

Introduction to Manifold GIS (tutorial)

1. Overview

Manifold is a modern, low-cost, high-performance GIS application that runs on the Windows operating system. Unlike ArcGIS, it is freely available to Cornell students, faculty, and staff, thanks to Manifold's generous Academic License, which includes nearly every extension available, and is equivalent to Manifold's "Ultimate Edition x64" license, which includes the Business Tools, Geocoding Tools, and Surface Tools extensions, as well as Database Administrator. Manifold supports massively parallel computing using NVIDIA graphics cards, and is also available for 64-bit versions of Windows.

Manifold is installed on the computers in all the Mann Library classrooms (Stone, B30A, and B30B) and research computers. To get a copy of Manifold for your own computer, go to:

<https://confluence.cornell.edu/x/e4CqB>

1.1. The Manifold user interface

- Menus, Toolbars, and Panes (Project and Info)
- Special toolbars: the "Selection Toolbar" and the "Transform Toolbar"
- Data Layers
 - Drawing = vector points, lines, and polygons
 - Image = raster images (e.g. aerial photos, satellite imagery, scanned maps)
 - Surface = raster data values (e.g. elevation, temperature, land cover)
 - Table = tabular data (e.g. tab-delimited, csv, Excel spreadsheet)
- Importing, Exporting, and Linking to data
- Saving your project -- all imported data is saved to your Manifold project (.map) file.

2. Exercises

2.1 Bird observations -- converting a table into points

2.2 Thematic mapping

2.3 County boundaries -- importing a shapefile

2.4 County demographics -- joining data from a spreadsheet

2.5 Creating a map -- combining data layers

2.6 Elevation -- importing a surface

2.7 Calculating elevation for each observation point

2.8 Speeding up the map display

2.9 Linking to remote imagery

For this tutorial, the data has already been downloaded and prepared for use with the exercises below. We'll be using data from several different sources:

- Bird observation data (from Avian Knowledge Network)
- New York county boundaries and demographic data (from U.S. Census Bureau)
- New York streets data (from NYS CSCIC)
- Elevation data (from U.S. Geological Survey)
- Aerial photos (from Microsoft Virtual Earth)

From any Mann Library classroom computer, double-click on the "Classroom Files" icon on the desktop, and browse to:
\\Classroom Files\GIS

Copy the entire Manifold1 folder to your local computer by dragging the Manifold1 folder to your Desktop.

Start Manifold from the Windows "Start" menu:

Start menu > All Programs > Manifold System > Manifold System 8.0

2.1 Bird observations -- converting a table into points

The bird observation data was downloaded from the Avian Knowledge Network (AKN). For this exercise, it has been pared down to just a small subset of the fields available, and has been saved as a comma-delimited .txt file. It includes Latitude/Longitude coordinates that we can use to create a layer of points.

Import the observation data:

- File menu > Import > Table...
- Navigate to Desktop > Manifold1
- Make sure that "Files of type" is set to "CSV Files"
- Open "AKN_BaldEagle.txt"
- You will see a preview of the data. Leave all the default settings and click "OK".
- Notice that the "AKN_BaldEagle" table now appears in the Project pane.
- Double-click to view the data.

To turn this table into a drawing:

- Right-click the "AKN_BaldEagle" table in the Project pane > Copy
- Right-click on empty space in the Project pane > Paste as > Drawing...
- In the dialog, you can select which fields to include (we'll keep them all)
- Manifold will guess which columns contain the x and y coordinates. Review this selection. (Although, for this example, no changes are needed.)
- Click "OK"

Notice that a drawing layer called "AKN_BaldEagle 2" now appears in the Project pane. Let's rename it:

- Right-click the "AKN_BaldEagle 2" layer > Rename... "Bald Eagle"

At this point, we can delete the original table, since we've copied all the data into the drawing:

- Right-click the original table "AKN_BaldEagle" > Delete

Double-click the "Bald Eagle" drawing to view the points.

- To view the data for each point, we'll need to turn on the Info pane, if it does not already appear beneath the Project pane: View menu > Panes > Info. Once the pane appears, you can resize it by dragging the border of the pane.
- Click any point to view the associated fields in the Info pane.
- Notice that the status bar at the bottom of the Manifold window shows the Latitude/Longitude coordinates of your cursor as you move across the map.
- Use the tools on the navigation toolbar to zoom in and out. Hover over any icon to see the name of the tool. You can also zoom by using the mouse scroll wheel.



