ChatGPT - Map projections

In this exercise, you will learn how to leverage ChatGPT to determine the most appropriate coordinate system (aka. "map projection" as many refer to it) for a particular study region and/or purpose. It will also show you the steps necessary to convert between coordinate systems so that everything is standardized.

I. Getting started

1. Launch the Microsoft File Explorer ( ) application
2. Copy and paste the following folder into your student folder
   a. M:\Gatormaps\Learn\ChatGPT
3. Open the ChatGPT folder and double-click on Map_projections.aprx
4. Take a few moments and explore the map layers

Northwest Pennsylvania

Since Allegheny College is centered in northwest PA and a significant amount of research involving local stakeholders is conducted here, this is a logical place to start. Regardless of map scale (e.g. as large as the Allegheny River basin to as small as Allegheny's campus), users have basically two (2) options:

● UTM Zone 17N NAD 1983 (meters)
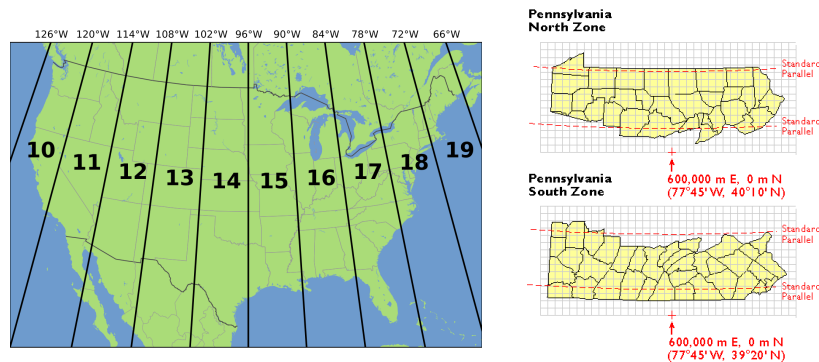● State Plane Pennsylvania North NAD 1983 (feet)

Figure 1: UTM zones for the contiguous U.S. (left) and State Plane North and South zones (right).

The Universal Transverse Mercator (UTM) coordinate system is most appropriate for scientific research as the units of measure are in meters. Zone 17 North extends roughly from the Equator to the North Pole N/S and from the center of Pennsylvania to to the western edge of Ohio (6° of longitude). So long as your study region falls within this zone and doesn't extend beyond, you're safe.

As you can probably guess, STP PA North is designed exclusively for the northern half of Pennsylvania. The units of measure here are feet, which makes it a good local government. For example, tax parcel information, where the land area of each property is expressed in acres, utilizes this coordinate system. Again, if any part of your study region extends beyond, a different coordinate system is necessary.

So, why do we need ChatGPT? Most likely, you don't. But, this is where we'll start exploring the use of ChatGPT to help make decisions about which coordinates to use.

Determining the "best" coordinate system

1. In a Web browser, launch ChatGPT and login

2. In the prompt, enter the following text and hit return:

   in arcgis pro, which coordinate system is best for mapping northwest pennsylvania

3. Scroll down and examine the results; Here are some key points:
   a. STP = U.S. feet, Lambert Conformal Conic projection, governments, surveyors, engineers
   b. UTM = meters, Transverse Mercator projection, use with GPS data

Transforming data into the desired coordinate system

All map layers to be overlaid must share a common coordinate system. This includes map projection, datum, and units. If a dataset does not match, it must be "projected" and given the desired parameters. It's not difficult, but the challenge lies in the correct geoprocessing tool and sequencing of those tools.

Scenario #1
Imagine your project requires data in UTM Zone 17N NAD 1983. You have GPS data that utilizes the WGS 1984 coordinate system. How would you go about getting the GPS data to match?

1. In the ChatGPT project, enter the following:

   in arcgis pro, how would you project point data in WGS 1984 to UTM Zone 17N NAD 1983

2. Scroll down and examine the results; Here are the key steps:

   a. Step 1 - Project tool (**for vector points, and polygons)
      i. Analysis > Tools > Search for… Project
         1. Input dataset: point layer (in WGS 1984)
         2. Output dataset: choose location and name

         3. Output coordinate system: click select (🌐) button
            a. projected coordinate systems > UTM > NAD 1983 > NAD 1983 UTM Zone 17N
         4. Geographic transformation: WGS_1984_(ITRF00)_To_NAD_1983
      ii. Click on Run

b. Step 2 - Verify the results

      i. Output layer - Open layer properties > Source

      ii. Confirm - NAD_1983_UTM_Zone_17N

Scenario #2

What if your data is in raster format? For example, you have an air photo that utilizes the WGS 1984 coordinate system. How would you go about getting the image data to match?

