Exploring Ithaca TCAT Bus Stops with Voronoi Map

Minmin Jin (mj467), Giri Kuncoro (gk256), Min Xia (mx76)
TA: Josh Cohen

Overview

TCAT is a not-for-profit corporation that serves public transportation in Ithaca, Tompkins County New York. They are well run and many of the bus drivers are so helpful. As international students who use the buses regularly to travel to campus, downtown, and around the county, we also love to explore the county's beautiful nature, attractions, and most importantly: foods. By using Voronoi map, we visualized which bus stops serve more eating places and attractions that hopefully help students who do not have private cars explore great places in Ithaca with buses.

Data Description

Using the BeautifulSoup package, a library to pull data out from HTML files, we wrote Python script to collect the bus stop locations and schedule data as well as campus building locations from the web pages into json files. We also wrote another Python script to call Yelp API through OAuth protocol to collect food and drink places in Ithaca into json file. In summary, we obtained our data from three sources as below:

- TCAT Bus Official Website (www.tcatbus.com)
- Cornell Map (http://www.cornell.edu/about/maps/)
- Yelp (http://www.yelp.com/ithaca)

First, it is quite a challenge to collect data (screen scraping) from TCAT bus website due to complexity of their website. In the end of the crawl, we collected 442 bus stops that include the location coordinate, name of the stop, bus routes, area, and daily schedule. We ignore the bus stops that are not given location coordinate since they are not yet operated in service by TCAT.

Second, Cornell Map embeds numbers of campus buildings in their html source code. This consists of libraries, fitness centers, and other campus attractions. In the end, the script collected more than 480 buildings around campus area that include the name and location coordinate.

Finally, Yelp provides a very good documentation on accessing their API in OAuth protocol. By querying with keywords "food" and "drink" in Ithaca, the script crawled more than 330 food

places and 180 drink places in Ithaca. The data includes name of the place, location coordinate, number of reviews, rating, and review contents.

Visualization

Visualization1: Where is the nearest bus stop from my position?

The map shows the bus stop points in Ithaca. We use Voronoi to divide the Ithaca map into clusters. In mathematics, a Voronoi diagram is a partitioning of a plane into regions based on distance to points in a specific subset of the plane. That set of points (called seeds, sites, or generators) is defined beforehand, and for each seed there is a corresponding region consisting of all points closer to that seed than to any other. These regions are called Voronoi cells.

In addition, we add another layer on the map to show the number of surrounding facilities near each Voronoi cell. The number of buildings are represented with different colors, for example, green cells mean there is only one building around the specified bus stop and red cells mean there are more than ten buildings around the bus stop. Users can click the checkboxes on the top right to filter the buildings or the blue button to decide whether to show the buildings.

We also integrate a geolocation API to locate the user's current position on the map with a blue marker. If the user's position is beyond the range of Ithaca, the marker will automatically be put around Phillips Hall. Then if a Voronoi cell is clicked, the map will show a black boundary of that region and the corresponding bus stop name will appear on the left-bottom position of the webpage. The bus stop name is linked to another web page which provides details of that stop.

Visualization2: What can we know about this region except for the bus stop?

The second page linked to the bus stop name presents more details about its surroundings. The first part is a more accurate map of that area. The second part shows the name of that area and a button which can return to the previous web page. The third part displays the upcoming buses through the stop with routes and corresponding times. The fourth part provides a list of five nearest restaurants, including the restaurants' name, rating, category and review. The restaurant's name is a link which redirects to the yelp page of that restaurant.

Overcoming Challenges

The primary challenges in our project came from the fact that we wanted to incorporate a D3 voronoi diagram with street map of Ithaca and be able to interact with them in mobile phone or tablet. There are several challenges: improper map tile display, calculating number of buildings in the voronoi segmentation, and cross browser compatibility issue.

First, there is a very high chance (9 of 10 trials) that only half of the map is displayed in the bus stop information page (detail.html) when we open the web page for the first time. The potential reason for the problem is that leaflet.js does not render properly when the map container size is changed. Luckily, it provides a function invalidatesize() to deal with such kind of problems. After setting a timeout to call the function, the chance of the improper display is drastically decreased (approximately only 1 of 20 trials).

Second, the D3 voronoi library doesn't provide method to check if points are inside certain voronoi segments. We then use ray-casting algorithm to find a point lies within polygon that is drawn above the leaflet map layer.

Third, we were facing issue with cross browser compatibility (as many other web developers face). Our work was working properly in chrome, but when we tried to open in safari, firefox and browsers in iPhone, the voronoi drawings didn't show up. We then resolved the issue by replacing "includes" method in our Javascript files into "indexOf" which is more compatible with the other browsers.

Finally, we intended to show the real time upcoming buses for a certain bus stop at a certain time. We crawled data from Tcatbus website but it turned out that the data was not up-to-date and the result was not as practical as we expected. Since the problem is beyond our scope, we have no choice but using the old-dated data.

The Story

Our visualization answers useful questions to explore great attractions in Ithaca with TCAT buses: where is the nearest bus stop from my current location? Where are great restaurants that can be reached around these stops? Which bus stops have the most number of attractions? What time will my next bus arrive? TCAT bus stops information are not found in Google maps, their website is not intuitive, and Ride14850, an app for knowing bus direction is not reliable and only for iOS, so exploring Ithaca with buses are rather difficult.

The results are pretty much what we expect from Ithaca area. That is, more interesting places (restaurants and city attractions) are found in collegetown and downtown area compare to other bus stops area. We were also amazed that TCAT bus serves until the greater Tompkins county area, notice the dots far away from Cornell campus in the outer ring of Tompkins.

We envision our work to be used to find new restaurants to try. For example, we would select one of the voronoi segment and click the bus stop information to find out what kind of restaurants we could try if we stop here. We can also check what time the next bus will come, so we can estimate our dinner/lunch there. It will be great if we could know what bus routes and where to transit to get to the place, but we ran out of time.

Overall, we think the visualization is useful, functional, and aesthetically pleasing. Although we would like to include several more features if time permits such as direction from current location to selected bus stops (using bus routes) and attractions information apart from nearest restaurant in bus information page, we are very happy with the final result. Lastly, you can also explore our work here http://tcatbus.github.io from desktop or mobile phones.

References and inspirations

- D3 voronoi method: https://github.com/mbostock/d3/wiki/Voronoi-Geom
- US airport voronoi: http://bl.ocks.org/mbostock/4360892
- Voronoi map with d3 and leaflet: http://chriszetter.com/blog/2014/06/15/building-a-voronoi-map-with-d3-and-leaflet/
- Point in polygon: https://github.com/substack/point-in-polygon
- Data source:
    - Cornell map & direction: http://www.cornell.edu/about/maps/
    - Tcat bus: http://tcat.nextinsight.com/allstops.php
    - Yelp API: https://www.yelp.com/developers