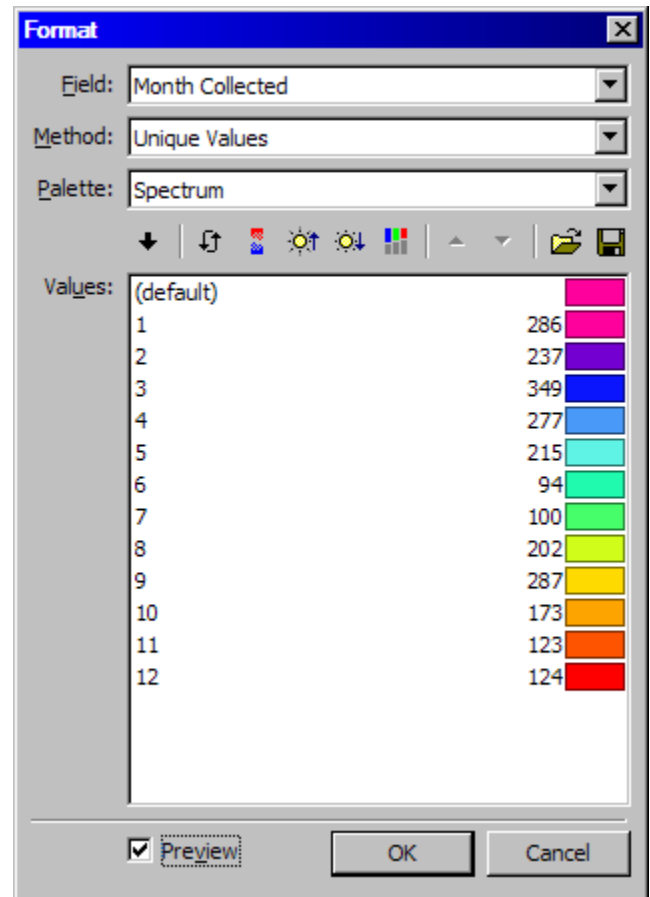
- Use the tools on the format toolbar to change the way the points are displayed. The right-most section of this toolbar controls the display of points. Again, hover over the controls to see what they control. Try changing the "Point Background" and "Point Size".



2.2 Thematic mapping

In addition to changing the point display options for the entire set of points together, we can also use the data in the underlying table to determine how each point is displayed. Click the "Point Background" color swatch, but instead of selecting a color, select "Theme..." (below the color options). Try setting the options according to the screenshot on the right.

Note that after you select a palette, you will need to click the down-arrow to apply it. There is also a "Preview" checkbox that will allow you to see the changes on the map as you change the options. You can adjust any value or color or by double-clicking on it.



2.3 County boundaries -- importing a shapefile

Although the points themselves suggest the shape of New York State, we may want to use county boundaries to provide more context to our points. To do this, we first need to import a shapefile of county boundaries into our Manifold project.

Import the counties data:

- File > Import > Drawing...
- Make sure that "Files of type" is set to "SHP Files"
- Navigate to Desktop > Manifold1 (if necessary)
- Open "county.shp"
- Click "OK" to import all available fields

Notice that the "County Drawing" layer now appears in the Project pane, and its related attribute table also appears. Double-click the drawing layer to view it. As before, you can click a county to view associated data; if it doesn't work at first, it may be because you have a tool selected -- press ESC to release the tool. If you want to unselect: Edit menu > Select None.

You can also change the way the counties are displayed, by using the left section of the format toolbar. The swatch 2nd from the left controls the background color of the polygons. Try changing it to another color.

2.4 County demographics -- joining data from a spreadsheet

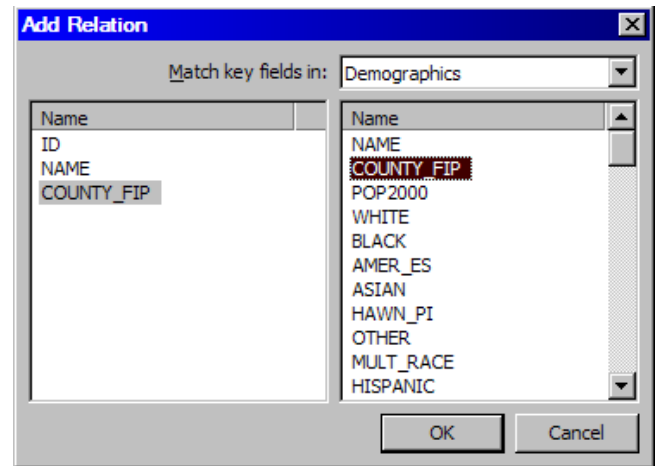
Our county shapefile didn't have very much interesting data for each county -- just the name and the county FIPS code (an identifier used by the U.S. Census). Suppose we have a Excel spreadsheet that contains these FIPS codes, as well as some additional demographic data for each county. We can load this data and join it to our county drawing. First, import the Excel file as a table:

- File menu > Import > Table...
- Make sure that "Files of type" is set to "XLS Files"
- Navigate to Desktop > Manifold1 (if necessary)
- Open "NY_county_demographics.xls"
- Click "OK" to import all available fields
- Notice that the table appears in the Project pane with the generic name "Database". Rename it to "Demographics" (in the project pane, Right-click > Rename)

In order to join this data to our county drawing, both tables need to have common identifier present in both tables. You can double-click the "Demographics" table in the Project Pane to view the data from the Excel spreadsheet. Notice that

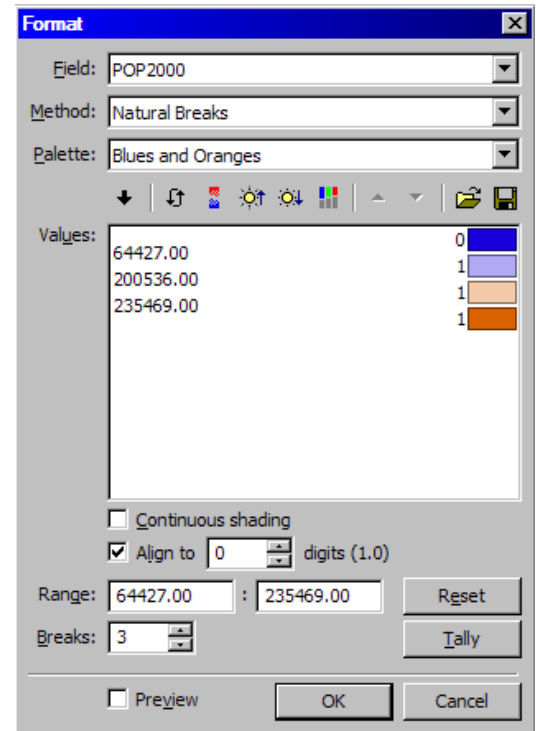
this table contains a column called "COUNTY_FIP", which contains the county FIPS code, a federally-assigned number. We will use the values in this column to join our data to the County drawing. (Lacking such an ID, we could try to use the county name, which would probably work, but we might run into problems with abbreviations and other matching issues.) To join the data:

- In the Project Pane, double-click to open the "County Table" (the one connected to the drawing -- you may need to click the "+" next to the County Drawing)
- Under the Table menu, select "Relations..."
- Click the "New Relation" icon (yellow star)
- Set the options according to the screenshot on the right.
- Click OK, and then check the box next to whatever fields you want to join. Choose several columns, including POP2000. If you want to join all columns, click the "Include All" button above the list. Click OK.
- Scroll to the right end of the "County Table" to view the joined data. Notice that the joined columns have a grey background.
- To make these joined columns a permanent part of the table, right-click the table header > Flatten All.
- Close the County Table window.



Now that our counties have some interesting demographic data, we can create a thematic map of the counties by defining a theme to color of each county based upon the value of a particular field.

- Click the "Area Background" color swatch, select "Theme..." and set the Field, Method, and Palette according to the screenshot on the right. Remember that you must click the down-arrow to apply the palette! Then click "OK".



2.5 Creating a map -- combining data layers

So far, we've only looked at a single data layer at a time. In order to combine our Bald Eagle points and our county boundaries, we need to create a map. A map can display several data layers at the time.

- In the Project pane, click the small down-arrow next to the "Create" button (yellow star), and select "Map"
- Select both layers to be included in the map, and click OK.
- Double-click the new map layer to view it.

Notice that there is a tab for each layer at the bottom of the map window. You can double-click layers to toggle them on/off, and you can drag the tabs to reorder the layers (top is to the left). Make sure that the Bald Eagle points appear on top of the counties.

You may need to adjust the colors and display options of your data layers, so that the Bald Eagle points are clearly visible on top of the counties. Whenever changing the formatting of a layer, be sure to first select the layer by clicking on its tab in the map, otherwise you are likely to format the wrong layer.

2.6 Elevation -- importing a surface

Suppose that we think that bald eagle habitat is related to altitude, so we want to know the elevation of the land at which the bald eagles were observed. This data wasn't included in our bird observation file, but we can use an elevation dataset to calculate the heights of each observation point. First, we need to load the layer of elevation data, in this case from a subset of GTOPO30 data that has been save as a .bil file.

