Instructional Guide for The
ArcGIS Book
Second Edition

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To work friends who become good friends.

Kathryn and Lyn
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*Page numbers are for reference only.*
How to use this book

This instructional guide is designed for anyone who wants to learn—or learn more—about ArcGIS Online and its supporting cast of online and mobile apps. It is also an exceedingly valuable tool for those who want to help others learn. Each chapter in the companion book, The ArcGIS Book: 10 Big Ideas about Applying The Science of Where™, includes QuickStarts with information about relevant software, data, and web resources as well as Learn ArcGIS lessons to provide hands-on practice in the chapter’s specific content. This guide starts where that volume leaves off. In it you’ll find videos, guided activities to develop basic GIS concepts and skills, and scenario-based lessons that put those skills to use to answer questions and address real-world problems.

A Swiss army knife is frequently used as a metaphor for a multipurpose, versatile, and adaptable tool. *Instructional Guide for The ArcGIS Book*, second edition, is a Swiss army knife for learning GIS. Use it as a personal tutorial, a refresher course, a lab manual, or a repository of training activities. Whatever your needs, this guide provides the tools you need to meet them.

**A personal tutorial**

Use this guide on your own to learn about ArcGIS Online. You’ll learn how to make maps and share them as web apps and story maps. You’ll learn how to access existing data online and to create and map your own new data. You’ll practice working with mobile and online apps like Survey123, the US Geological Survey’s Historical Topographic Map Explorer, and the Landsat Explorer. Go through the book from chapter to chapter or home in on the topics and skills that are most relevant to your own situation. There is no right way to use this guide; make it work for you.

**A refresher course**

Use this guide on your own to update your GIS skills and knowledge. Instead of working with software and data stored on your computer, you’ll learn to leverage the power of cloud computing and open data. Learn about the opportunities to collaborate and share your maps and data with an ArcGIS Online organizational account. Get hands-on practice in 3D GIS, live data feeds, and crowdsourcing with ArcGIS Online. Whatever your prior GIS experience, this guide will bring you to a new and higher level.

**A lab manual**

Use this guide with a group of learners to provide practice in basic skills and content. Focus on particular chapters and skills one at a time or let learners go through the entire book at their own pace. By using the book in this way, you are providing learners with a foundation of GIS skills and knowledge they can build upon down the road.
A repository of training activities

Use this guide to design and deliver GIS training in a focused setting such as teacher professional development. Have you been asked to provide training in “the basics” of ArcGIS Online? Look no further than the content of chapters 1 and 2. Does your audience want to learn about story maps? Use chapter 3. If they want to do their own field data collection, then focus on chapter 7. For those who are often called upon to train others in the use of GIS, Instructional Guide for The ArcGIS Book, second edition, is an irreplaceable tool. No matter what the focus of the training, this guide provides the essential ingredients to combine and blend in any way you choose.
Introduction

This learning guide is a companion to *The ArcGIS Book: 10 Big Ideas about Applying The Science of Where* (Esri Press, 2017). It provides further resources and hands-on lessons to build upon the learning opportunities provided in that volume. Each chapter of this instructional guide contains activities and lessons that correspond to and illustrate parallel chapters in the *ArcGIS Book*.

Using this guide, GIS students and seasoned pros will hone their GIS skills while they build and publish web maps and apps, use live data feeds in apps, communicate information using maps, create and share Esri® Story Maps, answer complex questions using web maps and analysis tools, and make 3D map presentations. All of the lessons in this learning guide use GIS to address a scenario-based problem. Each can be completed with ArcGIS℠ Online or Esri’s cloud-based GIS apps. Some lessons require logging into an organizational account, but many do not. None requires having data preloaded on student computers. Instead, they utilize the rich repository of data and maps in the ArcGIS Online cloud. The lessons need not be done in any particular order. Finally, the guide also includes supplemental videos, activities, strategies, and discussion questions for further exploring *The ArcGIS Book*.

Whether you are a self-learner, are currently teaching, or are planning to teach GIS, this *Instructional Guide for The ArcGIS Book*, second edition, provides valuable materials to explore and apply GIS concepts and use ArcGIS tools to visualize and analyze spatial data.
Throughout history, technological innovations have triggered major transformations in the way we lead our day-to-day lives—the steam engine, electricity, the automobile, the computer. One of the most recent such innovations is the internet, or the World Wide Web. This single domino has been a catalyst for paradigm shifts in the way we learn, shop, and navigate, to name just a few. Through web-based mapping and data storage, GIS—once the realm of technical specialists—has become available to everyone. Now, whether you’re a beginner or a professional, you can access, analyze, and share data and maps within your organization and beyond.

The activities, videos, and lessons in this chapter reveal the unique power of GIS and of web-based GIS in particular. The six lessons in chapter 1 offer instruction and practice with basic GIS concepts: layers, spatial distribution, classification, symbolization, filtering and querying, and building and publishing a web app. The chapter also includes questions that support reading comprehension, reflection, and discussion of ideas presented in chapter 1 of *The ArcGIS Book: 10 Big Ideas about Applying The Science of Where*. Finally, the chapter provides suggestions for further practice through lessons on Esri’s Learn ArcGIS site.
Introductory activities

Video

Videos elevate motivation and enthusiasm as well as enhance discussion. The following videos represent Esri’s new vision of GIS as “The Science of Where.” Teachers can use them to generate interest and stimulate discussion.

The Science of Where—Unlock Data’s Full Potential

Exploring The Science of Where

Leading The Science of Where

Applying The Science of Where
Activity

Explore Map Book Gallery, published annually since 1984:

GIS users around the world map mineral resources, ecosystems, hurricane surge, waterfowl migration, earthquake disasters, and wildfire maps, to mention just a few. Published annually since 1984, the Esri Map Book acknowledges the important and innovative accomplishments of such users. Leafing through, you’ll be amazed at the great variety of maps. As you look at the maps in the map books, select three maps and for each map record the following:

- Organization that produced the map
- Reason or problem for the map
- Layers included in the map
Lessons: Account not required

Remember, you can access online all you need for the lessons in this guide. Some activities and lessons require no sign in to ArcGIS Online (the first set of lessons in each chapter), while others require signing in to an ArcGIS organizational account (the last set of lessons in each chapter).

The ArcGIS Book: 10 Big Ideas about Applying The Science of Where starts you off by exploring many unique analytical maps and scenes accessible online, such as Highway Access in Europe and US Minority Populations. From the GIS map or scene interface, users employ visual and analytical tools that investigate everything from election results in 3D to the terrain of the Swiss Alps. Such tools solve problems; they help you find answers to questions along the way; and they’re available online.

The following section and the first four lessons explain how GIS works and then it explores these basic GIS concepts:

- Data layering in GIS
- The analytical concepts of symbolizing/classification
- Querying/filtering

Investigate each of the lessons to understand the analytical value of each tool.
How GIS works

The science of geography

GIS is both a technology and a science. It relies on a simple notion of organizing data into discrete layers that are aligned (georeferenced) in relation to one another in geographic space.
Lesson 1-1: Working with GIS layers

Build skills in these areas

- Opening and navigating an existing online map
- Understanding the difference between accuracy and resolution
- Accessing tables
- Interpreting legends
- Distinguishing between different types of layers
- Adding x,y (longitude and latitude) data
- Adding address data (geocoding)

What you need

- Account not required
- Estimated time: under 30 minutes

Scenario

Your company is introducing online GIS into its suite of tools that beginning employees must know to compete in today’s workplace. They have asked you to create an online lesson that introduces their employees to GIS. One of the main focuses that they want shown in the lesson is the wide variety of data types that can be represented in a GIS.

Open the map and basic navigation

1. Click GIS Layers to open the web map you will be using in the following exercise.

2. Take a few minutes to familiarize yourself with the interface.
   - Zoom In
   - Zoom Out
   - Locate the scale bar

3. Click Modify Map in the upper right corner.

4. Click Show Contents of Map under Details to show and review the content pane.

5. Practice turning the layers on and off by checking the boxes.

How many different layers do you see represented?

Understand the difference between resolution and accuracy on the World Imagery Layer

The map opens with Light Gray Canvas Basemap showing. This web map is designed to draw
attention to thematic content by providing a neutral background.

1. Turn on World Imagery by checking the box.

   *What data is represented by the World Imagery Layer?*

2. Check on the World Imagery layer.

   *What information is available? Record the date, resolution, and accuracy of the imagery.*

   It is important to understand the difference between the accuracy and the resolution of the imagery. Accuracy tells you how closely the image matches the true value on the ground. Resolution refers to the measurement of the finest detail that can be displayed by the sensor.

3. Expand the World Imagery layer by clicking World Imagery. Notice that there are different resolutions shown. This can be noticed as you zoom in and out of the image. This represents a multiscale image. For example, 30 cm resolution shows imagery at a much greater detail than 15 m resolution.

4. For the World Imagery layer, click More Options, then choose Show Item Details. Note the layer details open in a new web page or tab.

   *Using the Item details, write a sentence explaining the resolution and accuracy of the World Imagery layer.*

5. Locate your home city or a place of interest you wish to explore.

6. Click on a pixel in the map. Notice how the pop-up reveals details on the source of the imagery, its resolution, and its accuracy.
Observe a digital elevation model as an example of raster data

In its simplest form, a raster consists of a matrix of cells (or pixels) organized into rows and columns (or a grid) where each cell contains a value representing information, such as elevation of temperature. Rasters are digital aerial images or imagery from satellites. The World Imagery Layer in the previous section is an example of a raster image. In this section you will investigate a digital elevation model where each pixel represents an elevation.

1. Turn on the Digital Elevation Model.
2. Zoom in until you can see the image at the pixel level.

Describe two types of landscapes that you can distinguish with the digital elevation model of the US.

Examine attributes and legends of vector layers

There are four layers left to examine in your beginning GIS layer map: USA States, USA Freeway System, USA Parks, and USA Major Cities. All these layers are called vector layers. Each layer has a spatial component (polygon, line, point) that is dynamically linked to a table of attributes. Each layer has its own unique table of attributes that can be accessed by clicking the table icon below the layer name. Turn on each layer one at a time and open its attribute table. Complete this chart:

<table>
<thead>
<tr>
<th>Layer Name</th>
<th>Vector Type</th>
<th>Two attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA States</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USA Freeway</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USA Parks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USA Major Cities</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Enter x,y data (longitude and latitude)

This entire lesson is about geography, or location on Earth’s surface, as the unifying link in geospatial technologies. You do not have to rely on prepared or existing layers to enter data into your GIS system. You can add point data to your GIS map in several different ways. One way is to add point data to your GIS map by specific longitude and latitude coordinates.

1. Turn all layers off except World Imagery Layer.
2. In the upper right search tab enter the following longitude and latitude: -100.336389, 44.368056
   Hint: These values are in decimal degrees.
3. Click Add to Map Notes. The Map Note creates a new layer to store the point.
4. In the upper right search tab enter the following longitude and latitude: -84.388077, 33.749041
5. Click Add to Map Notes.
6. In the upper right search tab enter the following longitude and latitude: -112.096389, 33.448056
7. Click Add to Map Notes.

What cities were located by their longitude and latitude? Why are some of the numbers negative?

Enter address data (geocoding)

Another way of entering point data is by geocoding. Geocoding is the process of turning an address into a locational point on a map. The ArcGIS software has a built-in World geocoder which allows this to happen.
1. In the upper right search tab type the following address:
   16 Cory Street, Augusta, ME 04330
2. Click Add to Map Notes.
3. In the upper right search tab type the following address:
   77 North Front Street, Columbus, OH 43215
4. Click Add to Map Notes.
5. In the upper right search tab type the following address:
   2101 O’Neil Avenue, Cheyenne, WY 82001
6. Click Add to Map Notes.
7. Zoom to the USA layer to see the location of all the Map note points we have located.

Complete your assessment
In this lesson you have expanded your vocabulary.

Explain the meaning of the following words:
raster
attribute
georeferenced
geocoding
accuracy
resolution
vector

The *US Population Change 2000 to 2010* map indicates the annual rate of total population change in the US from 2000 to 2010. The map shows two spatial components: counties and census tracts. The census tracts are not revealed until the user is zoomed in at a scale of 750 kilometers to 100 kilometers. Counties are typical political divisions. A census tract is a constructed division as well.

**Build skills in these areas**
- Use a multi-scale map
- Write spatial descriptions of different geographic areas

**What you need**
- Account not required
- Estimated time: under 30 minutes
Scenario
The new startup company Build for Us has had so much success that they are looking to expand. The company knows that any geographic location that is increasing in population requires more housing and would need to buy more material from Build for Us. The company has asked for an analysis of counties and even sections of counties that would be a good place to locate new Build for Us facilities. They are looking for both general areas in the US and specific areas in certain counties.

1. Click the US Population Change 2000 to 2010 map and zoom out to see the contiguous US.
   This multiscale map allows you to view geographic data across a range of scales.
   What is the first spatial component that you see?
   What is the second spatial component that you see as you zoom in?
   What does a census tract represent?
Examine the legend and write a description of the legend in your own words.

What formula was used to calculate the percent change in population from 2000 to 2010?

Build for Us has asked for written spatial descriptions of the US, individual states, and specific counties. The company will use these descriptions along with the map to decide where to locate new Build for Us stores.

2. Using the scalability of the map, write spatial distribution descriptions for the following areas.

   Write a description of the spatial distribution of the US by county by population change from 2000 to 2010.

   Zoom in to your state and write a description of the spatial distribution of your state by population change from 2000 to 2010.

   Zoom in to your county and write a description of the spatial distribution of the census tracts by population change in your county.

   How could other state and county agencies use this information?

Symbolization and classification
Before explaining symbolization and classification in GIS terms, let’s look at the essence of these processes.

You’re familiar with using a symbol to represent something else: A heart represents love, a fist signifies anger, and balloons stand for celebration—don’t forget that you have an entire language of symbols on your phone, those expressive emojis. Esri mapping products provide a plethora of symbols to use professionally on your maps.
Classification is another concept you’re accustomed to. When you group things that are in some way the same, you are classifying them. “All the girls, stand together.” “Anyone who rides Bus 3, gather over here.” Classifying becomes easy in a GIS because of the inherent features of a GIS system.

Symbolization in GIS is a method of assigning different sizes, colors, and shapes to features. For example, capital cities are often represented by stars, and danger areas are usually shown in red.

Classification or styling allows GIS users to display their data by any variable that is attached to points, lines, or polygons. The variables attached are called attributes. The following exercise gives the learner an opportunity to explore several different types of symbolization and classification/styling.
Lesson 1-3: Analyzing Nepal earthquake epicenters

The *Nepal Earthquake Epicenters* map shows epicenters of the earthquakes that occurred in and around Nepal. The year of the earthquake, its epicenter, and its magnitude can be viewed by clicking the points on the map. The points are also symbolized by the magnitude of the earthquake. The district divisions can be seen on the map as outlines. In this lesson you will see how the data can be displayed differently by changing the symbolization of the map, which will allow the viewer to visualize and observe even more information.

Build skills in these areas
- Opening and modifying an existing online map
- Changing transparency
- Changing style to unique values
- Changing style to Counts and Amounts
- Changing size and color of symbols

What you need
- Account not required
- Estimated time: under 30 minutes
Scenario

The United Nations Disaster Assessment and Coordination (UNDAC) team members need an emergency response system map to respond to the Nepal earthquake. They have seen the original Nepal Earthquake Epicenters map and are impressed. However, for their immediate need, they have asked that the map be altered to show the following:

- The epicenters of the 2015 earthquakes must be seen at all scales.
- All 75 districts should be shown by population.
- All recorded earthquakes with a magnitude of 5 and above should be shown. On the Richter scale, earthquakes above 5 can be felt by everyone and can cause slight damage to all buildings.

1. Click the Nepal Earthquake Epicenters map.
2. In the upper right corner, click Modify Map.

As you zoom in and out of the map you can see that the Nepal Earthquake 2015 layer disappears and appears according to the scale of the map. The UNDAC wants this layer visible at all times.

3. Click the three dots at the end of the NE 0425 layer. This layer shows the epicenters of the earthquakes.
4. Go to Set Visibility Range.
5. Move the slider to the left to set the visibility to the World. This makes this layer visible at all scales.
6. Again, click Contents under Details if the content pane collapses.
7. Type Nepal in the search window and the map will zoom to the extent of Nepal and display the 75 districts. The 75 districts are shown, but only their outlines are visible. All values of the districts look the same, which means they are classified on the map as location and only show you the distribution of the data.
When you classify or style data, you have many options. The Change Style menu is your gateway to changing the look of your data.

8. Click Change Style under the District layer.

9. The individual districts can be seen more distinctly if you choose DISTRICT as the attribute. A single symbol will give you a unique symbolization by the district name.

All districts are not displayed in a unique color on the map.

10. Click Options.
   a. Use the top slider to scroll down.
   c. Click Done. All the districts will not be displayed until you click the double arrow pointing up.
      Clicking the double arrow will display all the districts uniquely.
   b. Click OK.

You have displayed the districts by a unique value, using the District name field; however, the UNDAC wants the districts displayed by population. Seeing the districts displayed in a choropleth map by population would provide the responders with information about districts that would need the most resources during an earthquake. Numeric data can be displayed with counts and colors that display the features on the map as a color gradient.
11. Click District and click Change Style.
   a. Under Choose an Attribute to Show, select POP_91. Notice that the display changes from unique symbology for each district to a range of colors representing the population density. Darker colors showing higher population and lighter lower population.
   b. Click Done.
12. Uncollapse the District layer to see the legend.
13. Right-click the District layer and select Create Labels to label the districts by name.
14. Write a brief explanation of how the legend helps you understand the map.
   What does the legend show about the population?

Your last task for the UNDAC is to show only the earthquakes with a magnitude of 5 and above. You want only the values of 5 and above to be shown on the map.

15. Click NepalEarthquake2015 and go to Change Style.
16. Click the Counts and Amounts (Size) options.
   • Scroll down and change the classes to 2.
   • Move the slider to 5.

This shows values 0–5 in one class and 5 and above in the Other class.
17. Click Legend.

You might have to expand the style pane to see the legend.

18. Click 0 to 5.
19. Click Fill and choose No Color.
20. Click Outline and choose No Color.
21. Click OK.

This leaves only the earthquakes with a magnitude of above 5 shown on the map.

22. Click 5 to 7.5.
23. Click Symbol, change the size of the symbol to 30, and choose a distinct symbol.

24. Click OK.

Where on the map are the earthquakes with a high magnitude in relationship to a district with a high population?

25. Check off the District layer and observe the basemap layer.

What would make rescue efforts difficult in the northern districts?
In this lesson you have learned how to classify data by unique values, counts, and amounts. You have learned how to change transparency and change the size and color of symbols for better cartographic display.

Filtering and querying
Again, terminology can seem more threatening than it needs to be. Filtering and querying mean asking a question and, at an advanced level, asking a couple of questions strung together. A simple question would be “Where can I eat lunch?” A complex question would be “Where can I eat lunch and shop for clothes?”

A GIS system allows you to do further analysis with the data after it is mapped. In this way, GIS is more than a map. The most basic analysis in a GIS allows the user to ask questions of the data. Asking questions of the data can involve asking questions using the attributes or asking questions using the location. Questions can be constructed so they return a set of spatial results that extract meaning from your data.

Earthquakes

This simple live map shows earthquakes that happened over the previous 60 days.
Lesson 1-4: Filtering and querying to understand earthquakes

On the map, earthquakes over the past 60 days are symbolized by magnitude and depth. Here are some basic facts about earthquakes:

- Earthquakes between 5 and 7 are the ones that occur most frequently and cause damage.
- Earthquakes that are 7 and above are extremely damaging and much rarer.
- Earthquakes deeper than 300 kilometers are usually associated with convergent boundaries.

<table>
<thead>
<tr>
<th>Richter scale of earthquake magnitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>magnitude level</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>less than 1.0 to 2.9</td>
</tr>
<tr>
<td>3.0-3.9</td>
</tr>
<tr>
<td>4.0-4.9</td>
</tr>
<tr>
<td>5.0-5.9</td>
</tr>
<tr>
<td>6.0-6.9</td>
</tr>
<tr>
<td>7.0-7.9</td>
</tr>
<tr>
<td>8.0 and higher</td>
</tr>
</tbody>
</table>

Build skills in these areas
- Opening and modifying an existing online map
- Filtering data by attributes

What you need
- Account not required
- Estimated time: under 30 minutes
Scenario

The US Geological Survey (USGS) wants to use its live-feed earthquake data to promote understanding of earthquakes and their magnitude and depth. The USGS has asked you, as a representative of the American Association of Geographers, to write a lesson using this live-feed earthquake data, combined with the querying/filtering capabilities of the ArcGIS Online software.

Note: All answers will vary because of the last 60-day time frame of the data.

1. Click Earthquakes, which shows earthquakes that happened over the previous 60 days.
2. Click Show Map Contents under Details.
3. Click USGS Seismic Data – All Events by Mag to show the legend.
4. Click Filter under the Points layer.
5. Choose Magnitude field from the drop-down menu.
6. Choose greater than from the Operator menu.
7. Click Unique.
8. Type 5 for the magnitude.
9. Click Apply Filter.

You now see only the spatial display of the earthquakes that meet your criteria.

A multiple expression filter can be created to show only earthquakes that have a magnitude of 5 through 7. If you have more than one expression, choose to display features in the layer that match. All requires that each of the criteria specified must be true.
You can ask questions that have more than one criterion. For example, you could ask to see all the earthquakes that have a magnitude of greater than 5 and a depth of more than 300 kilometers. If you have more than one expression, choose to display features in the layer that match All or Any of your expressions. All requires the criteria you have specified must be true. Any means that only one of your expressions must be true for the features to display.

10. Click Filter.
11. Click Remove Filter.
12. Click Edit.
   a. Click Magnitude is greater than 5.
   b. Add another expression.
   c. Depth (kilometers) is greater than 300. Type in 300 for kilometer.
   d. Click Value.
   e. Click All.
   f. Click APPLY FILTER.

The map shows earthquakes that have both a magnitude greater than 5 and a depth (kilometers) greater than 300.

In this lesson you have learned how to ask questions of spatial data using the attributes to show the designated spatial values on a map.
Although many of the lessons in this book do not require saving your work, others do. Membership in an ArcGIS organization (with Publisher privileges) will enable you to easily follow directions to create, save, and share maps in every lesson. If you do not have an organizational account already, follow the instructions below to obtain one.

**Connect with and deploy the ArcGIS platform**

If you’re an existing ArcGIS user and already have an ArcGIS subscription (with Publisher privileges), you’re good to go. If you don’t have these three things, continue reading.

**Get a Learn ArcGIS organization membership**

The Learn ArcGIS organization is available for students and others just getting started with ArcGIS. Follow this link to the Learn ArcGIS organization to activate a 60-day membership. With your new membership, you can immediately begin to use maps, explore data resources, and publish geographic information to the web. Getting a Learn account is the quickest and easiest way to experience web GIS at ArcGIS Online.

**Schools mapping software bundle**

The ArcGIS for Schools Bundle is available at no cost for instructional use to individual US K–12 schools, school districts, and states direct from Esri. Beyond the US, the bundle is available to schools worldwide through Esri’s network of international distributors. Every public, private, home school, and youth-service club is eligible. The software bundle includes the following:

- ArcGIS Online organizational and user accounts
- Ready-to-use web and mobile apps
- ArcGIS Community Analyst licenses
- ArcGIS Desktop Advanced licenses

Sign up at Schools Mapping Software Bundle.

Build and publish a web app

The US Census Bureau is preparing a report on changing population trends between 2000 and 2010. The Census Bureau has hired your data visualization company to produce a map showing rate of change by state and county during this time period. Your company has chosen to use ArcGIS Online to produce the required product. The Census Bureau has given you data for the population of 2000 and 2010 for both states and counties. It has asked for a map symbolized to distinguish areas of population growth from areas of population decline. The Census Bureau wants to be able to have a story map web app on its website that the public can view.

Build skills in these areas

- Opening a map
- Enriching layers
- Adding a field
- Calculating values
- Symbolizing the data
- Publishing a map as a web app

Scenario

In the following lessons you will enrich a layer to your map, add fields, and calculate values. You will also clarify the legend and publish the lesson as an app showing the rate of population change by region.
Open the map
2. Sign in to your ArcGIS organizational account.
3. Click the Show Map Contents Button under Details.

The map opens, showing the Topographic basemap, state, and county boundaries. States and counties are political boundaries.

Change basemap
A basemap provides a background of geographic context for your map and, in this instance, the Light Gray Canvas Map shows the population data better.

1. Click Basemap on the top menu and change the basemap to Light Gray Canvas.

Save the map
1. On the top of the page, click Save and choose Save As.

   ![Save Map Window]

2. In the Save Map window enter the following information:
   - Title: *US Population Change__your initials*.
   - Tags: Remove all tags and enter *IGARC2_pop__your initials*.
   - Summary: *Map indicates the annual rate of total population change from 2000 to 2010*.

3. Click *SAVE MAP*.

Show table and examine attributes
To see information about features in a layer, you can display an interactive table at the bottom of the map.
1. Click the Show Table icon for States.

2. Examine the table. Notice the table shows only basic information.

3. Close the table by clicking the X in the upper right corner.

**Enrich data for states**

Data enrichment produces an enriched layer that retrieves information about the people, places, and businesses in a specific area. Detailed demographic data is returned for your chosen area. You are interested in a layer that shows the total population of 2000 and 2010.

4. Click States and Perform Analysis.
   - The analysis icon can be activated by either clicking the analysis icon under State or by clicking Analysis in the top ribbon.

5. Click Data Enrichment and Enrich Layer.

6. Click Enrich Layer to activate the Enrich layer pane. States is the chosen layer to enrich with new data.

7. Click Select Variable to open Data Browser and browse for variables.
   - a. Be sure the United States is chosen in the upper right corner.
   - b. Click Population.
   - c. Click the Arrow to go to the next page (2 times).
   - d. Click Population Totals.
   - e. Click 2000 data in 2010 Geography (U.S. Census) to uncollapse the layer.
   - g. Click 2010 Population (U.S. Census).
   - h. Check 2010 total Population (U.S. Census).
5. Click Apply.
6. Give Result layer a unique name such as enriched_states_your initials.
7. Uncheck Use current map extent.
8. Click Run Analysis.
9. Click Save at the top of the menu.

Add field and calculate: states

1. Click Show Table on enriched_states. The interactive table appears at the bottom of your map.

Notice that the table now shows 2000 Total Population and 2010 Total Population. It also shows the Federal Information Processing Standard (FIPS) number developed by the US federal government for use in computer systems.

The information in the table that you need to calculate the annual rate of change from 2000 to 2010 is State_Abbr, the 2000 Total Population, and the 2010 Total Population.

2. Click Table Options in the upper right corner of the table and choose Show/Hide Columns.

3. Uncheck all the fields except State_Abbr, 2000 Total Population and 2010 Total Population. Close the table by clicking the X in the upper right.

Your next step is to add a new field to the table to store the calculation that you are going to make.
4. Click Table Options in the right corner of the table and choose Add Field.

You can now see the new field added to the table.

6. Click the column you have just created (Annual rate of change from 2000 to 2010) and choose Calculate. This opens the Expression Builder dialog box.

You are trying to find the average rate of change per year from 2000 to 2010. If you subtract the population of 2000 from the population of 2010 and divide by the population of 2000, you will have the rate of change for 10 years; if you divide that number by 10, you will have the annual rate of change; and if you multiply that by 100, you will have a percentage. The formula is shown below.

7. Click the Annual rate of change from 2000 to 2010 field and click Calculate.

8. Type or copy the following formula in the Expression Builder:

\[
\left( \frac{(TOTPOP10 - TOTPOP00)}{TOTPOP00} \right) / 10 * 100
\]
9. Click Calculate.

When you click Calculate, it populates the rows with the annual rate of change for each state.

10. Close the table by clicking the X in the upper right corner.

11. Click DONE.

Symbolize and adjust legend: states

You want to distinguish your features based on the color gradient provided by the field you just calculated. The color gradient you should choose is Counts and Amounts (Color).

1. Click Enriched States and click Change Style.

2. In the Choose an attribute to show window, choose annual rate of change 2000 to 2010.

3. Choose Counts and Amounts (Color).

4. Click Options.
5. Check Classify Data and choose Natural Breaks.
6. Choose 6 classes.
7. Click Symbols and choose Red to Green ramp.

### Virginia

1. Click Counties and Filter.

2. For the expression, choose:
   a. STATE_NAME.
   b. is.
   c. Click Unique.
   d. Scroll to Virginia.

3. Click Apply Filter.

Only Virginia counties are shown on the map.


5. Name the file.

6. Run Analysis.

Write a description of the spatial distribution of the US by state population from 2000 to 2010.

**Enrich data by Counties for States**

For this exercise counties of three states, Virginia, Nebraska, and Arizona, have been chosen.

8. Add field rate_change.

9. Use the following expression when you calculate in the Expression Builder.

\[
\frac{\left( \text{TOTPOP10} - \text{TOTPOP00} \right)}{\text{TOTPOP00}} \times 100
\]

10. Symbolize and adjust legend.

11. Save the map to use in your web app.

15. Click Save.

16. Remove the filter for Nebraska.

17. Filter for Arizona.

18. Repeat steps 4–11.

19. Click Save.

Create a web app

You can create a web app from your map using a configurable app template. Your client has asked that the population rate change map you have built be displayed as a web app. Your client has asked you to use the configurable Story Map Series Web App.

1. Click Share.

2. Click Create a web app.

3. Select Build a Story Map.

4. Select Story Map Series.

5. Click CREATE WEB APP.

6. Specify a title, tags, and summary for the new web app.

7. Click Done.

8. Select Tabbed on the Welcome to Map Series Builder.
9. Click Start.

10. Type **Rate of Change Population 2000 to 2010** as the title for your Tabbed Map Series.

11. Click the arrow.

12. Add State Change for the Add tab.

13. Type **US Population Change 2000 to 2010** for your map.

14. Check Legend.

15. Click Add.

16. Write an analysis of the map in the text box.

17. Add the map VA.

18. Add the map NE.

19. Add the map AZ.

20. Click Save.

21. Click Share on the top of the page. The Organization tab is highlighted.
22. Click View live.

Perform additional analysis

The enrichment tool gives you access to a vast amount of data. For an additional learning activity, choose a variable to study and, using the above exercise as a guide, repeat the process for the chosen variable. For example, you may be interested in calculating the change in density of the population older than age 65 in the past 10 years. You can do this analysis either by state or at the county level.

Steps for this exercise:
1. Enrich population over 65 in 2000.
2. Enrich population over 65 in 2010.
\[
\frac{(\text{Density 2010} - \text{Density 2000})}{\text{Density 2000}} \times 100 / 10.
\]
Lesson 1-6: Analyzing the opioid crisis in America

Symbolize data and calculate with Arcade

The current opioid epidemic killed more than 33,000 people in 2015 and is considered one of the worst drug crises in American history. Public officials are collecting data and looking for solutions to the problem. Data has been collected by both the Centers for Medicare & Medicaid Services (CMS) and the Centers for Disease Control and Prevention (CDC). Medicare and Medicaid data is public and derived from Medicare Part D information. The data includes information about prescribing rates and prescription claim rates. Prescriber-level data provides the number of prescriptions as well as the number of claims (including new prescriptions and refills) for opioid drugs. It is to be noted that the Medicare and Medicaid programs provide coverage for the elderly and the poor age 65 and older. Drug-poisoning deaths have been obtained from the CDC. The opioid related deaths are for the entire general population.

Data Dictionary County Opioid Data:

prescribed opioids 2013 – Part D (prescriptions written for opioid drugs)

opioid claims 2013 – prescriptions filled for opioid drug claims submitted to health care provider

overall claims 2013 – total drug claims of all types submitted to health care provider

prescribed opioids 2014 – Part D (prescriptions written for opioid drugs)

opioid claims 2014 – prescriptions filled for opioid drugs claims submitted to health care provider

overall claims 2014 – total drug claims of all types submitted to health care provider

Data Dictionary Opioid Opioid-Related Deaths:

POP2013 – population 2013

POP2014 – population 2014

POP2015 – population 2015

Deaths 2013 – deaths caused by opioid related factors

Deaths 2014 – deaths caused by opioid related factors

Deaths 2015 – deaths caused by opioid related factors

Build skills in these areas

- Classifying data by color
- Classifying data by count
- Normalizing Data
- Using ArcGIS® Arcade expressions to make calculations
- Using ArcGIS Arcade expressions to label

What you need

- User, Publisher, or Administrator role in an ArcGIS organization
- Estimated time: 2 hours
Scenario

Both the CMS and CDC have data collections. They know that the mapping of this data will help increase their understanding of the opioid crisis. They have contracted you as a GIS analyst to produce maps showing the following:

- Opioid Claims 2014
- Percentage Opioid Claims 2014 (Opioid Claims 2014/Overall Claims 2014)
- Number of opioid deaths normalized by population (2014, and 2015)

Both the CMS and the CDC know how powerful it is to visualize data in a variety of ways. They are depending on you to use different visual options to present their data.

Open and save the map

1. Sign into your ArcGIS organizational account.
2. Open USA Opioid Usage.
3. Notice that you have three layers of data in the Contents pane:
   - Opioid Related Deaths
   - County Opioid Data
   - Topographic
4. Examine the data by turning the layers on and off and by zooming in and out on the map.
5. On the top of the menu, click Save and choose Save As.

6. In the Save Map window, type USA Opioid Usage and add your initials.
7. Remove the tag IGARC2_opioid and add your own individual tag OR add your initials to the IGARC2_opioid tag.
8. Type as brief description, such as USA opioid usage study at the county and state level.
9. Click SAVE MAP.

Show table and examine attributes

To see information about features in a layer, you can display an interactive table below the map. Both the Opioid Related Deaths layer and the County Opioid Data layer have associated attribute tables.
1. Click the Show Table icon under the County Opioid Data layer.

2. Examine the table. Refer to the data dictionary at the beginning of the lesson to understand the data.

3. Close the table by clicking the X in the upper right corner.

**Calculate opioid claims 2014 compared with opioid claim rates 2014 by color**

The data can be displayed in color by any of the fields in the attribute table.

1. Click the Change Style icon under County Opioid Data.

2. Under Choose an attribute to show select opioid claims 2014.

3. Click SELECT under Counts and Amounts (Color).

4. Click Done.

It would be easier to describe the map if the state outlines were shown on top of the county data.

5. Check Opioid Related Deaths to display states.

6. Click the Change Style icon under Opioid Related Deaths.

7. Click OPTIONS.

8. Click Symbols.

9. Click Fill and No Color.

10. Click Outline and Black.

11. Click OK.

12. Click OK.

13. Click DONE.

This is not the best way to look at the data because the data has not been normalized. Normalization of data means to adjust the data to a common scale. For example, in this exercise if we just classify the data by the number of claims,
the states with the most people will invariably have the most. To standardize our data, we can divide the number of opioid claims by the total number of claims. This gives a percentage of claims and is a much better representation of the data.

14. Again click Change Style under County Opioid Data.

15. Click Counts and Amounts (Color) OPTIONS.


17. Click OK.

18. Click DONE.

19. Right-click and go to rename. Change the name of the layer to % of Total Opioid Claims.

Notice how the map has changed.

Write a paragraph comparing the data of opioid claims in 2014 with the opioid claims normalized (divided by the total claims) in 2014.

Write a sentence about the spatial display (normalized) of the data. Which states have the most opioid claims? Which have the least?

20. Zoom in to your state.

Write a brief paragraph about the spatial display of the data within your state. Is there a pattern?

Calculate opioid claims 2014 compared with opioid claim rates 2014 by size

In the previous part of this exercise you have symbolized your data using graduated color. In this part of the exercise you will symbolize your data by size.

1. Click the Change Style icon under % of Total Opioid Claims.

2. Be sure that the Choose an attribute to show is still opioid claims 2014.
3. Click Counts and Amounts (Size).
4. Click Select.
5. Click Counts and Amounts (Size) OPTIONS.
6. Divided by Overall claims 2014.
7. Click OK.
8. Click Done.

What are the advantages of using color symbolization? Size symbolization?

Compare opioid related deaths from 2014 to 2015

The Opioid Related Deaths layer provides public data about opioid related deaths. It also provides the total population for 2014 and 2015.

You know from the previous part of this exercise that if you display the opioid related deaths without normalizing them, the data will be skewed. In other words, the states with the most populations would most likely have the largest number of deaths. The deaths need to be normalized by population. You can create this custom attribute that you need by writing an ArcGIS Arcade expression in the New Expression tab. Arcade is a simple expression language that can be used across the ArcGIS Platform. You can use Arcade expressions to perform calculations and create labels.

1. Turn off County Opioid Data.
2. Click the Change Style icon beneath the Opioid Related Deaths layer.
3. Under the Choose an attribute to show tab, select New Expression.
The expression or attribute that you need to show the change in opioid deaths from 2014 to 2015 is the following:

\[ \left( \frac{\text{feature.no2015}}{\text{feature.POP2015}} - \frac{\text{feature.no2014}}{\text{feature.POP2014}} \right) \times 100 \]

This is a simple expression of normalized data. It starts off with two parentheses ( ( because we have to do one function and then a second function. The first is $\text{feature.no2015}$, the number of deaths in 2015, / is divided by $\text{feature.POP2015}$, the population in 2015. You then subtract $\text{feature.no2014}$, number of deaths in 2014 / divided by $\text{feature.POP2014}$, population in 2014. You then close the first parenthesis ). You multiply * by 100 to change to a percentage. Close the parenthesis ). Once you work with these expressions they become much simpler. You can copy the above expression and paste it into the expression box, but it is good practice to write the expression yourself.

4. Click Edit and change the name from Custom to Difference in Deaths 2014 to 2015.

5. Click SAVE.
6. Click OK.
7. Click Counts and Amounts (Color).
8. Click OPTIONS.
9. For Theme select Above and Below, which shows values above and below a specific value. In this case it would be above 0 to indicate an increase in deaths and below 0 to indicate a decline in deaths.

10. If the middle tab on the Above and Below Theme is not 0, click and type in 0.

11. Click OK.
12. Click DONE.
The states that have an increase in deaths are shown in purple and the states that have a decrease in deaths are shown in rust. The map would be more meaningful if the number of deaths gained or lost would be shown on the map. You can use another simple Arcade statement in the manage label menu to accomplish this.

13. Click the three dots at the end of the Opioid Related Deaths layer and choose Create Labels.


15. Write the expression $feature.no2015-$feature.no2014, which is Deaths 2015 – Deaths 2014.

16. Click edit and name the expression Change in Deaths.

17. Click SAVE.

18. Click OK.

19. Change the color to White and make the text Bold.

20. Click OK.

21. Save your map.

There are noticeable big increases and decreases between years.

Which states have decreased in deaths?

Which states seem to have the most increase in deaths?

In this lesson you have used different symbolization methods, and you have adjusted your data to a standard scale by normalization.
Teachers can use the items in this section as an assignment, an introduction, or an assessment, tailored to the sophistication of learners. Some learners can read all the sections at one time, while others are more comfortable with small segments. The questions and tasks are designed to stimulate thought and discussion.

**Thought leader: Jack Dangermond**

**GIS: Understanding The Science of Where**

*Write an explanation of The Science of Where. Include in your explanation thoughts on data integration and GIS as a platform.*

**Enabling a smarter world**

**GIS provides a framework and process**

*List the different parts of the GIS framework with a brief explanation of each part.*

**Web GIS is collaborative**

**Geography is the key, the web is the platform**

*What is meant by geography is the key?*

**What does georeferenced mean?**

**How has web GIS changed and expanded our use of georeferenced data?**

**How GIS works and ArcGIS information items**

**The science of geography Layers**

*List five different types of layers that can be represented on a map.*

**What is the difference between a map and a scene?**

*Investigate the maps. Pick one map and write about the information it portrays.*

*Investigate the scenes. Pick one scene and write about the information it portrays.*

**Geospatial analysis yields insights**

*Explain geospatial analysis.*

**Apps extend the reach of GIS**

*What is an app and what is its purpose?*
Additional resources

Understanding the Difference between Consumer and GIS Mapping Applications

Static Web maps vs dynamic Web GIS

Learn ArcGIS: Guided lessons based on real-world problems

Set Up an ArcGIS Organization
- Administering an ArcGIS organization.
- Designing the home page.
- Sharing content and creating groups.
- Creating custom roles and adding members.
- Calculating credits for analysis and storage.
- Managing licenses for ArcGIS apps.

The Power of Maps
- Exploring online maps and apps.
- Interpreting maps.
- Understanding spatial analysis.

