Exercise 1.1: ArcGIS® Online

The ArcGIS Online mapping service will be used throughout this book. In this exercise, you will create a student account, which will give you access to a wide range of geographic data layers and a suite of powerful analysis tools. After you set up your student account, you will create a new map, add several types of data, and begin to explore spatial patterns. The datasets include the following:

- Demographic data to explore median household income and identify high- and low-income areas
- Multispectral imagery to identify areas of healthy vegetation
- GPS point data of landmarks in New York City

The student account that comes with this book includes the following:

- A 180-day trial of ArcGIS Online
- An ArcGIS® Living Atlas of the World with maps and data, including access to foundation content from Esri on thousands of topics
- Two hundred (200) ArcGIS Online service credits that can be used for data storage, premium data access, geocoding, and analysis
Objectives

- Create and access your ArcGIS Online student account.
- Create a new geographic information systems (GIS) map.
- Organize GIS layers in a map.
- Interpret spatial patterns found in map data.

Activate your ArcGIS Online subscription

Your first step is to activate your subscription and create your organizational account. If you already have an ArcGIS Online organizational account, skip to the next step.

Create a new geographic information systems (GIS) map

In this step, you will open ArcGIS Online using a web browser and explore the features visible on a basemap.

1. In a web browser, type https://www.arcgis.com.

2. Sign in to ArcGIS Online using your organizational credentials.

3. Click the Map tab.

Map Viewer opens. Its details include options to see information about the map, the map contents, and a legend. You will see a topographic basemap but no additional layers. This is your starting map template to which you will add map layers.
A basemap provides a background of geographical context for the content you want to display in a map. When you create a new map, you can choose which basemap you want to use. You can change the basemap of the current map at any time by using the basemap gallery or using your own layer as the basemap. In this step, you will use the basemap from the basemap gallery. The basemap gallery includes a variety of choices, including topography, imagery, and streets.

Since this section of chapter 1 discussed remote sensing imagery, you will change the basemap to a satellite image.

4. **Click the Basemap button.**

![Basemap button](image)

5. **Click the thumbnail of the Imagery with Labels basemap.**

![Select a basemap](image)

You can view information about the basemap in the gallery by clicking Details and then Content. You can also see the description of the basemap using More Options.

6. **Click and hold the cursor to move around the image.**
7. Use the Zoom buttons to zoom in and out.

You can also use the mouse and scroll wheel, or the arrow keys on the keyboard. To zoom in, you can also press and hold the Shift key and drag a box on the map.

8. Zoom in to your home or school and see how much detail you can see. Zoom to other places that interest you, as well.

9. Use the Find address or place search bar to locate your home or school more quickly.

Question 1.1.1

How do the map labels change as you zoom in and out?

Question 1.1.2

Describe what you see in the remote sensing image basemap. What types of features and details can you see? What is the smallest object you can see?
Add GIS layers

At this point, you only have the Imagery with Labels basemap, but the power of GIS lies in working with multiple layers of data. ArcGIS Online subscriptions include access to a wide range of data layers. In this section, you will add a demographic data layer, a remote sensing data layer, and a GPS data layer, and interpret some patterns illustrated in the data.

Next, you will add a demographic data layer to the GIS map.

1. Click the Content button to see a list of layers.

2. Click the Add button and choose Browse Living Atlas Layers.
Using the Add button, you can search for layers, browse Living Atlas layers, add layers from the web, add layers from files, and add map notes. You can also get directions and add the route as a layer.

Living Atlas layers include world traffic, land cover, demographics, and so on. Most of these layers are free to use on your maps and can be viewed by anyone. Living Atlas layers may require an organizational subscription to access and, in some cases, may consume credits. These requirements are identified in the item description.

3. In the Search for layers box of the Living Atlas window, type USA Median Household Income and then press Enter.

4. Click USA Median Household Income.

5. In the window, click Add to Map.
6. **Zoom in and click any area of your choice.**

The area’s median household income details appear.

7. **Use the arrow in the dialog box to view the householder age and income level.**

You can turn the layer on and off by returning to the Contents pane (on the Content tab), and then clicking the small box to the left of the layer name. This will help you understand the area better.
Question 1.1.3

Zoom in to a US city of your choice. Describe the spatial distribution of income. Where are the high-income areas? Where are the low-income areas?

Question 1.1.4

What may account for these differences? Who are the high-income earners and who are the low-income earners? What landscape features may help explain the location of clusters?

8. Add another remotely sensed image layer.

9. Close the window and click the Default Extent button when you have finished exploring.

Clicking the Default Extent button zooms the map to its initial extent.

10. Click the Add button again, and then click Browse Living Atlas Layers.

11. Search for USA NAIP Imagery.

12. Click the USA NAIP Imagery: Color Infrared layer, and click Add to Map.

This map is a false color infrared image. In this type of image, healthy vegetation stands out as bright red.

13. As with the previous two layers, move around the map and explore the image.
14. Close the window and click the Default Extent button when you have finished exploring.

Add GPS point data

Pretend that you were in New York City and collected some point data of landmarks with your GPS unit. You have downloaded the data with latitude and longitude coordinates as well as an attribute field with the landmark name. Point data from GPS units can be added to ArcGIS Online as a comma separated value (CSV) file.

1. Click the Add button and choose Add Layer from Web.

2. In the Add Layer from Web dialog box, from the drop-down list, choose A CSV File.

   This will be the data you are referencing.

3. Copy and paste the following URL in the URL box:

   https://arcgis.com/sharing/rest/content/items/3e1b00a8a6524bb9bcceb9370347437a/data
4. Click Add Layer.

Your GPS points have now been added as a layer to your map.

