Proposal

1. Basic Info

The title of our project will be: Visualize the Impact of Meteorological Conditions on Utah 2017 Winter Traffic Patterns. Below is the information of group members.

Name	UID	Email
Shuying Zhao	U1474799	Shuying.zhao@utah.edu
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The online repository of our project can be found here: https://github.com/SicoJensennn/2024_Vis_Project.git.

2. Background and Motivation

Shuying is a graduate student in the department of atmospheric sciences, and she studies atmospheric chemistry, more broadly, air quality. Xincen, a bioinformatics student with a strong interest in huamn health, is particularly inspired by this work as it bridges urban development and air quality. During Shuying' s research, she found that the on-road vehicles can impact the air quality by multiple ways. On well-known path is that vehicles can emit carbon dioxide (CO_2) and methane (CH_4), which are significant greenhouse gases due to their high global warming potential (GWP). Another path is that the movement of vehicles can cause vehicle-induced turbulence to influence turbulent mixing which can lift and suspend particles on the road from the road surface. The suspended road dust can increase the concentration of fine particle matters with a diameter less than 2.5 mm

($PM_{2.5}$) and coarse particle matters with a diameter between 2.5 mm and 10 mm (PM_{10}). This will further impact human health. Moreover, the road salt applied in winter to prevent ice formation to maintain road safety can be suspended into the air and undergoes many chemical reactions to form chlorine nitrite ($ClNO_2$). The formation of $ClNO_2$ plays a significant role in wintertime atmospheric chemistry, as it can trigger reactions that affect the concentrations of $PM_{2.5}$, PM_{10}, O_3 eventually upon sunrise.

Studying the impact of meteorological conditions—such as wind speed, temperature, precipitation, and snowfall—on winter traffic patterns can provide valuable insights into seasonal variations in traffic flow.

By analyzing how weather influences driver behavior and traffic volume, we can develop predictive models to forecast traffic patterns more accurately during winter months. This, in turn, enables us to predict air quality more effectively, as traffic density and flow are major contributors to urban air pollution. Understanding these connections allows for better planning and management of both transportation and environmental health, helping reduce emissions and mitigate health risks associated with poor air quality during wintertime.

3. Data

Data	Source	Link
Traffic Volume	U.S. Department of Transportation	https://www.fhwa.dot.gov/policyinformation/tables/tmasdata/

Traffic Monitor Stations	U.S. Department of Transportation	https://www.fhwa.dot.gov/policyinformation/tables/tmasdata/
Meteorological Reanalysis Data	GEOS-Chem	https://geoschem.github.io
US Map		https://gist.github.com/mshafrir/2646763

GEOS-Chem is a global 3-D model of atmospheric chemistry drive by meteorological input from the Goddard Earth Observing System (GEOS) of the NASA Global Modelling and Assimilation Office. The grid resolution we are going to use is 0.25 * 0.3125. And the time we selected are from Jan 2017 to Mar 2017.

4. Data Processing

There are a few of substantial data clean up we need to do.

1) For the traffic volume data, we need to select Utah data, uniform the data type, and set the traffic volume to 0 if the dates are not in the table.
2) For the traffic stations, we need to select stations in Utah.
3) Gridded traffic data into 0.25 * 0.3125.
4) For the meteorological data, we need to find the grids that cover Utah, and we need to select the variables like temperature, snowfall and so on for us to use.

5. Analysis Problems

1) Do traffic flows have different patterns during the week and on weekends
2) Do traffic flows have diurnal patterns

3) Is there any relationship between the weather conditions and traffic flow

4) Which meteorology factors impact the most

5) Do the traffic flows in Salt Lake City less affected by weather conditions than in other areas?

