Unit I

Earth positional Data related to/ refer to earth surface

GIS Notes (UNIT 1 & 2)

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DHANYA MAM.

Chp 1: A General introduction to GIS
(Geographic Informatn system)

GIS is a computerized system for capturing, storing, querying, exploring, and analysing and displaying geospatial data.

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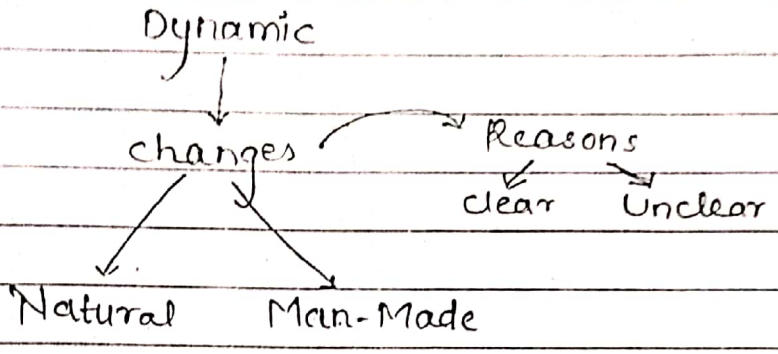
* Nature of GIS:

1. A Town/Urban planner might want to study the coverage by area, population growth, GIS helps a planner to explore and analyse
2. GIS professionals work with geo-spatial data i.e a positional data used for referencing geographical data to store location based data and attributes like pattern, forecasting, vegetation, terrian and many more.
3. Spatial data refers to positional data releative to the earth's surface.

* some fundamental observations:

1. The world is dynamic, many aspects of our daily lives and our environment are constantly changing and not always for the better. some of this changes appear to have natural causes and some others are manmade causes but sometimes changes remain unclear if we want to understand the changes we have to study the process or phenomenon that bring about geographic change.
It helps in decision making so we can take best action.

2. The fundamental problem in many of the GIS applicatn is that of understanding phenomena that have a spatial or geographic dimension along with temporal dimension



3. GIS object understanding study has different characteristics for different location and also that this characteristics changes over time.

* Defining GIS

[4 capabilites → handle → geo referenced Data]

① Data capture and preparation —(tedeous task)
② Data management —(store relevant data in DBMS)
③ Data manipulation and analysing
④ Data presentation

A GIS is a computer based system that provides the following set of capabilities to handle geo-referenced data.

~~GIS~~

① Data capture & preparation
② Data management
③ Data manipulatn & analysing
④ Data presentation

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- GIS is complete system to enter data to analyse it in various ways and to produce presentations from the data.
- It supports various kind of co-ordinate system and transformations analysis and large degree of freedom of choice in the way this information is presented.

Question

1. Define GIS, Explain the nature of GIS.
2. Define GIS. Explain the four set of capabilities.

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① Data capture and preparation:
- It is the most crucial and tedious task in GIS Data capture and input is done using existing data or by creating new data.
- New data can be created from sensed images, GPS devices, ~~screen~~ field survey, etc.
- Sometime new data requires editing, rectifying errors and geometric transformation.

② Data Management:
- Once the data is entered it must be verified and edited.
- Data is usually stored in tables, keys and their relationship established betⁿ tables.
- Data manipulatⁿ includes data verificatⁿ, attribute data management insertⁿ, updatⁿ, defination, retrival in different forms.

③ Data manipulation and analysing:
- Once the data has been collected and organised in a computer system we can start analysing it.
- Here we look at what process where involved in the eventual production of maps.
- After analysing some interpolation took place and we does the work of manipulating data as and when required

④ Data presentation:
- After the data is gathered and stored it is prepared for producing output. It deals with putting all together in a format that communicates the result of data analysis in the best possible way.
- Before presenting we have to see what the message is, who is the audience, what is the presentation medium, rules & techniques available for presentation.

* GI system, GI Science and GI applications

- GI system is a combination of functional GIS s/w and h/w components.
Users used to work on s/w and infrastructure support.
- (GI s/w is a specialized s/w to facilitate input, process, transform, analyse geo-spatial data.)
- people such as database creators or administrators, analysts work with the s/w and the users of end product.

- GI science is discipline that deals with all aspect of handling spatial data and geoinformath.
- It scientific field that attempts to integrate different discipline studying the methods and techniques

of handling spatial informat^{n}. Geo informatics, geomatics and spatial informat^{n} science are related term Emphasizing engineering approaches, computational solut^{n} and so on.

- GI applications are used to study the process or phenomena that brings about geographic change the difference bet^{n} a ~~geo~~ GIs and GIs applicat^{n} is that GIs s/w can be generally apply to many different applicat^{n}

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* Spatial Data and Geo Information

Data (Raw facts) —Processed→ Information

Spatial Data (positional data/value with respect to Earth surface) —Processed→ Geo-information.

- Spatial Data represents positional values. ~~special~~ spatial Data is also known as Geo referenced data. Processing of this geo referenced data ~~into~~ using ~~k~~knowledg tools and its applicat^{n} specific interpretation is known as geo information
- Geo information reduce uncertainity in ~~dicision~~ making.
- It is important that the quality of the base data should be assessed.
- Increasing availability and decreasing data capture equipment has resulted in many users collecting their

own data
- The real power of GIS lies in their ability to combine and analyse geo referenced data from a range of sources and also pay attention to quality control and error.
- Some degree of error is present in every spatial data set.
- They key components of spatial data quality includes
① positional Accuracy
② Temporal Accuraty
③ Attribute Accuracy
④ Lineage
⑤ Completeness
⑥ Logical Consistency

These components play an important role in assesment of data quality for several reasons
a] Even when source data have been subject to stringenet quality control, errors are introduced when this data are input to GIS.
b] A GIS Database normally contains data from different sources of varying quality.
c] Most GIS analysis operations will themselves introduce error
d] Natural resource databases contains data that are uncertain and therefore not suited to conventional quality control procedure.

