

E-TUTOR FOR LEARNING GIS

P.Venkatachalam, B.Krishna Mohan, M.Pandya, D.Choksi and J.K.Suri

Centre of Studies in Resources Engineering
Indian Institute of Technology, Powai, Bombay- 400076, INDIA
Tel (91-22-25767665) Fax. (91-22-25723190)
Email : pvenk@iitb.ac.in

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ABSTRACT:

Economic development of a country depends on a well formulated and effective strategic planning. Most of the data used for resources planning and management are spatial in nature. Geographic Information System (GIS) today is one of the major decision making tools in the areas of resources planning and management. One of the spin-offs of space research is Remote Sensing Technology. Remote Sensing is always viewed as an integrated field with GIS technology. Integration of Remote Sensing with GIS can play a pivotal role in strategic efficient planning, resources monitoring, allocation and management, environmental impact assessment studies etc. Understanding the capabilities of GIS technology, many planners and administrators are coming forward to adopt this technology in their planning processes. The problem in adopting this technology is not the cost of hardware or the availability of GIS software but the acute shortage of trained manpower to handle the technology. Steps have been taken by universities throughout the world to introduce GIS and Remote Sensing technology at undergraduate and graduate level degree programmes. Research organizations and commercial companies conduct a number of tailor made training courses in these areas. Developments in Internet technology have made the GIS capabilities accessible to wider audience globally. In addition to the conventional class room based education and training, there is a good demand for the demonstration kits and self-learning tutors. These tools can provide an effective way for putting across the spatial concepts, intrinsic analytical capabilities and a range of applications. Several technical books and self learning demonstration kits built around commercial packages are available to strengthen GIS education. This paper discusses the details of an E-Tutor for learning GIS developed at the Centre of Studies in Resources Engineering, Indian Institute of Technology, Bombay, India. It is built using Macromedia Director MX. The topics on GIS are hierarchically grouped into main sections and subsections. Text materials are supported with illustrations and examples to improve the presentation and understanding. Uniqueness of this tutor is that it gives interactive exercises to provide hands-on training on various functions of GIS.

1. INTRODUCTION

One of the spin-offs of space research is Remote Sensing Technology. Remote Sensing is always viewed as an integrated field with GIS technology. Integration of Remote Sensing with GIS can play a pivotal role in strategic efficient planning, resources monitoring, allocation and management, environmental impact assessment studies etc. Understanding the capabilities of GIS technology, many planners and administrators are coming forward to adopt this technology in their planning process. The problem in adopting this technology is not the cost of hardware or the availability of GIS software but the acute shortage of trained manpower to handle the technology. Steps have been taken by universities throughout the world to introduce GIS and Remote Sensing technology at undergraduate and graduate level degree programmes. Although public investment in GIS research such as Regional Remote Sensing Laboratories in the (U.K.) and the National Center for Geographic Information and Analysis (NCGIA) in the (USA) has added to the pool of skills, there is still a considerable unmet demand for GIS education (Raper and Green, 1992). The efforts of NCGIA are worth noting, as it is one of the few organizations that has attempted to establish and promote GIS education with core curriculum materials. Additionally, NCGIA is facilitating the development of the Secondary Education Project, a curriculum designed to develop and pool instructional materials and disseminate them through teacher workshops. Similar efforts have been undertaken by the University Consortium for Geographic Information Science to create a

standardized GIS curriculum (Baker, 2001). Several technical books and self learning demonstration kits built around commercial packages are available to strengthen GIS education. This paper discusses about an attempt made by CSRE, IIT, Bombay to build an E Tutor for learning GIS.

2. REVIEW OF GIS TUTORS

A number of GIS tutors working standalone or built around commercial GIS packages are available internationally. One of the early GIS tutors was ARCDemo developed at Birkbeck College, London, U.K. (Green, 1987). This demonstrator worked around Arc/Info GIS package and illustrated the capabilities of map editing, projection changes, map overlay, buffering and network analysis. Map Analysis Package MAP (Tomlin, 1983) was one of the earliest simple GIS tools demonstrating the raster based techniques in GIS. Many enhanced versions of MAP were released subsequently. IDRISI (Eastman and Warren, 1987) developed at Clark University, USA provided simple techniques to handle raster maps along with tutorials. IDRISI became one of the best training tools internationally for raster based GIS with recent upgrades to Windows platform. With the availability of PC based GIS packages in the Nineties, vendors started releasing self-learning demonstrators around commercial GIS products.

