Analysis of Vehicular Crashes in Iowa

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***Abstract*—The abstract goes here. On multiple lines eventually.**

***Index Terms*—keyword 1; keyword 2**

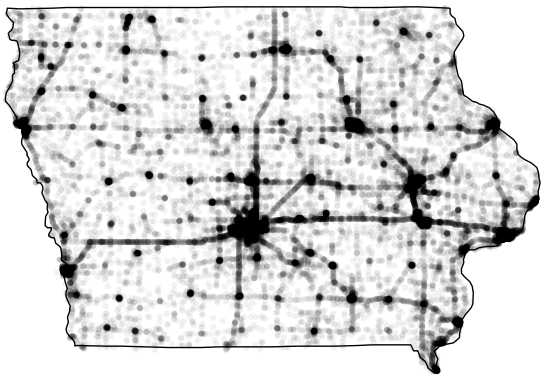


Fig. 1. Locations of all crashes in Iowa in 2021. Each crash is drawn with an opacity of only 5% to provide an x-ray of high-density regions in the spatial distribution. Only when twenty crashes happen in the same location, do we see a fully saturated black dot on the map. The map paints a picture of Iowa's population centers and its network of roads.

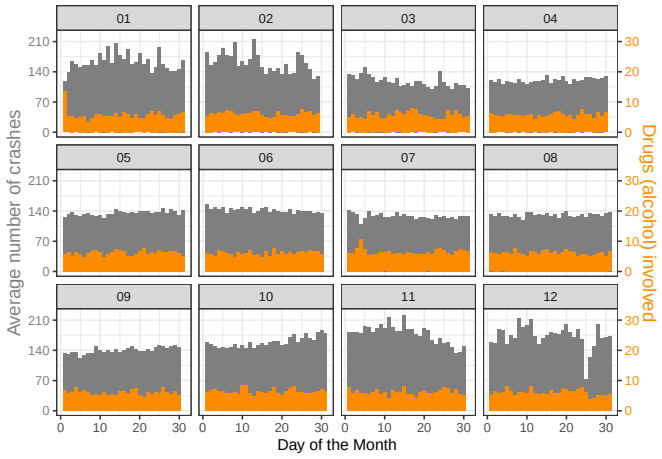


Fig. 2. Average number of crashes by day of the year.

I. Introduction

According to the Iowa Department of Transportation (2022), there are over 50,000 crashes per year in Iowa alone. These crashes cause millions of dollars in property damage and, unfortunately, the loss of life, with over 300 people dying in vehicular crashes each year. It is important to gain a greater understanding of the causes of these crashes to better create prevention strategies and protect the drivers on the road. By informing drivers of potential hazardous practices, they will be better prepared and encouraged to follow safe driving practices. The goal of this report is to explore some of the correlations between crashes and driving conditions to gain a better understanding of how to make the road a safer place.

The data for this project is collected by the Iowa Department of Transportation and made publicly available at https://icat.iowadot.gov/. Each row contains data for every recorded vehicle crash since January 2009 and is updated monthly. For each crash a large number of variables are collected: date, time and location of the crash, the number of vehicles and passengers involved; crash severity measured in property damage, number of injuries, or fatalities; contributing factors such as weather and road conditions are reported, and whether any of the drivers were driving under the influence.

Figure 1 shows a map of all location of crashes in Iowa in 2021. We see that crashes are truly everywhere.

In our project we are interested in the two biggest factors contributing to crashes: alcohol/drug involvement and crashes with animals. For that, we are looking at **XXX roadmap for the paper XXX**

II. First overview

Between Jan 1 2009 and the end of September in 2022 a total of 728,442 crashes in Iowa were reported. Figure 2 shows the average number of crashes in Iowa by day of year. We see that during spring and summer months there are on average fewer crashes than during the rest of the year. From November to February, we see an increased variability in the number of crashes – this is likely due to bad weather days with large number of crashes in some of the years. There is a clear holiday effect in the number of crashes: New Year's day, the Fourth of July, Thanksgiving, Christmas day and the day after have a much-reduced number of crashes. However, both New Year's day and the Fourth of July have a very large number of drunk crashes in comparison to the rest of the year (shown in orange). The fact that New Year's day has triple the number of drug-involved crashes as any other day is particularly scary because January first has the lowest amount of overall crashes in the month of January. We will further investigate the relationship between alcohol and crashes in section ***XXX***.

