Process Book

UFOdex

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COM-480
Data Visualization

1. Introduction

Many people find the mysterious unidentified flying objects (UFOs) interesting. You might read articles or watch videos about them. Yet, few people have actually spotted them. We believed the reason could be there aren't many guides of finding UFOs. Therefore, we decided to make “UFOdex” which is a tutorial based on the previous records of UFO sightings.

This process book records the process how we deployed our final product, covering stages from idea creation to product implementation. It describes how our initial plan evolved as it progressed. In the next section, this process book explains what our initial idea was and how we came up with it, followed by sketches and prototypes we created. Then, the article describes our final product by showing changes from the prototypes and the way of implementation. We also note the peer assessment in the book.

2. Initial Plan Creation

Dataset

We devised the idea to make a guide of UFO hunting from a dataset of past UFO sighting record in Kaggle. The dataset is originally scraped from National UFO Reporting Center (NUFORC) and preprocessed by Sigmoid Axel, containing 80,000 plus sighting reports from 1906 to 2014. Each report is associated with time, duration, location, shape, and description of the sighting situation.

Survey on Former Works and Exploratory Data Analysis

Some Kaggle users have already worked on basic analyses on the data and simple statistical results such as time and geological distribution of the sighting cases are now open. Their former works showed the results only in statistic ways. For example, they illustrate simple bar charts to list a number of reports grouped by nation or seasons. Thus, the viewers can only enjoy the given sketch and they cannot change information granularity on their own. We also conducted exploratory data analysis to get familiar and ensure that we obtained the same results as others. As a result, we decided to forward the former works and implement interactive visualization of UFO sightings, focusing on the sightings in US as the country accounts for more than 70% of all sightings in the world.

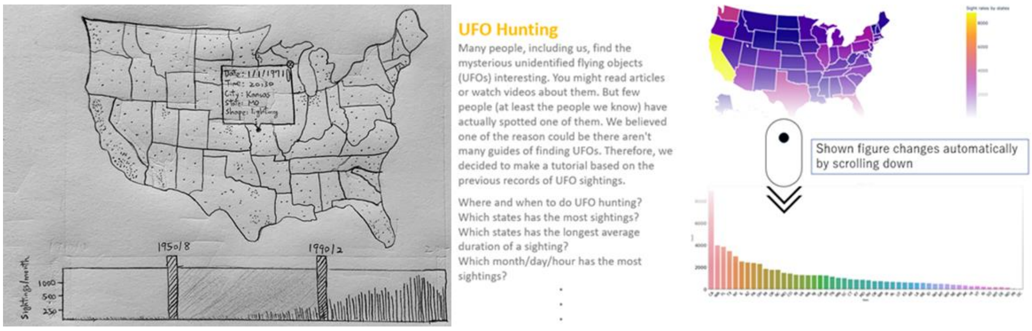
Initial Plan

At this stage our initial plan was to offer following information about UFO sightings.

- US map:
  - ➢ Show all sightings with markers and implement time range controller
  - ➢ Show detailed information of each sightings by click on the marker
- Detailed Instruction: Show where and when to do UFO hunting with some statistics
- Fun facts: Show interesting findings from the analysis such as distribution of shapes and common words used in the comments

3. Sketches and prototypes

Based on the initial plan, we created sketches (Figure 1) and the prototype of our tutorials for UFO hunting (Figure 2). At this stage, we planned to plot sightings with dots. The prototype is made with D3.js, so every svg object like map, dot, chart to show yearly sighting cases, and brush to select year range are created with it. As for detailed instruction, we planned to write description along with some statistical data. Also, we created charts used in the instruction part with D3.js. The interface to show our contents was a simple website designed with HTML and CSS.



UFO Hunting

Many people, including us, find the mysterious unidentified flying objects (UFOs) interesting. You might read articles or watch videos about them. But few people (at least the people we know) have actually spotted one of them. We believed one of the reason could be there aren't many guides of finding UFOs. Therefore, we decided to make a tutorial based on the previous records of UFO sightings.

Where and when to do UFO hunting?
Which states has the most sightings?
Which states has the longest average duration of a sighting?
Which month/day/hour has the most sightings?

