EcoMap: Urban Eco-Awareness by Visualizing Geographical Distribution of NYC Drop-Off Sites

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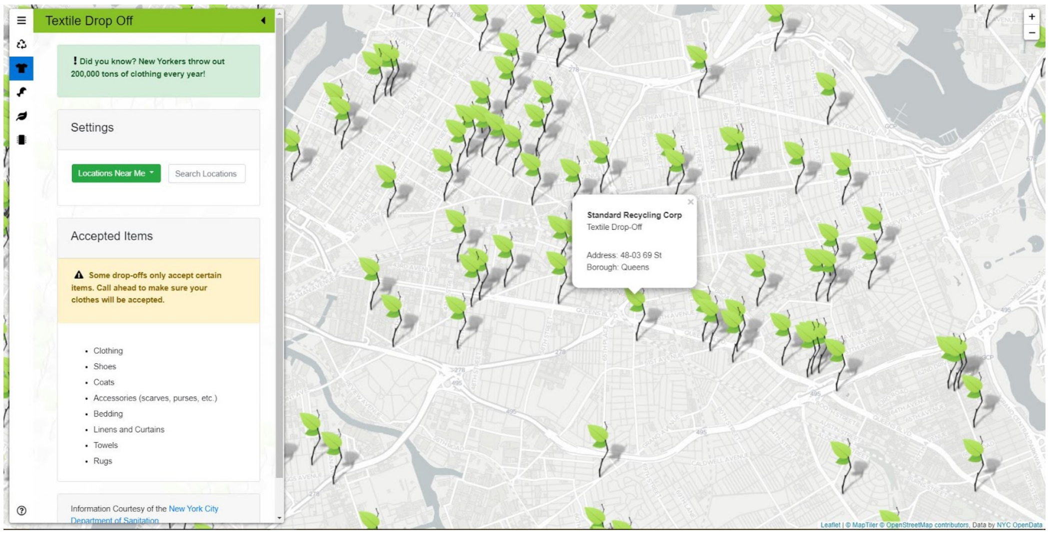

Figure 1. The final design of the EcoMap interface, demonstrating how users can use the side panes to search for special waste drop-off sites.

Abstract — For new and current residents of the New York City Metropolitan Area, it can be challenging to find available resources regarding proper disposal methods for special waste products. The New York City Department of Sanitation provides important data regarding drop-off sites for these special waste products and guidelines for disposal. EcoMap is an application that leverages this data in the form of an intuitive tool that allows users to increase their environmental awareness and find disposal sites in their area.

Introduction

For the average working adult, it is difficult to find eco-friendly methods of disposal for special waste products such as clothing, yard waste, food waste, and electronics. And for a newcomer to the city, it may be unclear what collection services are available for which materials. For this issue of unclear methods of special waste disposal, we propose EcoMap, an online geographic visualization tool that will allow users to find locations of public recycling bins and special waste disposal sites within the New York City Metropolitan Area. This tool will not only allow users to find convenient disposal sites but will also provide short guides to train users on the appropriate sanitation and disposal methods for recyclable goods.

The target demographic for this tool are young professionals, college students, and working adults living in or around the New York City Metropolitan Area.

The main goal of this visualization is to give working adults living in or around the New York City Metropolitan Area a way to increase their environmental awareness by providing a simple and intuitive tool which allows users to locate recycling bins, composting and drop-off sites in their area from data provided by the New York City Department of Sanitation.

G1. Help users locate drop-off sites for special waste materials.

G2. Make users aware of New York City guidelines for waste disposal.

G3. Increase environmental awareness in our target audience.

Our research question surrounding the development of this visualization concerns whether or not the weekly use of this visualization will aid working adults in reducing the number of special waste products improperly disposed of in a month. Does weekly use of this application lower the percentage of special waste products discarded by the user per month? In this case "special waste products" includes electronics, leaf and yard waste, food scraps, clothing, and other specified recyclables.

Our hypothesis is that weekly use of this application will both reduce the percentage of special waste products thrown away but will also increase the user's awareness of the resources available to them.

H1. Weekly use of the EcoMap application will decrease the percentage of special waste materials improperly disposed of per month.

