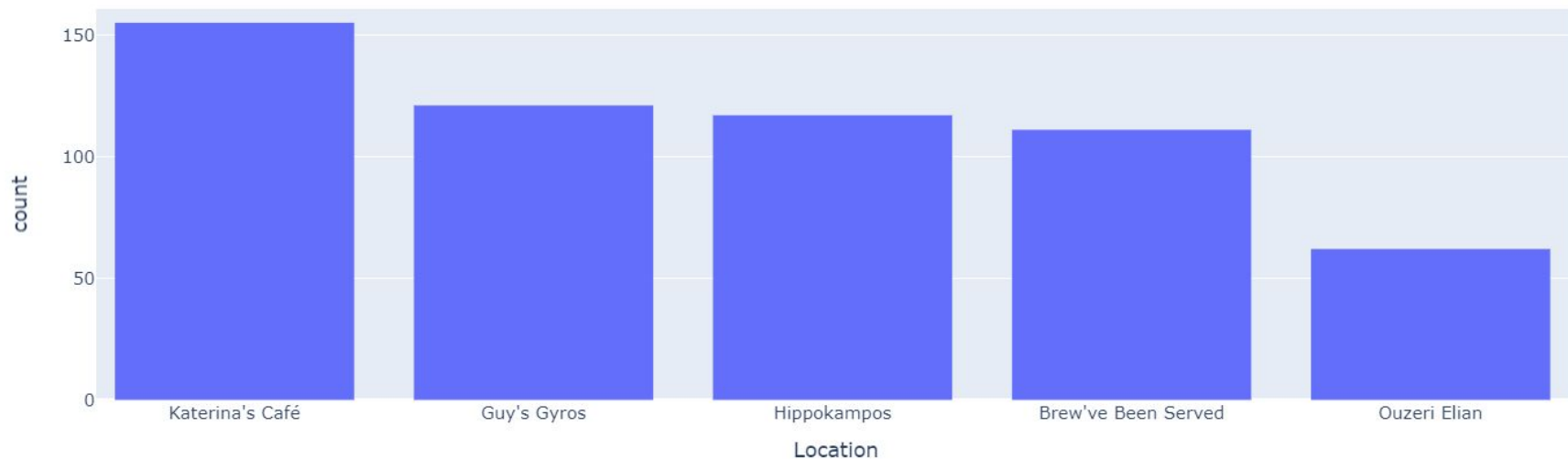
# Most Popular locations by Loyalty Card

Loyalty Card: Number of Transactions by Location



# Most Popular locations by Loyalty & Credit Card

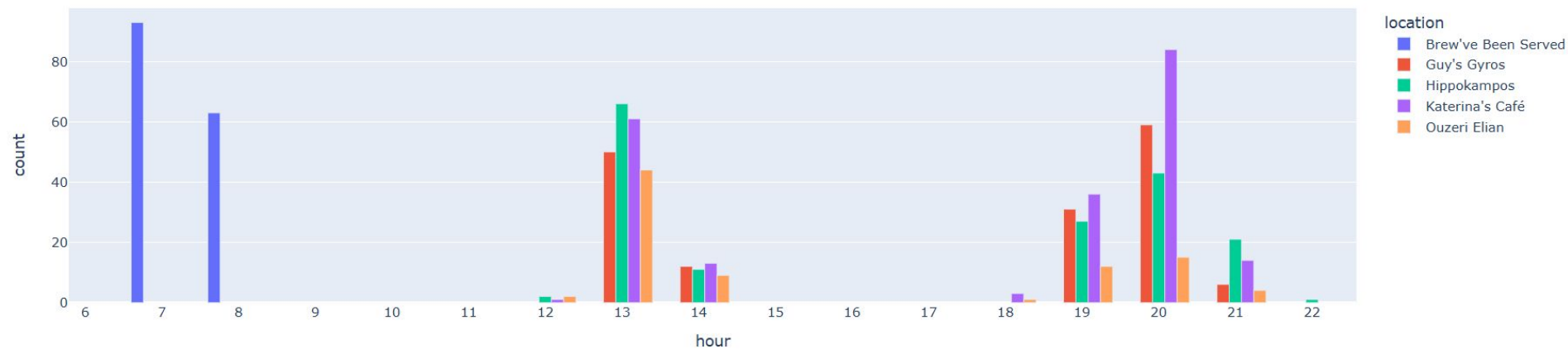
Loyalty Card and Credit Card: Number of Transactions by Location





