Applied Spatiotemporal Data Mining

Course description

With the continuing advances of geographic information science and geospatial technologies, spatially referenced information have been easily and increasingly available in the past decades and becoming important information sources in scientific research and decision making processes. To effectively take advantage of the rich collection of spatial (and temporal) data, statistical analysis is often necessary, e.g., to extract implicit knowledge such as spatial relations and patterns that are not explicit in the data. Spatial data analysis distinguishes itself from classical data analysis in that spatial analysis focuses on locations, areas, distances, relationships and interactions of measurements that are usually referenced as points, lines, and areal units in geographical spaces. In the past decades, a plethora of theory, methods and tools of spatial analysis have been developed from different perspectives, and converged as fruitful fields of geographic information science (GIScience) and spatial statistics.

The purpose of this class is to present the commonly used methods and current trends in spatial and spatiotemporal data analysis, and innovative applications in relevant fields (e.g., environmental science and engineering, natural resources management, ecology, public health, climate sciences, civil engineering, and social sciences). In this class, we will review the basic principles in spatiotemporal analysis and modeling, and discuss commonly used methods and tools. Students are expected to actively participate in class lecture, complete lab assignments, read assigned articles and develop a project of their own choice or directly related to their thesis/dissertation topics. The following topics will be covered in the class, but can be adjustable to meet the students' interests:

- Exploratory spatial data analysis
- Space-time geostatistics
- Spatial point process and species distribution modeling
- Spatiotemporal disease mapping
- Time series map analysis and change detection

Prerequisites

Prerequisites of this course includes an understanding of basic concepts of spatial analysis and statistics, which could be fulfilled with basic statistics courses or graduate level of GIS course. Students from different disciplines are welcome, please contact the instructor should there any question about the prerequisites.

Learning outcomes

After completing this course, the students of this class are expected to be able to:

- formulate real-world problems in the context of spatial and spatiotemporal analysis with a knowledge of basic concepts and principles in this field;
- understand commonly used concepts and methods in statistical analysis of spatiotemporal data;
- apply appropriate spatial and spatiotemporal analytical methods to solve the formulated problems, and be able to critically review alternative methods;
- utilize programmable scientific computing tools (e.g., R) to make maps, solve spatial and spatiotemporal analysis problems, and evaluate and assess the results of alternative methods;

Readings

- A reading list of articles will be provided. The following books will be frequently referred to for reading:
  - Bivand Roger S., Pebesma, Edzer J., and Gómez-Rubio, Virgilio (2008), *Applied Spatial Data Analysis with R*, Springer (eBook available at TTU library).
  - Cressie, N., & Wikle, C. K. (2011). *Statistics for Spatio-temporal Data.* John Wiley & Sons.

Sample course outline

Day	Sample topics	Readings	Hours
1	Class overview and introduction	Handouts	3
2	Point pattern analysis	Ch.7 BPG	3
3	Species distribution modeling	Handouts	3
4	Space-time geostatistics	Ch.8 BPG	3
5	Spatiotemporal regression	Ch.9,10 BPG	3
6	Time series map analysis	Handouts	3
7	Discussion and student presentation		5

Background of Instructor

Dr. Guofeng Cao is an Assistant Professor in the Department of Geosciences at Texas Tech University. His research interests include geographic information science and systems (GIS), cyberGIS and spatiotemporal statistics, with a primary focus on statistical learning of complex spatial and spatiotemporal patterns across different domains. His research has been supported by different funding agency. He has published 45 peer-reviewed papers including 30 journal articles. He received a B.S. in Earth Science from Zhejiang University, an M.S. in GIS from Chinese Academy of Science, and a M.A. in Statistics and a Ph.D. in Geography from the University of California, Santa Barbara. He also had several years of industrial experiences before moving back to academia.