H2. Weekly use of the EcoMap application will increase environmental awareness in users.

Data

Locational data is available courtesy of the NYC Open Data initiative, which provides free and public data published by the City of New York's internal agencies and external partners. Datasets concerning information about public recycling bins, litter baskets, and special waste disposal sites within the city of New York are provided by the Department of Sanitation (DSNY).

The DSNY also provides information on recycling laws and guidelines for apartment building residents, building managers, and schools. We consulted the DSNY's official website for information on how to get rid of harmful waste and electronics, and guidelines for recycling and donating goods for New York City residents.

Related Work

One feature meant as an extension to the original application was an expansion of the application to be used by elderly users. Work by Ganor provides insights on adapting user interfaces to the abilities of older users based on age-related needs and taking into account certain cognitive impairments. A few important design takeaways are that semantic detail and level of detail are important when choosing icons. There must be a close correlation between an icon's appearance and its function, and an icon must be as visually sparse as possible to increase response time in older users [1]. A part of the final user interface design, we used icons along the sidebar as buttons to filter locational data. This paper was a significant influence in choosing the appropriate icons. Another older publication by Hutchison also provides insights into how older users approach user interfaces. These insights include; text resizing or zooming capabilities for those aged 50 and older, large mouse targets and navigation features to take into account deteriorating muscle coordination, and simple screen design that will not frustrate those with little to no experience with web applications [2]. Much of Hutchison's insights were saved for implementation in future work because these elements would drastically affect the aesthetics of the application's sidebar plugin and would benefit from a separate "mode" for elderly users that would allow for larger text and icons.

Although some design consideration was given to elderly users, working professionals still remain as the target audience for the EcoMap application, as further "touch-based" design, which is out of the scope of his project, would have to be researched and thoroughly tested. But for our target audience, we have given further consideration to impairments or handicaps our users might have.

We found that the research paper by Singh provides relevant solutions to problems faced by users with memory or language impairments when encountering certain UI design elements. Unfortunately, for many of the proposed recommendations, such as auditory cues for lexical retrieval and screen improvements for attention deficits, we are not able to implement these into the existing design. But other measures can easily be implemented in the proposed interface, such as; concept icons for lexical retrieval, vocabulary limitations for memory deficits, and simple words and phrases for reading and planning deficits [3].

Implementation

Data

The data was cleaned using python libraries and placed into GeoJSON format, via a separate formatting routine, for integration into the map interface.

The data provided by NYC Open Data was spread across five different datasets. There were some inconsistencies in the location data, in that uncertain datasets contained more information than others. Each of the five datasets we worked with shared five common features: the name of the location, a street address, borough, and the longitude and latitude. But the textile and food waste datasets also contained useful information such as the date and times the vendors were open, the phone number associated with the vendor, and the items accepted at that location. There was a trade-off between allowing the markers from the datasets with more available information to display that information or to cut those columns and maintain data uniformity. It was ultimately decided to maintain data uniformity by only including common features of the five datasets. This decision was made because many of the extra columns contained large amounts of missing data.

The issue regarding data uniformity continued to guide data, which informed users of how to prepare their waste for disposal, as certain panes contained more information than others.

We were careful to cite our data source at the bottom of each pane. Since DSNY provides all of the data we need for the application a major design decision was how much data to include in the interface. For the final design, the interface only included data such as accepted items and any information that might affect a successful drop-off. Any other information was eluded to and links to the DSNY's website were clearly placed on the home pane.

User Interface

Bootstrap4 was used as the frontend framework in the place of pure HTML and CSS, it was a decision based on the past experience of the user interface designer. Its functionalities simplified formatting and allowed the use of design elements such as cards and modals.

The core feature of the user interface design is the sidebar. It acts as the main interaction tool for the user. It was built with the sidebar-v2 plugin, a responsive sidebar meant for easy integration with mapping libraries. The sidebar-v2 plugin was chosen because of its responsiveness and simplicity.