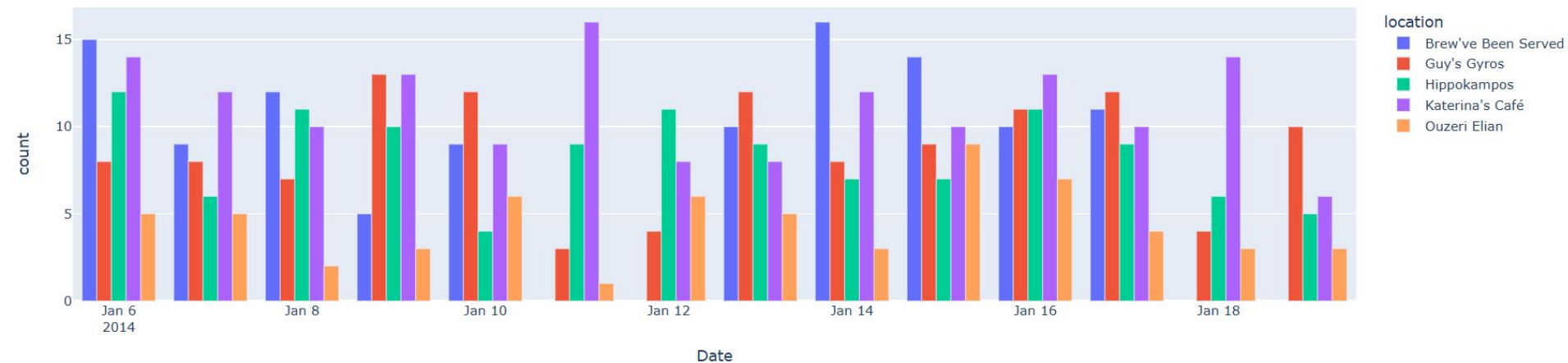
# Popularity Hours

Number of Transactions per Hour (Credit Card)



# Popularity Dates

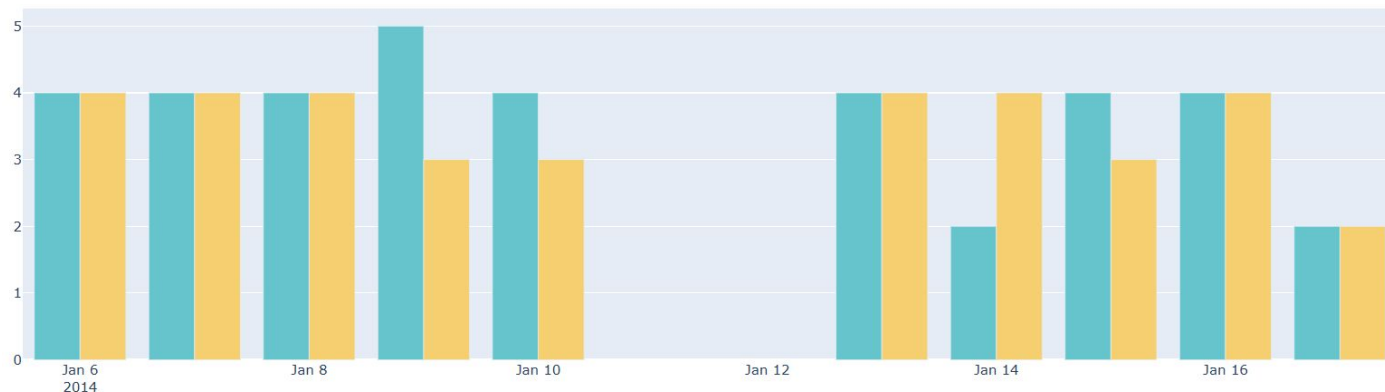
Number of Transactions per Date (Loyalty Card)



# Anomalies

*Sus or not sus*

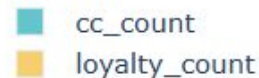
# Jack's Magical Beans



## Jack's Magical Beans - 2014-01-07 Credit Card Transactions

timestamp	location	price	last4ccnum	date
2014-01-07T12:00:00	Jack's Magical Beans	23.68	6899	2014-01-07
2014-01-07T12:00:00	Jack's Magical Beans	18.77	9241	2014-01-07
2014-01-07T12:00:00	Jack's Magical Beans	19.61	8156	2014-01-07
2014-01-07T12:00:00	Jack's Magical Beans	69.84	2463	2014-01-07

