M.Tech Geoinformatics

Geographic Information System
(24CC03)

Unit I: Introduction to GIS

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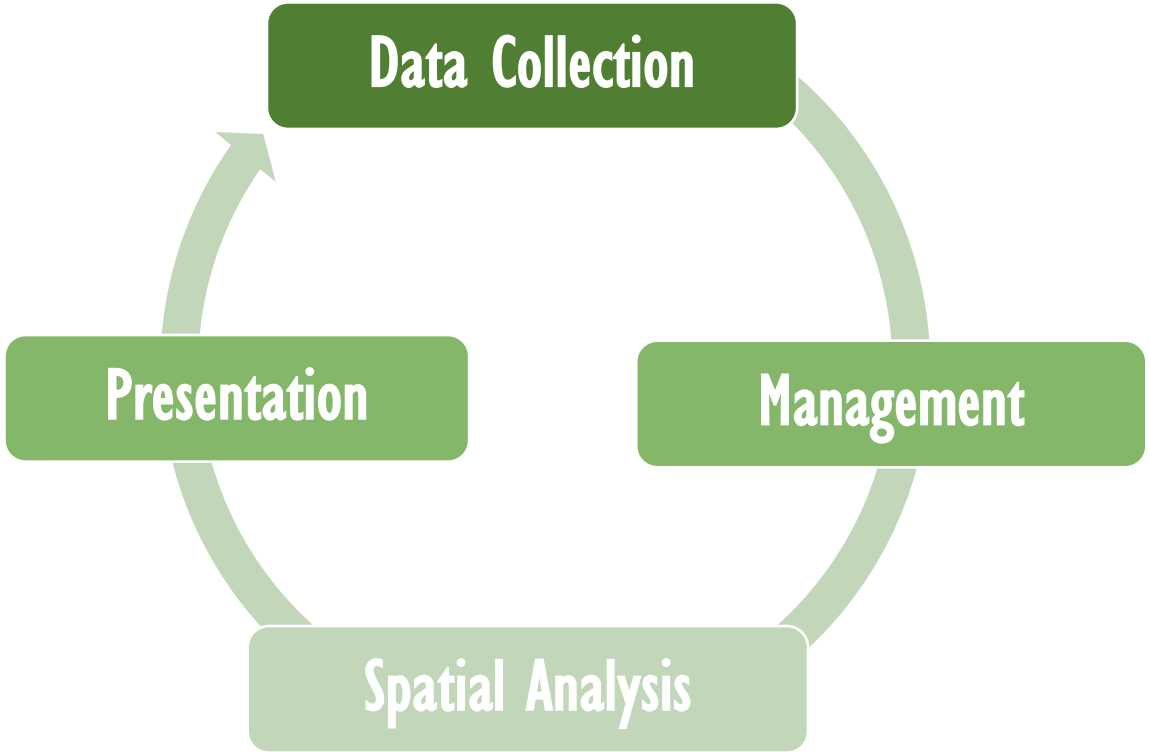
Introduction to GIS

What is GIS

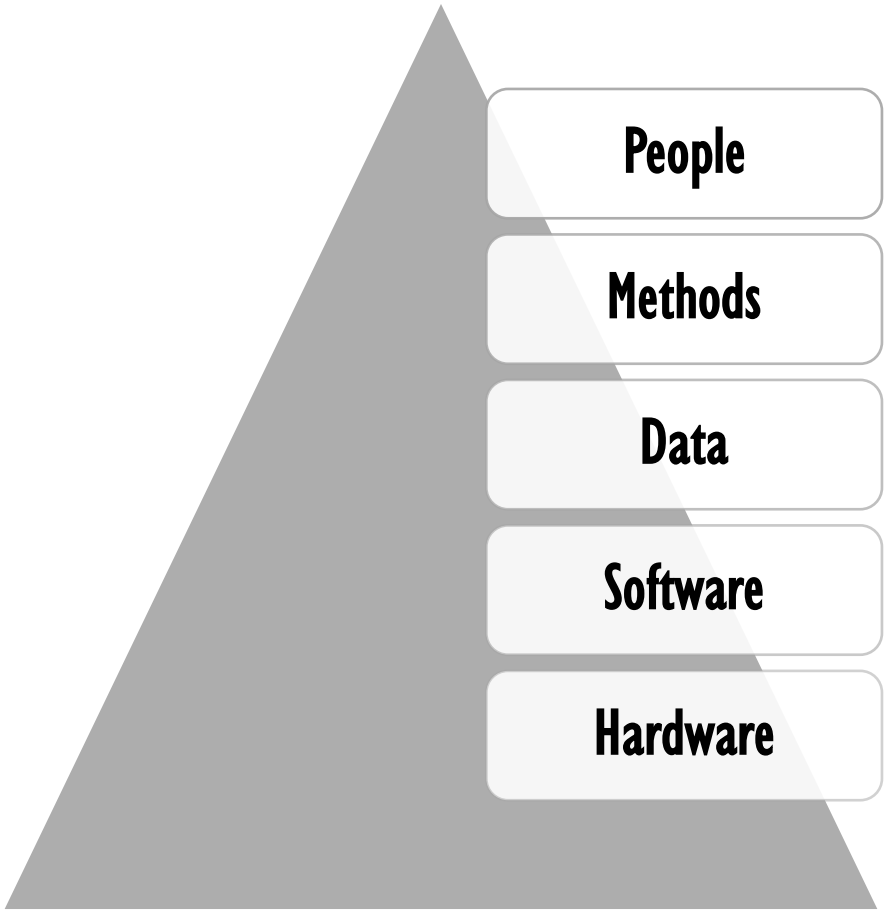
- A GIS is a computer-based system to aid in the collection, maintenance, storage, analysis, output, and distribution of spatial data and information.
- Data vs Information