Figure 1: Sketch of the map and the detailed instruction

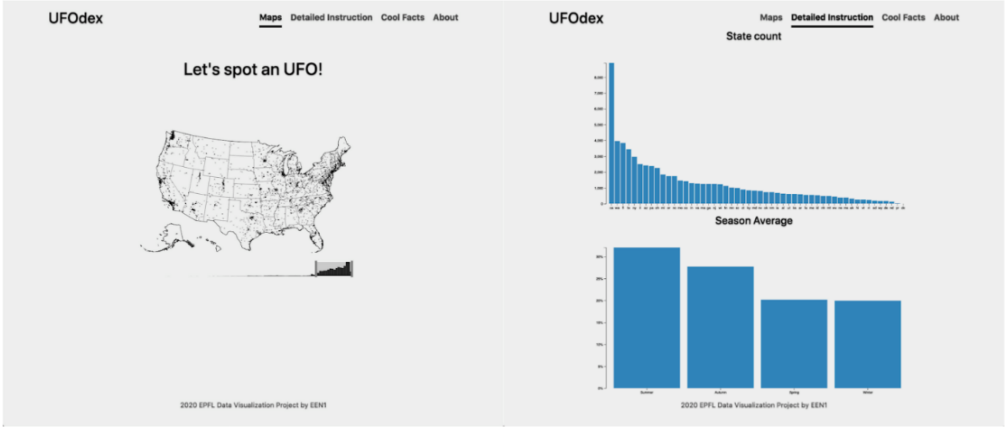


Figure 2: Prototype of the map, charts used in the detailed instruction, and the interface (website)

4. Final Product

We built our final product by the sketches and the prototypes shown previously. Here, we explain changes from the prototypes and some challenges and decisions during the implementation if any.

4.1. Interface

Concept of design

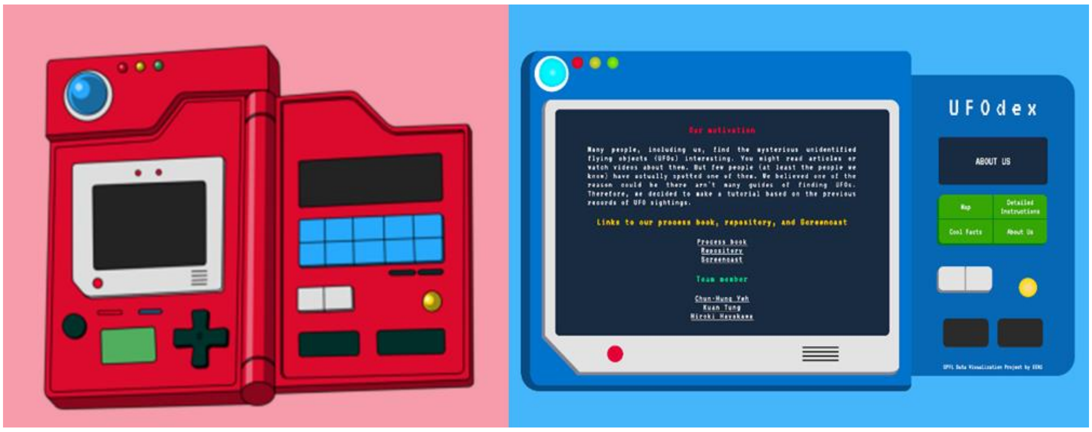
When we were making the prototype website for milestone 2, we did not think about the design of the interface. We simply put the map plot and other statistical plots on different pages, as shown in Figure 2. After getting feedback from the teaching assistant, we realized that we would need to pay more attention to the interface design. Otherwise, the website would be a place to host those different visualizations instead of connecting them and telling a complete story. Therefore, we came up with the idea of UFOdex.

At first, UFOdex was a random name that we thought could be an exciting title. However, when we were brainstorming how to connect all the visualizations, the idea creating a virtual Pokédex-like device came to mind. With this virtual device, users can navigate via plots like they are using different modes in the device. It can turn the website into a one-page website that is more intuitive to use. It fits our motivation perfectly, finding UFOs is like finding Pokemon, allowing us to tell a more immersive story.