### variable



- All the purchases are made by one person

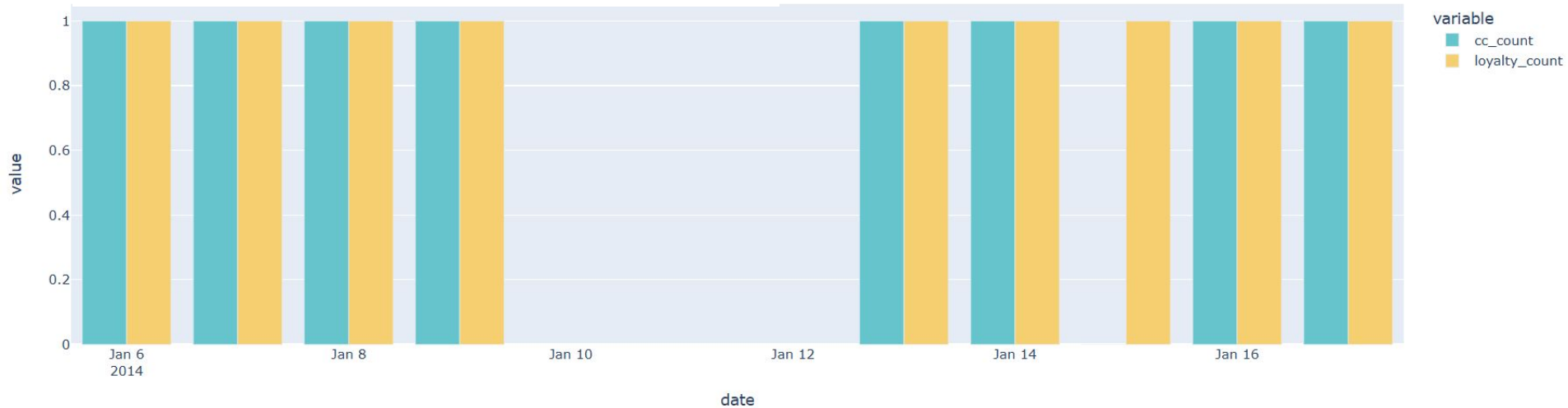
# Coffee Shack

Coffee Shack - 2014-01-08 Credit Card Transactions

timestamp	location	price	last4ccnum	date
2014-01-08T12:00:00	Coffee Shack	13.13	7117	2014-01-08

Coffee Shack - 2014-01-08 Loyalty Card Transactions

timestamp	location	price	loyaltynum	date
2014-01-08T00:00:00	Coffee Shack	13.13	L6417	2014-01-08



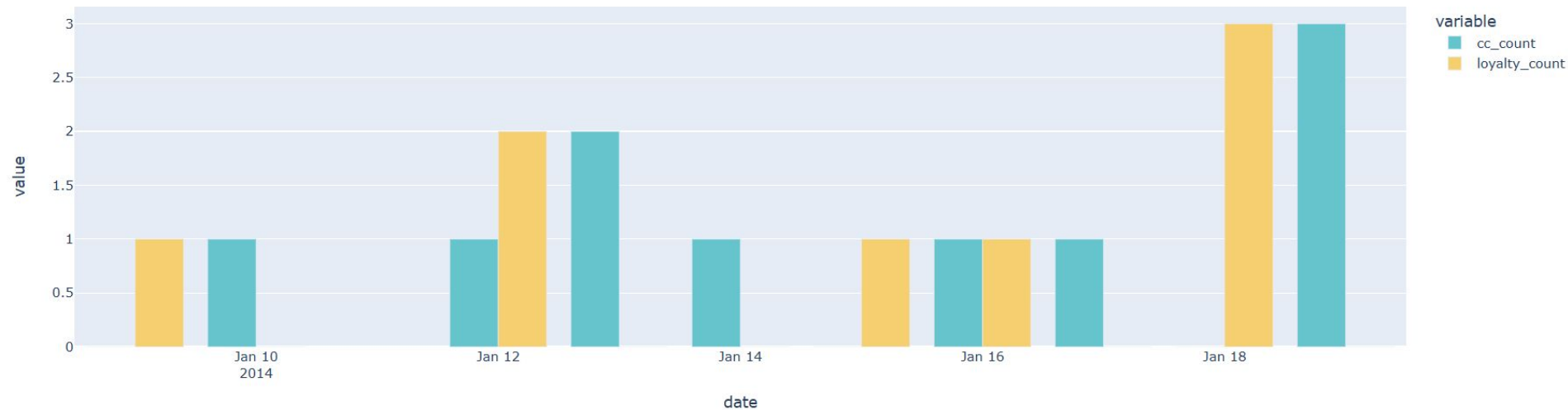
# Kronos Mart

Kronos Mart - 2014-01-12 Loyalty Card Transactions

timestamp	location	price	loyaltynum	date
2014-01-12T00:00:00	Kronos Mart	147.3	L4034	2014-01-12
2014-01-12T00:00:00	Kronos Mart	159.06	L8148	2014-01-12

Kronos Mart - 2014-01-13 Credit Card Transactions

timestamp	location	price	last4ccnum	date
2014-01-13T03:00:00	Kronos Mart	147.3	5407	2014-01-13
2014-01-13T08:01:00	Kronos Mart	159.06	6816	2014-01-13



# Task 2

- Adding the vehicle data to our analysis
- How assessment of the anomalies change?
- Discrepancies between vehicle, credit, and loyalty card data

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# Using GPS data

- Used QGIS to get coordinates of locations
- When GPS data stops for more than 5 min = stop
- Find closest location
- Use the file with car ID and name to find owner of each car
- Find stops and routes for each person
- Merge into stops.csv

We have the data that when and where each person did go to and how much time they spend there.



