DEVELOPING A CUSTOMIZED INTERACTIVE WEB MAP FOR MANAGING THE TREE DATASET OF THE CSULB CAMPUS

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Introduction

One of the most significant challenges faced by Universities is managing their spaces and assets. As campuses grow over time, it can become increasingly difficult to manage their assets effectively. Thus, it is important for them to design solutions for managing assets, such as trees, to develop effective maintenance strategies. The primary goal of this project is to develop a customized interactive web map to visualize tree locations and associated tree attributes on the California State University Long Beach campus (Figure 1). This interactive web map provides the possibility of updating, editing, and monitoring the campus tree dataset, and could be used by the CSULB management and staff teams to keep a record of tree maintenance operations.

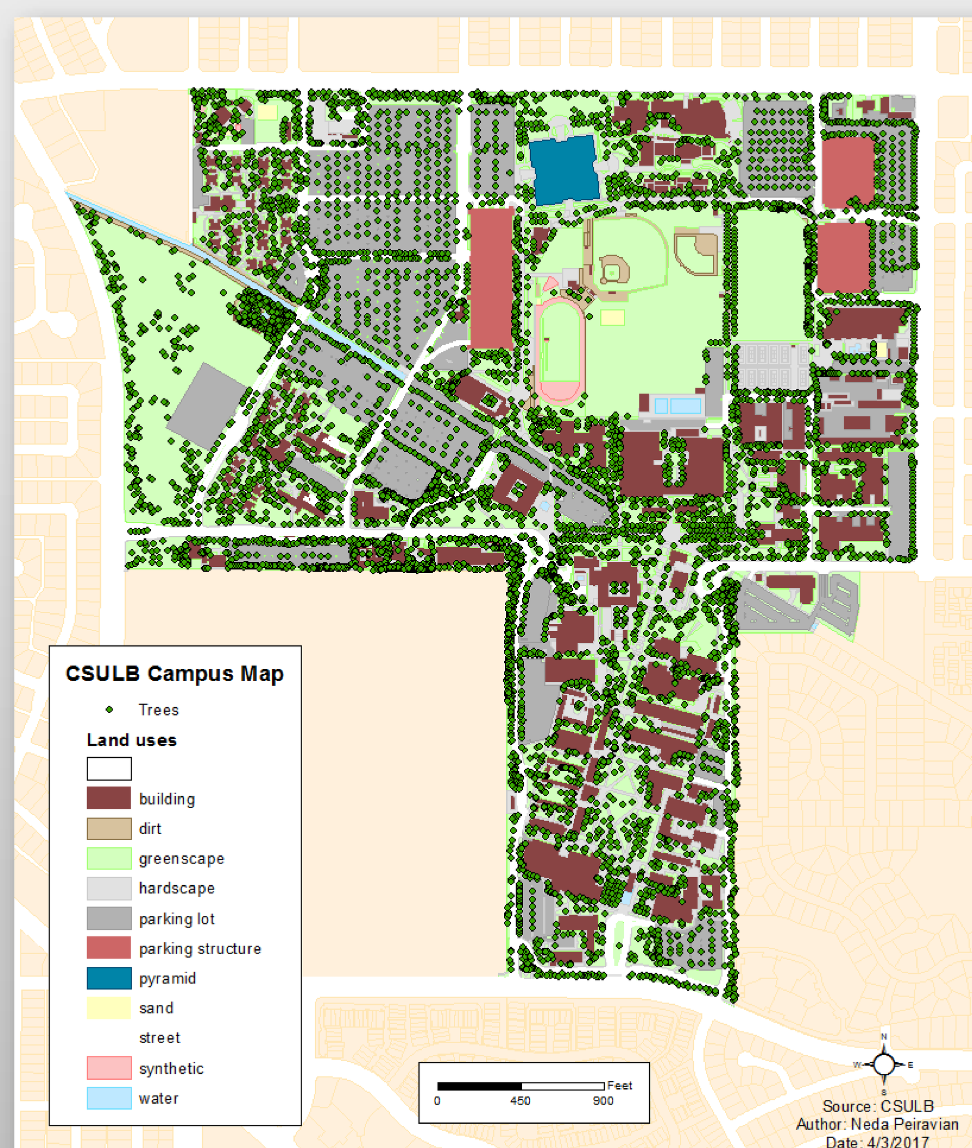

Figure 1. Study area – California State University Long Beach Campus map

Data and Data Sources

For developing the interactive web map, I used the current tree dataset that was collected and managed by the CSULB landscape team over the last ten years via ArborPro. This dataset contains attributes such as common name, scientific name, genus, family, cultivar/subspecies, canopy height, biomass, height, etc for the trees. I also used a basemap layer of the CSULB campus provided by the Geography department. The ArcGIS for JavaScript API was included in the interactive web map to facilitate the addition of custom geospatial functions (Table 1).

