

***WELCOME***

to

**EEOS 265 - Computer  
Applications in Geography**

*Getting Started with Geographic  
Information Systems*

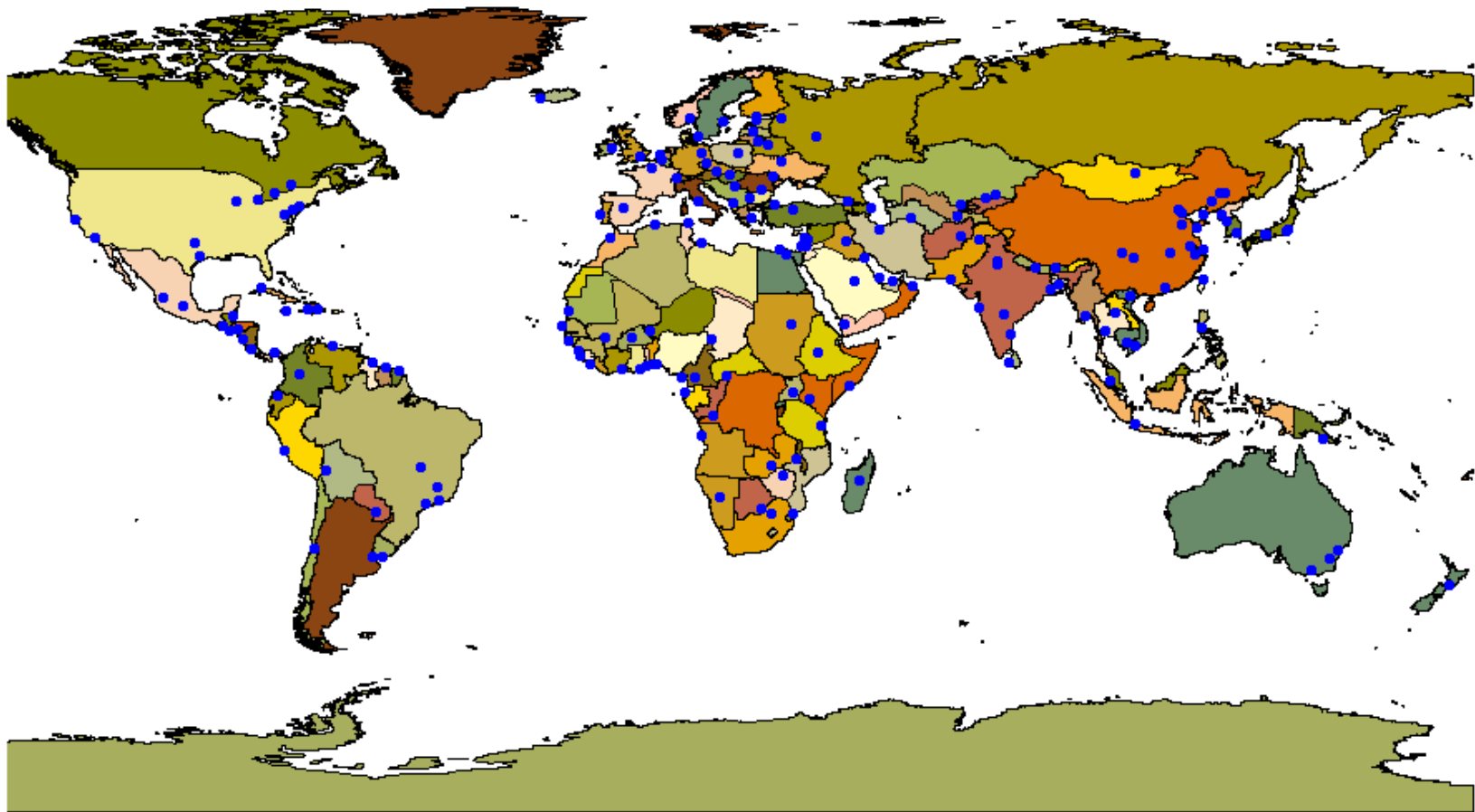
# What will you learn?

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

# Introduction to GIS – Science / Study / Systems

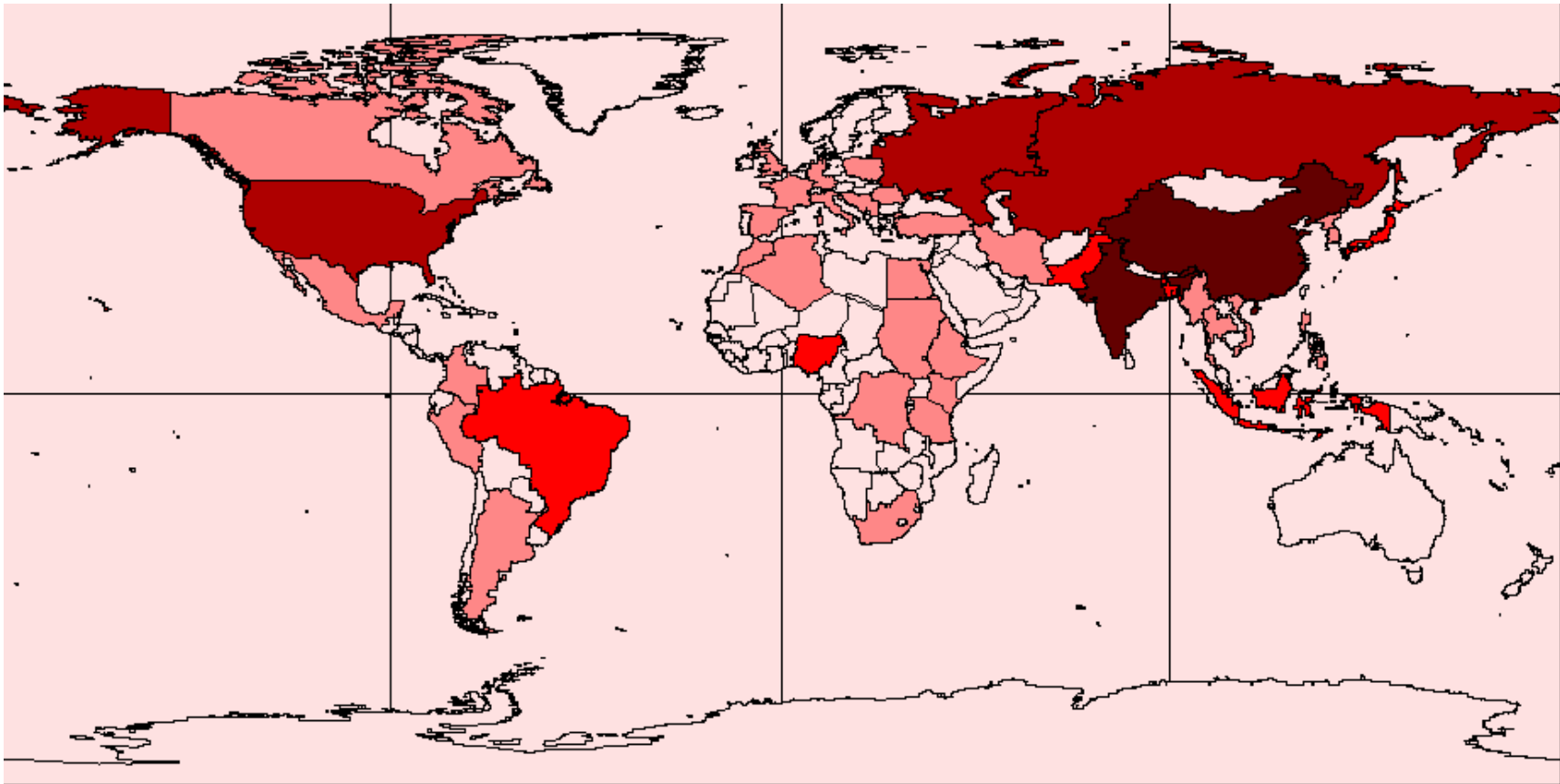
- What subject matter does geography study?
- How do geographers see things / what approach do they take?
- What is the role of geographic information?
- What is GIS?
- How does a GIS work?
- What components does a GIS include?

