

Project Title

Network Analysis of Urgent Health Care Facilities in LA County



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Abstract

With the ever increasing population and degradation of the environment, people's health is at risk, especially so for the children and aging baby boomers. Unhygienic conditions in densely populated metropolitan cities and urban areas proliferate diseases. As per the 2014 US census report population of LA county is about 10 million, with the city of Los Angeles itself accounting for about 3 million people. Thus, facilitating health care for such a humongous population is a daunting task for authorities. Urgent Health Care facilities are one among many health initiatives undertaken by the authorities to cater for the US population. These facilities accommodate unscheduled doctor's visit when patients cannot wait for a scheduled appointment. LA county has about 128 urgent care facilities for about 2344 census tracts. This project aims to find the adequacy of the urgent care facilities for children, adult and aged baby boomers of LA County. For the selected census tracts, time traveled by these segmented population from their homes to urgent care facilities are simulated from spatial analytics and network analysis using ArcGIS MAP software. This is a rudimentary step and the project has further scope to involve other medical facilities and counties within the US.

Introduction and Literature Review

Five popular types of health care facilities available in United States are hospitals, ambulatory surgical center, doctor's office, urgent care clinic and nursing home (Top Masters in Health Care). Urgent Care Clinics provide an unscheduled doctor's visit for less serious illnesses and injuries like a cold or influenza, minor cuts and abrasions, and sprains. Most locations offer extended hours (Health Services Los Angeles County). Thus, in order to improve the health care facilities and their services it is worth studying the urgent health care facilities and help people to access them and find the nearest facilities at the time of emergency. There are various similar

projects regarding use of GIS to determine urgent health care services one of those is the projects done by ABARIS GROUP (Abaris Group website). The services provided by this group is in the area of urgent care services including program determination, feasibility studies, valuation studies, site selection, new center implementation, marketing and existing program analysis. This firm has an extensive background in assisting hospitals with urgent care programs. The Abaris Group recently completed a project in southern California that required the design and implementation of a “medical mall” that included the urgent health centres, physician offices and so on. One of the fundamental approaches is to find the nearest urgent health care for a location using Network Analysis. The closest facility analysis is one of the features of Network Analysis tool. The closest facility solver measures the cost of traveling between incidents and urgent health care facilities and determines which is the nearest to one another. It displays best routes between incident and facilities, reports the travel costs and returns the driving directions.

Problem Definition

Urgent Health Care Facilities is defined as the delivery of ambulatory medical care outside of a hospital emergency department on a walk-in basis without a scheduled appointment(Wikipedia). Urgent Care Health Facilities are significantly important as they play the role of a medical home to a significant portion of the state’s population. With the growing funding provided by the government in health sectors, health facilities are becoming more accessible to all the people. But the problem we face here is, how to access these health centers? There are more than a hundred health centres per each state in America. But these centers will be of actual use when they are easily accessible. The project is created to address this problem. It answers questions such as:

- Which is the closest health facility to home work or any location?
- Which health centres are within a 10 minute radius from home, work or any location of LA county?
- What is the route to the nearest health facility?

The project is about creating a map that shows all the health centers in LA county. It helps people see which health centers are nearby to them. This map shows the route of the closest health centre. This is where the GIS technique comes in place. ArcGIS is used to create such maps. The project helps to ease the accessibility of health centers for the required population. It addresses the problem of people not knowing how to quickly access the locations of facilities. The goal of this project is for people to access the facilities when needed, find the quickest routes and reach them in urgent cases. The future goal of this project is to increase the map's area outside the LA county. But for now this project helps the people to have knowledge of health centers that help them in urgent conditions only in LA county.

Data Selection and Acquisition

There are 3 major datasets used in this project. They were as follows:

- Urgent Healthcare Facility of LA County
- Population Dataset of LA County
- Streets Dataset

Urgent Healthcare Facility of LA County:

This data was taken from open ArcGIS database. This dataset includes information regarding the location of the Urgent Healthcare Facility. This is to know that in times of emergency, the facility must be able to accept patients from the general population or patients from a significant subset of the general population.

