Lecture 1:
Overview of
Geographic Information Systems (GIS)

GE 118: INTRODUCTION TO GIS
Engr. Meriam M. Santillan
Caraga State University
What is Geographic Information?

- Data that involves an aspect of location on the Earth's surface or near-surface, which is converted to a form that is meaningful to a user.
- Built up from facts about the geographic world
What is Geographic Information?

- Sometimes referred to as *Spatial Information*
- Links *place/location, time*, and *attributes*
  - Example: “The temperature at 10am of June 20, 2014 in Caraga State University is 29 degrees Celsius.”
Why is it so important?

- Almost all our activities and decisions involve a geographic component.
- It helps us better understand the world around us.
- It enables us to develop spatial intelligence for logical decision making.
Defining Geographic Information Systems (GIS)

- “... a system of hardware, software, and procedures designed to support the capture, management, manipulation, analysis, modeling, and display of spatially referenced data for solving complex planning and management problems.” -- Rhind (1989)

- “… a computer system capable of assembling, storing, manipulating, and displaying geographically referenced information, i.e., data identified according to their locations.” -- USGS (1997)

- "Set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world for a particular set of purposes." -- Burrough (1986)
Defining Geographic Information Systems (GIS)

- "a computer based system that provides four sets of capabilities to handle geo-referenced data: --Arnoff (1989)
  - data input
  - data management (data storage and retrieval)
  - manipulation and analysis
  - data output."

- In simpler terms, GIS is a set of computer-based systems for managing geographic data and using these data to solve real-world spatial problems.
GIS layers to model the real world

http://geoworld.la.asu.edu/gis/
Why is GIS important?

GIS is a special class of information systems that keep track not only of events, activities and things, but also of *where* these events, activities and things happen or exist.

*Almost everything that happens, happens somewhere. Knowing where something happens is critically important.*

Longley, Goodchild, Maguire & Rhind
Why is GIS important?

- GIS is about finding patterns in data and solving real-world problems.
- It is able to easily integrate data from various sources and in different formats to come up with more accurate and timely decisions, thereby solving problems more efficiently.
Why is GIS important?

- Able to answer questions quickly and easily about location (Where? Why? How?).
- Illustrate patterns and trends that tabular data alone cannot show.
Questions GIS can answer

**Location:**  *What is at.............?*

- seeks to find out what exists at a particular location.
- location can be described in many ways, such as place name, post code, or geographic reference such as longitude/latitude or x/y.
Questions GIS can answer

Condition: Where is it …………?

- the converse of the first and requires spatial data to answer
- instead of identifying what exists at a given location, one may wish to find location(s) where certain conditions are satisfied (e.g., an unforested section of at-least 2000 square meters in size, within 100 meters of road, and with soils suitable for supporting buildings).
Trends: *What has changed since ..............?*

- may involve both the first two and seeks to find the differences (e.g. in land use or elevation) over time.
Questions GIS can answer

Patterns:  *What spatial patterns exists.............?*

- more sophisticated than the previous questions.
- to determine whether an occurrence is caused by its spatial location or proximity to a certain feature (e.g., whether landslides are mostly occurring near streams).
- might be just as important to know how many anomalies there are that do not fit the pattern and where they are located.
Questions GIS can answer

Modelling: *What if……………..?*

- to determine what happens if something is changed or something occurs (e.g., if a new road is added to a network or if a toxic substance seeps into the local ground water supply).