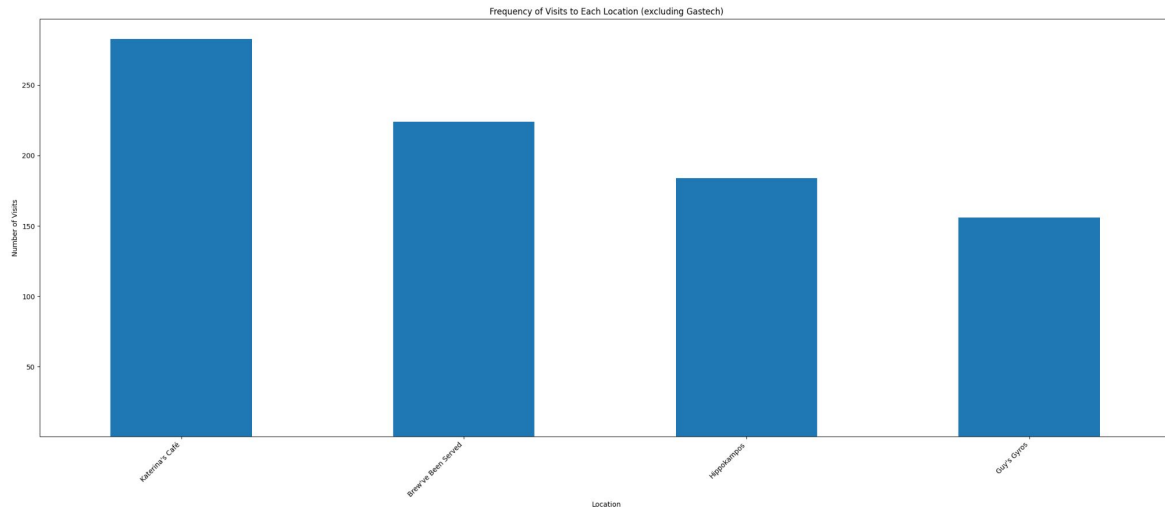
## Stops.csv

```
CarID,Name,arrival,departure,location,TimeSpent
1,Nils Calixto,2014-01-06 07:22:04,2014-01-06 07:57:01,Hallowed Grounds,00:34:57
1,Nils Calixto,2014-01-06 08:04:09,2014-01-06 12:17:01,Gastech,04:12:52
1,Nils Calixto,2014-01-06 12:26:27,2014-01-06 13:25:01,Hippokampos,00:58:34
1,Nils Calixto,2014-01-06 13:34:27,2014-01-06 17:44:01,Gastech,04:09:34
1,Nils Calixto,2014-01-06 17:48:03,2014-01-06 19:36:01,Hallowed Grounds,01:47:58
1,Nils Calixto,2014-01-06 19:42:27,2014-01-06 19:49:01,Hippokampos,00:06:34
1,Nils Calixto,2014-01-06 19:49:01,2014-01-06 20:27:01,Hippokampos,00:38:00
1,Nils Calixto,2014-01-06 20:33:30,2014-01-06 22:11:01,Hallowed Grounds,01:37:31
```

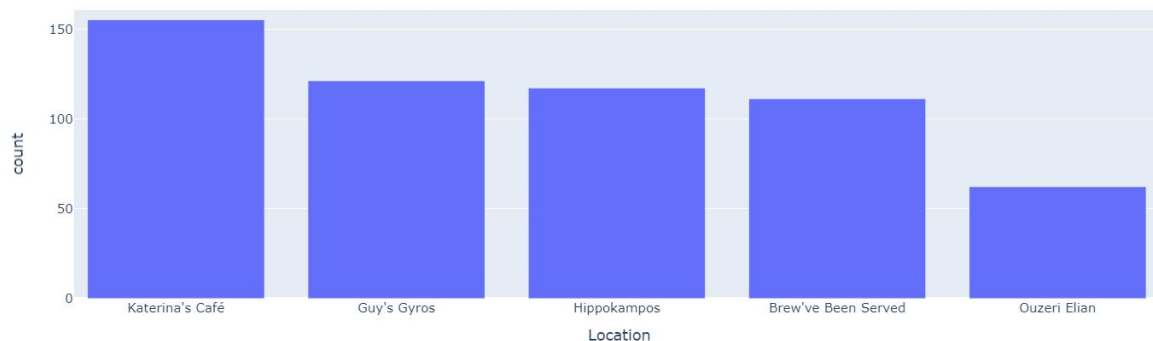


# Popular locations according to GPS data

- Number of visits is really different from count
- People go to these places but not always make purchases
- Order of locations is different so people make several purchases at the same visit



