Introduction
on
SPATIAL INFORMATION RETRIEVAL, ANALYSIS, REASONING AND MODELLING

Data related to various natural, anthropogenic and socio-economic phenomena are now available in numerous formats, most significant of which is spatial data that facilitate visualization at spatio-temporal intervals. Availability of such data from a wide range of sources in a variety of formats poses challenges to the Geographic Information Science (GISci) community. The utility and application of such data could be substantially enhanced through developments in technologies related to:

> **Retrieval**: Retrieval of noise-free information in the forms of themes (layers) from data requires robust image processing, spatial information theory techniques etc.
>
> **Analysis**: Once theme-specific layered information is retrieved, techniques are required to analyse themes.
>
> **Reasoning**: Theme specific layered information need to be integrated via spatial relationships and reasoning. Certain map algebraic concepts are of use.
>
> **Modelling**: Spatio-temporal behaviour of a phenomenon needs to be visualized

Much success has been achieved in the proper usage of data by addressing the above four aspects by individual groups. It is now at understandable level and there are overlaps between the concepts that emerged from different fields to deal with the above four aspects. In light of these overlaps, there exist demands to choose appropriate mathematical techniques that can offer robust solutions. As it stands, there are various techniques (e.g. mathematical morphology, fuzzy set theory, fractal geometry, rough set theory, granular computing, map algebra etc.) to address the challenges.

To **retrieve** noise-free phenomena to represent them in layered forms, which are basic inputs in GIS and to develop application specific information systems – these challenges are still unresolved. Subsequent to this, **analyses** of layered information to overcome constraints posed by restrictions due to spatio-temporal resolution must be done. Establishing spatial relationships across mapped layered information via spatial **reasoning** is still at the research level. Once, the robust strategies to retrieve, analyse, reason the information at multiscale and multitemporal modes are available, **modelling** the spatio-temporal behaviour of a phenomenon would be rather straightforward. It is realized that the better thematic retrieval procedures, and further analysis and reasoning would pave a way to better deal with the noise-free spatial maps in the context of modelling via GISci.

Spatial information theory provides theoretical basis in general to GISci (Samet 1990, Frank 1992, Frank and Egenhofer 1992, Goodchild 1997, Worboys and Duckam 2004). To achieve a significant success, it is opined that certain concepts from spatial statistics (Matheron 1975, Cressie, 1991) such as mathematical morphology (Matheron 1975, Serra 1982), fuzzy geometry (Zadeh, 1965), fractal geometry (Mandelbrot 1982), rough set theory (Pawlak 1982), and granular computing provide insights. Advanced concepts with more geometrical rigor that revolutionized the subject of spatial data analysis, for example, include mathematical morphology (Serra 1982), and fuzzy set theory (Zadeh 1965). The representative works with significant relevance to spatial information science appeared during the recent past include applications of these advanced concepts either individually or combinedly (i) on retrieval (e.g. Maragos and Schafer 1986, Pal and Rosenfeld 1991, Beucher and Meyer 1992), and (ii) on analysis and characterization of certain features (e.g. Maragos 1989, Rosenfeld and Pal 1988, Pal and Ghosh 1992). Many operations that fall under the name 'Map Algebra' (Tomlin 1983) involved in GISci-related analysis can be performed via mathematical morphology and fuzzy set theory (e.g. Pullar 2001, Stell 2007).

The motivation—to organise this seminar on *Spatial Information Retrieval, Analysis, Reasoning and Modelling*—stems from the following observation. For groups, which are familiar with both spatial information theory and theories involved in digital image processing and analysis, most of these ideas are quite familiar. But, surprisingly there has been little interaction between the groups respectively familiar with image processing and spatial information theory. This seminar is intended to serve as a forum for bringing together specialists in those two groups and facilitate interaction**.**

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