A Geographic Information System (GIS) can be used to display and analyze things like...

- Political data: city boundaries, countries and provinces, voting districts, population distribution
- Environmental data: tree locations and species, wildlife ranges, flooded areas, precipitation levels
- Sociological data: locations of burglaries, bicycle thefts, potholes, fire hydrants

And much more. A GIS is often used to facilitate informed decision making.

A typical cartographic workflow:

1. Planning Phase
   - **Consider your objective:** Why do you need to create the map? What message do you want to convey? How will the map be used?
   - **Consider your audience:** Who will use the map? How familiar are users with the subject matter?

2. Data Collection
   - What data supports your map objective?
   - What data do you need to help orient the map user, or provide more context on the surrounding area?
   - What will you use as a basemap?

3. Symbology
   - How can you use colour to draw attention to the key information on your map?
   - How can you clearly communicate with users? Consider the font, size, and colour of any text.
   - Which features are most important to label?

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Finding GIS data

Geospatial data is available from

- Governments—city, provincial, national
  - E.g. census data; many major cities and developed countries have Open Data portals
- Universities—if the data you’re looking for is not freely available online via a government website (which is often the case for developing nations), contacting a local university with a Geography department is a good next step
- Commercial vendors—e.g. The UM Libraries subscribe to a data package from DMTI, which provides access to Canada-wide data. Learn more on the DMTI tab of our GIS guide: libguides.lib.umanitoba.ca/gis

GIS Software

In this workshop, we will look at the following GIS software options:

<table>
<thead>
<tr>
<th>GIS Software</th>
<th>Advantages &amp; Uses</th>
<th>Drawbacks</th>
</tr>
</thead>
<tbody>
<tr>
<td>ArcGIS Maps for Office Excel Plug-in</td>
<td>- Very simple layout, easy to learn to use</td>
<td>- Can only display data using coordinates, addresses, or standard geographies (city, province, census geographies, etc)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Only compatible with Windows OS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Can add up to 50,000 points per layer, but the program functions better with less data</td>
</tr>
<tr>
<td>ArcGIS Online</td>
<td>- No software download required, all mapping done via web browser</td>
<td>- Not as many tools and options as the full ArcGIS Desktop software</td>
</tr>
<tr>
<td></td>
<td>- Complex geospatial computations can take hours on a standard computer; using ESRI’s server farm runs much more quickly</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- All UM students, faculty, and staff can qualify for an account via our institutional subscription</td>
<td></td>
</tr>
<tr>
<td>ArcGIS Desktop</td>
<td>- Currently one of the best GIS software options</td>
<td>- Complex software, steeper learning curve</td>
</tr>
<tr>
<td></td>
<td>- Available in Dafoe Library Brown Lab</td>
<td>- Requires a license ($500 for an individual computer)</td>
</tr>
</tbody>
</table>
Exercise 1: Mapping Manitoba Schools by Language

1. Open MB_Schools_2017.xlsx

2. Note the ArcGIS Maps tab at the top of the window:

   3. Click on that tab, and Sign In using your ArcGIS Online account Once signed in, you will have access to the mapping functions.

   4. Click the Add Map icon to get started.

   5. Choose the data you want to map:

      a. Click on “Cell range”. Click “Select range” button.

         • One quick method to select all cells with data is:

            • click the first cell (A1) - make sure to include the first row with headers

            • scroll to the last cell in the bottom right corner (K1008 on this spreadsheet),

            • SHIFT+click the last cell. Click OK, and OK again.

   3. Verify the mapping options.

      • Ensure that the map is recognizing the Location Type in your data (Coordinates in this spreadsheet). Expand the Location Format link to make sure that the Longitude and Latitude fields are matched with Longitude (X) and Latitude (Y). Click OK.

      • Style by Column—if you want to highlight the locations based on the data in a particular column, you can choose that here. For now we can select < None >, to simply map the locations of the schools.

      • Choose a way to visualize your data:

         • For this example, choose Location (Single symbol). This can be changed later on.

   4. Click “Add data”. Confirm options in the following pop up box.
Cluster Points

When you have many points in one area, they can be easily grouped together using the Cluster Points feature.

Click the Cluster Points icon to turn that feature on or off.

The cluster radius can also be edited to specify how close points need to be in order to be clustered together. The lower the cluster radius, the higher number of clusters you will have.

Layer Styles

Click the Layer Style button in the ribbon at the top of the map for different style options.

1. Select the layer you want to style from the drop-down box. Right now our map only has one layer, the cell range, which will be selected.

2. Click “More Styles” to see all options:

- **Heat Map** shows point density
- **Choose an attribute to show**: this allows you to style the points according to the values in a column of your choice. One of the options in this spreadsheet is the LANGUAGE field, which notes the predominant language used in that school. This is represented using a code (see table to the right).
  - Choosing an attribute will automatically switch the drawing style to Types (Unique Symbols)
- **Labels** can be edited to display full words in the Layer Style area as well

Clicking the Contents button in the top ribbon will allow you to click to make only schools

<table>
<thead>
<tr>
<th>LANGUAGE</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>English</td>
</tr>
<tr>
<td>F</td>
<td>French</td>
</tr>
<tr>
<td>H</td>
<td>Hebrew</td>
</tr>
<tr>
<td>G</td>
<td>German</td>
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<tr>
<td>U</td>
<td>Ukrainian</td>
</tr>
<tr>
<td>C</td>
<td>Cree</td>
</tr>
<tr>
<td>F/E</td>
<td>French &amp; English</td>
</tr>
<tr>
<td>E/F</td>
<td>English &amp; French</td>
</tr>
<tr>
<td>E/H</td>
<td>English &amp; Hebrew</td>
</tr>
<tr>
<td>E/G</td>
<td>English &amp; German</td>
</tr>
<tr>
<td>E/U</td>
<td>English &amp; Ukrainian</td>
</tr>
<tr>
<td>-1</td>
<td>Unknown</td>
</tr>
</tbody>
</table>
Adding Data from ArcGIS Online

ArcGIS Online allows users to upload and share data, either with their organization or publicly. Before you share any data, make sure that you have the right to do so—certain data agreements may prohibit public data sharing.