Table 1. List of data and data sources used in the project

Dataset	Source
Campus Trees	Collected by the CSULB landscape team via ArborPro.
Campus Basemap	Provided by the CSULB Geography Department.
ArcGIS API 4.3	https://developers.arcgis.com/javascript/

Methodology

ArcMap was used to generate the campus basemap and tree point layers. These layers were then shared through ArcGIS online. The programming languages used to create the interactive functionality of the web map include HTML, CSS and JavaScript. ArcGIS for JavaScript API 4.3 was used to customize the widgets (Figure 2).

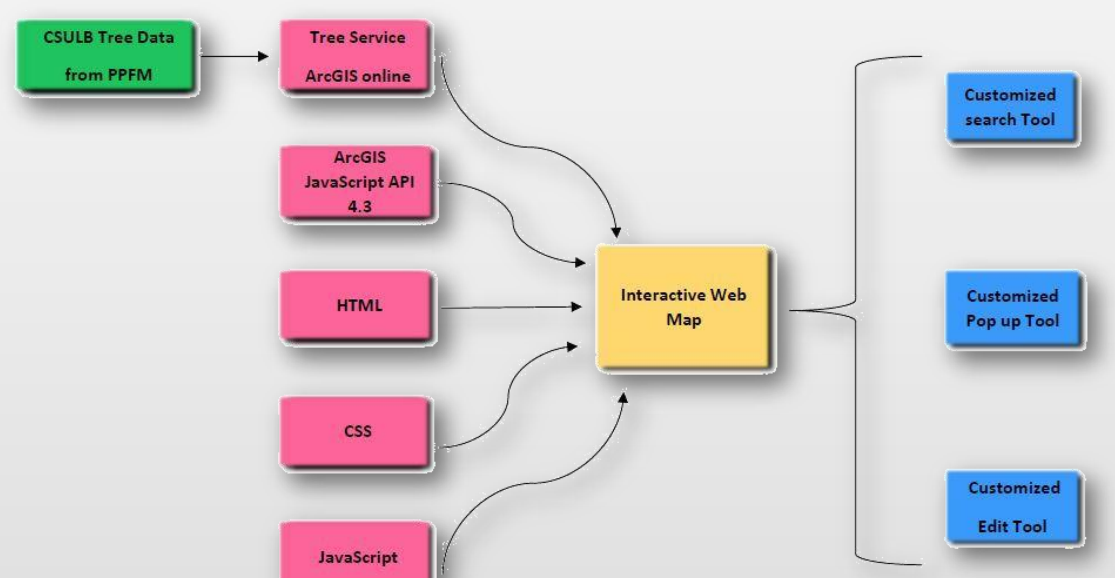

Figure 2. Web application workflow diagram.

First, a map view was created to allow the geospatial data to be brought into a div. Second, the feature services were loaded from ArcGIS Online into the web page. Afterwards, widgets such as zoom, home, and, legend were created by using object types defined in the API. Finally, the search widget and popup window, were customized through different JavaScript methods. The search widgets and popup widgets are the main widgets that were customized. I wrote two custom function to manage how search results were returned and how users could select and zoom to a search result. I also wrote a custom function that made it possible to edit and update attribute values using buttons that appear in the feature info popup window (Figure 3).

```
function applyEdits(params) {
  var promise = tree.applyEdits(params);
  promise.then(function(response) {
    var updatedFeatureObjectId = response.updateFeatureResults[0].objectId;
    console.log('Updated ', updatedFeatureObjectId);
  })
  .otherwise(function(error) {
    console.error("[ applyEdits ] FAILURE: ", error.code, error.name,
      error.message);
    console.log("error = ", error);
  });
}
```

Figure 3. Screenshot of the script showing the applyEdit function.

