Orlando Travel Visualization

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Abstract
This paper describes a project implemented as a part of the course requirement for CS 424 Visualization and Visual Analytics at the University of Illinois at Chicago. The project aims to visualize Orlando City travel data for the 30 days of April 2014. The data was provided by AirSage. With a group of three members we have produced three different visualizations that demonstrates an interactive approach of visualizing origin destination matrix. This paper describes this application and each visualization in detail. It is meant to provide an enjoyable experience to any user who wants to view animations and visual patterns for travel data of people and areas in Orlando. It can also be useful to many urban planner to help them understand the various travel trends for the areas in Orlando, how and for what purposes these travel trips are made when travelling between various areas (zones) in the Orlando metropolitan area.

Author Keywords
Taz Id: Unique number given to an area or zone in the Orlando Metropolitan area;

Start Zone or *Origin Zone*: Taz Id of trip start zone;

Destination Zone: Taz Id of destination zone;

Subscriber class: Type of trip makers. This can be home worker, resident worker, outbound commuter, inbound commuter, short term visitor, long term visitor;

Purpose: Observed type of trip categorized based on beginning and end of trip. This can be Home to Work, Work To Home, Home to Other, Other to Home, Other to Work, Work to Other, Home to Home, Other to Other, Work to Work;

Introduction

As a requirement for CS-424 Visualization and Visual Analytics course project, we were given a list of 6 options to select from. We chose option 6 which included visualizing daily trip matrix data for the month of April 2014 for the Orlando Metropolitan area. The data was produced by AirSage. As a part of the project we were given two challenges. The first challenge was to visualize the existing data and the second challenge included integrating external data into the visualization. For this challenge we created Orlando Travel Visualization application which is meant to allow the user to analyze various travel patterns in Orlando for the month of April 2014.

This application has three main visualizations which provides the user a detailed and aggregated view on the data. The visualization application enables the users to interact with large dataset of Orlando travel data. The tool provides statistical graphs with which the user can compare travel pattern between various zones. It also allows the user to view travel patterns for various zone individually. Along with travel patterns, data for trip purposes and traveler class is included in various visualizations. Weather data, too, is integrated into the website as we considered whether a big factor in deciding timing travel trips. This will allow users an insight into checking how weather can affect travel patterns. Multiple visualizations in the application have different types of animations that are aimed at enhancing the user's experience. These animations can be used to derive and analyze travel trends over an entire day. It can be used by casual users who may want to view travel data in an enhanced visualized manner or by urban planners and city governments to analyze travel trends for various types of people and areas in Orlando to make decisions on improving travel infrastructure and policies for the city.

Related Works

Perhaps the most similar prior work on our approach to visualize travel data is "Visual exploration of urban mobility" [1] by Senseable City Lab. They developed interactive applications to visualize Singapore public transit which seemed close to our current task.

We were inspired by their approach of representing getting into and out of bus as two concentric circles. We used an equivalent technique to represent the inbound and outbound count for each zone. A time slider was also incorporated to help in comparing the data over time.

We realized the importance of adding directionality and showing dynamic content from our data from the project "Shanghai Metro Flow" [2] by Nagel et al. They visualized the flow of people in Shanghai subway using pulsating circles dashing throughout the city. This movement provided a means to decipher the flow in the network. We used a similar approach using travelling circles representing the journey between zones for the

user selected time. An automated animation provided helps the user observe the change.

Data

The data was provided in a zip file TRB_DataContest_ASDataset which included a shapefile of Orlando Metropolitan area. This file also included a compressed folder with 30 daily trip matrix files in CSV format each for one day of April 2014. Each csv file included the following fields Origin_Zone, Destination_Zone, Start_Date, End_Date, Aggregation, Subscriber class, Purpose, Time of day, count. In the shape file data, the entire area is divided into 1267 zones and each zone is represented by a unique id. 1261 zones are labeled as internal zones and 6 zones are external zones. Zones have unique ids between 1 and 4005 with external zones having unique ids between 4000 and 4005. For each day a separate data file is provided having data for all the trips recorded during that day. Based on the data provided we decided to create the following three visualizations.

