Introduction to Geographic Information Systems (GIS)

January 10, 2011
Review of last class

Tours

Blogging

Questions?
Goals and Objectives

To create a knowledge base in each student that embodies a sound GIS skill set complimented by the development of a broader “geographic perspective.”

I order to attain this goal I must keep the students interested, active and challenged.

This will be achieved through class lecture and labs, multimedia presentations, guest lectures and a promotion of open discourse throughout the class.
What is GIS

Geographic Information Systems

2 parts:

Geographic (Geography)

Information Systems
What is GIS

Geography – Definition

gē·og·ra·phy (jē əgˈrə fē)
noun
1. the science that studies and describes the surface of the earth and its physical, biological, political, economic, and demographic characteristics and the complex interrelations among them.

2. the topographical features of a specific area.

3. a book on this subject. —geographer, n. —geographic, geographical, adj.

“The Study of the Earth”
What is GIS

Information System (Definition)

The organised collections of hardware, software, equipment, policies, procedures and people that store, process, control and provide access to information.
What is GIS

Geographic Information System (Definition)

• A geographic information system (GIS) integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information.
• GIS allows us to view, understand, question, interpret, and visualize data in many ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts.
• A GIS helps you answer questions and solve problems by looking at your data in a way that is quickly understood and easily shared.
• GIS technology can be integrated into any enterprise information system framework.

Source - www.GIS.com
What is GIS

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Source - www.GIS.com
What is GIS? (Geographic Information Systems)

= the automated...
➢ acquisition
➢ management
➢ analysis
➢ display

... of spatial data
What is GIS

GIS – The Big Picture

http://training.esri.com/Courses/StartGIS/index.cfm

• Pandemic Past Video

• Pandemic Present Video
What is GIS

Assignment 1.

1. Search the internet for a definition of GIS.
2. Post it on your blog.
3. Read another users definition and comment on it.
What is GIS

Stop for a second and think about how you would rate your understanding of what GIS is.

Don’t hesitate to ask questions.
Geography and Geomatics
The Geographic Approach/Perspective

“Geographic perspective – the perspective used by geographers when they use all available data and tools to first assess spatial distributions, then investigate the underlying spatial processes responsible for the observable spatial distributions, and finally make spatial predictions and decisions about how best to preserve or change the distributions”

http://training.esri.com/Courses/StartGIS/M1/what_is_the_geographic_approach_88471.cfm
The First Law of Geography

Waldo Tobler’s definition

"Everything is related to everything else, but near things are more related than distant things."
The Six Essential Elements of Geography

Geography educators have created a set of eighteen learning standards called Geography for Life. Each of these eighteen standards is organized into six essential elements.

1. The World in Spatial Terms
2. Places and Regions
3. Physical Systems
4. Human Systems
5. Environment and Society
6. The Uses of Geography

Billy's .pdf

Excercise –

Break off into groups of 2 and discuss one of the previous elements

From your understanding of what a GIS is, how could it be used as a toll within the element.

Think Geographically with relationships and analysis in mind

Geography

The Six Essential Elements of Geography
GIS fits best in this category
The World in Spatial Terms

1. How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective
2. How to use mental maps to organize information about people, places, and environments in a spatial context
3. How to analyze the spatial organization of people, places, and environments on earth's surface

The Six Essential Elements of Geography
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1. How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective
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Geography

Class discussion

How does Geography affect you?
Geomatics

Geomatics is – a category of Geography
GIS generally falls within the realm of Geomatics

Geomatics.pdf
Introduction to Geographic Information Systems

**Geomatics**

Define Geomatics

http://en.wikipedia.org/wiki/Geomatics
Introduction to GIS

• Review yesterday
  – Congratulations everyone scored 100% on the quiz 😊
  – Definition of GIS
    • Automated acquisition, management, analysis and display of spatial data
    • GIS the Big picture
  – Definition of Geography
    • Class discussion re. how geography impacts their life.
    • Looked at where GIS fits into Geomatics
  – Blog content was good. I think it is a good starting point for developing project ideas.
Geography quotes