HH: move this next paragraph to the appendix

Data cleaning included changing empty strings and illogical values into NA values. Day, month, and year values were extracted using R's lubridate package. Latitude and longitude columns were also created from the 'Position' column to further explore where crashes happen in Iowa.

Figure 3 shows barcharts of the average number of car crashes over the course of a day throughout the months of the year. Initially, we see two prominent peaks in the number of crashes around the times of morning and evening commutes. However, in late Spring a third peak appears at a later time that only disappears by September and merges to a single huge peak with the evening commuting time in November. Looking at crashes involving animals we see that this third peak is strongly correlated with the time that animals are hit in the evening. We are going to look at this phenomenon more closer in section **XXX**.

III. Sunrise/Sunset Analysis

After cleaning the data, our analysis focused on how time of the day when car crashes happen. We hypothesize that more crashes will happen in the morning and evening as the driver is travelling into the sun and has to deal with sun glare, preventing them from seeing clearly.

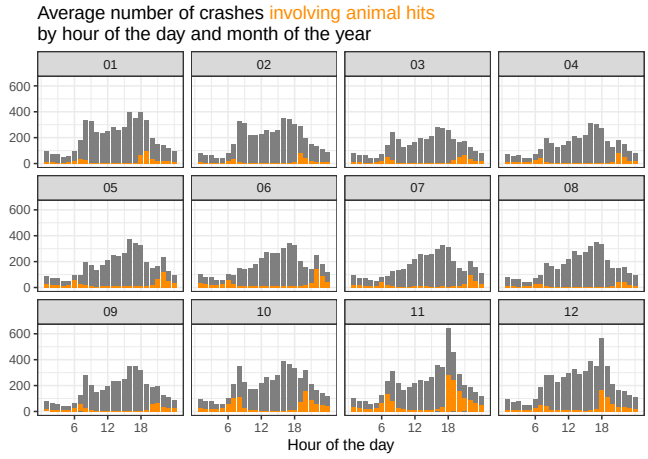


Fig. 3. Average number of crashes by hour of the day and month of the year. Crashes involving animal hits are shown in orange.

2020	Sunrise/Sunset		Daylength		Astronomical Twilight		Nautical Twilight		Civil Twilight		Solar Noon	
Mar	Sunrise	Sunset	Length	Diff.	Start	End	Start	End	Start	End	Time	Mil. mi
1	6:48 am → (99°)	6:05 pm ← (261°)	11:16:41	+2:47	5:16 am	7:38 pm	5:48 am	7:05 pm	6:20 am	6:33 pm	12:26 pm (40.8°)	92.121
2	6:47 am → (99°)	6:06 pm ← (262°)	11:19:29	+2:48	5:14 am	7:39 pm	5:46 am	7:06 pm	6:19 am	6:34 pm	12:26 pm (41.2°)	92.144
3	6:45 am → (98°)	6:07 pm ← (262°)	11:22:18	+2:48	5:12 am	7:40 pm	5:45 am	7:08 pm	6:17 am	6:35 pm	12:26 pm (41.6°)	92.166
4	6:43 am → (98°)	6:08 pm ← (263°)	11:25:06	+2:48	5:11 am	7:41 pm	5:43 am	7:09 pm	6:15 am	6:36 pm	12:26 pm (41.9°)	92.189
5	6:42 am → (97°)	6:10 pm ← (263°)	11:27:55	+2:49	5:09 am	7:42 pm	5:42 am	7:10 pm	6:14 am	6:38 pm	12:25 pm (42.3°)	92.212
6	6:40 am → (96°)	6:11 pm ← (264°)	11:30:45	+2:49	5:07 am	7:44 pm	5:40 am	7:11 pm	6:12 am	6:39 pm	12:25 pm (42.7°)	92.236
7	6:38 am → (96°)	6:12 pm ← (264°)	11:33:34	+2:49	5:06 am	7:45 pm	5:38 am	7:12 pm	6:11 am	6:40 pm	12:25 pm (43.1°)	92.259

Note: hours shift because clocks change forward 1 hour. (See the note below this table for details)

Fig. 4. Example table of the data collected for sunrise and sunset times.

A. Data Extraction

Because evening and morning times are variable throughout the year, one must look at when the sun is rising and setting. Because this data was not included in the original data set, the data was scraped from Time and AS (1995--). The data includes sunrise and sunset times for Ames, Iowa in 2020. The reasoning behind using Ames was that it is the nearest major town to the geographical center of Iowa. This would limit variation of sunrise and sunset times based on location. For approximately every 70 miles, there is a one minute change in sunrise and sunset times. By using Ames, these discrepancies to under three minutes. The year 2020 was chosen because it is the most recent leap year and would provide meaningful data for February 29.

Figure 4 shows an example table from timeanddate that was used for the data collection is as follows:

Using a function, the data was extracted for each month in 2020 and joined with the original crash data set.

B. Sunrise/Sunset Analysis

Figure 5 shows the minutes from sunrise compared to number of crashes, with a line denoting when the sunrise time is:

This clearly appears that there is a small spike, starting right before the sun rises.

There also seems to be a noticeable spike around 750 minutes after sunrise time. This likely corresponds to sunset time, so it is only logical to look at how sunset time affects

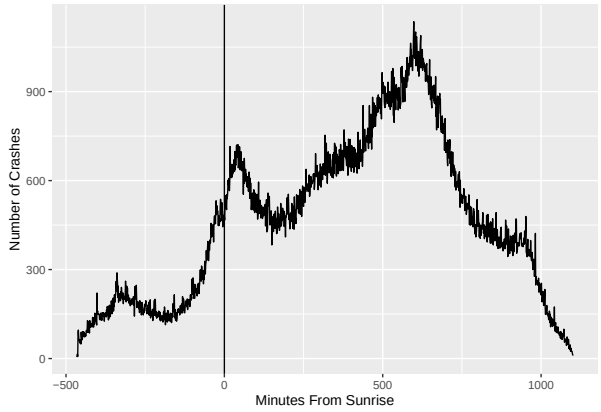


Fig. 5. A graph of all crashes by the difference between crash time and sunrise.

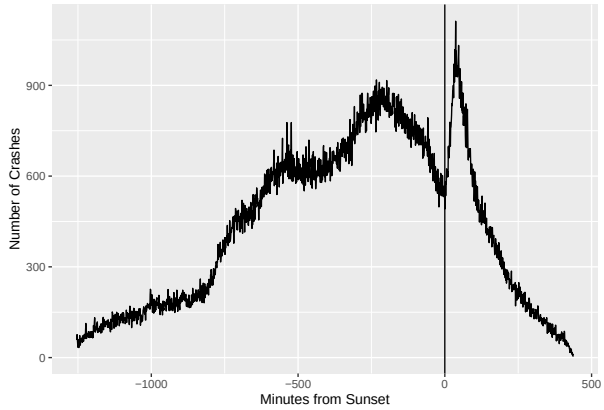


Fig. 6. A graph of all crashes by the difference between crash time and sunset

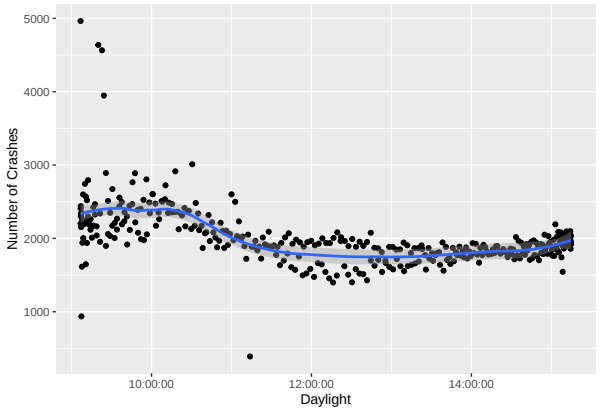
car crashes. Figure 6 shows the minutes away from sunset, with a line denoting where the sun sets.

There appears to be a pretty drastic jump right after the sun sets. According to the Council (2020), driving at dusk is extremely dangerous, as one's eyes take time to adjust to the relative darkness, shadows hide animals and road features, and driver sometimes fail to turn on their headlights. This may be a reason why there is such a strong correlation between sunset time and a spike in car crashes.

C. Daylight Analysis

One point of note is looking into how the length of the day affects car crashes. The following graph shows the number of crashes based on the length of the day. A line of best fit was added to the graph using LOESS smoothing.

There seems to be more variability in earlier months, but overall a downward trend.



There is very clearly a downward trend, showing that there is a correlation to fewer daylight hours and more crashes.

1) Conclusion:: A number of conclusions can be drawn from this data analysis. First, we can conclude that there is a correlation between sunset and sunrise time and frequency of crashes. The 30-minute window after the sun sets, especially, is correlated with an increase in crashes in Iowa. There is also a correlation between higher numbers of crashes and fewer daylight hours, but this may be correlated with the winter months being more dangerous for drivers. For future research, we would like to to further look into how rush hour traffic may affect these trends.

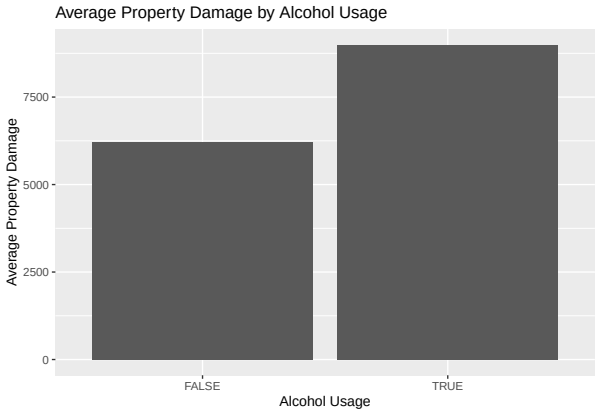
D. Alcohol Analysis

For my analysis, I would like to look into the relationship between alcohol and car crashes. I especially want to look into how the severity of car crashes and alcohol are related and what times are the most dangerous in terms of drunk drivers.

The main data set has a variable titled "Drug or Alcohol" with eight different levels. However, only two of these levels signify that substances were not involved. Because of this I created a helper variable titled "Drug_Usage" that is TRUE when there are substances involved and FALSE when there is none present.

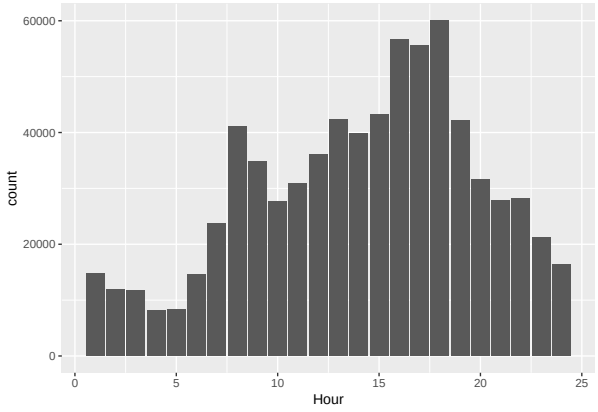
In order to perform further calculations, I also created some helper variables containing the total of crashes with and without alcohol, respectively.

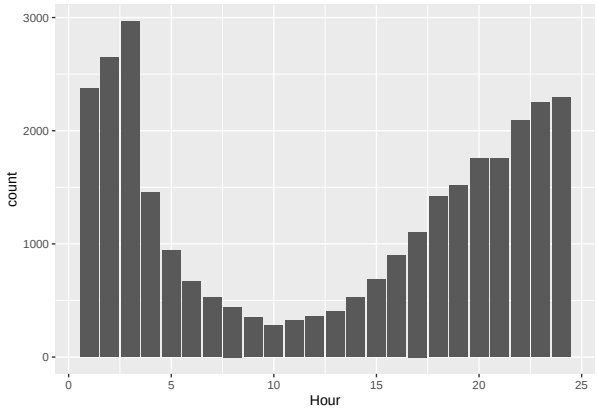
After that, I found the average property damage that results from crashes with and without drunk driving. As I expected, drunk crashes do cause more damage, almost $3000 more on average.



I also looked at the average fatalities per crash with and without alcohol. The actual values of the averages aren't super intuitive, as they are small decimals, but finding the average rate of fatalities is much more useful. When doing so, fatalities occur in sober crashes about 1 in 217 crashes, while fatalities in drunk crashes occur at about 1 in 20. This difference in fatality is expected, but I am shocked at how much higher it truly is.

Next, I decided to look into how time of day affects drunk driving. I plotted sober and drunk crashes and tried to find a pattern.

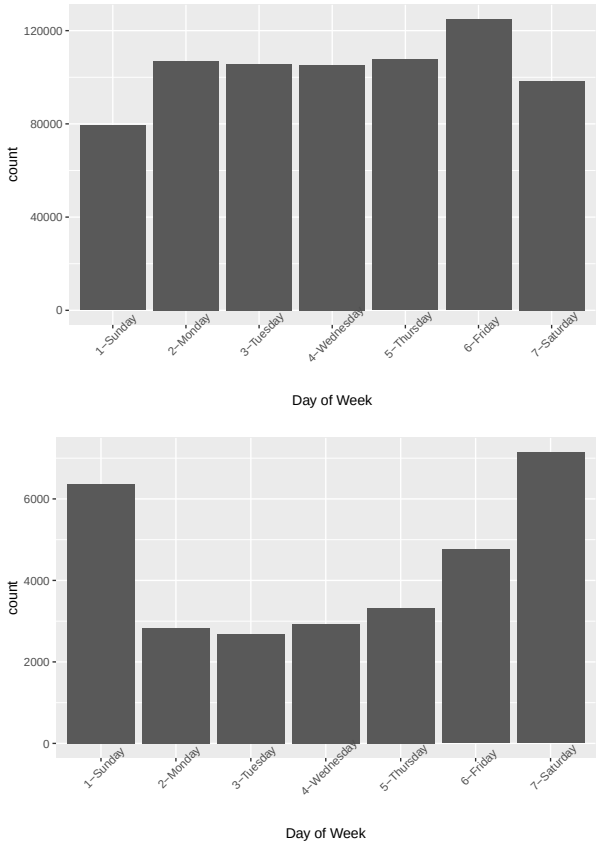




After that, I decided to try and find what percentage of crashes that occur during late night hours involve alcohol. To do so, I created a helper variable containing all crashes that

occurred between 10 P.M. and 4 A.M.

The next unit of time I decided to look at was day of the week. I expected to see a large spike on weekends, especially on Friday and Saturday. To do so, I once again plotted both sober and drunk crashes by day of the week and compared them.



E. Conclusion

1. Alcohol drastically increases the danger and severity of crashes: fatalities, injuries, and property damage all occur at an increased rate.
2. Nighttime and Friday and Saturday nights are the times with the most drunk driving, so it may be wise to avoid the roads at those times.
3. The worst nights to drive on are New Year's Eve and the Fourth of July, as they by far have the most drunk accidents of any other days in the year.

IV. Conclusion

The conclusion goes here.

Appendix

References

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Time, and Date AS. 1995--. “Ames, Iowa, USA - Sunrise, Sunset, and Daylength in 2020.” https://www.timeanddate.com/sun/usa/ames.