1.1 Project Title: Lock My Bike

A Website enabling bicycle riders to filter a geographic area for bike racks.
By Nicola Belliardi

1.2 Capstone Category and Related Courses

This capstone project falls under the web development capstone track;
below the Harvard Extension Courses related to it:

- CSCI E-12   Website Development
- CSCI E-3   Web Programming/JavaScript
- CSCI E-79   Art and Design of Information
- DGMD E-20   Mobile Front-End Design I
- DGMD E-25   Web Content Management Systems

1.3. Project Goal

Lock My Bike answers rider's need to easily locate bike racks available around them. In a city like Boston, bike parking locator applications are available to bike-sharing users who do not **own** their bike, but happen to rent it from commercial services such as Blue Bikes or Lime. No resource currently maps the racks available to private bike owners throughout the Boston hub; and being Boston a heavily bike-trafficked city - my capstone's target audience, based on data by the city of Boston, is potentially 40,000 daily-trips strong[1].

1.4. Learning Goals

The creation of a website, cross-device compatible, requires the mastering of several technologies; some of them libraries and frameworks that make most of the hard-coding something already at least partially taken care of, therefore allowing the author to focus on the novel aspects and core features of this project.

---

[1] "Bike Data." *Boston.gov*, 19 June 2018, www.boston.gov/departments/boston-bikes/bike-data.

In particular, Jquery and Jquery UI are technologies that power up the behavior aspect of my website, all while making sure it is mobile compatible. Whereas, for structure and styles I plan on relying on a content management system such as wordpress, I plan on recurring for additional look tune-ups to CSS-framework Bootstrap or alternatively BoldGrid and its very Bootsrap-like grid layout structure which comes with the Wordpress installation package.

Lastly, the dynamic visualization of bike racks in the shape of markers and tooltips on a map can be achieved through the use of Leaflet, an open-source Javascript library that enables data visualization on a map.

All in all, many resources to choose from - and a rewarding learning opportunity.

1.5. Elevator Pitch

Bicycle owners love their means of transportation, after all it's their bike which enables commute trips or just weekend bike escapades. Lock My Bike allows riders to locate, from desktop and cellphone, locking stations available within their area, supplying them with additional information such as costs (or lack thereof), dock overall conditions and whether the station is guarded or not.

With my experience in web development, and attention to a friendly and visually pleasing interface, I can deliver an in-demand service with the potential to grow from the initial Boston target area.

1.6. Target Audience, Personas & Empathy Maps

Although it is hard to quantify the users pool size my website could benefit, a starting point is to look at bikers numbers in Boston.
Based on data available on the City of Boston website for the year of 2017, an average of 40,000 bike trips are taken every day in the city[2]; this number, although only partially indicative of the total number of bikers on the road, represents more than 10% of the total vehicle trips taken during the same timeframe[3].

---

[2] "2017 Boston Bicycle Counts." Boston.Gov,
https://www.boston.gov/departments/boston-bikes/bike-data/2017-boston-bicycle-counts. Accessed 25 July 2019.
[3] "2017 Boston Bicycle Counts." Boston.Gov,
https://www.boston.gov/departments/boston-bikes/bike-data/2017-boston-bicycle-counts. Accessed 25 July 2019.

Capturing even a small share of those bike riders through social media promotion, along with a collaboration with the Boston Transportation Department (BTD) which has declared its interest in the project, can represent a sizeable site traffic volume; large enough to make the project worthwhile.

Data on the user base demographic is scarce, just as accurate statistics on bike trips numbers are. Still, it is inferred by data again provided by the City of Boston, that there has been a significant shift in commuting habits of Bostonians - namely between 2006 and 2016 the number of people biking to work has increased by 180%[4].

The Boston bikers community is extremely diverse, and along with commuters we can profile several other types of users that are likely to travel to/from and within the hub:

- Delivery workers (for restaurants and applications)
- Casual bikers with irregular ride patterns, unlike commuters

All of these riders personas have common needs that can be again summarized with a bulleted list:

- **Safe storage.** Some bikes are expensive, so a reasonable expectation to retrieve one's bike is a must
- **Ease in access.** Is the stations functional, broken or frequently crowded?
- **Cost, if any.** Is the rack free to use? If not, how much does it cost?

How does Lock My Bike answer those needs?

Lock My Bike aims to provide the platform users previously described (in an effort to exemplify these categories I may have forgotten a few), with enough information to allow them to make an informed choice about where they want to park their precious two-wheel rides.

---

[4] "Bike Data." *Boston.gov*, 19 June 2018, www.boston.gov/departments/boston-bikes/bike-data. Accessed 14 November 2019

What do riders seek from a bike-rack locator tool and how does Lock My Bike position itself in relation to these goals/expectations?

The website average user is moderately computer savvy, as much as someone using google maps could be. They expect to access a dock-locator tool on the fly, that is why the seamless navigation of the website from mobile is a paramount development goal.

The platform is easy to use, riders have only one goal in mind: finding a docking station and quickly sift through their available options. A minimalistic design for the website is the most coherent choice for a task-oriented resource such as Lock my Bike.

Fictional user profiles and empathy maps

I have outlined 3 profiles of Bostonian riders following the empathy map model[5]. Each profile is associated with 4 different quadrants: *says*, what the biker expressly wants from the service - data like these come from surveys for example; *thinks*, what the rider thinks but does not necessarily say because of a variety of reasons (for example fear of being judged); *does*, how he behaves typically and finally *feels*, what emotions he experiences as he interacts with the service.

