FUNDAMENTALS OF GEOGRAPHIC INFORMATION SYSTEM

DR. DIPANWITA DUTTA

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Geographic Information System

- Geographic/Geospatial Information
  - information about places on the earth's surface
  - knowledge about "what is where when"
    (Don't forget time!)
  - Geographic/geospatial: synonymous
- GIS--what's in the S?
  - Systems: the technology
  - Science: the concepts and theory
  - Studies: the societal context

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Definition

- The *common ground* between information processing and the many fields using spatial analysis techniques. (Tomlinson, 1972)
- A powerful *set of tools* for collecting, storing, retrieving, transforming, and displaying spatial data from the real world. (Burroughs, 1986)
- A computerized *database management system* for the capture, storage, retrieval, analysis and display of spatial (locationally defined) data. (National Center for Geographic Information and Analysis, 1987)
- A *decision support system* involving the *integration* of spatially referenced data in a problem solving environment. (Cowen, 1988)

Roger Tomlinson (Father of GIS)
1933-2014

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GIS is..

- set of integrated tools for spatial analysis
- encompasses end-to-end processing of data
  capture, storage, retrieval, analysis/modification, display
- uses explicit location on earth's surface to relate data
- aimed at decision support, as well as on-going operations and scientific inquiry

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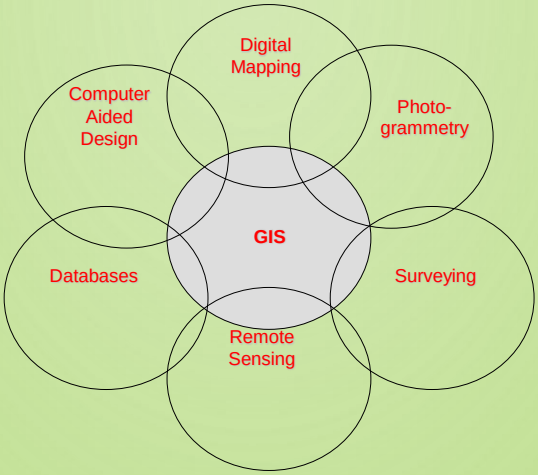
Cross-disciplinary Nature of GIS



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Components of GIS

1. Hardware
Hardware is the computer system on which a GIS operates.
2. Software
GIS software provides the functions and tools needed to store, analyze, and display geographic information.
3. **Data**
A GIS can integrate spatial data with other existing data resources, often stored in a corporate DBMS
4. People
GIS users range from technical specialists who design and maintain the system to those who use it to help them perform their everyday work.
5. Methods
A successful GIS operates according to a well-designed implementation plan and business rules, which are the models and operating practices unique to each organization.

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- Spatial data *(where)*
  - specifies location
  - stored in a *shape file, geodatabase* or similar geographic file

- Attribute (descriptive) data *(what, how much, when)*
  - specifies characteristics at that location, natural or human-created
  - stored in a data base *table*

Shape	Name	Class	Pop2000	State
Point	New York	City	8,008,278	NY
Point	Los Angeles	City	3,694,820	CA
Point	Chicago	City	2,896,016	IL

GIS systems traditionally maintain spatial and attribute data separately, then "join" them for display or analysis

- for example, in ArcView, the *Attributes of …* table is used to link a *shapefile* (spatial structure) with a *data base table* containing attribute information in order to display the attribute data spatially on a map

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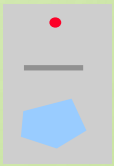
SPATIAL DATA TYPES:

1. Co-ordinate based

2. Vector data – discrete features:
   - Points
   - Lines
   - Polygons (zones or areas)



3. Raster data:
   A continuous surface

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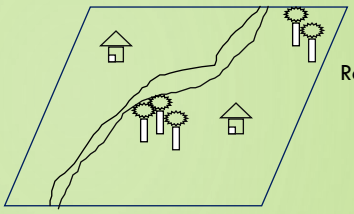
Concept of Vector and Raster

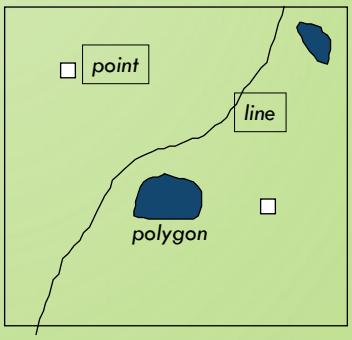


Real World

Raster Representation

	0	1	2	3	4	5	6	7	8	9
0								R	T	
1							R			T
2		H					R			
3							R			
4					R	R				
5				R						
6			R		T	T		H		
7			R		T	T				
8		R								
9		R								

Vector Representation



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GEOGRAPHIC DATABASE

Raster

Vector

Attribute Table

Value	Count	FEA_CODE	Prct_tran	Prct_land
160	62306	Paved Alley	5.056571	1.622552
161	441326	Paved Road	35.816712	11.492865
162	350	Unpaved Road	0.028405	0.009115
163	70285	Public Sidewalk	5.704123	1.830339
164	532582	Paved Parking Lot	43.222779	13.869323
165	96854	Paved Driveway	7.860384	2.522240
166	6119	Paved Trail	0.496600	0.159349
167	6513	Bridge	0.528576	0.169609
168	11518	Paved Median	0.934767	0.299948
169	4326	Grass or Planted Median	0.351085	0.112656