The first comprehensive computer aided learning tool for GIS was created in the Department of Geography, Birkbeck College, London, U.K. (Raper and Green, 1989) and was

named GISTutor. This tutor ran standalone on a PC without the need for a full fledged GIS package, presented an overview of GIS functions, provided illustrations through animations and had a flexible structure for all types of users. Detailed descriptions of GISTutor version I and II are given in (Raper and Green, 1992). GISTutor II is a hypertext based system allowing a user to explore a series of linked screens of information covering the basic and advanced topics. A review of GISTutor II has been given in (Stuart, 1995). Geocube 1.5 is one of the well-developed GIS tutors in France by Michel Bernard at SIAGE SABM, and Frame and Phillippe Miellel at Ted-Aliter in 1996. It provides an interactive introduction to GIS and gives a clear understanding of GIS technology. GeoCube is an application developed with Tool book version 3.0 hypermedia authoring system. (Tool Book is a product of Asymetrics Corporation and a run time version of Tool book is provided along with GeoCube.) GeoCube runs on MS DOS and Windows. The topics are categorised under Geographic Information, GIS functionality, GIS Implementation and GIS Technology. GeoCube is very well organized with graphical illustrations, icons and help functions. Clicking on a cube and moving it along the panel to a desired level can control the speed of the illustrations and animations. Some of the texts contain hyperwords, which are highlighted. By clicking on them one can get detailed information on these words. The hypertext approach used in GeoCube provides a framework in which a range of tools can be used to create dynamic teaching material to educate users about GIS. Geocal is a Windows based GIS tutor developed by Roy Alexander and group at CIT, Centre for Geography, Geology and Meteorology, Dept. of Geography at the University of Leicester, U.K. It is a good tutor for the beginners in the field of GIS. The tutor comprises four units - Introduction to GIS, GIS for utilities, GIS for business and GIS in agriculture. The number of illustrations and examples are very few but self-explanatory with hypertext links for detailed information. After every unit/subunit a simple quiz is provided on important aspects of the topic. Introduction to GIS is given in detail but the other three application units do not provide complete understanding of GIS capabilities. Keeping into view the need for GIS training in India and the availability of indigenous GIS tool GRAM++, an attempt was made to build a GIS training tool around GRAM++ (Venkatachalam et al., 2001). UNIGIS international Organization is offering distance learning courses in GIS since 1980. UNIGIS is a network of universities cooperating in the design and delivery of courses in GIS and has sites in fourteen countries. UNIGIS offers post graduate certificate, diploma and master's courses in GIS (unigis.org).

3. DEVELOPMENT OF E TUTOR FOR GIS

The E Tutor has been designed taking into view the requirement of wide range of users. The system has been made fully interactive and the users can proceed step by step. GIS theory is explained through a series of technical topics. Under each technical topic, text materials are explained supported by graphical illustrations and hands on exercises. Context sensitive help has been provided on technical words for understanding further details. A few GIS applications are given as show cases explaining the data used, methodology and the results. In addition to spatial theory, a few GIS functions such as network analysis, data base query etc. are explained through graphical animations. A bibliography covering GIS related literature and GIS glossary are also provided. Macromedia Director MX has been used in the development of the training tool as it supports hyperlinks

between topics, display of graphical images and text with animations. The spatial data theory is categorized under 21 broad sections and each section has a series of subsections. At every level graphical illustrations and examples are given to enhance the presentation and understanding. The technical layout and the hierarchical structure adopted in the GIS training tool is presented below.

