U.S. Traffic Fatality Rate Visualization Final Report

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Abstract

Traffic injury is one of the leading causes of deaths in the United States. It is valuable to understand the distribution of U.S. traffic fatality rates and the correlating factors. This visualization demonstrates the differences of traffic fatality rates in state level by applying a heatmap. It also displays the traffic fatality rate changes overtime for each state in line charts. In addition, the writers tried to investigate the correlation relationship between traffic fatality rate and alcohol consumption or normalized vehicle quantity by visualizing the information in bar chart and line chart. This visualization also provides nice interaction for users to understand data from different years.
Overall, it is an effective visualization.

Key words: traffic fatality, alcohol, vehicle quantity, visualization

Introduction

Road traffic injury is one of the leading causes of deaths in the United States according to the WHO (World Health Organization) report. To understand the distribution of U.S. traffic fatality rates[1] and the correlating factors are valuable for designing better regulations to reduce fatal traffic accidents.

The main research problems this visualization tries to investigate into are: a) how does the traffic fatality rate distribute across states in United States, b) how do the traffic fatality rates change over time, c) Is there correlation between the traffic fatal crash rate and the state alcohol consumption / motor vehicle quantity.

Our study aims at comparing the traffic fatality rates among the American states, not only based upon their geographic areas, but also based upon state alcohol consumption per capita and vehicle amount per capita to support our research problems.

In our visualization interface, people could get a first view of the traffic fatality rates for different states in the map. By using different gradient red colors to show the traffic fatality rates, the heatmap will tell whether certain parts of the U.S. have a higher traffic fatality rate than the other parts. One example from our visualization is that states in the west coast have comparatively lower traffic fatality rate than the inland states.

Meanwhile, people can view more details about traffic fatality rate for a specific state. For example, people can view the traffic fatality rate by manipulating a timeline, and then understand how the traffic fatality rates change overtime in the state they have chosen. Based on our visualization, the traffic fatality rate of each state normally kept declining along with years. People can also view the similar chart for alcohol consumption and vehicle amount.

In addition, the visualization will show the relationship between traffic fatality rate and alcohol consumption, and the relationship between traffic fatality rate and vehicle amount by displaying certain state data in a multiple line chart. It is surprising to find out that traffic fatality rate and alcohol consumption are inversely correlated in most states.

Related work

Currently more public attentions are given to the direct causes of fatal accidents. There are some researches and visualizations about car accidents: *Geographic Frequency of Fatal Incidents in 2007*(Collision Watch), *Death on Britain's Roads* (BBC News) and *States Traffic Fatality Safety Map of 2011*(NHTSA).

Geographic Frequency of Fatal Incidents in 2007 shows detail information about traffic fatal incidents across U.S. Audiences can tell the difference in fatal incidents

[1] The traffic fatality rate refers to deaths per 100 million vehicle miles traveled.

frequencies between different areas from this visualization. However, the visualization only includes data from year 2007, which does not show the changes over time. The visualization provides too many details which are not necessary; meanwhile, it is hard to detect the relationship between potential factors and frequency of fatal incidents.

Death on Britain's Roads shows the correlation between traffic fatalities and sex, age, weather etc in Britain. Similar to the former visualization, it also failed to show the changes of traffic fatalities over time and even failed to show the geographic difference.

States Traffic Fatality Safety Map of 2011 provides all the traffic fatality rate of different states. However, it only uses table to list all the information, the information has not been visualized.

Based on the limitation of the former visualization, our group is going to build up a visualization to display the difference in traffic fatality rate among U.S. states, the changes in traffic fatality rate over time, and also the relationship between traffic fatality rate and alcohol consumption/normalized vehicle amount.