Timeline

Table 2. Project Timeline

	Timeline	Technical steps
Step 1	8 May to 14 May	Provide study area map and publish campus map and tree points layers in ArcGIS online.
Step 2	15 May to 21 May	Finish the design of the application: put the tables, windows and buttons in HTML and design them by using CSS.
Step 3	22 May to 7 June	Develop the functions in the script that are associated with customized search widget and search table.
Step 4	8 June to 21 June	Develop the functions in the script that are associated with editing the tree attribute data.
Step 5	21 June to 28 June	Test the application; find the errors and debugging the script. Ask other users to work with it and make sure that the users have good experience and can learn it easily.

Results

User authentication is required for accessing the private version of the application when loading the web page. In the top-left part of the web map, there are five different widgets. The first and second widgets provide zoom in and zoom out functions to change the scale of the web map. The third widget is a compass to return to the initial extent of the map after changing the map orientation. The fourth widget is a home button that brings back the web map to the initial extent. The last widget is the legend visibility control button for accessing the legend. At the bottom-left of the map the interactive widget of the scale has been placed. The CSULB campus and the tree dataset are located in the center of the web application. By using the zoom in widget, the user would be able to explore different land uses on campus and zoom in to the location of the trees.

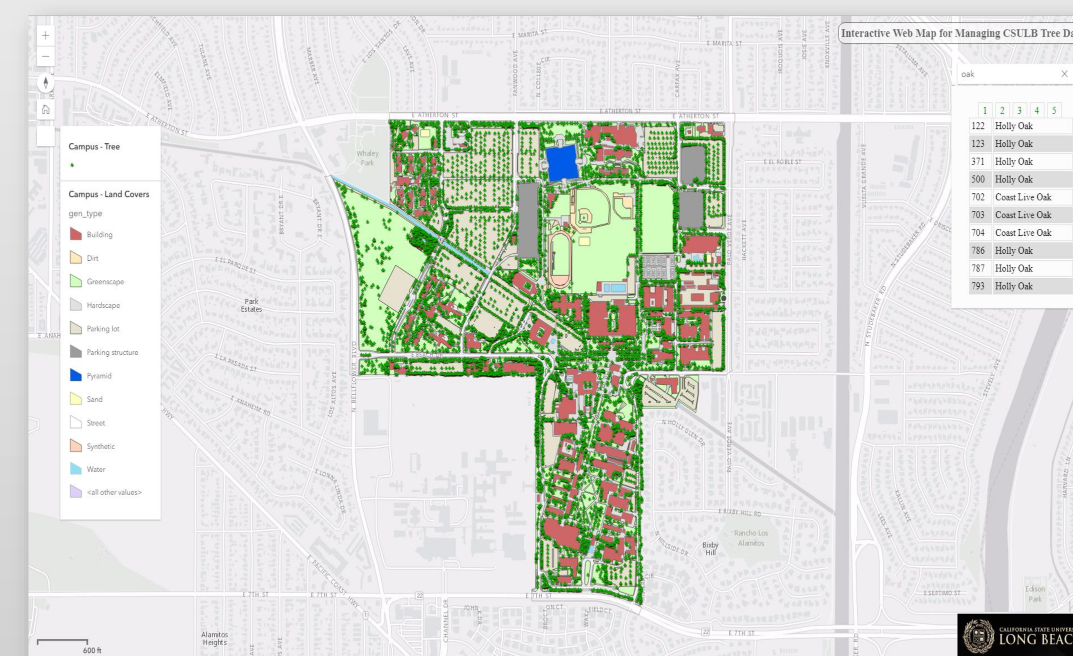

Figure 4. The interface of the web application upon initial page load

In the top-right, there is a custom search widget. The users can enter any tree ID or tree name to search the related tree in the search table. Also, the results in this popup are organized into different pages so the user can browse different search results using page tabs. When the user selects each result, a popup related to that result will open above that feature. In the fields of the table, the name of the attributes and the associated values are visible. In the bottom-left of the popup widget, there are three buttons. The first one is the edit button, which when clicked on will turn the attribute fields into the input boxes and users can edit the attributes. The second button in the popup is for updating the edited values, and the user can save all the edited attributes. Finally, the third button is designed to direct the users to a Google results page based on the common name of the tree species selected (see for example Figure 4).

