Department of Physical and Environmental Sciences

PSCB57H3-F - Fall 2017

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Geotab- Toyota Tacoma 2010 Fuel Consumption Observation and Analysis

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Introduction

Using the Geotab device, our group chose to perform fuel consumption analysis using statistical data collected from a 2010 Toyota Tacoma from mid-October to November. Geotab helped manage and reduce unproductive kilometers and fleet fuel consumption by tracking the vehicle's speed, idling time, vehicle maintenance and several different variables using a GPS tracking system. Geotab also compares fuel consumption data of different vehicles to identify areas within the vehicle that can be improved. However, our analysis of the data is specifically done

based on the relation of fuel economy with two parameters: temperature and distance travelled. We compared the results obtained to attempt to see how our designated driver's fuel consumption related to the official fuel consumption value published by Toyota in late 2009.

One limitation encountered was the timeframe in which data was obtained. Ideally data would have been obtained over an entire year to see how seasonal conditions or larger temperature changes affect fuel economy. Additionally, the geotab appears to have also run out of storage where only up to the tenth of November was recorded rather than most of the month as intended.

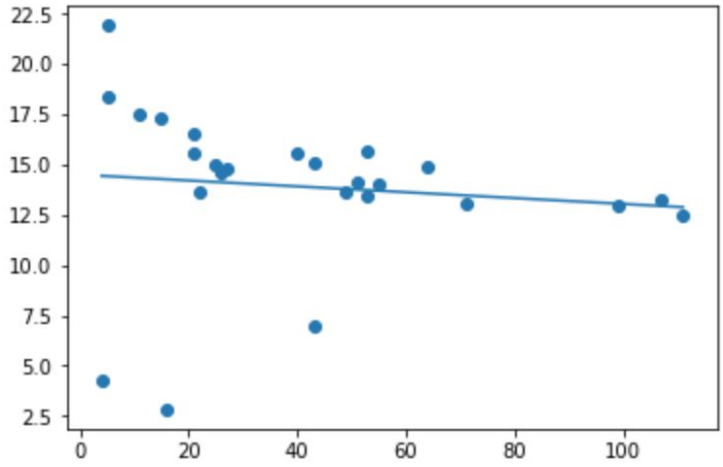
Distance-Fuel Economy with outliers:

This graph intends to look at linear change in fuel efficiency as the distance traveled in one day of gathered data to conclude the efficiency of the day increases including all outliers such as the 22.5l/100km data point which will be affecting our graphs dramatically. As for the reasoning of these outliers many factors might have played a part such as inaccuracy of the device, driving incidents, etc. However the reason is of less interest to us rather than concluding how this outlier is affecting our observation. Which we will discuss further in the next graph generated from same datasets but with outliers neglected.

```
In [6]: %matplotlib inline
        import matplotlib.pyplot as plt
        fig, ax = plt.subplots(1,1)

        ax.plot(tfine,linear)
        ax.scatter(distance,fueleconomy)
```

```
Out[6]: <matplotlib.collections.PathCollection at 0x1093d9c18>
```



Distance-Fuel Economy without outliers:

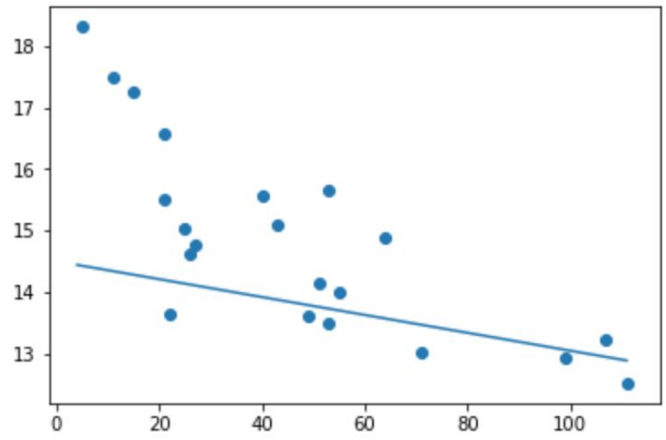
The graph below, as mentioned above, is plotted using the same the same dataset however by neglecting the outlier data points.

In both graphs we can visibly see the decline in our fuel efficiency factor, hence suggesting the longer distance traveled the more efficient we get. Second graph however has a steeper decline. With our observations in mind we can think of causation of outliers as elements beyond our control that can generate a rather lesser realistic results having the second graph and datasets to of more realistic accuracy. However with our given amount of data and analysis the latter cannot be concluded with certainty.

```
In [21]: %matplotlib inline
         import matplotlib.pyplot as plt
         fig, ax = plt.subplots(1,1)

         ax.plot(tfine,linear)
         ax.scatter(distance,fueleconomy)
```

```
Out[21]: <matplotlib.collections.PathCollection at 0x109231390>
```



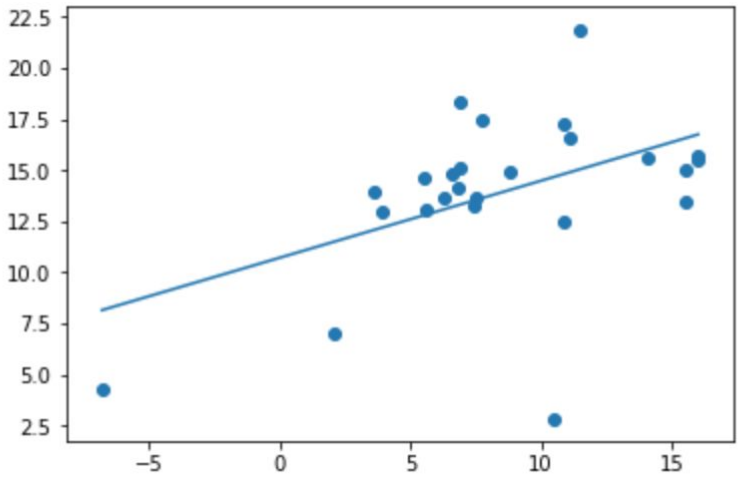
Temperature-Fuel Economy with outliers:

In the next two graphs we will be trying to make an observation as to impact of temperature to our fuel economy. The first graph, same as before, will include the temperature outliers being significantly cold or warm days in comparison to average temperature of our dataset and we will the impact of the outliers on our observation when we do plot our dataset without the outliers.

```
In [27]: %matplotlib inline
         import matplotlib.pyplot as plt
         fig, ax = plt.subplots(1,1)

         ax.plot(tfine,linear)
         ax.scatter(temp,fueleconomy)
```

```
Out[27]: <matplotlib.collections.PathCollection at 0x109577588>
```



Temperature-Fuel Economy without outliers:

The following, as stated before, is the graph plotted from the same dataset having it's outliers removed. As we can clearly observe the factor of fuel efficiency increases in value as the temperature increases.

The impact of outliers is not in disagreement with this observation but rather in how much this change in fuel economy factor should be. Quite clearly when we have more drastic change in temperature the slope in greater accounting that extreme weather conditions can make significant differences in our fuel efficiency. Although it worths noting that given the limited amount of data and sample set outliers can pose a danger to our conclusion since the difference in fuel economy causing the greater slope on the graph could be due to another factor that by coincidence has

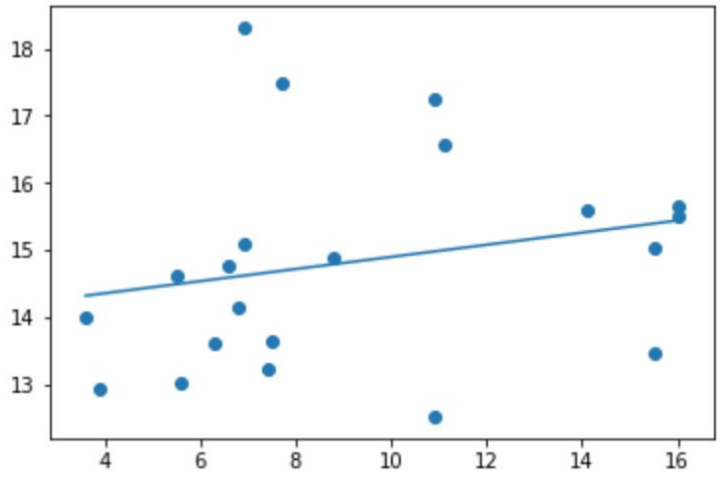
affected the same data point. Given a larger dataset, we could say affect of the coincidences would be significantly lowered.

Bottom line there is no good way in this case to conclude which graph is closer to reality of what we are putting to test with our given datasets. What will remain without disagreement is the effect of the change in temperature on fuel economy factor

```
In [34]: %matplotlib inline
         import matplotlib.pyplot as plt
         fig, ax = plt.subplots(1,1)

         ax.plot(tfine,linear)
         ax.scatter(temp,fueleconomy)
```

```
Out[34]: <matplotlib.collections.PathCollection at 0x109ed3908>
```



Conclusion

Although one month of daily fuel consumption is sufficient to analyze the relationship between fuel economy and distance travelled, it does not allow for fluctuations between extremities found in different seasons (winter and summer) to be observed. To gather this data, it

would require recording daily fuel consumption data over a period of 6 to 7 months of which we were unable to complete due to limited time provided for this undertaking.

Other conclusive observations that cannot be proposed relate to how fuel consumptions of all 2010 Toyota Tacoma vehicles cannot be illustrated using a single vehicle of the same make and model, currently utilizing the Geotab device, noting that fuel consumption can differ even from vehicles of the same model due to small variations being present for all vehicles (i.e., some vehicles do not achieve optimal fuel consumption ratings before 6,000 - 10,000 km). Additionally, fuel consumption rates can vary from the published consumption rates based on several factors such as location, time, age of vehicle and driving style, all of which are variables that our group cannot, realistically, alter.

References:

MPG Calculator Calculate Fuel Consumption / Efficiency in Miles per Gallon. (n.d.). Retrieved October19,2017,from http://opentoronto.com/calculators/MPG_calculator_calculate_MPG_fuel_efficiency_gas_consumption_fuel_economy.php

2010 Toyota Tacoma. (n.d.). Retrieved October 19, 2017, from http://www.fueleconomy.gov/feg/bymodel/2010_Toyota_Tacoma.shtml

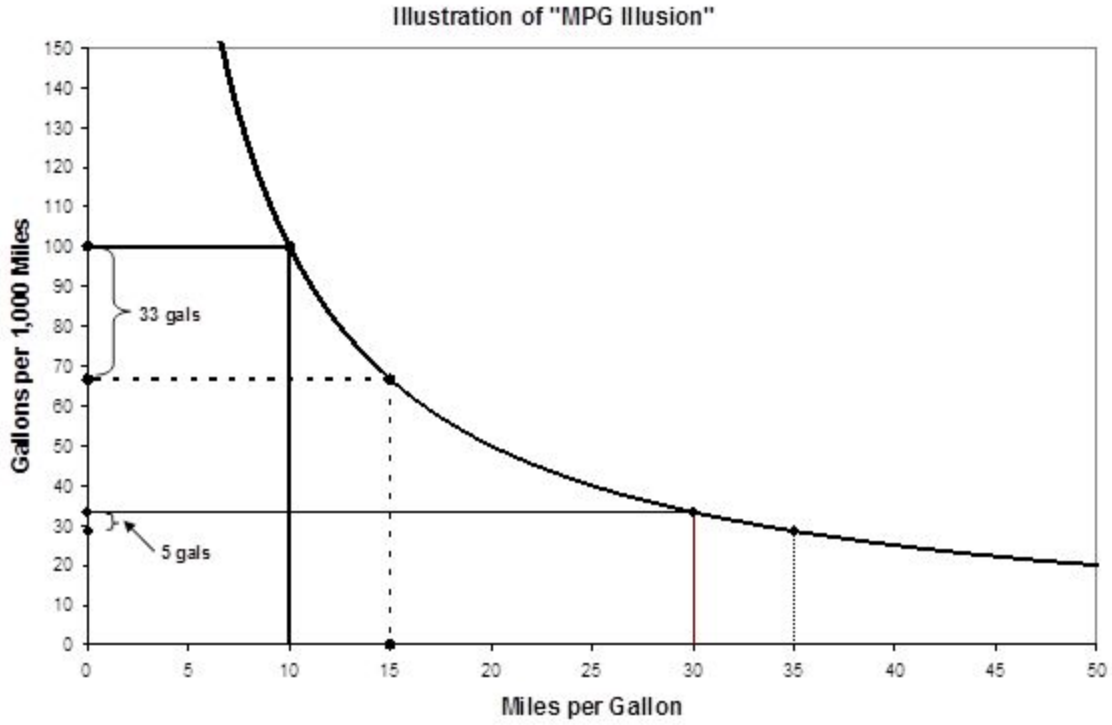
Government Publications:

Fuel Consumption Guide 2017 (2017) Retrieved from: http://publications.gc.ca/collections/collection_2017/rncan-nrcan/M141-5-2017-eng.pdf

Government of Canada, Public Works and Government Services Canada, Integrated Services Branch, Government Information Services, Publishing and Depository Services. (2013, April 03). Fuel consumption guide: M141-5E-PDF ; M141-5-PDF - Government of Canada Publications. Retrieved October 19, 2017, from http://publications.gc.ca/site/eng/369146/publication.html

Access historical weather, climate data, and related information for numerous locations across Canada. Temperature, precipitation, degree days, relative humidity, wind speed and direction, monthly summaries, averages, extremes and Climate Normals, are some of the information you will find on this site.

http://climate.weather.gc.ca/



(Source: https://www.fueleconomy.gov/feg/label/learn-more-gasoline-label.shtml)

While a miles per gallon (MPG) is a common metric to estimate fuel economy, this can be misleading. The chart above illustrates the nonlinear relationship between gallons used over a given distance and miles per gallon. For example, a vehicle that gets 10 MPG versus a vehicle that gets 15 MPG is about 33 gallons over 1000 miles while the fuel savings in gallons, for the same 5 MPG fuel economy jump, for a 30 MPG versus a 35 MPG vehicle is only about 5 gallons. This "MPG illusion" demonstrates why it may be more meaningful to express fuel efficiency in terms of consumption (eg. L/100km) rather than in terms of economy (miles per gallon). A fuel consumption metric allows for more accurate energy usage comparisons among vehicles.