5. Under Contents, click the Show Table button.

The Show Table button opens an interactive table at the bottom of the map and provides a quick way to locate the GPS points.

6. Select a row in the table.

7. Under Contents, click More Options and then click Zoom To.

This will zoom to the GPS point that you selected.

8. Click the point in the map to see its latitude and longitude locations, as well as the name of the place where the GPS reading was taken.

9. Click Zoom To.

You will see the location with imagery in the background.
10. Zoom to where you can see all six points.

11. Click Save, and then choose Save.

12. In the Save Map dialog box, type a title, tags that describe your map, and a summary, and then choose a folder in My Content to save the map.

After you save your map, it appears in My Content, where you can edit the item details. To access what you have saved, click Home, choose Content, and then click the My Content tab.

13. Click the Print button to print your map showing the GPS points.

Alternatively, you can take a screenshot of your map.
14. In the print window, use your web browser to print a paper copy or print as a PDF file. Your instructor will let you know which is preferred.

**Question 1.1.6**

Do the GPS points have accurate spatial accuracy and attribute accuracy? Confirm if these are correct for the Statue of Liberty and the Empire State Building by zooming in to the points.

Explain why you believe they are correct or incorrect.

**Conclusion**

You have now successfully activated your ArcGIS Online account and added different types of geographic data layers to your GIS map. Once you’ve saved your map, it appears in My Content and you can edit the item details. Nice job!

**Exercise 1.2: Map basics with ArcGIS Online**

**Introduction**

In this chapter, you read about the important characteristics involved with map making and map interpretation. In the following exercises, you will get a better feel for how these characteristics affect the way we present and read map data. You will see how map scale affects the features that you can see. You will also explore how map classification can influence our perceptions of the spatial distribution of wealthy and poor communities. In addition, you will see how maps of the wealth of nations differ substantially when mapping counts versus rates. Lastly, you will see how map projections can distort our views of the spatial extent of countries and continents.
Objectives

- Locate features in the map using the appropriate map scale.
- Evaluate how classification schemes affect maps.
- Explain how mapping counts versus rates can affect the message of a map.
- Demonstrate how map projections distort features.

Explore map scale

A great advantage of geographic information systems is that, unlike traditional paper maps, data can be created and viewed at different scales.

1. Open the Map Scale and Map Projection app in Web AppBuilder for ArcGIS by pasting the following link in a browser:

   - https://learngis.maps.arcgis.com/apps/webappviewer/index.html?id=2222d152d1b04b57856863d5412a74d9

2. Locate your school or another place of interest. You can use the search bar if needed. Zoom in to and out from your selected location.

Question 1.2.1

What happens to the size of features (parks, buildings, roads, and so on) as you zoom in and out?
Question 1.2.2

As you zoom in, do you see a larger scale or a smaller scale map? What do you see as you zoom out?

Question 1.2.3

Based on the chapter reading, which would be a larger scale map: 1:24,000 or 1:100,000? At which scale would buildings appear larger?

Classification: Where are the high-income neighborhoods and where are the low?

Do you live in a high-income neighborhood or a low-income one? This may seem like a simple question, but where you make your cutoff points for income categories can make a big difference in where your neighborhood lies. In the Explore map scales step, you explored the USA Median Household Income layer. You will look at it again now, but this time you will observe how classification schemes change the way data is presented in the map.

1. Go to http://arcg.is/1WkvHmz and sign in to your ArcGIS Online account.

The Chapter 1–Classification map opens, showing Gainesville, Florida. There are four copies of the USA Median Household Income layer, each with a note on which classification scheme it needs to be set to.

2. Locate your school or another place of interest in the United States. Use the Find address or place search box, if needed.
Important note

The map layers will only show at the Tract scale of analysis. Expand the layers by clicking the arrow to the left of the check box. If you are not at the proper scale, the Tract layer will be grayed out. Zoom in or out to activate Tract.

Now you will investigate how different classification schemes change the way the data is shown.

3. If you have not already done so, expand the 2017 USA Median Household Income – Change to Quantiles layer and make sure that Tract is active.

4. Hover your cursor over Tract, as in the preceding image, and click the Change Style icon.

5. In the Change Style pane, Under Counts and Amounts (Color), click Options.
6. Under Classify Data, set the following values:

- **Using:** Quantile

- **With:** 5 classes

   These values set the classes’ cutoff points so that there are an equal number of census tracts in each class.

7. **Click OK.**

8. **Click Done.**
9. Repeat the preceding steps for each of the next three layers.

Note

Make sure that only one layer’s check box is checked at a time to allow you to see the proper layer.
2017 USA Median Household Income–Change to Standard Deviation. 
Classify Data Using Standard Deviation

2017 USA Median Household Income–Change to Equal Interval. Classify 
Data Using Equal Interval

2017 USA Median Household Income–Change to Natural Breaks. 
Classify Data Using Natural Breaks

When you have set the four different classification schemes, turn on one layer at a time 
and look at the legend. Make note of some of the census tracts in the highest category. Also, 
make note of some in the lowest category.

Question 1.2.4
Do you find some census tracts that seem to change from one category to another, depending 
on the selected classification scheme? Why is this? Why can one classification put a census 
tract in the highest category, and another put it in a different category?

Question 1.2.5
If you worked for a community development organization and wanted to persuade funding 
agencies that many census tracts in your area are lower income, which classification scheme 
would you use? Why?
10. Print or take a screenshot of your map.

Question 1.2.6

If you worked for the mayor’s office and wanted to show that incomes have risen under his or her leadership, which classification scheme would you use? Why?

11. Print or take a screenshot of your map

Counts vs. rates: Where are the richest countries?

