

Detailed analysis of U.S. flight's on-time performance

Laksh Matai¹, Ashwini Giri¹, and Pallavi Yenigalla¹

University of Southern California, CA 90007, USA
{lmatai, agiri, yenigall}@usc.edu

Abstract. The paper presents an analysis on flight delays from various different aspects of carrier, region and time using advanced visualizations created with the help of d3.js.

Keywords: U.S. flights · Visualization · Analysis.

1 Introduction

There are more than a million Americans travelling in a plane everyday. These numbers increase significantly during holiday periods such as Thanksgiving and Christmas. To carry so many people there are thousands of flights arriving and departing at the same time through out the America. These flights are departing from different cities, in different weather conditions and are operated by different carriers. With the ever growing traffic its getting difficult to manage the flight program every year which leads to delay in flight travel. Although over the years we've seen increased reliability in flight travel we've also seen a trends of increased delays. Detailed study of historical data on U.S. flights from year 1993-2018 show a common pattern shared between the delays. Our findings show that there are fixed number of airlines which cause the most delay, there are fixed number of cities which have the most delay and there are fixed periods of time in an year where delay peaks. Using various visualizations that we've learn this semester through the course Information Visualization taught by Dr. Luciano Nocera, we try to represent this information on flight's on time performance. We've used Pandas library in Python to read data of multiple years and combine them to find their average values and store them as a csv file. We've also used tools such as Microsoft excel to read the data and get required values from it using its pivot table functionality. The visualizations that we've created are using d3.js and the website is created in Angular 6. We've used different node modules such as topojson, bootstrap, particles js to make the website more interactive and visually appealing.

2 Data

We've used data which has been collected over the years by Federal Aviation Administration (FAA). The U.S. Department of Transportation's (DOT) Bureau

of Transportation Statistics (BTS) tracks the on-time performance of domestic flights operated by large air carriers. Summary information on the number of on-time, delayed, canceled and diverted flights appears in DOT's monthly Air Travel Consumer Report, published about 30 days after the month's end, as well as in summary tables posted on the website. The data could be found at the url: https://transtats.bts.gov/DL_SelectFields.asp?Table_ID=236. The data is available in csv format and needs to be downloaded month wise. All the data from the year 2000 to 2018 was downloaded and combined to be used for this project.

3 Related Work

United States Department of Transportation has a database and it's visualization for Airline on-time performance that contains visualizations of the airline delay statistics and causes of delay to help user to understand and choose what is appropriate. We drew our inspiration from this to represent visualizations to create a story of the traveller.

4 Approach

4.1 Design Consideration

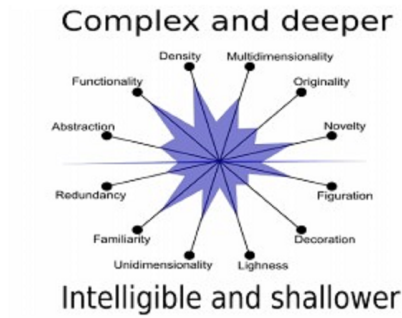


Fig. 1. Visualization wheel.

As exhibited in Fig-1, our design exhibits an equal balance between unidimensionality and multidimensionality. Various factors such as location of cities and connecting airports are displayed using maps and interactivity ensures multidimensionality. For our audience's understanding we have used familiar charts and avoided redundancy. The visualization is more abstract than figurative because most of referants applied are conceptual tools such as bar, line and donut rather than vivid physical realities. Sticking to functionality has been our forte.

4.2 Technical Considerations and Development Plan

This project has been developed on the Angular Cli framework. Separate components have been created for each of the charts created in angular. D3.js is a JavaScript library for manipulating documents based on data, which we have used to construct our charts for visualizing. We used bootstrap for grid layout and CSS for styling and creating buttons. Google API has been used to create the interactive maps.