Get Started with ArcGIS Online
- Adding layers to a map.
- Adding data stored as spreadsheet or file data to a map.
- Changing map symbols.
- Configuring pop-ups.
- Sharing the map as a web app.
Maps are among our oldest communication tools. They convey information with symbols, colors, lines, and words. They convey a “sense of place” in the broadest sense: the relationships and connections between places and the forces that shape social and physical characteristics. It does not matter what media delivers a map. Whether they are hand drawn, printed, digital, or online, maps deliver information to the viewer that is both analytical and artistic.

Cartography is the art of making maps, and in ArcGIS Online, you can easily access smart mapping tools to help you make the cartographic decisions that render your map informative. The tools suggest the best way to coordinate color and to represent and style your data. They allow novice users to gain experience with cartographic options and learn from practice. When any new data is added to your online map, you’ll see the smart mapping tools available on the interface.

This chapter includes a broad range of instructional topics, starting with the investigation into the variety of ArcGIS Online basemaps and ending with a scenario-based lesson on the availability of farmers’ markets. Within the topics, you’ll find ways to add and display data to your maps, to analyze your data, and to better design your maps.

The chapter also includes questions that support reading comprehension, reflection, and a discussion of chapter 2 narratives in The ArcGIS Book: 10 Big Ideas about Applying The Science of Where.
Introductory activities

Video

These videos show the way maps can help us tell stories and solve problems. Teachers can use them to generate interest and stimulate discussion. The Importance of Maps provides an overview of the vast range of issues that GIS maps can address. Esri UC 2017 User Map Submissions demonstrates the extent of that diversity through the display of numerous maps created by professional GIS users.

The Importance of Maps

Esri UC 2017 User Map Submissions
Activity 2-1
Scale and resolution
Mastering the difference between them

Maps have always been defined as a graphical representation of Earth’s surface, so mapmakers have always dealt with scale. With the introduction of digital orthophotos, the property of resolution became equally important to consider. Resolution is a linear dimension on the ground that is represented by each pixel. If resolution is high, you will be able to see more detail in a digital photo as you zoom in; if resolution is low, you will be able to see less detail.

Low Resolution  High Resolution

Scenario
You have been asked to give a presentation to beginning teachers about the difference between map scale and resolution. The designated audience is middle school students.

1. Go to ArcGIS Online — Mapping Without Limits
2. On the top of the site, click Map.
3. Click Basemap and change the basemap to Imagery.

Where is the scale shown on the map?
4. In the Find tab on the upper right, search for the following locations and zoom in as far as possible:
   - Washington, DC
   - Mount Kilimanjaro, Kilimanjaro, Tanzania
   - Moscow, Russia
   - Seattle, WA

   *Are there different zoom restrictions?*
   *Are the images clear at the last zoom?*

   Resolution, by definition, is a function of the satellite or aerial imagery used. A detailed description of the imagery resolution is found at [World Imagery Resolution](#).

   *In one or two sentences summarize what the resolution is after reading this description.*

   *Verbalize to a small group the difference between scale and resolution. Feel free to use the maps as visualizations.*

   **Activity 2-2**
   **Predominant Mapping**
   **US county crops 2007**
   The best maps are not only information products; they are visually interesting. In this exercise you will start with an unclassified layer and classify the data in several ways. Your assignment is to try to produce a map that is effective in showing county crop production in the US in 2007.
Open map and display multiple attributes

1. Open *US County Crops*.

The map opens without any symbolization. Your job is to use two different types of symbolization (color and size).

2. Click Content.

First you need to display the data by four unique attributes.


4. Under Choose an attribute to show, select Corn for grain, harvested acres.
5. Add Attribute.
6. Select All wheat for grain, harvested acres.
7. Add Attribute.
8. Select Soybeans for beans, harvested acres.
9. Add Attribute.
10. Select Upland cotton, harvested acres.
11. Add attribute.

The next part of this activity will introduce you to predominant mapping. A predominance map allows you to analyze multiple fields of related data and show the field that is predominant (has the most units). The multiple fields of data must share a common subject and unit of measurement. The predominant map can either be displayed by Predominant Category or Predominant Category & Size.

**Display by Predominant Category**
1. Select Predominant Category.
2. Click OPTIONS.

Change the colors to represent the crop types.

3. Click the square for corn and select yellow. Click OK.
4. Click the square for wheat and select dark tan. Click OK.
5. Click the square for soybeans and select dark brown. Click OK.
6. Click the square for cotton and select gray. Click OK.
7. Click the square for vegetables and select green. Click OK.

You can apply transparency to each feature based on the strength of the predominant attribute (percentage of total).

8. Click Set from Predominant Percentage.
9. Click OK to dismiss Predominant category.

*What is dominant in the Midwest and why? Why does the West Coast have a majority of vegetable production?*

**Display by Predominant Category & Size.**
You will now display your data by Predominant Category & Size with color showing the predominant category, size showing the sum of the categories and transparency showing the relative strength of the predominance.
1. In Change style dialog, click SELECT under Predominant Category & Size.

2. Zoom into the county level.

List the advantages and disadvantages of the two predominant category styles.
List the three variables displayed in predominant category and size maps.

In this activity you have explored predominant mapping by using both category and category and size styles.
Lessons: Account not required

Remember, you can access online all you need for the lessons in this guide, either with no sign in to an ArcGIS Online organizational account required (the first set of lessons in each chapter) or by signing in with an organizational account (for the last set of lessons in each chapter).
Lesson 2-1: Adding point data

Find patterns in mountains of data

You begin to get a strong sense of what maps can do from this lesson. The image shows a total of 58,000 airline routes on one map. The Web Mercator projection transforms the straight flight paths into curves. You are going to use this map to solve a spatial problem while also learning how GIS software deals with point data. Locational information contained in point data adds the spatial component that the map needs to locate the information. Point data can get its locational information from latitude and longitude or from a street address.

Build skills in these areas

- Opening and modifying an existing online map
- Filtering
- Adding x,y data
- Geocoding data
- Creating bookmarks

What you need

- Account not required
- Estimated time: 30 minutes – 1 hour
Scenario

The International Federation of Air Traffic Controllers’ Associations (IFATCA) wants to investigate flights going in and out of three of the busiest places in the world: London, New York, and Atlanta. The federation wants a visual representation of the flight routes to each of the airports within the three cities.

Open the map, add and filter data

1. Click *Airflow Pro*.
2. In the upper right corner, click Modify Map.
3. In the top menu, under Details, click Content. You should see two layers in the Content pane: World Dark Gray Base and flight routes.
4. Click Add on the Top menu and choose Search for layers.
5. The search pane opens.
   - In the search box, type “World Cities” owner:esri.
   - In: ArcGIS Online.
6. Add World Cities by esri.
7. Click Done Adding Layers.

You have been asked to map three individual cities that have the largest air traffic: London, New York, and Atlanta. You need to add a layer to obtain that information.

4. Click Add on the Top menu and choose Search for layers.
5. The search pane opens.
   - In the search box, type “World Cities” owner:esri.
   - In: ArcGIS Online.

As you zoom out, both layers disappear. This is because a visibility range has been set. Visibility range is used with multiscale maps and allows you to view geographic data across a range of scales or zoom layers. The next two steps set the visibility range to be at all scales.

8. Click the three dots More Options and select Visibility Range.
9. Change the slider to go from World to Building. (You can specifically set the scale to be 1:18,000,000 or you can move the right to buildings and leave the left on world.)

You now want to narrow down the cities to London, New York, and Atlanta. You do this by applying a filter, which presents a focused view of the feature layer World Cities.

10. Point to World Cities and click Filter.

11. Create your definition expression. Be sure to select Any.
   - CITY_NAME is London. (Type London.)
   - Be sure to click Unique.
   - + Add another expression.
   - CITY_NAME is New York. (Type New York.)
   - + Add another expression.
   - CITY_NAME is Atlanta. (Type Atlanta.)
   - Click Apply Filter.

Once again at the top of the Filter Menu be sure you change the setting from All to Any.

Locate and map airports

Now that the three cities are isolated, it is time to locate and map the individual airports.

To add the location of the individual airports, you will deal with two types of point data.

Type 1: Add the first set of airports to the City of London by using latitude and longitude (x,y) data.

Type 2: Add the second two cities (New York and Atlanta) with address information.

Add this feature data from a delimited text file (.txt) or a comma-separated values text file (.csv) that includes the locational information (latitude and longitude or address) along with any other attributes. What follows is an example
of a delimited text file for the London airports with latitude and longitude data. Notice how the headers are separated by commas with no spaces. That is why it is called a comma delimited text file. The name of the airport is the only attribute attached to the locational information. Notice also that the latitude and longitude are in decimal degrees. These must be exact and on one line and with no spaces.

Long, lat, name
-0.45361, 51.47196, Heathrow
-0.17899, 51.15518, Gatwick
-0.37557, 51.8798, Luton
0.23985, 51.88516, Stansted
0.70171, 51.56612, Southend

1. Copy the text above exactly as shown into a simple text application. Notepad is a great application to use for this. Be sure to copy the top line: Long, lat, name.

2. Save the file on your computer and name it airports_x_y.

3. Drag the airport_x_y file to your map. This is the power of GIS. You have taken a table of data and mapped it. If you click on any of the points, you can see the locational information as well as the name of the airport.

**Change symbology**

1. The airports are displayed by Types (Unique symbols) with the attribute as the name. Click legend to see airports displayed by name. You can switch back and forth from Contents to Legend.

   ![Change symbology](image)

2. Click the color ramp to activate the change symbol menu.

3. Move the Symbol Size to 15 and choose a shape.

4. Click OK.

5. Click Done.

**Geocode**

Add the second two cities (New York and Atlanta) with address information. Geocoding is the proper term for converting an address to an x,y coordinate. By default, ArcGIS Online uses the World Geocoding Esri service.

Below is what you need for a comma-delimited text file for New York and Atlanta.

Name, address, city, zipcode
Chapter 2: Mapping Is for Everyone—Lesson 2-1: Adding point data

Laguardia, LaGuardia Rd, Flushing, New York, 11371
John F Kennedy Int’l Airport I 678 S, Jamaica, New York, 11430
Hartsfield-Jackson, 6000 N. Terminal Pkwy, Atlanta, GA, 30320

1. Copy the above lines exactly as shown into a simple text application (like Notepad).
2. Save the file on your computer and name it airports_addresses.
3. Drag the airport_addresses file to your map and ADD Layer.
4. Match the symbology of the UK airports as set previously.

Create bookmarks

To get quickly from airport to airport on your map, as the map author, you need to create bookmarks. Bookmarks are based on the current location and scale of the map. When others click a bookmark, the map zooms to that location.

1. Zoom to the location and scale that you want to look at for London and its airports. You might want to change the basemap.
2. On the top of the site, click Bookmarks.
3. Click Add Bookmark.

4. Name the bookmark **London**.

5. Click the X in the upper right corner to close the bookmark.

6. Zoom to New York and create a bookmark. Name the bookmark **New York**.

7. Zoom to Atlanta and create a bookmark. Name the bookmark **Atlanta**.

By completing this map, you have given the IFATCA a visual representation of the flight routes to London, New York, and Atlanta. To do that, you used the following GIS skills:

- Searching for ArcGIS Online layers
- Filtering layers
- Mapping table data with an x,y coordinate
- Mapping table with an address
- Creating bookmarks
Lessons: Account required

Although many of the lessons in this book do not require saving your work, others do. Membership in an ArcGIS organization (with Publisher privileges) will enable you to easily follow directions to create, save, and share maps in every lesson. If you do not have an organizational account already, follow the instructions below to obtain one.

Connect with and deploy the ArcGIS platform

If you’re an existing ArcGIS user and already have an ArcGIS subscription (with Publisher privileges), you’re good to go. If you don’t have these three things, continue reading.

Get a Learn ArcGIS organization membership

The Learn ArcGIS organization is available for students and others just getting started with ArcGIS. Follow this link to the Learn ArcGIS organization to activate a 60-day membership. With your new membership, you can immediately begin to use maps, explore data resources, and publish geographic information to the web. Getting a Learn account is the quickest and easiest way to experience web GIS at ArcGIS Online.

Schools mapping software bundle

The ArcGIS for Schools Bundle is available at no cost for instructional use to individual US K–12 schools, school districts, and states direct from Esri. Beyond the US, the bundle is available to schools worldwide through Esri’s network of international distributors. Every public, private, home school, and youth-service club is eligible. The software bundle includes the following:

- ArcGIS Online organizational and user accounts
- Ready-to-use web and mobile apps
- ArcGIS Community Analyst licenses
- ArcGIS Desktop Advanced licenses

Sign up at Schools Mapping Software Bundle.
Lesson 2-2: Displaying crime data with heat maps

Washington, DC, July 2016

Esri has a smart mapping mission to enable anyone to visually analyze, create, and share professional-quality maps. In this lesson, you will analyze point data using heat maps within smart mapping. To begin your journey, explore the story map below.

How to Smart Map: Heat Maps

Build skills in these areas
- Finding and downloading a CSV file
- Uploading a CSV file
- Filtering
- Changing basemaps
- Using heat maps at different scales
- Comparing two variables

What you need
- Account required
- Estimated time: 30 minutes - 1 hour
Scenario
The Washington, DC, police department is planning the deployment of its resources for the month of August. The department would like to see different geographic patterns of criminal behavior on a map. The GIS staff has been given the July data on Friday afternoon and has been tasked with analyzing the data by the Monday morning briefing. The police chief is particularly interested in auto theft and burglary. The chief has asked for the following maps to be produced:

- A map showing total crime concentration
- A map showing auto theft
- A map showing burglary
- Two individual maps of auto theft and burglary for Ward 8

Find and download a prepared CSV file of July 2016 Washington, DC, crime
1. Click **Crime Incidents in 2016 July**.
2. Click **Download**.
3. Save the file to an appropriate place.

Log in to your organizational account, create new map, save
1. Log in to your **ArcGIS** organizational account.
2. Click Map.
3. Click **Show Map Contents** under Details.
4. On the top menu click **Save As**.

5. In the Save Map menu enter the following information:
   - **Title**: Crime in Washington, DC.
   - **Tags**: IGARC2_crime_your initials.
   - **Summary**: Crime in Washington, DC, displayed by heat maps.
6. Click **SAVE MAP**.

Upload and publish a prepared CSV file of July 2016 Washington, DC, crime
You can upload a CSV file to your ArcGIS Online file and publish it as a layer.
1. In the upper left corner click **Home** and Select **Content**.
2. Click Add Item>>From my computer.


4. Add Tags: IGARC2_your_initials.

5. Check Publish this file as a hosted layer.

6. Check Locate features using Address.

7. Add Item.

8. Change Choose an attribute to show location only.

9. Click DONE.

10. Change Choose an attribute to show to show location only.

11. Click DONE.

Open the attribute table and examine the attributes

1. Click Open Table under Crime Incidents in 2016 July.
2. Click Change style and change color to red.

3. Examine the table of attributes.

<table>
<thead>
<tr>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>114x506</td>
</tr>
</tbody>
</table>

How many total crimes are there?

How many wards?

4. Close the table by clicking X in the right corner.

Another basemap

1. On the top menu bar select Add>>Search for Layers.

2. Search for:

Find: Human Geography Detail.

In: ArcGIS Online.

3. Add Human Geography Detail.

The Human Geography Detail map provides a monochromatic style with a detailed reference layer including administrative boundaries, roads, and highways.
4. Click DONE ADDING LAYERS.

5. Set Human Geography Detail as Reference Layer. The reference layer is not only a visual layer; you can click on a feature in the reference layer and view data associated with that layer.
Produce a multiscale heat map of total crime in July 2016.

1. Click the Change Style icon under Crime Incidents in 2016 July.

2. Select Heat Map.

3. Click DONE.

Write a description of where the crime is concentrated.

Does the heat map change as you zoom in and out?

Why is a heat map effective to display this crime data?

Produce multiscale maps of auto theft and burglary

For this section of the exercise you first want to isolate auto theft, which is represented in the attribute table as THEFT F/AUTO. After analyzing the auto theft map you will then isolate burglaries.

1. Click Filter under the Crime Incidents in 2016 July.

2. Create the following expression: OFFENSE is THEFT F/AUTO.

3. Click APPLY FILTER.

This selects only the Auto Thefts.

4. Open the table.

How many crime incidents are theft auto?

5. Select the Change Style Icon.


7. Click DONE.

This gives a very different visualization of the data.

Where would you direct your personnel to crack down on auto theft?

8. Repeat steps 3–7 for Burglary. (Remove old expressions first.)

How many crime incidents are burglary?

Where would you direct your personnel to crack down on burglary?

Produce maps for ward 8 of auto theft and burglary

In this exercise you are going to concentrate your police effort in ward 8. This requires a double filter.
1. Filter for ward 8.
2. Add an expression.
3. Filter for THEFT/AUTO. (Don’t forget to remove previous filter.)

![Image of Filter: Crime_Incidents_in_2016_July]

4. Click Change Style.
5. Select Heat Map.

*How many auto thefts are there in ward 8?*

*Where is the auto theft most concentrated in ward 8?*

6. Repeat steps 1–5 for burglary.

*How many burglaries are there in ward 8?*

*Where are burglaries most concentrated in ward 8?*

In this exercise you have analyzed crime data using heat maps. You have examined both total crime and specific offenses as well as crime within a specified ward.
A closer look

Educational achievement varies throughout the US. The US Department of Agriculture’s Economic Research Service Division has compiled data for 2011–2015 (a five-year average) of educational achievement at the county level. The data used by the USDA was obtained from the US Census Bureau’s American Community Survey (ACS). The data is shown by normalized values (a percentage of county population). The data is comprehensive and is divided into numerous categories. For this exercise academic achievement is divided into the following categories:

- No high school diploma
- High school diploma
- Bachelor’s degree

Students who have had some college experience have not been calculated in the above categories. Because that variable has been left out, the achievement variables percentages will not add up to 100 percent.

Build skills in these areas

- Using filters
- Mapping by quantities
- Mapping multiple fields
- Using predominance maps
- Describing trends and patterns

What you need

- Account required
- Estimated time: 30 minutes - 1 hour

Scenario

The National Education Association is interested in patterns and trends of academic achievement in the US. The association has asked for maps that illustrate academic achievement at a county level.

Open and save an academic achievement county map

2. Sign in to your organizational account.
3. Click Save As on the top ribbon.

4. Save your map with the following information:
   - Title: United States Educational Achievement__Your Initials
   - Tags: Remove IGARC2_educational: insert IGARC2_ed_your initials
   - Summary: United States Educational Achievement
Represent data by quantities
1. Switch to Content.
2. Uncheck USA States.
3. Open the attribute table by clicking the Show Table icon beneath usa counties ed 2011 2015.

4. Click the Change Style icon under the usa counties ed 2011 2015 layer.

5. Choose an attribute to show: select % No Educational Degree.

6. Select Counts and Amounts (Color): SELECT.

7. Click done.

To perform analysis of the data, you need to show the state boundaries.

8. Turn off usa counties ed 2011 2015.
9. Turn on USA States.
10. Click the Change Style icon under USA States.
11. Click OPTIONS.
12. Click Symbols.
13. Change the Fill to No Color.
14. Change the outline to red with a pt 2.

What states have the highest percentages of students with no degree?
Do you see any regional trends?

What is the spatial distribution of counties with the highest percentage of college degrees? Of lowest?

Do you see any regional trends?

Filter the data
It would be interesting to know which counties are in the top 10 of both percentage with a degree and percentage with a college degree. You can find this out by filtering.

1. Open the Show Table.

2. With the table open click the field % College Degree and choose Sort Descending.

You see that the highest percent of the population with a college degree is in Falls Church, VA. You will now select all the counties that have above 50 percent with a college degree.


What is represented along the Mississippi River from Minnesota to Mississippi?

Explain the spatial distribution in Texas.

18. Repeat steps 4, 5, and 6, changing the attribute to % College Degree.
4. Write the expression: % College Degree is greater than 50.

5. Click APPLY FILTER.

What states have more than two counties with above 50 percent college degrees? Hint: you might want to show the table.

6. Click Filter.
7. Click REMOVE FILTER.
8. Click Filter.
9. Write the expression:

% No Educational Degree is greater than 20.

10. Click APPLY FILTER.

11. Consider changing basemap to Light or Dark Gray Canvas to better see the filtered counties.

What states have the greatest number of counties with 20 percent with no degrees?

Is there a regional trend?

Create a predominance map of academic achievement in predominant category and predominant category and size

A predominant category map allows you to map multiple related attributes to compare and show which attribute is predominant—that is, has the highest value—and the degree of its predominance compared with the other attributes in the layer. In this example, you would map % no degree, % high school degree, and % college degree. Each attribute is drawn with a different color, and transparency shows the relative strength of the attribute.

1. Remove the previous filter.
2. Click the Change Style icon under USA counties ed 2011 2015.
3. For choose an attribute to show, choose % No Educational Degree.
4. Click Add attribute.
5. Choose % High School Degree.
6. Click Add attribute.
7. Choose % College Degree.

8. Click Predominant Category>>OPTIONS.
9. Click the square by % No Educational Degree.
10. Select Fill >> Red.
11. Click OK.
12. Repeat for % High School Degree and choose Yellow.
13. Repeat for % College Degree and choose Green.
14. To set Transparency click Set from Predominant Percentage.
15. Click OK.

Create a predominance map of academic achievement in predominant category and size

A predominant category and size map not only allows you to map multiple attributes with color and transparency, it also adds the third element of size, with size representing the sum of the attributes for each feature.

1. Before clicking DONE, select Predominant Category & Size>>SELECT.
2. Click OPTIONS.
3. Click Predominant Category >> OPTIONS.
4. Manually change the color to same as above in predominant category.
5. Click Transparency>>Set from Predominant Percentage.
6. Click OK.
7. Click OK.
8. Click DONE.
9. Click SAVE.
This type of mapping is good for looking at individual counties.

10. Zoom into your county.

Describe the spatial distribution of academic achievement within your state.

In this lesson, you have displayed academic achievement data by counties using predominant category and predominant category and size styling.
One of the oldest sources of “open data” is the US Census Bureau. Decennial census data was always available, but it was not until the 1990 Census that data for the entire US became available in a digital format designed for use in a GIS. Today, census data is used for research, program design, and planning in every segment of our society—government, business, health, environment, education, and many, many more.

Census data can be mapped and analyzed at every geographic level from states to census tracts. In this lesson, you will map the distribution of minority populations across the United States by county. After creating your map, you will share it as a Bulleted Series Story Map.

Build skills in these areas
- Opening a map
- Making copies of a map layer
- Renaming map layers
- Classifying minority populations by percent of total county population
- Creating layers showing counties with minority populations greater than 50 percent
- Creating a bulleted series story map

What you need:
- An account in an ArcGIS Online public or organizational account
- Estimated time: over 1 hour
Scenario
The US Department of Education (DOE) is undertaking a study of minority student performance on standardized achievement tests. The DOE has hired your data visualization company to produce maps showing the distribution of minorities in the US. Your company has chosen to use ArcGIS Online to produce the required product. The Census Bureau has given you data for minority population by county. The DOE has asked for a map symbolized to show minority population as a percentage of total population and to specifically identify counties in which the minority population is 50 percent or higher.

Open the map
1. Sign in to your ArcGIS public or organizational account.
2. Search for IGARC2_minority. (Search under maps.)
3. Turn Off Only search in participants button.
4. Open the Minority Population by County map created by esripress_igarc2e.

Make copies of a map layer
1. In the list of map contents, click the More Options icon (three dots) under USA Counties and select Copy.
2. You can now see a new layer called USA Counties – Copy.
3. Repeat the copying step until you have five layers called USA Counties – Copy.
4. Click the same More Options icon (three dots) under USA States and click Move up.
5. Repeat until the USA States is the top layer in the Table of Contents.

You can now see the state boundaries as well as the county Boundaries and your map should look like this:

6. Save your map as Minority Populations by County [your initials].
Rename map layers

1. Click the More Options icon (three dots) under one of the USA Counties. Copy layers and select Rename.

2. Enter Black in the layer name box that appears.

3. Repeat this process naming the other USA Counties. Copy layers Hispanic, Asian, Native American/Alaskan, and Hawaiian/Pacific Islander. Note: The sequence doesn’t matter.

Your Table of Contents should now look like this:

Classify minority populations by percentage of total county population

1. Click the Change Style icon under the layer named Black.

2. Leave the attribute selection as Show location only and click Options to change the symbol to a bold color.

3. Now click Attribute Values beneath the Transparency slider. This means you want to set the transparency by an attribute value.

4. Select black from the drop-down list of attributes and Pop2010 from the Divided By list.
5. Now you see a window that says Set transparency based on the attribute values. Make the following changes in this window:
   
a. Under Transparency Range change High Value to 0% and Low Value to 100%.

b. Change the breakpoint on the slider from .22 to .2. Note: You can do this by clicking on the .22 and then typing in the new number.

c. Click OK, OK, OK, and Done.

6. Turn off all the minority group layers except Black and USA States. Your map now looks like this:

7. Repeat the same procedure for Hispanic, Asian, Native American/Alaskan, and Hawaiian/Pacific Islander.

8. Save your map frequently.

When you have symbolized all the layers, your map will look like this:

You need to pan to see Alaska and Hawaii. The appearance of the map may vary depending on your choice of colors and the sequence of layers from top to bottom.
Create layers showing counties with minority populations greater than 50 percent

1. Once again, copy the USA Counties layer.
2. Rename it Black 50% or higher.
3. Click the Change Style icon under the new layer and select Black from the drop-down menu under Choose an attribute to show.
4. Click Options in the Counts and Amounts (Color) drawing style.
5. In the Divided By drop-down list, select POP2010.
6. Under classify Data select 2 classes.
7. On the slider, change the breakpoint to .5.
8. Click Legend and change the 0 to 0.5 to No fill.
9. Click OK and Done.

Your Black 50% or higher layer should look like this:

10. Repeat this procedure two more times, creating a Hispanic 50% or higher layer and a Native American/Alaskan 50% or higher layer. (If you try to follow the same procedure with the Asian or Hawaiian/Pacific Islander layers you will get a message—“This value is out of range”—when you try to change the breakpoint to .5. This means there are no counties in which these minorities make up 50% or more.)

Your three layers showing counties with minority population at or above 50% should look like this:

11. You will need to save a separate map of the counties with 50% or higher minority population.
12. Turn off all the minority layers except for the ones showing the counties with 50% or higher minority population.

13. Use Save As to save this map as Counties: Minority Majority.

Create a bulleted series story map

1. Open your first saved map: Minority Populations by County [your initials].

2. Select Share and Create a web app.

3. Select Build a Story Map and then click Story Map Series.

4. Title the app Minority Populations by County – [your initials]. Give it tags and an app summary, then click Done.

5. In the Map Series Builder window, select Bulleted and then click Start.

6. Enter the title of your Bulleted Map Series: US Minority Populations by County and then click the arrow.


8. Choose Select a Map and browse the maps in your account to find Minority Population by County and click Add.

9. This will open a Builder window for your first map. Enter the following text in the Text area:

This map reflects the distribution of minority populations, by county, across the United States in based on 2010 Decennial Census data. The darkest color for any group indicates that it represents 20% or more of the total county population.

10. When you are finished, click Save (upper right).

11. Click the Add button (upper left) to add another bullet.

12. Title the new entry Minority Population 50% or Greater.

13. Once again, choose Select a Map and browse the maps in your account to find Counties: Minority Majority and click Add.

14. This will open a Builder window for your second map in the series. Enter the following text in the Text area:

This map shows U.S. counties in which the minority population is 50% or more of the total county population.

15. Save your story map once again.

Explore options in the Settings area. If you wish to do so, you can change the size of the legend and text panel, add tools such as a location finder, and set the theme colors of the app. Once you have made changes through the settings option, save your map a final time. As the app owner, you can always change these items again later.
Teachers can use the items in this section as an assignment, an introduction, or an assessment, tailored to the sophistication of learners. Some learners can read all the sections at one time, while others are more comfortable with small segments. The questions and tasks are designed to stimulate thought and discussion.

**Online mapping is transforming GIS**
What are three advantages of online maps over traditional printed maps?

**Basemaps and operational layers**
What is the difference between a basemap and an operational layer?

**Additional resources**

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**Web map properties**
Besides being scalable and fluid, name two other advantages of online maps.

**Learning to smart map**
What does smart mapping give to the online user?

**Map design 101: Drawing your audience into the story you’re telling**
What makes looking at maps a rewarding experience?

**Maps into the third and fourth dimensions**
What are the third and fourth dimensions?
Learn ArcGIS: Guided lessons based on real-world problems

**Bridging the Breast Cancer Divide.**
- Exploring maps and performing visual analysis.
- Adding fields, selecting features, and calculating values.
- Symbolizing the values.
- Performing hot spot analysis.
- Interpreting findings.

**Fight Child Poverty with Demographic Analysis**
- Adding layers to a map.
- Enriching layers with demographic data.
- Styling layers with smart mapping.
- Configuring pop-ups.
- Editing item details.
- Configuring a web app.
Esri launched story maps in 2012. Since that time, a “virtual explosion” of story maps has occurred. Online GIS has progressed from being a pioneering tool for online spatial visualization and analysis to a ground-breaking tool for *sharing* maps, data, and the *results* of spatial analysis online. Story maps have described places, revealed change over time, broken news, and recounted history. They have affected change, influenced opinion, created awareness, and sounded the alarm about impending threats. Story maps represent nothing short of a communication revolution with their ability to combine the spatial visualization of maps with text, photographs, audio, and video data. They use the tools and analysis capability of GIS but don’t require the user to be skilled or knowledgeable in those areas.

This chapter will provide practice in the creation of several types of story maps through four scenario-based lessons. Each includes step-by-step instruction for creating one or more story maps while simultaneously building and reinforcing fundamental ArcGIS Online skills. The chapter also includes questions that support reading comprehension, reflection, and discussion of the chapter 3 narrative in *The ArcGIS Book*. 
Introductory activities

Videos

In 2010 a devastating earthquake nearly leveled Haiti’s capital city of Port-au-Prince. Ushahidi stepped into the information void by using crowdsourced information to create a near real-time map of the city. The other video identifies six important map powers: to engage, to reveal, to protect, to educate, to transform, to inspire. Watch the video several times, pausing it as necessary, to look at the range of data displayed on individual maps.

Ushahidi Haiti
Activity

The power of story maps

Story maps reflect the same powers identified in the *Power of Maps* video. Go to the *Story Maps Gallery*

Find a story map that, to you, reflects each of these powers.

<table>
<thead>
<tr>
<th>Power</th>
<th>Story Map</th>
</tr>
</thead>
<tbody>
<tr>
<td>to engage</td>
<td></td>
</tr>
<tr>
<td>to reveal</td>
<td></td>
</tr>
<tr>
<td>to protect</td>
<td></td>
</tr>
<tr>
<td>to educate</td>
<td></td>
</tr>
<tr>
<td>to transform</td>
<td></td>
</tr>
<tr>
<td>to inspire</td>
<td></td>
</tr>
</tbody>
</table>
Lessons: Account required

Although many of the lessons in this book do not require saving your work, others do. Membership in an ArcGIS organization (with Publisher privileges) will enable you to easily follow directions to create, save, and share maps in every lesson. If you do not have an organizational account already, follow the instructions below to obtain one.

Connect with and deploy the ArcGIS platform

If you’re an existing ArcGIS user and already have an ArcGIS subscription (with Publisher privileges), you’re good to go. If you don’t have these three things, continue reading.

Get a Learn ArcGIS organization membership

The Learn ArcGIS organization is available for students and others just getting started with ArcGIS. Follow this link to the Learn ArcGIS organization to activate a 60-day membership. With your new membership, you can immediately begin to use maps, explore data resources, and publish geographic information to the web.

Getting a Learn account is the quickest and easiest way to experience web GIS at ArcGIS Online.

Schools mapping software bundle

The ArcGIS for Schools Bundle is available at no cost for instructional use to individual US K–2 schools, school districts, and states direct from Esri. Beyond the US, the bundle is available to schools worldwide through Esri’s network of international distributors. Every public, private, home school, and youth-service club is eligible. The software bundle includes the following:

- ArcGIS Online organizational and user accounts
- Ready-to-use web and mobile apps
- ArcGIS Community Analyst licenses
- ArcGIS Desktop Advanced licenses

Sign up at Schools Mapping Software Bundle.
Dr. John Snow is regarded as one of the founding fathers of modern epidemiology. During a major cholera epidemic in 1854 London, he collected and mapped data on the locations (street addresses) where cholera deaths occurred. His process was laborious and slow, but ultimately very informative. His painstaking and detailed analysis led to the identification of the epidemic’s source—a contaminated public water source. Today, John Snow’s data has been geocoded, making it accessible in a GIS. In this lesson, you will create a heat map showing the locations that experienced the highest number of cholera deaths in the epidemic. You will share this heat map as a basic story map. [Note: You can watch a short overview of John Snow’s work in Episode 4 of The Geospatial Revolution.]

Build skills in these areas
- Opening a map
- Changing the style of point data to create a Heat Map
- Creating a basic story map

What you need
- A public or organizational account in ArcGIS Online
- Estimated time: 30 minutes
Scenario
As part of a pre-med curriculum, you are taking a course in the history of epidemiology. Your first assignment is to prepare a presentation about Dr. John Snow’s investigation of cholera during an 1854 outbreak in London. Luckily for you, John Snow’s 19th century data has been georeferenced and can be explored in a GIS. You have decided to include a web map in your presentation that reflects Dr. Snow’s conclusion that contaminated public water pumps were responsible for the outbreak.

Open the map
1. Sign in to your ArcGIS organizational account.
2. Open *Disease Investigations: Cholera*.
3. Use Save As to save the map to the Content section of your organizational account. Replace the word Copy with your initials in the map title (e.g., Disease Investigations: Cholera_LM). It’s good practice to save again each time you modify the map.
4. Click the Contents tab to see the map’s layers. Turn on John Snow’s 1854 map of cholera cases (*Snow Map*). Zoom in until you can see the little hash marks at points along the streets. These marks indicate the number of cholera cases at a particular address. As you can see, some addresses had only one or two cases, but many addresses had more.
5. Use the Soho bookmark (click Bookmarks, then select Soho).
6. Now turn on Cholera cases by address. These are the same addresses Snow mapped, but they have been geocoded to be accessible in a GIS. Each red dot is an address and has data associated with it called attributes. One of the attributes for this point layer is num_cases. This is the number of cholera cases that Snow recorded at this address with his hand-drawn hash marks.
7. Click on any red dot to see its attributes in a pop-up window. The pop-up provides the address and the number of cases at that address.

Create a heat map
Snow collected data and recorded it on his map so he could determine where the greatest number of cholera cases and deaths occurred. This was a laborious process for Snow, but GIS provides tools that help us answer this question quickly. Geocoding the addresses and cholera data opens the door to many analysis processes in GIS. We’ll employ only one of these analysis processes today. We’ll analyze the location of cholera cases by creating a heat map. Heat maps use point layer data to calculate and display relative density. The colors are most intense where the most points are concentrated together. Here, we don’t want to locate where the greatest number of dots is but rather the greatest number of cases.

1. Turn on Public water pumps
2. Hover your cursor over the name of the layer, Cholera cases by address. When you do this, you will see a series of icons appear beneath the layer name. If you hover over an icon, you will see what it does. Click the Change Style icon.

3. Now you will change the map style to a heat map. Under Choose an attribute to show, select Num_Cases. In other words, we are telling the program that we want to create a map that focuses on the number of cases at any location.

4. Under Select a drawing style, select Heat Map, then Options.

5. Move the Area of Influence slider slightly to the right to enlarge the area of highest density on the map.
6. Click OK, then Done. Your map now looks like this. The yellow area indicates the part of Soho where the greatest number of cholera deaths occurred. As you move through orange, red, and purple to blue areas, the density of cholera cases drops off.

7. Click on the pump symbol in the center of the yellow area to learn its name. This is the famous Broad Street pump. Snow's painstaking analysis of the same data led him to the conclusion that the Broad Street pump was the source of the Soho epidemic. When the pump handle was removed, preventing people from using it, the epidemic came to an end. Through spatial analysis, many lives were saved and cholera was confirmed as a water-borne disease.

8. Before you create your story map, make the following adjustment to your map. Click the dots below John Snow's 1854 map of cholera cases and select Hide in Legend. This will simplify the legend in the story map you are about to create.

9. Save the map.

Create a basic story map

1. To create a story map, click Share (above the map) then click Create a Web App under Embed this map.
2. Click Build a Story Map.

3. Select Story Map Basic, then Create App.

4. In the web app dialog box, fill in the following information for your map.


6. Click Done.

7. You now see a configurable version of your new story map. Under Settings, type in the title you just used when creating the story map:

8. Type the following in Display Map Title: London Cholera Epidemic 1854.

9. As you can see, you can change the subtitle (it defaults to the map summary), create links from the headers, set the color theme, and choose whether to include a legend or a search tool in your map.

10. Experiment with different settings. Click Save to see what your map will look like. You can continue to make changes to the Settings. Click save to see the result of each set of changes. When you are satisfied with your story map, click Done.

Congratulations! You have created a basic web map of the 1854 John Snow cholera investigation using the Story Map Basic template.
Lesson 3-2: Creating a swipe story map

In the effort to answer questions and solve real-world problems, it is frequently necessary to explore the relationship between different variables. For example, to answer a question about whether there is a relationship between diabetes and obesity, the investigator needs to compare the rates of these two conditions. Spatial data—data tied to a specific location—is essential in this. Mapping rates of diabetes and obesity reveals patterns of distribution that suggest a definite connection between the two. Beyond visual observations of patterns, exploring this data in a GIS means it is also possible to query the data and employ a range of analysis tools to further explore the relationship.

Story maps provide different ways to compare maps and data. The Story Map Swipe and Spyglass™ apps enable users to interact with two web maps or layers simultaneously in a single scalable view. In this lesson, you will create a Story Map Swipe map to compare high school graduation rates with unemployment rates.

Build skills in these areas
- Opening a map
- Creating bookmarks
- Creating a Swipe Story Map

What you need
- An organizational account in ArcGIS Online
- Estimated time: 45 minutes
Scenario
How important is it for future members of the workforce to complete high school? What is the relationship between graduation rates and unemployment? A national education advocacy group focused on reducing high school drop-out rates has hired your data visualization company to produce a web map that compares high school graduation rates with unemployment rates.

Open the map
1. Sign in to your ArcGIS organizational account.
2. Open *Graduation Rates and Unemployment*
3. Use Save as to save it to your own account as *Graduation Rates and Unemployment-[your initials]*.
4. The two layers in this map are the ones you will use in your Swipe Story Map. Be sure both are turned on.

Create a Swipe Story Map
1. To create a story map, click Share (above the map), then click Create a Web App under Embed this map.

2. Under Build a Story Map, select Story Map Swipe and Spyglass.

3. Click Create Web App.
4. Type the following in the summary box: *Choropleth maps of US high school graduation rate, 2008 and US unemployment rate, 2010*
5. Click Done.
6. In the Swipe/Spyglass Builder, notice that the Vertical bar is the default selected layout. This is the one you want. Click Next.

7. In the next window, notice that A layer in a web map is the default selected layout. Again, this is the one you want. Click Next. Note: The Builder has identified Unemployment rate 2010 as the layer to be swiped. This just determines which of the two layers will be on the bottom and which on the top.

8. Accept the default layout settings and click Next.

9. Select colors for your map headers and give each header a title. Note: The Right Map will be the same as the one Builder identified as the map to be swiped.

10. Click Open the app.

11. Add a description of the swipe map in the box that says Edit me. Here is some example text:

   “According to the US Department of Labor, high school dropouts are 72 percent more likely to be unemployed as compared to high school graduates (2003).”

12. If you wish to modify the title or the subtitle (this is the map summary) you may do so.

13. When you have finished, click Save.
Your completed swipe map opens like this:

If you zoom in and move the swipe bar you can observe relationships at both the regional and local scales.

In this lesson, you created a Swipe Story Map using the Swipe and Spyglass template.

**Extended activity**

Create another Swipe Map using census and/or health data to explore possible relationships among variables, e.g., race and income, infant mortality rate and poverty.
Lesson 3-3: Creating a map series web app

ArcGIS Online story maps provide an excellent vehicle for portraying events over a span of time. Changes in land use, the spread of disease, the growth of US railroads, and urban sprawl are but a few topics that lend themselves to such story map presentations. The Story Map Series™ app is a useful vehicle for telling a story that evolves over time. In this lesson, you will create a tabbed Story Map Series to show the 10 largest world cities in different periods of time.

