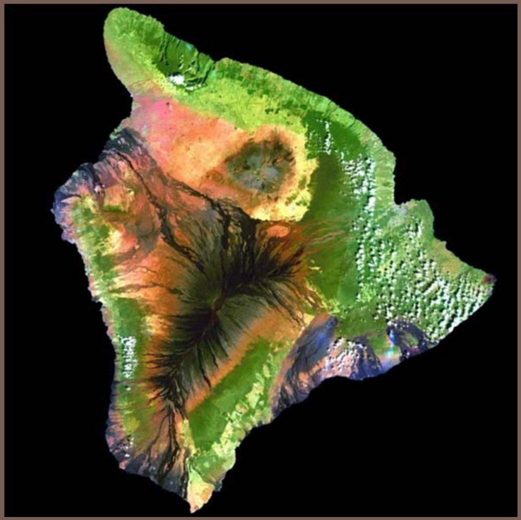
INTRODUCTION: BASIC GEOGRAPHIC CONCEPTS



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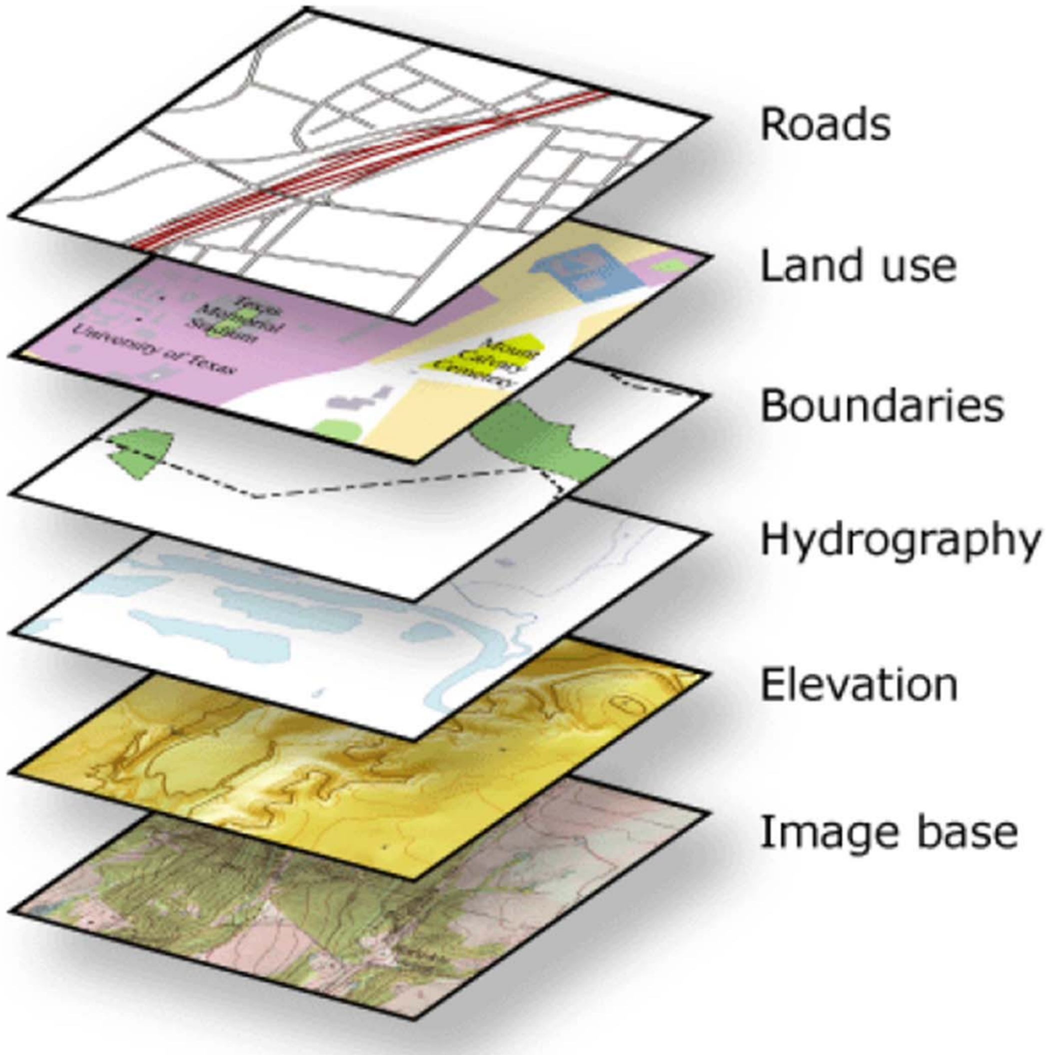
Outline

- What is geographical / spatial analysis and why do we care ?
- Different types of geographic data
  - Vector
  - Raster
  - Topological
- GIS Terms / Definitions
- Coordinate Systems ?
  - Geographic Coordinate Systems
  - Projected Coordinate Systems
  - Minimizing Distortion
- Common File Types:

Where ever you are….that's where you'll be…….

