

# Introduction to Geographic Information Systems

Geography 176A  
Fall 2013

## The sequence

- **Geog 176A** - Introduction to Geographic Information Systems, 4.0, Clarke
- Introduction to modern spatial data processing, development, implementation, and functions of geographic information systems; relations between GIS and remote sensing; and applications of geographic information systems to a variety of environmental issues.
- **Geog 176B** - Technical Issues in Geographic Information Systems, 4.0, Kuhn/Janowitz/Clarke
- Study of the technical issues underlying Geographic Information Systems, including coordinate systems and analytic geometry, database models and structures, algorithms and analytical procedures. Laboratory analysis of digital geographic information from physical and social sources, emphasizing the use of standard geographic information system software to illustrate techniques of spatial analysis, map digitizing, digital map display and decision support.
- **Geog 176C** - GIS Design and Applications, 5.0, Kuhn/Janowitz/Clarke
- Applying GIS theory and techniques to solve spatial problems in land and resource management, utilities and municipal government. Lectures will cover all stages of a GIS project, e.g. planning, design, and analysis, and presentation of results. In labs, students collaborate in groups to design, develop and present a GIS pilot study.

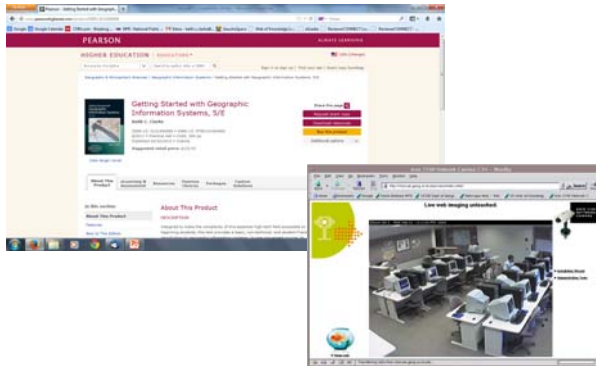
## What will I learn in 176A lectures?

- An overview of GIS
- How GIS data are captured, stored, retrieved, analyzed & displayed
- Where to go for information (self-help)
- GIS software and how it works
- Where GIS is going
- How to use a basic GIS
- GIS problem solving

## Learning by Listening



## Self Learning



## Learning by Doing



## Lecture 1: What is a GIS?

- Getting Started
- Some Definitions of GIS
- A Brief History of GIS
- Sources of Information on GIS

## Lecture 1: What is a GIS?

*GISs are simultaneously the telescope, the microscope, the computer, and the Xerox machine of regional analysis and synthesis of spatial data. (Ron Abler, 1988)*



### Geographic primitive

$$G = f(x, y, z, t, F)$$



### Objects and symbols



YZ



### Objects and instances

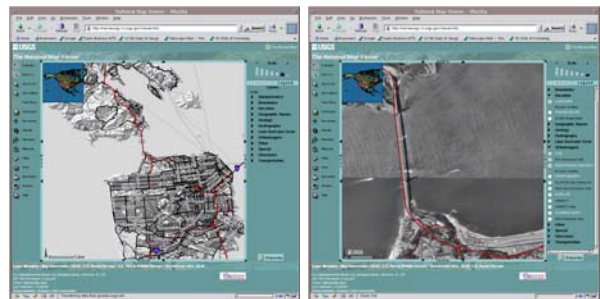
**ROADS AND RELATED FEATURES**

Roads on Provisional edition maps are not classified as primary, secondary, or light duty. They are all symbolized as light duty roads.

Primary highway	
Secondary highway	
Light duty road	
Unimproved road	
Trail	
Dual highway	
Dual highway with median strip	
Road under construction	
Underpass, overpass	
Bridge	
Drawbridge	
Tunnel	



### Symbols and images



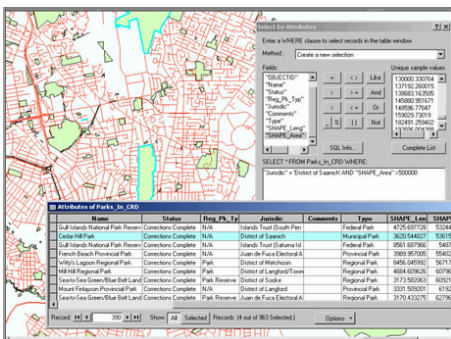
## Where did GIS come from?