Build skills in these areas
- Using the online library of Builder templates to select a template for your story map
- Searching ArcGIS Online for maps
- Creating a map series web app using the Map Series Builder

What you need
- A public or organizational account in ArcGIS Online
- Estimated time: 1 hour
Scenario
You have been hired to teach Urban Studies at your university. You plan to begin your course with a broad overview of the growth of cities through time. You have already created a series of web maps and data showing the top 10 cities (in population) in 100, 1000, 1500, 1800, 1900, 1950, and 2000. Now you need to convert those maps into a Map Series Story Map that tells the story of urban growth and distribution over this span of centuries.

Create a map series web app from within the app template
1. Go to the Story Maps Apps page and select Story Map Series – Tabbed Layout, then click Build.

2. Sign in to your ArcGIS Online organizational account.

3. Name your tabbed series map now.

4. Give your Tabbed Map series a title: World's Largest Cities 100 – 2000 CE (put your initials at the end of the title) and click the arrow.

5. This is where you will create your first tab. Title it 100 CE and in the Map drop-down list choose Select a map.

6. In the Select a Map box search in ArcGIS Online for a map titled citypop 100. Select the map by that name.

7. Check Legend next to Extras.
8. Enter the following in the empty text box:

Click a city icon to learn its modern name, ancient name (if different), population, and its rank among the top 10 cities at that time.

9. Zoom to an extent that includes the Western and Eastern Hemispheres.
10. Click Save in the upper right corner.
11. Click Add to add another tab.

12. Name the tab **1000 CE**.
13. Once again choose to select a map and this time search in ArcGIS Online for a map titled citypop 1000.
14. Add the same text to the empty text box that you added in step 8.
15. Click a city icon to learn its modern name, ancient name (if different), population, and its rank among the top 10 cities at that time.
16. Click Save and then Add to Add your third tab. This one will be titled 1500 CE. The map you should search for is citypop 1500.

17. Continue in the same manner to create the remaining tabs: 1800 CE, 1900 CE, 1950 CE, and 2000 CE.

18. The maps you will search for are citypop 1800, citypop 1900, citypop 1950, and citypop 2000.

19. Add the same content to the text box each time.

Your finished map looks like this:

![Map Series Example](image)

Each tab displays the top 10 cities for a particular year.

In this lesson, you created a Tabbed Series Story Map using the online Story Map Builder.

**Extended activity**
Create a similar Map Series focused on US cities between 1700 and 2000.

**Resources**
*Four Thousand Years of Urban Growth: An Historical Census* (St. David’s University Press, 1987), Tertius Chandler.
Lesson 3-4: Creating a spyglass story map

Story maps provide several ways to compare maps from different dates. The Story Map Swipe and Spyglass℠ apps are two of these, enabling users to interact with two web maps simultaneously in a single scalable view. In this lesson, you will create a spyglass story map to compare Washington, DC, in 1851 with imagery of the modern capital city. You will add Map Notes to the map to show the three locations for scenes in a play.

**Build skills in these areas**
- Opening a map
- Adding map notes to the map
- Creating a story map spyglass web app

**What you need**
- An organizational account in ArcGIS Online
- Estimated time: 1 hour
Scenario

This fictitious scenario will provide you with practice creating your spyglass story map.

A new play, set in 1851 Washington, DC, is scheduled to open in that city in six months. The theater owner wants to attract attention to the play and enhance theatergoers’ experiences by providing a way for them to relate the city they know to the city that is the setting for the play. They have hired your data visualization company to produce a web map that facilitates easy comparison between the 1851 city and its current configuration, shows key locations in the city that are portrayed in the play’s three scenes (National Hotel, Naval Observatory, US Patent Office), and enables users to search for specific addresses.

Open the map

1. Sign in to your ArcGIS organizational account.
3. Use Save as to save it to your own account as Washington D.C. 1851 and 2016 and replace the word Copy with your initials (e.g., Washington DC 1851 and 2016–LM).
4. Click the Contents tab to see the map’s layers. If you turn off the World Imagery layer, you will see the 1851 map beneath it.

Add map notes

1. Follow the steps below to create three map notes to show the locations of the National Hotel, Naval Observatory, and US Patent Office in 1851. The steps are the same for each note, but the information about each location will differ. Use the table that follows to fill in the information for each note.

   a. Enter −77.0193, 38.8931 in the search box above the map and click Enter.
   b. Choose Add Map Notes (under Add).
   c. Name the map note National Hotel and click Create. Click on the map note in the map and choose Edit to do this.
   d. Click the Pushpin tool and click the map at the location identified in step a. Explore symbols and choose an appropriate one for a national landmark.
e. Use the information in the following table to fill in the map note information options:

<table>
<thead>
<tr>
<th>Location</th>
<th>-77.0193, 38.8931</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title</td>
<td>National Hotel</td>
</tr>
<tr>
<td>Description</td>
<td>[none]</td>
</tr>
<tr>
<td>Image Link</td>
<td>[none]</td>
</tr>
<tr>
<td>Change symbol</td>
<td>Numeral 1, 📍 (accept the default symbol size)</td>
</tr>
</tbody>
</table>

f. When you have completed filling in the information, click Close and then click Edit. Your map should now look like the following. You can click on the map note to see a historic image of the National Hotel.

ArcGIS | Washington, D.C. 1851 and 2016

![Map with National Hotel]

Your map should now look like the following. You can click on the map note to see a historic image of the National Hotel.

![Map with National Hotel]

g. Create two more map notes in the same way using information in the tables below.

Note: Use the coordinates next to Location to create each new map note.

<table>
<thead>
<tr>
<th>Location</th>
<th>-77.05145, 38.8951</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title</td>
<td>US Naval Observatory</td>
</tr>
<tr>
<td>Description</td>
<td>[none]</td>
</tr>
<tr>
<td>URL to an image</td>
<td><a href="http://earlyradiohistory.us/1905tim1.jpg">http://earlyradiohistory.us/1905tim1.jpg</a></td>
</tr>
<tr>
<td>Image Link</td>
<td>[none]</td>
</tr>
<tr>
<td>Change symbol</td>
<td>Numeral 2, 📍</td>
</tr>
</tbody>
</table>
When you have finished, you will see the three map notes listed in your map Contents.

Zoom your map to an extent like the following (you just see the three map notes), then save the map.

Create a story map spyglass web app
1. To create your story map, click Share (above the map) then click Create a Web App under Embed this map.

2. Click Build a Story Map.
3. Select Story Map Swipe and Spyglass, then Create Web App.
4. Fill in the New App information box as follows, then click Done.

5. Click Select this layout under Spyglass, then click Next.

6. In the next window of the Swipe/Spyglass Builder, use the drop-down list to select World Imagery as the layer to appear within the spyglass, then click Next.

7. Select the following layout settings (enable description, pop-up, and address search tool), then click Next.

8. Uncheck enabled legend.

9. Enter the following headers on the next Swipe/Spyglass Builder window:
   
   Main Map Header Title: Washington, DC 1851.
   
   Spyglass Header title: Washington, DC Today.

10. Click Open the app.
11. Your app preview looks like this image:

Configure your story map swipe web app

1. Enter the following text in the Edit me! Box:
   
   Explore this map to compare Washington, DC in 1851 with the modern capital city. You can use the Search box to find a specific address and observe differences at that location. The location of the National Hotel, US Naval Observatory, and US Patent Office are identified by pop-up markers 1, 2, and 3. You can click a marker to learn more about that location.

2. You can experiment with different font sizes and families.

3. Before you save, you can edit the app’s Title and Subtitle as well.

4. When you are satisfied with the changes you’ve made, click Save under Story Configuration.

5. If you go to My Content and open the saved app from there, it looks like this:

6. Click on one of the pop-up icons to see the pop-up appear on the side of the map.

7. Search for a modern street address in the search box.

Move the spyglass around on the map and zoom in for a closer view.

Extended activity

Create a spyglass map to compare two historic maps or imagery from two different dates.
Teachers can use the items in this section as an assignment, an introduction, or an assessment, tailored to the sophistication of learners. Some learners can read all the sections at one time, while others are more comfortable with small segments. The questions and tasks are designed to stimulate thought and discussion.

**Story maps: The fusion of maps and stories come to life**

List components that can be incorporated into a story map.

Story maps “use the tools of GIS, and often present the results of spatial analysis, but don’t require their users to have any special knowledge or skills in GIS.” Identify two maps from the Story Maps Gallery that illustrate this idea.

**Maps tell stories. What kinds of stories can you tell?**

This section identifies eight kinds of stories that might be told with a story map. List and describe two more possibilities for this format.

**Thought leader: Allen Carroll: Why maps are so interesting**

Maps organize information spatially. What does this mean?

**What kind of story do you want to tell?**

Based on your own interests and knowledge, briefly describe two or more “stories” you’d like to tell with a story map.

**QuickStart: Things to consider when creating a story map**

Planning is very important when creating a story map. Pick one of the stories you just indicated you would like to tell with a story map and develop a plan for creating it by briefly writing the answers to the following questions:

- What is your purpose and goal in telling the story and who is your audience?
- Go to the Story Maps Gallery and identify two or more story maps whose subject matter is similar to the story you’d like to tell.
- Browse story map templates on the Story Maps Apps and identify the one that seems best for your story map project.
**Additional resources**


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**Learn ArcGIS: Guided lessons based on real-world problems**

**Tell the Story of Irish Public History**

- Adding layers from CSV files.
- Creating a web app.
- Creating a story map.
- Drawing conclusions from maps and data.

**Tell the Story of Irish Public History**

Gain historical insight by mapping fatalities from Ireland's 1916 Easter Rising.
You’re meeting friends at a restaurant you’ve never been to, so you do an internet search, click on its map location and the “Get directions” link to see how to get there, and in less than a minute, you’re good to go! We don’t think twice about this because it’s such an everyday thing. Yet it’s an indication that we’re in the midst of a remarkable era of transformation. Not so long ago you would have had to consult a phone directory and a local map to determine where the restaurant was and how to get there, and call your friends to relay the directions. You’d speak to them, and they’d take notes. That was what using and sharing data meant in the relatively recent past. But now, though there’s less to do, there’s so much more to it and so much more to do with it.

The transformative medium of “cloud” data storage means we now have immediate access to data, and not just about local restaurants and streets but also data about demographics, land cover, urban infrastructure, and much more. This is the kind of information that, when you think about it (which GIS also helps you do), becomes knowledge with which to solve problems and make decisions about vital issues. With such widely available “open” data, anyone can ask and answer geographic questions quickly. We can create and share maps integrating authoritative with local or regional data. ArcGIS Online is rapidly emerging as the technology of choice for using spatial data to explore and work out solutions for real-world problems. It truly is a whole new world.

This chapter provides guided practice in strategies for using open data to answer geographic questions and solve problems. Two scenario-based lessons demonstrate the power of open data to support informed decision making. Additionally, the step-by-step lessons build and reinforce fundamental GIS skills. Use the questions at the end of this chapter to support your reading comprehension, reflection, and discussion of the narratives presented in the corresponding chapter 4 of The ArcGIS Book.
Introductory activities

**Video**

The following videos run the gamut from showing the new ArcGIS Online capability, Smart Mapping, to explaining the basic concept of GIS to looking at local governments and businesses using geospatial technologies.

**Smart Mapping**

[Smart Mapping](#)

**What Is GIS?**

[What Is GIS?](#)

**Geospatial Revolution: Episode 2**

[Geospatial Revolution / Episode Two](#)
Activity

Welcome to MapQuiz by Esri

One component of ArcGIS Open Data, now accessible via the web, is imagery: photographic, satellite, and multispectral. This engaging quiz utilizes photographic imagery to test your geographic literacy. Sign in with a Facebook account to get started.
Lessons: Account required

Although many of the lessons in this book do not require saving your work, others do. Membership in an ArcGIS organization (with Publisher privileges) will enable you to easily follow directions to create, save, and share maps in every lesson. If you do not have an organizational account already, follow the instructions below to obtain one.

**Connect with and deploy the ArcGIS platform**

If you’re an existing ArcGIS user and already have an ArcGIS subscription (with Publisher privileges), you’re good to go. If you don’t have these three things, continue reading.

**Get a Learn ArcGIS organization membership**

The Learn ArcGIS organization is available for students and others just getting started with ArcGIS. Follow this link to the Learn ArcGIS organization to activate a 60-day membership. With your new membership, you can immediately begin to use maps, explore data resources, and publish geographic information to the web. Getting a Learn account is the quickest and easiest way to experience web GIS at ArcGIS Online.

**Schools mapping software bundle**

The ArcGIS for Schools Bundle is available at no cost for instructional use to individual US K–12 schools, school districts, and states direct from Esri. Beyond the US, the bundle is available to schools worldwide through Esri’s network of international distributors. Every public, private, home school, and youth-service club is eligible. The software bundle includes the following:

- ArcGIS Online organizational and user accounts
- Ready-to-use web and mobile apps
- ArcGIS Community Analyst licenses
- ArcGIS Desktop Advanced licenses

Sign up at Schools Mapping Software Bundle.
Lesson 4-1: Exploring and creating basemaps

Introduction to more, better, and unique basemaps

Build skills in these areas
- Combining multiple layers to create basemaps
- Using the basemap Firefly
- Uploading and using custom symbols
- Using Mapstyler to create new basemaps

What you need
- Account required
- Estimated time: 45 minutes

Scenarios
You have been tasked with showing your GIS colleagues new and different ways to customize basemaps. You are to reproduce various scenarios in which unique basemaps would be needed and give explicit instructions on creating these basemaps. You have decided to do a presentation highlighting the following:

- Basemaps created from multiple layers
- New Firefly basemap with custom halo icons
- Basemaps created by Mapstyler app

Scenario #1: Create basemap from multiple layers
Your team has been assigned a project on world hydrology. The following will produce a basemap that can be used as a standard for the project.

1. Sign in to your organizational account.
2. Click Map to open a new map in ArcGIS Online.
3. Choose Add>>Search for layers>>ArcGIS Online.
4. Uncheck Within Map Area.
5. Find: tinted hillshade.
6. Click DONE ADDING LAYERS.
7. Click Terrain: Elevation Tinted Hillshade.
8. Click Add to map.
9. Click the More Options icon (three dots) beneath the layer name, Terrain: Elevation Tinted Hillshade.
10. Click Move to Basemap.

12. Click Add>>Add to map.
13. Click DONE ADDING LAYERS.
14. Move World Hydro Reference Overlay to Basemap. This layer provides a reference overlay highlighting water features for use with layers related to the natural sciences.
15. Zoom in and out on the map. Notice how more or less detail changes as the scale changes by zooming in and out.
17. Click Add.
18. Click DONE ADDING LAYERS.
You should now have a basemap composed of four different layers to use as your customized basemap for your world hydrology map.

20. On the top menu, click Save As.

21. Enter the following information in the Save As Menu:
   - Title: World Hydro Map__Your Initials.
   - Tags: IGARC2_Your Initials.
   - Summary: World Hydro Basemap.
22. Save Map.

23. You can share your map with your organization or specific groups by selecting Share on the top ribbon.

**Scenario #2: Use Firefly cartography**

World Imagery Firefly is an alternative view of the default World Imagery Basemap. This map is designed to be used as a neutral imagery basemap, with desaturated colors, that is useful for overlaying other brightly styled layers. You will use this basemap with some custom images to create a map of college attendance of students of the senior class in a high school.

**Firefly Cartography** is a wonderful resource to read before doing this exercise.

**Prepare the Firefly basemap with basic state outlines and labels**

1. Sign in to your organizational account.
2. Click Add>>Browse Living Atlas Layers.
3. Search for Firefly.
4. Add as a basemap.

You notice immediately how subdued the Firefly basemap is compared to the standard imagery basemap. You will now add states and labels.

5. Search for Firefly.
6. Add layer to map As Basemap.
7. Search in ArcGIS Online for USA States (Generalized).
8. Add to the map.
9. Click DONE ADDING LAYERS.
10. Click Change Style under USA States (Generalized).
11. Click OPTIONS.
12. Click Symbols.
13. For Fill, click No Color. For Outline click Dark Gray.
14. Click OK.
15. Click OK.
16. Click DONE.
17. Click the three dots at the end of USA State and go to Create Labels.
18. Choose Abbreviation.
19. Choose Bold.
20. Choose Light Gray.

21. Click OK.
22. Click Save As at the top of the Menu.
23. Use the following parameters in the Save Map menu:
   - Title: Firefly University Attendance.
   - Tags: IGARC2_your initials.
   - Summary: Attendance of universities from VA high school.

You have now constructed a map using a Firefly basemap with labels.

**Add layers to the map**

To complete the next part of the exercise you will add two layers: the layer for Fairfax High School and the layer for the universities attended by the senior class.

1. Click Add and search for IGARC2_fhs in ArcGIS Online.
2. Add Fairfax_High_School and FHS_Universities.
3. Click DONE ADDING LAYERS.

4. Click the three dots to the right of Fairfax High School and move up to the top of the Contents.

5. Change Style in Fairfax High School.

6. Click OPTIONS.

7. Click Symbols.

8. Change the symbols size to 40.

9. Make the Color be Green.

10. Click OK.

11. Click OK.

12. Click DONE.

13. Save the map.
Connect origin to destinations

You can illustrate university attendance by creating lines from Fairfax High School to all the different universities. This can be done by using the analysis tool Connect Origins to Destinations. The tool can report straight-line distances from the origin to the destinations. Diagrams such as this are referred to as spider diagrams.

1. Click Analysis on the top menu.

2. Click Use Proximity.

3. Click Connect Origins to Destinations. This uses a straight-line distance.
   - Fairfax_High School is the point layer.
   - FHS_Universities is the Route to destinations.
   - Line distance is Measure. This tool connects origins to destinations using straight-line distance.
   - Result layer name is Fairfax_High_School to FHS_Universities_yourinitials.

4. Click RUN ANALYSIS.

5. Click Change Style under Fairfax High School to FHS Universities-Fairfax School to FHS.

6. Change Choose an attribute to show to Show Location Only.

7. Click OPTIONS.

8. Click Symbols.


10. Click OK.

11. Click OK.

12. Click DONE.

You can now see a line drawn from Fairfax High School to each individual university.
Symbolize universities by attendees

Of course, there are some universities that more than one student attended. The universities need to be symbolized by quantity of attendees.

1. Click Change Style under FHS Universities.
2. Under Choose an attribute to show select FHS_Attendees.
3. Click Counts and Amounts (Size) OPTIONS.
4. Click Classify Data.
5. Change the size to be 15 Min and 50 Max.
6. Click OK then DONE.
7. Click Save.

Use custom glow effect symbols

Point symbols with a glow effect are ideal for a Firefly basemap. The URLs below are addresses of four premade glow effect symbols that you can use by copying the URL for a custom image.

1. Click Change Style under FHS Universities.
2. Move FHS Universities layer above the lines layer.
3. Click Legend.
4. Modify the counts and amounts (Size).
5. Click the largest circle (12 to 20).
   • Click Use an Image.
   • Copy and paste the URL below for Icon 6 into the URL space.
   • Click the + sign.
6. Click OK.
7. Click the next circle (6 to 12).
8. Repeat steps 3 and 4 for Icon 5.
9. Click the next circle (2 to 6).
10. Repeat steps 3 and 4 for Icon 4.
11. Click the last circle (1 to 2).
12. Repeat steps 3 and 4 for Icon 3.
13. Click OK.
14. Click OK.
15. Click DONE.
16. Click Save.

Icon 6
https://learngis.maps.arcgis.com/sharing/rest/content/items/5f58156698b74f6d81dbe577ee04c276/data

Icon 5
https://learngis.maps.arcgis.com/sharing/rest/content/items/71888ef3b9ec45ddab3d3802182bf803/data

Icon 4
https://learngis.maps.arcgis.com/sharing/rest/content/items/392cc08348ca4d27be23ab4e6160b046/data

Icon 3
https://learngis.maps.arcgis.com/sharing/rest/content/items/932166c8bdf4428bbcb3b781b1079e32/data
In this exercise, you have displayed student attendance data at universities on a Firefly basemap with custom halo symbols. This gives you knowledge of how to use more cartographic options.

**Scenario #3: Produce Mapstyler basemap**

As chief cartographer for a major university you have been tasked with producing three basemaps: one representing historical colors, one oceanic colors, and one that represents emergencies. You have chosen the app Mapstyler.

Mapstyler has been designed by Esri UK to make vector tile color editing simple. There are two methods of selecting colors for a new basemap. You can use a random color shuffle button or you can select an image that has a color scheme that is appealing to you and drag the image onto the map and let the vector tile basemap adopt the colors in the image. After you have selected a basemap of your choice you save the basemap to your content by clicking the heart in the upper right corner.

1. Open Mapstyler. (The opening default map varies and you may have to zoom in to trigger the display.)
2. Examine the three tabs: SAVE, SHUFFLE, and UPLOAD.
3. Click SHUFFLE to cycle through examples.
4. Or click on a color and pick a specific color and click APPLY.

Remember your task is to pick a color that represents a historical cartographic look.
5. Click Save to save your map into your organizational Contents.

6. Go to your Contents.

7. Click mapstyler-12-8-2017.

8. On the Overview page for your map, click the edit to the right of the title and rename your basemap.

9. Click Save.
Upload the image

Using the Upload mode, you can select a jpeg or png image and drag it onto the map. The vector tiles will adopt the color palette of the image. You can then use the shuffle button to reorder the colors.

1. Open Mapstyler.
2. Do some research and find a map that the stylistically represents your ideas. Make an image of the map (jpg or png format). Tiffs cannot be used.
3. Drag the map to the area designated below.
4. Click Save at the top right to save your new basemap into your content.

5. Rename your basemap.

Make your new map the basemap

1. Create a new web map.

2. Search for the name of your new basemap.

3. Click and Use as Basemap.

4. Click Done Adding Layers.

5. Add more layers to your map.

Create a custom historical, ocean, and emergency map.
Farmers’ markets provide people with access to healthy food. The Supermarket Access Map shows the location of farmers’ markets. The map is designed for learners to use to answer the question: “How many Americans live within a reasonable walk or drive to a farmers’ market?” Exploring the Supermarket Access Map gives insight into the following lesson.

**Build skills in these areas**
- Opening a map
- Filtering a layer by county
- Deriving drive times
- Deriving walk times
- Symbolizing data
- Adding a live World Traffic feed
- Publishing a web app that compares three different counties

**What you need**
- Account required
- Estimated time: 1 hour 30 minutes

**Scenario**
Many county chambers of commerce have been asked to sponsor farmers’ markets. In this lesson, you will provide maps for county officials showing the location of markets within their counties and reasonable drive and walk times from the markets. For analysis purposes, a 10-minute drive time and a 1-mile walk time will be used to determine what is reasonable. Once you have created these proximity drive areas you will add an Esri World Traffic Service. The World Traffic Service presents near real-time traffic information for different regions in the world and is updated every 5 minutes. The Traffic Service can be used to provide even more information about market choices.

You will map three different counties that represent different geographic areas. The three counties are as follows:

- Fairfax, VA
- Fulton, GA
- Dallas, TX

After deriving drive and walk times of markets with the specified counties, you will clarify the legend and publish as an app showing the availability of markets with the three different counties. It is your plan to present your map and analysis to the individual chambers of commerce.
Open the map and save into your organization

1. Sign in to your ArcGIS organizational account.
2. Open Farmers’ Markets.

The map opens showing the Topographic basemap, state, and county boundaries. States and counties are political boundaries.

3. On the ribbon click the Save button and choose Save As.
4. In the Save Map window, type Farmers’ Markets_yourinitials
5. Type tags: IGARC2_your_initials.
Write a brief description of the map’s content.

Select and filter a specific county (Fairfax, VA)

A filter presents a focused view of a feature layer in a map. In this case, you only want to view and analyze the farmers’ markets that are in Fairfax, VA. Fairfax County is the most populous county in the Commonwealth of Virginia and contains 13.6 percent of Virginia’s population.

1. Move the farmers’ market layer to be above USA counties.
2. Click on the feature layer Farmers’ Market and click Filter.
3. Create your definition expression.
   - County is Fairfax.
   - Add another expression.
   - State is Virginia.
4. Click APPLY FILTER.
5. Zoom to the filtered area.
6. You should now see only the farmers’ markets in Fairfax County, VA.

7. Display the table for Farmers’ Markets. You will see that there are 19 markets within Fairfax County, VA.

Calculate 10-minute drive time
You are now ready to perform analysis and derive the 10-minute drive time and the 1-mile walking distance from each of the farmers’ markets.

1. Click the Perform Analysis Tab under the Farmers’ Markets layer.

2. Click Use Proximity.

3. Click Create Drive-Time Area and use the following parameters:
   - Choose point layer to calculate drive-time areas around = Farmers’ Markets.
   - Driving Time = 10 Minutes.
   - Areas from different points = Split. The split tool takes areas from different input locations that would overlap each other and splits them in the middle so they abut one another instead. This is useful when you want to see which areas are within a given time or
distance of the input points and, at the same time, determine which input point is closest to that area.

- Result layer name = 10min_drive_fairfax.

4. Click RUN ANALYSIS.

---

**Calculate 1-mile walking distance**

1. Click Perform Analysis on the Farmers’ Market layer.

2. Click Use Proximity.

3. Click Create Drive-Time Areas and use the following parameters:
   - Choose point layer to calculate drive-time areas around = Farmers’ Markets.
   - Measure: Walking Distance….1 mile.
   - Areas from different points = Split.
   - Result layer name = 1mi_walk_fairfax_yourinitials.

4. Click RUN ANALYSIS.

5. Click filter under Farmers’ Markets.

6. REMOVE FILTER. All the Farmers’ Markets are visible.

7. Move Farmers’ Markets to the top of Contents.

8. Save as Fairfax Farmers’ Market.
9. Share with Everyone. You will have to update sharing.
10. Click DONE.

Select and filter a specific county (Fulton, GA)

Next you will make a map of the farmers’ markets in Fulton, GA. You will be making maps of several different locations. These maps will be used to make a story map at the end of the exercise. Fulton is the home of Atlanta, which is the capital and the most populous city in the state of Georgia.

1. Click on the feature layer Farmers’ Market and click Filter.
2. The definition expression should be
   • “County is Fulton.”
   • Add another expression.
   • State is Georgia.

There should be 10 farmers’ markets.

3. Repeat steps 3–6 as you did for Fairfax County walking distance.

There are two farmers’ markets very close together at the northernmost point of the county.

4. Save as Fulton, GA Farmers’ Markets.

Select and filter a specific county (Dallas, TX)

Dallas, TX, is the second-most-populous county and the third-largest city in Texas.

1. Click on the feature layer Farmers’ Market and click Filter.
2. The definition expression should be
   • “County is Dallas.”
   • Add another expression.
   • State is Texas.

3. Repeat steps 3–6 as you did for Fairfax County Walking Distance.

There should be six farmers’ markets.

There are two farmers’ markets very close together at the northernmost point of the county.

4. Save as Dallas, TX Farmers’ Markets.
5. Share with everyone. You will have to update sharing.

**Add live World Traffic Service**

Esri has published a set of “live feeds” layers featuring frequently updated data from several sources, including NOAA, NASA, and USGS. This group includes this set of live feeds as both ready-to-use web map and map layers. The World Traffic Service live feed presents near real-time traffic information for different regions in the world. The data is updated every 5 minutes. This live traffic feed can provide additional information about market accessibility.

1. Click on Home and go to Content.
2. Open Fairfax Farmers’ Market_yourinitials.
3. Go to Add and search for World Traffic Service in ArcGIS Online.

![World Traffic Service](image)

4. Click DONE ADDING LAYER.

5. Turn off USA Counties.
6. Turn off 1 mi walk fairfax.
7. Filter Farmers’ Markets again for County = Fairfax and State = VA.
8. Click Perform Analysis.
9. Click Proximity.
10. Click Create Drive-Time Areas.

- Driving Time = 10 Minutes.
- Check Use Traffic.
- Click Traffic based on typical conditions.
- Pick Current Date (if day of the work week).
- Time is 4:30 PM (Rush Hour).

11. Areas from different points = Split.
12. Result layer name = 10min_fairfax_traffic_yourinitials.

13. Run ANALYSIS.

14. Compare the results for the original 10-minute drive time with the new drive time with traffic service used.

15. Click Save.

16. Click Share.

17. Repeat for Fulton, GA.

18. Repeat for Dallas, TX.

Are the drive time areas different when live traffic feed is added?

How does this live traffic feed help you make decisions about market accessibility?

Create a web app

You can create a web app from your map using a configurable app template. Your client has asked that the population rate change map you have built be displayed as a web app. Your client has asked you to use the configurable Story Map Series web app.

1. Click Save again to be sure your work has been saved as Dallas, TX Farmers’ Markets.

2. Click Share. Share with your Individual Organization or with Everyone.

3. Click CREATE A WEB APP.
4. Select Build a Story Map.
5. Select Story Map Series.
6. Click CREATE WEB APP.
7. Specify a title, tags, and a summary for the new web app.
   • Title is **Farmers’ Markets Accessibility**.
8. Click DONE.
10. Click START.
11. Click SETTINGS on the top ribbon.
12. Click Map Options.
13. Uncheck Synchronize map locations.
14. Click APPLY.
15. Click the Arrow.
16. Tab title = Dallas, TX.
17. Dallas, TX, Farmers’ Markets for your map.
18. Click ADD.
19. Write an analysis of the map in the text box such as “The Dallas, TX, area has four areas of access to framers’ markets. There is considerable area that has no access.”
20. Click Add.
21. Add Fulton, GA Farmers’ Markets to the tab.
22. Select a Map.
23. Choose Fulton, GA Farmers’ Markets.
24. Write an analysis of the map in the text box.
25. Repeat steps 18–22 for Fairfax, VA.
26. Click SAVE in the upper right corner.
27. Click SHARE on the Top Ribbon; the Organization Tab is highlighted.
28. Click View story.
Lesson 4-3: Helping restore a watershed

Chesapeake Bay states land-use enrichment

The Chesapeake Bay is the largest estuary in the contiguous US. The watershed covers 64,000 square miles and is fed by 50 major rivers and streams. Everything always flows downstream. Because of this downstream flow, all the results of human habitation run into the ocean. Human habitation includes farms and developed lands. As the land is farmed and developed more, there is less land to absorb and filter the water. Restoration efforts have made modest ecological gains but they have been largely offset by rapid population growth. Agriculture and developed land is one of the land-use classifications that are used to study the health of the bay.

Build skills in these areas

- Opening a map
- Enriching a layer
- Configuring pop-ups
- Using pop-up media
- Calculating percentage
- Publishing as a web app

What you need

- User, Publisher, or Administrator role in an ArcGIS organization
- Estimated time: 1 hour 30 minutes

Scenario

The Chesapeake Bay Foundation is interested in correctly assigning funds and resources to the seven states that make up the Chesapeake Bay watershed. To do this, the foundation asked for both quantitative and qualitative information from its GIS department. The foundation wants to know what percentage of land use is in each designated state’s watershed area and presented in a compelling way to present to the community.

Open and save the map

1. Sign in to your ArcGIS organizational account.
2. Open Chesapeake Bay Landuse.
The map opens showing the Topographic basemap and the outline of the Chesapeake Bay showing the section of each state that is in the bay.

3. On the ribbon click the Save button and choose Save As.

4. In the Save Map window, type **Chesapeake Bay Landuse _Your Initials**.

5. Type tags and a brief description of the map’s content.

---

**Display the Bay Area by state abbreviation**

The Bay Area by State layer is displayed without any cartographic styling.

1. Click Contents.

2. To open the Change Style pane click the Change Style icon, which opens the Change Style Pane.

3. The states are shown by location only. Choose **STATE_ABBR** in the Choose an attribute to show tab.

4. Click DONE.

---

Write several spatial observations about the Chesapeake Bay watershed. Include in your observations a discussion of political vs natural boundaries. The observations that are written here will be used later in the exercise when you construct your story map.

**Use the data enrichment tool**

The data enrichment tool helps you explore the character of areas. Detailed information is returned for the chosen area. For this area, you would like to
know information about the percentage of land use or landcover in each of the states represented in the Chesapeake Bay.

1. Click the Perform Analysis icon.

2. Click Data Enrichment.

3. Click the Enrich Layer tool to activate the Enrich Layer menu.

4. The Bay Area by State is selected by the layer to enrich. Click SELECT VARIABLES to pick the land cover information that you want to retrieve.

5. In the Data Browser in the upper right corner be sure that United States is selected.

6. Click the arrow to show the next page.

7. Click Landscape.

8. Click LANDCOVER.

9. Select all seven variables by selecting the Landscape Analyst Variables.

10. Click APPLY.

11. The Result layer name = Enriched Bay Area by State_yourinitials.
12. Uncheck Use current map extent.
13. Click RUN ANALYSIS.

The Enriched Bay Area by State layer will be added to the Content Pane.

14. Click on the Show Table icon.

When you open the table, you will see that each bay state has been populated with percentage of land use.

15. When you examine the table you will see several fields that are not necessary for the analysis. Click Table Options in the right corner and then click Show/Hide Columns. Uncheck the fields listed below:
   - STATE_Name
   - ID
   - ENRICH_FID
   - sourceCountry
   - HasData
   - aggregtopm,etjpd

16. Close the table by clicking the X in the right corner.

17. Uncheck Bay Area by State in the Contents Pane.
18. Display Enriched Bay Area by State by STATE_ABBR.
19. Click DONE.

**Configure attributes and show charts**

You can display the bay states by land use percentage, but the amount of information that you portray is neither compelling nor quantitative. A better way to present your data is to create a chart. A chart will graphically display the values of numeric attribute fields, in this case, percentage of land use.

Before you chart your data, you need to configure your pop-ups.

1. Click the three small dots after Enriched Bay Area by State and go to Configure Pop-up.
2. Enter a title for your pop-up. Title = Enriched Bay Area by State.
3. Display: A list of field attributes.
4. Click Configure Attributes and uncheck the following:
   - STATE_NAME
   - ID
   - ENRICH_FID
   - sourceCountry
   - HasData
   - aggregationmethod
5. Click within the attributes and change to the following. Ensure the following stay on:
   - STATE_ABBR
   - % Open Water
   - % Barren Land
   - % Developed
   - % Forest
   - % Herbaceous
   - % Pasture/Crops
   - % Wetlands

6. Click OK.

7. Under Pop-up Media click ADD and add a Pie Chart.

8. Configure Bar Chart as follows:
   - Title = Chesapeake Bay Land Use
   - Caption = % of Land Use by State
   - Check:
     - % Open Water
     - % Barren Land
     - % Developed
     - % Forest
     - % Shrub/Scrub/Grassland/Herbaceous (NLCD)
     - % Pasture/Hay/Cultivated Crops (NLCD)
     - % Wetlands

9. Click OK.

Now when you click on each of the states it shows the percentages of land use in both a table and a pie chart.

Use the table

Don’t forget the interactive table is a quick way to analyze information and make decisions. Sorting by a specific attribute is always useful.

   1. Show the table.
   2. Click the field % Developed.
3. Choose Sort Descending. That puts the values in order from highest to lowest, and you can see that DC is by far the most developed state, followed by MD and VA.

<table>
<thead>
<tr>
<th>STATE_ABBR</th>
<th>% Open Water</th>
<th>% Barren Land</th>
<th>% Developed</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC</td>
<td>3.47</td>
<td>0.08</td>
<td>80.76</td>
</tr>
<tr>
<td>MD</td>
<td>6.73</td>
<td>0.31</td>
<td>17.65</td>
</tr>
<tr>
<td>VA</td>
<td>3.55</td>
<td>0.18</td>
<td>10.93</td>
</tr>
</tbody>
</table>

You can also sort the table to arrive at more quantitative data.

4. Close the table.
5. Click Save.

**Create a web app**

The Chesapeake Bay Foundation asked you to show the percentage of land use area in the bay by each state in a compelling way to present to the community. You have decided to make a story map to fulfill this task. You have selected a story map that presents a series of maps and other content organized using tabs.

1. Click Save to be sure your work has been saved.

You have decided that the individual state maps that you want to use in your story map will look better if the basemap is Imagery with Labels.

2. Change the basemap to Imagery with Labels.
3. Save the map as **Answers: Chesapeake Bay Landuse 2**.
4. Click Share and Share with Everyone.

   Answers: Chesapeake Bay Landuse 2 is the beginning map for your story map series.

   You will also need individual maps of each watershed.

5. Filter the map by STATE_ABBR and select NY.
6. Save the map as NY.
7. Share with everyone.
8. Repeat steps 5–7 for all the states.
You should have seven maps.
10. Open Answers: Chesapeake Landuse2.
11. Click Share.
12. Click CREATE APP.
13. Click Build a Story Map.
14. Click Story Map Series.
15. Click CREATE WEB APP.
16. Specify a title, tags, and a summary for the new web app.
17. Click DONE.
19. Type Chesapeake Bay Watershed as the title for your Tabbed Map Series.
20. Click the Arrow.
21. Add Land Use Analysis for the ADD TAB.
22. Select or create a map pull-down and pick Chesapeake Bay Landuse.
23. Click ADD.
24. At the Top Ribbon click SETTINGS.
25. Click Map options.
26. Uncheck Synchronize map locations.
27. Click APPLY.
28. Add some appropriate text about the Chesapeake Bay to the text box such as:

The Chesapeake Bay is the largest estuary in the contiguous US. The watershed covers 64,000 square miles and is fed by 50 major rivers and streams. Everything always flows downstream. Because of this downstream flow, all of the results of human inhabitation run into the ocean. Human inhabitation includes farms and developed lands, and as the land is farmed and developed more, there is less land to absorb and filter the water. Restoration efforts have made modest ecological gains, but they have been largely offset by rapid population growth. Agriculture and developed land is one of the land use classifications that are used to study the health of the bay.

29. Click ADD.
30. Select a map. Select NY.
31. Click ADD.
32. Click on the bay part of New York and copy the percentages and add to your text box.
33. Repeat steps 28–30 for the other six states.
34. Click SAVE in the upper right corner.
35. Click VIEW LIVE to review your story map.
Teachers can use the items in this section as an assignment, an introduction, or an assessment, tailored to the sophistication of learners. Some learners can read all the sections at one time, while others are more comfortable with small segments. The questions and tasks are designed to stimulate thought and discussion.

The Living Atlas: The ArcGIS platform provides rich content

How have open data repositories such as the Living Atlas changed the way GIS users plan and implement projects?

The ArcGIS data community: A global network for creating and sharing authoritative geographic information resources

The work of organizations that make up the global GIS community has changed with the emergence of web GIS. Explain how this GIS work has changed.

What kind of data is available? Definitive, authoritative basemaps

There are several key concepts to understand about basemaps: they are multiscale, provide global coverage, and are continuous. In your own words, briefly define each of these concepts:

- multiscale
- global coverage
- continuous

Demographics

Explain the concept of data enrichment.

Opening data to the world of possibilities

What are open data sites and what benefits do they provide?

Imagery

In your own words, briefly compare these types of imagery: photographic, satellite, and multispectral.

Landscapes: Landscape analysis layers

What are ELUs?

Thought leader: Richard Saul Wurman

A map is a pattern made understandable

In your own words, explain what the phrase “understanding precedes action” means to you.
Explore the Urban Observatory and explain how it reflects the concept that “understanding precedes action.”

Learn ArcGIS: Guided lessons based on real-world problems

Map Voter Data to Plan Your Campaign
Geocoding addresses from a spreadsheet.
Enriching layers using Tapestry data.
Mapping US Census data.
Creating a presentation.

Get Started with Tapestry
Using the Zip Lookup tool.
Finding key information.
Identifying the best Tapestry segments for each scenario.

Where Does Healthcare Cost the Most?
Displaying and classifying data.
Analyzing hot spots.
Once data is mapped, a unique set of tools available in ArcGIS Online can be used to perform an analysis. These extensive spatial tools are the cornerstone of GIS and enable you to delve deeper into any project or inquiry before you. There are tools to summarize and aggregate data based on a geographic entity, network and locational tools, surface analysis tools, visibility analysis tools, tools that combine layers of data, and statistical tools, to list a few. They may sound out of reach to you now, but they are not. They are simple to engage, extend your reach, and enable you to answer questions and solve problems, faster and more accurately than almost anyone could do without them.

This chapter offers the opportunity to do the following:

- Create custom pop-ups.
- Use Arcade expressions to calculate values and label map features.
- Apply analytical spatial tools to select a location for a new hospital.

Use the questions at the end of this chapter to support your reading comprehension, reflection, and discussion of the narratives presented in the corresponding chapter 5 of The ArcGIS Book.
Introductory activities

Videos

The opening video from the 2015 Esri International User Conference highlights the relationship of humans to their environment. It is followed by the ArcGIS Overview video which highlights the integration of GIS into a network of GIS users.

*EsriUC 2015 opening video*

*ArcGIS Overview*
Activity

Discover your local green infrastructure assets using the Green Infrastructure app.

