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Data Visualization

**Border Crossing Entry Data Analysis**

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# Overview

The Border Crossing Entry Data from Data.gov provides comprehensive insights into cross-border activities in the United States, detailing the movement of vehicles, pedestrians, and other transportation modes. By analyzing this dataset, key trends over time, regional differences, and transportation and trade patterns can be uncovered. The purpose of this project is to utilize the data visualization life cycle to transform raw data into actionable insights. This involves data cleaning, exploratory analysis, and explanatory storytelling to create an engaging narrative.

This analysis is critical for understanding the impact of cross-border activity on U.S. transportation systems and trade. Policymakers, economists, and transportation planners can leverage these insights to make informed decisions. Additionally, the findings provide valuable context for optimizing infrastructure and resource allocation at high-traffic ports.

# Data Description

The Border Crossing Entry Data is sourced from the Bureau of Transportation Statistics (BTS). It provides summary statistics for inbound crossings at the U.S.-Canada and U.S.-Mexico borders, categorized by port of entry. The data includes information on multiple crossing types such as:

* Trucks
* Trains
* Containers
* Buses
* Personal vehicles
* Passengers
* Pedestrians

**Data Source**

The data is collected by U.S. Customs and Border Protection (CBP) and provides insights into inbound crossings at U.S.-Canada and U.S.-Mexico borders. It includes counts of vehicles, containers, passengers, and pedestrians entering the United States, offering a comprehensive view of cross-border activity.

**Dataset Features**

* Port of Entry: Specific border crossing locations.
* Border: Designates crossings at the northern (U.S.-Canada) or southern (U.S.-Mexico) borders.
* Measure: Crossing types, such as trucks, trains, buses, personal vehicles, passengers, and pedestrians.
* Value: Count of vehicles, containers, passengers, or pedestrians for each measure.
* Date: Monthly summary statistics to analyze trends over time.

**Data Challenges**

* Handling Missing Values: Address gaps using imputation or exclude incomplete data when necessary. Gaps in monthly data were addressed by aggregating totals across measures or excluding incomplete data when necessary.
* Data Aggregation: Summarize data by time (e.g., monthly) and region for meaningful comparisons.
* Category Management: Managing multiple crossing types to ensure insights are clear and not overwhelming.

**Opportunities**

This dataset allows for robust visual storytelling that links geographic locations to temporal and categorical patterns. Key findings can be visualized in both static and interactive formats to communicate insights effectively.

# Methodology

**Data Cleaning**

1. Identify and handle missing or inconsistent values in the dataset.
2. Format dates for proper time-series analysis by converting the Date column from a custom *dd-mmm* format to a standard *Date* type, ensuring compatibility with visualization tools.
3. Standardize column names and data categories for consistency. Adjusted the Border column by removing the word "Border" from each entry, leaving only the simplified values US-Canada and US-Mexico for improved clarity and filtering.

**Exploratory Data Analysis (EDA)**

1. Analyze overall trends in border crossing activity over time.
2. Compare activity levels between the northern and southern borders.
3. Examine the distribution of crossing types, highlighting which modes (e.g., trucks, buses, cars) dominate.
4. Filter data to focus on key periods (e.g., 2024) and high-impact regions to uncover actionable trends.

**Visualization Development**

1. Design line charts to illustrate temporal trends in total border crossings.
2. Develop bar charts to compare transportation modes across borders.
3. Develop an interactive geographic map to visualize activity at different states.
4. Design a bubble chart to represent the distribution of crossing types across all time.
5. Create a treemap to display ports by total crossing volume, providing a comprehensive view of cross-border activity.

**Tools and Techniques**

1. Utilize Tableau for creating dynamic visuals and interactive maps.
2. Structure insights into a narrative to ensure a logical flow.

# Exploratory Analysis Insights

**Temporal Trends**

Line charts reveal fluctuations in border crossing volumes over months and years. In 2024, crossing volumes showed a steady increase from January to July, with notable peaks during summer months, likely tied to increased trade and travel activity. This highlights the importance of focusing resources during high-traffic periods.

**Regional Comparisons**

Bar charts comparing northern and southern borders highlighted significant differences in activity levels. The southern border exhibited higher crossing volumes, driven by major trade routes and dense populations near border cities. In contrast, the northern border reflects more consistent and moderate levels of activity, aligning with its role in U.S.-Canada trade.

**State-Level Activity**

The interactive geographic map reveals distinct patterns in border crossing volumes across states. Southern states like California and Texas exhibit significantly higher activity compared to northern states, reflecting their proximity to major trade and commuter routes. This provides valuable insights into regional traffic distribution and its implications for resource allocation.

**Crossing Types**

The bubble chart visualizes the distribution of crossing types across all time. Personal vehicle passengers and personal vehicles dominate the dataset, followed by pedestrians and trucks. This highlights the prominence of commuter and passenger traffic, which significantly outweighs commercial crossings.

