Erin Farley: All right, welcome, everybody. Good afternoon. We're going to get started. My name is Erin Farley, and I'm one of JRSA's research associates. For those of you who may be less familiar with JRSA, it stands for Justice Research and Statistics Association, and we are a national nonprofit organization dedicated to the use of research and analysis to inform criminal and juvenile justice decision making. We are comprised of a network of researchers and practitioners, which at the core include directors and staff from state statistical analysis centers.

Erin Farley: Before I welcome our presenter today, I wanted to let attendees know that we do have a skill building webinar scheduled for July 13. It is going to cover web scraping, and it's going to be hosted and led by Matthew [Studenberg 00:01:20], who is an attorney and IT director for the Maryland Volunteer Lawyers Service. So if you are interested in web scraping, I recommend you registering. You can go ahead and do that on our website.

Erin Farley: All right. So moving on, it is my pleasure today to welcome you to our webinar, and today we are going to be presenting on mapping criminal justice data with ArcGIS. It's going to be led by Elizabeth Groff, who is from Temple University. She received her PhD in geography in 2006 and an MA in 2005 in criminology and criminal justice frame the University of Maryland, and she has spent the last 20 years applying geographic theory and methodology to the study of crime-related issues at both the local and national levels. So we are very happy to have her here today to talk about ArcGIS.

Erin Farley: Before I go ahead and pass it over to her, give me one second. I want to just cover a few technical issues. We will be recording today's session for future playback. The link to the recording will be posted on JRSA's website, and we usually post that the following day, so it should be up and available tomorrow. Today's webinar is being audio cast via both speakers on your computer and teleconference, and we recommend listening to the webinar using your computer speakers or headphones. And to access audio conference, select "audio" from the top menu bar, and then select "audio conference". Once audio conference window appears, you can view the teleconference call and information, or join the audio conference via your computer.

Erin Farley: If you have any questions for the presenter or would like to communicate, please submit all your questions to the option that is all participants. You can see that on this image, the picture, it's in blue. If for some reason you want to just provide to the host or the presenter, you can see that there are those options. But we just generally recommend sending it to all participants. And we will answer most questions. Unless it's a technical issue or a pressing question, we'll probably save them to the end.

Erin Farley: If you do have any technical difficulties or get disconnected during the session, you can reconnect using the same link that you used to join, and you can also email Jason Trask at jtrask@jrsa.org.
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Erin Farley: In the last five minutes of today's webinar, we will ask you to complete a short survey. The information will provide us with a plan ... provides us with the information to better plan and improve our webinars, and also to meet our reporting requirements.

Erin Farley: In addition, we know that there are a number of people who do watch the webinar together using the same computer, so we're really trying to get a sense of how many people are out there watching this webinar. So if you do have a group that's viewing, please take a moment to go to the chat window and type in the name of the person registered and the total number of additional people in the room. This will, again, help us to track the number of people attending our webinars, and we would greatly appreciate it. So, thanks.

Erin Farley: And I would also just like to thank our partners, the Bureau of Justice Statistics, for helping to make this webinar possible.

Erin Farley: So I think that's it, and I will pass it over to Liz to get started. Let me go to the next slide, and pass the magic ball to you. So I think it is all you now. So, thank you again, Liz.

Elizabeth Groff: Okay, thanks. So, hello. The focus of this session is on information that's going to help you start mapping more quickly, and that's necessary because we only have about an hour together, and because now, you can get entire degrees on geographic information systems. So we're just covering the beginning, basic concepts. But I think that will be enough so that by the end of the session, you will be able to create your own map.

Elizabeth Groff: So we're going to start out just discussing briefly some advantages of mapping, discuss a conceptual overview of geographic information systems more generally, and ArcGIS in particular, then run through a step-by-step example of mapping UCR data, and end with some problem solving tips.

Elizabeth Groff: I'm going to be going back and forth, talking for a bit with slides, and then going to a live ArcMap session, and then going back to the slides, just so you know what's happening.

Elizabeth Groff: Let's start with the advantages of spatial analysis. Well, the first thing you can do with a geographic information system that's basic but critical is you can identify where things are located in space. And we can do this now through a variety of different applications, such as Google Maps or those kinds of things. But if we want to do it in a more structured fashion, we really need a GIS, so we can answer questions like, what's the distribution of locations, such as subway stations, bars, or parks, that we think might be related to crime? Or we can look at protective factors, like the locations of afterschool programs.
Elizabeth Groff: 

Sorry, I'm going to have to remember to use the correct thing to advance the slide.

Elizabeth Groff: 

We can also combine spatial data together, and this actually is true, there's an old saying, spatial is special. And it's special because we don't have to have a database item in common. So those of us who have worked with databases for a long time, you have to have a field that exists in both of the two tables you want to join to be able to join them. But we don't have to have that when we have spatial data. We can use literally the location of things.

Elizabeth Groff: 

So we can answer questions like, which neighborhoods have the most access to public transportation, because we can use the neighborhood boundaries and their location, and then look to see what subway stations, for instance, fall within each neighborhood, or what the total linear feet of bus routes is that falls within a particular neighborhood.