# Is Geography Just Place Names?



# There Are Many Other Sorts of Geographic Information

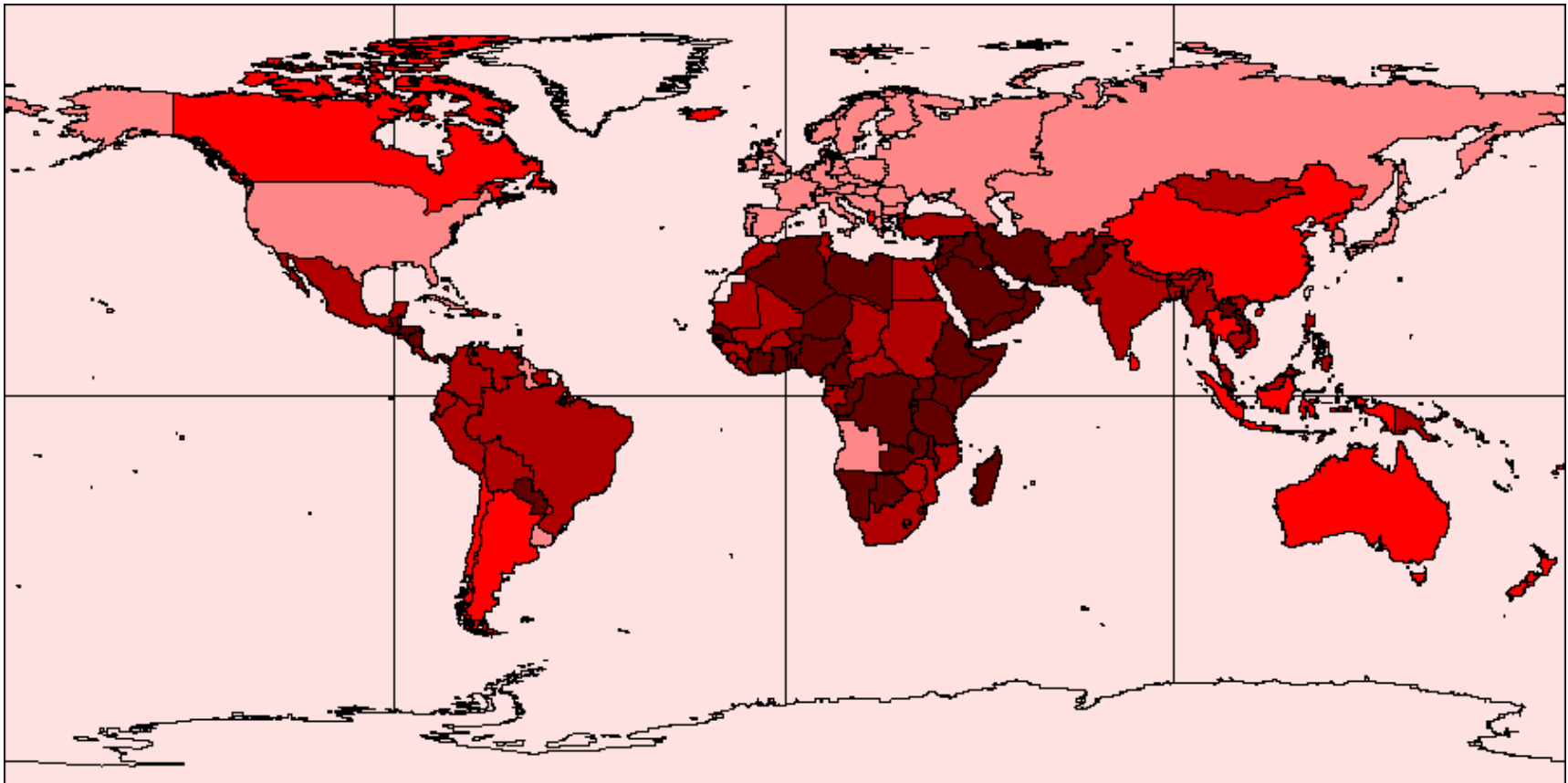
## World Population by Nation



The darker the red fill, the greater the population

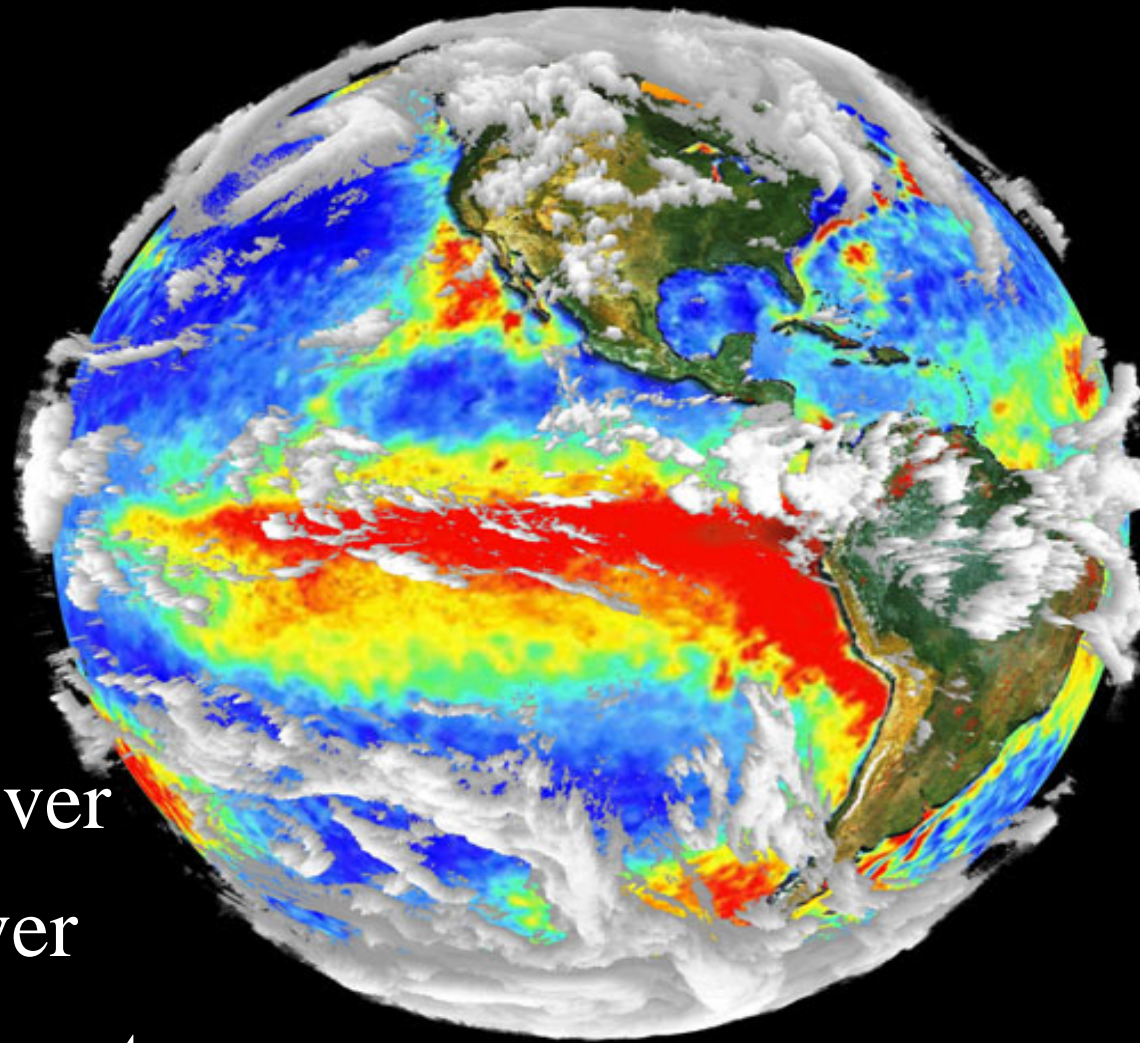
# We Can Also Map Rates of Change

## World Population Growth Rate by Nation



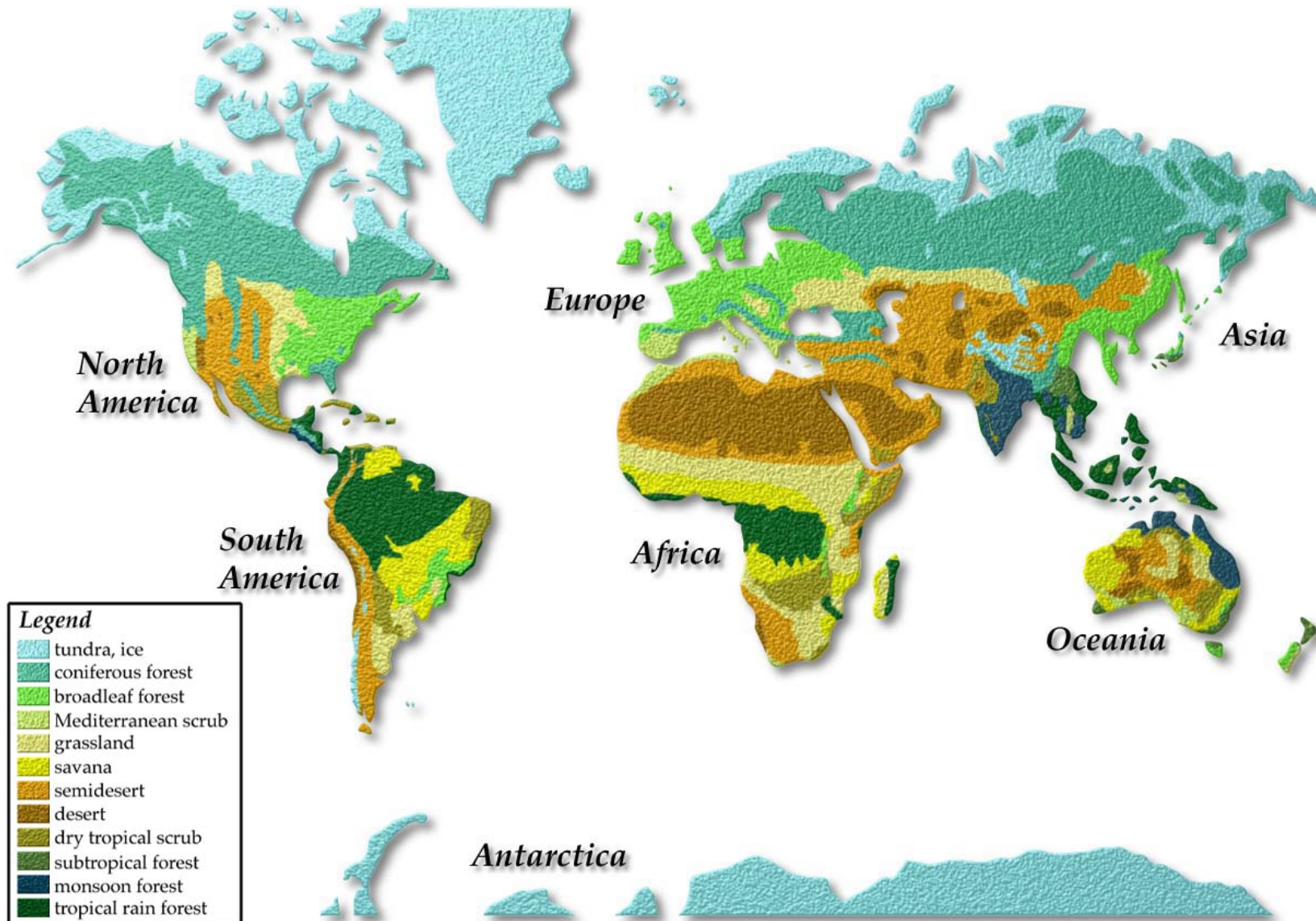
The darker the red, the greater the population growth

