Map

Ben Best

r3-train
July 12, 2021

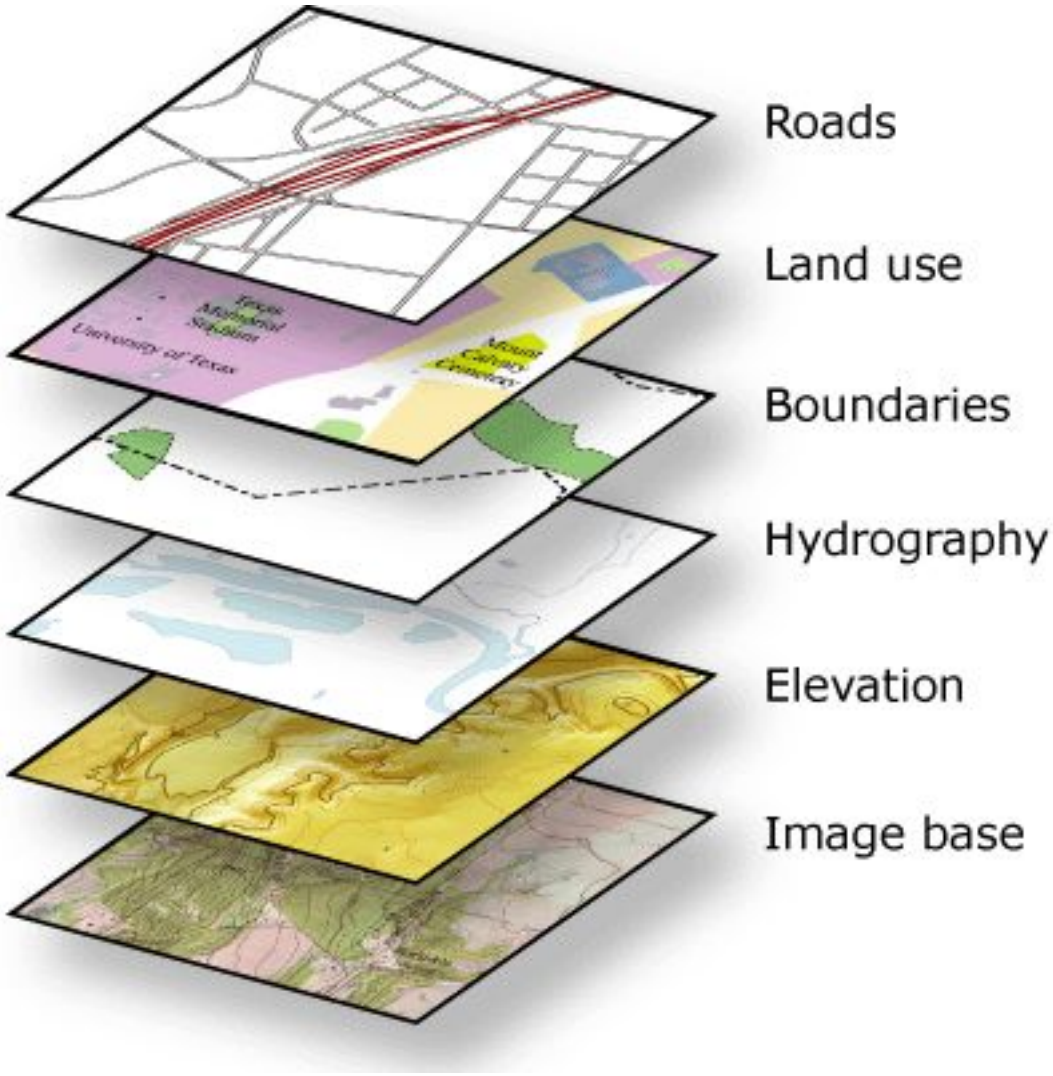
Outline

- Background
- Projections
- Data

Outline

- Background
- Projections
- Data

GIS: Layers of Data



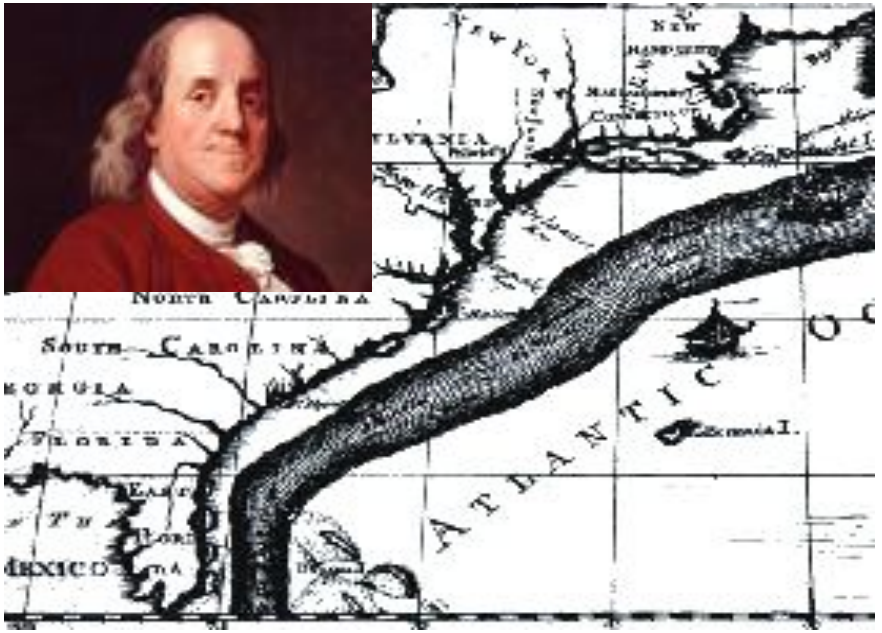
A **geographic information system** (GIS) integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information.

GIS allows us to view, understand, question, interpret, and visualize data in many ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts.

GIS first termed by Roger Tomlinson (1968) A Geographic Information System for Regional Planning

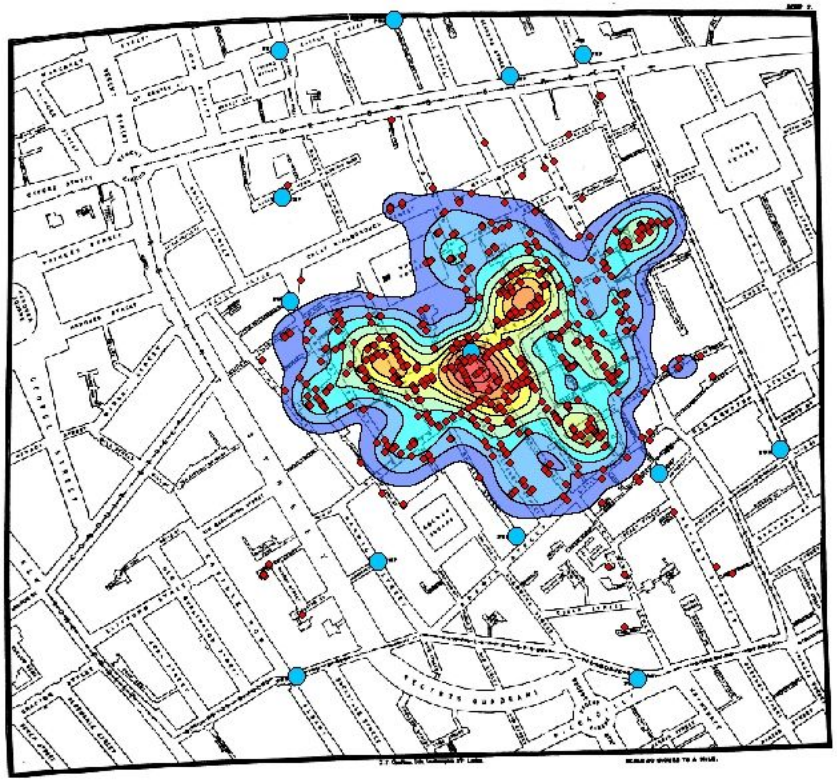
History

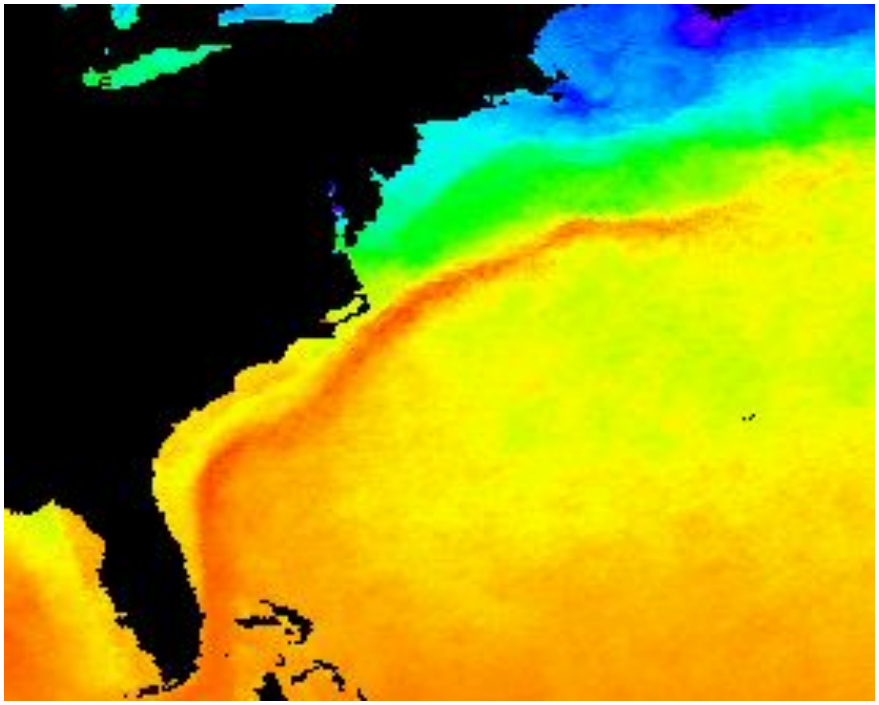
First “GIS”: John Snow’s 1855 map of 1854 cholera outbreak in London spatially related to a few wells. Epidemiology