System description

We merged several datasets [2, 3, 4, 5] from National Highway Traffic Safety Administration, US census bureau, and National Institute on Alcohol Abuse and Alcoholism to build the project dataset. All the variables used in the visualization are normalized. The variables include state, year, traffic fatality rate, alcohol consumption per capita, and vehicle amount per capita. All the numerical variables used in the visualization are normalized. States (51) and year (2004 to 2009) are categorical data while traffic fatality rate, and alcohol consumption per capita, and vehicle amount per capita are numerical data. The traffic fatality rate ranges from 0.61 to 2.41. Alcohol consumption per capita (Gallon per capita) ranges from 1.79 gallon per capita to 4 gallon per capita. We use normalized vehicle amount to represent the vehicle amount of the state, the unit is number of vehicles per capita.

The visualization is built by using techniques including Javascript, CSS/html, JQuery, Leaflet.js [6]. The main components of the visualization interface are timeline, heat map, and detail line chart, bar chart and control panel.

Timeline
On the top of the visualization, there is a timeline where the users can drag the car slider from 2004 to 2009 to select a year that he or she is interested in. After the selection, the heat map and the line and bar chart would show the information of the selected year. When first loading in the visualization, the page shows year 2004 data (Chart 1), after scrolling the timeline from 2004 to 2009, the heatmap and bar chart will show year 2009 data (Chart 2).

Heat Map
We visualized the traffic fatality rates of all states on U.S map, and differentiate them with gradient colors. A darker red color indicates that the state has higher traffic fatal crash rate. A lighter red color indicates the state has lower traffic fatal crash rates. The area of each state is clickable. Once clicking a state area, users can choose the state to view more detail information in the line chart.

Detail Line Chart
When hovering over certain state area, users can view the values of traffic fatality rate, vehicle quantity and alcohol consumption from 2004 to 2009 of this state in the line chart. We will use different colors to represent the three lines. The red line is for the traffic fatality rates. The yellow line is for the alcohol consumption per capita. The blue line is for the vehicle amount per capita.