# Geography Also Looks at the Physical Environment



- Cloud Cover
- Land Cover
- Sea Temperature

# Vegetation Biome Map





# What Do Geographers Do?

- Primarily, geographers **make maps**
  - maps of place names
  - maps of human population and its growth
  - maps of temperature
  - maps of the spatial distribution of vegetation, etc.
- Maps are **the means** by which geographers work
  - through the analysis of many maps, geographers produce new maps that provide insights into some spatial phenomenon.
- Maps are **a final product**: They are the **medium** that geographers use to **present spatial information**

# The First Law of Geography

## Tobler's Law:

- The central tenet of Geography is that **location matters** for understanding a wide variety of phenomena.
- Everything is related to everything else, but things that are closer together are more related to each other than those that are further apart

# Geographers' Perspectives on the World

- Location **matters**
- Real-world **relationships**
- Horizontal **connections between places**
- Importance of **scale** (both in time and space)

# Geographic Information

- Includes knowledge about **where** something is
- Includes knowledge about what is at a given **location**
- Can be very detailed:
  - e.g. the locations of all buildings in a city or the locations of all trees in a forest stand
- Or it can be very coarse:
  - e.g. the population density of an entire country or the global sea surface temperature distribution
- There is always a **spatial** component associated with geographic information

# Lecture 1: What is a GIS?

1.1 Getting Started

1.2 Some Definitions of GIS

1.3 A Brief History of GIS

1.4 Sources of Information on GIS

# Lecture 1: What is a GIS?

- GIS (usually) stands for **Geographic Information System**.
- It is **comprised** of hardware, software, network, data, and trained personnel to support the capture, management, manipulation, analysis, and display of geographically referenced data for solving complex municipal management and planning problems, and for serving the public better and more efficiently.

# Lecture 1: What is a GIS?

- A **geographic information** or **geographical information system** (GIS) is a system for creating, storing, analyzing and managing spatial data and associated attributes. In the strictest sense, it is a computer system capable of integrating, storing, editing, analyzing, sharing, and displaying geographically-referenced information. In a more generic sense, GIS is a tool that allows users to create interactive queries (user created searches), analyze the spatial information, and edit data.
- **Geographical Information Science** is the science underlying the applications and systems, taught as a degree program by universities.

([www.wikipedia.org](http://www.wikipedia.org))

# Where did GIS come from?

- GIS is **built upon knowledge** from geography, cartography, computer science and mathematics
- 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
  - a toolbox
  - an information system
  - an approach to science
  - an multi-billion dollar business
  - plays an important role in society
- 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

# 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
<b>Crimes during 2003</b>		
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).

## **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).*

# **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

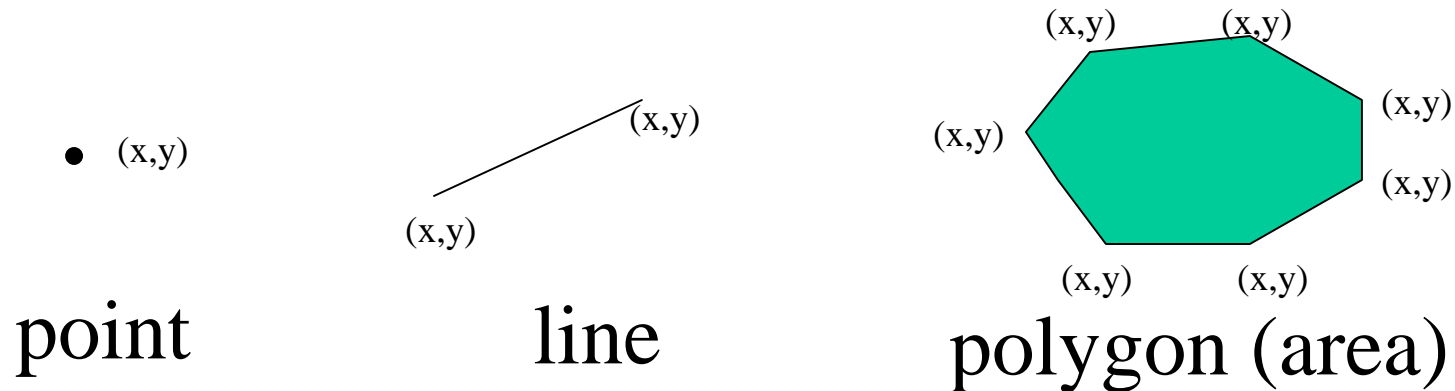
- Dueker's definition uses **the feature model** of geographic space.
- The standard feature model divides a mapped landscape up into **features**, that can be **points, lines, or areas**.
- Using a GIS involves **capturing the spatial distribution of features** by measurement of the world or of maps (making **observations**?).
- 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.

# Observations?

Observations of features, activities, and events. The term feature is a term from cartography, meaning thing to be placed on a map.

- **Point features:** These are features with only a location, no length or area. e.g. On campus, the following are well represented as point features: The Old Well, the flag pole, etc.
- **Line features:** These are feature with several locations strung out along the line in sequence, and are too narrow to represent their width. e.g. roads, rivers, etc.
- **Area features:** These consist of one or more lines that form a loop. e.g. shorelines enclosing a lake.

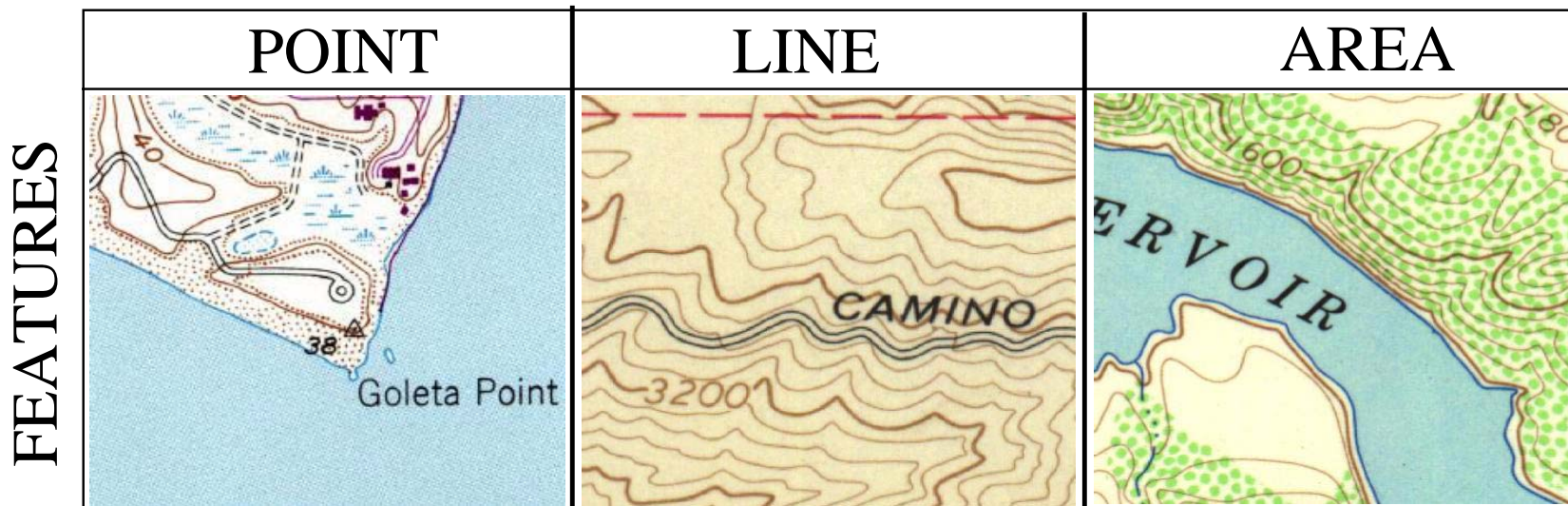
# Geographic Features (Vector Model)



- **A point:** specified by a pair of  $(x,y)$  coordinates, representing a feature that is too small to have length and area.
- **A line:** formed by joining two points, representing features too narrow to have areas
- **A polygon (area):** formed by a joining multiple points that enclose an area



# 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 (continued)

- 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**

# A Hybrid Definition

- Dueker's definition **only applies** to the **vector model** of the real world, which represents the real world on maps as point, line, and area features. In fact, there are **other spatial data models** of the world (e.g. the raster model) where that definition does not apply.
- A more useful definition is a **hybrid**:
  - *GIS is an information system that allows for **capture, storage, retrieval, analysis and display** of spatial data.*

# Definition 3: GIS is an approach to science

- **Geographic Information Science** is research both *on* and *with* GIS.
- The technology of GIS has become **much simpler, more distributed, cheaper** and has crossed the boundary into disciplines such as anthropology, epidemiology, facilities management, forestry, geology, and business.
- GIS is used as **a new approach** to science.