The Geographical Intersection of Information



How knowledge is obtained…..

- Information
  - Geographical
    - Vector Data (Points, Lines, Areas)
      - Raster Data (Grids/Cells)
  - Non-Geographical
    - Socio Economic
      - Descriptive Attributes

Why should you care?

The most powerful analytical tool at your disposal!

Data Types

Vector Data:

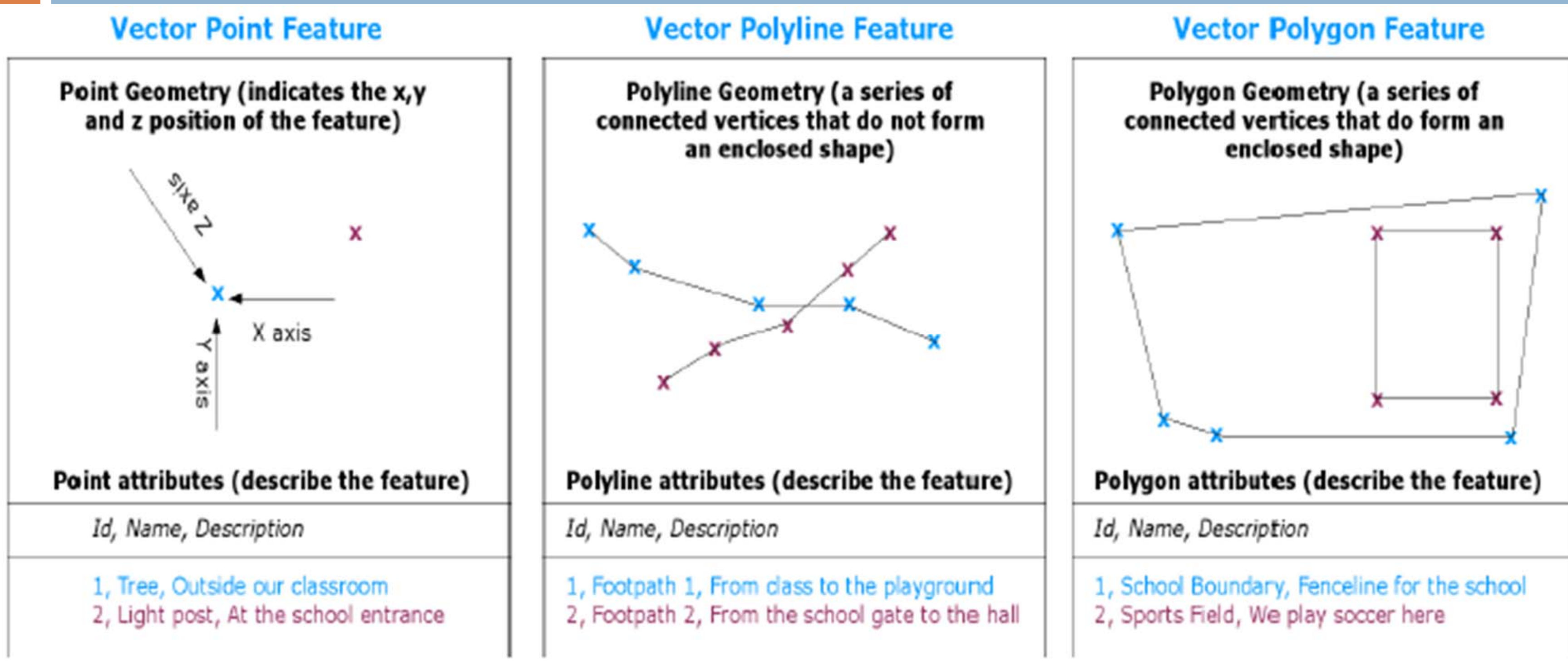
A vector is made up of three different types of elements:

1) nodes, which are single sets of coordinates (x, y, z) which define a point (such as a spring);
2) lines, which are curvilinear strings of coordinates which define a curved line (such as a stream); and
3) polygons, which are collections of lines which inscribe an area (such as a lake).

