BAY AREA DELIVERIES

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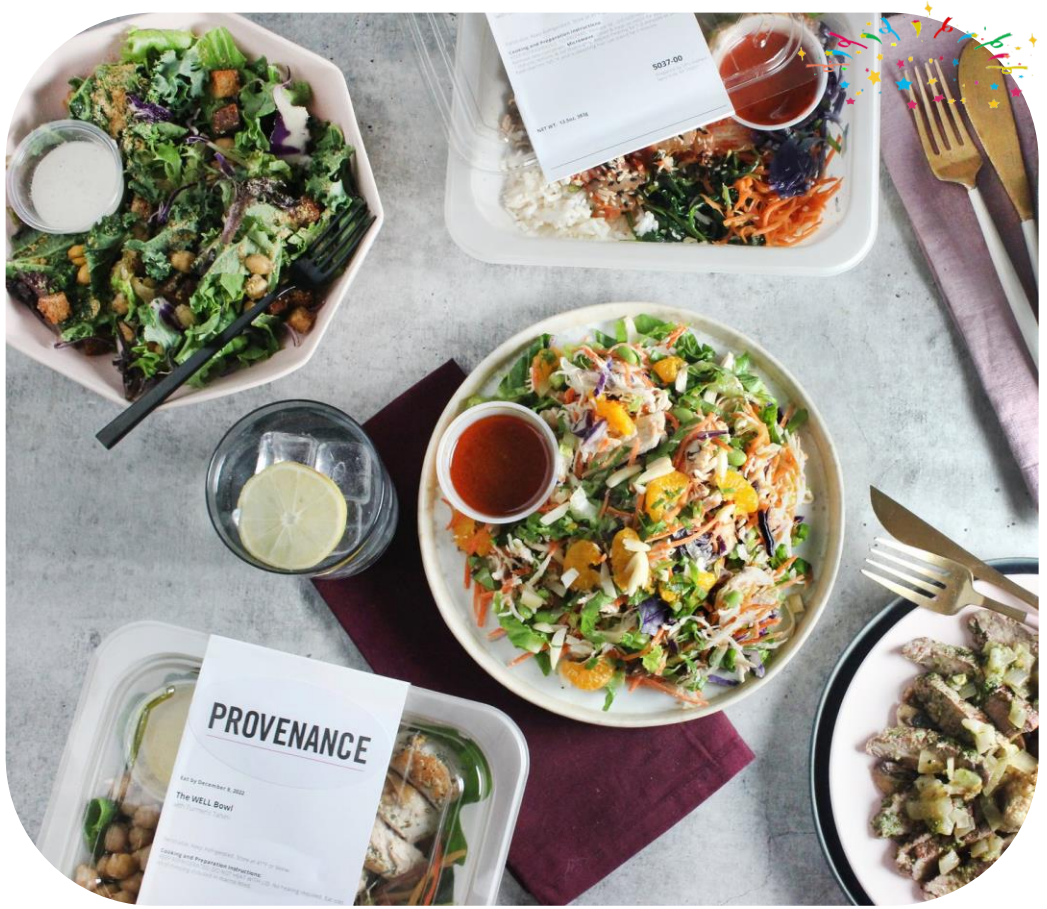
DATASCI 205 | PROJECT 3 | SECTION 4 | SUMMER 2024

Business Case Overview

AGM wants to expand their food delivery services and optimize the addition of new pickup locations at BART stations and streamline delivery routes. We believe this will improve business efficiency and increase customer satisfaction.

➢ Bay Area Delivery devised a plan to use a combination of NoSQL database (Neo4j, MongoDB, and Redis) to help support AGM's future expansion vision.



NoSQL Database Applications

Neo4j (Graph Database)

- **Shortest path algorithm:** optimize meal delivery routes
- **Closeness and Betweenness Centrality:** determine optimal locations for central delivery centers
- **Louvain Modularity algorithm:** identify community group and define the distribution hub
- **Page Rank:** helps to prioritize delivery routes based on node importance within station network.

