Geographic Information System

TYIT
Elective I - Semester V

Curriculum

Unit1: Spatial Data Concepts

Unit 2: Data Input and its representation

Unit 3: Geometric transformation and Attribute data input

Unit 4: Data exploration, query and vector data analysis

Unit 5: Raster Data Analysis and data display

Practical - QGIS

- Creating and Managing Vector Data: Adding vector layers, setting properties, formatting by Digitizing Map Data.
- Working with Attributes, Attribute Data Query on the map created in Practical 1.
- Performing Spatial Queries on the map created in Practical 1.
- Raster mosaicking and clipping
- A. Importing Spreadsheets or CSV files Using Plugins, Searching and Downloading Open Street Map Data
- Working with attributes, Terrain Data
- Georeferencing Topo Sheets and Scanned Maps
- Managing Data Tables and Spatial data Sets: Table joins, spatial joins, points in polygon analysis
- Creating a Map using Print Composer

Reference Books

- Introduction to Geographic Information Systems by Kang-tsung Chang, 5th Edition, Tata McGraw Hill.
- Principles of Geographic information Systems- An Introductory Text Book, Editors, Otto Huisman and Rofl A., The International institute of Geoinformation Science and Earth Observation, 4th edition, 2009.

Unit 1: Spatial Data Concepts

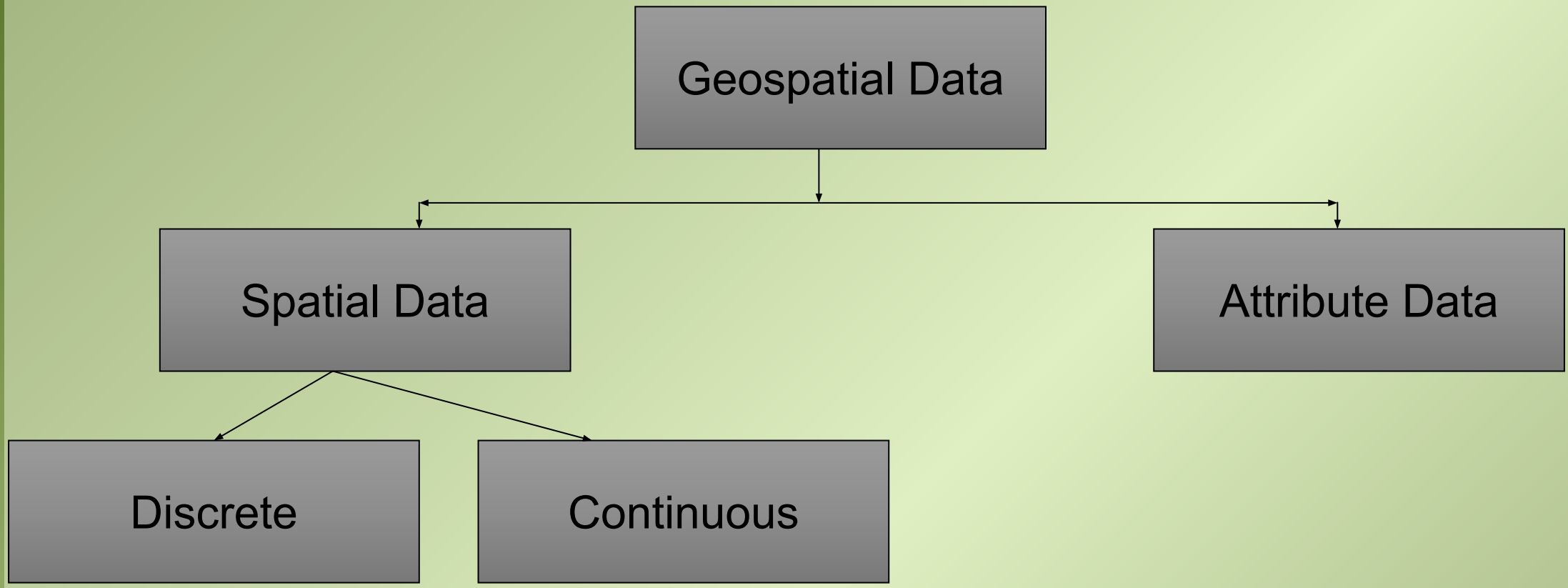
Topics to be covered

- Introduction to GIS
- Geographically Referenced Data
- GIS Components
- Geographic Projected and Planer Coordinate System
- Map projections
- Data model.
- GIS Operations
- GIS Systems, GIS Science and GIS Applications.
- The real world and representations of it: Models and modelling, Maps, Databases, Spatial databases and spatial analysis

Defining GIS

- A geographic Information System is a computer system that is used for capturing, storing, querying, analyzing and displaying **geospatial data or geographical data**.
- Geospatial Data are data that describes both the locations and the characteristics of special features such as roads.