Elizabeth Groff: 

We can also answer questions like, which neighborhoods get more afterschool programming dollars? And again, we'd be using neighborhood boundaries, but this time, if we had a file that showed the locations of afterschool programs and then also the amount of money that they were allocated, then we could aggregate to the neighborhood.

Elizabeth Groff: 

Another advantage of geographic information systems is being able to identify where things are clustered. And when we think about concentrations or hotspots, we typically think of very ... analyses that look at areas within a city and find hotspots of retail outlets or bars or crimes or drug overdoses. But we can also look at larger areas to see where, for instance, counties with a high violent crime rate are next to other counties with a high violent crime rate.

Elizabeth Groff: 

Finally, we can look at where things are changing. So we can look at change over time at things like, which counties have declining property crime levels, and are they close to one another? Or, which neighborhoods have the highest increases in numbers of people who were formerly incarcerated?

Elizabeth Groff: 

So I hope that gives you just a very brief introduction to the types of things we can do with a geographic information system. Now, I wanted to give you a visual on what's happening in a GIS. And I think, to me, after teaching this for a few years now, I think that cartoons are actually pretty effective.

Elizabeth Groff: 

So if you look at the graphic on the right, at the very bottom picture, that is a cartoon representation of the real world. And to make that cartoon representation, we had to simplify the real world quite a bit already. Well, what we do when we convert things for use in GIS is simplify the real world even more, and we simplify and group features, similar types of features, together in different layers, almost like the layers on a cake. Or if you're like me and over
50, you might remember transparencies where you overlaid them and you could look at where places were in common.

Elizabeth Groff: So that's what the GIS is doing in a much more sophisticated fashion. So it's dividing the real world into layers that represent, for instance, land use, or elevation, or parcels of land ownership, streets, or customers. And if we could imagine taking a pencil and sticking it down through any part of that stack of layers, we would know exactly how many customers were at that point where the pencil went in, whether it was located on a street or not, if it was located in a parcel, who owned that parcel, what the elevation was, et cetera. And we'd know all that just based on geography.

Elizabeth Groff: All right. So I hope I've piqued your interest, for those of you who didn't know much about ArcGIS to begin with, or GIS at all. So how do you get started? Well, the bottom line is most of us get started using software that our employer has, or our university has. But there are many different mapping applications that are available. A few of them are free, like QGIS, Quantum GIS, and GRASS. And I also found a recent website, if you wanted to take a look at it. For those of you who don't have access to GIS through your employer, these are a list of ... Or this includes a list of all the new open source GIS applications.

Elizabeth Groff: In addition, of course, there are many GIS packages that cost money. Maptitude, MapInfo, and Esri have all been around for a very long time. Esri is probably the largest professional GIS firm, and it certainly has the lion's share of the market in federal government, state government, local government, and in universities.

Elizabeth Groff: Okay. So let's move on to a conceptual overview of GIS terms. Some basic vocabulary ... You'll hear me talking about features, and these are the geographic component of data, the actual lines that describe a street network, or the areas that describe buildings, or the points that describe the fire hydrants. So that's one type of data that we use in a GIS.

Elizabeth Groff: Another type is a tabular component. So it's the attributes or the characteristics of the features. So if we think, for example, of streets, then streets might have attributes that includes the type of the street, the name of the street, the direction, its length, address ranges, speed limit, things like that. So it's a constant ... In a GIS, you're constantly using both attribute data and feature data.

Elizabeth Groff: Now, feature data is further divided into three different main types of feature data. And each one of these types is important because it has different spatial analysis capabilities, and you can use different symbology on them. So points, then, are a location that's described. It's zero-dimensional, it's described with a single X, Y pair. Zero-dimensional just means it doesn't have length or width. It's just one point. And here, the example is the points in the upper left there, the graphic.
Elizabeth Groff: Lines, then, things like streets and streams and bus routes, they have coordinate pairs that describe the shape of the line. So in GIS, we can only draw a straight line. So every time the line changes direction, we have to put another coordinate pair down and start measuring a straight line from there. So curves have lots of coordinate pairs very close to one another.

Elizabeth Groff: And then polygons are the last type of feature. It's a two-dimensional feature, it has length and width. It's also described by a set of coordinate pairs that start with the same coordinate pair that they end with. So you see in the example, it's (2,4), and then it ends with (2,4). It starts and ends with (2,4). So hopefully that gives you a visual of what I'm talking about when I talk about features that are points, lines, and polygons.

Elizabeth Groff: So let's move on and discuss a little about ArcGIS Desktop. So I'm using ArcGIS Desktop because of the market saturation that it has. Of course, all the concepts I'm talking about are equally applicable whether you're talking about ArcGIS or whether you're talking about some other type of GIS software.

Elizabeth Groff: So ArcGIS Desktop actually refers to a suite of products. There are three of them that are most frequently used. ArcMap, ArcCatalog, and ArcToolbox. I'm going to talk about each one of them, but I just wanted to let you know that all the examples I'm going to do today are in version 10.4, and that's because that is what the university has given me.

Elizabeth Groff: ArcMap is really the core application. That's what analysts tend to open up, and they start working in it to look at the data file that they have, to join spatial data and tables, to add symbology, and to conduct all kinds of spatial analysis. So the workflow typically is to open ArcMap, and then from ArcMap, you can open ArcCatalog and ArcToolbox and use them within your ArcMap session, which makes it very easy to deal with.

