Hazardous Road Conditions for Bicyclists in the City of Madison
Coursera Capstone
IBM Data Science
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Background:

Madison, Wisconsin is a community full of bicyclists, but the city was not originally built to be bicycle friendly. The city has made great strides in creating bike paths and bike lanes throughout the city and has even received Platinum Bicycle Friendly Designation from the League of American Bicyclists. However, the city still has several bicycle and motor vehicle accidents every year. In the last year, (January 2019 to January 2020) there have been 113 crashes reported, two of which were fatal.

There is also a public health issue of excessive drinking in Dane county which holds the city of Madison. In Dane County, excessive alcohol consumption contributes to an annual average of 170 alcohol-related deaths and 472 alcohol-related crashes. We know that of the 113 crashes reported last year, six of them the report had an alcohol flag. Five of the crashes involving alcohol resulted in injuries and one caused a fatality.

Problem:

The goal of this study is to determine if the listed bike route hazards that are known by the city of Madison are correlated to the crashes reported in the last year. I plan to explore the different categories of hazards, such as difficult crossings or lack of bike path connections and evaluate if these areas are more likely to have crashes reported by bicyclists. Similarly, I plan to also look at the top venues near accidents to determine if there is any association of venues that serve alcohol and motor vehicle and bicycle crashes.

The overall objective is to inform the city of Madison on areas that need focus for improvements for bicycle safety. This evaluation of hazards and locations of accidents will help the city of Madison to determine where limited resources will be best used.

Data:

The data will be obtained from three locations. The first is the Bike Hazards data provided by the City of Madison via their GeoData@Wisconsin website. This data is housed and updated by the University of Wisconsin-Madison. The Bike Hazards data includes suburbs of Madison, but for this analysis we are focusing on the city of Madison proper. The second source of data is the Community Maps - Wisconsin County TSC Crash Mapping website. Community Maps provides a statewide map of all police reported motor vehicle crashes in the state of Wisconsin from 2010 to the current year. Community Maps is maintained by the Wisconsin Traffic Operations and Safety (TOPS) Laboratory for research purposes and as a service to the Wisconsin Department of Transportation Bureau of Transportation Safety. This data was then filtered to include those motor vehicle crashes that had a "Bike Flag" associated with them.

The two data sets will be overlaid in a geographic map that can be used to visualize clusters of hazards and accidents. The data will be categorically separated based on the hazard category to determine the types of hazards that are most associated with accidents (if any) and where the highest volume of accidents occur within the city of Madison. The final dataset will come from FourSquare, this data houses the top venues within the city of Madison. I plan to leverage this data to determine if there is any trend of accidents near venues that serve alcohol.

Methods:

Once the data from all three sources was acquired, I imported them into the Jupyter notebook via pandas. The only cleaning that was done was to drop those hazards that did not have a jurisdiction listed. This was done to eliminate excess data that could not be verified as located within the city of Madison proper as there was no exact location listed. The final hazard sample for the "City of Madison" was 94 out of 221 listed hazards. A map of the city was overlaid with the geographic pinpoints of both hazards and reported bike accidents (Figure 1). This created a visual representation to explore clustering and the areas within the city where accidents were most frequent.

To determine if known bike hazards were associated with reported accidents, I calculated the distance to the closest bike hazard to each accident. This data was then put into a histogram that grouped the distance in meters of the closest hazard to the number of accidents (Figure 3). Bike hazards were then explored by hazard type. A bar chart was used to determine the most common bike hazard types in Madison (Figure 4). Knowledge of the most common type of bike hazard can inform advisory committees on the greatest need for bikers in the city.

Additional analysis was done to explore the types of venues that are most common near accidents. I did not limit the venue types to only those that serve alcohol as I wanted to see if there were other types of venues that were associated with bike accidents. Figure 5 shows the top 15 venues by proportion of all venues in the city of Madison and the top 15 venues by proportion of venues near bike accidents. This is interesting as some of the venues that are not as common in the city of Madison are in the top 15 types of venues near bike accidents. Table 1 is a summarization of this data. Within the Jupyter notebook that will be submitted with this report there is another map displaying the bike accidents and hazards, with the addition of a pop-up displaying the top 5 venues near an accident.

Results:

Figure 1 shows the dispersion of bike hazards in the city of Madison and surrounding suburbs in blue and the bike accidents reported as of December 2019. This map demonstrates the high concentration of accidents in downtown Madison. Figure 2 is a focused look on downtown Madison, which is where the University of Wisconsin Madison is located. The ratio of accidents to hazards is almost 2 to 1 (38 accidents to 20 hazards). The main campus area has no bike hazards and is particularly bike friendly, yet it has several accidents (Figure 2, green rectangle around central campus area).

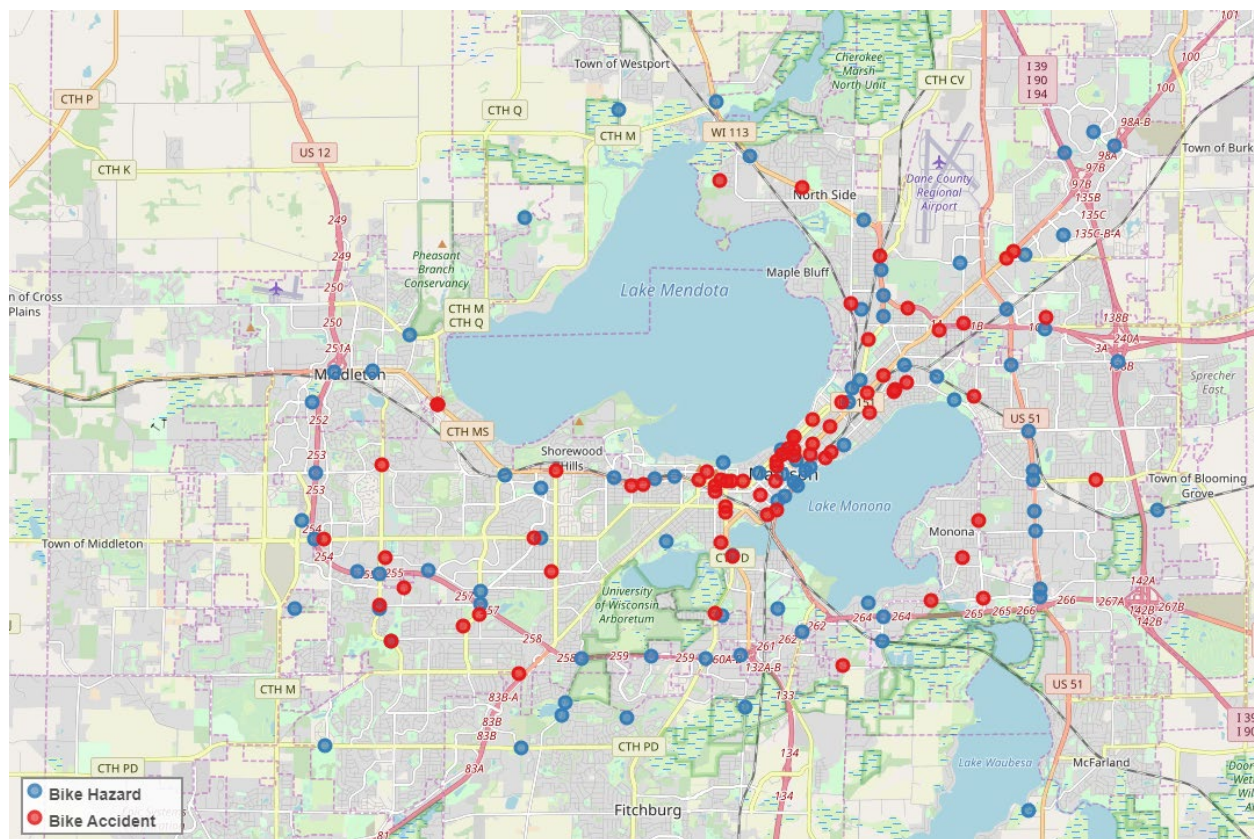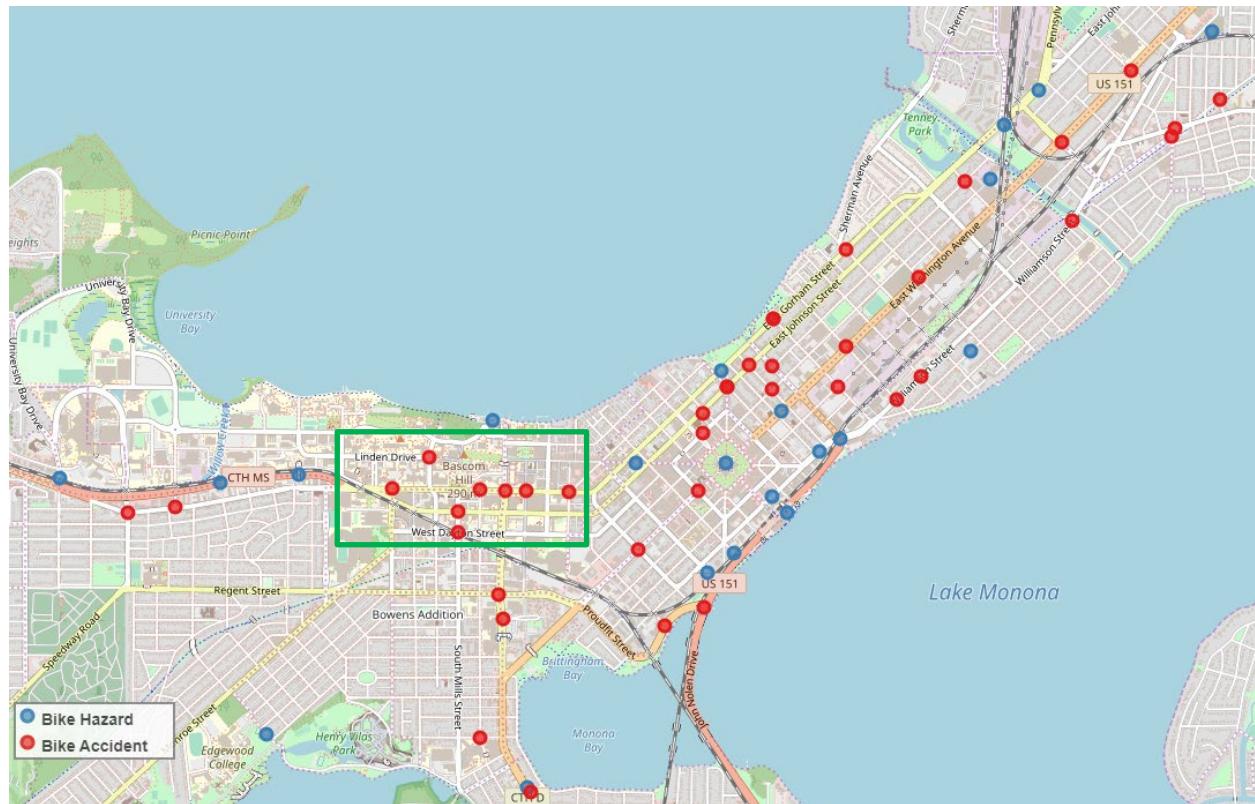**Figure 1: Map of Bike Accidents and Hazards in Madison**

**Figure 2: Map of Bike Accidents and Hazards in Downtown Madison**

Further exploration was done to get an initial read on the distance relationship of hazards to bike accidents, this data is seen in Figure 3. As a preliminary analysis I wanted to determine if hazards were generally close to where accidents in Madison were occurring. The histogram shows that very rarely is a bike hazard within a mile of an accident. However, this data is most likely skewed due to the number of hazards spread out in the suburbs of Madison, where hazards are more likely, and accidents are less. Future analysis should be done by neighborhood to determine if there is a difference in the areas around Madison. In this study, those hazards closest to accidents are most likely in the downtown area. As the map above shows the city is an isthmus and is very narrow in the downtown area, which limits the distance that a hazard can be from an accident. This could bias any analysis of downtown due to the increased number of people and the closer proximity due to the landscape.

Figure 3: Histogram of the Distance to the Nearest Bike Hazard from an Accident (n=113)

Distance to Nearest Bike Hazard
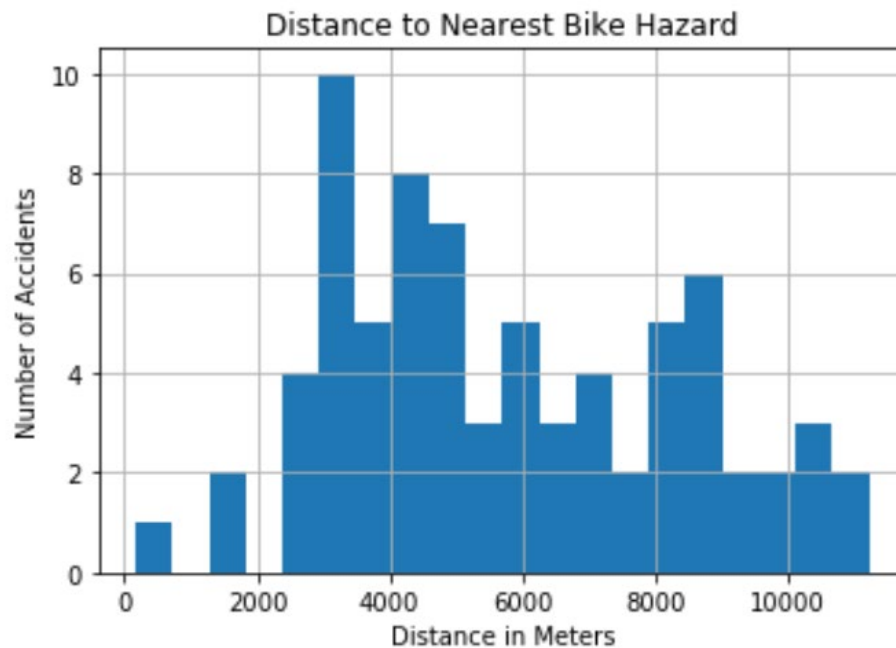
Another goal of this analysis was to understand what types of hazards bicyclists in Madison were facing. This data could help policy makers focus on particular renovation projects when resources are limited for additional bicycle safety improvements. A simple bar chart is displayed in Figure 4, that shows the count of the major type of hazards in the city. Connection issues are the highest reported bike hazard in Madison. Connection issues relate to connections between bike trails/lanes. The two most common connection issues are places where there is no connection at all, so the trail/lane ends and there is no designated trail or bike lane from that point forward, or the connection is challenging, for example you have to go several blocks without a designated bike trail/lane to get to the next bike path safely.

Figure 4: Bar Chart of the Types of Bike Hazards (n=94)
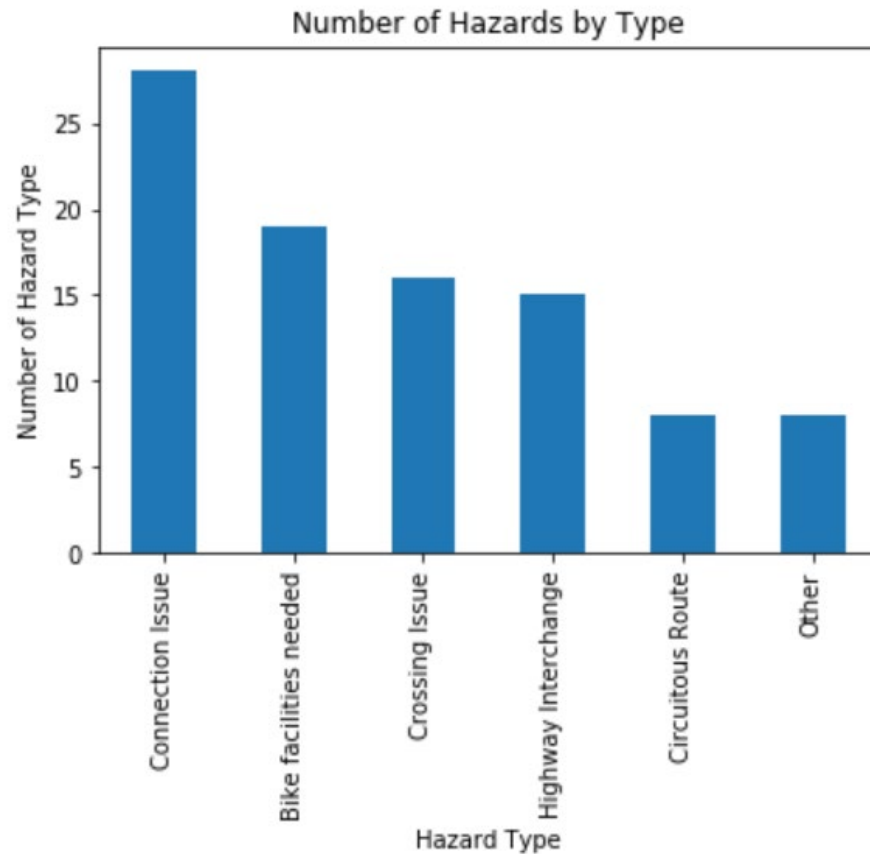
The final goal of this preliminary study was to discover the types of venues that are located in proximity to accidents that included a motor vehicle and bicycle. Our hypothesis is that places serving alcohol would be close to these types of accidents. Figure 5 and Table 1 summarize the venue data by proportion of total venue types in the city overall and the proportion of the venue type near an accident. Surprisingly the number one type of venue near bike accidents was coffee shops (3.5%), however, there is a high proportion of coffee shops in Madison (3.6%). Second was the venue we thought would be number one near accidents which is bars (3.4%), there is a slightly higher proportion of bars in Madison (3.7%) compared to coffee shops yet the proportion near accidents was slightly lower. However, bars are not the only place

on the list that does or could serve alcohol, many of the places in the top 15 venue by proportion near accidents serve alcohol, such as restaurants, music venues, pubs, and breweries. Gyms and fitness centers were ranked 6th for the highest proportion of that type of venue in the city, yet no bicycle accidents were reported near them. Similarly, with grocery stores and clothing shops. This is an interesting initial find as it shows that although there are high numbers of a type of venue in the city, it is not a direct relationship to the likelihood of being near a bike accident. It is the first step to understanding that the type of venue is more likely a factor in being near an accident than the density of the venue type.

Figure 5: Proportion of Venue Type in the City of Madison and the Proportion Near Bike Accidents
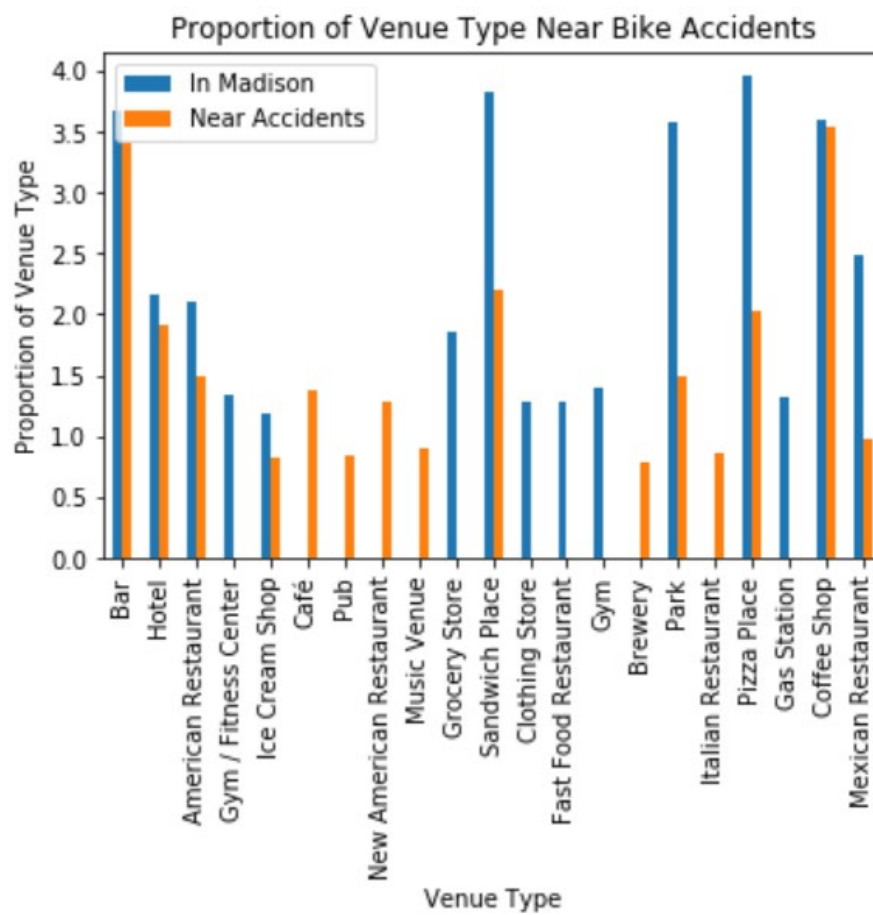
Table 1: Proportion of Venue Types in Madison and Near Bike Accidents