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* The real world and representation of it :

* — Models and Modelling

A model is a represent of whole or some part of the real world having certain characteristic in common with the real world.
- It is use to study and operate on the model itself instead of the real world, in order to test what happens under various condition and analyse the affects of changes
- There are different type models :-
  ① simulation
  ② Data
  ③ Clay
  ④ Mathematical model, etc
- Map is the most commonly used model in GIs.
- Most of the maps and database can be static model, as they represent a single state of affair.
- Dynamic model or process model emphasized changes that have taken place, are taking place or may take place in future.
- Dynamic models are more complicated than static models and requires much more computation.

* — Maps

Map is a graphic representation of real world at a certain level of detail which is determine by the scale having physical boundaries and features.

- Cartography is a art and science of map making, functions as a interpreter, translating real world phenomena in correct, clear and understandable representation for our use.
- Earlier we use to have traditional paper maps that is generally restricted to 2 Dimensionals static representatn and is always displayed in a fixed scale. But, now-a-days digital mapping is also available.
- Digital map is also called digital cartography, it is a process by which a collection of data is ~~combin~~ complied and formatted into a virtual image.
- The primary function of this technology is to produce map that give accurate representations of a particular area and also helps to show in detail.
- Selection of proper map scale is one of the first and important step in map design

* Database.

Database is a repository for storing large amount of data.
It has different functions like
① Concurrent access
② It support storage optimizatn
③ Data ~~and dignity~~ Integrity
④ Query facility
⑤ Query optimatn - Database will try to execute each query in the data manipulatn language in the most efficient way.
- Databases can store almost any kind of data.
- Database have many such tables each of which

stores data of certain kind.
- ~~The~~ In table data is organised or stored in rows and columns

* — Spatial database and spatial analysis

- GIS applicatn uses spatial data for spatial analysis and spatial database for storage
- Spatial Database is also known as geo database, where we store representatn of real world geographic phenomena for use in a GIS
- It stores about spatial referenced system and supports all kind of analysis that are inherently geographic in nature.
- We can do computatn and interpolatn.
- The phenomena by which we want to store representat in spatial database may have line, point, area or image characteristics.
- Different storage technique exists for different kind of data.

• Spatial analysis -
- It is a generic term for all manipulation of spatial data carried out to improve one's understanding of the geographic phenomena that the data represents.
- It involves questions about how the data in various layers might relate to each other and how it varies over space.
- Geo-spatial analysis is used in applicatn area like the environmental and life sciences.

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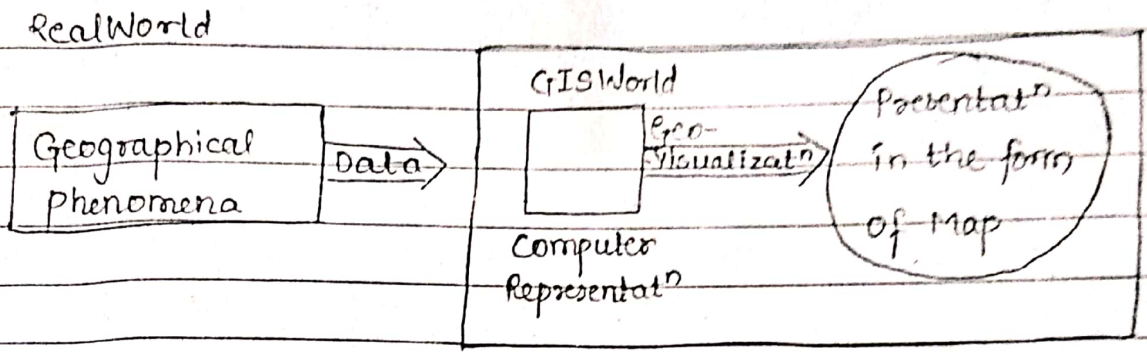
Chp 2: Geographic Information and Spatial Database

Models and Representation of Real World



- GIS helps to analyse and understand more about to real world processes and phenomena
- Modelling is the process of producing an abstractn of the real world, to observe and ~~understand~~ study easily.
- It is the process of representing key aspect of the real world using computer system. This representatn are made up of spatial data stored in the memory of a computer. This digital representatn can be subjected to various analytical functions and computations in GIS
- And the output can be visualized in different ways depending upon the application domain of the model. It may be necessary to manipulate the data with specific technique.
- Modelling began with the process of translating the ~~reliable~~ relevant aspects of the real world into a computer representation.
- It can be done using direct observation or by indirect means.

- Geo visualizatn gives a better understanding to both representation of phenomena and eventual output from any analysis and can use to create it from the computer representation either on screen, printe paper or both.
- Models are never profect their are so many limitations.

→ Geographic Phenomena

A geographic phenomena is something that
① can be named or described
② can be georeferenced
③ can be assigned a time at which it is present

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Example:
— In water management the objects of study can be river basins, groundwater levels, water budget and measurement of total water use. All these can be named, described, georeferenced and provided with a time interval at which it exist.
— A spatial phenomenon occurs in two or three dimension.
* Euclidian space can be defined as a model of space in which location are represented by coordinate in 2D and 3D And distance and direction can be defined with geometric formula.

Q. Define geographic phenomenon? What are geographic field and geographic object?

Types of Geographic phenomenon

In GIS, if we are representing a phenomena it requires to state what it is (name) and where it is.