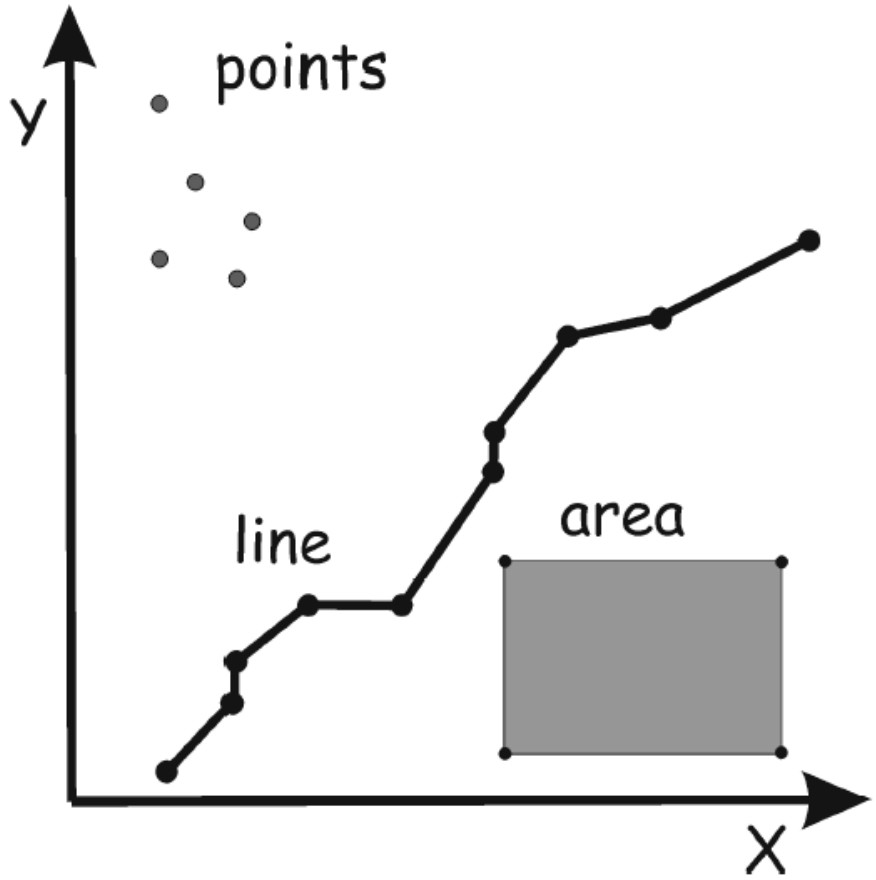
GIS History

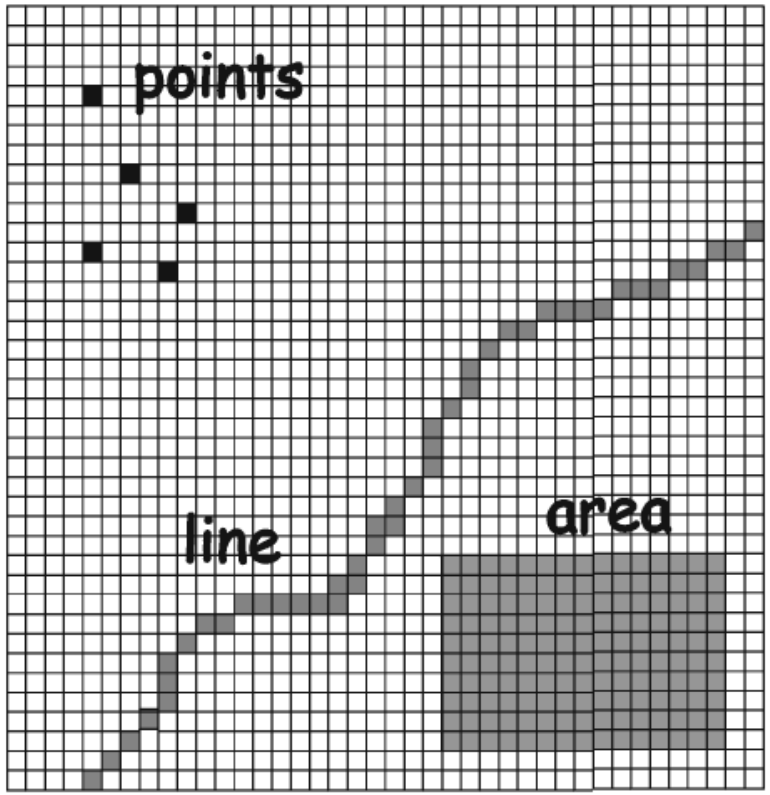
- 1960s: John Snow, Minard's Map (Napoleon)
- First GIS – Roger Tomlinson 1960, operational from 1971
- USA – Government Organisations: USGS, US Forest Services, others incl. CIA
- Academia
  - Edinburgh – GIMMS 1970s (Sold from 1973), MSc GIS 1985
  - Harvard – Computer Graphics and Spatial Analysis Lab 1965
- ESRI 1969 Env. Consultancy – Arc/Info 1982 - ArcView Desktop 1995 - ArcGIS 1999
- Demographics Consultancy – MapInfo 1986
- OpenSource – GRASS, Quantum GIS (QGIS), gvSIG, …
- Web GIS – WMS, WFS, Google Maps, Google Earth, OGC, OpenStreetMap

