GEOGRAPHICAL INFORMATION SYSTEM

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CONTENTS

Introduction To Geographical Information System

Geo:- EARTH

Geography:- Study of earth and where things are.

Information:- For capturing, managing, analyzing and understanding Information.

System:- A set of Software, hardware and Data.

What Is GIS:-

- Geographical Information System (GIS) is a computer based information system used to **digitally represent** and analyze the **geographic features present** on the **Earth's surface and the events that taking place on it.**
- Geographic Information Systems provide a method for integrating and analyzing spatial (digital map based) information such as "where is the nearest movie theater?"
- Alongside related non-spatial information (what movies are playing there?).
- Many people are becoming far more **familiar** with seeing the results both textually - for example when their phone shows them the nearest pub - and on open map systems such as Google Maps.

GIS Capabilities/ Analysis with GIS :

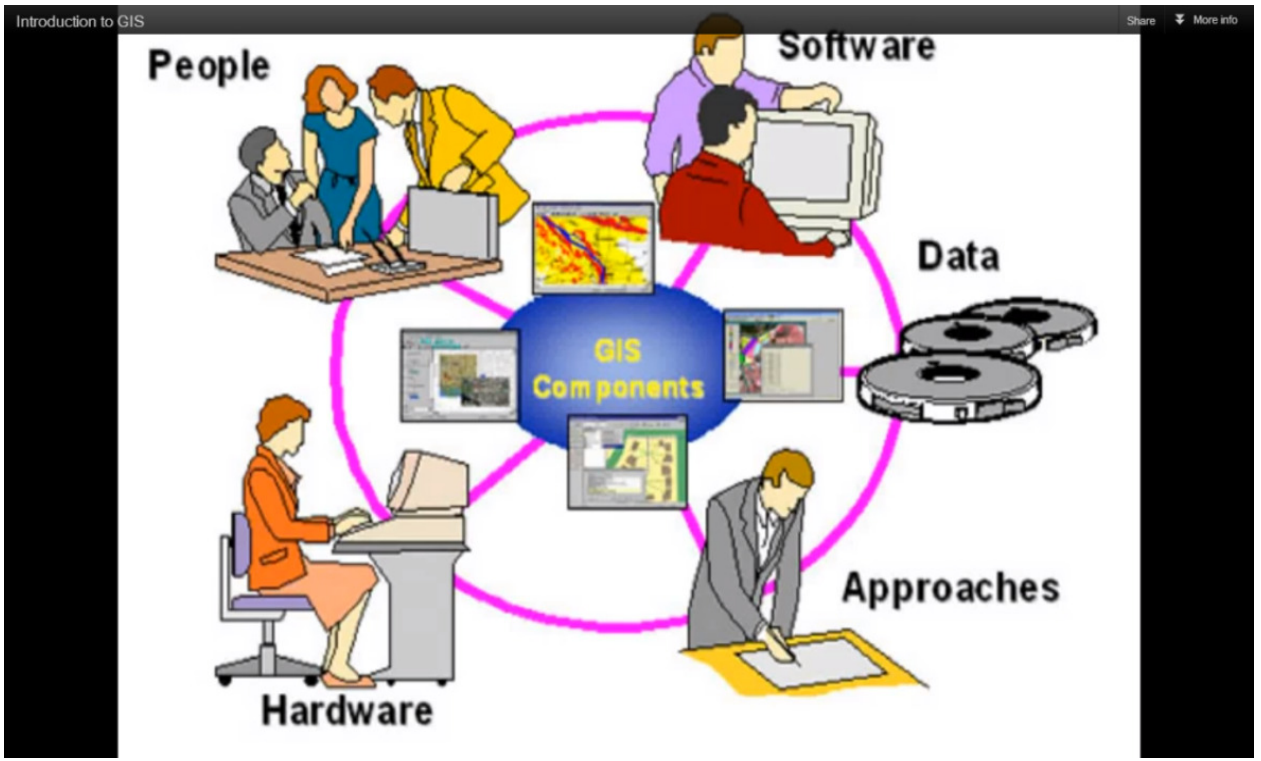
- **Location:** What is at a particular location...? Where is it….?
- **Condition:** identify a location where certain conditions exist..?
- **Trends:** What has changed since...?
- **Patterns:** What things are related..?
- **Modeling:** What if…?

The Need For GIS:

- The real world has a lot of spatial data
  - manipulation, analysis and modeling can be effective and efficiently carried out with a GIS
    - the neighborhood of the intended purchase of house
    - location of historical sites to visit
- The earth surface is a limited resource
  - rational decisions on space utilization
  - fast and quality information in decision making

Components of GIS:-

A working Geographic Information System seamlessly integrates five key components:



Hardware:-

- Computer
- Digitizer
- Scanner
- Printer/Plotter

Software :-

GIS software provides the functions and tools needed to store, analyze, and display geographic information. **The Key components of GIS Software are:-**

- **Tools** for entering and manipulating geographic information such as addresses or political boundaries
- A database management system (DBMS)
- **Tools that create intelligent digital maps** you can analyze, query for more information, or print for presentation
- An easy-to-use graphical user interface (GUI)

Major GIS software

- ***ARCGIS (ArcView 10.1)***

  ArcView: ESRI, the producer of ArcView, has been an industry leader in the production of GIS software and in the support of GIS education. **Access ready-to-use** ArcGIS for Desktop Basic (formerly known as ArcView), which allows one to view spatial data, create layered maps, and perform basic spatial analysis.

- ***GRASS GIS*** (**Geographic Resources Analysis Support System**)

- ***Google Map***

- ***Google Earth***

Data:-

- GIS incorporates geographical features with tabular data in order to map, analyze, and assess real-world problems.
- Data that is in some way **referenced to locations on the earth**. Attribute data can be generally defined as additional information about each of the **spatial features.**
- Geographic data and related tabular data can be produced by digitizing images from aerial photographs or published maps.
- An **example** of this would be college. The actual location of the College is the spatial data.
- Additional data such as the College name, specialization, capacity would make up the attribute data.

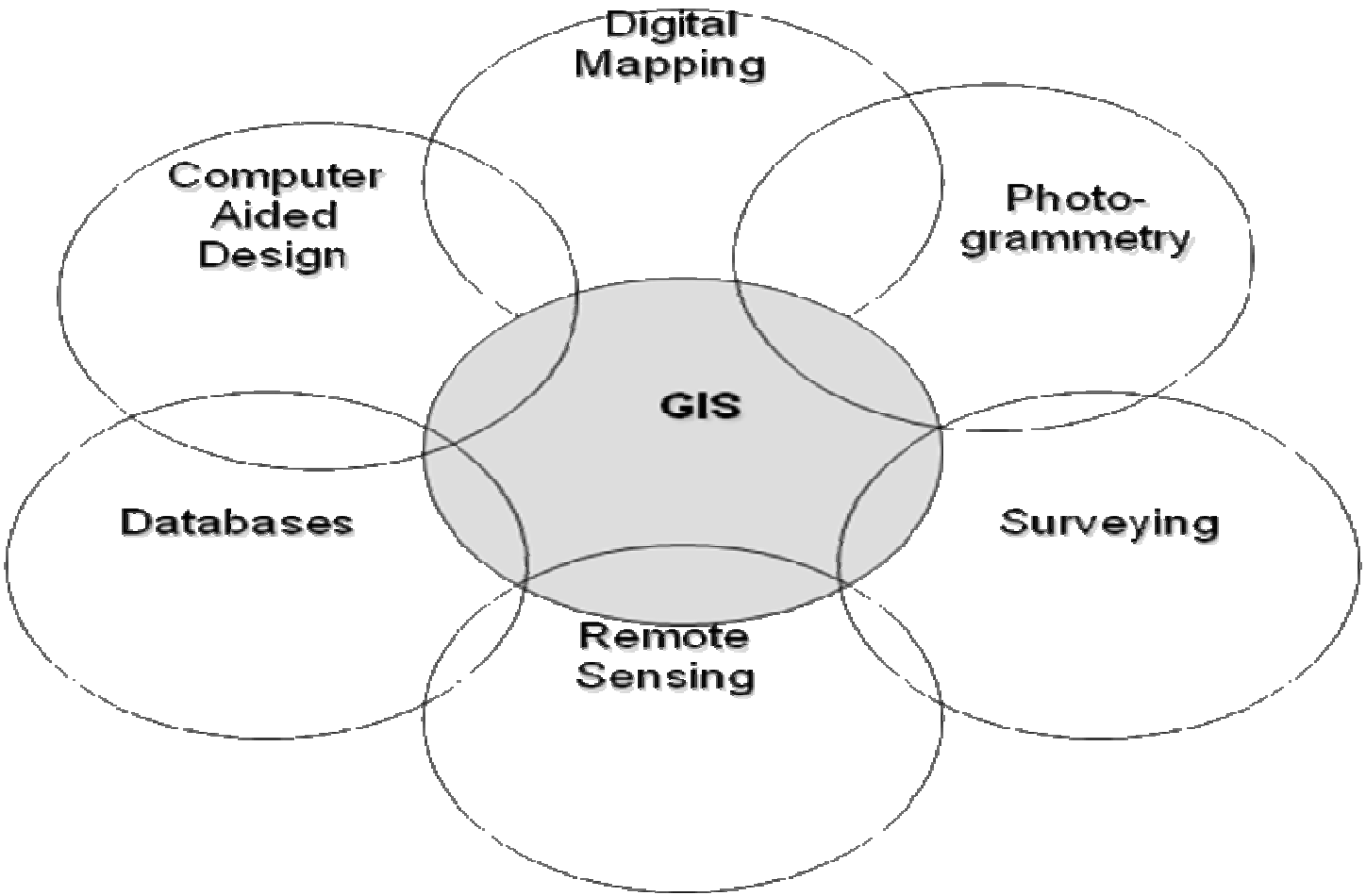
People:-

GIS users range from technical specialists who design and maintain the system to those who use it to help them perform their everyday work.

M E T H O D S

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

CROSS-DISCIPLINARY NATURE OF GIS



1. ***Digital Mapping:-***

- If you want to use already existed maps which are not in digital form, but in a form that can be recognized by computer can be used in GIS by converting them into Digital form so that they can be used.
- Maps can be digitized by hand-tracing with a computer mouse on the screen or on a digitizing tablet to collect the coordinates of features.
- Electronic scanners can also convert maps to digits.

2. Photogrammetry :-

Photogrammetry is art, science, and technology of obtaining the geometric properties (of shape, size, relative position of figures, and the properties of space)of objects from photographic images. Photogrammetry is as old as modern photography.

3. Surveying :-

- **Surveying** or **land surveying** is the technique, profession, and science of accurately **determining the three-dimensional position of points and the distances and angles between them(relative position of points or physical and cultural details).**
- These points are usually on the surface of the Earth, and they are **often used to establish land maps, boundaries for ownership** or governmental purposes and cultural details about the area or land.

4. Remote Sensing:-

- Remote sensing is the technique of deriving information about objects on the surface of the earth without physically coming into contact with them but with the help of sensors like cameras scanners carried on airplanes, satellites.
- These sensors collect data in the form of images.
- These sensors are at a considerable height from the earth surface and recording the observations on a suitable medium (images on photographic films and videotapes or digital data on magnetic tapes).