# 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”*



# 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.”*

# How Does GIS Work?

**Geographic Information System**

## Chain of Operations

**Capturing  
Data**

**Storing and Retrieving  
Data**

**Analysis  
And  
Display of  
Data**

# Capturing Data

## Capturing Data

- The first fundamental step is **identifying some features or phenomena of interest** and creating a digital representation of it (e.g. field work with GPS or any number other ways of producing data)





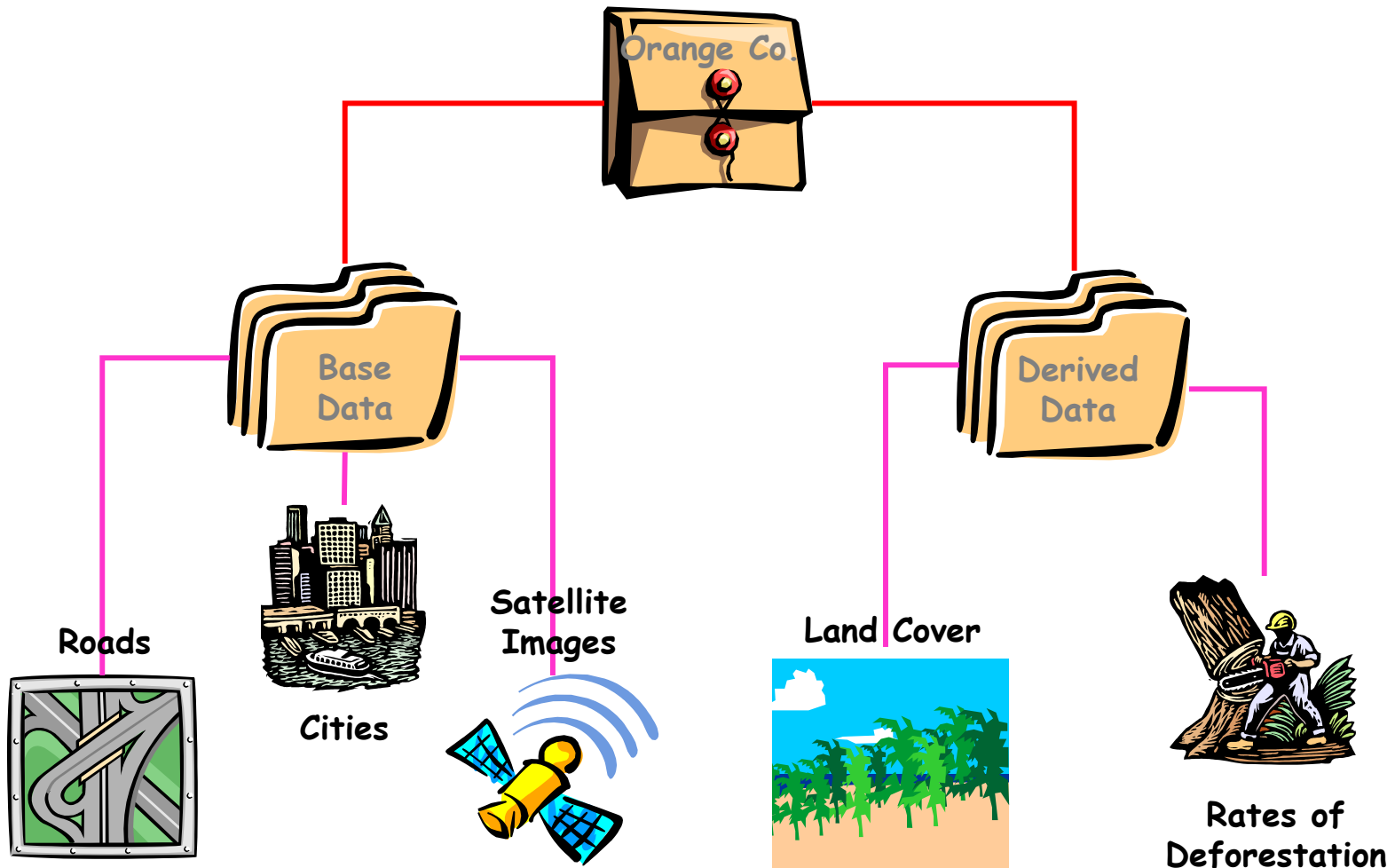
# How Does GIS Work?

## Storing and Retrieving Data

- The next step is to **store the data** in a database
- Database organization is the **key** to a successful project