3. In the ChatGPT project, enter the following:

    in arcgis pro, how would you project image data in WGS 1984 to UTM Zone 17N NAD 1983

4. Scroll down and examine the results; Here are the key steps:

    a. Step 1 - Project Raster tool (**for raster grid cells)

      i. Analysis > Tools > Search for… Project Raster

        1. Input raster: image layer (in WGS 1984)

        2. Output raster: choose location and name

        3. Output coordinate system: click select (🌐) button

          a. projected coordinate systems > UTM > NAD 1983 > NAD 1983 UTM Zone 17N

        4. Resampling technique:

          a. Nearest (for categorical data like landcover)

          b. Bilinear or Cubic (for continuous data like imagery or elevation)

        5. Output cell size: < leave blank >

        6. Geographic transformation: WGS_1984_(ITRF00)_To_NAD_1983

      ii. Click on Run

    b. Step 2 - Verify the results

      i. Output layer - Open layer properties > Source

      ii. Confirm - NAD_1983_UTM_Zone_17N

Scenario #3

Occasionally, you may run across a dataset whose coordinate system is < Undefined > or missing. Less likely, you may have a layer whose parameters were specified incorrectly and they need to be overwritten. How would you go about assigning the coordinate system and then getting it to match?

1. In the ChatGPT project, enter the following:

in arcgis pro, a layer is missing its coordinate system. it is most likely WGS 1984. how would you assign it the correct coordinate system and then project it to UTM Zone 17N NAD 1983

2. Scroll down and examine the results; Here are the key steps:

    a. Step 1 - Define projection tool (**for vector and/or raster)

        i. Analysis > Tools > Search for… Define projection

            1. Input dataset: layer with NO coordinate system

            2. Coordinate system:

                a. Geographic coordinate system > World > WGS 1984

        ii. Click on Run

    b. **Steps 2-3: Same as previous depending on vector or raster

Practice

For the scenarios below a) determine the most appropriate coordinate system for the study region and/or purpose and b) identify the geoprocessing tool and sequencing of tools necessary to complete the task.

Mapping the contiguous United States

STP divides the state into North/South zones. If you want to map the entire state, you'll need something different. Enter the following into the ChatGPT prompt and examine the results:

in arcgis pro, what is the most appropriate coordinate system for mapping the contiguous US and what should the parameters be

ChatGPT recommends the Albers Equal Area Conic map projection, which makes sense since the contiguous US is situated in the northern hemisphere and has more of an east-to-west extent. The key parameters to note are stated in the table below.
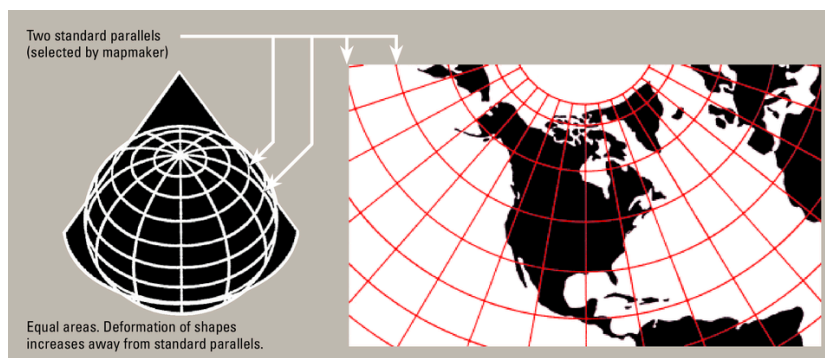

Figure 2: A conic map projection. Source: U.S. Geological Survey, 2025.

Parameter	Value	Explanation

Central Meridian	-96.0	Line of longitude that defines the center and the x-origin; Choose a meridian that runs most closely through the center of the study region
Latitude of Origin	23.0	Defines the point from which y-coordinates (northing) are measured; typically South of the area being mapped to ensure all y-coordinates are positive (+)
1st Standard Parallel	29.5	Line of latitude where the planar surface intersects the globe; Scale is constant along the lines and distorted outside of (condensed between and stretched beyond)
2nd Standard Parallel	45.5	Line of latitude where the planar surface intersects the globe; Scale is constant along the lines and distorted outside of (condensed between and stretched beyond)

USA Contiguous Albers Equal Area Conic NAD 1983

1. Start a new ArcGIS Pro project file

2. Next, add following map layers from:

    a. M:\Gatormaps\Learn\Map_projections

        i. Latitude & Longitude.lyrx

        ii. us_states.shp

3. Right-click us_states > Properties

    a. Click on Source

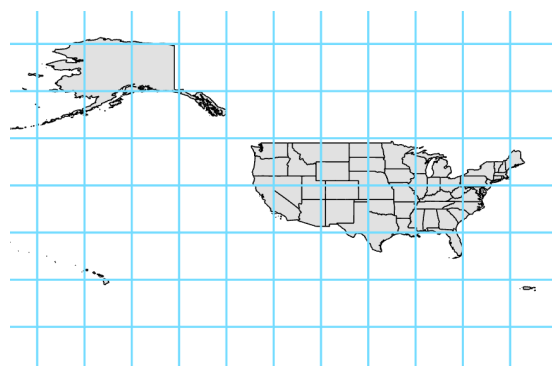   b. Expand spatial reference

        i. NAD 1983

Figure 3: U.S. map in a geographic coordinate system (NAD 1983).