Benjamin Franklin, US Postmaster in 1769: “A River In The Sea”. Oceanography

Now





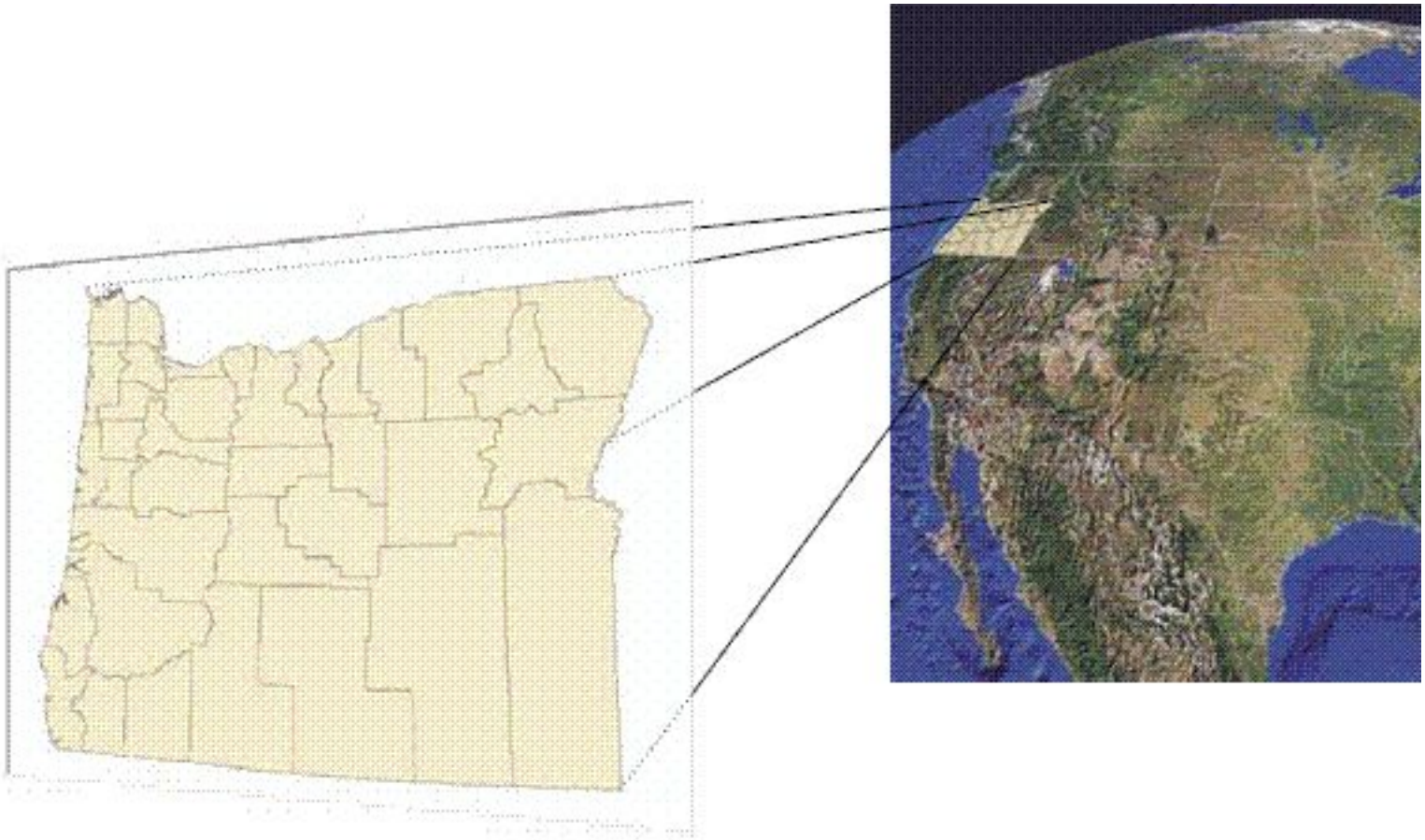
Interpolated surface (IDW)
from point values, plus contouring

