Traffic Ticket Quotas in Seattle

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ABSTRACT
In this paper, we explore the possibility that there are traffic ticket quotas implemented in the city of Seattle.

CCS Concepts
• Applied computing~Law, social and behavioral sciences.

Keywords
Traffic ticket; Ticket Quota; Quota; Seattle; Police;

1. INTRODUCTION
According to multiple sources [1], more than 100,000 traffic tickets are issued per day in the United States, and each ticket costs $150 on average. A traffic ticket quota is the number of traffic infractions a police officer must administer in a given period of time. Ticket quotas are illegal in many states, such as California, Texas, and Florida. In Washington State, a bill [2] to prohibit traffic ticket quotas was introduced in 2016, but it is not in effect yet. Still, both Washington State Patrol and Seattle Police state that there is no regulation regarding the minimum number of traffic stops [3]. Some police departments use "productivity goals", "work productivity" or performance reviews as excuses to implicitly enforce traffic ticket quotas.

The purpose of this project is to explore the possibility that a traffic ticket quota is implicitly enforced in the city of Seattle.

2. RESEARCH QUESTIONS
There are two questions that will be explored in this project:

- Are there traffic ticket quotas imposed on police officers in Seattle?
- What are the most common places and time for traffic stops?

In order to answer the first question, the definition of ticket quota must be established. According to multiple news sources, there are hourly quotas [4], daily quotas [5], monthly quotas [6], but in many case, the numbers are not explicitly stated, or use a different type of metric, such as shift-averaging [7], where police officers are separated in small groups and the lowest group get penalized. For this project, we will focus on finding ticket quotas that are imposed daily, weekly or monthly.

3. DATA
3.1 Data Overview
The dataset is provided by The Stanford Open Policing Project [8] and can be obtained either from their website or from Kaggle [9]. It contains records of traffic stops by law enforcement in the city of Seattle from January 2009 to December 2015. For this project, we will focus on the years 2013 to 2015 in order to analyze the data of groups of police officers in the same time period and hypothetically under the same quotas. The csv file is 74.5 MB, with 27 columns and 319,959 rows of data. The data corresponds to 1,652 unique police officers.
The Stanford Open Policing Project data are made available under the Open Data Commons Attribution License.

3.2 Features
The main features out of the 27 columns to focus on this dataset can be seen below in Table 1.

Figure 1: Important features, descriptions and examples.

Column	Description	Example
date	Date of traffic stop.	'2006-01-01'
time	Time of traffic stop.	'02:23:42'
lat	Latitude.	47.664980
lng	Longitude.	-122.323142
type	Type of stop	'vehicular'
violation	Type of violation	'450: DRIVING UNDER THE INFLUENCE'
citation_issued	Whether or not a traffic ticket was issued.	False

3.3 Data Cleaning
For the reason given in section 3.1, we will focus on traffic stops made between January 2013 to December 2015. We will also focus on vehicular stops, since stops on pedestrians are not traffic stops (e.g. prostitution). Both the 'date' and 'time' columns are changed to datetime format and the missing values are removed for the entire dataset.

4. METHODOLOGY
4.1 Set-up
The analysis in this project is done using Jupyter Notebooks. It uses Python 3.7.3 and the following libraries:

- geopy 1.19.0 (https://geopy.readthedocs.io/en/stable/)
- gmplot 1.2.0 (https://pypi.org/project/gmplot/)
- matplotlib 3.0.2 (https://matplotlib.org/3.0.2/contents.html)
- numpy 1.16.2 (https://docs.scipy.org/doc/numpy/reference/)
- pandas 0.24.2 (https://pandas.pydata.org/pandas-docs/stable/)

Additionally, in order to display the interactive maps properly, one must set up a Google Cloud account with credit card information, even for the trial version. The steps to set up an

account and get the API key needed are in the following link: https://cloud.google.com/maps-platform/pricing/

4.2 Precinct Detection

The original dataset does have a column named 'precinct' that denotes the precinct where the traffic stop was made. However, a single officer could have worked in multiple precincts if operating near the precinct limits. Therefore, in order to find which police officer belonged in which of the five precincts, the averages of their latitude and longitude values where averaged, and the officers were assigned a precinct based on their distance.