As the name UFOdex suggested, we were inspired by Pokédex, as shown in (Left). However, we cannot merely copy the design. It is not only because we need originality, but because it will not fit our topic flawlessly. We adapted from a flat design Pokédex on CodePen [1]. We noticed several places that we would need to redesign to convert it from a Pokédex to an UFOdex. We list them and the design choices we made to fix them in the following,

1. The screen is too small.
   → Increase the size of the screen and change the ratio of the right panel and the left panel.
2. There are too many redundant buttons.
   → Remove most of them and only keep the ones we need.
3. The color theme does not fit our topic.
   → Select new colors for all the components. Our primary color was inspired by the 2020 Pantone color of the year, Classic blue. We believed that this mysterious color is a perfect match with the UFO topic. We had thought about using gray or black since they are often related to mysteries as well. But we believed that finding UFOs should be a fun experience, so we decided to go to a more colorful route.

The final design is shown in (Right).



Our motivation

Many people, including us, find the mysterious unidentified flying objects (UFOs) interesting. You might read articles or watch videos about them. But few people (at least the people we know) have actually spotted one of them. We believed one of the reason could be there arn't many guides of finding UFOs. Therefore, we decided to make a tutorial based on the previous records of UFO sightings.

Links to our process book, repository, and Screencast

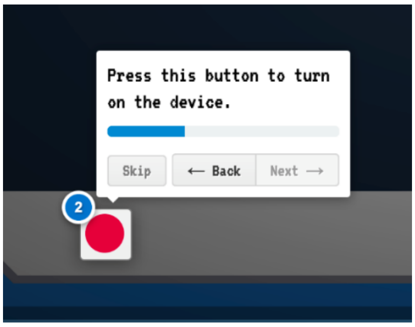
Process book
Repository
Screencast

Team member

Chun-Hung Yeh
Kuan Tung
Hiroki Hayakawa

Figure 3 (Left: Pokédex, Right: UFOdex)

Since our UFOdex is not a typical website alike, we prepared tutorials for users to get familiar with the interface, as shown in the screenshot in Figure 4. Users will learn basic operations after the initial tutorial. People who are already familiar with the website will have the option to skip those guides.



Press this button to turn on the device.

Figure 4: Tutorial for the interface

Implementation

The website interface implementations can be split into three parts, the visual interface, the control logic behind it, and the tutorial.

We found a Pokédex implementation built with plain CSS [1]. We adapted the structure and transformed it into UFOdex by playing with the HTML elements and CSS codes. In [1], the author used Sass as the stylesheet language, which is more readable than plain CSS. We used it as well, and it helped us make the design process less time-consuming.

Then, we used jQuery to implement the control logic behind the interface. It may not be as elegant and powerful as the modern frameworks, like React and Vue. Nonetheless, it is easy to learn and has all the features we need. We applied it to change CSS value dynamically ($().css()), define what happens when a user clicks a button ($().click()), and set fade in and out animation ($().fadeTo()).

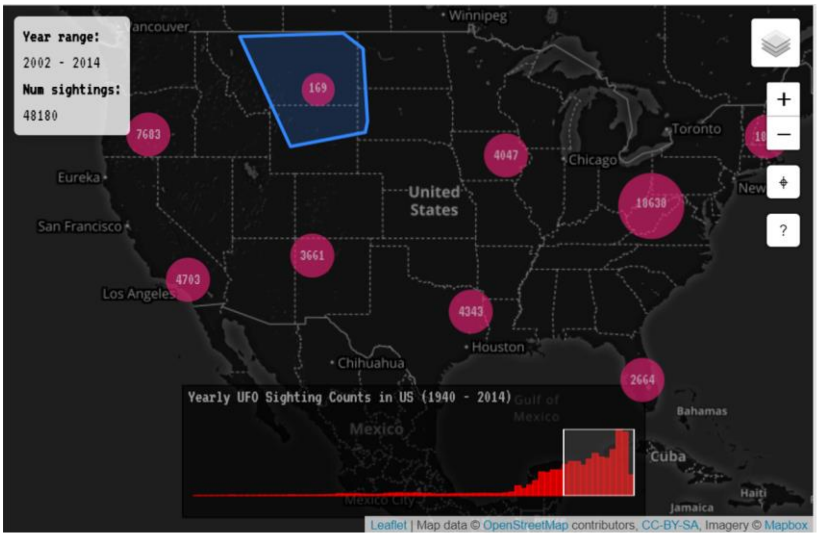
We used intro.js to build the step-by-step tutorial. It is a light-weight yet powerful Javascript engine. We can easily define steps with a list of objects. We set a few custom options (e.g., showBullets to false and showProgress to true) to make the pop-up windows that contain guides more visually pleasing. Custom font and colors were set to make it look consistent with our interface.

