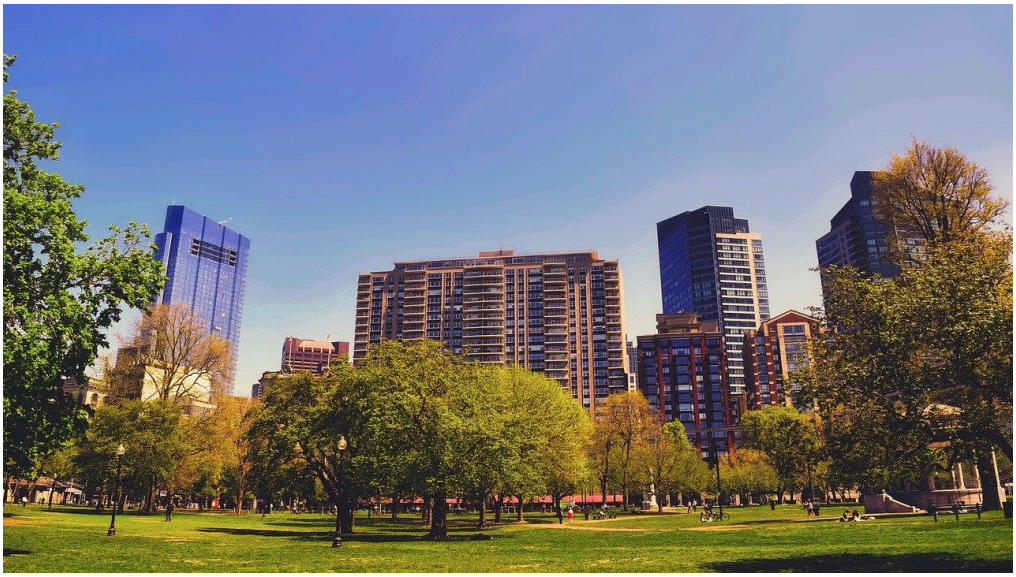
Deliverable 4: City of Boston 15-minute city

Research of the features that can make Boston a “15-minute city” where essential services and resources are all 15minutes from each other via walking and biking distance



New Urban Mechanics Team 1

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I. Background and Motivation

From project proposal:

We would like to research the features that can make Boston a "15-minute city" where essential services and resources are all 15 minutes from each other via train, bus, or walk. Essential services within the city include: hospitals, healthcare providers, grocers, supermarkets, parks/green spaces, etc. We will target dense urban areas for the 15-minute city concept, this will be done by identifying parcels of land in the city with the highest concentration of essential services and then finding the shortest paths between them.

II. Introduction of Data

Originally, we had 170,731 small parcels, found and defined in many common Boston zoning viewers. In the beginning, we were given separate datasets, each representing all the services/businesses, grocers, and green spaces in Boston. To create the ultimate dataset that combines all the information, we have conducted research on 5 different categories of essential services: *supermarket, grocery, hospital, health care and green space* (i.e. public park). Statistically, we have found valid addresses for 68 supermarkets, 1,876 groceries, 156 hospitals, 2,493 health cares and 1,027 green spaces in the City of Boston.

To be more specific, supermarket include the large-sized stores such as Target and Costco, whereas the grocery includes the smaller scale of stores such as 7-Eleven and convenience stores. For hospital, it includes the large scale of health clinic centers such as Massachusetts General Hospital, whereas healthcare providers include the small scale of health providers such as personal health-clinic offices. Lastly, green space includes any scales of parks and gardens. Note that the number of hospitals may be too big because some hospitals have different buildings and these buildings are counted separately.

III. Research Method

Because the distance in a city usually refers to the road distance instead of a straight line, our primary design was to use Google Map's Distance Matrix API (DMA) for accurate calculation of the distance between each parcel and the essential services. However, DMA is not a free service itself and has a usage cap each month, so we need to come up with solutions to avoid going beyond that limit while still completing our task. That comes in two ways: 1) reduce the number of parcels we have and 2) reduce the number of essential services we search for each parcel.

a) To simplify the computation as well as to avoid going beyond the free usage cap of Google distance matrix API, we have successfully combined these small parcels into 13,121 big parcels based on their geographical location. For example, if two houses are on different small parcels but their distance is less than 50 meters, they are considered to be within the same bigger parcel. We choose 50 meters as the parameter because it is a

relatively short distance that can be covered in seconds. For different purposes, the parameter can be changed.