Geographic field

— It is a geographic phenomenon for which for every point in the study area a value can be determined.

— A field is a mathematical function 'f' that associates a specific value with any position in the study area.

— If (x, y) is the position in study area, then f(x, y) stands for the value of the field at locality (x, y).

— fields can be continuous or discrete.

— In a continuous fields the underline function is assumed to be mathematically smooth.

— Discrete fields divide the study space in mutually exclusive bounded parts with all location in one part having the same field value

— Example :- Continuous fields :
Air temperature, pressure, elevation, barometric temperature, etc

Discrete fields :
Landuse and soil classification.

— A fields based Model consist of a collectn of geographic fields, some are continuous & some are discrete.

— The discrete field store cell value of type integer so it is also called as Integer Raster.

— The continuous field store cell value of type float so it is also called as floating point Raster.

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Different Data values which is used to represent geographic phenomena

① Nominal — Qualitative / Categorical Data value
② Ordinal — hierarchical scheme
③ Interval $\xrightarrow{(+,-)}$ Quantitative
④ Ratio $\xrightarrow{(*,\div)}$

① Nominal

— They are value that provides a name or indentifier to distinguish and classify between different values
— It is also called as categorical data because the values are sorted according to some set of categories.

eg:- Coding schemes for land use, soil types, etc

② Ordinal

— There data value that can be put in some natural sequence but they donot allow any type of computation

eg:- temperature can be classified as hot, warm, cold

③ Interval

— They are quantitative that allow simple form of computat' like subtract^n, addit^n.
— Interval data has no arithmetic zero value and does not support multiplicat^n or division.

eg:- Time of day, centegrade temperature, franheit temperature, pH values, etc

④ Ratio

— They allows all form of arithmetic computation. It have a natural zero value. Multiplicat^n & division of value are possible.

- Continuous field can be accepted to have ratio data value.
eg:- distance measured in meters.

Note:-
- Nominal and categorical data value are qualitative data
- Interval and ratio data value are quantitative data
- Ordinal data values ~~are~~ refers to ranking scheme or some kind of hierarchical data.

* Geographic object
- They have discrete and bounded entities
- Geographic phenomenon is a collection of geographic object.
- Some object are usually easily distinguish and named. and their position in space is determined by the following parameter
  ① location – where it is
  ② shape – what form is
  ③ size – how big or small is
  ④ orientation – which direct^n it is facing

- How the GIS application uses the informat^n about geographic object determines which of the above four parameter is required to represent it.

eg:- In an automative Navigation system we can have different geographic objects like petrol stat^n, road, etc.
- In the case of petrol station location alone is enough to describe them.
but in case of roads we have to consider locat^n, shape, size & orientat^n.

- Here all the parameter seems to be the relevant information component.
- Collection of geographic objects can be an interesting phenomenon at a higher aggregation level.

* Boundary:-
- It is use represent shape and size of contiguous area matter
- It is used for geographic object or discrete geographic field
- Locatn, shape & size are fully determined if we know an areas boundary.
- They are of two types:-
  ① Crisp
  ② fuzzy

- Crisp boundaries are more common in man-made phenomena and it is having a precise boundary line.
- fuzzy boundaries are more common with natural phenomena.

* Computer representatn of geographic informatn.
- Geographic phenomena have characteristic of continuous functions over space.
- Suppose, if we want to measure elevatn of earth surface it can be measured as many locatn and each locatn may have different values to represent such phenomenon in computer memory either
  ① tried to store as many observatn pairs as possible.
  ② try to find a function or formula to find out

derivation elevatn of at given locatn.

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- Both the options are practically not possible.
- So we are choosing sample location with their elevatn and they are stored in memory.
- We also uses interpolatn functions with auto co-relation for the value of locations that are not stored.
- Here we have Tobler's first law of geography.
- (It refers to the fact that locations that are closure together are more ~~mor~~ likely to have similar values than locations that are far apart.)

- Geographic phenomena having infinite characteristic should be represented in a memory in a finite manner.
- for making it finite we will be doing certain manipulatns, then fields are implemented with a tessellation approach and objects are implemented with topological vector approach.

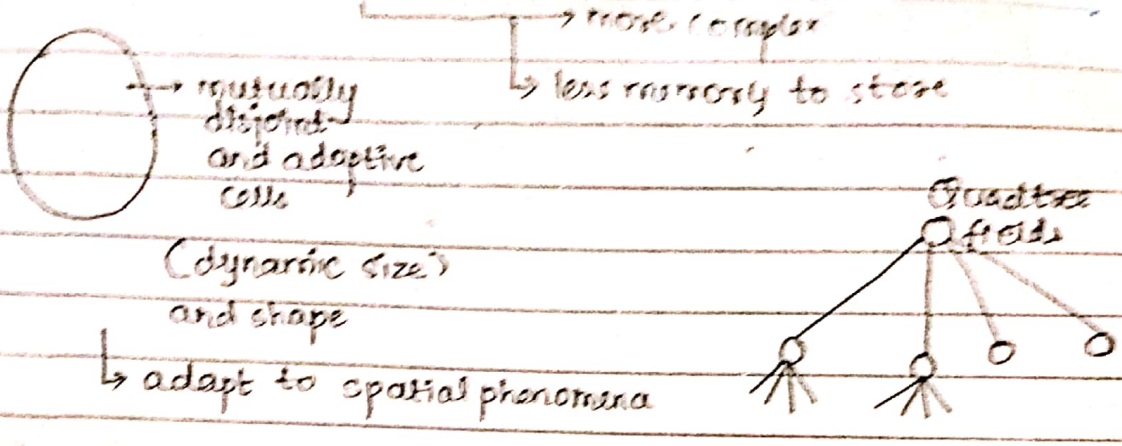
1. * Regular tessellation:

- Tessellatn is a partitioning of space into mutually exclusive cells that together make-up complete study area, with each cell some value is associated to ~~Geho~~ characterized that part of space
- There are 3 type of regular tessellation:
  1. square cell
  2. Hexagonal cell
  3. Triangular cell
- In regular tessellations the cells are of same space and size.