Visualizations

The map of Orlando is drawn using Leaflet. The zones on the map are drawn by converting the shapefile into a GeoJson file and plotting that data on the leaflet map using D3. All other visualization features are implemented using JavaScript and d3. The top menu bar design and look is implemented using the CSS classes provided by importing the pure IO CSS library. The code for visualization logic is implemented in JavaScript and JQuery. All other styling is done by custom CSS classes.

Visualization 1

The user can click on Visualization 1 on the top menu to load this visualization. One of the aim of this visualization was to consume data with a goal of analyzing and discovering travel trends for each day of April 2014 for Orlando Metropolitan area. A key focus kept in mind was for the user to enjoy the data represented. The user has the ability to switch between a static view and animations of the same data which provides the user flexibility to view in detail for a given time or to view the travel trends within a certain time frame.

View 1

Visualization 1 provides 3 separate views of the data. Once the Orlando Travel application is launched, the user is redirected to Visualization 1 view 1. This view shows the hour wise magnitude of inbound and outbound trips for each zone on a map of Orlando with zones encompassed by a grey border. Each zone has an associated red and a green circle. Red circles represent the outbound trips and green circles represent in inbound trips for that zone. The radius of the circle encodes the number of inbound or outbound trip for the zone. At the bottom of the map there is an hourly slider which the user can interact with to view data for various hours of the day. The data smoothly transitions as the hour changes to give the user a sense in travel trends. A panel is placed in the top right corner which indicates the weather data for the selected day. The user can hover over any zone and a legend appears displaying the county to which the zone belongs to and the id of the zone. On the top of the map there is a dropdown for day. The user can view data for any of the 30 days of April in 2014. Once the user selects a new day the visualization animates to show the data for

