DCS 1100
Fall 2016
Georeferencing Assignment
Due electronically at 5:00pm Monday, 9/12

Lab Overview
You should be able to complete all of the ArcGIS activities during a 90-minute period. There are two guided help sessions available for you on Friday, September 9 in 304 VAC: 9:30-11:00 or 1:00-2:25.

The Big Picture:
This lab is part of our ongoing discussion about comparing the analog and digital worlds. In today's case: how can such a comparison help us to understand the experience and representation of space in a historical period and culture (or even our own)?

1. Set up and introductions.
   Follow instructions for starting the project.
2. Georeferencing Tutorial (Self-guided, but support on site at times listed above.)
   Follow instructions for comparing (georeferencing) the historical "PAGB1904.jpg" with a modern topographical map. Everyone must complete this georeferencing exercise with this map.
3. Georeferencing a Historical Map of Your Choice
   Choose one of the maps in the folder "HistoricalMaps" to georeference. "gbma1886a.jpg" is particularly challenging.
4. Critical reflection (250-500 words).
   Answer the following question in paragraph form: How does the comparison of the historical and digital maps reveal the assumptions that we make about the visual information on maps? Use specific examples from the readings and your activities during this assignment to demonstrate your point.
5. Submission
   - Submit your assignment as a Word document or pdf on Blackboard by the deadline. Include all screen captures (with explanatory captions of what they depict) and your two exported maps in the Word file with your answer to question 4.
   - Save your .mxd projects and link tables (based on the 1904 map and then on the map of your choice) in your student folder (//microwave/courses/dcs1100/). *The deadline for saved file times is 5:00pm on Monday, Sept. 12.*

Introduction to ArcGIS and Spatial Analysis

Spatial Analysis

Spatial analysis is a way to gather information on the locations and features of spatial data. Digital humanists (especially in digital history and archaeology) can use spatial analysis to help answer questions about location and visualization. Spatial analysis can give a more complete explanation of what was visible at a certain location. The outputted data and images can confirm or challenge our current perceptions of location. The resulting visual data offers a quantitative approach to determining how we make decisions based on what we see and where we are. Spatial analysis creates visual data that help digital humanists investigate multiple interpretations and narratives of location-based events.

You will use spatial analysis to compare the spatial representation and messages of maps from the Civil War with modern topographical maps. The output data will suggest one view of what Chamberlain could have seen at Gettysburg. If Chamberlain had this visual data, would he have made different decisions? By having this data can we better understand his decisions? You will use **ArcGIS**, a software program that scholars in many disciplines, including digital humanists, can use to produce and analyze geospatial data. You will **georeference** maps (first assignment) and use **geoprocessing tools** (second assignment) to see the **visibility** of Chamberlain's position at Little Round Top.

Vocabulary:

Geoprocessing: ArcGIS offers many tools that enable you to manipulate spatial data. This means that your input image will look different from your output.

Georeference: Georeferencing is taking something that does not have clear spatial referents, and applying coordinate systems and projections to it. It is essentially pasting it onto the earth where it belongs. For example, comparing an old map (presumably hand drawn) to a modern map that has been created using digital spatial and coordinate systems data. You will pick notable points of comparison on the historical map and will reference the map to the same points on the modern map with coordinates. This will put the old map into a digital representation of a physical space.

Raster: A spatial data model that processes space as an array of cells in rows and columns. This means that groups of cells with the same value represent the same kind of geographic feature.

Visibility and Viewshed: These geoprocessing tools allow you to determine visibility from a particular point on the map using a digital elevation model (**DEM**).

DEM (digital elevation model): A raster layer where each cell's value represents the elevation at the center of the cell.

