Client-Side Web GIS

Layer Symbology and Pop-Ups

Image from NASA: https://commons.wikimedia.org/wiki/File:Earth_Western_Hemisphere_transparent_background.png#filelinks

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In this module we will discuss layer symbology and pop-ups in the context of web maps.

Module Topics

1. Data symbology options in ArcGIS Pro and ArcGIS Online
2. Pop-up configuration

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These are the topics covered in this module.

Layer Symbology

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We will begin with layer symbology.

Layer Symbology in ArcGIS

- Same symbol for all features
- Different symbol for each category or unique value
- Graduated colors
- Unclassified colors
- Graduated symbols
- Proportional symbols
- Dot Density

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There are many different ways to symbolize data.

You can display each feature with the same symbol, for example display all polygons as black outlines with a gray fill. In this case, you are not showing a theme or attribute, just the spatial extent.

For categorical data, you can use different colors to represent different categories. You can also assign a different color to each unique feature.

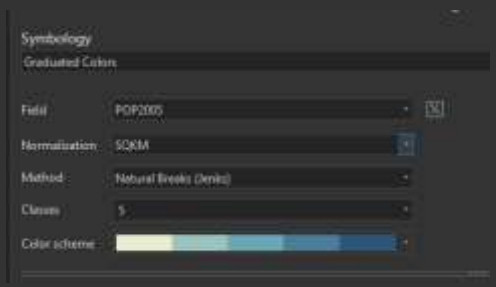
Graduated colors and unclassified colors are used to produce choropleth maps to symbolize numeric or ordinal data.

Graduated and proportional symbols are used to produce graduated and proportional symbol maps that use size to represent a quantity.

Dot density is used to generate dot density maps.

Normalization

- Divide value by another value to normalize the measurements
- For example: population vs. population per square kilometers
- Provides for a fairer comparison
- Should normalize when producing choropleth maps



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When symbolizing a quantity, it is also possible to apply normalization. To apply normalization, an attribute is divided by another attribute.

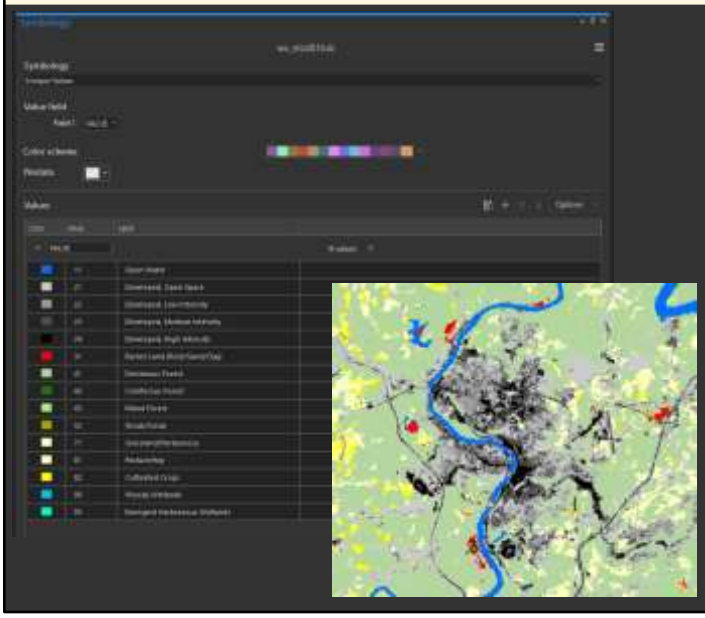
For example, population can be normalized by area to obtain population density. The number of disease occurrences can be normalized by population to obtain the rate of the disease in the population.

It is possible to normalize by area or by number of individuals.

All proportions or percentages are already normalized.

When generating choropleth maps, normalized data should be used. This is not required when generating proportional or graduated symbol maps.

Symbolizing Categories



- Land cover type, private vs. public, urban vs. rural, soil types, etc.
- Use colors that make sense for the category (if appropriate)
- Colors should not be ordered

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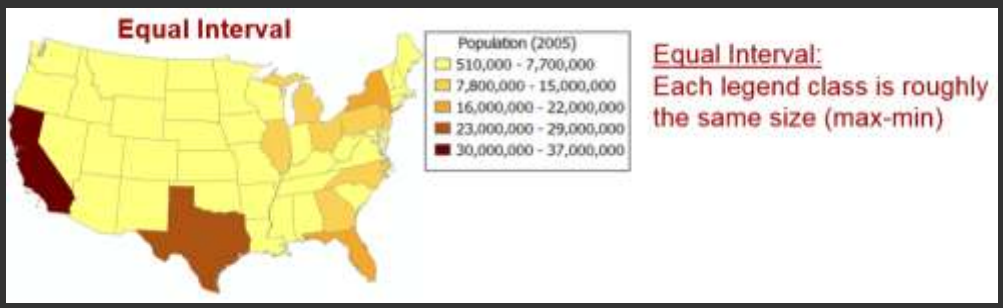
When you display nominal data using colors, it is best to use non-order colors, since you don't want to imply that the data are ordinal or numeric.