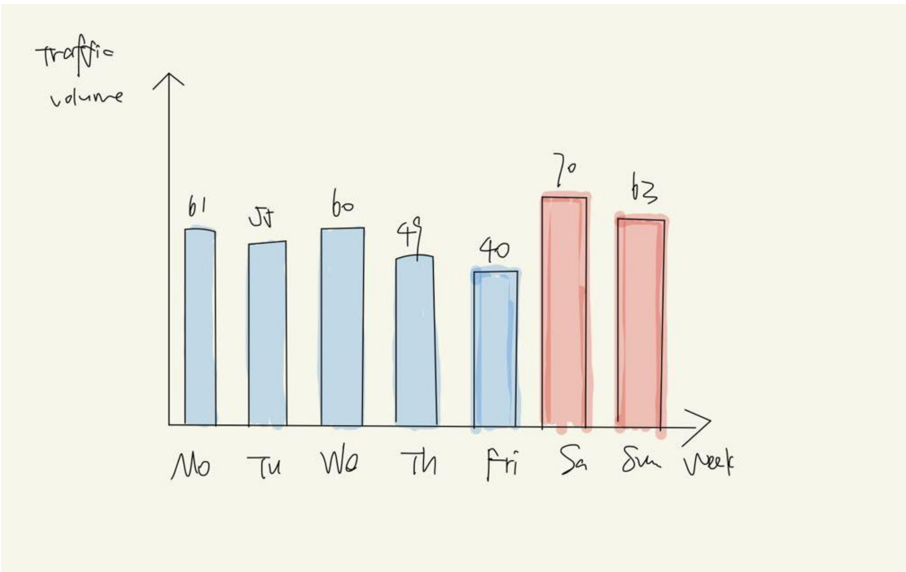
6. Visualization Design

1) Weekly Patterns (Question 1)

Use a bar chart to display daily traffic volume, helping to identify traffic volume patterns on different days of the week.

Visualization Details:

Bar Chart: The X-axis represents the days of the week, and the Y-axis represents traffic volume. Use different colors to distinguish weekdays from weekends. Through the bar chart, users can quickly identify the differences in traffic volume between weekdays and weekends, providing a foundation for further analysis.

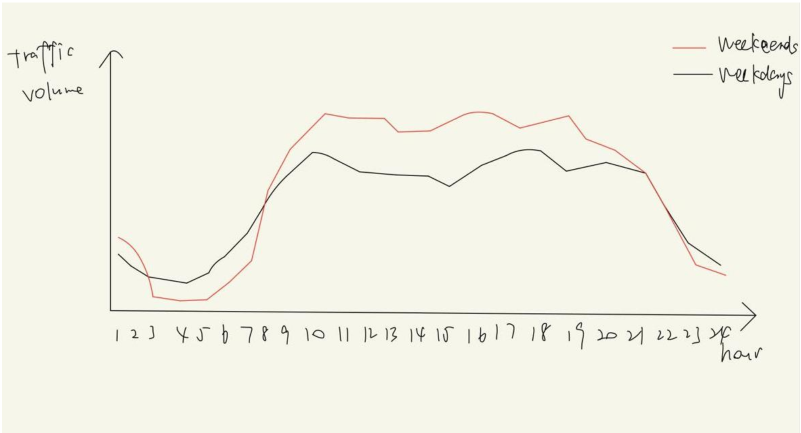


2) Daily Patterns (Question 2)

Use a line chart to display 24-hour traffic patterns, helping to observe traffic fluctuations across different times of the day.

Visualization Details:

Line Chart: The X-axis represents the 24 hours of the day, and the Y-axis represents traffic volume. Different colors are used to represent the 24-hour traffic patterns for weekdays and weekends. By comparing the lines, users can identify peak and low traffic periods, recognizing key traffic times and variations in daily traffic patterns.



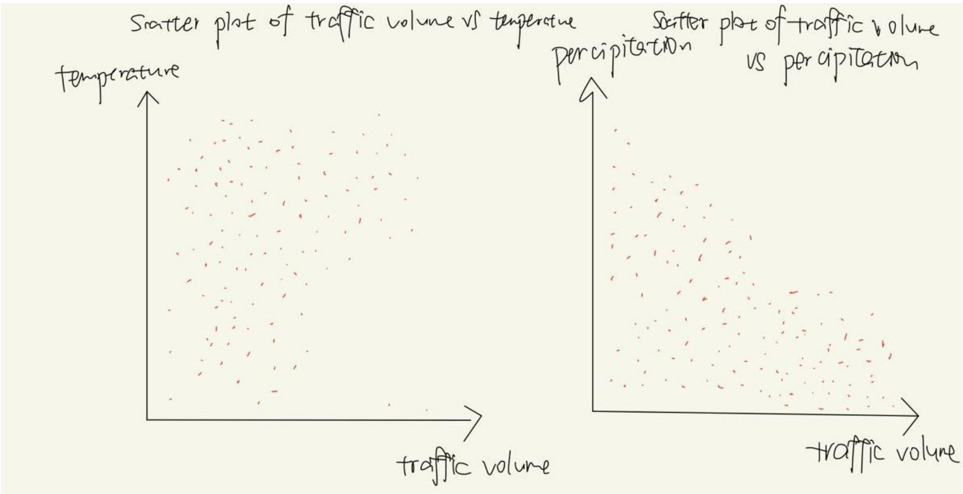
3) Weather Impact (Questions 3 & 4 & 5)