An example of merged small parcels is shown below. These small parcels are in the same block, and combining them does not affect the statistical value of our research.

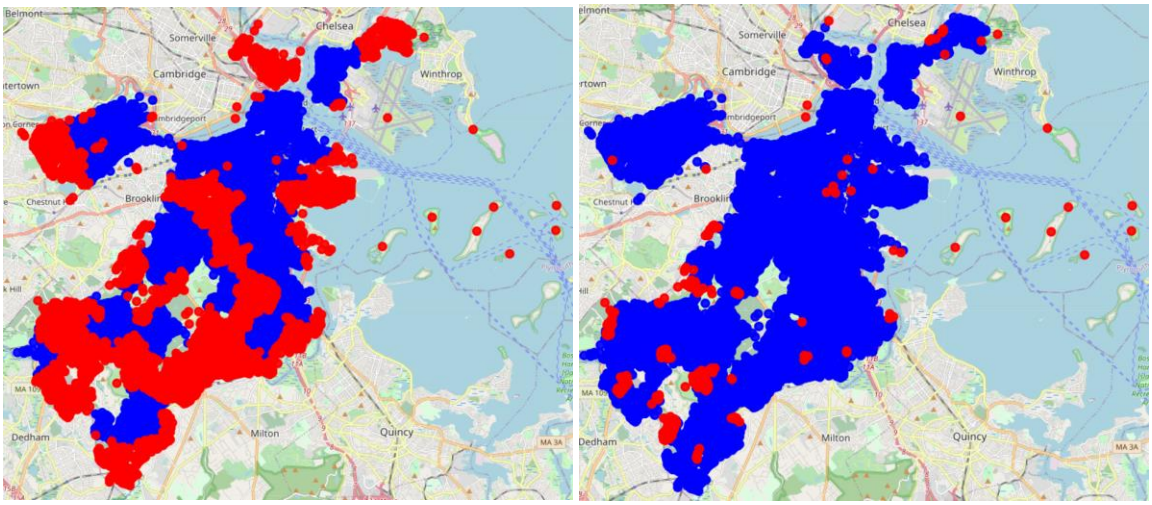
```
'27 -37 CHESTNUT ST #103, CHARLESTOWN,02129',
'27 -37 CHESTNUT ST #107, CHARLESTOWN,02129',
'27 -37 CHESTNUT ST #109, CHARLESTOWN,02129',
'27 -37 CHESTNUT ST #102, CHARLESTOWN,02129',
'27 -37 CHESTNUT ST #104, CHARLESTOWN,02129',
'27 -37 CHESTNUT ST #106, CHARLESTOWN,02129',
'27 -37 CHESTNUT ST #108, CHARLESTOWN,02129',
'27 -37 CHESTNUT ST #110, CHARLESTOWN,02129',
```

b) Using Euclidean distance, each big parcel is matched with several closest essential amenities of each kind. This redundancy compensates for the fact that the one with the smallest Euclidean distance may not be the one with the shortest road distance. Note that when using the second closest essential amenity to calculate distance for those parcels that do not satisfy a 15-min range, the number of parcels covered increase by 744 in total. Compared to the total number of parcels we have found, this is a strong indication that the matching of each pair and its first closest services has already been very effective.