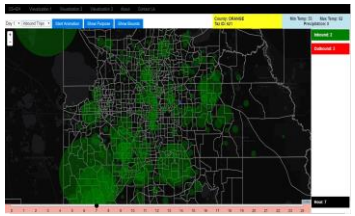

Figure 2.1 Inbound Trips for Day 1 Hour 7 for each zone

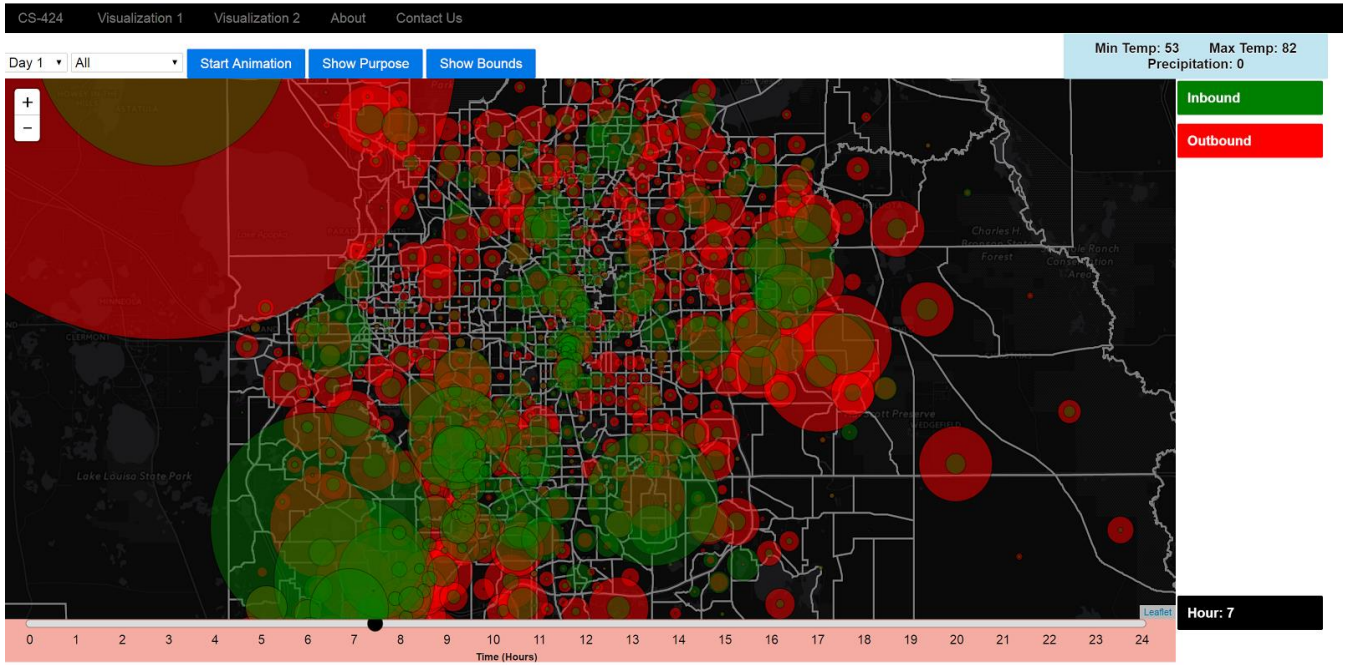

Figure 1. Showing inbound and outbound trips for Day 1 Hour 7

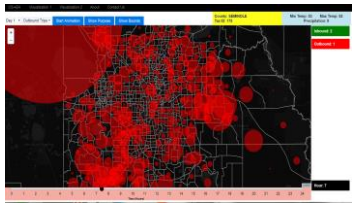

Figure 2.2 Outbound Trips for Day 1 Hour 7 for each zone

the newly selected day. Figure 1 shows all the aspects of view 1 of visualization 1. On the top of the map the user has a dropdown to filter inbound and outbound trips. View for outbound trips is shown in Figure 2.

The Start Animation button animates data through each hour of the day. The animation starts from hour 0 and ends at hour 24. The hour is increased every 5 seconds. The user can use the slider to take the animation to a particular hour while the animation is in progress. The animation will continue from that changed hour. The click of start animation button pops up a Stop Animation button which enables the user to stop the animation at any time. On the bottom right of the screen there is a label which displays the hour for which data is being displayed.

When the view 1 is not animating the user has the option of clicking on the View Purpose button on the top of the map. Clicking this button shows the user view 2 of visualization 1.

