# Food Distribution at GW's 23 Commencement

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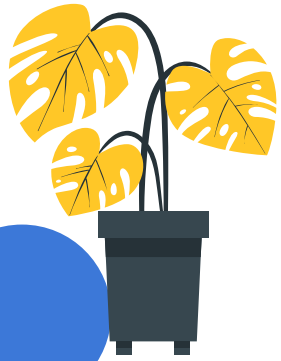
# About the Project



# Problem and Motivation

## Goal

Meet the requirement of food delivery under graduation ceremony.  To provide timely and efficient food distribution to multiple colleges with a lot of considerations on May 21st, 2023, our team has designed two scenarios for the food distribution in 23 GW's Commencement.

## Motivation

Providing timely food delivery to multiple schools is essential to ensure that students receive the necessary sustenance to participate fully in the graduation ceremony.

## Solution

- Food delivery— Develop a prioritization system
- Pick up station— Combine the actual geographical location

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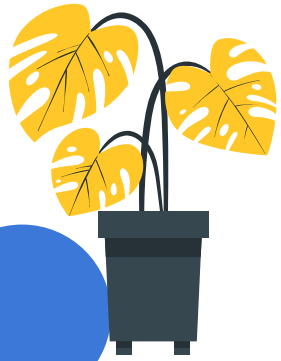
# Preparation for the Project



# Analytical Models and Data Collection


| Scenario | Model | Data Collection |
|---|---|---|
| Logistics Planning: Food Delivery | Traveling Sales Problem (TSP) | Real distance among the marked locations searched by Google Map |
| | TSP with Precedence Constraints | 1. Real distance via Google Map<br>2. Simulation: Precedence pairs |
| | Vehicle Routing Problem | Real distance among the marked locations searched by Google Map |
| Food Pick-up Locations | Set Covering Problem | 1. Real distance via Google Map<br>2. Simulation: Candidate facilities |
| | Clustering: K-mean & K-median | The latitude and longitude of each location |

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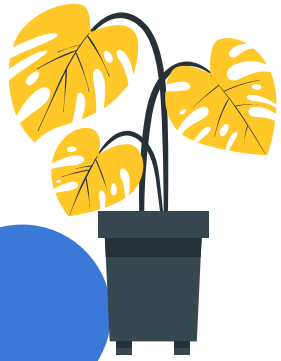
# Scenario 1: Food Delivery Problem



# Travelling Salesman Problem (TSP)

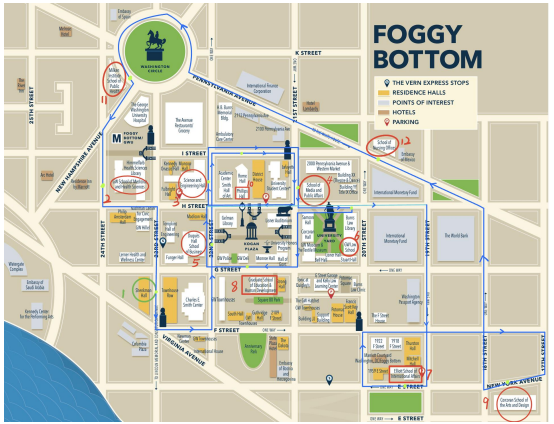
## Implementation

1. Set the source at Shenkman Hall, collected the distances among every node, and input data.
2. Got the optimal route and the objective, the total amount of distance to accomplish the route.
3. Set the source at Thurston Hall and repeated the process.
4. Compared the objectives of the two cases and identify a better one.

**Result: The case starting from the Shenkman Hall would be better** because of less objective.

## Difference

1. Differences between the actual distances and what we see on the map(e.g. gates)
2. Single lane roads



# TSP with Precedence Constraints

**Occasion**

A prioritization system for food delivery based on some specific needs
(e.g.  gaps in the timetable of the specific college events)

**Implementation:** Added the precedence pairs in the former model.

**Result:** The optimal route has changed and the objective, the total distance, gets longer.

# Vehicle Routing Problem

**Thoughts:** Would two-vans delivery always be more efficient that one-van delivery?

## Simplification

1. 2^11
2. 2^3
3. One example of Node 8

## Implementation

1. Grouped the nodes by their locations except for Node 8.
2. Added Node 8 to Shenkman Hall and got the objectives of Shenkman Hall and Thurston Hall.
3. Added Node 8 to Thurston Hall and got the objectives of Shenkman Hall and Thurston Hall.
4. Compared the objectives.