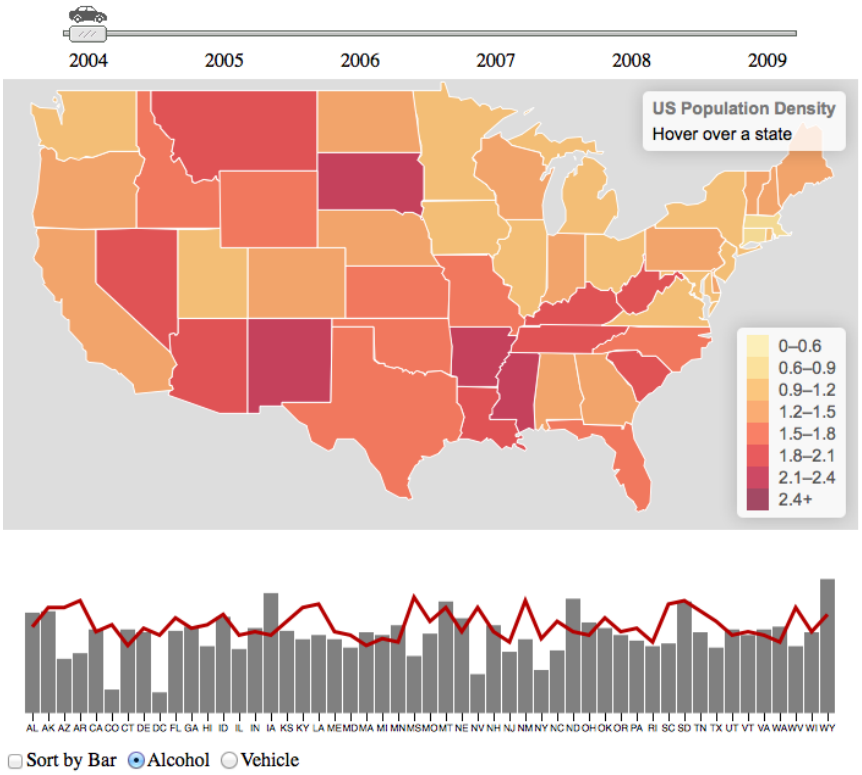

Chart 1: U.S Traffic Fatality Heatmap of 2004

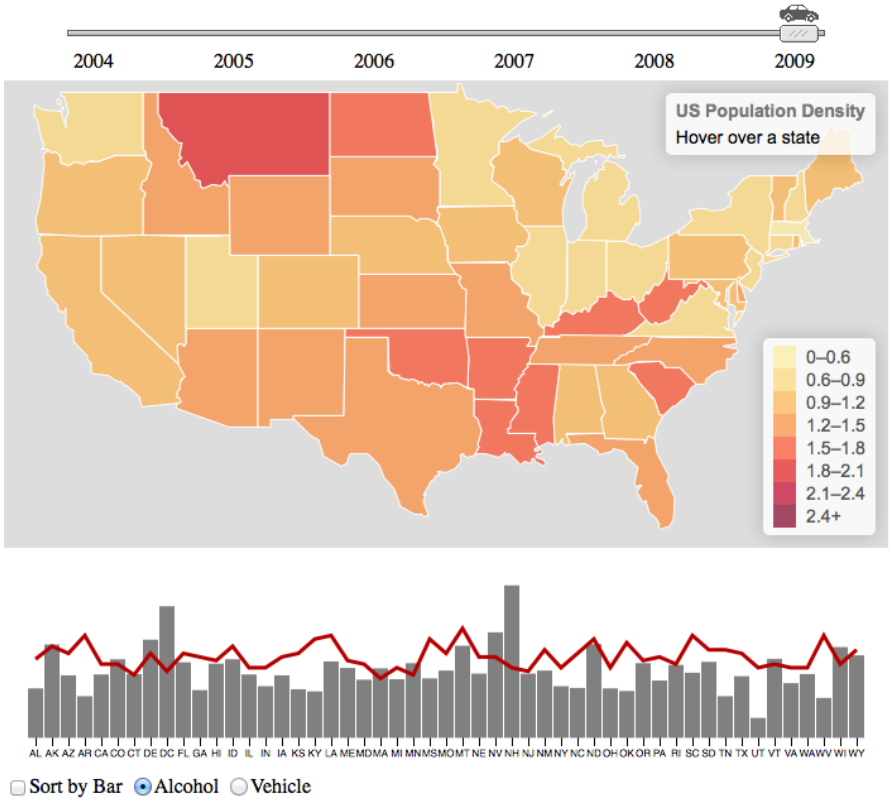

Chart 2: U.S Traffic Fatality Heatmap of 2004

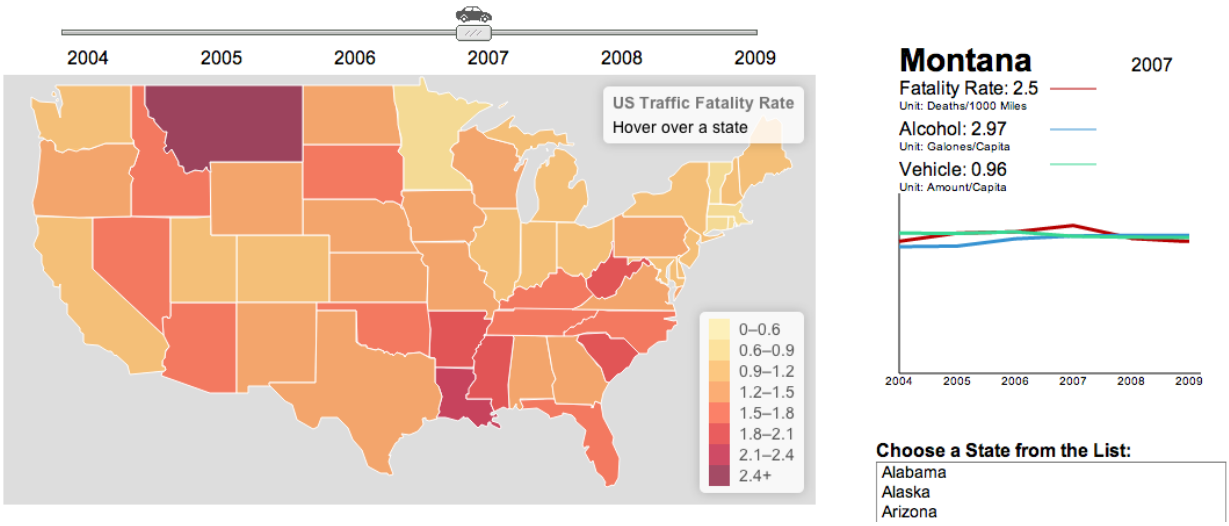

Chart 3: Hover over a state in the visualization

Chart 3 shows when user hovers over Washington state, the detailed timeline information will be showed on the right of the map. The fatality rate kept declining since 2005, but the alcohol consumption increased during 2005 to 2009. These 2 factors are inversely correlated in Washington.

Line and Bar Chart

We use a combined chart (line chart and bar chart) below the heat map to visualize the comparison between the traffic fatality rate and a selected variable (alcohol consumption or vehicle quantity) of all the states. The x-axis represents the states. The traffic fatality rate is represented by the red line. The bars are for the selected compared