Components of GIS



Data Models





Vector Data

Point

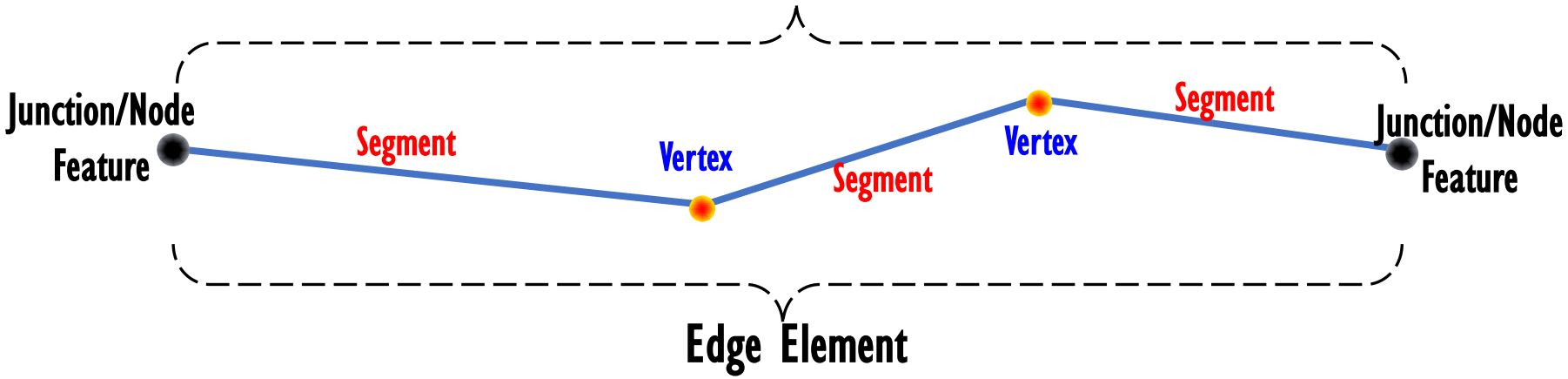
- Discrete locations in 0-dimension with a single x,y coordinate pair and zero area.
- Eg. — tree, oil well, label location

Polyline

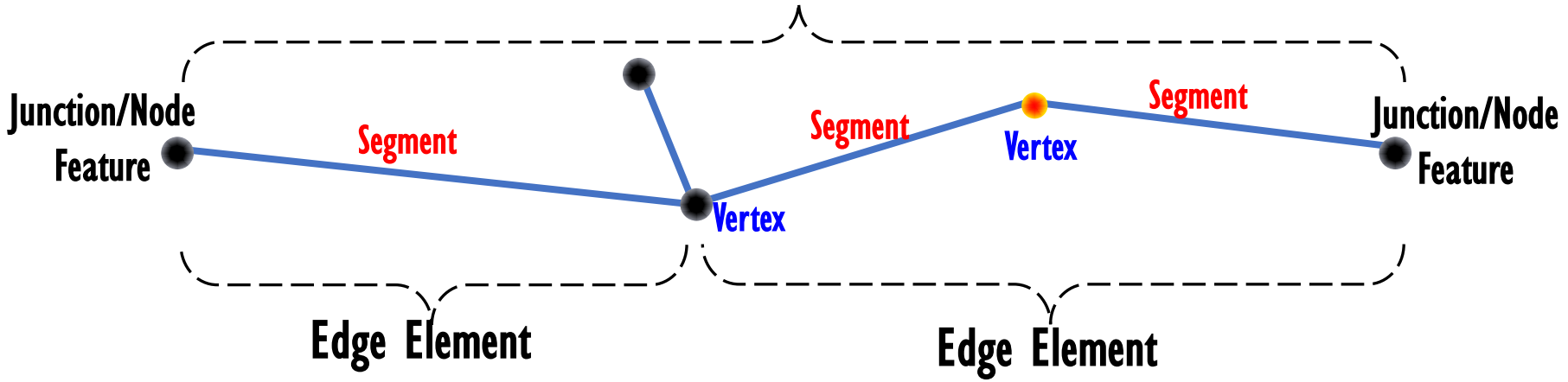
- Set of atleast two ordered, connected coordinates in 1-dimension.
- Eg — roads, water pipelines

Polygon

- Closed figures that encompass a homogenous area in 2 dimensions. It should have three or more ordered and connected x,y pairs.
- Eg — lakes, districts