- File > Import > Surface...
- Make sure that "Files of type" is set to "BIL Files"
- Navigate to Desktop > Manifold1 (if necessary)
- Open "elevation.bil"
- Click "OK"

Notice that the Elevation layer appears in the Project pane, along with an associated terrain (which we'll ignore for now). Double-click the "Elevation" layer to view it. Notice that, as you move the mouse across the image, the height value (in meters) appears in the status bar at the bottom of the screen. (For example, "Z: 213.00")

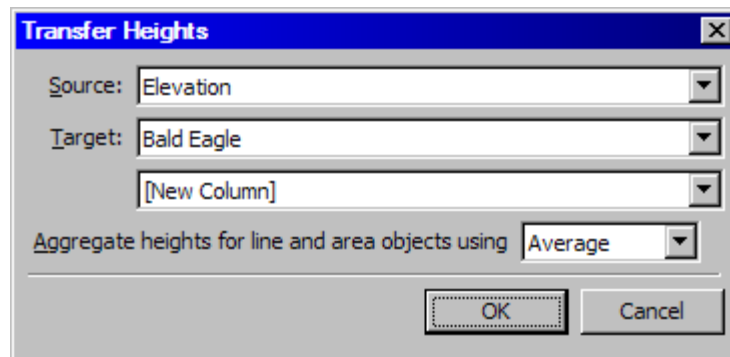
We can change the way this layer appears by going to the "View" menu > Display options.

- Set Display = "Height"
- Set Palette = "Altitude in Meters"
- Click the down-arrow to apply the palette.
- Make sure the "Shading" checkbox is checked.
- Click "OK".

2.7 Calculating elevation for each observation point

Next we want to calculate the elevation of the land at each point where a bald eagle was observed.

- Close the elevation layer and open the Map.
- Drag the Elevation layer from the Project Pane onto the Map window.
- In the map, turn off the County layer, and make sure that the Bald Eagle points are on top of the elevation layer.
- Click the "Elevation" tab at the bottom of the map to select that layer.
- Surface menu > Transfer Heights, and set the following:



Click OK, and in this case it happens so fast that it may look like nothing has happened. But click on a point and see the Info pane (or open the Bald Eagle table) to see that elevation values ("Height") have been added to each observation.

We could also use this same technique to summarize the elevation data for the counties. In that case, we would want to set the "Aggregate heights for line and area objects using..." option to average, maximum, minimum, or sum, depending on what we want.

2.8 Speeding up the map display

You might have noticed that the display rate has slowed since adding the Elevation layer to the map. This is because the elevation data is in a different projection, using a different coordinate system. This means that Manifold has to transform the coordinates of each cell in the Elevation layer each time it redraws the map. We can speed things up a bit by setting the projection of our map to that of the Elevation layer. (Points, lines, and polygons are usually easier to reproject than raster data.)

- At the bottom of the map, right-click the "Elevation" tab > Use Projection

2.9 Linking to remote imagery

Manifold can dynamically link to imagery from remote Web servers, including Microsoft Virtual Earth, Yahoo Maps, and various OGC WMS servers. In order to access Virtual Earth or Yahoo imagery, the connectors to these image servers must first be installed on your computer. (These connectors are already installed on the Mann Library computers. -- See <https://confluence.cornell.edu/x/vM8uBg> for configuring your own computer.) One advantage of using remote imagery is that you do not have to store massive image files within your project. But you will need a good network connection in order to load the imagery.

In this example we will link to satellite imagery from Virtual Earth:

- In your map, zoom to the extent for which you would like to load the imagery.
- File > Link > Image...
- Set "Files of type" to "Manifold Image Servers"
- In the dialog box that appears, set "Server" to "Virtual Earth Satellite Image"
- Click "refresh" button (two arrows circling)
- After the connection to the server is made, click "OK"
- From the Project pane, drag the new image layer onto your map. Manifold will not re-project remote imagery, so if you get a message about the projection being incompatible with the map, don't worry, and:
 - Click "yes"
 - Right-click the map tab for the new image layer > "Use projection"

Try zooming into the satellite imagery. New image tiles will be loaded as you zoom or pan.

3. Learning more

There is no published user manual for Manifold. The best documentation, including detailed examples of all the tools and functions, can be found in the program's "Help" menu. This documentation is also available on the Manifold website:

<http://www.manifold.net/doc/manifold.htm>

In the real world, finding data is half the challenge. If you need to find geospatial data, here is a good starting point:

<http://mannlib.cornell.edu/research-help/gis/gis-data>

This tutorial was created for the "Manifold GIS" workshop at Mann Library, Cornell University, and was last updated on 2010-09-13 by Keith Jenkins <kgj2@cornell.edu>.