Laser Airplane Incidents

Final Project CS4804 (C-term 2025)

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Laser Incident Analysis Dashboard

The Laser Incident Analysis Dashboard is an interactive web-based tool designed to analyze and visualize laser-related aviation incidents across the United States through the years 2016-2024. The dashboard includes separate tabs which provide insights into the frequency, distribution, and characteristics of laser incidents using various data visualization techniques.

Key Features:

Dynamic Visualizations: Users can explore multiple visual representations of the laser incidents including:

- **Top 5 Laser Colors:** Displays the most common laser colors involved in incidents, where users can view the data through a bar chart.
- **Incidents by State:** Shows the distribution of incidents across the U.S through a choropleth map.
- **Incidents Over Time:** Analyzes the frequency of incidents by the hour of the day through a bar chart.
- **Incidents by Altitude:** Displayed through a histogram, this visualization highlights the altitude at which incidents occur.
- **Incidents by Aircraft Type:** Categorizes incidents based on the top 10 aircraft types with the highest incident rates, shown through a histogram.
- **Incidents by City:** Takes the top 10 cities with the highest incident rates and shown through a pie chart.

Year Based Filtering: For each of these visualizations, users can adjust the year slider to analyze each trend over the specific year (2016-2024) or they can view all years combined.
Data Processing and Cleaning: The dashboard ensures an accurate visualization by parsing incident times, standardizing state abbreviations, and filtering invalid data.
Interactive and User-Friendly: We used D3.js and Plotly.js to create each of these visualizations, which allows seamless interaction and real-time updates based on user selections.

Questions We Thought About:

-Do laser color correlate to injuries?
-Are there more laser incidents in larger populated states?
-What is the most common laser color?
-Are there any specific factors that might correlate to if there were injuries or not?
-Does the type of aircraft correlate to the amount of injuries?

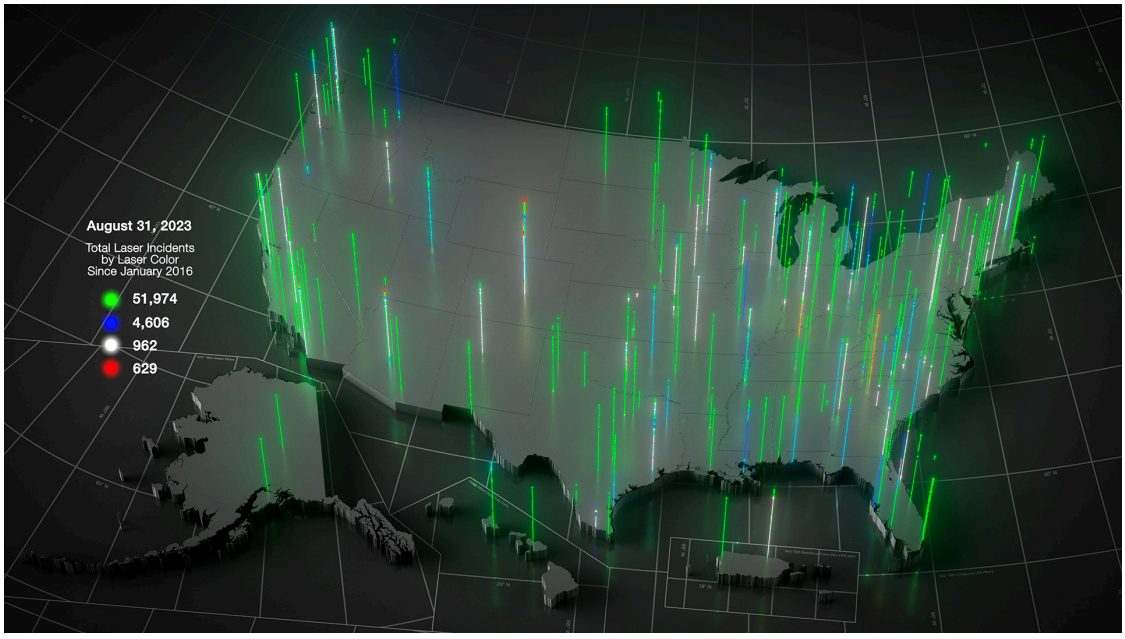
Process

Feb 20, 2025: Group Meeting
Below are a list of possible datasets we looked at using before deciding on the reported laser incidents for 2024. Compared to all of the datasets, that one has the most amount of valuable data we can use for our project.

Changes in Food Consumption Trends among American Adults since the COVID-19 Pandemic
Fast Fashion Dataset
Impact of Fast Fashion on environment
Food prices dataset
meteorite landings
online casino gambling data CT
CT monthly casino slot revenue
Reported Laser Incidents for 2024 | Federal Aviation Administration

Feb 21, 2025: Group Meeting

Distributed tasks where one person works on getting the map to load (tilted) and one works on cleaning and separating the datasets.

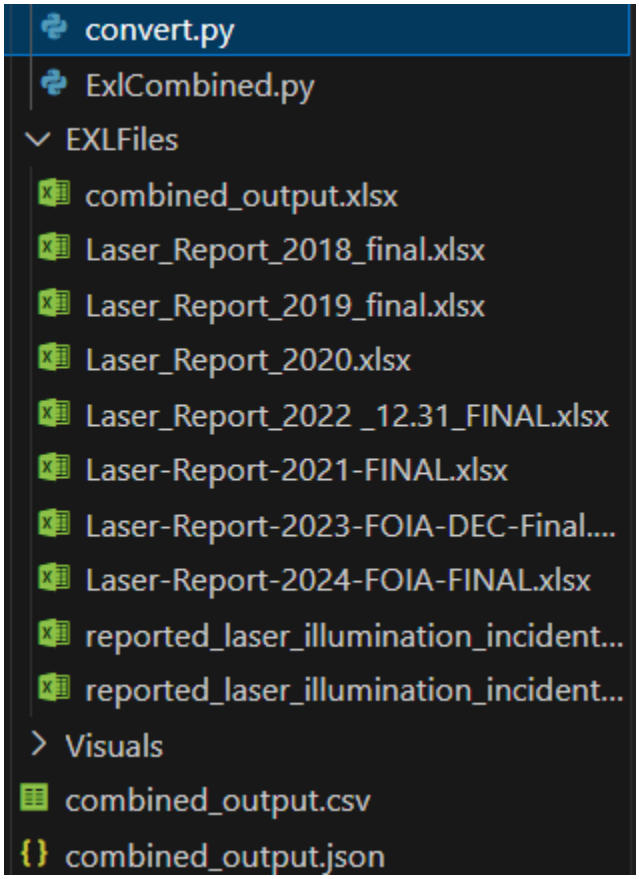


Example of tilted map taken from
https://www.maps.com/laser-strikes-map-shows-faa-incidents-from-2016-to-2023/