FeatureID / OID*
Geometry*
Length*
Name
State
StartPlace
EndPlace
Default fields



Attributes & Field Data Types

Shapefile

- Integer
- Float
- Double
- String
- Date

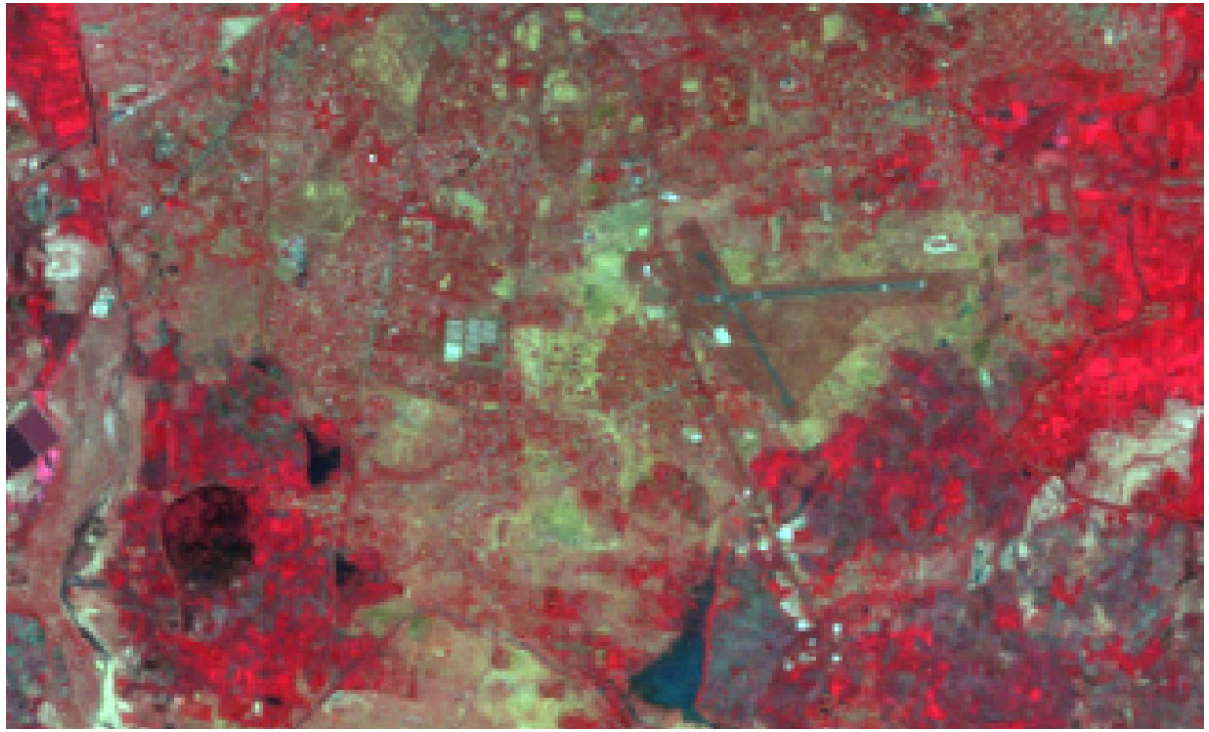
Geodatabase / File Geodatabase

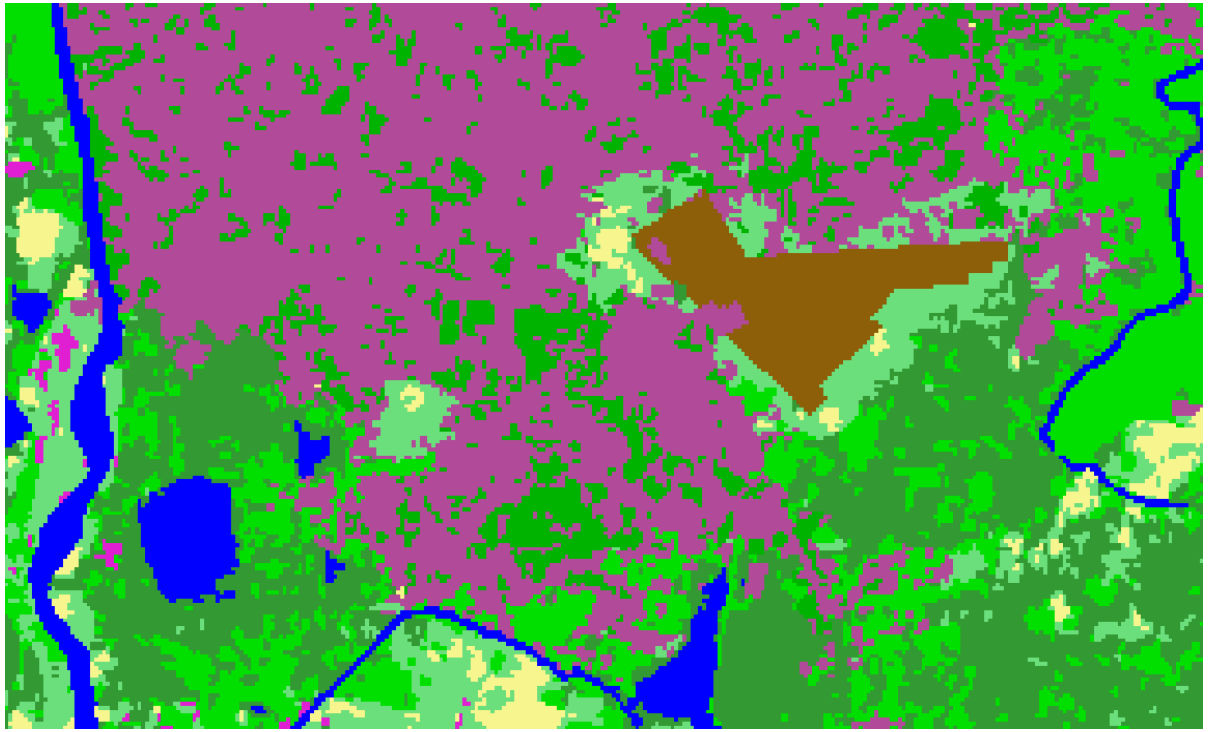
- Integer
- Float
- Double
- String
- Date
- Blob
- GUID
- Raster

Data Type	Examples
Short Integer (16 Bits)	-32,768 to 32,767
Integer (32 Bits)	4,29,49,67,296
Long Integer (64 Bits)	1,84,46,74,40,73,70,95,51,616
Float (32 Bits)	3.4E+/-38
Double (64 Bits)	1.7E+/-308
String	"A", "GIS World"
Date	09.08.2024 14:15:00
Blob	Unstructured data in binary format
GUID	{12345678-1234-1234-1234}
Raster	.jpg, .PNG, .TIF