- If some countries have too much history, we have too much geography. *Mackenzie King*
- Sometimes I think war is God's way of teaching us geography. *Paul Rodriguez*
- "I get to go to overseas places, like Canada." *Britney Spears*
- "No matter where you go, there you are" Buckeroo Banzai
- "It is wonderful to be here in the great state of Chicago" *Dan C. Quayle*

www.GIS.com
Components of GIS

- Hardware
- Software
- Data
- Methods
- People

www.GIS.com
Components of GIS

Hardware

Printers
Computer
Plotters
PDA’s
Cell Phones
Components of GIS

Software

GIS Software

ArcGIS, Manifold,
Google Earth

Word Processing

Database

3rd party translation tools

GPS

www.GIS.com
Components of GIS

Data

Spatial Data
  Government or private data
Tabular data
GPS data and attributes

www.GIS.com
Components of GIS

Methods
Automated scripts
Geo-processing tools
Components of GIS

People

GIS Technicians/Analysts
GIS Managers
End users
Data collectors

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Components of a GIS

Break
Review

History of GIS

5 components of GIS

GIS Assignment

GIS and Natural disasters

www.GIS.com
Today

Components of GIS
- Spatial vs Non-spatial data
- Geo-entities (features)

Lecture with Roger Wheate

GIS Assignment Presentations
Stop for a second and think about how you would rate your understanding of what GIS is.

What are some of the key points we have discussed?
Components of GIS

Spatial vs non-spatial data

Take a look at your definition of GIS from your blog. Does it contain the terms “spatial” and “non-spatial.” If not what similar terms does it contain?
Spatial data contains 2 broad groups of properties:

- Geometric (Geometry)
  - Relates to the measurement of points, lines, polygons and surfaces
  - Geometric properties include position, length, direction, area, perimeter etc.
Components of GIS

Topological

**Topology** describes the spatial relationships between adjacent features, and uses x, y coordinates to identify the location of a particular point, line, or polygon.

- Relational characteristics that do not change even if the geometric properties change
- Connectivity, inclusion, adjacency
In GIS we make rules to ensure topology is “correct”

- Parcels cannot overlap. Adjacent parcels have shared boundaries.
- Stream lines cannot overlap and must connect to one another at their endpoints.
- Adjacent counties have shared edges. Counties must completely cover and nest within states.
- Adjacent census blocks have shared edges. Census blocks must not overlap, and census blocks must completely cover and nest within block groups.
- Road centerlines must connect at their endpoints.
- Road centerlines and census blocks share coincident geometry (edges and nodes).
Components of GIS

Non – Spatial (Tabular data)

- Has the properties of ‘Value’ and ‘time’
- Has a unique ID that relates to the spatial data
- Data can be linked to Spatial to enhance the detail of it
Components of GIS

*All GIS software store information regarding geometric properties and non-spatial properties of data. Only some software packages (e.g. ArcGIS Workstation, Manifold) store information (rules) regarding the topological properties of data.*
Components of GIS

Geo-entities (Features, shapes, drawings)
- Used to represent geographic features

Points
Lines
Polygons

Surfaces
Components of GIS

Points

- Represent features with a single x,y coordinate
- Zero dimensional
- Takes less space to store the data

Spatial questions that we ask of a point
- Does it exist?
- Where is it?
- What is around it?
Components of GIS

Lines

- Represent linear features with a minimum of 2 x, y coordinates
- One dimensional
- Takes more space than a point to store the data

Spatial questions that we ask of are similar to a point and
- What is its length?
- What is its orientation (directionality)?
- Is it straight or curved (sinuosity)?
Components of GIS

Polygons

- Represent area features
- 2 dimensional
- Takes more space than a line to store the data

Spatial questions that we ask of are similar to a point and
  - What is its area?
  - What is its perimeter?
  - Does it overlap with adjacent features
  - Does it have holes in it?
Assignment

• List 5 examples of features that each geo-entity could represent in;
  – Urban Areas
  – Environment
  – Health

• No duplications allowed

Question
Features can be represented by more than one Geo-entity. What determines this?