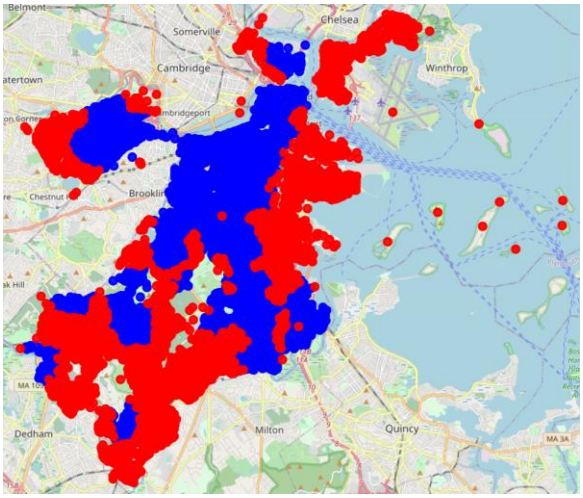
IV. Visualization and Analysis

For all figures below, the red represents the parcels that are not covered in the 15-min walking range for the indicated essential service while blue stands for the opposite.

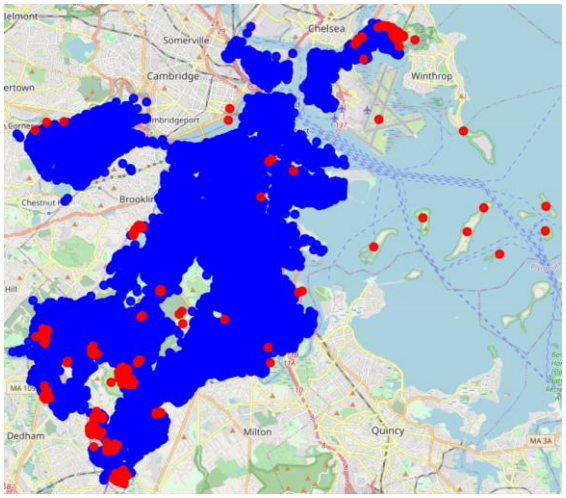
a) What percentage of residents are 15 minutes within essential amenities in a parcel of land?



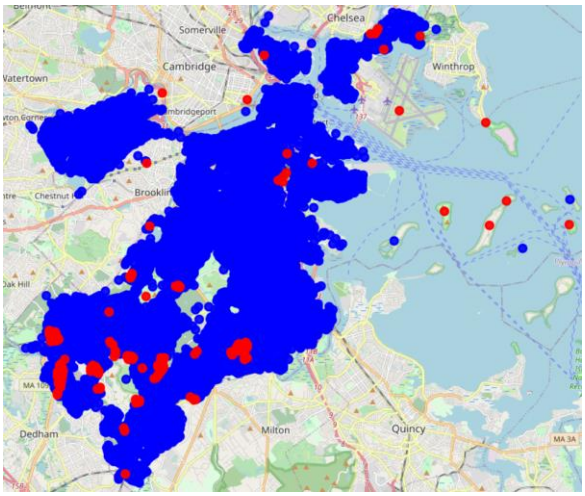
Supermarket; 46% parcels not covered.



Grocery; 2.5% parcels not covered.



Hospital; 46% parcels not covered.



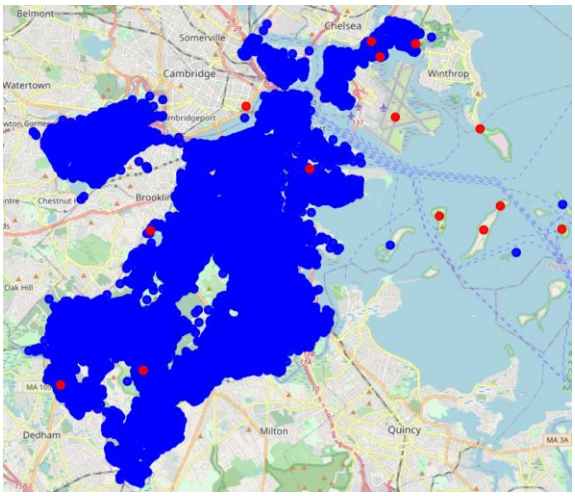
Healthcare; 2.3% parcels not covered.

Parks and green space; 1.5% parcels not covered.

