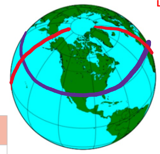
Module 3: Spatial Data

Sunday, 17 March 2019   5:04 PM

Module 3

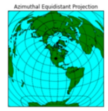


Longitude:
- 0°W = Greenwich UK (prime meridian)
- 180°E = 180°E

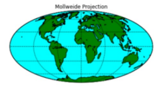
Latitude:
- 90°N = North Pole
- 0° = equator
- 90°S = South Pole

Maps of the Earth become distorted because it is a 3D sphere being projected onto a 2D plane:
- Small maps have less distortion
- Large maps have considerable distortion for:
  - Angles
  - Area
  - Distance

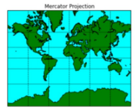
Azimuthal Equidistant Projection



Mollweide Projection

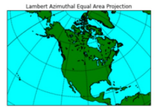


Mercator Projection



Robinson Projection

Lambert Azimuthal Equal Area Projection



Projection methods can be classified by what the preserve:

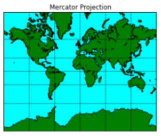
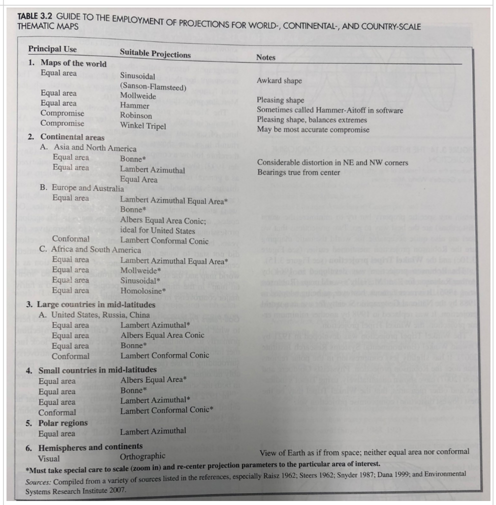
Projection Name	What it preserves
Equal area Equivalent	Area
Conformal	Angles locally
Equidistant	Distance from a particular location
Azimuthal	Direction from a particular location **Good for**: flow maps from single origin
Compromise	Ensure area and angle distortions are "not too bad"
Mercator	Developed for nautical travel in 1500's Used by Google today Used a rectangular grid for meridians and parallels. **Pros** Vertical scale (latitude) increases so it remains the same as the horizontal scale. .: by linking vertical and horizontal scale - region drawn on the map locally retain their shape; and - ensured that a straight line drawn between two points on the map gave the correct bearing (direction) in which to travel between two points. **Cons** Distorts the apparent size/area because the scale is not consistent .: at high latitude are disproportionately large Mercator Projection 
Guide to which projection to choose for different purposes and regions	

TABLE 3.2 GUIDE TO THE EMPLOYMENT OF PROJECTIONS FOR WORLD-, CONTINENTAL-, AND COUNTRY-SCALE THEMATIC MAPS

Principal Use	Suitable Projections	Notes
1. Maps of the world		
Equal area	Sinusoidal (Sanson-Flamsteed)	Awkard shape
Equal area	Mollweide	Pleasing shape
Equal area	Hammer	Sometimes called Hammer-Aitoff in software
Compromise	Robinson	Pleasing shape, balances extremes
Compromise	Winkel Tripel	May be most accurate compromise
2. Continental areas		
A. Asia and North America		
Equal area	Bonne*	Considerable distortion in NE and NW corners
Equal area	Lambert Azimuthal Equal Area	Bearings true from center
B. Europe and Australia		
Equal area	Lambert Azimuthal Equal Area*	
	Bonne*	
	Albers Equal Area Conic; ideal for United States	
Conformal	Lambert Conformal Conic	
C. Africa and South America		
Equal area	Lambert Azimuthal Equal Area*	
Equal area	Mollweide*	
Equal area	Sinusoidal*	
Equal area	Homolosine*	
3. Large countries in mid-latitudes		
A. United States, Russia, China		
Equal area	Lambert Azimuthal*	
Equal area	Albers Equal Area Conic	
Equal area	Bonne*	
Conformal	Lambert Conformal Conic	
4. Small countries in mid-latitudes		
Equal area	Albers Equal Area*	
Equal area	Bonne*	
Equal area	Lambert Azimuthal*	
Conformal	Lambert Conformal Conic*	
5. Polar regions		
Equal area	Lambert Azimuthal	
6. Hemispheres and continents		
Visual	Orthographic	View of Earth as if from space; neither equal area nor conformal

***Must take special care to scale (zoom in) and re-center projection parameters to the particular area of interest.**

Sources: Compiled from a variety of sources listed in the references, especially Raisz 1962; Steers 1962; Snyder 1987; Dana 1999; and Environmental Systems Research Institute 2007.

When graphing data you need to decide:

- Number of **classes** or bins/ categories for *continious* data.
  - Rule of thumb is:

$$C = 1 + 3.3 * \log(n), \text{ where}$$
$$C = number\ of\ classes$$
$$n = number\ of\ observations$$

  - Class intervals should
    - NOT overlap
    - Contain all observations
  - Techniques to choose classes include:
    - Equal interval: divide equally based on *range*
    - Equal frequency: divide equally based on *number of observations per bin*
    - Jenks Optimisation: minimises variance within each class a maximises it between them
- How to **aggregate** or **cluster** the data:
  - When looking at level of detail in map, how best to aggregate across boarders
  - Choice in how to aggregate can change results - eg: aggregating horizontally gives different result to aggregating vertically
  - .: must be done *well* otherwise is misleading!