(1 word answer)
SCALE
Introduction to Geographic Information Systems

Components of GIS

Surface

- Represent features in 3 dimensions (terrain, sub-surface, structures)
- Takes a significant amount of data to store

Spatial questions that we ask of are:
- Volume
- Slope
- Aspect
- Profile
- Visibility
Components of GIS

Note

A group of geo-entities can be represented by a single record. The will be referred to as multi-point, Multi-line and Multi-polygon.
Components of GIS

Geo-entities and layers

When we add spatial data in a GIS we refer to it as a layer. A layer can only have one geo-entity in it.

For instance you would not be able to have stop signs (point) and roads (lines) in the same layer.

You can have geo-entities representing different features in a layer (e.g. Streams and roads)
Components of GIS

A small ArcGIS demo
Geo-entities (Features) need to be stored and organized in a manner that allows them to be easily retrieved, transferred and manipulated. We have seen that both spatial and non-spatial data exists in an organized manner. In a GIS the spatial data can be structured as vector or raster data.
Vector data represents the location of point, line and polygon data at a high precision (See yesterday's lecture)

- A point is represented by a simple pair of coordinates.
- The line is represented by an ordered list of pairs of coordinates.
- The area is represented as a polygon with ordered pairs of coordinates that close the polygon (the first and last pair being the same).
Vector data (Con’t)

Coordinates for vector data can be any unit, but are primarily based on recognized coordinates system (Meters, latitude/longitude)

A line starts and ends with a ‘node’. When there are multiple segments within a line at each change in direction, there is a ‘vertex’
GIS Spatial Data Structures

**Raster and Vector Data**

**Raster data**

Raster data is stored in the computer in the form of a matrix or grid.

<table>
<thead>
<tr>
<th>LINES</th>
<th>ELEMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
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<td>9</td>
<td></td>
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<tr>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

Each cell within the grid contains a value. Cells with no data contain the value ‘0’. In the simplest raster system, the value stored for each cell is the attribute component of the geographic data. In Fig. 4, cells with value of "1" are forests, cells with value of "2" are croplands, and cells with value of "3" are rangelands.
GIS Spatial Data Structures

Raster and Vector Data

Raster data

Generally the common elements within a raster system are stored in separate layers.

- Soil classes
- Rivers
- Roads
Introduction to Geographic Information Systems

• http://geogratis.cgdi.gc.ca/geogratis/en/geo101.html;jsessionid=F3D12C2C445B82C40D6D6D3FA02FFD3D

• Raster Vector graphing exercise

• Search for the advantages and disadvantages of the raster and vector data format.

• John demo the
  • Raster data
GIS Spatial Data Structures

Raster and Vector Data

Raster Method

Advantages
• Data structure is simple.
• The method is compatible with remotely sensed or scanned data.
• Procedures for spatial analysis are simple.

Disadvantages
• Greater disk storage is often required.
• Topological relationships are difficult to represent.
• Unless extremely small cell sizes are used, the graphic output is often aesthetically less pleasing.
• Projection transformations are more difficult.
Vector Method

**Advantages**
- Compact data structure requires less disk storage.
- Topological relationships are readily maintained.
- Graphic output is aesthetically more pleasing and more closely approximates hand-drawn maps.

**Disadvantages**
- Data structures are complex.
- Overlaying multiple vector maps is often time consuming.
- Output graphics may take hours to draw on plotters.
- Some spatial analysis procedures are difficult.
- Software and hardware for vector systems are often more expensive.
- The method is not as compatible with remote sensing data.
GIS Spatial Data Structures
Raster and Vector Data

Week review
Geographic perspective
Why Geography is important
Introduction to GIS
5 Components of GIS
History of GIS
What is GIS

http://training.esri.com/Courses/StartGIS/index.cfm

Map gallery 2010


www.GIS.com