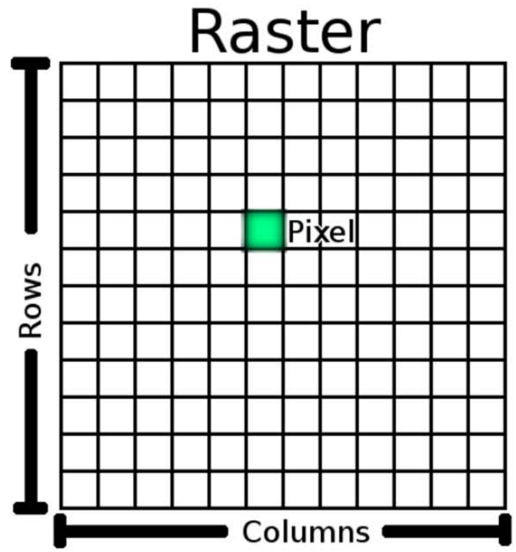
Raster Data:

A data structure (logically, a 2-dimensional array) that contains rows and columns of numbers of a single data type. Each number represents the value of some parameter (like elevation or red spectral intensity). Each number (or cell value) is often used to control the color and intensity of one pixel on a computer's display screen. A complete computer image can be displayed from the values in a raster that has as many rows and columns as the computer has pixels for the screen.

Vector Data


Vector Point Feature
Vector Polyline Feature
Vector Polygon Feature
Point Geometry (indicates the x,y and z position of the feature)
Z axis
X axis
Y axis
Point attributes (describe the feature)
Id, Name, Description
1, Tree, Outside our classroom
2, Light post, At the school entrance
Polyline Geometry (a series of connected vertices that do not form an enclosed shape)
Polyline attributes (describe the feature)
Id, Name, Description
1, Footpath 1, From class to the playground
2, Footpath 2, From the school gate to the hall
Polygon Geometry (a series of connected vertices that do form an enclosed shape)
Polygon attributes (describe the feature)
Id, Name, Description
1, School Boundary, Fenceline for the school
2, Sports Field, We play soccer here

Raster Data


Raster
Pixel
Rows
Columns


0
0.4
degrees
N
© QGIS 2009


0
0.04
degrees
N
© QGIS 2009

Topological Data

A description of the relationship between node, line, and polygon elements from vector data. Usually describing the intersection of two or more topologically coded data sets that produces one data set that is uniformly topologically coded with respect to graphic entities and to attribute data

Line

A level of spatial measurement referring to a one-dimensional defined object having a length and direction and connecting at least two points. Examples are roads, railroads, telecommunication lines, streams, etc.

Node

A single point defined by a set of coordinates in space, and one of the types of elements in a vector object. Nodes may be lone points, or may occur as the terminal point at the end of one or more line elements.

Polygon

A two-dimensional figure with three or more sides intersecting at a like number of points. In GIS systems, an area.

GIS Terms/Definitions

Geocoding

Process of assigning alphanumeric locational identifiers (such as the municipal address or physical location) to spatially related information. For example, an address may be matched to an address range on a street segment, or a given spatial area (i.e., the limits of a polygon, a line segment, a point along the segment, or an absolute point that has been coordinated). The process implies a geographic base file which can be used to pass addresses in order to find out characteristics about the geometry.

CAD - Computer Aided Drafting/Design/Drawing.

CAD is used for computerized drafting. Many CAD systems also provide more advanced features like solid modeling and simulation. CAD generally lacks topology of objects and direct links to an attribute database, which are essential features in GIS modeling and analysis operations.

GIS Terms/Definitions

Cadastral Mapping

A mapping endeavor with ownership and value being the primary concerns. Principal usage is for tax analysis.

Cardinal direction

The four principal directions: North, South, East and West.

Cartesian coordinates

A coordinate system in which the locations of points in space are expressed by reference to three perpendicular axes, called the *coordinate axes (x,y,z)*.

Coordinate Systems

A particular kind of reference frame or system, such as plane rectangular coordinates or spherical coordinates, which use linear or angular quantities to designate the position of points within that particular reference frame or system.