This too may seem like a straightforward question, but as you will see in this section, it depends exactly what you are measuring. Economic data based on counts can give a very different impression compared with data based on rates. Following, you will see how mapping counts and rates for gross national income can produce very distinct maps.

1. Open the Chapter 1–Counts vs. Rates map in Web AppBuilder for ArcGIS by pasting the following link in a browser:

- https://learngis.maps.arcgis.com/apps/webappviewer/index.html?id=13acb1b2610147ffb6279f2c52306aca

2. Use the Layer List and Legend buttons to view the data.

You will see the following two layers:

- World GNI–GNI PPP—This is gross national income in purchasing power parity dollars. It is a measure of annual economic output for each country, adjusted for the cost of living
in each country. This figure is a count, since it is a measure of total annual economic output.

- World GNI–GNI per capita PPP—This is gross national income per capita in purchasing power parity dollars. This is a measure of annual economic output for each country divided by the total population, then adjusted for the cost of living in each country. This figure is a rate, since it takes GNI and divides by population.

3. In the layer list, toggle between turning on the World GNI PPP and the World GNI per capita PPP layers. As you switch back and forth between the two layers, answer the following questions.

**Question 1.2.7**

Which countries seem to have the largest economies in terms of GNI PPP?

**Question 1.2.8**

When you click the countries to view the GNI PPP values in the pop-up window, how do the US and China compare?

**Question 1.2.9**

Based on the GNI PPP map, which countries are richer: China and India, or the Scandinavian countries of Norway, Sweden, and Finland?

4. Turn on the GNI per capita PPP layer by clicking the check box by its title. Make sure to uncheck the other layer.
5. **Click various countries to see their GNI per capita PPP values.**

These numbers represent average annual income per capita in purchasing power parity.

**Question 1.2.10**

How do the US and China compare?

**Question 1.2.11**

Based on the GNI per capita PPP map, which countries are richer: China and India, or the Scandinavian countries of Norway, Sweden, and Finland?

**Question 1.2.12**

On average, who has a higher standard of living, someone in China, India, Mexico, or Brazil?

**Question 1.2.13**

When people say China now has the world’s largest economy, which data are they using, the GNI PPP count data, or GNI per capita PPP rate data?

**Question 1.2.14**

Do people in China, on average, have a standard of living like that of countries such as the US? Why or why not?

**Question 1.2.15**

When someone asks which are the richest countries, which is correct, the count data or the rate data? Why?
Map projections: How big is Greenland?

Online maps are stored with a continuous tiling system to support the seamless display of map data for large scale subareas (e.g., imagery and streets within a city). This requires a single map projection for the world. The spherical Mercator projection is used. This is often referred to as the Web Mercator projection. ArcGIS Online uses the Web Mercator map projection. In this chapter, you read about the types of distortions Mercator projections create. Here you will see just how dramatically features can be distorted by map projections.

1. Open the Map Scale and Map Projection app in Web AppBuilder for ArcGIS by pasting the following link in a browser:

   - https://learngis.maps.arcgis.com/apps/webappviewer/index.html?id=2222d152d1b04b57856863d5412a74d9

2. Visually compare the size of Greenland with that of Africa and calculate the area in square miles for each.

3. Click the Measure button near the top of the screen to open the Measurement dialog box.

4. Click the Area icon within the Find area, length, or location window.

5. Click around the outline of Greenland to show how many square miles it contains. Make note of the number of square miles.

6. Do the same for Africa.
Question 1.2.16
Visually, how do Greenland and Africa compare in size?

Question 1.2.17
How does the number of square miles compare?

Question 1.2.18
From the text, of the four spatial elements that can be distorted by map projections, which can you be sure is incorrect on this map?

Conclusion
As you have seen in these exercises, there are multiple ways in which maps can be manipulated to give very different impressions of the data. When working with map data, you must carefully consider if your mapping decisions present the data in a fair and informative manner.

Exercise 1.3: Location and distance

Introduction
How we identify where we are in the world, and our proximity to other places, can be measured in absolute and relative terms. In this exercise, you will use latitude and longitude to identify the absolute location of places and view a map to understand how relative location impacts human actions. You will also see how different types of distance measurements provide different results when mapping population around a school or store.
Objectives

- Apply the geographic coordinate system to locate features on a map.
- Illustrate how relative location influences features and places.
- Calculate distance in absolute and relative terms.

Location: Latitude and longitude—where are you?

1. Open Chapter 1–Latitude and Longitude by pasting the following link in a browser:

   • https://learngis.maps.arcgis.com/apps/webappviewer/index.html?id=604cd228714346bea1868956386dafaf

   Next, you will determine the approximate latitude and longitude of places, to one-tenth of a degree.

   To estimate the location of each city, you need to interpolate. Interpolation involves estimating the value of a point between two known values. In the following example, Las Vegas, Nevada, is bounded by the 1-degree longitude lines of 115W and 116W, and the 1-degree latitude lines of 36N and 37N. To estimate the location of Las Vegas to one-tenth of a degree, first interpolate between 115W and 116W. Las Vegas looks as if it is located at about 115.1W. Then, between 36N and 37N, it looks as if the city lies at about 36.2N.

2. One at a time, zoom to the following cities (or use the search box):

   • Paris, France
   • Chicago, Illinois
• Santiago, Chile

• Sydney, Australia

3. Zoom out just enough so that you can see the 1-degree lines of latitude and longitude that form a box around the city.