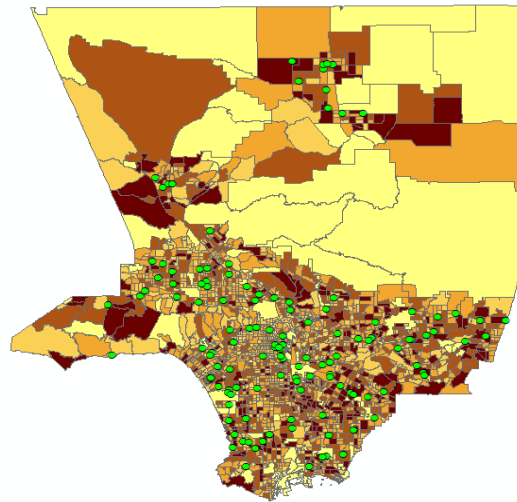


Fig.1 Urgent Healthcare Facilities in LA County

Population Dataset of LA County:

The population dataset is from the 2014 Esri Demographics Complete. This dataset included the detail of population in each county in LA. Further, it also provides the demographics of the population which included gender, sex and age. This helped in segmenting the population by age which was related to the need of urgent care facilities in that location. For e.g. if the number of children between 0-20 years and people of older age between 50-90years is more in that case the need of an Urgent Care Facility in that area is higher.

Street Data:

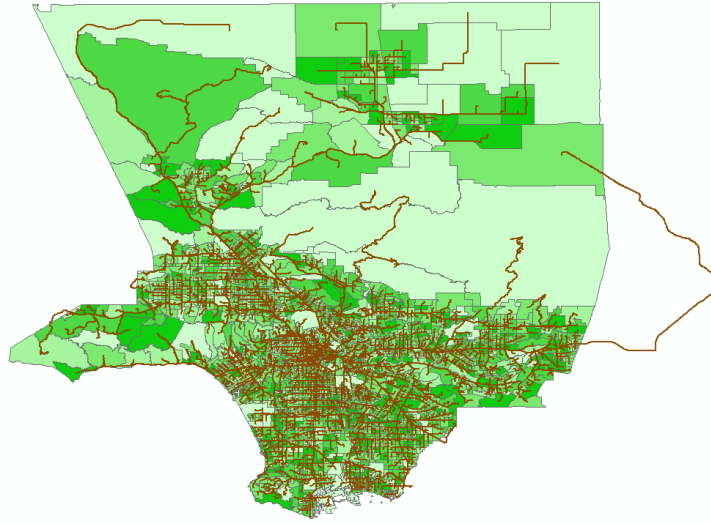


Fig.2 Street data with routes to Urgent Healthcare Facilities

This dataset was provided by Professor Au Vo. The street data had information regarding the streets of LA county. This data was used for network analysis. New closest facility feature of network analysis tool was employed to plot the feasible Urgent Healthcare Facilities. This helped in finding the closest facility near any point.

SYSTEM:

Softwares Used:

ArcMAP version 10.5



METHODOLOGY:

The most important goal of performing this project was to judge the overall presence of Urgent Healthcare facilities. One of the primary tasks in the project was to calculate the relative position of the facilities, thereby determining the closeness from the central point. The analysis performed also yielded estimate of time to access a particular facility. The results traced optimal locations for the facility.

Following is an in-depth description of all the techniques used to perform our analysis:

Centroid:

Centroids determine the central location of a particular cluster. This technique was beneficial since we required a mutual point to calculate the distance to each Urgent Healthcare Facility. The centroid was the required common point inside a particular region in LA county. These were created in ArcMap using the "Feature to Point" tool under Data Management Tools in order to generate points at the Centroid of each feature.