Elizabeth Groff: So the ArcMap interface, and we'll look at this live too, but ... it looks like a typical GUI interface. It has a set of menu options across the top, and then it has a bunch of different buttons or tools in the next two bars. On the right hand side is where you'll see the map, and on the left will be the table of contents.

Elizabeth Groff: So I just wanted to highlight here that when you open your ArcMap for the first time, you're going to get a couple of different options for setting up a template or using a template or opening one of the recent projects that you viewed. So I just wanted to highlight that for you. You may not see that today, 'cause I've already got a session that's open.

Elizabeth Groff: All right. Now, ArcCatalog, then. Why would we even have ArcCatalog if we can do all those things in ArcMap? Well, what ArcCatalog does is allows us to create some data formats, so we can't create within ArcMap, like the file-based geo database. It also lets us rename our shapefiles very easily, and the reason why...
that's important will become clear in just a few minutes. You can export data from there, and most importantly, you can set up a home directory to make it easy to get back to where you're working. You can also set up connections to various folders on your desktop so that when you're in ArcMap, you can immediately see what's in those folders.

Elizabeth Groff: The two main data formats within ArcGIS are the shapefile, which has been around for as long as I've been using ArcGIS, 25 years or so, and it's really become the standard for data exchange among GIS folks. Calling something a shapefile is actually a misnomer in that it's a set of files that have the same root name, but have different extensions. Three of them are required for you to actually be able to display the data that you've gotten from someone else in ArcMap. So you have to have the .shp file, the shapefile that has the actual X, Y coordinates in it. You have to have the .shx file, which is the index. And you have to have the .dbf, which contains any fields that are already associated with that file.

Elizabeth Groff: The other type of file extension that's really handy if someone's going to send you data is the .prj file. And that's the projection file. You want to, when you're getting data from someone else, you should always ask them if they can send you the .prj, because then you'll know exactly what coordinate system the data are in, and it just makes your life a lot easier.

Elizabeth Groff: The other major type of data storage format in ArcMap is the geodatabase, and in particular, I want to focus on the file-based geodatabase. Esri has worked very hard to increase the robustness of this format, and now recommends it to all users over the shapefile. It has a couple of advantages. One is that because it looks like a little ... Well, it looks like a little oil drum to me. But I'll show it to you in a minute. It holds all of your data layers in one icon there. More functionality, there's no limit on the file size in a geodatabase, and it's a much more stable format for large files.

Elizabeth Groff: Finally, ArcToolbox is the extension that holds all the geoprocessing tools that are in ArcGIS. You can access some geoprocessing tools directly from the ArcMap interface, the ones that are used more often. But ArcToolbox has literally hundreds of other tools for all different types of analyses.

Elizabeth Groff: The one caution, I would say, from having used this for a while, is if you're going to do some data manipulation that is tabular in nature, I would suggest doing that before you bring it into ArcGIS. That's not the software's strength.

Elizabeth Groff: All right. So we're going to switch over now, and I'm just going to show you what the interface looks like, and talk a little bit about ... just in the form of an orientation, talk about how to use ArcCatalog too. So let me switch over ...
Elizabeth Groff: Yeah.

Erin Farley: This is Eric. I was wondering if you could just take a second and describe, when you're referring to tabular analysis, maybe you could just describe what that usually is, for anyone who might not be familiar with what you're referring to.

Elizabeth Groff: Okay. So let's say it's when a crime analyst is looking at a database file, and they do attribute queries to subset the data. So you might say, return for me all of the residential burglaries, and then I want a table that shows the number per shift during the day, or per day of week, things like that.

Erin Farley: Okay. Thank you. Do you usually do that in SPSS or Stata, things like that?

Elizabeth Groff: Yes, [crosstalk 00:24:12].

Erin Farley: The specific statistics ... Okay, so cross tabs, things like that?

Elizabeth Groff: Yeah, yeah.

Erin Farley: Okay. All right, thank you so much.

Elizabeth Groff: Sure. And I hope you guys will write in any questions you have. I'm happy to stop and address them before we get too far.

Elizabeth Groff: Okay. So this is the ArcMap interface. This is the menu bar across the top. It's similar to other GUI menu bars, with things about files over here under File, editing different views, which we'll talk about. I'm not going to go through ... We don't nearly have the time to go through each one of these. But I want to point out some of the big picture features.

Elizabeth Groff: Okay. So this is the ArcMap interface. This is the menu bar across the top. It's similar to other GUI menu bars, with things about files over here under File, editing different views, which we'll talk about. I'm not going to go through ... We don't nearly have the time to go through each one of these. But I want to point out some of the big picture features.

Elizabeth Groff: So there's a lot of redundancy between the menus or these different buttons, or they call them tools, in ArcGIS. So ArcGIS automatically loads four different toolbars, and you can tell that you're in a toolbar because of these three dots right here. That starts a toolbar. It runs all the way over to the little arrow that's pointing down where you mouse over. It says toolbar options. That's one toolbar, that's a standard toolbar that has things like opening files, saving them, printing, adding data.