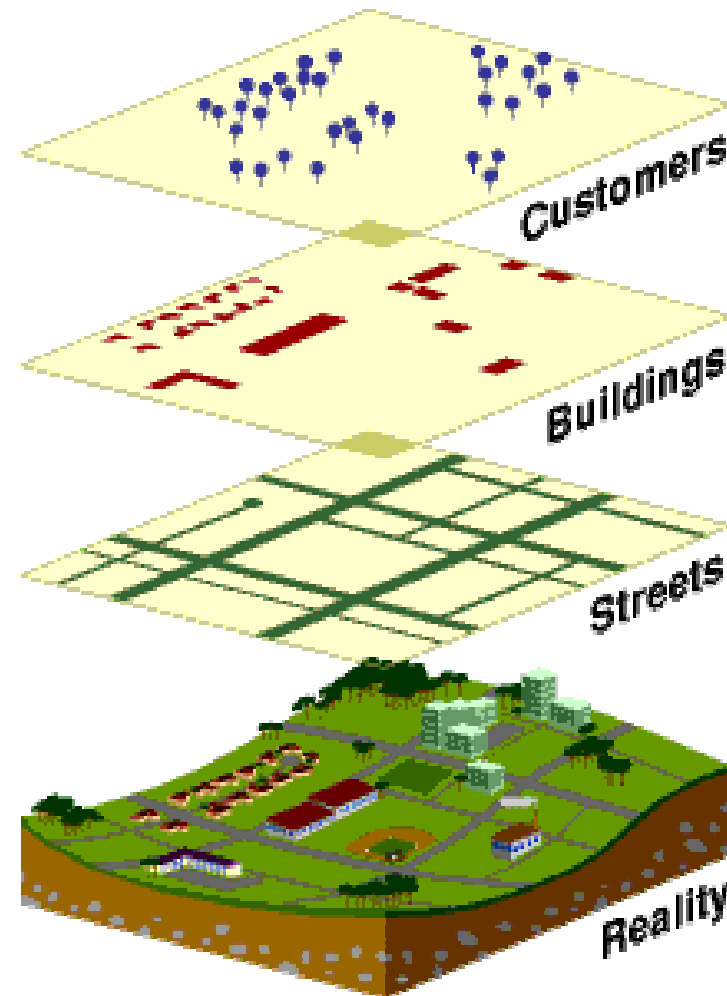
# Simple Database Example



# How Does GIS Work?

Analysis  
And  
Display of  
Data

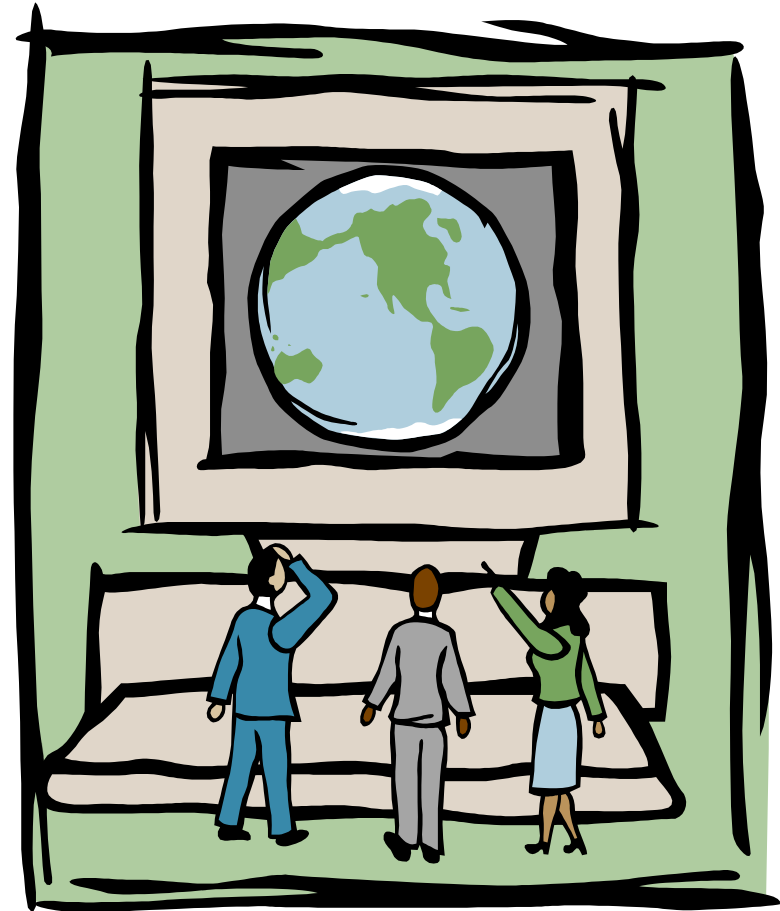
- Each layer corresponds to a **theme** in our example database
- Analysis can be performed on the layers **individually** or **in combination** with other layers.



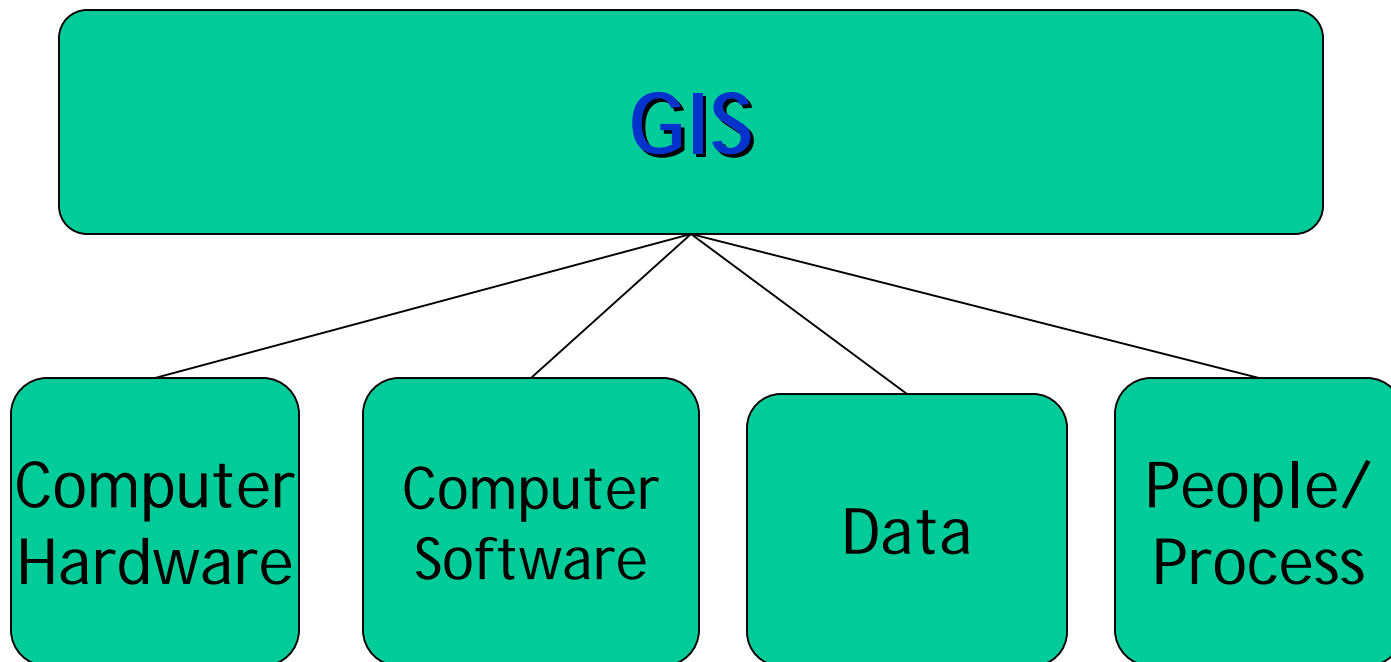
# How Does GIS Work?

Analysis  
And  
Display of  
Data

- After analysis, the resulting information is **communicated**, most often through a map
- The information can then be used to **make decisions**



# Components of a GIS



# Computer Hardware

## Computer Hardware

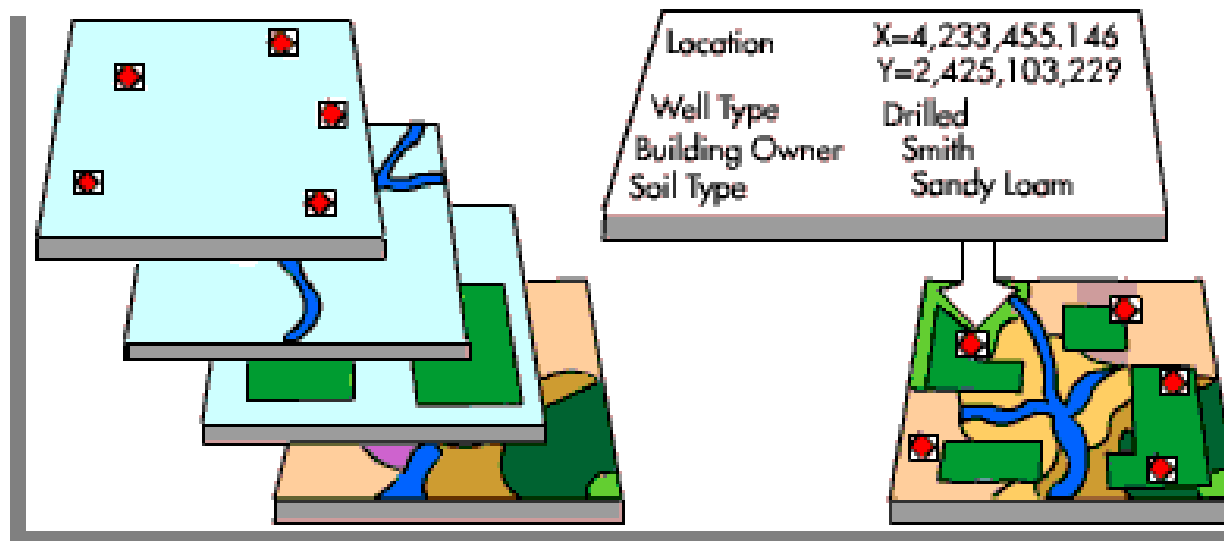
- Computers
- Disk storage
- Digitizers and scanners
- Printer and plotter output devices



# Computer Software

Computer  
Software

- A program like any other, but designed specifically to **manage and manipulate spatial data** in the ways described previously



# GIS Software Packages

## Environmental Systems Research Institute (ESRI)

- Arc/INFO - originally developed for UNIX systems, the latest version (versions 8.x and 9.x a.k.a. ArcGIS) is now exclusively for PCs
- ArcView (3.x) – developed in parallel for PCs and UNIX systems, replaced by ArcGIS