Esri has produced a set of tools and data to help communities protect the places and natural resources that help people, wildlife, and the economy thrive. Developing these tools has resulted in a GIS layer that defines habitat cores. A core is an area or patch of relatively intact habitat that is sufficiently large to support more than one individual of a species. In this activity, you will investigate a political boundary (your state) and derive information about the percentage of intact habitat core within your state boundary. You will then investigate your local county (political boundary). You will also record the ratio of how many more roads they are in relationship to streams within your state.

1. Search for the following places to navigate to designated states.
2. Complete this table:

<table>
<thead>
<tr>
<th>Place/State</th>
<th>% Intact Habitat Core Area</th>
<th>Roads vs Streams (more roads than streams)</th>
<th>National Average (more roads than streams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phoenix, AZ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Richmond, VA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Albany, NY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>San Diego, CA</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Which of the designated states has the most intact core habitats. The least?

Why do you think Arizona has 8.4 times more roads than streams?

Compare two counties within your state.

3. Zoom out until you can see your entire state.
4. Click the layer Land cover.

Write a description for the distribution of land in your state. What is the dominant land cover: agriculture? Urban? Forest?

Locating and mapping a local habitat core

With a green infrastructure strategy, communities work to preserve and connect open spaces, watersheds, wildlife habitats, parks, and other critical landscapes. Communities are trying to identify local valuable landscapes, prioritize which to protect, and plan connections within and beyond their boundaries. Your task is to look at your county and make recommendations as places where local habitat cores could be identified.

1. Go to Green Infrastructure Core Information.
2. Open and read the document.

What are the dimensions of a core habitat area?

What are other parameters to consider when defining core habitats?

3. Go to ArcGIS Online.
4. Click Map to create a new map.
5. Click Modify Map in the upper right corner.
6. Click Add and search for Intact Core Habitat Areas in ArcGIS Online.
7. Uncheck within map area.
8. Click Add.
9. Click DONE ADDING LAYERS.
10. In the upper right corner in the Find address or place tab, search for your county. As an example: Loudoun, VA.
11. On the top menu ribbon click Basemap and change the Basemap to Imagery with Labels.

12. On the top ribbon click Manage Bookmarks (to the left of the search tab) and Select Add Bookmark.

13. Name the Bookmark.

Your assignment now is to zoom in and see if you can identify an area that would be a candidate for an intact habitat core. You must take in all the specifications you have read and then you must see if the area under consideration has a large enough area. After you have selected an area, you need to measure to see if it meets the 200 acres and 200 meters wide specification.

14. Carefully examine the area.

15. Select an area.

16. Click the Measure tool on the top ribbon:
   - Click Area.
   - Unit of Acres.

17. Click Area and click the map once for every vertex of the area you want to measure. Double-click to complete the area.

18. See if the area is 200 acres or more.

19. Click the Distance tool and measure to see if the area is 200 meters wide.

Write a paragraph or give an oral report about reasons that the core habitat area that you picked is appropriate.
Lessons: Account not required

Remember, you can access online all you need for the lessons in this guide. Some activities and lessons require no sign in to ArcGIS Online (the first set of lessons in each chapter) while others require signing in to an ArcGIS organizational account (the last set of lessons in each chapter).
Lesson 5-1: Analyzing a severe windstorm
Spatial analysis and emergency management

This section provides a real-life example of GIS being used for emergency management. You are tasked with creating maps that would be used by first responders or the public during an emergency. You will use symbolizing/classification and querying/filtering along with the geospatial tools of proximity and overlay.

To work on this lesson, you do not have to be logged in to an organizational account; however, if you’re not, you cannot save your work. Here are some suggestions for how to deal with this:

- Block off a long period of time.
- Assess the work in parts.
- Take screenshots of your work to show completion to your instructor.

Emergency management unfolds at all levels and benefits from a technology designed to make spatial decisions. Maps can be produced for first responders and decisions can be made for resource management. Because of these benefits there is a growing demand for the use of GIS at all levels of emergency management. Thought leader Linda Beale summarizes it best: “GIS offers the technology to explore, manipulate, analyze, and model data from multiple sources. With spatial analysis hazard mapping and predictions developed for risk assessment, you can use models to evaluate response strategies, and maps to illustrate preventative strategies and for risk communication and negotiation.”
Build skills in these areas
- Symbolizing
- Classifying
- Creating map notes layers
- Using advanced filtering
- Generating a heat map

What you need
- Account not required
- Estimated time: 30 minutes–1 hour

Scenario
A derecho is a widespread, long-lived, straight-line wind storm that is associated with a land-based, fast-moving group of severe thunderstorms. At 10 p.m. on June 29, 2012, a derecho hit Fairfax County, Virginia. Within one hour, the county’s Emergency Operations Center was activated and additional agencies from the public schools, facilities management, park authority, Virginia Department of Transportation, Dominion Power, and local phone companies were contacted. The Fairfax County GIS department was called to provide maps of the situation. These maps were to be made available online to first responders and the public. As a GIS analyst, you oversee a map that shows the following:

- Census tracts displayed by population density
- Hospitals, schools, and fire stations symbolized
- Symbolized rivers and highways

Opening map and classification/styling
1. Open Fairfax Derecho.

2. Click Contents under Details on the top of the page to reveal the map layers available for your analysis.

3. Check Census Tracts to turn the layer on.

The census tracts are shown as one color or by location only. The request from the Emergency Center was to display the census tracts by population density in 2010. This will show where there is the highest concentration of people. The attribute to choose is POP10_SQMI, which indicates the number of people per square mile in 2000.

4. Click Change Style under Census Tracts.

5. Choose POP10_SQMI for the attribute and click Counts and Amounts (Color).

6. Click Done.
7. Click Census Tracts in the Contents pane to expand the legend. Notice the density varies from 3,951 people per square mile to 0 people per square mile. You can definitely see that there are sections of the county that have more people per square mile than others.

8. Click Census Tracts again to close the legend. The rivers first draw into the map at an appropriate size. It would be better if the rivers were blue to indicate water.

**Symbolization**

The map will be easier to read and interpret if it is symbolized correctly. Rivers, highways, schools, hospitals, and fire stations all need to be symbolized.

1. Uncheck the Census Tracts layer you have symbolized.
2. Check Rivers to turn on the layer.

3. Click Rivers and click Change Style.
4. Click Options.
5. Click Symbols and choose an appropriate color.
6. Click OK.
7. Click Done.
8. Repeat steps 3–7 for Highways.

Choose an appropriate color. You need to appropriately symbolize schools, hospitals, and fire stations.

9. Turn on Schools and click Change Style.
10. Click Options.
11. Click Symbols.
12. Click People Places and choose a symbol to represent a school.
13. Change the Symbol Size to 12.
14. Click OK.
15. Click Done.
16. Repeat steps 9–15 for Hospitals. Look under the category Safety Health for more symbols.
17. Repeat steps 9–15 for Fire Stations. Look under the category Safety Health for more symbols.

Queries to find highway intersections where live wires are down

It has been identified that live wires are down at the following intersections:

- Georgetown/Leesburg
- Leesburg/Dranesville
- Dolley Madison/Capital Beltway

You need to first find the intersection and mark with a map note.

1. Turn off by unchecking all layers except Fairfax County and Highways.

Filter highways to identify the locations of the intersection. The first intersection to be identified is Georgetown and Leesburg.

2. Click Filter on the Highways Layer.

3. You need two expressions from those shown below:
   - Name is Georgetown. You must click Unique.
   - Add another expression.
   - Name is Leesburg.
   - Click Any. Any means that only one of your expressions must be true for the features to display.

4. Click Apply Filter.

Mark the location of the intersection with a map note.

5. On the top of the page, choose Add and Add Map Notes.
6. Name the Map Note Georgetown and Leesburg.
7. Click Create.
8. Choose the Pushpin and place it on the intersection.
9. Title = Intersection of Georgetown and Leesburg.
10. Description = Powerlines damaged and down.

Identification of deployed fire stations with a drive-time around 10 minutes each
1. Check Fire Stations.
2. Filter using the following expressions:
   - Station is Fox Mill.
   - Station is Springfield.
   - Station is Wolftrap.
   - Check Any.

If you are not logged into an organizational account you cannot perform an advanced analysis on drive-times. The drive-time area has been made, and all you do is check it to turn it on. A drive-time area is the area that can be reached with a specified drive-time. It is a proximity analysis.

3. Check Travel from Fire Stations (10 Minutes).
4. You might want to click Other Options and Move Fire Stations above the Travel from Fire Stations (10 minutes).

11. Click Close.
12. Click Details.
13. Click Highways and Filter.
15. Repeat steps 2–14 for the Leesburg/Dranesville intersection. Remember Any.
17. Remove filter from roads before proceeding.
Locations of where roads cross rivers
1. Turn off all layers but Fairfax County, Highways, and Rivers.

Intersect is one of the overlay geospatial analysis functions. Because all the layers are bound together geographically, these analytical functions work.

2. Turn on the Intersect Highways and Rivers layer. This layer shows where the highways cross the roads. The color of the dots will vary.

Continuous surface maps from point data
The Command Center would like a continuous surface map made from both the phone outages and the power outages. Heat maps show an occurrence of a set of points as a continuous density surface. To produce the density calculation, a filter is applied to blur or smooth the surface representation, and it removes noise and unnecessary detail. A heat map has all the following characteristics:

- It is scalable.
- It has no units.

- No data is formed.
- It is not to be confused with temperature.

1. Uncheck all layers except Highways and No Power. The No Power layer represents areas that are without electrical power. To perform more analyses, you might want to turn other layers, such as hospitals and fire stations, on and off.

2. Click No Power and click Change Style.

3. Select Heat Map. A heat map represents the geographic density of features on a map.

4. Click Done.

You might want to change Basemap to Imagery and turn on Hospitals, Schools, and Fire Stations. Notice that as you zoom in and out the heat map is scalable, allowing you to investigate the data at all scales.

5. Repeat steps 3 and 4 for Phone Outages.

In this lesson, you have created maps for first responders by using a variety of GIS skills: symbology, classification, filtering, and proximity.
Lessons: Account required

Although many of the lessons in this book do not require saving your work, others do. Membership in an ArcGIS organization (with Publisher privileges) will enable you to easily follow directions to create, save, and share maps in every lesson. If you do not have an organizational account already, follow the instructions below to obtain one.

Connect with and deploy the ArcGIS platform

If you’re an existing ArcGIS user and already have an ArcGIS subscription (with Publisher privileges), you’re good to go. If you don’t have these three things, continue reading.

Get a Learn ArcGIS organization membership

The Learn ArcGIS organization is available for students and others just getting started with ArcGIS. Follow this link to the Learn ArcGIS organization to activate a 60-day membership. With your new membership, you can immediately begin to use maps, explore data resources, and publish geographic information to the web. Getting a Learn account is the quickest and easiest way to experience web GIS at ArcGIS Online.

Schools mapping software bundle

The ArcGIS for Schools Bundle is available at no cost for instructional use to individual US K–12 schools, school districts, and states direct from Esri. Beyond the US, the bundle is available to schools worldwide through Esri’s network of international distributors. Every public, private, home school, and youth-service club is eligible. The software bundle includes the following:

- ArcGIS Online organizational and user accounts
- Ready-to-use web and mobile apps
- ArcGIS Community Analyst licenses
- ArcGIS Desktop Advanced licenses

Sign up at Schools Mapping Software Bundle.
Lesson 5-2: Climbing high
Custom pop-ups

A map can show descriptive information about features configured to display in a pop-up. Pop-ups can bring to life the attributes associated with each feature layer in a map. You can show images and can link to external web pages. As a map owner, you can reconfigure the pop-ups to define the list of visible fields and how to present information. Instead of manually typing in every pop-up, you can use a custom expression to modify a list of field attributes, choose contents from a single field for display, or remove the attributes altogether. In this lesson, you will configure pop-ups from a text file using information, links, and images.

The information for the following lesson has been obtained from the Daily News Dig, which in turn used Wikipedia: List of highest mountains on Earth.

Build skills in these areas

- Adding a text file
- Configuring pop-ups using a custom attribute display
- Configuring pop-ups with images
- Researching and adding information to a text file

What you need

- Account required
- Estimated time: 30 minutes–1 hour

Scenario

The International Climbing and Mountaineering Federation has hired you as a GIS specialist to create an interactive map of the 10 highest mountains. The federation has asked that you identify the following information about each mountain:

- Name of Mountain
- Range
- Elevation
- Image of Mountain
Open and save a map

1. Sign in to your organizational account.
2. Click Map on the top ribbon to create a new map.
3. Click Show Contents of Map under Details.
4. Zoom all the way out to a world view.
5. Change the Basemap to Terrain with Labels.
6. On the top ribbon go to Save As.
7. Save your map with the following information:
   - Title: Climbing High_Your_Initials.
   - Tags: IGARC2_climb_your_initials.
   - Summary: Information about the 10 highest mountains in the world to climb.
8. Click SAVE MAP.

Add a new CSV file

You can add layers to a map by importing data that has been saved in a delimited text file (.csv or .txt). The delimited text file with location must have either latitude-longitude or address information. For this lesson, latitude-longitude will be used.

A table has been prepared that has the following fields:
- lat : latitude
- lon : longitude
- name : name of the mountain
- range : parent range of mountain
- elev_ft : elevation in feet
- thumb_url : URL of a thumbnail of an image of the mountain
- photo_credit : URL to the location of the source of the photo

Notice that the latitude and longitude are expressed in decimal degrees and that there are no spaces after each comma.

1. Copy the information below that has been researched and prepared.

```
lat,lon,name,range,elev_ft,thumb_url,photo_credit
```
2. Paste it into any application where it can be saved as a text or a CSV file (Notepad++ or Microsoft® Office is the most commonly used software).

3. Save the file and name it **mountains**.

4. Click Add from the top menu and go to Add from File.

5. Choose File. Navigate your computer and find the mountain.txt file that you saved above.

6. Click IMPORT LAYER.

7. Click Types (unique symbols)>>OPTIONS.

8. Click the three bars by COUNT.


10. Click OK.

11. Click OK.

12. Click DONE.

13. Click Save.

You can see four of the five mountains distinctly. Zoom in to see the mountains that are close together.
Configure custom expression attributes

In this section, you will use the Custom Attribute Display to enter a combination of free text and fields chosen from the drop-down list. The pop-up will be customized to show the name of the mountain, the range, and elevation of the mountain.

1. Click More Options at the end of mountains layer.

2. Select Configure Pop-up

3. Choose A custom attribute display.

4. Choose CONFIGURE.

5. In the Custom Attribute Display window you can add a combination of free text and fields chosen from the drop-down list.
This is the expression that you are constructing.
{name} is located in the {range} range and has an elevation of {elev_ft} feet.

4. Add Image.

6. Click OK.

This is how the pop-up appears when opened.

7. Save the map.

Configure media: Images with photo credit

Finally, you want to construct your pop-up to display an image and a photo credit for the image.

1. Go to Configure Pop-up on the mountain layer.
2. Under Pop-up Media click Add.
3. Scroll down toward the bottom of the pop-up configuration.

8. Click OK.
9. Click CONFIGURE.
10. Add Photo Credit from the drop down.
11. Copy {photo_credit}. (Refer to image below for visual directions.)
12. Click the Link button to create a link and set its properties.
13. Paste {photo_credit} field name in the URL tab.
14. Type Photo Credit in the Link Text.
15. Click Set.
16. Click OK.
17. Test the Photo Credit link.
18. Click Save.

When the pop-up is opened, a thumbnail of the image is available that can be tapped to reveal the larger image, and the link to the photo credit is available.

Assessment: Research and add information to the preexisting mountain text file

For the last part of the exercise, you need to research and add the required information about the 5 remaining of the 10 highest climbing mountains. You can use the Daily News Dig, but do not feel limited to this one resource. You need to find the information about the last five mountains:

- Cho Oyu
- Dhaulagiri
- Manaslu
- Nanga Parbat
- Annapurna

Remember:

- There can be no spaces in the delimited CSV text file.
- The latitude and longitude have to be expressed in decimal degrees.
- You will have to repeat the procedure in its entirety with the newly constructed file.
Lesson 5-3: Creating thematic maps with hexagons
Analyze Toxic Release Inventory

Analyze health insurance
The most common shape type in GIS analysis and thematic mapping is the grid. Over the past few years, the hexagon has become increasingly popular. There are several advantages to using hexagons. Read more about the increasing use of hexagons and their advantage at Why hexagons? Esri has provided a series of hexagons called hexbins that can be accessed for aggregating and summarizing spatial data in the Living Atlas of the World. Individual published layers of hexagons can also be generated. Hexagons are useful in displaying data that has many overlapping points.

Build skills in these areas
- Aggregating point data
- Using hexbins from the Living Atlas of the World
- Enriching data
- Using an individual published hexagon layer
- Filtering data

What you need
- Account required
- Estimated time: 30 minutes–1 hour

Scenario #1: Analysis of Toxic Release Inventory
The Toxic Release Inventory (TRI) is a listing of US facilities that have certain toxic chemicals that may pose a threat to human health and the environment. The Environmental Protection Agency has asked for a visualization of the TRI sites that produce or have produced carcinogens. You have the point data, but many of the points are overlapping, which makes it hard to visualize patterns and clusters in the data. You have decided to use hexbins to visualize the data and have decided on a 10 km resolution hexbin.

Open and save the map
1. Sign in to your organizational account.
2. Open USA TRI Carcinogens.
3. Click Content.
4. On the top ribbon click Save As.
5. Save the map with the following parameters:
   - Title: USA TRI Carcinogens.
   - Tags: IGARC2_TRI_your initials (delete the IGARC2_TRI tag).
   - Summary: Toxic release sites within the USA.

![Save Map](save_map.png)
**Aggregate TRI points within 20 km hexbin**

1. Click perform analysis under the feature TRI USA carcinogen.

2. Click Summarize Data>>Aggregate Points. Using a layer of point features (TRI USA carcinogens) and a layer feature (hexbin), this tool determines which points fall within each area and calculates statistics about all the points with each area. The layer hexbin will be obtained from the Living Atlas of the World.

3. Click Aggregate Points.
   - TRI_USA_carcinogen is the layer containing points to aggregate into areas.
   - Choose Living Atlas Analysis Layer in the Choose layer containing aggregation areas. You will find this on the drop-down menu under Choose the polygon layer.
     - Click Hexbins.
     - Choose North America Hexbins 25km.

4. Uncheck Use current map extent.

5. Uncheck Keep areas with no points.

6. Uncheck Use current map extent.

7. Before running analysis, check number of credits used and validate that you have sufficient credits to do this analysis.

8. Click RUN ANALYSIS.

9. Check off the TRI USA Carcinogen layer.

10. Click Change Style under Aggregation of TRI USA carcinogen to North America Hexbins 25km.

11. Choose an attribute: Count of Points.

12. Select Counts and Amounts (Color).

13. Click OPTIONS.


15. Choose a dark red to light red ramp.

16. Change the basemap to Dark Gray Canvas to make the symbols Pop.
17. Click OK.
18. Click DONE.

Interpret the data

1. Move USA States (Generalized) above the aggregation of TRI USA.
2. Zoom in and around the US.

Which states seem to have the highest concentrations of TRI sites?

What layers could you add to enhance your observations?

Scenario #2: Enrich hexagons with health insurance data

Kaiser Permanente Health Care Organization is proposing to bring its quality care affordable health plan to the state of South Carolina. Kaiser has asked you to construct a map showing the population that has health care within South Carolina.

Open and save a map

1. Open Hexagon Health.
2. Sign in to your organizational account.
3. On the top ribbon, click Save As.
4. Save the map with the following parameters:
   - Title: Hexagons Healths_yourinitials.
   - Tags: IGARC2_health_yourinitials (delete the IGARC2_health tag).
   - Summary: Representative hexagons for the USA.

Filter South Carolina

1. Click Content.
2. Click Filter under Hexagons.
3. Construct the expression:

STATE_ABBR is SC

4. Click APPLY FILTER.

The hexagons for only South Carolina are selected.

5. Click Analysis on the top ribbon.

6. Click Data Enrichment.

7. Click Enrich Layer. Be sure that United States is selected in the upper corner box.

8. Click SELECT VARIABLES.

9. Click Population.

10. Select 2017 Total Population (Esri).

11. Click Back.


14. Click APPLY.

15. Uncheck Use current map extent.

16. Add your initials to the Result layer name.

17. Check credit usage.

18. Click RUN ANALYSIS.

Normalize and symbolize the data

1. Select Change Style under Enriched Hexagons.
2. Choose an attribute to show select Health Insurance.

3. Select Counts and Amounts (Color).

4. Choose OPTIONS.

The colors that you see on the map in South Carolina represent the number of people insured. To obtain the percentage of residents that are insured, you must divide the number of people by the total population. That will give you a more realistic interpretation of the data.

5. The default is Divided by NONE. Use the drop-down menu to select Divided by 2017 Total Population.

6. Click Symbols and choose a dark red color ramp.

7. Click OK.

8. Click Done.

Interpret the data

What parts of South Carolina have the largest percentage of people with insurance?

Assessment

Repeat the above process using your state or, if you live in South Carolina, another state that interests you.
Lesson 5-4: Introducing ArcGIS Arcade expressions
Calculate percentage unemployment

Show population increase and decrease 2010–1017
The December 2016 release of ArcGIS Online introduced the ability to use Arcade expressions. You now can perform calculations and map data without creating a field in the source data.

Build skills in these areas
- Creating an Arcade expression for calculations
- Creating an Arcade expression for labeling

What you need
- Account required
- Estimated time: 30 minutes–1 hour

Scenario
In preparation for the 2020 election, both Democrats and Republicans have asked for maps of county unemployment and maps of where counties have lost population. They want to use these maps to strategize their campaign stops.

Open and save a map
1. Sign in to your organizational account.
2. Open USA Unemployment and Population Change.

Create percentage unemployment arcade expression
You are trying to calculate the percentage of unemployment in each county of the US.

3. On the top ribbon click Save As.
4. Save the map with the following parameters:
   - Title: USA Unemployment and Population Change_your initials.
   - Tags: IGARC2_arcade_yourinitials (delete the IGARC2_arcade tag).
   - Summary: Using arcade expressions to explore % unemployment and rate of population change.

```plaintext
Save Map
Title: USA Unemployment and Population Change-Copy
Tags: IGARC2_arcade_your initials
Summary: Use of arcade expressions to show percent unemployment
Save in folder: 
```

Chapter 5: The Power of Where—Lesson 5-4: Introducing ArcGIS Arcade expressions
2. Click Contents.

```
<table>
<thead>
<tr>
<th>STATE_NAME</th>
<th>FIPS</th>
<th>Total Population in 2017</th>
<th>Unemployed in 2017</th>
<th>Total Population in 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Dakota</td>
<td>38073</td>
<td>5,642</td>
<td>81</td>
<td>5,465</td>
</tr>
<tr>
<td>Iowa</td>
<td>19009</td>
<td>5,996</td>
<td>11</td>
<td>6,180</td>
</tr>
<tr>
<td>South Dakota</td>
<td>46102</td>
<td>14,137</td>
<td>1046</td>
<td>13,596</td>
</tr>
<tr>
<td>Idaho</td>
<td>16015</td>
<td>7,155</td>
<td>205</td>
<td>7,028</td>
</tr>
</tbody>
</table>
```

What attributes are available to use?

3. Close the table by clicking the X on the right corner.

4. Open the Change Style icon under the Unemployment and Population in the USA feature and for the attribute to show choose New Expression.

When you click New Expression, a scripting window appears alongside a list of the layers’ attributes and their aliases. The scripting window is where you will write your expression. Your manager has requested a map that shows percentage of unemployed. The formula for finding percentage unemployed would be: 

\[(\text{unemployed}/\text{total population}) \times 100\]

Using an Arcade expression, the syntax changes as follows:

\[($\text{feature}.\text{UNEMPLY_2017}/$\text{feature}.\text{TOTPOP2017}) \times 100\]

5. Using the list of formatted fields, build your Arcade expression to match the one above.

6. Click on Test.

The result is correct but there are 16 unnecessary decimal places. You need to round the expression to 2 decimal places. Try adding the Round function.
7. Type:
Round(($feature.UNEMPLY_2017/$feature.TOTPOP2017)*100,2)

8. Change the name Custom at the top by clicking Edit and typing % Unemployed 2017.

9. Click Save.
10. Click OK.
11. Click Change Style.
12. Choose an attribute to show: % Unemployed.
13. Click Counts and Amounts (Color).
14. Click SELECT.
15. Click DONE.
Is there a spatial pattern of unemployment? Click DONE.

Show counties that have increased or decreased in population from 2010 to 2017.

The formula to show increase or decrease in population would be population2017-population2010. An Arcade expression can be used to show the relationship to 0. Any value below 0 will be a decrease and any value above 0 will be an increase.

1. Click Add attribute.
2. Click New Expression. (You may need to delete the old expression.)
3. Edit the name to Change in Population.

The following Arcade expression shows that anything below 0 or negative will show a decrease and anything else will show an increase.

```javascript
var dif=($feature.TOTPOP2017-$feature.Population2010);
if (dif<0)
{return 'Decreased';}
else
{return 'Increased';}
```
4. Type or copy the expression in the script box.
5. Click Save.

This expression creates a variable named dif that represents the value of population in 2010 subtracted from pop in 2017. It then tests if the difference is greater or less than 0. If less than 0, it returns that the population decreased, and if not, it returns that the population increased.

6. Click OK.
7. Change the style to Counts and Amounts (Color).
Label counties % change

Arcade expressions can also be used to create custom labels. The map would provide more information if the % of change was shown on each county.

1. Click the three small dots under Unemployment and Population in the USA.
2. Select Create Labels.
3. Under Name choose New Expression.
4. Type or copy the following expression:

\[ \text{Round}(((\text{feature}.\text{TOTPOP2017}-\text{feature}.\text{Population2010})/\text{feature}.\text{Population2010})*100,2) \]

5. Click Edit and change Custom to % Change.
6. Click OK.
7. Click OK.

Now the counties are labeled with percentages.

Do you see any correlation between the counties that have the highest percentage of unemployment and the counties that have lost population?
Lesson 5-5: Siting a new hospital in Loudoun County, VA
Use GIS to create new knowledge

Two analytical functions in ArcGIS Online are proximity tools and tools that manage layers. In this exercise, you will use the proximity tools of buffer and drive-time and the managing layers tool of intersect.

Build skills in these areas
- Using analytical functions to solve a problem
- Using proximity tools of buffer and drive-times
- Using overlay skill of intersect
- Enriching layers

What you need
- Account required
- Estimated time: 30 minutes–1 hour

Scenario
The Loudoun County Board of Supervisors has requested that the GIS Department analyze the county for a potential new hospital. The potential site must meet the following parameters:

- One mile away from the existing main roads
- Two miles from the most populated places
- Twenty minutes away from the existing hospital

Open and save a map
1. Sign in to your organizational account.
2. Open Loudoun Hospital.
3. On the top ribbon click Save As.
4. Save the map with the following parameters:
   - Title: Loudoun Hospital_your initials.
   - Tags: IGARC2_hospital_yourinitials (delete the IGARC2_arcade tag).
   - Summary: Site selections for a new hospital in Loudoun County, VA.

5. Become familiar with the layers by turning them on and off.

Use proximity tools of buffer and drive_time
In this section of the lesson, you will use two proximity tools to create additional layers to solve the problem. You will use the create buffer and the create drive-time areas proximity tools.
1. Click Perform Analysis under Places.

2. Choose Use Proximity.

3. Select Create Buffers and use the following parameters:
   - Buffer size = 2 miles
   - Expand Options
     - Dissolve
     - Exclude
   - Result layer name = `bufplaces2mi_yourinitials`
   - Uncheck Use current map extent.

4. Click RUN ANALYSIS.

5. Uncheck Places.

6. Click Perform Analysis under Loudoun Hospital.

7. Choose Use Proximity.

8. Select Create Drive-Time Areas and use the following parameters:
   - Measure = 20 minutes
   - Areas from different points = Dissolve
• Result layer name = drive20min_hospital_yourinitials
• Uncheck Use current map extent

9. Click RUN ANALYSIS.

Erase 2-mile buffered places within 20-minute drive-time from hospital

The hospital should not be located anywhere within the 20-minute drive time. Use the analytical overlay tool to erase those areas.

1. Click Perform Analysis under bufplaces2mi.
2. Choose Manage Data.
3. Choose Overlay layers and use the following parameters:
   • Overlay layer = drive20min_hospital
   • Overlay method = Erase
   • Result layer name = suitable1_yourinitials
• Uncheck Use current map extent

1. Click Perform Analysis under roads.
2. Choose Use Proximity.
3. Select Create Buffers and use the following parameters.
   • Buffer size = 1 mile
     o Expand options
     » Buffer type = Dissolve
   • Result layer name = bufrds1mile_yourinitials
   • Uncheck Use current map extent
4. Click RUN ANALYSIS.

**Buffer 1 mile from Loudoun roads**
1. Click Perform Analysis under roads.
2. Choose Use Proximity.
3. Select Create Buffers and use the following parameters.
   • Buffer size = 1 mile
     o Expand options
     » Buffer type = Dissolve
   • Result layer name = bufrds1mile_yourinitials
   • Uncheck Use current map extent
4. Click RUN ANALYSIS.
**Use manage layers tool intersect**

Now you want only the areas that are within the 1 mile buffer of the road and the buffered area of the places. For this you will use the intersect tool.

![Intersect](image)

1. Click Perform Analysis under the bufrds1mile layer.
2. Click Manage Data.
3. Select Overlay layers and use the following parameters:
   - Overlay layer = suitable1
   - Overlay method = Intersect
   - Result layer name = potentialhospitalareas_yourinitials
   - Uncheck Use current map extent
4. Click RUN ANALYSIS
5. Uncheck suitable1.
6. Uncheck bufrds1mil.

The areas shown are the areas that meet all the criteria of the problem:

- One mile away from the existing main roads
- Two miles from the most populated places
- Twenty minutes away from the existing hospital

**Make a decision**

Your last task is to rank the areas. You can change the basemap. You can use the measuring tool to calculate acreage or you can add additional layers from ArcGIS Online.

*Write a paragraph defending your site selection.*
Teachers can use the items in this section as an assignment, an introduction, or an assessment, tailored to the sophistication of learners. Some learners can read all the sections at one time, while others are more comfortable with small segments. The questions and tasks are designed to stimulate thought and discussion.

**Geographic analysis**

Write a paragraph explaining this statement: GIS is more than a map.

Give at least three examples where spatial analysis tools have been used to solve problems.

**Visualization**

What can my map show me?

**Insights: Real-time exploration and analysis of maps and data**

What is Insights for ArcGIS workflow?

**Modeling: Using the language of spatial analysis**

What is a typical modeling sequence?

**Spatial problem solving: A conceptual framework**

What are the steps of spatial problem solving?

**Thought leader: Linda Beale—The challenge is making complex data understandable**

Explain the specific role GIS plays in health analysis.
Learn ArcGIS: Guided lessons based on real-world problems

Track Crime Patterns to Aid Law Enforcement
Symbolizing data.
Determining proximity.
Summarizing data.
Creating heat maps.

Help the Lincoln Police Department allocate resources to combat crime.
Streamline Deliveries with Drive-Time Analysis
Creating drive-time areas.
Finding and modifying driving directions.
Saving routes as map layers.
Analyzing data with Esri’s USA Tapestry Segmentation layer.

I Can See for Miles and Miles
Using spatial analysis to create viewsheds.

Streamline Deliveries with Drive-Time Analysis
Create delivery zones so Wok & Roll stays in business.

I Can See for Miles and Miles
Identify areas from which turbines on a proposed wind farm would be visible.
To be a perfect graphic representation of the world, a map would have to be a sphere. Viewing it in 3D makes it so. The expectation for data to be viewable in 3D is generational. Introducing Esri’s ArcGIS Scene to a mixed-age group, you find the older generation becoming a bit awed that they can manipulate, turn, and tilt data in a 3D setting. Anyone under 10 is not impressed. Young learners live in a world of 3D and expect data to be displayed in 3D; after all, they have been playing sophisticated 3D games for years.

What does 3D data bring to the table? It introduces vertical and volumetric information. Data in 3D is a tool for city planners and urban designers, and volumetric analysis serves those investigating things like groundwater contamination. In Esri’s ArcGIS Scene, you not only can see your data in 3D but also navigate around and through the data at both a local and a global level.

This chapter gives you the opportunity to do the following:

- Reflect current events combined with 3D geospatial technology.
- Make a 3D presentation.
- Visualize time zones.

Use the questions at the end of this chapter to support your reading comprehension, reflection, and discussion of the narratives presented in the corresponding chapter 6 of The ArcGIS Book.
Introductory activities

Videos
These map videos represent Esri’s 3D ArcGIS Online software:

Author Web Scenes Using ArcGIS Online

Esri’s Prototype Lab
Activity
Vocabulary match game
Mapping in 3D has its own unique terminology. Explore this terminology by matching the term with the online map illustrating the concept.

1. 2D map
2. 3D crime visualization
3. local scene
4. photorealistic
5. fixed symbols
6. global scene

Map A
Map B
Map C
Map D
Map E
Map F
Remember, you can access online all you need for the lessons in this guide. Some activities and lessons require no sign in to ArcGIS Online (the first set of lessons in each chapter) while others require signing in to an ArcGIS organizational account (the last set of lessons in each chapter). The following section has lessons that explore the 3D environment.
Lesson 6-1: Understanding current events in 3D
Use a virtual globe to broadcast the news

The world is three dimensional, and many GIS applications require that 3D experience. Esri’s Scene Viewer allows you to visualize data on a world sphere. The Scene Viewer provides a variety of tools for orientation, navigation, search, and toggling basemaps and layers.

The virtual globe of Scene Viewer is also a way to combine current events with geospatial technology. It provides a geospatial focus for a wide range of subjects and can connect many curriculum areas. It provides the opportunity for learners to look at geospatial news at all levels: global, regional, and local.

Build skills in these areas
- Manipulating a globe within a 3D environment
- Searching for geographic locations
- Connecting news with a world sphere
- Presenting material using geospatial technology

What you need
- No sign-in required
- Estimated time: under 30 minutes

You have been asked to pick one of the scenarios below and prepare a newscast using the virtual globe as your visualization tool.
Scenario (world)
Since 2011, Syria has been in a civil war. More than 4 million people have fled to neighboring countries. Some countries are more welcoming than others. Research your topic and use the globe as your visualization.

1. Go to ArcGIS Online.
2. Click on Scene on the top ribbon.
3. Click the X to close the 3D Scene Viewer information tab.
4. Take time to learn the navigational buttons:
   - Click the Home button to return to the initial position.
   - Click + to zoom in. You can also use your mouse and scroll wheel to zoom in and zoom out or press and hold the middle mouse button and move down or up to zoom in or out.
   - Click the Pan button to pan. Click and hold the left mouse button and drag the map in the direction you want to move it. You may also pan by using the arrow keys on the keyboard.
   - Click Rotate button to rotate. Click and hold the left mouse button and drag the map in the direction you want to rotate it.
   - Click the Compass button to reorient your scene North. You may also press N on your keyboard.
5. Search for Syria using the search button in the upper right corner.
6. Zoom in to the designated location.
7. Change the basemap to different maps for different information.
8. Below are some focus questions:

   Why is it dangerous to go through Greece without going through Turkey?
   What routes either by land or water would the refugees have to take to get to Germany?
   Name the countries and water bodies.
   Hungary and Austria have shown signs of resistance to the refugees and are closing or threatening to close their borders. How would this affect the routes the refugees would have to take?
Scenario (regional)

Hurricane Irma was a powerful hurricane that made landfall at Cudjoe Key, FL. The storm caused catastrophic damage to the Florida Keys and particularly Cudjoe Key and the surrounding area. Research the topic and then use the globe to explain. Below are some focus questions:

- *When Hurricane Irma made landfall at Cudjoe Key, what was the hurricane strength? Category and sustained winds?*
- *What towns are close to Cudjoe Key?*
- *Why is Cudjoe Key particularly vulnerable?*

1. Repeat steps 1–7 above. Search for Cudjoe Key, FL.
Scenario (local)
Pacifica, CA, has declared a state of emergency because citizens have to leave their homes because of erosion. Research the topic and then use the globe to explain. Below are some focus questions:

*Is this emergency weather related? How?*

*Will the residents get any financial relief?*

1. Repeat processes 1–7 above. Search for Pacifica, CA. The specific address where the apartments are falling into the sea is 310 Esplanade Ave., Pacifica, CA.
2. Right-click and change from 2D to 3D to see a vantage point similar to the one in the graphic below.
Lessons: Account required

Although many of the lessons in this book do not require saving your work, others do. Membership in an ArcGIS organization (with Publisher privileges) will enable you to easily follow directions to create, save, and share maps in every lesson. If you do not have an organizational account already, follow the instructions below to obtain one.

**Connect with and deploy the ArcGIS platform**

If you’re an existing ArcGIS user and already have an ArcGIS subscription (with Publisher privileges), you’re good to go. If you don’t have these three things, continue reading.

**Get a Learn ArcGIS organization membership**

The Learn ArcGIS organization is available for students and others just getting started with ArcGIS. Follow this link to the Learn ArcGIS organization to activate a 60-day membership. With your new membership, you can immediately begin to use maps, explore data resources, and publish geographic information to the web. Getting a Learn account is the quickest and easiest way to experience web GIS at ArcGIS Online.

**Schools mapping software bundle**

The ArcGIS for Schools Bundle is available at no cost for instructional use to individual US K–12 schools, school districts, and states direct from Esri. Beyond the US, the bundle is available to schools worldwide through Esri’s network of international distributors. Every public, private, home school, and youth-service club is eligible. The software bundle includes the following:

- ArcGIS Online organizational and user accounts
- Ready-to-use web and mobile apps
- ArcGIS Community Analyst licenses
- ArcGIS Desktop Advanced licenses

Sign up at Schools Mapping Software Bundle.
Lesson 6-2: Visualizing water landforms
Present the planet’s geometric masterpieces

A water landform is a feature of the planet’s surface that is associated with water. Water landforms are caused by geologic processes, and some of them are geometric masterpieces.

Build skills in these areas
- Opening Scene
- Searching for a location either by longitude, latitude, or address
- Creating slides and saving a presentation

Scenario
As an instructor of geography, you have decided to give your students an exam on the identification of water landforms by imagery. You are putting together a visualization of five different water landforms to be identified. The landforms are found by either longitude and latitude or by address. The water landforms that are to be identified are listed here:

- Gulf of Mexico Continental Shelf
  −88.278,27.889
- Maldives
- Kenai Fjords
- Isthmus of Panama
- Mississippi Delta
  −89.844,29.413

Open scene
1. Sign in to your ArcGIS organization.
2. Click Scene on the top Ribbon.
3. Close the Scene Viewer by clicking the X in the right corner.

What you need
- User, Publisher, or Administrator role in an ArcGIS organization
- Estimated time: under 30 minutes
4. Take time to learn the navigational buttons in the left corner:
   
   - Click the **Home** button 🏡 to return to the initial position.
   - Click + to zoom in. You can also use your mouse and scroll wheel to zoom in and zoom out or press and hold the middle mouse button and move down or up to zoom in or out.
   - Click the **Pan** button ⬇️ to pan. Click and hold the left mouse button and drag the map in the direction you want to move it. You may also pan by using the arrow keys on the keyboard.
   - Click **Rotate** button 🔒 to rotate. Click and hold the left mouse button and drag the map in the direction you want to rotate it.
   - Click the **Compass** button ⛵️ to reorient your scene North. You may also press N on your keyboard.

5. Search for −88.278,27.889 using the search button in the upper right corner. A pointer appears at the location. That longitude and latitude show the continental shelf in the Gulf of Mexico.

6. Zoom in to the location.

7. Pick an appropriate basemap by clicking the Basemap icon. Oceans is a good choice.

8. Click the Modify scene button (Pencil) in the upper left of your screen to open the Scene designer.
9. Click the Slides arrow.

10. Click CAPTURE SLIDE.

11. Add a title.
12. Click Done.
13. Repeat processes 5–11 searching for the Maldives.
15. Repeat processes 5–11 searching for the Isthmus of Panama.
16. Repeat processes 5–11 searching for −89.844,29.413. That longitude and latitude show the Mississippi Delta.
17. Click SAVE SCENE.
18. Complete the metadata:
   - Title: Water Landforms_yourinitials.
   - Summary: Examples of water landforms.
   - Tags: IGARC2_landforms_yourinitials.
19. Click SAVE.
Lesson 6-3: Responding to an earthquake off the western coast of Mexico
View depth of earthquake and aftershocks in 3D

Build skills in these areas
- Building a story map that includes video, maps, and scenes
- Adding live earthquake feed data from an URL
- Minimizing the Scene Viewer

What you need
- User, Publisher, or Administrator role in an ArcGIS organization
- Estimated time: 30 minutes–1 hour

Scenario
On September 8, 2017, an 8.1 magnitude earthquake hit off the southwestern coast of Pijijiapan, Mexico, toppling hotels and houses. It hit about 73 miles from Tres Picos, Mexico. Its epicenter was 102 miles west of the southern Chiapas state, and it had a depth of about 21 miles. The quake was so powerful, it was felt by people in Mexico City, 650 miles away. You have been asked to build a story map to document the event. The story map used as a presentation will be the introduction to start the discussion asking for humanitarian aid.