Loyalty Card and Credit Card: Number of Transactions by Location



# Jack's Magical Beans



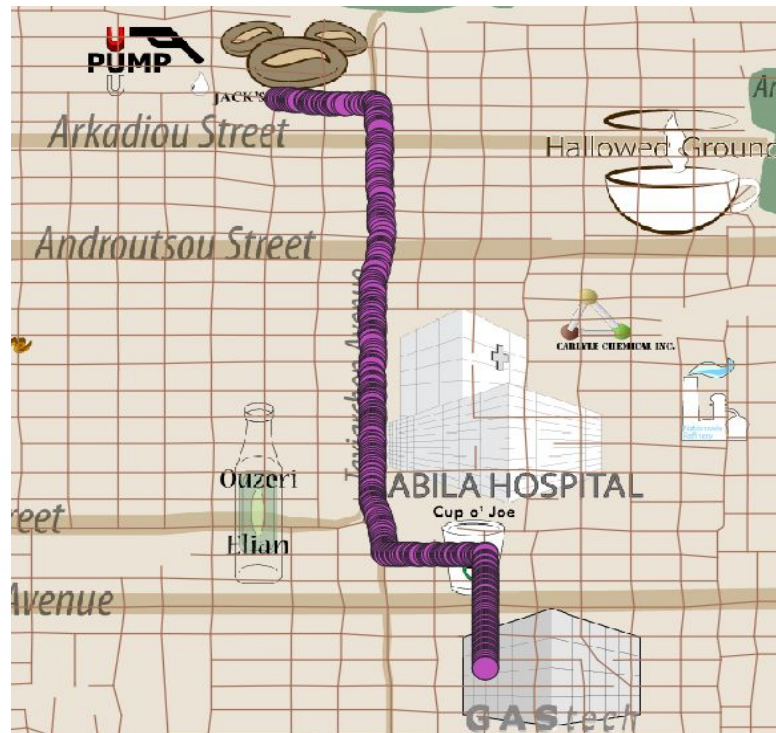
- **Isak Baza:** Lives near the place usually visits in the morning before going to work.
- **Orhan Strum:** same as Isak.
- **Nils Calixto:** Doesn't live nearby and never goes to this cafe.

None of them are actually there at 12:00!

## Jack's Magical Beans - 2014-01-07 Credit Card Transactions

timestamp	location	price	last4ccnum	date
2014-01-07T12:00:00	Jack's Magical Beans	23.68	6899	2014-01-07
2014-01-07T12:00:00	Jack's Magical Beans	18.77	9241	2014-01-07
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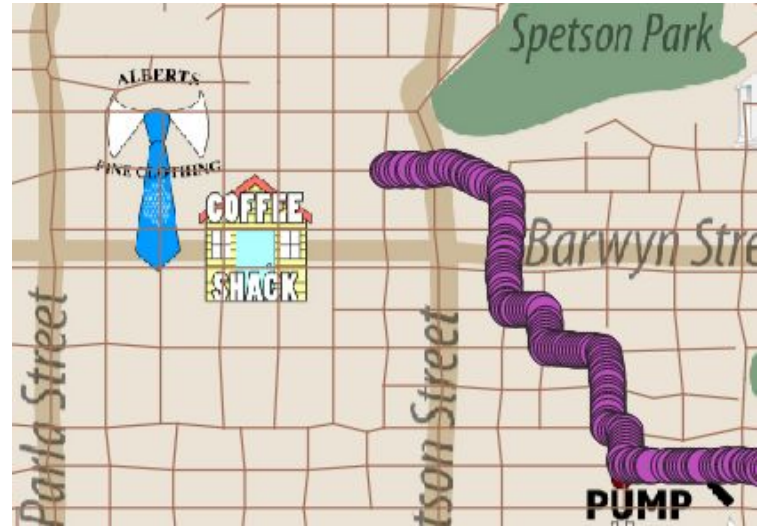
[back](#)



# Discrepancies

GPS data has a specific time, but no specific location information. We can only infer from what locations are near the end of each track.

Credit card data has specific times and specific locations, while loyalty cards only have dates and locations, not specific times.



timestamp	location	price	loyaltynum	date
2014-01-10T00:00:00	Bean There Done That	15.39	L7783	2014-01-10
2014-01-10T00:00:00	Bean There Done That	3.92	L3191	2014-01-10
2014-01-10T00:00:00	Bean There Done That	13.41	L3014	2014-01-10
2014-01-10T00:00:00	Bean There Done That	18.67	L4149	2014-01-10

# Task 3

- Can you infer the owners of each credit card and loyalty card?
- What is the evidence?
- Uncertainties?

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# Credit Card and Loyalty Card

The data for purchasing history of both cards contain

- Date
- Price
- Location

Merging the card data based on the three criteria

```
timestamp,location,price,loyaltynum
01/06/2014,Ouzeri Elian,34.71,L7291
01/06/2014,Brew've Been Served,11.34,L8566
01/06/2014,Hippokamos,13.26,L8566
01/06/2014,Abila Zacharo,12.05,L9254
```

Loyalty card data

```
timestamp,location,price,last4ccnum
01/06/2014 07:28,Brew've Been Served,11.34,4795
01/06/2014 07:34,Hallowed Grounds,52.22,7108
01/06/2014 13:22,Ouzeri Elian,38.9,2540
01/06/2014 13:23,Hippokamos,13.26,4795
01/06/2014 13:24,Guy's Gyros,15.44,1415
```

Credit card data

# Credit Card to Employee

Look for matches between stops data and transaction history of credit cards.

