ACME Gourmet Meals (AGM) Business Proposal

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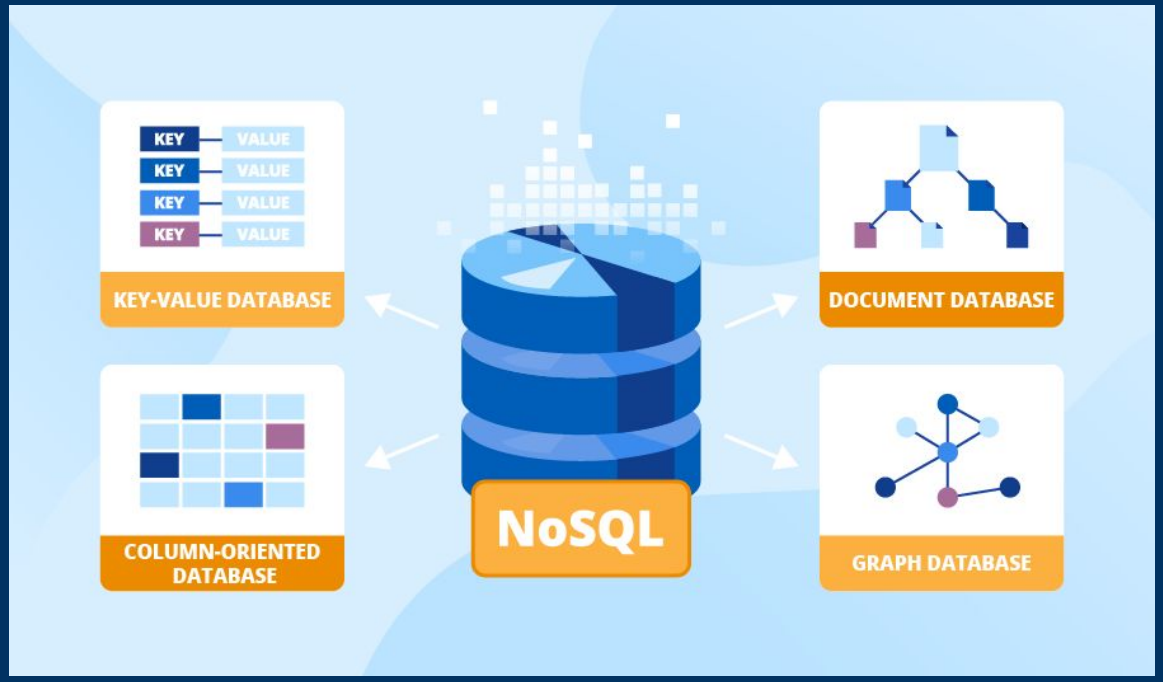
Introduction

- **Overview**
  - Revolutionizing AGM's food delivery system with cutting-edge technology
- **Who We Are**
  - Experienced AGM data engineers pursuing M.S in DS through Berkeley's MIDS program
- **Key Areas of Focus**
  - NoSQL database technology to optimize existing processes
- **High Level Impact**
  - Streamline and automate delivery operations, position AGM as an industry leader
- **Audience**
  - AGM executives who can turn our vision into reality



Neo4J

- **Business Examples:**
  - selecting additional optimal food pickup locations based on existing customer locations and general population using closeness and community detection algorithms

  - delivery route optimization from distribution store to selected BART stations using shortest paths algorithm

- **Advantages of Graph Databases over Relational Database:**
  - efficient traversal of complex relationships/connections between entities
  - faster performance for complex queries
  - flexible schema for adding new data types and relationships

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Harmonic Centrality

- **Business Use Cases:**
  - Targeting stations in high-value areas based on existing customers
  - Prioritized delivery resource allocation (delivery drones/robots and cars) for local deliveries and inventory management

- **Algorithm:**
  - selects well-connected, centrally located nodes by summing the inverse of the distance between the nodes
  - Suitable for disconnected graph
  - Higher weight for shorter distances

- **Implementation**
  - Graph connecting every station nodes to existing customer nodes that are X miles apart

- **Results:**
  - Oakland and Berkeley areas have the largest community of existing customers
  - For 2 miles distance between stations and customers: Ashby
    - prioritized for more delivery drones and robots
  - For 5 miles distance between stations and customers: Rockridge
    - prioritized for more local delivery cars/trucks

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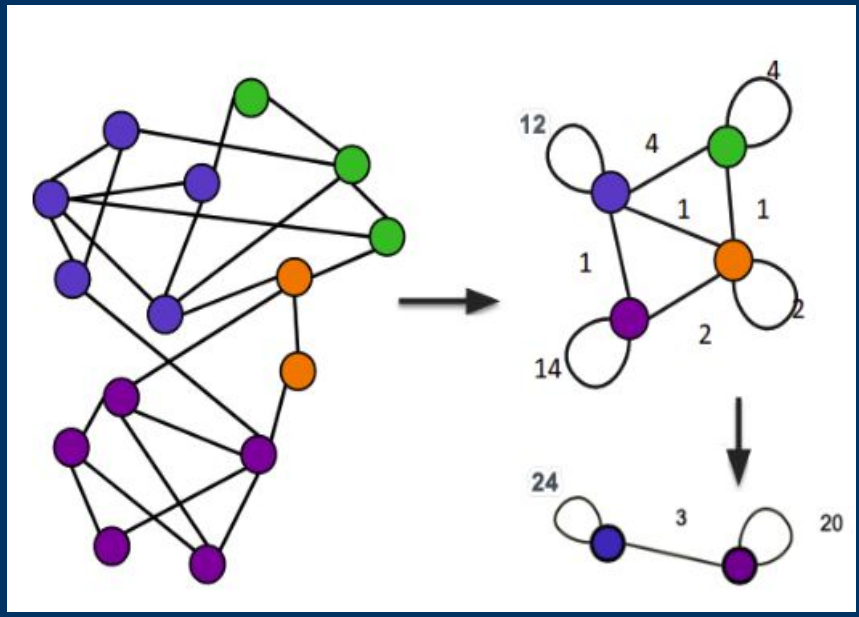
Louvain Modularity

- **Business use cases:**
  - expansion of customer base by adding pickup locations in populated cities throughout the entire Bay Area
- **Algorithm:** identify groups of closely connected nodes
- **Implementation:** identify groups of closely connected bart stations.



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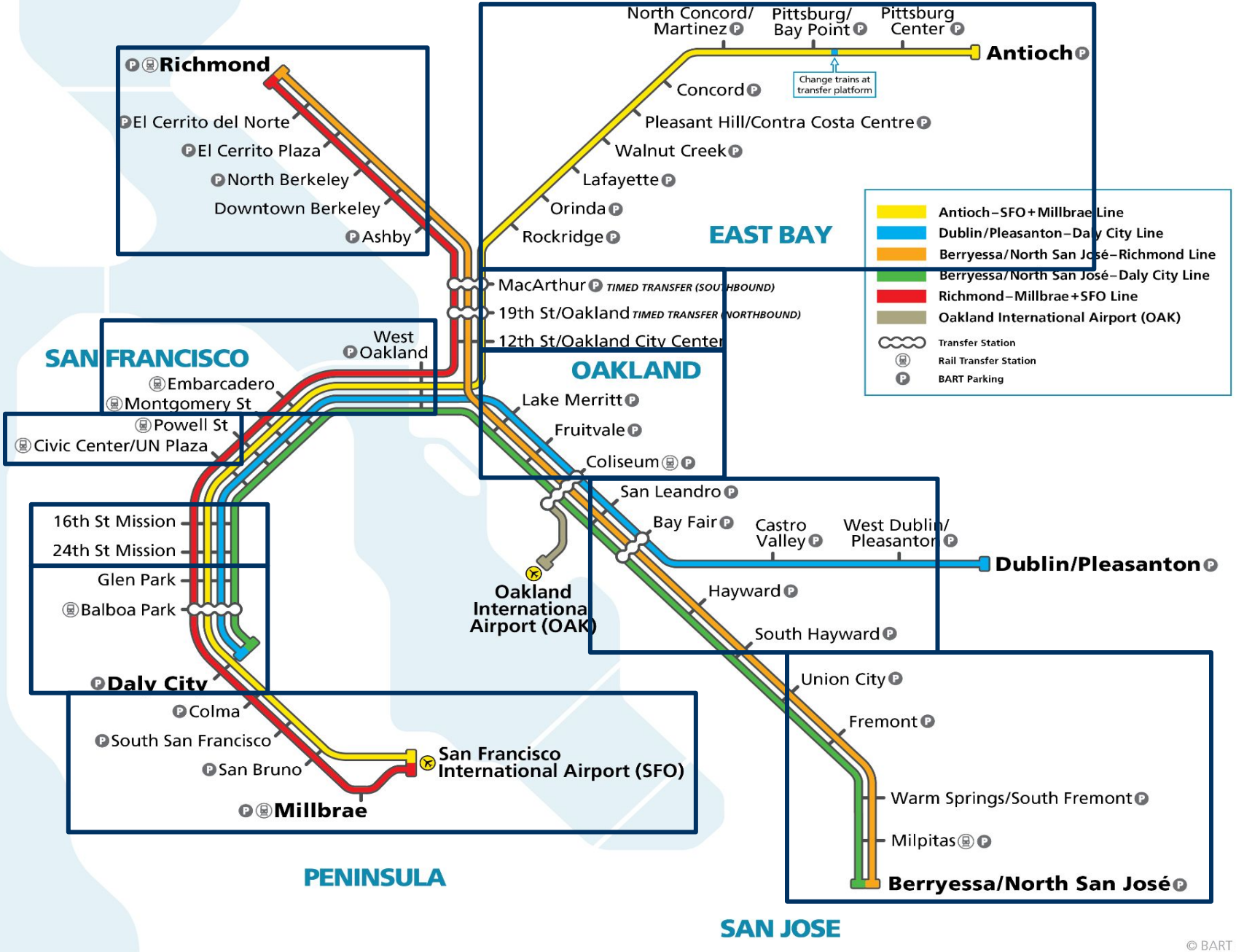
Louvain Modularity Communities



Geodesic Fencing

- Identify population size within 3 miles of each station to identify stations that can serve the most customers

- Use with Louvain Modularity to select one station inside a community that can serve the most customers.

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Geodesic Fencing

Population Size 3 miles away for selected stations

Ashby - 226,433
Rockridge- 317,026
Glen Park - 624,151
Montgomery Street - 425,020
Bay Fair - 286,050
19th Street - 298,398
South San Francisco - 229,815
Berryessa/North San Jose - 293,347

Shortest Paths

- Business Use Cases:
  - Optimizing Delivery Routes: Minimize the delivery time from the warehouse to pick up locations by finding the fastest paths across BART networks.
  - Customer Satisfaction: Faster delivery times lead to improved user experience and increased retention
  - Efficiency: Reduce the number of Drone recharges and fuel cost resulting in increased profitability.

- Algorithm:
  - Dijkstra's Algorithm implemented – priority queue and visiting nodes in order of their current shortest known distance.

- Implementation:
  - Created nodes to represent stations and main warehouse (ACME)
  - Connected nodes (station to stations & store to store) based on meters then converted into time

```
------------------------------
Shortest Path from depart Dublin to Acme Gourmet Meals:
   Total Cost (Seconds): 188.94
   Approx. Minutes: 3.1
------------------------------
   depart Dublin (Step Cost: 0.0, Cumulative Cost: 0.0)
   blue Dublin (Step Cost: 0.0, Cumulative Cost: 0.0)
   blue West Dublin (Step Cost: 180.0, Cumulative Cost: 180.0)
   arrive West Dublin (Step Cost: 0.0, Cumulative Cost: 180.0)
   Acme Gourmet Meals (Step Cost: 8.94, Cumulative Cost: 188.94)
```

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Redis vs. Relational Database

- **Open Source and In-Memory**: Redis is a fast, open-source, in-memory data structure store, ideal for real-time applications like delivery robots
- **Superior for Real-Time Operations**: Relational databases are not optimized for real-time, high-frequency operations, whereas Redis achieves these natively with minimal complexity
- **Built-in Pub/Sub Messaging**: Redis natively supports publisher/subscriber messaging for seamless robot communication, reducing overhead compared to relational databases
- **Complementary to Relational Databases**: Relational databases can store redundant data (e.g: order history, customer profiles, financial records) while Redis handles high-speed operations.

```
Update published: Order 12345 - Status: Dispatched - Location: Warehouse - Coordinates: {'lat': 37.8555, 'lon': -122.2604}
Simulating delay for Dispatched: 8 minutes
Update published: Order 12345 - Status: In Transit - Location: En route from 3000 Telegraph Ave, Berkeley - Coordinates: {'l
at': 37.8565, 'lon': -122.2594}
Simulating delay for In Transit: 14 minutes
Update published: Order 12345 - Status: Arriving - Location: Near 38 Iowa Street, Berkeley - Coordinates: {'lat': 37.8555,
'lon': -122.2604}
Simulating delay for Arriving: 3 minutes
Update published: Order 12345 - Status: Delivered - Location: Customer's Door at 38 Iowa Street, Berkeley - Coordinates: {'l
at': 37.8555, 'lon': -122.2604}
Simulating delay for Delivered: 2 minutes
```

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Redis

- **Business case:** real-time delivery updates sourced from delivery robots/drones.
  - Will emulate real-life food delivery services like Doordash or Uber eats
- Using shortest path algorithm, delivery robots/drones will pick up orders at a station and travel from the station to a customer's address in order to successfully delivery food
- Autonomous vehicle advantages:
  - Reduced costs, environmentally friendly, reduced wait times, and more
- Redis aligns perfectly with the dynamic, real-time nature of food delivery by robots, supplemented by its ability to handle geo-spatial data

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MongoDB

- Business Case: Provide persistent document-oriented database that will hold persistent data retrieved by Redis and used for business intelligence.
- Solution:
  - MongoDB as a document-oriented database can store customer data as documents making it efficient for retrieval and can scale as the business grows.

- Advantages over Relational database
  - More efficient retrieving data than using multiple joins as data can be stored as separate collections
  - Scales Horizontally
  - Allows for flexible data models

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Conclusion

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