Raster Data

- Raster data is generally represented in a grid format and the cells are generally called **pixels.**
- Attributes are recorded by assigning each cell a single value
- easy to do overlays/analyses, just by 'combining' corresponding cell values: **"yield= rainfall + fertilizer"**
- simple data structure: directly store each layer as a single table





Attributes

- Vector – Multiple Attributes (Properties)
  - Attributes are of each feature (point, line, poly)

- Raster – Single Attribute (Value) e.g. pH
  - Each cell has a different value of this attribute

  - BUT! Can also have in turn Value Attributes e.g. 1 = Acid, 7 = Neutral, 14 = Alkaline

  - BUT! Again only one per value!

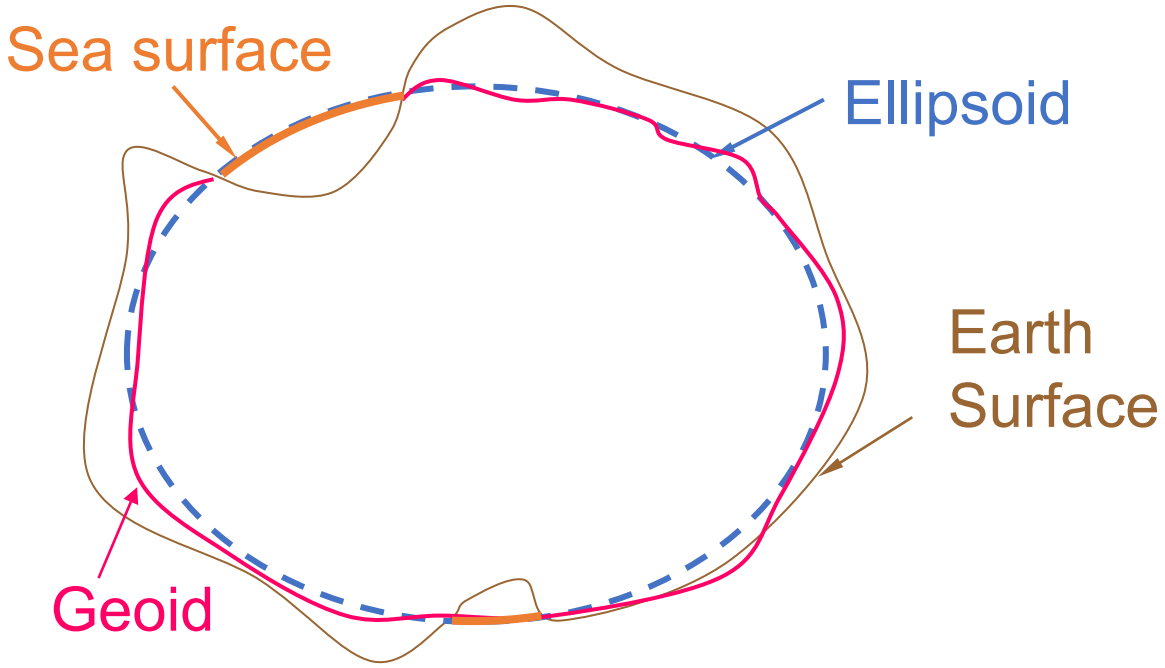
Attributes Table		
Point ID	model	year
1	a	90
2	b	90
3	b	80
4	a	70
5	c	70

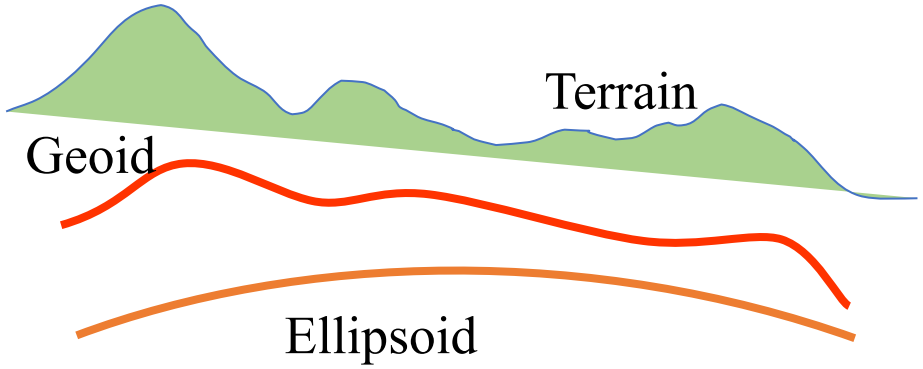
Coordinates Table		
Point ID	x	y
1	1	3
2	2	1
3	4	1
4	1	2
5	3	2