- Tom bike TO work

---

[5]Bland, David. "What Is an Empathy Map?" SolutionsIQ, 21 Apr. 2016, www.solutionsiq.com/resource/blog-post/what-is-an-empathy-map/.
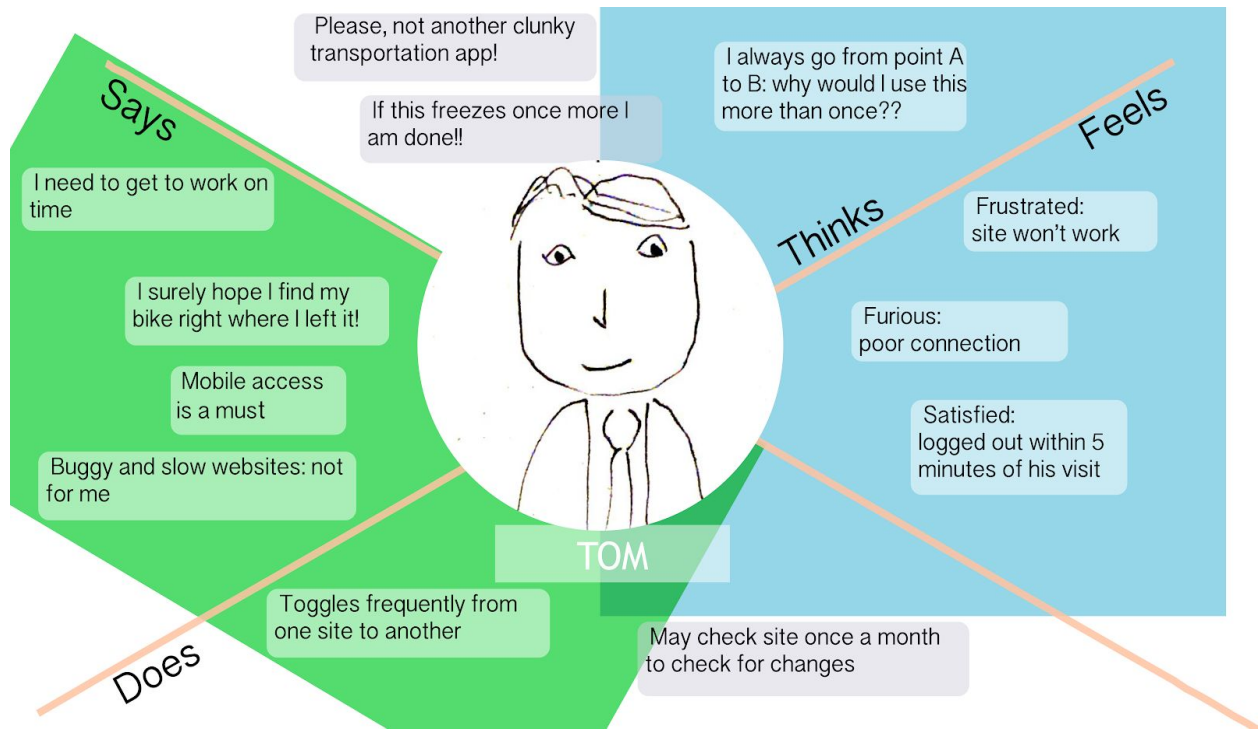
Figure 1. Empathy map for one of the website users personas: Tom, a biker who commutes to/from work every weekday.
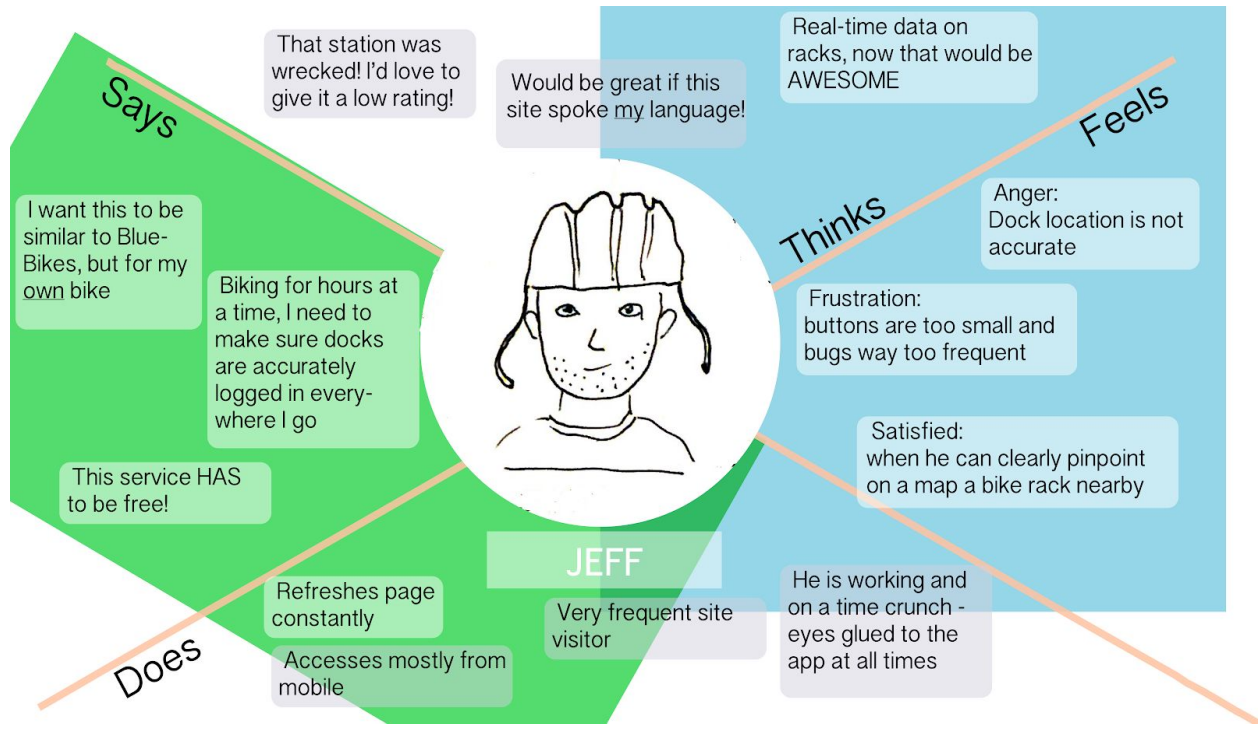
- Jeff bikes FOR work

Figure 2. Empathy map for one of the website users personas: Jeff, a biker who uses the website as he completes deliveries for a delivery mobile application.