One must consider that the area of operations and the averaging of geographical coordinates to not be exact, having the chance of assigning an officer to an erroneous precinct. Not only this will make it harder to detect commonalities in citation numbers within precincts, but it could also mark an officer not under a ticket quota as an officer who is under one.

4.3 Periodicity

Given that this project focuses on daily, weekly and monthly quotas, additional time series from the original data must be created using different granularities. The new datasets count the number of citations per hour, per day, per week and per month for each police officer.

Creating autocorrelation plots with hourly time series gives insight on whether the time series is correlated with a "delayed" version of itself. In other words, if there is a hint of periodicity in the hourly time series, it would mean that there is a daily quota since the pattern for dispensing tickets would repeat itself daily. Likewise, autocorrelation plots with daily time series gives insight on whether there is periodicity on a weekly basis, and weekly time series would reflect on ticket quotas on a monthly basis. A positive autocorrelation would mean that whenever a police officer gives a certain amount of tickets in a period, a proportional amount of tickets would be dispensed in another period in the future. In contrast, a negative autocorrelation value would mean that if a police officer gave an above-average amount of tickets first, he or she would give a lesser amount of tickets in the future, and vice versa.

4.4 Hypothetical Quotas

In order to see whether traffic ticket quotas are applied, we set up increasing hypothetical quotas for each granularity of the time series. In other words, we set up the daily, weekly and monthly quotas to range from 1 ticket per period to 10 tickets per period and see the proportion of police officers who would hit the quota.

We assume that if quotas were set in place for officers to follow, most of them would be hitting the quota. Otherwise, it would not make sense that there was a quota if officers do not follow the rules.

4.5 Place and Time

In order to see where most traffic tickets are dispensed, we use the gmplot library to produce a heatmap given the latitude and longitude coordinates of the data points. The heatmap values range from green to red as the number of data points in that area increases.

For the most common times for traffic tickets, the hourly time series is grouped by hour and the results displayed in a histogram.

5. RESULTS

5.1 Quotas

5.1.1 Periodicity

There is no ground truth regarding whether traffic ticket quotas are implemented in the city of Seattle. Therefore, we can only present evidence for and against the existence of ticket quotas.

The autocorrelation plots for the hourly, daily and weekly time series show some weak periodicity in the data.

The autocorrelation plot for the hourly time series, as seen in Figure 1 seems to indicate that in the first two hours, there is positive autocorrelation, and negative autocorrelation between five and seven hours, implying that police officers either pick up their slack when nearing the end of their shift, or they dispense less tickets given that they dispensed more earlier in the day.

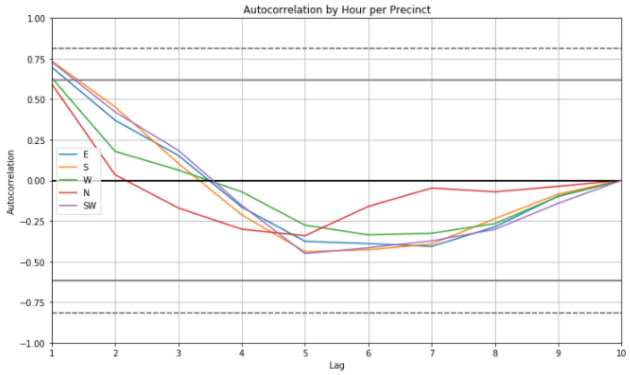

Figure 1: Autocorrelation plot for hourly time series.

The autocorrelation plot for the daily time series shows some weak negative autocorrelation when lag = 2 (every two days). This means that if a police officer dispensed less tickets the first day, he or she will dispense more 2 days later. The autocorrelation is weak and shows no sign of a weekly periodicity.