Spatial autocorrelation measures the **correlation** of a variable with itself through space;
- Is a measure of similarity (correlation) of nearby observations
- Examples of statistical tests include:
  - Moran coefficient (Moran I)
  - Geary's C

Methods of displaying **multivariate data** include:
- Interactivity
- Different colours
- Mix of colour and texture
- Multiple maps side by side
- Overlaying two data maps

Uncertainty can be displayed:
- Intrinsically: tightly couple visualisation of uncertainty with attribute - e.g.
  - Crispness
  - Resolution
  - Transparency
- Extrinsically: decouple visualisation from visualisation of uncertainty - e.g.:
  - Error bars
  - Separate graph with confidence intervals

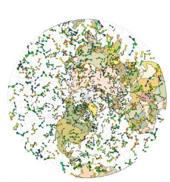
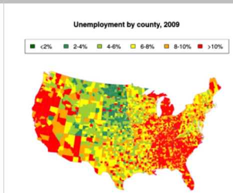
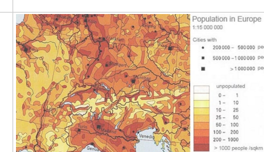
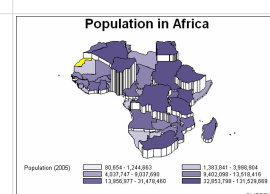
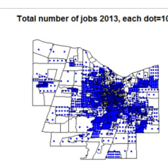
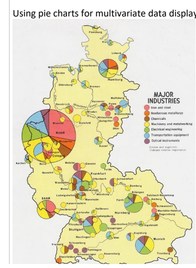


Figure 2.9: *Bowtie plots* can be used on a map to show uncertainty in the observed direction (called azimuthal data) to some point of interest. The centre of the bowtie is the location of the observation, the orientation of the bowtie is the direction while the width gives the uncertainty. This is similar to shaded regression lines. Based on: http://gis.stackexchange.com/questions/31294/how-to-visualize-azimuthal-data-with-uncertainties

	Visualisation Name	Definition	Advantages	Disadvantages	Examples
Spatial data	Choropleth	Shows categorical or ranked (ordinal, quantitative: continuous or discrete) data associated with regions that have **fixed** boundaries. Better to use **densities** rather than totals so that large areas do not dominate the map	Quick and easy to interpret	MUST have a legend for it to make sense. Assumes that the data is uniform across the region, which is not always the case.	
	Dasymetric maps	Similar to choropleth map but use regions or zones that have **uniform value**			
	Prism	Similar to choropleth map but uses **height** to show the data	Well suited to compare quantitative data		
	Dot density	Quantitative data associated with a region with **fixed** boundaries. Number of dots drawn semi-randomly on region ~ data value.	Can be used for **multivariate visualisation** by using different colours/ symbols	Reader may see patterns in the semi-random dots that don't exist Reader preception of differences is non-linear Difficult to see small differences	 Figure 2.2: Based on: https://github.com/mikeasilva/dot-density-map
	Proportional symbol	Uses a symbol to show ordered data associated with a region or particular location.		Not suitable for interval data = Things without a natural 0 - eg. Temperature Only shows things that are ≥ 0	Using symbols  Using pie charts for multivariate data display 

Uncertainty can be displayed:

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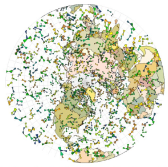

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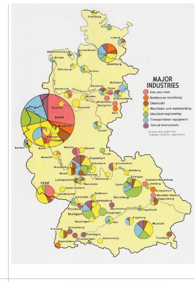
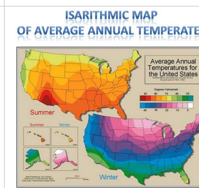
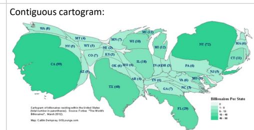
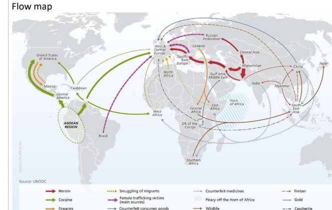
					
	Contour (isarithmic) & three-dimensional maps	Maps data conceptual height or elevation across a map.	Good for continuous data	Not good for discrete data	
	Cartogram	Come as **two** different types: *Contiguous*: regions remain connected but the size of region are distorted (they try to keep the shape recognizable) *Non-contiguous:* regions do NOT remain connected and shape of the region areas are preserved			Contiguous cartogram:  Non-contiguous cartogram: 
	Flow map Aka origin-destination (OD) maps	Show movement from one area to another. - Arrows indicate direction - Line width or colour show magnitude - Proportional symbols may be used to show magnitude of total flow To picture flow changes over **time** use: - Animations - **Space-time cubes**	Good to show movement of objects e.g. People, goods		Flow map  Space time cube