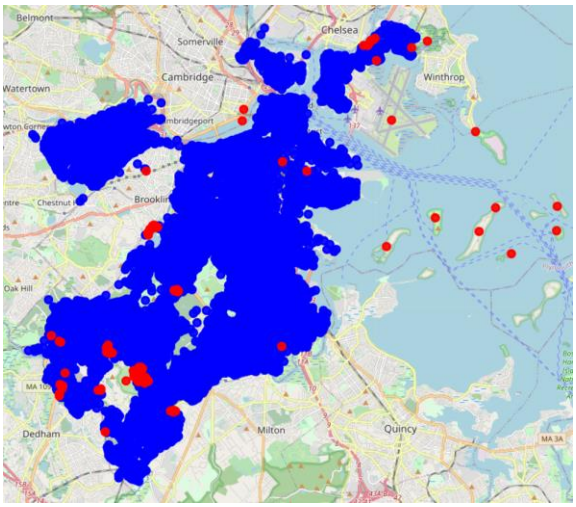
The percentages of parcels that lack each kind of essential amenity (supermarkets, groceries, hospitals, health cares and green spaces) are 0.468, 0.0298, 0.472, 0.0316, 0.039.

Furthermore,

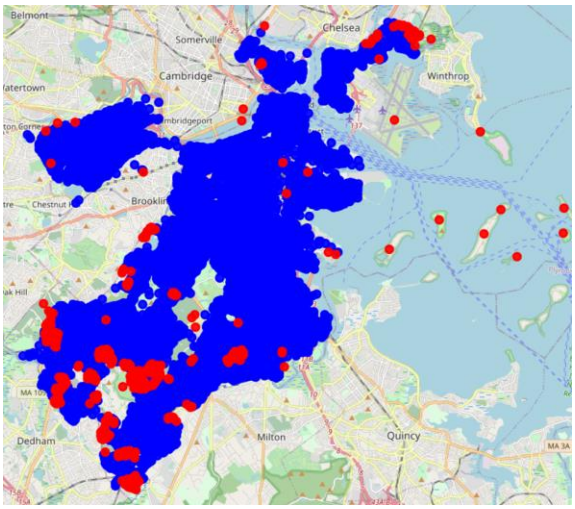
0.1% of the parcels are not covered by at least 1 essential service,



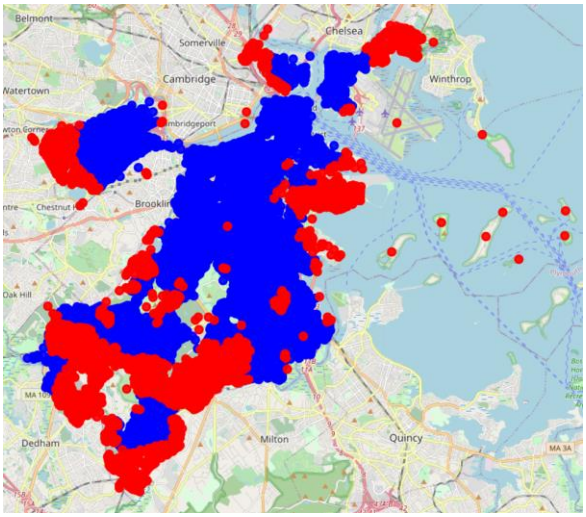
0.98% of the parcels are not covered by at least 2 essential services,



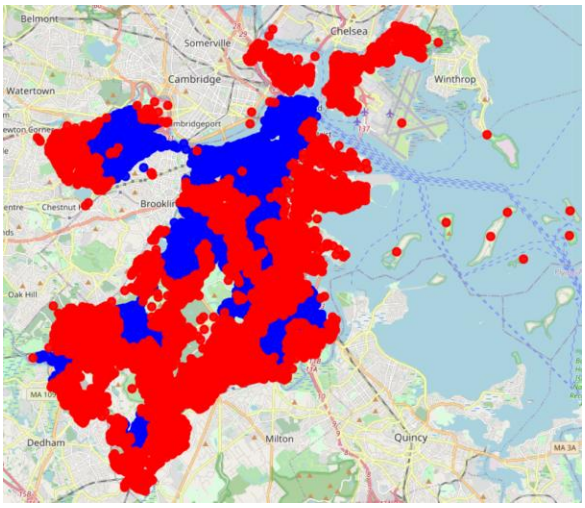
3.7% of the parcels are not covered by at least 3 essential services,