## MapInfo Corporation

- MapInfo: PC-based GIS

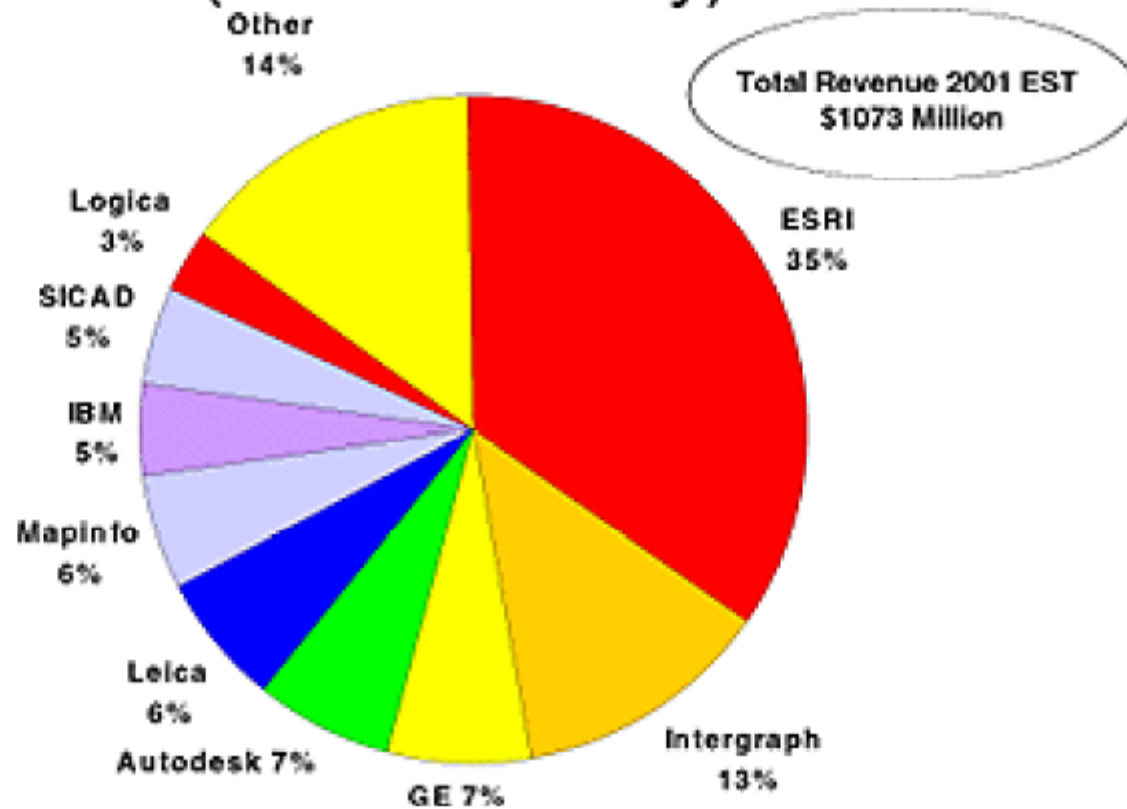
## Clark University

- IDRISI: PC-based GIS



# GIS Software Vendors

## 2001 Worldwide GIS Revenue (Software Only)



# Data



- The **geographic information itself**, including the location information and attribute information

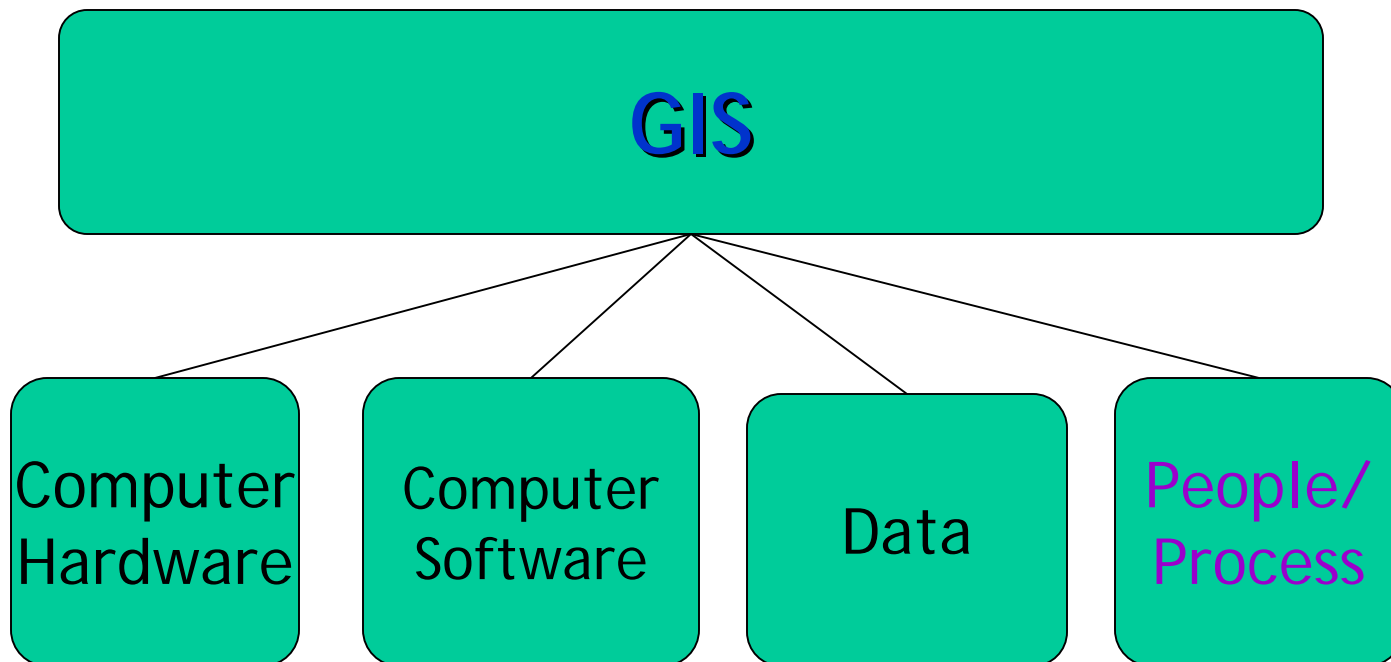


# GIS Data

- **Data properties:** Spatial data, i.e. data that are associated with geographic locations
- **Data format:** digital (analog for traditional paper maps)
- **Data Inputs:**
  - sampled from the real world
  - digitizing from paper maps
  - produced by government agencies, e.g. census bureau, USGS, USFS, state government
  - space or airborne remote sensing (NASA, NOAA, commercial, etc.)

**About 80% of the duration of many large scale GIS projects is concerned with data input and management**

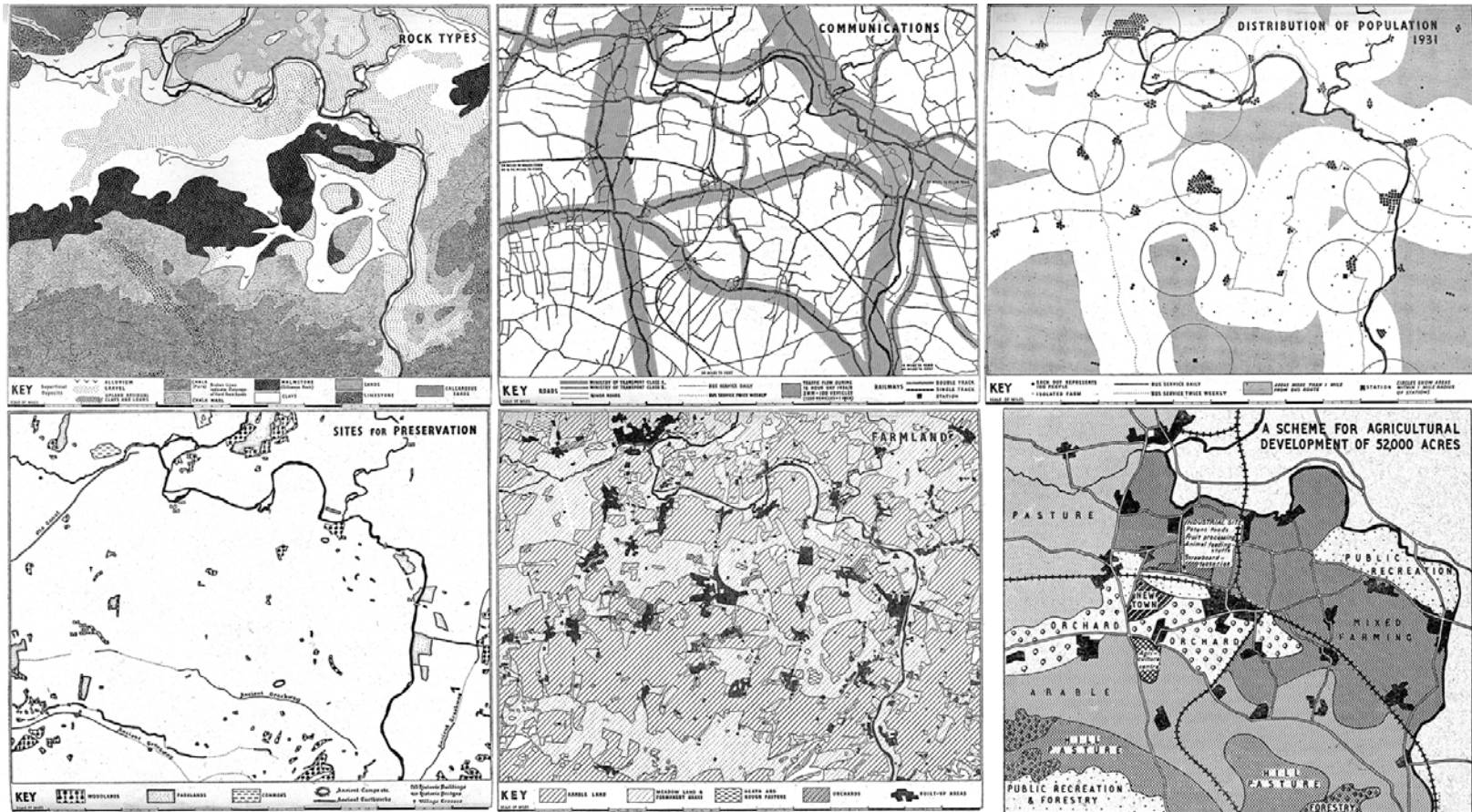
# Components of a GIS



# 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** from Britain in a 1950 planning textbook
- **Ian McHarg** used blacked out transparent overlays for site selection in *Design with Nature* published in 1969.

