Chapter 01: Getting Started with GIS

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Introduction

The field of **Geographic Information Systems**, or **GIS** as most everyone calls it, has slowly moved from an obscure tool for a few professionals to an almost subconscious part of modern society. Sadly, as important as GIS is, it has never achieved the same recognition as **computer science**, the **Global Positioning System (GPS)**, or any of the other components of which it is comprised. Every student of GIS will have to go through the following scenario at least once when he or she is asked about his or her studies:

> **Interested relative:** So what are you studying in school?
> **GIS Student:** GIS.
> **Interested relative:** Oh, I love GPS! I couldn't get anywhere without it!
> **GIS Student:** Well, no, it's GIS, which can incorporate GPS and a host of other technologies…
> **Interested relative:** I don't get it.
> **GIS Student:** It's like Google Maps. You can ask the computer for directions because it uses a database of road networks and address grids…
> **Interested relative:** Right, GPS, like I said.
> **GIS Student:** (Changing the subject) Um, so what have you been up to Aunt Agnes?

You may be tempted to just tell people that you're a **geographer** thinking that that will give people a better idea. Nope, they will just assume that you have spent your life memorizing countries and their capitals. We can't get no respect, and a lot of that comes from within the discipline itself. We haven't done a good job of explaining ourselves, which is what this introduction will try to rectify.

GIS fits into the broader category of geospatial technologies, which also incorporates remote sensing (things like satellite photos) and GPS. If we breakdown the name itself, we can begin to get an idea as to what it is. **"Geographic"** reveals that we are interested in space and place, or locations of things, which we will explore more in the second chapter. **"Information"** suggests that we are not simply interested in raw data, but in taking it and making something useful. With better information, we can make better decisions. **"Systems"** refers to the fact that we are increasingly connected and utilize multiple technology platforms. So from the name alone, we could infer that GIS is all about gathering information about things or events in space and incorporating it into some sort of workflow or process.

That still may seem a bit abstract, which is probably why many people often equate it to a program like *ArcGIS*, which is the most popular software in the industry (what *Microsoft Office* is to word processing and spreadsheets). GIS is more than this however. One cannot write the

great American novel simply by downloading *Microsoft Word*. GIS is fundamentally a way to visualize and streamline spatial reasoning. To really understand what GIS is and isn't, one must learn to think like a geographer.

Thinking like a geographer

Many geography professors lament the fact that spatial reasoning is ignored in the first twelve years of education. As young students, we are encouraged to perfect our verbal skills through reading comprehension and vocabulary tests. Proficiency in algebra is deemed quite important as well. When students are introduced to critical thinking it is often within a vacuum, but the truth is many of our real problems occur over geographic places or regions. Yet a basic understanding of spatial patterns, issues of scale, or the visual display of information are all ignored until a student gets to college and enrolls in the a geography course. We geography professors then expect students to be able to look a map and derive patterns or solve spatial problems, which of course they struggle with because it was never part of their education.

One of my favorite examples of spatial thinking was published in 2009. John Agnew and Thomas Gillespie of UCLA, along with five undergraduate students, posed the question of finding Osama bin Laden. Remember that in 2009, bin Laden's whereabouts were a mystery. Many Americans simply assumed that he was hiding in a cave somewhere in Afghanistan. Why? Well... because that's just where terrorists hide. But didn't he require a dialysis machine to stay alive? Wouldn't he need electricity of some sort for that? We as a nation never even discussed that; we were mad and vengeful and didn't spend too much time on scientific reasoning. Gillespie and Agnew wanted to fix that. They treated the problem of finding Osama bin Laden as a biogeography problem. Rather than a terrorist they thought of him as a creature rarely spotted in the wild. They assembled the following table of attributes known about the man and then listed what that meant in terms of his "habitat."

Life history characteristics	Physical Structure Attribute
Is 6'4" tall	Tall building
Requires a dialysis machine that uses electricity	Electric grid hookup or generator
Prefers physical protection	Walls over 3 meters high
Enjoys personal privacy	Space between structures
Retains a small number of body guards	More than 3 rooms
Prefers to remain protected from aerial view	Trees for cover when outside

Armed with this knowledge they then used the distance-decay theory which suggests that the likelihood of finding him diminished the further we moved from his last known location, and the theory of island biogeography which suggests that any species is going to have a greater survival rate on a large island compared to a small island (they substituted city for island). They eventually settled on the city of Parachinar, Pakistan just over the border from Afghanistan. Then the students combed through satellite imagery and found three possible structures where bin Laden could be hiding. They all had multiple structures, security walls, and so on, matching the criteria from the above table.