For every stop record count the matching transactions at that location for the duration of stay.

Match each credit card to the person with highest occurrences.

The owner of Loyalty Card is then implicitly inferred.

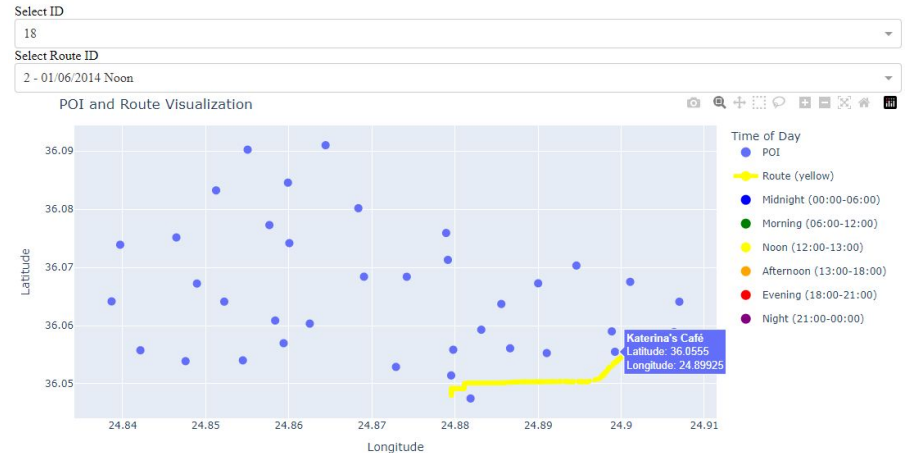
...

```
Card 7108 belongs to Hideki Cocinaro
Card 9617 belongs to Birgitta Frente
Card 8129 belongs to Lidelse Dedos
Card 3492 belongs to Kare Orilla
Card 7889 belongs to Lucas Alcazar
```

```
01/06/2014,Katerina's Café,32.64,L5553
```

```
01/06/2014 13:50,Katerina's Café,32.64,9617
```

## POI and Route Visualization



# Uncertainty in The Method

Does not compare the loyalty card against the gps data.

Difficult to differentiate between multiple users of the same card or vice versa.

# Uncertainty in The Data

The points of interest that are used to create the stops data are chosen from the map of town.

These points of reference are used to measure the distance between stopping points to localize where each car has stopped.

Uncertainties from this data will propagate.



# Task 4

Given the data sources provided, identify potential informal or unofficial relationships among GASTech personnel. Provide evidence for these relationships.

- Find unofficial relationships

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# Network Visualization

Based on the data obtained from the previous task, by looking for **overlapping time** periods when two people were at the same location, and by adding a specific threshold to filter it, we can infer whether they know each other or not

Key Features:

**Interactive Graph:** Visualize relationships based on meeting data.

**Filters:** Adjust meeting times and duration with sliders.

**Color-Coded Edges:** Edges indicate the number of meeting locations.

**Edge Selection:** Click on an edge to highlight it in blue and view meeting details.

**Detailed Info:** See detailed meeting information in the info panel when an edge is selected.

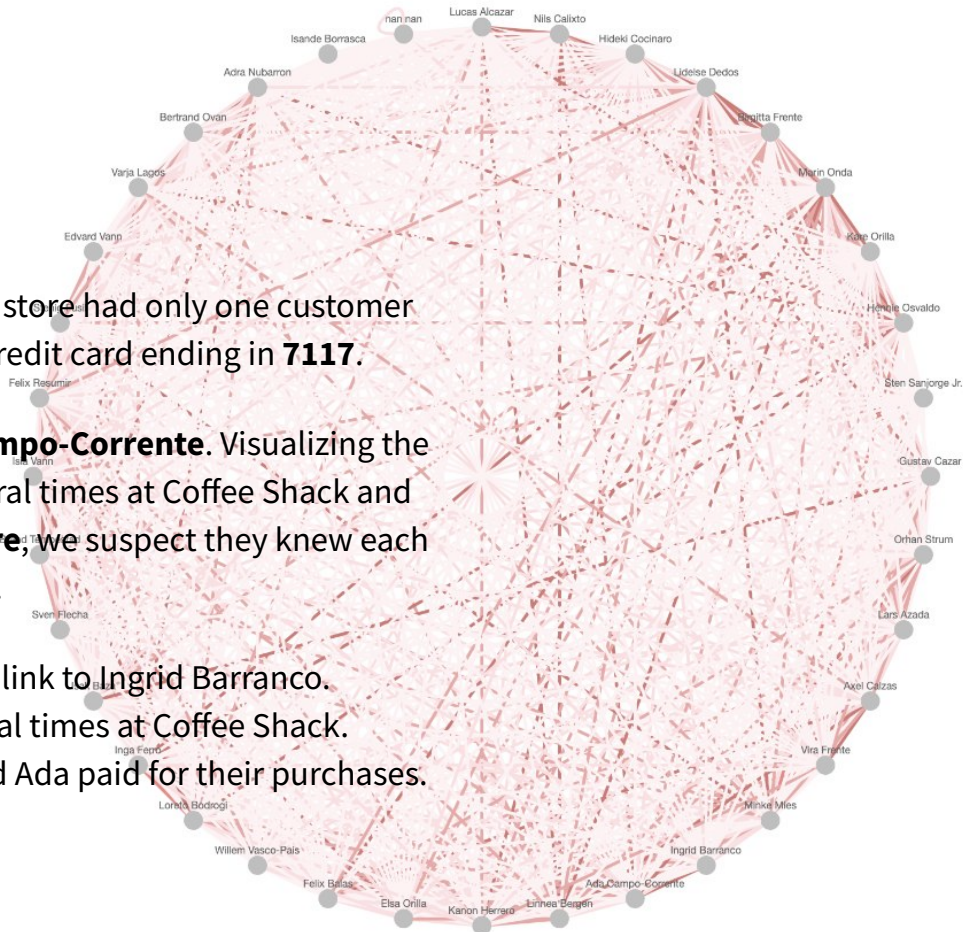
# Relationship

Due to an anomaly at **Coffee Shack**, we found the store had only one customer daily, with all transactions made using the same credit card ending in **7117**.

Task 3 results identified the cardholder as **Ada Campo-Corrente**. Visualizing the relationship network, we saw Ada met Ingrid several times at Coffee Shack and other stores. Since **only Ada's card was used there**, we suspect they knew each other and Ada paid for their meetings at this store.

By examining Ada's network, we found a deep red link to Ingrid Barranco. Detailed information revealed that they met several times at Coffee Shack. Therefore, we can deduce that they met there, and Ada paid for their purchases.

[back](#)



# Task 5

Do you see evidence of suspicious activity? Identify 1- 10 locations where you believe the suspicious activity is occurring, and why

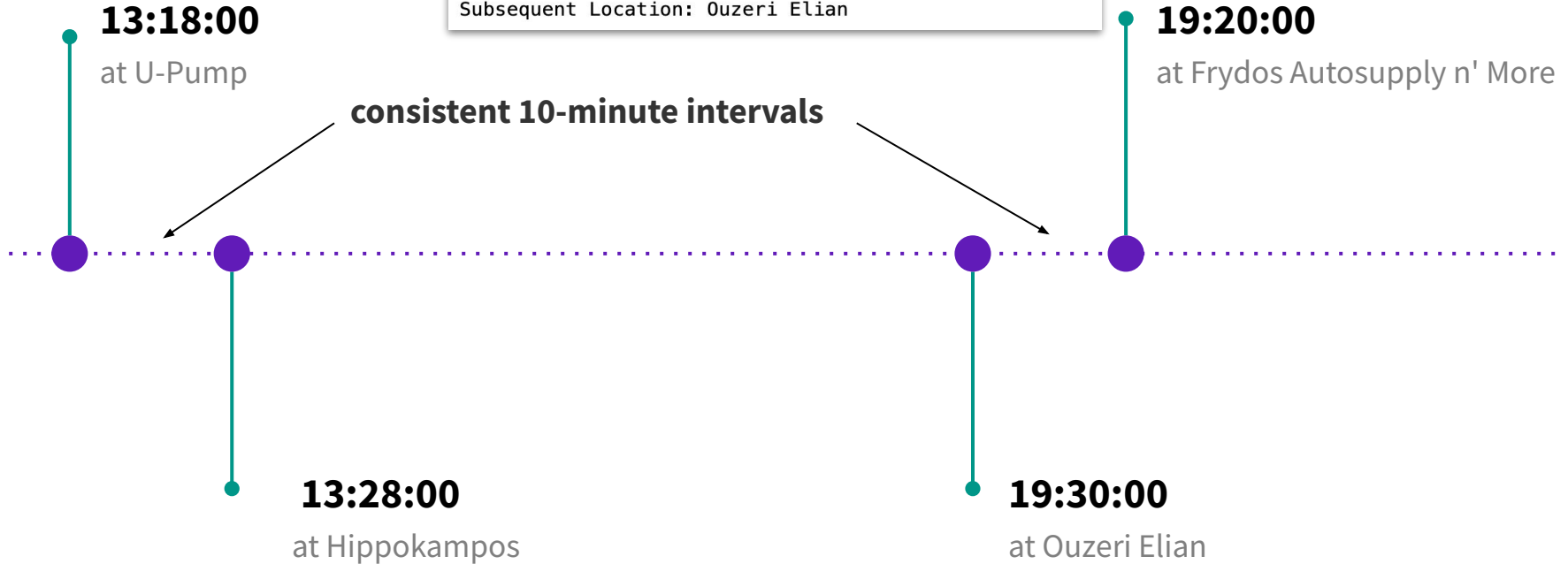
- Who's suspicious?
- Which location is suspicious?

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# Doppelgänger ?

Credit Card Ending: 9551  
Initial Transaction Time: 2014-01-13 13:18:00  
Subsequent Transaction Time: 2014-01-13 13:28:00  
Initial Location: U-Pump  
Subsequent Location: Hippokampos

Credit Card Ending: 9551  
Initial Transaction Time: 2014-01-13 19:20:00  
Subsequent Transaction Time: 2014-01-13 19:30:00  
Initial Location: Frydos Autosupply n' More  
Subsequent Location: Ouzeri Elian



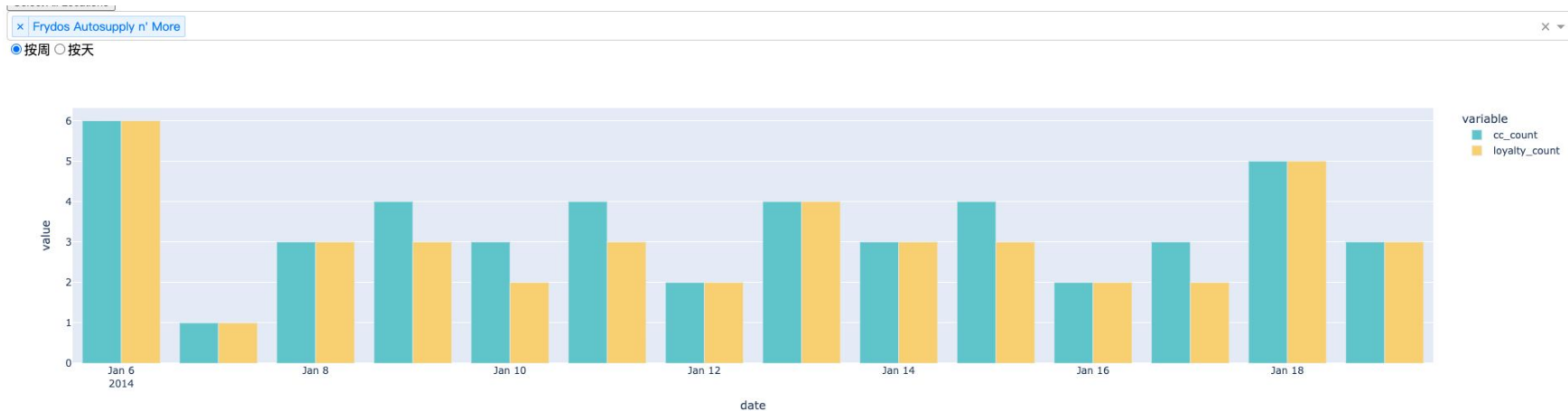
# Large transactions

Nil again...

Top 10 High Value Transactions



# Route Visualization



## Frydos Autosupply n' More – 2014-01-13 Credit Card Transactions

timestamp	location	price	last4ccnum	date
2014-01-13T19:20:00	Frydos Autosupply n' More	10000	9551	2014-01-13
2014-01-13T19:41:00	Frydos Autosupply n' More	188.57	8129	2014-01-13
2014-01-13T19:59:00	Frydos Autosupply n' More	64.6	8411	2014-01-13
2014-01-13T21:11:00	Frydos Autosupply n' More	202.05	2418	2014-01-13

## Frydos Autosupply n' More – 2014-01-13 Loyalty Card Transactions

timestamp	location	price	loyaltynum	date
2014-01-13T00:00:00	Frydos Autosupply n' More	188.57	L8328	2014-01-13
2014-01-13T00:00:00	Frydos Autosupply n' More	64.6	L6110	2014-01-13
2014-01-13T00:00:00	Frydos Autosupply n' More	202.05	L9018	2014-01-13
2014-01-13T00:00:00	Frydos Autosupply n' More	87.57	L2169	2014-01-13



# Nils is suspicious... and Frydos Auto Supply n' More.

During the first 2 simultaneous transactions, Nil leaves Gas Tech at 12:15 and arrives near **Hippokampos** at 12:24. He went past U-pump at around 12:20 but **didn't stop** there. So we deduced that this transaction was not made by Nil himself.

For the 2 simultaneous transactions in the evening, Nil stayed at **Ouzeri Elian from 18:49 to 19:56**, so he was able to use his card there. But **Frydo's Auto Supply n' More** is far away from Ouzeri Elian. And the the transaction amount is massive there.



# One more thing

Don't forget, [Coffee Shack is also suspicious...](#)

One consistent custom...

Potential Affair there...

Like we mentioned:

[Jack's Magical Beans](#)

# Tack!

*Thanks for listening, have a nice day!*