4. Use this technique to estimate the locations of the preceding cities.

5. Locate your school and estimate the latitude and longitude.

Question 1.3.1

Which lies closest to 0 degrees latitude: Singapore, Philippines, Vietnam, or Cambodia?
Question 1.3.2

Which is located at the highest latitude: Tierra del Fuego, Argentina; Melbourne, Australia; Reykjavik, Iceland; or Anchorage, Alaska?

Question 1.3.3

Which is closest to 180 degrees longitude: Fiji; Auckland, New Zealand; Honolulu, Hawaii; or Brisbane, Australia?

Question 1.3.4

Which South American country is named after the equator?

You can check your latitude and longitude estimates by using the Measurement tool and clicking the Location button .

6. Click the Basemap Gallery button to change the basemap to Imagery with Labels.

7. Copy and paste the following two coordinates into the search bar, and then answer the following questions.

- –94.9122 29.3794
- –94.7952 29.2869
Question 1.3.5

Based on relative location alone, which of the following houses most likely has a higher value?

Why?

Question 1.3.6

Which has a relative location closest to Tunisia, where a Tunisian emigrant might enter Europe: Spain, Italy, Greece, or France?

Question 1.3.7

Based on its relative location and the fact that countries tend to be concerned with places close to them, we would expect Pakistan to be most involved with trying to influence political outcomes in which of the following: Afghanistan, Iraq, Israel, or Saudi Arabia?

Distance: Euclidian vs. Manhattan/Network—are we there yet?

In this step, you will explore the difference between Euclidian and Manhattan/Network absolute distance, and relative distance in terms of time.

1. In a browser, go to ArcGIS Online at https://www.arcgis.com, and sign in to your account.

2. Click the Map tab to open a new map.

3. Navigate to your school and add a map note using either of the following methods:
- Enter a place name in the search box. In the Search result box, click Add to Map Notes to add a point at your selected location.

- Click Add > Add Map Notes. In the Add Map Notes dialog box, enter a name and click Create. Choose a Points feature and click on the map where you want the feature to be located, then click Close.

4. Calculate the 1-mile Euclidian distance around your map note to see how many people live within the area:

- Click the Analysis button.

- Expand Data Enrichment and click Enrich Layer.
In the Enrich Layer pane, set the parameters as follows:

- Choose layer to enrich with new data: <select your map note>

- Click Select Variables

- In the Data Browser pane, click Population. (Make sure United States is selected in this pane.)

- Check 2017 Total Population (Esri), then click Apply.
- Define areas to enrich: Line distance, 1 mile

- Check the box to Return result as bounding areas to create a feature on the map showing the area.
Give your layer a unique name.

Click Show credits. The analysis should use less than one credit. If it is much higher, double-check your settings.
o Clear the Use current map extent check box.

o Click Run Analysis (scroll down in the Enrich Layer pane if necessary to see this button).

5. Calculate the 1-mile Manhattan/Network distance around your map note.

- Click the Analysis button.

- Expand Data Enrichment and click Enrich Layer.

- In the Enrich Layer pane, set the parameters as follows:
  
  o Choose layer to enrich with new data: <select your map note>

  o Click Select Variables

  o In the Data Browser pane, click Population. (Make sure United States is selected in this pane.)
Click select variables, then click Population.

Check Total Population (Esri), then click Apply.

Define areas to enrich: Driving Distance, 1 mile

Check the Return result as bounding areas box to create a feature on the map showing the area.

Clear the Use current map extent check box.

For Result layer name, change the name to Enriched Map Notes (Points) Manhattan.

The name must be different since Enriched Map Notes (Points) was used in the Euclidian distance step.

Click Show credits. The analysis should use less than one credit. If it is much higher, double-check your settings.

Click Run Analysis (scroll down in the Enrich Layer pane if necessary to see this button).
6. Calculate the four-minute driving (relative distance) area around your map note.

- Click the Analysis button.
- Expand Data Enrichment and click Enrich Layer.
- In the Enrich Layer pane, set the parameters as follows:
  - Choose layer containing features to buffer: <select your map note>
  - Click Select Variables.
  - In the Data Browser pane, click Population. (Make sure United States is selected in this pane.)
  - Click Select Variables, then click Population.
- Check Total Population (Esri), then click Apply.

- Define areas to enrich: Driving Time, 4 minutes

- Check the Return result as bounding areas box to create a feature on the map showing the area.

- Clear the Use current map extent check box.

- For Result layer name, change the name to Enriched Map Notes (Points) Drive 4 minutes.

  The name must be different since Enriched Map Notes (Points) was used in the Euclidian distance step.

- Click Show credits. The analysis should use less than one credit. If it is much higher, double-check your settings.

- Click Run Analysis (scroll down in the Enrich Layer pane if necessary to see this button). If an error occurs, check the Use current map extent box and run the analysis again.
A new layer with a four-minute driving time (relative distance) area is added to your map.

**Question 1.3.8**

Why does the Manhattan distance encompass a smaller area than the Euclidian distance?

**Question 1.3.9**

How do freeways and major roads increase connectivity and make places closer in relative terms?

**Question 1.3.10**

People often use Euclidian distance when measuring areas around a store or facility. Why is this often a poor choice?

7. Print your map, showing both the Euclidian and the Manhattan distance layers that you created.
Conclusion
In this exercise, you saw different ways of identifying location and measuring distance.

Often, absolute location and distance are useful in your analysis. In many cases, however, using relative location and relative distance is preferable.

Exercise 1.4: Spatial patterns and spatial relationships—an analysis of homicide patterns in Chicago

Introduction
Violent and property crime have an inherently spatial component in that they occur in specific places. Often, crimes follow regular spatial patterns, occurring more in some places than in others. Because of this, police departments, geographic researchers, and others aim to identify these patterns and develop solutions to reduce crime. In this exercise, you will examine real 2015 homicide data from the city of Chicago. Based on this data, you will identify homicide clusters and then compare them with data on poverty to see if any spatial relationship exists between the two.

Objectives
- Understand spatial patterns of real-world data.
- Calculate clusters with density surface and hot spot analysis.
- Analyze the spatial relationship between two variables with overlay analysis.

Homicide density surface: Where are homicides occurring?
1. Open the Chapter 1–Chicago Homicide 2015 map (http://arcg.is/1Wkvhg5) and sign in to your ArcGIS Online account.
The map opens with the Chicago Homicides 2015 point layer turned on. This is the location of all homicides during 2015.

To better visualize patterns, use the Calculate Density tool. This creates a density surface based on point locations and is useful in showing the spatial patterns of homicides.

2. **Click the Analysis button > Analyze Patterns > Calculate Density.**

3. **Set the parameters as follows:**

   - Choose point or line layer from which to calculate density: Chicago Homicides 2015.

   - Uncheck the Use current map extent check box.

   - Click Show credits. The analysis should use less than one credit. If it is much higher, double-check your settings.

4. **Click Run Analysis.**
Question 1.4.1

Does the density surface show clusters, random patterns, or dispersion of homicides?

Question 1.4.2

If there are clusters, what might account for these patterns?

Question 1.4.3

What are several ways that police departments can use this information?

Homicide hot spot analysis: Which places have high homicide rates?

Hot spot analysis is a sophisticated tool that calculates areas with a high statistical probability of being part of a cluster. Whereas a density surface provides a good visual perspective on where clusters may be, hot spot analysis can say with statistical certainty where clusters are.
You ran the density surface using count data—the point locations of each homicide. But when you study crime patterns, it is often better to look at rates. By dividing the number of homicides by the number of people in the surrounding area, you can control for population density. For instance, some places may have few homicides only because no people live there.

Next, you will map hot spots by homicide rate based on census tracts (in other words, homicides/population for each census tract).

1. **Turn off the Chicago Homicides 2015 Density layer (that you created) and the Chicago Homicides 2015 layer.**

2. **Turn on the Chicago Homicide Tracts layer to see the tracts that will be used for the analysis.**

3. **Click the Analysis button > Analyze Patterns > Find Hot Spots.**
4. Set the Find Hot Spots parameters as follows:

- Choose layer for which hot spots will be calculated: Chicago Homicide Tracts

- Find clusters of high and low: HomicideRate

- Uncheck the Use current map extent check box.

- Click Show credits. The analysis should use less than one credit. If it is much higher, double-check your settings.

5. Click Run Analysis.
A new layer called Hot Spots HomicideRate is added to your map.

6. Click the Legend tab to see the legend.

![Legend](image)

**Question 1.4.4**

Compare the density map for homicide counts with the hot spot map of homicide rates by turning each layer on and off. In the north of the city next to Lake Michigan, why does one type of measurement, the density count map, show a homicide cluster, while another type of measurement, hot spot analysis of homicide rates, shows a cold spot?

**Question 1.4.5**

What may be some characteristics of hot spot neighborhoods that could contribute to a high homicide rate? What may be some characteristics of cold spot neighborhoods that could contribute to a low homicide rate?

**Spatial relationships: How does the homicide rate relate to the poverty rate?**

So far you have analyzed the spatial patterns of Chicago homicides. Now you will look at the spatial relationship between homicide rates and poverty rates.
1. Make a hot spot map of poverty rate.

2. Turn off the map layers from the previous step.

3. Click the Analysis button > Analyze Patterns > Find Hot Spots.

4. Set the parameters as follows:
   - Choose layer for which hot spots will be calculated: Chicago Homicide Tracts
   - Find clusters of high and low: PovertyRate
   - Uncheck the Use current map extent check box.
   - Click Show credits. The analysis should use less than one credit. If it is much higher, double-check your settings.

5. Click Run Analysis.

**Question 1.4.6**

Turn the Hot Spot layers for poverty rate and homicide rate on an off to visually compare the two layers. How well does the homicide rate map relate to poverty rate hot spots?
**Question 1.4.7**

In what ways can poverty contribute to high homicide rates?

**Conclusion**

In this exercise, you mapped and analyzed the spatial relationship between homicides and poverty. While there are probably other factors associated with homicide rates, this is a useful first step in understanding and combating murder in the city of Chicago.

**Exercise 1.5: Places and regions**

**Introduction**

We talk and hear about regions on a daily basis, but identifying exactly where they are and where their boundaries lie can be tricky. In this exercise, you will identify a formal region, a functional region, and a perceptual region.

**Objectives**

- Apply data to identify a formal region.
  
- Apply data to identify a functional region.
  
- Create a perceptual region based on a sample of student opinions.

**Formal region: Where is Silicon Valley?**

The world-famous Silicon Valley is a region of high-technology industry and has been the birthplace of companies such as Intel® Corporation, Apple® Inc., Google®/Alphabet®, Twitter®, Inc., and many more. But while the whole world knows that the region exists, exactly where is
it? In this step, you will map variables to identify the cities that make up the formal region known broadly as Silicon Valley.

1. Sign in to your ArcGIS Online account and open the Chapter 1–Formal Region map at http://arcg.is/1WkvkIK.

The map centers on California and consists of census places (akin to cities) with data from the US Census Bureau’s 2014 American Community Survey.

To identify the cities with large technology sectors, you will map data indicating where people with computer and math occupations live, as well as data on revenue derived from technology companies.

There are four layers in the map:

- Occupations- Computer and Math. This shows the total number of people who work in computer and math occupations, based on their place of residence.