The autocorrelation plot for the weekly time series shows negative autocorrelation in the third week, providing evidence that there could be a monthly quota, since the periodicity matches, as seen on Figure 2.

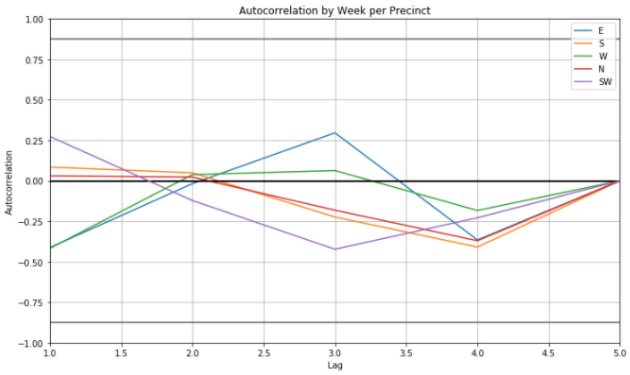

Figure 2: Autocorrelation plot for weekly time series.

Therefore, using periodicity, we find some evidence for daily and monthly quotas, even though the quota amount is not specified.

5.1.2 Hypothetical Quotas

In order to see if traffic ticket quotas are present in the data, we set up hypothetical scenarios, each with a different type of quota

(daily, weekly and monthly). We set up the quotas from 1 ticket per period to 10 tickets per period and see the proportion of officers who passed the quota *at least once*. This may seem too low of a bar, but even so, the results are underwhelming.

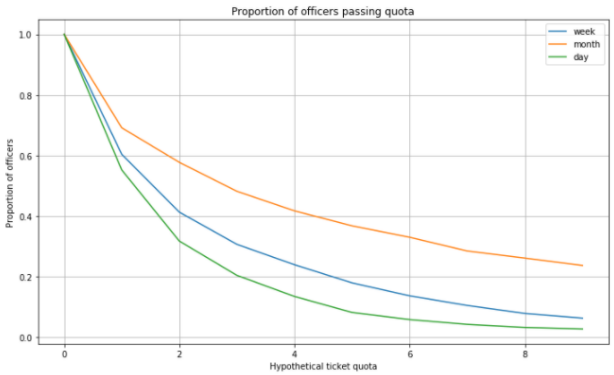

Figure 3: Hypothetical Quotas

The figure above shows that around 60% to 80% of police officers hit the quota once when it was set at tickets issued greater or equal than 1. Less than 60% of officers pass when the quota is set to greater or equal than 2.

Given the examples of ticket quotas from the news articles mentioned before, such as 3 tickets per hour or 18 per day, the low values for the hypothetical quotas show that either there is not a quota set for police officers, or it is very low, like 2 tickets per month.

The number of police officers that perform traffic stops without issuing any tickets, and the gaps in the data between the dates the tickets were issued by any single officer are large enough to indicate that daily or weekly quotas are simply not realistic.

Therefore, it is likely that there are no quotas in place.

Of course, we must consider that the analysis is not 100% correct, meaning that quotas do exist, but could not be found using these methods. Further errors can be introduced in the different stages of the data pipeline, such as the precinct assignment, in the time period chosen, or in the aggregation of the data.

5.2 Place and Time

The heatmap in Figure 4 shows the most common location for traffic tickets. It follows that the majority of the traffic tickets are issued in the city center, where the density of drivers is highest. Excluding downtown, the most popular spots are the commercial centers, such as Westwood Village or Northgate Mall. Major highways and avenues are also common locations for traffic tickets, such as State Route 99 and Rainier Ave S.

Most of the traffic tickets happen during the middle of the week (Wednesday, Thursday, Friday), and between 8pm and 1am.

5.3 Conclusion

While there is some evidence that there is a ticket quota, it is not conclusive enough to confirm that there is one. The number of tickets given per year decreased, many officers not giving tickets at all during some months. It is also plausible that there is no quota established, given that nowadays using quotas for performance assessment is antiquated.