Geospatial Data



Data Models – in which way data is stored

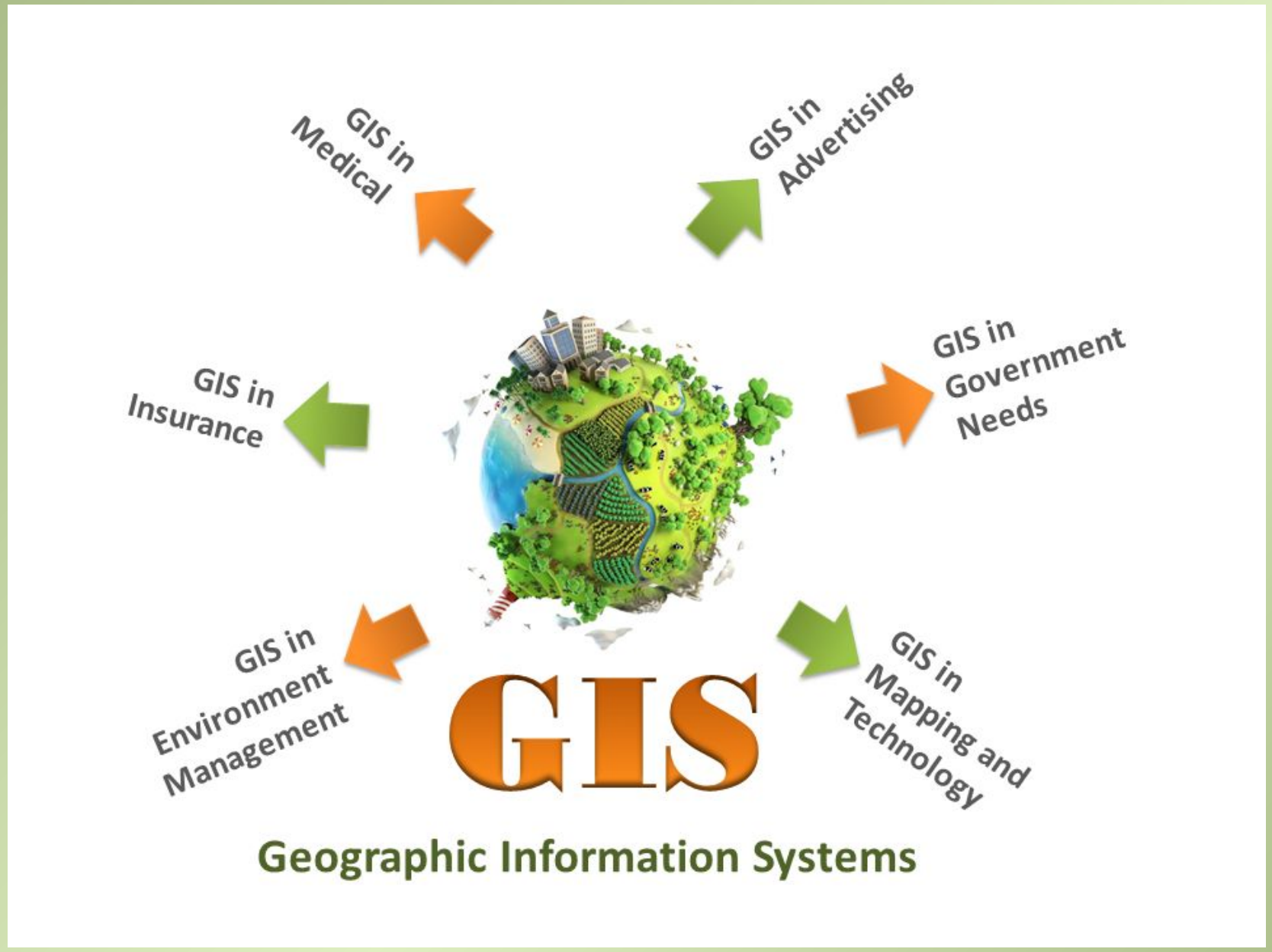
- Vector Data Model
- Raster Data Model
- Georelational data model
- Object based data model