Feb 22, 2025:
Worked on creating the tilted map. Tried to use MapBox to recreate the map shown above, but it wasn't free. I ended up figuring out a way to use GeoJSON and a free U.S map taken from ne_110_admin_1_states_provinces.json. Combined xlsx files to csv and json format using python.

This is what the map looks like with just one layer. It's not as 3D as the example map, but it is tilted and we will be able to add on top of it. (rotations can be altered). Option 1

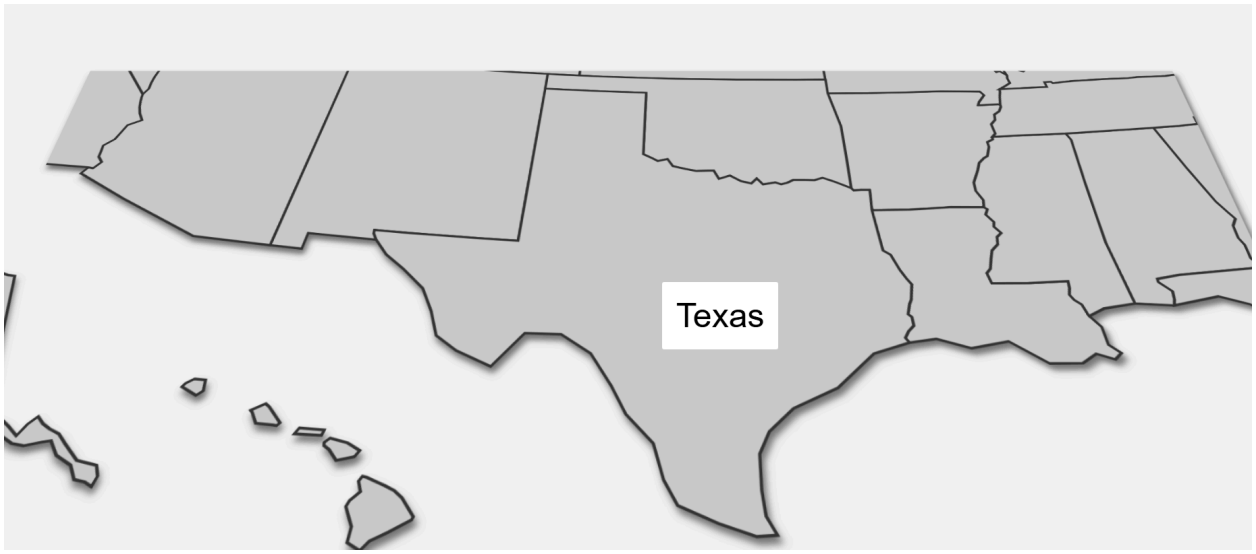
This is what the map looks like with 2 layers, giving it a more 3D vibe, we will also be able to add on top of this map and rotate it however. Option 2



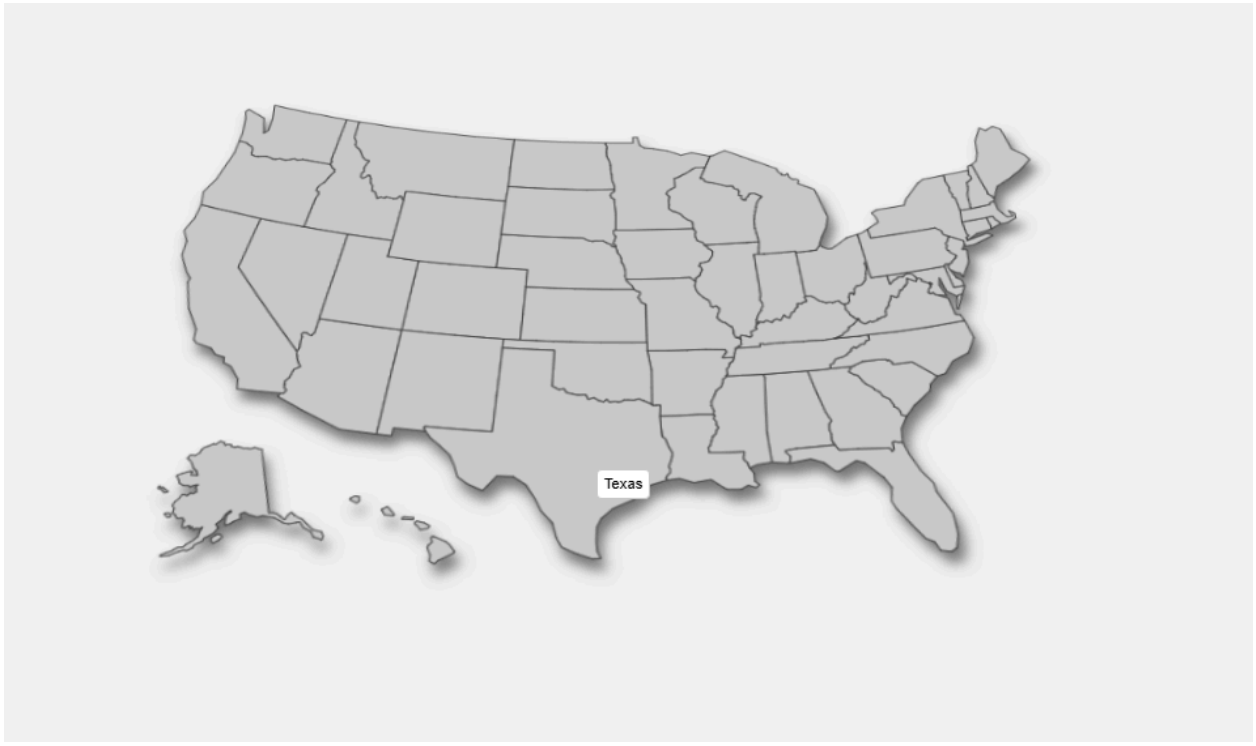
Used Python to combine excel files from each year into 1 file and converted it to csv and json.