Before preparing the story map, you must create the maps and scenes to populate the story map. The maps and scene required are as follows:

- Map showing live earthquake feed
- 3D map of earthquake depth

Scene 1: A scene displaying a 3D view of the location of the earthquake
1. Sign in to your ArcGIS organization.
2. Click Scene.
3. Close the Scene Viewer.
4. Click Modify Scene.
5. Click ADD LAYERS.
7. Click the plus button to Add.
8. Search again for Recent Earthquakes and Add.

9. Click DONE.
10. On the right tab change the basemap to Imagery.

11. Click Done.
12. SAVE SCENE using the following parameters:
   - Title: Scene 1: Mexico Earthquake.
   - Tags: IGARC2_quakes_yourinitials.
   - Summary: Mexico Earthquake September 8, 2017.

13. Click SAVE.
14. On the top line of the browser, copy the URL to be used in your story map. Paste the URL in a text document that you can access later.
15. Make some notes about what you are visualizing.

Map 1: A map showing live earthquakes

The US Geological Survey provides live feed earthquake data in a CSV ASCII text file. This live feed can be added to an ArcGIS Online map by referencing the URL file. Your map will then be updated from the source every time you refresh or open your map.

1. Go to Home.
2. Click Map.
3. The CSV ASCII text file can be accessed at USGS Earthquake Data.
4. Scroll to Past 30 Days>>M2.5+ Earthquake.
5. Right-click and Copy the link location.
6. Go back to the new map.
7. To add the layer to your map click Add>>Add layer from Web>>CSV file.

8. Use the drop-down menu to select the CSV file.

9. For type of data choose CSV file.

10. Paste the location from USGS.

11. Click ADD LAYER.

12. Click DONE.

13. Change Choose an attribute to show to mag (magnitude).

14. Click Counts and Amounts (Color)……. SELECT.

15. Click OPTIONS.

16. Click Classify Data.
   - Using: Natural Breaks
   - 4 Classes
17. Click OK.
18. Click DONE.
19. Right-click and rename the layer Earthquakes.
20. Change the Basemap to Oceans.
21. On top ribbon click Save As.
22. Use the following parameters in the Save menu:
   • Title: USGS Live Earthquakes_yourInitials.
   • Tags: IGACR2_quakes_yourinitials.
   • Summary: Live earthquake feed from USGS.
23. Click SAVE MAP.

**Scene 2: A scene showing earthquake depth**
1. Go to Home and select Scene.
2. Close the Scene Viewer.
3. Click Modify Scene.
4. Select ADD LAYERS.
7. Click DONE.
8. Save SCENE using the following parameters:
   • Title: Scene 2: 3D Quake Depth_yourinitials.
   • Tags: IGACR2_quakes_yourinitials.
   • Summary: Visualization of earthquake depth in 3D.
9. Click SAVE.
10. Click Configure Layer on the tab at the end of the layer file.
11. Choose depth 2 as the main attribute to visualize.
12. Click 3D Counts & Amounts>>SELECT.
13. Click OPTIONS and select a circle as the symbol.
14. Click DONE.
15. On the upper right ribbon, change the basemap to imagery. On the Basemap chooser menu turn the see-through ground tab on.
16. Click DONE.
17. Save SCENE.
18. Click SAVE.

19. Click DONE.

20. Save SCENE.

21. Click SAVE.

You have been asked to document the Mexico September 8 earthquake in a story map. Story maps let you combine maps, scenes, multimedia, and text.

**Build a story map using the scenes and map prepared above**

1. Go to your table of contents and click USGS Earthquakes_yourinitials.

2. Click Create Web App>>Using a Template.

3. Click Build a Story Map.
Chapter 6: Mapping the Third Dimension—Lesson 6-3: Responding to an earthquake off the western coast of Mexico

4. Click Story Map Journal.

5. Click CREATE WEB APP.

6. For Summary enter:

   Presentation of earthquake that hit off the coast of Mexico on September 8, 2017.

7. Click Done.

8. Add some text about the earthquake. You can also add a hyperlink.

9. Click ADD.

**Story map: Section 1—A live video**

1. Click Video.

2. Click YouTube.

3. Copy and paste this link into the web page link: https://youtu.be/pQgs2H1shpc

4. Click Check.

5. Click Select this video.

6. Enter a Section title: “Video of Earthquake.”

7. Click Next.


10. Click the Blue arrow to proceed.

You have four options for CONTENT: Map, Image, Video, and Web page. To make your story map powerful, start with a video. The link to the video below has a standard YouTube license so it can be used in your story map.

**Story map: Section 2—A scene displaying a 3D view of the location of the earthquake**

Before starting this section, go to Content and open Scene 1: Mexico Earth Earthquakes, open the scene, and copy the URL.

1. Click ADD SECTION.

2. Section Title: “Location of the Earthquake.”

3. Click Web Page.

4. Paste the URL in the URL tab. If you want to use the Scene Viewer in a story map but you want to eliminate unneeded tools and menus, add &ui=min to the scene viewer URL. This will hide all but the map and slide navigation tools.

5. Click Configure.

6. Click NEXT.

7. Add some text.

   This map shows the location of the three identified cities that were affected by the earthquake. It also shows a ShakeMap. A ShakeMap is a product of the USGS Earthquake Hazards Program in conjunction with regional seismic networks. ShakeMaps provide visualization of shaking intensity following significant earthquakes. ShakeMaps help federal, state, and local organizations prepare for post-earthquake recovery.

8. Click ADD.
**Story map: Section 3—A map showing live earthquakes**

Before starting this section, go to Content and open Quakes Live, open the map, and copy the URL.

1. Click ADD SECTION.
2. Section Title: “Live USGS Earthquake Feed.”
3. Click Map.
4. Select the map: Quakes Live.
5. Click NEXT.
6. Add some text.

   **USGS live earthquake feed for the last 30 days of earthquake with a magnitude of 2.5 or above.**

7. Click ADD.

**Story map: Section 4—A scene showing earthquake depth**

1. Click ADD SECTION.
2. Title: “Quake Depth 9/8/2017 Mexico.”
3. Click Web Page.
4. Paste the following URL: http://learngis.maps.arcgis.com/home/webscene/viewer.html?webscene=f4ca9a902abe4266b428266047edd8b8&ui=min
5. Click Configure.
6. Click NEXT.
7. Add text:

   **This scene shows depth of earthquakes in 3D below ground.**

8. Click ADD.
9. Click SAVE.
10. Click VIEW STORY.

In this section you have used videos, maps, and scenes to create a presentation about the September 8, 2017, earthquake off the coast of Mexico.
Lesson 6-4: Styling LAS point cloud layers in Scene Viewer
Baltimore City, MD, LAS lidar

Scene Viewer now has the capability of styling published LAS data into three distinct categories: elevation, class, and intensity.

Build skills in these areas
- Opening Scene Viewer
- Navigating a published LAS dataset
- Using Smart Mapping Styling for elevation, class, and intensity

What you need
- User, Publisher, or Administrator role in an ArcGIS organization
- Estimated time: under 30 minutes

Scenario
The City of Baltimore has access to a published LAS dataset. City officials would like an explanation of what the different classifications of lidar points are. They have asked you to use the published dataset to explain.

Open Scene Viewer and identify structures
1. Sign in to your organizational account.
3. Change the basemap to Imagery with labels.
4. Use the middle mouse button to switch to perspective view and look at structures from the side, particularly the baseball stadium.
5. Zoom around on the map and identify:
   - Change the basemap to Imagery with Labels
   - Baseball Stadium – Camden Yards
   - Cranes
   - B & O Railroad Museum

Classify Points
1. Click the Modify Scene icon in the upper left corner.
2. Click Configure Layer at the end of the Lidar Point Cloud Data feature. This gives you three different styles:
   - Class
   - Elevation
   - Intensity

Class: Every lidar point can have a classification assigned to it that defines the type of object that has been reflected. Lidar points can be classified into various categories, including bare earth or ground, top of canopy, and water.
**Elevation**: Symbolizes points based on point elevation.

**Intensity**: A measure, collected for every point, of the return strength of the laser pulses that generated the point. It is based, in part, on the reflectivity of the object struck by the laser pulse.

In this lesson, you have visualized a lidar dataset and explored three types of classification.
Lesson 6-5: Teaching world time zones
Chart the hour for online students

For centuries, humans have marked time by the position of the sun. The sun rose in the east, moved across the sky, and set in the west. Solar noon occurred when the sun was directly overhead. However, solar noon in one location could occur in the middle of the night in another. What could we do to solve this problem? The answer came through establishing worldwide standard time zones. There are 24 time zones, each 15 degrees of longitude wide. The starting point for the standard time zones is the Prime Meridian. Travelers moving westward from the Prime Meridian move their clock back to earlier times (minus 1 hour for each time zone), while those moving eastward change to later times (plus 1 hour for each time zone). A traveler going around the world would have to change not only the time but also the date. Establishing the International Date Line solved this problem. Travelers moving westward advance their calendars one day as they cross the International Date Line (Saturday to Sunday), and travelers moving eastward move their calendars back one day (Saturday to Friday).

Build skills in these areas
- Opening Scene Viewer
- Searching and adding layers
- Configuring layers

What you need
- User, Publisher, or Administrator role in an ArcGIS organization
- Estimated time: under 30 minutes

Scenario
A large university that has a major department in International Relations and Diplomacy has asked you as a GIS educator to provide them with a lesson that will explain worldwide standard time
zones. The university has asked that the course be online and that it be a hands-on experience. ArcGIS Online is the software that is available at the university.

Open Scene Viewer, search for and add layers, configure, and save

1. Sign in to your ArcGIS organizational account.
2. Click Scene on the top Ribbon.
3. Take time to learn the navigational buttons:
   - Click the Home button .house to return to the initial position.
   - Click + to zoom in. You can also use your mouse and scroll wheel to zoom in and zoom out or press and hold the middle mouse button and move down or up to zoom in or out.
   - Click the Pan button  to pan. Click and hold the left mouse button and drag the map in the direction you want to move it. You may also pan by using the arrow keys on the keyboard.
   - Click Rotate button  to rotate. Click and hold the left mouse button and drag the map in the direction you want to rotate it.
   - Click the Compass button  to reorient your scene North. You may also press N on your keyboard.

You need to add the following layers to construct the lesson:

- Prominent World Longitude and Latitudes
- World Time Zones
- Cities_tzones

4. Click + ADD LAYERS.
5. Where it says Search for layer… type **Prominent World Longitude and Latitudes**.
6. Click the + button.

7. Click DONE.
8. Click the pull-down arrow at the end of the layer name.
9. Change Symbols to Change symbols and make the Size (px) be 4.
10. Click DONE.
11. Click + ADD LAYERS.
12. Search for World Time Zones. Click + World Time Zones Feature layer by esri.
13. Click DONE.
You now have two layers on your map. You can turn these layers on and off by clicking the icon on the top right corner.

14. Click + ADD LAYERS again and search for city_tzones and add to your scene.

15. Click DONE.

16. City_tzones seem to be floating in space.

17. Click the drop-down tab to Configure city_tzones.

18. Select 3D Object OPTIONS.

19. Change the Elevation Mode to On the ground.

What cities are represented?

20. Click DONE.

21. Add appropriate metadata:

   - Scene title: World Time Zones.
   - Tags: time_zones,scene.
   - Summary: Spatial display of World Time Zones.

22. Click SAVE SCENE.

23. Click SAVE SCENE again.

Describe the standard time zones.

Why do some of the standard time zones have irregular boundaries on land?

Explain the need for an International Date Line.

How many time zones are in the continental US?
24. Go to My Content to open the World Time Zones Scene.

Use the constructed Scene to complete this chart:

<table>
<thead>
<tr>
<th>Start City</th>
<th>Day/Time</th>
<th>Travel Direction</th>
<th>End City</th>
<th>Day/Time</th>
<th># Time Zones Crossed</th>
</tr>
</thead>
<tbody>
<tr>
<td>London</td>
<td>Mon 11 AM</td>
<td>West</td>
<td>Denver</td>
<td>Mon 4 AM</td>
<td></td>
</tr>
<tr>
<td>London</td>
<td>Mon 11 AM</td>
<td>East</td>
<td>Denver</td>
<td>Mon 4 PM</td>
<td></td>
</tr>
<tr>
<td>Paris</td>
<td>Wed 1 AM</td>
<td>West</td>
<td>Minneapolis</td>
<td>Tues 6 PM</td>
<td></td>
</tr>
<tr>
<td>Paris</td>
<td>Wed 1 AM</td>
<td>East</td>
<td>Minneapolis</td>
<td>Tues 6 PM</td>
<td></td>
</tr>
<tr>
<td>Rio de Janeiro</td>
<td>Friday 10 PM</td>
<td>West</td>
<td>Tokyo</td>
<td>Sat 10 AM</td>
<td></td>
</tr>
<tr>
<td>Rio de Janeiro</td>
<td>Friday 10 PM</td>
<td>East</td>
<td>Tokyo</td>
<td>Sat 10 AM</td>
<td></td>
</tr>
</tbody>
</table>
Teachers can use the items in this section as an assignment, an introduction, or an assessment, tailored to the sophistication of learners. Some learners can read all the sections at one time, while others are more comfortable with small segments. The questions and tasks are designed to stimulate thought and discussion.

The evolution of 3D mapping: Advantages of 3D
What advantage does vertical information give?
What is human-style navigation?

Important 3D terminology: Getting the z-terminology straight
Explain these terms (including the difference between them where appropriate):
maps and scenes
local and global surfaces
real size and screen size

Representing the world in 3D
Define photorealistic.
What makes 3D cartography powerful?
What two factors are involved to create a feeling of virtual reality?

What makes a great scene?
What is meant by implying a 3D scene is designed to be immersive?
What are the three choices of styling 3D content?
List two ways to illustrate thematic views.

Thought leader: Nathan Shephard—The rise of the 3D cartographic scene
What does Nathan discuss?
Who uses 3D cartography? Go to ArcGIS Web Scenes Gallery and investigate three of the maps.
Learn ArcGIS: Guided lessons based on real-world problems

Get Started with Scene Viewer
Navigating a scene.
Adding layers to a scene.
Making layer groups to organize data.
Capturing slides.
Creating a 3D web app.

Fly Through South America in a 3D Animation
Creating a scene with imagery layers.
Adding and labeling map notes.
Creating an animation.
Exporting an animation to video format.
“With billions of users worldwide, apps are a technology trend that has captured the world’s attention. Online maps provide the information that powers the use of GIS. And every map has an interface—a user experience for putting that map to use. These experiences are apps, and they bring GIS to life for users.” (The ArcGIS Book, p. 92)

Have you ever been out to dinner and noticed that no one is talking to you? They are on their smartphones, their iPads, or their Androids. It is the invasion of the apps. You can find a place to eat, a hotel, a ball game; sitting down, standing, or walking, you can look up almost any information. Wherever you are, you can check the weather forecast or know when a plane is landing.

Apps are lightweight computer programs designed to run on the web with smartphones, tablets, and other mobile devices. While all such applications serve a purpose, GIS apps are even more useful because they are map centric and spatially aware. GIS apps can collect data, alert you to geographic events, and answer questions through analysis.

This chapter gives you the opportunity to do the following:

- Visit ArcGIS Marketplace and pick out two apps of interest to you, then download and investigate them.
- Participate in a collaborative data experience showing participant skill and location of everyone using Instructional Guide for The ArcGIS Book.
- Explore a flood modeling app and a historic map app.
- Learn different ways to collect field data.

The lessons in this chapter offer practice (and entertainment) in downloading and experiencing apps. Use the questions at the end of this chapter to support your reading comprehension, reflection, and discussion of the narratives presented in the corresponding chapter 7 of The ArcGIS Book.
Introductory activities

Videos

These videos below represent the new trend using ArcGIS mobile apps:

**ArcGIS Apps for the Field**

ArcGIS Apps for the field

See how to improve field operating efficiency with ArcGIS apps. Eliminate your reliance on paper-based workflows to coordinate and

**Survey123 for ArcGIS: Leveraging Your Survey Data in Other Apps**

Survey123 for ArcGIS: Leveraging your Survey Data in Other Apps

This video shows you how to leverage your survey data into other applications such as Story Maps and Web AppBuilder.

**Esri Solutions for Business**

Esri Solutions for Business

esri • 4.4K views • 1 year ago
Activity
Investigate ArcGIS Marketplace

1. Go to ArcGIS Marketplace.

What is marketplace?

Who can use the apps?

Select two apps and explain why you would want to use them. Download them to your mobile device and enjoy.
Lessons: Account not required

Remember, you can access online all you need for the lessons in this guide. Some activities and lessons require no sign in to ArcGIS Online (the first set of lessons in each chapter) while others require signing in to an ArcGIS organizational account (the last set of lessons in each chapter).
Lesson 7-1: Collecting data collaboratively
Learn from The ArcGIS Book

Apps provide the interface for the efficient collection of spatial data so you can leverage your handheld device as a data collection tool. As a user of *Instructional Guide for The ArcGIS Book*, you are being asked to enter your location and learning environment into the cloud using an editable feature service (a shared tool) and working on the map collaboratively. Record your location by clicking on the map and recording the following information:

- Higher education
- K–12 education
- Online program

**Build skills in these areas**
- Opening a map with an editable features service
- Contributing information to a collaborative map

**What you need**
- Account not required
- Estimated time: 5 minutes

**Scenario**

The ArcGIS Book Team wants to collect data about the learners using *Instructional Guide for the ArcGIS Book*.

1. Go to *Instructional Guide User Map*.
2. Click Edit on the top of the page.
3. Click Learners in the table of contents.
4. Click to add a point on your location on the map.
5. Fill out the information requested.

You are now part of an online collaborative map collection.
Lesson 7-3: Exhibiting changes over time
Use the USGS Historical Topographic Map Explorer app

In 1879, the US Geological Survey (USGS) began to map US topography and continued to do so until 2006. As the years passed, making good use of satellite imagery, the USGS continuously updated map versions of each area. USGS topographic maps were provided at a variety of scales ranging from 1:24,000 to 1:250,000. Today, they are available digitally to view and download via the following:

**TopoView app**

The most current maps are available from The National Map.

**USGS Historical Topographic Map Explorer**, a web-based app.

In this lesson, you will learn how to use one of those apps, the **USGS Historical Topographic Map Explorer**, to find historical maps that reveal and portray changes over time at your location (for example, changes in land use, roads, neighboring structures). You will use the **USGS Historical Topographic Map Explorer** to identify maps you would like to use in your project.

**Build skills in these areas**

- Opening the USGS Historical Topographic Map Explorer
- Searching for historical topographic maps of a specific location
- Identifying maps that support your project goals

**What you need**

- A computer or mobile device with internet connectivity
- Estimated time: 30 minutes
- Account not required

**Scenario**

The school board in Fairfax, Virginia, has decided to create a public exhibit about the history of the Lanier Middle School in the public library.
The exhibit will be designed by students with separate teams designing different exhibit components. You are part of a team that will focus on changes over time in landscape, land use, and settlement patterns around the school.

Open the app and search

1. Open the USGS Historical Topographic Map Explorer.
   The USGS Historical Topographic Map Explorer is a highly customized map designed to act as a catalog to visually show available historic maps covering geographic areas across the US.

2. In the search box (Find a Place), enter the following address:
   3801 Jermantown Road, Fairfax, VA 22030.

3. Select it from the drop-down list (it will be first).

4. Zoom out just slightly so you can see the Lanier Middle School Building.

5. Click on it.
   A red + appears where you clicked, and a list of historical maps about this specific area and location are displayed across the bottom of the screen.

   ![Map Explorer Screenshot](image)

   Note that a color key to the various map scales is displayed on the left. For our web app, we want maps at the 24,000 or 62,500 scales because they will provide the most detail.

Identify maps that support your project goals

1. Point to the earliest 62,500-scale map, and you’ll see a thumbnail of the map (Fairfax, 1915).

2. Click the timeline marker to display the map in the main window.
   The 1915 map of Fairfax is displayed and listed in the left map panel. You can remove the map by clicking the x in the upper left corner. You can turn it on and off by making it transparent. Notice that the red + still indicates the location of the school even though the school is not on this map. You may want to zoom out slightly to get a sense of the area at this scale.

   ![Map Image](image)

3. Choose another map from the list below the display.
   The next map chronologically is Fairfax 1944. When you add it to your map, your display looks like this:

   ![Map Image](image)
a. Use the slider to the right of the map to modify transparency.

b. Zoom out to get a sense of the larger surrounding region.

c. Make note of changes that occurred in this 30-year period as reflected in differences between the maps.


When you’ve added all the maps, your contents bar looks like this:

---

Explore and compare the maps to identify ones that tell the clearest story of changes around the Lanier Middle School from 1915 to the present. Note that you can download any of these maps as a geopdf. The download link is next to the map thumbnail in the Table of Contents.

If you have an organizational account, you can add these maps to ArcGIS Online.
Lessons: Account required

Although many of the lessons in this book do not require saving your work, others do. Membership in an ArcGIS organization (with Publisher privileges) will enable you to easily follow directions to create, save, and share maps in every lesson. If you do not have an organizational account already, follow the instructions below to obtain one.

Connect with and deploy the ArcGIS platform

If you’re an existing ArcGIS user and already have an ArcGIS subscription (with Publisher privileges), you’re good to go. If you don’t have these three things, continue reading.

Get a Learn ArcGIS organization membership

The Learn ArcGIS organization is available for students and others just getting started with ArcGIS. Follow this link to the Learn ArcGIS organization to activate a 60-day membership. With your new membership, you can immediately begin to use maps, explore data resources, and publish geographic information to the web. Getting a Learn account is the quickest and easiest way to experience web GIS at ArcGIS Online.

Schools mapping software bundle

The ArcGIS for Schools Bundle is available at no cost for instructional use to individual US K–12 schools, school districts, and states direct from Esri. Beyond the US, the bundle is available to schools worldwide through Esri’s network of international distributors. Every public, private, home school, and youth-service club is eligible. The software bundle includes the following:

- ArcGIS Online organizational and user accounts
- Ready-to-use web and mobile apps
- ArcGIS Community Analyst licenses
- ArcGIS Desktop Advanced licenses

Sign up at Schools Mapping Software Bundle.
Lesson 7-4: Adding history to ArcGIS Online

View topographic maps from the Living Atlas of the World

In this section you will add historical topographic maps to an ArcGIS Online map from the Living Atlas of the World.

Build skills in these areas

- Adding historical topographic maps as layers to ArcGIS Online
- Creating a web application to show change over time at one location

What you need

- An ArcGIS Online organizational account
- Estimated time: 1 hour

Scenario

Your team has decided to create a web application for the exhibit that will enable viewers to compare historical topographic maps of your school's surroundings at different historical dates. Your responsibility is to create the web application. Others on your team will provide content based on research.

Create a new map in your ArcGIS Online account

1. Open a new browser tab and go to ArcGIS Online. Sign in to your organizational account.

2. Open a New Map.

3. After using the find address box to zoom to the Lanier Middle School (3801 Jermantown Road, Fairfax, VA 22030), click Add to Map Notes to place a marker there.

4. Click the map note.

5. Click Edit.

   This offers the opportunity to change the symbol to pushpin, etc.

6. Click on the map note in the map and change its title to Lanier Middle School.

7. Click Edit to stop editing.
8. Also rename the map notes layer in the Table of Contents, *Lanier Middle School*.

9. Save your map as *Lanier Middle School*.

10. Fill in the map information with tags and a summary (*Historical topo maps of the Lanier MS area*).

**Add historical topographic maps as layers to an ArcGIS Online map**

1. Click Add.

2. Click Browse Living Atlas Layers.

   Under All Categories, choose Historical Maps.

   First add the 1:62,500 group.

3. Click the more options symbol (three dots beneath the layer name in the map’s Contents list).

4. Choose Image Display Order from the drop-down list, and in the window that opens:
   a. Leave An attribute at Date Current.
   b. Change the Highest priority value to 1915.
      This means you are adding the 1915 map from the 1:62,500-scale group.
   c. Click Apply.
   d. Click Close.

5. Click more options again and click Copy.

   You need to copy the set of maps because you want to add a second map (1944) from the 1:62,500 group.

   A copy of the USA Historical Topo Maps 1:62,500 has now been added to your map.

6. Go to Image Display Order on the new copy of the layer and change 1915 to 1944.
You can see the two map layers that you’ve added by toggling on and off.

7. Rename the layers in the Table of Contents with the appropriate year:
   a. For the first map you added (the lower one), click more options and click Rename.
   b. Change the layer name to 1915.
   c. Repeat this with the layer copy.
   d. Rename this layer to 1944.


9. Add the USA Historical Topo Maps 1:24,000.

10. Use the same procedure you did with the first group of maps, to add maps from the 1:24,000-scale group. Go to Image Display Order in that layer and replace 1800 with 1955 (the next map you want to add).

11. Click Apply.

12. Click Close.

13. Copy the USA Historical Topo Maps 1:24,000 layer three times because you want to add three more maps from this group (1966, 1979, and 1994).

14. Repeat the selection procedure to add each of these three layers to your map. Save your map frequently.


   When you have added all the layers, your map will look like this.

16. Save your map.

   The final layer in your map will be a contemporary topographic map.

17. Go to Add>Search for layers>In ArcGIS Online and search for USA topographic.

   In the Search results, choose and add USA Topo Maps.
18. In the Search results, choose and add USA Topo Maps.

19. For each of your map layers, click More Options (ellipsis) and Hide in legend.

Create a web application to show change over time at one location

1. Click Share.
2. Check Share with everyone and click Create a New Web App.
3. On the Create a New Web App page, leave the selection to Show All.
   • Scroll down until you see the Map Tools app.
   • Click Create App.
4. ADD A MAP SUMMARY (Historical topo maps of the Lanier MS area) and any additional tags you want to add about details of your app.
5. Click Done.
   • General: leave default settings.
   • Theme: choose colors for map components (you can change these later).
7. Click Save and click View.

8. Click Save.
9. From your My Content list, open the web app you have created for the museum exhibit.
Lesson 7-5: Enabling citizen collaboration
Create an editable web layer to map graffiti: Survey123

Two uses for mapping graffiti come immediately to mind. The first use is to classify the type of graffiti that is present and the second is to specify what graffiti needs to be removed by the municipal authorities. Because graffiti has a spatial component, clusters can be found across the city representing gang, political, or religious trends.

Build skills in these areas
- Creating a web designed Survey 123 form
- Creating relationships within the survey
- Using a thumbnail
- Publishing and sharing a survey

What you need
- User, Publisher, or Administrator role in an ArcGIS organization
- Estimated time: 1 hour

Scenario
As a GIS consultant, you have been asked to create an editable web layer that is accessible online to the public. This editable web layer will enable citizens to work collaboratively on one map. The size of the group is negligible so many citizens can work at one time. A map containing the editable web layer can be made anywhere in the world and be accessed wherever there is an internet connection. The survey collects data about types of graffiti and whether it should be removed by the municipal authorities.

The editable web layer will use configured relationships to enforce data integrity.

Open and create a web-designed Survey123
1. Go to Survey123.
2. On the top ribbon on the right, sign in to your ArcGIS Online organizational account.
3. Click Create a New Survey.
4. Using the web designed>>click Get Started.
5. Fill out the Create a New Survey template with the following:
   - Name: Graffiti.
   - Tags: IGARC2_graffiti_yourinitials.
   - Summary: Survey to collect data about types of graffiti and remedial action.
6. Click Create.
Add logistical questions

Here is the information the survey is going to collect about observed graffiti.

a. What is your name?
b. What is the date?
c. What is the type of graffiti?
   • Ideological
     o Political (pertaining to hate groups such as Nazi or ISIS)
     o Racial (pertaining to race)
   • Territorial
     o Tags (gang symbols)
     o Memorials (honor the slain)
   • Artistic
d. Does the graffiti require repair?
   • Yes
   • No
e. Where is the graffiti located? (geo-enabled location)

On the right panel, you are presented with a list of questions. The type of questions that you choose on the right panel must be dragged into the Web Designer.

1. Click Singleline Text.
2. Type the question: What is your name? This identified the taker observing the graffiti.
   a. Check: This is a required question.
   b. Click Save.
3. On the top of the right panel click Add.
4. Click Date.
5. Type the question: What is the date? Modify date if different from current date.
   a. Check Submitting date.
   b. Check This is a required field.
   c. Click Save.
6. Once again at the top of the right panel, click Add.
7. Click Single Choice.
8. Type the question: What is the type of graffiti?
   a. Choice 1 is Ideological – Political.
   b. Choice 2 is Territorial – Gang Related. Make this choice the default.
   c. Choice 3 is Artistic – Street Art.
   d. Choice 4 is Other.
   e. Layout is Vertical.
   f. Check This is a required question.
   g. Save.
9. Once again, at the top of the right panel click Add.

10. Click Single Choice.

11. Type the question: Should remedial action be taken to remove it?
   a. Choice 1 is Yes.
   b. Choice 2 is No.
   c. Layout is Vertical.
   d. Check This is a required question.
   e. Save.

12. On the top of the right panel, once again click Add.

13. Select GeoPoint to designate a location on the Earth’s surface.

14. Type the question: Where is the graffiti located?
   a. Change the Default Map to Imagery.
   b. Click the bullseye button on the map, and it will zoom to your area. The map will then be set for this location area.
   c. Check This is a required question.
   d. Click Save.
   e. Click preview to observe your survey.
   f. After previewing the survey, click X to return to the survey designer.

Construct your survey with relationships for integrity of data

One of the greatest concerns when collecting data is data integrity and efficiency. Integrity and efficiency are maintained if the collector is presented with specific choices that maintain the integrity of the attributes. You can arrange this by using the drop-down menus that you choose as a collector. For instance, as the collector in the
next step, you will create a collection function that allows you to further classify the type of graffiti and whether it needs repair. This is done by setting rules. For example, if the collector selects “ideological” as the type of graffiti, then a drop-down will appear that will allow further classification of the graffiti as either “political” or “racial.” If the collector chooses “territorial,” then once again the data can be further classified as “tags” or “memorials.” The repair question requires only a simple “yes” or “no” classification.

1. Click Add.
2. Click Single Choice and type the question: If answer is ideological choose:
   a. Choice is political.
   b. Choice is racial.
   c. Choice is Other.
   d. Appearance is Vertical.
   e. Save.
3. Click on the “What is the type of graffiti?” question and select the set rule icon.
4. Choose IF ideological, choose “If answer is ideological choose.”
5. Click OK.
6. Click Save.
7. Click Add.
8. Click Single Choice and type the question: If answer is territorial choose:
   a. Choice is tags.
   b. Choice is memorials.
   c. Layout is Vertical.
   d. Save.
9. Click on the “What is the type of graffiti?” questions and select the set rule icon.
10. Choose IF ideological, choose “If answer is territorial choose.”
11. Click OK.
12. Click Save.
13. On the bottom right, click Preview and test your survey.
14. Click X in the upper right corner to close the preview.

Select an appearance and publish
1. Click Appearance on the top ribbon.
2. Select a Theme.
3. Have all the layout elements turned selected.
4. Click Save.
5. Click Preview.
6. Click Publish. Publishing will send the survey into the cloud where it can be accessed by collectors who can work on the map collaboratively.
   It will ask you if you want to save all changes.
7. Click Publish.
Lesson 7-6: Determining how bad the graffiti is
Gather data with your smartphone

Build skills in these areas
- Downloading the Survey123 app to your mobile device
- Downloading the Graffiti survey to your mobile device
- Marking a point and collecting the data
- Observing collected survey data in a web browser
- Observing collected data in ArcGIS Online

What you need
- An ArcGIS Online organizational account
- Survey123 app
- Estimated time: 1 hour

Scenario
Your town council has decided to earmark money for the removal of graffiti. The council needs to know the location and extent of the graffiti before the town can come up with the money for a cleanup plan. Girl Scouts have been equipped with mobile devices to mark and collect information about the graffiti. The council is extremely interested in the type of graffiti that is present.

Download the Survey123 app to your mobile device
1. Go to the app store on your mobile device.
2. Search for and download the Survey123 mobile app.

Access the Graffiti Survey form on a mobile device
1. Click the Survey123 icon on your mobile device.
2. Sign in to ArcGIS Online organizational account.
3. Click Get Surveys.
4. Download the Graffiti Survey by clicking on the blue cloud with the down arrow.

5. When it says Graffiti Survey download complete, click OK.

This downloads the survey to your mobile device.

6. After downloading, click Graffiti.

The survey will download to your mobile device. The app will ask you:

Allow “Survey123” to access your location while you are using the app?

7. Click Allow. This turns on the GPS in your mobile device, enabling location services, and you will now see your survey. Your GPS may already be turned on, in which case there is no need to do this.

8. To change the basemap, click the map.

9. Click the three lines on the top right.

10. Change the basemap to World Imagery.

11. Fill out the survey form.

12. Click Continue this survey.

13. Collect the graffiti points.

14. After collecting the graffiti points, click Send NOW. This sends your survey points into the cloud.

Access the Graffiti Survey in a web browser

The web browser is where you can share your form with your organization so that others can download. This is also where you can go to review responses to your survey and download your survey data.

1. Go to: Survey123.

2. Sign in to your organizational account.

3. Click My Surveys.

4. Click the Graffiti Survey under All Surveys.

The web browser has five tabs at the top. Each tab gives you additional information about the data you have collected during your survey

- **Overview** tells total records, participants, and dates.
- **Design** allows you to make adjustments to your survey.
- **Collaborate** gives permission to participants to see and submit data.
• **Analyze** gives you histograms about your data.
• **Data** shows your collected points on the map.

5. Click on each of the tabs and investigate the information.

**Access the Graffiti Survey in ArcGIS Online**
1. On the bottom left, click Open in Map Viewer to open the Graffiti Survey as a map within your account.
2. Click a point on the map to access the data.

3. After opening, you can save your map with the appropriate metadata.
4. For the public to access your map, choose Share with everyone. For now, only those in your organization can view the map.

In this exercise, you have collected data with the survey you have prepared in lesson 7-5.
Lesson 7-7: Owning a feature service
Access a service definition

This lesson introduces you to service definitions. A service definition is a file that is produced every time a feature service is created. It contains all pertinent information about the feature service. It allows you to duplicate a preexisting feature service, add the service to your organization, and transfer all ownership to you.

**Build skills in these areas**
- Finding a service definition template
- Downloading a service definition
- Publishing a service definition as a unique feature service
- Collecting data with the feature service

**What you need**
- User, Publisher, or Administrator role in an ArcGIS organization
- Estimated time: 30 minutes

**Scenario**
You want to do a training session in which participants gather information about area trees. You have located a service definition that you can use as a template. The service definition that you have located provides the following information:

- Collector
- Type of tree (needle, broadleaf, palm)
- Height in estimates of 5 feet
- Diameter of canopy (estimate in feet)
- Area for comment
- Attachment ready—jpeg and png images can be uploaded

You need to download the service definition and then upload and publish it to your organizational account. When published you can collect data.

**Find and publish a service definition**
1. Sign in to ArcGIS Online organizational account.
2. Click Search.
3. Search for IGARC2_tree.
4. Uncheck the Only search in your Organization tab.

5. Download the file Tree Collection by clicking Open and save to your computer.

6. In ArcGIS Online, click My Content at the top of the page.

7. Click Add Item From my computer.

8. Browse to the Tree.sd file and choose file.

9. Be sure the Publish this file is checked.

10. Add the appropriate tags such as IGARC2_tree_yourinitials.

11. Click Add Item.

It will take several minutes to upload and publish the tree service definition.

12. After the feature service is created, click Open and click Add layer to map. After the feature service is added to the map, you will see the Edit icon on the top of the page.

13. Click Edit. When you click the Edit icon, the trees collector icon is exposed.

14. Click the tree icon.

15. Click the location of the tree on the map. The collection menu is exposed.

The collection menu allows you to not only collect data, but the Choose File allows you to upload a jpeg or png image.

In this lesson, you have uploaded and published a service definition template designed to collect tree data.
Lesson 7-8: Mapping tree data
Use Collector for ArcGIS

Collector for ArcGIS allows you to use your smartphone or tablet to collect data.

Build skills in these areas
- Downloading Collector app to a mobile device
- Creating a group with an editable feature service
- Sharing a map with workers in the field
- Collecting data

What you need
- User, Publisher, or Administrator role in an ArcGIS organization
- Estimated time: 1.5 hours

Scenario
You have been assigned the task of preparing a map using the tree collection service you prepared in lesson 7-7. Remember, this is the collection template that you need to have a group of instructors use in a training session. You now have it uploaded, shared, and ready to access on your mobile app.

Create a map and share with a group in ArcGIS Online
1. Sign in to ArcGIS Online organizational account.
2. In My Content, find the tree feature service.
3. Add the tree feature service to a new map.
4. Save the map with the appropriate metadata.
5. Under Home, select Groups.
6. Click Create New Group.
7. Add the following parameters:
   - Group Name: Tree Collection.
   - Tags: IGARC2_tree_yourinitials.
   - Summary: Content for tree collection.
   - Click Only group members can view this group.
   - Click Group members can contribute content to the group.

Account required
8. If you have a .jpg image that you want to represent the group, click the icon button and add the image.

![Image of a map with a 'Groups' option]

9. Return to your map in My Content and share with the group you have just created. Be sure to click Done without creating an app.

Your map is now ready to be viewed in Collector. Collector will NOT recognize a map unless it is shared with a group.

**Download Collector for ArcGIS**

To complete this lesson, you will be asked to download and learn to navigate the mobile component of GIS: Collector for ArcGIS. Collector for ArcGIS is designed to improve the efficiency of fieldwork and the accuracy of your GIS. Use your mobile device to collect and update information in the field, whether connected or disconnected.

1. On your mobile device, go to the app store, search for Collector for ArcGIS, and download the app.

![Image of Collector app sign in]

2. Open the mobile app to sign in to your organizational account.

3. Click ArcGIS Online and sign in to your organizational account.
Accessing map and navigating and collecting with Collector

1. Open the Collector app and you will see the Tree Collection map you made and shared with the group; it’s aptly named Tree_Collection.

2. Open the map and allow Collector to access your location using the app. The Collector device has different icons on iOS and Android devices. However, all of them universally do the same thing.

3. Familiarize yourself with the Collector app with whatever operating system you are using and figure out how to do the following:
   - Change the basemaps.
   - Measure.
   - See a legend.
   - Collect a point.

The point collection is critical. As a general rule, to collect a point you need to do the following regardless of the operating system you use:
   - Click the GPS point.
   - Fill out the collecting form.
   - Submit the form.

The point you and the other collectors are collaboratively gathering on the map is saved in the cloud.
Lesson 7-9: Using Web AppBuilder for ArcGIS®

Web AppBuilder for ArcGIS provides a foundation for building web applications in ArcGIS. It builds intuitive, focused apps that run anywhere, on any device, without writing a single line of code.

Build skills in these areas
- Building an app using ready-to-use widgets
- Customizing the look of your apps with configurable themes
- Publishing the apps

What you need
- User, Publisher, or Administrator role in an ArcGIS organization
- Estimated time: 1 hour

Scenario
Community leaders have asked your GIS department to create an app of the county that allows users to do and create the following:

- Scalebar
- Search
- Add data
- Basemaps
- Legends
- Measurement
- Query

Create a map and share as a Web AppBuilder
1. Sign in to your ArcGIS Online organizational account.
2. On the top ribbon click Content.
3. Click Create.
4. Click Using the Web AppBuilder.

5. Document the new web app using the following parameters:
   - Title: Basic Locational and Directional App.
   - Tags: IGARC2_app_yourinitials.
• Summary: (Basic app that allows the user to find locations, measure, and add data).

6. Click OK.

Add a theme, map, and add basic widgets
1. Pick the Billboard Theme.
2. Click Map on the top ribbon.
3. Use current map view.
4. Click Widget on the top ribbon.
5. Add the following standard widgets:
   • Scalebar
   • Search
     ○ On the icon for search, click pencil for edit.
     ○ Click OK to add the Esri World Geocoder.
     ○ Click OK.