Some features are commonly associated with a color. For example, in a land cover dataset water is generally associated with blue and forest is associated with green. In these cases, it is best to use colors that are associated with these features.

Some features will not have colors that are associated with them. For example, we don't generally associate colors with soil types. In this case, you would choose colors based on visual appeal and the ability to tell the categories apart.

Equal Interval

- Breaks data range into equal intervals
- Does not take into account natural breaks in the data



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When using colors to map a quantity, the data are often binned so that a range of values is represented by a single color.

In ArcGIS, this is known as graduated colors. This binning or classification is also performed for graduated symbol maps.

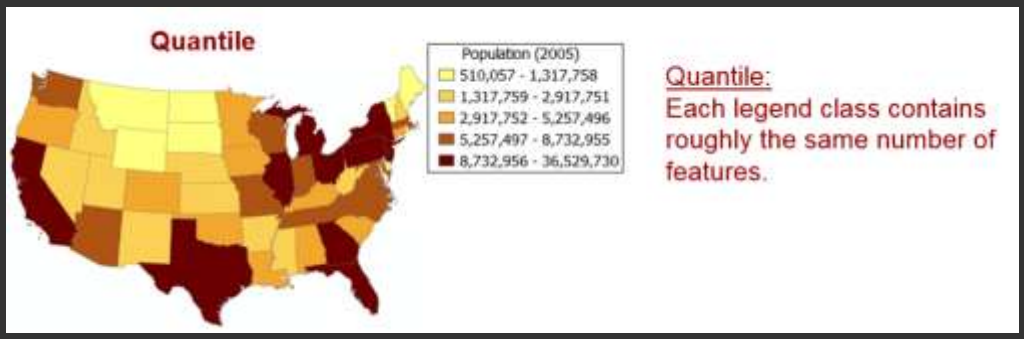
A method must be used to determine breaks between the bins.

One method used is equal interval. In this case, the same range of values occur in each bin.

For example, if you had a range of values from 0% to 100% and five bins, then the data would be divided into 0-20%, 20-40%, 40-60%, 60-80%, and 80-100%.

Quantiles

- Same number of features in each bin
- Does not take into account natural breaks in the data



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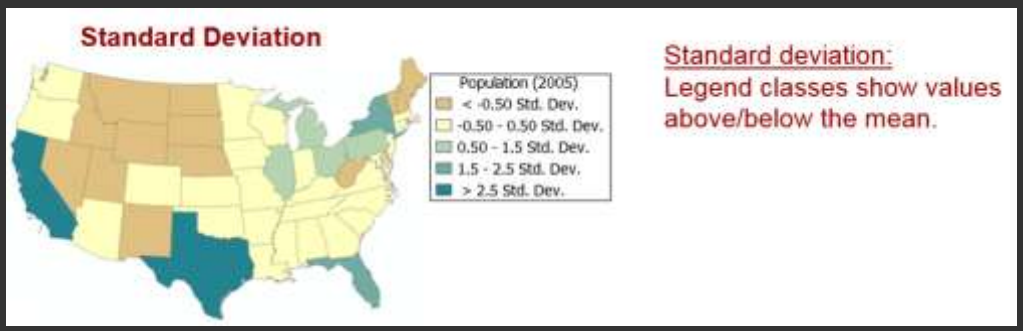
The quantiles classification method is commonly confused with equal interval. Using this method, an equal number of map features is placed in each bin as opposed to an equal range of values.

For example, if all 50 states were being symbolized using 5 classification bins, then 10 states would be placed in each bin.

This is generally the preferred classification method for ordinal data.

Mean-Standard Deviation

- Bins defined based on standard deviation of data subtracted or added to mean



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The mean-standard deviation method makes use of the central tendency and variability of the data.

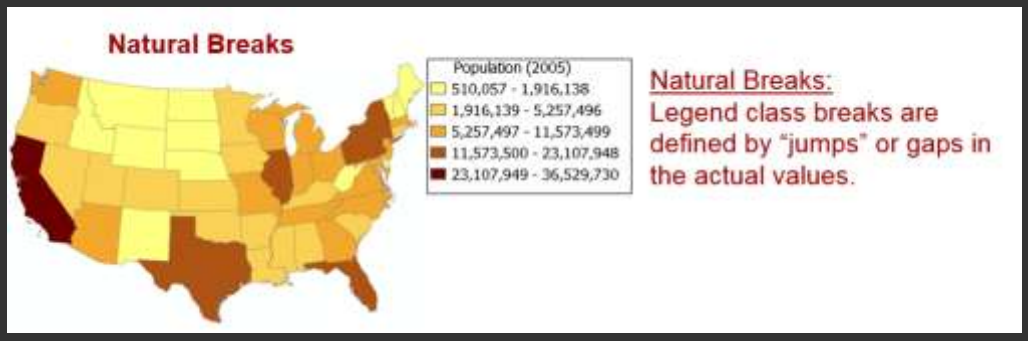
The data are symbolized based on their standard deviation from the mean. Values that are much lower than the mean will show a negative standard deviation, values close to the mean will have a standard deviation near zero, and values much higher than the mean will have a positive standard deviation.