Feb 24, 2025: Group Meeting

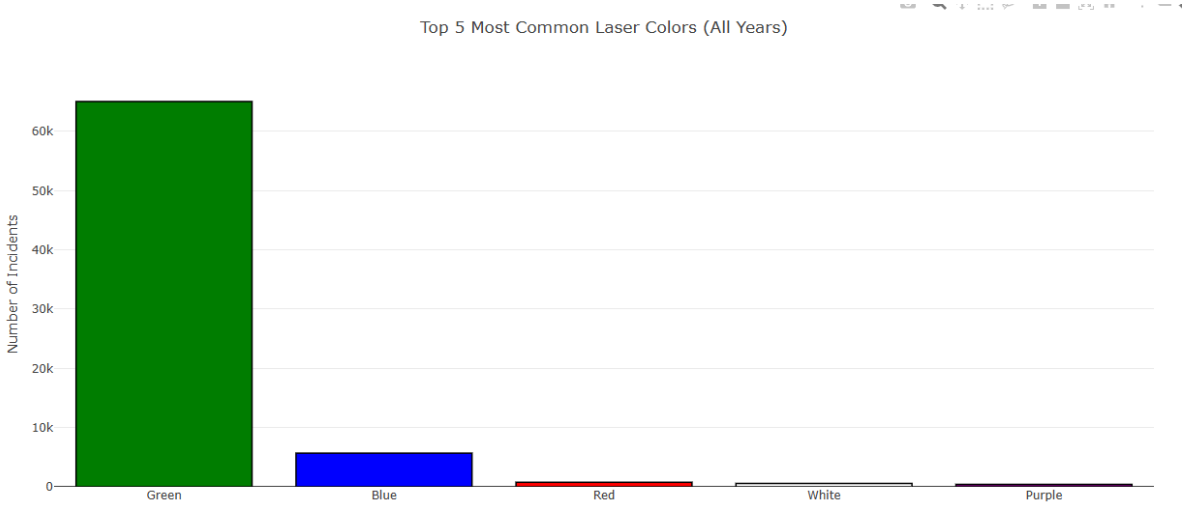
Worked on fixing up the previous map. Now, you are able to zoom in and zoom out on specific states and when you hover over a state, it will show the state name. Created laser graph.



Zoomed in

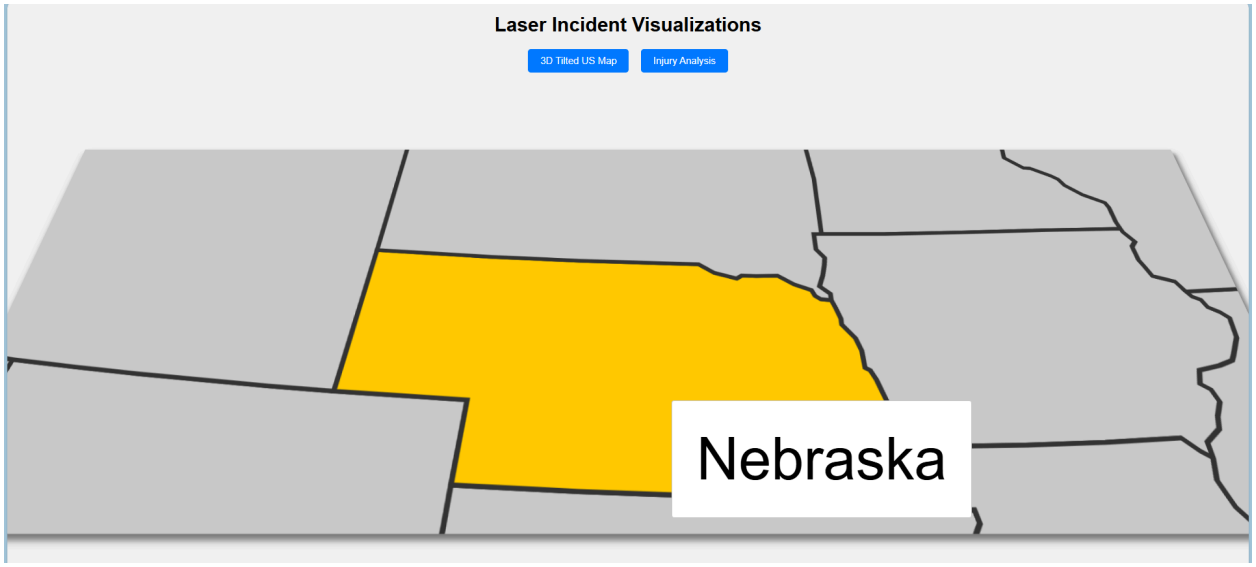


Zoomed out



Created graph that shows top laser colors using plotly and d3.