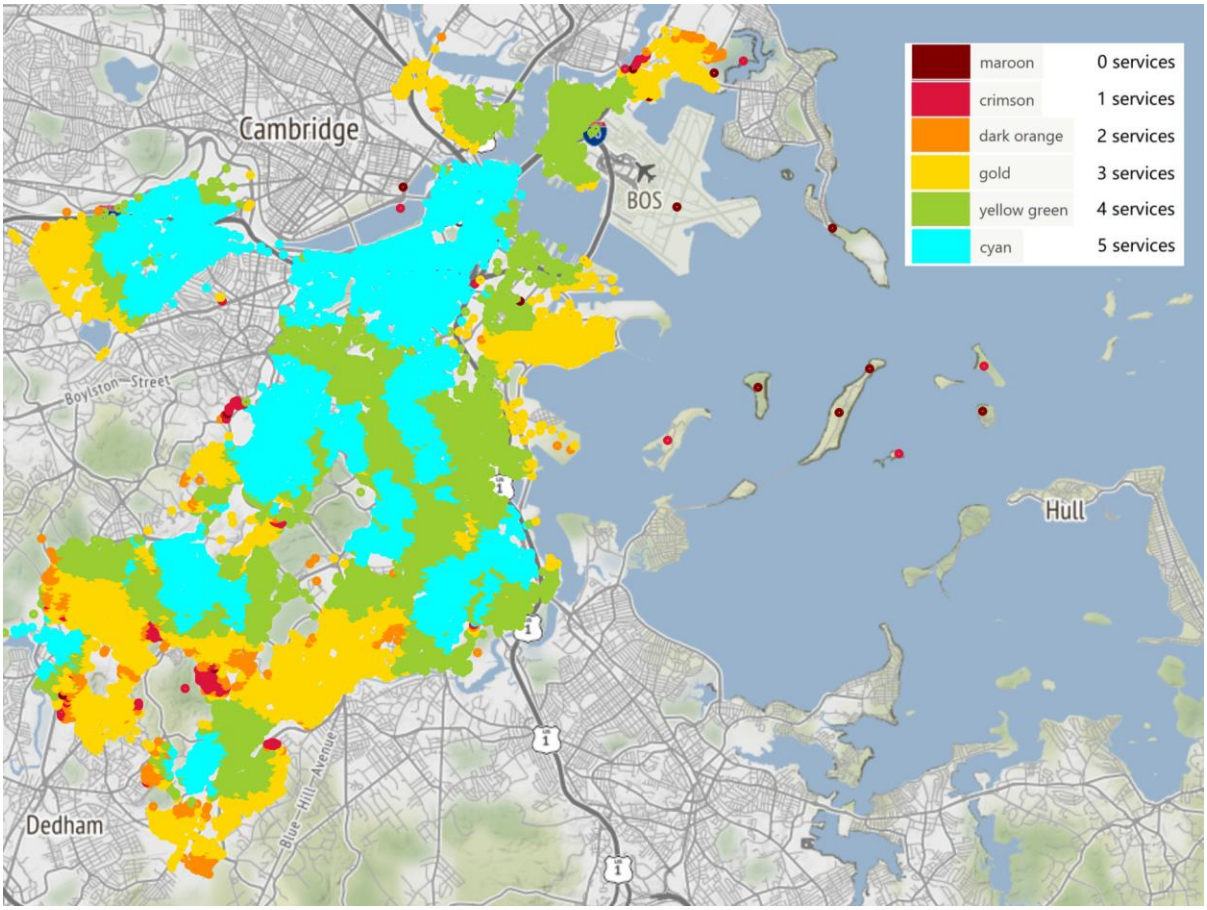
29.8% of the parcels are not covered by at least 4 essential services,



and 63.9% of the parcels are not covered by all 5 essential services.



