Asian Institute of Technology
School of Engineering and Technology

AT76.19 ***Advance Spatial Analysis Methods 3*** **(2 - 3)** **Semester: January**

Course Objective: This course aims at providing advance knowledge in discrete and continuous spatial data understanding and analysis. Students will also be exposed to advance modeling techniques, exploratory spatial data analysis, interpolation techniques, terrain modeling, and geostatistical analysis.

Learning Outcomes:

The students on the completion of this course would be able to:

1. Analyze the discrete and continuous databases
2. Identify and communicate the mathematical, statistical, logical and cartographic modeling methods
3. Rank and compute weights for decision making for planning and site suitability
4. Analyze patterns, trends and hotspots, and find spatial auto-correlations in different multi-criteria phenomenon.
5. Use the concept of geospatial analysis and modeling tools in GIS software such as ArcGIS, Quantum GIS
6. Develop applications in various areas for Urban planning and management, Disaster Risk Management, Agriculture, Health

Pre-requisite: AT76.01 Geographic Information Systems

Course Outline:

I. Advance Spatial Analysis Methods for Decision Support
   1. Introduction
   2. Importance of Spatial Data Characterisation
   3. Importance of Advance Spatial Data Analysis for Decision Support

II. The Analysis of Discrete Entities in Space
   1. Operations on Attributes of Geographic Objects
   2. Attribute Descriptors
   3. Point Descriptors: Central Tendency, Dispersion and Distribution
   4. Operations on Attributes of Multiple Overlapping Entities in Space
   5. Cartographic Operations
   6. Pattern Detectors: Nearest Neighbor Analysis, Application
   7. Characteristics of Linear Features: Directional Statistics and Network Analysis

III. The Spatial Analysis using Continuous Fields
   1. Map Algebra and Cartographic Modeling

2. Point Operations
3. Spatial Analysis Using Convolution
4. Deriving Surface Topology and Drainage Networks
5. Spatial Regression Analysis and Modelling

IV. Analytical Hierarchical Processing (AHP)
1. Introduction to AHP
2. Ranking matrix, Random Index and Evaluation of consistency ratio
3. Multi-Criteria decision making
4. Application of AHP for land suitability

V. Information Value Approach (IV)
1. Introduction
2. Bayesian Algorithm for Information Value Index
3. Application of IV for Dengue Incidence Analysis

VI. The Spatial Pattern Descriptors
1. Spatial Relationship
2. Spatial Autocorrelation
3. Scatter Plots: Moran-I
4. Spatial Indices

VII. ArcGIS Structure and Geostatistical analysis
1. Variogram analysis
2. Histogram analysis
3. Modeling of spatial trends
4. Semivariogram creation, linking, selection
5. Advance tools for spatial analysis

VIII. Spatial Analyst – Interpolation Techniques
1. Interpolation techniques
2. Implementation and comparison
3. Spatial interpolation comparison

IX. 3D- GIS
1. Topographic Descriptors
2. TIN Modeling
3. Creating 3 D building model and embedding in online databases

Laboratory session(s):

1. Overview of Arc GIS advance tools
2. Customization and automation in ArcGIS using model builder
3. Interpolation techniques and terrain modeling
4. Exploratory spatial data analysis (ESDA) and Geostatistical analysis using spatial analyst

5. Publishing geospatial information on Internet
6. Pattern Analysis – Moran's I (hotspot mapping)
7. Agricultural land suitability using Analytical Hierarchical Processing (AHP)
8. Open Source Software – Quantum GIS
9. 3D GIS
10. Miniproject planning and proposal development

Learning Resources:

Textbook(s):

P.A. Longley and Michael Batty:
Advanced Spatial Analysis, ESRI Press, Redlands, California, 2003

Reference Books:

D. O'Sulllivan and D. J. Unwin:
Geographic Information Analysis. John Wiley and Sons, Inc., New York, 2003.

Shashi Shekar and Hui Xiong (Eds.):
Encyclopedia of GIS, Springer, Verlag, 2007.

Roger Tomilson:
Thinking about GIS, ESRI Press. Redlands, California, 2007.

Journals and Magazines:

International Journal of GIS, Taylor & Francis
International Journal of Geoinformatics, Association of Geoinformation Technology
International Journal of Health Geography, BMC, Springer Nature

Others:

Lecture Notes and other ancillary learning resource books

Teaching and Learning Methods: This course is blend of learning concepts and hands on exercises for developing the skills to apply various software related to GIS and also implement advance modeling through programming in GIS. Each class will comprise of conceptual and knowledge development lectures and discussions which will be followed by hands on exercises and assignments.

1. **Laboratory Sessions:** Laboratory exercises will expose students to different advance tools in GIS, other modeling software and analysis techniques. Students have to submit all assignments individually. There will be a lab test to evaluate their skill on GIS tools.

2. **Discussion Sessions:** Every class will have discussion sessions to engage all the students.

Time Distribution and Study Load:

Lecture: 30 Hrs
Laboratory: 45 Hrs
Laboratory Assignments and Term Paper40 Hrs
Self-studies: 80 Hrs

Evaluation Scheme:

The final grade will be based on the following weight distribution: Laboratory assignments (20%), midsem exam (20%), final exam (45%) and term paper (15%). Closed book examinations are used for both midsem and final exams.

An "A" would be awarded if a student can show the ability of having extensive knowledge on in all learning outcomes and ability to display excellent performance in practical exercises and term paper. A "B" would be awarded if a student shows an overall understanding of the topics covered, a "C" would be given if a student meets below expectation on both knowledge acquired and analysis. A "D" would be given if a student does not meet basic expectations of the topics presented in the course.

Instructor: Prof. Nitin K. Tripathi