GIS Operations

- Spatial Data Input
- Attribute Data Management
- Data exploration
- Data analysis
- Data Display
- GIS Modelling

GISystems, GIScience, GIS Applications

- GIS requires both hardware and software, and people such as the database creators or administrators and the users of the product. Thus, together it makes a GISystems.
- Geo-Information Science is the scientific field that attempts to integrate different disciplines studying the method and techniques of handling spatial information. (GIScience is a study of all methods and techniques used to understand and process data)
- GIS Application


GIS in Medical
GIS in Advertising
GIS in Insurance
GIS in Government Needs
GIS in Environment Management
GIS in Mapping and Technology
GIS
Geographic Information Systems

GIS Components

- Hardware
- Software
- People
- Data
- Organization

Geographic Projected and Planer Coordinate System

- The geographic coordinate system is the reference system for locating spatial features on the Earth's surface.
- The geographic coordinate system is defined by longitude and latitude.
- Both longitude and latitude are angular measures: longitude measures the angle east or west from the prime meridian, and latitude measures the angle north or south of the equatorial plane.

- Meridians are lines of equal longitude. The prime meridian passes through Greenwich, England, and has the reading of 0°.
- Using the prime meridian as a reference, we can measure the longitude value of a point on the Earth's surface as 0° to 180° east or west of the prime meridian.
- Meridians are therefore used for measuring location in the E–W direction.
- Parallels are lines of equal latitude. Using the equator as 0° latitude, we can measure the latitude value of a point as 0° to 90° north or south of the equator.
- Parallels are therefore used for measuring location in the N–S direction

Approximation of the Earth

- Viewed from space, the Earth looks like a perfect sphere. But it is not because the Earth is wider along the equator than between the poles.
- An approximation of the shape and size of the Earth is an oblate spheroid, also called ellipsoid, an ellipse rotated about its minor axis.
- An ellipsoid approximating the Earth has its major axis (a) along the equator and its minor axis (b) connecting the poles

Datum

- A datum is a mathematical model of the Earth, which serves as the reference or base for calculating the geographic coordinates in the case of a horizontal datum and for calculating elevations in the case of a vertical datum

Different types of coordinate systems

2D Geographic Coordinates (Φ, λ)

- The most widely used global coordinate system consists of lines of geographic latitude (Φ) and longitude (λ)

3D Geographic Coordinates (Φ, λ, h)

- The ellipsoidal height of a point is a vertical distance of the point from origin

2D Geocentric Coordinates (x, y)

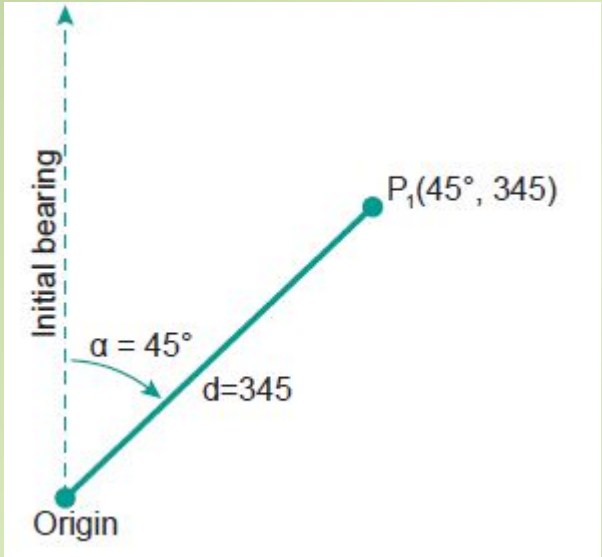
- It makes use of cartesian coordinate systems with x and y axis

3D Geocentric Coordinates (x, y, z)

- It makes use of cartesian coordinate systems with x, y and z axis

2d Polar coordinates (, d)

- The distance d is calculated from origin to the point connected and angle between point and a fixed direction (clockwise direction)