Elizabeth Groff: Then there's the tools toolbar, and you'll notice that as I mouse over these different tools, it gives me a description of what the tool does. Now, most of these are intuitive to us from just working with different mapping packages on the internet now. But this is all about zooming and moving around in your map, and then there's a drawing toolbar for inserting different graphic types, changing fonts, et cetera. And then there's also a layout toolbar that only becomes active when I switch my view from the data view that I'm in now to a
layout view, and now these buttons all become active. We’ll be talking about using the layout view later, where you compose your final map.

Elizabeth Groff: I also wanted to point out that when you right click anywhere in this gray area, you’ll get a list with all the other toolbars with more tools that you can add into your ArcMap project. And typically what I do, and I think a lot of analysts do, is you tend to add them in as you need them so you don’t get an overly cluttered interface. So let’s say that somebody sent you a file of drug markets, and you wanted to edit some of the drug markets to reflect some changes in their geographies. So you might add it, or you would add in this editor toolbar, and now you see I have a new toolbar right here, that all the tools are grayed out. But if I had added in a shapefile or a feature class in a geodatabase and told it I wanted to edit that, then chose start editing, then these tools would become active.

Elizabeth Groff: As soon as I’m done with this toolbar, I can right click over here again and get rid of the editor toolbar. So it’s that simple.

Elizabeth Groff: Another thing I wanted to point out to you guys while we’re in here is how to start our catalog and what it looks like. So, let me start with the table of contents. Beginning users often accidentally close the table of contents, and then you feel totally lost, ‘cause you can’t see how to even get started again. So up here is the table of contents. Just click on that, it comes back again.

Elizabeth Groff: The next button over opens our catalog, so you can see all the different folders that you’re connected to on your laptop already. You can connect to new ones, you can set your home directory, et cetera. So I could navigate ... Let me show you. All of these things that look like little oil drums to me are different geodatabases, and inside the geodatabase is all of these different layers or feature classes, to be exact, is what they’re called inside a geodatabase.

Elizabeth Groff: So I could add something from one of these to my view. And then, let’s say, oh. But I really want to get back to where my home area is. What the home button does for you, when you set it, is it allows you to quickly go back to the area that you’ve associated with this particular project.

Elizabeth Groff: I’m just going to remove this, and show you how you would set your home directory, because part of my workflow is always to open a new project, set the home directory, so I just go up to options, home folder, navigate to where I want to set the home directory, and then say okay, and [fly 00:29:27], and I’m actually in where I want to set to be my home directory. So, okay.

Elizabeth Groff: Now I want to save my project, because I just want to hang onto it. I’ve already set up my home directory, I don’t want to close it and lose that. So I’m going to go up here to save as and call it ... demo. Save it. And now you see how it shows up as bold, because that’s what I have. That’s the [MX 00:30:06] data I’m using
right now. It’s always important to remember that MXD is the file extension for projects, so when you’re searching for one, that’s what you’re looking for.

Elizabeth Groff: Okay. So let’s talk some more about working with spatial data. So I’m going to switch back here to the presentation. All right.

Elizabeth Groff: When you sit down to try to do an analysis, you’re going to need to have a geographically enabled file. That geographically enabled file could be a boundary file of things like counties or school districts, police districts, census tracts, drug markets. Really, it could be anything that you’re interested in studying.

Elizabeth Groff: You might also be studying things like streets, so you would have a line file of streets, or studying the relationship between bus routes and crime. So you’d have a file of bus routes, which would be a line file. Or you could have a point file of transit stations, stadiums, other facility types. But you’re going to have to have at least one geographically enabled file.

Elizabeth Groff: In a perfect world, our attribute data would come packaged with our geographically enabled file, but in reality, that doesn’t happen that way. So we have these base files, almost like ... I think of them as almost like stems. So you might have a generic street file in the city that you’re studying, or major roads for an entire county or state. And then you add the data that you need to that particular file to be able to do the analysis you want to do.

Elizabeth Groff: So let’s say you get one of these stem files, let’s say counties, for example. And now you have to add the attribute data that you want to study. Are you interested in opioid overdoses, are you interested in violent crime, property crime, gun seizures? Whatever it is, you have to get the data already aggregated to the county, and then you can join those two things together. Or you would have to get events data to describe events and use a spatial join to join the boundaries that you want to study, so maybe the police districts or the counties, with the data that you want to use.

Elizabeth Groff: All right. So let’s look at an example. Let’s say we were studying Georgia, which we’re going to use in our example, and we would have this feature layer of the boundaries of Georgia counties. Its table looks something like this, where it has ... Behind this polygon field are all those coordinates I was telling you about. But thankfully, ArcGIS doesn’t show them to us. And then a FIPS code that goes for census purposes and a county name. There was also a label name in here, that you could label the counties in all caps if you wanted to.

Elizabeth Groff: So that’s our features right here, our feature data. Then we would have another spreadsheet, for instance, of data. And this can be held in Excel as a handy one to use, and it might have the UCR data that we’re interested in. What’s critical here is that we have at least one field between the two that’s the same.
So joining data, then, as I just was saying, happens in two ways. Either a tabular join, where you're joining based on a common field, or a spatial join, where you're joining based on the information, the geographic location, that's in your two different feature layers that you have.

