

CRI-MAP

{CRIME MAPPING): SPATIAL AND TEMPORAL ANALYSIS OF CRIME DATA USING KERNEL DENSITY ESTIMATION}

OBJECTIVES

Visualizing the geographic and temporal distribution of crime incidents helps in developing tools and techniques to capture crime series and forecast future crime occurrences. This project needs enough data and infrastructure for successful implementation and it follows a procedural method of

1. Creating hierarchal system of location data
2. Creating database with all spatial and non-spatial data
3. Creating heat map based on temporal and spatial analysis
4. Visualizing the results
5. Evaluate programs and policies

METHODS

The flow of research methodology is as follows:

- Collection of crime co-ordinates
- Plotting of map
- Spatial and temporal analysis
- Framing policing solution

Heat map can be constructed using kernel density estimate interpolation routine to produce intensity calculations $g(x)$ such that:

$$g(x) = \text{sum of } [W * I] [3 / (\pi * h * h)] [(1 - (d^2 * h^2))]^2 \quad (1)$$

where d represents distance between a crime location and a reference point (center of grid cell), h is the bandwidth (radius). W is a weighting and I an intensity value at the crime event location

REFERENCES

1) Bowers, K.J., Johnson, The future of crime mapping, British journal of criminology. 2) Roth, R.; Ross, K.; Spatio-temporal crime analysis in U.S. Law enforcement agencies: Current practices and unmet needs.

INTRODUCTION

Cri-Map is a project that utilizes GIS for crime mapping and its analysis for effective law enforcement and crime management. Cri-Map aids crime analysis by identifying and highlighting crime prone areas in a region. The analysis uses KDE (Kernel Density Estimation) which is a non-parametric way to estimate the probability density function of a random variable. KDE shows areas of crime hot-spot, areas deficient in security, areas requiring constant police patrol, peak time and days when people face the maximum crime and of what type. The study proves that GIS helps in developing supporting pattern and crime trend analysis enhancing the implementation of various surveillance methodologies to reduce overall crime and disorder.

THEORIES

Following theories help explain point concentration of crime.

- Place theories
- Neighborhood theories
- Repeat victimization theories

"the chance of repeat burglary over a period of one year was four times the rate to be expected if the events were independent" Based on the temporal attributes, time at which the person/object **last seen** and time at which person/object **found missing**, we use the hot-spot matrix classification for aoristic anaylsis.