This method can be useful if you want to compare how a feature deviates from the average or mean conditions.

This method generally should not be used if the data have a distribution that is far from normal, such as multimodal or skewed data.

Jenks-Caspell/Fisher-Jenks

- Algorithms that attempts to find "natural breaks" in the data
- ArcGIS uses an implementation of Fisher-Jenks



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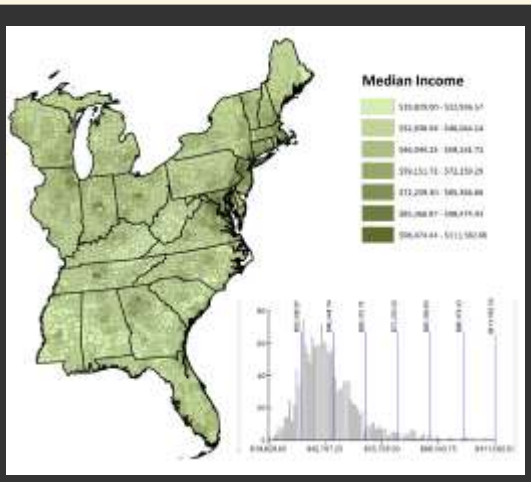
The natural breaks method makes use of an algorithm to find "natural breaks" in the data.

Class breaks are then positioned relative to these natural data breaks.

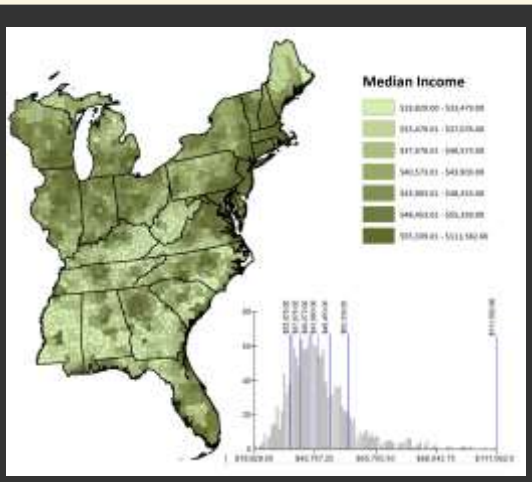
This is a data-driven classification scheme.

It can be misleading if there are no breaks, jumps, or gaps in the data distribution. In that case, it would be finding breaks that don't really exist or are just noise.

Classification Methods Compared



Equal Interval



Quantile

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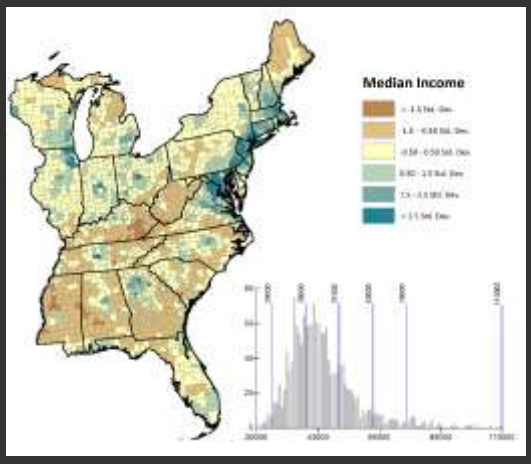
Here are some comparisons.

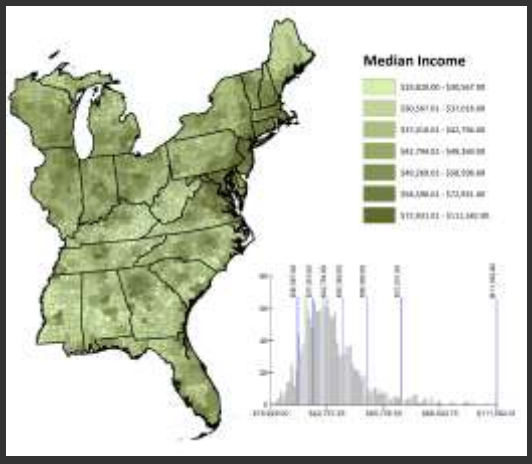
For equal interval, the class breaks, represented by the blue lines in the distribution, are equally spaced, or there is an equal range of values in each classification bin.

In contrast, the breaks are not evenly spaced for the quantile classification. Instead, a roughly equal number of features will be placed in each bin.