Let's take a look at a tabular join. This is the one that we're used to using just with databases. So you might have one spreadsheet with the content names, and you're joining it to another table with the county names. That's a straightforward operation.

We can also join data spatially. So this is an example. We might have two areas here, and we've got some kind of locations or events that have happened, and there is no field in common. I can remember this was a huge problem back before GIS came along, because if you had crimes and you wanted to aggregate them to, let's say, some other polygon like school districts, it was almost impossible if you had a busy police department.

So now it's very straightforward. The GIS uses the locations of the points and compares those to the boundaries of the polygon, and can tell which polygon each point falls within. The same is true of lines that go across polygons, or lines that cross points. So basically, any features you can use to select other features.

One thing that you can do in ArcMap that's similar to what you do already in databases are those attribute queries that I was talking about earlier. So in any database, whether it's Access or whatever you're using, you can create a query that subsets your data. For example, looking at all the street robberies, or looking at all the robberies that happened on Mondays or Wednesdays or weekends. You can do that in ArcMap also. But the added benefit of using ArcMap really comes when you have a spatial question you want to ask also.

So let's say you wanted, instead of just looking at all the robberies, you wanted to look at all the robberies that happened within a block of a CCTV camera. So you could use the spatial locations of those robberies and measure one block away from the camera, and be able to associate those two things.

So I've been talking for a while now, but I just wanted to try to sum this up and give you an easy graphic to follow. So when you start an analysis, the first thing you want to do is identify what your spatial units of analysis are, and then collect them. So they might be boundaries, like as I said, counties or police districts. They might be streets, or they might be something else. So you want to collect those.

Then you want to decide what other spatial data that you want to work with. Are you going to be looking at individual crime incidents? If so, then you need to collect those. Are you going to be considering locations of facilities, like bars or retail stores? Then you need to collect those.
Elizabeth Groff: Get all your spatial data together, and identify what other attribute data you need. So look to see, what's not already included with my spatial data collected? What do I need to be able to study and answer the research question I'm trying to answer? And when I say research question, I mean that loosely. What question do you have that you want to answer?

Elizabeth Groff: The third step is then to either use an attribute join or a spatial join to put those datasets together, and the final step then is to conduct whatever analysis that you're going to conduct that's appropriate to the question. And you could be doing simple descriptive analysis like we're going to be doing here, or you continue on and do some kind of quantitative analysis.

Elizabeth Groff: Okay. So let's move on, and I want to stop though, for a second here, and thank Stefanie Lopez-Howard, who's the director of the Georgia Statistical Analysis Center, for sharing her UCR data so I'd have something to show you guys here. So I'm going to run through an example that we're going to use throughout the rest of this webinar of how you can map UCR data. I'm going to switch over again to ArcGIS.

Elizabeth Groff: All right. One of the buttons that you're going to use most often is this add data button. So if you click on the add data button, and I go to my home, it takes me to where I've stored all the data for this particular demo. So the first thing I want to load up are my counties for Georgia. I'm going to add those in.

Elizabeth Groff: And I just want to show you that we have the same functionality if we go to file, add data. It's the exact same thing. So in my life, I've decided there are button people and there are menu people. So you know who you are. Use the one that fits your workflow.

Elizabeth Groff: All right. Now, I also want to add some UCR data. So I have Excel files show up as the name of the workbook. So if you click on that ... double click on that with your left mouse button ... then you get a list of all the sheets in that particular workbook. So let's use UCR total.

Elizabeth Groff: All right. So now you see the way ArcGIS ... This is a table of contents ... shows feature data differently than tabular data. So tabular data being data that doesn't know where it is in the world. So if I open this up, I can see the fields that are in this particular Excel file, and I haven't converted this. I'm using this right as an Excel file within ArcGIS. And we see that we have the county, and we have some violent and property crime rates for 2013 and 2016, or I should say, numbers. Then we have a change, and then a percent change calculated already.

Elizabeth Groff: In our counties feature layer, all we've got basically is the county name and the FIPS code, which is a census identifier. Now, notice when I open the table, it didn't open another little screen, and that's because it uses tabs. So I can go
back to the UCR data by clicking on the tab that I added first, or look at the counties data.

Elizabeth Groff: Okay. When we're going to do a join in ArcMap, the first thing that we have to double check ... We don't have to do it, but it's nice to know what's going to happen ... is we need to click on county, and look at properties. So I'm checking the property here, the type, and I can see that it's a string field. Okay. That's good, that's reasonable. 20 is the width.

Elizabeth Groff: Let's go look at the county in the UCR file. Also a string field. Good news for us. The length is quite a bit different, but hopefully, that won't be a problem.

Elizabeth Groff: All right. So when you're going to join data, you always want to join your tabular data to your features. So I'm going to right click on my feature layer name, go into joins and relates, and I'm going to choose join. Okay. Whenever you get a popup menu like this, until you understand it, it's a great idea to read what the help is telling you. So join lets you append additional data to this layer's attribute table so you can symbolize the layer's features. That's good. It sounds like what we're looking for.