- Tech Company Revenue. This shows the total revenue earned by technology companies in thousands of dollars, based on the location of the company.

- Occupations- Computer and Math/Total. This shows the ratio of people working in computer and math occupations divided by the number of people working in all occupations, based on their place of residence.
- Tech Revenue/Total Revenue. This shows the ratio of total revenue earned by technology companies in thousands of dollars divided by the total revenue earned by all companies, based on the location of the company.

You will use data from these four layers to map Silicon Valley as a formal region, using the following logic. First, you want to select only census places with a substantial cluster of computer and math workers, as well as those with higher levels of revenue from technology companies. Thus, your selection criteria will include only places with at least 3,000 computer and math workers, and places with technology revenue of at least $5 million (in thousands of dollars). Since these criteria may select large urban places, even if technology does not dominate their economies, you will also want ratio data. Therefore, the criteria will include places where at least 15 percent of revenue comes from technology companies and where at least 5 percent of workers are in computer and math occupations.

To identify Silicon Valley as a formal region using these criteria, you will use the Derive New Locations tool.

2. Click the Analysis button, expand Find Locations, and click Derive New Locations.
3. In the Derive New Locations pane, set the parameters as follows:

- In step 1, click Add Expression.

- In the Add Expression dialog box, set the expression so that Occupations- Computer and Math, where (attribute query) Computer_Math_Occ is at least 3000. Click Add.

- Click Add Expression again.

- In the Add Expression dialog box, set the expression so that Tech Company Revenue where (attribute query) Revenue1000s is at least 5000000. Click Add.
Click Add Expression again.

In the Add Expression dialog box, set the expression so that
Occupations- Computer and Math/Total where (attribute query)
Pct_Computer_Math_Occ is at least 0.05. Click Add.

Click Add Expression again.

In the Add Expression dialog box, set the expression so that Tech
Revenue/Total Revenue where (attribute query) Pct_TechRevenue is at
least 0.15. Click Add.
4. **In step 2, give your layer a unique name.**

5. Uncheck the Use current map extent box to ensure that all California places are included in the analysis.

6. Click Show credits. You should use less than two credits in the analysis. If not, check the expressions in step one.

7. Click Run Analysis.
Your new layer will be added to your map and visible in the Content pane.

As you can see, no places in California meet all four criteria used to identify Silicon Valley. Your map now shows the places with substantial counts and ratios of computer and math workers, and technology revenue. While many places around the world strive to copy Silicon Valley, few have been able to come close in terms of its concentration of skilled workers and successful companies.

8. **Zoom to the area identified through your analysis.**

9. **Save your map and print or take a screen shot.**

**Functional region: Identifying regions with commuting patterns**

In the United States, administrative units used for local policy and planning typically consist of counties and cities. But the movement of goods, people, and capital rarely remain constrained by county and city boundaries. For this reason, it is useful to identify regions in functional terms. In other words, which areas function as cohesive units, regardless of standard political boundaries?

In this section, you will examine US census data on commuter flows between census tracts to identify functional regions and the counties in which they are included. By identifying functional regions in this way, policymakers can better coordinate urban planning and economic development. Transportation plans, extension of water and sewer lines,
homebuilding and commercial development all work better when administered in functionally related areas rather than by often-obsolete county and city boundaries.

1. **Open the Chapter 1 Functional Region Commuting Patterns map at**
   
   https://arcg.is/0DnTye, and sign in to your ArcGIS Online account.

   The map opens with two active layers. The Mega Regions layer shows functional mega-regions, which are regions where commuting patterns have stronger connections internally than with adjacent areas. The Commuter Flows layer shows the 2006–10 commuting patterns used to calculate mega-regions. The data includes census-tract to census-tract flows of 50 miles or less with at least 50 people. Yellow lines represent the greatest flow volume, followed by orange and then red, which represents the smallest flow volumes.

2. **Zoom in slightly to an urban area of your choice using the Zoom In and Zoom Out buttons.**

   Within each mega-region, you can see that there are many local nodes of activity, as represented by the yellow flow lines. In some cases, these nodes are relatively distinct from the larger functional regions, while at other times they are closely enmeshed in a broad interconnected area.

   Pretend you are a regional planner and must identify the area to include for transportation and housing planning in your selected urban area. Visually determine the area by looking at the commuter flow lines. The functional area should include places connected by many flow lines and by high flow volumes, as represented by the yellow and orange lines.
3. Click the Add button, and then click Add Map Notes.

4. Give your map note a name, such as Functional Region boundary, and then click Create.

5. In the Add Features pane of the map note, click the Freehand Area tool.

6. Draw the area around your selected urban area.

7. Give the area a title and click Close.

    The following image is an example of a selected urban area.

8. Click the Close arrow to the right of Add Features to see the Contents pane.
Now that you have identified your functional region, you must identify the counties that it incorporates to coordinate planning for transportation and housing.

9. Click the Analysis tab > Find Locations > Find Existing Locations, and set the following parameters:

- Choose layer containing features you want to find using attribute and spatial queries: USA Counties
- Build a query to find features: click Add Expression
- In the Add Expression window:
  - USA Counties intersects Functional Regional Boundary (Areas).
  - Click Add.
10. Click Show credits. The analysis should use less than one credit. If it is much higher, double-check your settings.

11. Click Run Analysis.

**Question 1.5.1**

Based on the textbook, describe functional regions and describe how you identified one in this exercise.

12. Print or take a screenshot of your map.

The following image is an example of the analysis you just performed.
You have now identified the functional region of your selected urban area and the counties that fall within it. With this information, you can begin to coordinate transportation and housing policies with the appropriate county and city governments.