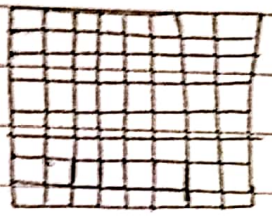
- The field attribute value assigned to a cell is associated with the entire area occupied by the cell.
- square cell tessellation is the most commonly used regular tessellation.
- We are calling this tessellation as a raster. (A raster is a set of regularly spaced and contiguous cells with field values.
- The field values represents cell values, this means that the value for a cell is assumed to be valid for all locations within the cell.) :
- The size of the area that is a single raster cell represent is called the rasters resolution or raster grid.

- To improve the continuity of cells, do the following two things:
  ① make the cell size smaller.
  ② assume that a cell value only represent elevation for one specific location in the cell and provide a good interpolation function for all other locations that has the continuity characteristics.
- An important advantage of regular tessellation is that, using known partition space, computation specific to the partition can be applied, this results in fast calculat° of the algorithm.
- Disadvantage — They are not adaptive to spatial phenomenon that we want to represent that is cell boundaries are both artificial and fixed.

2. Irregular Tessellation :



Region quadtree



- Irregular tessellation are partition of space into mutually disjoint and adaptive cells of dynamic size and shape allowing them to adapt to the spatial phenomena that they represent.
- They are more complex and adaptive and take less amount of memory for store
- Region quadtree is based on regular tessellation of square cells and takes advantage of cases where neighbouring cells have the same field value so that they can together be represent as one bigger cells.
- Quadtrees are more adaptive because they apply the spatial auto correlation principle.
- When the cells has the same value they are represented together in the quadtree.
- The square nodes at the same level represent equal area sizes, allowing quick computation of the area associated with some field value.
- The top node of the tree represent the complete raster.

3. * vector representation:

- It associate ~~with~~ geo-references with geographic phenomena
  A geo-reference is coordinate pair where from some geographic space and is also known as vector.
- TIN :
  - It is a representation of geographical field that can be considered as a hybrid betn tessellation and vector representation
  - It is the commonly use data structure in GIS s/w.
  - TIN is the standard Implementath technique for digital terrain models.
  - It can be used to represent any continuous field.
  - A TIN is a vector representation each anchor point has a stored geo-reference or irregular tessellation, as the choosen triangulation provides a partitioning of the entire study space.
- It can be represented in the form of point, line and area

① point representatn.
- points are defined as single coordinate pairs (x,y) in 2D or 3D
- They are used to represent object that are shapeless, sizeless, 1-dimensional features
- Attribute data is stored for each point object, it is also called as attribute or thematic data.

② Line representatn
- Line data are used to represent 1-dimensional objects such as road, railroads, canals, rivers and powerlines.
- While mapping tourist information.
- Connect Collectn of connected lines represent network

③ Area representation:
- Area feature is represented by collection of arc/node structure that determines a polygon as the areas boundary

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* Topology and Spatial Relationship

Topology deals with spatial properties that do not change under certain transformations.

* Topologgical relationship:
- Topology are built from simple elements into more complex elements. Nodes define line segments and line segments connect to define lines which intern defines polygon.
- fundamental issues relating to order, connectivity and adjanacy of geographical elements forms the basis of more sophisticated GIS analysis. These relationship is referred as topological mapping.
- The matematical properties of the geometric sp space used for spatial data can be desctibed as:

① The space is a 3D eucidean space.
② Space is a metric space which means cwman always compute the distance between two points using a function or metric.
③ space is a topological space that is we can find a neighbourhood around it.
④ Interior and boundary are properties of spatial feature that remain invariant under topological mappings.

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- Advantages:-

① Questions related to neighbourhood of an area can be easily represented.

② Within the topological space, features that are easy to handle can be used as representation of geographic object. These features are called as simplices. When we combine various simplices into a single factor we obtain a simplicial complex.

③ The properties of interior and boundary do not change under topological mapping. It is possible to study relation between spatial feature.

* Scale and Resolution

Map scale is defined as ratio between distance on paper map and distance of same stretch in the terrain.

eg:- 1:50,000 scale-map means that 1 cm on the map represents 50,000 cm in the terrain.

- Large scale means the ratio is large i.e There is much detail.
- Small scale means small ratio i.e less detail
- When applied to spatial data the term resolution is commonly associated with the cell-width of the tessellation applied.

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* Representation of Geographic fields.

- Tessellation
  - Raster
    - 2D array of field values
- TIN
- Vector
  - Isolines
    - Points with same field value
  - Contour Lines
    - Different field values eg:- elevation

- It can be represent through tessellation, tin, vector representation.
- The choice is determine by the requirements of the application.
- Raster representation of a field a raster of 2D array of field value that is collection of MXD values.
- It also contain additional attribute to represent some extra information.

Vector representation of field: It use isolines and contour lines and Isoline is a linear feature that connects the coins with equal field value. When field is different we used contour lines.