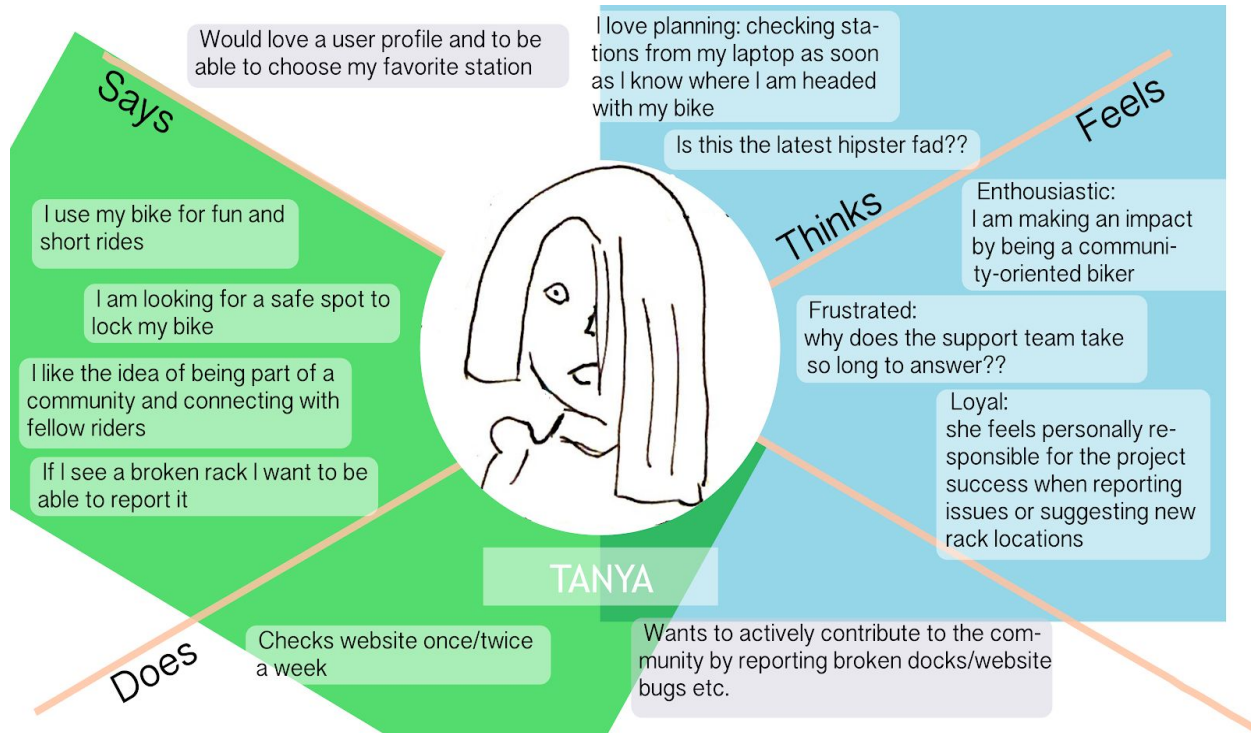- Tanya bikes on weekends, each time to a new neighborhood.

Figure 3. Empathy map for one of the website users personas: Tanya, she uses the website as a complement to her recreational bike rides.

I have recruited several testers to help me gather feedback on the several iterations my process will go through. They fall within the profiles aforementioned and will surely provide additional insight about our target users as I watch them interact with the website.

1.7. Metrics, Rubric and User Survey

Project Rubric

Despite categorizing a capstone as successful or unsuccessful isn't always black and white, with the following rubric I have outlined 5 levels of performance; each with specific and relevant standards - whether they are met or not determines the ranking of the project.

Criteria\Performance Level	Does not meet expectations	Barely meets expectations	Average	Successful	Very successful

Value proposition	Copy and website content make purpose of website unintelligible.	Purpose of website is outlined but unclear or outright confusing.	Understanding of website goal is clear to users.	Service is market-ready, with copy effectively promoting the intended website goals.	Content is proofread and website mission effectively advertised upholding high marketing standards.
Mechanics/behavior	Lousy coding leads user to frequently refresh browser window and eventually leave the website. Navigation/links are broken.	Navigating the website is possible but bugs prevent the website from performing some tasks.	Navigation is smooth and behavior of the website work as intended.	The website mechanics not only work but code is elegant and maintenance-ready thanks to thorough comments. Site has been tested for glitches.	Website mechanics work under all conditions, including heavy traffic. Security is factored in the coding and website and data stored is within reason breach-proof.
Layout	No styling is applied except for default browser rendition. Page layout works against goal-oriented use of website.	Styles are randomly and/or sparsely applied. Page layout does not respect industry common practices.	Page layout meets industry standards for the website category. No user feedback was collected on the website appearance.	Website is shaped by user's feedback and follows best practice/trends in web development. Layout adapts to viewport.	Website is a style trend-setter in its category. Seamless and eye-pleasing navigation experience from all devices.
Usability	Interacting with website is a confusing and frustrating experience. Attention is focused on page structure and none on the end-user.	Users can guess how the website works, but all elements do not contribute to a user-friendly experience. Navigation from other devices is not implemented.	Little cognitive load is requested from the user to use the website. No effort to improve accessibility is implemented. Website is cross-device compatible but navigation is clunky.	Users' and UI experts feedback has contributed to shaping the website; it is accessible. Features are easy to find and no section is more than 2 clicks away.	Design affordances make the website flawless to navigate and fully accessible. User-friendly platform for users from different age categories and not only necessarily for the computer savvy.

Table 1. Capstone rubric: measuring the project success in relation to five criteria.

User Survey

The following survey will be presented to test users via a free google form.

1) Was the purpose of the website clear to you?

2) Did you find the website easy to use?

3) If you answered no to the previous question, what didn't work as you expected?

4) Does the website effectively provide the service it purportedly offers?

5) If you answered no to the previous question, explain why

6) Were you able to smoothly access the website from different devices (tablet, phone, desktop, etc.)?

7) Please comment on the look of the website, what did you like about it and what would you like to change?

8) What did you love the most about your experience on the website?

9) How likely are you to recommend this service to friends and/or family members?

10) What features would you like our development team to include in a future release?

2. Competitor Review.

Although none of the services presented in this chapter offers search capabilities for publicly available bike parking spots, the selection below offers a glimpse of comparable technologies from which I have gleaned ideas and drawn inspiration.

In the following paragraph I will provide a description of said technologies, along with pros and cons. Finally, I will summarize and compare features in a simple chart.

