Food Delivery from Restaurants

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Table of Contents

1. Summary

In recent times the restaurant's food delivery model has changed drastically. The online ordering facility offered more options and convenience, so more and more consumers are opting for the online ordering. This has affected the operations of the restaurants and has given different new challenges to the restaurant owners. Now it is hardly possible for restaurant owner alone to handle the orders and also to provide the logistics, to deliver the consumers demand.so they are outsourcing the delivery activities to third party.

In traditional online delivery system, the online platform simply takes orders from consumers and route them to restaurants which handle the delivery themselves. In contrast, recently new-delivery players build their own logistics networks, providing delivery for restaurants that don't have their own drivers. In this new delivery supply chain there are many challenges we can think of, as broadly classified below. Solutions to the some of the challenges are addressed in this project.

1.1. Challenges faced by the Freight service providers to restaurant's food supply

1.1.1. Consumer's Orders delivery planning (Admin activity):

- **Orders consolidation:** First challenge is the order consolidation, wherein the consumer's orders are consolidated from the web portal or phone call or other means of communications, we may not think these order as a new orders altogether there may be orders for return of the bought goods, incomplete orders attending or order changes etc.
- **Orders clustering:** Order received in the first step need to be classified into different logical groups based on location of the restaurants, consumer location, priority of the order, food shelf life, quantity of the order, frequency of the order, available resources to supply (fleets/drivers) and even the behaviour type of the customer. This activity helps the freight provider to meet the customer demand more effectively and with reduced cost. We discuss more about this classification of the orders based on the