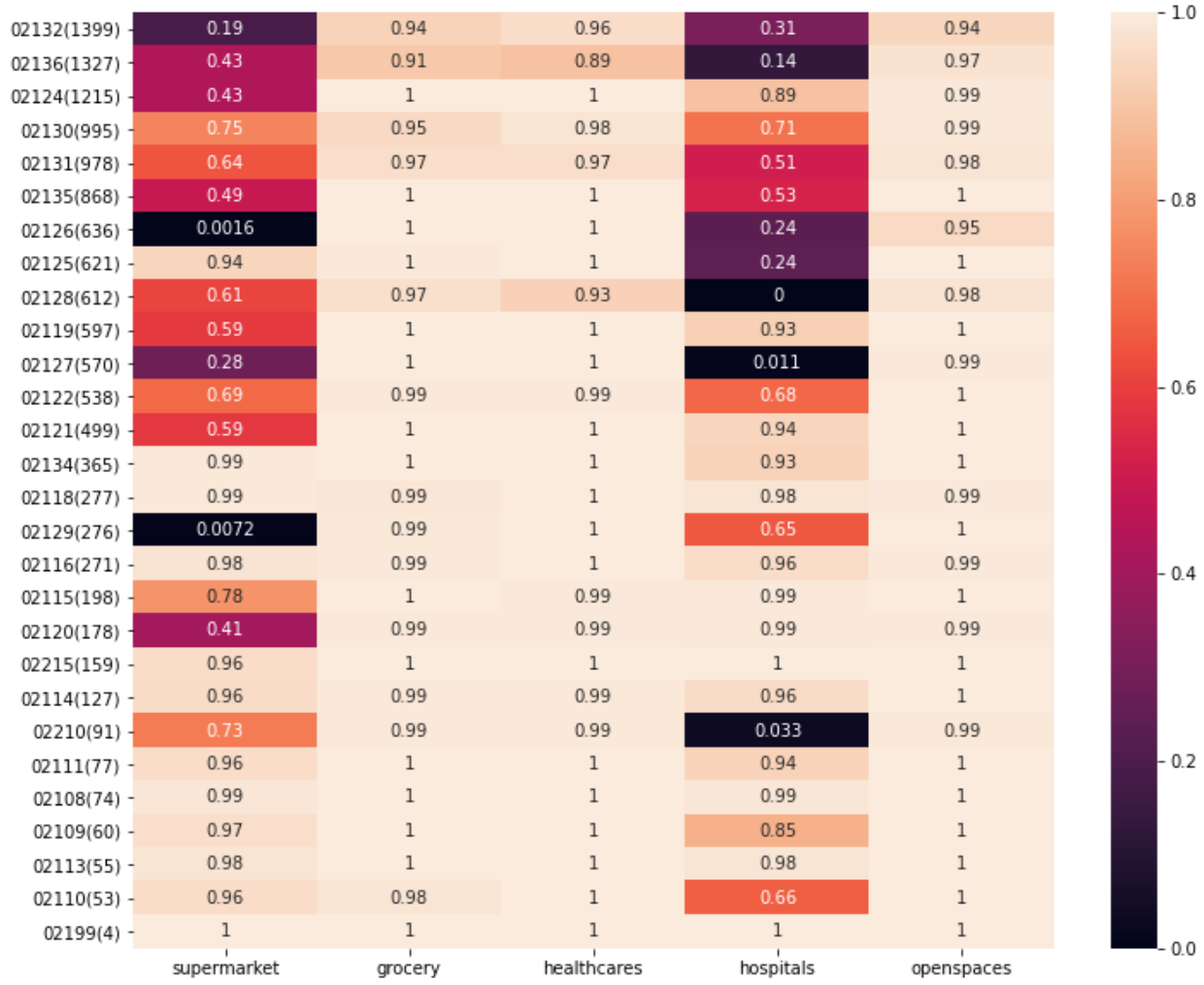
Here is an overview of the coverage situation



b) Which areas of the city are underserved in terms of a lack of essential amenities?

Area analysis is done in terms of zip codes. For our dataset, we have 29 zip codes: [2136, 2111, 2131, 2116, 2129, 2132, 2127, 2126, 2122, 2113, 2215, 2118, 2124, 2125, 2114, 2119, 2121, 2130, 2110, 2128, 2199, 2115, 2120, 2134, 2135, 2210, 2109, 2108, 2133].

The heatmap of coverage rate of each service for each zip code is shown below, sorted in descending order of zip code size i.e. number of parcels included in each zip code. X axis represents services, Y axis is in the format of "zip code (number of parcels included in this zip code)".



It can be seen clearly that the most underserved services are supermarkets and hospitals. In this context, we can list the zip codes that are underserved:

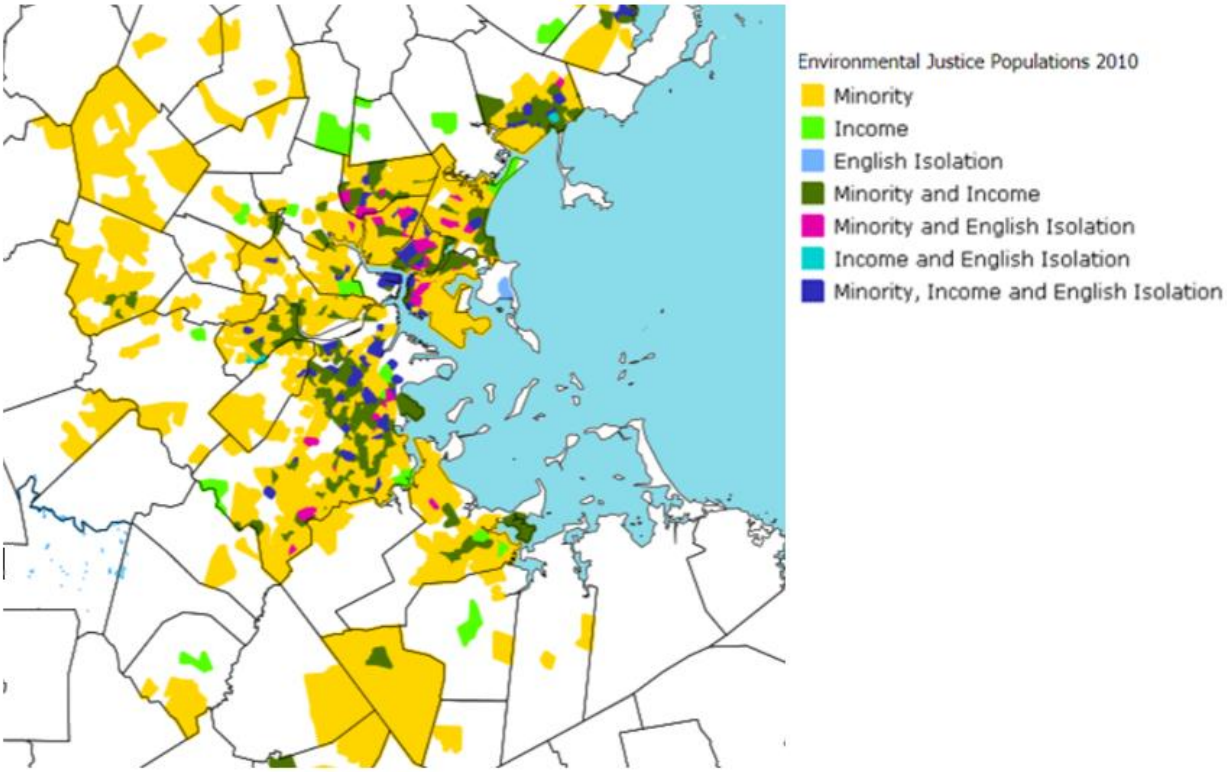
supermarket-underserved areas: 02120, 02126, 02127, 02129, and 02132

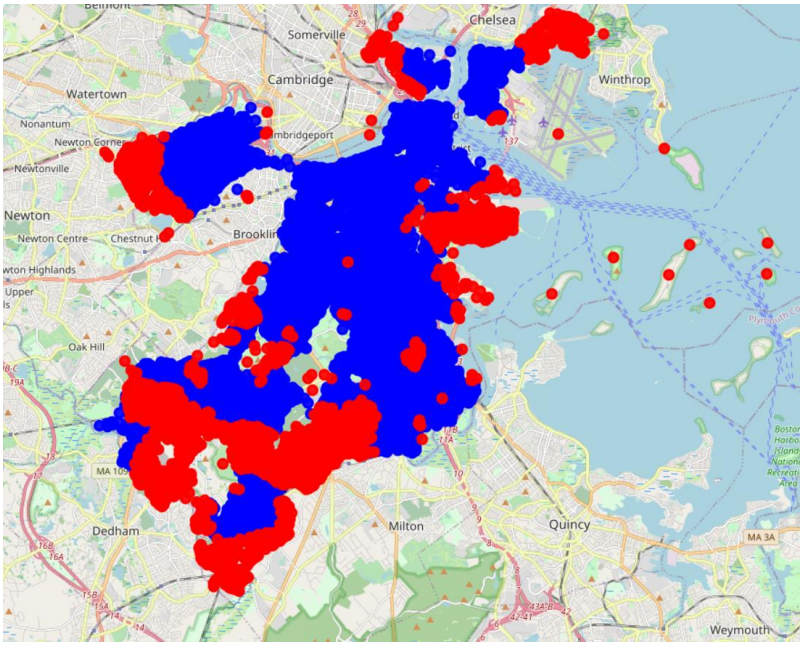
hospital-underserved areas are 02125, 02126, 02127, 02128, 02132, 02136, and 02210.

c) demographic analysis:

The demographic map we use are from Environmental Justice Demographics: http://maps.massgis.state.ma.us/map_ol/ej.php

A screenshot of that map is given below:





Given that we have a visualization for the map with the number of services accessible from each parcel, we can analyze the result by comparing it to the demographic map. Assume that we define parcels to be insufficient of essential amenities if those parcels have access to less than 4 essential services.

The first image above shows the demographic information, and the second image marks area with less than 4 essential services with red. Note that the demographic image contains an area that is larger than Boston city.

As we can see from the first image, the city of Boston is very diverse. Most of the areas are marked with “minority” (yellow), “minority and income” (dark green), “minority and English isolation” (purple) and “minority, income and English isolation” (dark blue).

From the second image, we can notice that the most underserved areas are located in the outer region of Boston. Also, there’s a huge cluster of underserved parcels in the southern part of Boston. Although those underserved areas are covered by a wide range of minorities, it’s hard to conclude that there’s a concrete relation or pattern between underserved regions and minorities. First of all, significant portions of underserved areas do not consist of minorities (areas that are not colored in the first image). Second, many of the well-served areas, colored blue in the second graph, are in fact marked minority (and even income and English isolation) in the demographic graph. Therefore, we couldn’t find a solid relation between distribution of essential services and certain groups of people who were considered to be minority.

In general, the number of access to services does not depend on an individual's language, income or race, but depends on their location. According to the first image, most neighborhoods in Boston have a diverse population, and we can infer that there is a correlation between population density and number of services provided.

Due to the design of the project, we only considered services that are within the governance area of Boston, excluding the essential services in different districts such as Brookline. Thus, most of the underserved areas in the outer regions of Boston are potentially miscalculated. If we conduct the same research on a much larger scale that incorporates the regions such as Brookline or Newton, then the percentage of areas that are underserved in terms of essential services may decrease.

V. Limitations and Possible Plans

As we mentioned above, the free usage capacity of Google Map’s Distance Matrix API is limited, so we had to refine the scope of our project. For instance, our initial plan was to research other essential services with the following purposes: recreation, education, and social. However, we would need to pay the extra API requests after exceeding the free limits, thus we had to cut off the features that have lower priority.