I. Introduction

- Overview and definition
- Contributing disciplines
- Components of GIS
- GIS and other information systems
- Applications

II. History of GIS

- Stages of evolution
- Motivation for GIS development
- North American contribution
- British experience
- Academic and research sectors
- Commercial sector

III. Concept of GIS Data

- Definition of space
- Representing reality
- Modes of spatial data
- Components of spatial data
- Scales of measurement
- Spatial objects
- Nonspatial attributes
- Spatial dimension
- Spatial relations
- Georelational data model
- Object relational data model

IV. Spatial Data Sources

- Primary data collection
- Sampling methods
- Secondary data sources

V. Map Projections

- Geographical coordinate system
- Datum
- Scale
- Conical projection
- Cylindrical projection
- Azimuthal projection

VI. Spatial Data Modelling

- Data Model definition
- Raster data model
- Raster data encoding
- Vector data model
- Vector data structure and topology

VII. Spatial Data Input and Editing

- Scanning and digitization
- Spatial data editing
- Error Removal and topology creation
- Rasterization
- Data base creation

- VIII Geometric Transformation**
- IX Attribute Data Management**
 - Database models
 - Relational database management system
 - Normalization
- X Spatial Data Analysis**
 - Attribute query
 - Vector analysis
 - Vector operations of two layers
 - Vector operations of single layer
 - Raster analysis
 - Display operations
 - Local neighbourhood operations
 - Extended neighbourhood operations
 - Zonal operations

- XI Spatial Data Interpolation**
 - Global interpolation methods
 - Local interpolation methods
- XII Digital Terrain Mapping**
 - Digital elevation model
 - TIN model
 - Terrain mapping methods
 - Slope and aspect

- XIII Watershed Delineation**
 - Preprocessing DEM
 - Flow Direction and Flow Accumulation
 - Derivation of drainage
 - Watershed delineation

- XIV Network Analysis**
 - Short path analysis
 - Service area mapping
 - Location allocation analysis

- XV Spatial Statistics**
 - Descriptive statistics
 - Point based statistical measures
 - Area based statistical measures
 - Spatial patterns
 - Gravity model

- XVI Remote Sensing**
 - Principles
 - Data sources
 - Preprocessing
 - Enhancement
 - Classification
 - Integration of remote sensing with GIS

- XVII Spatial Data Visualization**
 - Output devices
 - Use of colour schemes
 - Types of maps
 - Map layout

- Tables and charts

- XVIII GPS**
 - GPS data generation
 - Types of GPS
 - Applications

- XIX Spatial Decision Support System**
 - Definition and Concept
 - Application

- XX Spatial Data Accuracy**
 - Sources of errors
 - Accuracy estimation
 - Meta database

XXI Applications

The technical sections are explained briefly with examples and assisted with graphical illustrations. (Figures 1, 2, 3, 4, 5 and 6)

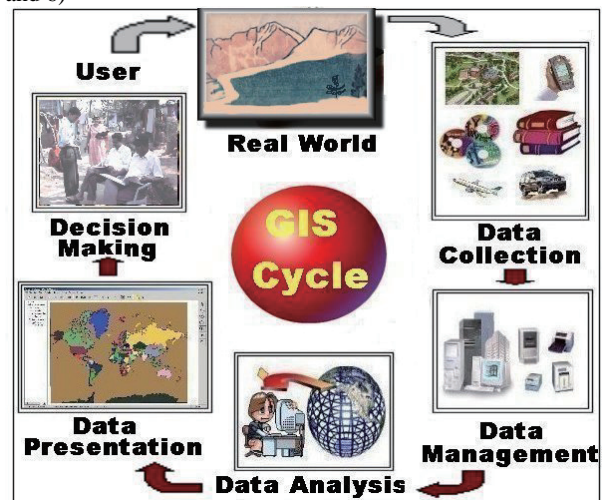


Figure 1 – Components of GIS

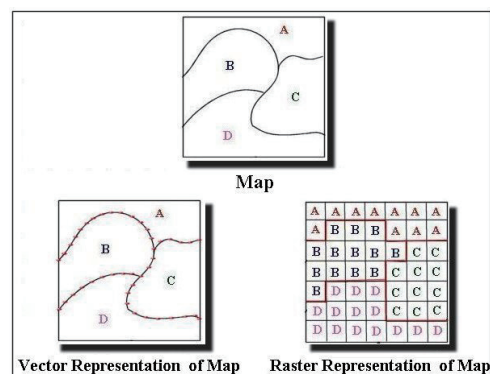


Figure 2 – Vector and Raster Representation

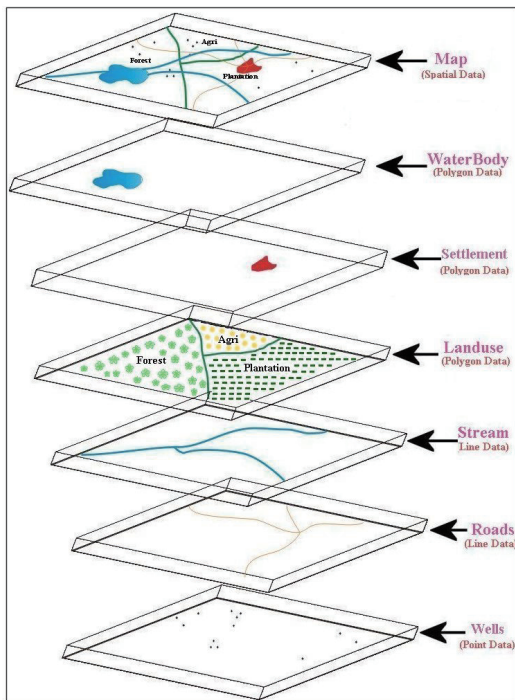


Figure 3 - GIS Layers

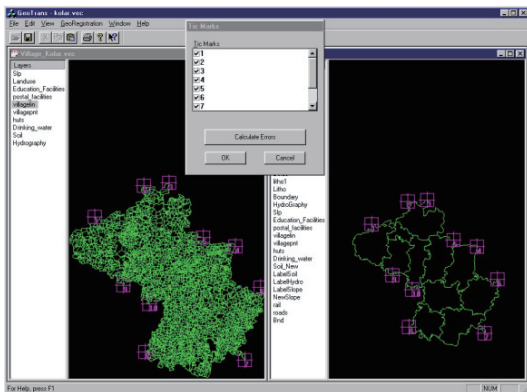


Figure 4 – Geo-registration of maps

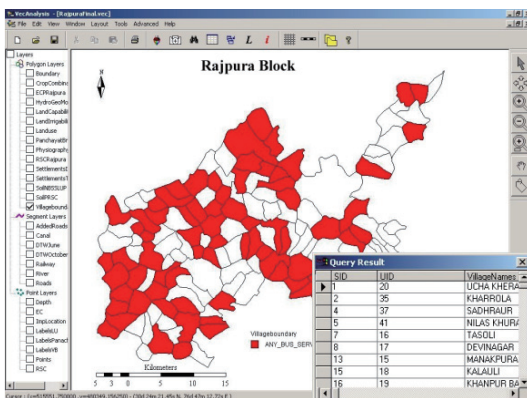


Figure 5 – Example of attribute query

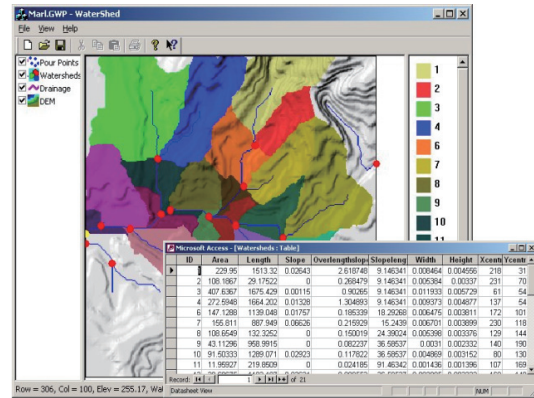


Figure 6 – Example of watershed delineation

Some of the functionality are also explained through animations. Hands-on exercises with test data sets are provided to the users to enhance their understanding on GIS functionality. Following the technical sections, case studies on waters resources management, rural land management and spatio-temporal analysis are given as show cases. The training tool also covers a list of GIS journals, books, magazines, internet resources on GIS and a glossary on GIS terminology.

4. CONCLUSION

GIS applications are growing rapidly. With the availability of high resolution remote sensing data, desk top GIS and Internet based GIS, awareness is increasing among the user community on the capabilities of GIS technology. The development of an E Tutor for learning GIS provides exposure to the technology minimizing the initial learning curve. This Tutor can become a powerful motivator for understanding and using GIS technology in varied applications.

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