4.2. Map

Concept of Design

In our prototype, we made a plot of UFO sightings for over a century. However, the sighting numbers reported before 1940 are small and their credibility is lower than recent cases. Thus, we determined to plot sightings after 1940. In US, the total count of the sightings for the last 70 years is over 60,000. If we depicted every sighting with a single marker, the plot became so dense that users would have difficulty to obtain information above. Besides, making such plot is computationally expensive. Hence, we decided to depict markers of each individual report only when the map sufficiently zooms in otherwise it shows sightings with clusters. Moreover, we enable our users to control the information granularity that they see on the map. Users can go back and forth from clusters to a single sighting with a description. The UFO map is interactive like many online map services so users can travel around on it. In addition to the space axis, the map offers a degree of freedom in time axis, meaning that users could choose time range, and the map shows the reports occurred in a certain period. The map also includes a function like a mini game that users can enjoy during seeking around there.

Figure 5 shows US map in our final product.



Year range:
2002 - 2014
Num sightings:
48180

Yearly UFO Sighting Counts in US (1940 - 2014)

Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Imagery © Mapbox

Figure 5: UFO map in US

Implementation

Map, Map controller, Markers

Javascript provides useful libraries and plugins (e.g. Leaflet.js and Leaflet-MarkerCluster plugin) helping us create interactive map. To create a button to change the view to the initial points, we used the easyButton plugin [3]. In addition, a button created with the plugin acts as an initiator of a mini game. Clicking the button causes an event to show browser alert to note the beginning of the game and an UFO appears somewhere on US map. Users capture the UFO by clicking it and compete the time taken. After catching the UFO, another alert notices the end of the game and score time. We depict single UFO sighting as a Leaflet markers and use markerCluster plugin [4] to create clusters from the sighting markers. With markerCluster plugin, the map automatically zoom in to sub-clusters or single marker by clicking it. Bindpopup is used to show up details about the single sightings.

Chart, Time range control

D3.js is used to create a bar chart to show yearly sighting counts, and the chart is laid on the svg layer on the map. In many cases, D3.js is used to plot svg markers on the Leaflet map, so with default setting the marker are fixed on the map and when panning the map, the markers also move on the screen. In our case, we want our svg bar chart to stay at the same position while panning. Thus, every time pan event occurs, we translate the position of the map to the initial point by calculating the distance from origin to current position, making it possible for the chart to stay at the initial position on the screen. Also, with default settings, we cannot click the svg. This means we cannot move the brush. Therefore, we deactivate the map controlling function when a cursor is on the chart.

4.3. Detailed Instructions & Fun Facts

Concept of Design

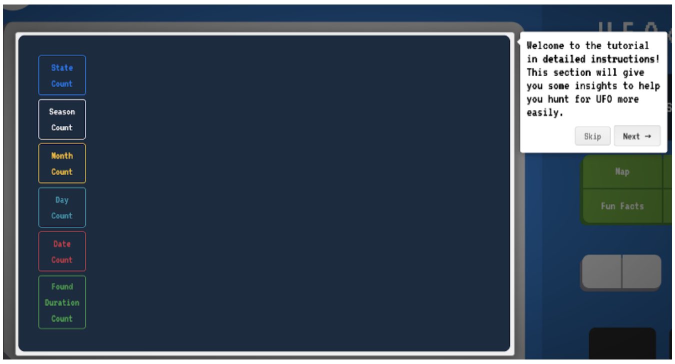
We organize both sections to offer the users with practical information helping them spot UFOs easily. In the prototype, we simply built static bar charts showing basic statistics. As a result, we decided to transform them to user-friendly visualizations and give our users suggestions on where and when they will most likely to see a UFO. To this end, we managed to visualize the following plots.

1. Bar chart: It shows clear comparisons among discrete categories. We utilized it to visualize statistical outcomes such as season count, month/day count, and found duration count.
2. Choropleth map: This plot provides an easy way to present how a measurement varies within a geographic area. Accordingly, we applied it to visualize the sighting count across all states.
3. Calendar heatmap: Similar to the ordinary heatmap, it shows magnitude as color in two dimensions, giving obvious visual cues about how the sighting level varies of all dates.
4. Force-directed graph: It helps to visualize connections between objects in a pleasing way. Since we found out that there are two groups describing UFOs' shape and appearance, we opted this graph to make two clusters for them.
5. Word cloud: It is a collection of words depicted in different sizes. The bigger and bolder the word appears, the more often it's mentioned in a given text. In our case, we exploit its property to present the frequent words inside onlookers' comments on UFOs.

Besides the plots, we offer our users a series of tutorials assisting them in being more comprehensible to our plots. When users press the yellow button in UFOdex, the tutorials will pop up to convey our advice so users are able to find the optimal way for their UFO hunting.

Implementation

In the beginning, we built a concise interface with some buttons on the left for users to click (See Figure 6). Then, to guide our users, we set a yellow starting button on the control bar to help our users know more about the upcoming plots.



Welcome to the tutorial in detailed instructions! This section will give you some insights to help you hunt for UFO more easily.

Figure 6: Visualization Interface and Its Tutorial

As for the visualizations by our data, we mainly used D3.js to implement them. For the bar charts, instead of a plain bar for each category, we added color gradients to the bars to highlight the extreme cases. Specifically, yellow stands for the maximum while green represents the small values. (See Figure 7) In addition, we implemented a mouseover and tooltip so users can obtain exact figures of each bar when they move their cursors to that specific position. Lastly, we added bar-rising animation to further beautify the bar charts. For the choropleth map and calendar heatmap, we applied the same color scale to specify different counting levels in each state and date as well as a hovering function to point out actual UFOs cases that occurred in each state and date respectively. As a result, users could understand how UFO findings are distributed across geography and time domain so that they can determine the state to go and hunt with a better chance.