The **GIS Dictionary** is a good resource if you need to look up terms.
http://support.esri.com/en/knowledgebase/Gisdictionary/browse

Georeferencing Data

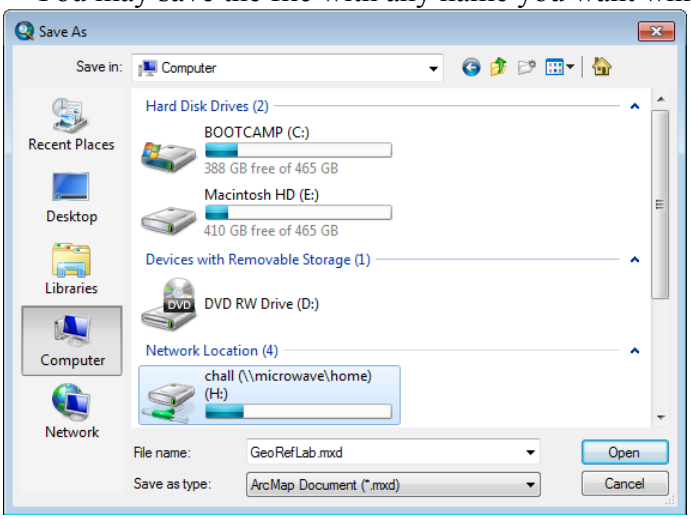
1. First, start the computer using Windows, not the Mac OS. This will take a few minutes while the computer restarts.

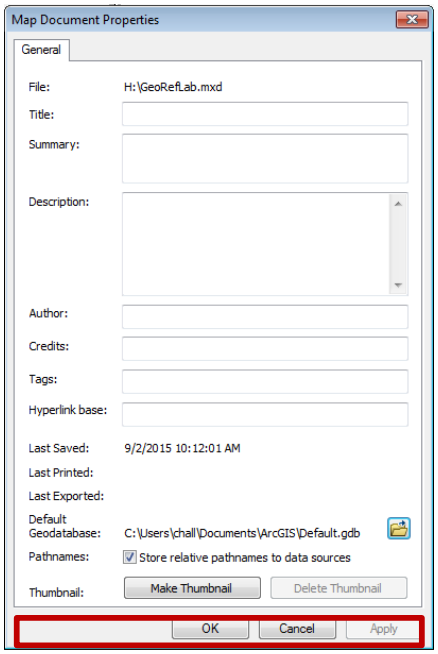
2. Then you'll need to connect to the course microwave space in order to access the data and maps that you will use. On your desktop, click on the File Explorer Icon  . Then right click (CTRL+click or click with two fingers) on "This PC" and choose "map network drive." (You may have to click the drop-down arrow on the top right, next to the blue help button  in order to make the menu appear.) Select a letter (the default "Z" is fine) from the dropdown options, and then type the following path \\microwave\courses\dcs1100.

3. Open that folder and copy the "GeoreferencingLab" (all in the \dcs1100\materials folder) folder to your student folder. This could take 7-8 minutes.

4. Open ArcGIS by clicking the Start/Windows icon  in the lower left of the desktop. Click All Apps > ArcGIS > ArcMap10.4. In the window that opens, select a blank project (double-click or highlight and click OK).

5. Immediately save the new project to your student folder in the course folder for DCS1100. From the "File" menu choose "Save As" and navigate to "This PC", scroll down to the DCS1100 microwave space, and the Student Folders. Be sure that you have selected ***your*** folder (scroll down to the "Z" drive you selected in Step 2; do not use "H"). You may save the file with any name you want while keeping the .mxd extension.