Remote sensing of
sea-surface temperature

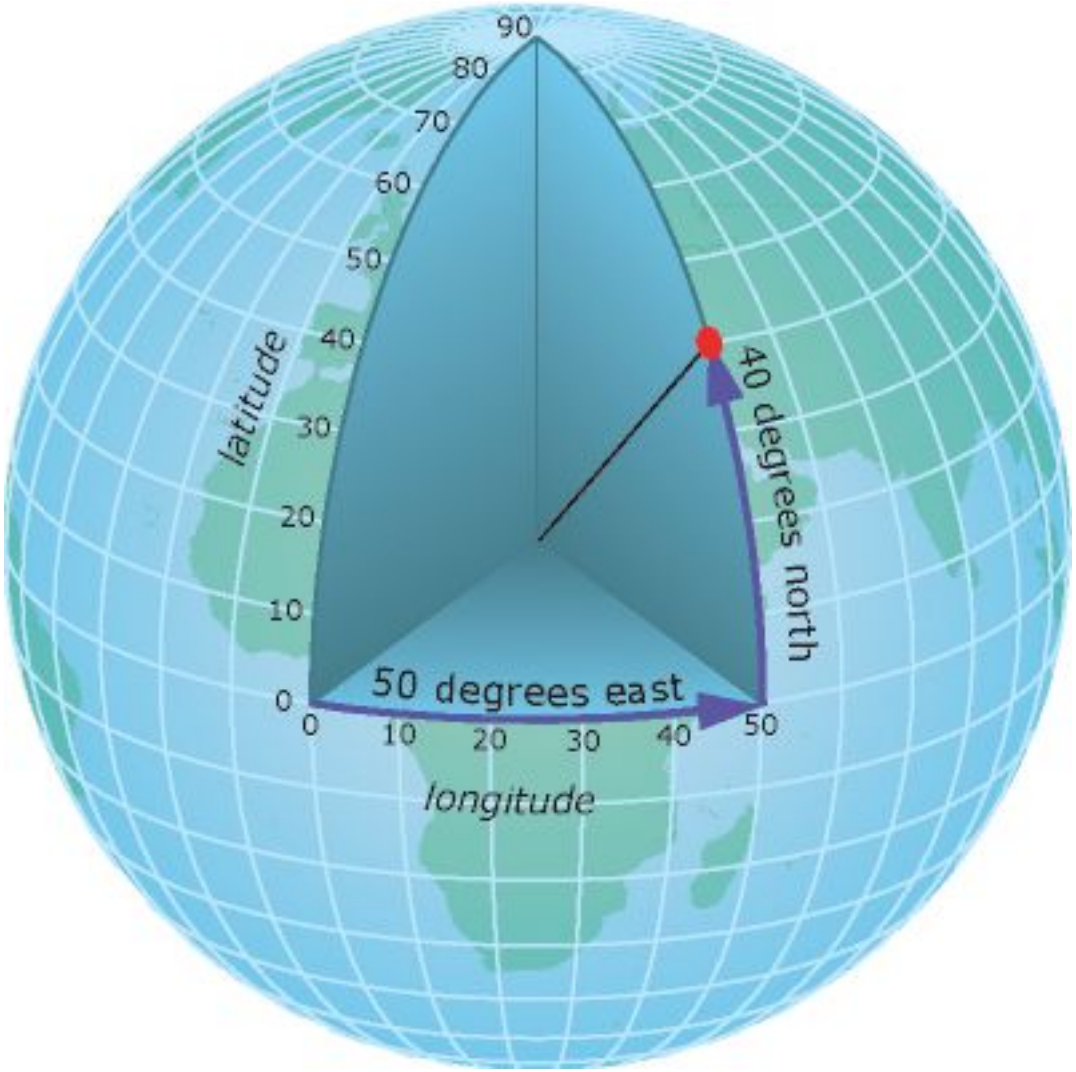
Outline

- Background
- Projections
- Data

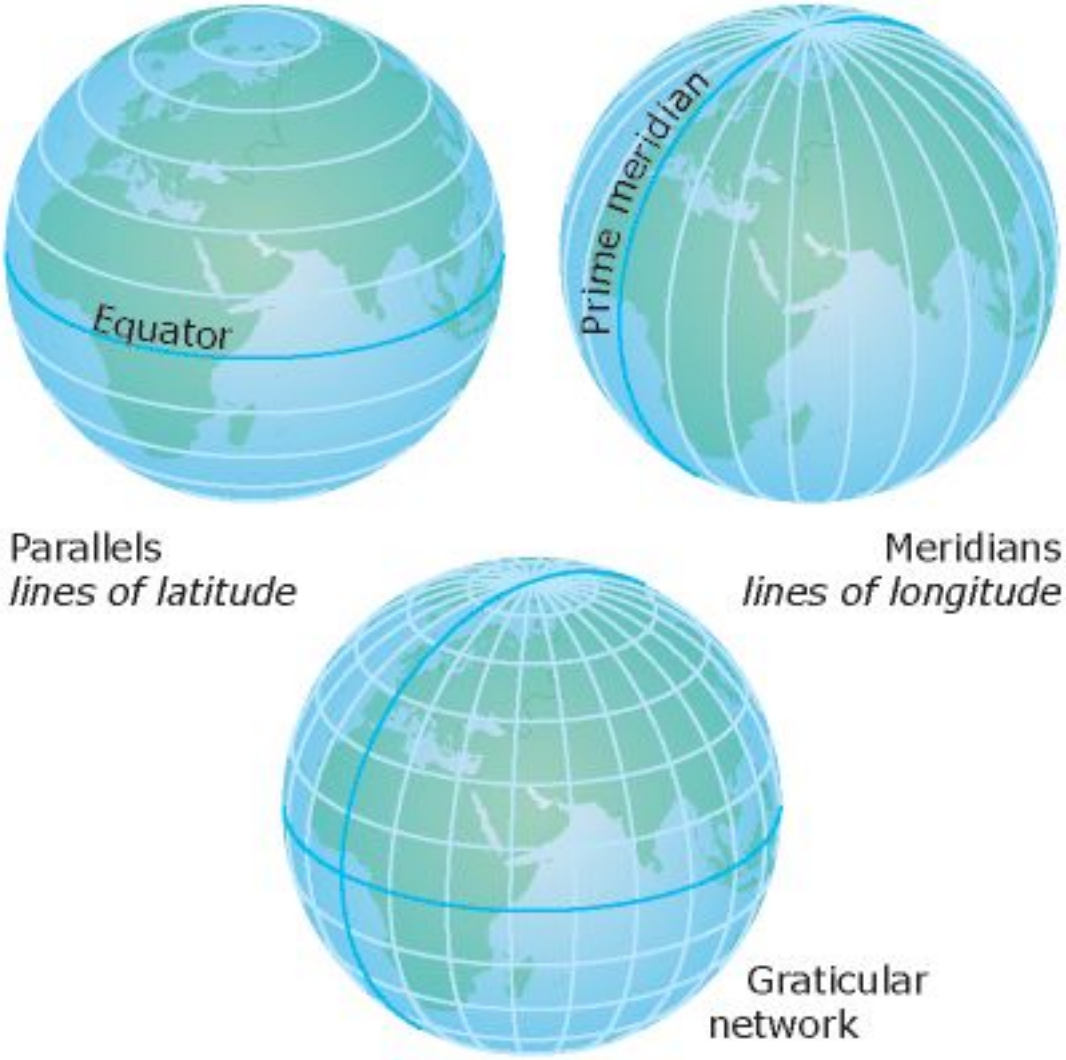
Georeferencing



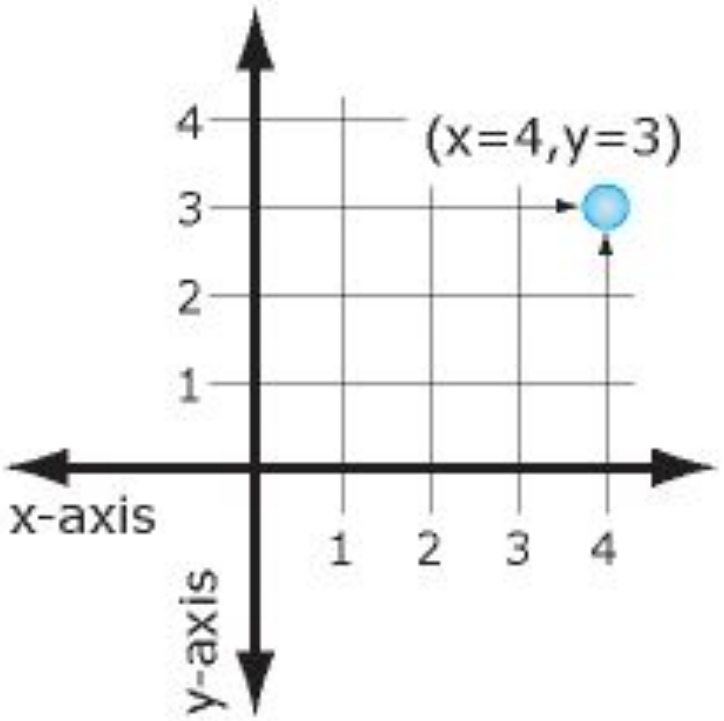
Spherical Earth

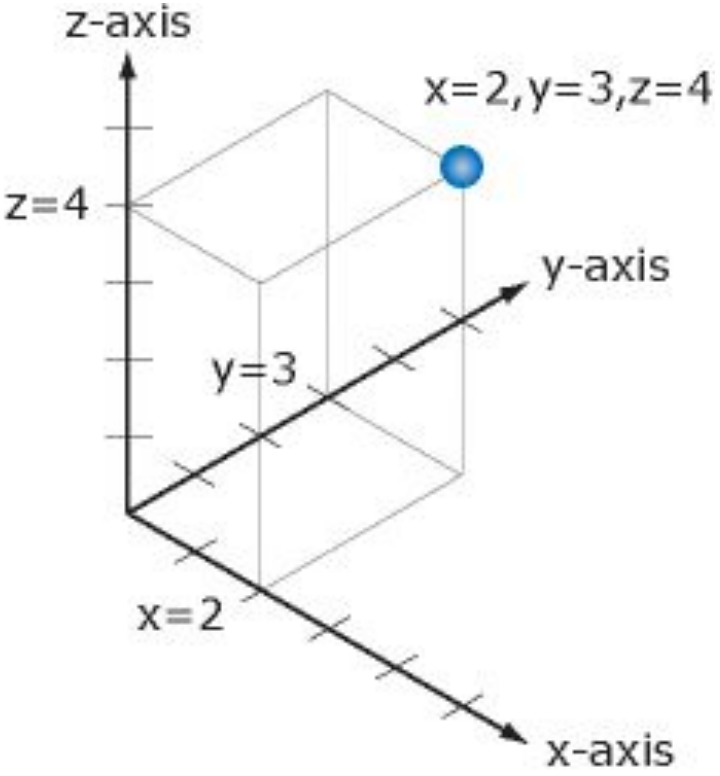


Geographic Coordinate System



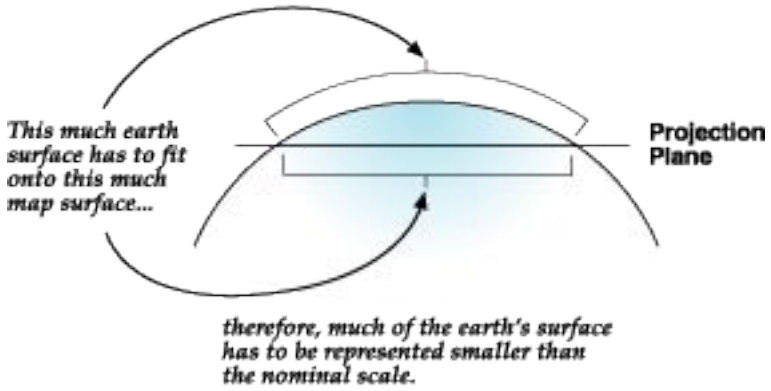
Cartesian Coordinates



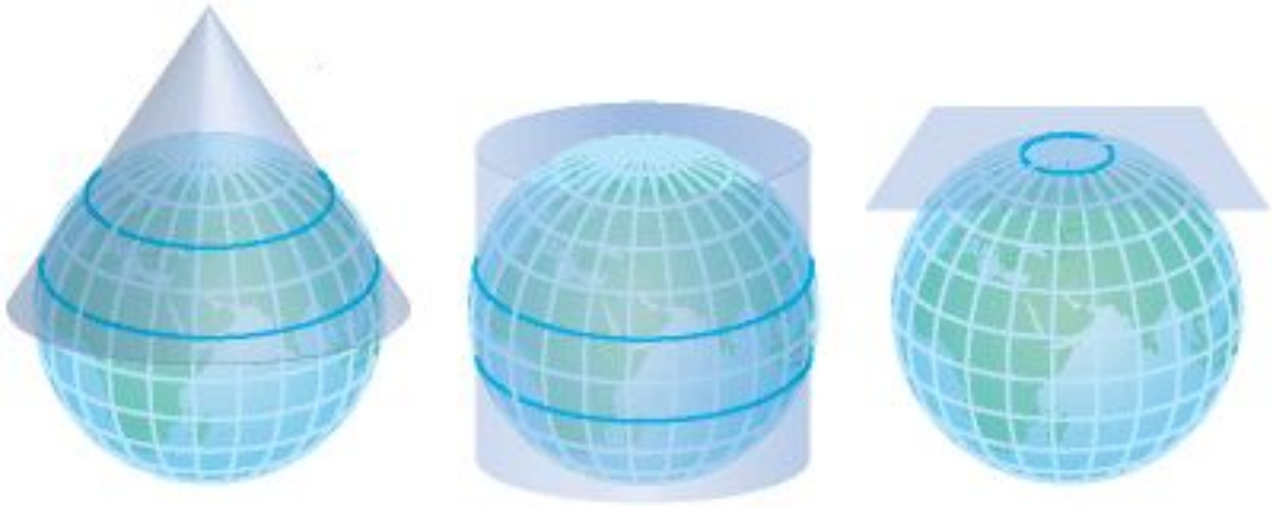


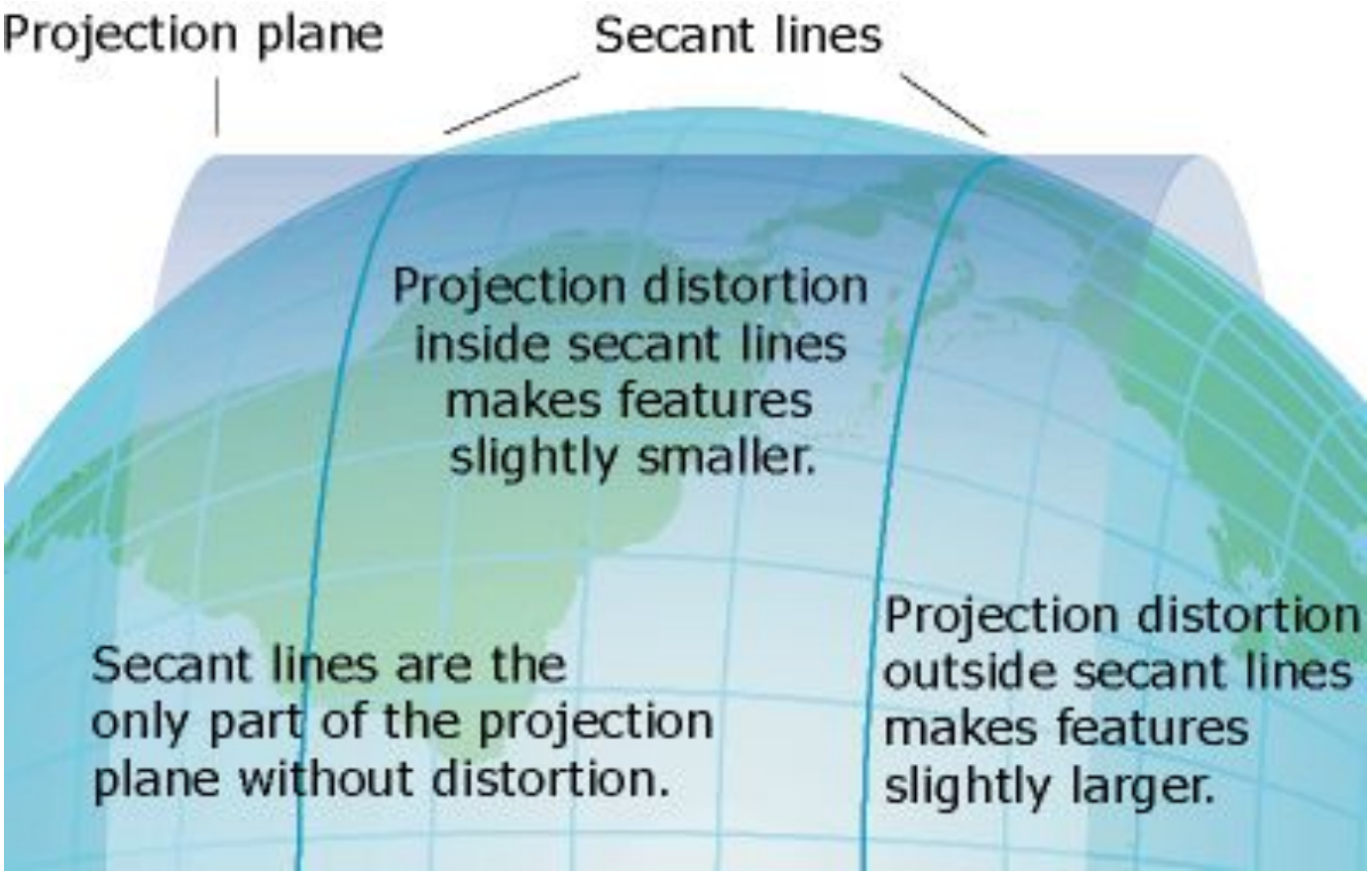
Map Projections

Geographic to Projected Coordinate System



Unlike a geographic coordinate system, a projected coordinate system has constant lengths, angles, and areas across the two dimensions. However, all map projections representing the earth's surface as a flat map create **distortions** in some aspect of distance, **area**, **shape**, or **direction**.




Projection plane
Secant lines
Projection distortion inside secant lines makes features slightly smaller.
Secant lines are the only part of the projection plane without distortion.
Projection distortion outside secant lines makes features slightly larger.

Visualizing Distortion of Projections

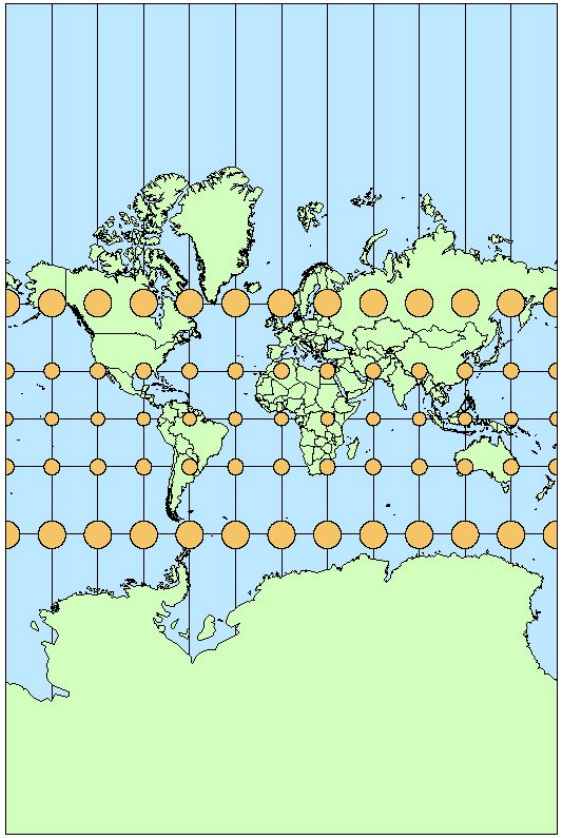
Tissot's Indicatrix

view from space of geographic coordinate system

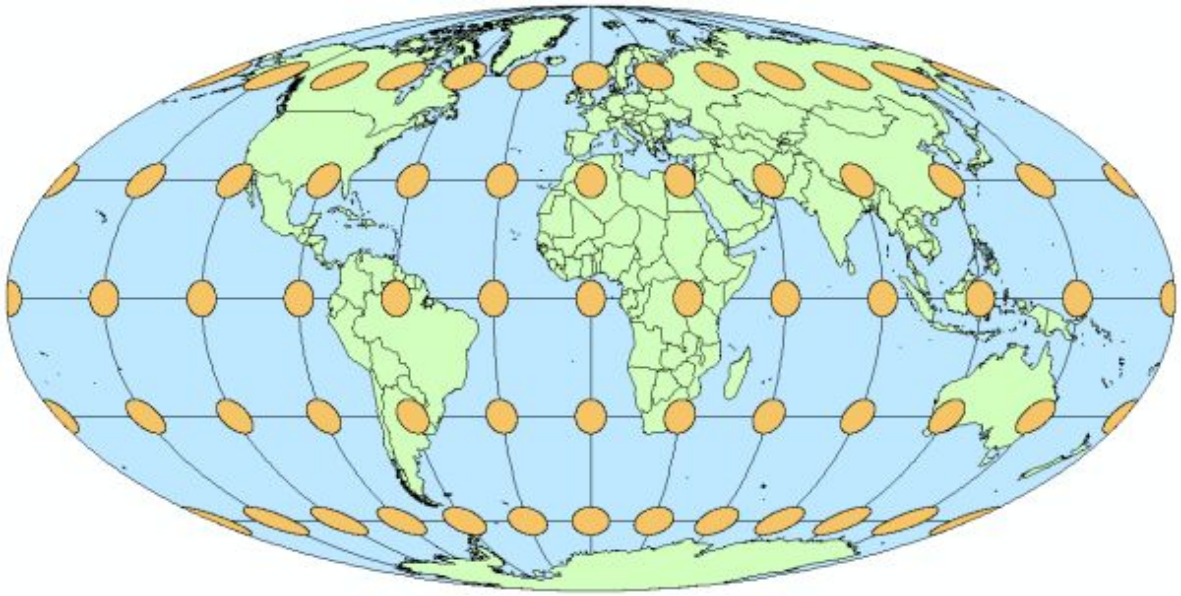
Distortions,
at least 1 or more:

- Distance
- Angle
- Area

Equal Angle or Area

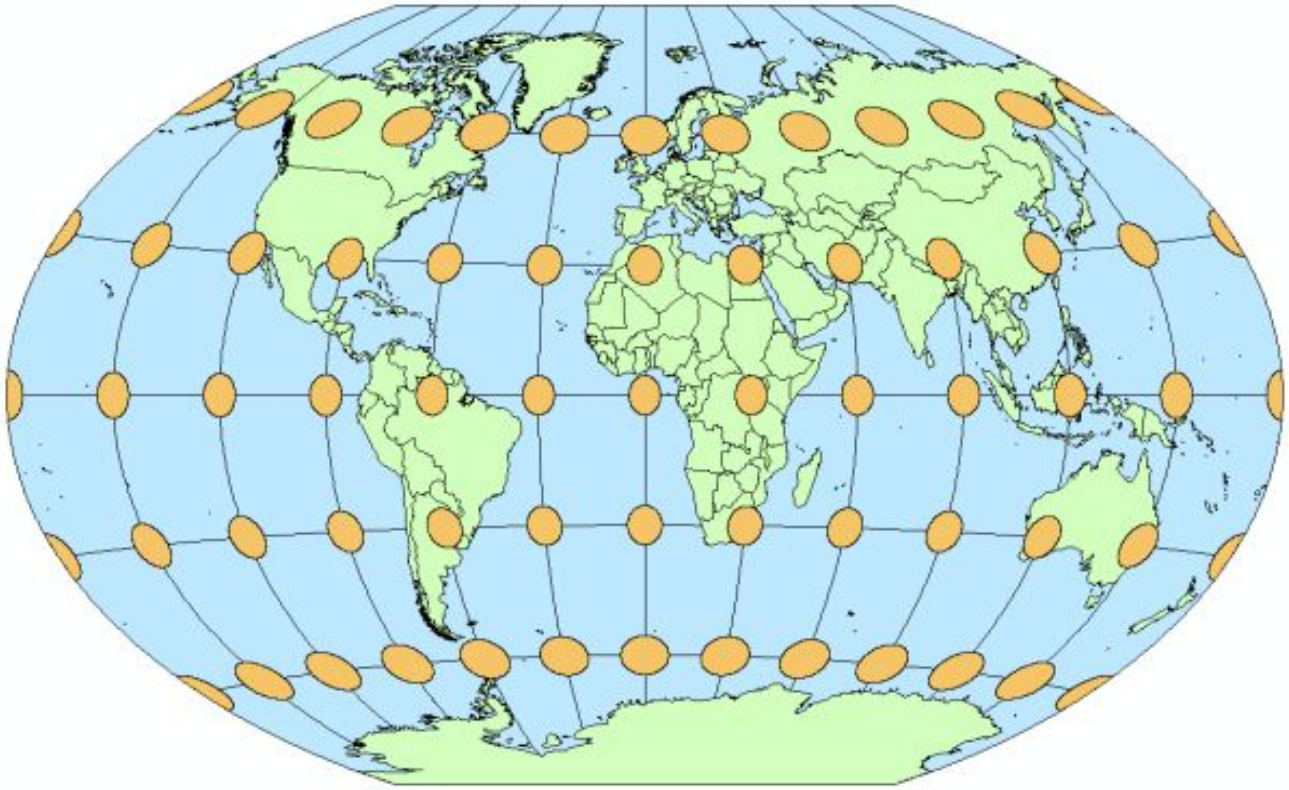


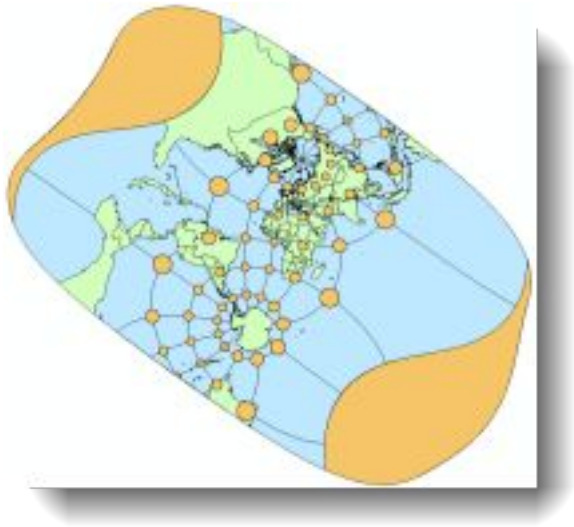
Conformal (preserved angle, distorted area): ***Mercator***



Equal area (distorted angle): ***Mollweide***

Compromise Projection





Oblique Mercator

Compromise projection (vary in size, shape, angle): ***Winkel Tripel***

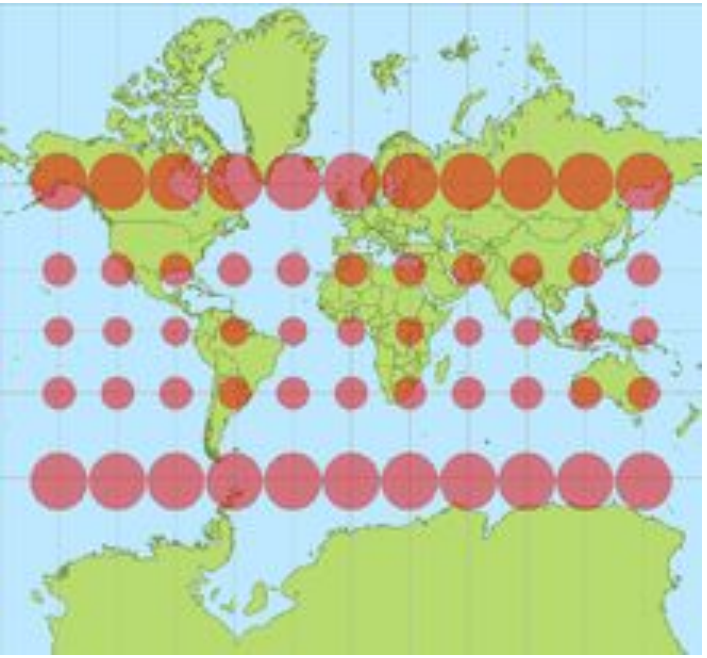
Why are We changing the Maps?

"Because … the Mercator projection has fostered European imperialist attitudes for centuries and created an ethnic bias against the Third World…."
says the Organization of Cartographers for Social Equality
[West Wing season 2, episode 16]

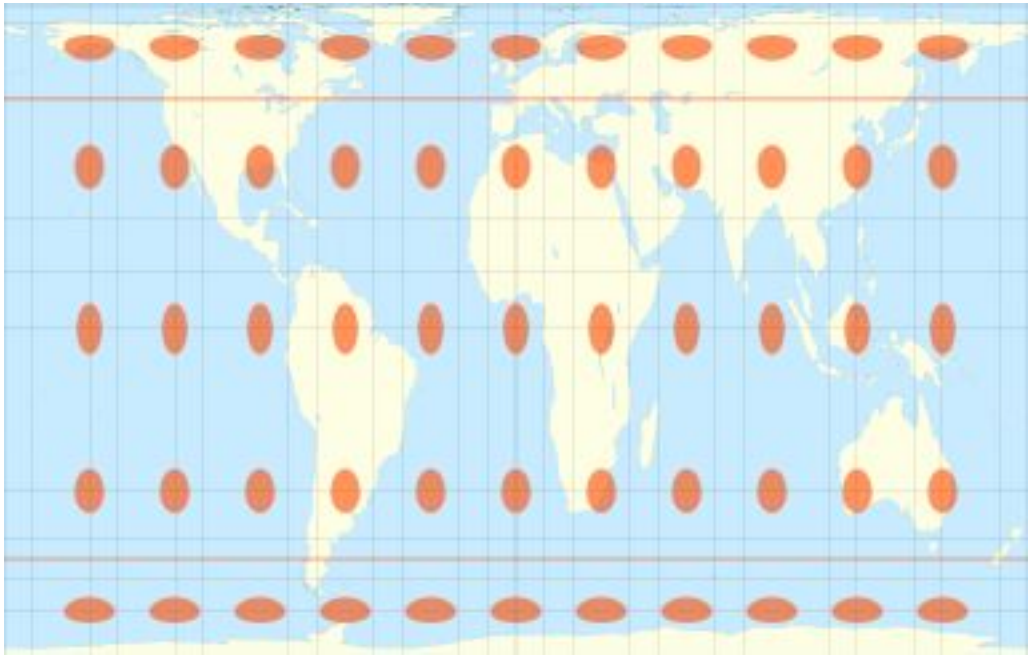
http://www.youtube.com/watch?v=vVX-PrBRtTY

Why are We changing the Maps?

Also: Maps That Prove You Don't Really Know Earth – YouTube
https://www.youtube.com/watch?v=KUF_Ckv8HbE



Mercator



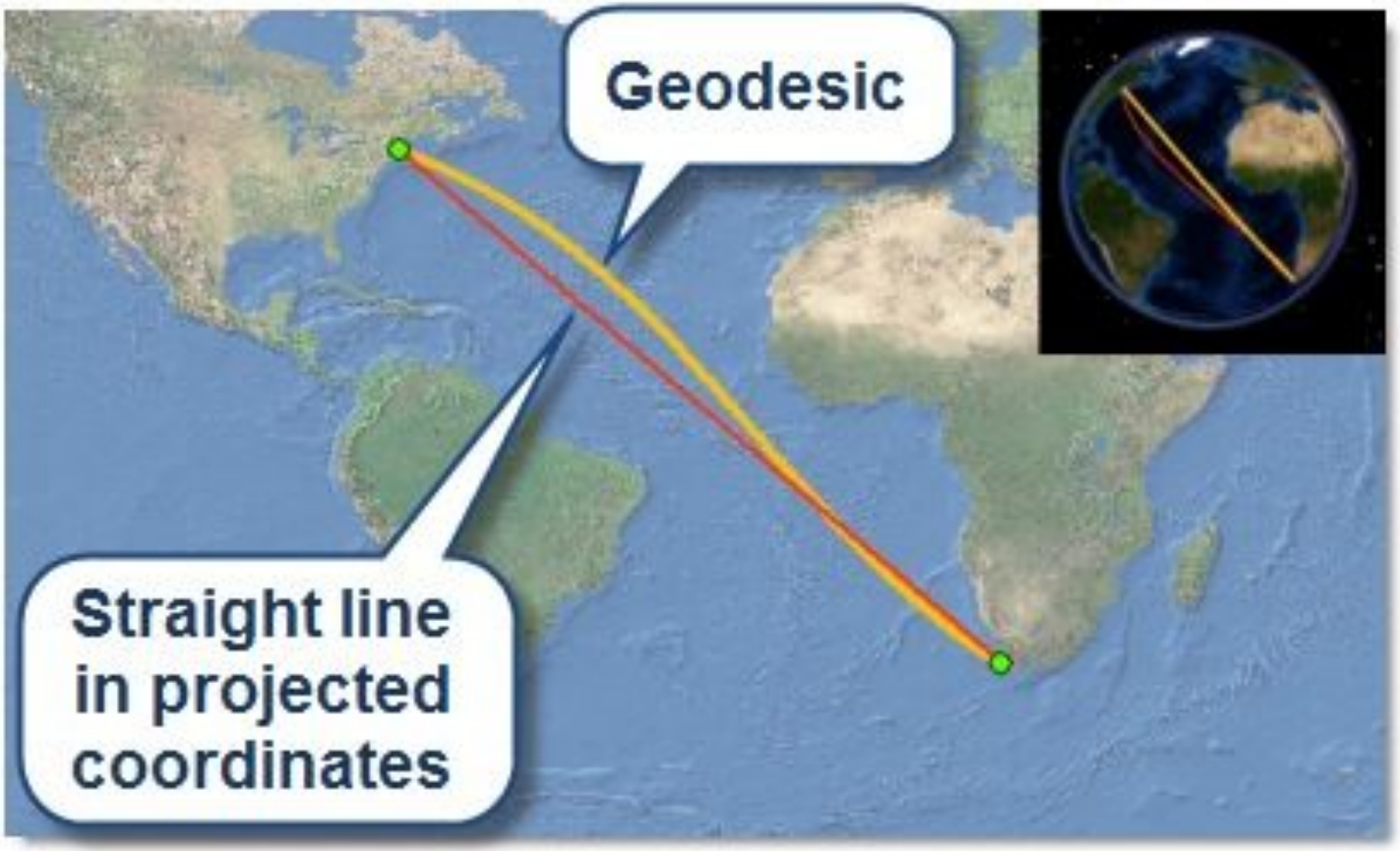
Galls-Peters

Greenland
Iceland
Finland
Sweden
Norway
Russia
United Kingdom
Poland
Germany
Ukraine
Kazakhstan
Mongolia
France
Italy
Spain
Turkey
China
South Korea
Japan
Afghanistan
Iraq
Iran
Pakistan
Algeria
Libya
Egypt
Saudi Arabia
India
Thailand
Mali
Niger
Sudan
Chad
Nigeria
Ethiopia
Kenya
DR Congo
Tanzania
Indonesia
Angola
Namibia
Botswana
Madagascar
South Africa
Australia
Canada
United States
Mexico
Venezuela
Colombia
Brazil
Peru
Bolivia
Chile
Argentina
North Atlantic Ocean
South Atlantic Ocean
South Pacific Ocean
Indian Ocean

True Size of Africa

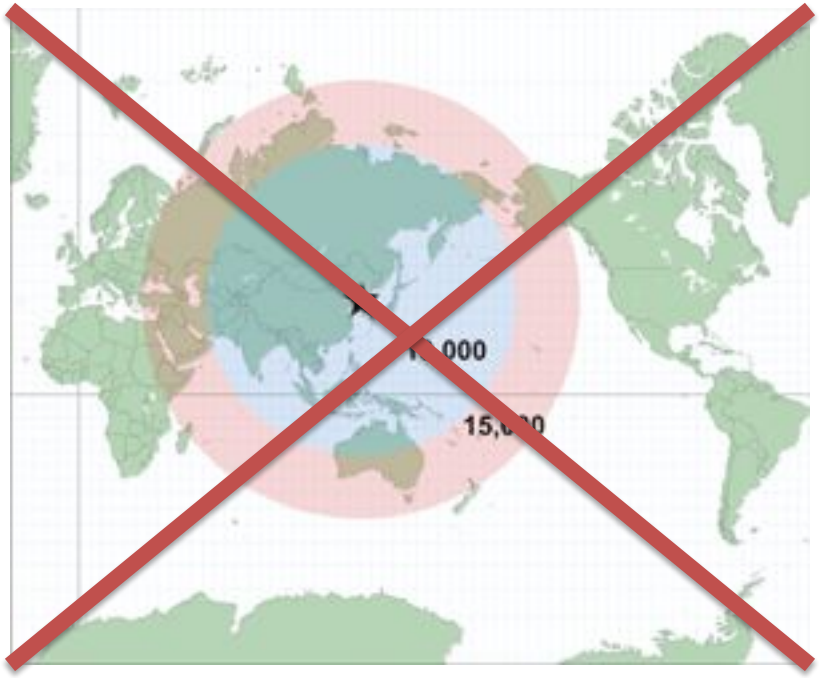
Geodesic Distance, Area & Buffer

geodesic = shortest distance along surface of a geoid (aka spheroid)
New to ArcGIS 10.1, so often do not need to project layers from geographic.

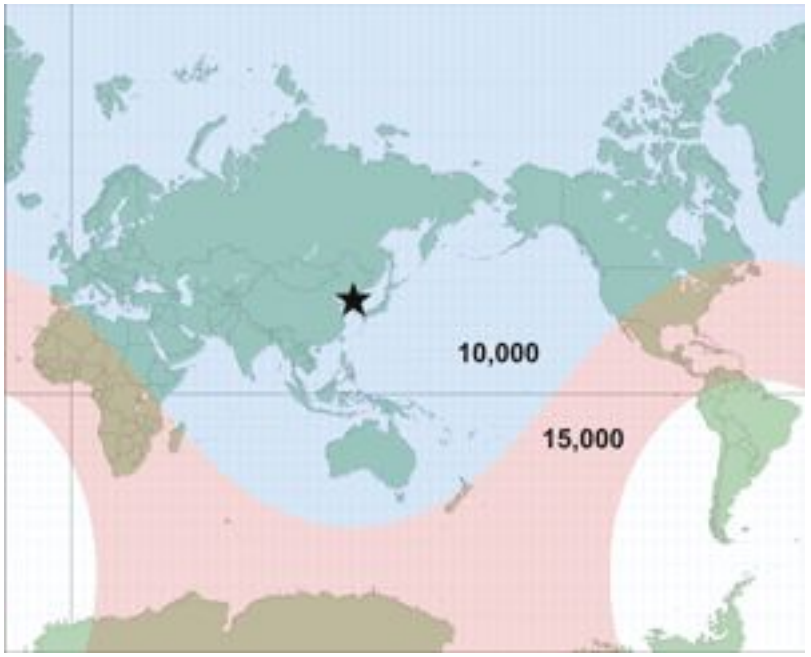


Geodesic Real World Example

"Ranges" for missiles launched from North Korea



Originally published map
in major newspaper



Updated true buffer distance map
(2 weeks later)

Outline

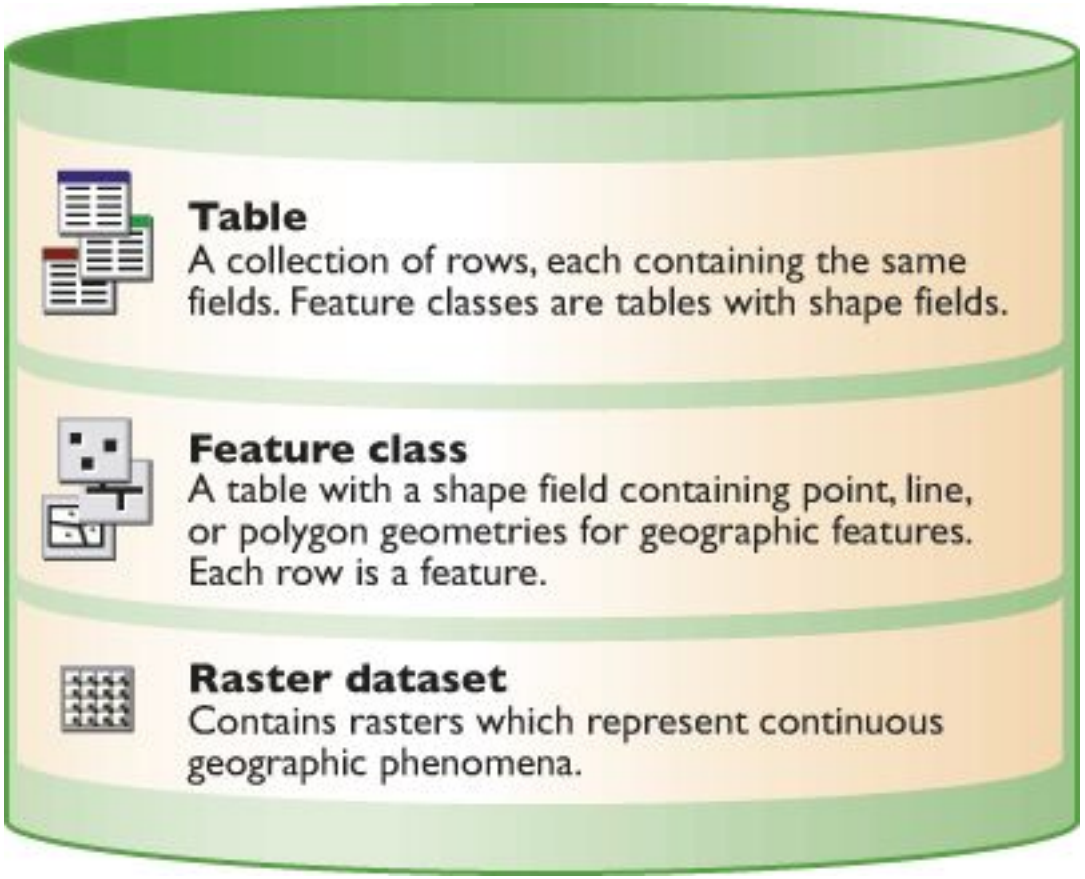
- Background
- Projections
- Data

Common Data Types

Most common file extensions:

Vector

Imagery



*.dbf – dbase

.shp - shapefile (.dbf, *.shx…)

*.tif - GeoTIFF

Geodatabase

*.gdb folder

Table Basics

Parcels feature class

Shape	ID	PIN	Area	Addr	Code
	1	334-1626-001	7,342	341 Cherry Ct.	SFR
	2	334-1626-002	8,020	343 Cherry Ct.	UND
	3	334-1626-003	10,031	345 Cherry Ct.	SFR
	4	334-1626-004	9,254	347 Cherry Ct.	SFR
	5	334-1626-005	8,856	348 Cherry Ct.	UND
	6	334-1626-006	9,975	346 Cherry Ct.	SFR
	7	334-1626-007	8,230	344 Cherry Ct.	SFR
	8	334-1626-008	8,645	342 Cherry Ct.	SFR

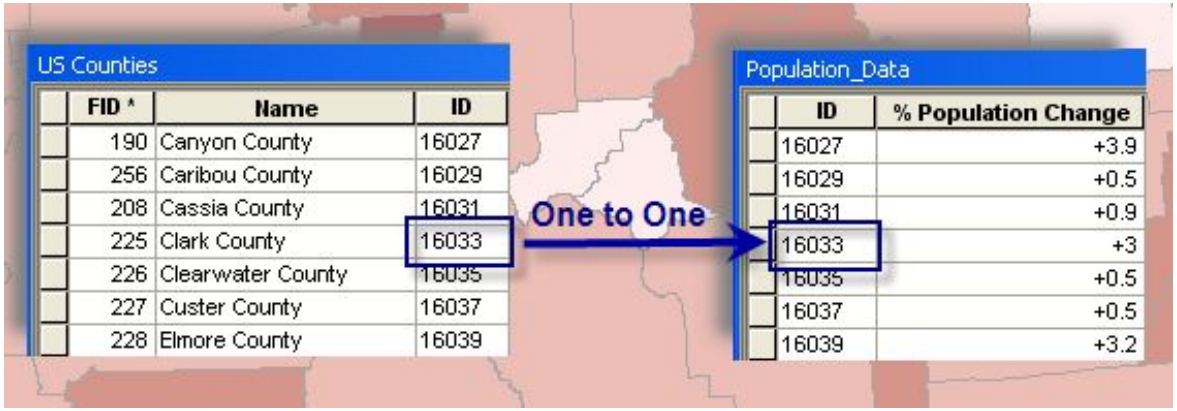
Related ownership table

PIN	Owner	Acq.Date	Assessed	TaxStat
334-1626-001	G. Hall	1995/10/20	$115,500.00	02
334-1626-002	H. L Holmes	1993/10/06	$24,375.00	01
334-1626-003	W. Rodgers	1980/09/24	$175,500.00	02
334-1626-004	J. Williamson	1974/09/20	$135,750.00	02
334-1626-005	P. Goodman	1966/06/06	$30,350.00	02
334-1626-006	K. Staley	1942/10/24	$120,750.00	02
334-1626-007	J. Dormandy	1996/01/27	$110,650.00	01
334-1626-008	S. Gooley	2000/05/31	$145,750.00	02

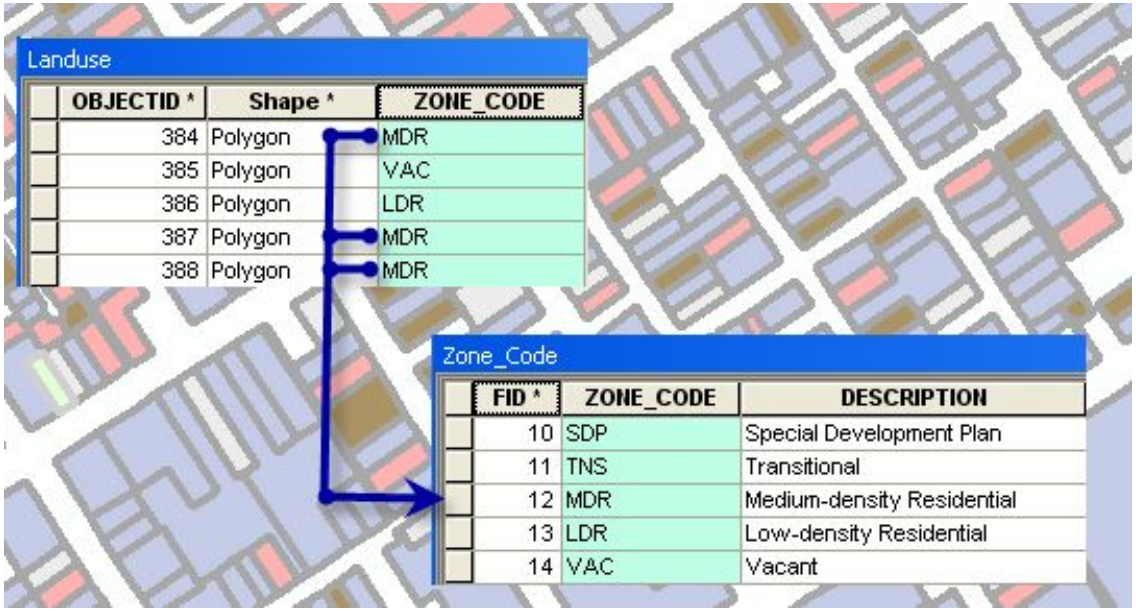
- Rows, Columns
- Data types: integer, float, character, date
- Relationships

Table Relationships

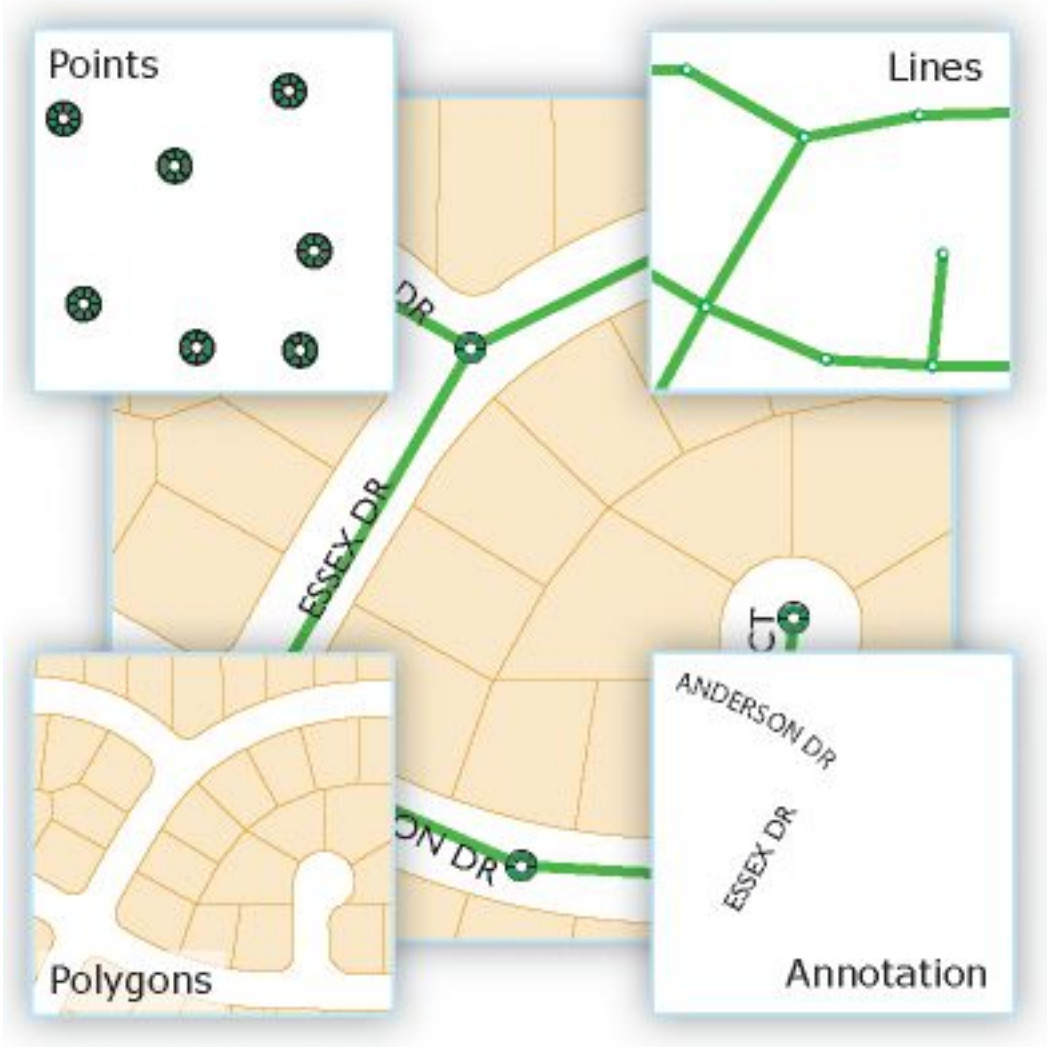
One to One: **Join**



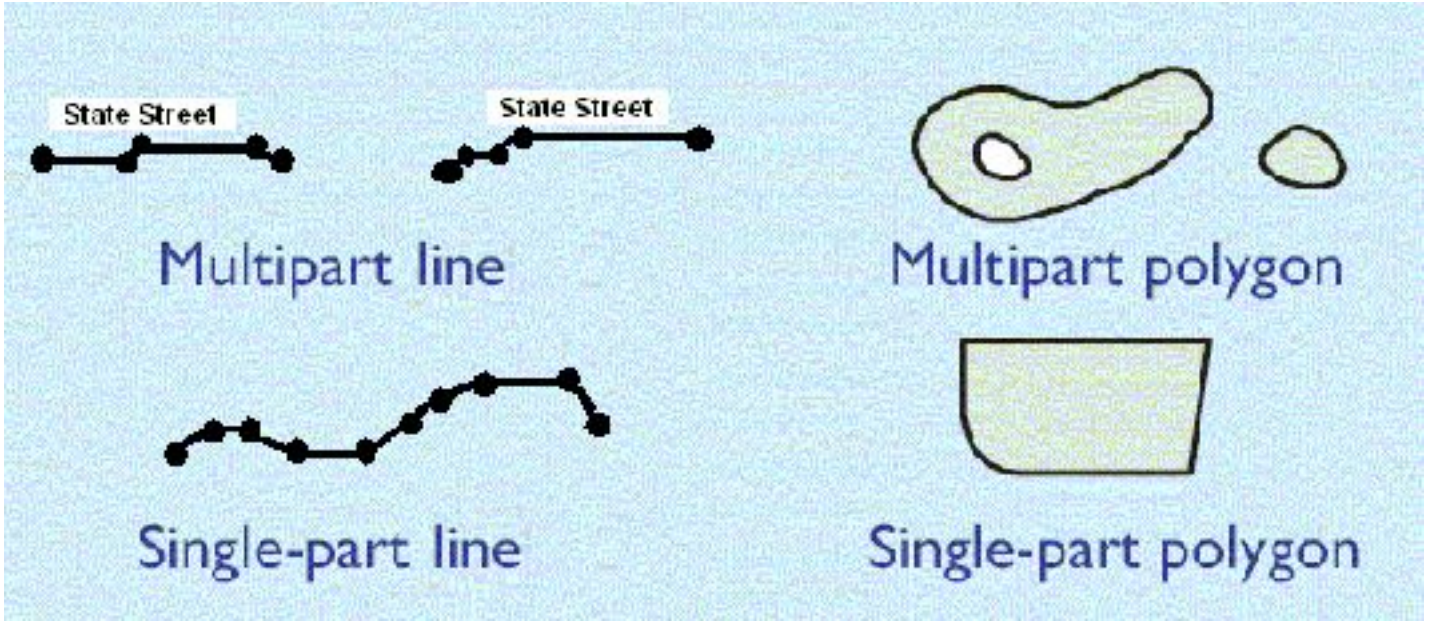
One to Many: **Relate**



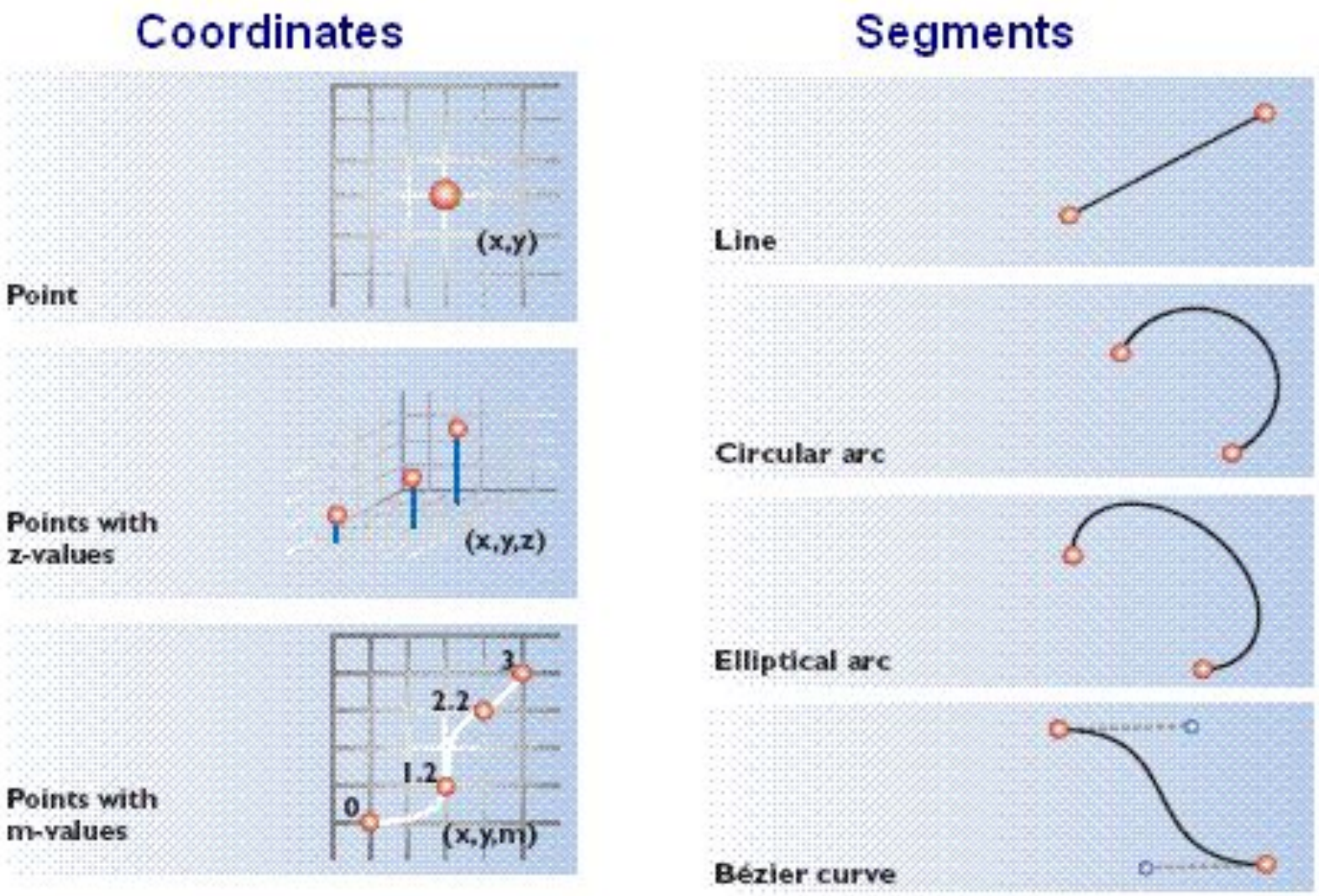
Feature Classes (aka Vector)



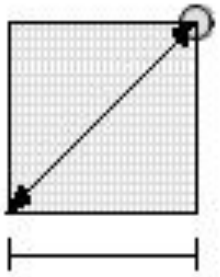
Vector: Multipart



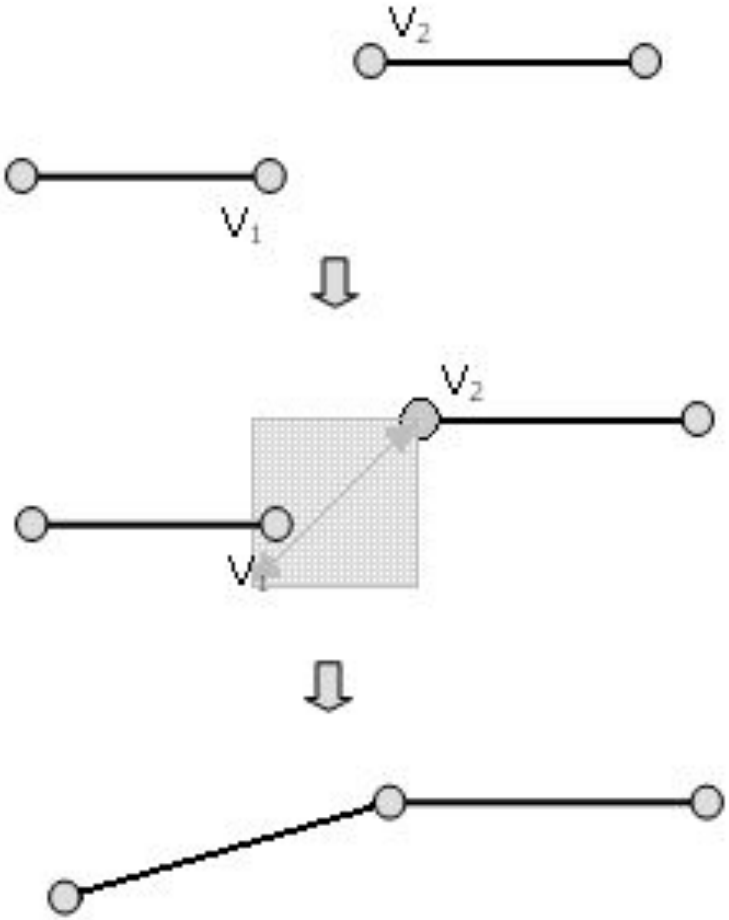
Vector


Coordinates
Segments
(x,y)
Point
Points with
z-values
(x,y,z)
3
2.2
1.2
0
Points with
m-values
(x,y,m)
Line
Circular arc
Elliptical arc
Bézier curve

Vector: Tolerance



XY tolerance = 0.001 M

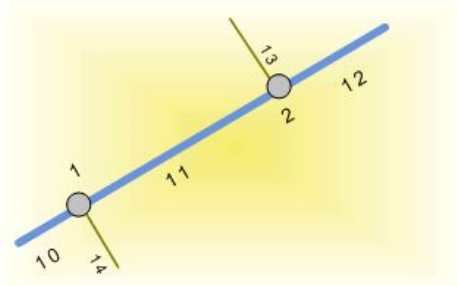


Influences snapping behavior between vertices when editing or performing spatial analysis.

Vector: Topology

Topology: sharing of edges, boundaries, nodes amongst features.

linear features connected, eg water network



Water mains (Lines)

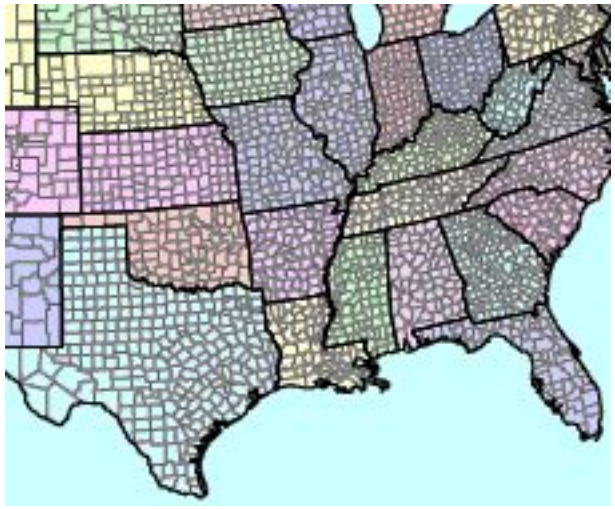
OID	Shape	Diameter	Material
10		8	Concrete
11		10	PVC
12		8	Concrete

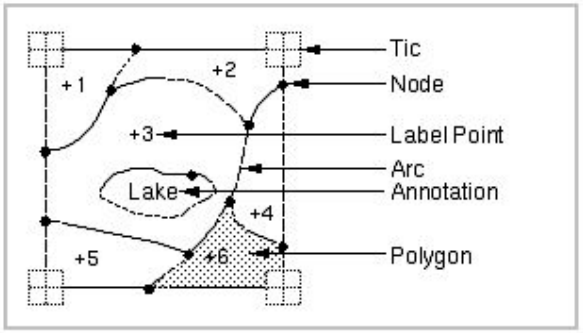
Water junction fittings (Points)

OID	Shape	Equip ID	Valve Type
1		816-32	T203
2		816-45	Y53

Water services (Lines)

OID	Shape	Service ID	Material
13		1001	Cast iron
14		1002	Copper



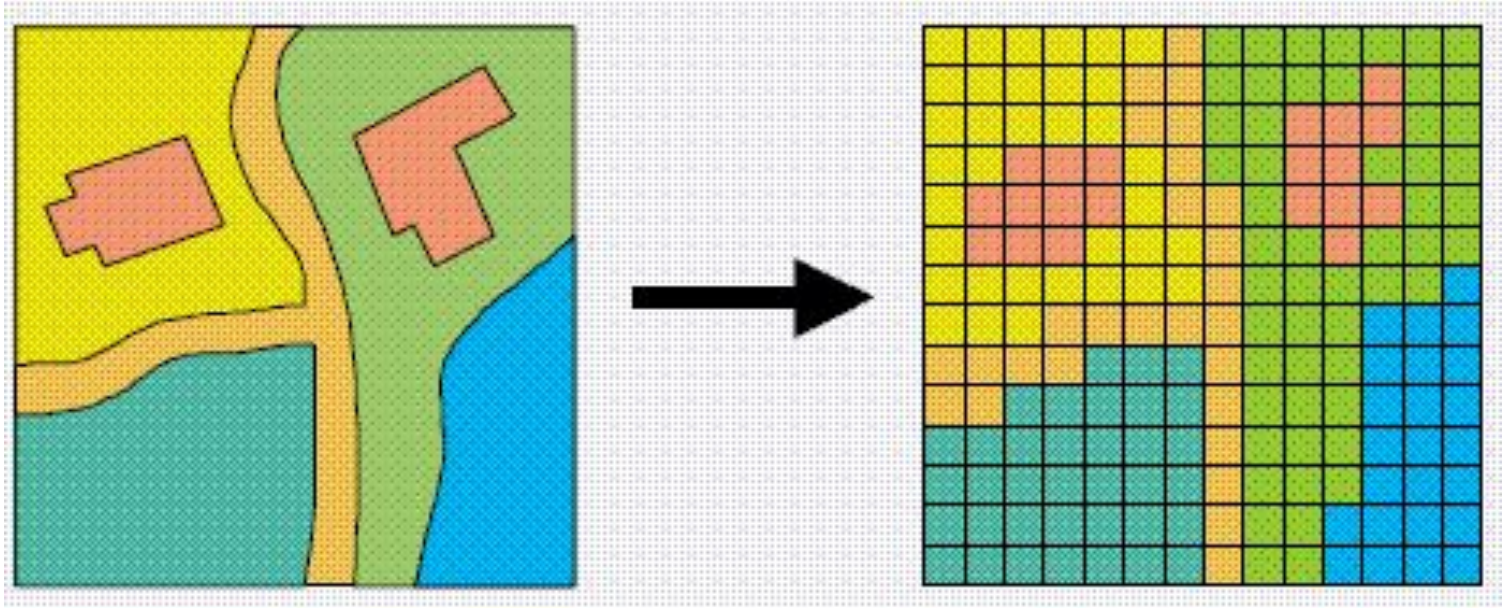


Polygon features share edges

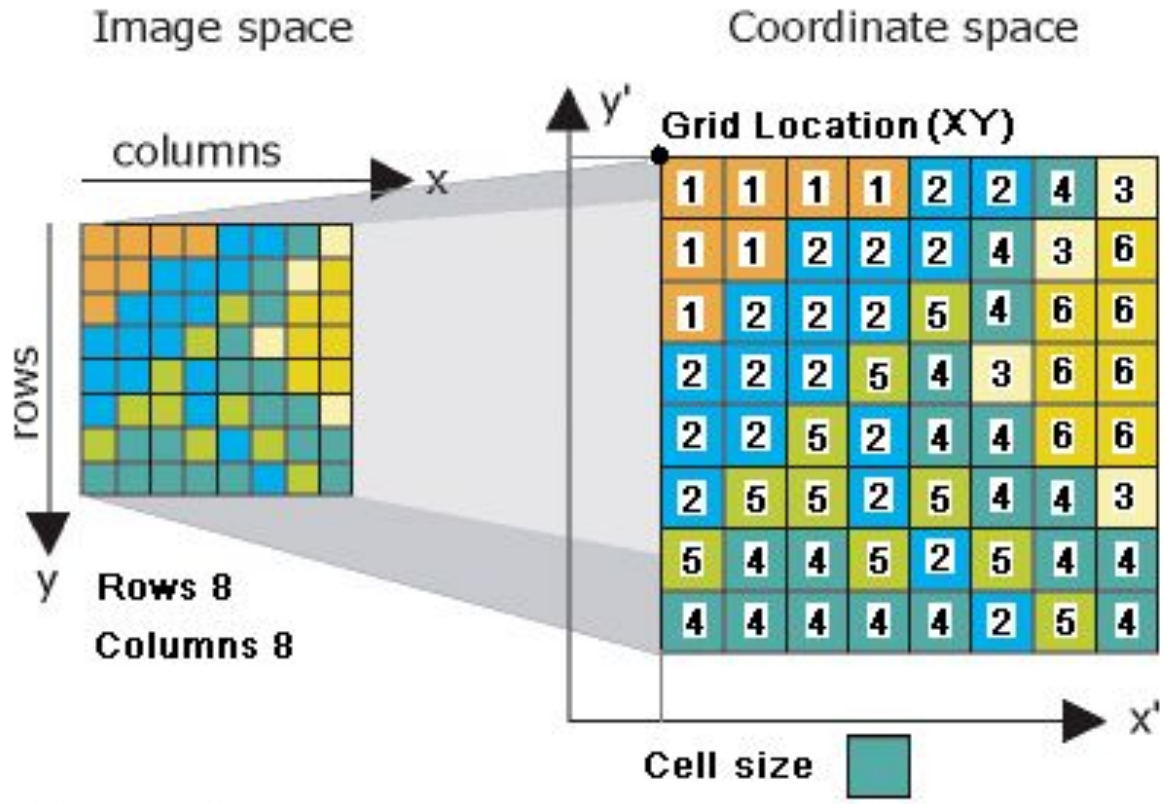
Can be explicitly handled during editing of feature classes in geodatabase,
but only implicitly with shapefile tolerances. Legacy of "coverages"

Raster

"Raster is faster, but vector is corrector."



Raster

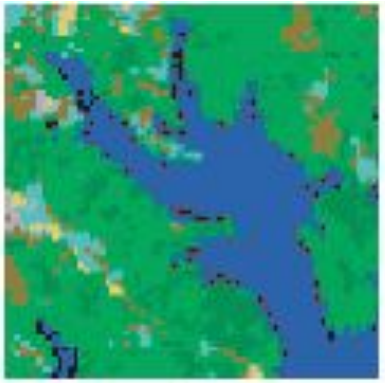


List of cell values

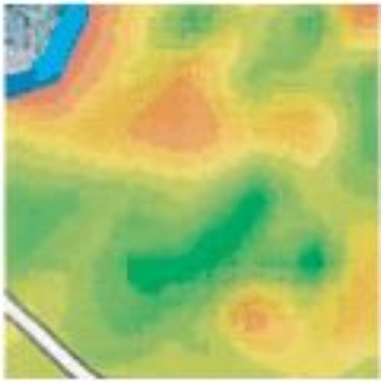
[1111224311222436122254662225436622524466255254435445254444444254]

Raster Uses

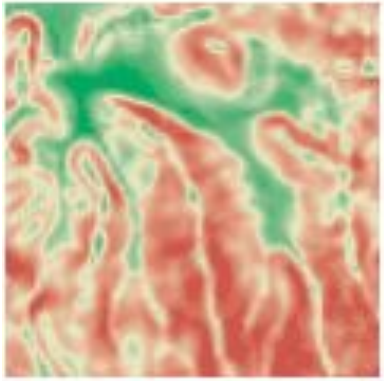
Photography



Land Use

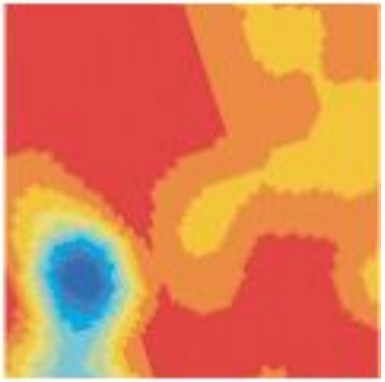


Concentration



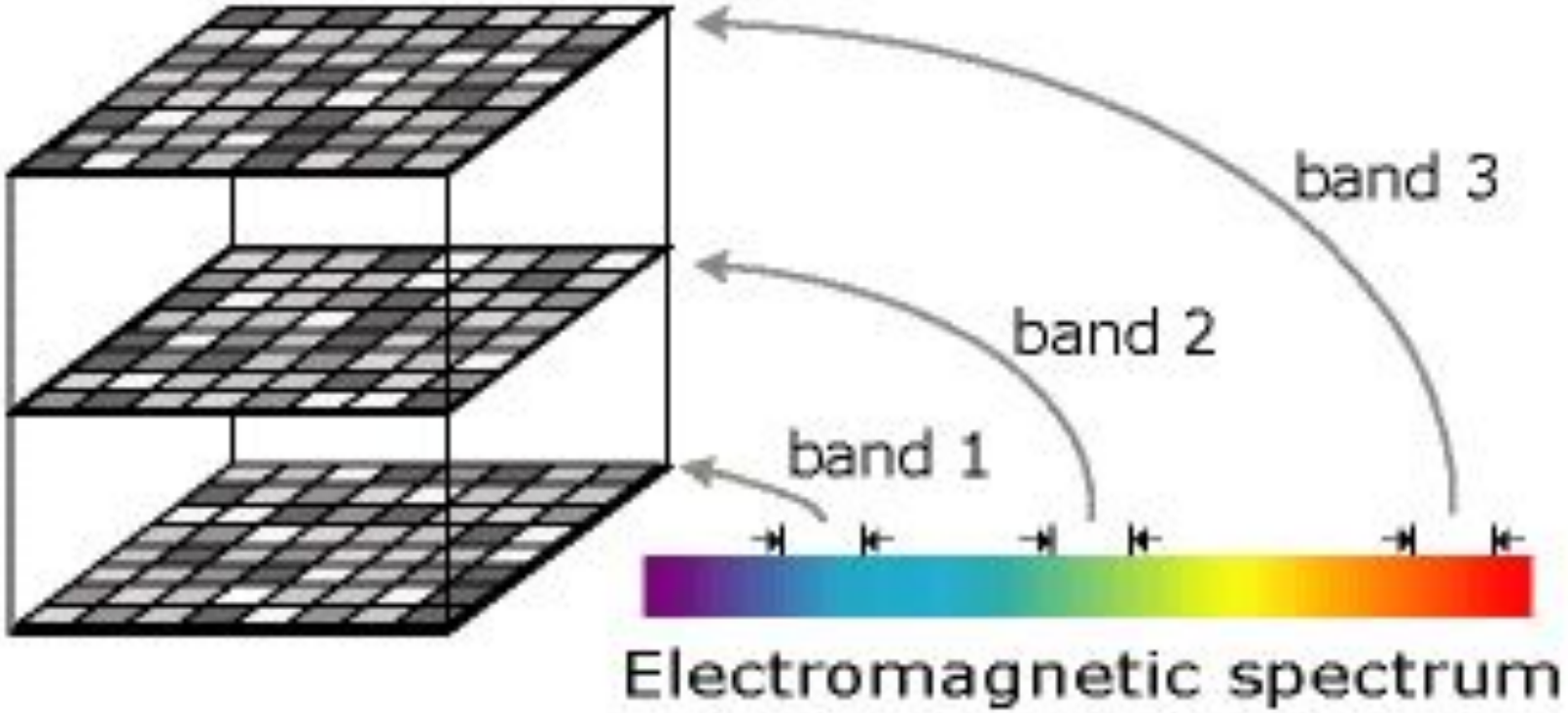
Slope

Elevation



Population

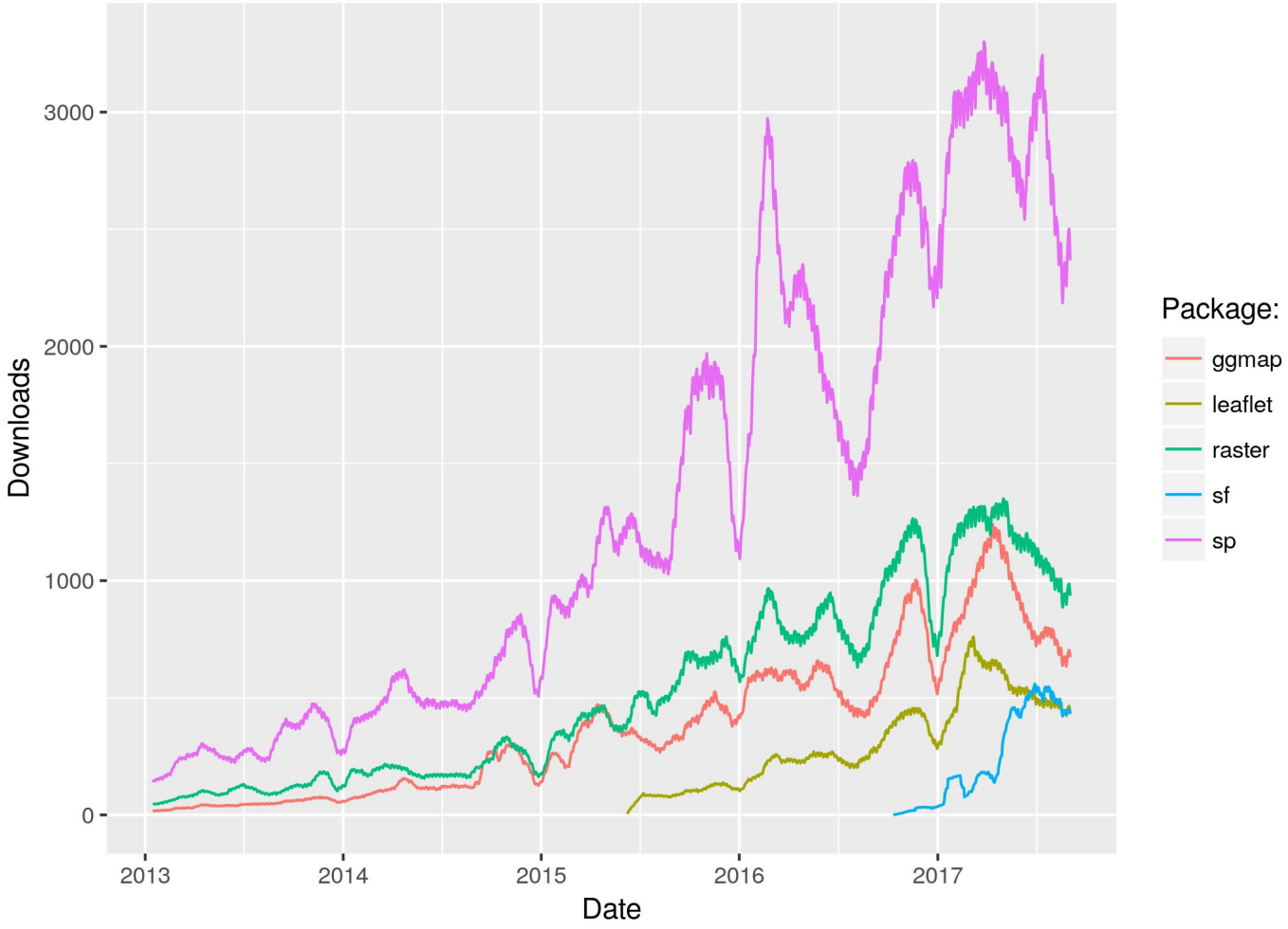
Raster: Bands



GIS Packages in R

Packages are bundles of functions in R.

See: CRAN Task View: Analysis of Spatial Data



Source: Lovelace et al (2017) Geocomputation with R