Classification Methods Compared



Mean-Standard Deviation



Natural Break

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In the mean-standard deviation classification, we can represent deviation from the mean median income by county.

Orange counties are lower than the mean while blue counties are higher than the mean.

The last example represents natural breaks in which an algorithm selects the breaks based on jumps or gaps in the data distribution.

There is not necessary a best classification method, as this is case specific and there are pros and cons for each.

When deciding on a classification method, you should think about the nature of the data and how best to represent it.

Manual Classification

- Define your own breaks

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It is also possible to define your own breaks or classification bins.

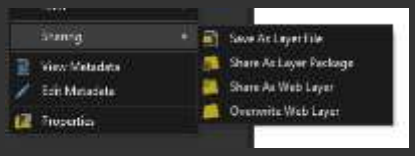
When you do this, it is important to not manipulate the data to tell the story you want to tell.

There is a whole book on this topic titled “How to Lie with Maps.”

If you decide to use manual breaks it is generally best if the breaks have some meaning.

For example, if a program that awards grant money for economic development to counties makes its decision based on certain percent poverty thresholds, it would make sense to symbolize using these thresholds to see which counties are candidates for a certain dollar amount from the program.

Layer Files (ArcGIS)



- Can be used to save layer symbology for later use

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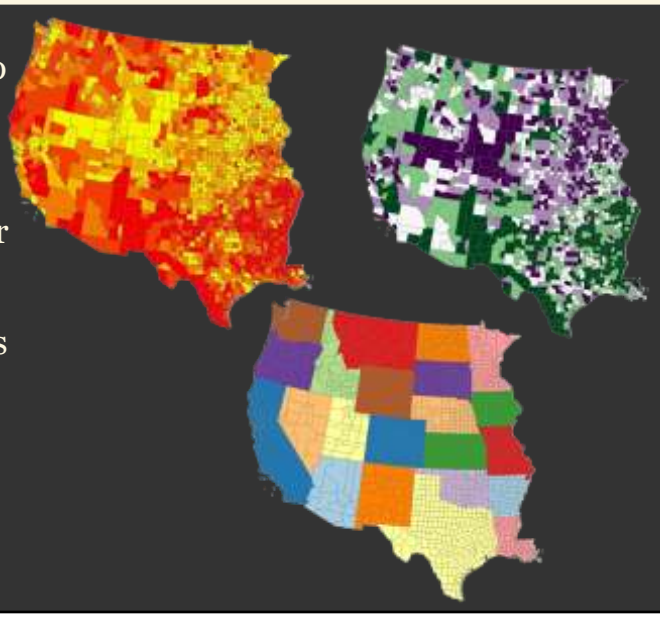
Layer files can be generated in ArcGIS Pro to store the symbology used to display a layer. This will include the legend labels and the display method.

If you plan to reuse symbologies, I recommend saving them to layer files.

Color Ramp

- You can change the colors used to symbolize your data
- You can also change the number of categories
- Nominal Color Scheme = used for categorical data (not ordered)
- Sequential Color Scheme = used for continuous data that increases in one direction
- Diverging Color Scheme = used for continuous data that diverges
- Think about how we perceive colors



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Different types of color ramps are available to symbolize data.

Nominal color schemes are used to display nominal data or unordered categories. Since you don't want to imply an order, you should never use ordered colors. In the example above, unordered colors are assigned to represent each different state.

Sequential color schemes are used when data values increase in one direction. For example, you could use such schemes to symbolize elevation, temperature, or median income.

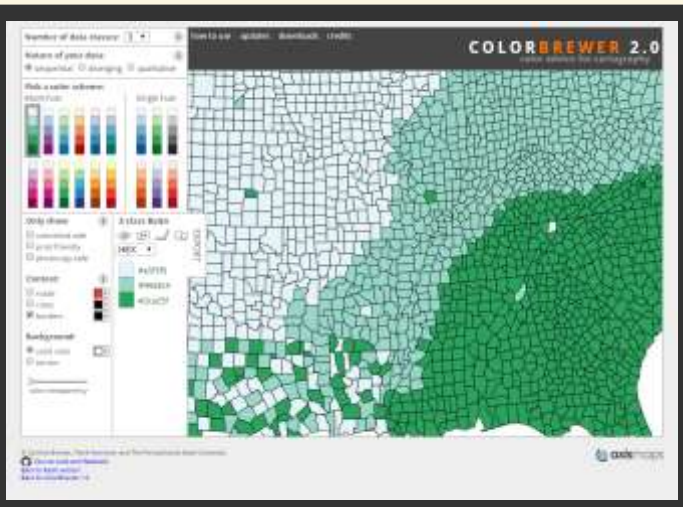
Divergent color schemes are used to symbolize patterns that diverge. You could use this method to display population change where one set of ordered colors represents loss, another represents gain, and a neutral color represents no change. Diverging ramps are also commonly applied to data classified with the Mean-Standard Deviation method since it shows divergence or difference relative to the mean.