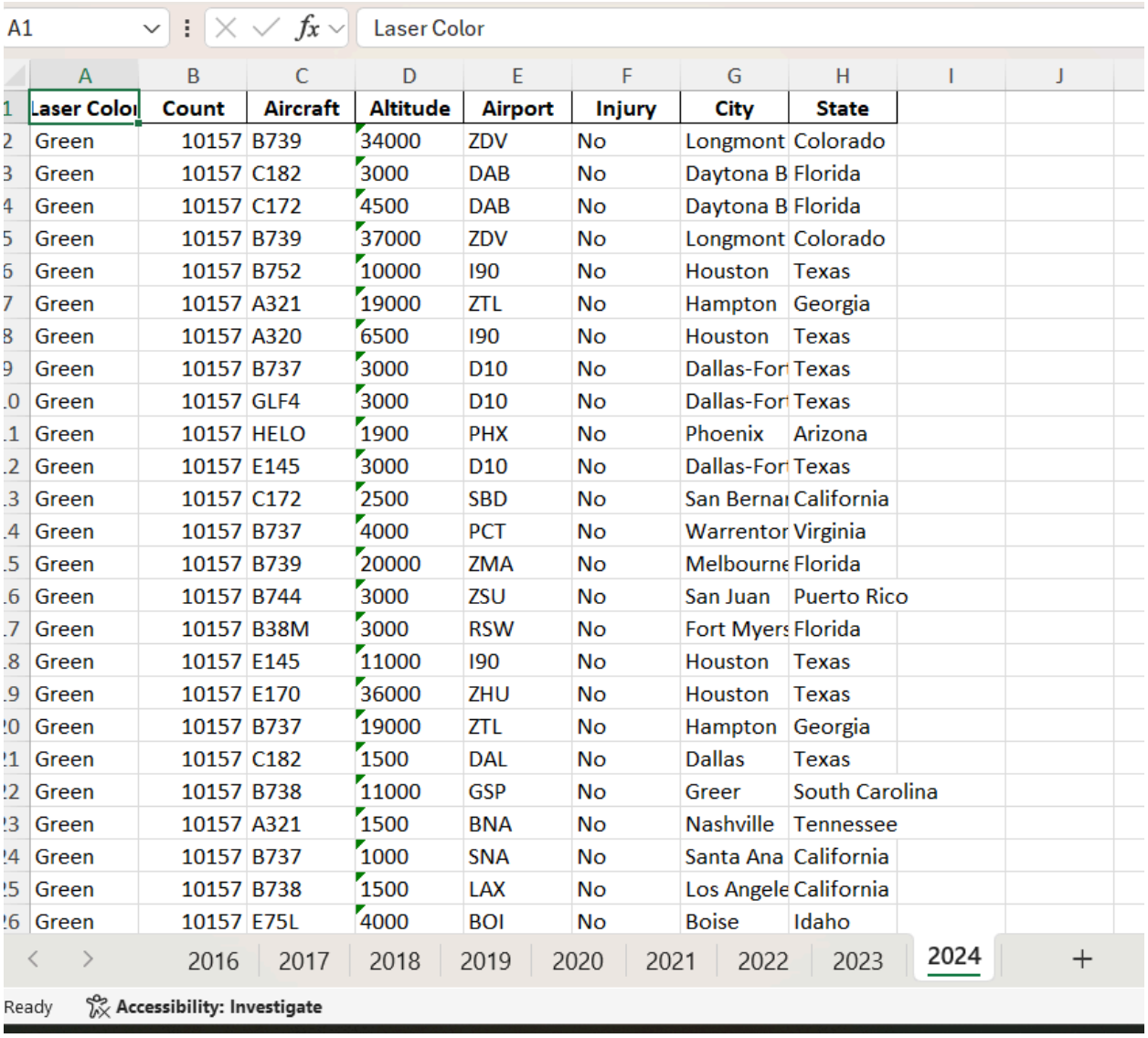
Feb 25, 2025:
Adding highlights to the map. When you click on the state that you want to view, it highlights the state.



Added map to display laser incidents by state

Feb 26, 2025: Group Meeting

Continued working on the code and further delegated more tasks to try and accomplish by Friday (Feb 28, 2025). Created a new spreadsheet that separates the other created spreadsheet even further. This spreadsheet separates the incidents by year (2016-2024) and also displays the top 4 laser colors, in the most to least popular. Also added a laser incident analysis dashboard that shades states on a scale based on if there were more laser incidents and hovering over the state shows the number for that specific year or filter.



A1 | Laser Color

	A	B	C	D	E	F	G	H	I	J
1	Laser Colo	Count	Aircraft	Altitude	Airport	Injury	City	State		
2	Green	10157	B739	34000	ZDV	No	Longmont	Colorado		
3	Green	10157	C182	3000	DAB	No	Daytona B	Florida		
4	Green	10157	C172	4500	DAB	No	Daytona B	Florida		
5	Green	10157	B739	37000	ZDV	No	Longmont	Colorado		
6	Green	10157	B752	10000	I90	No	Houston	Texas		
7	Green	10157	A321	19000	ZTL	No	Hampton	Georgia		
8	Green	10157	A320	6500	I90	No	Houston	Texas		
9	Green	10157	B737	3000	D10	No	Dallas-For	Texas		
10	Green	10157	GLF4	3000	D10	No	Dallas-For	Texas		
11	Green	10157	HELO	1900	PHX	No	Phoenix	Arizona		
12	Green	10157	E145	3000	D10	No	Dallas-For	Texas		
13	Green	10157	C172	2500	SBD	No	San Bernar	California		
14	Green	10157	B737	4000	PCT	No	Warrentor	Virginia		
15	Green	10157	B739	20000	ZMA	No	Melbourne	Florida		
16	Green	10157	B744	3000	ZSU	No	San Juan	Puerto Rico		
17	Green	10157	B38M	3000	RSW	No	Fort Myers	Florida		
18	Green	10157	E145	11000	I90	No	Houston	Texas		
19	Green	10157	E170	36000	ZHU	No	Houston	Texas		
20	Green	10157	B737	19000	ZTL	No	Hampton	Georgia		
21	Green	10157	C182	1500	DAL	No	Dallas	Texas		
22	Green	10157	B738	11000	GSP	No	Greer	South Carolina		
23	Green	10157	A321	1500	BNA	No	Nashville	Tennessee		
24	Green	10157	B737	1000	SNA	No	Santa Ana	California		
25	Green	10157	B738	1500	LAX	No	Los Angele	California		
26	Green	10157	E75L	4000	BOI	No	Boise	Idaho		