Coordinate Transformation

2D Polar to 2D Cartesian transformations

The transformation of polar coordinates (α, d), into Cartesian map coordinates (x, y) is done when field measurements, angular and distance measurements are transformed into map coordinates. The equation for this transformation is:

$$x = d(sin(a))$$

$$y = d(cos(a))$$

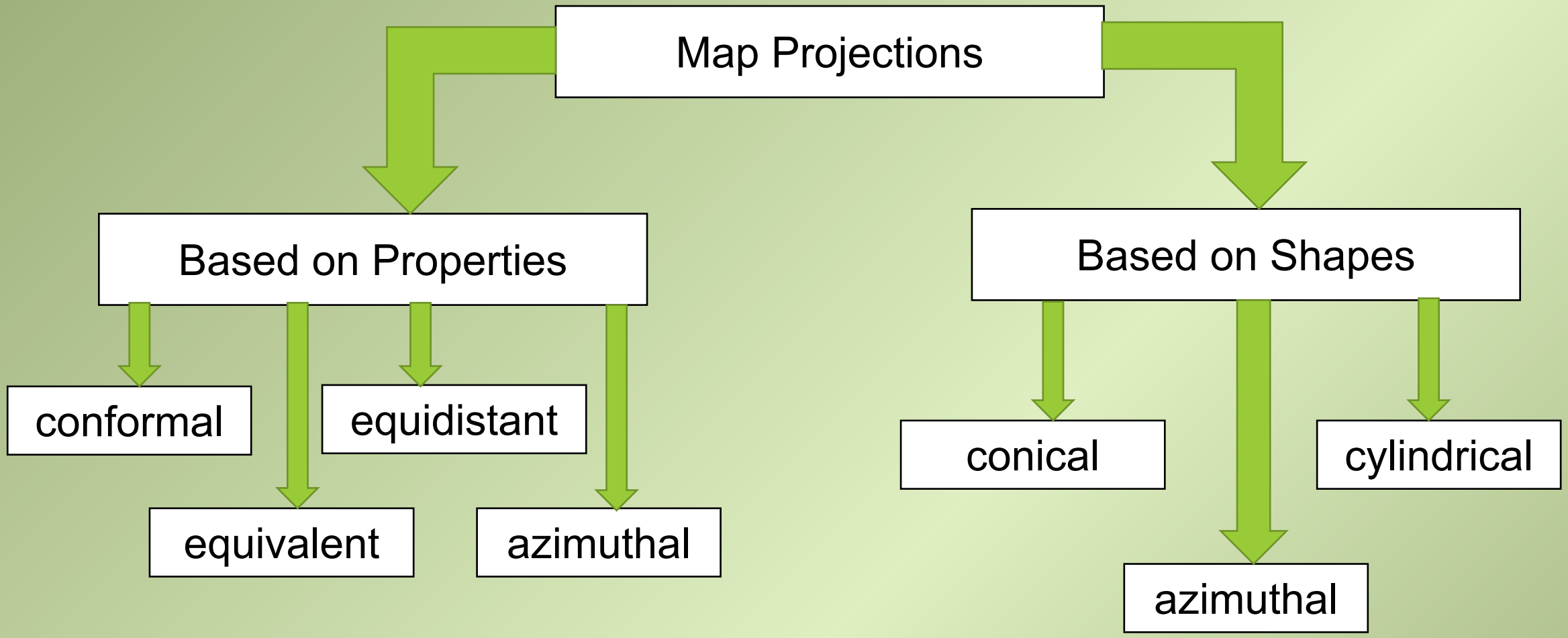
The inverse equation is:

$$a = tan^{-1}(\frac{x}{y})$$

$$d^2 = x^2 + y^2$$

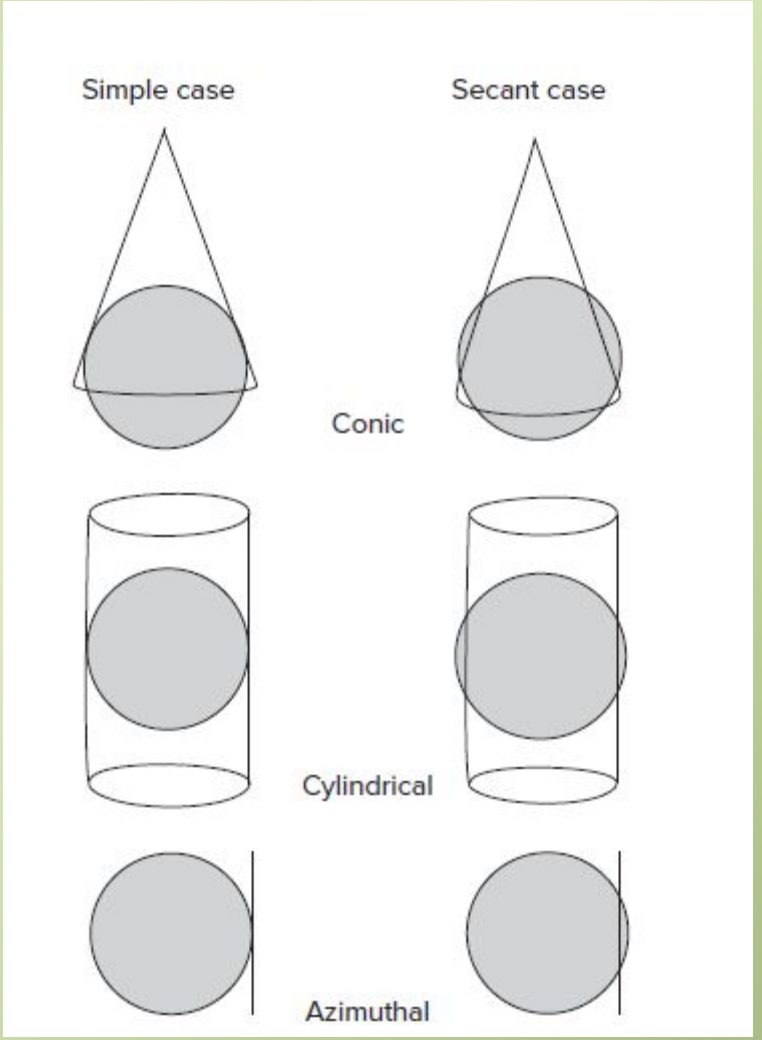
Map projections

- A map projection transforms the geographic coordinates on an ellipsoid into locations on a plane.
- The outcome of this transformation process is a systematic arrangement of parallels and meridians on a flat surface representing the geographic coordinate system.
- A map projection provides a couple of distinctive advantages:
  - First, a map projection allows us to use two-dimensional maps, either paper or digital.
  - Second, a map projection allows us to work with plane coordinates rather than longitude and latitude values.


Map Projections
Based on Properties
Based on Shapes
conformal
equidistant
equivalent
azimuthal
conical
azimuthal
cylindrical

- A conformal projection preserves local angles and shapes.
- An equivalent projection represents areas in correct relative size.
- An equidistant projection maintains consistency of scale along certain lines.
- An azimuthal projection retains certain accurate directions

- A map projection is called a cylindrical projection if it can be constructed using a cylinder, a conic projection if using a cone, and an azimuthal projection if using a plane.
- For a conic projection, the cone can be placed so that it is tangent to the globe or intersects the globe
- A cylindrical projection behaves the same way as a conic projection.
- An azimuthal projection, on the other hand, has a point of tangency



Spatial Data and Information

- By data we mean representations that can be operated upon by a computer.
- By Spatial data we mean data that consists of positional values, such as x, y coordinates (Geospatial data)
- Geoinformation is a specific type of information resulting from the interpretation of spatial data.
- When the data is to be shared among different users, the users need to know not only what data exists, but also what format it is, whether data provided meets their requirements or not. This is called as “Metadata” (Data about data).

Models and Modelling

- A representation of some part of real world can be considered as a model because the representation will have certain characteristics in common with the real world.
- This then allows us to study and operate on the model itself instead of the real world, in order to test what happens under various conditions, and help us answer the question “what if”
- The process by which we create models and use them for analysis is called as Modelling.
- A **real-world model** is a representation of a number of phenomena that we can observe in reality, usually to make some type of study, computation, etc.

- **Application models** refers to the models with a specific application, including real world models or analytical model.
- Maps and databases are commonly called as **Static model**, as at any point of time, they represent a single state of affair.
- **Dynamic model** or Process models emphasizes changes that have taken place, are taking place or may take place sometime in future.

Maps

- Maps are the best-known models of the real world.
- A disadvantage of the traditional paper-based maps are that they are generally restricted to 2D static representations, and that is always displayed in a fixed scale.
- The map scale determines the spatial resolution of the graphic feature representation. The smaller the scale, the less detail a map can show.
- Cartography is the science and art of map making, functions as an interpreter, translating real world phenomena into correct, clear and understandable representation for our use.

Cartographers

Databases

- A database is a repository for storing large amounts of data.
  - Allows concurrent use.
  - Supports storage optimization
  - Supports Data integrity
  - Has a query facility
  - Offers Query optimization

Spatial database and spatial analysis

- GIS must store its data either temporary or in a permanent manner for analysis purpose.
- With advancement in technologies, spatial databases are used which can store not only the traditional data but also representation of real-world geographic phenomena for use in GIS
- Database which can store characteristics along with location are called as “Spatial Database” or “Geodatabase”
- Spatial Analysis is the generic term for all manipulations of spatial data carried out to improve one’s understanding of the geographic phenomena that the data represents.