* Representation of geographic object

- It is mostly done using vector or tessellation.
- Vector is naturally supported one, since object are ~~and~~ identify the parameter of locations, shape, size and orientation. They can easily express in terms of vectors.
- Tessellation are also used to represent the geographic object mostly ~~up~~ unproccessed digital images can be stored in GIS using ~~ratio~~ raster or tessellation.
- Area object are represent in raster with area boundaries may appear as lagged edges by using raster.
- Line can be represented as strings of neighbouring raster cells of equal value.
- It also supports different operations such as connectivity operation and distance computations.

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Organizing and Managing Spatial Data:

- The main principle of data organization applied in GIS system is that of a spatial data layer.
- Spatial data layer is either representation of continuous or discrete field or it collection of objects of the same kind.
- The data is organize so that similar element are in singk data layer.
- Data layer contains spatial data of any type that is attribute of schematic data which describe the fields and object in layer.
- Attribute data is arrange in tabular form.
- Data layers can be overlaid with each other.
- A GIS can be used to study the spatial relationship between different phenomena requiredly computations which overlaid one data layer with another.

* Temporal Dimension

- Geographic phenomena is dynamic while developing GIs application different scales of measurements we will apply like different questions involving time we will include like:

1. When and where did something happened?
2. How fast did this change occur?
3. In which order did the changes happened?

- GIs has limited support for the representation of time it is because temporal dimension is of continuous nature.
  - so for representing it in computer we have to discritize the time dimension.
  - Spatio temporal data models are base of organizing representation of space and time in GIs, for this we are using several techniques like snapshot state. A snapshop state represent a single point in time of an ongoing natural or man-made process
  - We may store a series of snapshop state to represent change.
  - Time can be represented in different base like
    1. Discrete and continuous time
    2. Valid time and transaction time
    3. Linear, branching and cyclic time
    4. Time granuality
    5. Absolute and relative time

①

- Time can be measured as discrete or continuous scale. Discrete time is composed of discrete elements
  eg:- sec, hour, day, month, year, etc

- Continuous time doesnot have discrete element and for any two different points in time their is always another point in between.
- We can structure time by events or periods.
- When we represent time periods by a start and end time we can derived temporal relationship between events and periods

(2)

- Valid time is a time when an event really happened
- Transaction time when the event was stored in the database or GIS.

(3)

- Time can be considered as linear showing past, present & future.
- There is a single timeline.
- Branching has different time line from a certain point in time..
- Cyclic has repeating cycle such as seasons or days of a week.

(4)

- It is the precision of a time value or in GIS or database
  eg:- year, month, sec, day, etc
- Different applicatn has different granuality.
- In Geog Geological mapping applicatn time granuality is in the order of thousand or millions of year.

(5)

- Absolute time marks a point on timeline where event happened
  eg:- 6 October 1983 at 11pm

- Relative time is immediate to other points in time
eg:- yesterday, last year, 2 weeks later, etc

Conclude:-

Using GIS we will analyse how changes occurs, so in spatio temporal analysis we consider changes of spatial and thematic attributes over time. so we can keep either spatial domain fix and attribute changes over time for a given locatn in a space or else we can assume attribute domain fix and consider spatial changes over time for a given thematic attribute. finally we can assume both the spatial and thematic attribute domain variable and how the fields changes over time

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Data Management and Processing system

* Hardware and software trends:

- Information and communication technology is an ever expanding field in both dimensions hardware and software.
- Advances in computer hardware takes place at an increasing rate that is we have more powerfull processes, increasing affordable and portable pc's.
- To support these hardware, software providers produce applicath program and os which provide more functionality.
- At the same time significant development happens in computer networks which allows fast and reliable exchange of data.
- Mobile phones used to connect to computer on internet, we use protocols like UMTS, HSDPA, etc. Then we have bluetooth, wifi standards with wireless LAN and dial up telephone modems for supporting digital & telephone links.
- And we have various LAN and WAN technology which supports different transmission rate.

* GIs

1. Definition of GIs from chp1 (4 capabilities)
2. A GIS planning projects required data sources from different Institutes that is government agency and recognized private agencies like national mapping agencies geological, soil and national senses bureau.
3. The data sources obtained may be from different time period and the spatial data may be in different scales or projection.

- With the help of GIS the spatial data can be stored in digital form and we will make transformation and conversion easily with the software, with the spatial data thus prepared the spatial analysis function of the GIS can be applied to perform the required task.

*GIS software

1. Definatn from chp1
2. The main characteristics for of GIS software package are its powerful analytical functions that provide means for deriving new geo-informatn from existing spatial and attribute data.
3. All GIS pakages available in the market have their own strength and weakness resulting from the development history and the application domains of the package that is some GIS's have focused more on support for raster based functionality others more on vector based spatial object, but a complete GIS should support both raster as well as vector.
4. Some GIS packages are ILWIS, Intergraph's g.Geomedia, ESRI's, ArcGIS, Mapinfo from Mapinfo corp
5. ILWIS supports raster processing.
6. Intergraph's Geomedia, ESRI's, ArcGIS support vector based spatial data and their operation.

