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Chapter X

Application of Tracking Signals to Detect Time Series Pattern Changes in Crime Mapping Systems

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Abstract

Tracking signals are widely used in industry to monitor inventory and sales demand. These signals automatically and quickly detect departures in product demand, such as step jumps and outliers, from "business-as-usual". This chapter explores the application of tracking signals for use in crime mapping to automatically identify areas that are experiencing changes in crime patterns and thus may need police intervention. Detecting such changes through visual examination of time series plots, while effective, creates too large a workload for crime analysts, easily on the order of

1,000 time series per month for medium-sized cities. We demonstrate the so-called smoothed-error-term tracking signal and carry out an exploratory validation on 10 grid cells for Pittsburgh, Pennsylvania. Underlying the tracking signal is an extrapolative forecast that serves as the counterfactual basis of comparison. The approach to validation is based on the assumption that we wish tracking signal behavior to match decisions made by crime analysts on identifying crime pattern changes. We present tracking signals in the context of crime early warning systems that provide wide-area scanning for crime pattern changes and detailed drill-down maps for crime analysis. Based on preliminary results, the tracking signal is a promising tool for crime analysts.

Introduction

Police generally know the current crime patterns in their jurisdictions and accordingly allocate manpower to precincts and shifts, target patrols to hot spots, and take other tactical actions. What is less well known to police is how crime patterns are changing, so that police can reallocate manpower in response to changes. We learned this lesson in the early 1990s when we built a crime mapping system for the Pittsburgh, Pennsylvania, Bureau of Police under a drug market analysis program (DMAP) grant funded by the National Institute of Justice. Many times, our DMAP crime mapping system detected enforcement-induced displacement of street-level drug dealing before narcotics detectives were able to do so. Follow-up surveillance of new drug dealing locations detected by our system always proved the maps to be right.

From this experience, we learned the value of building crime early warning system (CEWS) maps. These maps display crime changes to provide a jurisdiction- wide scan for areas needing changes in tactical deployment of police. Used on an interactive basis in a geographic information system, the maps provide drill down to areas of high change to provide detailed, diagnostic information. We provide example maps in this chapter, but before proceeding to them, it is important to distinguish two types of change: experienced and forecasted change.

Experienced change is the sort mentioned above, which has the objective of quickly detecting any sort of crime innovation (departures from business-as-usual crime patterns), such as crime displacement in response to enforcement. Underlying analytic problems are 1) to provide counterfactual forecasts (business as usual) as the basis of comparison for the most recent historical crime data and 2) to sort out true pattern changes from random variations. More is on these