GIS Terms/Definitions

Plane coordinates

Coordinates specifying the locations of points in a plane. In cartography the plane usually is a projection of the Earth's surface onto a flattened cone or cylinder, and the x and y values scaled along the rectangular axes are called eastings and northings, respectively.

Euclidean distance

The shortest distance joining two points in the plane

Join

A process of connecting two or more separately digitized maps

GIS Terms/Definitions

Label

A vector element that contains text used to identify a node, line, or polygon element.

Layer

Refers to the various overlays of data, each of which normally deals with one thematic topic. These overlays are registered to each other by the common coordinate system of the database.

Legend

The part of the drawn map explaining the meaning of the symbols used to code the depicted geographical elements.

GIS Terms/Definitions

Map scale

The relationship that exists between a distance on a map and the corresponding distance on the Earth. It may be expressed as an equivalence, one inch equals 16 statute miles; as a fraction or ratio, 1:1,000,000; or as a bar graph subdivided to show the distance that each of its parts represents on the Earth.

Network analysis

Analytical techniques concerned with the relationships between locations on a network, such as the calculation of optimal routes through road networks, capacities of network systems, best location for facilities along networks, etc.

http://resources.arcgis.com/glossary

Coordinate Systems

Observations about Earth……

- It isn't flat, perfectly round or two dimensional
- It's a sphere

- Geographic Coordinate System
- Projected Coordinate System

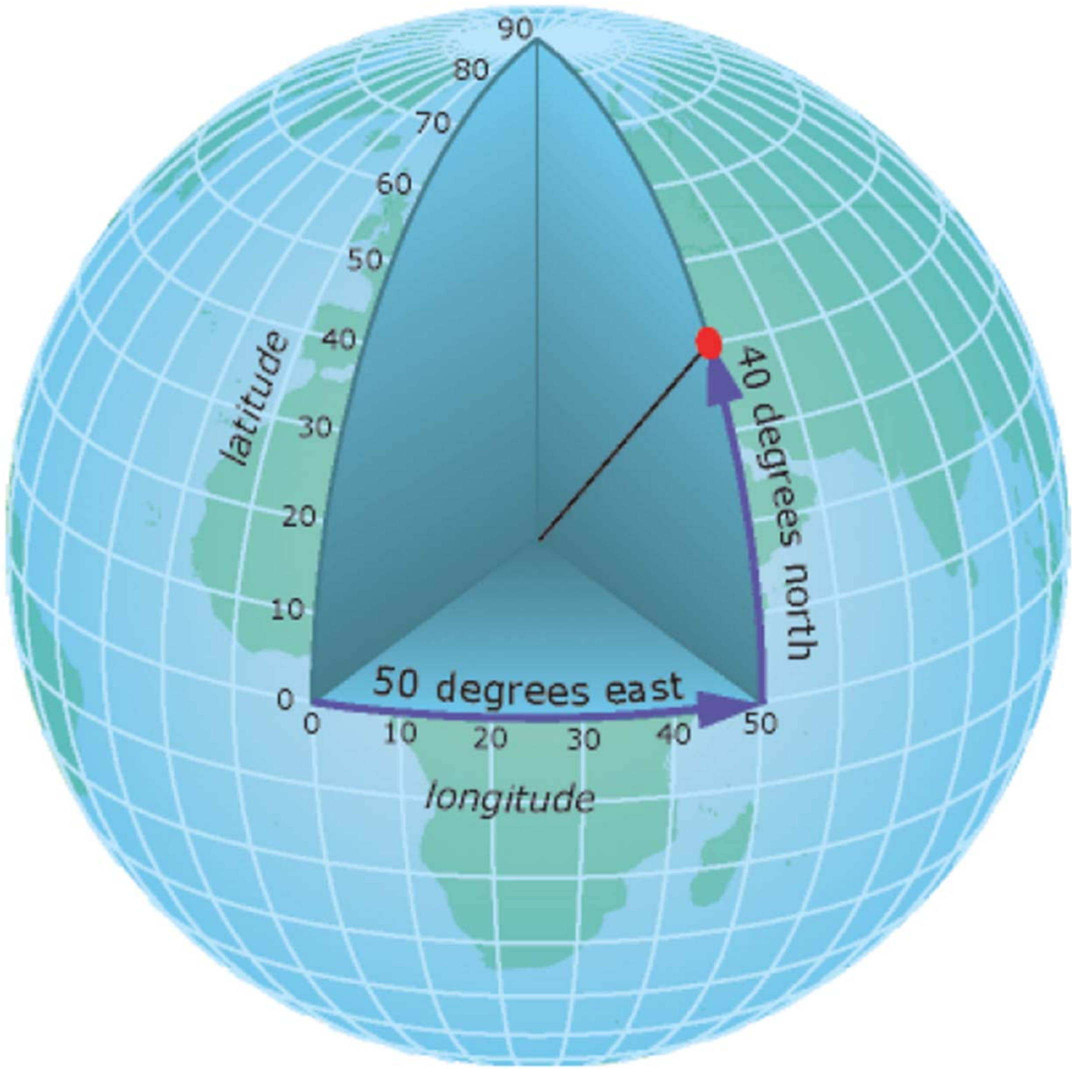
Geographic Coordinate System

- Uses degrees of longitude (x), latitude (y) and sometimes height (z) to describe a precise location on the earth.

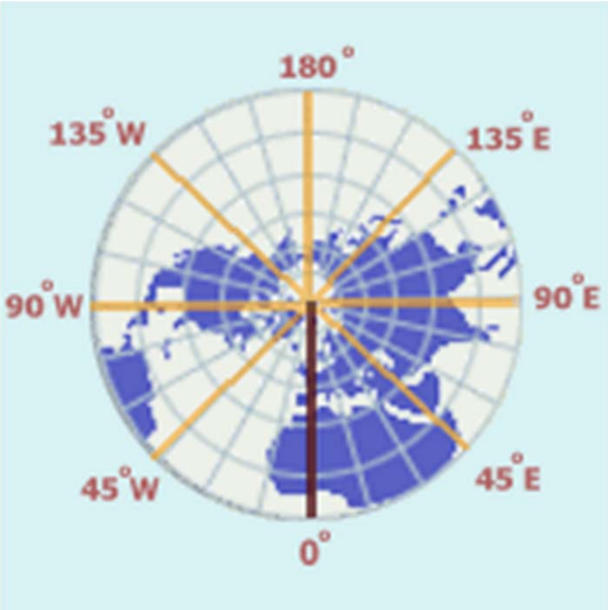
  - The latitude reference is the equator and each hemisphere is divided into 90 sections, each representing one degree of latitude

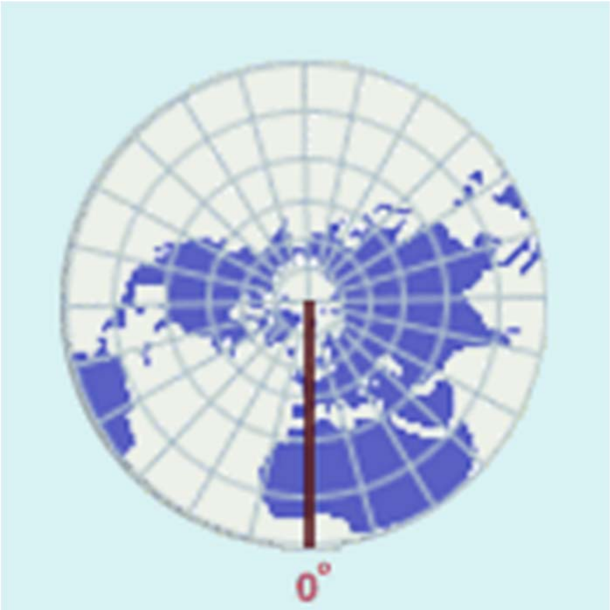
  - The longitude reference is the prime meridian, running perpendicular to the equator from the North Pole to the South Pole.