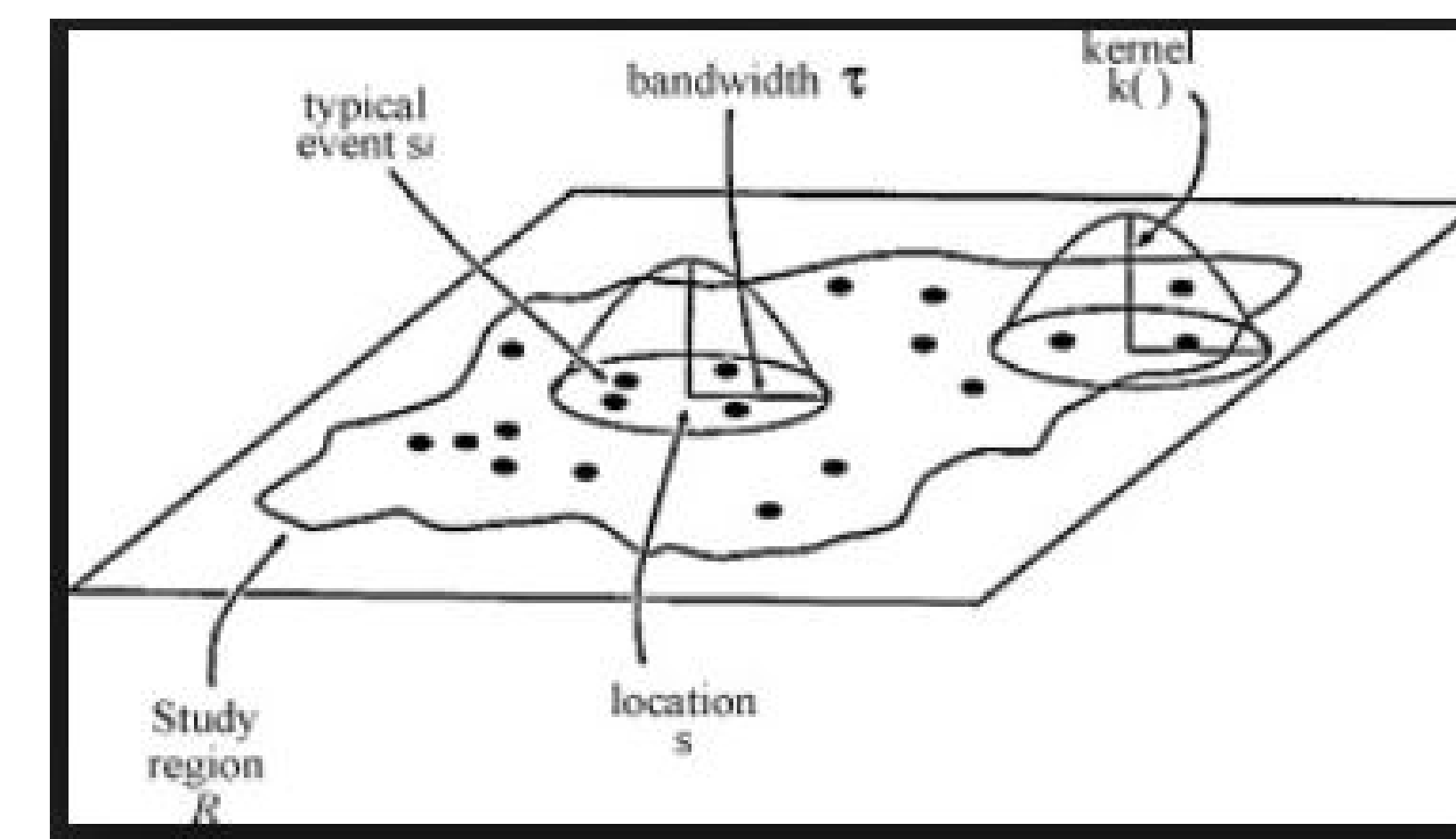
Dispersed	Clustered	Hot-point
Diffused	Focused	Acute

Table 1: Hot-spot matrix

FUTURE RESEARCH

Future research method includes point process model, a method based on the concept of artificial neural networks and methods that combine polygon grid cells and raster-based GIS.

RESULTS



Crime data are mapped by a process called geo-coding. Geo-coding involves interpreting an address location which is usually a caretsian coordinate (x-y). A cluster of co-ordinates constitute a hot-spot. With hot-spots, heat map can be obtained as in Fig 2. Geo-coding hit rate is used to indicate the success rate of coding process. At-least 85 percent of crime events must be geo-coded for subsequent maps to retain overall accuracy.

Figure 1: Kernel density estimation

Kernel density estimation begins with overlaying grid on top of study area and calculating a density estimate based on center points of each grid cell. Distance between the incident and center of grid cell is then weighted based on a specific method of interpolation (eg., kernel function) and bandwidth.