Other than just choosing from one of these color schemes, you can also choose what colors and number of classification bins to use.

It is also important to think about how we perceive color. For example, in

western cultures, red generally indicated danger or alert while blue indicated calm or safe. Green could indicate money or currency or ecological health. These perceptions are important to consider, as they can have a large intended or unintended impact on how your maps communicate data.

ColorBrewer 2.0



http://colorbrewer2.org/#type=sequential&scheme=BuGn&n=3

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The ColorBrewer2 website is made available by Cynthia Brewer, Professor of Geography at Penn State.

This website can be used to help you decide on appropriate colors to use in a map layout.

It provides options for sequential, diverging, and qualitative color schemes.

You can also explore colors that are color vision impairment, print, and photocopy safe. You can also change the number of bins.

Once you have found a color ramp you like, these colors can be applied to a map in your GIS or graphics editing software using the provided HEX, CYMK, or RGB codes.

This is a great site, and I highly recommend that you check it out.

Some considerations

- Layers published from ArcGIS Pro can maintain the original symbology
- Can also maintain pop-ups
- Not all symbols may work in ArcGIS Online
- I find it easiest to edit symbology and pop-ups in ArcGIS Pro as opposed to ArcGIS Online
- However, it is pretty simple to edit layer symbology in ArcGIS Online

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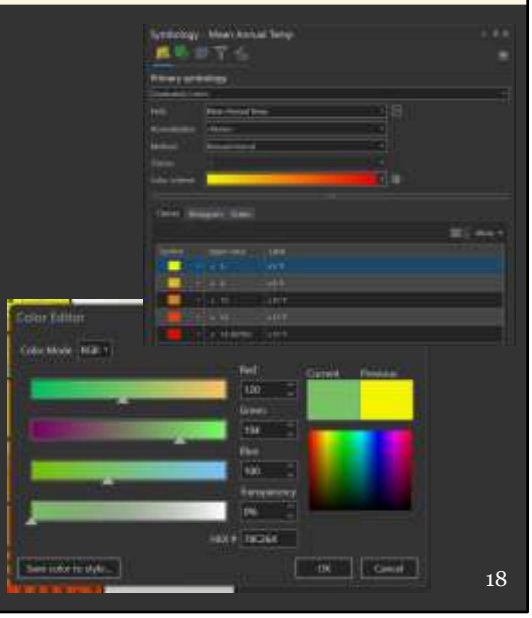
I generally prefer to prepare layer symbology and pop-ups using ArcGIS Pro as opposed to ArcGIS Online. However, this is just personal preference. Generally, when layers are published from ArcGIS Pro to ArcGIS Online, configured symbology and pop-ups will be maintained. However, this is not always the case, especially for very unique or customized symbols. If there are issues with your symbology or pop-ups after publishing, you can always edit them in ArcGIS Online.

Symbology in ArcGIS Pro (Vector)

- Right-click layer in Contents pane → Symbology
- Symbology options will depend on layer type
- Methods = Single Symbol, Unique Values, Graduated Colors, Bivariate Colors, Unclassified Colors, Graduated Symbol, Proportional Symbol
- Selecting Colors
  - Gallery
  - Properties



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This slide discusses symbology options within ArcGIS Pro for vector data specifically. Symbology options can be accessed by right-clicking on the layer in the Contents Pane then selecting symbology. This will open the Symbology Pane.

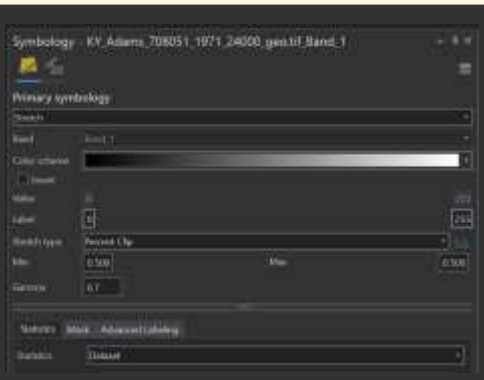
A variety of methods are available to symbolize vector data. A single symbol can be used when no attribute information is displayed. When categories are differentiated, you can use Unique symbols. To show or map a continuous variable, you can use graduated colors, unclassified colors, graduate symbols, or proportional symbols. To display two continuous variables using two color ramps, you can use bivariate colors.

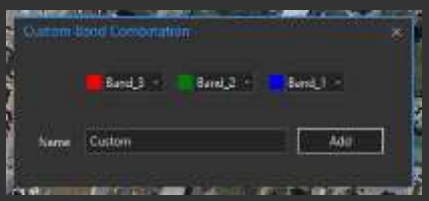
Our Digital Cartography and GIScience courses provide additional information and content relating to symbolizing data.

