Explain the GIS, applications and its benefits.

Geographic information systems (GIS) (also known as Geospatial information systems) are Computer Software and hardware systems that enable users to capture, store, analyze and manage spatially referenced data. GISs have transformed the way spatial (geographic) data, relationships and patterns in the world are able to be interactively queried, processed, analyzed, mapped, modeled, visualized, and displayed for an increasingly large range of users, for a multitude of purposes. In a general sense, the term describes any information system that integrates stores, edits, analyzes, shares, and displays geographic information. GIS applications are tools that allow users to create interactive queries (user-created searches), analyze spatial information, edit data in maps, and present the results of all these operations. Geographic information science is the science underlying geographic concepts, applications, and systems.

Application:

Mineral Mapping

Satellite Imagery and aerial photography have proven to be important tools in support of mineral exploration projects. They can be used in a variety of ways. Firstly they provide geologists and field crews the location of tracks, roads, fences and inhabited areas.

Pipeline Corridor Mapping

Improve Safety and Security for Pipeline and Transmission Surveys: Satellite imagery and GIS data have significant potential to reduce a number of safety and security issues for pipeline corridor planning as well as supply managers with solutions through spatial representation of data for land, lease management, exploration, production, transmissions, environmental, financial and facilities management.

Defense and Security

Satellite imagery and GIS maximizes security programs which can enable local governments to better assess and understand how to develop programs to save lives, protect property and enhance the future economic stability of their communities. The current threats to a country range from incidents of terrorism and information attacks on critical infrastructure to the potential use of weapons of mass destruction and the spread of infectious diseases. Each one of these threats could cause massive casualties and disruption to a country.

Airport Mapping Database

Satellite Imaging Corporation (SIC) provides 3D airport mapping using high resolution stereo satellite imagery to support airport pre-planning and design, airport layout plans (ALPs), navigational mapping, and airport security and aviation safety operations.

Urban Development

Satellite imagery for urban and land development can be used to gather strategic planning information pertaining to a district or an entire city. High resolution satellite imagery and LiDAR incorporated into a GIS (Geographic Information Systems) and CAD (Computer Aided Drafting) has gained popularity among Planners, Developers and Engineers for large scale mapping of any region for most urban and land development applications.

Benefits

1. Improved decision by government officials
2. Instantaneous collaboration through the cloud
3. Layer complex data to drive improve decision making
4. Improved transparency for citizen engagement
5. Identify at-risk or under-served populations within a community
6. Management of natural resources
7. Improved communications during a crisis
8. Cost savings by improved decision making
9. Planning for demographic changes to community

Why digital mapping is necessary in GIS? Explain with practical example.

Digital mapping (also called digital cartography) is the process by which a collection of data is compiled and formatted into a virtual image. The primary function of this technology is to produce maps that give accurate representations of a particular area, detailing major road arteries and other points of interest. The technology also allows the calculation of distances from one place to another.

Differentiate between geographic phenomena and data modeling.

Geographic phenomena(do your self)

A **data model** in geographic information systems is a mathematical construct for representing geographic objects or surfaces as data. For example, the vector data model represents geography as collections of points, lines, and polygons; the raster data model represent geography as cell matrices that store numeric values; and the TIN data model represents geography as sets of contiguous, non-overlapping triangles. Data models are a set of rules and/or constructs used to describe and represent aspects of the real world in a computer. Two primary data models are available to complete this task: raster data models and vector data models.

Raster data model:
Continuous numeric values, such as elevation, and continuous categories, such as vegetation types, are represented using the raster model. The raster data model represents features as a matrix/lattice of cells in continuous space. A point is one cell, a line is a continuous row of cells, and an area is represented as continuous touching cells.

Vector data model:
Discrete features, such as customer locations, are usually represented using the vector model. Features can be discrete locations or events, lines, or areas. Lines, such as streams or roads, are represented as a series of coordinate pairs. Areas are defined by borders, and are represented by closed polygons. When you analyze vector data, much of your analysis involves working with (summarizing) the attributes in the layer's data table.

1. Explain the spatial database design with example.

A spatial database system may be defined as a database system that offers spatial data types in its data model and query language, and supports spatial data types in its implementation, providing at least spatial indexing and spatial join methods. A spatial database includes collections of information about the spatial location, relationship and shape of topological geographic features and the data in the form of attributes. The design of the spatial database is the formal process of analyzing facts about the real world into a structured model. Database design is characterized by the following phases: requirement analysis, logical design and physical design. In other words, you basically need a plan, a design layout and then the data to complete the process.

Steps in database design

1. Conceptual

a. software and hardware independent

b. describes and defines included entities

c. identifies how entities will be represented in the database

d. i.e. selection of spatial objects - points, lines, areas, raster cells

e. requires decisions about how real-world dimensionality and relationships will be represented

f. these can be based on the processing that will be done on these objects

g. e.g. should a building be represented as an area or a point?

h. e.g. should highway segments be explicitly linked in the database?

2. Logical

a. software specific but hardware independent

b. sets out the logical structure of the database elements, determined by the data base management system used by the software

3. Physical

a. both hardware and software specific

b. requires consideration of how files will be structured for access from the disk

5. what do you mean by spatial reference ? Explain the quality aspects of spatial data?

Geographic data for any particular area is stored in separate layers. For example, roads store in one layer, parcels in another, and buildings in a third. To enable the data in each layer to integrate when displayed and queried, each layer must reference locations on the earth's surface in a common way. Coordinate systems provide this framework. They also provide the framework needed for data in different regions to be referenced in different ways. Each layer in the geo database has a coordinate system that defines how its locations are geo referenced.

In the geo database, the coordinate system and other related spatial properties are defined as part of the spatial reference for each dataset. A spatial reference is the coordinate system used to store each feature class and raster dataset as well as other coordinate properties such as the coordinate resolution for x,y coordinates and optional z- and m- (Measure) coordinates. If required, you can define a vertical coordinate system for datasets with z-coordinates that represent surface elevation.

When we refer to the concept of geographical information quality is necessary to know that this subject is usually covered by the quality elements. These elements quality should be evaluated in function of the foreseen use and the production cost. Without fear of committing mistakes, we can affirm that every day exist less economic resources and this fact forces the administrators of public resources to find technical solutions that guarantee the optimization of each cent. The direct consequence of this action is the demand of precise and accurate projects. Happily, the manufacturing companies of mensuration equipment accompanied the technological evolution of recent years and have launched new instruments every year with ever more affordable costs. Three decades ago, the acquisition of good angular measurement instruments incorporating an electronic distance measurement, cost around three to four tens of thousands of dollars. Nowadays it is possible to acquire more compact and better quality instruments for one third of the original value. This fact has contributed greatly to the small survey companies and even city halls of small cities, as they can be equipped with instruments that, since they are used in a convenient way, guarantee quality of the collected information.

2. Explain with example of metadata and design of GIS.

A metadata record is a file of information, usually presented as an XML document, which captures the basic characteristics of a data or information resource. It represents the *who*, *what*, *when*, *where*, *why* and how of the resource. Geospatial metadata commonly document geographic digital data such as Geographic Information System (GIS) files, geospatial databases, and earth imagery but can also be used to document geospatial resources including data catalogues, mapping applications, data models and related websites. Metadata records include core library catalogue elements such as Title, Abstract, and Publication Data; geographic elements such as Geographic Extent and Projection Information; and database elements such as Attribute Label Definitions and Attribute Domain Values. Metadata is defined by the New Merriam-Webster Dictionary as “data that provides information about other data”. Geographic metadata is used to document the attributes of geographic data, e.g. database files and data develop within a Geographic Information System (GIS), in the same way that the nutrition label to the right documents the attributes of a food product. Geographic metadata seeks to answer questions such as: Who developed the data? When was the data collected? How were the data processed? How are the data attributes defined? In what formats are the data available? How does one obtain the data? The information in the metadata provides context for the data and supports the effective application of the data.

Metadata is an important, but unfortunately oft overlooked component of GIS data. Metadata is 'data about the data' and it's vital to understanding to source, currency, scale, and appropriateness of using GIS data. Metadata can be stored as an inherent part of the GIS data, or it may be stored as a separate document.

Examples of information (this is not a comprehensive list) contained within metadata are: creation date of the GIS data, GIS data author, contact information, source agency, map projection and coordinate system, scale, error, explanation of symbology and attributes, data dictionary, data restrictions, and licensing. Essentially, metadata is a description of the GIS data set that helps the user understands the context of the data.

3. Explain the system analysis and design of GIS.

The practice of design focuses on planning the structure and features associated with any system. Design activities can focus on something as simple as a coffee maker or as complex as an aircraft carrier. The product of the design practice is a plan that can be used for implementation. This is what is referred to as "the design." So there are really two things happening - there is a process associated with designing something, and then the product of that process is often called the *design*.

All of you have substantial background knowledge about GIS systems, how they are applied, and what their capabilities include. To help frame things a bit, I'd like you to consider my argument that, in the GIS world, design centers on a few key components:

- **Users -** Who will be the target audience for your system?
- **Tasks -** What do the users expect to accomplish with the system?
- **Data -** Which source materials will be required to complete system tasks?
- **Products -** What outputs from the system are needed?

The Process of GIS Design

The basic design process we'll focus on in this course is outlined in the graphic below. This depiction of the design process has four key stages, each of which is influenced in part by some sort of evaluation activity.

Needs Assessment refers to the user and task requirement analysis stage where the goal is to identify the key components I listed above (users, tasks, data, and products).

- **Concept Development** takes the results from needs assessment and formalizes those results into specific design plans, which in the GIS case could include interface mockups and system programming architectures.
- **Prototyping** is an activity that demonstrates the design concepts in a form that can be readily evaluated.
- **Implementation** is the final phase of work that combines results from the previous design phases and results in execution of the complete, refined project.
- **Evaluation** is any activity intended to measure the success of a particular design phase. It is presented in the graphic below as something that occurs throughout each of the other discrete activities.