Boston Bike Parking on Google Maps

Link here, or copy and paste the below URL:
https://www.google.com/maps/d/u/0/viewer?ie=UTF8&om=1&source=embed&oe=UTF8&msa=0&mid=16COZks u1VP_zbBgFgs_IYvUVYr8&ll=42.31870116435869%2C-71.09612349999998&z=12
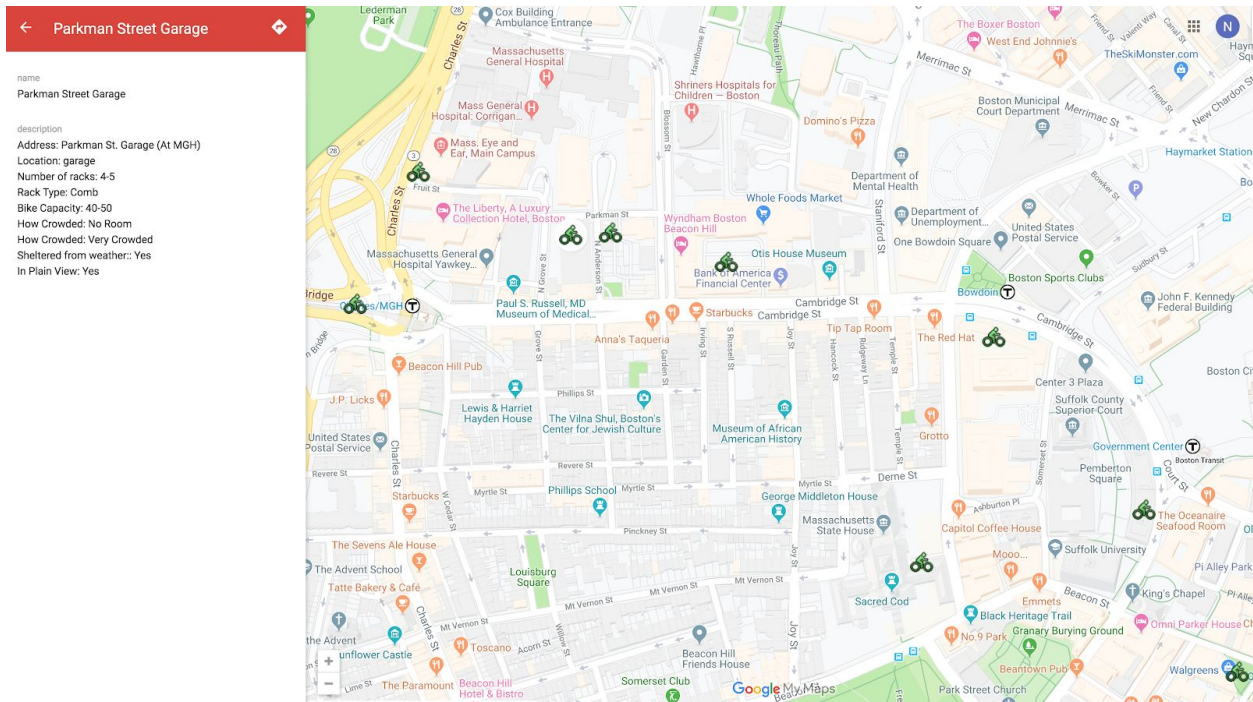
Figure 4. Screenshot from the Boston Bike Parking map, the aside on the left details some of the information of a single bike rack that has been selected.

This sublayer of google maps benefits of the immediacy of use and pleasing layout inherited from the Google Maps platform. It is the only current online resource available to look up public bike racks.

It is easy and intuitive to navigate and, upon clicking on the bike icon, the user is shown several information about the bike rack including critical ones - such as how crowded a station is, or whether it is sheltered.

There are few cons to this website: first of all, the map can be filtered based on the address, but won't list the racks near you, it will instead center the map with boundaries around the area you searched. Lastly, few stations are logged in the system. To be exact they are currently 57 and there is no possibility for bikers to log new ones.

Bottomline: this is a fantastic public resource lacking chiefly better bike parking search capabilities.

Blue Bikes

Link here, or copy and paste the below URL:
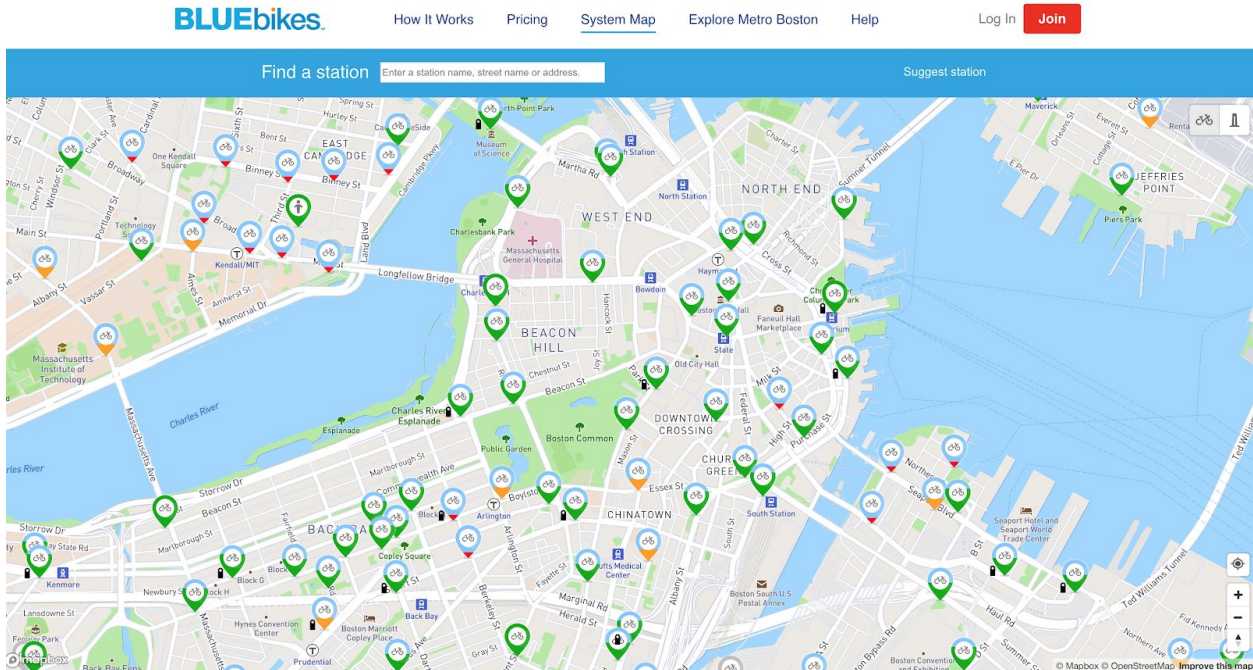**https://member.bluebikes.com/map/**

Figure 5. Screenshot from the Blue Bikes website. This particular view shows an overview of the dock network and occupancy level (color-coded within the dock pin marker)

Bluebikes, formerly known in Boston as Hubway, provides an unparalleled user experience - both online and on the app. The extensive dock network owned by this company is neatly displayed with visuals that also embed with a simple color-coded system the current parking availability at any dock.