**Port-Specific Activity**

The treemap displaying ports by total crossing volume emphasizes the importance of specific locations in cross-border activity. Critical hubs like El Paso and San Ysidro stand out, highlighting the concentration of activity and its strategic importance for border management.

# Explanatory Analysis Findings

**Visualization 1: Line Chart**

* Purpose: To display temporal trends in total border crossings.
* Insights: Seasonal spikes and long-term growth patterns were identified, particularly during peak travel and trade periods in 2024.

**Visualization 2: Bar Chart**

* Purpose: To compare crossing types by border (northern vs. southern).
* Insights: Personal vehicle passengers and personal vehicles dominate at both borders, followed by pedestrians and trucks. Certain southern ports have significantly higher pedestrian traffic compared to northern ports.

**Visualization 3: Geographic Map**

* Purpose: To visualize cross-border activity by region.
* Insights: The map highlights significant differences in crossing volumes between the northern and southern borders, emphasizing the southern border's higher overall activity. This reflects its critical role in cross-border travel and trade.

**Visualization 4: Bubble Chart**

* Purpose: To represent the distribution of crossing types across all time.
* Insights: Personal vehicle passengers and personal vehicles are the largest categories, followed by pedestrians and trucks. This highlights the dominance of passenger and commuter traffic over commercial crossings.

**Visualization 5: Treemap**

* Purpose: To display ports by total crossing volume, providing a comprehensive view of cross-border activity.
* Insights: The treemap emphasizes the prominence of El Paso and San Ysidro as critical hubs for border crossings, along with other ports contributing to overall trends. This visualization highlights the concentration of activity and its importance for resource allocation and infrastructure planning.

# Dashboard Integration

The visualizations were combined into an interactive Tableau dashboard titled “Border Crossing Analysis Dashboard” to present a cohesive narrative. The dashboard includes the following:

**Interactive Features**

* Filters:
* Toggle between northern and southern borders.
* Filter data by Measure (e.g., trucks, pedestrians, personal vehicles).
* Select specific Port Names to focus on individual locations.
* Click on any state to dynamically update all visualizations across the dashboard.
* Interact with the treemap to filter data by specific ports.
* Select any month on the line chart to focus on trends during that period.
* Click on crossing types in the bubble chart to update the entire dashboard view.
* Tooltips: Display detailed information on crossing types, crossing volumes, and regions for better context.

These interactive capabilities allow users to tailor their exploration of the data, enhancing engagement and uncovering personalized insights.

**Colors**

The map and treemap both use a gradient color scheme to highlight crossing volumes, with darker shades indicating higher values.

The bar chart and bubble chart use distinct colors to differentiate categories, enhancing clarity and comparison.

**Layout**

* The dashboard starts with the line chart to provide temporal trends.
* The bar chart and bubble chart illustrate comparisons of crossing types.
* The geographic map serves as the centerpiece, with filters dynamically updating all other visualizations.
* The treemap offers a detailed view of ports by total crossing volume, complementing the overall analysis.

**Purpose**:

The dashboard enhances the storytelling experience by enabling users to interact with the data dynamically, explore specific dimensions (e.g., ports, crossing types), and draw their own insights.

# Findings and Implications

**Key Insights**

1. Seasonal trends in border activity suggest opportunities for resource allocation during peak times.
2. Northern and southern borders exhibit distinct patterns in transportation mode usage, reflecting geographic and economic differences.
3. Ports of entry play varied roles, with some contributing significantly to trade and others serving commuter traffic.
4. Passenger vehicles and pedestrian crossings dominate activity, as shown in the visualization of crossing types, highlighting the significant role of daily commuter traffic in overall border dynamics.

**Implications**

* Policymakers can optimize border staffing and infrastructure investment based on crossing patterns.
* Economists can better understand cross-border trade dynamics and their impact on the U.S. economy.
* Transportation planners can forecast future needs based on historical patterns.
* Enhanced collaboration with Canadian and Mexican authorities could improve data collection and provide a more comprehensive view of border activity.
* Future infrastructure investments should prioritize enhancements at high-traffic ports to handle projected growth efficiently.

# Relevance

This project demonstrates the power of data visualization in uncovering meaningful insights. By exploring cross-border activity, it offers a valuable case study in transportation analysis, trade evaluation, and resource planning. The visualizations created not only inform but also engage stakeholders, making complex data accessible and actionable. Additionally, the insights support infrastructure optimization at high-traffic ports of entry and guide policymakers in addressing trends in trade, migration, and commuter traffic. By integrating historical trends and geographic data, this project bridges technical analysis with practical applications, providing a critical tool for tackling challenges in border management and regional planning.

# Sources:

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