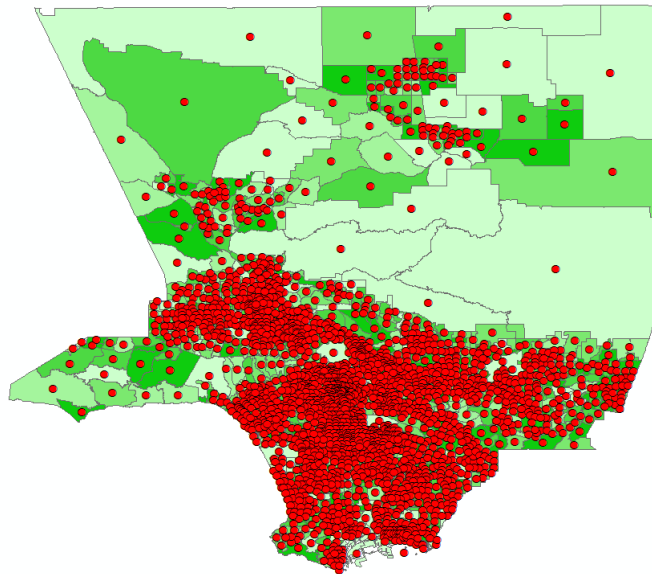


Fig.3 Centroids to determine location to each Urgent Healthcare Facility

Segmentation:

The data obtained post performing the geographical analysis was too generic and needed to be refined in order to obtain the essential traits of the living population. These characteristics would help make conclusions about the population likely to be more susceptible to the requisition of such facilities. Segmenting the population provides accurate data based on the desired characteristic. It also indicates the areas of focus in order to bring changes to the obtained results. The trait chosen in this case was age. The available data had ranges 0-5 years, 5-10 years, 10-15 years and so on. The team decided to integrate all these ranges and add general terms to them. Eventually, the population was divided into three age ranges-

Children : 0 to 20

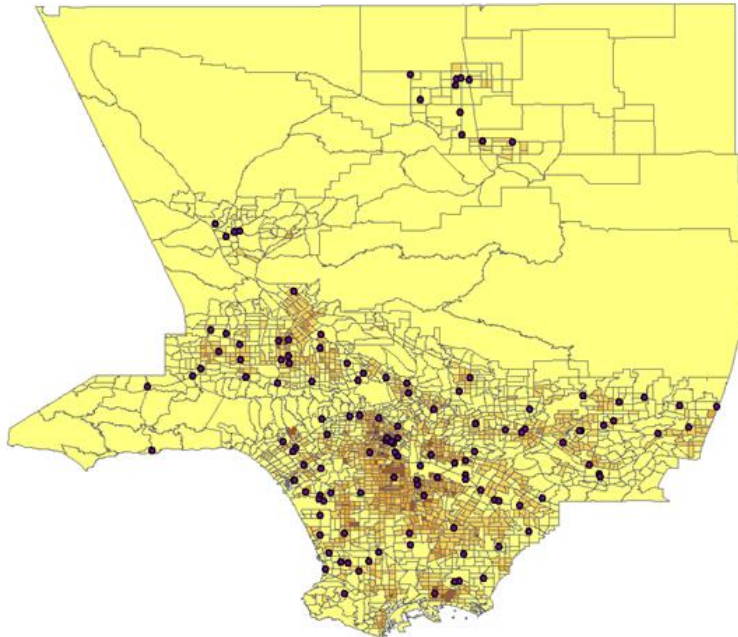


Fig.4 Population Segmentation age between 0-20 years

Middle age : 20 to 50

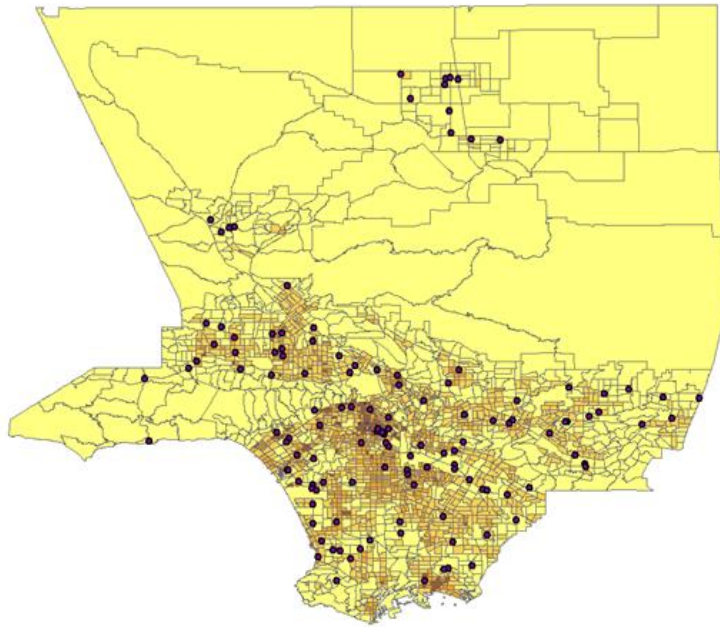


Fig.5 Population Segmentation age between 20-50 years

Old aged : 50 to 95

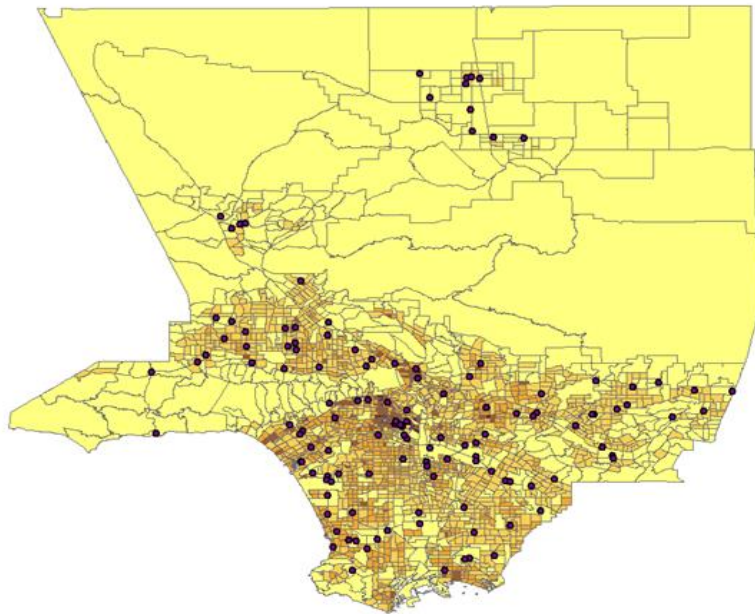


Fig.6 Population Segmentation age between 50-95 years

This segmentation helped us seek the more prone age range. In order to perform segmentation, we made use of queries to build an expression and classify the ranges. We made use of Attribute table to integrate available ranges and build new columns. The tool used was Field calculator. Eventually, we combined ranges 0-20 years, 20-50 years, and 50-95 years. The end result obtained was a choropleth map showing population density of the three segments along with centroids for each census tract and presence of Urgent Healthcare Facilities.

Buffer:

Buffers help create buffer polygons around one or more input features. The radii of the buffers are variable and could either be 1 mile, 3 mile or 5 miles. We constructed buffers around the centroids in order to spot different Urgent Healthcare Facilities present in that particular buffer. Also, buffers helped determine which centroid to consider while calculating distance from each facility. Buffers were created using the Editor menu, post selecting the desired feature we wanted to create it around. The target layer was a polygon and the distance for the radii was included in map units to build the buffer.

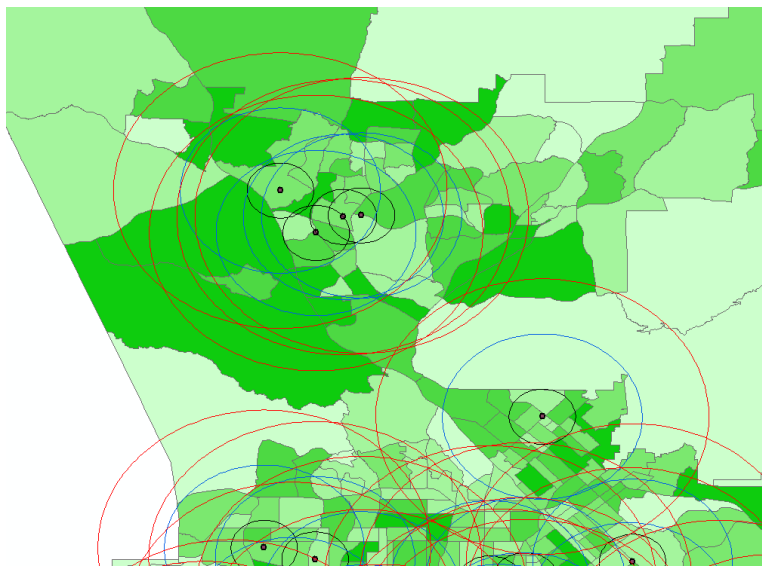


Fig.7 Buffer of 1 mile, 3 miles, 5 miles around the centroid

Network analysis:

Network analysis uses various network datasets to obtain a network model with innumerable routes. This analysis can be used to determine the cost of accessing a route in terms of distance and time. We chose to use the Closest facility feature as an integral part of our analysis. This feature accommodates both distance and time to calculate nearest facility. A ten minute time buffer was set to plot census tracts that are closest to a particular urgent care facility of interest. This analysis provided a combination of each centroid with each facility, thereby providing too many results. We narrowed it down to determine the regions with maximum and minimum facilities.

Children Segmentation: Required Urgent Facilities in areas: Wilmington and San Pedro

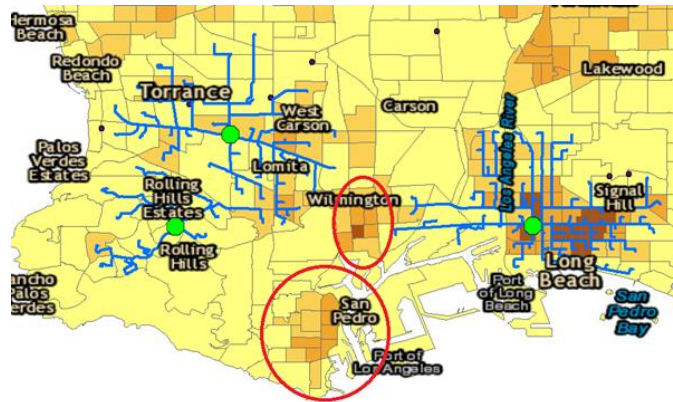


Fig.8 Network Analysis for required Urgent Facilities - Children

Middle Aged Segmentation: Required Urgent Facilities in areas: Sunland and Montrose

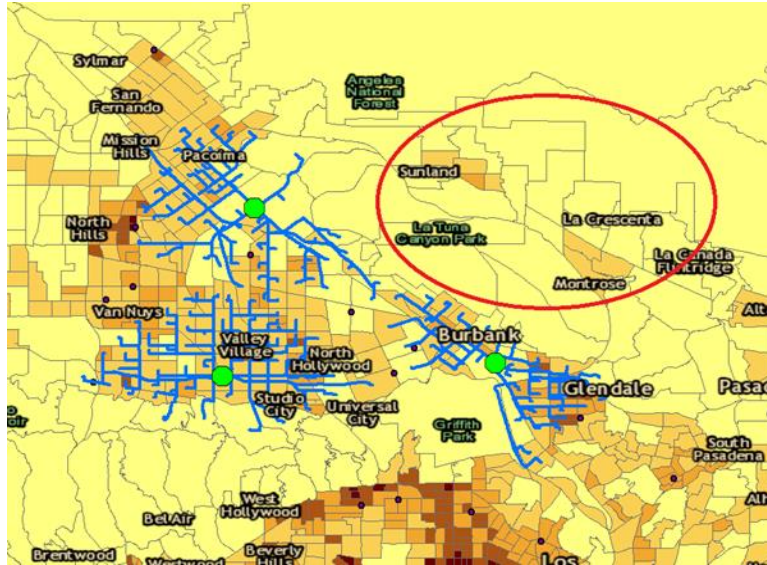


Fig.9 Network Analysis for required Urgent Facilities - Middle Aged

Old Aged Segmentation: Required urgent care facility near Port Ranch

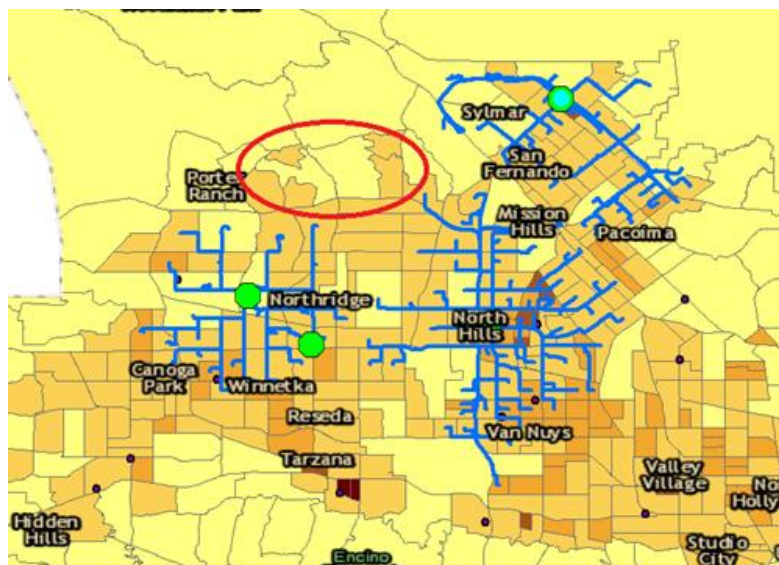


Fig.10 Network Analysis for required Urgent Facilities - Old Aged

Results/ Discussion:

The given study stressed on the analysis of the current Urgent Healthcare Facilities present in the LA county. The locations of each facility were recorded in order to depict if the number of facilities would suffice the living population in the county. The use of different methodologies such as buffers, network analysis, density analysis proved to be a pedestal to ensure that we reached the desired findings. There were a number of generic and technical outcomes derived in the given case including the following:

1. Representation of the population of LA county and corresponding Urgent Healthcare Facilities to obtain a direct relationship between the two variables.
2. Depiction of buffers in 1,3 and 5 mile radii in order to find the closeness of each facility relative to the region.
3. Choropleth map obtained after segmenting the population based on age.
4. Number of people in a particular age group that need more access to such facilities
5. Number of regions where presence of such facilities can be increased.
6. Relative time to access each facility.
7. Apt implementation of concepts in ArcGIS.
8. Proliferated skills that lead to efficient teamwork

However, dealing with the given project was not an easy work. The team encountered a number of challenges while working on some of the elements of the project . These included the following:

1. Foreseeing the problems that the population would face in times of emergency.
2. Techniques to effectively utilize the available datasets.

3. Dividing the integrated population into multiple segments.
4. Integrating the street data set along with the base map of LA County data.

For the research question, we researched on adequacy of Urgent Health Care facilities in LA county.

After conducting the children segmentation, we found out the areas Wilmington and San Pedro require Urgent Health Care facilities. For the middle aged segmentation, the areas Sunland and Montrose need Urgent Health Care facilities. And for the old aged segmentation, Port Ranch is the area that needs Urgent Health Care facility.

CONCLUSIONS:

After consideration of all the segments for Urgent Health Care Facility of LA County, we came to a conclusion that about 85,580 children does not have access to Urgent Health Care Facility in Wilmington and San Pedro areas. Similarly, about 31,200 number of middle aged population does not have access to Urgent Health Care Facility in Sunland and Montrose areas. Further, about 12,250 number of old aged population does not have access to Urgent Health Care Facility in Porter ranch area. Thus, summarizing for every segment we considered Urgent Health Care Facilities are required in 6 areas.

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