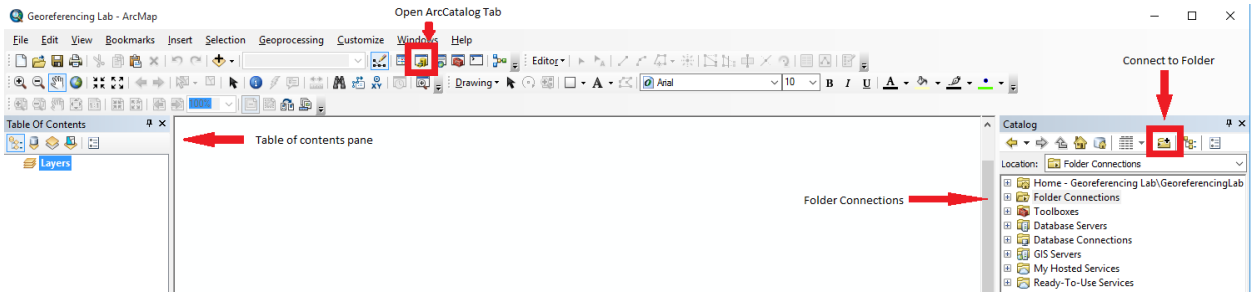


6. Now also make sure that any of your relevant data is also saved to that same space by again clicking "File" and "Map Document Properties" all the way at the bottom of the menu. Make sure that at the bottom of the dialog box the box for "Pathnames" is checked to store relative pathnames to data sources. Click "Apply". This means that when you submit your work, your

professors will be able to open it correctly. Otherwise your historical map may save to the machine you are using today, not a commonly accessible space like microwave.

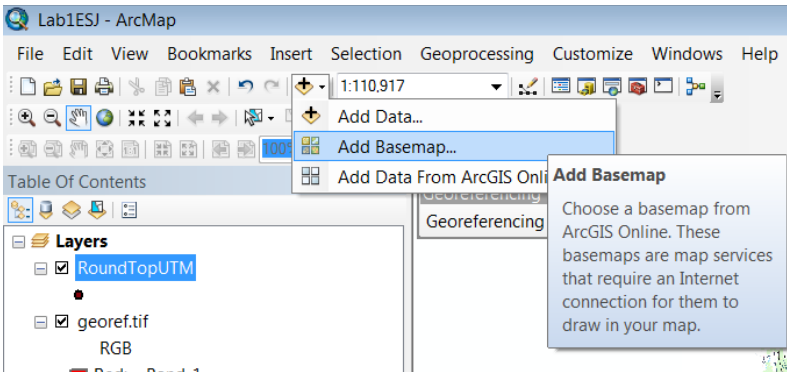
7. **Connect to your data:** When you open ArcGIS, you will want to add a link to the data from your microwave space to the ArcCatalog pane (the tab found on the right hand side). If the tab is not already on the right of your screen, click the catalog button . You may need to add your personal folder to the connected folders in catalog. Do this by clicking the Connect to Folder button. Starting with "This PC" and then clicking through folders and subfolders, link to your student folder. **Submit a screen capture of your Catalog pane.**

8. **Connect to your default geodatabase.** Now that you have this folder linked to Arc, open the "Catalog" tab and expand the folders until you find the *Default Geodatabase* ("Default.gdb") in the "C:\\Users\userid\Documents\ArcGIS…" path. Click and drag that file into your Home folder. Go back to *Map Document Properties*, and make this file (in your student folder) your *Default Geodatabase*. Click "Apply". NOTE: At this point, your default geodatabase should no longer contain the path "C:\\Users\userid\Documents\..."



MAP WINDOW

9. **Add a reference point:** To make finding Gettysburg a little easier, we have created a georeferenced point for Little Round Top. Expand the Geoeoreferencing Lab folder in the ArcCatalog pane, and open the Georeferenced folder. Drag the *RoundTopUTM.shp* file to the map window. A point should appear. Click on the point symbol in the Table of Contents pane (on the left), and change the symbol to something bright so that it will show up against the basemap background we are about to add.
10. **Add a base map.** We will be attempting to use ArcGIS online during the tutorial. ArcGIS online provides a wide range of maps that are useful for Georeferencing. For our purposes, we will use a topographic map. Now click on the little arrow next to the Add Data button , which will give you a drop down menu. Select Add Basemap. (Picture below.)



Now Select USA Topo Maps. You should see a map of Gettysburg towards the center of your Map Window. You may need to adjust the scale of the map so that the map window isn't entirely dark green. The menu is next to the "Add Data" button you just used. Instead of 1:1,11 you might choose 1:24,000.

NOTE: As a backup, use the following step: **Working from your student folder** drag the file *georef.tif* from the folder connection in the catalog pane (right hand side) into the main window or to the table of contents pane (found on the left side).