1.1.2. Transportation fleet management:

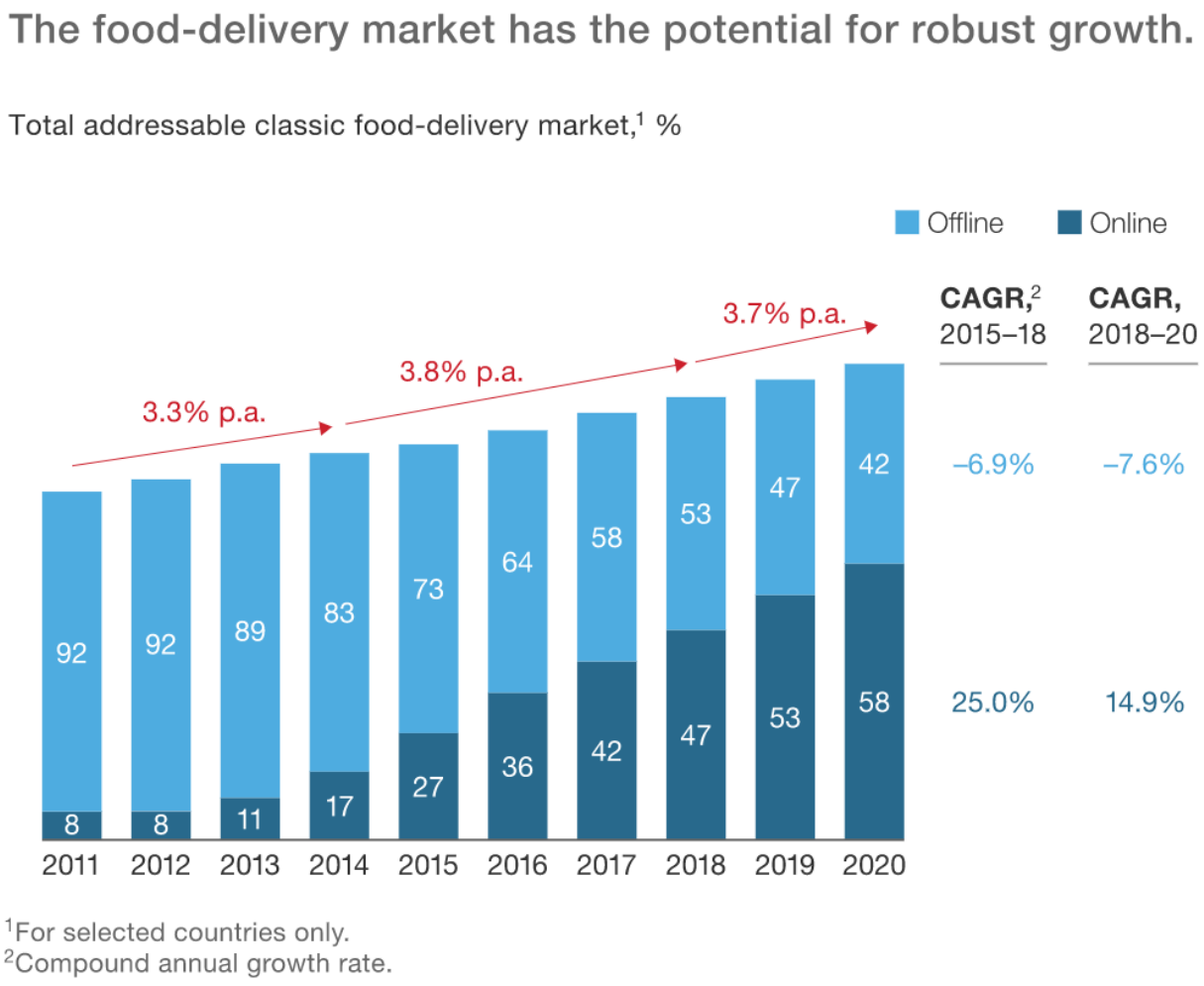
- **Fleet optimization:** One of the major challenges in the transportation of the food demand is arranging for the vehicle/fleet of transportation with required numbers of required capacity and on required time. We can think of many more complexities here that are, type of containers for different temperature zones of the food, compartmentalization of the food vehicle to carry different kind of food. Considering the type of business we also should take care of the rules of the government regulatory bodied. We should use these resources optimally to save the cost.
- **Route optimization:** after fleets are assigned to deliver the orders one needs to work on how to deliver the demand what path/road to take for optimal delivery on time with minimum cost. This can be solved with vehicle routing problem (VRP) algorithms such as Dijkstra's algorithm; simulated annealing for traveling salesman problem (TSP).The more details of the simulated annealing is discussed in this document.

1.1.3. What-if scenario running for business strategies and human resource management

- **Business scenario validations:** This activity involves the evaluations of the business process changes to search for the opportunity to reduce cost and extend the new business or enhance the existing business through business process re-engineering (BPR).
- **Human resource such as Driver's /Supervisors management etc.:** In this section as the restaurant business not only consigned to the food alone we will be needing additional head count to manage the activities

2. Introduction

The growing online food ordering business is in need of faster and accurate solutions, which can dynamically address the issues and challenges faced by the freight service providers in real time for the restaurant business. In one of the studied of McKinsey & Company the online food ordering will grow in coming years and will be in need of the business solutions (Reference: https://www.mckinsey.com/industries/technology-media-and-telecommunications/our-insights/the-changing-market-for-food-delivery) , here are the results of the studied we can very well see the online food ordering is grown from 8% of the business in 2011 to projected growth of 58% in 2020 and still has greater potential to grow, and more and more food delivery business are moving to new type of delivery business where entire food delivery is handled by the freight service provider.



This is the results of the market analysis made by the McKinsey Company showing the robust growth of the food delivery market in future in the first chart,

Valuations for new-delivery companies are rising rapidly.

Key players	Market valuation, Aug 2016, € million	Foundation	Life-cycle stage	Business model: Classic delivery	Business model: New delivery
Just Eat	4,620	2001	IPO (2014)	●	
GrubHub	2,950	2004	IPO (2014)	●	
Delivery Hero	2,740	2011	Series I (2015)	●	●
Deliveroo	1,000	2013	Series E (2016)		●
Takeaway.com	1,000	2000	Series B (2014)	●	●
Foodpanda	500	2012	Series E (2015)	●	●

McKinsey&Company

The second chart shows the migration to the new delivery business.

1.2. Business Problems

In this project we are going to address few of the approaches with which we can solve issues faced by the freight service provider and restaurant owners who handle their delivery service by themselves.

a) Consumer order delivery planning - order clustering: In this step we divide orders from the restaurant among drivers who deliver the order to the consumers from the restaurants.

b) Route optimization: come up with the delivery route plan for the drivers who will take the food from restaurants and supply them to consumer's locations.

1.3. Interest :

This will be of interest of the existing as well as the new comers in the freight service providers for the restaurants business in any locations, the route optimization and orders planning will be of use for even to the new small restaurant owners if they want to automate few of the logistics activities thus handling their logistics of their own. We can expect supply chain enthusiasts also to learn the new business idea in the area of restaurant supply chain.

1.4. Data Requirements

1.4.1. Consumer order delivery planning – Order clustering

We can fetch the orders details from the online portal of the individual restaurants, or from the portals of the restaurant aggregators like zomato, Just Eat, Food pandas etc. For order clustering we need to look for the quantity of order, temperature zone of the food, food delivery priority, food delivery window timing, source- restaurant location, destination -consumer location, and some information about the history of the consumers about their behavior, with these information we can cluster the orders to manage them better.

Here in this example solution a dummy orders list prepared with one order of quantity one from each consumer which is assigned to a single restaurant for supply, but the solution has all capability to enhance any combinations restaurant and consumers with any order quantity.

The source –restaurant location is identified from the Foursquare API with their latitude and longitude information, as we are not using any particular online restaurant aggregator or portal for our study the dummy consumer location in the vicinity of the restaurant is assumed.

1.4.2. Route Optimization :

The restaurant locations are taken from the Foursquare API for route optimizations. In all optimization calculation the Euclidian distance is used, so the on road rules restrictions, barriers , toll roads are ignored in this project, but the optimization solution has all the capability to handle the by road distances as well.

For the route optimization, large/infinite capacity is assumed for the order carrying vehicle, that is the vehicle can carry any amount of orders and assumed drivers are available readily to attend the order.

The delivery window to meet the consumer demand is assumed to be 24/7 with no restriction on the time of delivery; the solution can be enhanced to handle these restrictions also.

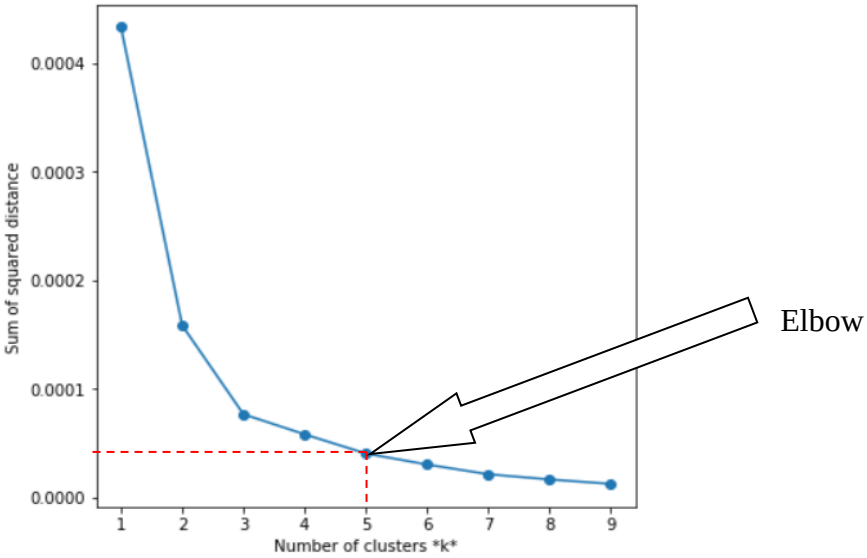
1.5. Data Cleaning

The data received from the Foursquare API will be in the JSON format with all the venue information for the given radius and center location, We need to consider only restaurants information for our studied, so all the venues with category name ending with ‘Restaurants’ are used for the example study. We are considering the latitude and longitude information only for our analysis here.so all the information other than the latitude and longitude are ignored from the data fetched from the Foursquare API.

3. Methodology

1.6. Consumer order delivery planning – Order clustering

The unsupervised K-Mean clustering is used to cluster the orders from the restaurants and assigned to the each driver for delivery. The number of clusters to be made is decided with the k-mean clusters elbow approach wherein the number of clusters to be created are evaluated based on the plot of sum of squared distance for different value cluster number. The numbers of cluster is chosen such that the change in the sum squared distance id negligible for increase in the cluster size.



1.7. Route Optimization

The simulated annealing algorithm is used to optimize the traveling route for the drivers to supply for all the consumers from their restaurants for the details we can refer to the link (https://ericphanson.com/blog/2016/the-traveling-salesman-and-10-lines-of-python/) .The code from this is used for this project with certain constrains to solve the restaurants food delivery business.

In this problem note that the driver can only visit the consumer after he/she visiting the restaurant the consumer is order from.to take care of this following steps are done.

1. Use the simulated annealing (SA) algorithm is used to come up with the optimal route to travel the entire restaurant that has order to deliver.
2. The first visited restaurant is added to the final delivery sequence.
3. Once the restaurant is added in the final delivery sequence, now the driver has the option of visiting the restaurant's consumer location also in the second run of the SA algorithm.
4. The step 2 and 3 are repeated in loop to come up with the delivery plan for all he restaurant and consumer locations.

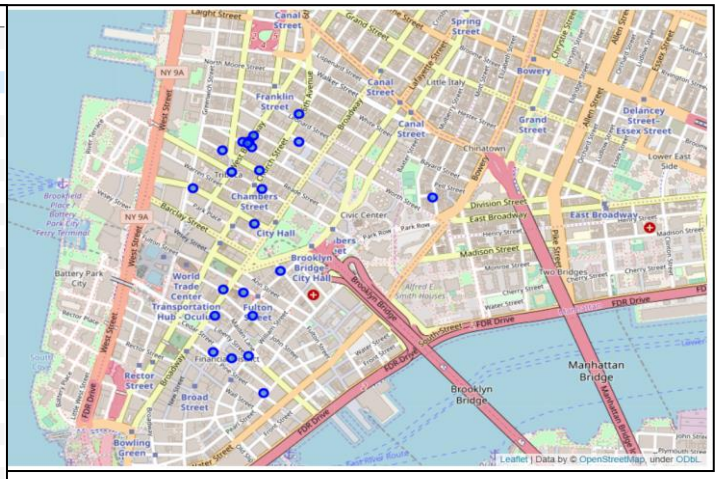
4. Results

For the result discussion we consider a use case where the fright provider location is at, “New York City, NY” (40.7127281, -74.0060152) and we assume the scope of the business is the entire restaurants within the 1000 m of the radius.
With the Foursquare API we identified 23 restaurants for which we can provide the freight service.

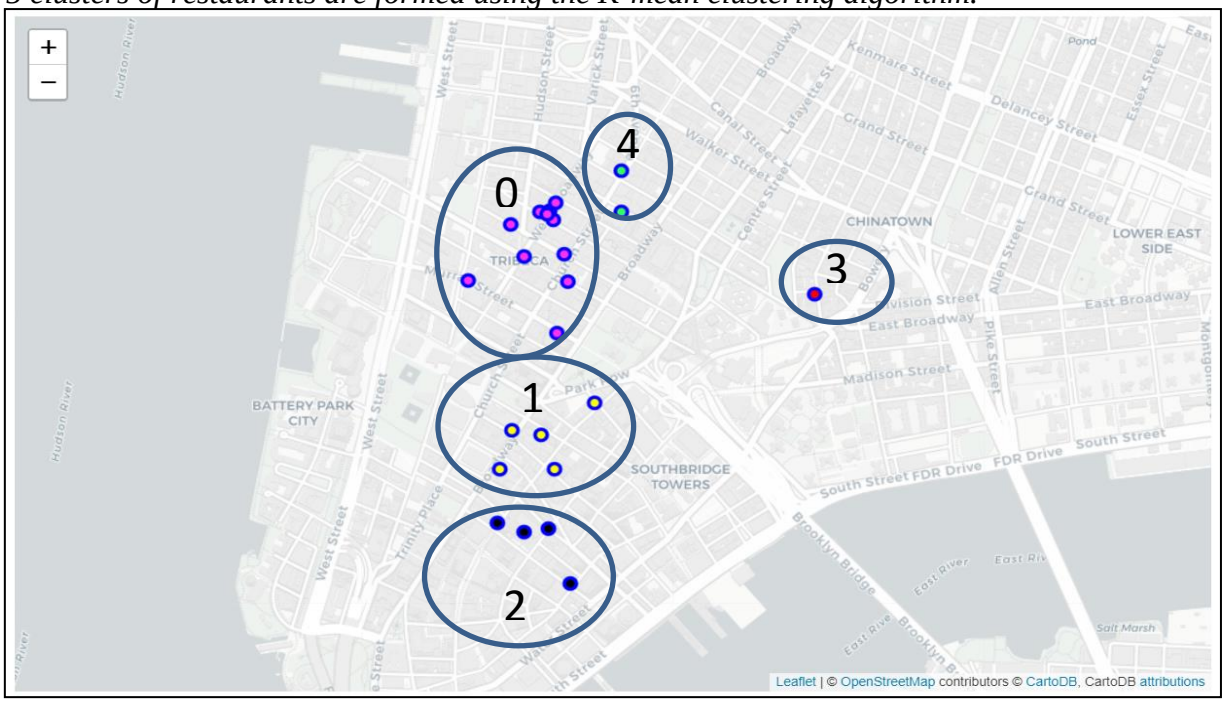
Note: the location of the freight provides also affect its business this scope of the location analysis is not discussed in this document.

The 23 restaurants considers for our study are as below.

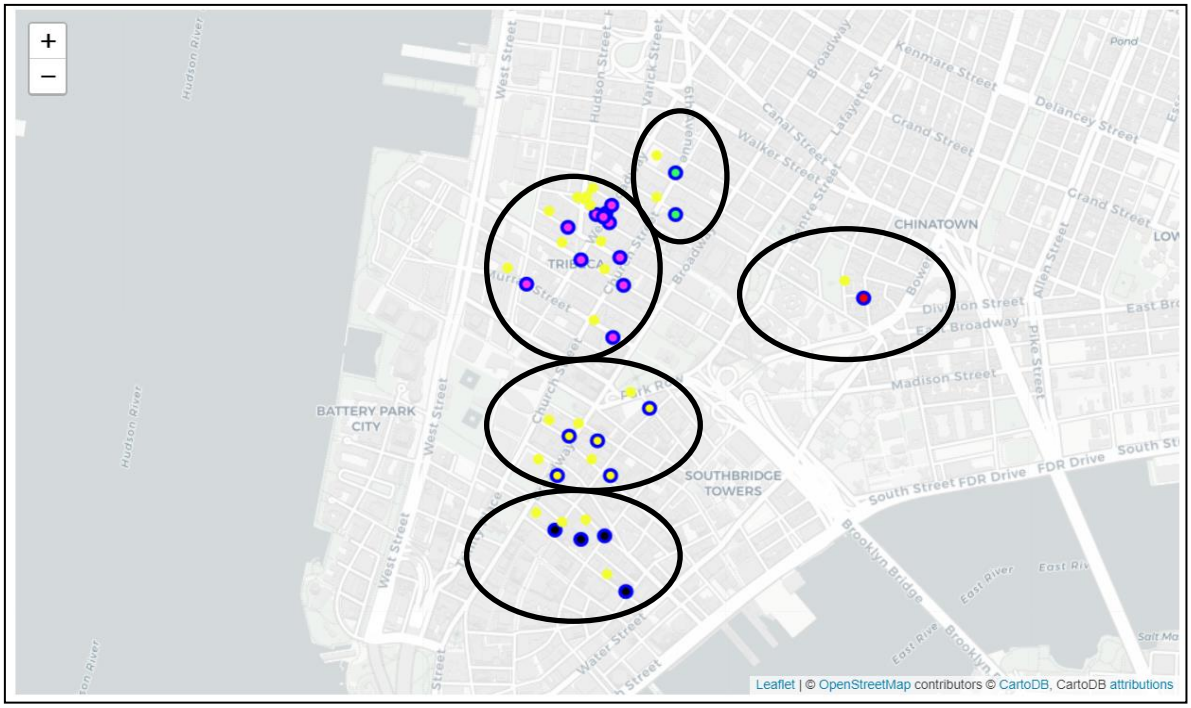
	name	categories	lat	lng
0	Augustine	French Restaurant	40.711310	-74.006660
1	Aahar Indian Cuisine	Indian Restaurant	40.713307	-74.007994
2	Racines	French Restaurant	40.714754	-74.007581
3	Nish Nūsh	Falafel Restaurant	40.715537	-74.007725
4	Nobu Downtown	Japanese Restaurant	40.710532	-74.009593
5	Chick-fil-A	Fast Food Restaurant	40.710419	-74.008550
6	Nish Nush	Falafel Restaurant	40.709418	-74.008056
7	Little Park	American Restaurant	40.715487	-74.009133
8	Atera	Molecular Gastronomy Restaurant	40.716752	-74.005712
9	Takahachi	Sushi Restaurant	40.716526	-74.008101
10	Juice Press	Vegetarian / Vegan Restaurant	40.714788	-74.011132
11	Tiny's and the Bar Upstairs	American Restaurant	40.716793	-74.008220
12	Khe-Yo	Asian Restaurant	40.716753	-74.008584
13	Restaurant Marc Forgione	New American Restaurant	40.716380	-74.009629
14	Sushi of Gari Tribeca	Sushi Restaurant	40.716684	-74.008343
15	The Odeon	French Restaurant	40.717010	-74.008042
16	La Parisienne	French Restaurant	40.709423	-74.009992
17	Manhatta	New American Restaurant	40.707654	-74.009138
18	Two Hands Restaurant & Bar	Australian Restaurant	40.717937	-74.005695
19	Taim	Falafel Restaurant	40.707727	-74.008265
20	Shanghai 21	Shanghai Restaurant	40.714423	-73.998904
21	The Capital Grille	American Restaurant	40.707903	-74.010086
22	Crown Shy	Restaurant	40.706187	-74.007490



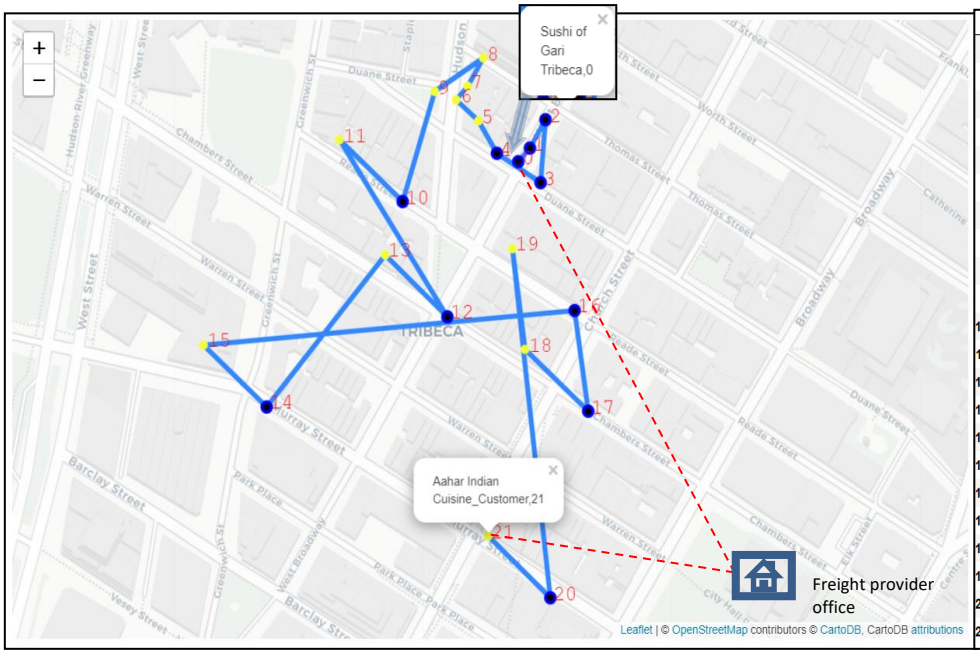
5 clusters of restaurants are formed using the K-mean clustering algorithm.



The yellow circles in the map below shows the consumer's locations along with the restaurants- for this use case we assumed the consumer locations are within the cluster limit.



After route optimization: here is the delivery plan for the cluster # 0



	Locname	Lat	Lang	Tour
0	Sushi of Gari Tribeca	40.7167	-74.0083	0
1	Tiny's and the Bar Upstairs	40.7168	-74.0082	1
2	The Odeon	40.717	-74.008	2
3	Takahachi	40.7165	-74.0081	3
4	Khe-Yo	40.7168	-74.0086	4
5	Takahachi_Customer	40.717	-74.0088	5
6	Sushi of Gari Tribeca_Customer	40.7172	-74.009	6
7	Tiny's and the Bar Upstairs_Customer	40.7173	-74.0089	7
8	The Odeon_Customer	40.7175	-74.0087	8
9	Khe-Yo_Customer	40.7172	-74.0093	9
10	Restaurant Marc Forgione	40.7164	-74.0096	10
11	Restaurant Marc Forgione_Customer	40.7169	-74.0103	11
12	Little Park	40.7155	-74.0091	12
13	Little Park_Customer	40.716	-74.0098	13
14	Juice Press	40.7148	-74.0111	14
15	Juice Press_Customer	40.7153	-74.0118	15
16	Nish Nūsh	40.7155	-74.0077	16
17	Racines	40.7148	-74.0076	17
18	Racines_Customer	40.7152	-74.0083	18
19	Nish Nūsh_Customer	40.716	-74.0084	19
20	Aahar Indian Cuisine	40.7133	-74.008	20
21	Aahar Indian Cuisine_Customer	40.7138	-74.0087	21

5. Conclusion

This project gives us the starting solution to solve challenges of the restaurants food delivery business, and introduce most of the aspects of this business; the simplified use case can be enhanced further to address all the plausible use cases of this business.

1.8. Future Directions

Here is the consolidated list of enhancement which can be made to this solution to be production ready.

Order clustering problem

- The solution has to be tested for the end point conditions of the optimization that is what if only one restaurant and consumer locations are present?
- Here we assumed one to one mapping on the restaurant and consumer but in reality one consumer can order by may order from more than one restaurant.
- The priority orders, food temperature zone, consumer behavior are to be considered for better evaluation of the solution discussed here.

Route Optimization

- The solution used here is very primitive and may not give the best solution if compared to the global optimal
- Further cleaning of the optimization model needs to be done for better implementation