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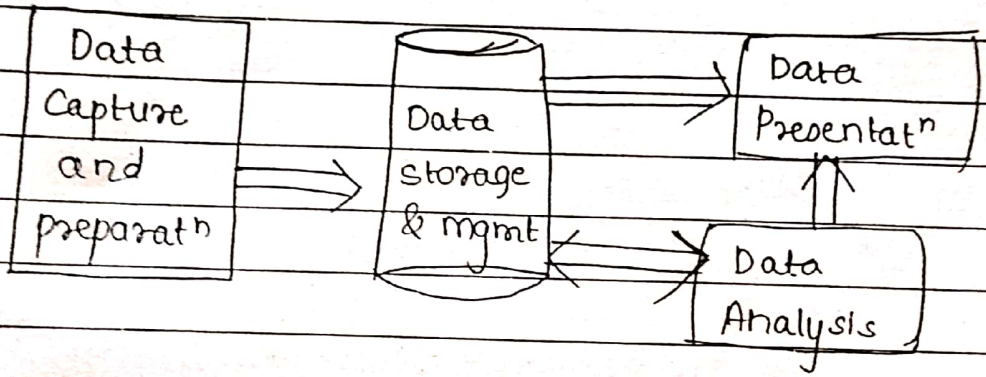
* GIS architecture and functionality:
- GIS consits of s/w, hardware, data, people and an infrastructure.
- GIs consst of several functional ~~computation~~ components which support key GIs function.
- These are data capture and preparation, data storage, data analysis and presentath of spatial data.



1. Data capture and preparation:
- Data can be collected through primary source or secondary source.
- Capturing and acquisition is done through scaning, photogrammetic, remote sensing, field survey, etc
- These data is then prepared for an applicatn under consideration by removing error, checking quality, rasterization, vectorization, etc

2. Data storage and management:
- Here data is organized in the PC, the different types of information required for a GIS require storage which allows the information to be updated and queried for analysis by the user.
- Spatial data usually stored as themes, layers or coverage. Attribute data is an informath about an object or

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3. Data analysis:

- It is the heart of GIS
- A good s/w package allows the user to define and execute spatial and attribute procedure.
- Once the data is organized in the system we can start analysing it, here we look what processes were involved in the production of final output.
- Overlaying, buffering, modelling and analysis are some of the method using building a project.

4. Data presentation:

- After the carefull preparatn on several mapping tools which are integrated with GIS the maps are presented to user.
- The final map are of high cartographic quality.
- Before presenting the analyst should consider so many things like, what is the message, who is the audience, what kind of presentatn medium, rules and techniques of presentation, etc.

*SDI (Spatial Data Infrastructure)

- SDI deals with the sharing of spatial data between GIS in various organizations with the key importance and aspects of data dissemination, security, copyright and pricing requirement.
- SDI is defined as "the relevant based collection of technologies, policies and institutional arrangements that facilitated the availability of access to spatial data.
- In SDI, we have different aggrements between organizations and s/w system how to share the

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geographic information.
- In SDI, standards are the starting point for those aggrements.
- In GIs, we have to follow so many standards, starting from the data capture to data presentation.
- These standard are developed by Iso and OGC (Open Geospatial Consortium).
- SDI provides the users with different facilities for finding, viewing, downloading and processing data.
- SDI are normally distributed over space.
- Computer networks are used as the means of communication.
- With the development of internet much of the functionality provided by geo-web services.
- S/w program act as a intermediate between geographic data and the users of the web.

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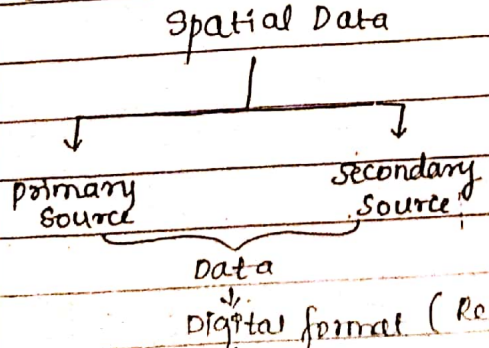
* Stages of Spatial Data Handling :-

① Spatial Data capture and preparation.
② Spatial Data storage and Maintenance.
③ spatial Data Query and analysis.
④ Spatial Data presentation.

①



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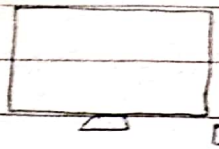

Organize spatial Data in PC in different,

Data layer

Raster Vector

relationships
phenomena

using → GIS S/w

Maintenance → Make the ~~Data set~~ up to date
(Real world continuously changing)

③

Spatial Query (special type of database Query supported by spatial database or geodatabase)

Spatial Analysis is used to derive new geo information by using spatial Query. And geo informatn is processed ~~d~~version of Spatial data [spatialdata —process→ Geoinformatn]

④

Present —infront of→ Audience

Tabular Display Onscreen Maps

Cartographic technology

Using GIS, we present the maps in front of audience with better quality.

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* DBMS (Database Management System)

* Database → Large computerized collection of Data.
* Database Designing → It is difficult task.
* DBMs → offers lots of functionality for database organizatⁿ an handling.

** Reasons of using DBMS :

① Supports storage and manipulatⁿ of very large datasets.
② Data correctness.
③ Concurrency.
④ Provides high level declarative query language.
⑤ Use of datamodel. (RDBMs)
⑥ Back up and Recovery functions.
⑦ Controls Data Redundancy.

* Stages of spatial datahandling

① Spatial data capture and preparation
– Data can be collected through primary source or secondary source.
– Capturing and acquisition is done through scanning, photogrammetric, remote sensing, digitization of analog map, field survey, GPS survey or manual data entry.
– In recent years, there has been a significant increase in the availability and sharing of digital (geospatial) data.
– The data, once obtained in digital format, ma

* GIS and spatial Databases :—

1. * Linking GIS and DBMS:

— GIS supports spatial data and thematic or attribute data.

— Its stores spatial data and attribute data separately so its provide a link between spatial data and these non spatial attribute data.

— GIS packages store the things in the form of tables. So, dbms's handles attribute data in a secure way for multiple user at the same time.

— GIS had to link the spatial data represented with raster or vectors and the attribute data stored in an external DBMs.

— With raster representation each raster cell stores a characterictics value. This value can be used to look ~~out~~ up attribute data in an accompanying database table.

— In vector representation, a spatial object like points, lines or polygon are automatically given a unique indentifier call object id or feature id by the system.

— It is used to link the spatial object represented in vector with it's attribute data in an attribute table.

2. * Spatial database functionality:

— GIS Software packages are able to store spatial data using a range of commercial and open source DBMS's with help of spatial extensions.

— Some GIS software have integrated database engines and therefore, do not need these extension.

— 'QGIs' have database software builtin.

— Designer of a GIS application can choose whether to store the application data in the GIS or in the dbms.

— Spatial databases is also known as geo database, and

are implemented on existing DBMS.
— Spatial database allows users to store, query and manipulate collections of spatial data.
— Spatial data can be stored a special database column known as "geometry column".
— Geo database allows a wide variety of users to access large data sets and the management of their relations guaranteeing their integrity.
— OGC has released a series of standards relating to geo database like,
① which table may be present in spatial database.
② the data formats.
③ a set of SQL like instructions for geographic analysis.
— Architecture of spatial database differs from a standard RDBMS, because it can handle geometry data and manage projection and have larger set of commands.
— Spatial database support the storage of image data, the capabilities of spatial databases will continue to evolve over time.

14/12/19 2. * Querying a spatial database:

— A spatial dbms provides support for geographic coordinate system and transformations.
— It also provide storage of the relationship bet^n features including the creation and storage of topological relationshi
— We can use spatial query to find the things from spatial database.
— Suppose, if we want to find all the metro city within 20km of the river ganga then we will use spatial query.

-> Select C.name from River as R, City as C where C.Type = "Metro" and R.Name = "Ganga" and ST_Intersects (C.Geometry, ST_Buffer (R.Geometry, 2000))

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In this where clauses use ~~ST_~~ ST_Intersects() funct^n to perform a spatial join bet^n a 20~~00~~km buffer of the selected river and selected subset of city. The Geometry column carries the spatial data.

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Chp 4 : Spatial Referencing and positioning

Spatial Referencing Introduct^{n}:-

* CRS and or SRS

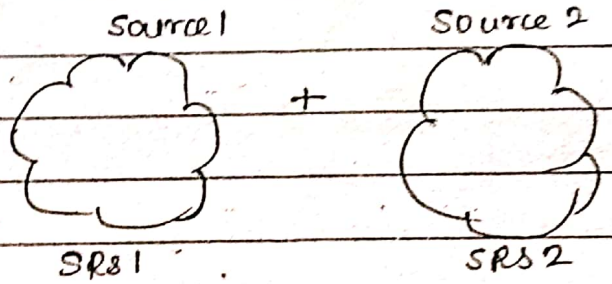
① SRS → Spatial Reference system

② CRS → Coordinate Reference system

SRS → It is a coordinate based regional, local or global system used to locate geographical entity.
It defines specific map projection as well as transform between SRS.

Spatial Referencing :

Data collect^{n}



- Data is collected from various sources, so to combining those data is difficult.
- ~~So~~ for combining it we use spatial referencing

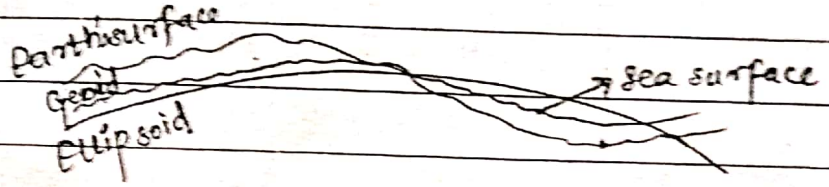
- A frequently occuring issue is the need to combine spatial data from different sources that use different SRs.
- Spatial referencing is one of the feature of GIS with their ability to combine ~~spat~~ spatially referenced data.
- It provides a background of relevant concept relating to the nature of Spatial Referenced system (SRS) and the translation of data from one SRS into another.

Reference Surface for Mapping

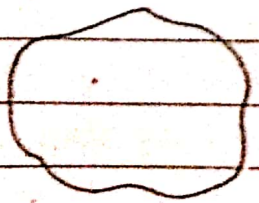
2 Main reference surface ?

- approximate shape of earth
- Geoid
- Ellipsoid

Deviation → Geoid separation (N)

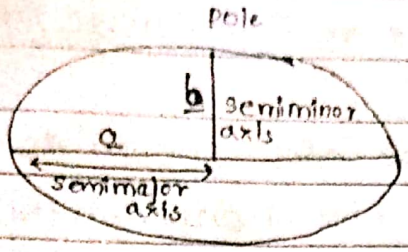


- The surface of the earth is anything but uniform. Ocean can be treated as regionably uniform but surface of the land masses has variatn bet^n mountains and valleys.
- This variatn make it impossible to approximate the shape of the earth using simple mathematical mode. so, we are using two main reference surfaces to approximate the shape of earth. One referenced surface is called geoid and the ~~one~~ other referenced surface is called ellipsoid.
- The deviation bet^n geoid and referenced ellipsoid is called Geoid separatn and it is denoted by (N). Due to irregularity, mass anomalies in this distributn the global ocean result in an undulated surface. This surface is called as geoid.