2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | +

Ready | Accessibility: Investigate

Updated Laser Incident total map nad added year filter

Laser Incident Analysis Dashboard

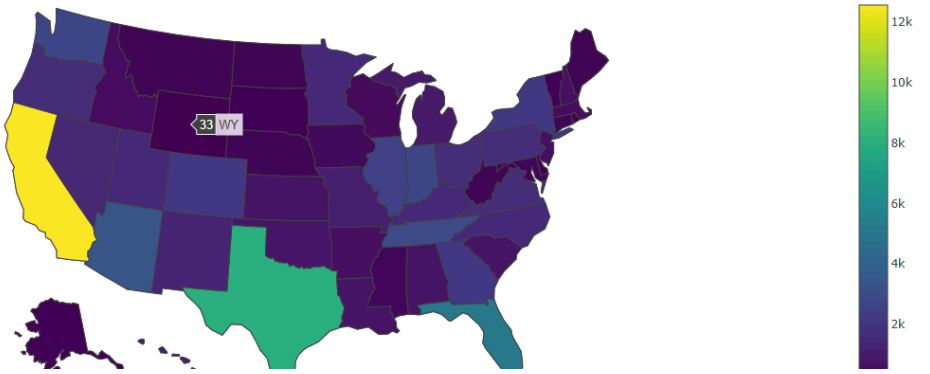
Incidents by State

Select Year:

Show All Years

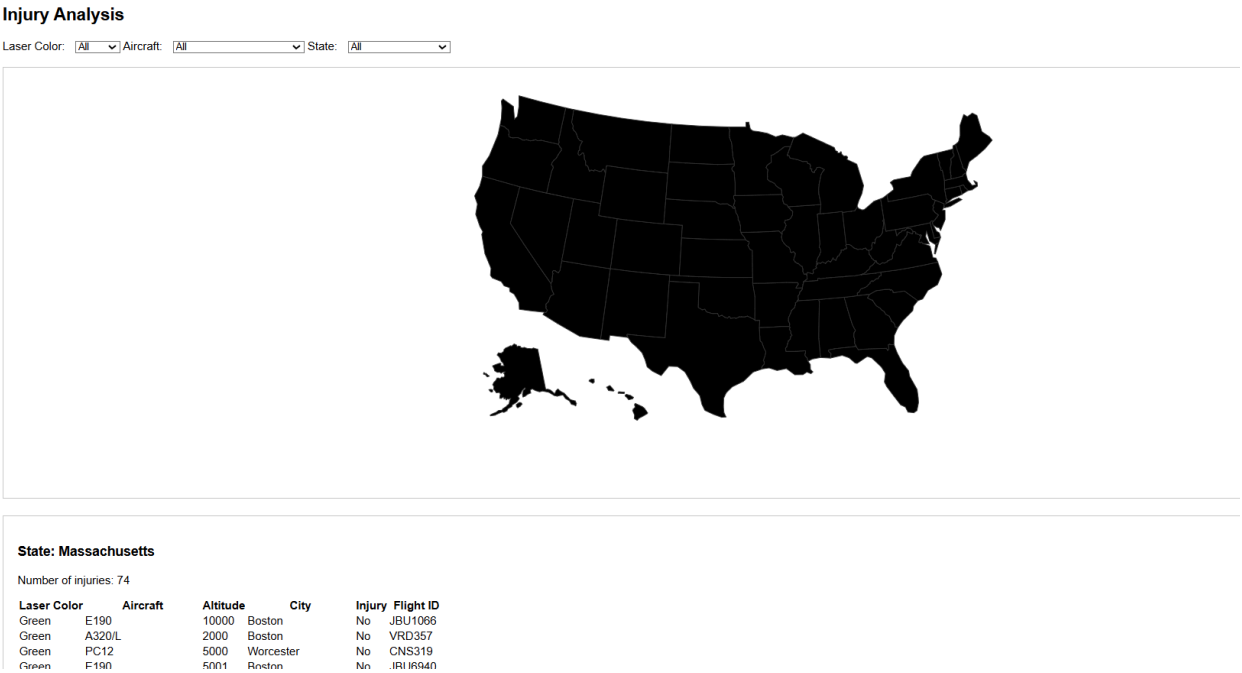
Selected Year: All

Laser Incidents by State (All Years)

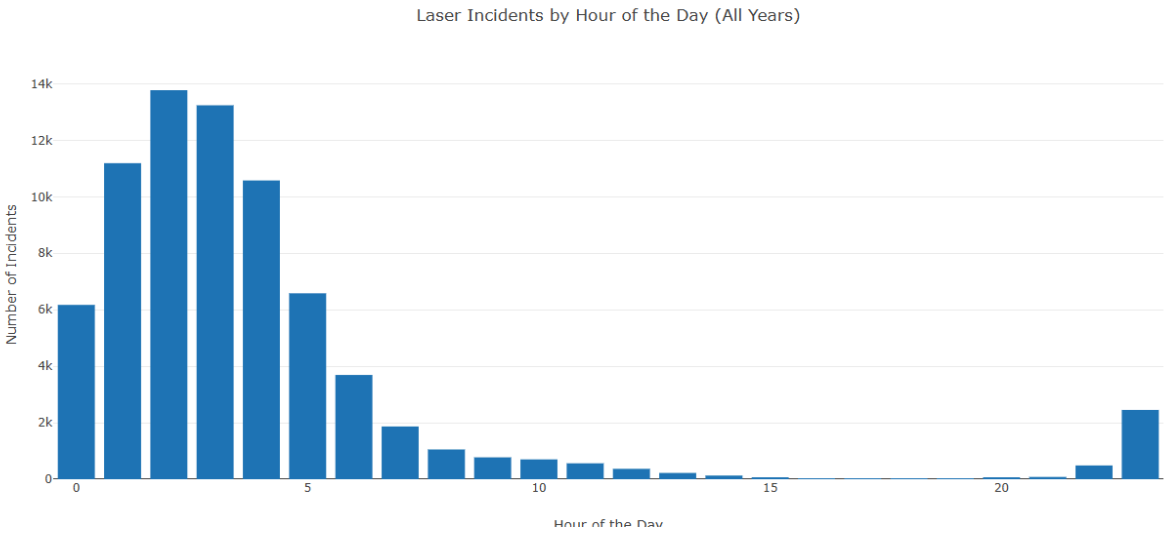


Feb 27, 2025:

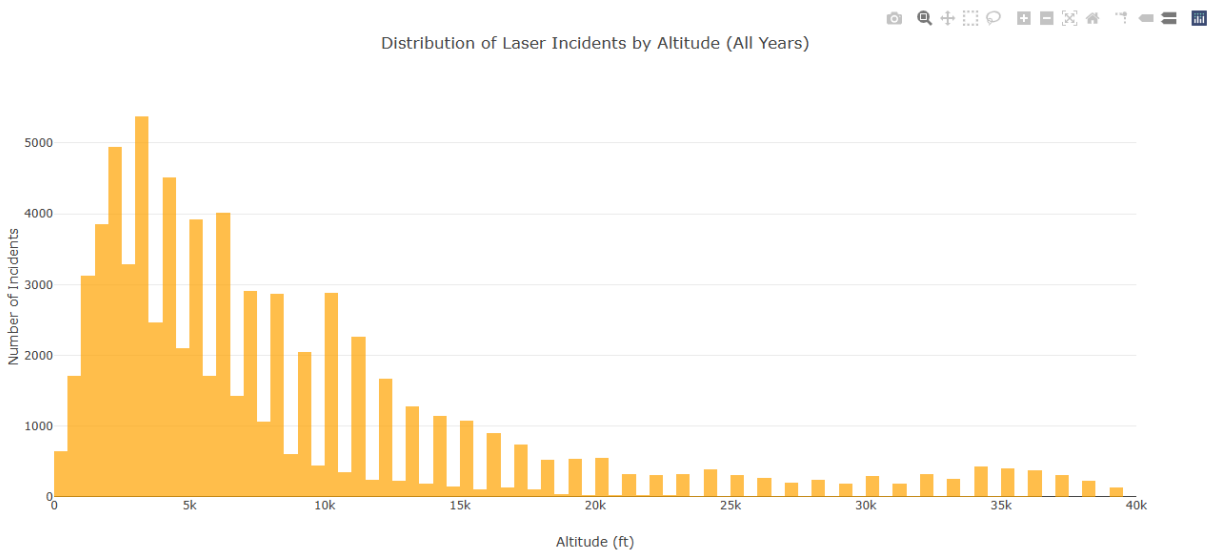
Worked on fixing up the previous excel sheet (forgot to add the time of incident). Also worked on fixing the status of what currently displays on the live server. Also added an interactive graph for incidents by hour.



This is what shows in the Injury Analysis tab currently. Right now, the drop down tabs don't function correctly, so I will need to work on that.



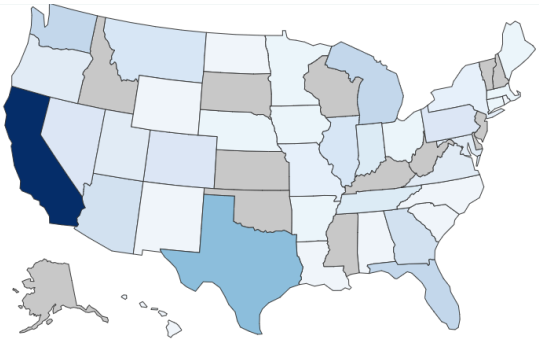
Added incidents by hour of day



Added incidents by altitude

Feb 28, 2025: Group Meeting

Worked on fixing the visuals, specifically in the injury analysis tab.



State: California

Number of injuries: 44

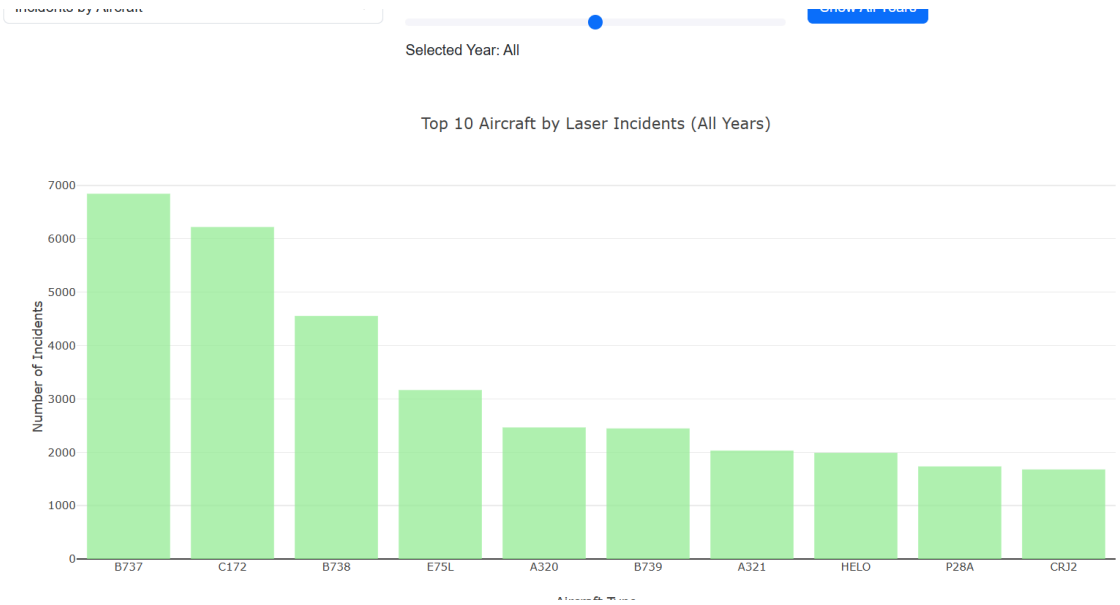
Reset Zoom

Laser Color	Aircraft	Altitude	City	Injury	Flight ID
Blue	B206	1500	Sacramento	Yes	N3QY
Blue	CH7B	2000	Palo Alto	No	N443AC
Blue	B739	17000	Ontario	No	UAL719
Blue	SA-160	1500	Santa Monica	No	N310MF
Blue	B712	12000	Los Angeles	No	DAL2789
Blue	B712	12000	Oxnard	No	DAL2780
Blue	CRJ2	12000	Concord	No	SKW5634
Blue	B737	14000	Ontario	No	UAL701
Blue	B737	UNKN	San Diego	No	SWA2167
Blue	E170	3000	Sacramento	No	CPZ5971
Blue	HELO	1000	Hollister	No	STF1

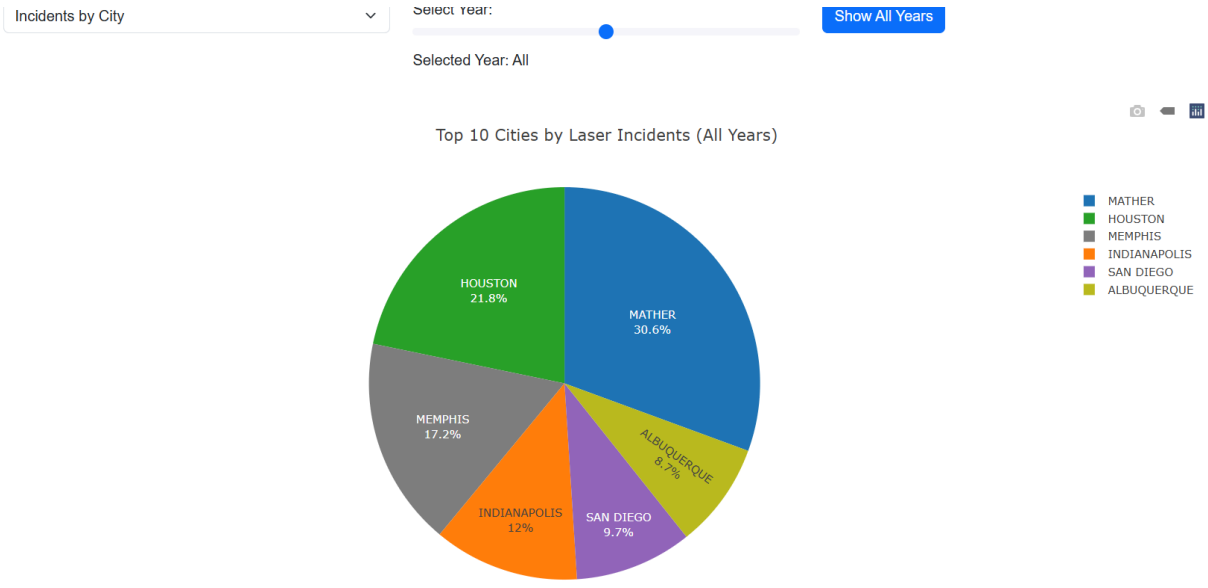
This is what currently shows, but there is an issue with the code reading and relaying the actual year. Also the default color (when option ‘All’ is selected is red, so that also needs to be fixed.

March 4-6, 2025: Group Meetings

Created a few more visualizations, Incidents by Aircraft and Incidents by Cities. Both take the top 10 aircrafts/cities for the respective year and show the number of incidents.



Top 10 Aircraft



Top 10 cities

Data:

The dataset provided focuses on laser strike incidents reported to the Federal Aviation Administration (FAA) from 2016 to 2024, highlighting a critical safety issue in aviation. Laser strikes, which involve intentionally aiming lasers at aircraft, pose a significant risk to pilots, passengers, and flight operations. The dataset includes annual incident counts, detailed reports of individual incidents, and information on enforcement actions taken by the FAA. Key variables such as incident date, time, flight ID, aircraft type, altitude, airport location, laser color, and injury status are provided, offering a comprehensive view of each event. This data underscores the persistent and growing threat of laser strikes, with pilots reporting 12,840 incidents in 2024 alone. By analyzing this dataset, we aim to identify trends, assess the effectiveness of enforcement measures, and explore strategies to mitigate this dangerous behavior. The findings will contribute to enhancing aviation safety and informing public awareness campaigns to reduce laser-related risks.

Combined data output head:

Incident Date	Incident Time	Flight ID	Aircraft	Altitude	Airport	Laser Color	Injury	City	State
2021-01-01	00:00:00	48	ASH6151	E75L	2000	SAV	Green	No	Savannah	Georgia
2021-01-01	00:00:00	56	SKW3321	E75L	17000	ZOA	Green	No	Fremont	California

Function

The Laser Incident Analysis Dashboard is a web-based tool for visualizing laser incident data using interactive charts and maps. Built with HTML, CSS, and JavaScript, it uses D3.js and Plotly for data visualization and Bootstrap for responsive design. The dashboard allows users to explore data through various visualizations, filter by year, and switch views using a dropdown menu.

The process begins with data loading and preprocessing. The `loadData` function fetches data from `combined_output.json`, cleans it by converting "Incident Time" to a numeric format, mapping state names to abbreviations, and removing invalid rows. The `filterDataByYear` function filters data based on the selected year, with an option to show all years.

The dashboard offers six visualizations. The first, "Top 5 Laser Colors," is a bar chart showing the most common laser colors. The second, "Incidents by State," is a choropleth map displaying incidents by state. The third, "Incidents Over Time," is a bar chart showing incidents by hour of the day. The fourth, "Incidents by Altitude," is a histogram of incidents by altitude. The fifth, "Incidents by Aircraft," is a histogram of incidents by aircraft type. The sixth, "Incidents by City," is a pie chart showing the top 10 cities with the most incidents.