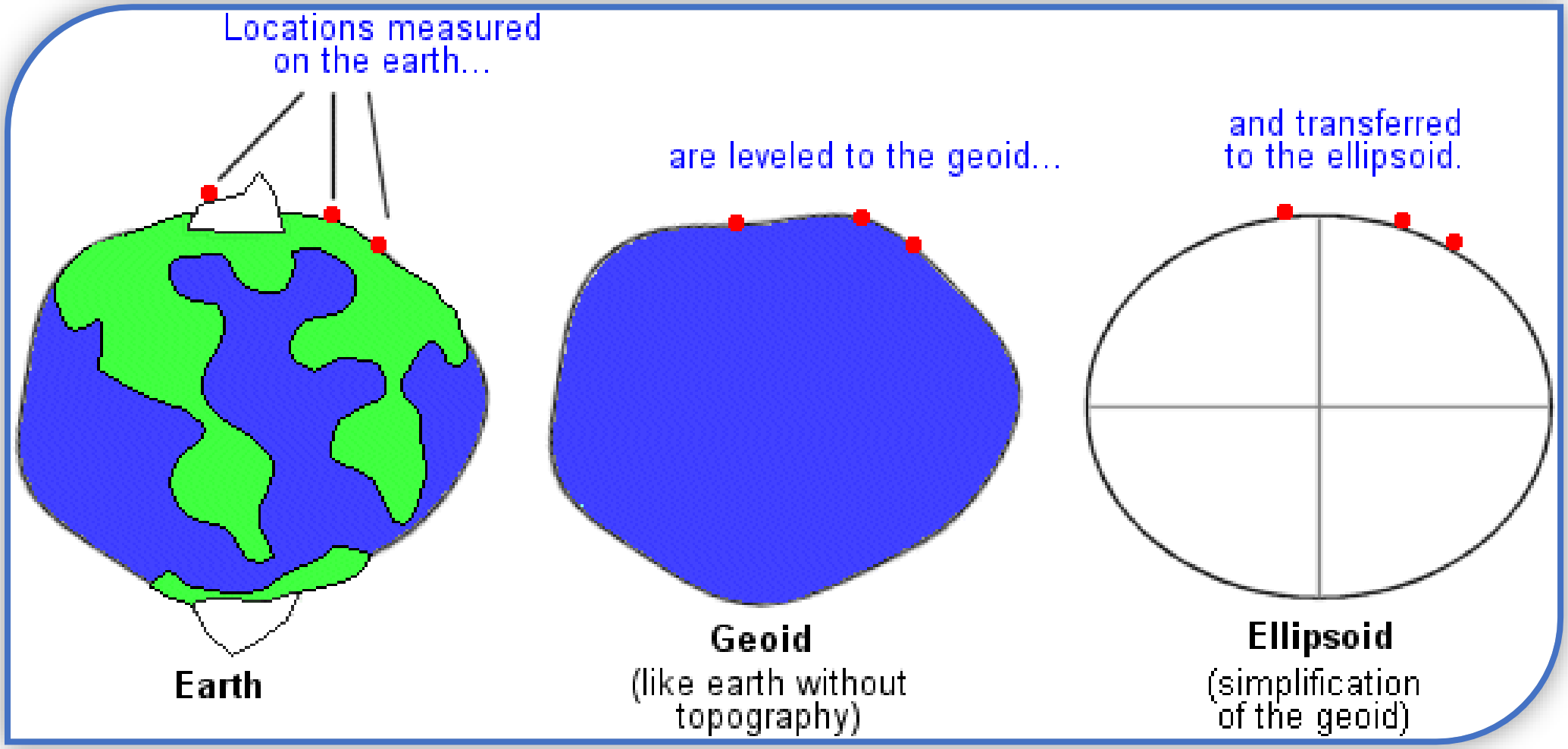
Also there is a geometry/shape definition file/table for each features.

Shape of the Earth

- **Geoid** is the shape that the *surface of the oceans* would take under the influence of Earth's gravity and rotation






Locations measured
on the earth...
are leveled to the geoid...
and transferred
to the ellipsoid.
Earth
Geoid
(like earth without
topography)
Ellipsoid
(simplification
of the geoid)

Datum

- In geodesy, a datum is a set of reference points on the earth's surface and an associated model of the shape of the earth (reference ellipsoid) to define a Coordinate System
- **Horizontal datum:** are used for describing a point on the earth's surface, in latitude and longitude or another coordinate system
- **Vertical datum:** measure elevations or depths

Map Projections & Coordinate Systems

Map Projection

- Map projections in surveying are methods used to transform the spherical surface of the earth into a two-dimensional plane.
- A map projection minimizes distortions in the representation of the earth's surface

Coordinate System

- Coordinate systems are sets of mathematical rules used to locate positions on the earth's surface.
- A coordinate system provides a consistent and standardized way to locate and measure positions