→ Geoid

Ellipsoid:



- We also need a reference surface for the description of the horizontal co-ordinates of points of interest.
- Since, we will later project this horizontal coordinate on to a mapping plane, the reference surface for horizontal coordinate requires a mathematical definition and description.
- The most convienent geometric reference is the obilate ellipsoid.
- The shape of ellipsoid may be define in number of ways.
  ① The geodetic practice, the definath is by semimajor axis (a) and flattening (f) is dependent of on both the semimajor axis (a) and seminor axis (b).

$$f = \frac{(a-b)}{a}$$

It can also be defined by its semimajor axis (a) and eccentricity (e) which is given by,

$$e^2 = \left(1 - \left(\frac{b^2}{a^2}\right)\right) = \frac{a^2-b^2}{a^2} = 2f - f^2$$

given 1 axis and any one of the other 3 parameter, the other two can be derived.

- Typical values of the parameter for an ellipsoid are

$a = 6378135.00\ m$

$b = 6356750.52\ m$

$f = \frac{1}{298.26}$ $\quad e = 0.081881881066$

2D cartesian | 2D polar | 2D geographic | 3D Geographic

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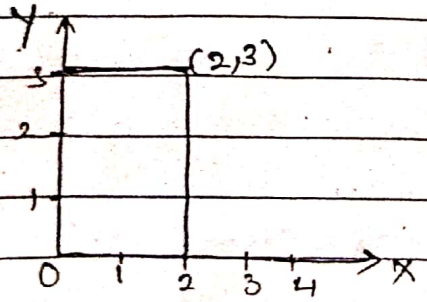
Coordinate System / Cartesian co-ordinate / planar co-ordinate

- Spatial coordinates are also known as global coordinates and are used to locate objects either on the earth surface in 3D space, or on the earth reference surface (ellipsoid) in a 2D space.
- Specific examples are the geographic coordinates in a 2 Dimension or 3 Dimension space and the geocentric coordinates system also known as 3D cartesian coordinate system. Planar coordinate system on the other hand are used to locate data on the flat surface of a map in 2D space.
- Example: 2D cartesian coordinates and the 2-D polar coordinates.

* 2D Cartesian coordinates (x, y) :-

- A flat map has only 2 Dimensions, ~~with~~ width (left to right) and length (bottom to top).
- Transforming the 3D earth into a 2D map is subject of map projection and coordinate transformation.
- It is also known as planar rectangular coordinates and it is used to describe any point in a map plane, unambiguously



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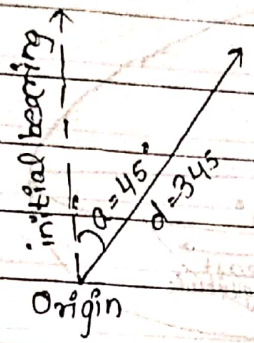
* 2D polar cordinates (a, d) :-

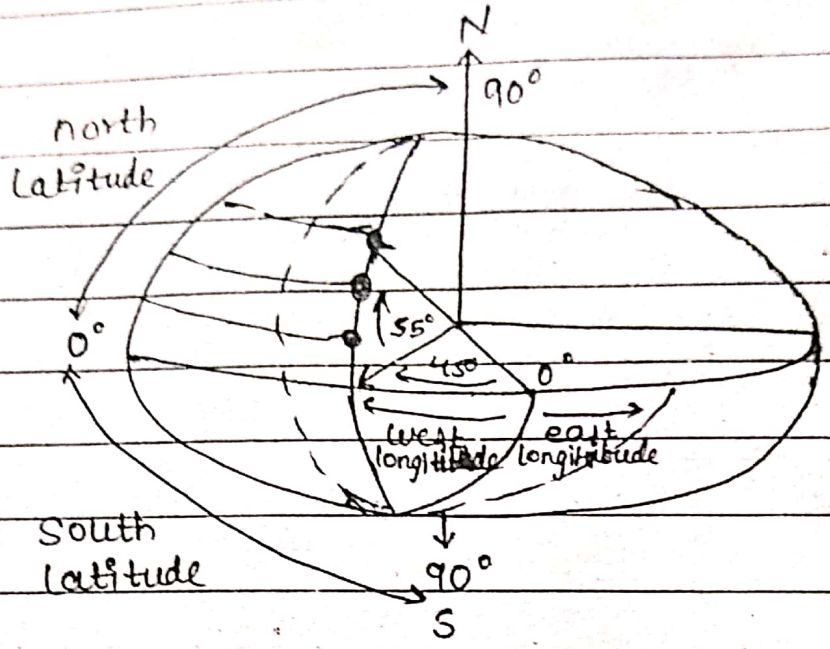


- a = azimuth or bearing measured → clockwise direct

- Another possibility of defining a point in a plane is by polar coordinates (a, d), these is the distance 'd' from the origin to the point concern and angle 'a' betⁿ a fixed directⁿ and ~~the~~ directⁿ to the point.
- Angle 'a' is called azimuth or bearing and is measured in clockwise directⁿ. It is given in angular units, while the distance 'd' is expressed in length units

* 2D geographic coordinates :- (phi and lambda) (ϕ, λ)

- The most widely used global coordinate system consist of lines of geographic latitude ~~(φ)~~ (phi or fori) and longitude as (lamda or l).
- Lines of equal latitude are called parallels, they form circles on the surface of the ellipsoid.
- Lines of equal longitude are called meridans and they form ellipses or meridian ellipses on the ellipsod.
- Both lines form the gratitude when projected on to a map plane.
- The concept of geographic coordinates can also be applied to a sphere as the reference surface.



* 3D geographic coordinates ($\phi \lambda h$) :-

- 3D geographic coordinates ($\phi \lambda h$) are obtained by introducing the ellipsoidal height 'h' to the system.
- The ellipsoidal height 'h' of a point is the vertical distance of the point in equation above the ellipsoid.
- It is measured in distant units along the ellipsoidal normal from the point to the ellipsoid surface.
- 3D geographic coordinate can be used to define a position on the surface of the earth i.e point p.