Nevertheless, enforcement of traffic laws can serve an important role for protecting drivers. However, traffic ticket quotas are detrimental because they cost drivers thousands of dollars in

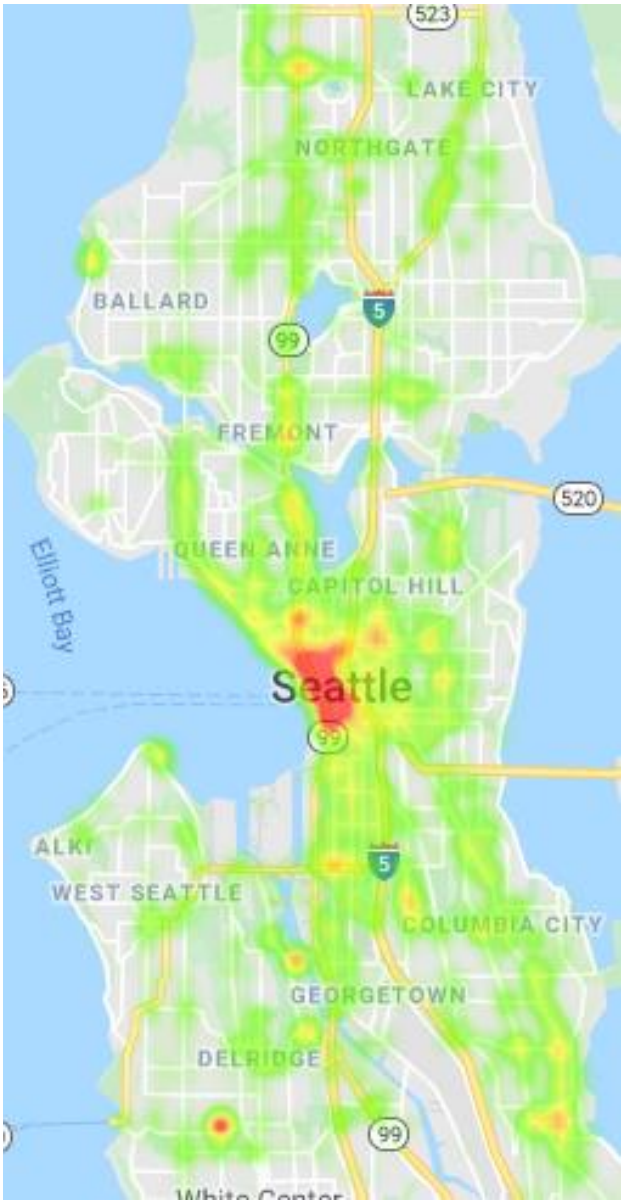

Figure 4: Heatmap of Seattle

unreasonable and groundless fines. Additionally, it creates friction between the public and police officers due to mistrust and animosity towards unfair ruling. Furthermore, it creates a negative work environment for police officers since they are required to produce a number of tickets, which is used as a metric to assess performance.

6. FUTURE WORK

For starters, the original dataset only spans to December 2015. Given that a bill was introduced in 2016 to prohibit the use of traffic ticket quotas as a performance metric, it would be interesting to see if there was an impact regarding the number of tickets issued.

Additionally, the reasons for traffic tickets are either “moving violation”, “driving under the influence”, or “miscellaneous”. Further exploration with detailed reasons would be beneficial, as

we could see the actual reason for stopping, e.g. “speeding”, “passing red light”, “passing stop sign”, etc.

For this project, only daily, weekly and monthly time series were created to study the data. However, traffic ticket quotas could also be hourly, biweekly, quarterly, etc. Additional research regarding different granularities could expose quotas not present in this project.

Additional cities or states could be chosen depending on whether we absolutely know that there are traffic ticket quotas imposed in order to validate the methods used in this project.

Lastly, it would be interesting to see if time series forecasting was possible using machine learning. If ticket quotas were present, the predictions would follow the same rule, making the identification easier.

7. REFERENCES

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