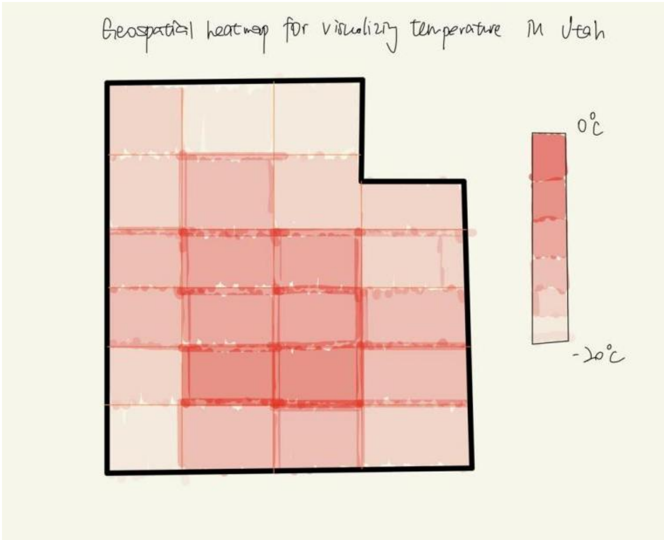
Use a scatter plot to analyze the relationship between traffic volume and weather factors like temperature and precipitation, combined with an interactive gridded map to show weather impacts across different regions.

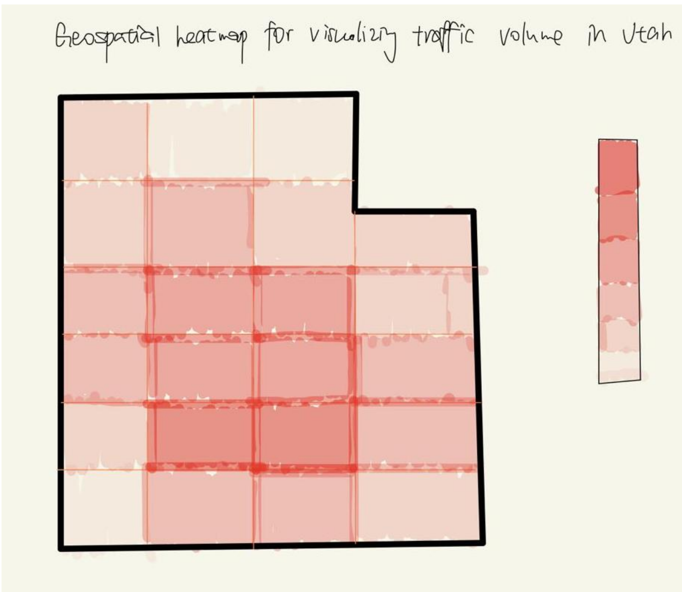
Visualization Details:

Scatter Plot: The X-axis represents weather factors (e.g., temperature or precipitation), and the Y-axis represents traffic volume, with each point representing an observation. The map is overlaid with different grid areas, allowing users to click on any grid to view the relationship between weather factors and traffic volume in that specific area.

This combination of visualizations provides an intuitive view of the impact of weather factors on traffic volume.







4) Final design

Combining the best features from the three prototype designs, the final design employs an interactive gridded map. Users can click on each grid on the map to view related traffic patterns and weather impact.

Visualization Details:

Interactive Gridded Map: The map is overlaid with clickable grids, allowing users to select different regions to view detailed data. Time selectors and weather filters enable users to choose specific times and weather conditions.