Now this study was published eight years after we lost track of bin Laden and the authors admitted that it was unlikely he was still hiding in this city. Instead, this was an exercise in showing how thinking like a geographer could have been very useful as opposed to just sending bombs into caves because we "had a feeling" that that was where he was. When the study was published, we still had no idea where he was and the Department of Defense laughed it off and assured us that they had their own intelligent methods to find him. Soon after the publication the US launched some drone strikes in the region around Parachinar leading many to wonder if it was related. This also should make us think about the moral ramifications of our work.

One of the things I love about this study is how relatively simple it was from a technology standpoint. These researchers did not have access to highly classified data. They used public domain satellite imagery and geographic theory while the US government was utilizing state of the art equipment and a literal army of people looking for the man. Good geographic research can be done cheaply if you know what you're doing.

As we know now, Osama bin Laden was in fact found a few years later in May of 2011 in Abbottabad, Pakistan. It was a large city, and he was found in a compound that matched the UCLA description perfectly. While movies like *Zero Dark Thirty* give the credit to the CIA and "enhanced interrogation" in finding the man, one must wonder if the rational thinking of these UCLA geographers played a role in finding him. As a geographer, and a Bruin, I myself think the study helped.

Implementation
The above example was the work of some smart folks who have studied geography for quite some time. You may wonder how you can begin to do this same kind of work if you're simply starting out in learning geospatial technologies. Chances are that you have already thought spatially many times before, but didn't pay much attention to it. Have you ever questioned Google's directions? Have you ever rearranged furniture in your bedroom? To truly think spatially is to simply ask how geography influences things, whether it is how to get from Point A to Point B or where your bed should be situated in your room. We think spatially all of the time, but we never question it. Part of learning GIS is to view our problem solving skills a little differently. CSUN geography Steve Graves refers to his students as "Jedis" in that they can "use the force" to understand the world in ways common folk cannot. Stick with GIS and you'll be a Jedi in no time…

To really think spatially from a GIS perspective, you should follow these four steps:

The Steps to "Doing" GIS
1. Observe a problem, ask a question
2. Envision the workflow
3. Gather the data
4. Turn the data into information

1. Observe a problem, ask a question

When we want to solve such a question, we can work **deductively** or **inductively**. To think deductively, we use known ideas to solve local, unknown questions. For example, we use deductive reasoning when solving a crime. When a dead body is found, detectives can use their knowledge of how bodies deteriorate, marks left by various weapons, and so on to understand what happened in this particular crime. They solve unknown problems using prior knowledge.

Inductive reasoning works the other way. Sometimes we don't have knowledge that explains an event or thing, so we test it to eventually work toward developing a theory that can later be used for deductive reasoning. This type of reasoning uses the scientific method to ensure that the mysterious event or thing is properly understood.

Let's use the example of starting a new business. It may not seem like a "problem" but imagine you want to go into business for yourself yet are worried about your success. So you ask a question: *Where is the best location for a new bicycle shop?* The question is spatial in that the answer will be a location somewhere on the Earth. This is a perfect thing for GIS to help us find.

Before you move on, answer the following question: *What type of reasoning do we need to employ and why?* **Write the answer in the space below.**

Envision the workflow

Regardless of approach, after you have asked your spatial question, you need to begin thinking about the data you need, followed by your workflow. Using our example from above, we need to think of the things that would be important for a bicycle shop's success. Creating a small business requires a lot of time and money so we don't want to randomly place it anywhere in a city. So what does a business like ours require to be successful? At this point in our process you don't need to be at the computer. Often the best work comes with a pen and paper or by using a white board. Simply list out the kinds of things you need to think about to make sure your business is successful. **Add to the list below:**

Important data	Reason
Customers	We want to know where are potential customers are and be located near them
Proximity to bicycle lanes, trails	Make it easy for cyclists to get to the shop, also easy to lead group rides from it
Removed from competition	We don't want to place our shop too close to other bicycle shops. We should target an underserved location

Gather the data

We know what we want to do, so now we need to gather the data to make our GIS project a reality. Data can come from a variety of sources and can be available in very useable formats or quite difficult with which to work. Chapter 04 will go in depth into the different ways to gather data and how to figure out if your datasets are really good to use or not. The main thing to realize at this point is that no matter how clever your GIS project may be, it won't become a reality without good data. This may mean you need to go out into the field, maybe to Google, or maybe to a dusty file cabinet in the basement of a government building.