In the top menu of your map, click the From ArcGIS icon. As an example, search for “Canada census Mother Tongue”.

Click Details to see more information about this data—the provider (an unknown person, or a company like ESRI), and the source of the data (e.g. Statistics Canada) are important to consider.

For this exercise, add the first few results to the map: “Mother tongue ratios in the National Capital Region...” and “2011Census: Mother Tongue by Dissemination Area”. These show census data on respondents’ first language for Ottawa and Kitchener.

In the Contents pane, try:

- Selecting a layer to explore, and using the “Zoom to Layer” icon in the green bar at the bottom to view it in the map
- For the Ottawa layers (Francophones and Anglophones), try checking and un-checking layers to view them one at a time

Mapping with ArcGIS Online

ArcGIS Online is a great option for browser-based mapping. On this platform, you can keep content private, share it with a group, with all UofM users, or with the public.

- Log in at arcgis.com (use default login from page 1 if necessary)
Adding Data to ArcMap

To add data to ArcMap, first you need to connect the folder containing the data using ArcCatalog.

1. Click the Connect to Folder icon
2. Choose the folder you need to connect

That folder will then show up under Folder Connections in the Catalog.

You can add data to your map in two ways:

- From the folder in the Catalog, click and drag the correct file to the Table of Contents
- Click the Add Data button in the Standard toolbar. Note that the Connect to Folder icon is also available in the next box that pops up.
Mapping Speakers of Indigenous Languages across Manitoban Reserves

We have:

- An outline layer of all census subdivisions in Manitoba (ManitobCSDs Shapefile, inside Manitoba.gdb)
- A table data on speakers of indigenous languages in Manitoban reserves (AborLang.xlsx)

Note: The census subdivisions file was taken from a file that showed all census subdivisions across Canada; therefore, the coordinate system is not ideal for Manitoba (the map is slightly skewed). To fix this:

1. Right-click anywhere in the Data Frame > Data Frame Properties
2. In the Coordinate System tab, select:
   
   Projected Coordinate Systems > National Grids > Canada > NAD 1983 CSRS UTM Zone 14N

To display the data in the AborLang table, we can join it to the census subdivisions layer. Each table has the CSD number (CSDUID field in ManitobaCSDs, and CSD field in AborLang), so they can be joined using this shared field.

To join a table:

1. Right-click ManitobaCSDs in the Table of Contents > Joins and Relates > Join...
2. In this layer, the join will be based on the CSDUID field
3. Select AborLang$ as the table to join; in that layer, the join will be based on the CSD field

Open the ManitobaCSDs Attribute Table (right-click in Table of Contents); you should see the new data that has been added at the end of the table.

To display the data in one of the fields by colour:

1. Double-click ManitobaCSDs in the Table of Contents; this brings up the Layer Properties box
2. In the Symbology tab, set Show: to Categories
3. Under Value Field, you can select the field of interest; e.g. Cree_languages, Ojibway, Dene
4. After selecting a field to symbolize, click the Add All Values button
5. Choose a Color Ramp that shows a strong difference between the smallest and largest numbers in the range
6. Click Apply.

Navigating the ArcMap Interface

A few useful options on the Tools toolbar:

A: Magnifying glasses— click to zoom in or out, or draw a box around an area to zoom in
B: Pan tool (hand) - use this to move the map around within the data frame
C: Full Extent (globe)- view the full extent of all features on the map
D: Fixed Zoom — zoom in or out on the center of the map
Highlighting Regions with Dene Speakers

In the Dene field of the ManitobaCSDs Attribute Table, we can double-click the heading (“Dene”) to sort features based on this attribute. This shows us that there are three reserves with Dene speakers.

- We can highlight these rows by clicking the grey box at the start of each row; CTRL+click to highlight multiple rows
- Once these rows are selected, we can right-click one of the grey boxes at the beginning of the row, and click Zoom to Selected

We may want to create a shape on our map to indicate the approximate extent of the range of Dene speakers. To do this, we can create a new layer for the map.

**To create a new layer (aka “Feature Class”):**

1. Find Manitoba.gdb in the Catalog; Right-click > New > Feature Class
2. Give the new layer a name, e.g. LanguageRegion. Note that names cannot contain spaces.
   - The Alias of the name can contain spaces; this is what will show up in the Table of Contents.
3. The coordinate system should be automatically set to the current system used by the Data Frame (i.e. NAD 1983 CSRS UTM Zone 14N)
4. XY Tolerance—accept default; Database Storage Configurations—accept default
5. Under Field Names, include a “Name” field, with Data Type = Text

After clicking Finish, you will see that the new layer “Language Region” has been added to the Table of Contents. Now, we can create features within this layer.

**To create new features within a layer:**

1. Right-click the Language Region layer in the Table of Contents > Edit Features > Start Editing. The Editor toolbar will pop up.
2. On the Editor toolbar, click the Create Features tool:

   The Create Features window will open next to the Catalog.

3. In the Create Features window, select Language Region. Under Construction Tools at the bottom of the window, select Polygon.
4. Click on the map to plot points for the corners of your polygon shape. Double-click the last point to finish drawing the feature.
5. To name the feature, right-click Language Region > Attribute Table. You can change the <Null> value in the Name field.
6. In the Editor toolbar, click Editor > Save Edits, and then Editor > Stop Editing.

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