- Background in geography, cartography, computer science and mathematics
- Fusion of information systems and imaging/positioning technologies
- Geographic Information Science is a new interdisciplinary field built out of the use and theory of GIS

## Defining GIS

- Different definitions of a GIS have evolved in different areas and disciplines
- All GIS definitions recognize that spatial data are unique because they are linked to maps (Space matters!)
- A GIS at least consists of a database, map information, and a computer-based link between them

## Maps and information



## Spatial and non-spatial data

Part Number	Quantity	Description
1034161	5	Wheel spoke
1051671	1	Ball bearing
1047623	6	Wheel rim
1021413	2	Tire
1011210	3	Handlebars

Crimes during 2003		
Date	Location	Type
22-Jan	123 James St.	Robbery
24-Jan	22 Smith St.	Burglary
10-Feb	9 Elm St. #4A	Assault
13-Feb	12 Fifth Avenue	Breaking and Entering
14-Feb	17 Del Playa	Drunk and Disorderly

### Definition 1: A GIS is a toolbox

*"a powerful set of tools for storing and retrieving at will, transforming and displaying spatial data from the real world for a particular set of purposes"*

(Burrough, 1986, p. 6).

*"automated systems for the capture, storage, retrieval, analysis, and display of spatial data."* (Clarke, 1995, p. 13).

### GIS as toolbox

- General vs. Specialized
- Cutting vs. Joining
- Complex and simple
- Cheap and expensive



### Definition 2:

### A GIS is an information system

*"An information system that is designed to work with data referenced by spatial or geographic coordinates. In other words, a GIS is both a database system with specific capabilities for spatially-referenced data, as well as a set of operations for working with the data"* (Star and Estes, 1990, p. 2).

### GIS as information system



Storage

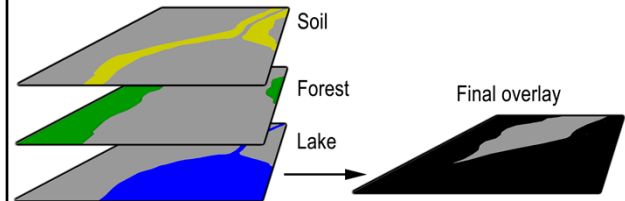


Query

## Map storage: Layers and themes



## Map Overlay



Dueker's 1979 definition (p. 20) has survived the test of time.

*"A geographic information system is a special case of information systems where the database consists of observations on spatially distributed features, activities or events, which are definable in space as points, lines, or areas. A geographic information system manipulates data about these points, lines, and areas to retrieve data for ad hoc queries and analyses"* (Dueker, 1979, p 106).

## The Feature Model

- Dueker's definition uses the *feature model* of geographic space
- The standard feature model divides a mapped landscape up into features, that can be points, lines, or areas
- Note that maps also include text (and volumes)
- Using a GIS involves capturing the spatial distribution of features by measurement of the world or of maps
- Almost all human activity and natural phenomena are spatially distributed, so can be studied using a GIS
- A GIS uses map features to manage data

## The Feature Model

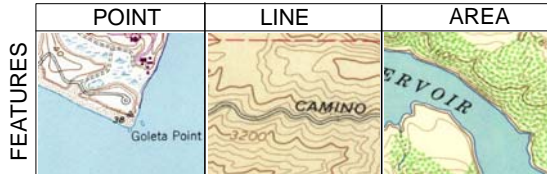


Figure 1.2 The Feature Model: Examples of a point feature (38 foot elevation bench mark), a line feature (road, contours) and area features (reservoir, vegetation).

