Geographic Information Systems 2018/19
Week 2, Topic 2

Mark Foley
School of Computing
DIT, Kevin Street

mark.foley@dit.ie

In this session...

Commonly used map projections

Projected Coordinate Systems

Irish Grid and Irish Transverse Mercator

Types of map projections

Can be grouped by “preserved property”

- Conformal (preserves local angles and shapes)
- Equal area or Equivalent (represents area in correct relative size)
- Equidistant (maintains consistent scale along certain lines)
- Azimuthal (retains certain accurate directions)

Preserved property often included in name

A projection can have more than one preserved property but conformal and equivalent properties are mutually exclusive

Conformal and equivalent properties are global (apply to the whole projection)

Equidistant and azimuthal are local (may only be true to or from the centre of the projection

Preserved property important for selecting which projection to use

Case

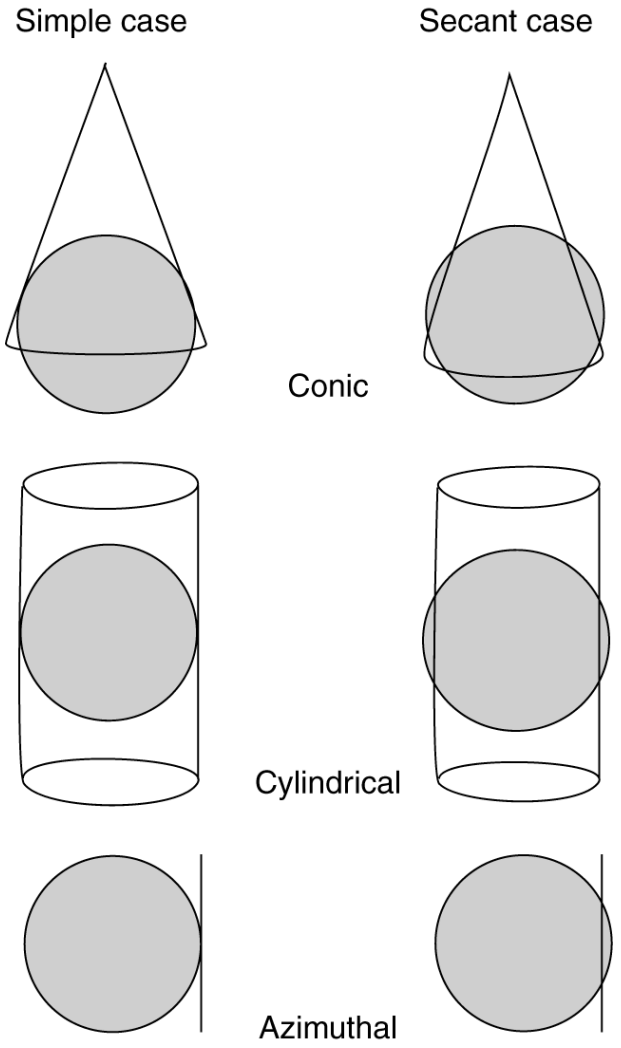
Recall how reference globe can be used to illustrate projection

Simple case

- One line or point of tangency

Secant case

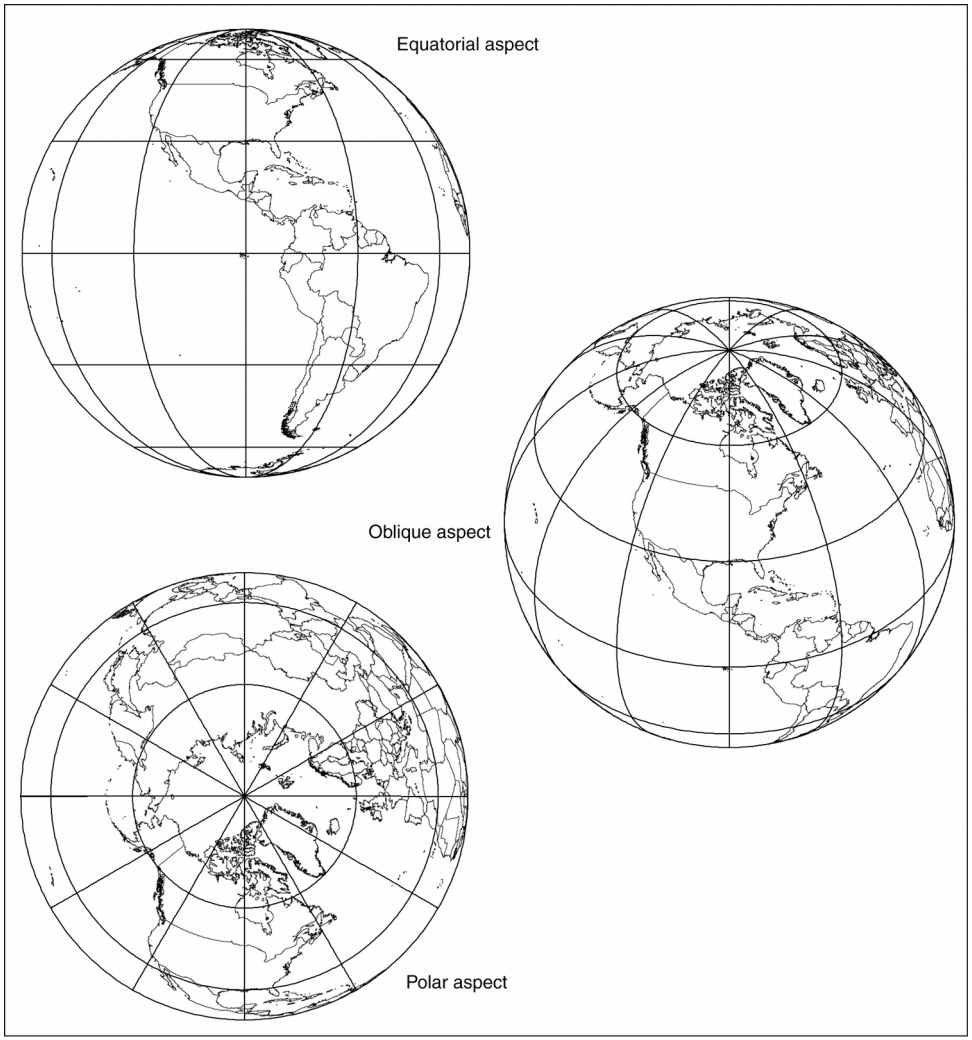
- More than one line of tangency



Aspect

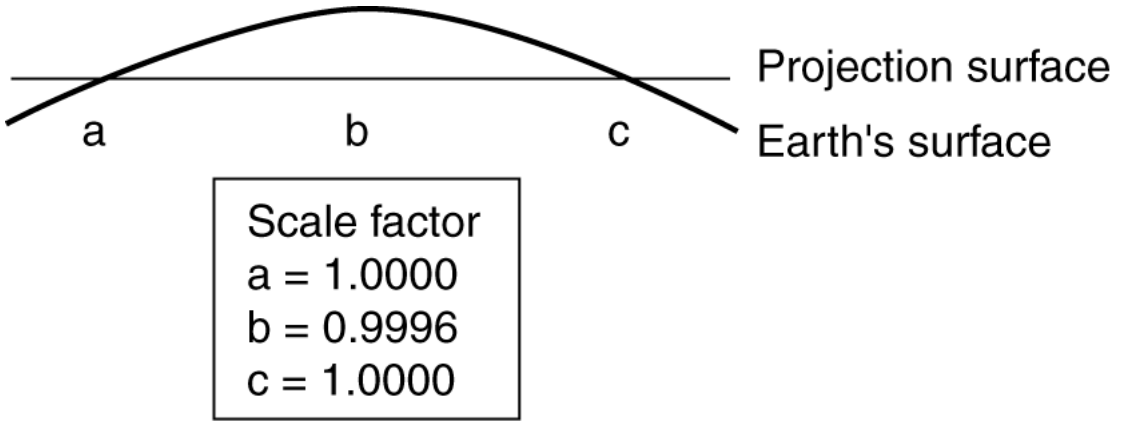
Aspect describes the placement of a geometric object relative to a globe

Irish Grid and Irish Transverse Mercator (ITM), for example, use a transverse aspect (the “cylinder” is wrapped around a standard meridian rather than the Equator)



Projection parameters

- Standard line
  - Line of tangency
  - Can be a standard parallel or standard meridian
  - Has no distortion
- Principal scale
  - Reference globe's radius to Earth's radius
  - Only applies along standard lines
- Scale factor
  - Principal scale normalized to 1 along standard lines
  - Measures distortion when not on standard lines



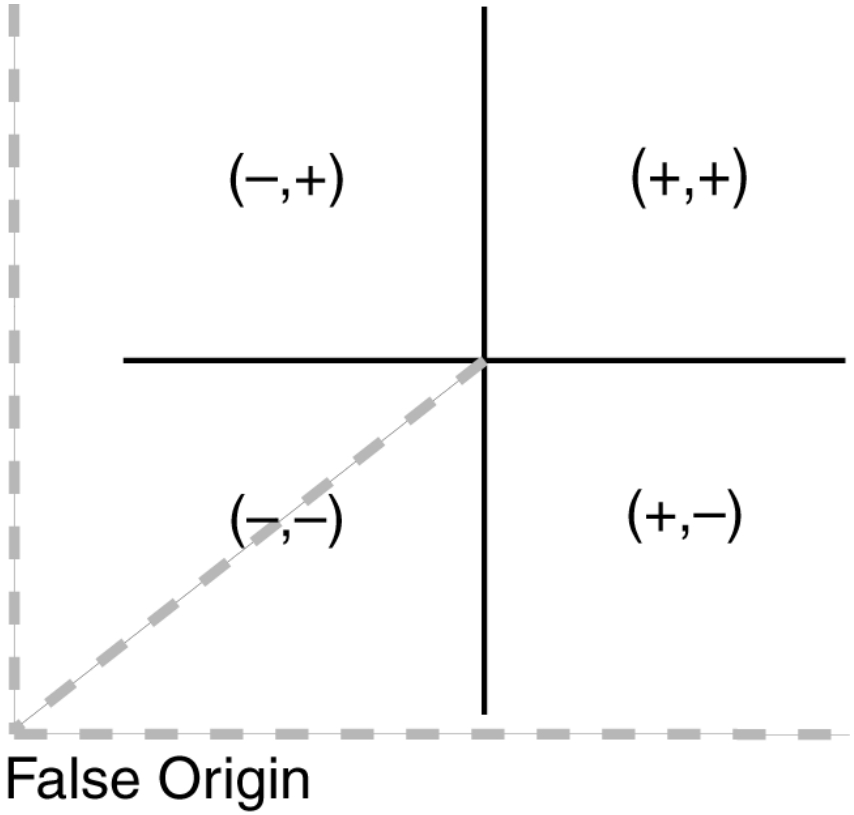
Projection parameters

Central lines

- Parallel and meridian that define centre of projection

False Origin

- Origin is at the centre of projection
- False origin moves this to SW corner so that all coordinates are positive



Common map projections

- WGS84 (World Geodetic System 1984)
  - Geographic coordinate system
  - Used in GPS
- Transverse Mercator
  - Variation of Mercator
  - Uses standard meridian (rather than standard parallel)
  - Conformal
  - Parameters: scale factor, central meridian, longitude of central meridian, latitude of origin (or central parallel), false easting & false northing
  - Irish Grid and Irish Transverse Mercator (ITM) are based on this
- Web Mercator
  - Used by web mapping providers such as Google and OpenStreetMap
  - Mercator projection based on sphere instead of ellipsoid for simplicity

Projected coordinate systems

Built on a map projection

Used for detailed calculations and positioning

Defined by the map projection and the geographic coordinate system (datum) that the map projection is derived from

Geographic coordinate systems use longitude and latitude

Projected coordinate systems use eastings and northings

Map Scale

A side note on map scale…

- Ratio of distance on map to corresponding distance on the ground
- Large scale => small area
- Small scale => large area
- 1:25000 is a larger scale than 1:250000 (representative fraction)

So, why is all of this important?

Datasets in different coordinate systems cannot be used together or displayed on the same map

You need to normalise to a consistent choice for this

You might need to convert data from one coordinate system to another

GIS software comes pre-loaded with the necessary parameters to convert between systems

The EPSG (European Petroleum Survey Group) publishes a database of coordinate system information plus some very good related documents on map projections and datums

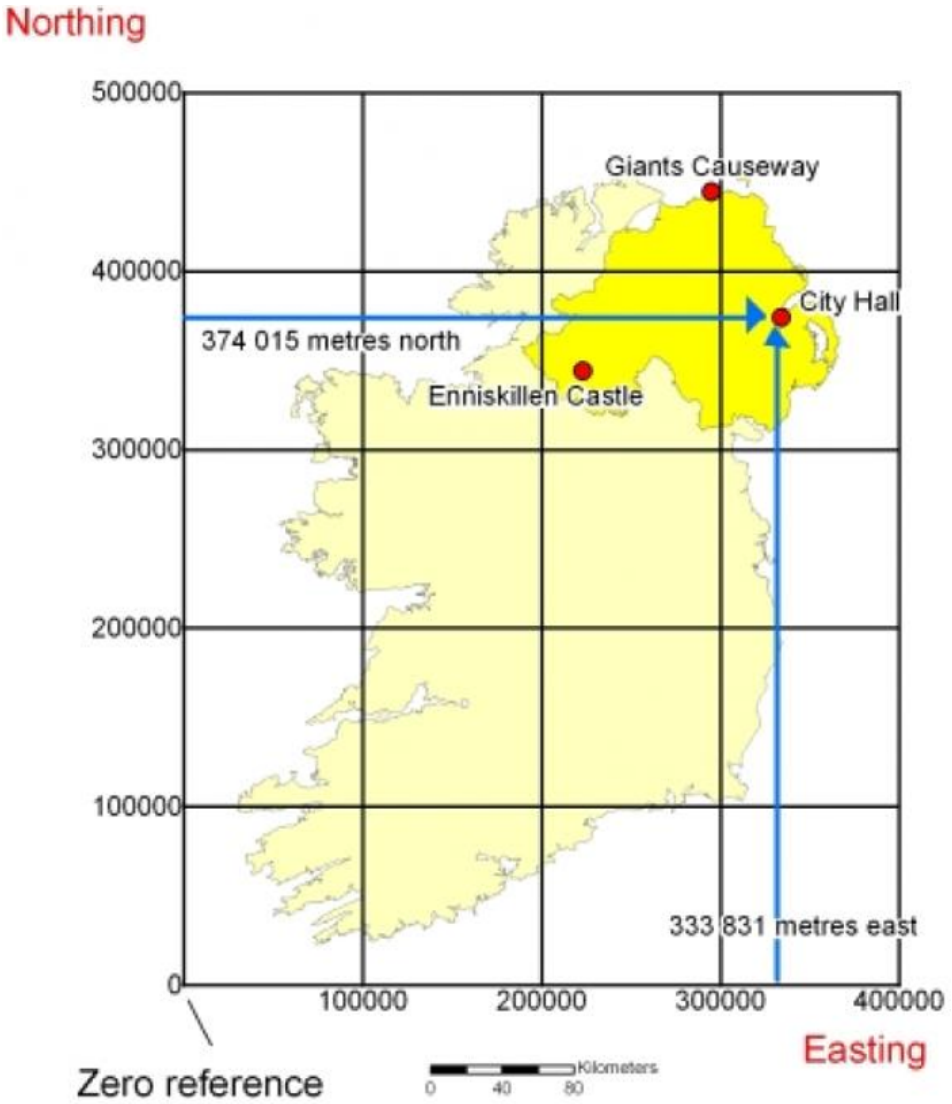
Each coordinate system has a code number assigned by EPSG. The most common ones you're likely to encounter in Ireland are

- WGS84 → EPSG:4326
- Web Mercator (aka Spherical Mercator) → EPSG:3857
- TM75/Irish Grid → EPSG:29903
- Irish Transverse Mercator (ITM) → EPSG:2157

Irish Grid

In this example, City Hall, Belfast is at 333831, 374015

ITM coordinates are also in metres but use a different set of parameters especially reference ellipsoid and false origin. This ensures, among other things, that coordinate pairs in either Irish grid or ITM will not be mistaken for each other.



Projection File

There are various representations of the Coordinate data which contain the same information

Well-known text (WKT) example:

PROJCS["TM75 / Irish Grid",GEOGCS["TM75",DATUM["Geodetic_Datum_of_1965",SPHEROID["Airy Modified 1849",6377340.189,299.3249646,AUTHORITY["EPSG","7002"]],TOWGS84[482.5,-130.6,564.6,-1.042,-0.214,-0.631,8.15],AUTHORITY["EPSG","6300"]],PRIMEM["Greenwich",0,AUTHORITY["EPSG","8901"]],UNIT["degree",0.017453292519943 3,AUTHORITY["EPSG","9122"]],AUTHORITY["EPSG","4300"]],PROJECTION["Transverse_Mercator"],PARAMETER["latitude_of_origin",53.5],PARAMETER["central_meridian",-8],PARAMETER["scale_factor",1.000035],PARAMETER["false_easting",200000],PARAMETER["false_northing",250000],UNIT["metre",1,AUTHORITY["EPSG","9001"]],AXIS["Easting",EAST],AXIS["Northing",NORTH],AUTHORITY["EPSG","29903"]]

Coming next...

Using coordinate systems in GIS