



Optimizing Public Health Accessibility with Voronoi Diagrams

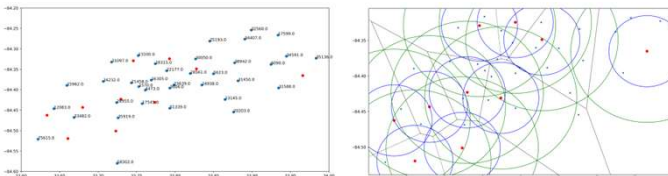
Alexander Xu

Motivation

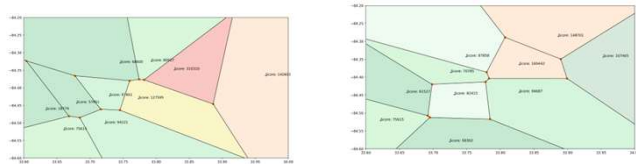
- The demand for global public health systems continues rise, leading to growing patient volumes. However, these systems still face significant challenges.
- A key issue is the large disparities in access that disproportionately affect minority and economically disadvantaged communities.
- This project seeks to analyze how mathematical models can be used to optimize the placement of public health facilities for access and equity, developing and testing new strategies.

Results

- Applying this methodology to Atlanta, I recorded population data in 37 local zips and the locations of 10 public health facilities.



- Using standard deviation, we can determine the level of disparity in our current system. After applying our k-means algorithm, we obtain optimized positions.



$$\sigma = \sqrt{\frac{\sum (x_i - \mu)^2}{N}} = 66437.668$$

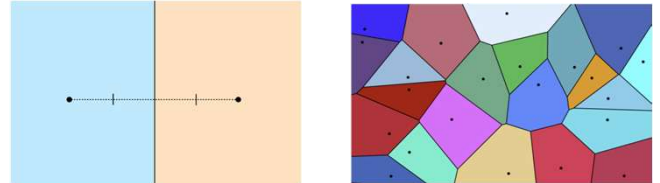
$$\sigma_{\text{new}} = 37249.681$$

44% improvement

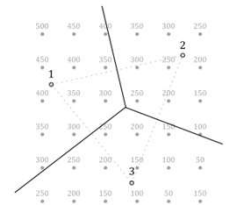
- By applying Voronoi diagrams and the k-means algorithm, the balance of patient load is greatly improved
- These techniques could be applied to a wide range of emergency response and environmental monitoring problems.

Methodology

- Voronoi diagrams, geometric structures that partition space based on proximity to a given set of source points.



- Utilizing population data from the US Census, we create a map of population density and determine the population in each Voronoi cell.

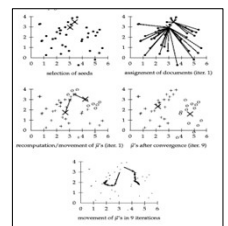


- We develop a cost function based on population and other factors, which gives an idea of the load each facility is handling.

$$S_i = r_i (pop_F(F_i) + outPop_r(F_i) + extPop_c(F_i))$$

$$= r_i \left(pop_F(F_i) + \sum_{p \in outP_{i,r}} pop(p) + \omega \left[\sum_{p \in extP_{i,c}} pop(p) \right] \right)$$

- Using the k-means algorithm, we can algorithmically “move” facilities to their optimal positions based on the score function.



Bio

- Alex Xu is a senior at Johns Creek High School.
- He actively volunteers in public health initiatives and is passionate about public health & environmental advocacy. He is also an USA(J)MO qualifier.



Acknowledgments:



CEISM
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