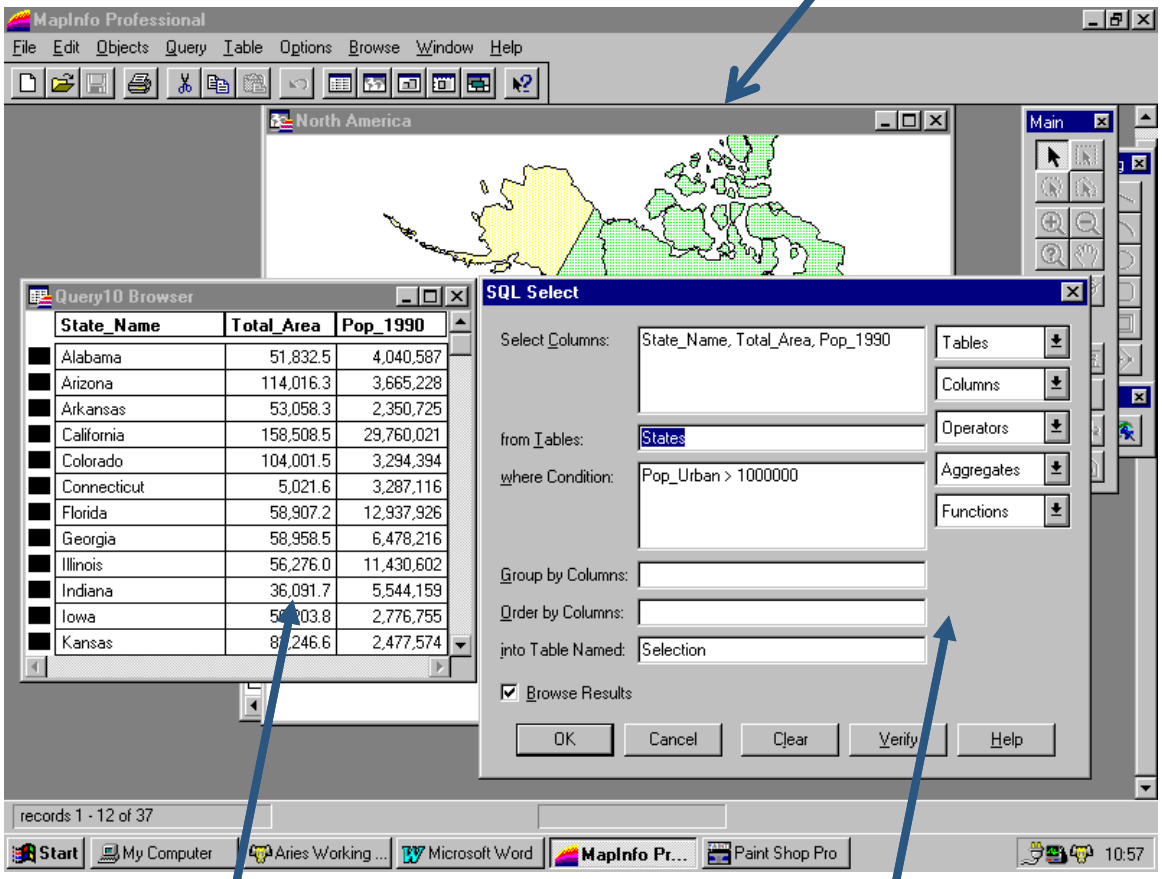
5. Statistical databases:-

There are many different designs of DBMS's, but in GIS the relational design has been the most useful.

In the relational design, data are stored conceptually as a collection of tables. Common fields in different tables are used to link them together.

- Spatial relational databases
  - exactly the same as any other relational database (RDBS) except that at least some of the Tables consist of entities with a geographic location.
- geographic information about Geographic objects in the Table.
  - Place name, longitude, latitude, Pin code, description..etc.

- At a simple level a GIS may just form the graphical interface to a database



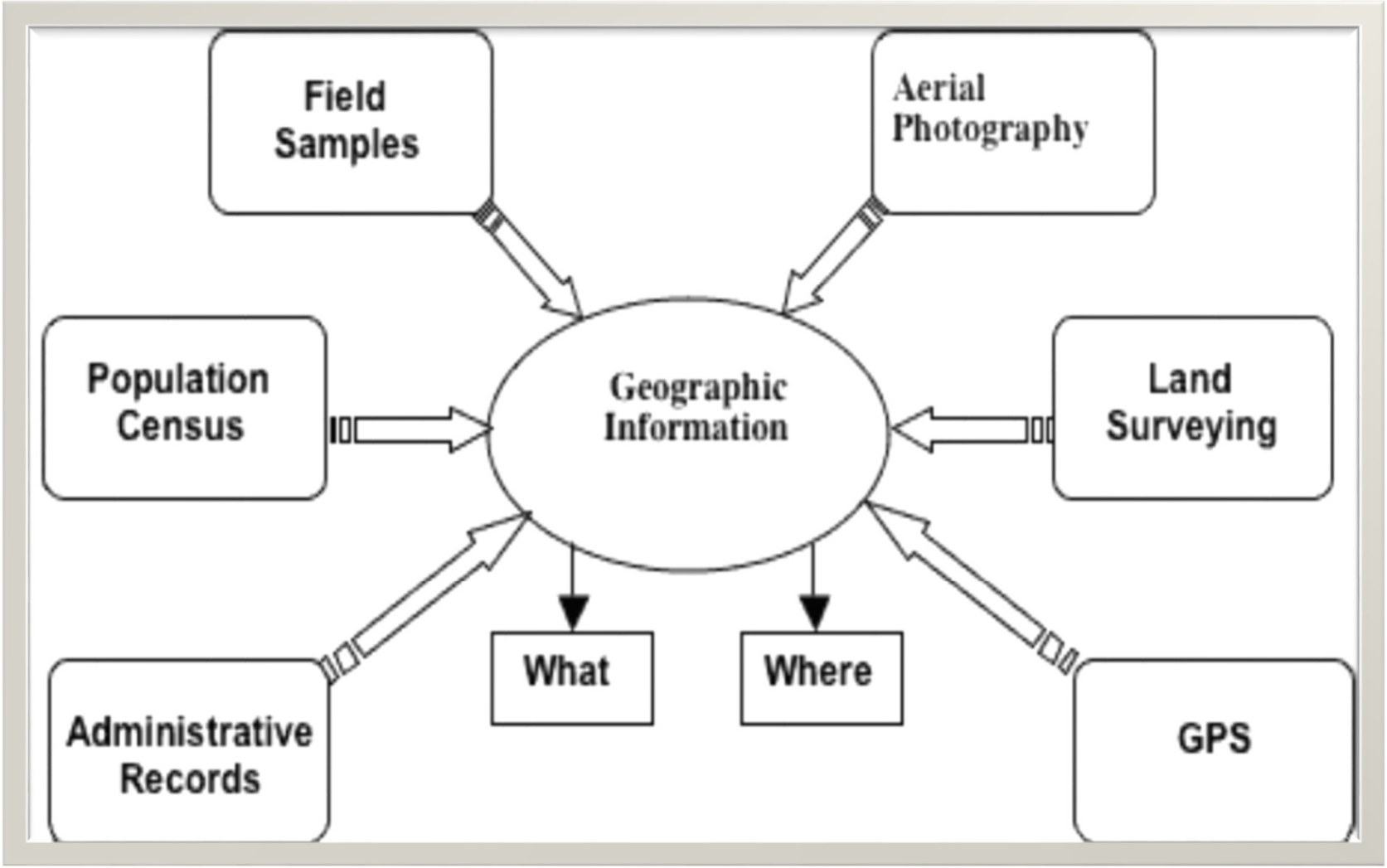
6. ***Computer Aided Design:***

- CAD is an automated system for the design, drafting and display of graphically oriented information.
- CAD is used with GIS and the benefit is CAD allows a user to create a very accurate drawing whether it is a map, site plan, profile, etc.

All the above defined systems are used with GIS to make it more efficient.

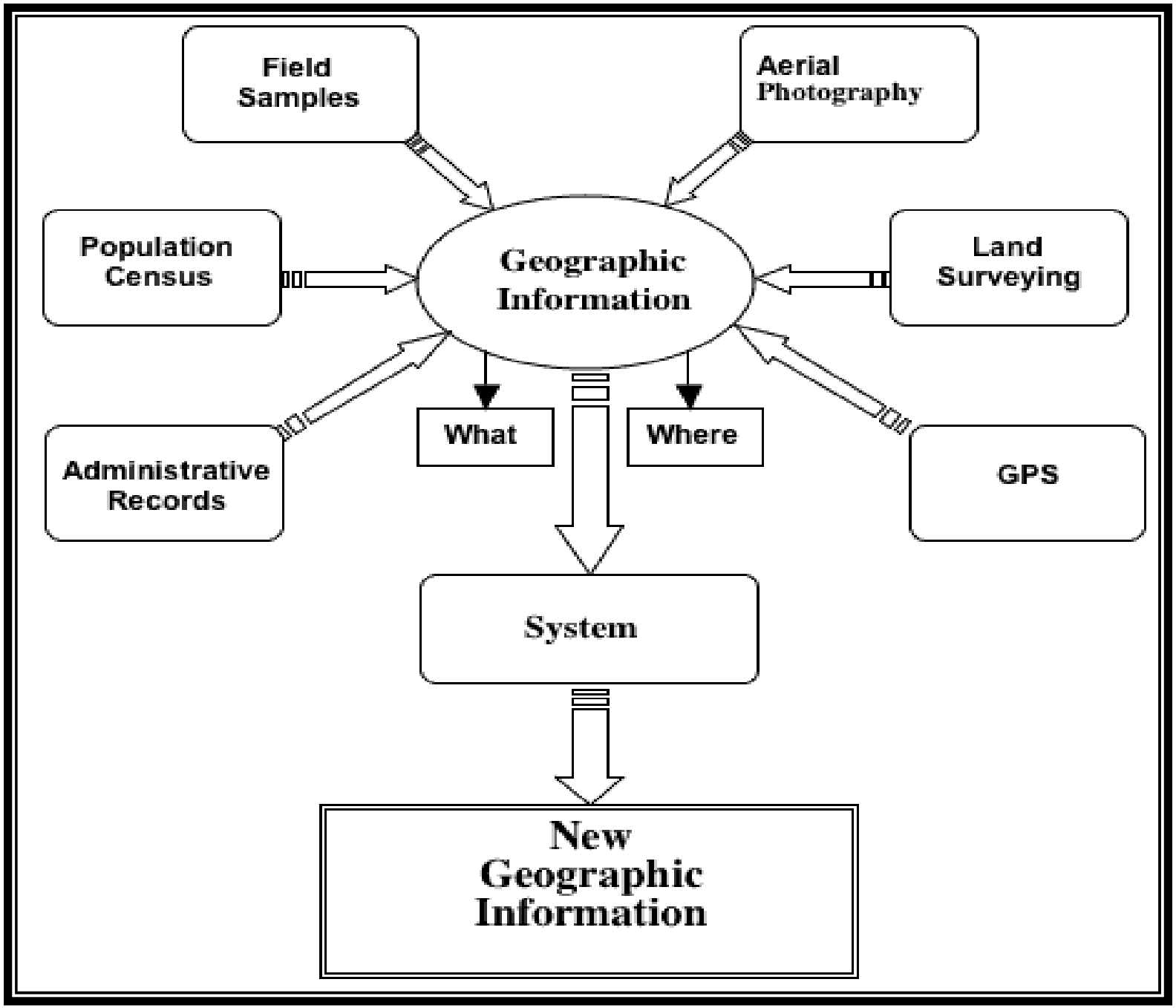
CREATING GIS:

- Essentially, geographic information **states what is where.**
- So to create geographic information, we have to record these two elements somehow.
- They can be captured through many different types of observations, measurements and surveys.
- Data can be sourced from aerial photography, satellite images, field samples, land surveying, population censuses, global positioning systems (GPS) and government administrative records among others.