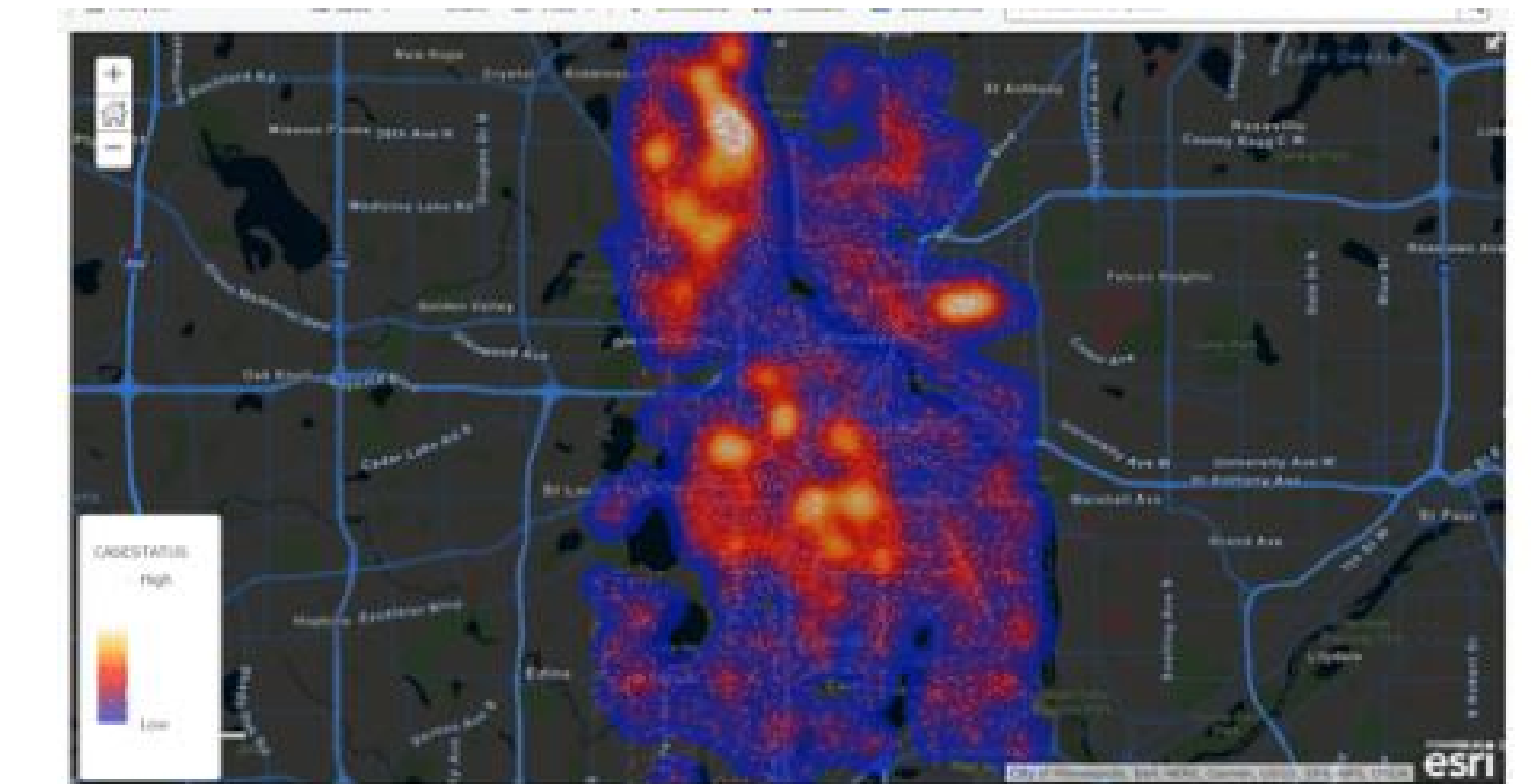
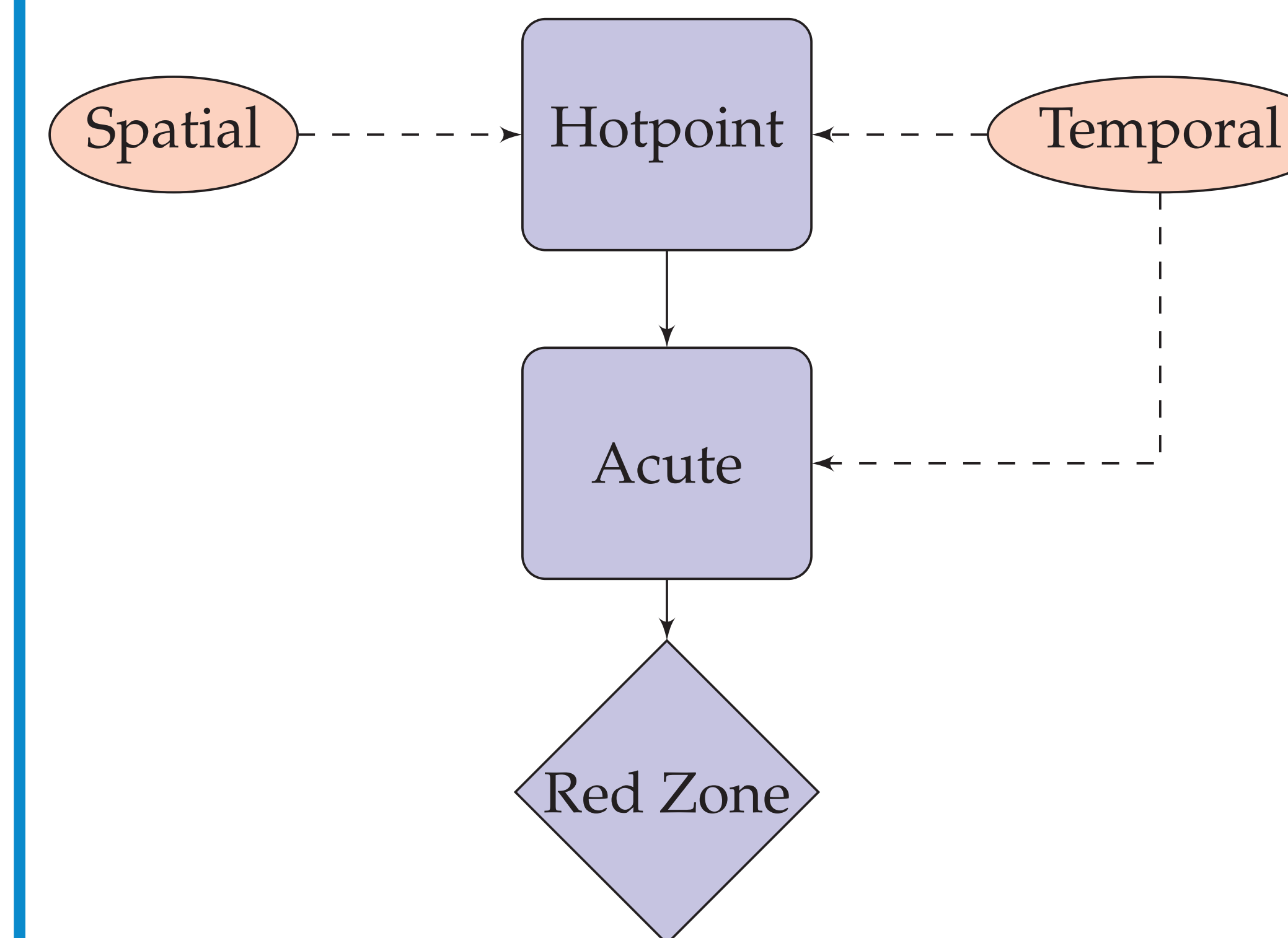


Figure 2: Heat-map

CONCLUSION



- With the advancement of Geographic In-

formation System (GIS) and crime theories, crime hot-spot mapping has drawn increasing attention.

- Crime researchers and practitioners have put a lot of effort in studying how crime hot-spot mapping can be used to assist police and decision makers with allocating their limited resources and manpower to areas where crime events are most likely to occur.
- Since the KDE method also yields a hit rate, this method could thus be identified as the most accurate method at predicting crime.
- One limitation that has to be taken care is the sampling method used to collect crime data

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In grid based modelling, it is easy to represent continuous data such as distance from another cell (eg.,distance from major road) and degree of concentration (eg.,density of crime)