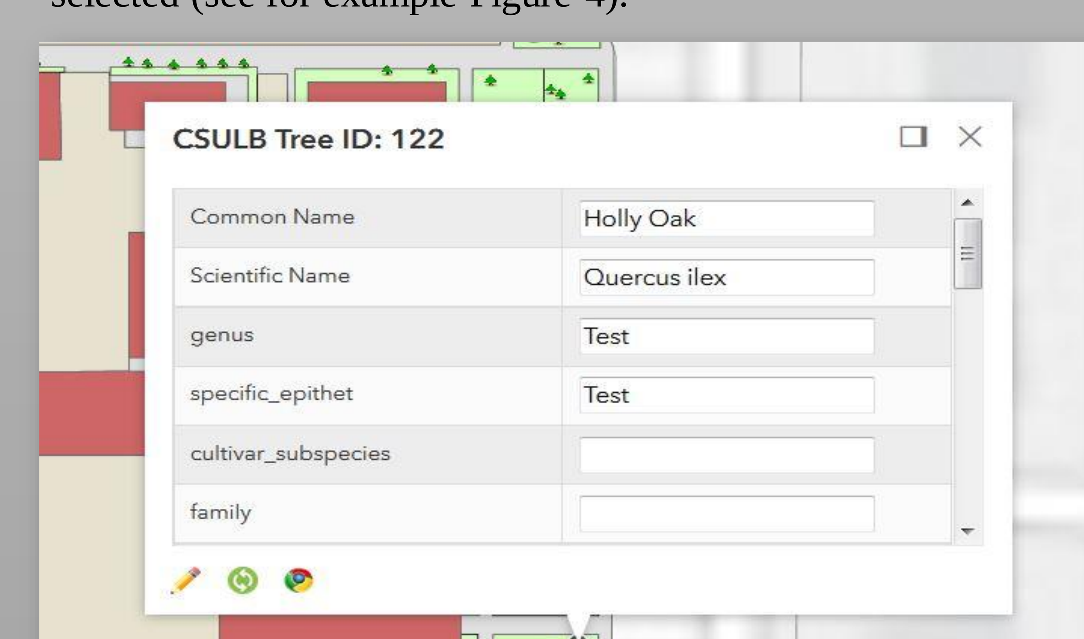

Figure 4. The customized search widget that returns the results in the search table and the customized popup showing tree ID and attributes.

Discussion

This interactive web map provides an efficient method for updating the CSULB's tree asset data. However, if I had another chance, I would like to create essentially the same application using alternative approaches to evaluate whether the other approaches provide additional functionality or easier and cheaper options. One of the possible alternatives would be to use PostgreSQL and publish services with GeoServer. PostgreSQL is one of the most popular open source geospatial data storage solutions. Other options would be to use other free mapping libraries such as OpenLayers and Leaflet. The OpenLayers API integrates with GeoServer and is very flexible for custom applications. The Leaflet API is also lightweight, very customizable, and relatively simple to use. The results of this project met the project goals. I evaluated the validity of the results and the application has the necessary functionality to manage the tree dataset. However, it seems that the CSULB landscaping team is less likely to use this application unless they are certain it will be beneficial and superior to current, established workflows. The landscape team, the management team, and the public are the proposed beneficiary groups of this project. The positive impacts of this project for the landscape team is that they can easily control the data and update it while viewing the spatial location of each tree. The management team can use this map to assess the impacts of different financial and maintenance programs and start planning new programs for the future. The GIS Code of Ethics was seriously considered as I worked on my project. The four primary categories that I observed as relevant to this project include the obligation to society, the obligation to employees, the obligations to colleagues and the profession, and the obligations to individuals in society.

Conclusion

It is crucial for large organizations to use efficient solutions to manage their assets. The CSULB campus is home to thousands of trees, so it needs an easy-to-use application for maintenance staff to manage such a large number of trees. Through my work on this project I was able to successfully design a solution for tree data management on the CSULB campus by developing a customized web mapping application. Improving the quality of the results in the future is possible. If I had another chance to re-conduct the same project, I would develop it as a mobile app. Also, I would probably use QGIS and Leaflet as they are open source and provide free access to a wider variety of tools and basemaps. In the future, this application can be developed as a template, so different organizations can use it and import their own data, and utilize the application's functionality. By incorporating 3D capabilities into the template, users can obtain a better view of the height, current conditions, and canopy of the trees, and run the 3D analyst tools such as visibility, skyline, and viewshed.

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