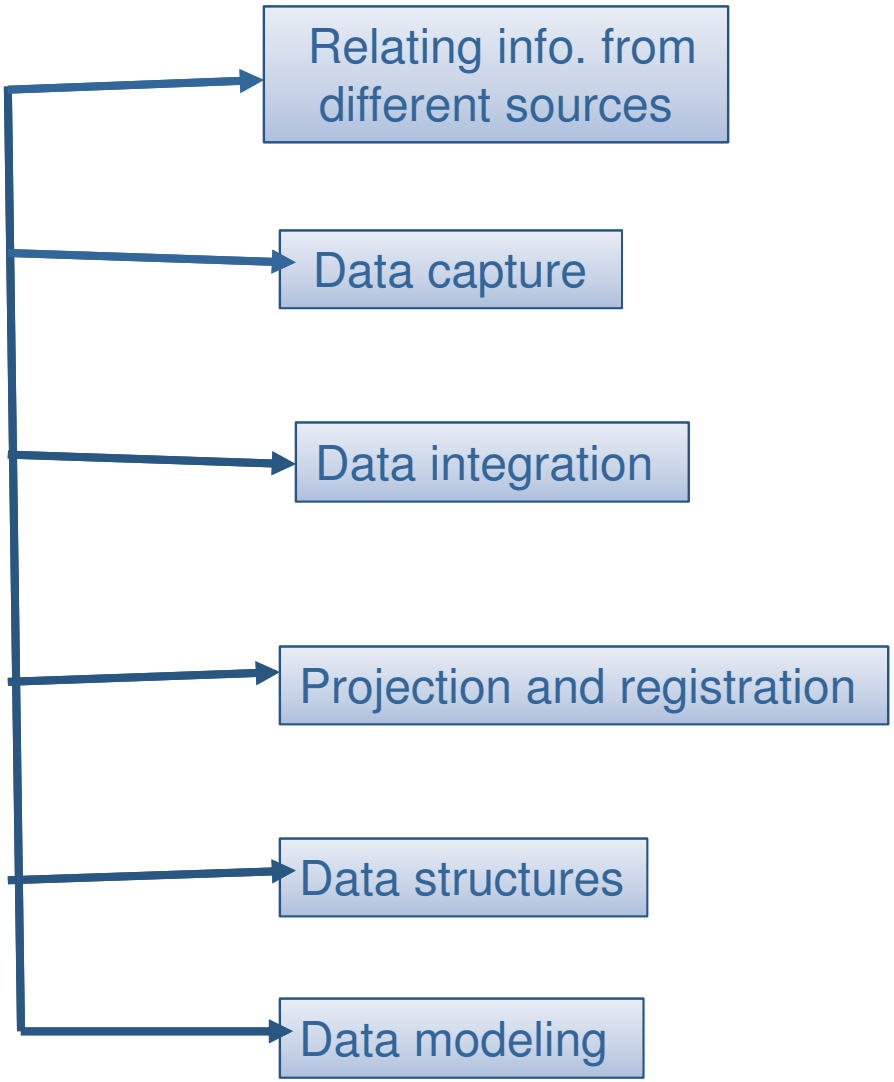


How To Combine Geographic Information..?

- If we are combining a number of different geographic information themes together, they may be from different sources, in different formats and covering different study areas.
- Therefore, we need to use a system to deal with the *__disparate__ sources and organize them so that they can be combined.
- A Geographic Information System does just that It is a tool for the input of different geographical information themes so that they can be stored, organized, displayed and analyzed.
- **It uses geography as the common denominator between separate themes** so that they can be combined.
- Its purpose is to provide answers to questions based on geographical data



How Does GIS Works :



1. ***Relating Information From Different Sources:-***

- The power of a GIS comes from the ability to relate **different information in a spatial context and to reach a conclusion about this relationship.**
- Most of the information we have about our world contains a location reference, placing that information at some point on the globe.
- A GIS, therefore, can reveal **important new information that leads to better decision making.**

2. Data Capture:

- How can a GIS use the information in a map? If the data to be used are not already in digital form, that is, in a form the computer can recognize, various techniques can capture the information.
- Maps can be digitized by hand-tracing with a computer mouse on the screen or on a digitizing tablet to collect the coordinates of features.
- A GIS can be used to emphasize the spatial relationships among the objects being mapped.

- ***Data capture***—putting the information into the system —involves identifying the objects on the map, their absolute location on the Earth's surface, and their spatial relationships.
- **Software tools** that automatically extract features from satellite images or aerial photographs.
- A computer-aided mapping system may represent a road simply as a line, a GIS may also recognize that road as the boundary between wetland and urban city.

3. Data Integration:

- A GIS makes it possible to link, or integrate, information that is difficult to associate through any other means.
- Thus, a GIS can use combinations of mapped variables to build and analyze new variables.

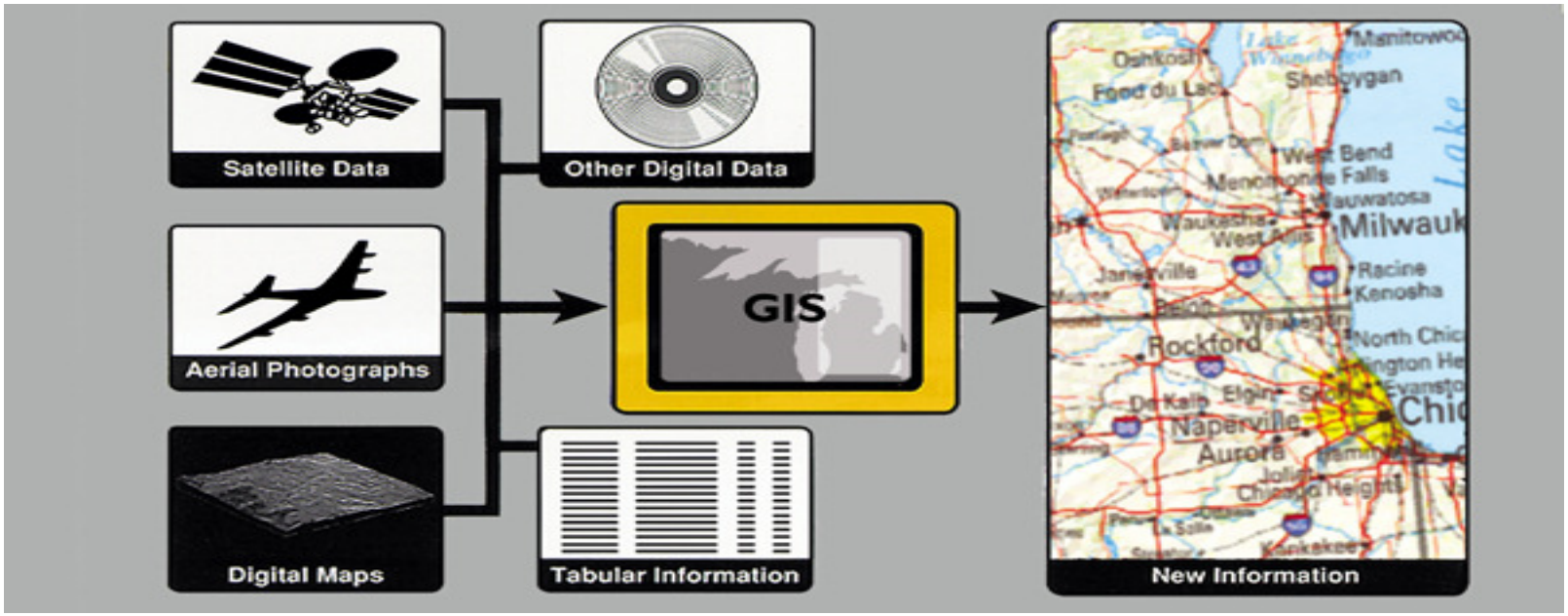


FIG:- Data integration is the linking of information in different forms through a GIS.

- **For example**, using GIS technology, it is possible to combine agricultural records with hydrography (The science of the measurement and description and mapping of the surface waters of the earth with special reference to navigation) data to determine which streams will carry certain levels of fertilizer runoff.
  - Agricultural records can indicate how much pesticide has been applied to a parcel of land.
  - By locating these parcels and intersecting them with streams, the GIS can be used to predict the amount of nutrient runoff in each stream.

4. Projection & Registration:

- Projection is a fundamental component of mapmaking. A projection is a mathematical means of transferring information from the Earth's **three-dimensional, curved surface to a two-dimensional medium**—paper or a computer screen.
- Different projections are used for different types of maps because each projection is particularly appropriate for certain uses.
- Since much of the information in a GIS comes from existing maps, a GIS uses the processing power of the computer to transform digital information, gathered from sources with different projections, to a common projection

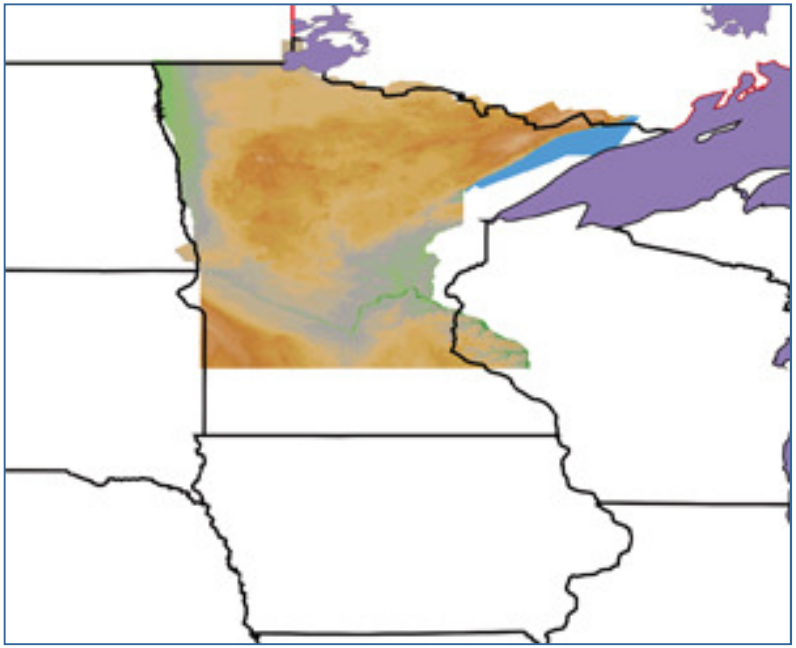
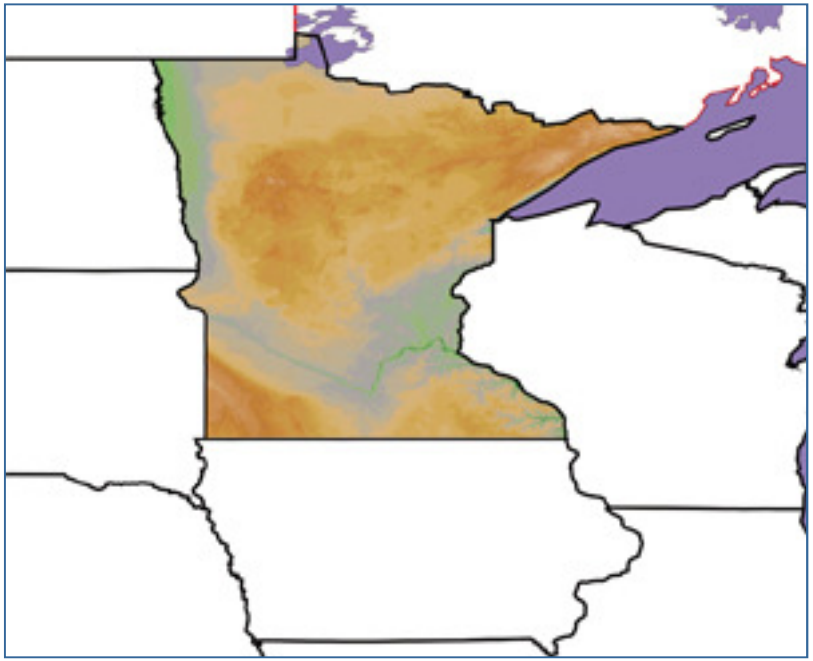


