Application for facility location problem in Waste Management with K-Mean clustering algorithm

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Outline

- Problem description
- Methodology
  - K-means clustering
  - Solving FLP with k-means
- System requirements
- Technical choices
- Tests
- Demo

Facility Location Problem

- Facility location problem is fundamental problem studied in operational research and theoretical computer science.
- Applications in:
  - data mining, image processing, information retrieval, etc.
- Many economical decsion problems concern selecting and/or placing certain facilities to serve given demands effciently.
- Examples:
  - Setting up manufacturing plants, distribution centers, hospitals, fire stations, etc.
- FLP is used in Waste Management for determining optimal locations for processing waste.

Problem definition

- Each location includes a capacity
- The locations and capacities are garbage collection facilities
- Their capacity is the annual amount of waste accumulated in tonnes

- The result of the clustering will be an optimal placement of k facilities that process the accumulated waste
- The optimization minimizes the distance between accumulation sites and processing plants, with considering their capacities

K-means Clustering Algorithm

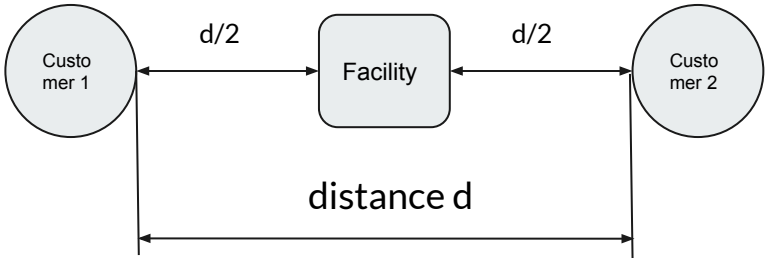
Finding the k cluster centers and assign the objects to their nearest cluster center

- K is the number of clusters
- Centroid-based clustering
- Finding the k cluster centers and assign the objects to their nearest cluster center
- Gets the minimum squared distance
- Each customer is assigned to exactly one cluster

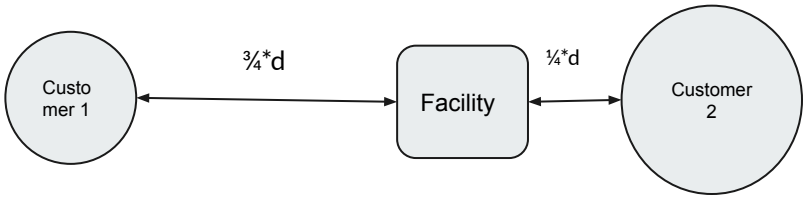
In case if we have capacities for each customer, we can use “center of mass”

Center of mass: example

When customers have equal capacities: c1=c2



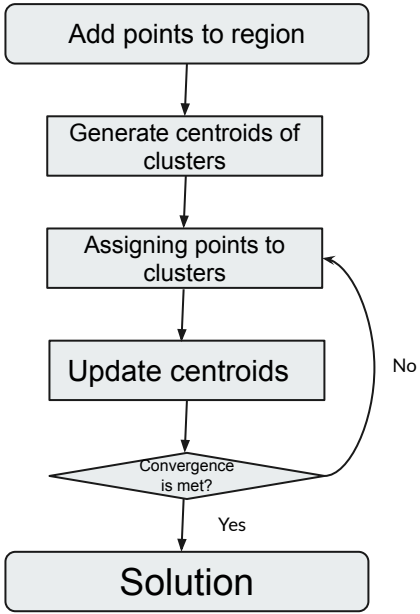
When customers have different capacities: c1 = ½ * c2



Steps in k-means for FLP

1. Choose the number of clusters, k
2. Randomly generate centroids of clusters,
3. Assign each point to the cluster based on its capacity and distance to centroid.
4. Recompute the new cluster centroids.
5. Repeat steps 3 and 4 until convergence criterion is met or number of iterations is reached.

As a solution we have coordinates of clusters and cluster centers.



System requirements

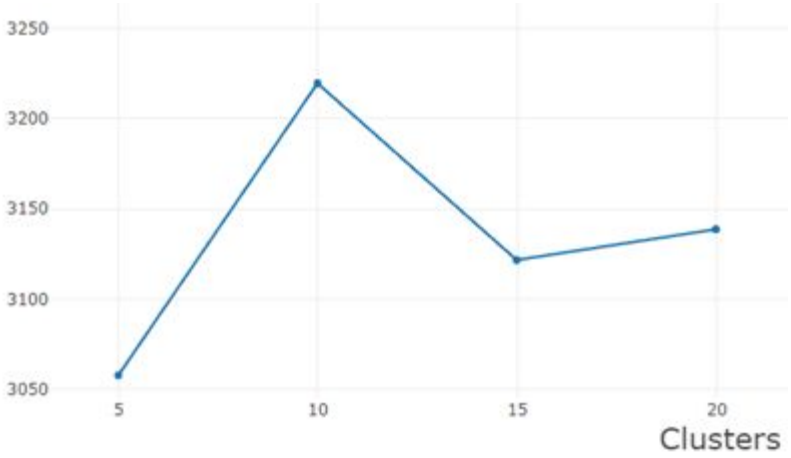
- Map
  - scale, zoom and move
- Graphical interface
  - drawing on the map
  - choosing number of clusters
  - choosing number of accumulation sites
- Run in parallel
  - multithreading

Technical choices

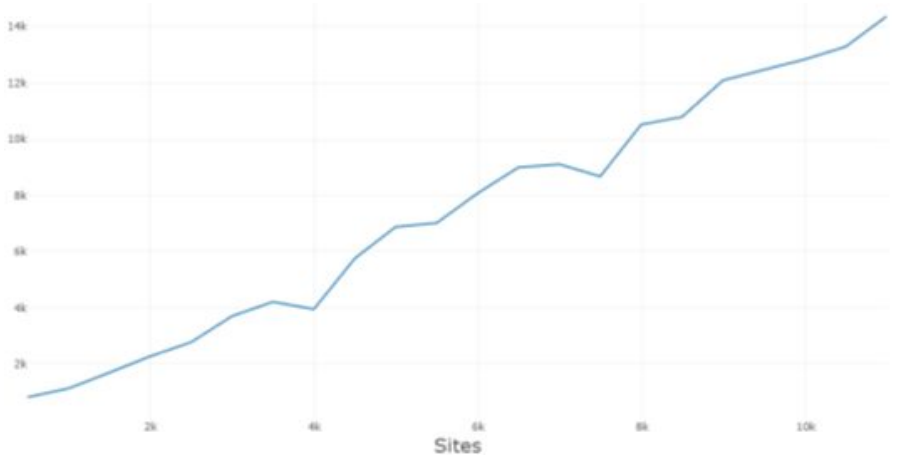
- Programming languages
  - Java
    - JavaFX WebView
  - Node JS
    - Openlayers library

Tests

Tests with fixed number of sites (3000)



Tests with fixed number of clusters (20)



Thank you!

Any questions?