variable. Users can choose the compared variable by radio buttons, and also can sort the columns by alphabetic order of state names or the value of selected variable.

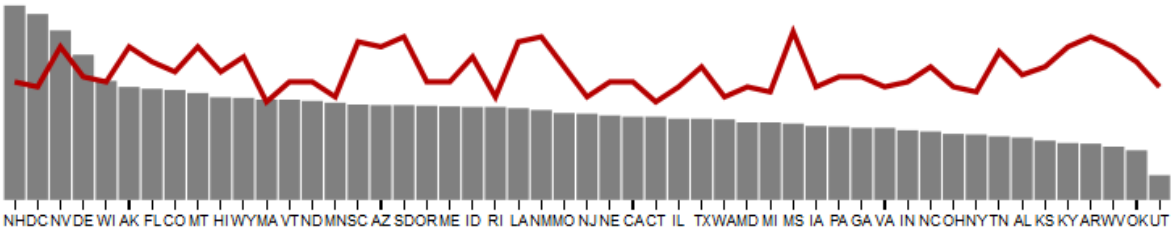

Chart 4: Fatality Rate vs. Alcohol Consumption, Sorted by Alcohol Consumption 2004

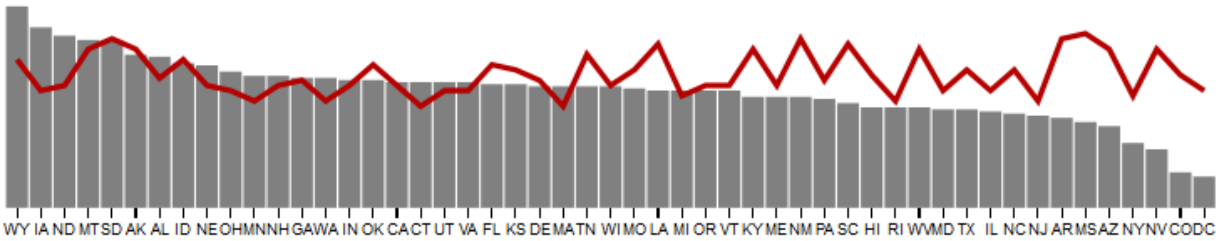

Chart 5: Fatality Rate vs. Vehicle Quantity, Sorted by Vehicle Quantity, 2004

Chart 4 and Chart 5 do not show significant correlation relationship between traffic fatality rate and alcohol consumption or vehicle quantity.

Scrollable List

A scrollable list is added on the right of visualization, which allows the user to select a specific state. The state will be highlighted in the bar chart. Also a detailed line chart of the selected state is generated above. When the state is highlighted, the user can identify the

selected state's ranking of alcohol consumption or vehicle quantity.