FIG:- An elevation image classified from a satellite image of Minnesota (state) exists in a different scale and projection than the lines on the digital file of the State and province boundaries.



The elevation image has been re-projected to match the projection and scale of the State and province boundaries

5. Data structures :

- Can a property ownership map be related to a satellite image, a timely indicator of land uses? Yes, but, because digital data are collected and stored in various ways, the two data sources may not be entirely compatible. So a GIS must be able to convert data from one structure to another.
- Data restructuring can be performed by a GIS to convert data into different formats
- **For example,** a GIS may be used to convert a satellite image map to a vector structure by generating lines around all cells with the same classification, while determining the cell spatial relationships, such as adjacency or inclusion.

1	1	1	1	1	1	1	3	3	3
1	1	1	1	1	1	1	3	3	3
1	1	1	1	1	1	3	3	3	3
1	1	1	2	2	2	2	3	3	3
1	1	1	2	2	2	2	3	3	3
1	1	1	2	2	2	2	3	3	3
1	1	1	1	2	2	2	3	3	3
1	1	1	1	1	1	3	3	3	3
1	1	1	1	1	1	1	3	3	3
1	1	1	1	1	1	1	1	3	3

Figure 13a. Magnified view of the same GIS data file, shown in raster format.

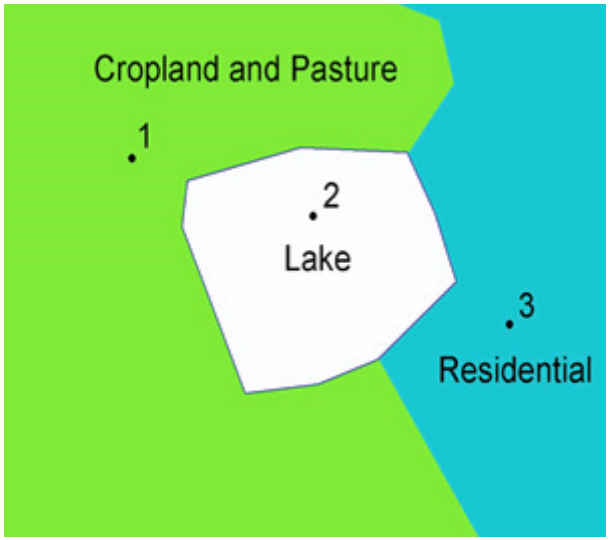


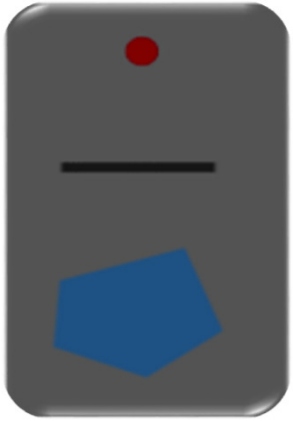
Figure 13b. Magnified views of the same GIS data file. converted into vector format.

6. Data Modeling:

- It is impossible to collect data over every square meter of the Earth's surface. Therefore, samples must be taken at distinct locations.
- A GIS can be used to depict two- and three-dimensional characteristics of the Earth's surface, subsurface, and atmosphere from points where samples have been collected.
- **GIS Spatial Data Model :-**
  - Traditionally spatial data has been stored and presented in the form of a map. Three basic types of spatial data models have evolved for storing geographic data digitally. These are referred to as:
    - ✓ Vector Data Model
    - ✓ Raster Data Model

- # Vector Data

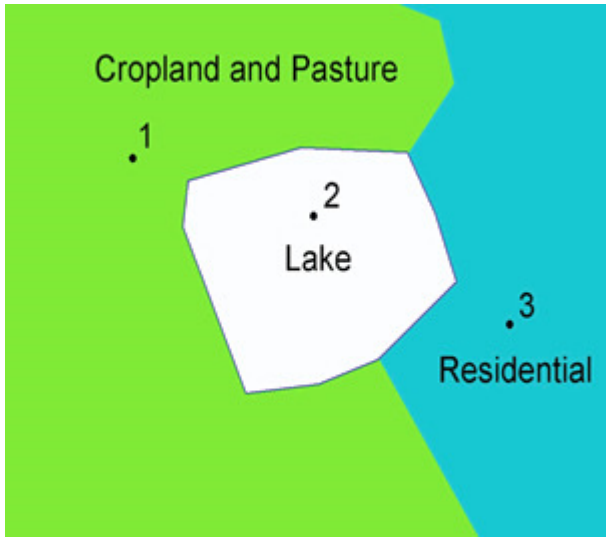
  - **Map features**
    - Points, lines, polygons
    - Feature attributes
  - Every feature has attributes
    - (e.g. name, area, population)



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

- # Raster Data

  - Stored electronic image or picture taken as an aerial photograph or satellite image.
  - Composed of a rectangular array of square cells, called pixels, with a number in each cell representing the solid color fill of that cell.



In Vector model: as geometric objects: points, lines, Polygons

1	1	1	1	1	1	1	3	3	3
1	1	1	1	1	1	1	3	3	3
1	1	1	1	1	1	3	3	3	3
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1	1	1	2	2	2	2	3	3	3
1	1	1	1	2	2	2	3	3	3
1	1	1	1	1	1	3	3	3	3
1	1	1	1	1	1	1	3	3	3
1	1	1	1	1	1	1	1	3	3

Fig:- Raster model as image files composed of grid-cells (pixels)

- A new hybrid method of storing data is that of identifying point clouds, which combine three-dimensional points with **RGB** information at each point, returning a "**3D** color image".
- GIS thematic maps then are becoming more and more realistically visually descriptive of what they set out to show or determine.