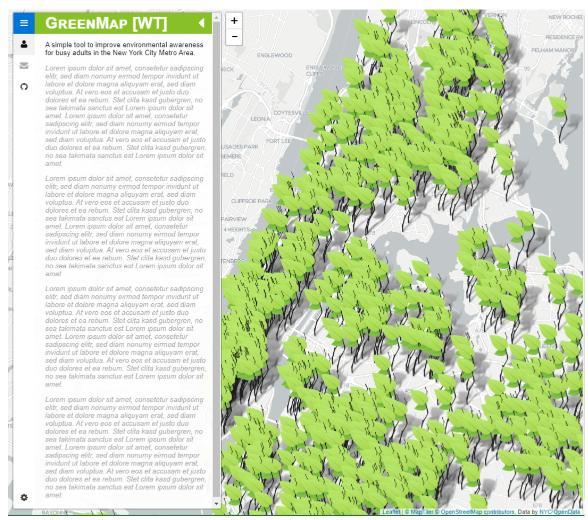

Figure 2. Initial v2-sidebar plugin with working application name.

Users can click on the logos along the side of the sidebar to filter drop-off locations and view information on how to prepare material for disposal.

Some elements of the Bootstrap framework did not work well with the sidebar-v2 plugin, which was very restricting to work with. For example, the logos used as the filter buttons along the sidebar were often misaligned and it was difficult to add CSS to elements within the sidebar panes without accessing the CSS the plugin was using and commenting out conflicting sections. The responsiveness of the sidebar was also not up to par, the header portion of the sidebar was not resizable. In the future, we would like to explore other options for the main interface.

Backend Features

The backend is based on Leaflet's JavaScript bindings with community plugins. It uses MapTiler's Positron tileset, the GeoJSON data format, and jQuery both for frontend-backend glue and to asynchronously load the data files from the server.

The two core backend features are layer swapping and layer filtering. Each location is placed into a layer according to its category (e.g. "compost drop-off" or "public recycling bin"), and these layers are swapped in and out as the user navigates the sidebar. Only one layer is visible at a time, to reduce clutter and confusion. Each sidebar rollout panel includes an interface for a keyword search and a proximity search. While an implementation of the proximity search is unfortunately missing from the supplementary code, the keyword search is fully functional. Upon pressing enter with any text in the search box, the currently-active layer is culled to show only the locations whose names contain all keywords, and the camera is zoomed to fit.

There are a few more features which were not implemented in time, but would be added before a public release. We consider the two most important of these to be the addition of a border which defines the bounds of our data, and an automated system which periodically pulls new data from OpenData and integrates it into the visualization.

Design Evolution

User Interface

The user interface was originally meant to leverage functionality over form, and that was a design decision that stayed in place throughout the duration of the project. The interface was kept simple and the implementation of the sidebar kept navigation fairly intuitive. No visual embellishments were added, the clean lines and a neutral color scheme were kept in place: whites, greys, and a light green which was color-matched to the green of the map markers. The concept for the aesthetic of the application was based on INaturalist and its environmental-based design.

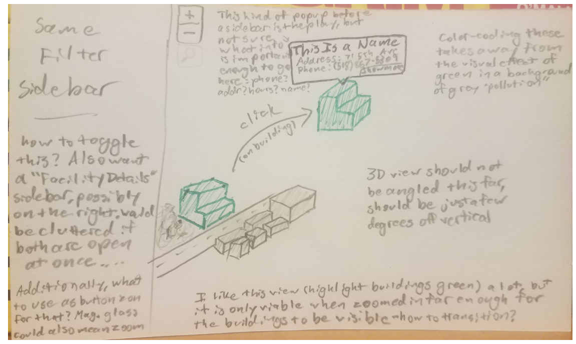

Figure 3. Initial design for the user interface, it includes a sidebar and a map interface.

The sidebar was always part of the design. Though the original design called for the sidebar to be revealed upon the user hovering on the left side of the screen.

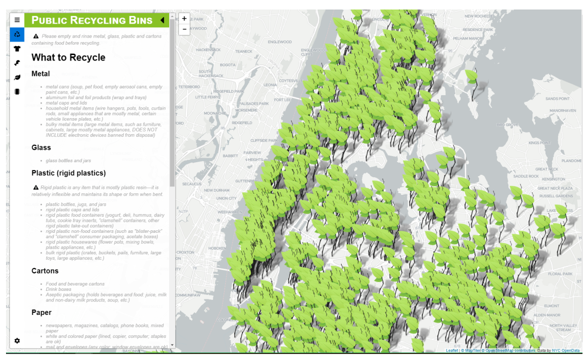

Figure 4. Final design for the sidebar.