While the wealth of real-time information about docks, and the appealing design set BlueBikes as the standard of every bike station locating tool, it is worth noting that unfortunately it tracks only stations part of its network.

Bottomline: a modern and clean commercial solution for bike rental from which a free and publicly-available resource can borrow a lot as far as look and user experience.

Lime Bike

Link here, or copy and paste the below URL:
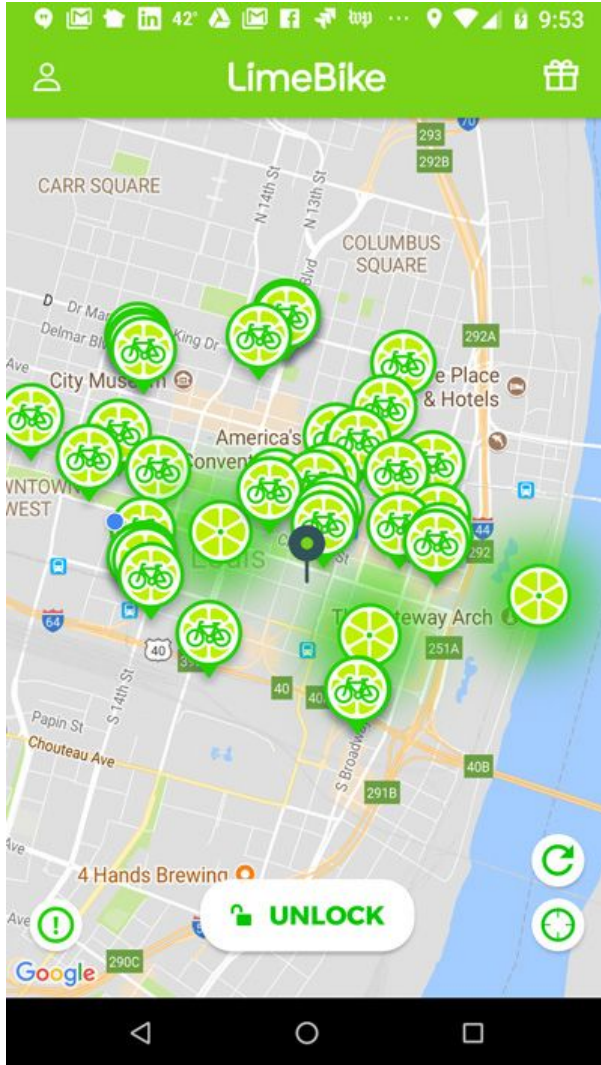https://www.li.me/en-us/home

Figure 6. Screenshot from the Lime mobile application. This is an overview of vehicles available in proximity of the user.

Lime is yet another bike and electric scooter company which has started operations in the Boston greater area. Similarly to BlueBikes, it offers a real time way to monitor its inventory - this time bikes, and not racks - as lime offers riders an entirely dock-less experience.

Using Lime is yet again another user-friendly and visually pleasing experience. Surprisingly, finding a bike is not possible from the desktop website, but exclusively through the app which allows access only to registered users.

Bottomline: captivating design and easy-to-use features make Lime a valid alternative to BlueBikes. Because of Lime's offer of scooters and focus on the mobile app, its reach is limited to a younger segment of riders' population.

Feature comparison chart

In the table that follows Lock My Bike and three other services are compared based on 10 different features.

Features	BlueBikes	Lime	Boston Bike Parking	Lock My Bike
Cross-device compatible	✓	X	✓	✓
Finds a parking near you	✓	✓	X	✓
Provides real-time info on available parking	✓	✓	X	X
Lists public bike parking	X	X	✓	✓
Provides info on type of rack, safety overview etc.	X	X	✓	✓
Free to use	X	X	✓	✓
Mobile App Optimized	X	✓	X	X
Gives tools for users to report racks new to the network	X	X	X	✓
Large number of racks recorded (100+)	✓	✓	X	✓
*Tentative Bonus Feature: rate a station	X	X	X	✓

Table 2. Chart of features comparison.

3. Technology Requirements/Resources

Several technologies will contribute to the realization of the Lock My Bike project.
In this section I provide a list of the resources which I will use, along with how they contribute to the project and their pros and cons relative to alternative solutions.

- ## CSS, bootstrap and BoldGrid

  DGMD E-20 Mod, Mobile Front-End Design I

  CSS takes care of all styling aspects of the website. To diminish the amount of hard-coding I can take advantage of the BoldGrid layout builder which comes with the *Wordpress.com* downloaded package, or disable the Wordpress default styles and remove Boldgrid, loading instead on the website the Bootstrap framework which simplifies portability from desktop to mobile environments. In addition to the aforementioned tools, I can also leverage the capabilities of Jquery UI, a JavaScript library which provides a very easy to deploy "theme roller", a ready-made customizable website design template.

- ## HTML

  CSCI E-12 Website Development

  Responsible for the structure of the capstone. My desktop-native project can't do without the semantic nodes hallmark of HTML 5.

- **Javascript**

  CSCI E-3 Web Programming/JavaScript

  This scripting language is the motor of every behavior/action within "Lock My Bike". From actively interpreting what address the user is typing in the search a bike dock station, to dynamically manipulating the DOM - JS is my weapon of choice.

- **Jquery**

  CSCI E-3

  Building on the previous paragraph, this Javascript-based library too provides with the high-potential DOM manipulation and animation features of JS - only with a simplified and lighter coding workload. Jquery in particular enables a less Javascript-intensive way to run AJAX calls from the client to the server allowing thus the retrieval of data (in this capstone case, information about the bike racks) stored in JSON files.

- **Jquery UI**

  CSCI E-3

  This collection of widgets and user interface animations/interaction can simplify the otherwise laborious task of creating from scratch tools such as, among others, sliders and calendars. For the scope of this project I may not rely on Jquery, but is nice to know that need be some ready-to-use and tastefully styled solutions can be implemented with the simple inclusion of a cdn link to Jquery UI in the head of the HTML page and a few lines of script.

- ## JavaScript Object Notation (JSON)

  CSCI E-3, CSCI E-12

  Even though my knowledge of JSON is limited to few modules that were included in the courses listed in the subtitle, I have identified in this data formatting system the ideal vehicle for the information I intend to encode along with every bike rack location. To be more precise, the type of data encoding that will be used for this project is GeoJSON, a format used to encode mainly geographic data structures. An example of information I would like to include as attribute-value pairs are for example: address, latitude and longitude coordinates, type of rack, institution responsible for its installation etc.

- ## Leaflet

  Leaflet is a convenient way to visually represent data and related information on a map. It is a library based on Javascript and it is free to use which is its main advantage when compared to similar solutions available on the market. There is also a Leaflet plugin which can be installed on wordpress but it seems somewhat limited in comparison with the full package downloadable directly from the Leaflet website.

  There is a thriving plugin environment developed to support Leaflet that is freely available online. I intend to install some of these extensions, as they greatly extend the framework core functionalities.

  There are alternative solutions to Leaflet, such as D3 - another Javascript library strongly geared towards data visualization but with a steep learning curve - and Arc CIS - a subscription-based mapping tool.

  Regardless of the technology chosen, I possess no prior familiarity with these tools but I intend to acquire it by reading the carefully compiled documentation available online.

- ## Dreamhost

  CSCI E-12

  Web hosting provider used to register the "Lock My Bike" domain and host the webpage. There are numerous alternatives, but Dreamhost ranks as one of the most cost-effective solutions.

- **Wordpress**

  DGMD E-25 Web Content Management Systems

  This Content Management System may not allow as much flexibility as building a website from scratch, but its out-of-the-box features allows me to worry less about trivial details such as button styles, and focus on the site behaviour. One additional interesting Wordpress capability is how it allows to easily introduce different levels of website access (and with it restrictions and authorizations) that could be useful if, for example, I allowed users to create their own profiles with which to save their favorite stations, rate them and leave comments.

- **Sublime Text - or similar IDE**

  DGMD E-20

  A free to use code editor with basic live preview features (for taking a peak at your webpage locally), useful command auto-completion and check for brackets left open.
  There are several alternatives to this IDE, such as Komodo but the differences between editors are of little relevance to the scope of this project.

- **Cyberduck**

  Used throughout all of the HES graduate program

  A free to use FTP client with several alternatives on the market, one of them being Filezilla; which one to use boils down to personal preference.

4. Design Workflow

As riders/users access www.lockmybike.com, thanks to Wordpress/BoldGrid/Bootstrap baked-in multi-platform compatibility code they are presented with different layouts, the choice of which depends on the device they are browsing from.
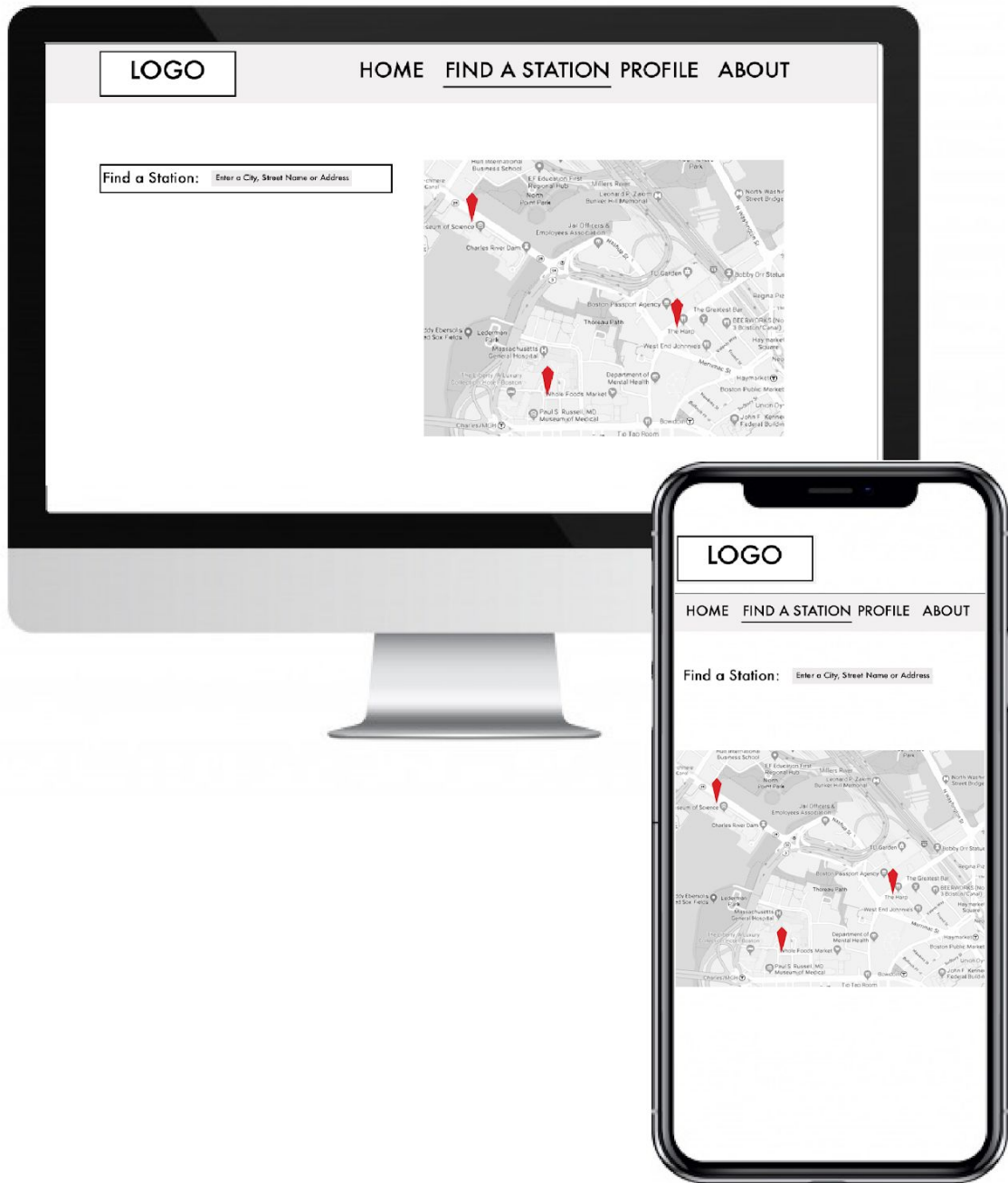
Figure 7. Mockup of Lock My Bike loaded on desktop computer and mobile device.