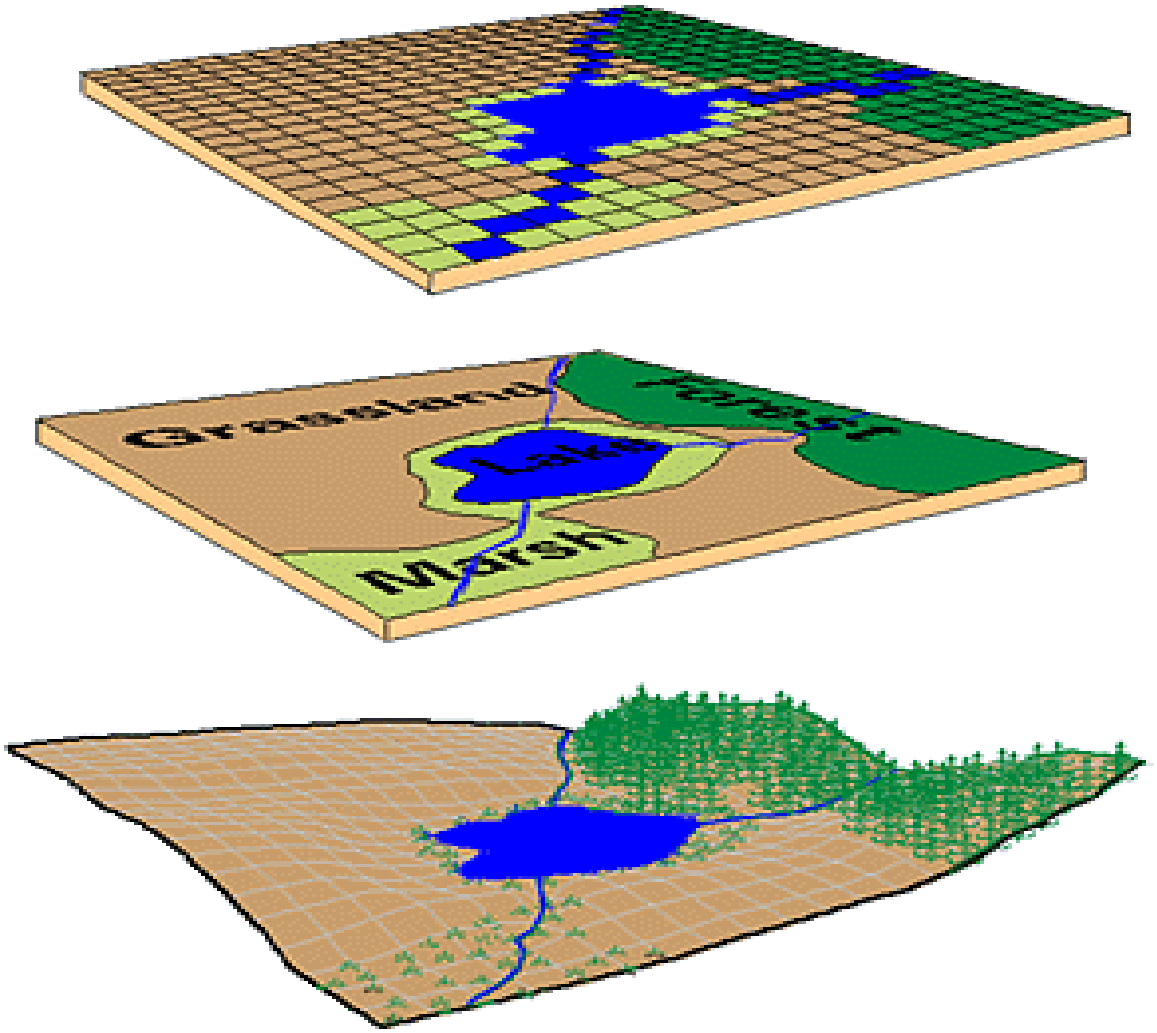
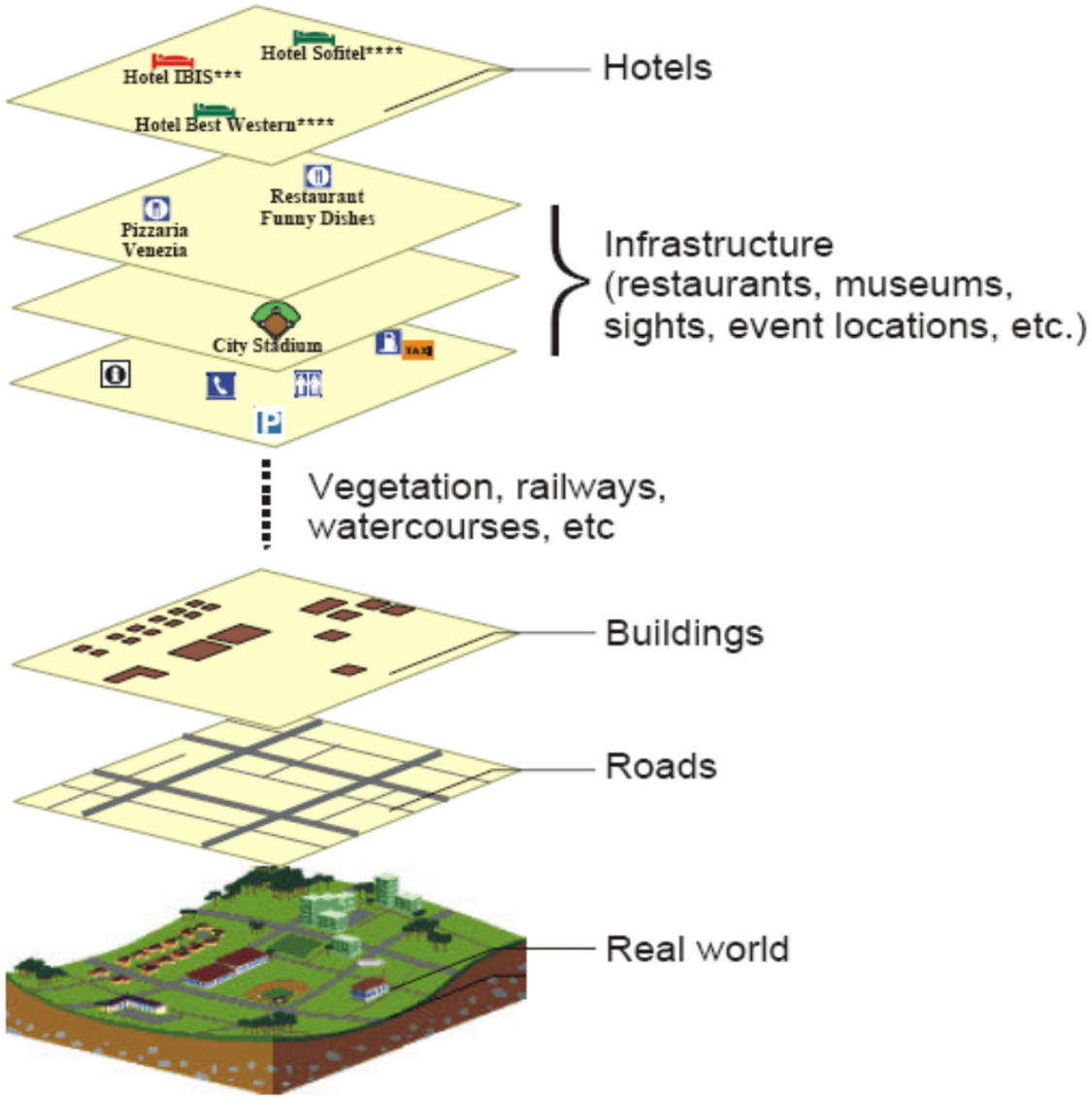
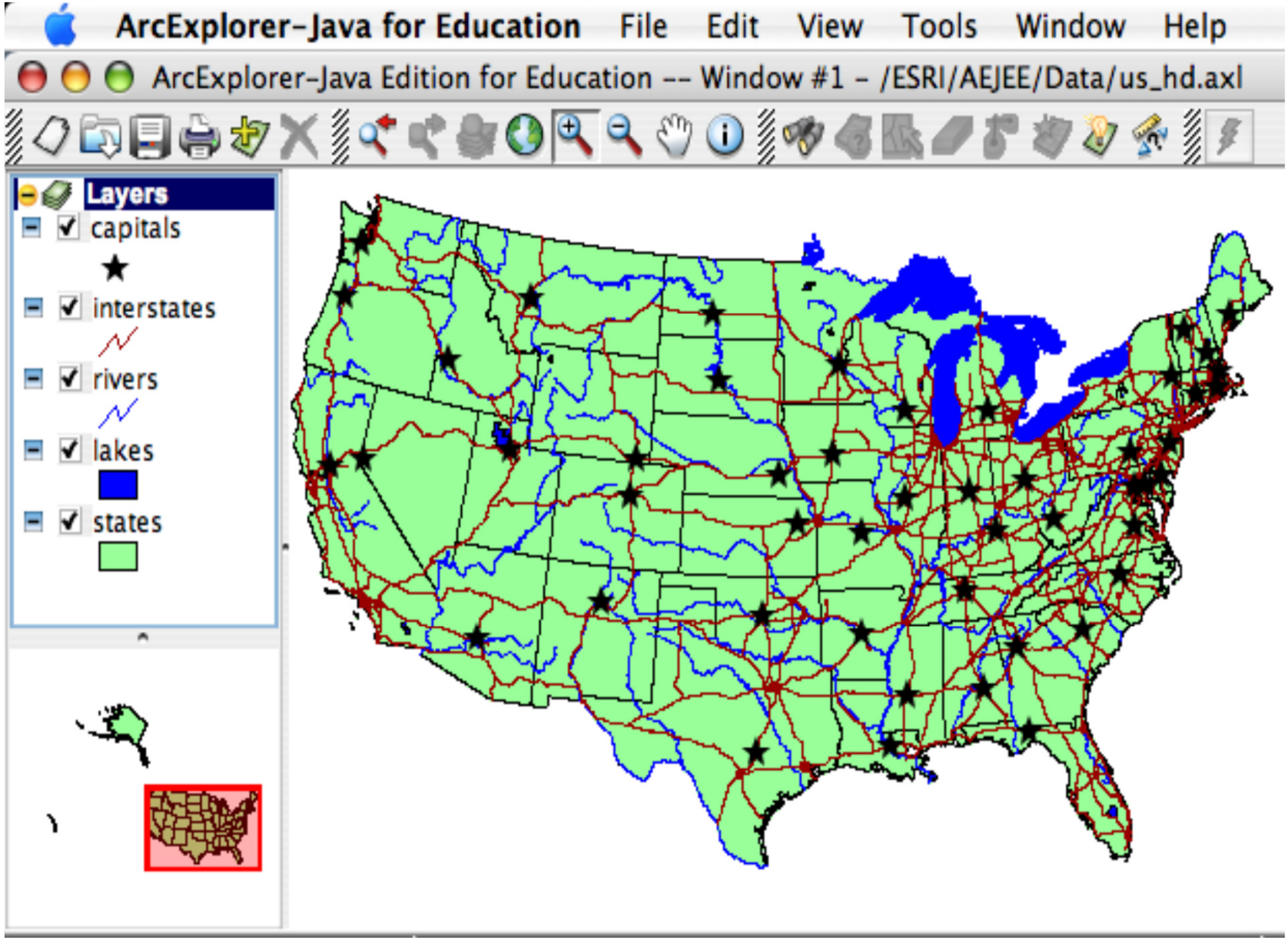


Figure:- Raster, Vector n Real Model

Information is organized into layers:

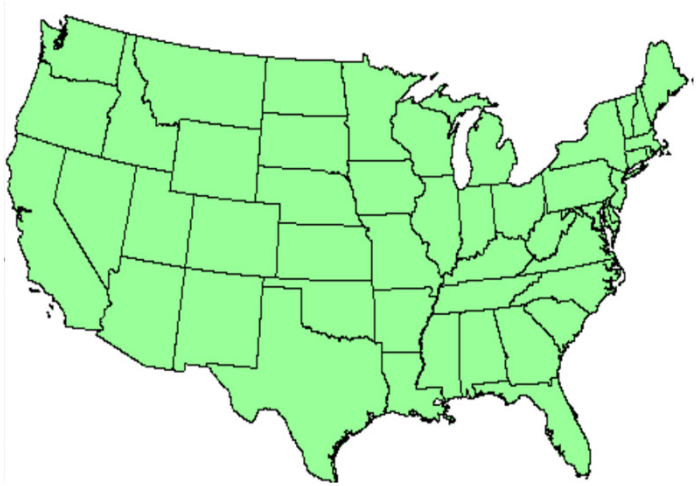
GIS organizes information in many layers. Each layer represents a particular theme or feature of map.



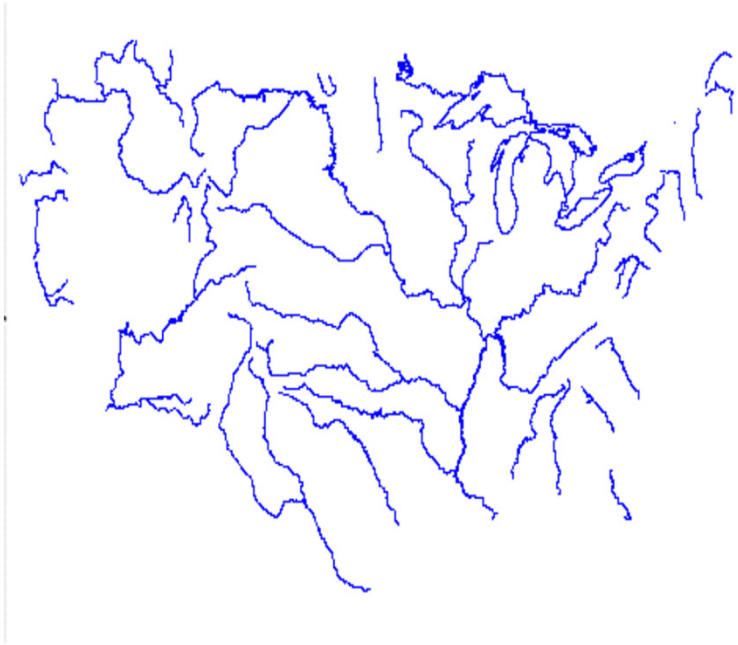


Lakes

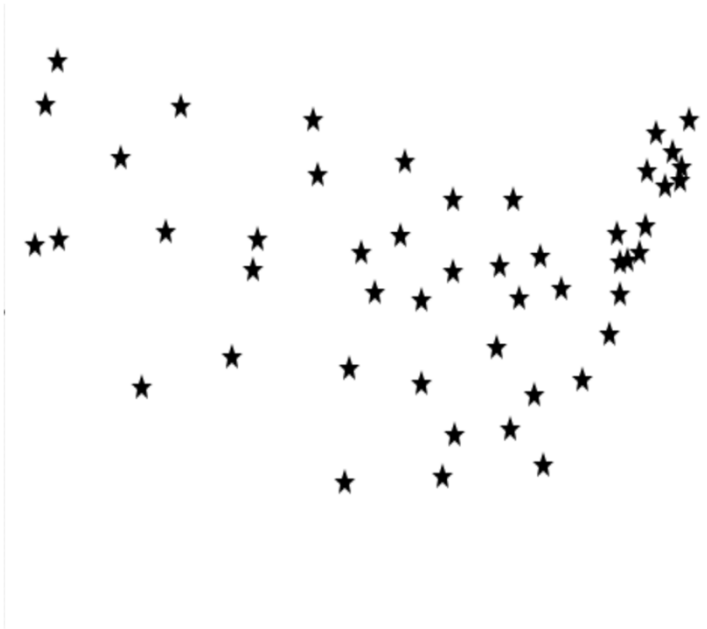
Roads



States



Rivers



Cities

WHY IS GIS UNIQUE..?