Elizabeth Groff: There are two types of joins you can do, as we've been talking about. You can join attributes from a table, or you can join data from another layer based on spatial location.

Elizabeth Groff: So we're going to join attributes from a table, because our UCR data is not spatially enabled. So we know that we're going to use the county field as our field in common, and ArcGIS, because this is the only other file in here, has loaded in UCR total and county as a likely choice for a join field.

Elizabeth Groff: Let's validate our join, because will give us some idea if something's going wrong, and indeed, there is a little bit of a problem here. We have 156 of 159 records matched. So let's keep going and see what the problem is.

Elizabeth Groff: Oops. Must have clicked ... Try that one more time. Oh, I know what it is. So you have to be on the actual table that you've joined to, which is this counties table. So we can see here that Baker, which is a county that's in the feature data, is not in our UCR data. So if this was an actual analysis, you would figure out whether Baker really wasn't supposed to be there. But we're just going to assume that it's not supposed to be there and continue on, 'cause we don't have a whole lot of time.

Elizabeth Groff: So, let's see. So at this point, we now have our UCR data attached, and we can actually make a map. So we could right click here, go to properties, look at our symbology ... We want to use quantities because we have total numbers or percentages, things like that. So we definitely want graduated colors under quantities.
And then let's just take a quick peek at the violent crime in 2013. A common mapping convention is you think about the kind of data that you have, and then you pick a color that goes with that data. So when you think about something bad, like crime, then you think about warm colors like oranges and reds and browns. And so the higher, then, that the crime rate is, the darker the color. The lower, the lighter the color.

So we can apply that and just take a quick look and see a pattern which is not surprising, around the major metropolitan area in Georgia. But when you have a choropleth map, you don't want to map totals, because it's misleading. So we're going to add some other data, and create a more defensible map using a choropleth map technique.

All right. So let me switch back over, and talk a little bit from the slides here. All right, about how we can go on and improve our map.

So one of the ways we can improve our map is by including population. And to include population, we have to actually find some population data. Now, most of us immediately think about the census, and that's a logical thing to think about. But if it wasn't such an obvious improvement, like population, there might be other types of data that we'd want. And luckily for us, we live now, and the internet has opened up all kinds of resources for us to use.

So there's all kinds of geospatial repositories out there, that if you use your favorite search engine and search under geospatial repository, the name of the state, or open data and the name of the state that you're interested in, you can find a lot of data out there. I just put three examples that I've used before. PASDA, because I'm in Pennsylvania. The Pennsylvania Spatial Data Access has a ton of data out there, mostly from state and local, as well as federal agencies. Georgia also has an open data site, and does ArcGIS, which has a lot of information out there. So feel free to consult these URLs. We can also use the add data button, and I'm going to show you a little bit different variety of that, in an ArcMap session, to find data.

So in this next section of our session, I'm going to take you through how you would actually find and use additional data to make a better map, a better choropleth map. I'm also going to show you, to end the session, how you would make a presentation quality map. So let's get on that.

All right. So you see my state of Georgia has migrated a little bit, so I'm going to grab my pan hand there and pull it down just a little bit. And then switch over to the pointer tool, which keeps me from accidentally panning around. All right.

So when we want to add data within an ArcMap session, we go to the same add data button, but we use the little arrow that's pointing down, and go into add data from ArcGIS online. Now, we know that we want Georgia, and we want...
county, and population. So I'm just going to search to find if there's any data out there that meets those criteria, and I see there's both 2000 data and 2010.

Elizabeth Groff: So let's look at the details of that. It's important to go ahead and look at the data before you download it. It saves you time to see if the data that you're looking for, the particular fields, are actually in there. So let's move down, and we're looking for total population. Yeah, there we go. It's got total population, and I forgot to look to see if it had county name. One would assume, but ... Yeah, but it's called Name 10. So we're going to have to remember that when we go to do our join.

Elizabeth Groff: So normally, you would just press add, and it would add it in. But my internet connection has been super slow, so I'm just going to pull across a census layer that I saved, that exact same one that you would get if I had attached to it using ArcGIS online, and you can see ... You can open the attribute table, and here we can see all the fields that we would like to have. Most importantly, the total pop in 2010.

Elizabeth Groff: Okay. So let's check our Name 10 field and make sure that that's a string. And indeed it is, so we are good there. All right. We're ready to do our join.

Elizabeth Groff: So remember, this counties Georgia layer we've been working with actually has the features plus the UCR, and now we're going to add our population data. So let's go to joins again, and choose join. We're going to join attributes from a table, and we're going to use the county field in this counties Georgia, and census counties is what we're using to join to it. And we're going to find Name 10, that's our county field in the new information we just downloaded. And we're going to validate our join, see how we do this time. Perfect. All field and data source validation tasks were completed successfully. So we say okay, and when we open the table, we now see the UCR data that we wanted, plus all of the census data that we wanted also. And in particular, the population.

Elizabeth Groff: So we are ready to create a field. So it's good to create a field that is a rate per population when using choropleth mapping. Creating a field is very straightforward. We want to come up here to the table options, and we want to add a field. We need to name the field, and so this is just going to be violent rate. And we're going to define it to be a double so that it can have decimal places. Whenever ArcGIS adds a field, it puts it at the very end of the file. So here's our new field.