For our example of the new bike shop, we can look at our above list and start to think about where we would find such data. The customer data may be tricky to find, but we could contact a local cycling club to see if it was okay to survey their members. This doesn't require fancy GPS equipment, just a notepad and pen or an online survey form. Bike lanes and trails could already exist at the local planning or public works department. Many share these files online, or are

willing to email them to the public. The data for existing bike shops can be found by simply going online and searching local bike shop addresses and entering them into a spreadsheet.

Using your other needed data from the table above, write out where you may find it below. Don't worry about actually finding it yet, just list the possible source of the data.

Important data	Possible Source
Customers	Cycling club surveys
Proximity to bicycle lanes, trails	Local planning or public works department
Removed from competition	Google search of existing businesses

Turn the data into information
Once you have gathered your data, the next step is to take it and turn it into information. This may sound like the same thing, but there are very important differences. Data are numbers or words. They may be a count of something or a list of names, but data don't really tell us anything. Information gives us answers. It is the result of taking the data and making sense of it. This is also what makes a GIS professional a truly important individual in a business or agency. Companies and governments have all sorts of data, perhaps zip codes of customers or fire station addresses. The GIS professional takes that data and makes it valuable. What is the spatial distribution of those customers? Are more of them in the current store's zip code or are they traveling a long distance to shop there? Are the fire stations properly distributed across the city? What are the response times?

For our bike shop, we need to take those potential customers and see how close they are to the competition. We need to look at the existing bike friendly infrastructure and see if it is concentrated on one side of town or evenly distributed. These are the skills you will learn as you work through this book. The best part is that they often take minimal effort to do. For example, we can generate a **raster surface** (a term we will explore later) to show the density of bike lanes and trails in a city. This process takes a few mouse clicks and you get an impressive map as a result. The real skill comes in knowing if a density surface is truly the best way to create information or if perhaps another tool would do the job better.

Software

In most GIS classes, students are exposed to *ESRI's* suite of software. ESRI is the leading company in producing powerful applications for GIS. It might help to think of them as the *Microsoft* of the geospatial industry. ESRI used to stand for *Environmental Systems Research Institute*, but they haven't gone by that name in a long time. So we just call them ESRI. They also get mad when you sound out their name, i.e. *Ezree*. They want you to say *Eee-Ess-Are-Eye*. That said, most of us say it like *Ezree* just to mess with them.

ArcGIS is the primary product from ESRI. You can purchase one of three "levels" of the software. Each level has a different amount of tools available to the user, and as you can imagine, to get more cool stuff you need to pay more money. Previous versions of the software used the terms *ArcView, ArcEdit,* and *ArcInfo* to differentiate between the cheapest, medium-range, and most expensive versions, respectively. Starting with ArcGIS 10.2, they have switched to the terms *Basic, Standard,* and *Advanced* to convey the same idea.

Regardless of level of the software, ArcGIS is made up of several different programs. *ArcMap* is where you will do most of your work and you will see it in most of the exercises that follow. *ArcCatalog* used to be a standalone program, but is now embedded into ArcMap. It is like Windows Explorer, but it is designed to work better with GIS data (although it has its own issues as you will learn). *ArcToolbox* is another program that is now embedded into ArcMap. This is where you will find the cool stuff to manipulate GIS data and conduct the necessary work to produce answers for your spatial questions.

Summary

GIS is an important field that few people seem to know exists. Even those who are aware of it don't fully grasp what it truly is. It is more than just making maps of the world and generating atlases. We can conduct research for something as exciting as tracking down terrorists or as simple as finding a location for a new business. Either way, we need to think like geographers in doing so and then use our GIS tools to make our research into something useful.

References

Gillespie, T. W., J. Agnew, E. Mariano, S. Mossler, N. Jones, M. Braughton, and J. Gonzalez. Finding Osama bin Laden: An Application of Biogeographic Theories and Satellite Imagery. *MIT International Review.* Web-published essay installment for 17 February 2009. Accessed at: http://web.mit.edu/mitir/2009/online/finding-bin-laden.pdf

Graves, S. 2014. Geography as a "Jedi" discipline. *The California Geographer.* 53(1). p. 21-29. Accessed at: http://scholarworks.csun.edu/handle/10211.3/120358