- GIS handles SPATIAL information - information referenced by its location in space.
- GIS makes connections between activities based on spatial proximity.
- GIS stores related geographic features in separate collections of files called map layers
- Map layers can be reused easily and assembled into any number of map compositions and overlaid for analysis

Top Benefits of GIS

GIS benefits organizations of all sizes and in almost every industry. There is a growing awareness of the economic and strategic value of GIS.

Better Decision Making:

GIS is the go-to technology for making better decisions about location. **Common examples include real estate site selection, route selection.** Making correct decisions about location is critical to the success of an organization.

Improved Communication:

GIS-based maps and visualizations greatly assist in understanding situations and in storytelling.

They are a type of language that improves communication between different teams, departments, disciplines, professional fields, organizations, and the public.

Better Recordkeeping:

Many organizations have a primary responsibility of maintaining authoritative records about the status and change of geography and GIS provides a strong support. GIS provides a strong framework for managing these types of records with full transaction support and reporting tools.

Managing Geographically:

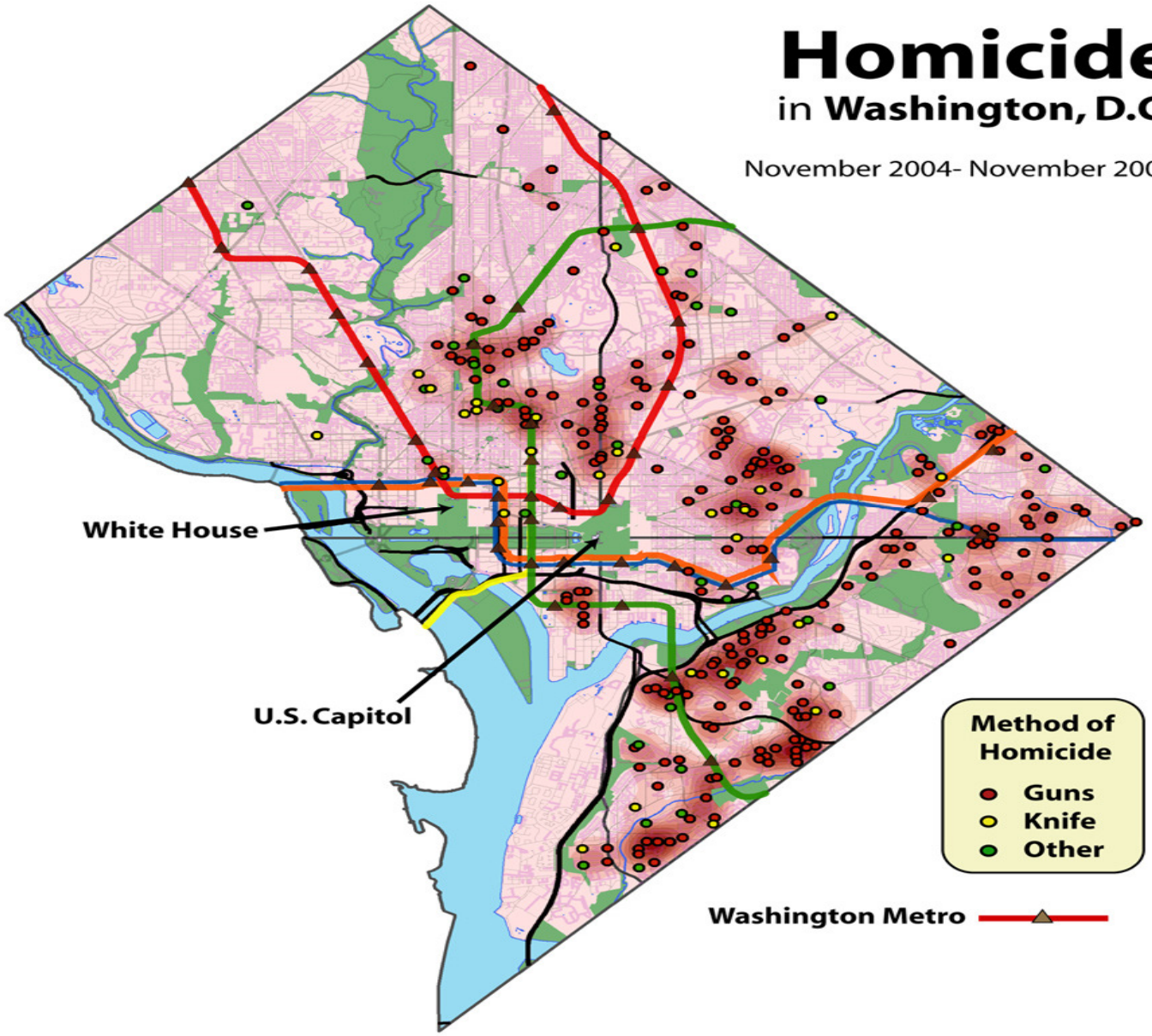
GIS is becoming essential to understanding what is happening—and what will happen—in geographic space.

- **Geospatial data are better maintained in a standard format.**
- **Revision and updating are easier.**
- **Geospatial data and information are easier to search, analysis and represent.**
- **Geospatial data can be shared and exchanged freely.**
- **Time and money are saved.**

GIS Applications:

Crime mapping:-

- It is used on police crime maps. Collection of data regarding incidences and arrests on geographical areas which in turn helped increase police patrols to reduce crimes.
- **For Example :-** In the case where there is a **kidnapping and** the perpetrators (committers) of crime call to demand something then this technology can be used to locate the individual exactly where he or she is calling from.



Media and Press:

Journalists and editors use GIS in a number of ways:

- Creating valuable graphic images that help tell compelling stories.
- Researching in depth information for articles.

Example:-

Mapping The Medals In Olympic :-

Sport	Gold	Silver	Bronze	Total	
	0	2	4	6	
Badminton	0	0	1	1	+
Boxing	0	0	1	1	+
Shooting	0	1	1	2	+
Wrestling	0	1	1	2	+

Fig : Database of the medals India has Won in Olympics.

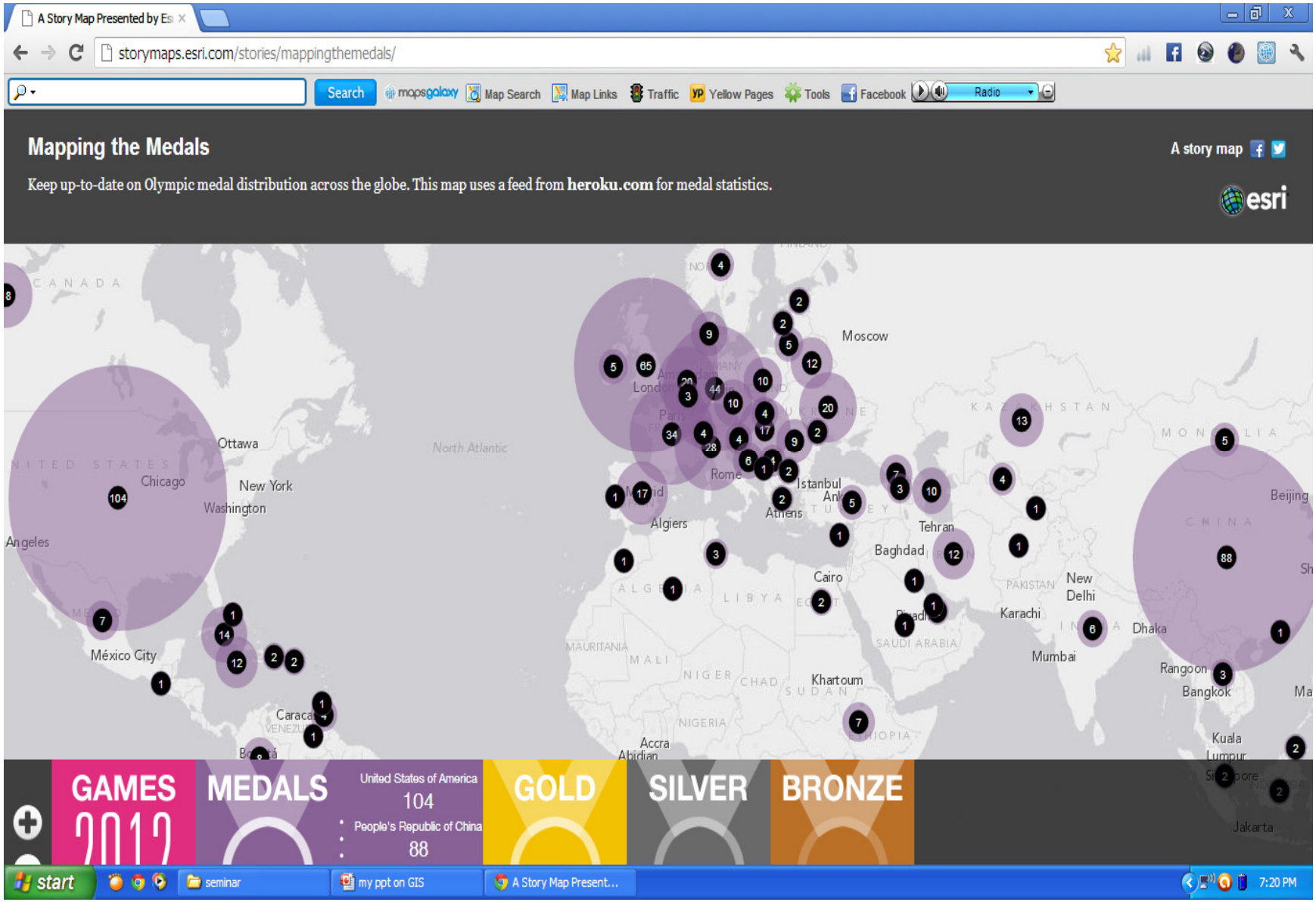


Fig: Keep up to date on Olympic medals distribution across the world using GIS.

Census:-

Integration of GIS technology in Census Mapping

- GIS introduced in Indian Census in 1992.
- Such software, as, ArcInfo, ArcView and ArcGIS have been extensively used.
- About 60 skilled professionals are engaged in GIS related work in 17 centers located in different parts of the country.