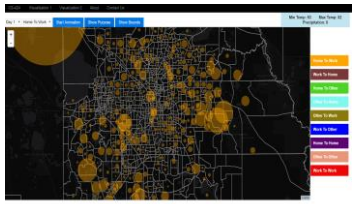

Figure 3. Shows Home to Work Trips for each zone for Day 1

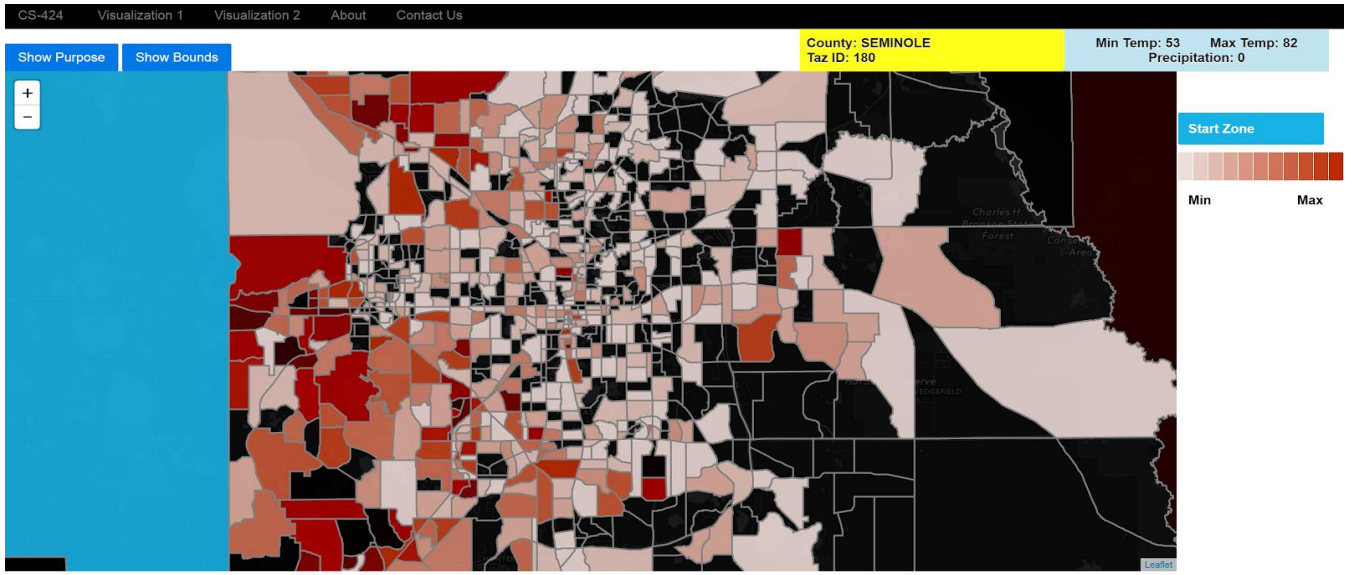

Figure 4. Shows start zone in the blue and the destination zones for the start zone

View 2

View 2 allows the user to select a particular purpose of a trip from a dropdown placed above the map. For the selected purpose view 2 displays the total count for that purpose for each zone on the map. Each purpose type is encoded by color and the radius of the circle encodes the count of that purpose type for the zone. The user can view data for only one purpose type at one time and has a choice of selecting any of the following 9 purpose types: home to work, work to home, home to other, other to home, other to work, work to other, home to home, other to other, and work to work. The data is displayed for a complete day and not hour wise as in view 1. A legend of label for each purpose is shown on the right of the map. Also similar to view 1 weather data for the selected day is displayed on the top right corner of the screen.

Once the user hovers over a zone, the corresponding zone gets highlighted and the label for that purpose type shows the count of the purpose type for the zone for the selected day. The user has the option to view data for any of the 30 days of April 2014 by picking a

day from the day dropdown. Figure 3 shows all the aspects of view 2.

The user can start animating between the purpose types by clicking Start Animation button. The animation updates every 5 seconds. After animating through all the purpose types the animation stops, however the user can stop the animation anytime by clicking the stop animation button. The user can go back to view 1 of visualization 1 by clicking on the show bounds button on top of the map.

View 3

Once the user clicks on a particular zone from view 1 or view 2, the view 3 for visualization 1 is shown. This view displays the start zone as the zone which was clicked in light blue color and shows all the destination zones in the day for the selected start zone in a range of colors from white to maroon. The count of trips to the destination zones from the selected start zone is encoded in the range of colors from white to maroon. Destination zones colored closer to white have low number of trips from start zone and destination zones colored closer to maroon have high number of trips from the start zone. Figure 4 shows a start zone with Taz id 4003 and destination zones for that start zone for day 1.

This visualization allows the user to analyze which zones are the most or least travelled to for a selected origin zone. On the top right of the screen weather data is displayed for the selected day. The user can gauge travel trends while considering the weather on that day. This data and visualization is useful for urban and city planners to improve any transportation infrastructure or facilities between zones for particular days be it weekend or week day or any public holiday.

Visualization 2

A major motivation during the starting phase of our project was incorporating directionality to provide a sense of movement in the travel data. In addition to that, we were interested in animating it through time to allow user to observe the changes in the flow of travel between two zones.

In order to achieve this, our second visualization predominantly uses origin and destination information in the data to show a travelling circle moving from origin zone to the destination zone with its radius representing the weighted count. We then added an additional dimension of time to visualize multiple travelling circles that represents travel data for a particular hour. The next undertaking was to create an animation through each hour for providing dynamicity in the visualization. Figure 4 shows this visualization.

The user is also provided with the ability to filter by counties, subscriber class, purpose of travel and most importantly by zones. When user clicks on the zone that he is interested in, the user can see the filtered animation through time that displays travel data moving from and into the selected zone. Figure 5 shows the filtering feature. For the circles to transition smoothly, we partitioned the huge data into subsets of 5000 samples. We believe that incorporating GPUs with d3 or using a better system would give us the ability to extend the size of data in each subset.

Figure 5. Showing the Animation for Orange County for Day 1 Hour 13 for Sample 1 to 5000

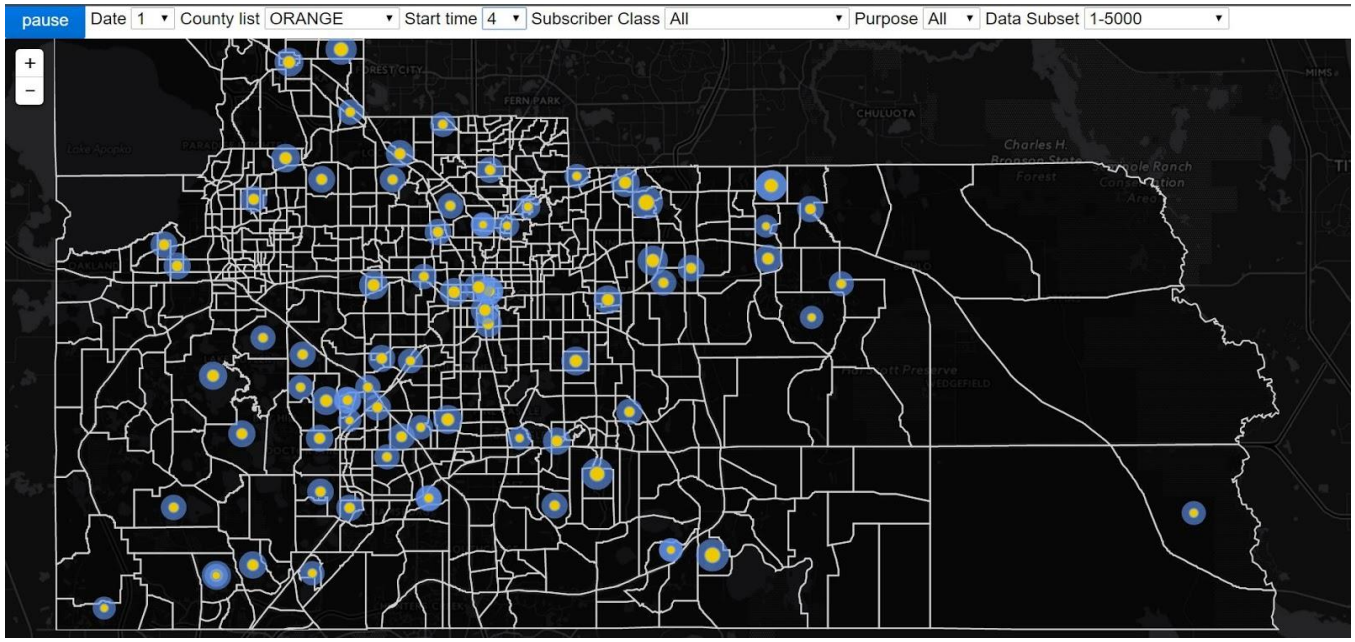

Figure 4. Showing animation for Orange County for Day 1 Hour 4 for Sample 1 - 5000

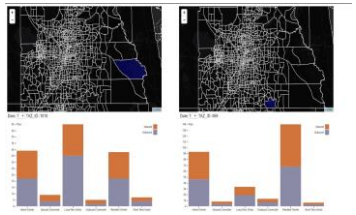

Figure 6. Comparing Inbound and Outbound Trips Each for Subscriber Class

Visualization 3

This visualization was created with the intention of providing the user with a tool to compare zones on number of trips made by subscriber class over different days. The initial view contains two map views of Orlando both of which are interactive. When user clicks on a particular zone, a bar chart is shown below the map. The bar chart shows number of inbound and outbound trips made by each subscriber class. Similarly, bar chart is shown when user clicks a zone on the second map. There is a drop down provided to the users below each map that enables them to change the days. Using this visualization, user can compare same zone for different days or different zones on same or different days. Figure 6 shows the third visualization.

Validation and Analysis

Visually analyzing the travel trends in zones revealed that lots of commute happened in zones in lower left region and upper middle region than in exterior counties. This trend is distinctly observable during weekends. On investigating the map, we found that Disney themed water parks, resorts, Hollywood studios in its lower left region in Orange County has lots of

inflow for all days in the month of April. An interesting find was that for most external zones, the trips are within the zone, which indicates that people mostly travel closer to home restaurants, friends' places or other places on Friday evenings and Saturday evenings. On Sundays, evening and night travel trips are much lower than on any other day of the week. Unfortunately, the temperature range was similar for all the 30 days of April there is very little evidence that weather played an important factor in trips.

In order to validate our visualization project we decided to conduct a user study based on two performance factors Time on Task and Efficiency. In addition to these performance factors we also want to have the users fill out System Usability Scale survey which we can be combined with the performance factors to further validate the system in the future. For evaluation we decided to choose 4 tasks based on critical functionalities we wanted to test. Each task was given a time of 40 seconds to be considered successfully completed. The 4 tasks were as follows.

1. Visualization 1 Task: See only the Inbound Trips for day3 for all the zones and start the animation for day 3.

2. Visualization 1 Task: Find the Work to Home purposes for day 6 and start the animation. Stop the animation explicitly.

3. Visualization 2 Task: Start the animation for day 15 for sample range 25001 to 30000 viewing data for Orange County.

4. Visualization 3 Task: Find for any two zones, the zone for which the home workers inbound trips was greater.

Each task was asked to be completed by 5 people who had never used the system before. Each user was given 40 seconds to complete the task since it was their first time using the system. One team member recorded the time. When the results were recorded the task completion percentage and average time on task was calculated for each task and was as follows:

Task	Task Completion %	Avg. time on task
Task 1	100	22
Task 2	80	29
Task 3	80	26
Task 4	100	20

A threshold of 60 percent was kept for task efficiency and 40 seconds on time on task. All 4 of the tasks passed the validation criteria for efficiency and time on task. While completing the user study feedback was taken. The suggested user feedback which was implemented is mentioned in the User Feedback section. White box and black box testing was performed by developers on their own visualization. Also each developer's visualization was tested by other team members for functionality and user experience changes.

User Feedback

Based on user feedback the map background was changed from colored background to black, due to conflicting colors in the map. Also the color encodings

was made diverse to identify the different colors. The position of label and dropdowns and buttons was changed to the top for better usability.

Our project primarily focused on revealing travelling trends to user. We believe adding interactivities would allow the user to focus on different viewpoints. The visualizations also are helpful in providing traffic insight for an analyst. It deviates from traditional matrix approach in visualizing and show it as a geospatial data that animates through time.

Future Work

We have further plans to add an additional visualization in the form of cartograms which distorts zones based on the trip count. This would add a contrasting feature of comparing size of the zone and trip count. Furthermore, we propose visualizing accessibility in the zone and marking events and malls near the zone as a means of reasoning the various travel trends that was observed in our visualizations.

Conclusion

As our cities grow the stress on existing infrastructure increases. Understanding travel patterns of people for various days can allow urban planners to understand where and when travel infrastructure need to be improved. This may include building infrastructure or changing and enhancing public transportation systems for a city. This tool can be used to visually understand travel trends between various areas in a city and aid in planning and management decisions to improve travel infrastructure at places which would in large help the thousands of daily commuters in reducing travel times. One of our aims is to empower city planners and governments to take actions to better public transport so that commuters are diverged away from personal vehicles and switch to the better public transport. This tool can also be used by casual users to enjoy and understand various travel trends.

Acknowledgements

We would like to thank Professor Angus Forbes for contributing significantly to the success of this project and for giving an interesting challenging and inspiring topic to work on. His suggestions on various visualizations, especially recommending animations in the visualizations were very useful. We would like to thank Professor Sybil Derrible for his opinions of our project as an expert on the domain and providing various insights regarding the analytics of traffic data. We also want to thank our TA Shivangi Singh for discussing ideas and providing feedback.

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