Detecting and preventing emerging epidemics of crime

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Detecting and Preventing Emerging Epidemics of Crime

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OBJECTIVE

We apply recently developed spatial biosurveillance techniques to the law enforcement domain, with the goal of helping local police departments to rapidly detect and respond to (or better yet, to predict and prevent) emerging spatial patterns of crime.

BACKGROUND

Geographic surveillance techniques have become increasingly important in law enforcement and crime prevention. New methods for mapping crime [1] and for automatically detecting crime "hot spots" [2] using electronic case reports have increased situational awareness and enabled more rapid police response to emerging high crime areas. Additionally, recent work in crime forecasting [3-4] has enabled law enforcement officials to predict and prevent rises in crime using a variety of leading indicator data.

However, current crime detection and forecasting methods require a coarse aggregation of cases (e.g. by month, by square mile), due to both computational considerations and the relatively small number of serious crimes. These limitations reduce the spatial and temporal precision with which departments can pinpoint clusters of crime, as well as their ability to rapidly respond to these clusters. Thus we propose the use of expectation-based spatial scan statistic methods [5-6] originally developed for the biosurveillance domain, which can use a finer aggregation of data and can efficiently search for emerging space-time clusters of varying size and duration. We will use these methods both for detection of clusters of violent crime, and for prediction of such clusters by detecting clusters of leading indicator crimes.

METHODS

We collected two datasets of crime offense reports from the Pittsburgh Bureau of Police, one reporting violent crimes (VC) such as murder and armed robbery, and one reporting "leading indicator" (LI) crimes such as simple assault and disorderly conduct. Total crime counts from 1990-1999 were aggregated by week and mapped spatially to a 52 x 64 grid of 1000 x 1000 foot cells. For each dataset, we used the expectation-based Poisson scan statistic [6] to predict the expected crime count of each cell for each week, and to detect space-time clusters (1-4 weeks duration, radius ≤ 20) with higher than expected counts. Statistical significance of each detected cluster was computed by randomization testing, and all significant primary and secondary clusters were reported.

The detected VC clusters were then used as a gold standard, and we examined how many of these clusters could be predicted by the LI data. A VC cluster was counted as "successfully predicted" if one of the 100 highest scoring LI clusters was spatially close (centers within distance 10) and 1-3 weeks prior.

RESULTS

For the 477 weeks of violent crime data from 1991-1999, we found 93 clusters (81 primary + 12 secondary) significant at $\alpha = .01$, within the 15-20% alert rate expected by domain users. Computation time was 8 minutes per week, including 100 randomizations. Of the 93 significant VC clusters, 19 were successfully predicted by the LI data, significantly more than the 10.7 expected by chance ($p < .02$). Of the 60 highest scoring VC clusters, 18 were successfully predicted, nearly triple the 6.7 expected by chance ($p < .003$). Using only 50 LI clusters instead of 100, we were able to predict 12 of 60 VC clusters, as compared to 3.6 expected by chance ($p < .005$).

CONCLUSIONS

Our analysis of the violent crime and leading indicator data demonstrates that expectation-based scan statistics can efficiently and accurately detect significant spatial clusters of crime, at a higher spatial and temporal resolution than previously proposed crime detection techniques. Moreover, we demonstrated that detected clusters of leading indicator crimes can be used to predict significant clusters of violent crime 1-3 weeks in advance, allowing police departments to dynamically allocate patrols to these areas and carry out other interventions to prevent crime.

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