**Perceptual region: Identifying the Middle East**

We all know that the Middle East exists, but exactly where is it? In this section, you will draw a line around where you perceive the Middle East to be. After your classmates have done the same, you will be able to add their map layers to yours to see where the class perceives the region to be.

1. **Sign in to your ArcGIS Online account, click My Content, and then open the Chapter 1–Perceptual Region map (http://arcg.is/1Wkvos8).**

   Consider where you think the Middle East is.

2. **Using the skills you have learned, click Add > Add Map Notes.**
3. Make a name and click Create.

4. Select the Freehand Area tool.

5. Use the tool to draw the region.

6. Give it a title and click Close.

   The following is optional:

7. Click Save As to save your map.

8. In the Tags space, include a tag unique to your class (as indicated by your instructor), such as class section number, and then click Save Map.

9. Click the Share tab and choose Everyone.

   Your instructor can then open a new map, click Add > Search for Layers, and Find <unique tag>. Student maps can be added and seen together.

10. Print or take a screenshot of your map and print it.

    If instructed, share your map with the class. Is there a class consensus on where the Middle East lies? Why or why not? How did people make their decisions?
Conclusion
As you have seen in this exercise, regions can be identified in several ways. Formal regions are identified by mapping one or more variables, functional regions form through linkages between places, and perceptual regions are based on how people subjectively view places.

Exercise 1.6: Origin, spatial diffusion, and spatial interaction

Introduction
New ideas, products, and technologies typically have an origin point from which they diffuse to new locations. At the same time, spatial interaction tends to occur more often between people and places that are close to one another than between people and places that are far apart. In this exercise, you will examine how cell phone technology has diffused and how the spatial interaction concept of distance decay applies to commuting patterns.

Objectives
- Describe and analyze the diffusion process by observing data on global cell phone usage.
- Assess the concept of distance decay with commuting data.

Diffusion: Spatial diffusion of cell phones
Cell phones are an integral part of people’s lives around the world. But while some people cannot imagine life without a cell phone, of course, there was once a time when they were the exclusive use of the rich. In this section, you will see maps showing how cell phone usage diffused around the world since 1984.
1. Open the Cell Phones per 100 People map:

   - https://learngis.maps.arcgis.com/apps/TimeAware/index.html?appid=725304260766412fae7d1f8dcc80b3fb

2. Use the time slider to observe how cell phones diffused over time up to the year 2014.

   All countries had zero to five cell phones per 100 people up until the 1988–1991 time period.

3. Drag the time slider slowly to 1988–1991 to see the first countries with over five cell phones per 100 people.

   ![Time slider](image)

**Question 1.6.1**

During the 1988–91 time period, which three countries stand out? Click each country and look at its attribute data. What percent of the population had cell phones?

**Question 1.6.2**

Now slowly drag the slider to the following years (it may take a few seconds to load the map). Do you see evidence of contagious diffusion? With which countries?
**Question 1.6.3**

Do you see evidence of hierarchical diffusion? What is the hierarchy based on? Which countries saw greater cell phone usage according to this hierarchy?

**Question 1.6.4**

Look at the map legend. By 2014 (the last time interval on the slider, showing 2012–2015), how many cell phones per 100 people were found in countries with the darkest shade of blue? What does a value over 100 mean?

**Question 1.6.5**

How many cell phones did people in the United States have in 2014? Russia? Argentina? Brazil?

Click each country to see the values.

**Question 1.6.6**

In 2014, which countries had the lowest cell phone rate? What are some examples of the cell phone rate in those countries?

**Question 1.6.7**

What barriers to diffusion may have slowed cell phone diffusion to some countries?

**Distance decay: Commuting to downtown Atlanta**

No one likes a long commute. Because of this, it is a safe bet that commuting patterns will follow Tobler’s Law, or the idea of distance decay: there should be more spatial interaction between places that are close together than places that are far apart. To test this hypothesis,
you will look at commuting patterns by census tract to downtown Atlanta, Georgia, to see if people who commute there tend to live closer to or farther from work.

1. **Open the Chapter 1 Distance Decay: Atlanta Commuters map and sign in to your account:**

   - [https://arcg.is/0CnLST](https://arcg.is/0CnLST)

   This is a sample of data from the functional region section in Exercise 1.5. It shows all commutes of 80.5 km (about 50 miles) into downtown Atlanta census tracts. Yellow represents a larger commuter flow, orange represents moderate flows, and red represents lower flows.

   You will use the Filter tool to determine the number of commuters coming from different distances and to complete the following table.

2. **Hover your cursor over the Atlanta Central Business District Commuters layer and click the Show Table icon.**

3. **In the table, click Options > Filter.**

4. **In the Filter window, create the expression: Length in KM is at most 10. Then click Apply Filter.**
This selects the flow lines of commuters within 10 kilometers of downtown.

5. **In the Atlanta Central Business District Commuters table, click the Flow field heading, then click Statistics. In the table, write down the Sum of Values in the first row. When you have finished, close the Statistics window.**

6. **In the Atlanta Central Business District Commuters table, click Options > Filter.**

7. **In the Filter window, click Edit. Set the first expression to Length in KM is greater than 10. Then click Add another expression and set the second expression to Length in KM is at most 20. Click Apply Filter.**
This selects the flow lines of commuters from between 11 and 20 kilometers of downtown.

8. In the Atlanta Central Business District Commuters table, click the Flow field heading, then click Statistics. In the table, write down the Sum of Values in the second row. When you have finished, close the Statistics window.

9. Repeat the preceding steps, changing the Length in KM values in the Filter window to 20 and 30, then 30 and 40, 40 and 50, 50 and 60, 60 and 70, and 70 and 80. The completed table will then show the number of commuters by distance from downtown.