11. Now add the historical map *PAGB1904.jpg* (found in your folder connection in the Catalog) by dragging it into the map pane. Don't worry if your map isn't immediately visible – we'll fix that in Step 13. ArcGIS will warn you that this map is lacking a coordinate system, but that is okay. When you georeference the map, it will adopt the coordinate system from the base map.

12. Add the **Editor** and **Georeferencing** toolbars so that you will be ready to georeference. Click on **Customize** (upper center of Arc) **> Toolbars >** . Click on both Editor and Georeferencing so that they will appear in the main window. You can dock these new tools along with the other tools at the top of our screen.

    a. Warning: Resize the ArcMap window now so that it is maximized. We have encountered issues with the laptops where resizing later causes the software to crash!

13. Even though we are interested in Little Round Top, center your map on the town of Gettysburg so that placing the historic map is easier. Use the navigation bars on the edges of the map window to find the town north of the battlefield.

    a. Tip: If you "lose" your map or points, you can "Zoom to Layer" to get back to where you were on the map. Right click on the layer (likely the RoundTopUTM point) and select "Zoom to Layer."

14. First, in the Georeferencing toolbar, be sure that the map you are georeferencing (*PAGB1904.jpg*) is listed in the drop down menu. Then click on the drop down menu

under georeferencing. Select **Fit to Display.** This will position the historical map so that it is visible along with the base map you are using.

   a. Tip: If things start getting unwieldy, you can remove the historic map layer and start over. In the "Table of Contents" pane find the layer for your map and right click (use two fingers to click). Don't forget to **Fit to Display** again.

15. This step will take most of your time for this assignment. In the Georeferencing toolbar (on the far right, from the drop-down menu by the symbol for "rotate"), select the **Scale** tool. Adjust your historical map so that it overlays the base map and takes up the same amount of space in the frame. Use the "Tip" below and make small adjustments. You can use the **Shift** tool to move the historical map around in the frame. Try to have the same points on the two maps line up. For example, look at where downtown Gettysburg is on the base map and then try to size the historical map so that the center of the town is roughly in the same place and of the same dimensions.
    a. Tip: Make the historical map slightly transparent so it is easier to compare its positioning to the base map. To do this, right-click on the historical map layer (in the Table of Contents pane on the left). Select **Properties.** Go to the **Display** tab and set the transparency. You can always change the transparency back when you are done georeferencing.

16. Now you are ready to georeference your map!

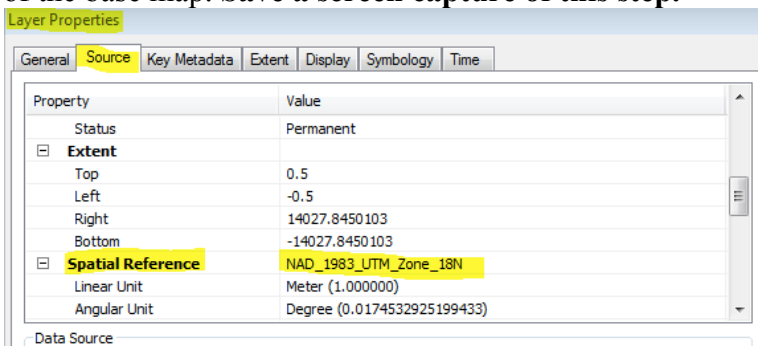
17. In the **Georeference** toolbar (above), click on **Add Control Points** . You will then select various points on the historical map to compare their placement to the same points on the basemap. Be sure that you can place each point in the same place on ***both*** maps. Intersections usually make a nice, precise point. **When georeferencing, always be sure to start with your historic (non-georeferenced map) to add a control point first, and then add the same control point to the base modern day Topo map**.

    a. Tip: Observe the change in landscape and location overtime. What location makes for a good control point? For example, a historical map has a river that is no longer visible on a modern map. What happened to the river? What caused this change?

18. *Turn off* the base map layer. Go to the Table of Contents (left-hand side) and uncheck the little box next to the base map layer name. This will temporarily make only the historical map visible.