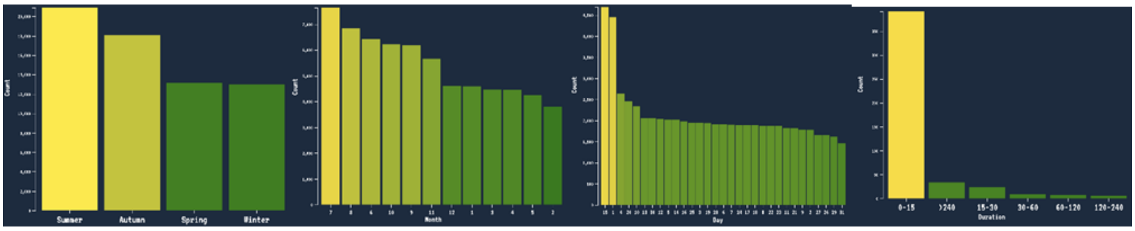


Figure 7: Bar Charts about Season, Month/Day, and Found Duration

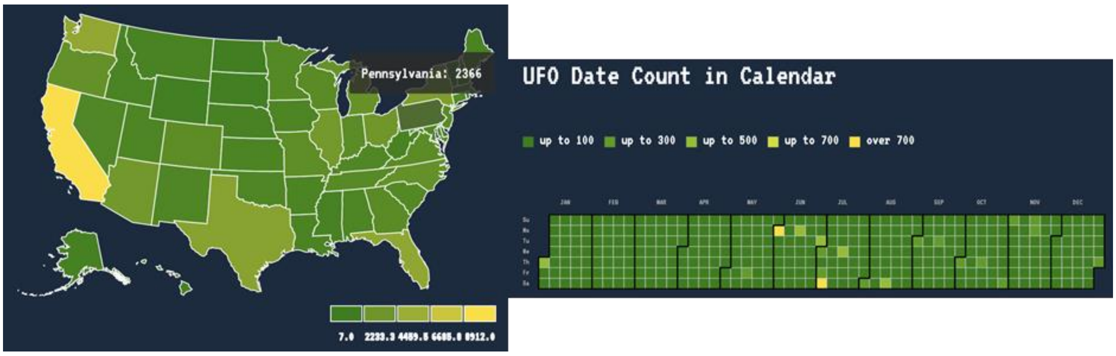
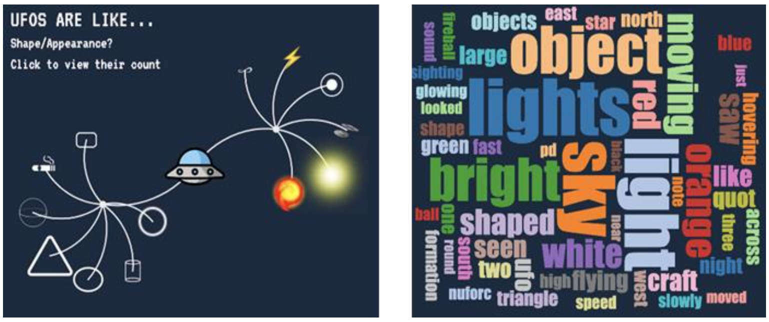


Figure 8: Choropleth Map and Calendar Heatmap

Regarding the plots in fun facts, we first constructed the basic network where a central node is connected with two groups of nodes. These two groups would then be used for the shape and appearance separately. Afterward, we added the icons on top of the nodes in each group. The size of the icons is dynamic with respect to the count number. As usual, there is a hovering function which enables users to click and view the description about a certain shape/appearance. Last but not least, to generate the comments' word cloud, we first gathered all the comments in the dataset. Next, we removed the filler words and punctuation marks to leave meaningful words. After computing the count for each word, we visualize the word if its corresponding count is more than 2,000. In the end, we placed a random color on that word to make it vivid.


UFOS ARE LIKE...

Shape/Appearance?

Click to view their count

Figure 9: Force-directed Graph and Word Cloud

5. Future Work

Interface

- Use a modern framework (e.g. React, Vue.js) to build the website
- Make a mobile friendly version

Map

- Include additional information like the sightings that turned out to be fake and highlight them
- Change cluster marker to a chart to show some statistics about the sightings in there

Instruction & Fun Facts

- Add a filter combining both geographical and time factors
- Add a time option for word cloud so users can see how frequent words vary in different time ranges.

6. Peer Assessment

Chun-Hung Yeh

- Exploratory data analysis and finalize project proposal in Milestone 1
- Design and implementations of detailed instructions and fun facts for Milestone 2 and 3
- Contents of detailed instructions and fun facts in the process book
- Organize the content in the process book

Kuan Tung

- UFO map design (sketch) and implementation for Milestone 2
- Website Interface design and implementation for Milestone 2 and 3
- Contents of website interface in the process book
- Organize codes and GitHub repository (README for Milestone 3)
- Make the screencast

Hiroki Hayakawa

- Project proposal for Milestone 2
- UFO map design update and implementation for Milestone 3
- Contents of introduction, prototype, and map in the process book.
- Design and organize the process book

7. Reference

[1] Kyla Burgess, “Pokedex on codepen”, https://codepen.io/kyla-burgess/pen/YzyWwrw

[2] Figure 2. Pokédex, Image from https://stories.mlh.io/build-your-own-pokedex-on-android-with-algolia-instant-search-3d2b157e652b

[3] Leaflet.EasyButton, https://github.com/CliffCloud/Leaflet.EasyButton

[4] Leaflet.markercluster, https://github.com/Leaflet/Leaflet.markercluster