Elizabeth Groff: If we right click on that field, we can calculate it using some fields in the table. Now, this is warning that you'll get each time unless you turn it off, and I didn't turn it off 'cause I wanted you to see it. It always warns you that you're about ready to do an edit outside of an edit session which can't be reversed. Within an edit session, you can reverse things. What we're doing doesn't really matter, so we're fine.
Elizabeth Groff: So we say yes, and now we get the field calculator tool. So we are just going to find violent, 13, and we're going to divide it, which is our total violent crime, by our population. And multiply that product by a thousand to get a rate per thousand population. And say okay. And I get another error that's telling me basically that you have some null fields, and I'm not going to be able to calculate these values. Do you want me to go on? Yes, we want it to go on. We know the null fields are in there. So what it does, then, is calculate a 0 for those null fields, which is fine. That's what we expect, and we're going to fix that in just a few minutes.

Elizabeth Groff: So at this point, we could actually look at our map using our new fields. So let's go to properties again. Let's look at our new field, which is all the way at the bottom. We'll keep the same color ramp. And we're going to see a very different picture of violent crime in 2013. So this map is basically showing us a risk map.

Erin Farley: Hey, Liz?

Elizabeth Groff: Yeah?

Erin Farley: Can I jump in with another question?

Elizabeth Groff: Of course.

Erin Farley: So this is just maybe just to highlight an option that people will have available to them. So it looks like you have your data points for each county, whether it's rate of violent crime or this new variable, and what it does is it takes that range and then it divides it by five equal categories, 'cause it looks like it did it for the last variable, and it's doing it for this. And so you can ... Correct me if I'm wrong. Let's say you weren't looking necessarily at ... You actually had a benchmark in mind. So what you could do is actually go in and alter the ranges to look at something specifically. Am I making sense?

Erin Farley: So you can see the range from the lightest to the darkest is probably automatically calculated by ArcGIS, but you can go in and pick and select a specific category or distribution that you want to look at based on some preconceived or some sort of assumption. And, yeah, manually alter the classifications.

Elizabeth Groff: Right, yes. So you can change all these values and everything. Right now, I'm just letting it use its natural breaks, actually, which is ... It's not actually equal, as you can see from the graph.

Erin Farley: Oh, okay, okay.

Elizabeth Groff: But I didn't tell you guys that, Erin. So I have to keep a few things ... No, Erin is exactly right, yes. You can do this all manually too.
Erin Farley: The only reason why I say this is because I was working in ... Gosh, what was it ... map info last year, and this was one of the biggest challenges for me, is realizing that I didn't want the natural breaks, and that I actually wanted to calculate my own based on an important point. So I just wanted to highlight that for people who might be thinking about the same thing, or come across that in the future.

Elizabeth Groff: No, thank you, thank you. That's a great point.

Erin Farley: Thanks, sorry. Okay, I'm done.

Elizabeth Groff: All right. So I wanted to show you a couple things that we need to do to fix up our map, if you will. One thing is, we need to make sure that our counties that have null values don't show up as if they actually have low values, because that's not accurate. So we want to come over here to the classify button that Erin just referred to, except this time, we're going to exclude those three counties, and we're going to use a query to do that. And I'm going to query on the county field in the UCR file, and if I click on get unique values, it reads that field, UCR, the county field. And, is null. All right. Oops. I always close that.

Elizabeth Groff: And then I want to set up my legend so that those three will look different than the other classifications that we actually have data for. And I'm going to label this no data, just to be transparent. Okay, okay. And then the other thing is, there's way too many decimal points here. So we can easily fix that by right clicking on any one of these classes and coming up here to number of significant data decimal places, and pulling that down to just a two. And now it's much cleaner to read, especially when you look over in the table of contents. Oops. That looks different than what I expected.

Elizabeth Groff: So let's undo my exclusion right now. Let's see here. Properties. Oh, here we go. Cancel. That's why it looked different. Here we go. This is the map I was looking for. And you can see now that the three different counties that we have null values for now show up with no data, and it's easy to spot them. And it's easy to read the legend too.

Elizabeth Groff: Okay. So just one last thing that I wanted to show you is we can also look at change over time, and we can do it in a couple of different ways with this data, and that's why wanted to get 2013 data and 2016 data. One way would be to create individual little maps and put them on the same larger map. So two different panels. Another way to do it would be to actually compute a change, a quantitative change, and compute that per thousand population.

Elizabeth Groff: So that would involve, however, adding another field here. So let's add another field and call this one violence change. We're going to have to make that a double again. Now we can ... We're already at the end of the file. We can calculate that, just like we did the last time. But this time, we're looking for our absolute change in violent crime between those two years, dividing it by our
pop. That's the only pop we have. Looking for total pop. 10 times a thousand ... Same error message as we got the last time. And now we have a change in violent crime per 1,000 people.

Elizabeth Groff: So if we go back ... Actually, if we copy this layer, we come up here to layers and we right click on it, we can paste that layer. And notice how it kept our no data, and it kept our number of digits too, decimal places. So now what I'm going to do is come up here and change the way this one is symbolized so that instead of showing the violent crime rate per 1,000, it shows the change in violent crime. Now, because we have negative values up to positive values, we want a different kind of scale. We want a scale that begins with cooler colors and goes to warmer colors. Something like this one. And then the counties that didn't change as much or in the middle, they end up with a yellow color.