You can choose from pre-defined colors and symbols using the Gallery in ArcGIS Pro. To select your own symbols and associated graphical parameters, you can use the Properties options in ArcGIS Pro.

Symbology in ArcGIS Pro (Raster)

- Right-click layer in Contents pane → Symbology
- Symbology options will depend on layer type
- Methods = RGB, Stretch, Discrete, Classify, Unique Values, Vector Fields
- Selecting Colors
  - Gallery
  - Properties





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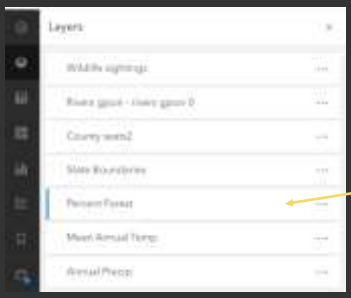
Symbolizing raster data in ArcGIS Pro is similar to symbolizing vector data; however, different symbology options are available. Symbology options can be accessed by right-clicking on the layer in the Contents Pane then selecting Symbology.

RGB symbology can be used to display a multi-band raster grid as an RGB composite where bands or layers are assigned to the RGB channels. This is commonly used for imagery to generate simulated true color or false color composites.

For single-band raster grids, data can be symbolized using stretch, discrete, classify, unique values, or vector fields methods. For continuous data, stretch and classify are commonly used. For categorial raster data, such as land cover, unique values are commonly used.

Layer Symbology in ArcGIS Online (Vector)

- Make sure layer of interest is selected under Layers
- Click on Style button
- Style options will depend on layer geometry and attribute(s)
- Based on Smart Mapping for data visualization and exploration



Make sure layer of interest is selected

https://www.esri.com/en-us/arcgis/products/mapping/smart-mapping

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Layer symbology options for vector data are a bit different in ArcGIS Online in comparison to ArcGIS Pro. Style options are available under the style icon on the right-side of the Map Viewer. The styles that are available for use will depend on the number and type of attributes being displayed. We will talk about different options in the following slides.

ArcGIS Online makes use of Smart Mapping for layer symbology. The link on this slide provides additional information about smart mapping as implemented in ArcGIS Online. This is a data driven approach to selecting layer symbology.

Layer Symbology in ArcGIS Online (Points)

- Counts and Amounts (size) = width of line based on continuous attribute
- Counts and Amounts (color) = color of line based on continuous attribute
- Color and Size = width of line and color based on continuous attributed
- Types (unique symbol) = unordered colors for categorical/nominal data
- Location (single symbol) = single symbol/no attribute visualized
- Heat Map = density of points (kernel density)

*Other methods available
*Available symbology will depend on the number of and types of attributes being visualized

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This slide describes some options for symbolizing point vector data in ArcGIS Online using the Smart Mapping methods. Again, the methods available will depend on the types and number of attributes being displayed.

Layer Symbology in ArcGIS Online (Lines)

- Counts and Amounts (size) = width of line based on continuous attribute
- Counts and Amounts (color) = color of line based on continuous attribute
- Color and Size = width of line and color based on continuous attributed
- Types (unique symbol) = unordered colors for categorical/nominal data
- Location (single symbol) = single symbol/no attribute visualized

*Other methods available
*Available symbology will depend on the number of and types of attributes being visualized

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This slide provides examples for line vector data.

Layer Symbology in ArcGIS Online (Polygons)

- Counts and Amounts (size) = graduated or proportional symbol
  - If Classify data is selected = graduated symbol
  - If Classify data is not selected = proportional symbol
- Counts and Amounts (color) = choropleth
  - If Classify data is selected = Classified colors
  - If Classify data is not selected = Unclassified colors
- Color and Size = combine graduated/proportional symbol and choropleth
  - Can assign different attributes to size and color
- Dot Density = Dot density
- Types (unique symbol) = for categorical/nominal data with no implied order
- Location (single symbol) = single symbol/no attribute visualized
- Relationship = bivariate choropleth
- Types and Size = color shows category and size show a continuous variable

*Other methods available
*Available symbology will depend on the number of and types of attributes being visualized

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This slide provides example symbology options for polygon vector data. Again, the symbologies available will depend on the types of attributes being displayed and the number of attributes.

Layer Symbology ArcGIS Online (Raster)

- More limited symbology options in ArcGIS Online in comparison to vector data
- Cannot change symbology of a Raster Tile Layer (pre-rendered tiles)
- Suggest preparing symbology in ArcGIS Pro then sharing a Raster Tile Layer.

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There are generally more limited symbology options in ArcGIS Online for raster data. When data are rendered into cached tiles as a Raster Tile Layer, it is not possible to update the symbology. Thus, it is best to apply the desired symbology in ArcGIS Pro prior to rendering the raster data to a Raster Tile Layer. Changing the symbology will require re-publishing the tile cache.