## Dueker (ctd)

- A GIS is flexible enough to be used for ad hoc query and analysis (in space, about place)
- A GIS can do analysis, modeling and prediction

### Definition 3: GIS is an approach to science

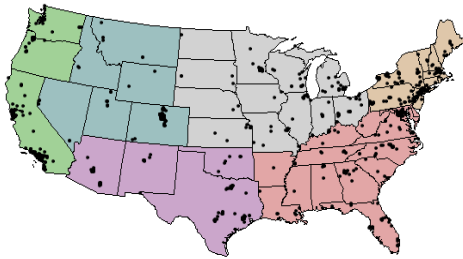
- Geographic Information Science is research both *on* and *with* GIS.
- "the generic issues that surround the use of GIS technology, impede its successful implementation, or emerge from an understanding of its potential capabilities."*  
(Goodchild, 1992)

### Definition 4: GIS is a multi-billion dollar business.

*"The growth of GIS has been a marketing phenomenon of amazing breadth and depth and will remain so for many years to come. Clearly, GIS will integrate its way into our everyday life to such an extent that it will soon be impossible to imagine how we functioned before"*



### GIS as an industry



Source: <http://www.spatial.maine.edu/ugis/testproc/hartung/hartung.html>

### Definition 5: GIS plays a role in society

*Nick Chrisman (1999) has defined GIS as “organized activity by which people measure and represent geographic phenomena, and then transform these representations into other forms while interacting with social structures.”*

### Chrisman’s View

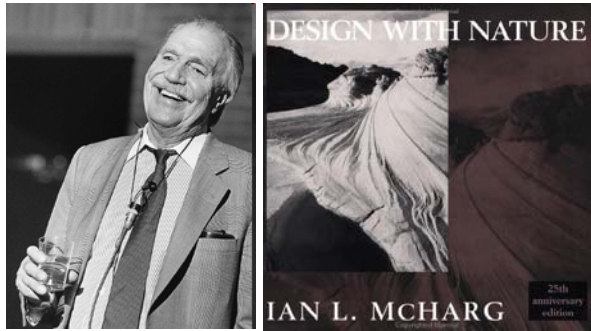


### A Brief History of GIS

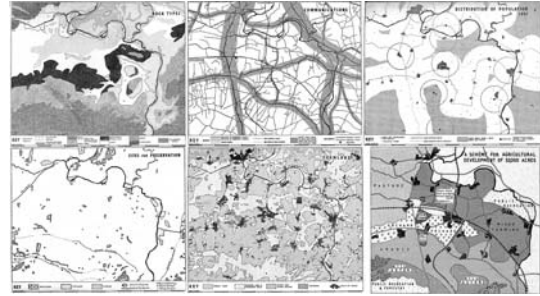
- GIS’s origins lie in thematic cartography
- Many planners used the method of map overlay using manual techniques
- Manual map overlay as a method was first described comprehensively by Jacqueline Tyrwhitt in a 1950 planning textbook
- HcHarg used blacked out transparent overlays for site selection in *Design with Nature*



## Ian McHarg



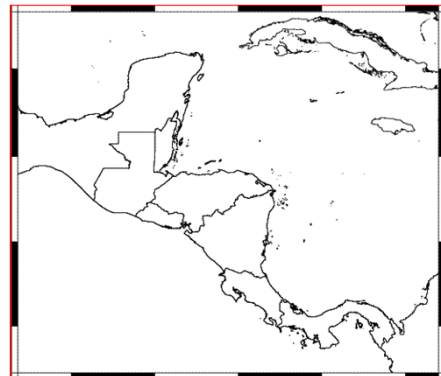
## Tyrwhitt: Town & Country Planning



## A Brief History of GIS (ctd)

- The 1960s saw many new forms of geographic data and mapping software
- Computer cartography developed the first basic GIS concepts during the late 1950s and 1960s
- Linked software modules, rather than stand-alone programs, preceded GISs
- Early influential data sets were the World Data Bank and the GBF/DIME files
- Early systems were CGIS, MLMIS, GRID and LUNR
- The Harvard University ODYSSEY system was influential due to its topological arc-node (vector) data structure