Project from GCS NAD 1983 to Albers Equal Area Conic

    a. Step 1 - Project tool

        i. Analysis > Tools > Search for… Project

            1. Input dataset: us_states (in NAD 1983)

            2. Output dataset: choose location and name (e.g. us_states_albers)

            3. Output coordinate system: click select (🌐) button

                a. projected coordinate systems > Continental > North America > USA Contiguous Albers Equal Area Conic

    b.   Right-click on file > Details…

        i.   Central meridian: -96.0

        ii.   Standard parallel 1: 29.5

        iii.   Standard parallel 2: 45.5

        iv.   Latitude of origin: 37.5

        v.   When finished, close the details window

    c.   Output coordinate system: click on OK

      4.   Geographic transformation: **Unnecessary since input is NAD 1983

  ii.   Click on Run

  b.   Step 2 - Verify the results

    i.   Output layer (e.g. us_states_albers) - Open layer properties > Source

    ii.   Confirm - USA Contiguous Albers Equal Area Conic

**The coordinate system of the map is defined by the FIRST layer added to it. In this case, it would be GCS NAD 1983 since that is the coordinate system of the us_states.shp layer. You won't see the results of projecting your data until you change the coordinate system of the map to be that of us_states_albers.

  c.   Step 3 - Visualize the results

    i.   Uncheck (☐) us_states to remove it from view

    ii.   In Contents pane, right-click Map (🖼) > Properties

    iii.   Click on Coordinate Systems > Expand Layers

    iv.   Choose Pennsylvania Albers Equal Area Conic

    v.   When finished, click on Apply and OK
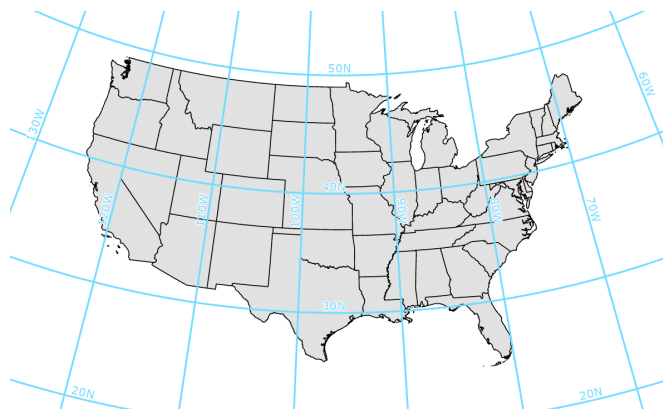
  d.   Zoom into the contiguous U.S.

Figure 4: U.S. map in a USA Contiguous Albers Equal Area Conic NAD 1983.

Accurate representation of the U.S. Notice however, that Pennsylvania seems to be slightly rotated.

<u>Mapping the entire state of Pennsylvania</u>

STP divides the state into North/South zones. If you want to map the entire state, you'll need something different. Enter the following into the ChatGPT prompt and examine the results:

> in arcgis pro, what is the most appropriate coordinate system for mapping the entire state of pennsylvania and what should the parameters be

It looks like a "custom" coordinate system is needed. The following steps will show you how to take the Albers Equal Area Conic coordinate system that is designed for mapping the United States and customize it specifically for Pennsylvania.

Parameter	Contiguous U.S.	Pennsylvania
Central Meridian	-96.0	**-77.75**
Latitude of Origin	23.0	**39.333333**
1st Standard Parallel	29.5	**40.5**
2nd Standard Parallel	45.5	**42.5**