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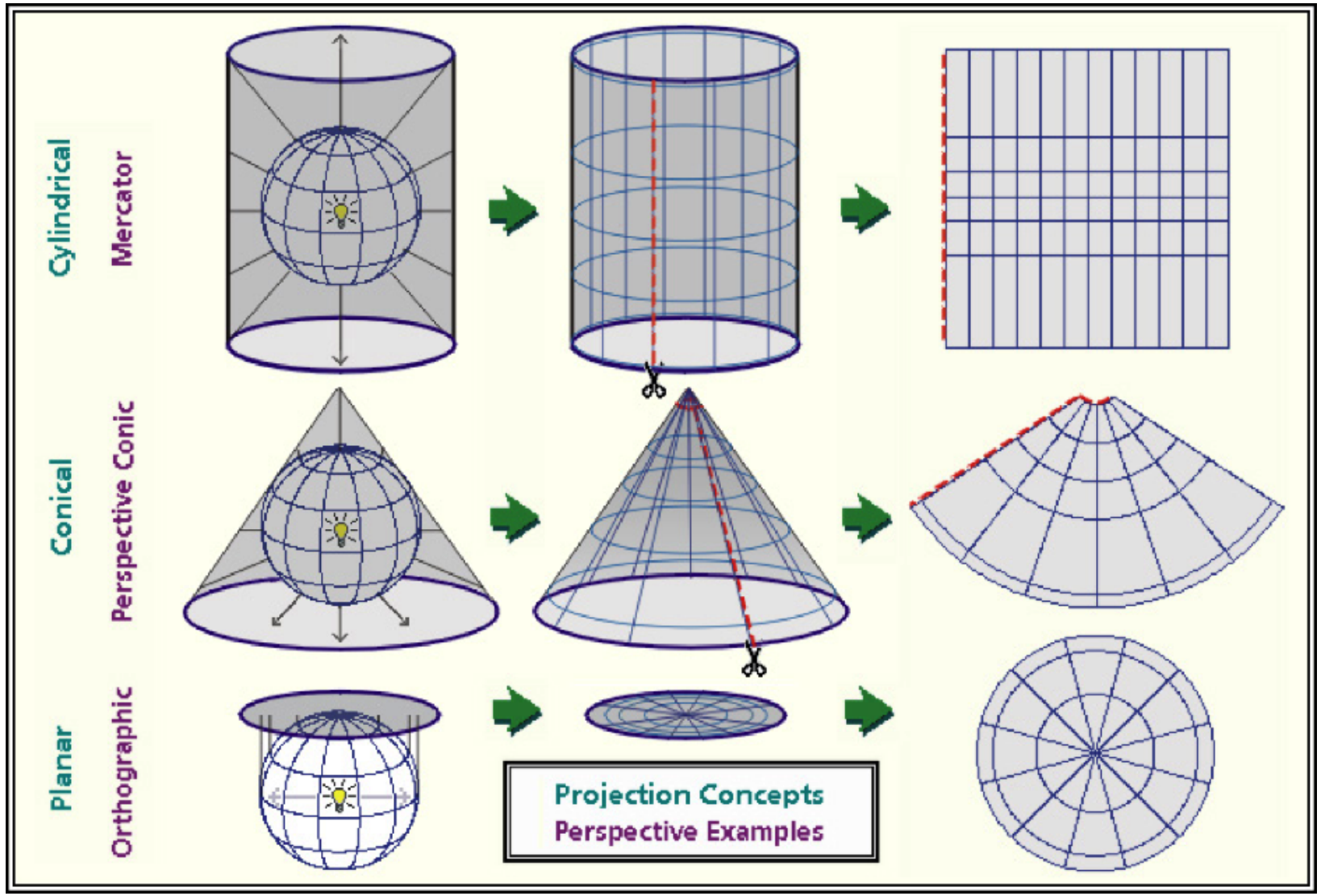
Spatial Data can be measured/located in:

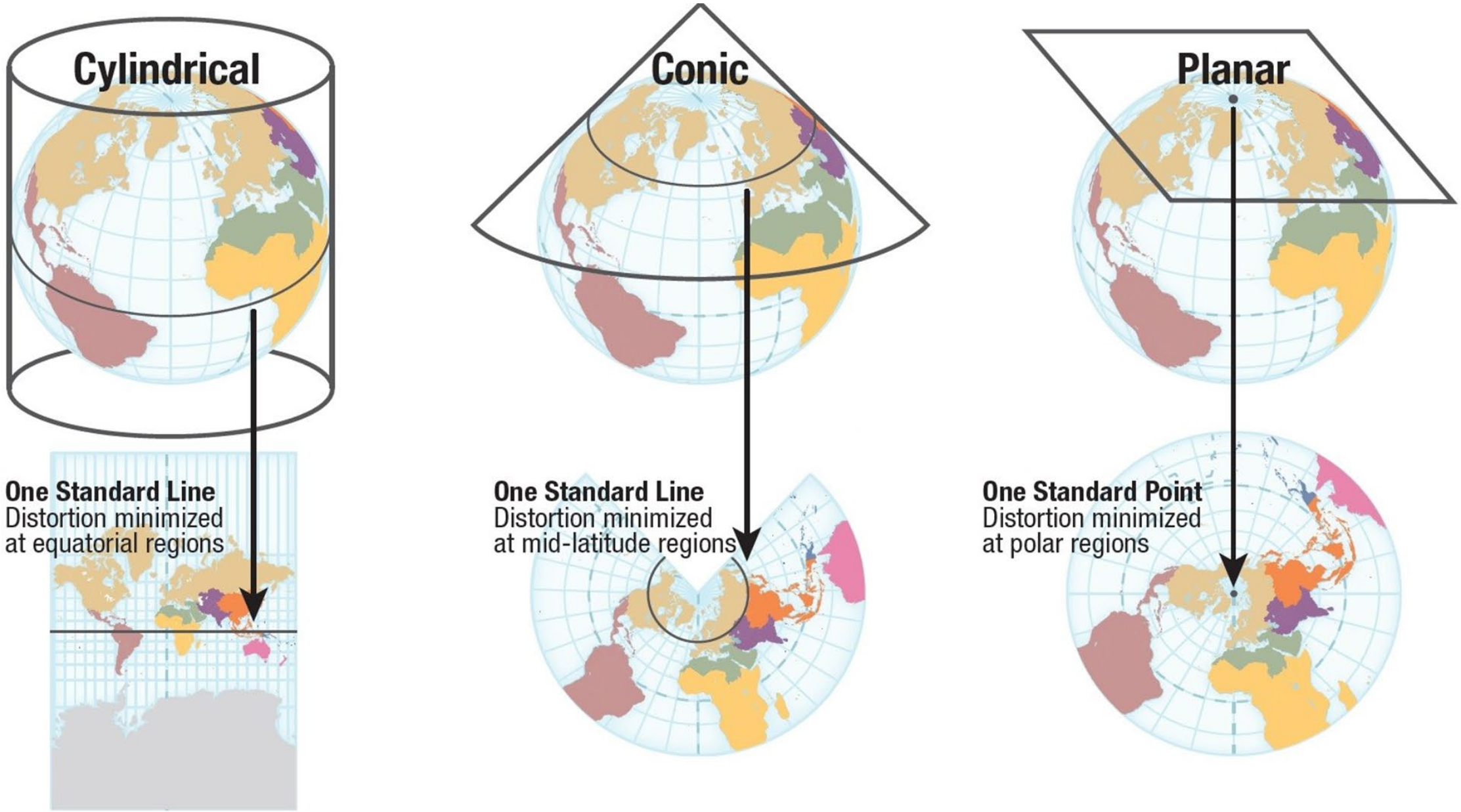
- Angular Units – Latitude, Longitude, e.g. 56°23'4" (DMS) / 56.38° (DD)
- Linear Units – Flat Grid-based: Easting, Northing, e.g. 100025 metres / feet