# Tyrwhitt: Town & Country Planning



# A Brief History of GIS (continued)

- 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 by the US Census Bureau
- **Early systems** were CGIS, MLMIS, GRID and LUNR
- The Harvard University ODYSSEY system was influential due to its **topological arc-node (vector) data structure** in the 70s

# A Brief History of GIS (continued)

- GIS was **significantly altered** by (1) the PC and (2) the workstation
- During the **1980s**, new GIS software could better **exploit more advanced hardware**
- 1980s and **early 1990s** saw GIS **mature** as a technology
- The development of **Graphical User Interfaces (GUIs)** led to GIS's **vastly improved ease of use** during the **1990s**
- Integration with **GPS and remote sensing**



# A Brief History of GIS (continued)

- GIS owes
  - its birth to a **cluster of interrelated events and human interactions** in the 1960s, and
  - its **spectacular growth** to the microcomputer, the workstation, and the Internet.

# Sources of Information on GIS

- The amount of information available about GIS can be **overwhelming**
- **Sources of GIS information** include journals and magazines, books, professional societies, the World Wide Web, and conferences
  - GIS has Web pages, network conference groups, professional organizations, and user groups
- Most colleges and universities now offer **GIS classes** in geography departments

# GIS Resources: Conferences



# Major GIS-Only Journals

- International Journal of Geographical Information Systems
- Geographical Systems
- Transactions in GIS
- Geospatial solutions
- Geoworld

# Specialty Journals

- GIS Law
- GrassClippings
- GIS Asia/Pacific
- GIS World Report/CANADA
- GIS Europe
- Mapping Awareness

# Journals that Regularly Contain GIS Papers

- Annals of the Association of American Geographers
- Cartographica
- Cartography and GIS
- Computers, Environment, and Urban Systems
- Computers and Geosciences
- IEEE Transactions on Computer Graphics and Applications
- Photogrammetric Engineering and Remote Sensing

# Journals that Occasionally Contain GIS Papers

- Cartographic Perspectives
- Journal of Cartography
- Geocarto International
- IEEE Geosciences
- International Journal of Remote Sensing
- Landscape Ecology
- Remote Sensing Review
- Mapping Science and Remote Sensing
- Infoworld

# Popular Distribution Magazines

- Geospatial Solutions
- GIS Law
- Geoworld
- GPS World
- Mapping awareness/Mapping awareness and GIS in Europe/Asia/Africa
- ArcNews



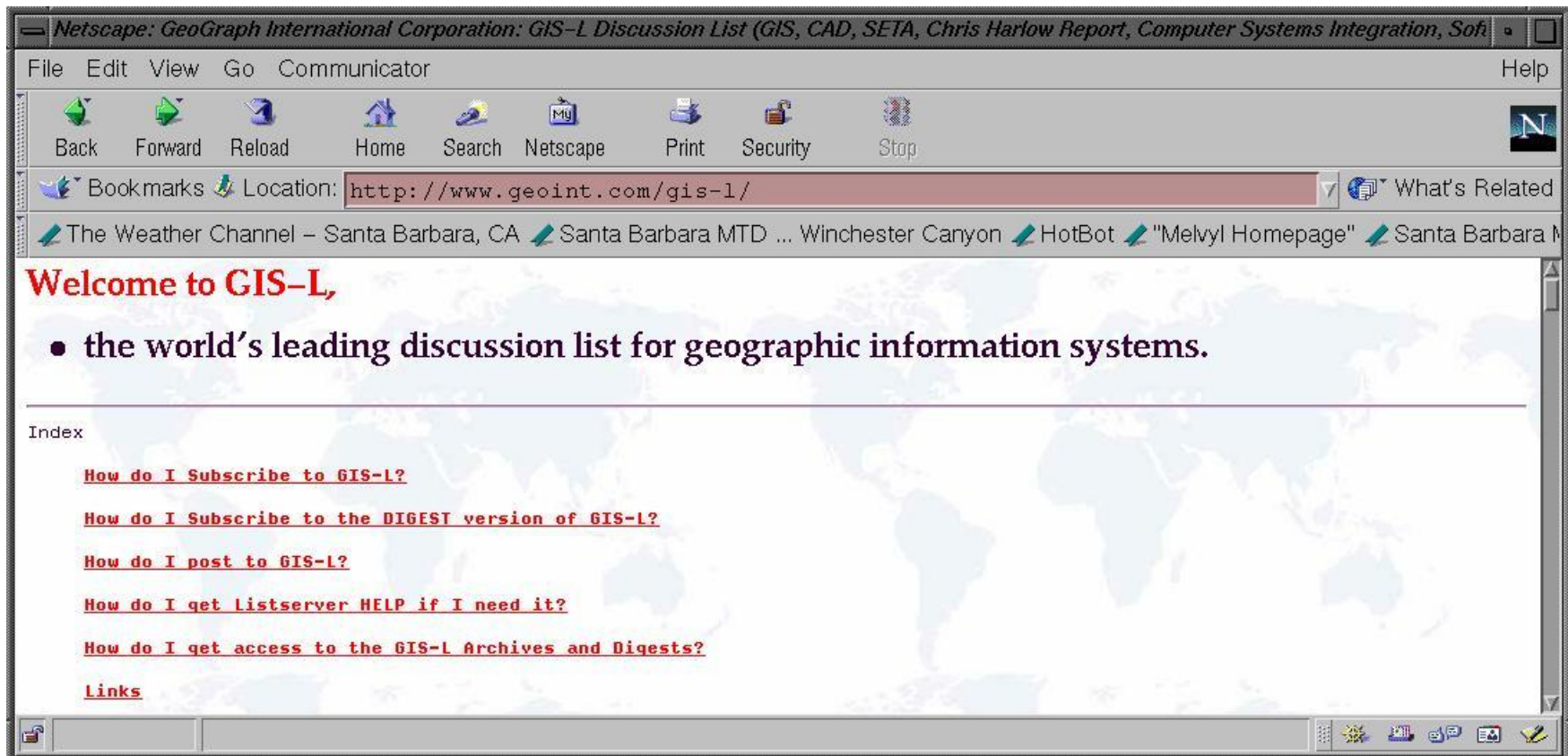
# Proceedings of Conferences

- AUTOCARTO International Symposium on Automated Cartography
- GIS/LIS. Sponsored by AAG, ACSM, AM/FM, ASPRS, URISA. Held every year, retired in 1998.
- International Advanced Study Symposium on Topological Data Structures for Geographic Information Systems
- Proceedings International Symposium on Spatial Data Handling. IGU Commission on GIS.
- SSD Advances in spatial databases

# Professional Organizations

- AM/FM International Automated Mapping and Facilities Management. (Now GITA)
- AAG: The Association of American Geographers.
- ACSM: American Congress on Surveying and Mapping.
- ASPRS: American Society for Photogrammetry and Remote Sensing.
- NACIS: North American Cartographic Information Society.
- URISA: Urban and Regional Information Systems Association.

# WWW Resources: Discussion Lists



# WWW Resources: MassGIS

The screenshot shows a Microsoft Internet Explorer browser window displaying the MassGIS website. The browser's address bar shows the URL <http://www.mass.gov/mgis/>. The website header features the "Mass.gov" logo and navigation links for "mass.gov home", "online services", and "state agencies". A search bar is also present.

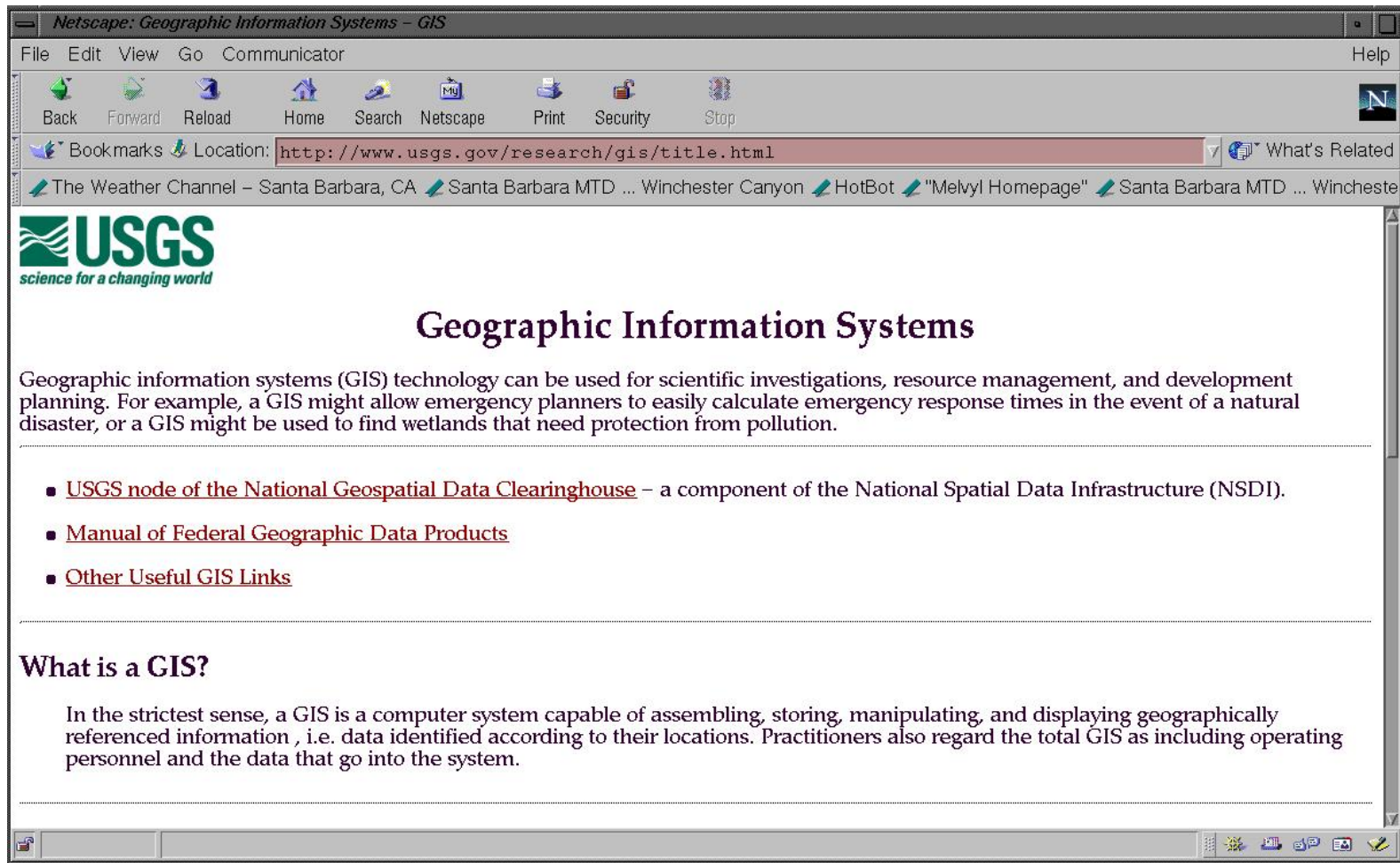
The main content area is titled "Massachusetts Geographic Information System" and includes the "MASS GIS" logo. Below this, it identifies the "Commonwealth of Massachusetts" and the "Executive Office of Environmental Affairs". A central banner states: "MassGIS is the Commonwealth's Office of Geographic and Environmental Information".

