Learning Outcomes

- Define coordinate system and map projection
  - Relate coordinate systems and map projections
- Distinguish between *defining* and *changing* coordinate systems
- Create new GIS data from addresses and paper maps
- Explain how to integrate GPS point data
Georeferencing and Geocoding

- Linking data we have to geographic frames of reference
  - Supporting the display of our data in a GIS and its integration with other geographic data
- Geocoding: matching addresses to geographic coordinates (latitude and longitude)
- Georeferencing: matching geographic images to coordinates
Frames of Reference

- Global: systems that provide discrete coordinates for locations anywhere on the Earth’s surface.
- The geodetic latitude of a point is the angle between the equatorial plane and a line normal to the reference ellipsoid.
- The geodetic longitude of a point is the angle between a reference plane and a plane passing through the point, both planes being perpendicular to the equatorial plane.
- The geodetic height at a point is the distance from the reference ellipsoid to the point in a direction normal to the ellipsoid.
Frames of Reference

Global Frames of reference are applied to a model of the Earth (size and shape)

- Earth’s actual shape is too complicated
- Spheroidal and Ellipsoidal models are used
- Any single model of the Earth’s size and shape is called a geodetic datum
Geographic and Projected Coordinates

\((\phi, \lambda)\) \rightarrow \text{Map Projection} \rightarrow (x, y)
Coordinate Systems in ArcGIS

- Latitude and Longitude (3-D object surface, locations indicated in degrees)
- Projected (2 D and Planar, X, Y in distances)
- All GIS data is stored according to a coordinate system
  - Sometimes the information about the coordinate system DOESN’T come with the data (but the underlying information is still stored with respect to one)
    - In these situations we need to define or specify the coordinate system (“define” command)
  - Sometimes we want to change the data from one coordinate system to another
    - In these situations need to transform or project the data from one coordinate system to another (“project” command)
Address Matching and Geocoding

- Frames of Reference
  - Continuous
  - Discrete, Objects, and Areas
    - Street Address: Palmetto Seafood Co.
      2200 Gervais St.
      Columbia, SC 29204-1808 USA
    - Section, ¼ section, township
    - Larger? City, province, etc

- Uh-oh, problems
- For the most part databases produce successful geocoding results
UTM Coordinates for the Three Geocoded Locations of 2200 Gervais St

498,427.32m E
3,762,666.33m N

498,356.96m E
3,762,638.27m N

Distance = 39.8m

498,393.93 m E
3,762,642.28m N
Georeferencing a Paper Map

- Sometimes the data we want is only available in a hard copy
  - Or is an image
- If we know some important things about the contents of the image or map we can coordinate it with global reference systems
- Establish links between the image and a geographically known database
Control Points

- Link points are called “control points”
- Control points should be:
  - Easy to confirm (same location in the world)
  - Be spread across the space being georeferenced
  - Have good overlap between the two datasets
  - Established by clicking as close as possible to your intended target is important (zooming in helps)
Frames of Reference

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Universal Transverse Mercator

- Locations indicated in meters (from a pair of origins)
  - Lat/Long locations in degrees make it difficult to derive distances between places or make measurements in non-spherical coordinates
  - Most of us intuitively understand meters, kilometers, etc. for distance and area better than degrees, minutes, and seconds
However…

This apparent simplicity comes at the cost of a complex frame of reference and multiple origins
NAD 83 UTM Coordinates
Zone 14  96° to 102° West

Austin, Capital Dome
621,161 m E
3349,894 m N

121,161 m East of Central Meridian
3348,894 m North of Origin at Equator

False Easting at Central Meridian of 500,000 m

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Geodetic Datums

Earth Surfaces

Ellipsoid Surface

Topographic Surface

Geoid Surface

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