MongoDB (Document Database): Store real-time traffic data for both **BART** and **Street Traffic**

Redis (Key-pair Database): to track **real-time delivery status** and **manage inventory** dynamically

Food Delivery

Business Interest

Application

Neo4j

MongoDB

Redis

Conclusion

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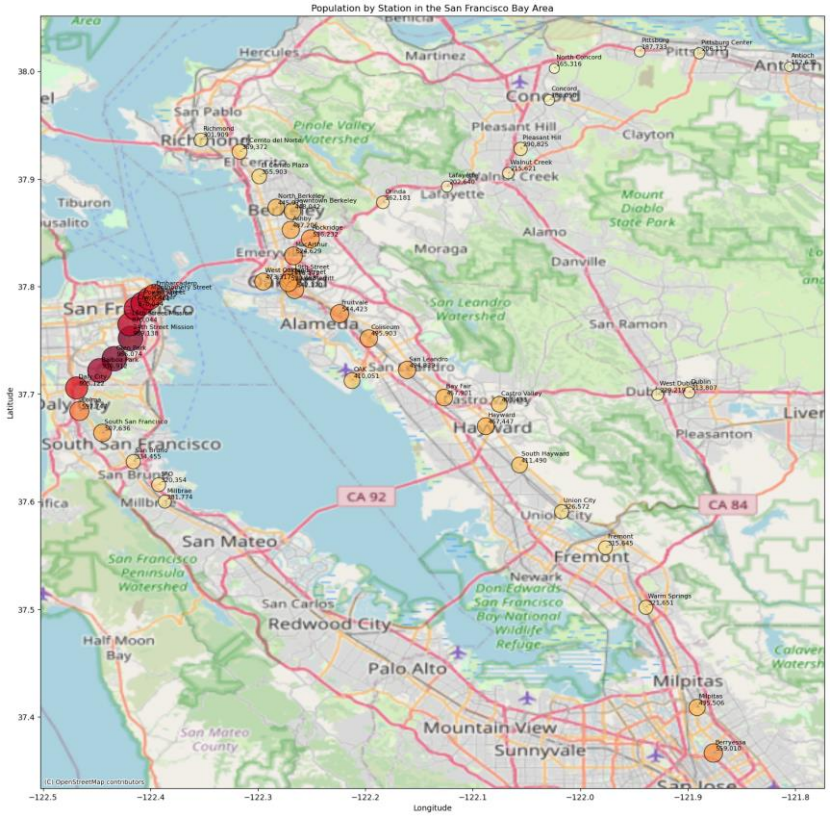
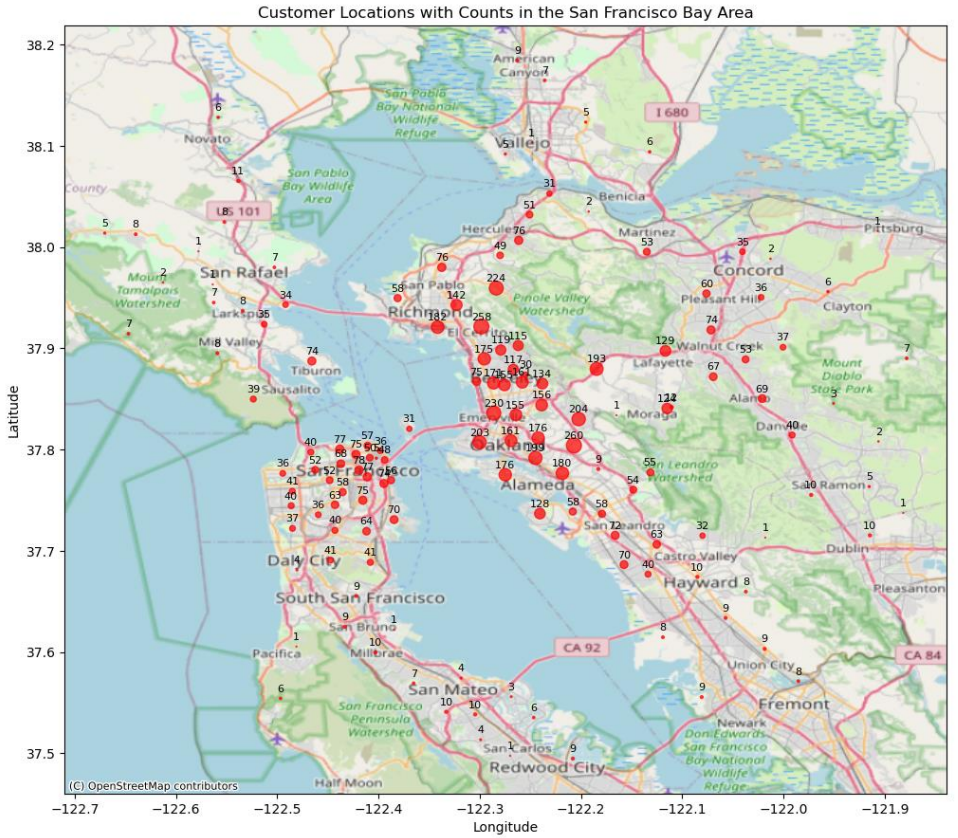
Station Population Distribution



Customer Distribution



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Business Scenario 1: Find optimal delivery route (Single-Source Shortest Path)

Store (latitude, longitude)

relationship

Geodesic Distance

Nearest Depart Station

BART

Calculate the Shortest Path

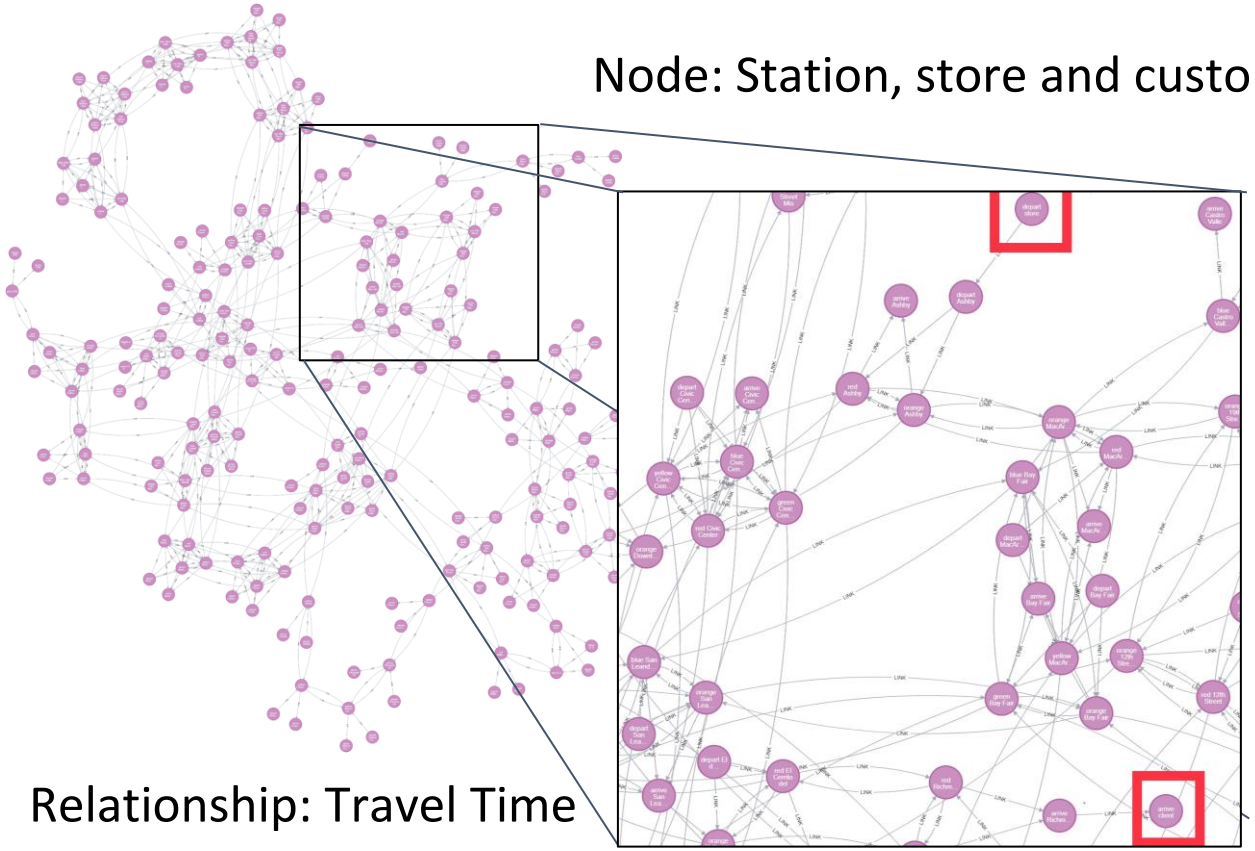
Customer (latitude, longitude)

relationship

Geodesic Distance

Nearest Arrive Station

Business Scenario 1: Find optimal delivery route (Example case)



Node: Station, store and customer location

Relationship: Travel Time

```
# Set up the store and client location
store_location = (37.8555, -122.2604)
client_location = (38.0138,-122.6703)
store_name = "depart store"
client_name = "arrive client"
```

```
--------------------------------
   Total Cost:  978
   Minutes:  16.3
--------------------------------
depart store, 0, 0
depart Ashby, 0, 0
red Ashby, 0, 0
red Downtown Berkeley, 180, 180
red North Berkeley, 120, 300
red El Cerrito Plaza, 180, 480
red El Cerrito del Norte, 180, 660
red Richmond, 300, 960
arrive Richmond, 0, 960
arrive client, 18, 978
 16.3
```

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Business Scenario 2: Select one station to be delivery center

Consideration: Delivery center should have the shortest average distance to other stations.

➢ Stations with high closeness centrality and betweenness score is ideal candidates for central delivery

	name	closeness
0	West Oakland	0.137729
1	12th Street	0.135047
2	Lake Merritt	0.133280
3	Embarcadero	0.132576
4	19th Street	0.127444
5	Montgomery Street	0.126801
6	Fruitvale	0.125870
7	Powell Street	0.120608
8	MacArthur	0.119942
9	Coliseum	0.117110

	name	betweenness
0	Rockridge	5509.000000
1	Orinda	4997.000000
2	Lafayette	4469.000000
3	12th Street	4176.426217
4	MacArthur	4138.430736
5	Lake Merritt	3988.568790
6	Walnut Creek	3925.000000
7	19th Street	3888.013767
8	Fruitvale	3697.419834
9	West Oakland	3476.772638

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Business Scenario 3: Select a distribution center within community

Consideration: Delivery centers should be strategically and evenly distributed throughout the BART transit system

➢ Louvain Modularity can be utilized to define the community groups within the BART transit system.

➢ Utilizing closeness centrality and betweenness scores will aid in identifying the optimal locations for delivery centers within each community group.

	name	community
0	12th Street	14
1	19th Street	14
2	MacArthur	14
3	16th Street Mission	20
4	24th Street Mission	20
5	Balboa Park	42
6	Daly City	42
7	Glen Park	42
8	Embarcadero	52
9	Montgomery Street	52
10	West Oakland	52
11	Berryessa	54

11 Community Groups in Total

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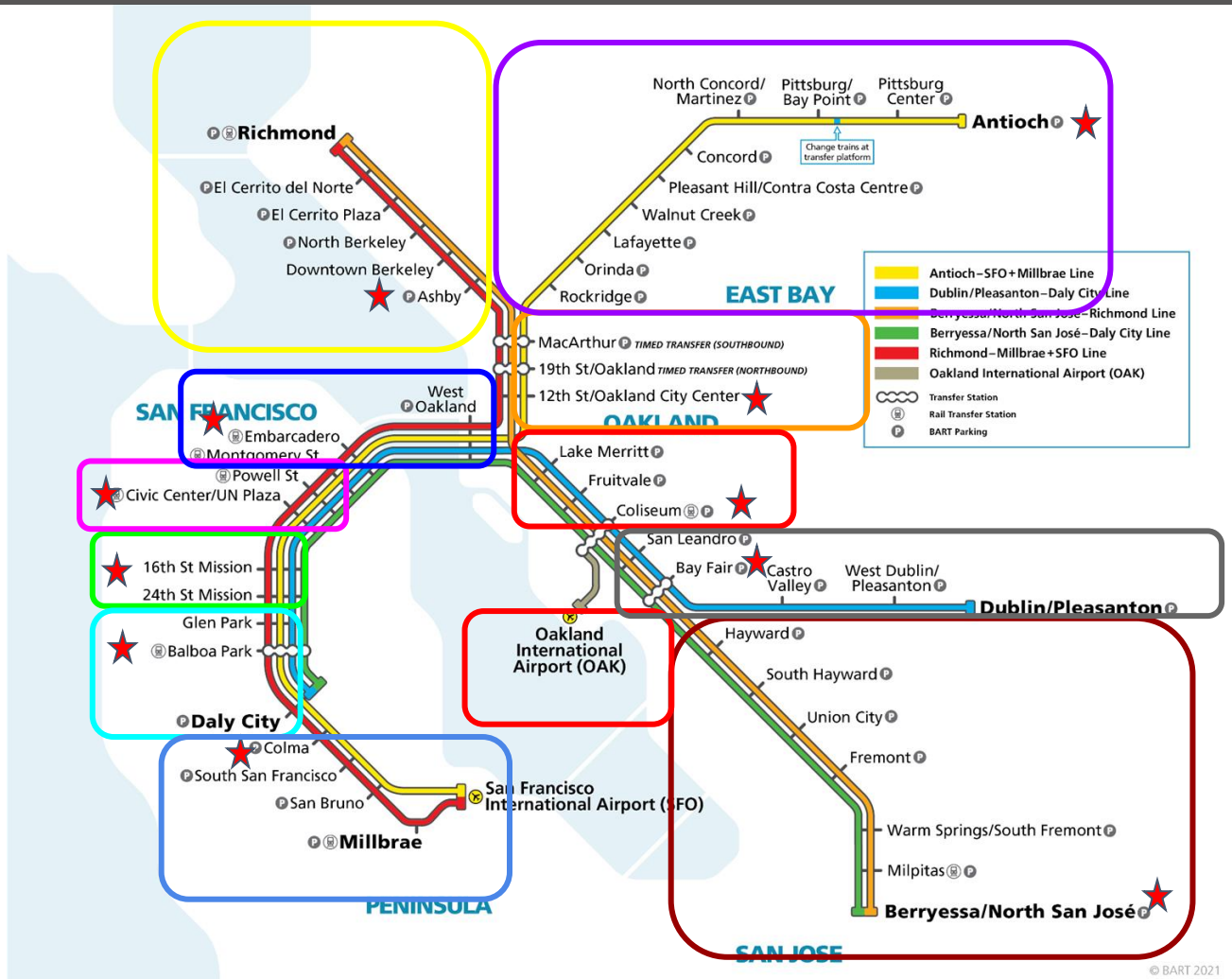

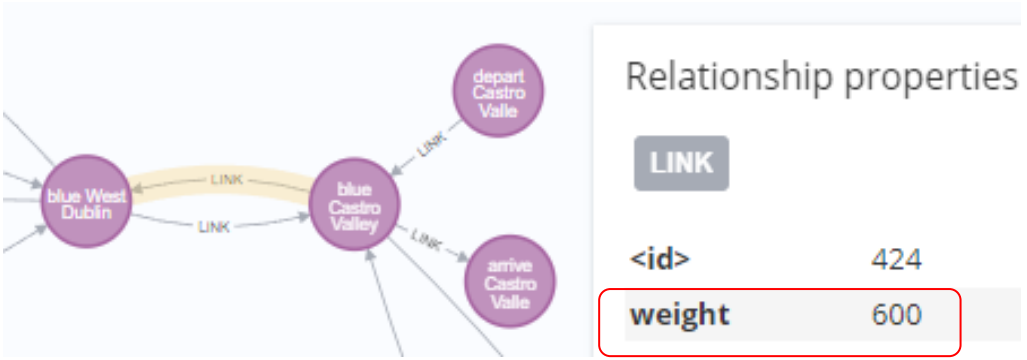

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2024

San Francisco BART Traffic Data JSON


```
{
 "station_id": "SF1",
 "station_name": "San Francisco Station",
 "coordinates": [7/31/2024
  "type": "Point",
  "coordinates": [-122.3959, 37.7833]
 },
 "trains": [
  {
   "train_id": "101",
   "line": "Red Line",
   "arrival_time": "2024-07-31T10:00:00Z",
   "departure_time": "2024-07-31T10:05:00Z",
   "status": "On Time"
  },
  {
   "train_id": "102",
   "line": "Blue Line",
   "arrival_time": "2024-07-31T10:15:00Z",
   "departure_time": "2024-07-31T10:20:00Z",
   "status": "Delayed"
  }
 ]
}
```


2024

San Francisco Street Traffic Data JSON


```
{
 "road_segment_id": "SEG123",
 "start_location": {
  "type": "Point",
  "coordinates": [-122.4000, 37.7700]
 },
 "end_location": {
  "type": "Point",
  "coordinates": [-122.4050, 37.7750]
 },
 "current_condition": "Heavy",
 "incident_reports": [
  {
   "incident_id": "INC456",
   "description": "Accident involving
                   multiple vehicles",
   "timestamp": "2024-07-31T09:30:00Z"
   "severity": "High"
  }
 ]
}
```


2024

AGM Pre-Computed Delivery Path


```
{
 "path_id": "PATH789",
 "start_location": {
  "type": "Point",
  "coordinates": [-122.4000, 37.7700]
 },
 "end_location": {
  "type": "Point",
  "coordinates": [-122.4050, 37.7750]
 },
 "path_points": [
  {
   "type": "Point",
   "coordinates": [-122.4010, 37.7710]
  },
  {
   "type": "Point",
   "coordinates": [-122.4020, 37.7720]
  }
  // Additional points along the path
 ],
 "distance": 2.5,  // in miles
 "estimated_time": 10  // in minutes
}
```


Using mongoDB.

1. **Schedule Monitoring:** Using our BART Traffic Data collection, we can track train schedules, manage delays, and provide real-time updates to passengers.
2. **Performance Analysis:** Analyze station performance based on train arrival and departure times, helping to improve AGM's overall scheduling and operational efficiency.
3. **Monitor Current Conditions:** We can use our Schedule Monitoring data to assess current traffic conditions and make informed decisions about route planning.
4. **Incident Management:** Track and manage incidents affecting traffic flow, providing timely alerts and updates to drivers.
5. **Find Optimal Routes:** We can use our Precomputed Routes data collection to identify and provide optimized routes between locations based on precomputed paths, distance, and estimated travel time.
6. **Navigation Systems**: Integrate path information into navigation systems to enhance route guidance and improve travel efficiency.

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Redis (NoSQL Key-Value Database) Use Cases for AGM

1. **Real-Time Delivery Tracking:** Use Redis to monitor real-time delivery updates, measuring elapsed time to prioritize customers who have been waiting the longest.
2. **Inventory Management:** Redis can also be used to manage real-time inventory levels, ensuring data accuracy as stock fluctuates.
3. **Traffic and Driver Monitoring:** Use Redis to capture live traffic conditions and track delivery driver locations, facilitating responsive route adjustments.

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Key Takeaway

While SQL and relational databases are powerful and versatile, they are not always the optimal solution for every data storage need