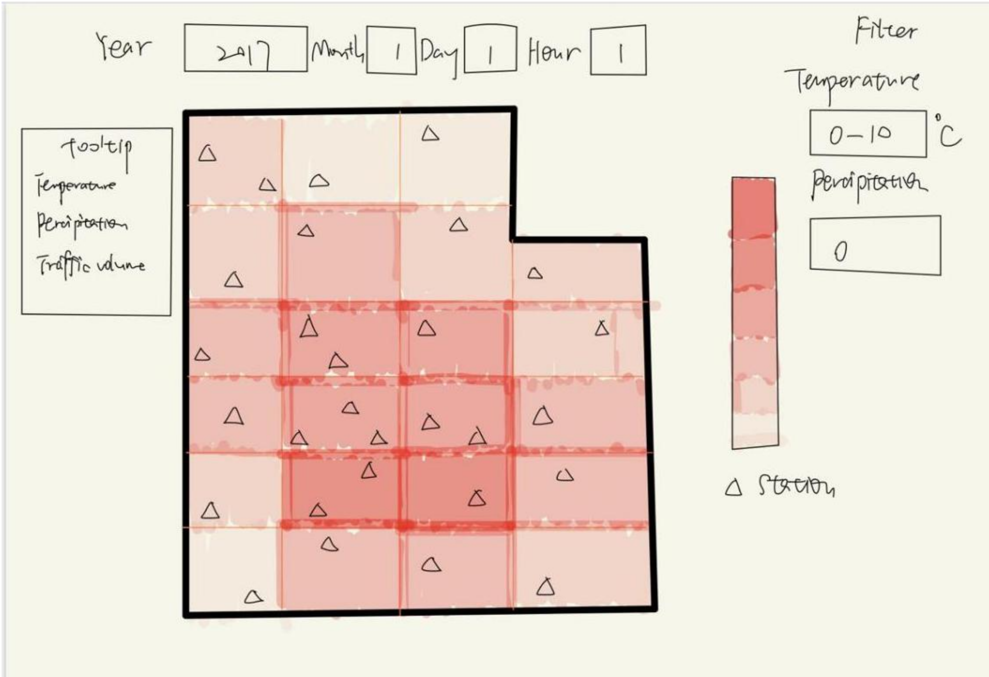
Weather Impact Plot: Below the gridded map, scatter plots are generated for each weather factor, showing the relationship between factors and traffic volume within each selected region.

Interactive Calendar Chart: Provides an annual calendar view, allowing users to hover over specific days to view detailed traffic data and weather conditions or select specific months to analyze overall traffic patterns for that month.

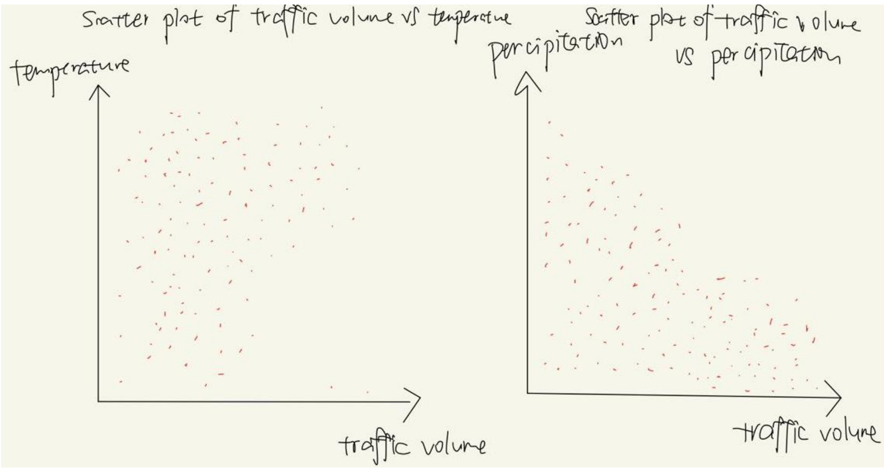
Visual Encoding Choices:

Color Coding: Different colors distinguish weekdays from weekends, helping users quickly understand weekly and daily traffic patterns.