On the left side, there is a "GIS Events" section with the following information:

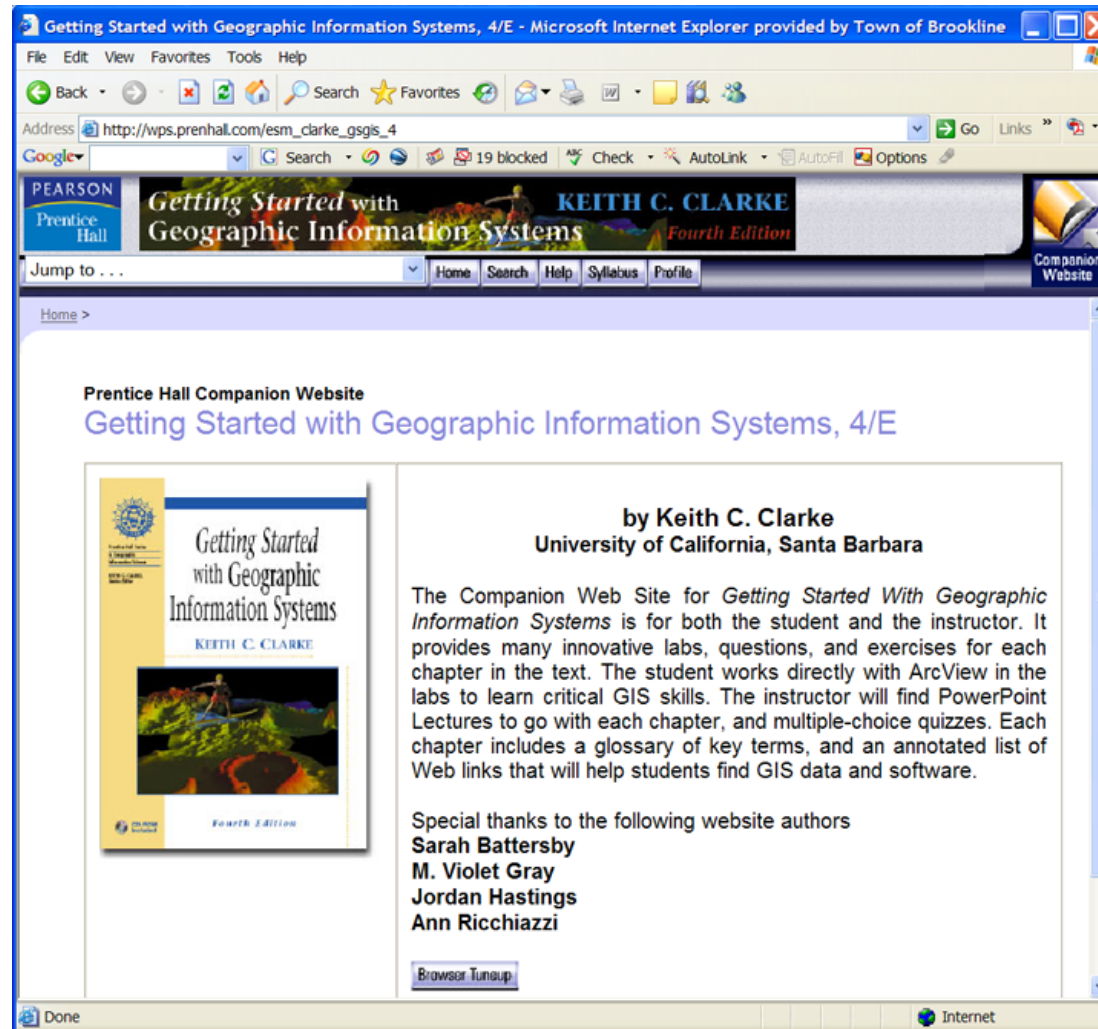
- Massachusetts Geographic Information Council**  
Next Meeting: Thu., September 28  
"The FEMA Flood Map Modernization Program"  
\*\*\*\* Save the Date! \*\*\*\*
- GIS Day 2005 Recap**
- What's New**  
**June GISette Newsletter**  
Read and sign up
- 2005 Ortho Imagery**  
Download MrSID and JPEG 2000  
Order MrSID mosaics
- Massachusetts Conservation Mapping

In the center-right, there are three main navigation buttons: "Order Maps & Data", "Make a Map Online", and "Download Free Data". Below these is a map of Massachusetts with several interactive links overlaid: "What's New", "About MassGIS", "MassGIS - Data", "GIS Resources", "Municipal GIS", "Data Viewer", "GIS Education", and "Standards".

# WWW Resources: NSDI



# WWW Resources: Textbook Pages



Getting Started with Geographic Information Systems, 4/E - Microsoft Internet Explorer provided by Town of Brookline

File Edit View Favorites Tools Help

Address [http://wps.prenhall.com/esm\\_clarke\\_gsgis\\_4](http://wps.prenhall.com/esm_clarke_gsgis_4)

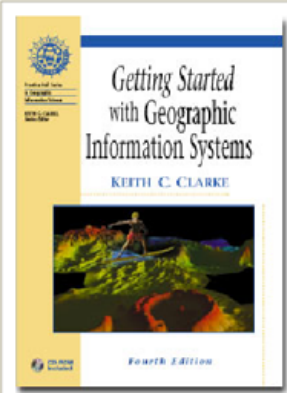
PEARSON Prentice Hall

**Getting Started with Geographic Information Systems** KEITH C. CLARKE *Fourth Edition*

Jump to ... Home Search Help Syllabus Profile Companion Website

Home >

**Prentice Hall Companion Website**  
**Getting Started with Geographic Information Systems, 4/E**



**by Keith C. Clarke**  
**University of California, Santa Barbara**

The Companion Web Site for *Getting Started With Geographic Information Systems* is for both the student and the instructor. It provides many innovative labs, questions, and exercises for each chapter in the text. The student works directly with ArcView in the labs to learn critical GIS skills. The instructor will find PowerPoint Lectures to go with each chapter, and multiple-choice quizzes. Each chapter includes a glossary of key terms, and an annotated list of Web links that will help students find GIS data and software.

Special thanks to the following website authors  
**Sarah Battersby**  
**M. Violet Gray**  
**Jordan Hastings**  
**Ann Ricchiazzi**

Browser Tuneup

Done Internet

# GIS daily internet news/jobs

- <http://www.geoplace.com>
- <http://www.giscafe.com>
- <http://www.gis.com>
- <http://www.geographynetwork.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>

# Introduction to GIS – Science / Study / Systems

- What subject matter does geography study?
  - **The spatial organization of any/all phenomena on the surface of the Earth (human and physical)**
- How do geographers see things / what approach do they take?
  - **Location matters etc.**
- What is the role of geographic information?
  - **Geo. info. is the data geographers analyze**



# Introduction to GIS – Science / Study / Systems

- What is GIS?
  - Several definitions, all relating to approaches to understanding the world in terms of spatial organization of phenomena
- How does GIS work?
  - The chain of operations involving geographic information
- What components does a GIS include?
  - Hardware, software, data, and people/process

# Next Topic:

GIS's Roots in Cartography