Add custom widgets
1. Click Widget 1.
2. Select Add Data.
3. Click OK.
4. Click OK.
5. Click Widget 1.
6. Click Basemap gallery.
7. Click OK.
8. Click OK.
9. Repeat steps 1–4 for Legend.
10. Repeat steps 1–4 for Measurement.
11. Repeat steps 1–4 for Query.
12. Click Save.

Preview and launch
1. On the bottom left tab, click Preview.
2. If you are happy with your work, click Launch.

In this lesson, you have created an app with both standard and custom widgets.
Teachers can use the items in this section as an assignment, an introduction, or an assessment tailored to the sophistication of learners. Some learners can read all the sections at one time, while others are more comfortable with small segments. The questions and tasks are designed to stimulate thought and discussion.

**The rise of spatially intelligent apps**

*What is an app?*

*How is a GIS app unique?*

*Where do apps come from?*

*List some ways to solve a problem with an app.*

**Thought leader: Jeff Shaner**

On the scene at the Deepwater Horizon oil spill

*How did the use of mobile GIS influence the Deepwater Horizon emergency response?*

**Case study: US Geological Survey**

In 2009, the US Geological Survey began the release of a new generation of topographic maps in electronic form and in 2001 complemented them with the release of high-resolution scans of historical topographic maps of the US dating back to 1882. View these using the USGS Historical Topographic Map Explorer. Use the app to do the following:

*Find the area you want to explore.*

*Use the timeline to select the maps.*

*Compare the maps.*

*List three of Esri’s ArcGIS ready-made apps.*
Learn ArcGIS: Guided lessons based on real-world problems

**Manage a Mobile Workforce**
- Publishing a web layer.
- Creating a web map.
- Sharing maps with workers in the field.
- Using Collector for ArcGIS.

**Manage a Mobile Workforce**
Collect fire hydrant inspection results from the field using Collector for ArcGIS.
Get Started with Survey123 for ArcGIS

Creating a survey with the Survey123 for ArcGIS website.
Submitting a survey with a URL link in a web browser and the Survey 123 field app.
Analyzing survey results in the Survey123 website.
Sharing survey results with other ArcGIS platform client apps.
The convergence of photography and airplane flight in the early twentieth century resulted in the ability to truly experience a birds-eye view of Earth for the first time. The emergence of photography in the mid-nineteenth century had produced early efforts with hot-air balloons and kites, but it wasn’t until the achievement of airplane flight that aerial imagery came into its own. During World War I, aerial photography played an increasingly important role in both reconnaissance and map-making; by the end of the war, it had become a vital military tool for both sides.

Since that time, birds-eye views have grown to include views from planes, satellites, and, more recently, drones. The scale and resolution have improved dramatically with each iteration, and modern imagery now includes “invisible” data from sensors as well as reflected visible light. Today, geographers use remote sensors to study Earth’s surface.

Remote sensing has applications for virtually every human industry, activity, and concern. Using remotely sensed data, farmers are increasing crop yields, commuters are monitoring traffic flow, and environmentalists are investigating climate change. With the rapid proliferation of unmanned aerial vehicles (UAVs), the number of remote sensing applications is growing exponentially. Imagery and remote sensing are informing decision making in every arena and will only grow in value and importance in years to come.

In chapter 8, you will compare image resolution across different scales, analyze landscape imagery to assess current weather conditions, use the Esri Landsat Explorer App to monitor hydraulic fracking activity, and use Landsat imagery to visualize the effect of a forest fire in California and vegetation damage caused by Hurricane Maria in Puerto Rico.
Videos
Videos elevate motivation and enthusiasm as well as enhance discussion. The following videos represent the production of imagery as visible intelligence:

**Esri Launches Landsat Explorer Web App**

![Esri Launches Landsat Explorer Web App](image1)

**Know How Landsat 8 Completes Its One Rotation to Give Brighter Imagery**

![Know How Landsat 8 Completes Its One Rotation to Give Brighter Imagery](image2)
Activity
Understanding the Landsat program

Landsat sensors have been continually generating and sharing pictures of Earth since the 1970s. It is the most persistent Earth observation program ever used. Landsat data is used so extensively that a knowledge of the history of the program and the science behind it is necessary.

Go to the NASA Landsat Science web page and answer the following questions:

What is Landsat and when did it begin?

What are the orbit paths of the Landsat satellites?

What is the resolution of the spectral bands?

What is the resolution of the thermal bands?

What is the difference between the spectral band and the thermal band?
Lessons: Account not required

Remember, you can access online all you need for the lessons in this guide. Some activities and lessons require no sign in to ArcGIS Online (typically, the first set of lessons in each chapter), while others require signing in to an ArcGIS organizational account (the last set of lessons in each chapter).
Lesson 8-1: Using global imagery basemaps
Something for everyone

The Esri World Imagery Basemap and World Imagery Basemap with labels provide satellite imagery for the world and high-resolution imagery for the US and other areas around the world. The default World Imagery Basemap as shown in the drop-down menu does not contain metadata. If you add World Imagery from the search menu, there is a citation layer that provides metadata about the imagery. It is from this information that you can see the provider of the data, the date of acquisition, the resolution, and the accuracy.

Build skills in these areas
- Adding World Imagery layer with citation layer
- Accessing metadata of the World Imagery layer
- Comparing resolution across world locations

What you need
- Account not required
- Estimated time: under 30 minutes

Scenario
The instructional GIS team of your university has asked you to prepare a lesson introducing the Esri World Imagery Basemap. The team has asked that you develop an exercise that students can do to understand the difference in resolution and accuracy at different locations.

Add World Imagery Basemap with citations
1. Go to ArcGIS Online.
2. Click Map to open the Map Viewer.
3. Click Modify Map in the upper right corner.
4. Click Add and Search for Layers. Use the following parameters:
   - world imagery.
   - ArcGIS Online.
5. Add World Imagery by esri.
6. Click DONE ADDING LAYERS.
7. Click World Imagery in the contents pane to expand the legend.
This is a multiscale image; as you zoom in, the scale changes.

What objects can be seen at the following resolutions?

- Low Resolution 15 meters
- High Resolution 60 cm
- High Resolution 30 cm

Investigate locations around the world

1. In the upper right, search tab search for the locations shown below.
2. Zoom in to the location until the image becomes blurry.
3. Click on the image to display the metadata.

On your own, locate the places in the following table and record the image detail:

<table>
<thead>
<tr>
<th>Location</th>
<th>Provider</th>
<th>Resolution</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>O'ahu, Hawaii</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shanghai, China</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oslo, Norway</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abu Dhabi, UAE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Washington, DC</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Lessons: Account required

Although many of the lessons in this book do not require saving your work, others do. Membership in an ArcGIS organization (with Publisher privileges) will enable you to easily follow directions to create, save, and share maps in every lesson. If you do not have an organizational account already, follow the instructions below to obtain one.

Connect with and deploy the ArcGIS platform

If you’re an existing ArcGIS user and already have an ArcGIS subscription (with Publisher privileges), you’re good to go. If you don’t have these three things, continue reading.

Get a Learn ArcGIS organization membership

The Learn ArcGIS organization is available for students and others just getting started with ArcGIS. Follow this link to the Learn ArcGIS organization to activate a 60-day membership. With your new membership, you can immediately begin to use maps, explore data resources, and publish geographic information to the web. Getting a Learn account is the quickest and easiest way to experience web GIS at ArcGIS Online.

Schools mapping software bundle

The ArcGIS for Schools Bundle is available at no cost for instructional use to individual US K–12 schools, school districts, and states direct from Esri. Beyond the US, the bundle is available to schools worldwide through Esri’s network of international distributors. Every public, private, home school, and youth-service club is eligible. The software bundle includes the following:

- ArcGIS Online organizational and user accounts
- Ready-to-use web and mobile apps
- ArcGIS Community Analyst licenses
- ArcGIS Desktop Advanced licenses

Sign up at Schools Mapping Software Bundle.
Lesson 8-2: Accessing landscape layers in the Living Atlas of the World
A collection of global geographic information

In the Living Atlas of the World Layers provided by Esri, there is a group called Landscape Layers. This Layer group contains a collection of ready-to-use layers from Esri to support landscape analysis. The Landscape Layers are used to plan and manage natural resources and the relationship with the environment.

**Build skills in these areas**
- Accessing the Landscape Layers in Esri’s Living Atlas layers
- Doing basic analysis using four of the Landscape Layers

**What you need**
- An ArcGIS Online organizational account
- Estimated time: under 30 minutes

**Scenario**
You have been instructed to become familiar with the Landscape Layers of Esri’s Living Atlas of the World. You need to show your competence by adding and performing basic analysis on four layers:

- USA Geology Units
- USA Aquifers
- USA Drilling Platforms
- Current Wind and Weather

Two of the attributes are Rock Type and Maximum Age. You can use the filtering tool to ask questions of the USA Geologic Unit Layer.

**Explore Living Atlas Landscape Layers**
1. Sign in to ArcGIS Online organizational account.
2. Open a Map in Map Viewer and change the basemap to light gray.
3. Click Add.
4. Type Soils and Geology in the search pane.
5. Select USA Geology Units and add to map.
6. Click the show table to display the table of attributes.
7. Click Filter and construct the following expression to show all the rock layers that are volcanic:
   Rock Type is Volcanic
8. Click APPLY FILTER. Only the rocks that are volcanic are shown.
9. Open the Filter again.
10. Remove Filter and Click Edit.
11. Type the following expression:
    Maximum Age is Jurassic
12. Click APPLY FILTER and zoom in to USA.
13. Investigate the USA Geology Unit shown in the Contents Pane.
15. Select All Categories>>Landscape>>Water>>USA Aquifers (first USA Aquifers in the series).
16. Add to map as a Layer.
17. Click Filter and construct the following expression to isolate the High Plain aquifer:
    Aquifer Description if High Plain aquifer
18. Click APPLY FILTER.

Explore the resulting aquifer and its strategic importance to the states where it is located.

19. Remove the USA Aquifers from the Contents Pane.
22. Add to map as a Layer.
23. Click Filter and construct the following expression to isolate all the drilling platforms below a depth:
    Water Depth is greater than 1500.
24. Open the table.
    How many drilling platforms are below 1500?
25. Click APPLY FILTER.
27. Select All Categories>>Landscape>>Climate and Weather>>Current Wind and Weather Conditions.
28. Add to map as a Layer.

This is an extremely rich dataset containing a routine weather report with data for a location temperature; dew point, wind speed, gust, and direction; precipitation; cloud cover and heights; visibility; and barometric pressure. The data can be filtered and symbolized by all of their variables.
Fracking is a well stimulation technique. Fracking involves the high-pressure injection of water or other products into a well. This injection creates cracks in deep-rock formation that allow the release of natural gas and petroleum more easily. Fracking’s pros and cons have been widely debated. The process of hydraulic fracturing is highly controversial, with one side heralding the economic benefits and the other side weighing in on the potential environmental impacts of increasing earthquake activity. The town council of Denton, TX, passed a city referendum in 2014 to prohibit hydraulic fracturing. This referendum was rescinded when the state of Texas passed a bill that prohibited the banning of fracking.

**Build skills in these areas**
- Using Esri Landsat Explorer app
- Visualizing data using band combinations
- Filtering and selecting specific dates to analyze and compare
- Investigating change with time-enabled data
- Interactively comparing two images using a swipe tool
- Creating a story map of the temporal images

**What you need**
- An ArcGIS Online organizational account
- Landsat Explorer app
- Estimated time: 30 minutes–1 hour

**Scenario**
The Denton town council is still petitioning to stop fracking in their town. The council knows that more than 300 fracking wells exist within the city limits of Denton. Council members have asked your remote sensing company to prepare a time-enabled visualization of the number of wells introduced into Denton since 2001.

**Open Esri Landsat Explorer.**
1. In the upper right corner, sign in to your organizational account.
2. In the search box search for Denton, TX.
Render natural color band combination and add Denton city limits

1. Go to the Renderer icon on the left panel and change the band combination to Natural Color.
   This band combination approximates the spectral range of vision of the human eye. The natural color band combination has been pansharpened using the 15 m panchromatic band to achieve better imagery resolution.

2. Go to Add Data from ArcGIS online icon and search for Denton, TX.
3. Search in ArcGIS Online for IGARC2_wells.

IGARC2_wells is the Denton, TX, boundary that defines the city limits of Denton.
Identify fracking wells and compare two images from different time periods

1. Zoom in to an area on the map and identify the white rectangles that are the fracking wells.

2. Zoom back out so you can see beyond the city limits of Denton.

3. Pick the Time Selector on the left panel. On the slider, click the show dates drop-down list and choose September 11, 2017.

4. Click the blue arrow pointing down to Set Current as Secondary Layer.

What is the date of the image that is being viewed? Hint: Use the Identify Icon.

You are now ready to use the time selector to pick dates to visualize and compare.
5. Click the Swipe icon on the left panel.

6. Use the time slider to select April 15, 2001, which is 16 years later than the first image.

7. Swipe back and forth between the two time periods. Move the image around to different locations.

What do you observe about the quantity of fracking wells?

What area within Denton city limits appears to have added the most fracking wells?

Create a story map comparing the two images

1. Go to the time slider and choose April 15, 2001.

2. Click the Stories icon on the side ribbon. Hint: Hold down control and click Stories.
3. Click on Create new story.

4. Title the story: Fracking in Denton, TX.

5. Click the blue arrow for next.

6. Add the following text where it says: “Add your description here.”

   In 2015, the town of Denton, TX, voted overwhelmingly to ban fracking inside city limits. Citizens were concerned about how close neighborhoods were to the wells. After the citizens voted to ban fracking, the Texas Oil and Gas Association filed two lawsuits that were eventually upheld and prohibit bans on fracking.

7. Click the Create Link icon and add the following link. You can either copy or type the following address into the URL. Add the description.

   Description: Fracking in Denton, Texas

8. Click ADD.

9. Select the time slider and pick the date September 11, 2017.

10. On the left panel, click ADD SECTION and add the title: 16 Years Later.

11. Enter the following: Denton, Texas, 16 years later. Notice the increase in fracking wells.

12. Click ADD.

13. Click FINISH.

14. The web address is shown in the link. You have to sign in to your organizational account or paste the bitly address into a browser.

Lesson 8-4: Visualizing La Tuna Canyon fire damage
One of Los Angeles’s biggest wildfires in 2017

During the fall of 2017, a series of wildfires burned across California. During the early months of 2017, significant rainfall reduced the severe drought conditions of the state. This had led officials to believe that the fire season would be near normal. However, the rain had caused a spike in vegetation growth that dried out and increased fire activity. The La Tuna Canyon fire, which began in the foothills of Los Angeles, became one of the biggest wildfires in the history of the city. The fire burned more than 7,000 acres and forced the evacuation of many communities.

Build skills in these areas
- Using Esri Landsat Explorer app
- Visualizing data using band combinations
- Filtering and selecting specific dates to analyze and compare
- Investigating change with time-enabled data
- Interactively comparing two images using a swipe tool
- Computing the change between two dates
- Using a burn index to identify change

What you need
User, Publisher, or Administrator role in an ArcGIS organization.

- Estimated time: 30 minutes–1 hour
- Esri Landsat Explorer app

Scenario
The Los Angeles Fire Department wants before and after images of the La Tuna Canyon fire to impress upon the citizenry the extent of the destruction. Fire officials have asked your GIS department to research and present a comparison.

Open, search, and change band combinations using Esri Landsat Explorer App

1. Open Esri Landsat Explorer.
2. In the upper right corner, sign in to your organizational account.
3. In the search box, search for La Tuna Canyon.
4. Zoom in to the La Tuna Canyon area.
5. Go to the Renderer icon on the left panel and change to basemap only.
6. Identify the following:
   - Bob Hope International Airport
   - Burbank
   - La Tuna Canyon Road
   - North Hollywood
7. Go to the Renderer icon on the left panel and change the band combination to Natural Color.

This band combination approximates the spectral range of vision of the human eye. The natural color band combination has been pansharpened using the 15 m panchromatic band to achieve better imagery resolution.

Compare two images before and after the fire.

The La Tuna Canyon fire started on September 1, 2017, and the Los Angeles Fire Department declared that it was 100 percent contained on September 9, 2017. There are Landsat images available for the La Tuna Canyon area from August 28, 2017, which is before the fire started, and October 15, after it had been contained. You are now ready to use the time selector to pick dates to visualize and compare.

1. Pick the Time Selector on the left panel. On the slider, click the show dates drop-down list and choose September 1, 2017.

2. Click the blue arrow pointing down to Set Current as Secondary Layer.

3. Click the Swipe icon on the left panel.

4. Use the show dates drop-down list to select August 28, 2017, which is before the fire was started.

5. Swipe back and forth between the two time periods. Move the image around to different locations.

As you swipe back and forth, can you identify the burn scar?
Change detection and Burn Index

Change Detection tool can calculate changes in burned area.

1. Click the Change Detection icon on the left panel.
2. Change to Burn Index and Difference Mask.
   The burn index uses band combinations to define areas that have burned and to index the severity.
   The difference mask mode calculates the difference between the two images and when using the burn index, it is the burn/post-fire regrowth area. The change area defined is subject to the resolution to which the viewer is zoomed in to the image.
   What is the burn/post-fire regrowth area?

Define area of interest

You can define an area of interest, which will make the measurement more accurate. The burn scar is so irregular that it will be more accurate if you just define a polygon and not try to digitize the area.

1. Click Define Areas of Interest on the Change Detection Menu.
2. Click a polygon around the area.
3. Double-click to end the area.
4. Click Apply and notice how the burn/post-fire growth area changes.

What is the burn/post-fire regrowth area?

In this lesson, you have looked at data from two different time periods and compared them by a specific band combination called a burn index. Using the burn index, you have calculated the change in both the general image and a specific defined area.
Lesson 8-5: Assessing Hurricane Maria damage
The browning of Puerto Rico

Hurricane Marie made landfall on Puerto Rico as a category 4 hurricane on September 20, 2017. The storm brought intense winds and rainfall that lasted for several days, damaging vegetation, pulling trees out of the ground, and blowing leaves off trees. The damage and extent of vegetation can be seen by Landsat imagery before and after the storm.

Build skills in these areas

- Adding Landsat 8 imagery to a map
- Enabling and configuring time animation
- Filtering historical satellite imagery using different band combinations:
  - NDVI
  - Color infrared

What you need

- User, Publisher, or Administrator role in an ArcGIS organization
- Estimated time: under 30 minutes

Scenario

The Federal Emergency Management Agency (FEMA) is doing a post-assessment of vegetation damage caused by Hurricane Maria in Puerto Rico. The agency has asked you to compare Landsat imagery of before and after the event.
Create a map, add temporal multispectral data, and save.
1. Sign in to ArcGIS Online organizational account.
2. Click Map to open the map viewer.
3. In the search box in the upper right of the map, search for Puerto Rico.
5. Add to map as a layer.
6. Click CLOSE.
7. On the top ribbon, click Save As and add appropriate metadata.

Enable and configure time animation
1. In the Contents pane, point to the Multispectral Landsat layer. Click the More Options button and choose Enable Time Animation.
2. On the time animation toolbar, click the Configure button and show advanced options in the end of the Time Slider.
3. For Time Span, change the start time to June 1, 2017, and the end time to October 17, 2017.
4. For Time Display, change the display interval to 1 week.
5. Click OK and play the time animation again.
6. Click the first image in the map window to open a pop-up of the image.

The acquisition date for this image was June 13, 2017, and the last image after Hurricane Maria was October 3, 2017. Next, you’ll filter the multispectral layer to display only the best image from before and after Hurricane Maria landed.

7. Click on More Options and Disable Time Animation.
8. In the Contents pane, point to the Multispectral Landsat layer and click the Filter button.
9. Delete the two expressions.
10. Configure the following expression:

   **Acquisition Data is on June 13, 2017.**
11. Click Apply Filter.
12. Click on More Options and rename the layer **Before Maria**.
13. Click on More Options and copy and paste the file.
14. Rename the copied file **Before Maria**.
15. Click Filter.
16. Click Edit expression.
17. Configure the following expression.

   **Acquisition Date is on October 3, 2017.**

18. Rename the file **After Maria**.

*What are your observations about the before and after Maria images?*

**Change band display to NDVI and color infrared**

There are two types of band combinations that are vegetation indicators. One is the normalized difference vegetation index (NDVI) with color map. The NDVI shows thick, vigorous vegetation as dark green and sparse vegetation as brown. The second band combination is near-infrared, red, green (5,4,3) with dynamic range adjustment applied on apparent reflectance. Healthy vegetation is bright red, whereas stressed vegetation is dull red.

**Use NDVI band combination**

The NDVI shows thick vigorous vegetation as dark green and sparse vegetation as brown.

1. Click on More Options>>Before Maria>> Image Display. Hint: Turn off After Maria layer.
2. Under Renderer choose NDVI colorized.
3. Click CLOSE.

4. Repeat steps 1–3 for More Options>>After Maria>>Image Display.

The NDVI shows thick, vigorous vegetation as dark green and sparse vegetation as brown. Write a comparison of the two images. Hint: Turn layers on and off to review differences between the NDVI for each.

The second band combination is near-infrared, red, green (5,4,3) with dynamic range adjustment applied on apparent reflectance. Healthy vegetation is bright red whereas stressed vegetation is dull red.

**Use color Infrared band combination**

The color infrared combination consists of bands near-infrared, red, green (5,4,3) with fixed stretch applied on apparent reflectance. Healthy vegetation is bright red, whereas stressed vegetation is dull red.

1. Click on More Options>>Before Maria>> Image Display.
2. Under Renderer, choose Color Infrared.
3. CLOSE.
4. Repeat steps 1–3 for After Maria.

The color infrared band combination shows healthy vegetation as bright red, whereas stressed vegetation is dull red. Write a comparison of the two images.

In this lesson, you have used temporal imagery before and after Hurricane Maria to visualize the effect of the hurricane on the island of Puerto Rico vegetation.
Teachers can use the items in this section as an assignment, an introduction, or an assessment tailored to the sophistication of learners. Some learners can read all the sections at one time, while others are more comfortable with small segments. The questions and tasks are designed to stimulate thought and discussion.

Write briefly about the historical timeline of imagery. Specifically refer to the following milestones:

- World War II: Reconnaissance and intelligence gathering
- Humans exploring the moon
- The Landsat program
- The human era of GIS

How does imagery expand your perspective?

Thought leader: Lawrie Jordan . . . ArcGIS now includes a complete image processing system.

What does Lawrie Jordan mean when he says, “We like to say that the map of the future is an intelligent image”?

List four applications of imagery.
Learn ArcGIS: Guided lessons based on real-world problems

Depict Land-Use Change with Time-Enabled Apps
Adding Landsat imagery to a map.
Enabling and configuring time animation.
Filtering historical satellite imagery.
Changing band combinations.
Creating and sharing time-enabled web apps.

Depict Land-Use Change with Time-Enabled Apps
Use historical imagery and time animation to show land-use change in Thailand.
Oso Mudslide – Before and After
Create an app with Web AppBuilder.
Adding metadata.

Oso Mudslide - Before and After
Show disaster imagery by creating an app with Web AppBuilder.
“Houston, we have a problem.” That famous phrase evokes the image of a roomful of technology analysts, surrounded by computers and monitors, working feverishly to solve a problem with data coming in from a range of sources. That image, in turn, may bring to mind the Esri Operations Dashboard app and its role in our lives today. The app is designed to monitor a range of operations by providing a centralized command center focused on a specific, shared goal. It can be used to monitor daily logistical operations, such as service deliveries, or critical situational operations, such as a city’s emergency response to a fire. The app also displays the statistics of specific events such as Olympic competitions or voting returns as they are reported by precinct during a critical election.

An organization can maintain continuous awareness of its operations by using the Esri Operations Dashboard to visualize field data in customized maps, bar charts, histograms, lists, gauges, graphs, and photo attachments. Live data feeds can be added to the dashboard, and data can be queried or filtered based on attributes such as time. The app is easy to configure and can be shared across the organization or publicly.

In this chapter, you will watch example videos of operations dashboards, and you will download the app to use on your computer. You will construct a real-time flood map, configure a real-time wildfire map, map the 2016 presidential election results by predominant mapping and Z-Score, and create an interactive map of 30 years of tornadoes.

Use the questions at the end of the chapter to support your reading comprehension, reflection, and discussion of the narratives presented in the corresponding chapter 9 of The ArcGIS Book.
Introductory activities

Videos
These videos show the Operations Dashboard web app for event security and coastal protection:

*Raceway Event Protection National Security Demo – Operations*

![Raceway Event Protection National Security Demo - Operations](image)

This brief video shows the use of the operations dashboard web application for event protection. The operations dashboard works on desktops and tablets and provides a common view of an event plan before and during the event. This allows for multi-agency sharing of the situation data and plans in a command center and in the field. | in ArcGIS | November 19, 2014

*Collector and Operations Dashboard for ArcGIS: Monitoring Coastal Security*

![Collector And Operations Dashboard For ArcGIS: Monitoring Coastal Security](image)

This brief video demonstrates using Collector for ArcGIS and the Operations Dashboard for coastal monitoring missions. | in ArcGIS | November 12, 2014

Watch now
Activity
Aspects of a real-time GIS

Operations Dashboard for ArcGIS® is software used to monitor deliveries, services, people, vehicles, and other assets, anywhere in the world. It is designed to work with real-time data.

Write a sentence explaining each of the following aspects of a real-time GIS:

- Acquiring real-time data
- Performing continuous processing
- Communicating the results
Lessons: Account not required

Remember, you can access online all you need for the lessons in this guide. Some activities and lessons require no sign in to ArcGIS Online (the first set of lessons in each chapter) while others require signing in to an ArcGIS organizational account (the last set of lessons in each chapter).
Lesson 9-1: Exploring real-time data sources

Real-time data takes on many different forms and has many different applications.

Build skills in this area
- Exploring real-time data feeds

What you need
- Account not required
- Estimated time: under 30 minutes

Scenario
You have been asked to run a seminar on real-time data sources provided by Esri. You are going to use The ArcGIS Book as your text.

Use the ArcGIS Book
1. Go to The ArcGIS Book.
2. Go to chapter 9.
3. Scroll to Examples of real-time data sources.

Examinate at least three of the examples of real-time data sources and write a brief description.
Lessons: Account required

Although many of the lessons in this book do not require saving your work, others do. Membership in an ArcGIS organization (with Publisher privileges) will enable you to easily follow directions to create, save, and share maps in every lesson. If you do not have an organizational account already, follow the instructions below to obtain one.

Connect with and deploy the ArcGIS platform

If you’re an existing ArcGIS user and already have an ArcGIS subscription (with Publisher privileges), you’re good to go. If you don’t have these three things, continue reading.

Get a Learn ArcGIS organization membership

The Learn ArcGIS organization is available for students and others just getting started with ArcGIS. Follow this link to the Learn ArcGIS organization to activate a 60-day membership. With your new membership, you can immediately begin to use maps, explore data resources, and publish geographic information to the web. Getting a Learn account is the quickest and easiest way to experience web GIS at ArcGIS Online.

Schools Mapping Software Bundle

The ArcGIS for Schools Bundle is available at no cost for instructional use to individual US K–12 schools, school districts, and states direct from Esri. Beyond the US, the bundle is available to schools worldwide through Esri’s network of international distributors. Every public, private, home school, and youth-service club is eligible. The software bundle includes the following:

- ArcGIS Online organizational and user accounts
- Ready-to-use web and mobile apps
- ArcGIS Community Analyst licenses
- ArcGIS Desktop Advanced licenses

Sign up at Schools Mapping Software Bundle.
Lesson 9-2: Constructing a map with real-time data
Combine streams, flood status, and 72-Hour precipitation forecast

Real-time data is as current as the data source that is updating it, whether that data is being updated every second, minute, or hour, or daily. Real time is a concept that typically refers to the awareness of events at the same rate or at the same time as they unfold (without significant delay).

Build skills in these areas
- Accessing the Landscape Layers in Esri’s Living Atlas
- Constructing a map with several real-time services

What you need
- An ArcGIS Online organization account
- Estimated time: under 30 minutes

Scenario
Your county government has asked you to construct a USA flood map that can be made available to the public to provide real-time data of the following:
- Streams
- Flood status
- National Weather Service precipitation forecast

Making a real-time map
1. Sign in to ArcGIS Online organizational account.
2. Click Map.
3. Change the Basemap to Light Gray.
4. On the top menu go to Add>>Browse Living and type Esri_Hydro_Reference_Overlay in the search pane.
5. Click Add.
6. Click DONE ADDING LAYERS.
7. On the top ribbon, go to Add>>Browse Living Atlas>>Earth Observations>>Live Stream Gauges (Flooding).
8. Click Add as a layer.
9. Click CLOSE.
11. Click Add as a layer.
12. Click CLOSE.

Notice at the bottom a time slider appears. The data is time enabled and shows the predicted values at six-hour intervals for the next three days.
13. On the top ribbon, click Save As and save your map with the following metadata:

- Title: USA Flood Map.
- Tags: IGARC2_flood_yourinitials.W
- Summary: This map shows real-time flood conditions across the US.

14. SAVE MAP.

Make a story map
A story map allows you to present your map with navigation tools and backgrounds.

1. Click share on the top menu bar and share with your organization.

2. After sharing your map, click CREATE A WEB APP.
3. Click Build a Story Map.
4. Click Story Map Basic.
5. Click CREATE WEB APP.
6. Change the title to US Flood Map.
7. Summary: This map shows real-time flood conditions across the US.
8. Click DONE.
9. To allow public access, check the subscriber content boxes:
   - Click USA Stream Gauges (Flooding).
   - Click National Weather Service Precipitation Forecast.
10. Select Web Map.
11. Click Save.
12. Click Launch.

In this lesson, you have constructed a map with real-time data and used a web application to display the data. This map will satisfy the county government.
Lesson 9-3: Using Operations Dashboard
Real-time fire monitoring in California

In this chapter’s activity, you downloaded the Operations Dashboard software, which will be used in this lesson.

Build skills in these areas
- Constructing a map with real-time data
- Building an Operations Dashboard with widgets
- Sharing the Operations Dashboard

What you need
- An ArcGIS Online organization account
- Estimated time: 30 minutes–1 hour

Scenario
California state officials would like an Operations Dashboard built to monitor the active fires burning in California. You have been assigned the task of preparing and delivering the app.

Create a map with real-time data
1. Sign in to ArcGIS Online organizational account.
2. Open a Map in Map Viewer.
3. In the search box on the top right, search for California.
4. On the ribbon, click Add.
5. Choose Browse the Living Atlas Layers>>Earth Observations>>USA Wildfire Activity.

Hint: Results may vary because wildfires are not always burning.
6. Add to map as layer.
7. CLOSE.
8. Click USA Wildfire Layer to Uncollapse.
9. Only check the Active fire report.
10. Click the Filter icon under Active fire report.
11. Construct the following expression: State is CA.
12. APPLY FILTER.
13. Go to the top ribbon and Save As using the following parameters:
   - Title: Real-Time Fire Data USA _ your initials.
   - Tags: IGARC2_fire_yourinitials.
   - Summary: Active fires in the USA.
14. Click SAVE MAP.
Create a dashboard

1. Use the app switcher in the upper right corner to go to Operations Dashboard.
2. Click Operations Dashboard.
3. Click Create Dashboard.
4. Document the dashboard and Create dashboard.
5. Select the Real-Time Fire Data in California previously made.
6. Check Active fire report.
7. Click Capabilities Tab and check the following:
   • Under Feature Actions, choose Show pop-up.
   • Under Feature Actions, choose Select.
   • Under Other Choose, Feature Pop-ups.
   • Under Other Choose, Coordinates.
8. Click OK.
9. Click WIDGETS on the top Tab.
10. Click Add Panel.
11. Click Thirds.

This gives you the necessary tiers to add three widgets.
Configure Operations Dashboard

1. In the upper left corner of the map, click the configure map tools.

2. Check the following tools:
   - Basemaps
   - Clear Feature Selection
   - Layer Filters
   - Map Contents
   - Find Places
   - Select Features

3. Click Close.

Widgets are the core of operation views. Your operation view is blank until you add a widget. In this exercise, you will add three widgets: the description widget, the feature details widget, and the query widget.

Add description widget

The description widget displays a description as static text.

1. Click Add Widget.
2. Choose Description.
3. Enter the following text:
   Title: GeoMAC Outgoing Datasets.
   This layer presents recent wildfire activity for the US, featuring data from GeoMAC. Wildfire activity is downloaded from the GeoMAC Outgoing Datasets compiled by the USGS. GeoMAC was designed to give fire managers near real-time information based on agency reports and fire perimeter data. GeoMAC is updated daily based on input from incident intelligence sources, GPS data, and infrared (IR) imagery from fixed wing and satellite platforms.

4. Click OK.

Add feature details widget

Display detailed information about one feature or row, including a title, description, field information, and one or more media elements.

1. Click Add Widget.
2. Click Feature Details and OK.
3. For title add: Information about each fire.
4. Click OK.

Add query widget

The query widget runs predefined queries about features.

1. Click Add Widget.
2. Click Query and OK.
3. Enter the title: Area over 200 acres.
4. Description: Locates fires that have burned or are burning over 200 acres.
   (This data is live data. There is not burning over 200 acres all year.)
5. Click Add.
6. Click Name: Over 200 acres.
7. Construct the expression:
   Area Double is greater than 200
8. Click Add.
9. Click OK.
10. Click OK.
11. The query will appear in the widget tab. To run the query, click on the query and do the following:
   - Click the query.
   - Check: Limit the results to the current map extent.
   - Click Select.
   - Click the back arrow on the query to clear the features.

**Save**

You are now ready to save your first Operations Dashboard.

1. Go to FILE.
2. Click Save As.

   - Title: *Real-Time Fire in California*.
   - Description: *Map showing real-time fire in California*.

3. Click Save.

Your Operations Dashboard has been saved in your organizational account. Go to contents and open the dashboard to see it in action.

In this exercise you have built your first Operations Dashboard that displays information using the real-time fire feed from GeoMAC. You have customized the dashboard with a description, information about each feature, and a query asking for fires over 200 acres.
Lesson 9-4: Visualizing 2016 presidential election data
Apply predominant mapping, Z-Score

The 2016 presidential election in the US ended in a surprise victory for Republican candidate Donald Trump. GIS can offer a geographic perspective of the election results and can provide information to upcoming candidates concerning the “where” of the electoral contest.

Build skills in these areas
- Visualizing election 2016 data using predominant mapping
- Visualizing election 2016 data with calculated Z-Score
- Using Arcade expressions

What you need
- User, Publisher, or Administrator role in an ArcGIS organization
- Estimated time: over 1 hour

Scenario
Officials with both the Republican and the Democratic national committees have contracted you to provide them with a visual representation of the 2016 presidential election data. They want to geographically and mathematically display the election results in various ways. You have contracted to visualize the data using predominant mapping and a Z-Score.

Finding and saving a map with 2016 population data
1. Sign in to ArcGIS Online organizational account.
3. On the top tab click Save As.
4. Save using the following metadata:
   - Title: Presidential Election 2016_yourinitials.
   - Tags: IGARC2_election_yourinitials.
   - Summary: Presidential election results by county for 2016.
5. Click SAVE MAP.

Predominant category
Category compares attributes that share a common subject and unit of measurement to see which has the highest value. Color shows the predominant category, and transparency shows the relative strength of the predominance.

1. Click the style icon under election 2016.
2. Choose an attribute: % GOP.
3. Add attribute.
4. Choose an attribute % DEM.
5. Choose Predominant Category.
What does the map tell you about voting patterns in the 2016 presidential election?

**Category and size**

This type of predominant mapping is the same as predominant mapping by category except that it adds the additional variable of size, showing the sum of the categories. With predominant mapping by category and size, you can show three variables on the map.

1. Select Category and Size.
2. Click Counts and Amounts>>OPTIONS.
3. Click Specify size range.
4. Change the size to Min of 4 px and Max of 15 px.
5. Click OK.
6. Click DONE.
7. On the top tab, click Save As and save your map using the following metadata:
   - Title: Presidential Election 2016 Predominance_yourinitials.
   - Tags: IGARC2_election_results.
   - Summary: Visualization of presidential election 2016 results using predominant mapping.

8. Click SAVE MAP.

**Z-Score**

A Z-Score is a numerical measurement of a value’s relationship to the average in a group of values. If a Z-score is 0, it represents the score is identical to the average score. Z-Scores may also be positive or negative, with a positive value indicating the score is above the average and a negative score indicating it is below the average. Positive and negative scores also reveal the number of standard deviations the score is either above or below the average. One standard deviation either plus or minus accounts for about 68 percent of the people, in this case representing 68 percent of the people either voted Democratic or Republican.

**How to calculate Z-Score of %DEM**

- Data you want to examine (in this case, % Dem).
- Subtract the average of % DEM from % DEM.
- Divide the subtraction figure by the standard deviation (% DEM – average)/standard deviation.
2. On the top tab click Save As.
3. Save using the following metadata:
   - Title: Presidential Election 2016 Z-Score_yourinitials.
   - Tags: IGARC2_electionZ_yourinitials.
   - Summary: Presidential election results visualized by Z-Score.
4. Click SAVE MAP.

Find the average and the standard deviation of %DEM...calculate Z-Score
1. Right click election 2016 and open the attribute table.
2. Scroll right to the field % DEM.
3. Right-click on %DEM and click Statistics.
4. When you display the Statistics write down the Average and the Standard Deviation.
5. Click CLOSE.
6. Click the style icon under election 2016.
7. Scroll down and select New Expression.
8. Click Edit and Name this Expression: Z-Score % DEM.
9. Click Save.
10. Type the following expression. Click Globals to display attributes.

\[ \frac{($feature.DEM_per)-0.3174}{0.1527} \]

11. Click Save.
12. Click Counts and Amounts (Color).
13. Click OK.
14. Click DONE.
15. Click Options and change the name of the layer to Z-Score % DEM.
16. Click OK.

What does the Z-Score legend represent?

How to calculate Z-Score of %GOP

1. Right click and copy the Z-Score %DEM.
2. Under Options rename the file Z-Score %GOP.

Find the average and the standard deviation of %GOP...calculate Z-Score

3. Open the attribute table and click %GOP.
4. Click Display Statistics.
5. Record the Average and the Standard Deviation.
6. Click Add attribute.
7. Select another New Expression and title it Z-Score GOP.

8. Type the following expression:
   \[
   \frac{((\text{feature.GOP\_per}-0.6354))}{0.1559}
   \]

9. Click OK.
10. Click Counts and Amounts (Color).
11. Click OK.
12. Click DONE.

You can visualize these by turning the layers on and off.

13. Click Save.

In this exercise, you have visualized the presidential election data in 2016 by predominant mapping and Z-Score. You have made observations about the spatial distribution of the political parties’ voting preferences on your map.
Lesson 9-5: Clustering to extract information
Analyze 30 years of tornadoes

Clustering allows you to visually extract meaningful information from a dataset that has a large number of points. Clustering is applied dynamically at multiple scales, and you can adjust the number of point features grouped into clusters using the provided slider.

Build skills in these areas
- Configuring clustering on a point layer
- Configuring clustering pop-ups

What you need
- An ArcGIS Online organizational account
- Estimated time: under 30 minutes

Scenario
The Weather Channel is doing a segment on tornadoes and has asked for an interactive map of the past 30 years of tornadoes within the US.

Open a web map and search for data
1. Sign in to ArcGIS Online organizational account.
2. Click on Map to open the Map Viewer.
3. Click Add in ArcGIS Online. Type “tornadoes” owner:t3gkeranen in the search pane.
4. Add tornadoes to the map.
5. Click DONE ADDING LAYERS.
6. On the top ribbon, click Save As and save the map with the following metadata:
   - Title: Sixty Years of Tornadoes_yourinitials.
   - Tags: IGARC2_tornadoes_yourinitials.
   - Summary: Sixty years of tornadoes in the United States.
7. Click SAVE MAP.
8. Click the Table icon below tornadoes.
How many tornadoes are shown?

How many years of data do the tornadoes represent?

9. Close the table by clicking the X in the upper right corner.

This map has too many points and points on top of points, so the individual states cannot be seen.

10. Click on More Options and select Clustering.

11. Use the slider to decide how much clustering you want to use. Less clustering yields more dots on the map, and more clustering yields fewer. Clustering is multiscalable so the clusters update as you zoom in and out.

In this lesson, you have used clustering to help visualize large point datasets.
Teachers can use the items in this section as an assignment, an introduction, or an assessment tailored to the sophistication of learners. Some learners can read all the sections at one time, while others are more comfortable with small segments. The questions and tasks are designed to stimulate thought and discussion.