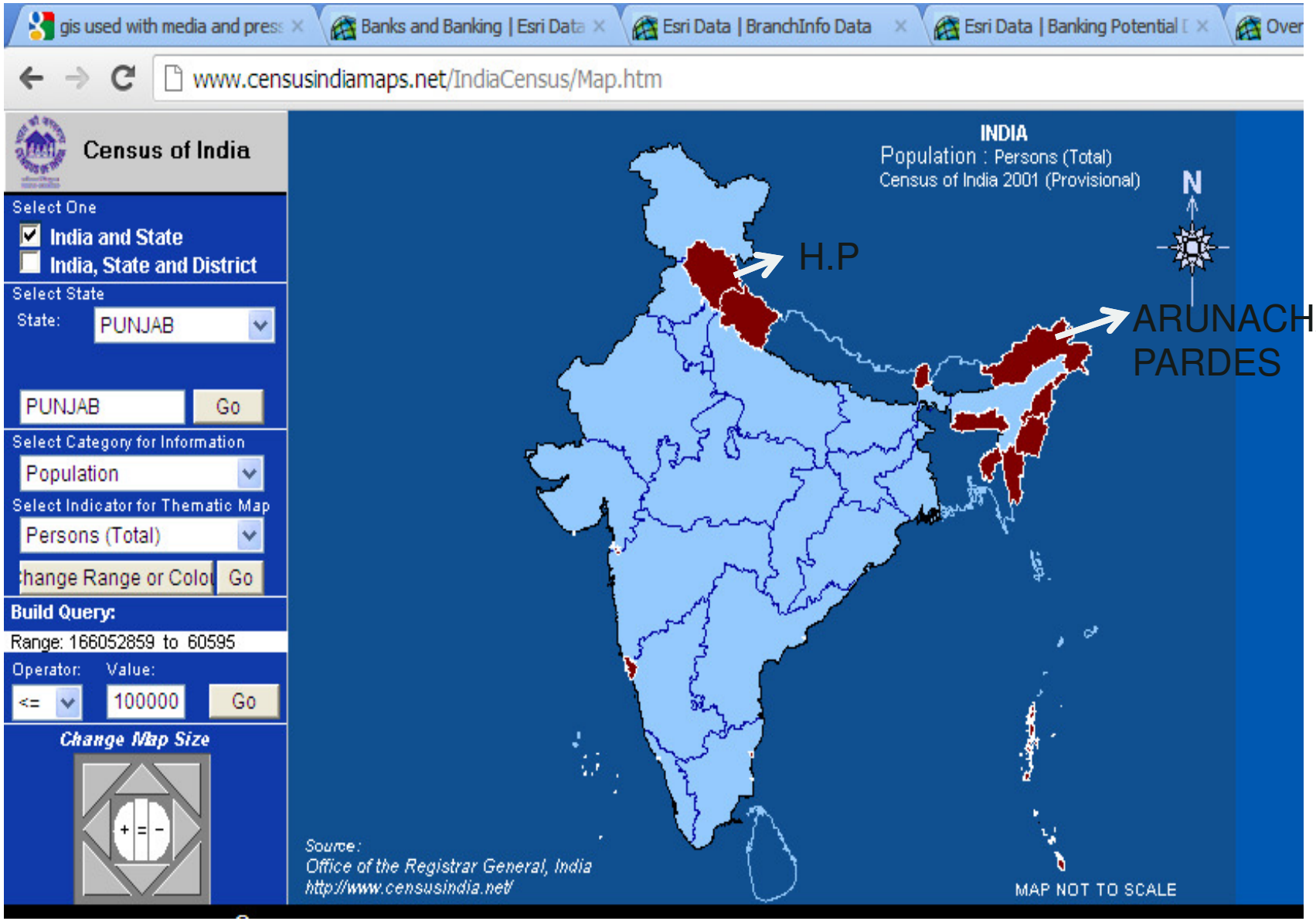


Fig:- show the states which have population less than 1crore.

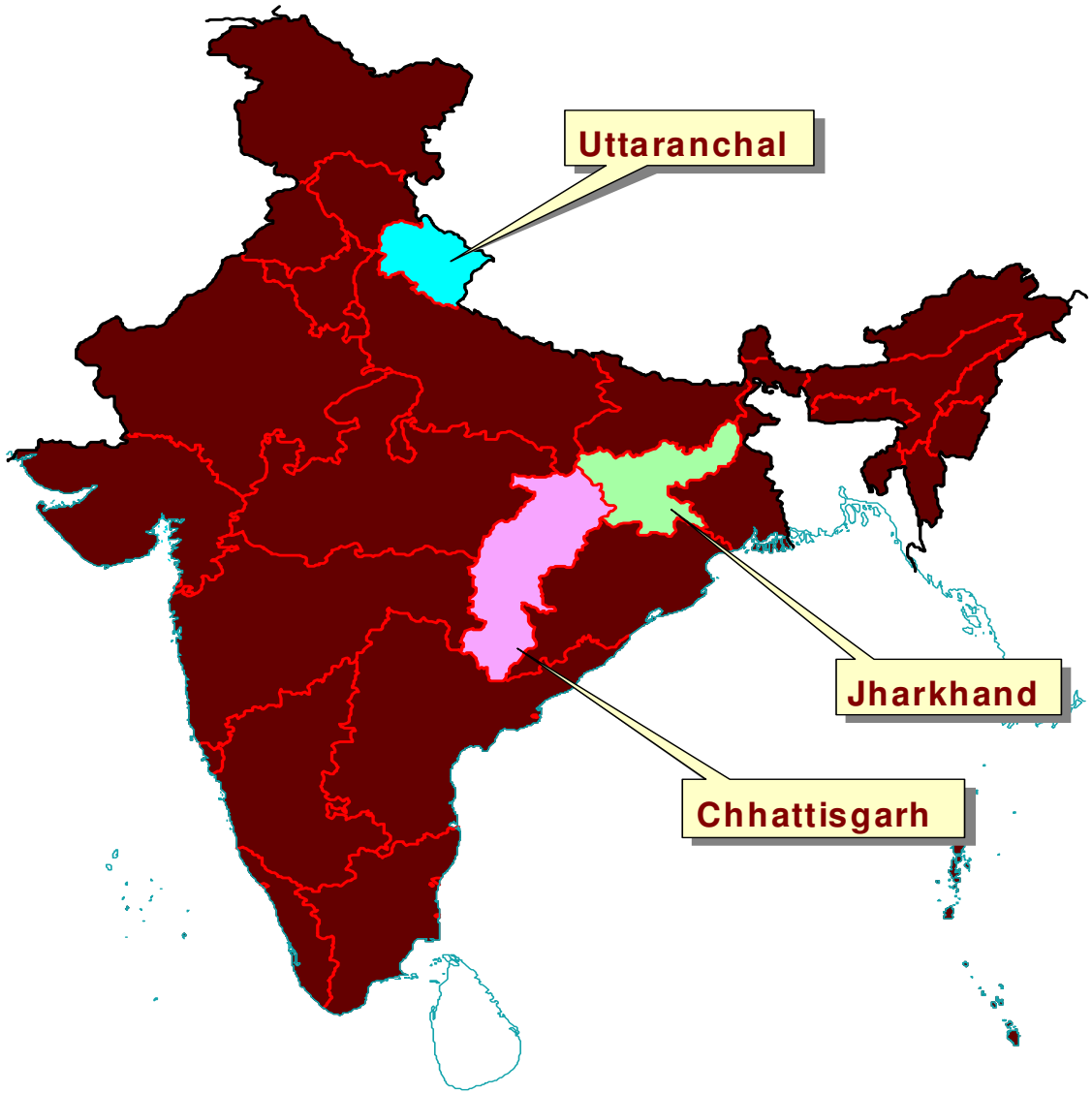


Fig:- In India Newly Created States During 1991-2001

Real Estate:-

- **Residential Real Estate**:-

  A single map lets your customer compare multiple properties and their respective proximity to desired amenities such as schools, parks, and shopping centers

- **Commercial Real Estate:-**

  Evaluate and analyze key factors when sating new premise for restaurants, stores, warehouses, corporate offices etc.:

  * Location of potential competitors
  * Crime rates
  * Transportation infrastructure
  * Regional labor pool characteristics
  * Environmental risk factors (i.e., flood plains, toxic sites, and others)

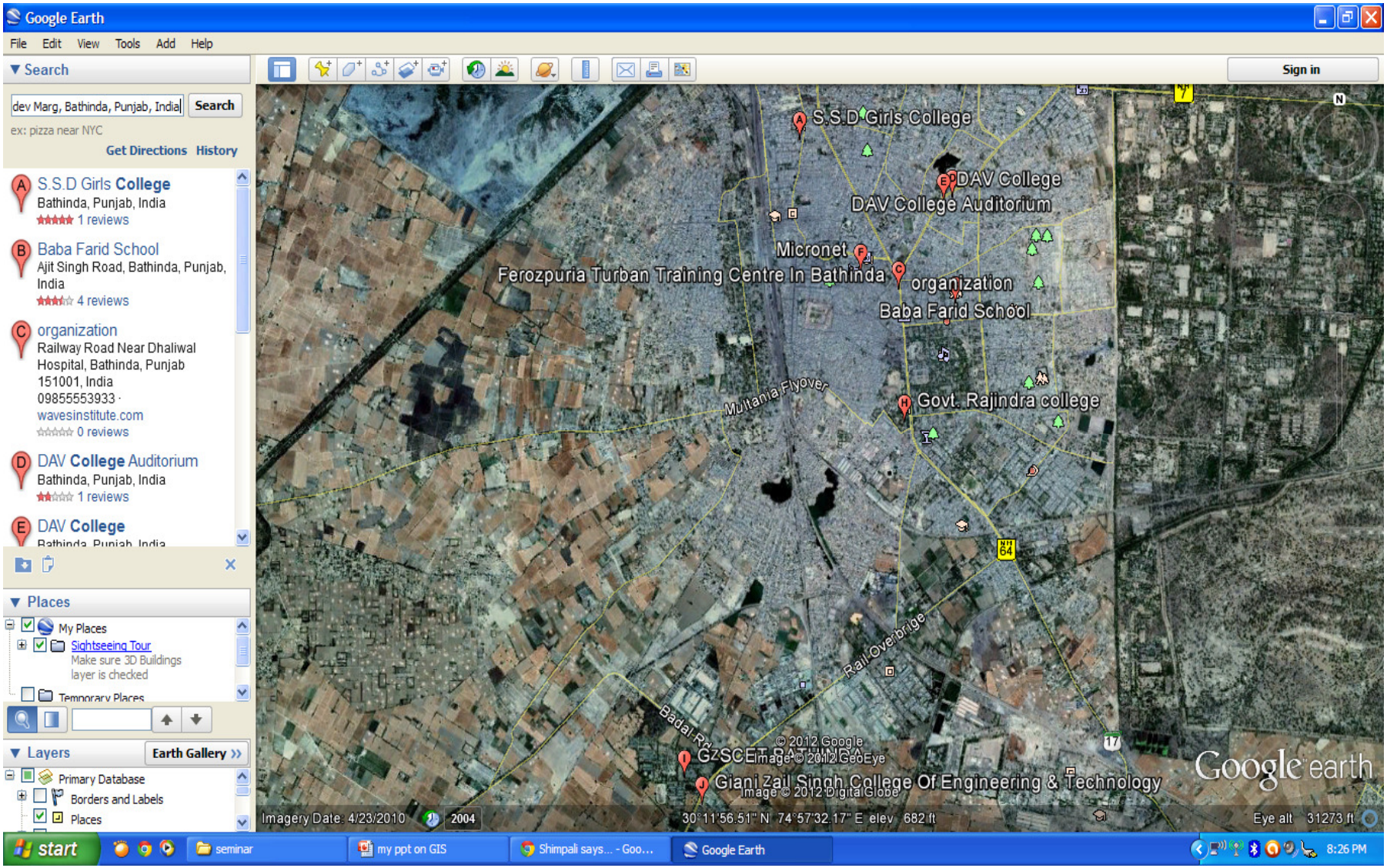


Fig:- Colleges NEAR Namdev Marg, Bathinda, Punjab, India

GIS in Tourism :-

- Visualization of tourist sites through digital images or videos
- Valuable information on tourist locations
- Selective information like route planning, accommodation, cultural events, special attractions etc.
- Easily accessible information over the internet.
- Interactive maps that respond to user queries.
- They will find all information on click, measure distance, find hotels and restaurants and even navigate to their respective links.