Coordinates:

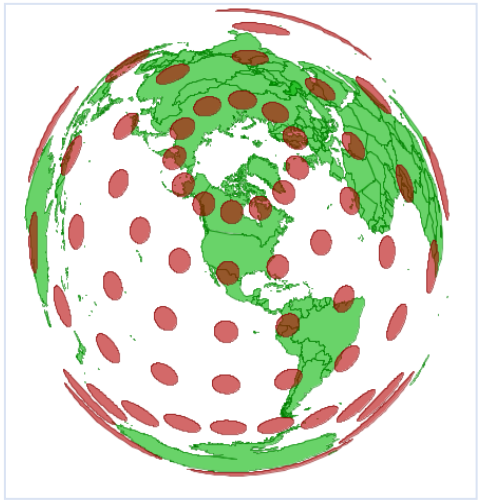
- Spherical (Angular)/Geographic Coordinate = 'Geographic' CRS e.g. Polyconic
- Cartesian (Linear)/Projected Coordinate = 'Projected' CRS e.g. UTM

- All CRS are based on a reference datum – a model of the Earth's surface/shape. This MUST be correctly defined, for any later projection (curved to flat) to work correctly.

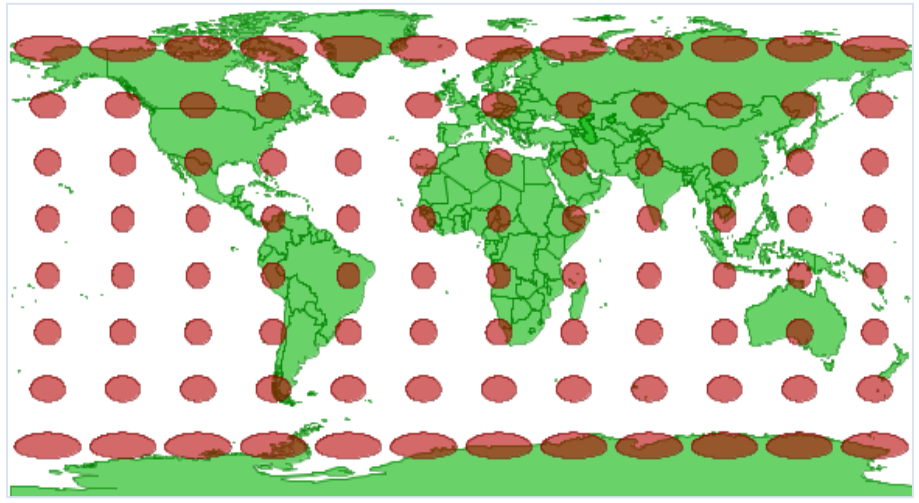

Cylindrical
Mercator
Conical
Perspective Conic
Planar
Orthographic
Projection Concepts
Perspective Examples


Cylindrical
One Standard Line
Distortion minimized
at equatorial regions
Conic
One Standard Line
Distortion minimized
at mid-latitude regions
Planar
One Standard Point
Distortion minimized
at polar regions

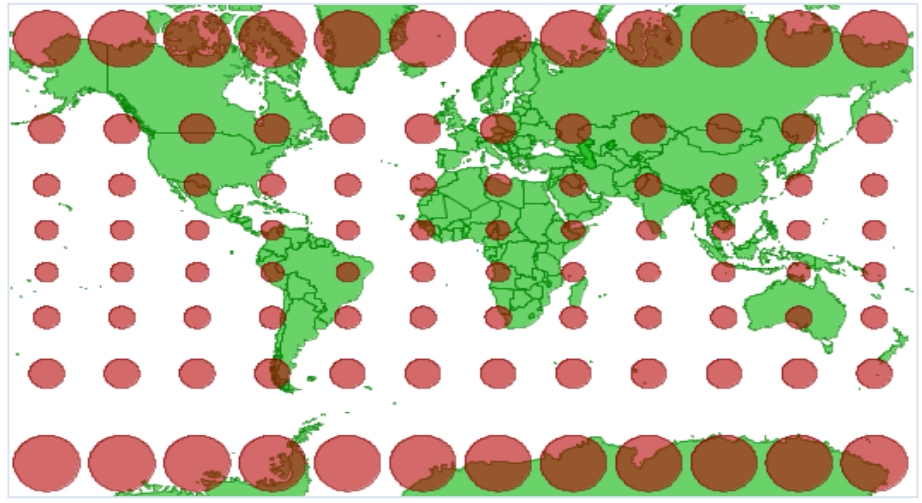
Globe



Geographic Coordinate System



Projected Coordinate System



Thank You!