*How real is real time?*

*What are the components of a real-time dashboard?*

*What is the Internet of Things?*
Learn ArcGIS: Guided lessons based on real-world problems

Oversee Snowplows in Real Time
Creating a web map with real-time data.
Building an operation view.
Creating a web app.
Monitor Real-Time Emergencies
Create web maps.
Create operation views.
Add and customize operation view widgets.
GIS is the prototypical team sport. Contributions from numerous members, hailing from a range of backgrounds and playing many different roles, meld to pursue a shared goal. The GIS game is played at local, state, national, and ultimately, global levels. For example, a state’s Audubon Society is using GIS to identify endangered habitats with the help of data from its environmental management department along with bird counts collected by local observers.

Cloud computing and the mobile/app revolution have increased the ability of members of the GIS community to work together and collaborate through data sharing. Just as significantly, technological advances have also expanded the GIS community far beyond the world of professional GIS users. Today, the community potentially includes nearly everyone on the planet. To join in, all you need is a smartphone, tablet, or computer. Whether at work or at home, every time you access data from the cloud, store smartphone photos online, or use a mobile device to report a power outage, you are engaging with and contributing to the global GIS community.

In this chapter, you will create your own web app for data collection using the Web AppBuilder and create a crowdsourced story map about ethnic diversity in your community.

Use the questions at the end of the chapter to support your reading comprehension, reflection, and discussion of the narratives presented in the corresponding chapter 10 of The ArcGIS Book.
Videos

These videos show how California uses ArcGIS Online for improved emergency response and how a crowdsourced traffic and navigation app helps commuters and decision-makers.

**ArcGIS Online Case Study: Emergency Management—Cal OES**

Waze: The Crowdsourced Traffic App Reducing Daily Commute

**Activity**

Building smarter communities

Communities across the globe today are facing many specific issues, and ArcGIS is a well-established and reliable tool used to help address these issues.

1. Examine the following initiatives and identify the data collected and used and the type of analysis performed.
2. Complete the table below:

<table>
<thead>
<tr>
<th>Initiative</th>
<th>Data Collected</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce Vector-borne Disease</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduce Homelessness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduce Opioid Addiction</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Lessons: Account not required

Remember, you can access online all you need for the lessons in this guide. Some activities and lessons require no sign in to ArcGIS Online (typically, the first set of lessons in each chapter) while others require signing in to an ArcGIS organizational account (the last set of lessons in each chapter).
Lessons: Account required

Although many of the lessons in this book do not require saving your work, others do. Membership in an ArcGIS organization (with Publisher privileges) will enable you to easily follow directions to create, save, and share maps in every lesson. If you do not have an organizational account already, follow the instructions below to obtain one.

**Connect with and deploy the ArcGIS platform**
If you’re an existing ArcGIS user and already have an ArcGIS subscription (with Publisher privileges), you’re good to go. If you don’t have these three things, continue reading.

**Get a Learn ArcGIS organization membership**
The Learn ArcGIS organization is available for students and others just getting started with ArcGIS. Follow this link to the Learn ArcGIS organization to activate a 60-day membership. With your new membership, you can immediately begin to use maps, explore data resources, and publish geographic information to the web. Getting a Learn account is the quickest and easiest way to experience web GIS at ArcGIS Online.

**Schools mapping software bundle**
The ArcGIS for Schools Bundle is available at no cost for instructional use to individual US K–12 schools, school districts, and states direct from Esri. Beyond the US, the bundle is available to schools worldwide through Esri’s network of international distributors. Every public, private, home school, and youth-service club is eligible. The software bundle includes the following:

- ArcGIS Online organizational and user accounts
- Ready-to-use web and mobile apps
- ArcGIS Community Analyst licenses
- ArcGIS Desktop Advanced licenses

Sign up at Schools Mapping Software Bundle
Lesson 10-1: Using the Web AppBuilder for ArcGIS
Measure Wi-Fi strength

Educators are always looking for compelling and useful ways to engage their students and facilitate learning. A map designed to record Wi-Fi strength at various locations provides an opportunity for students to collect data collaboratively and compare data across a broad geographical range.

Build skills in these areas
- Downloading an existing service definition
- Uploading service definition and publishing as a layer
- Creating a map
- Creating a web app using the Web AppBuilder

What you need
- An ArcGIS Online organizational account
- Estimated time: 1 hour

Scenario
Your county GIS department received grant funding to examine the current Wi-Fi resources available within the county. They have enlisted volunteers to use a collaborative map to record Wi-Fi collection. They have hired you to build the map.

Find and publish a service definition
1. Sign in to ArcGIS Online organizational account.
2. Click Search in the upper right corner.
3. Search for IGARC2_wifi.
4. Uncheck the Only search in your Organization tab.
5. Download the file wifi by clicking Open and save to your computer.
6. In ArcGIS Online click My Content at the top of the page.
7. Click Add Item From my computer.
8. Browse to the wifi.sd file and choose file.
9. Be sure the Publish this file as a hosted layer box is checked.
10. Add the appropriate tags such as IGARC2_wifi_yourinitials
11. Click Add Item.
It will take several minutes to upload and publish the tree service definition.

12. After the feature service is created, click Open on the Overview tab.

After the feature service is added to the map, you will see the Edit icon on the top of the page.

13. Click Edit. When you click the Edit icon, the Wi-Fi collector icon is exposed.

14. Click the Wi-Fi icon in the Table of Contents.

15. To add a new location, click the location where the Wi-Fi is to be recorded. The collection menu is exposed.

16. Go to the top ribbon and click Save AS.

17. Save the map with the following metadata:
   - Title: Wi-Fi Strength_your initials.
   - Tags: IGARC2_wifi_your initials.
   - Summary: Editable feature service to collect Wi-Fi strength.

18. Click SAVE MAP.

Create a web application using Web AppBuilder

Web AppBuilder for ArcGIS® is an intuitive application that allows you to build web apps without writing a single line of code. It includes powerful tools, and as you add the tools you can see them right away in the app. Below, you will create an app that allows you to collect data on Wi-Fi signal strength.

1. On the top ribbon click Share.

2. Decide whether you want the map to just be seen within your organization, a specific group within your organization, or everyone (public). Click the appropriate box.

3. Click CREATE A WEB APP using the Web AppBuilder tab.

4. Enter the summary: App to collect strength of Wi-Fi signal.

5. Click GET STARTED.

6. Select the Billboard Theme.

7. On the top ribbon click Map tab.

8. Set Default extent to an extent that is slight larger than your collect points. This is to define the extent to be less than the entire world.

9. Choose the Wi-Fi Strength map you have just constructed.

10. Click OK.

11. On the top ribbon click the WebAppBuilder widget tab. Add widgets for Coordinates, My Location, and a Scalebar. Notice you could also add an overview window and a widget to return to your Def extent as set previously.

12. Click Save.

13. In the lower part of the Widget tab, click the gray Widget 1 to configure it.
   - Select Edit as the option for this widget.
   - Next make some edit configuration changes if you wish. For example, enable undo and redo as well as cut and reshape.
14. Click OK.

15. Click Widget 3 and select Layer List.

The Layer List widget displays operational layers on the map and provides basic functionalities, such as turning the layer on and off, zooming to items, showing transparency items, moving up and down, opening with an attribute table, and showing the description or item details.

16. Click OK.

17. Click OK.

18. Click Save.

19. Click Launch.

In this lesson you have downloaded a service definition, published it as a feature service, created a web map, and created a Wi-Fi collection app using Web AppBuilder that allows participants to locate and enter the strength of Wi-Fi successfully.
Crowdsourcing has become an essential component of information gathering and analysis in today’s world. Crowdsourcing includes everything from citizens reporting downed trees after a storm to students participating in the scientific investigation of biodiversity called BioBlitz.

If you are a publisher or administrator in an ArcGIS Online organization account, you can design your own crowdsource story map by using the Esri Story Map Crowdsource app. The Crowdsource Builder experience allows you to set the properties of your crowdsourcing app. For example, you can decide whether an addition to the story map is posted immediately after it is created or whether it needs to be approved before posting. Projects can range from local to national, or even global.

In this lesson, you will build a crowdsource story map to reveal ethnic diversity in your community.
Build skills in these areas

- Opening the Story Map Crowdsource Builder
- Creating a crowdsource story map
- Setting properties for the crowdsourcing app

What you need

- Administrator or Publisher privileges in an ArcGIS organizational account
- Estimated time: 30 minutes

Scenario

You are the director of a nonprofit, community-based organization whose mission is to support immigrant communities through health, educational, and vocational services. You have been invited by the local Rotary Club to give a presentation about ethnic diversity in your city. In preparation for the presentation, you have invited your organization’s constituents to contribute to a crowdsourcing story map called Melting Pot. Contributors will add a photograph, title, and description of something that reflects the ethnic makeup of their neighborhood such as (but not limited to) non-English signs, ethnic restaurants, and ethnic markets.

In this lesson, you will create a crowdsourcing story map about ethnic diversity in San Francisco. You can follow these directions to create a crowdsourcing story map about your own community by making simple modifications as noted.

Select a photo for your story

1. Log in to your ArcGIS organization.
2. Search for an image called Rancho Grande. You will use this for your cover image.
3. Uncheck the Only search in your Organization tab.
4. Download the image and save it on your desktop.

Alternatively, you can select a different photograph from your own community and store it appropriately on your own computer.

Format your crowdsourcing story map

1. Start the Story Map Crowdsourcing Builder. You will be prompted to sign into your ArcGIS Online organizational account.

Note: For detailed help and suggestions, read “How to create a great crowdsourcing story map” before you begin.

You may encounter a warning that this is a beta release of Story Map Crowdsourcing.

2. Click Build a Crowdsource Story.
3. Click Next.
4. Enter the title Bay Area Melting Pot for your story.
5. Click Next.

This title will appear on your story’s cover page. If you are telling a story about your own community, modify the title accordingly.

6. Format your cover page.
   - Upload a cover photo.
     - Drag and drop the image called Rancho Grande that you downloaded to your desktop previously.
Alternatively browse to the image from your own community stored on your computer that you would like to use for your story cover.

- Add additional text on the cover message beneath the title:

![Image of a story map with a cover message and a logo]

Add a photograph, title, address, and description of something that reflects the ethnic makeup of your neighborhood such as (but not limited to) non-English signs, ethnic restaurants, and ethnic markets.

- Edit text above the arrow at the bottom of the page that takes people to the map (e.g., Contribute to the Map).

- Click Next.

7. Configure participation criteria from the drop-down list under Settings Contributions.

- Under Contributions, check Accept new contributions.

- Check the appropriate selection depending on whether you want to review new contributions.

- Edit the text on the Participate button if desired.

- Click Next.

Learn more about the many options for building your story map from the Story Map Crowdsource Tutorial.

8. Configure the map Header under Settings Header.

You can upload your own logo and include a URL to link to your logo.

9. Indicate the types of social media connections your map will offer under Settings Social.

10. Configure your map.

- Set the home map location for your story.
  - Navigate in the map to the area you want to use.
  - Press the button next to the navigation controls to store the current area as the home location.
Share your crowdsource story

1. Click the Share button and share your story publicly or just within your organization. This will determine both who can see your map and who can contribute to your map.

You can also share your story through social media or embed it into a web site.

Review contributions to your story

1. Open your story in the Crowdsource Builder.
2. Click Review New Contributions.

In this lesson you created a crowdsource story map that is now ready to receive contributions from others.
Identify some of the unique characteristics of the professional GIS community.

What are some of the opportunities that an ArcGIS organizational account provide to its members and to the organization overall?

What are the core elements of geodesign as a planning methodology?

What do the three apps shown under social GIS and citizen science have in common?

What does Clint Brown mean when he says GIS is collaborative?

What does Lauren Bennett mean when she says spatial analysis is changing everything?
Learn ArcGIS: Guided lessons based on real-world problems

Monitor Whales with a Multilingual Survey
Creating a Survey123 form.
Building expressions.
Sharing a survey.
Using a survey with a mobile device.
Adding survey data to a web map.
Analyzing survey data.
Activity: Map Book Gallery
As you look at the maps in the map books, select three maps and for each map record the following:

- Organization that produced the map
- Reason or problem for the map
- Layers included in the map

Answers will vary.

Lesson 1-1: Working with GIS layers
How many different layers do you see represented?
There are seven layers represented on the map.

What data is represented by the World Imagery Layer?
USDA FSA (NAIP 2015) aerial imagery is represented.

What information is available?
The type of image, date, and resolution are provided.

Record the date, resolution, and accuracy of the imagery.
The image was taken by USDA FSA (NAIP 2015) on Tuesday, September 8, 2015. The image has a resolution of 1 meter and an accuracy of 6 meters.

Using the item details, write a sentence explaining the resolution and accuracy of the World Imagery Layer.
A resolution of 6 meters means that you can zoom into the image until the area measure is about 6 meters before the image starts to be blurred. The accuracy of 1 meter means that is the difference between the image and the true value on the ground.
Describe two types of landscapes that you can distinguish with the digital elevation model of the US. Answers will vary, including Rocky Mountains, Appalachian Mountains, etc.

Complete this chart:

<table>
<thead>
<tr>
<th>Layer Name</th>
<th>Vector Type</th>
<th>Two attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA States</td>
<td>Polygon</td>
<td>Population and region</td>
</tr>
<tr>
<td>USA Freeway System</td>
<td>Line</td>
<td>Road number and length in sq. mi.</td>
</tr>
<tr>
<td>USA Parks</td>
<td>Polygon</td>
<td>National Forests, State Parks, and National Parks</td>
</tr>
<tr>
<td>USA Major Cities</td>
<td>Point</td>
<td>City Name and population</td>
</tr>
</tbody>
</table>

What cities were located by their longitude and latitude?
- Pierre, South Dakota
- Atlanta, Georgia
- Phoenix, Arizona

Why are some of the numbers negative?
The numbers are negative because they are to the west of the Prime Meridian, which is expressed as negative numbers in the Cartesian map coordinate system.

Explain the meaning of the following words:
- **raster:** A data file that consists of a rectangular grid of pixels.
- **attribute:** Information appended in tabular format to spatial features.
- **georeferenced:** Something is associated with locations on Earth.
- **geocoding:** The computational process of transforming a postal address description to a location on Earth’s surface (spatial representation in numerical coordinates).
- **accuracy:** The degree to which a measurement conforms to the true value.
- **resolution:** The measurement of an image where the values are seen as true.
- **vector:** A representation of the world using points, lines, and polygons.


What is the first spatial component that you see?
Counties are the first spatial component seen.

What is the second spatial component that you see as you zoom in?
Census tracts are the second spatial component seen.

What does a census tract represent?
“Census tract,” a concept established by the US Census Bureau to facilitate analyzing populations, refers to an area roughly equivalent to a neighborhood. In general, a census tract encompasses a population of anywhere between 2,500 and 8,000 people. Census tracts are described as “relatively permanent,” but they change over time.
Examine the legend and write a description of the legend in your own words.
The US government takes a census count of the population every decade. Here, percent change is a measure (in percentages) of the difference in values between the population sizes of counties in 2010 compared with 2000. In the case, the difference between the numbers of people by county shows both increase (+) and decrease (-).

What formula was used to calculate the percent change in population from 2000 to 2010?
Percent change = (2010-2000)/2000 * 100.

Write a description of the spatial distribution of the US by county by population change from 2000 to 2010.
The Midwestern states show a decrease in population, while Florida, Arizona, Southern California, and southern Nevada show an increase in population.

Zoom in to your state and write a description of the spatial distribution of your state by population change from 2000 to 2010.
Answers will vary.

Zoom in to your county and write a description of the spatial distribution of the census tracts by population change in your county.
Answers will vary.

How could other state and county agencies use this information?
State and county agencies can and do use this information to predict where schools, fire departments, hospitals, and other public facilities should be built. Infrastructure is another area in which this data is useful for advanced planning.

Lesson 1-3: Analyzing Nepal earthquake epicenters
What does the legend show about the population?
The legend shows the population in a color gradation, with the darker shades indicating more people and the lighter indicating fewer. The most populated districts are on the southern edge of Nepal.

Where on the map are the earthquakes with a high magnitude in relationship to a district with a high population?
Most of the earthquakes are to the north of Nepal, and the population is heavier in the south.

What would make rescue efforts difficult in the northern districts?
The terrain is rough.
Build and publish a web app
Write a description of the spatial distribution of the US by state population from 2000 to 2010. The Northeast and Louisiana show a decline in population over the 2000 to 2010 time period. The western states, particularly Nevada, show a gain in population.

Lesson 1-6: Analyzing the opioid crisis in America
Symbolize data and calculate with Arcade
Write a paragraph comparing the data of opioid claims in 2014 with the opioid claims normalized (divided by the total claims) in 2014. The opioid claims map in 2014 shows, as would be expected, the counties with the most population to have the most opioid claims. When the data is normalized, the spatial distribution is much more relevant because the data has been standardized by the total claims, which gives a percentage instead of a raw number.

Write a sentence about the spatial display (normalized) of the data. Which states have the most opioid claims? Which have the least? There is a concentration of opioid claims in Nevada, California, and along the Gulf of Mexico.

Write a brief paragraph about the spatial display of the data within your state. Is there a pattern? Answers will vary.

What are the advantages of using color symbolization? Size symbolization? The color symbolization makes it easier to pick out patterns at a county level. The size symbolization makes it easier to interpret at the state level.

Which states have decreased in deaths? Deaths have decreased in North Dakota, Nebraska, Maine, Vermont, Iowa, Arkansas, Mississippi, Hawaii, and Alaska.

Which states seem to have the most increase in deaths? Deaths have increased in all the other states.

The ArcGIS Book, chapter 1
Questions for reading comprehension, reflection, and discussion
Thought leader: Jack Dangermond
GIS: Understanding The Science of Where
Write an explanation of The Science of Where. Include in your explanation thoughts on data integration and GIS as a platform. GIS can provide a platform for integrating data about anything. This platform can understand, take action, and communicate on challenging issues for problem solving and decision making.
Enabling a smarter world
GIS provides a framework and process
List the different parts of the GIS framework with a brief explanation of each part.
The GIS framework consists of data management and integration, visualization and mapping, analysis and modeling, action, decision making, and finally planning and design.

Web GIS is collaborative
Geography is the key, the web is the platform
What is meant by geography is the key?
Geography is the organizing key; information in web GIS is sorted by location. Because all these layers share this common key, any theme of data can be overlaid and analyzed in relation to all other layers that share the same geographic space.

What does georeferenced mean?
Georeferencing data means associating it with a specific, physical place.

How has web GIS changed and expanded our use of georeferenced data?
Web GIS means that suddenly you have much more than just your and your colleagues’ data layers available to you. Web GIS puts nearly everything that anyone has ever published and shared about any particular geographic area within your reach. Web GIS exponentially expands the potential of your data visualization and analysis capabilities.

How GIS works and ArcGIS information items
The science of geography
Layers
List five different types of layers that can be represented on a map. Buildings, demographic data, satellite imagery, vegetation health, and trees are all layers that can be represented on a map.

What is the difference between a map and a scene?
A web map consists of a basemap and a set of data layers presented as a two-dimensional map. A scene combines basemap layers with operational overlays but displays them in the third dimension or in the z axis.

Investigate the maps. Pick one map and write about the information it portrays.
Answers will vary.

Investigate the scenes. Pick one scene and write about the information it portrays.
Answers will vary.
**Geospatial analysis yields insights**

*Explain geospatial analysis.*

Geospatial analysis is applying analytical techniques to data that has a geographic or spatial component.

**Apps extend the reach of GIS**

*What is an app and what is its purpose?*

An app is an interface that gives a user experience for putting a map to use.
Activity 2-1: Scale and resolution
Mastering the difference between them

Where is the scale shown on the map?
The map scale is shown in the lower left corner of the map.

Are there different zoom restrictions?
Yes. Some zoom to 4 ft. and others to 6 ft.
Are the images clear at the last zoom?
When zoomed to the full extent, visibility is not clear.

In one or two sentences summarize what the resolution is after reading this description.
The resolution of the imagery depends on the satellite or aerial imagery provider, and the resolution refers to the number of pixels in an image. The resolution is calculated by the width and the height of a pixel and the total number of pixels the image contains.

Verbalize to a small group the difference between scale and resolution. Feel free to use the maps as visualizations.

Activity 2-2: Predominant Mapping
US county crops 2007

What is dominant in the Midwest and why?
Corn, wheat, and soybean are dominant in the Midwest.

Why does the West Coast have a majority of vegetable production?
The climate of the West Coast of California is conducive to vegetable production.

List the advantages and disadvantages of the two predominant category styles.
Predominant category maps by color can show predominance and strength. Predominant category by size and color can show predominance, sum, and strength.
List the three variables displayed in predominant category and size maps.
The three variables that are shown are as follows:
• Color shows the predominant category.
• Size shows the sum of the categories.
• Transparency shows the relative strength of the predominance.

Lesson 2-2: Displaying crime data with heat maps
Washington, DC, July 2016
How many total crimes are there?
There are 3,429 crimes.

How many wards?
There are eight wards.

Write a description of where the crime is concentrated.
The crime is concentrated in the center with a streak going straight north.

Does the heat map change as you zoom in and out?
Yes, the heat map is multiscale, which allows it to change as you zoom in and out.

Why is a heat map effective to display this crime data?
Heat maps are effective to display crime because they are multiscale and can show concentrations at different scale levels.

How many crime incidents are theft auto?
1,002 crimes are theft auto.

Where would you direct your personnel to crack down on auto theft?
Personnel needs to be assigned to the locations where auto theft is most concentrated as shown by the map.

How many crime incidents are burglary?
109 crimes are burglary.

Where would you direct your personnel to crack down on burglary?
There is some concentration of burglaries in the middle of the city; however, it is dispersed throughout the city except in the northern tip.

How many auto thefts are there in ward 8?
There are 70 auto thefts in ward 8.
Where is the auto theft most concentrated in ward 8?
There are concentrations around Washington Highlands and Douglas Dwellings; however, the thefts are also widely dispersed.

How many burglaries are there in ward 8?
There are 23 burglaries in ward 8.

Where are burglaries most concentrated in ward 8?
The burglaries do not have a discernable pattern.

Lesson 2-3: Educational levels in the USA
A closer look
What states have the highest percentages of students with no degree?
Texas, Kentucky, Louisiana, Mississippi, and Alabama have a high percentage of students with no degree.

Do you see any regional trends?
The southern part of the US seems to have the highest percentage of students with no degree.

What is represented along the Mississippi River from Minnesota to Mississippi?
There is a band of students with no degree along the southern part of the Mississippi River.

Explain the spatial distribution in Texas.
There is a concentration of students with no degrees on the border between Texas and Mexico.

What is the spatial distribution of counties with the highest percentage of college degrees? Of lowest?
Vermont, New Hampshire, Connecticut, Massachusetts, New Jersey, Maryland, and Colorado all have high concentrations of college degrees.

Do you see any regional trends?
The Northeast has a high concentration of college degrees and also western Montana and Colorado.

What states have more than two counties with above 50 percent college degrees? Hint: you might want to show the table.
Virginia and Colorado have two or more counties with 50 percent college degrees.

What states have the greatest number of counties with 20 percent with no degrees?
Texas, Georgia, and Mississippi all have a large number of counties with 20 percent with no degrees.

Is there a regional trend?
The states that have more counties with more than 20 percent without degrees are in the South and Southern California.
Describe the spatial distribution of academic achievement within your state. Answers will vary.

The ArcGIS Book, chapter 2
Questions for reading comprehension, reflection, and discussion

Online mapping is transforming GI:
What are three advantages of online maps over traditional printed maps? Online maps can be created by anyone, updated, and shared on any mobile device.

Basemaps and operational layers
What is the difference between a basemap and an operational layer? A basemap is a map that provides a background or a geographic palette to display your map. Esri provides several basemaps, each with a different focus. An operational layer consists of the user's own subject matter that will be overlaid on the basemap.

Web map properties
Besides being scalable and fluid, name two other advantages of online maps. Online maps can be continuously updated and simple pop-ups can be added to contain a wealth of information.

Learning to smart map
What does smart mapping give to the online user? Smart mapping is designed to quickly suggest pleasing and effective cartography based on the data being used.

Map design 101
Drawing your audience into the story you’re telling
What makes looking at maps a rewarding experience? Maps that are interactive and reward the user with information are great maps.

Maps into the third and fourth dimensions
What are the third and fourth dimensions? The third dimension is vertical or 3D and the fourth dimension is temporal or time.
Chapter 3: Tell Your Story Using a Map
Inform, engage, and inspire people with story maps

The ArcGIS Book, chapter 3
Questions for reading comprehension, reflection, and discussion

Story maps: The fusion of maps and stories come to life
List components that can be incorporated into a story map.
Interactive maps, text, photos, video, and audio
[Story maps] “use the tools of GIS, and often present the results of spatial analysis, but don’t require their users to have any special knowledge or skills in GIS.” Identify two maps from the Story Maps Gallery that illustrate this idea.
Answers will vary.

Maps tell stories. What kinds of stories can you tell?
This section identifies eight kinds of stories that might be told with a story map. List and describe two more possibilities for this format.
Answers will vary.

Thought leader: Allen Carroll: Why maps are so interesting
Maps organize information spatially. What does this mean?
Maps arrange information according to its location by latitude/longitude coordinates, zip code, street address, etc. This enables us to see patterns and relationships and provides context for our explorations.

What kind of story do you want to tell?
Based on your own interests and knowledge, briefly describe two or more “stories” you’d like to tell with a story map.
Answers will vary.

QuickStart: Things to consider when creating a story map
Planning is very important when creating a story map. Pick one of the stories you just indicated you would like to tell with a story map and develop a plan for creating it by briefly writing the answers to the following questions:
   - What is your purpose and goal in telling the story and who is your audience?
   - Go to the Story Maps Gallery and identify two or more story maps whose subject matter is similar to the story you’d like to tell.
Browse story map templates on the Story Maps Apps and identify the one that seems best for your story map project.
Answers will vary.
Chapter 4: Great Maps Need Great Data
The Living Atlas of the World provides the foundation

Lesson 4-1: Exploring and creating basemaps
Introduction to more, better, and unique basemaps
Create a custom historical, ocean, and emergency map.
Maps will vary.

Lesson 4-2: Deriving accessibility
Can you stroll to the farmers’ market?
Write a brief description of the map’s content.
The map has four layers: a topographic basemap, state and county political boundaries, and point data for farmers’ market locations.

Are the drive-time areas different when live traffic feed is added?
The drive-times are the most different if you use the traveling to and from work during rush hours.

How does this live traffic feed help you make decisions about market accessibility?
If you were going to the market during rush hour, it would take longer.

Lesson 4-3: Helping restore a watershed
Chesapeake Bay states land-use enrichment
Write several spatial observations about the Chesapeake Bay watershed. Include in your observations a discussion of political vs natural boundaries. The observations that are written here will be used later in the exercise when you construct your story map.
In this map, you see that political boundaries represent the boundaries of the states and a natural boundary that represents a physical boundary, in this case, the Chesapeake Bay Watershed. The bay’s watershed is irregularly shaped; the northern part of the watershed is narrower than the southern part. The bay’s watershed includes parts of seven states, with Virginia and Pennsylvania having the most land area and Maryland and Virginia having the most coastline.

The ArcGIS Book, chapter 4
Questions for reading comprehension, reflection, and discussion
The Living Atlas: The ArcGIS platform provides rich content
How have open data repositories such as the Living Atlas changed the way GIS users plan and implement projects?
By providing ready-made basemaps and authenticated data, GIS users can spend less time assembling the components for their projects and more time performing analysis, answering questions, and solving real-world problems.

**The ArcGIS data community: A global network for creating and sharing authoritative geographic information resources**
The work of organizations that make up the global GIS community has changed with the emergence of web GIS. Explain how this GIS work has changed.
During the early days of GIS, the compilation of relevant data layers was one of the primary tasks of each organization. Today, this data is increasingly available to everyone via the web, providing these organizations with access to a continuous coverage of geographic information worldwide.

**What kind of data is available? Definitive, authoritative basemaps**
There are several key concepts to understand about basemaps; they are multiscale, provide global coverage, and are continuous. In your own words, briefly define each of these concepts:
- **multiscale**: The amount that detail changes as you zoom in or out.
- **global coverage**: Refers to maps that cover the entire surface of Earth.
- **continuous**: These basemaps seamlessly wrap around Earth.

**Demographics**
Explain the concept of data enrichment.
Data enrichment is the ability to add to your map relevant demographic data to the problem or issue under investigation.

**Opening data to the world of possibilities**
What are open data sites and what benefits do they provide?
Citizens can directly access thousands of open government datasets, which they can search, download, filter, and visualize through their web browsers or mobile devices.
These open data sites enhance government transparency and foster collaboration among community groups.

**Imagery**
In your own words, briefly compare these types of imagery: photographic, satellite, and multispectral.
- **photographic**: Aerial photography and videos taken from airplanes and, increasingly, drones.
- **satellite**: Imagery created from data collected by Landsat satellites.
- **multispectral**: Imagery created by combining visible and invisible light collected remotely by satellites or planes.

**Landscapes: Landscape analysis layers**
What are ELUs?
Ecological land units (ELUs) are areas of distinct bioclimates, landforms, lithology, and land cover that form the basic components of terrestrial ecosystem structure.

**Thought leader: Richard Saul Wurman**

**A map is a pattern made understandable**

*In your own words, explain what the phrase “understanding precedes action” means to you.*

*Explore the Urban Observatory and explain how it reflects the concept that “understanding precedes action.”*

Answers will vary.

Exploring and analyzing relevant data are essential before you attempt to address a problem or issue.
Chapter 5: The Power of Where
How spatial analysis leads to insight

Activity
Discover your local green infrastructure assets using the Green Infrastructure app.
Complete this table:

<table>
<thead>
<tr>
<th>Place/State</th>
<th>% Intact Habitat Core Area</th>
<th>Roads vs Streams (more roads than streams)</th>
<th>National Average (more roads than streams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phoenix, AZ</td>
<td>89%</td>
<td>8.4</td>
<td>5.5</td>
</tr>
<tr>
<td>Richmond, VA</td>
<td>49%</td>
<td>7.0</td>
<td>5.5</td>
</tr>
<tr>
<td>Albany, NY</td>
<td>53%</td>
<td>5.4</td>
<td>5.5</td>
</tr>
<tr>
<td>San Diego, CA</td>
<td>74%</td>
<td>7.0</td>
<td>5.5</td>
</tr>
</tbody>
</table>

Which of the designated states has the most intact core habitats? The least?
Arizona has the most intact core habitats and Virginia has the least.

Why do you think Arizona has 8.4 times more roads than streams?
There are relatively few streams in Arizona.

Compare two counties within your state.
Answers will vary.

Write a description for the distribution of land in your state. What is the dominant land cover: Agriculture? Urban? Forest?
Answers will vary.

What are the dimensions of a core habitat area?
A core habitat area should be at least 200 acres and at least 200 meters wide.

What are other parameters to consider when defining core habitats?
A core with larger volume and smaller perimeter is better than one that is long and skinny. Cores with water bodies, perennial streams and rivers, and wetlands are considered better than those without.
Write a paragraph or give an oral report about reasons that the core habitat area that you picked is appropriate. Answers will vary.

**Lesson 5-3: Creating thematic maps with hexagons**

- Analyze Toxic Release Inventory
- Analyze health insurance

Which states seem to have the highest concentrations of TRI sites? Texas, Ohio, Indiana, and Pennsylvania have high concentrations of TRI sites.

What layers could you add to enhance your observations? Adding urban areas and rivers would enhance observations.

What parts of South Carolina have the largest percentage of people with insurance? Along the coast and around Columbia are areas with the largest percentage of people with insurance.

**Lesson 5-4: Introducing ArcGIS Arcade expressions**

- Calculate percentage unemployment
- Show population increase and decrease 2010–2017

What attributes are available to use? Total population in 2017, 2010, and the number of unemployed in 2017 are the attributes available.

Is there a spatial pattern of unemployment? Unemployment is higher in the South, particularly along the Mississippi delta, and the Southwest. Unemployment is low in the western states of North and South Dakota, Montana, and Oregon.

Do you see any correlation between the counties that have the highest percentage of unemployment and the counties that have lost population? There is a high correlation between the location of the counties with high unemployment that have also lost population since 2017.

**Lesson 5-5: Siting a new hospital in Loudoun County, VA**

Use GIS to create new knowledge

Write a paragraph defending your site selection. Answers will vary.

*The ArcGIS Book, chapter 5*

Questions for reading comprehension, reflection, and discussion

Geographic analysis

Write a paragraph explaining this statement: GIS is more than a map.
The first step of any spatial problem is to put the data on a map; however, maps are more than locational information. They are the production and storage of analytical spatial information. This spatial information allows the user to solve problems using a particular suite of geospatial tools.

*Give at least three examples where spatial analysis tools have been used to solve problems.*
Spatial analysis tools have been used to determine relationships of storm events, detect patterns of crime, and find best locations and paths for public transportation.

**Visualization**

*What can my map show me?*
Visualization shows the area you’re investigating and the data affected.

**Insights**

*Real-time exploration and analysis of maps and data*

*What is Insights for ArcGIS workflow?*  
ArcGIS Insights is a browser-based analytic workbench that enables you to interactively explore and analyze data from many sources.

**Modeling**

*Using the language of spatial analysis*

*What is a typical modeling sequence?*
Data is input and undergoes geoprocessing and is output as a result.

**Spatial problem solving**

*A conceptual framework*

*What are the steps of spatial problem solving?*
The steps of spatial problem solving are as follows:
- Ask and explore.
- Model and compute.
- Examine and interpret.
- Make decisions.
- Share results.

**Thought leader: Linda Beale**

*The challenge is making complex data understandable*

*Explain the specific role GIS plays in health analysis.*
Health outcomes are spatial and characterized by human and physical geographies. GIS offers the technology to explore, manipulate, and analyze data from multiple sources. The ability of doctors, researchers, and the public to access multiscale interactive web maps during a time of crisis makes GIS so useful and valuable in these situations.
Chapter 6: Mapping the Third Dimension
A change in perspective

Activity
Vocabulary match game
E__1. 2D map A. Map 1
D__2. 3D crime visualization B. Map 2
F__3. local scene C. Map 3
C__4. photorealistic D. Map 4
B__5. fixed symbols E. Map 6
A__6. global scene F. Map 7

Lesson 6-1: Understanding current events in 3D
Use a virtual globe to broadcast the news

Why is it dangerous to go through Greece without going through Turkey?
If the refugees don’t go through Greece, they have to go through the Mediterranean Sea.

What routes either by land or water would the refugees have to take to get to Germany? Name the countries and water bodies.
To get to Germany, the refugees have to go either through the Mediterranean or the Black Sea and Romania, Bulgaria, Hungary, Austria, and Czech Republic.

Hungary and Austria have shown signs of resistance to the refugees and are closing or threatening to close their borders. How would this affect the routes the refugees would have to take?
That would make the distance the refugees have to travel much greater.

When Hurricane Irma made landfall at Cudjoe Key, what was the hurricane strength? Category and sustained winds?
Category 4 hurricane with sustained winds of 130 mph.

What towns are close to Cudjoe Key?
Marathon and Key West

Why is Cudjoe Key particularly vulnerable?
Cudjoe Key is surrounded by water, as is every other part of the Florida Keys.
Is this emergency weather related? How?
Major El Niño storms and high tides have caused the erosion of the cliff.

Will the residents get any financial relief?
The apartment building has been condemned and demolished and both the state and federal governments will help with financial relief for the residents.

Lesson 6-5: Teaching world time zones
Chart the hour for online students
Describe the standard time zones.
There are 24 time zones, each 15 degrees of longitude wide. The same clock time is kept within each zone.

Why do some of the standard time zones have irregular boundaries on land?
There are irregular boundaries on land to avoid having a time change at an inconvenient location.

Explain the need for an International Date Line.
The International Date Line identifies where the date changes for travelers.

How many time zones are in the continental US?
There are four times zones in the continental US: Eastern, Central, Mountain, and Pacific.

What cities are represented?

Use the constructed Scene to complete this chart:

<table>
<thead>
<tr>
<th>Start City</th>
<th>Day/Time</th>
<th>Travel Direction</th>
<th>End City</th>
<th>Day/Time</th>
<th># Time Zones Crossed</th>
</tr>
</thead>
<tbody>
<tr>
<td>London</td>
<td>Mon 11 AM</td>
<td>West</td>
<td>Denver</td>
<td>Mon 4 AM</td>
<td>7</td>
</tr>
<tr>
<td>London</td>
<td>Mon 11 AM</td>
<td>East</td>
<td>Denver</td>
<td>Mon 4 PM</td>
<td>17</td>
</tr>
<tr>
<td>Paris</td>
<td>Wed 1 AM</td>
<td>West</td>
<td>Minneapolis</td>
<td>Tues 6 PM</td>
<td>6</td>
</tr>
<tr>
<td>Paris</td>
<td>Wed 1 AM</td>
<td>East</td>
<td>Minneapolis</td>
<td>Tues 6 PM</td>
<td>18</td>
</tr>
<tr>
<td>Rio de Janeiro</td>
<td>Friday 10 PM</td>
<td>West</td>
<td>Tokyo</td>
<td>Sat 10 AM</td>
<td>12</td>
</tr>
<tr>
<td>Rio de Janeiro</td>
<td>Friday 10 PM</td>
<td>East</td>
<td>Tokyo</td>
<td>Sat 10 AM</td>
<td>12</td>
</tr>
</tbody>
</table>

The ArcGIS Book, chapter 6
Questions for reading comprehension, reflection, and discussion
The evolution of 3D mapping
Advantages of 3D
What advantage does vertical information give?
Maps that contain vertical information can show hill shading, contours, and volumetric information.
What is human-style navigation?
When data is presented in 3D, the viewer intuitively understands the size and relative positions of objects.

Important 3D terminology:
Getting the z-terminology straight
Explain these terms (including the difference between them where appropriate):
maps and scenes: Exemplified 2D or 3D views.
local and global: This represents two different scene environments: Global scenes extend across large distances, and local scenes have a fixed study area.
surfaces: All surface data includes an x, y, and z value for any point on it.
real size and screen size: There is value in having some symbols remain the same, both in the scene and on screen.

Representing the world in 3D
Define photorealistic.
A photorealistic view recreates reality by using textures.

What makes 3D cartography powerful?
3D cartography takes 2D thematic mapping techniques and moves them into 3D.

What two factors are involved to create a feeling of virtual reality?
A 3D view feels like virtual reality when photorealistic and thematic techniques are used in combination.

What makes a great scene?
What is meant by implying a 3D scene is designed to be immersive?
A 3D view allows people to see space in 3D. A 3D view is immersive because it invites people to imagine themselves within the scene.

What are the three choices of styling 3D content?
Fully photorealistic, fully thematic, and a combination of photorealistic and thematic.

List two ways to illustrate thematic views.
Thematic 3D views use common 2D cartographic techniques such as classifications. Authors of 3D scenes also create thematic, simplified representations to more effectively convey information.

Thought leader: Nathan Shephard
The rise of the 3D cartographic scene
What does Nathan discuss?
Nathan talks about the benefits of communicating spatial data in 3D and the fact that cartographers are no longer limited to two dimensions.

Who uses 3D cartography? Go to ArcGIS Web Scenes Gallery and investigate three of the maps.
Answers will vary.
Chapter 7: The Power of Apps
Focused tools that get the work done

Activity
What is marketplace?
The ArcGIS Marketplace is a destination that allows ArcGIS Online organizations to search, discover, and get apps, data, and additional capabilities from qualified providers (Esri Business Partners, Esri Distributors, Esri Startups, and Esri) for use within their organization.

Who can use the apps?
ArcGIS organizational members can use the marketplace.

Select two apps and explain why you would want to use them. Download them to your mobile device and enjoy.
Answers will vary.

Lesson 7-2: Assessing risk of inundation
Use STORMTOOLS
Consider the answers to each of these questions as you compare Properties A, B, and C:
How will potential levels of future sea level rise affect the property?
Answers will vary.

Is the property vulnerable to storm surge during a 100-year coastal storm (for example, 1938 hurricane)?
Answers will vary.

How deep will the water be during a 100-year coastal storm on the property?
Answers will vary.

How will the property’s vulnerability to 100-year coastal storms change by 2050?
Answers will vary.

Based on your analysis with the STORMTOOLS data, identify the property that seems to be the least vulnerable to flooding from sea level rise and/or storm events and which one seems the most vulnerable.
Which one would you like to purchase? Why?
Answers will vary.
Lesson 7-3: Exhibiting changes over time
Use the USGS Historical Topographic Map Explorer app
Explore and compare the maps to identify ones that tell the clearest story of changes around the Lanier Middle School from 1915 to the present. Note that you can download any of these maps as a geopdf. The download link is next to the map thumbnail in the table of contents.
Answers will vary.

