Visualizing the Landscape of Transit Systems in the USA

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Abstract. Transportation systems are a critical element of connectivity, but their complexities can barely be visualized. The project showcases an interactive web-based visualization dashboard of U.S. transit systems-flights, highways, buses, and railways-using the latest technology stacks with Bootstrap, Streamlit, and Deck.gl. It gives users the facility to study trajectory maps, highlight patterns, and filter transport modes. This tool has great value for transportation planners and policy makers.

Keywords: Transit Systems · Visualizations · Dashboard · Trajectory Maps · Transportation · Buses · Railways · Flights · Highways.

1 Introduction

Transportation systems are crucial in facilitating economic and social mobility in the United States. From flights, highways, buses, and railways, these complex networks hold a place in regional and national connectivity. However, understanding these systems in an integrated manner remains an uphill task, especially when analyzing patterns of accessibility and usage across multiple modes of transport.

This paper will introduce the interactive dashboard that solves this challenge. The dashboard was built with Bootstrap, Streamlit, and Deck.gl and provides trajectory maps and dynamic visualizations to explore U.S. transit systems. By filtering between transport modes and zooming into specific regions, users uncover insights on connectivity and mobility. Empowering transportation planners, policymakers, and researchers with a unified visualization of the transit landscape will help them make informed decisions.

2 Related Work

Most research on transit system visualization is about single-mode transportation, either by air travel or by highway networks. GTFS tools (General Transit Feed Specification) and visualizations from OpenStreetMap have been in wide usage to map transit data. However, very few tools integrate a multitude of transportation modes into one interface. Other work has also involved heat maps of traffic analysis, trajectory visualization for flights, and interactive dashboards

for urban planning. This project combines these ideas into one platform that integrates all data: flights, highways, buses, and railways. It offers the capability for a more granular exploration than could be afforded in prior tools.

3 Data

The datasets used for this project provide comprehensive coverage of transit systems in the United States across three major modes of transport. These datasets include:

- **Air Routes**: This dataset contains details about flight trajectories, airport hubs, and inter-state connectivity. It enables the creation of heat maps to visualize areas with high flight activity and detailed trajectory maps originating from specific airports.
- **Rail Routes**: This dataset includes information about major train lines and their stops, allowing for detailed visualizations of rail connectivity across states.
- **Road Routes**: This dataset provides data on the U.S. highway network, highlighting major highways and their connectivity patterns.

Each dataset was preprocessed to ensure compatibility with the visualization tools and to enable seamless integration into the interactive dashboard. This preprocessing involved data cleaning, geospatial alignment, and conversion into formats suitable for Deck.gl layers, such as GeoJSON and CSV.

4 Approach

The visualization dashboard is designed to provide an interactive exploration of transit systems in the United States. The following technologies were utilized:

- **Bootstrap**: For designing a responsive and user-friendly layout.
- **Streamlit**: To develop the web application, enabling the integration of interactive charts, maps, and filtering options.
- **Deck.gl**: To render high-performance geospatial visualizations, such as trajectory maps, heat maps, and icon layers for stops.

The approach involves creating a multi-layered visualization framework where each transportation mode is visualized at different zoom levels:

- At a high-level view, a heat map highlights flight activity density. Hovering over specific hubs reveals flight trajectories and displays an interactive bar chart of the top 10 connected states.
- Zooming in highlights major highways in the region, providing an overview of road network connectivity.
- Further zooming reveals bus routes with their stops displayed as icons, enabling detailed exploration of regional bus networks.

– Train routes and stops are visualized similarly, allowing users to explore rail connectivity in detail.

The integration of these visual layers provides a cohesive and interactive way to analyze transit patterns at varying scales.

5 System

The implemented system is a single-page dashboard designed to visualize multiple modes of transportation in an interactive and user-friendly manner. It provides the following functionalities:

– **Flights**: A heat map shows regions with high flight activity. When a state or airport is hovered over, flight trajectories to other states are displayed. Clicking on an airport populates a bar chart showing the top 10 connected destinations.
– **Highways**: On zooming in, all major highways in the selected area are highlighted on the map, providing an overview of road connectivity.
– **Buses**: Further zooming reveals major bus lines and their stops, represented with an icon layer for easy identification.
– **Trains**: At the same zoom level, train lines and their stops are displayed, offering a detailed view of rail connectivity.

The dashboard is built to handle large datasets efficiently and provides a seamless user experience. By leveraging Deck.gl for rendering, the system ensures high performance and responsiveness, even with complex geospatial data.

6 Conclusion

This project explores how interactive dashboards can revolutionize the analytical and visual ways of looking at transit systems. Flights, highways, buses, and railways are integrated into one tool for a comprehensive outlook at transportation in the United States. Such a dashboard would have great potential applications for transportation planning, policy analysis, and public accessibility. Future work could explore real-time updates, additional transportation modes, and enhanced analytics to further improve the platform's utility.

References

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