Analyzing and Visualizing the Spatial and Seasonal Variability of Crime Incidents in Seattle, Washington from 2017 – 2019 Using Space-Time Cube and Optimized Hot Spot Analysis

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Abstract

Since 2010, the city of Seattle has been working towards being more transparent when it comes to its data. For us, this meant that we had access to crime reports from the Seattle Police Department (SPD) stretching across just over two decades (nearly 900,000 reports). From what we could gather (and infer), there is a plethora of research regarding crime such as crime rates, crime trends, crime spatiality, and many others. We grew attached to the idea of researching spatio-temporal variability, specifically seasonality, among the SPD crime records, something we thought as a combination of the previously mentioned angles but with our own twist. Thus, we narrowed the 22 years of crime reports down to the years 2017 through 2020, and narrowed the reports based on crime; the selected offense types were Drug/Narcotic Violations, Aggravated Assault, and Destruction/Damage/Vandalism of Property. With our data in scope, we analyzed the reports by season both spatially and temporally. We found that the downtown area near Pike's Place (about 4 square miles) had the densest and most consistent crime rates across all of the observed offense types. In regards to seasonality, we see the same patterns in crime spikes across all variables year-round. During the winter, Seattle experiences a drop in reported crimes. On the contrary, for spring across years 2017 through 2020 the crime rates begin to reach high levels, and by July and August, the number of crimes reported is at the peak for the whole year. However, one of the things to notice is that in recent years for 2019 and 2020 there has been a decrease in reported crimes. From our research findings and our statistical report, it is concluded that Seattle had a decrease in crime rates for the previously mentioned crime offense types. Furthermore, our findings show that the three categories of crimes that we covered have

been the most common in Seattle for a long time, and on the other hand, Seattle has experienced different results in other crime categories such as homicide and theft. The outcome of these new crime incidents has become relatable to other controversial topics such as homelessness and public disturbances such as the riots in recent months.

Keywords

Space-Time Cube, Space Time Analysis, Optimized Hot Spot Analysis, Clustering, Crime Patterns, Occurrence and Density, Distributive (In)Justice, Seattle, Seattle Police Department

Introduction

What is the spatial-temporal variation of crime incidents relative to police precincts in Seattle, WA?

In the city of Seattle, at least one crime happens every day. Analyzing crime data can be a complex task to do because there are tens of thousands of crimes reported every year (for Seattle). For our research purposes, we focused on three crime offense types; Drug/Narcotic Violations, Aggravated Assault, and Destruction/Damage/Vandalism of Property. Our purpose was to see correlations, patterns, and relationships over the entire year by seasons (a.k.a seasonality). The visualizations displayed on our story map show (the analysis of) the spatial and temporal patterns from 2017 to 2020. Through the data wrangling, mapping, and statistical analyses, we were able to determine the correlation between time and space for crime reports in Seattle.

Methodologies and Data Sources

Methodologies The main methodologies we incorporated to understand the patterns and trends of various Seattle crime offenses were space-time cubes and hot spots. The space time cubes allowed us to model and map incidents over a geographic study area and time period. The complementary hot spot analysis provided a visualization of crime locations that are statistically significant, something that was easier to interpret spatially than the space time cubes.

To assist in contextualizing our findings we included statistical analyses in the forms of a line graph which showed each offense type's frequency trend line across the entire time period; and a circular graph which visualized the total counts of the observed crimes across each month for each year. By illustrating offense incidents with these

methods, we can understand the demand for SPD services, when and where to optimize resources, and what decision-making processes can/should be improved.

Data Sources The primary data set stems from the SPD (Seattle open data portal), this is what had all of the crime reports. We pulled law enforcement locations from ArcGIS Hub and the SPD precinct shapefiles from Seattle's open data portal.

Findings

The Seattle Police department has divided the geographical area into five boundaries which include North, East, South, West, and Southwest. These precinct boundaries are considered to be neighborhood boundaries (or natural boundaries) and within those precinct boundaries are the sectors that patrol officers are responsible for. Considering the relationship between our hot spots analysis map and police stations there needs to be a better tactic to control criminal action. For instance, SPD maintains the ability to patrol (theoretically a form of controlling crime) but for future references the plan should be to incorporate long term investment programs that would help them to reduce crime rates for these common (Drug/Narcotic Violations, Aggravated Assault, and Destruction/Damage/Vandalism of Property) crimes.

Challenges

Challenges we faced include data types not being what we expected them to be, thus having to manually change them. Deciding on a definition for a season (date-wise) was not difficult, as we found some answers online, but because of their unique dates (i.e. 3/20/xx, 12/21/xx, etc.) adding a column for Season proved tedious and required a bit of Python and string manipulation in order to correctly attribute the correct season to each data point.

Conclusion

From our hot spot maps and space-time cube analyses, we conclude that the three crimes reoccur in downtown Seattle throughout the year. West, southwest and especially north Seattle, experience shifts. These areas show a change in crime counts and density, or no difference at all. This begs the question, what is the spatial and seasonal variation of crime incidents in Seattle, WA? Our findings revealed patterns of seasonality with slight fluctuations. Summer is a particular season that stands out as values for all crime types are typically high. Additionally, the change in counts and density from spring to summer is evident in the maps above. Based on our statistics, we see that the maps reflect the individual count of crime incidents. One of the interesting years that crime rates decrease is in 2019 and by the beginning of 2020 the crimes count for Destruction/Damage/Vandalism of Property has a downturn. Our findings conclude that Seattle in recent times has decreased in crime rates, perhaps, in large part to the current pandemic. There is the exception to the protests and riots that occurred post winter 2020. Nevertheless, parts of downtown Seattle will remain a breeding ground for crime. Counts and density fluctuate minimally throughout the year. Patterns, however, are evident outside the core of the city, especially in north Seattle. Our research shows that there is a spatial relationship and seasonal variation of crime in the Emerald City.

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