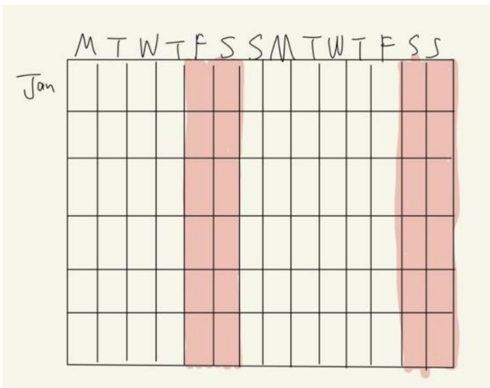
Interactive Functionality: Clicking on a grid area displays a detailed scatter plot of data for that region. Through interactions between map grids and weather factors, users can explore the influence of specific weather conditions on traffic volume.



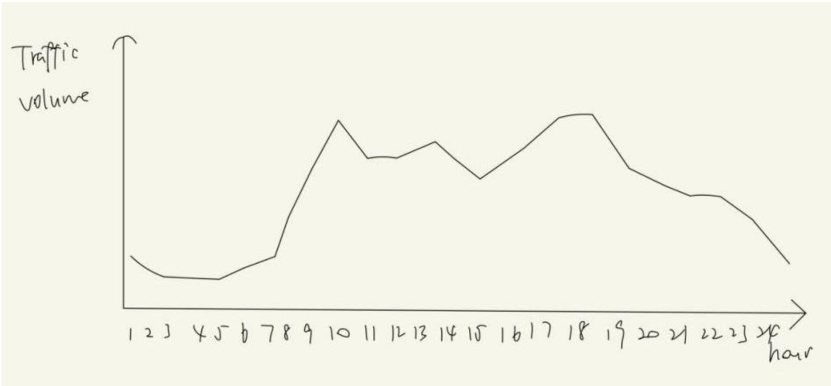
When clicking on each regions, it will show the scatter plots.

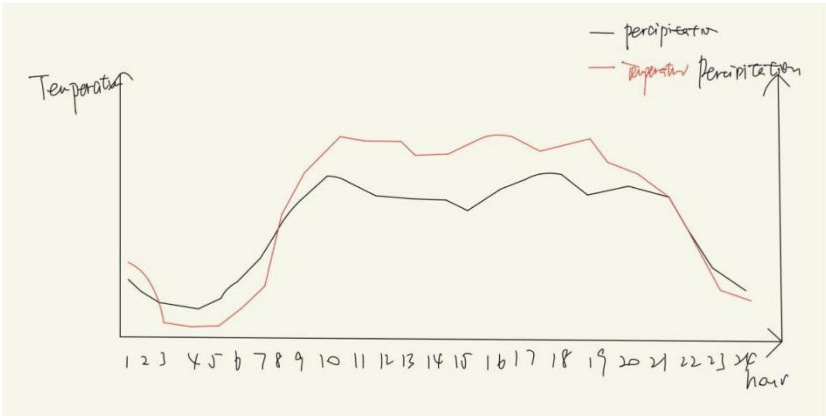


This is a calendar chart.



When clicking on the specific date, it will show the traffic volume and weather conditions.





7. Must-have Features

The visualization design features an interactive user interface with a consistent color scheme for clear data representation. The interface highlights weather correlation displays and traffic flow distribution, allowing users to explore traffic patterns across both spatial and temporal dimensions. With distinct visual cues, users can analyze diurnal and weekly traffic flow patterns and observe how weather conditions impact traffic volume, ensuring an intuitive and cohesive experience.

8. Optional Features

Add a traffic flow prediction model to display the potential impact of future weather conditions on traffic.

Include a terrain layer on the map to help users understand how geographical features influence traffic flow.

Present traffic flow variations over time on the map in an animated format, allowing users to clearly observe traffic trends.

9. Proposal Schedule

Stage 1: 10.30-11.05, Data Cleaning and Preprocessing

Prepare gridded traffic, station, and weather data.

Stage 2: 11.05-11.12，Prototype Design

Create three prototype visualizations, conduct initial testing, validate data accuracy.

Stage 3: 11.13-11.23, Final Design Development

Combine the best elements of each prototype into an interactive map dashboard, implementing key features.

Stage 4: 11.23 - 11.30 Summary

Summarize project results, write the final report.