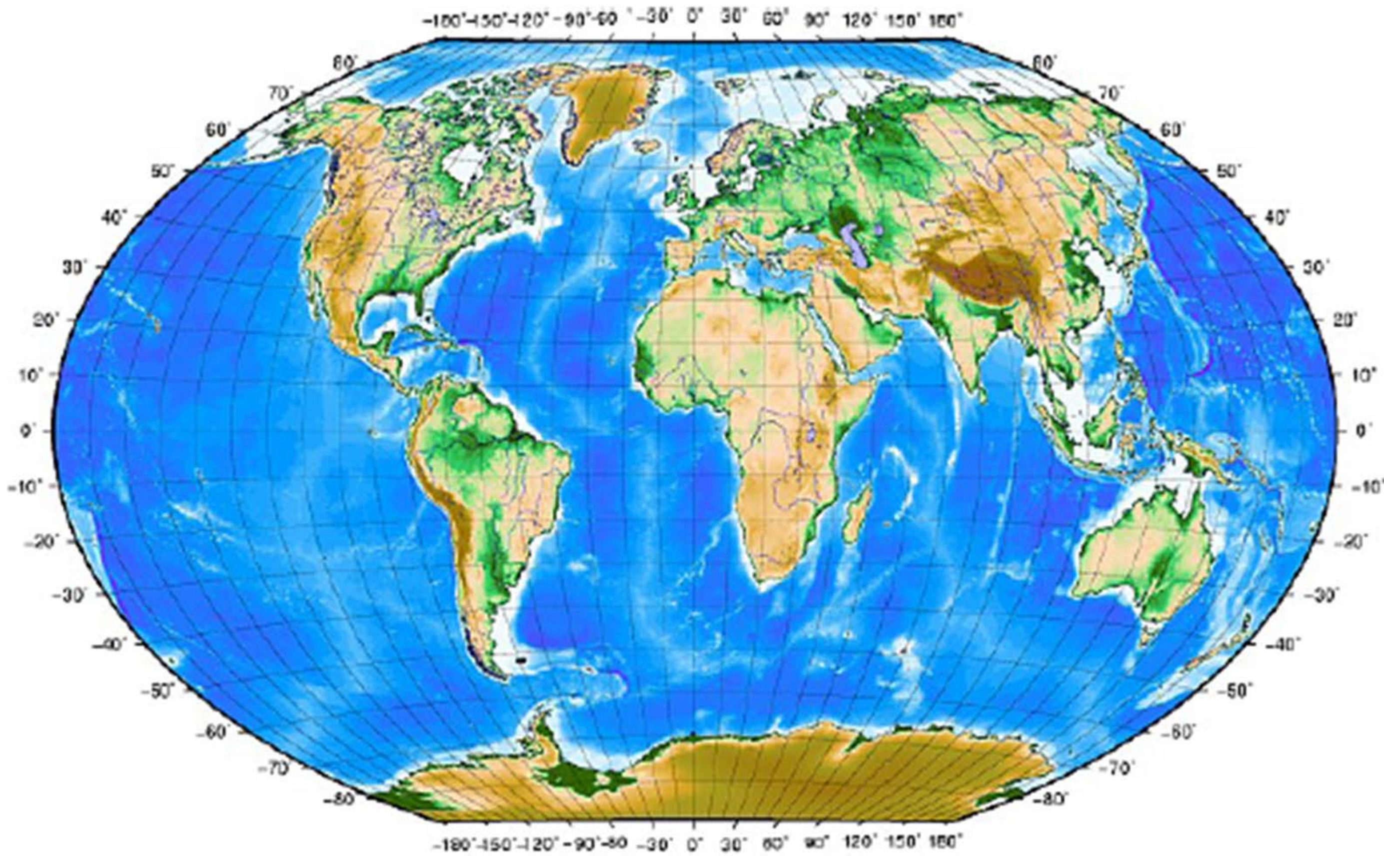
Geographic Coordinate System



Coordinate Systems






-180° -150° -120° -90° -60° -30° 0° 30° 60° 90° 120° 150° 180°
80° 70° 60° 50° 40° 30° 20° 10° 0° -10° -20° -30° -40° -50° -60° -70° -80°

Geographic Coordinate System

- In order to achieve an acceptable degree of accuracy, degrees are divided into minutes and seconds.
  - 1 degree = 60 minutes
  - 1 minutes = 60 seconds
  - 3600 seconds in a degree

- So at the equator, one 1 second of latitude and 1 second of longitude is equal to 30.87624 meters

Geographic Coordinate System

Degrees of latitude and longitude can be further subdivided into minutes and seconds: there are 60 minutes (') per degree, and 60 seconds (") per minute. For example, a coordinate might be written 65° 32' 15". Degrees can also be expressed as decimals: 65.5375, degrees and decimal minutes: 65° 32.25', or even degrees, minutes, and decimal seconds: 65° 32' 15.275". All these notations allow us to locate places on the Earth quite precisely – to within inches.