5 System

5.1 Interactivity, Colour Scheme, Transition

5.2 U.S. map and bar chart

This visualization shows a city wise breakdown of which carrier causes most delay.



Fig. 2. Locations of cities in US for visualization.

In the Figure 2 user has clicked on Los Angeles and the text below the map has changed to Los Angeles, Figure 2 shows the subsequent bar chart below the map which shows carrier delay. The bar charts update for each city and show different departure delays.

5.3 U.S. map, interactive card and hierarchy chart

This visualization shows a city wise breakdown projected on US Map of Airports connectivity for Domestic Airlines. User needs to click on a city and then lines/routes will appear representing connectivity from the clicked airport to other airports in the United States. Based on the Clicked city, the marks card beside the map will update itself with the new values showing information and cause of delay for selected city. Figure above displays the connecting airports to San Francisco along with a card that contains information about San Francisco International Airport. It also displays the monthly, daily and hourly statistics of the delays of the selected airport. The US connecting graph displays the inbound and outbound connectives of all airports in the US.

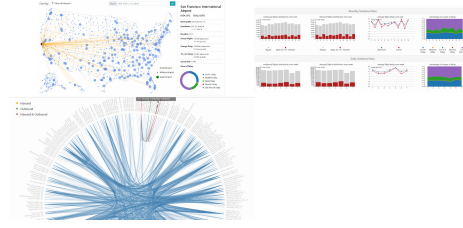


Fig. 3. Airport connections from San Francisco with card displaying cause of delay.

5.4 Line Chart for delay with card for carrier type

This visualization allows the user to select a carrier type which displays the departure and arrival delay for the carrier selected along with a card displaying information about the carrier.

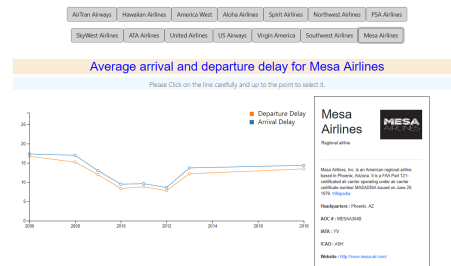


Fig. 4. Arrival and departure delay from 2001-2018.

Figure 4 displays the arrival and departure delay for Mesa Airlines from the year 2001 to 2018. The card on the right gives more information about Mesa along with links to the website and its Wikipedia page.

5.5 Bipartite Graph

Air transport is the second highest mode of transportation in the US. This visualization portrays the on-time performance of flights affected by delays, flight cancellations and diversions for the year 2017. Delays are categorized into air carrier, extreme weather, airplane arriving late and security delays. A monthly evaluation of cause of delay is also presented which explains the various causes of delay for the month selected. User selects a month; the bipartite chart updates the various causes of delay for carriers and in major airports for the selected month.

The figure depicts the statistics of various delays wherein the user can select a month between January 2017 - August 2018; the bipartite graph shows the delays of various carriers and also in major airports.



Fig. 5. Delay due to carrier, weather, airplane late arrival and security reasons.

6 Conclusion

The main goal of our project is to summarize the large airtime performance data set to make visualizations that will be useful to user to make decisions for planning air travel. Target audience is frequent travellers, or anyone who is planning to travel by air and have a comfortable travel. We processed and visualized it in various perspectives, so that people don't have an overwhelming travel experience. Many interesting visualizations and a website has been created that is worth looking into while planning to travel by air.

References

1. Michael Bostock, Vadim Ogievetsky and Jeffrey Heer.: D3: Data-Driven Documents. Journal 2011
2. Albert Cairo,: The Functoinal Art: An Introduction to Information Graphics and Visualization. New Riders (2012)
3. Leadlet: Leaflet, <http://leafletjs.com>
4. Murray, S.: Interactive Data Visualization for the Web.O'Reilly Media (2013)
5. Ware, C.:Visual Thinking for Design. Morgan Kaufmann (2008)
6. D3.js, <https://d3js.org/>.
7. <https://angularjs.org/>.