<table>
<thead>
<tr>
<th>Distance from downtown Atlanta</th>
<th>Sum of Values for Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–10 km</td>
<td></td>
</tr>
<tr>
<td>11–20 km</td>
<td></td>
</tr>
<tr>
<td>21–30 km</td>
<td></td>
</tr>
<tr>
<td>31–40 km</td>
<td></td>
</tr>
<tr>
<td>41–50 km</td>
<td></td>
</tr>
<tr>
<td>51–60 km</td>
<td></td>
</tr>
<tr>
<td>61–70 km</td>
<td></td>
</tr>
<tr>
<td>71–80 km</td>
<td></td>
</tr>
</tbody>
</table>

10. Plot the values from the table in the chart and connect them with a line to see if commuting patterns to downtown Atlanta follow the pattern predicted by distance decay.
Conclusion

Spatial diffusion and spatial interaction are key concepts in geography. Understanding how new products and technologies diffuse to different places is of use to businesspeople as well as economic development specialists. Likewise, the spatial interaction concept of distance decay has many applications, such as for understanding traffic flow patterns and where people will demand housing in relation to employment centers.

Exercise 1.7: Environmental perception—flood risk in Miami

Introduction

Environmental perception influences how humans view and interact with the natural environment. How people perceive natural hazards risk has an important impact on where...
humans live. In this exercise, you will look at urban development patterns and flood risk in Miami, Florida. Miami lies at a low elevation along the hurricane-prone southeastern seaboard, making it susceptible to flooding. Moving forward, climate change and rising sea levels are likely to increase flooding risk even more. Yet people keep building in flood-prone areas.

Objectives

- Calculate the number of people at risk of substantial flooding in Miami.
- Discuss how natural hazard risk perception influences where people live.

1. Open the Chapter 1-Natural Hazards Perception map and sign in to your account:
   - http://arcg.is/1U9h0MK

   The map shows flood zones in Base Flood Elevations (BFEs) for Miami-Dade County. BFEs show the number of feet water should rise with a 1 percent annual chance. This is equivalent to the often used “100-year flood risk.”

2. Calculate the number of people at risk of substantial flooding in 1990 and in 2014.
   - Click the Analysis button > Summarize Data > Summarize Within.
On the Summarize Within pane, set the parameters as follows:

- Choose area layer to summarize other features within its boundaries: Flood Zone

- Choose layer to summarize: Block Group Population 1990

- Add statistics from the layer to summarize: Field → TotalPop, Statistic → Sum

- Uncheck the Use current map extent

Click Run Analysis.
3. Repeat the same process, using the Block Group Population 2014 layer in step 2.

You now have new layers that summarize the total population within each BFE flood zone.

4. Click the Show Table button under the new layer you created, Summarize Block Group Population 1990 within Flood Zone, and open the table.

In the table you will see fields for Sum TotalPop and STATIC BFE. The STATIC BFE field shows the number of feet of flooding that can be expected once every 100 years. By reading across the rows, you can see how many people live within each Base Flood Elevation interval. In other words, it shows how many people are at risk of 2 feet of flooding, 3 feet of flooding, and so on.

If you click on a row, you will see the corresponding area for each BFE level on the map.
5. Filter layers to determine how many people are at risk of the most serious flooding.

- First, calculate the population at risk of 10-foot flooding. This is flooding that will completely inundate first floors and reach into second floors of buildings.

- Next, calculate the population at risk of 5-foot flooding. This is flooding that will reach above first floor window sills.

- Click the Filter button 🔄 under Summarize Block Group Population 1990 within Flood Zone.

- In the filter window, create a filter so that STATIC BFE is at least 10.

- Click Apply Filter.

In the map you can see which areas have a BFE of at least 10 feet (turn off the other layers to see more clearly).
6. If the Summarize Block Group Population 1990 within Flood Zone table is not still open, open it by clicking the Show Table button under the layer name.

7. In the table, click the Sum TotalPop field name > Statistics.

8. Write down the value for Sum of Values in the last column of the first row in the following table.

   ![Table Image]

   This is the number of people living in areas at risk of at least 10 feet of flooding in 1990.

9. Click the Filter button under Summarize Block Group Population 1990 within Flood Zone.

10. Click Remove Filter to remove your previous filter.

11. Click the Filter button again to make a new filter, but change the expression:

   - In the filter window, create a filter so that STATIC BFE is at least 5.

12. Click Apply Filter.

13. As previously, from the table get the Statistics value.

14. Write down the value for Sum of Values in the middle column of the first row.

   This is the number of people living in areas at risk of at least 5 feet of flooding in 1990.
15. Repeat the same process from steps 5 through 15 with the Summarize Block Group Population 2014 within Flood Zone layer.

- 2014, 10’ flood Sum of Values: write the value in the last column of the second row.

- 2014, 5’ flood Sum of Values: write the value in the middle column of the second row.

<table>
<thead>
<tr>
<th>Year</th>
<th>People at risk: 5’ flooding</th>
<th>People at risk: 10’ flooding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Question 1.7.1**

Based on your population numbers, how do people appear to perceive flood risk in Miami?

**Question 1.7.2**

Why do you think people ignore environmental risk?

**Question 1.7.3**

How does flood insurance influence perception of risk? Can insurance rates limit growth? What else can people do to limit risk?

**Question 1.7.4**

What will happen as risk increases due to climate change?
Conclusion

As you have seen in this exercise, a significant number of people are at risk of serious flooding in the Miami area, despite regular news about the dangers to low-lying areas from climate change. How people perceive natural hazard risk heavily influences where we live.