**Result:** The objective of the one-van delivery would be better in the example.

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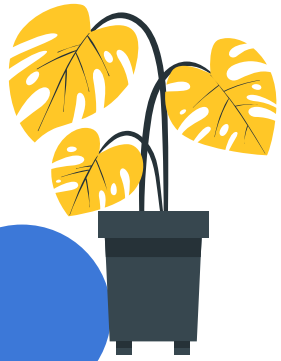
# Scenario 2: Pick-up Location



# Set Covering Problem

**Objective:** Find minimum pick-up locations (candidate facilities) to cover all colleges (demand locations)


## Data Collection

- Demand Location: 11 colleges
- Coverage Distance: 0.32
- Candidate Facility: 5 locations
- Distance between Demand Location and Candidate Facility

**Result:** **The minimum pick-up stations are 2** with Shenkman Hall and Thurston Hall

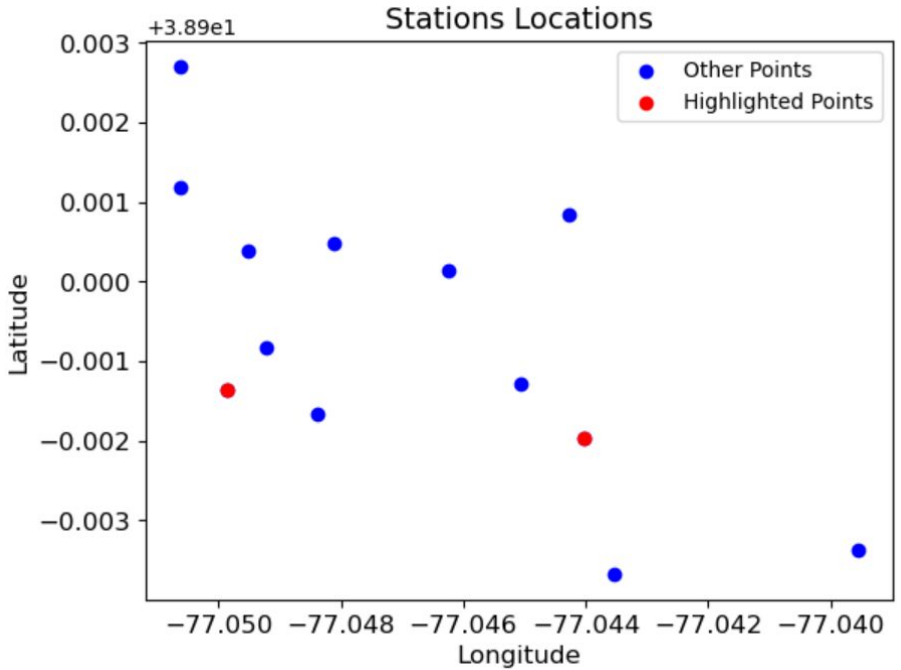
## Limitation

- The candidate facilities are not chosen randomly around the colleges on the map
- The coverage distance is not completely random, and needs to analyze and make a decision according to the known distance

# Clustering: Data Collection

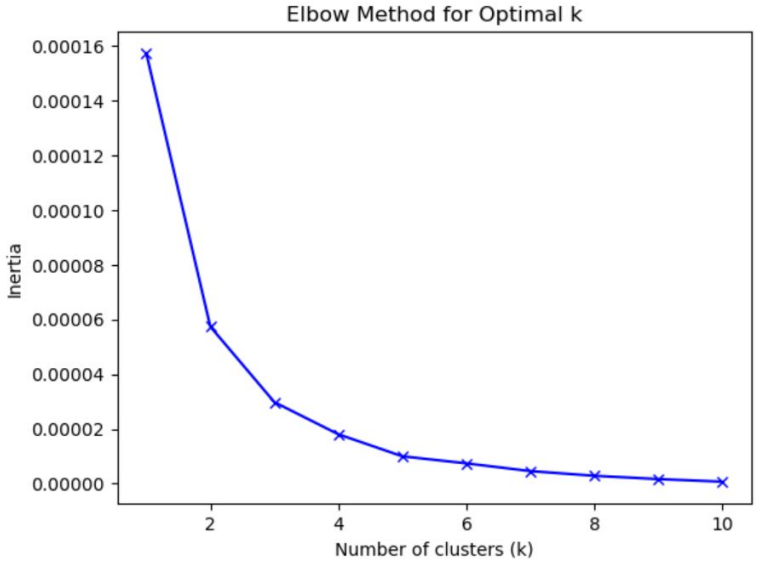
| Canteens and Colleges | Latitude | Longitude |
|---|---|---|
| Thurston Hall | 38.89802389 | -77.04403504 |
| Shenkman Hall | 38.89863688 | -77.04986 |
| School of Medicine and Health Sciences | 38.90118486 | -77.0506355 |
| Science and Engineering Hall | 38.90039115 | -77.04951445 |
| School of Media and Public Affairs | 38.90013894 | -77.0462463 |
| Duques Hall School of Business | 38.89917099 | -77.0492324 |
| GW law School | 38.89871772 | -77.04506193 |
| Elliott school of international affairs | 38.89632618 | -77.04354111 |
| Graduate School of Education & Human Development | 38.89834127 | -77.04839263 |
| Corcoran School of the Arts & Design | 38.89662355 | -77.03953849 |
| Phillips Hall Columbian College of Arts & Sciences | 38.90048732 | -77.04810611 |
| Milken Institute School of Public Health | 38.90270405 | -77.05062654 |
| School of nursing offices | 38.90083459 | -77.04427794 |

# Location visualization



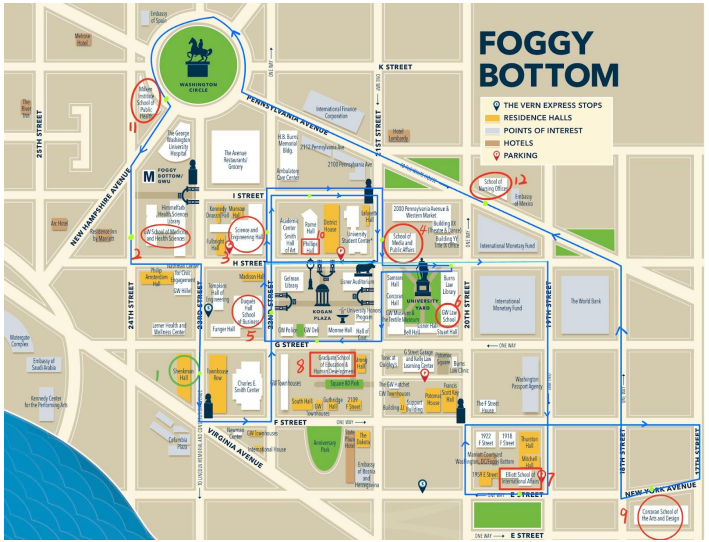

Red dots indicate canteens (left red dot is Shenkman Hall and right ted dot is Thurston Hall ), blue dots indicate colleges.

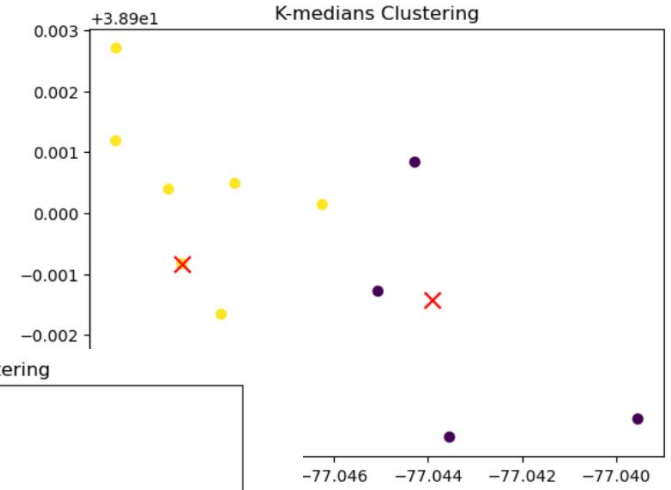
# Optimal K

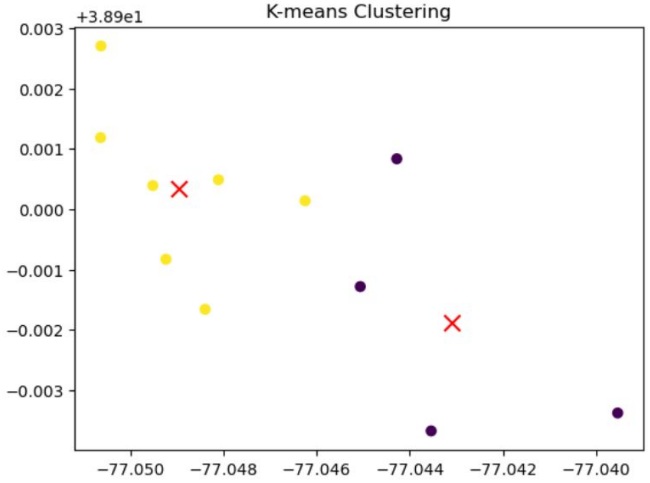



Calculate the optimal k in this model, according to the plot we have at this point optimal k = 2.

# Predicted Results



# Conclusion

### Scenario 1
### Food Delivery

Source node at the Shenkman Hall via one van

### Scenario 2
### Pick-up Location

Best Location: Shenkman Hall and Thurston Hall

# Thanks!