- answering this type of question requires both geographic and other information (as well as specific models).
Aspatial Questions

- questions that do not require the stored value of latitude and longitude or where places are in relation with each other.
- e.g., "What's the average number of people working with GIS in each location?"
Spatial Questions

- can only be answered using latitude and longitude data and other information such as the radius of earth.
- e.g., "How many people work with GIS in the major centres of Delhi" OR "Which centres lie within 10 Kms. of each other? ", OR "What is the shortest route passing through all these centres".
Advantages of GIS over manual methods

Traditional method:
- overlaying thematic maps manually to choose areas of coinciding constraints and opportunities.
- compilation of facilities data manually and drafting on large scale street map bases.
- difficulties with the manual overlay method include registering maps which may be published at different scales or projections.
- the more layers of maps included in the analysis and the more complex they are, the more the likelihood of human error entering the analysis and the longer the process takes.
Advantages of GIS over manual methods

**GIS:**

- can take maps from different sources and register them easily and is consistent in its analysis of multiple layers of map data.
- faster than manual methods of analysis, allowing the flexibility to try alternate variables in analysis.
Ease of registering and analyzing multiple map layers

http://www.geog.ubc.ca/courses/geog470/lectures/Intro/overlay_model.jpg
5 GIS Components

http://www.soi.city.ac.uk/~dk708/pg2_1.htm
GIS Components

Hardware

- consists of the computer system on which the GIS software will run.
- Made up of a configuration of core and peripheral equipment used for acquisition, storage, analysis, and display of geographic information.
- The computer forms the backbone of the GIS hardware, the heart of which is the Central Processing Unit (CPU).
GIS Components

Software

- provides the functions and tools needed to store, analyze, and display geographic information.
- Examples are ArcView, MapInfo, ARC/INFO, AutoCAD Map, etc.
- Can range from a simple package designed for a single PC to a major industrial-level workhorse for an entire group of networked computers.
GIS Components

Data
- The core of GIS
- May be geographic or tabular/attribute data
- Attribute data are additional information that describe the characteristics of spatial data.
GIS Components

Data

- Geographic data can be classified into three types:
  - Geodetic control network – foundation of all geographic data; established by high-precision surveying methods
  - Topographic base – result of mapping programs by mapping agencies
  - Graphical overlays – thematic data pertaining to specific GIS applications; may be derived from the topographic base, site investigation, field survey, remote sensing, etc.
GIS Components

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.
- Can be classified into three categories:
  - Viewers
  - General users
  - GIS specialists
<table>
<thead>
<tr>
<th>Types of GIS Users</th>
<th>Who are they?</th>
<th>Use for GIS</th>
<th>GIS Requirements</th>
<th>Role in GIS</th>
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</thead>
<tbody>
<tr>
<td><strong>Viewers</strong></td>
<td>Public at large</td>
<td>Occasionally browse a geographic database for referential information</td>
<td>Accessibility to information, ease of use</td>
<td>Passive users; No active role in GIS design and operation; significant impact of GIS development as a whole since they are the largest user class</td>
</tr>
<tr>
<td><strong>General users</strong></td>
<td>Facility managers, resource planners, scientists, engineers, land administrators, lawyers, business entrepreneurs, and politicians</td>
<td>Conducting business, performing professional services, decision-making</td>
<td>May vary considerably, ranging from simple spatial queries to very complicated temporal-spatial modeling</td>
<td>Active users since GIS is implemented to support their needs; has a direct and considerable influence on the successful use of GIS</td>
</tr>
<tr>
<td><strong>GIS specialists</strong></td>
<td>Those who actually make GIS work: GIS managers, database administrators, application specialists, systems analysts, and programmers</td>
<td>Maintenance of geographic database, provision of technical support for the viewers and general users, building of applications for advanced spatial data analysis and modeling, production of information products according to user specifications</td>
<td></td>
<td>Most direct role in the success of GIS implementation</td>
</tr>
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</table>
GIS Users and Interactions

- **GIS specialist**
  - Develop applications for
  - Request support from

- **General GIS users**
  - Develop applications for
  - Use GIS as a means to provide service to

- **Geographic information viewers**

Lo and Yeung (2002)
Method

- a successful GIS operates according to a well-designed plan and business rules, which are the models and operating practices unique to each organization.

- various techniques used for map creation and further usage for any project.
Thank you!