One of the original ideas behind the interface was to have guides sprinkled throughout the application which would act as "pop-ups" that informed users about environmental guidelines. This pop-up would be in the form of a Bootstrap modal. But this design idea was put aside very early in the design process because pop-ups would distract from the purpose of the application. The information originally included in the pop-ups was integrated into the sidebar panes and the only modal included in the final design was upon load of the application and included basic information on the application and its use.

Backend

The first iteration of the map used vector tiles, which were chosen due to their ability to zoom near-seamlessly. However, the current version uses raster tiles due to compatibility issues with Firefox. Even the community workaround plugin was unable to We also experienced unexpected compatibility problems with jQuery, where more modern DOM selectors were behaving unreliably. This is believed to be due to an incomplete implementation of the “search”-type HTML input element by Firefox, but we did not arrive at a definitive answer as we moved on after designing functionally-equivalent selectors which did not suffer the same problems.

Not to be left out, Chrome stood out by being much more difficult to optimize for. While the datasets are a bit too large for either of the two browsers to feel completely lagless when filtering, Firefox is comparatively more capable. The primary approach taken to optimization was simply reducing the number of things on the screen to be filtered, which also had the effect of minimizing clutter. The interface was changed to disallow more than one “type” of facility to be shown at once, and this nearly eliminated UI lag for all categories but yard waste. There are several avenues for further decluttering we have not explored, most promisingly marker clustering, which is implemented in a popular first-party plugin.

Performance when loading data is especially important, since the absence of a fully-featured multithreading API in JavaScript means the faux-asynchronous data import still stalls UI animations. It is also used behind the scenes when filtering, via an ephemeral layer which is recreated for each search due to technical limitations. The importance of this feature resulted in major improvements, advancing from raw synchronous calls to XMLHttpRequest and custom GeoJSON parsing to jQuery dispatches which load/parse the GeoJSON and hand it off to Leaflet in one continuous motion.

Peer Feedback

One of the previous design decisions would be to add more interface elements to the application. The sidebar is currently the only element on the application and this leaves much of the application window open to the map interface, leaving most of the window as “blank space”. To remedy this issue I wanted to add interfaces to the bottom and right of the window, but it was suggested that we leave the interface at the one sidebar to prevent from adding any additional clutter.

It was also suggested that the icons which provide the filtering function of the application along the sidebar be matched with the logos used for the map markers, which would provide more context into which locations are being shown on the map. While this was a good idea and part of the initial design, it was decided to off-put this implementation to future work to maintain the overall theme of the application.

Division of Labor

Baxter worked on designing the interface drafts and theme, implementing the backend and necessary bindings, and Leaflet integration.

Davis worked on data collection, preprocessing and formatting tasks, and setting up the user interface design. This includes integrating outside packages and researching frontend frameworks.

For the presentation, proposal, and final project presentation both authors worked on writing slides and creating sections of the proposal and the final report.

Conclusion and Future Work

In the future, we would like to further extend the target audience of the application to include elderly and younger users. Much of the research done on user interface design strategies included methods for improving the EcoMap experience for elderly users and an appropriate next step would be to add some of the more difficult design elements to the application. The DSNY also provides a few resources for children that could also be easily incorporated into the application.

It is also possible that EcoMap could be extended to other urban areas such as Boston and Seattle. We have not looked into what data is available for these areas but an extension is definitely a possibility, as the backend is not tied to NYC.

References

[1] Ganor, N., & Te'eni, D. (2016). Designing Interfaces for Older Users: Effects of Icon Detail and Semantic Distance. *AIS Transactions on Human-Computer Interaction*, *8*(1), 22.

[2] Hutchison, D., & And Others. (1997). Designing User Interfaces for Older Adults. *Educational Gerontology*, *23*(6), 497–513.

[3] Singh, S. (2000). Designing intelligent interfaces for users with memory and language limitations. *Aphasiology*, *14*(2), 157–177 .https://doi-org.libproxy.rpi.edu/10.1080/026870300401531