Layer Symbology ArcGIS Online (Vector Tile Layer)

- https://doc.arcgis.com/en/arcgis-online/reference/update-vector-tile-style.htm

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This link provides instructions on how to update styles for vector tile layers. We will not cover this topic in this course.

Layer Pop-Ups

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We will now discuss building and configuring layer pop-ups.

Recommendations

- Disable pop-ups when unnecessary (such as for reference layers)
- You can edit pop-ups in both ArcGIS Online and ArcGIS Pro (I prefer ArcGIS Pro)
- Pop-up edits made in ArcGIS Pro should carry over to ArcGIS Online when the layer is published
- Only show fields, graphics/images, and/or charts that are meaningful
- Try to avoid using poorly formatted field names (use alias/display names or provide a better name)
- Take some time to format text and numbers
- If you want to include different links for each feature, include the links in an attribute table column
- If you want to include different graphics/images for each feature, include links in an attribute column
- If the same link for graphic will be used for all pop-ups, you do not need to include this link in the attribute table
- ArcGIS Arcade and HTML code can be used to further customize pop-ups

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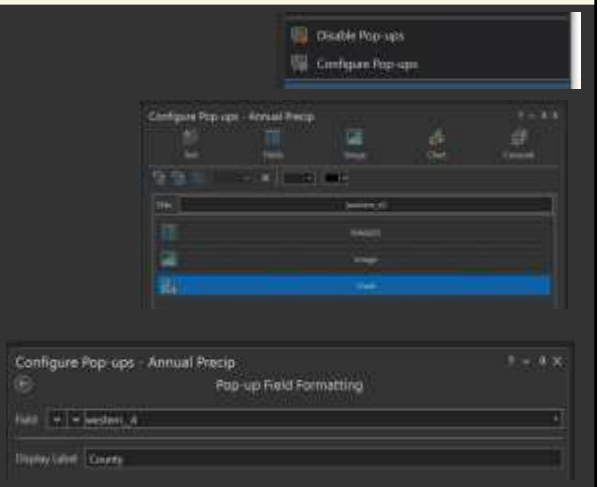
I often observe that web maps have poorly formatted pop-ups, which can make the resulting web map and app appear very unprofessional. Thus, you should carefully edit pop-ups associated with your layers. If a pop-up is not needed for a layer, it should be disabled.

This slide provides some general recommendations for generating pop-ups. Please take some time to read through the recommendations.

Pop-Ups in ArcGIS Pro

- Right-Click Layer in Contents Pane → Disable/Enable Pop-ups
- Right-Click Layer in Content Pane → Configure Pop-Ups
- When referencing fields, field names are provided in {}
- Can add:
  - Title
  - Text
  - Fields
  - Image
  - Chart
  - Carousel
- Can edit text font, font size, and color
- Can change field names using field options: Display label



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Similar to symbology, pop-ups can be edited in ArcGIS Pro prior to publishing the associated layer to ArcGIS Online. I generally prefer to edit pop-ups in ArcGIS Pro as opposed to ArcGIS Online. You can disable or enable pop-ups by right-clicking on the layer in the ArcGIS Pro Content Pane and selecting Disable or Enable Pop-ups. When pop-ups for a layer are enabled, you can select Configure Pop-ups to edit them.

When you are editing pop-up information, field names will appear in curly brackets ({}), such as when specifying a title or adding text. This allows for the pop-up to vary between features by referencing data stored in the attribute table.

A variety of content can be added including a title, text, fields as a table, images, charts, and carousels. Carousels allow users to swipe between content.

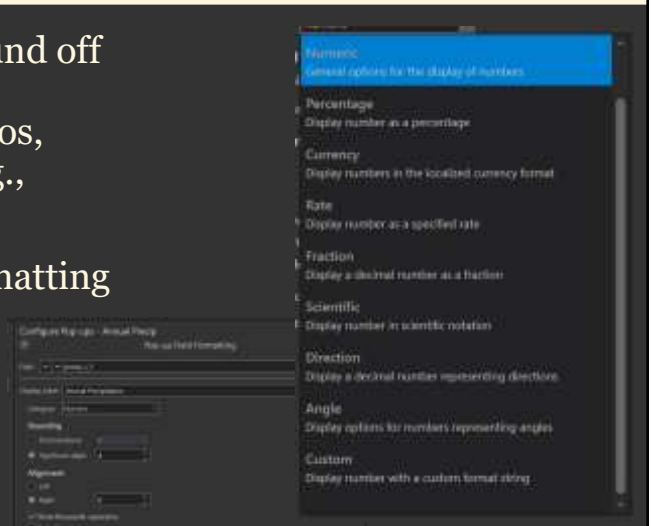
You can also edit the text font, font size, and color of title and text components.

You can change how field names will appear by setting a Display label. If an alias is applied to a field name, this alias should be use by default. If no alias is defined, then you can specify a Display label. I find that failing to use meaningful field names in pop-ups is a common mistake/issue. You should make sure that all displayed text is meaningful and user friendly. For example,

“Area in square kilometers” reads better than “areaSKM_geom”.