Below, a visual sketch representing which technologies and processes work together as soon as the user types an address in the search tab on the *Lock My Bike* interface:

Find a Station: Enter a City, Street Name or Address

JQuery runs an AJAX Call to the JSON File containing bike racks data

DATA encoded in the JSON file

```
{
"address" : "443 Boylson Street",
"zipcode":"02116",
"quantity": 2,
"lat":"-71.0729",
"long':"42.35132",
}
```

Leaflet

Leaflet, a Javascript-based library, takes care of the mapping of data-points so that the end-user can visualize docking stations right where they belong - a map!

Find a Station: 02114

Figure 8. Exemplified scheme of how bike racks data are dynamically served to the client as the user launches a query on the site.

19

In the process described above, Jquery (and not Javascript because of its easier setup of AJAX calls) is tasked with the heavy lifting of: establishing an AJAX request to the web server, requesting the bike rack data stored in the GeoJSON file (referred here for sake of simplicity as JavaScript Object Notation file - or JSON) and eventually presenting them in an easy-to-read format for the viewer - all without the need to reload the page.

A behind-the-scenes explanation of how Jquery AJAX calls work is represented in the drawing below:
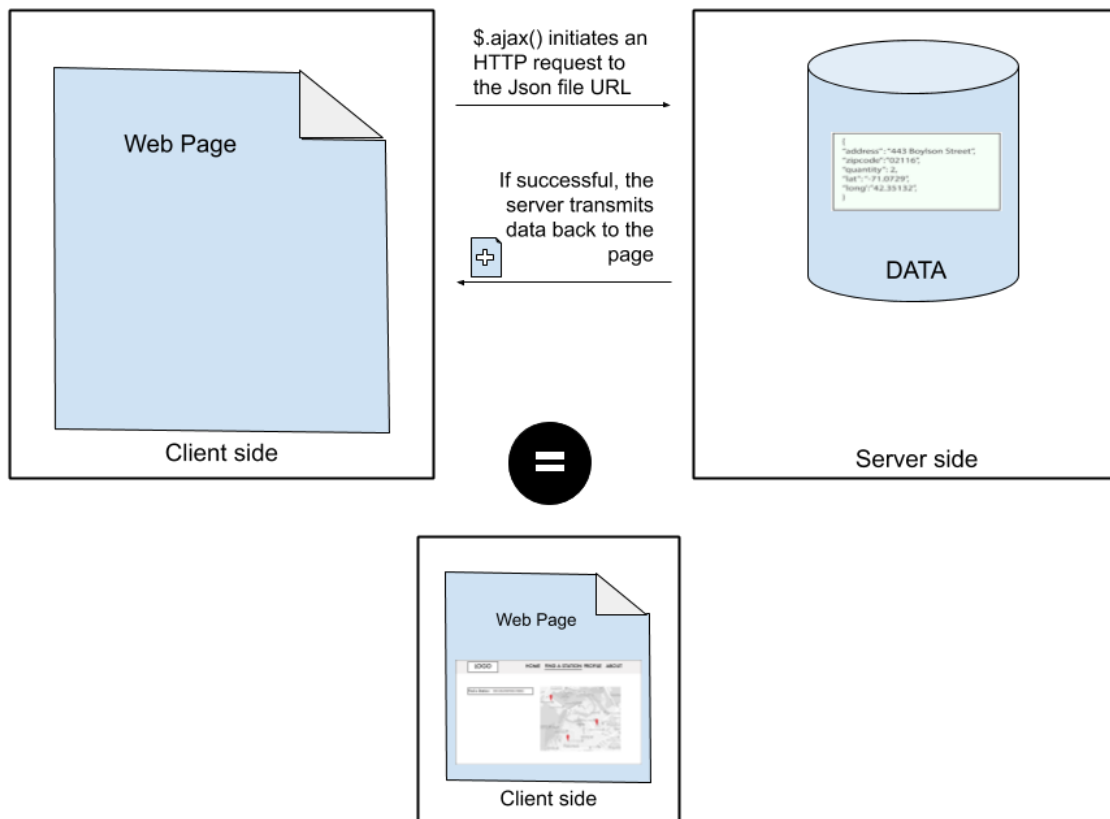

Figure 9. Drawing exemplifying the Jquery AJAX request sent to the server, and the process with which the JSON encoded data fetched is then displayed in a user-readable way on the page.

5. Mockups and User Journey

Lock My Bike, wire-framing user interactions

Joshua is almost done with work, he's planning to bike to a new gym, but is unsure of whether there are bike racks near it that are both secure and not too crowded.

STEP 1: Joshua's research journey starts on his desktop when he logs to lockmybike.com. The homepage is straightforward: it contains only 3 tabs and a footer.

STEP 2: Upon landing on the home, Joshua clicks on the "FIND A STATION" tab, he intuitively connect it with the task he has in mind

STEP 3: Joshua can now type the details about his destination area that he's most familiar with, say it's the area near the Boston Sports Club in Cambridge.

Joshua types...

Find a Station: 02139

STEP 4: He's presented with several options under the zip code he provided. He can browse whichever station he prefers based on the additional info he has found (sheltered rack y/n, usually busy)

Upon clicking on the pin, more info are presented, alongside with, in some cases, a picture of the docking station.
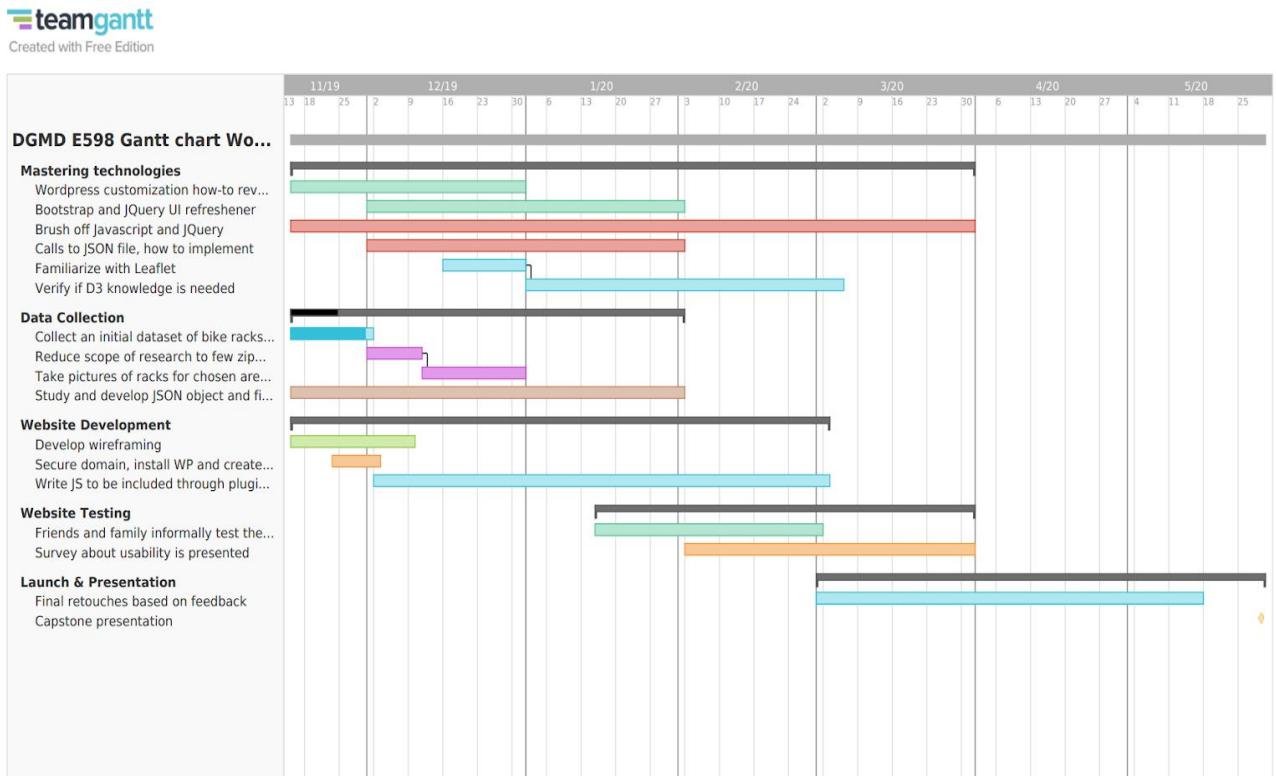
6. Work Plan and Milestones

Figure 10. Gantt chart representing high-level summary of tasks from November 14th, 2019 to the capstone presentation in May 2020. (created with Teamgantt free edition - www.app.teamgantt.com)

7. References

● "An Open-Source JavaScript Library for Interactive Maps." *Leaflet*, www.leafletjs.com/. [Accessed Nov. 19. 2019].

● "A Sophisticated Text Editor for Code, Markup and Prose." *Sublime Text*, www.sublimetext.com/. [Accessed Nov. 19. 2019].

- Bland, D. "Agile coaching tip – What is an empathy map?" 21 April 2016. Retrieved from https://www.solutionsiq.com/resource/blog-post/what-is-an-empathy-map/ [Accessed Nov. 19. 2019].

- "Blog Tool, Publishing Platform, and CMS." *WordPress*, www.wordpress.org/ . [Accessed Nov. 19. 2019].

- "BlueBikes Boston Network Overview." *Bluebikes*, https://member.bluebikes.com/map/ . [Accessed Nov. 19. 2019].

- "Boston Bike Parking Map." *Google My Maps*, Google, 0AD, www.google.com/maps/d/u/0/viewer?ie=UTF8&om=1&source=embed&oe=UTF8&msa=0&mid=16COZksu1VP_zbBgFgs_IYvUVYr8&ll=42.31870116435869%2C-71.09612349999998&z=12 [Accessed Nov. 19. 2019].

- "CSS w3schools Website." *CSS Tutorial*, www.w3schools.com/css/default.asp . [Accessed Nov. 19. 2019].

- "Free JavaScript Training, Resources and Examples for the Community." *JavaScript.com*, www.javascript.com/ . [Accessed Nov. 19. 2019].

- "GeoJSON." *GeoJSON*, geojson.org/. [Accessed Dec. 7th, 2019].

- GmbH, iterate. "Cyberduck: Libre Server and Cloud Storage Browser for Mac and Windows with Support for FTP, SFTP, WebDAV, Amazon S3, OpenStack Swift, Backblaze B2, Microsoft Azure & OneDrive, Google Drive and Dropbox." *Browse with Cyberduck on MacOS and Windows*, www.cyberduck.io/. [Accessed Nov. 19. 2019].

- "Introducing JSON." *JSON*, www.json.org/. [Accessed Nov. 19. 2019].

- JS Foundation. "Jquery Project Website." *JQuery*, www.jquery.com/ . [Accessed Nov. 19. 2019].

- JS Foundation. "Jquery UI Project Website." *JQuery UI*, www.jqueryui.com/. [Accessed Nov. 19. 2019].

- "Lime Bike Website." *Lime Micromobility | Electric Scooter and Bike Rentals*, www.li.me/en-us/home. [Accessed Nov. 19. 2019].

- Otto, Mark, and Jacob Thornton. "Bootstrap." · *The Most Popular HTML, CSS, and JS Library in the World.*, www.getbootstrap.com/ . [Accessed Nov. 19. 2019].

- "Online Gantt Chart Software." *TeamGantt*, www.teamgantt.com/. [Accessed Nov. 19. 2019].

- "w3schools HTML Tutorial Website." *HTML Tutorial*, www.w3schools.com/html/ . [Accessed Nov. 19. 2019].

- "What Is Web Hosting?" *DreamHost*, DreamHost, LLC, www.dreamhost.com/. [Accessed Nov. 19. 2019].