Venue Type	Proportion of Venue Type Near Bike Accidents	Proportion of Venue Type in Madison
Coffee Shop	3.5%	3.6%
Bar	3.4%	3.7%
American Restaurant*	2.8%	2.1%
Sandwich Place	2.2%	3.8%
Pizza Place	2.0%	3.9%
Hotel	1.9%	2.2%
Park	1.5%	3.6%
Café	1.3%	0.0%
New American Restaurant	1.3%	0.0%
Music Venue	0.9%	0.0%
Italian Restaurant	0.9%	0.0%
Mexican Restaurant	0.9%	2.5%
Ice Cream Shop	0.8%	1.2%
Pub	0.8%	0.0%
Brewery	0.8%	0.0%
Gym/Fitness Center**	0.0%	2.7%
Grocery Store	0.0%	1.8%
Clothing Store	0.0%	1.3%
Fast Food Restaurant	0.0%	1.3%

*New American Restaurant included in American Restaurant Category
**Gym included in Gym/Fitness Center Category

Discussion and Future Directions:

This preliminary study into the factors related to accidents involving motor vehicles and bicyclists yielded findings that can be built on for future studies. First, hazards aren't directly correlated with bike accidents, however, there may be more value in looking into different neighborhoods and areas of Madison, than taking the city as a whole. The downtown campus area has a much higher proportion of bicyclists, particularly students. This could explain the high density of accidents in that area. One potential future study could look at the timing of accidents, do they occur more frequently at the beginning of semesters? This would be a time when new students would be on campus, either driving or biking and may be unfamiliar with the rules of the road and how to maneuver traffic safely. One potential public safety initiative would be to

require students with bikes to get a registration sticker for their bike and upon getting that sticker provide them with instruction on how to bike in the city and a map of safe routes on campus. This would not prevent poor driving, but it could help new bicyclists learn safety techniques.

Through the creation of higher-level categories for bike hazards noted within the city of Madison, we know that connection issues are the most frequent issue bicyclists face in the area. As the city seeks to improve their bicycle friendly status this is an area that would be a beneficial area of focus for improvement. The second most frequent was bicycle facilities needed, which would include places to park a bike safely, signage for trails and paths, and potential service sites for bike repairs. Many of these are simple fixes that could be taken care of by store owners or property owners. Signage may be the parks duty to improve or the cities. However, bicycle repair stores would be a hard fix for the city as these are usually commercial business and not part of the city's duty. However, crossing issues are third and could also be an easy signage fix for the city. Creating signage and flashing crossing areas to help motorists see coming bicyclists and yield right of way when necessary.

Finally, our initial analysis of top venues near accidents showed that just because a venue type is frequent in the city it is not necessarily more likely to be near an accident. Places serving alcohol held several of the top 15 venue types near bicycle accidents. Further analysis should be done utilizing statistical analysis for these types of venues. I have a working hypothesis that particularly downtown where there is a high density of bars and big events occur that there would be a higher correlation of accidents near alcohol serving venues. I believe this could also coincide with exploring the time at which accidents occur downtown and on campus. Are many of the accidents near alcohol serving venues happening in the evening or after dark hours?

Conclusion:

This preliminary study of the hazards faced by Madison bicyclists and the factors that could be related to increased accidents involving motor vehicles and bicyclists has offered up several paths for further analysis. In particular, breaking up the city by smaller neighborhood sections could improve the accuracy of the findings. Downtown has a much different geographic layout and population than most of the other neighborhoods in Madison. This is due to the isthmus and the location of the University. Venue density does not seem to be related to the odds of the venue being near an accident, this requires further understanding of how the type of venue may be influencing the accidents nearby. Finally, we know that connection issues between bike paths is a problem in the city and could be a starting spot for local policymakers to begin improvements for bicycle safety.