User interaction is central to the dashboard. A dropdown menu lets users select visualizations, and a year slider filters data dynamically. A "Show All Years" button resets the slider and displays data for all years. A predefined color map (`laserColorMap`) assigns colors to laser colors in the "Top 5 Laser Colors" visualization, defaulting to gray for unmatched entries.

The dashboard uses D3.js for data manipulation, Plotly for charts and maps, and Bootstrap for responsive design. Data sources include `combined_output.json` for the main dataset and `top_cities_by_year.json` for city data. Error handling ensures robustness by managing invalid or missing data.

Future enhancements could include additional visualizations like heatmaps or scatter plots, real-time data updates via APIs, export functionality for saving charts, and advanced filtering options for states, cities, or aircraft types.

Tasks

The main tasks for this project include the following:

1. **Data Collection and Preparation:**
    a. Gathering and compiling data on laser incidents reported between 2016 and 2024, including relevant details such as laser color, altitude, city of occurrence, aircraft type, and flight ID.
    b. Cleaning and processing the data to ensure the correct format for visualization and analysis
2. **Data Analysis:**
    a. Analyze the trends in the dataset, focusing on factors like laser color, incident frequency by state, and aircraft type.
    b. Explore the connections between incident severity and factors such as altitude, aircraft type, and city of occurrence.
3. **Visualization Development:**
    a. Created six visualizations to help users understand the key aspects of the data.
        i. Top 5 laser colors involved in incidents
        ii. Incidents by state

iii. Incidents over time
iv. Incidents by altitude
v. Incidents by aircraft
vi. Incidents by city

4. **User Experience and Interaction:**
    a. We ensure that the visualizations are intuitive and interactive, providing an engaging way for users to explore each.

Users

The target audience for this project includes anyone interested in understanding and analyzing incidents involving laser strikes on airplanes. By compiling and visualizing data from multiple sources, our project aims to provide valuable insights into the prevalence, patterns, and potential risks associated with laser incidents in aviation.

Our dataset includes records of laser incidents reported between 2016 and 2024. We provide contextual information such as the altitude at which the incidents occurred, the city of the report, the type of aircraft involved, the top 5 laser colors involved, and the corresponding flight ID number. To facilitate a comprehensive analysis, we offer six visualizations; the top 5 laser colors, incidents by state, incidents by aircraft type, incidents by city, incidents by altitude, and incidents over time. These visualizations allow for a deeper understanding of how laser strikes impact different types of aircrafts and highlight a regional or flight condition pattern that may make certain arrears more vulnerable to such incidents.

By leveraging data visualization techniques, we aim to make this information more accessible and interpretable, enabling users to explore and interact with the data in a meaningful way.

Analysis & Conclusion:

Results from Data:

Most popular laser colors: green (most common), blue

Most popular States: Texas and California

Most common time of day: 1-4 AM

Most common altitude: 3,000 - 4,000 ft.

Most common Aircraft: B737, C172, B738

Most common cities: Houston, Mather, and Memphis

The analysis reveals that laser incidents are a significant threat to aviation safety, particularly during nighttime hours and at lower altitudes. To mitigate these incidents, the following solutions and recommendations are proposed:

Public Awareness Campaigns:

- Launch educational campaigns to inform the public about the dangers of shining lasers at aircraft. Emphasize that it is a federal crime with severe penalties, including fines and imprisonment.
- Use social media, billboards, and local news outlets to spread awareness, especially in high-incident areas like Houston, Mather, and Memphis.

Increased Penalties and Enforcement:

- Strengthen penalties for individuals caught shining lasers at aircraft. Ensure that law enforcement agencies are equipped to track and prosecute offenders.
- Use surveillance technology in high-risk areas to identify and apprehend perpetrators.

Pilot Training and Reporting:

- Train pilots to handle laser incidents effectively, including techniques to minimize the impact of laser exposure on their vision.
- Encourage pilots to report all laser incidents promptly, providing detailed information to help authorities identify patterns and hotspots.

Aircraft Modifications:

- Equip aircraft, especially commonly targeted models like the B737, C172, and B738, with laser-blocking filters or protective coatings on cockpit windows to reduce the impact of laser strikes.

Community Engagement:

- Work with local communities in high-incident areas to address the root causes of laser misuse. Engage schools, youth organizations, and community leaders to promote responsible behavior.

Real-Time Monitoring and Alerts:

- Develop real-time monitoring systems to detect laser activity near airports and flight paths. Use this data to alert pilots and law enforcement immediately.

Research and Development:

- Invest in research to develop advanced technologies for detecting and neutralizing laser threats, such as laser detection systems and countermeasures.

The Laser Incident Analysis Dashboard effectively transforms raw data into actionable insights, making it a valuable tool for researchers, policymakers, and aviation authorities. Its modular design and interactive features allow for easy exploration of laser incident trends, aiding in the development of strategies to mitigate such incidents in the future. By combining data-driven insights with targeted solutions, we can reduce the frequency of laser incidents and enhance aviation safety for pilots, passengers, and communities. Future enhancements to the dashboard could include additional visualizations, real-time data integration, and advanced filtering options to further improve its utility

Citations

Basic pie chart — Matplotlib 3.3.4 documentation. (n.d.). Matplotlib.org. https://matplotlib.org/stable/gallery/pie_and_polar_charts/pie_features.html

Bostock, M. (2019, August 5). *Zoom to Bounding Box*. Observable. https://observablehq.com/@d3/zoom-to-bounding-box

FAA. (2020). *Laser Incidents | Federal Aviation Administration*. Faa.gov. https://www.faa.gov/about/initiatives/lasers/laws

Natural Earth» Blog Archive» Admin 1 – States, Provinces - Free vector and raster map data at 1:10m, 1:50m, and 1:110m scales. (n.d.). Natural Earth. https://www.naturalearthdata.com/downloads/110m-cultural-vectors/110m-admin-1-states-provinces/