A degree of latitude is approximately 69 miles, and a minute of latitude is approximately 1.15 miles. A second of latitude is approximately 0.02 miles, or just over 100 feet.

A degree of longitude varies in size. At the equator, it is approximately 69 miles, the same size as a degree of latitude. The size gradually decreases to zero as the meridians converge at the poles. At a latitude of 45 degrees, a degree of longitude is approximately 49 miles. Because a degree of longitude varies in size, minutes and seconds of longitude also vary, decreasing in size towards the poles.

Projected Coordinate System

- Projected coordinate systems portray the earth in a two-dimensional flat surface (paper or computer screen).
- To more accurately represent locations on the earth's surface, map makers studied the shape of the earth (geodesy) and created the concept of the spheroid.
- A datum links a spheroid to a particular portion of the earth's surface. Recent datums are designed to fit the entire earth's surface well.
- The most commonly used datums in North America are:
  - NAD 1927 (North American Datum 1927) using the Clarke 1866 spheroid
  - NAD 1983 (North American Datum 1983) using the GRS 1980 spheroid
  - WGS 1984 (World Geodetic System 1984) using the WGS 1984 spheroid

Projection Families

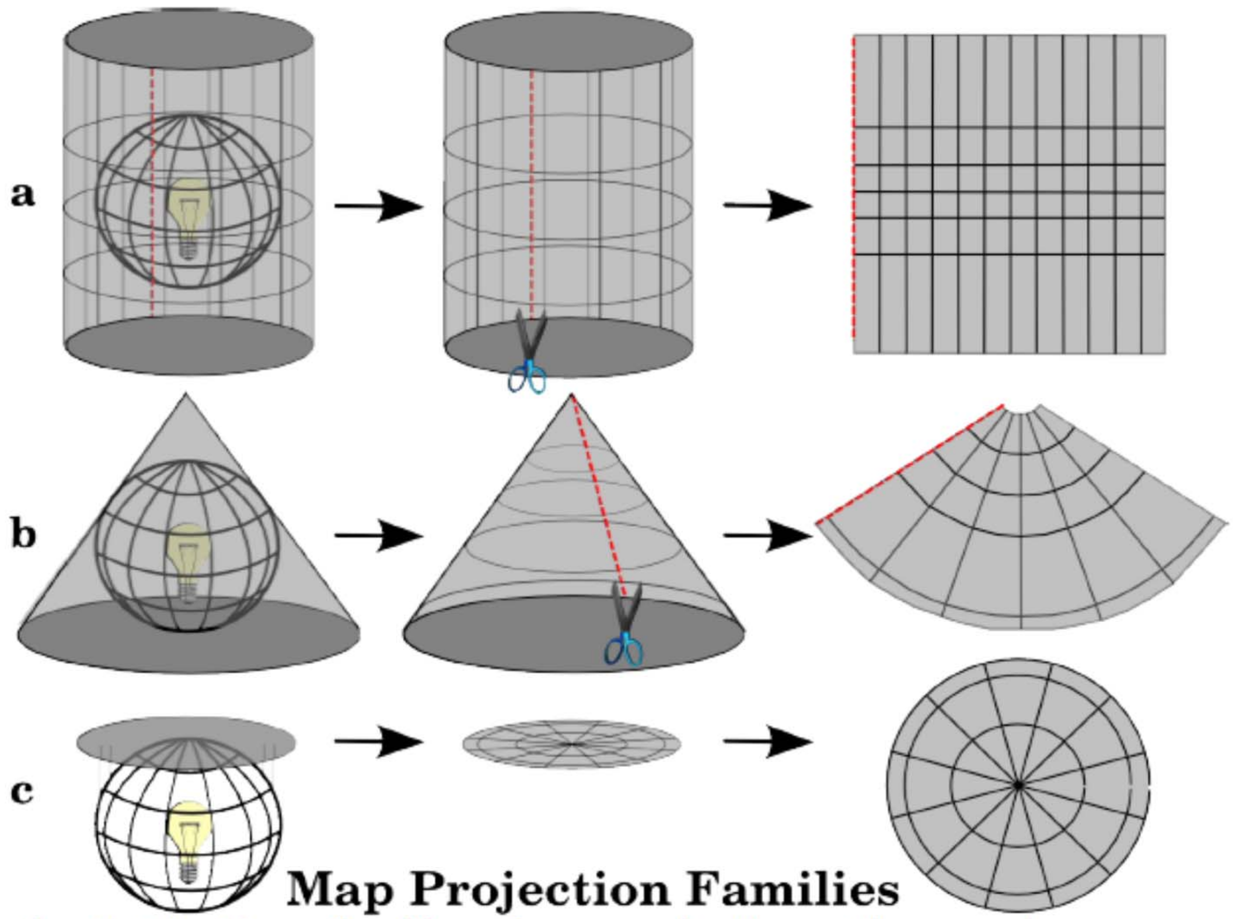


Illustration 1: The three families of map projections. They can be represented by a) cylindrical projections, b) conical projections or c) planar projections.

Geographic Distortion

- Every projection has some degree of distortion on:
  - Angle
  - Distance
  - Area

- The goal is to minimize the distortion based the specific spatial analysis performed.

Minimizing Distortion

- Minimize All Aspects:
  - Winkel Triple Projection
  - Robinson Projection

- Minimize Angular Distortion (Conformal or Orthomorphic Projections):
  - Mercator Projection
  - Lambert Conformal Conic Projection

Minimizing Distortion

- Minimize Distance Distortion (Equidistant Projections)
  - Plate Carree Equidistant Cylindrical Projection
  - Equirectangular Projection
  - Azimuthal Equidistant Projection

- Minimize Area Distortion (Equal Area Projections)
  - Lambert's Equal Area Projection
  - Mollweide Equal Area Cylindrical Projection

Common File Types

Document type	Filename extension	Notes
ArcMap document	.mxd	A file containing a map, its layers, display information, and other elements used in ArcMap.
ArcGlobe document	.3dd	A file containing a globe, its layers, and 3D display properties for use in ArcGlobe. Part of the 3D Analyst extension.
ArcScene document	.sxd	A file containing a 3D scene, its layers, and 3D properties for use in ArcScene. Part of the 3D Analyst extension.
ArcGIS Layer file	.lyr	A layer is a set of rules for displaying and working with datasets in ArcMap and ArcGlobe. Layer definitions include symbol assignments, classifications, labeling rules, and other map use properties.
Shapefile	.shp	A file used for storing the geometric location and attribute information of geographic features.
Published Map File for ArcReader	.pmf	A read-only map file created using the ArcGIS Publisher extension. Read-only maps can be used in ArcReader and ArcMap. They can also be served on the Web.
ArcGIS Style file	.style	A predefined set of colors, symbols, and graphical elements used for displaying and representing geographic datasets according to a mapping standard.
ArcGIS Address Locator file	.loc	A Locator dataset and rules used for geocoding addresses in ArcGIS. Locators are types of geodatabase datasets and can be saved independently of the geodatabase as a disk file for sharing and use
Metadata files	.xml	Metadata documents for individual file-based datasets are stored in XML files and often managed in ArcGIS workspace folders.
Map projection file	.prj	Coordinate system and map projection information for a dataset
Geoprocessing scripts	.py. aml	Python (.py) and ArcInfo Workstation AML scripts used for geoprocessing in ArcGIS

Type	Extension	Description
ESRI	Coverage	ArcInfo Workstation coverages
	Grid	ArcInfo GRID raster format
	Tin	ArcInfo triangulated irregular network (TIN) format
	Shapefile (SHP)	ESRI shapefile format
Vector	TIGER/Line	U.S. Census Bureau's TIGER/Line Files
	MIF/MID	MapInfo Vector Interchange File MapInfo Table Interchange for MIF
	TAB	MapInfo Native Dataset
	VPF	National Geospatial Intelligence Agency's Vector Product File format
	GML	Open Geospatial Consortium's GML Interchange Specification
Raster	IMG	Leica ERDAS Imagine image files
	BMP	Bitmap raster format
	TIF	TIFF raster format
	JPG	JPEG raster compression format
	JP2	JPEG 2000 raster format
	SID	MrSID raster format

Type	Extension	Description
CAD	DXF	CAD transfer file. Uses ASCII or binary drawing file interchange.
	DGN	MicroStation design file format
	DWG	AutoCAD drawing file format
Tables	XLS	Excel spreadsheets
	DBF	dBase data file format
	Info	Arc/Info Workstation INFO tables
	MDB	File format for Microsoft's Access database
	TXT	Text file often used to hold attribute columns delimited by commas or tabs