# Chapter 118
# Fractal Estimation Using Extended Triangularisation and Box Counting Algorithm for any Geo-Referenced Point Data in GIS

**R. Sridhar**
*Sri Ramakrishna Mission Vidyalaya College of Arts and Science, India*

**S. Balasubramaniam**
*JSS University, India*

## ABSTRACT

*Fractal dimension is often used as a measure of how fast length, area, or volume increases or decreases with increase or decrease in scale, or as a measure of complexity of a system. In this paper, input depends only on the Geo-referenced point data where the point event has occurred. An Extended Triangularisation Algorithm is developed to cover the area of point data as a polygon and its perimeter is calculated. Box Counting Algorithm is applied on those point data to calculate the Fractal values, which in turn work as an input to Prediction Plot Linear Model, to show that fractal value increases or decreases as perimeter of Polygon increases or decreases. To validate this model, Crime data was used and its results were analyzed. It provides information to police officials about the intensity of crime, area of patrolling and deputation of police in the sensitivity area. This model could be applied for any Geo-referenced point data such as cancer data, hypertension data and so on.*

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## INTRODUCTION

The fractal concept introduced by Mandelbrot provides a framework for the analysis of natural phenomena in the morphological complexity of objects applied in various scientific domains. Fractal is an irregular geometric object with an infinite nesting of structure of different sizes. The most important properties of fractals are self-similarity, chaos and non-integer fractal dimension and are often considered as parameters including the morphological complexity of objects (Mandelbrot, 1983). The fractal dimension analysis has been applied to study a wide range of subjects in recent years (biology, medicine, Geographical Information System).

The fractal dimension analysis method has been successfully used in biology/medicine to diagnose blood cells, human cerebellum, to detect small peripheral lung tumors, tumors in brain and micro-calcification in mammograms (Buczko & Mikolajczak, 2005). The fractal dimension for the dendrites, single and double-layered snowflakes, confirms that the dendrite growth has taken place in the diffusion limited condition (Bharathi, 2010).

Landscape structure or shape is complex and is determined by complex interactions of physical, biological, political, economic, and social factors (Luo, 2006). Mandelbrot's fractal theory, as a research front coupled with concepts of complexity, criticality, and self-organization, has been introduced in order to explore the relationship between landscape changes and factors such as human related disturbances. For example, Krummel, Fox, Yarnasarn, Ekasingh, and Podger (1987) examined the fractal dimension of forest patches using the perimeter area method. They found that smaller forest patches had lower mean fractal dimension than larger patches. They concluded that small forest patches were the result of anthropogenic activities. This kind of decrease in landscape complexity with increasing anthropogenic activity was also reported by O'Neill, Milne, Turner, and Gardner (1988). A research on habitat complexity in the prairie-forest ecotone also indicated that agricultural development would reduce fractal dimension of habitat edges and could have deleterious effects on native plants and animals (Pogue & Schnell, 2001). Benguigui et al. (2000) determined the built-up city area in Tel Aviv using fractal dimension

The fractal dimension measures the complexity with which lakes fill space. The smaller fractal dimension of lakeshore indicates less capacity of the space-filling. Anthropogenic activities, such as filling lake, resulting from complex interactions of economic and social factors, result in the value of fractal dimension changing. It shows that the response of lakeshore shape fractal dimension provides a valuable tool for elucidating the underlying processes (Zeng & Liu, 2008).

Vectorising the fault system in Carboniferous of Junggar Basic in GIS Software and store it as polyline layer in Geodatabase of GIS to manage and analyze, then calculate the fractal dimension of three types which are box dimension, information dimension and cumulative length dimension using spatial functions of GIS, in the last, use weights-of-evidence model to calculate the correlation coefficients in GIS environment between oil-gas accumulation and three types of fractal dimension in order to quantify the importance of fault system (Li, Zhang, Ding, Wang, & Xiang, 2010).

Lin, Lam, and Siu (2008) presented a fast approach based on valley field detection and fractal dimensions *(FD)* to extract eye pairs in a complex background image, which can then be used to represent a face region.

Although fractal dimensions are widely used in spatial and landscape pattern analysis and the related literature are found to be enormous (Rex et al., 1990; Thomas, Pierre, & Christophe, 2008; Thielen, San José, Montes, & Lairet, 2008), limited research was available regarding period based crime data. A method called R/S technique, based upon chaos theory, is used in an attempt to provide a different insight into the phenomenon of temporal crime data. This analysis uses an il-