## WDB II and CAM



SAGE 1963 Canada GIS 1967  
IBM-PC 1982 ArcView 1.0 1994

THE PRINCIPAL ZONES OF SOIL LIMITATIONS FOR AGRICULTURE IN CANADA

- PREDOMINANTLY FROZEN GROUND
- IMPROVING, BUT WITH RESERVE AT OR NEAR THE SURFACE
- PRINCIPAL ZONES WITH SOIL POTENTIAL FOR AGRICULTURE

### A Brief History of GIS (ctd)

- GIS was significantly altered by (1) the PC and (2) the workstation
- During the 1980s, new GIS software could better exploit more advanced hardware
- User Interface developments led to GIS's vastly improved ease of use during the 1990s
- During the 1980s, new GIS software could better exploit more advanced hardware

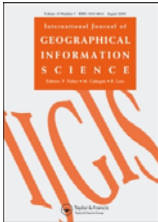
### Sources of Information on GIS

- Sources of GIS information include journals and magazines, books, professional societies, the World Wide Web, and conferences
- GIS has Web Home pages, network conference groups, professional organizations, and user groups
- Most colleges and universities now offer GIS classes in geography departments
- Lots of commercial and shareware sites

### GIS Resources: Conferences

## Major GIS-Only Journals

- International Journal of Geographical Information Systems
- Cartography and Geographic Information Science
- Geographical Systems
- Transactions in GIS
- Geoworld (Geoplace.com)



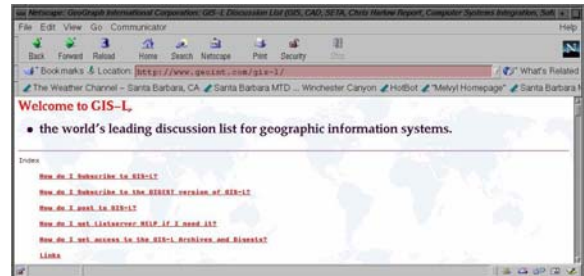
## Professional Organizations

- GITA: The Geospatial and Information Technology Association (<http://www.gita.org>)
- AAG: The Association of American Geographers. (<http://www.aag.org>)
- ACSM: American Congress on Surveying and Mapping (<http://www.acsm.net>)
- ASPRS: American Society for Photogrammetry and Remote Sensing (<http://www.asprs.org>)
- NACIS: North American Cartographic Information Society (<http://www.nacis.org>)
- URISA: Urban and Regional Information Systems Association (<http://www.urisa.org>)
- ACM: Association for Computing Machinery SIG-SPATIAL/GIS

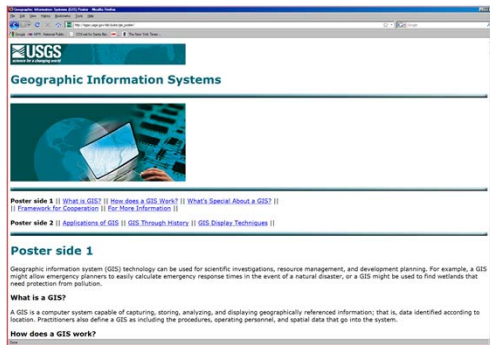
## GIS: Commercial websites



## WWW Resources: USGS



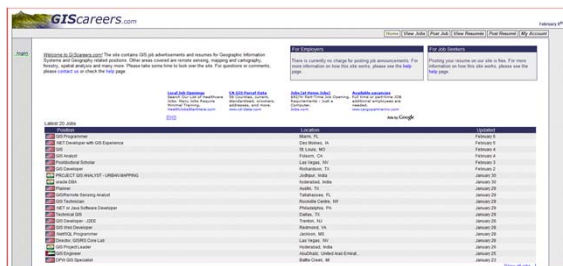
### WWW Resources: NSDI, GOS, Data.gov



### GIS daily internet news/jobs

- <http://www.geoplace.com>
- <http://www.gisSAFE.com>
- <http://www.gis.com>
- <http://www.census.gov/geo/www/faq-index.html>
- <http://www.geo.ed.ac.uk/home/giswww.html>
- <http://www.lib.berkeley.edu/EART/abbrev.html>

### Jobs e.g. GIScareers.com



### Next Topic:

GIS's Roots in Cartography