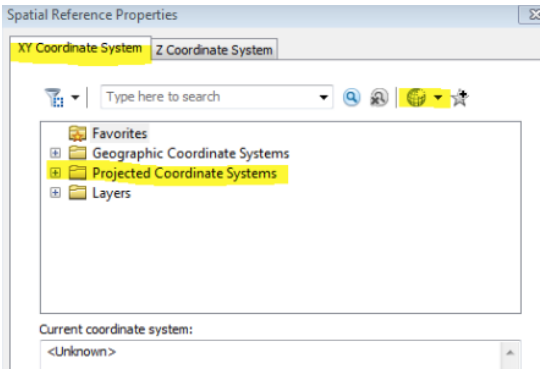
19. Now, click on the location on the historical map that you want to georeference. This will add your first point.

20. With **Add Control Points** still selected, *turn on* the base map layer. Go to the Table of Contents and check the little box next to the base map layer name. This will make the base map visible again.
21. Click on the same location on the base map that you previously chose on the historical map. This will become your first control point. ArcGIS will then compare the location of the point on the historical map to the location of the point on the base map. It will correct the historical map so that it now aligns with the base map.
22. Add control points in at least three more locations. Choosing at least four points (they can just be near Little Round Top since that is the specific area on the map we are interested in) will give ArcGIS more information for georeferencing. Once you have added at least three control points, you will notice that the historical map was manipulated. It could appear stretched, slanted, etc. If the georeferenced historical map looks pretty similar to the original historical map that means the original was relatively similar to modern measurements. If the georeferenced map looks very warped that means that the original was depicting and measuring the space differently.
23. Click on **View Link Table**  in the **Georeference toolbar.** You should save the data as a ".txt" file in case you want to return to this data later on or compare different data sets. This will show you the data behind the visualization you got by georeferencing.
    a. Note: In the link table, you will see something called **RMS error**. This number tells you the level of accuracy. A lower number means a higher level of accuracy.
    b. Note: If you added a control point in the wrong location or have one control point that is too much of an outlier, you can delete it in the Link table and add a new control point on the map.
24. Once you are done, click **Update Georeferencing** in the Georeference Toolbar**.** This is one of the options in the drop down menu under georeferencing.
25. Check your coordinate system. Right click on the historical map layer in the table of contents (found on the left hand side) and click on properties. Click on the Source tab and scroll down until you see the name of the current coordinate system. This will show you the coordinate system of the base map. **Save a screen capture of this step.**



    a. For this tutorial, we are using **UTM Zone 18N NAD 83** as our standard coordinate system. This projection is good only for a small part of the country (not even all of Pennsylvania), so don't assume that you should use the projection

everywhere. We want it to match the underlying data. If you currently have a different coordinate system, you can change it by using the **Project Raster tool.** Click on Arc Toolbox→Data Management Tools→Projections and Transformations→Raster→Project Raster. (Shown below.)



i. When you have the **Project Raster** window open, the **input raster** will be the historical map layer (ending in .jpg) and the **output coordinate system** will be **UTM Zone 18N NAD 83** (The input coordinate system is what you found in step 17, the maps will probably be in WGS_1984 Web Mercator auxiliary sphere. Click on the button next to input coordinate system→projected→world and scroll until you see it)**.** You can find this by clicking on the button (the pointing hand) to the right of the output coordinate system, selecting projected coordinate systems→UTM→NAD 1983→UTM Zone 18N NAD 83.

26. Export your map. Make sure that the georeferenced historical map is sitting above the basemap, and that the point for Round Top is showing. Click on File> Export Map… make sure your map is a .png file.
27. Repeat these steps for a second map from the historical maps folder.

What data do you have after georeferencing?

- Modern topo map
- Historical map without spatial context
- Historical map with spatial context and coordinate system, adjusted for accuracy
- Link tables (2) with your added control points
- Screen captures of your work (4 – 2 for each map)
- Exported historical map (2)

Notes: