Culver Road and East Main Street Intersection

Traffic Analysis Report

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Introduction

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Data Analysis

To assess the traffic conditions at the Culver Road and East Main Street intersection, we determined the current state of the intersection in terms of federal DOT guidelines for this class of intersection, as well as analyses to examine trends and patterns in the traffic recorded and to predict occurances of traffic congestion based on time of day, day of the week, and the weather conditions present.

Traffic Analysis

There are a few common characteristics to examine when determining the traffic flow for a particular intersection. Namely, it is important to determine the amount of delay experience by drivers as they enter the intersection, the density of the vehicles as they pass through the intersection, and the velocity at which traffic flows through the intersection. With these three variables, it is possible to determine the effects of traffic congestions on the flow of traffic through the intersection.

The amount of time that vehicles wait at an intersection is refered to as the Level of Service (LOS). Ranked in letter grades from A to F, the LOS is an identifier for the overal health of the intersection. Ideally, an intersecton should be classified as being either A, B, or C, denoting free flow, reasonably free flow, and stable flow, respectively. The 2010 Highway Capacity Manual classifications for LOS can be seen in Table 1, in which grade A intersections have less then 10 seconds of vehicle control delay, whereas grade F intersections have more than 80 of vehicle control delay.

Table 1: Level of Service classifications published in the 2010 Highway Capacity Manual.

LOS	**Vehicle Control Delay (Sec.)**
A	≤ 10
B	$10 - 20$
C	$20 - 35$
D	$35 - 55$
E	$55 - 80$
F	≥ 80

Using these classifications, we examined the average vehicle control delay for each five minute observation period. As shown in Figure 1, the majority of observations have a Grade F Level of Service (58.38%). Each of the other levels of service occured in between 7.45% and 8.63% of observations. This suggests that the Culver Road and East Main Street intersections is experienceing traffic congestion, in which each vehicle move in lock step with the vehicle in front of it [1].

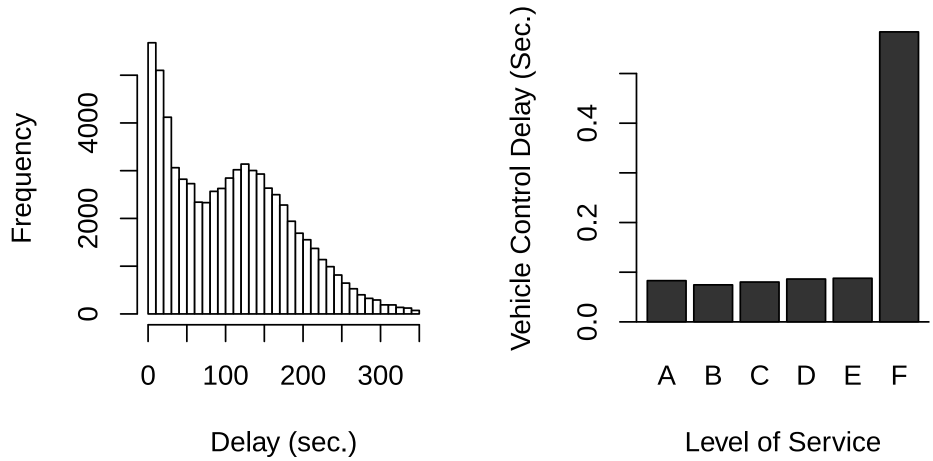

Figure 1: The Culver Road/East Main Street intersection has a poor Level of Service. The histogram on the left shows the distribution of the average vehicle control delay for each observation. The distribution is bimodal with peaks at zero seconds and 140 seconds. The median delay was 103 seconds with a IQR of 123 seconds. The bar plot on the right shows the distribution of each LOS grade for each observation in our data set. Observations were given a letter grade based on the average vehicle control delay for each 5 minute interval. The majority of all observations had a delay of greater than 80 seconds, suggesting that the intersection is predominantly grade F.

We also examined the relationship between the traffic density and traffic volume, also known as flux. Whe plotted, the relationship between the traffic density and the traffic volume creates the fundamental diagram of traffic flow [1], as shown in Figure 2. Using linear regression techniques, we were able to estimate the free flow velocity to be 19.5 miles per hour and the traffic wave velocity to be 2.43 miles per hour against the direction of traffic. We also determiend thecritical traffic density to be 42.8 vehicles per mile. As the vehicle denisty passes the critical density, the traffic flow becomes more unstable leading to traffic waves and congestion. To maximize the traffic flow, the vehicle density must remain below the critical density.

Trend and Pattern Analysis

To examine the general trend in the metrics we were provided, we performed linear and multivariate regression. These techniques allows us to approximate the traffic volume and delay. Figure 3 shows the median delay for each week and the median traffic volume for each week with the linear regression for each data set. Our data suggest that the median amount of time that vehicles wait at the intersection may be increasing by 0.24 seconds per week. Our data also suggest that the median number of vehicles utilizing the intersection may be increasing by approximately 11 vehicles per week. Although the correlation coefficients are rather low, we are confident that the traffic congestions will worsen as more vehicles utilize the intersection.

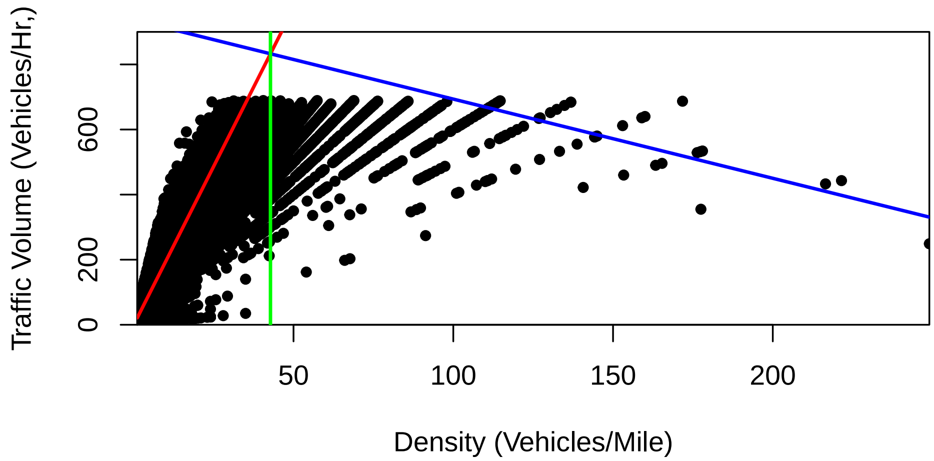

Figure 2: Fundamental diagram of traffic flow provides free flow and traffic wave velocities. Traffic density was calculated by dividing the traffic volume by the traffic speed. Using linear regression, we found the free flow velocity (19.5 mph) as depicted in red, the traffic wave velocity (2.43 mph) as depicted in blue, and the critical density (42.8 vehicles per mile) as depicted in green.

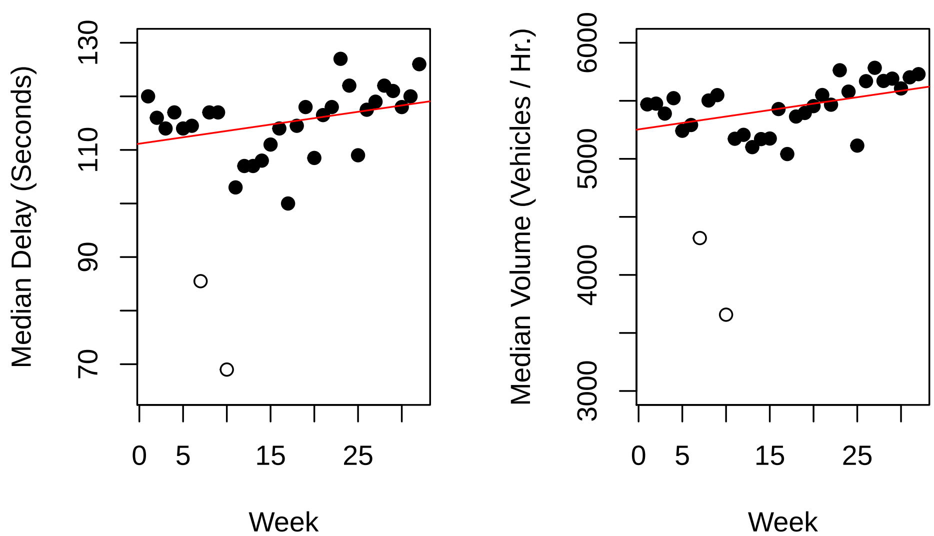

Figure 3: The median traffic delay and median weekly traffic volume are increasing over time. A linear regression of the median traffic delay for each week suggests that the traffic delay may be increasing 0.24 seconds per week ($R^2 = 0.13$). Similarly, a linear regression of the median number of vehicles to pass through the intersection per week suggests that the number of vehicles utilizing the intersection may be increasing at a rate of 11.08 vehicles per week ($R^2 = 0.24$).

We can also use the recorded vehicle volumes for each day to detect traffic abnormailties as a means of locating interesting traffic patterns. To perform this analysis we constructed template days of the week, seven traffic time series that are the median traffic volume for every 5 minute interval. We then calculated the correlation between the weekday template and the day of interest for each day in our data set. A plot of each day's correlation, as shown in Figure 4, outlines the variablity in each day's traffic patterns.

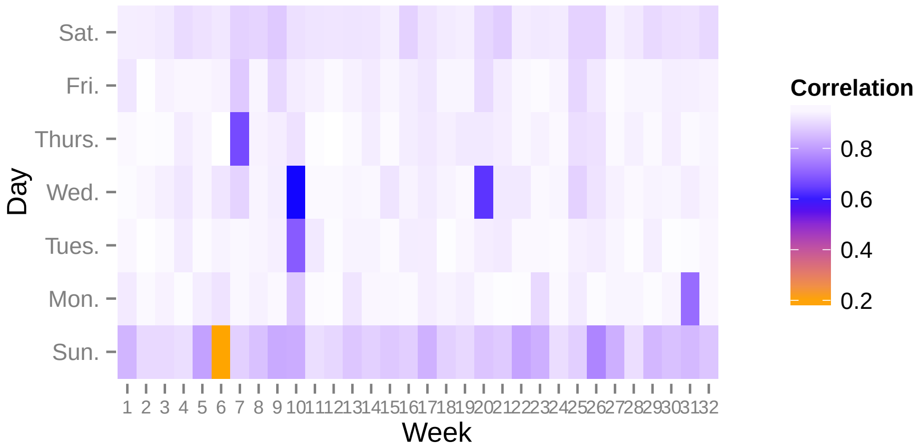

Figure 4: Correlation analysis shows holidays, data collection errors, and small-scale traffic patterns. In this color scale, white indicates high correlation, purple indicates moderate correlation, and orange indicates low correlation. Some days of interest include the seventh Thursday, which corresponds with Thanksgiving, the tenth Tuesday and Wednesday correspond <UNKNOWN>.

Bayesian Analysis

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Weather Analysis

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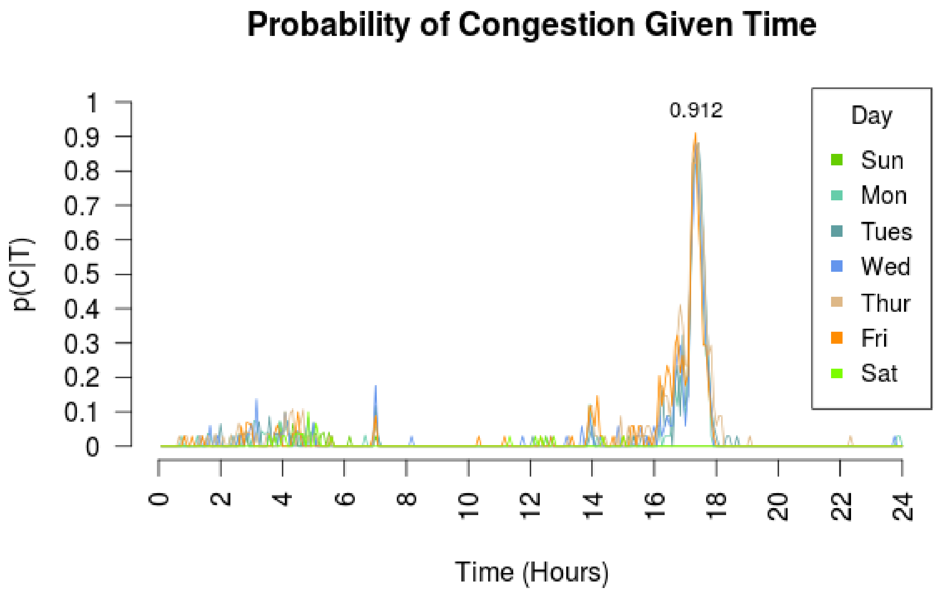

Figure 5: Probability of observing congestion when given a specific time. A maximum of 91.2% probability of congestion is marked on the graph and occurs at approximately at 5:15pm on Fridays.

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Recommendations

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Cited Literature

Bibliography

[1] Transportation Research Board of the National Academies, *Highway Capacity Manual 2010.* 5th edition, 2010.