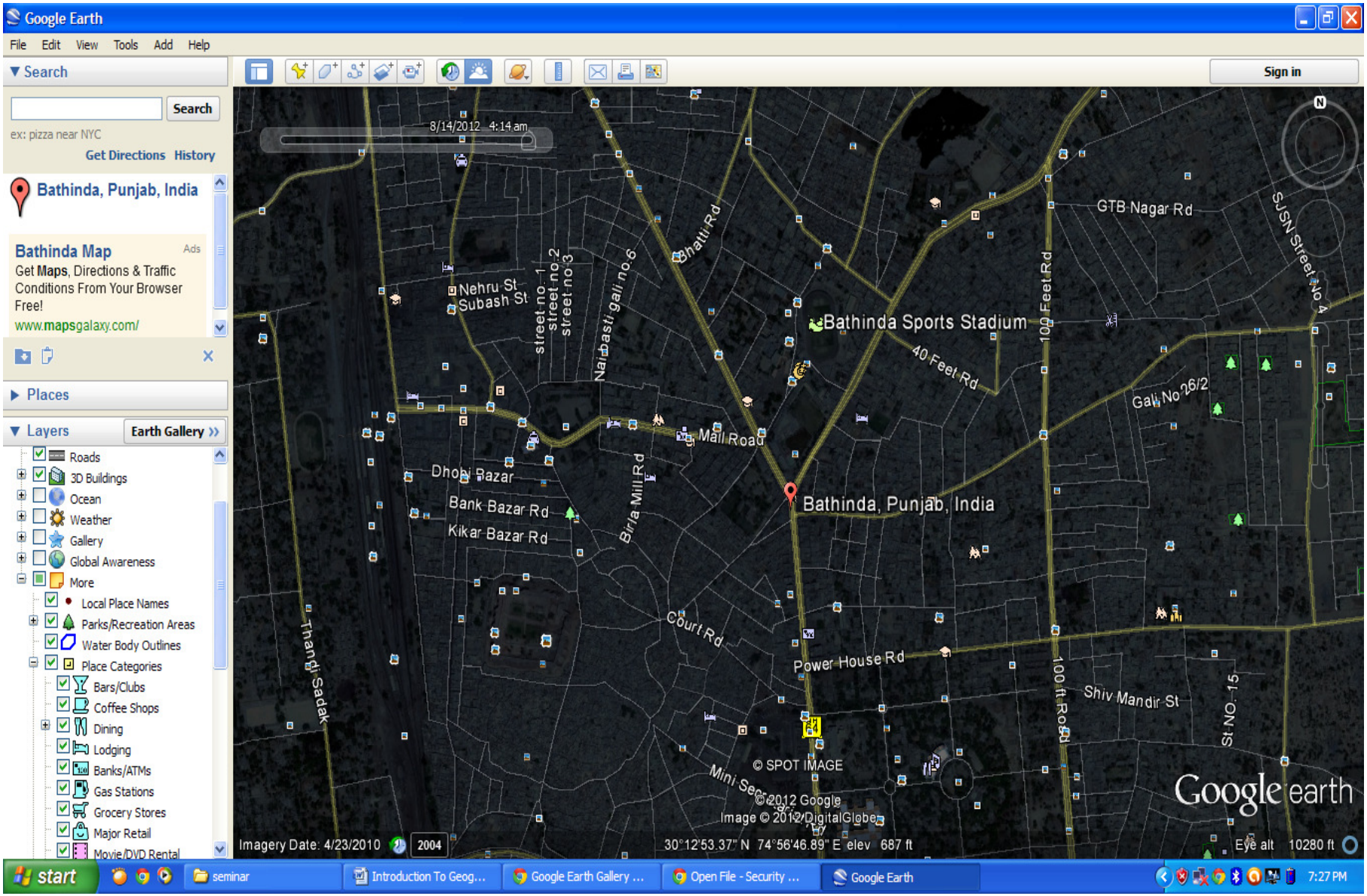


Fig: Bathinda map

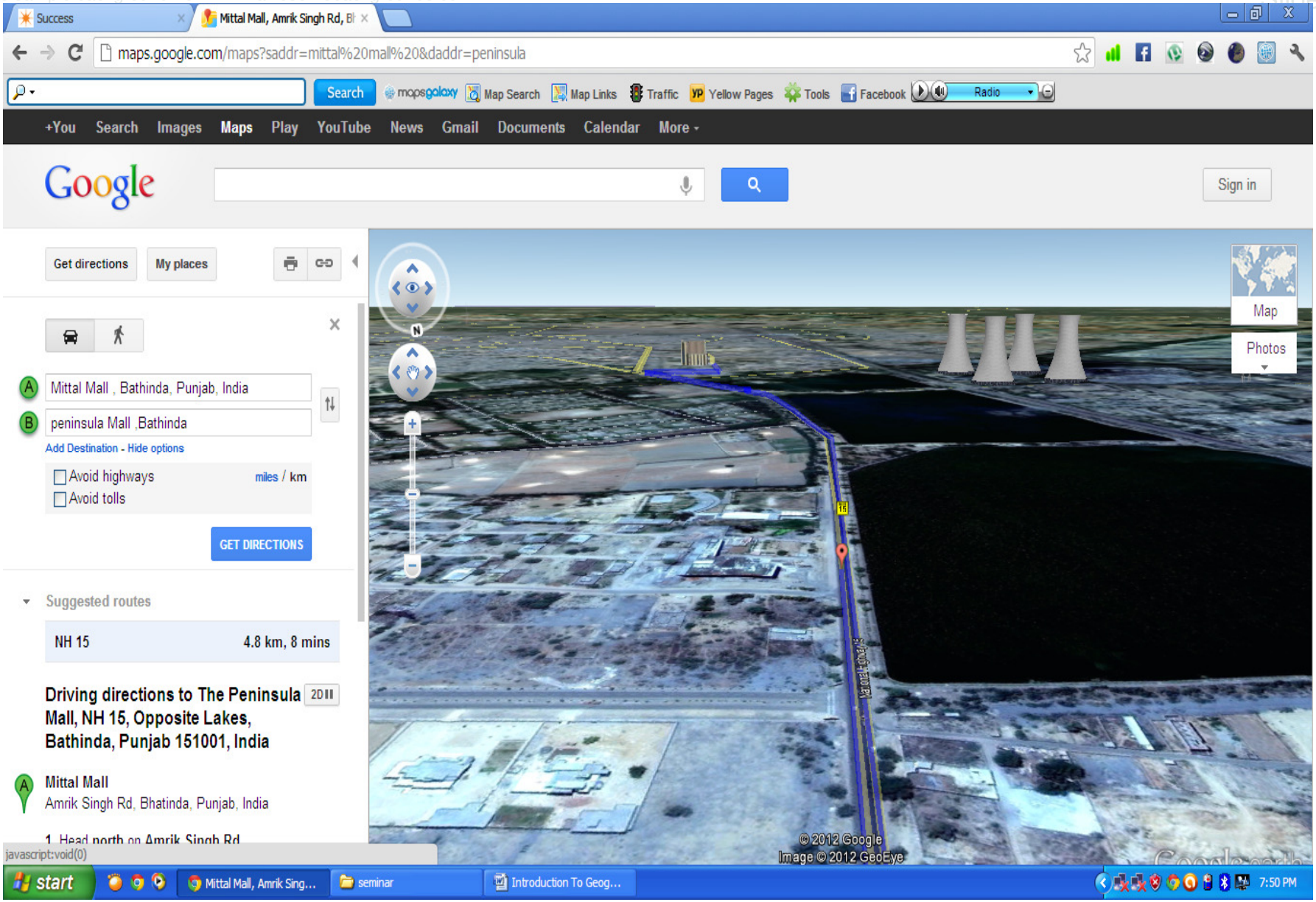
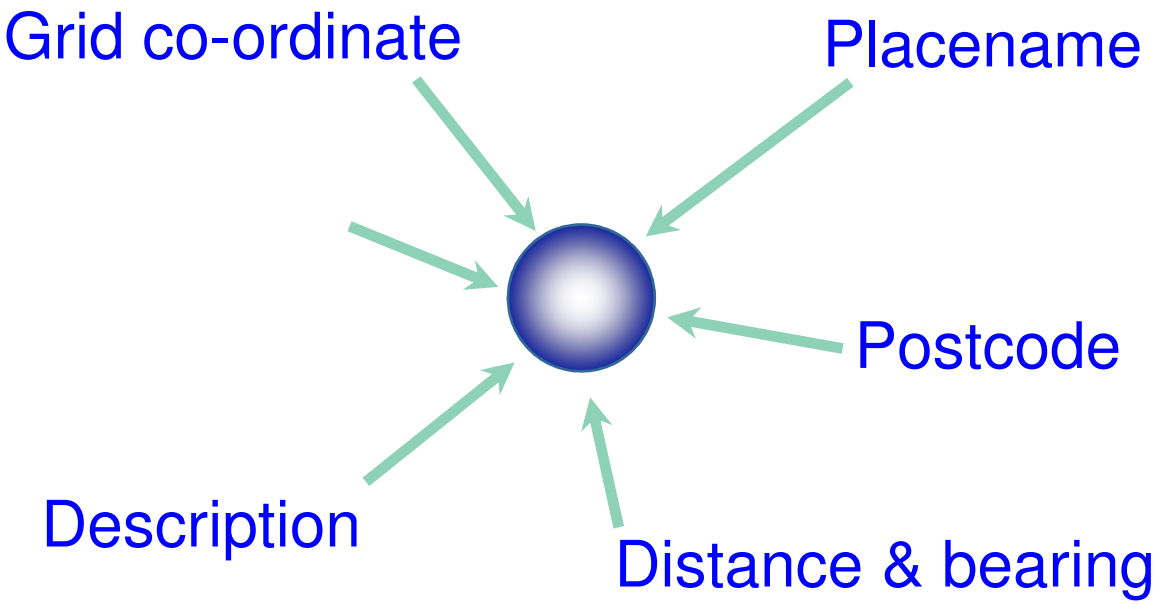


Fig:- Mittal Mall To Peninsula Mall

What makes data spatial...???



Characteristics of spatial data

The shape of a building or county
The course of a river, the route of a road
The shape of the landscape.

Back 1