Custom coordinate system

1. **Instructions assumes you are continuing to work

    a. Step 1 - Project tool

        i. Analysis > Tools > Search for… Project

            1. Input dataset: us_states (in NAD 1983)

            2. Output dataset: choose location and name (e.g. us_states_pa)

            3. Output coordinate system: click select (🌐) button

                a. projected coordinate systems > Continental > North America > USA Contiguous Albers Equal Area Conic

                b. Right-click on file > Copy and Modify…

                    i. Name: Pennsylvania Albers Equal Area Conic

                    ii. Central meridian: -77.75

                    iii. Standard parallel 1: 40.5

                    iv. Standard parallel 2: 42.5

                    v. Latitude of origin: 39.333333

                    vi. When finished, click on Save

                c. Output coordinate system: click on OK

            4. Geographic transformation: **Unnecessary since input is NAD 1983

        ii. Click on Run

    b. Step 2 - Verify the results

     i. Output layer (e.g. us_states_pa) - Open layer properties > Source

     ii. Confirm - Pennsylvania Albers Equal Area Conic NAD83

**Again, you won't see the results of projecting your data until you change the map's coordinate system.

    c. Step 3 - Visualize the results

     i. Uncheck (☐) us_states_albers to remove it from view

     ii. In Contents pane, right-click Map (🖼) > Properties

     iii. Click on Coordinate Systems > Expand Layers

     iv. Choose Pennsylvania Albers Equal Area Conic

     v. When finished, click on Apply and OK
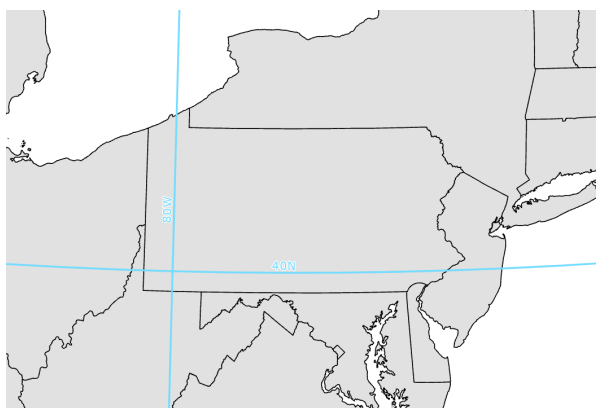
    d. Zoom into Pennsylvania

Figure 5: Map of Pennsylvania with customized map projection parameters.

Notice that the state of Pennsylvania appears correct, but everything else is out of whack.

Creating projection (.prj) files

If ChatGPT can recommend coordinate systems and define parameters, what's to stop it from writing a custom projection (.prj) file for you? This would arguably be the easiest way to do things. All you have to do is import the auto-generated .prj file and everything will be set accordingly!

Enter the following into the ChatGPT prompt and examine the results:

  write a coordinate system file in arcgis pro to project data into Pennsylvania Albers Equal Area Conic NAD 1983

There you go! ChatGPT produced the syntax needed to define the coordinate system. All you have to do is copy the text, paste it in Notepad, and save it as a projection (.prj) file.

📄 **.prj File Content: Pennsylvania Albers Equal Area Conic (NAD 1983)**

```prj
PROJCS["PA_Albers_Equal_Area_Conic_NAD83",
    GEOGCS["GCS_North_American_1983",
        DATUM["D_North_American_1983",
            SPHEROID["GRS_1980",6378137.0,298.257222101]],
        PRIMEM["Greenwich",0.0],
        UNIT["Degree",0.0174532925199433]],
    PROJECTION["Albers"],
    PARAMETER["False_Easting",0.0],
    PARAMETER["False_Northing",0.0],
    PARAMETER["Central_Meridian",-77.75],
    PARAMETER["Standard_Parallel_1",40.5],
    PARAMETER["Standard_Parallel_2",42.5],
    PARAMETER["Latitude_Of_Origin",39.333333],
    UNIT["Meter",1.0]]
```

Figure 6: Projection (.prj) file syntax for Pennsylvania Albers Equal Area Conic NAD 1983.

1. Copy the syntax generated by ChatGPT
2. Click on Start > Programs > Windows Accessories > Notepad
   a. Paste the syntax into Notepad
   b. Click on File > Save As…
   c. Browse to the desired location
   d. **Change the save as type to All Files (*.*)
   e. Name the file pa_albers.prj and click Save
3. When finished, close Notepad

   e. Step 1 - Project tool
      i. Analysis > Tools > Search for… Project
         1. Input dataset: us_states (in NAD 1983)
         2. Output dataset: choose location and name (e.g. us_states_pa_new)
         3. Output coordinate system: click select (🌐) button
            a. Click on Add Coordinate System (🌐⌄) > Import Coordinate System
            b. Browse to and select the pa_albers.prj file > click on OK
            c. Output coordinate system: click on OK
         4. Geographic transformation: **Unnecessary since input is NAD 1983
      ii. Click on Run

   f. Step 2 - Verify the results
      i. Output layer (e.g. us_states_pa_new) - Open layer properties > Source

ii.   Confirm - Pennsylvania Albers Equal Area Conic NAD83

You're done… It's as easy as that!