Evaluation

We gained a lot of valuable feedback from the peer evaluation session and from our usability tests. Since we had an interactive prototype at the peer evaluation, users were able to test our original design at the early stage. We also held usability tests over two target users after we finished our development. Following the evaluation model learned from the class, we summarized the feedback and corresponding improvements as below:

1. Labels and legends are used to help understanding of the charts. Having the perspective of a clean interface, we did not include some of the legends and labels. However, testing users reported that they were necessary for interpreting the information. We refined our design with enough legends, labels and provided the unit information to the line chart.

2. A list of states and searching function would facilitate the exploration. We added a list of states to our final design with consideration of users who are not familiar with the U.S. map. They can select from the list to locate the state and to obtain the detailed information of it.

3. The testing users found it straightforward to display the traffic fatality using a heat map. They felt surprised to find out the states with higher capita alcohol consumptions do not necessarily have higher fatal rates. Hence they have curiosity to explore the factors that may contribute to high traffic fatality rates, which we will discuss in the future work.

Discussion

The heatmap is effective in showing distribution of traffic fatality rate across U.S. From the heatmap, several states such as Arkansas and Mississippi are distinguished from other states by their dark colors. They have the highest traffic fatality rates of all the states. Also, west coast states and northeast states have light colors than other states, which means those states have comparatively low traffic fatality risk than other states.

The visualization is also effective to show the traffic fatality rate change over time. When we change the timeline from 2005 to 2009, we can find the colors for all the states become lighter and lighter, so we can safely conclude that the traffic fatality rate declined in most of the states during those years.

In addition, when user clicks a state area or choose a state in the list, the detail line chart for each state will be showed. We can find the traffic fatality rates of most states shows the traffic fatality rate declines from year to year. And the alcohol consumption was increasing due to the improvement in economy during those years, which indicating the alcohol consumption is inversely correlated to traffic fatality rate. It also shows slightly negative correlation between traffic fatality rate and alcohol consumption in the yearly bar chart and line chart. It is surprising because alcohol is one of major causes of traffic crashes, but state alcohol consumption level is not necessary positively correlated to fatality rate. Vehicle amount per capita stayed stable while traffic fatality rate is declining, we cannot identify significant correlation between the 2 variables.

This visualization is not effective to identify the correlation between traffic fatality rate and alcohol consumption rate or traffic fatality rate and vehicle amount from our visualization. We used sort function to sort the bar chart by alcohol consumption and vehicle quantity. But it is still difficult to identify their correlation relationship. Meanwhile, there are too few data in the line chart to detect correlation. A scatter plot for all the data lines will be useful to identify the correlation between fatality rate and the other 2 factors. Statistical analysis may also help with it.

Future work

In addition to all the data visualization presented, we expected to add more interactive feature and visualization to facilitate understanding the dataset. We planned to change the map visualization by filtering data with the range of alcohol consumption and vehicle quantity, which are operated with the sliders on the left. For example, if a user selects the range of alcohol consumption value, the color of the states whose alcohol consumption value is out of this range would become light grey. The user will have more flexibility to focus on the data they are interested in with different sliders.

For the data analysis, we were not able to identify significant correlation between traffic fatality rate and alcohol consumption from the visualization results, as the patterns are not so apparent in the bar and line chart that can lead to conclusion of the correlation. Thus we expect to add a scatter plot to visualize those variables to identify the correlation, as the scatter plot can show the relationship between two variables in a regressive way and help make patterns more visible.

As traffic fatality rate is correlated to other factors, such as economy, transportation policies, population, population density and etc, it will provide more insightful findings to include other factors as well. To investigate whether these factors have an influence on the fatality rate will complement the alcohol and vehicle factor in our study. So to add more variables to our visualization is also part of our future work to further investigation of traffic fatal rate.

References

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6 Leaflet Map, http://leafletjs.com/examples/choropleth.html