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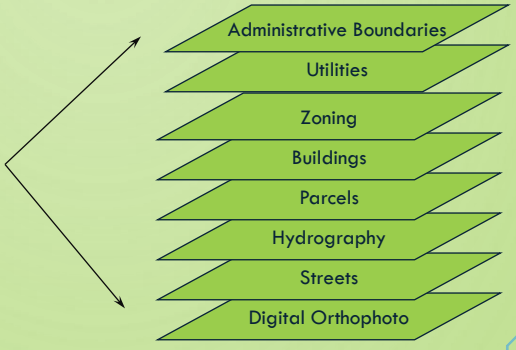
THE GIS DATA MODEL: IMPLEMENTATION

GEOGRAPHIC INTEGRATION OF INFORMATION



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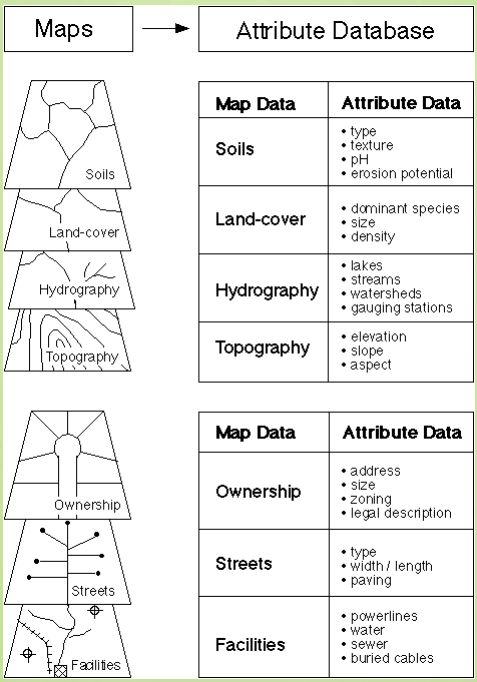

Map Data	Attribute Data
Soils	• type • texture • pH • erosion potential
Land-cover	• dominant species • size • density
Hydrography	• lakes • streams • watersheds • gauging stations
Topography	• elevation • slope • aspect

Map Data	Attribute Data
Ownership	• address • size • zoning • legal description
Streets	• type • width / length • paving
Facilities	• powerlines • water • sewer • buried cables

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WHY STUDY GIS?

- 80% of **local government** activities estimated to be geographically based
  - plats, zoning, public works (streets, water supply, sewers), garbage collection, land ownership and valuation, public safety (fire and police)
- A significant portion of **state government** has a geographical component
  - natural resource management
  - highways and transportation
- **Businesses** use GIS for a very wide array of applications
  - retail site selection & customer analysis
  - logistics: vehicle tracking & routing
  - natural resource exploration (petroleum, etc.)
  - precision agriculture
  - civil engineering and construction
- **Military and defense**
  - Battlefield management
  - Satellite imagery interpretation
- **scientific research** employs GIS
  - geography, geology, botany
  - anthropology, sociology, economics, political science
  - Epidemiology, criminology

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The Major Areas of GIS Application

- Local Government
  - Public works/infrastructure management (roads, water, sewer)
  - Planning and environmental management
  - property records and appraisal
- Real Estate and Marketing
  - Retail site selection, site evaluation
- Public safety and defense
  - Crime analysis, fire prevention, emergency management, military/defense
- Natural resource exploration/extraction
  - Petroleum, minerals, quarrying
- Transportation
  - Airline route planning, transportation planning/modeling
- Public health and epidemiology
- The Geospatial Industry
  - Data development, application development, programming

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EXAMPLES OF APPLIED GIS

- **Urban Planning, Management & Policy**
  - Zoning, subdivision planning
  - Land acquisition
  - Economic development
  - Code enforcement
  - Housing renovation programs
  - Emergency response
  - Crime analysis
  - Tax assessment
- **Environmental Sciences**
  - Monitoring environmental risk
  - Modeling stormwater runoff
  - Management of watersheds, floodplains, wetlands, forests, aquifers
  - Environmental Impact Analysis
  - Hazardous or toxic facility siting
  - Groundwater modeling and contamination tracking
- **Political Science**
  - Redistricting
  - Analysis of election results
  - Predictive modeling
- **Civil Engineering/Utility**
  - Locating underground facilities
  - Designing alignment for freeways, transit
  - Coordination of infrastructure maintenance
- **Business**
  - Demographic Analysis
  - Market Penetration/ Share Analysis
  - Site Selection
- **Education Administration**
  - Attendance Area Maintenance
  - Enrollment Projections
  - School Bus Routing
- **Real Estate**
  - Neighborhood land prices
  - Traffic Impact Analysis
  - Determination of Highest and Best Use
- **Health Care**
  - Epidemiology
  - Needs Analysis
  - Service Inventory

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- Advantages of GIS
  - Exploring both geographical and thematic components of data in a holistic way
  - Stresses geographical aspects of a research question
  - Allows handling and exploration of large volumes of data
  - Allows integration of data from widely disparate sources
  - Allows analysis of data to explicitly incorporate location
  - Allows a wide variety of forms of visualisation
- Limitations of GIS
  - Data are expensive
  - Learning curve on GIS software can be long
  - Shows spatial relationships but does not provide absolute solutions
  - Origins in the Earth sciences and computer science. Solutions may not be appropriate for humanities research

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ACKNOWLEDGEMENT:

http://www.utdallas.edu/~briggs/gisc6381.html

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