Elizabeth Groff: So if we apply that ... And let's ... Yeah. Now we can see a very different kind of pattern emerge. We can see groups of counties where we were seeing violent crime increases that we might want to look further at.

Elizabeth Groff: All right. So let's say ... One last thing. Let's fix our legend here real quick, by going in here and changing, formatting our labels, so we don't have so many decimals. Okay. So the last thing is I just want to show you how to make a map here. And to make a map, we have to go into the layout view. So here, we're going to go to view, and layout view. And, all right. So now you'll notice our layout tools are available to us. So the first thing we want to do when we're making a map is make our map as big as we possibly can to fit it on the sheet, because the map is the main event.

Elizabeth Groff: So we want to make that as big as we can. And then we want to start thinking about ... that people read a map the way they read words on a page. They read left to right, at least in this hemisphere, left to right and top to bottom. So when you're thinking about the things you want to emphasize in your map, you want to try to get the more important things toward the top and toward the left. Now, you're also held hostage by the fact that the shape of whatever it is you're mapping dictates what you can do. So Georgia doesn't really ... The shape does not make it easy to put a legend over here, or really anything. It makes it much easier to put it right here. So that's what we're going to do.

Elizabeth Groff: Okay. You've got five elements that you need to have on any map that you're going to produce. All those elements are here under the insert menu. So you want to insert a title. That might be Change in Violent Crime, 2013-2016. You, of course, would want to think of a more exciting title than that. Sorry. And then you want to insert a legend, and the legend tells people who they should read your map.
So I'm not going to go through all these options. As you can see, there are quite a few of them. I'm just going to go all the way through. We don't need a legend label.

All right. So we've got a problem here. We've got a little overlap going on. So the way to fix that is to change to my pan hand, and pull this down and over a little bit to the left. Okay. Now, I've got an extra ... Move this up just a little bit. All right.

Then we want to have a north arrow. I'm just a big fan of simple things, so I'll just use a simple north arrow. You certainly can use more fancy ones. And we want to have a scale bar. So we want people to understand what the distances are on our map. Okay.

And then finally, we want to insert a little bit of text that explains to the user where these data came from. So we might say something like source, population from 2010 census, and I do the same for the other data. But I'm not going to take the time to type all that in. So then we pull that down here to the very bottom.

All right. So let's see if we can't do something a little bit better with our title for our legend. Let's call this Violent Crime Change. And then let's change our bottom ... just to per 1,000, so we know it's per population.

Hang on one second. Okay. I've got double labels in there. Of course this only happens when you're doing a demo, it doesn't happen the other eight times that I went through the demo. But anyway, you wouldn't want that, and you would take the time. But I don't want to use your time to figure it out.

So at this point, you've got a map. You can look at it in print preview. So, let's see here. You see how it looks. You can, if you like it, you can print it. You can also save it by exporting this map to any kind of file pretty much you can think of. EPS, PNG, bitmap, et cetera. And insert it into a report or some other document, or a PowerPoint.

So just one quick thing then here at the end ... is problem solving. So, of course it's not as easy to do anything as I just presented it to be. So you're going to spend a lot of time, when you use any kind of software, at figuring out your problems, figuring out your challenges. So again, search engines should be your best friend. Entering into a search engine, ArcGIS and some question, even using natural language, gets an amazing number of answers.

You also have a great source from the ArcGIS help pages, and if you're trying to do anything more technical, there's a listserv thing called Stack Exchange where a lot of people exchange challenges and problems they've had, and I've gotten a
lot of good solutions off of that. So don't feel like you're alone out there. There are lots of different mechanisms to get help.

Elizabeth Groff: So, thank you. And I'll take any questions.

Erin Farley: Well, thank you, Liz. Let's see if we have any questions. While we are doing that, we will open the poll for those to complete. If you just take a couple minutes and fill out some answers, we'd appreciate it.

Erin Farley: Let's see. Okay. I don't see any questions popping up right now, but do you have an email address that ... if anybody here has a question, they might be able to follow up with you and ask about further details?

Elizabeth Groff: Of course. It should be in the presentation, sorry about that.

Erin Farley: Oh, great, okay. I probably just overlooked it, thank you.

Elizabeth Groff: Oh, no, you didn't. I don't see it here. I only put up questions. So maybe you can add it into my PowerPoint, but it's groff ... So my last name ... at temple.edu.

Erin Farley: Great.

Elizabeth Groff: Yeah, pretty straightforward.

Erin Farley: Okay, okay, great. Thank you.

Elizabeth Groff: No problem.

Erin Farley: All right. I think that's ...


Erin Farley: Well, it was really hot yesterday. It's a little bit cooler today. So it's definitely ... slightly appreciating it. It's 85 in DC right now.

Elizabeth Groff: Wow.

Erin Farley: So ... it's a little on the warm side. All right. Well, I don't see anybody popping up any chat, but again, we'll provide your email address, just groff@temple.edu, and-