The ArcGIS Book, chapter 7
Questions for reading comprehension, reflection, and discussion
The rise of spatially intelligent apps
What is an app?
Apps are lightweight computer programs designed to run on the web, smartphones, tables, and other mobile devices

How is a GIS app unique?
GIS apps are a special breed because they’re map centric and spatially aware.

Where do apps come from?
Apps take ArcGIS where you go and where GIS users go.

List some ways to solve a problem with an app.
Telling a story.
Engaging with people.
Taking GIS into the field.
Collecting high-resolution, up-to-the-minute aerial photographs.

Thought leader: Jeff Shaner
On the scene at the Deepwater Horizon oil spill
How did the use of mobile GIS influence the Deepwater Horizon emergency response?
The responders began to share maps, data, videos, and photos, enabling responders to better coordinate with emergency command centers and ensure high levels of situational awareness.

Case study: US Geological Survey
In 2009, the US Geological Survey began the release of a new generation of topographic maps in electronic form and in 2001 complemented them with the release of high-resolution scans of historical topographic maps of the US dating back to 1882. View these using the USGS Historical Topographic Map Explorer. Use the app to do the following:
Find the area you want to explore.
Use the timeline to select the maps.
Compare the maps.
Answers will vary.

List three of Esri’s ArcGIS ready-made apps.
Collector
Survey123
Explorer
Chapter 8: Imagery Is Visible Intelligence
A geographic Rosetta stone

Activity
Understanding the Landsat program
What is Landsat and when did it begin?
The Landsat program is a series of Earth-observing satellite missions jointly managed by NASA and the US Geological Survey.

What are the orbit paths of the Landsat satellites?
The Landsat 8 and Landsat 7 satellites both maintain a near-polar, sun-synchronous orbit, following the World Reference System. They each make an orbit in about 99 minutes, complete more than 14 orbits per day, and provide complete coverage of Earth every 16 days.

What is the resolution of the spectral bands?
The spectral bands have a resolution of 30 meters.

What is the resolution of the thermal bands?
The thermal bands have a resolution of 60 meters.

What is the difference between the spectral band and the thermal band?
The spectral bands measure reflected light and the thermal bands measure emitted heat.

Lesson 8-1: Using global imagery basemaps
Something for everyone
What objects can be seen at the following resolutions?
Low Resolution 15 meters
Major roads and buildings can be seen at this resolution.
High Resolution 60 cm
You can identify individual buildings.
High Resolution 30 cm
You can count cars in parking lots and parking spaces.
On your own, locate the places in the following table and record the image detail:

<table>
<thead>
<tr>
<th>Location</th>
<th>Provider</th>
<th>Resolution</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>O’ahu, Hawaii</td>
<td>Digital Globe</td>
<td>0.31 meters</td>
<td>4.2 meters of true location</td>
</tr>
<tr>
<td>Shanghai, China</td>
<td>Digital Globe</td>
<td>0.31 meters</td>
<td>10.2 meters of true location</td>
</tr>
<tr>
<td>Oslo, Norway</td>
<td>Digital Globe</td>
<td>0.5 meters</td>
<td>4.2 meters of true location</td>
</tr>
<tr>
<td>Abu Dhabi, ARE</td>
<td>Digital Globe</td>
<td>0.5 meters</td>
<td>4.2 meters of true location</td>
</tr>
<tr>
<td>Washington, DC</td>
<td>esri</td>
<td>0.08 meters</td>
<td>0.3 meters of true location</td>
</tr>
</tbody>
</table>

Lesson 8-2: Assessing landscape layers in the Living Atlas of the World
A collection of global geographic information
How many drilling platforms are below 1500?
There are 50 drilling platforms in water depth below 1500.

Lesson 8-3: Monitoring fracking in Denton, TX
Use panchromatic Landsat
What is the date of the image that is being viewed?
Answers will vary.

What do you observe about the quantity of fracking wells?
There are many more in 2017 and 2001.

What area within Denton city limits appears to have added the most fracking wells?
The southwestern corner of Denton appears to have added the most fracking wells.

Lesson 8-4: Visualizing La Tuna Canyon fire damage
One of Los Angeles’s biggest wildfires in 2017
As you swipe back and forth, can you identify the burn scar?
The burn scar is easily recognized.

What is the burn/post-fire regrowth area?
Answers will vary.

What is the burn/post-fire regrowth area?
Answers will vary.
Lesson 8-5: Assessing Hurricane Maria damage

The browning of Puerto Rico

What are your observations about the before and after Maria images?
The image is much browner, indicating much less vegetation. There is less vegetation because the leaves have been blown off the trees, and some of the trees have been uprooted.

The NDVI shows thick, vigorous vegetation as dark green and sparse vegetation as brown. Write a comparison of the two images.
There is much more dark green, indicating more vigorous vegetation in the before image than in the after image. The after image is much more brown, indicating sparse vegetation.

The color infrared band combination shows healthy vegetation as bright red, whereas stressed vegetation is dull red. Write a comparison of the two images.
The vegetation image shown in the after Maria image is much duller, indicating stressed vegetation.

The ArcGIS Book, chapter 8

Questions for reading comprehension, reflection, and discussion

Write briefly about the historical timeline of imagery. Specifically refer to the following milestones:

- World War II: Reconnaissance and intelligence gathering
- Humans exploring the moon
- The Landsat program
- The human era of GIS

During World War II, major advances in the use of imagery for intelligence were developed to identify precise locations. In July 1969, televised images transmitted to Earth from the moon showed that this transferring of imagery was a possibility. The Landsat program, which was began in 1972, has provided a constant observation of Earth for the past 40 years. The human era of GIS began with multiscale online images of the world provided by Google, Microsoft, and other companies.

How does imagery expand your perspective?
Imagery allows you to understand patterns, see beyond the visible, forecast and report weather, and see beyond the apparent by peering into the past.

Thought leader: Lawrie Jordan
ArcGIS now includes a complete image processing system.

What does Lawrie Jordan mean when he says “We like to say that the map of the future is an intelligent image”?
He means that if users can see it, they can understand it, and imagery provides that understanding.
List four applications of imagery.
Daily access to new information
A constant look back in time
Meaningful collections
Powerful analytic capabilities
Activity
Aspects of a real-time GIS
Write a sentence explaining each of the following aspects of a real-time GIS:

Acquiring real-time data
An organization can visually represent the live status of its network with information captured by sensors in the field about factors such as storm effects, wind speed and direction, temperature, and current positions of police cars or ambulances.

Performing continuous processing
After displaying data in real time, next you want to perform an analysis, such as filtering or detecting patterns.

Communicating the results
Sharing where a storm is hitting and the location of a child who has been left on a school bus are examples of communicating results.

Lesson 9-1: Exploring real-time data sources
Examine at least three of the examples of real-time data sources and write a brief description.
Answers will vary.

Lesson 9-4: Visualizing 2016 presidential election data
Apply predominant mapping, Z-score
What does the map tell you about voting patterns in the 2016 presidential election?
There is a huge divide between rural and urban areas. The cities vote more Democratic and the rural areas vote more Republican.

What does the Z-Score legend represent?
The 1 means that 68 percent of the people voted Democratic.

Lesson 9-5: Clustering to extract information
Analyze 30 years of tornadoes
How many tornadoes are shown?
There are 56,155 tornadoes shown.
How many years of data do the tornadoes represent?
The years represented are 1950 to 2011 or 61 years.

The ArcGIS Book, chapter 9
Questions for reading comprehension, reflection, and discussion
How real is real time?
Real-time dashboards are used by local governments to monitor snowplows and trash trucks, by law enforcement to monitor crime, and by transportation to monitor the flow of traffic. Real-time data is as current as the data source that is updating it, whether that data is being updated every second, minute, hour, or daily. Real-time data is accessible from any source of data captured by sensors.

What are the components of a real-time dashboard?
Real-time dashboards are composed of a map with inserted widgets and can be shared with your organization.

What is the Internet of Things?
The Internet of Things is composed of autonomous vehicles, public safety services, utilities, and telecommunication infrastructure. Sensors are being implemented on our planet.
Chapter 10: GIS Is about Community
Web GIS is the GIS of the world

Activity
Building smarter communities

<table>
<thead>
<tr>
<th>Initiative</th>
<th>Data Collected</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce Vector-borne Disease</td>
<td>Details, date, status, assignment</td>
<td>Heat map of traps</td>
</tr>
<tr>
<td>Reduce Homelessness</td>
<td>Veteran status, sheltered, medical needs, mental health needs, transportation needs, encampment details</td>
<td>Best location for a new shelter, able to provide food and services better</td>
</tr>
<tr>
<td>Reducing Opioid Addiction</td>
<td>Location of providers</td>
<td>Opioid death heat map</td>
</tr>
</tbody>
</table>

The ArcGIS Book, chapter 10
Questions for reading comprehension, reflection, and discussion

Identify some of the unique characteristics of the professional GIS community.
GIS is currently used in virtually every segment of society: government, industry, academia, conservation. It is one of the fastest-growing segments in the tech field of our economy. GIS professionals perform a vital role in addressing critical issues, such as access to resources, environmental collapse, and climate change. GIS professionals have a strong bond with local, state, and national networks.

What are some of the opportunities that an ArcGIS organizational account provides to its members and to the organization overall?
- To create, organize, and share geographic information with appropriate groups.
- To create maps for users and constituents outside the organization and share these online.
- To share maps and information layers throughout the organization and beyond.
- To organize content by creating and managing groups.

What are the core elements of geodesign as a planning methodology?
Planning is based on a community of collaborators who identify the following:
- Project objectives
- Special resources
- Opportunities for support
Constant feedback loops occur between local citizens and stakeholders (community engagement).
What do the three apps shown under social GIS and citizen science have in common?
All three apps shown under the banner Social GIS and crowdsourcing are interactive, allowing users to input information for an intended purpose. The first two collect information from the user, while the last one provides information to the user.

What does Clint Brown mean when he says GIS is collaborative?
GIS provides a kind of integration engine: As more and more layers of data are amassed and maintained, GIS provides the means for integrating them in countless ways. This global collection of information can be applied to the analysis of virtually any issue, including climate change, the spread of disease, and food production.

What does Lauren Bennett mean when she says spatial analysis is changing everything?
The use of spatial analysis is taking a central role in the way that organizations think about their data and make informed decisions.
Special thanks to Jack Dangermond, Clint Brown, and Christian Harder for the vision and inspiration that motivated us to write this book. Their enthusiasm and encouragement made it a reality. Thanks in particular to Colin Childs, whose thoughtful editing improved our work substantially. Finally, we also appreciate the supportive assistance of the many members of Esri Press team.
About the authors


Data and image credits, web links

All screen captures are by Esri.

Chapter 1

The ArcGIS Book: 10 Big Ideas about Applying The Science of Where
The ArcGIS Book second edition: Esri Press
Access at http://thearcgisbook.com

Learn ArcGIS: Guided lessons based on real-world problems

The Science of Where
Video produced by Esri
Standard YouTube license
Access at https://www.youtube.com/watch?v=XrU8GX7manc&t=1s

Exploring The Science of Where
Video produced by Esri
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Access at https://www.youtube.com/watch?v=OWuTYgzdzCE&t=45s

Leading The Science of Where
Video produced by Esri
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Access at https://www.youtube.com/watch?v=Kq8y7N1kxR4

Applying The Science of Where
Video produced by Esri
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Access at https://www.youtube.com/watch?v=Kmr5j3RjjPw&t=32s

Esri Map Books: Esri
Access at http://www.esri.com/mapmuseum

The ArcGIS Book: 10 Big Ideas about Applying The Science of Where
Esri Press
Access at http://thearcgisbook.com
Highway Access in Europe
Esri/NAVTEQ
Access at http://nation.maps.arcgis.com/apps/PublicInformation/index.html?appid=b15b0ab8b17049f4a9c6da16b29504e7

US Minority Populations
Data sources: Esri Maps and Data/US Census

GIS Layers
Map by Kathryn Keranen

US Population Change 2000 to 2010
Map by Esri
Data sources: Esri, HERE, DeLorme, NGA, USGS, HERE. Copyright ©2010 Esri|Copyright © 2015 Esri

Nepal Earthquake Epicentre Locations
Map by Esri
Data sources: Esri, DeLorme, NGA, USGS, DeLorme

Earthquakes of the World Map
By Esri
Data sources: USGS, Esri, HERE, DeLorme, NGA
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**U.S. Population Change 2000 to 2010**  
Map by Kathryn Keranen  
Data sources: States and counties: Esri  
Access at [https://learngis.maps.arcgis.com/home/webmap/viewer.html?webmap=daa1b065b0fd47d8be0d5c935d57b0ea](https://learngis.maps.arcgis.com/home/webmap/viewer.html?webmap=daa1b065b0fd47d8be0d5c935d57b0ea)

Centers for Medicare and Medicaid Services  
Data source: [http://CMS.g](http://CMS.g)  

CDC Centers for Disease Control and Prevention  
Access at [https://www.cdc.gov/drugoverdose/data/statedeaths.html](https://www.cdc.gov/drugoverdose/data/statedeaths.html)

**USA Opioid Usage**  
By Kathryn Keranen  
Data sources: Esri, public domain data from Centers for Disease Control and Prevention (CDC). Behavioral Risk Factor Surveillance System Survey Questionnaire. Atlanta, Georgia: US Department of Health and Human Services, Centers for Disease Control and Prevention  

“Understanding the Difference between Consumer and GIS Mapping Applications”  
Article: *Civil + Structural Engineer*  

“Static Web Maps vs. Dynamic Web GIS”  
Article: *Public Works: GIS & Asset Management*  

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Access at [http://www.esri.com](http://www.esri.com)  
Set Up an ArcGIS Organization; Guided lessons based on real-world problems  
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The Power of Maps: Guided lessons based on real-world problems
Produced by Esri
Access at http://www.esri.com
http://learn.arcgis.com/en/

Get Started with ArcGIS Online: Guided lessons based on real-world problems
Produced by Esri
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http://learn.arcgis.com/en/

ch01_fig01: Video: is The Science of Where – Unlock Data’s Full Potential
Esri/Esri Events
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Access at https://www.youtube.com/watch?v=XrU8GX7manc&t=1s

ch01_fig02: Video: Exploring The Science of Where
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ch01_fig03: Video: Leading The Science of Where
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ch01_fig04: Video: Applying The Science of Where
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ch01_fig05: Map Book Volume 26/Esri Press
ch01_fig06: Map Book Volume 27/Esri Press
ch01_fig07: Map Book Volume 28/Esri Press
ch01_fig08: Map Book Volume 29/Esri Press

ch01_figs 10–12 GIS Layers
Maps by Kathryn Keranen, Esri interface
Data sources: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, NOAA/NCET, Federal Highway Administration
ch01_fig13 US States and Cities
Map by Kathryn Keranen
Data source: Esri

ch01_fig14 Population Change
Map by Esri
Data sources: Esri, HERE, DeLorme, NGA, USGS, HERE. Copyright © 2015 Esri

ch01_fig15 Population Change
Map by Esri, Esri interface
Data sources: Esri, HERE, DeLorme, NGA, USGS, HERE, copyright ©2010 Esri, copyright© 2015 Esri

ch01_figs16–31 Nepal Earthquake
Maps by Esri, Esri interface
Data sources: Esri, DeLorme, NGA, USGS, DeLorme

ch01_fig32 Earthquakes
Map by Esri
Data sources: USGS, Esri, HERE, DeLorme, NGA

ch01_fig33 Richter Scale Table
Table by Kathryn Keranen
Data source: USGS

ch01_figs 34–38 Earthquakes
Maps by Esri, Esri interface
Data sources: USGS, Esri, HERE, DeLorme, NGA

ch01_fig39–64 USA Population Change
Maps by Kathryn Keranen
Data sources: Esri, states and counties

ch01_figs65–82 USA Opioid Usage
Maps by Kathryn Keranen. Esri interface
Data sources: Esri, public domain data from Centers for Disease Control and Prevention (CDC). Behavioral Risk Factor Surveillance System Survey Questionnaire. Atlanta, Georgia: US Department of Health and Human Services, Centers for Disease Control and Prevention

ch01_fig83 Learn ArcGIS
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The Importance of Maps
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Access at https://www.youtube.com/watch?v=Cf7Gafe_jpw&t=36s

ArcGIS Online—Mapping Without Limits
Esri

World Imagery Resolution
By Esri
Data sources: Imagery Basemap: CNES/Airbus DS, GeoEye, USDA FSA, USGS, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community
Access at http://www.arcgis.com/home/item.html?id=c1c2090ed8594e0193194b750d0d5f83
http://www.arcgis.com/home/item.html?id=10df2279f9684e4a9f6a7f08febac2a9

US County Crops 2007 Clean
Map by Kathryn Keranen
Data sources: Esri, USDAA
Access at https://learngis.maps.arcgis.com/home/webmapviewer.html?layers=f6aa37a7376b4cbd8cc52abfdf8d63c4
Airflow Pro
Map by Esri
Data sources: Global Air Traffic data/Airflow Pro

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How to Smart Map: Heat Maps
Smart Mapping by Esri. Data sources: Esri 2016 Updated USA Demographics
Access at https://www.arcgis.com/apps/Cascade/index.html?appid=ca7e12f6e8c0474bb4269889bda8ce41

Crime incidents in 2016 July
Access at http://opendata.dc.gov
ArcGIS Online Map by Esri
Access at http://arcgis.com

The United States Department of Agriculture: Economic Research Service
Data sources: USDA. USDAA
Access at https://www.ers.usda.gov/

United States Census Bureau’s American Community Survey (ACS)
Data source: US Census Bureau

United States Educational Achievement
Map by Kathryn Keranen
Open Data Information: https://www.usda.gov/policies-and-links
Available at www.agcensus.usda.gov/Publications/2012/Online_Resources/Ag_Census_Web_Maps/Overview/
https://learnngis.maps.arcgis.com/home/webmap/viewer.html?webmap=8aa8054a0e0345068bf6e42634b5f6c1
2010 US Minority Populations
Map by Lyn Malone
Data sources: Esri Maps and Data, US Census Bureau
Access at https://learngis.maps.arcgis.com/home/webmap/viewer.html?webmap=dd9114e507f74184be6b1d32df61d4ba

Smart Mapping in ArcGIS Online – Predominance
Video produced by Esri
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Bridging the Breast Cancer Divide
Produced by Esri

Fight Child Poverty with Demographic Analysis
Produced by Esri

ch02_fig01 The Importance of Maps
Video published by Esri/Esri Events
Access at https://www.youtube.com/watch?v=mR2CWUOSC08

ch02_fig02 Esri UC 2017 Map Submissions
Video published by Esri/Esri Events
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Access at https://www.youtube.com/watch?v=Cf7Gafe_jpw&t=36s

ch02_fig03 Low-Resolution Image
Esri’s World Imagery Map
Data sources: Imagery Basemap: CNES/Airbus DS, GeoEye, USDA FSA, USGS, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community
Citations: http://www.arcgis.com/home/item.html?id=c1c2090ed8594e0193194b750d0d5f83

ch02_fig04 High-Resolution Image
Esri’s World Imagery Map
Data sources: Imagery basemap: CNES/Airbus DS, GeoEye, USDA FSA, USGS, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community
Citations: http://www.arcgis.com/home/item.html?id=c1c2090ed8594e0193194b750d0d5f83
ch02_fig05 ArcGIS Online
Esri interface

ch02_figs06–10 US County Crops
Maps by Kathryn Keranen, Esri Interface
Data sources: Esri, USDA

ch02_figs11–23 Airflow Pro
Maps by Esri, Esri interface
Data sources: Global Air Traffic data/Airflow Pro

ch02_fig24 Smart Mapping: Heat Maps.
Produced by Esri
Data source: 2016 Updated USA Demographics

ch02_fig25 Crime Image
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ch02_figs26–42 ArcGIS Online
Maps by Esri, Esri Interface

ch02_figs43–57 United States Educational Achievement
Maps by Kathryn Keranen, Esri Interface

ch02_figs58–72 Minority Population by Counties
Maps by Esri
Data sources: Esri Maps and Data, US Census Bureau

ch02_fig73 Smart Mapping in ArcGIS Online—Predominance
Video by Esri/Esri Events
Access at https://www.youtube.com/watch?v=0bY4-dS1-LA&t=35s

ch02_fig74 Learn ArcGIS
Chapter 3

Interviews with several Ushahidi team members as well as others involved with the crisis response in Haiti Video Produced by Ushahidi, published on Feb 7, 2010 Access at https://www.youtube.com/watch?v=huQpn0D0eK4

The Power of Maps
Produced by Esri
Access at http://www.esri.com/videos/watch?videoid=vLCLM4Cupx8&channelid=UCJ203R9PsZn6wF_zYfsp1SA&title=the-power-of-maps

Story Map Gallery
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Access at https://storymaps.arcgis.com/en/gallery/#s=0

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http://learn.arcgis.com/en/


Disease Investigations: Cholera
Map by Lyn Malone
US National Center for Geographic Information
Access at https://learnegis.maps.arcgis.com/home/webmap/viewer.html?webmap=6fb43b7db1d34716aad53583406f98b1

The Linked Burdens of Obesity and Diabetes
Map by Esri
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Graduation Rates and Unemployment
Map by Lyn Malone
Data sources: ©2012 Esri, US Census Bureau
Access at https://learnegis.maps.arcgis.com/home/webmap/viewer.html?webmap=266b4f8f5af4400f8e96297ad76cd09a

Story Map Apps page
Map by Esri

World’s Largest Cities 100–2000 CE
Map by Lyn Malone

Washington, D.C. 1851 and 2016
Map by Lyn Malone
Data sources: World Imagery and Washington, DC, 1851, Esri
Access at https://learnegis.maps.arcgis.com/home/webmap/viewer.html?webmap=a3c9580679b14614bb3a0e96af558cc3

What Kind of Story Do You Want to Tell?
By Esri

How to Create a Great Crowdsourc Story
Map by Owen Evans of the Esri maps team

Story Maps Gallery
Examples of Esri Story Maps by Esri
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Tell the Story of Irish Public History
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ch03_fig01 Video: Ushahidi Haiti
Produced by Ushahidi, published Feb 7, 2010
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ch03_fig02 Video: The Power of Maps
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ch03_figs03–14 Disease Investigations: Cholera
Maps by Lyn Malone, Esri Interface
Data sources: Wikipedia, digitized version of John snow’s map, https://www.bing.com/images/search?view=detailV2&ccid=5k26Nf8i&id=7DCA1445C9896594A4889478B5A434A37AE350611&thid=OIP.5k26Nf8iQ4NNUfy_MrmAdwHaG6&mediaurl=http%3a%2f%2fwww.ganfyd.org%2fimages%2f2%2f2f2c%2fJohn_Snow_cholera_map.jpg&exph=2840&expw=3045&q=wikimedia+snow-cholera-map&simid=608038393427396771&selectedIndex=1&ajaxhist=0
US National Center for Geographic Information

ch03_figs15–22 Graduation Rates and Unemployment
Maps by Lyn Malone, Esri Interface
Data sources: World Imagery and Washington, DC, 1851, Esri

ch03_figs23–29 World’s Largest Cities 100–2000 CE
Maps by Lyn Malone, Esri Interface
Data sources: Tertius Chandler, *Four Thousand Years of Urban Growth: An Historical Census*, digitized by Lyn Malone for *Mapping Our World*

ch03_figs30–49 *Washington, DC, 1851 and 2016*
Maps by Lyn Malone, Esri Interface
Data sources: World Imagery and Washington, DC, 1951, Esri

ch03_figs50–51 *Rancho Grande: In the Mission District*
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ch03_figs52–54 *Melting Pot*
Map by Lyn Malone, Esri Interface.

ch03_fig55 *Learn ArcGIS*
Access at http://www.esri.com
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ch03_fig56 *Tell the Story of Irish Public History*
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**Chapter 4**

*Smart Mapping*
Video produced by Esri
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*What Is GIS?*
Video produced by Esri
Access at https://www.youtube.com/watch?v=LHDCRjAxpl0

*Episode 2 Geospatial Revolution: Powering Business*
Video produced by WPSU Penn State and Esri
Access at http://geospatialrevolution.psu.edu/episode2

*Welcome to MapQuiz*
By Esri
Learn ArcGIS: Guided lessons based on real-world problems
Access at http://www.esri.com
http://learn.arcgis.com/en/

Esri: Environmental Systems Research Schools Mapping and Software Bundle

Icons 3–6 Firefly Glowing Point Image Symbols
Created by John Nelson, Esri product engineer
Access at https://nation.maps.arcgis.com/home/item.html?id=cd04820333f42869c84908884dae411

Mapstyler
Created by Esri UK http://esriuk.com/labs

Supermarket Access Map
Map by Jim Herries
Data sources: Esri, NAVTEQ

Farmers Market
Map by Kathryn Keranen
Data sources: ArcUSA, US Census, and Agricultural Marketing Service, US Department of Agriculture
Access at https://learngis.maps.arcgis.com/home/webmap/viewer.html?webmap=ec2123eaeb964a7a8c47e2f09e09f7b9

World Traffic Service
Map service of world real-time traffic
Data sources: Esri, HERE
Access at http://learngis.maps.arcgis.com/home/webmap/viewer.html?layers=ff11eb5b930b4fabba15c47feb130de4

ArcGIS Organization
Esri ArcGIS Online Organization

Chesapeake Bay Landuse
Map by Kathryn Keranen
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Map Voter Data to Plan Your Campaign
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ch04_fig04 Welcome to MapQuiz
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ch04_figs05–06, 9–11, 13–17, and 19 ArcGIS Online
Esri interface

ch04_fig07 Terrain: Elevation Tinted Hillshade
Esri interface
Data sources: USGS, NGA, NASA, CGIAR, GEBCO, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, GSA and the GIS User Community

ch04_fig08 World Hydrology
Esri interface
Data sources: Esri, NASA, WWF, USGS EROS, Global Runoff Data Centre, GeoNames, Commonwealth of Australia Bureau of Meteorology, USGS, EPA....Licensed under Esri Web Services and API Terms of Use
ch04_figs12, 18, and 20–21 World Imagery Firefly
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ch04_figs22–30 Mapstyler interface
App from Esri UK

ch01_figs31–42, 44, and 48–49 Farmers’ Market
Map by Kathryn Keranen, Esri interface
Data sources: ArcUSA, US Census, and Agricultural Marketing Service, US Department of Agriculture

ch04_figs43,45–47, and 50 World Traffic Service
Map Service of World Real-Time Traffic, Esri Interface
Data sources: Esri, HERE

ch04_figs51–72 Chesapeake Bay Landuse
Map by Kathryn Keranen, Esri Interface
Data sources: ArcUSA, US Census, USGS

ch04_fig73 Learn ArcGIS
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Access at http://learn.arcgis.com

ch04_fig75 Get Started with Tapestry
Access at http://learn.arcgis.com

ch04_fig76 Where Does Healthcare Cost the Most?
Access at http://learn.arcgis.com

Chapter 5

EsriUC 2015 Opening Video. Get to know all the latest on Esri ArcGIS Platform
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ArcGIS Overview
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New Rules of GIS
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Access at https://www.youtube.com/watch?v=xJT5wH4IdKY

Green Infrastructure App
Published by Esri

Building Green Infrastructure in the U.S.: A Framework for Sustainable Growth
Published by Esri
Access at http://esri.com/greeninfrastructure

World Imagery + Green Infrastructure
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Data sources: Esri, DigitalGlobe, Earthstar Geographics, CNES/Airbus DS, GeoEye, USDA FSA, USGS, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community
Green Infrastructure Center Inc., Esri

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Map by Kathryn Keranen
Data sources: ArcUSA and US Census
Access at https://learngis.maps.arcgis.com/home/webmap/viewer.html?webmap=7a6d3c2eb031442bad422f6dabc23ff4

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http://learn.arcgis.com/en/


“Top 10 Highest Mountains in the World to Climb”
Article: Daily News Dig
Access at http://dailynewsdig.com/highest-mountains/
“List of Highest Mountains on Earth”

Why hexagons?
Data sources: Esri ArcPro Help file

Toxic Release Inventory (TRI) Program
Data sources: United States Environmental Protection Agency https://edg.epa.gov/EPA_Data_License.html/
The Toxics Release Inventory (TRI), a resource of the US Environmental Protection Agency, is a set of publicly available databases containing information on releases of specific toxic chemicals and their management as waste, as reported annually by US industrial and federal facilities.
Access at https://www.epa.gov/toxics-release-inventory-tri-program

U.S. Environmental Protection Agency https://edg.epa.gov/EPA_Data_License.html
A government work is generally not subject to copyright in the US and there is generally no copyright restriction on reproduction, derivative works, distribution, performance, or display of a government work.
https://www.epa.gov/
USA TRI Carcinogens
Map by Kathryn Keranen, Esri Interface
Data sources: Esri, HERE, Garmin, NGA, USGS, US Census, EPA, Esri, HERE, Garmin, NGA, USGS

Hexagon Healths
Map by Kathryn Keranen, Esri interface
Data sources: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA, Esri, HERE, Garmin, FAO, NOAA, USGS, EPA
Access at https://www.arcgis.com/home/webmap/viewer.html?webmap=e1876a54cc7d46148cf8d86a255efbccc&extent=-95.3533,22.8229,-62.5701,50.7546

USA Unemployment and Population Change
Map by Kathryn Keranen, Esri Interface
Data sources: Esri, HERE, Garmin, FAO, NOAA, EPA, AAFC, NRCan, US Census Bureau, Esri Enriched Data
Access at https://learngis.maps.arcgis.com/home/webmap/viewer.html?webmap=a7d2ca9664394fa6825ff687288b86f3
Loudoun Hospital
Map by Kathryn Keranen, Esri Interface
Data sources: Esri, HERE, Garmin, USGS, NGA, EPA, USDA, NPS, Esri, HERE, Garmin, USGS, NGA, EPA, USDA, NPS
Access at https://learngis.maps.arcgis.com/home/webmap/viewer.html?webmap=f8c0e41c8e994be880f9f1af1b1ef0b0&extent=-78.5549,38.6499,-76.7326,39.5155

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Track Crime Patterns to Aid Law Enforcement
Map by Esri

Streamline Deliveries with Drive-Time Analysis
Map by Esri

I Can See for Miles and Miles
Map by Esri

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ch05_fig02 Video: ArcGIS Overview
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ch03_fig03 Video: New Rules of GIS
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ch05_fig04 Green Infrastructure App
Esri Interface
Published by Esri

ch05_figs05–06 and 08–09 Green infrastructure habitat core
Esri Interface
Published by Esri
ch05_fig07 World Imagery combined with Green Infrastructure. This work is licensed under the Web Services and API Terms of Use. Data sources: Esri, DigitalGlobe, Earthstar Geographics, CNES/Airbus DS, GeoEye, USDA FSA, USGS, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community Green Infrastructure Center Inc., Esri Green Infrastructure Center Inc., Esri

ch05_fig10–22 Fairfax Derecho
Maps by Kathryn Keranen, Esri Interface
Data sources: ArcUSA and US Census

ch05_fig23–36 ArcGIS Online
Map by Learner, Esri Interface
Data source: Daily News Dig

ch05_fig37–49 USA TRI Carcinogens
Maps by Learner, Esri Interface
Data sources: Esri, HERE, Garmin, NGA, USGS, U.S. Census, EPA, Esri, HERE, Garmin, NGA, USGS

ch05_fig43–62 USA Unemployment and Populations Change
Maps by Kathryn Keranen, Esri Interface
Data sources: Esri, HERE, Garmin, FAO, NOAA, EPA, AAFC, NRCan, US Census Bureau, Esri Enriched Data

ch05_fig63–74 Loudoun Hospital
Maps by Kathryn Keranen, Esri Interface
Data sources: Esri, HERE, Garmin, USGS, NGA, EPA, USDA, NPS, Esri, HERE, Garmin, USGS, NGA, EPA, USDA, NPS

ch05_fig75 Learn ArcGIS
Access at http://www.esri.com
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ch05_fig76 Track Crime Patterns to Aid Law Enforcement
Access at http://learn.arcgis.com

ch05_fig77 Streamline Deliveries with Drive-Time Analysis
Access at http://learn.arcgis.com

ch05_fig78 I Can See for Miles and Miles
Access at http://learn.arcgis.com
http://learn.arcgis.com/en/projects/i-can-see-for-miles-and-miles/
Chapter 6

Author web scenes using ArcGIS Online
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Access at https://www.youtube.com/watch?v=tWiGw56oPuM

Esri’s Prototype Lab
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ArcGIS Online: Complete, Cloud-Based Mapping Platform
Esri
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Learn ArcGIS: Guided lessons based on real-world problems
Access at http://www.esri.com
http://learn.arcgis.com/en/


USGS Earthquake Data
Data courtesy of USGS at https://usgs.gov
https://earthquake.usgs.gov/earthquakes/feed/v1.0/csv.php

ArcGIS My Scene
Scene by Kathryn Keranen
Data sources: Esri, HERE, Garmin, FAO, USGS, NGA, USGS, NGA, NASA, CGIAR, GEBCO, N Robinson, NCEAS, NLS, OS, NMA, Geodatasyrelsen, USGS and the GIS User Community
Access at http://learngis.maps.arcgis.com/home/webscene/viewer.html?layers=85f713c237fd4bf4ba70856e3dc01e60

ArcGIS My Scene
Earthquake video from CNN news broadcast
Access at http://learngis.maps.arcgis.com/home/webscene/viewer.html?layers=85f713c237fd4bf4ba70856e3dc01e60

Scene 2: 3D Quake Depth
Scene by Kathryn Keranen
Data sources: Earthstar Geographics | Source: USGS, NGA, NASA, CGIAR, GEBCO, N Robinson, NCEAS, NLS, OS, NMA, Geodatasyrelsen, the GIS User Community and USGS
Access at http://learnegis.maps.arcgis.com/home/webscene/viewer.html?webscene=f4ca9a902abe4266b428266047edddb8&ui=min

_Baltimore Lidar_
Scene by Kathryn Keranen, City of Baltimore Open Data Policy: https://creativecommons.org/licenses/by/3.0/
Data sources: City of Baltimore, Baltimore County, VITA, Esri, HERE, Garmin, INCREMENT P, Intermap, USGS, EPA, USDA, USGS, NGA, NASA, CGIAR, GEBCO, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen and the GIS User Community
Access at http://learnegis.maps.arcgis.com/home/webscene/viewer.html?webscene=c7b524c09e8b4dddb906779ca35949ab6

_Gallery: Featured Maps from the Living Atlas_
Featured maps from the Living Atlas of the World published by Esri
Access at https://www.arcgis.com/home/gallery.html#f=scenes&c=esri&t=maps&o=modified

_Get Started with Scene Viewer_
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_Fly Through South America in a 3D Animation_
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ch06_fig01 _Sharing 3D content demo with Nathan Shephard_
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ch06_fig02 _Esri’s Prototype Lab_
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ch06_fig03 _Scene_
Esri Scene interface
Access at http://arcgis.com

ch06_figs04 and 19 _ArcScene Topography Map_
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Data sources: Esri, HERE, Garmin, Intermap, USGS, NGA, EPA, USDA, NPS | Source: USGS, NGA, NASA, CGIAR, GEBCO, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen and the GIS User Community
ch06_figs05–07 and 09 ArcScene Imagery
Published by Esri, Esri Scene interface
Data sources: Earthstar Geographics, CNES/Airbus DS | Source: USGS, NGA, NASA, CGIAR, GEBCO, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen and the GIS User Community

ch06_figs08 and 28 ArcScene Globe
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Data sources: Esri, HERE, Garmin, FAO, NOAA, EPA, USGS, NGA, NASA, CGIAR, GEBCO, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen and the GIS User Community

ch06_figs10–18, 20–27, and 29–34 ArcScene
Maps by Learner, Esri Scene interface.

ch06_fig35 Learn ArcGIS
Access at http://www.esri.com
http://learn.arcgis.com/en/

ch06_fig36 Get Started with Scene Viewer
Access at
http://learn.arcgis.com

ch06_fig37 Fly Through South America in a 3D Animation
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Chapter 7

ArcGIS Apps for the field
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Esri Solutions for Business
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ArcGIS Marketplace: Discover a World of Apps, Content and Capabilities
Esri

ArcGIS: Learners Using the ArcGIS Book
Map by Kathy Keranen
Data sources: Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
Access at http://www.arcgis.com/home/webmap/viewer.html?webmap=b28b81a16d67420387ac1b2ad89b7746&extent=-180,-89.5666,180,89.0839

STORMTOOLS for Beginners
Data Sources: RI CRMC, URI OCE, URI EDC, URI CRC, NOAA
Access at http://learngis.maps.arcgis.com/home/webmap/viewer.html?webmap=a54ede99a2704409a320183de01766b6

USGS Historical Topographic Map Explorer
Esri
Data sources: USGS and Esri
Access at http://historicalmaps.arcgis.com/usgs/

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Access at http://www.esri.com
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Esri: Environmental Systems Research Schools Mapping and Software Bundle

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IGARC2_tree
Feature service definition
Created by Kathryn Keranen
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ch07_fig03 Esri Solutions for Business
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ch07_fig04 ArcGIS Marketplace
Esri

ch07_fig05 Instructional User Guide
Map by Kathryn Keranen, Esri Interface

ch07_figs06–13 STORMTOOLS app
STORMTOOLS app interface
Data sources: RI CRMC, URI OCE, URI EDC, URI CRC, NOAA

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Chapter 8

Esri Launches Landsat Explorer Web App
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Know How Landsat 8 Completes Its One Rotation to Give Brighter Imagery
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Access at https://www.youtube.com/watch?v=0XE6xH4FLwA
Landsat Science
Data sources: USGS, NASA
Access at https://landsat.gsfc.nasa.gov/about/

ArcGIS Online
Produced by Esri
Access at http://arcgis.com

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http://learn.arcgis.com/en/


Esri Landsat Explorer
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Depict Land-Use Change with Time-Enabled Apps
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Access at http://learn.arcgis.com

Oso Mudslide – Before and After
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ch08_fig01 Esri Launches Landsat Explorer Web App
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ch08_fig02 Know How Landsat 8 Completes Its One Rotation to Give Brighter Imagery
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ch08_fig03 Landsat Science
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Access at https://landsat.gsfc.nasa.gov/about/
Chapter 9

Raceway Event Protection National Security Demo – Operations
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Collector and Operations Dashboard for ArcGIS: Monitoring Coastal Security
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Download Operations Dashboard for ArcGIS
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The ArcGIS Book, second edition
Esri Press

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http://learn.arcgis.com/en/


ArcGIS Online
Map by Learner, Esri Interface


Presidential Election Map 2016
Map by Kathryn Keranen

Tornadoes
Layer published by Kathryn Keranen
Data source: USGS http://usgs.gov

Oversee Snowplows in Real Time
Access at http://learn.arcgis.com

Monitor Real-Time Emergencies
Access at http://learn.arcgis.com

ch09_fig01 Raceway Event Protection National Security Demo-Operations
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Chapter 10

ArcGIS Online Case Study: Emergency Management—Cal OES
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Reduce Vector-borne Disease
Esri
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Reduce Homelessness
Esri
Access at http://thearcgisbook.com
http://esripm.maps.arcgis.com/apps/Cascade/index.html?appid=9addf622e85c4423a76a07152cdaf40e

Reducing Opioid Addiction
Esri
http://thearcgisbook.com
https://esripm.maps.arcgis.com/apps/Cascade/index.html?appid=4dde566c953e4342b3a870c15acba4e9

Wi-Fi Service Definition
Created by Kathryn Keranen
Access at http://www.arcgis.com/home/search.html?q=IGARC2_wifi&t=content&start=1&sortOrder=desc&sortField=relevance

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http://learn.arcgis.com/en/

ArcGIS Online
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Mapping without Limits
Esri Template
Access at http://arcgis.com

Story Map Crowdsourse Tutorial
Produced by Esri.

Monitor Whales with a Multilingual Survey
ch10_fig01 California Governor’s Office of Emergency Services (Cal OES) Uses ArcGIS Online to Respond to Emergencies
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ch10_fig02 Show How Crowdsourced Traffic and Navigation App WAZE Integrates with the ArcGIS Platform to Deliver Real-Time Information
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ch10_fig03 Wi-Fi
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ch10_figs04–05 ArcGIS Online
Maps created by Learner, Esri interface

ch10_fig05 Rancho Grande: In the Mission District
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ch10_figs06–07 Rancho Grande Story Map Crowdsource Builder
Maps by Learner, Esri interface

ch10_fig08 Learn ArcGIS
Access at http://www.esri.com

ch10_fig09 Monitor Whales with a Multilingual Survey
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Instructional Guide for The ArcGIS® Book

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