Pop-Ups in ArcGIS Pro

- Can edit numeric attributes to round off values, apply alignment, show thousands separator, pad with zeros, show plus sign, or add a suffix (e.g., units)
- Can apply additional number formatting by changing the Category



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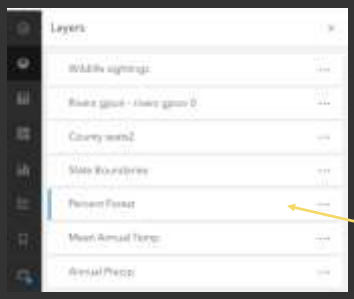
It is possible to further edit how numeric data are displayed by rounding off values, applying alignment, adding the thousands comma separators, padding value with zeros, showing plus signs, or adding a suffix. Adding a suffix can be useful for displaying units.

You can also change the category of a numeric value. Several options are available, as highlighted on this page. For example, Percentage will automatically add the % symbol to the number.

Unfortunately, I have found that number formatting applied in ArcGIS Pro does not always transfer to ArcGIS Online when data are published. Also, number formatting options in ArcGIS Online are currently much more limited than those in ArcGIS Pro. Hopefully, these issues will be resolved in future releases.

Pop-Ups in ArcGIS Online

- Make sure layer of interest is selected under Layers
- Click on Pop-ups button



Make sure layer of interest is selected

https://www.esri.com/en-us/arcgis/products/mapping/smart-mapping

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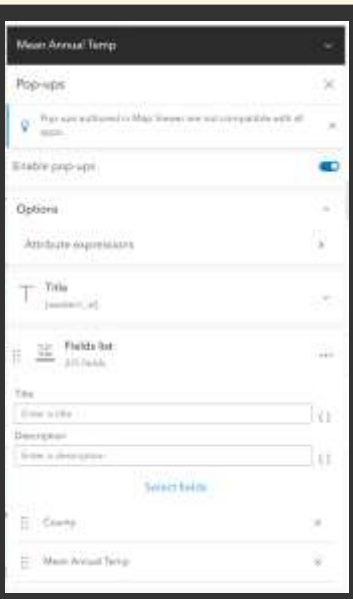
This slide shows where the pop-up options are available in the Map Viewer. The icon will be on the right-side of the page.

Pop-Ups in ArcGIS Pro



- Can enable or disable pop-ups
- I recommend configuring table alias names and numeric formatting in ArcGIS Pro before publishing to ArcGIS Online
- When referencing fields, field names are provided in {}
- Can add alternative text when referencing graphics/images to aid in accessibility
- Pop-ups authored in Map Viewer are not compatible with all apps

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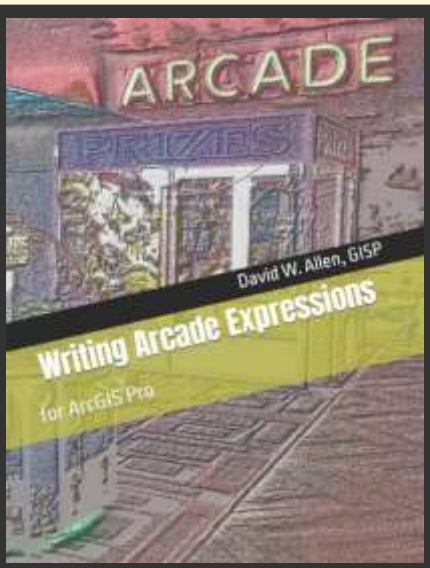
You can enable or disable pop-ups in ArcGIS Online within the Map Viewer, similar to ArcGIS Pro. Also similar to ArcGIS Pro, curly brackets are used to reference fields when creating titles or text. If you add graphics, such as charts, or images to the attribute table, I highly recommend adding alternative text to aid in accessibility.

As already noted, some pop-up formatting conducted in ArcGIS Pro may not work in ArcGIS Online. Further, pop-up edits made in the Map Viewer may not function in all apps. I am hopeful that future updates will alleviate some of these issues.

Note that it is possible to dynamically change images used in pop-ups. This can be accomplished by providing the URL to the required image in a text field in the attribute table. You can then have the pop-up render the image from the provided URL.

Learn ArcGIS Arcade



- Used to create custom content in ArcGIS applications
- https://www.amazon.com/Writing-Arcade-Expressions-ArcGIS-Pro/dp/0578533006
- https://developers.arcgis.com/arcade/

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The Arcade language can be used to further customize pop-ups. This is a language created by ESRI for the creation of custom content. Please see the book linked on this slide for some additional information associated with this language. The second link is for an ESRI webpage associated with this language.

This is the end of this lecture module.

Please return to the West Virginia View Webpage for additional content.

Thanks! Hope you found this useful.