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Abstract

The ability to accurately predict the spatial distribution of crimes, or the probability that a crime will occur in a given location, can result in improved, sustainable crime reduction, and most importantly, increased citizen and officer safety. Over 130,000 crimes were committed in Bloomington, Illinois from December 2002 to December 2012. The location and the severity of these crimes were submitted to spatial statistical software to generate a series of crime distribution maps and to perform spatial Analysis of Variance (ANOVA) tests to determine if the spatial patterns of crimes vary from year to year, between seasons, or with the time of day. The maps clearly show that the locations of crimes do vary, but the spatial ANOVA tests indicate that the variation does not meet the criteria of statistical significance. This information will allow police officers in Bloomington to prepare for and respond to crime more efficiently.

Introduction

Crimes are not uniformly distributed through space or time. Crime rates tend to decrease with seasonal temperature (this directly does not affect domestic crimes). Every year during the winter, crime rates decrease and then gradually start to increase as the weather improves, peaking during the summer months between June and August when kids are off from school and people are outside enjoying the nice weather. The time of day also plays an important role in determining whether or not a crime will occur. It would be unfair to feel much more confident in these odds of taking a vehicle during the day than being hit by the thieves, than during the day time where there are not many places to go unnoticed. Understanding the variation in the spatial and temporal distribution of crimes is critical to assigning police personnel and other resources to crime prevention and punishment.

We hypothesize that the spatial and temporal distribution of crimes in Bloomington, Illinois will vary by year, season, and time of day and that these differences will be readily apparent in density maps and in spatial statistical tests. These maps will reveal that some locations are more likely to be victimized by crime than others and may vary over time. We also are interested in realizing whether or not the statistical tests have been applied to crime data.

Objective

Create a sense of maps showing the spatial distribution of the likelihood of time by year by season, and by time of day for Bloomington Illinois for the last ten years. Use these maps to clearly assess crime patterns through time. The expected outcome is determining if there is a significant difference if the difference in spatial patterns over time are actually significant. To our knowledge, this is the first time these statistical tests have been applied to crime data.

Methods

KDE is similar to creating a density curve of a population based on a histogram of a sample. The Parzen-Rosenblatt kernel density estimation, a two-dimensional geographic space. The result is the estimated number of crime committed per square meter per year. Crime maps were created for each year (2002-2012), by season, and by time of day. Broken into four-hour increments starting at midnight. Statistical Analysis: The mean center of a spatial pattern is similar to the mean of typical data – it is the point defined by the mean longitude and the mean latitude of the observations. The standard distance is the spatial equivalent of the standard deviation – it is the mean squared Euclidean distance of each observation from their mean centers. A circle with a radius equal to the standard distance, centered on the mean center, should encompass 68% of the observations; just as 68% of observations are within a standard deviation of their mean. The equation for the statistic of an ANOVA test and a t-test require the mean and the standard deviation of the samples. However, if the mean center and standard distance are used instead, we hypothesize that the two tests becomes assessments of the spatial centrality of sample point distributions. The null hypothesis states that there is no statistically significant spatial difference between the sample point distributions. This does not mean that the sample observations occur in exactly the same locations, but that they tend to be concentrated in nearly the same locations. The dispersion of crimes in these data does not vary much (they are spread throughout the city in a roughly uniform way), which may keep these tests’ ability to find statistically significant differences. The mean centers of crime are very, but dispersion does not, so the standard distances are fairly consistent. The spatial ANOVAs and t-tests may not find statistically significant differences because the mean centers of all the groups are well within each other’s standard distances.

Results

The results of these maps should be beneficial to the Bloomington Police Department in order to better use their limited resources by being able to properly allocate the number of officers depending on the time of day or the season. The results also can be used for sending police officers near the high school during the times when there are a spike in crimes, and then transitioning those officers to the mall as the day goes on and the focus is transferred to the mall.

Conclusion

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Sources:
