# What is GIS?

ISTC Topic: 1.1

## In this Chapter you will learn

- Various Definitions for GIS
- About the main components of a GIS
- Who some of the main GIS users are

## 1.1 The Definition of GIS

Ask someone what a **Geographic Information System**, or GIS for short, is and they will most likely come up with definitions like

- "Maps on the computer"
- "A computerized tool for solving geographic problems"
- "A database with spatial features"

None of those definitions are wrong; however none of them describe *everything* about a GIS. Yes, a GIS can quickly and easily display maps on a computer either inside the GIS program, or when served to an internet site. Yes, a GIS is a database – it stores data just like an Excel Spreadsheet or a Microsoft Access database, except that a GIS also stores the *location* for all the data. And yes, a GIS does have a wealth of tools that allow you to quickly solve geographic problems such as "how many parcels, greater than 5 acres, can I find within 300 feet of a canal".

The "G" in GIS stands for **Geographic** which refers to the Earth. This means that data inside a GIS is **georeferenced**, or tied to a specific location on Earth. Figure 1.1 shows two possible ways in which data can be georeferenced.

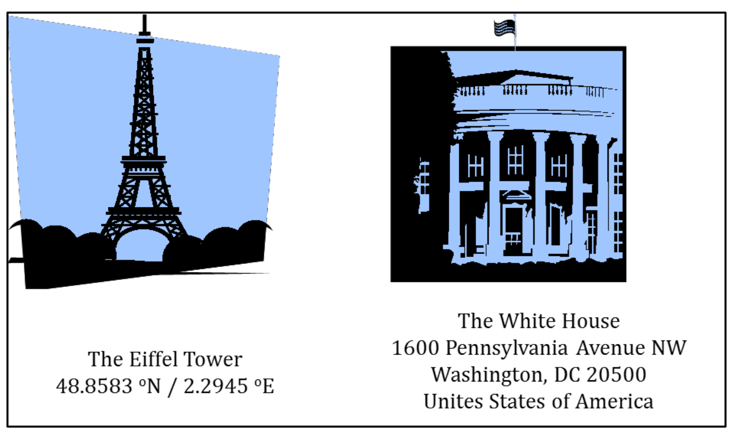
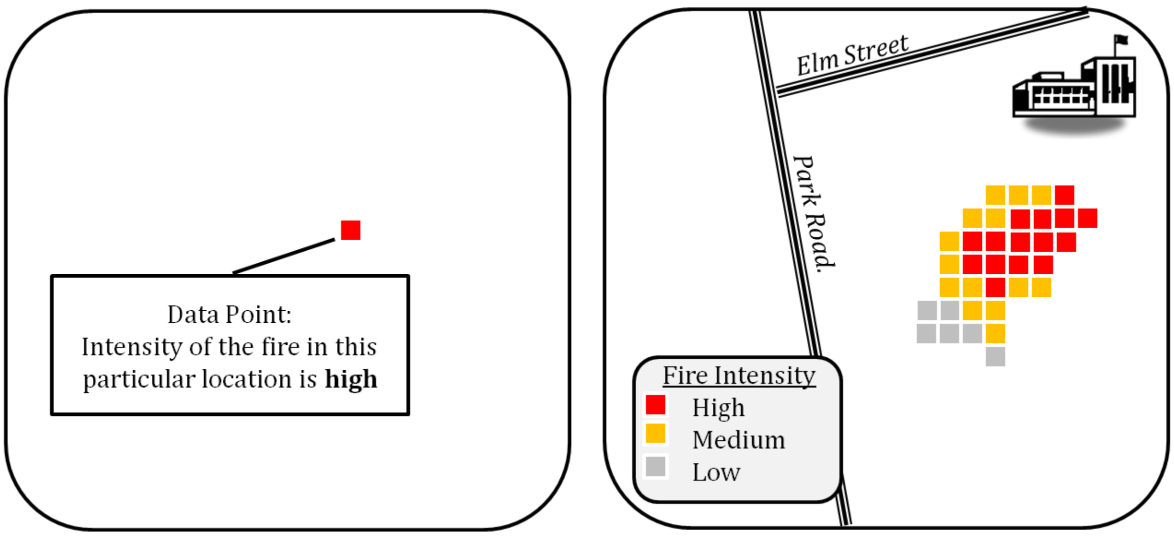



*Figure 1.1. Two possible ways to georeference a location on Earth. The Eiffel Tower is georeferenced by its latitude and longitude coordinates while the White House is georeferenced by a unique address.*

While most data used inside a GIS is indeed geographic, some people do use GIS to make maps of other planets or parts of the human body.

The "I" in GIS stands for "Information". We already defined GIS as a spatial <u>data</u>base. **Data** is raw information that does not have a context. For example a data point could be the identification number, owner name and location of one parcel. **Information** is processed data. For example, by showing all the parcels on a map in relation to each other and to features like roads, canals and schools, data becomes information. A GIS is an ideal tool to transform raw data points into useful information. An example of the difference between data and information is provided in figure 1.2.




A. One data point, showing the intensity of a fire, by itself provides very little information

B. The same single data point combined with other fire data points shows that this fire is moving in a NE direction. By adding information about roads users can orient themselves and get to the fire. By adding schools and other buildings emergency personnel know who needs to be evacuated. We have turned data into information.

*Figure 1.2. The difference between data (Figure A) and information (Figure B).*

## 1.2 Components of a GIS

The six main components of a GIS are illustrated in figure 1.3.

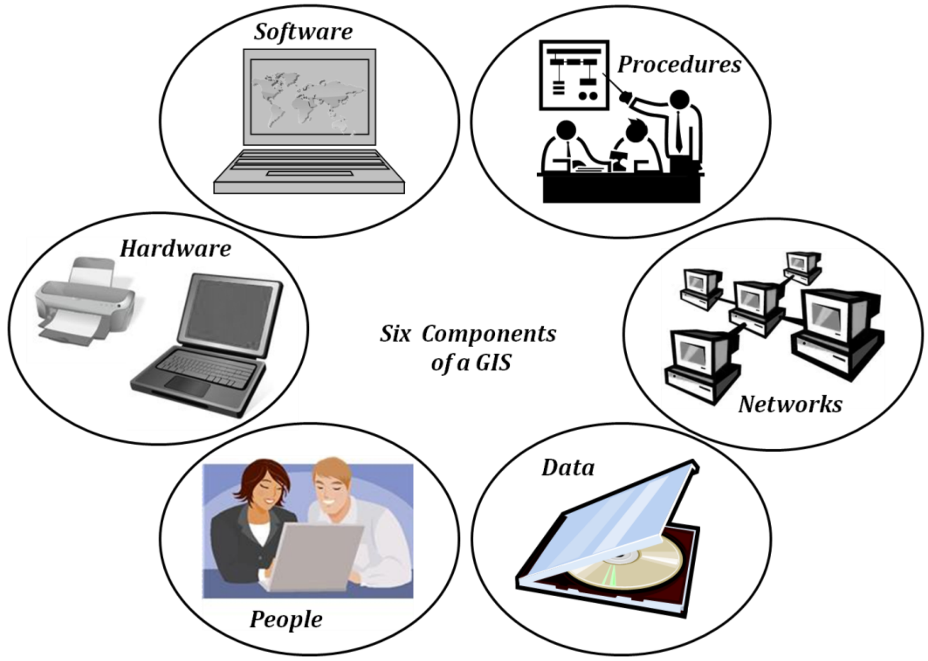



*Figure 1.3. The six components of a GIS*

1. **Hardware** includes the computers that run GIS software, scanners that can be used to bring information currently on a paper map into a GIS. Printers and plotters print maps and other information. Hardware also includes all the components necessary to connect a GIS to the internet.

2. **GIS Software** such as ArcGIS, ArcGIS Server and GeoMedia. In the future GIS users may choose to use ESRI's software services on the cloud. In that case a user does not need to install GIS software, but instead log in to a remote computer that has the software already on it. The **cloud** refers to remote servers and remote computers, for example hosted by Amazon or Google that a user can log into remotely and operate it almost as if it were their own computer. To run a GIS you would also need other software such as an operating system and software to browse the internet.

3. **Procedures** are needed to establish workflows. For example, an assessor's office will have a workflow for processing deeds starting from when the deed arrives, all the way through its processing cycle. Procedures establish how data enters the GIS, how GIS data is manipulated, and who is responsible for each step along the way. If procedures are followed consistently, than the quality of the GIS data will also be predictable and consistent. Procedures can also establish workflows to ensure **QA/QC** (Quality Assurance and Quality Control) of the GIS data. For example, checks can be put in place to make sure that roads in a GIS layer are connected to each other so that when someone needs to figure out how long it takes to traverse along this road network, the analyses actually works.

4. **Networks** are now a crucial part of a GIS. About 3-6 years ago many GIS folks would store their GIS data and applications on their own computer hard drives. Data was most frequently shared by mailing CD and DVD's to each other and all GIS software applications were installed on their local machines. Since then the GIS world has changed a lot, and is still changing at a fast rate. A

wealth of information is shared online and available through the World Wide Web. Most agencies with multiple GIS users have set up networks so that all users can access the same databases, or share GIS software licenses. A new trend towards "cloud computing" shifts software, data and GIS services to remote sites (for example to clouds managed by Google or Amazon) and at some point a GIS user may simply only need a monitor, an internet connection and a browser to be able to do all their GIS work remotely.

5. **Data** can either be spatial (for example the location of all the roads, canals and bridges in a county) or non-spatial (for example a tables that show lists of Parcel ID numbers with their assessed values). A wealth of data is available on the internet and most agencies also create new data. A good rule of thumb is to not pay for GIS data until you are absolutely sure this same data cannot be obtained for free from a different website.

6. **People**. While a GIS system cannot operate without any of its six components, the most important component are people. This does not only apply to the people who design computers, establish network capabilities and program GIS software, it also applies to people like you, the GIS users. GIS users decide which problems need to be solved, and how GIS can help solve them. GIS users operate the GIS software and collect and manipulate data. The concept of **GIGO** applies here, which stands for **Garbage In Garbage Out**. For example, if the wrong goals are set for a GIS project, the result may be a gorgeous map, but does not address the goals that should have been set. If people create data that is of poor quality, then all the analyses based on this data will also be poor.

## 1.3 GIS Models our World

Just like clay can be used to sculpture a model of a person, and plastic can be used to model a 1:48 scale representation of a WWII aircraft, so does GIS model things in our world. A GIS mostly model the world with points, lines and polygons as illustrated in figure 1.4.

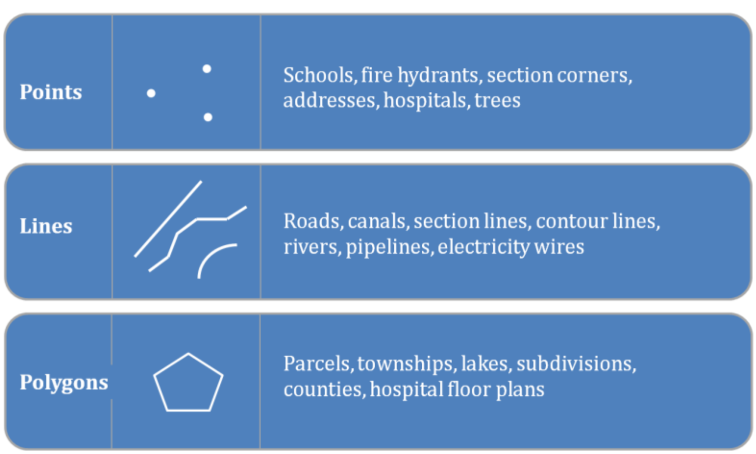



*Figure 1.4. Points, lines and polygons can be used in a GIS to model our world.*

While a GIS typically models a tree as a point, it is always good to keep in mind that a tree in the real world is more than a point. It has a canopy, a root system and it interacts with its environment. Similarly, a river is not a line. Perhaps it looks like a thin line when you are flying over it, but up close it has a definite width that probably varies along the length of the river and changes over time. The point is that a GIS is a simplified model of the real world.

There are no rules that state, for example, whether a river needs to be represented by a line, which is only 1D ("one dimensional") or a polygon which is 2D, or even a photograph of the river. Similarly in figure 1.4 you can see that hospitals are both listed under points *and* polygons. Choosing which geometry type to use depends on the data available to you and the purpose of your GIS project. For example, do you need to show a road map with the shortest distances to a hospital (a point at the front door of the hospital will suffice), or a map showing evacuation routes inside a hospital (where a polygon showing the floor plan would be more appropriate).

Points, lines (also referred to as **polylines**) and polygons model the world as a mostly empty space, except for those areas where a school, parcel, street, *etc*. exists.

Some things, however, exist everywhere. For example, every location has an elevation, a soil type or a temperature. Things that occur *everywhere* are typically modeled with **rasters**. A common type of raster is an aerial photograph. As illustrated in figure 1.5 a rasters is made up from pixels, which are called **cells** in GIS. The individual cells are clearly visible in figure 1.5.D below.


*Figure 1.5. This raster displays an aerial image. The area in the black box in figure A is enlarged in figure B. The black box in figure B is enlarged in figure C. The black box in figure C is enlarged in figure D. One cell is labeled in figure D.*

## 1.4 GIS Users

The number of GIS users has grown dramatically. For example, only 15 people attended the ESRI International Users Conference in 1981. By 2008 this number exceeded 14,000 attendees. Off course, people that attend the conference are only a small portion of the hundreds of thousands of people that use GIS world-wide.

GIS is used at all levels of government. For example, on the federal level the Bureau of Homeland Security maps potential risks and hazards, FEMA uses it to produce flood maps, the Census Bureau uses it to plan and map census results and the USGS produces topographical maps. Many state agencies in Idaho use GIS. For example, Water Resources uses GIS to view and analyze water rights and water use in Idaho, the Department of Lands uses it to manage their endowment lands and the Tax Commission uses GIS to manage Tax Code Areas. Cities need GIS to display their infrastructure, manage their assets such as water and sewer lines, parks and tree inventories as well as model different planning scenarios and present those cartographically to the public during public meetings and hearings. Counties use GIS to manage their parcels, support E911 operations, mosquito abatement and elections. Note that this list in just a small sample of the many things counties and other government agencies can do with their GIS. An example of a different county GIS-application is provided in figure 1.6.

Many businesses, such as insurance companies, the media and real estate companies use GIS. Utilities and Communications organizations use it to manage, model and plan their assets. GIS also plays an important role in Defense, Education, Public Safety, Transportation and the management of Natural Resources. A comprehensive list of GIS users linked to case studies showing how they use GIS can be found on http://www.esri.com/industries.html.

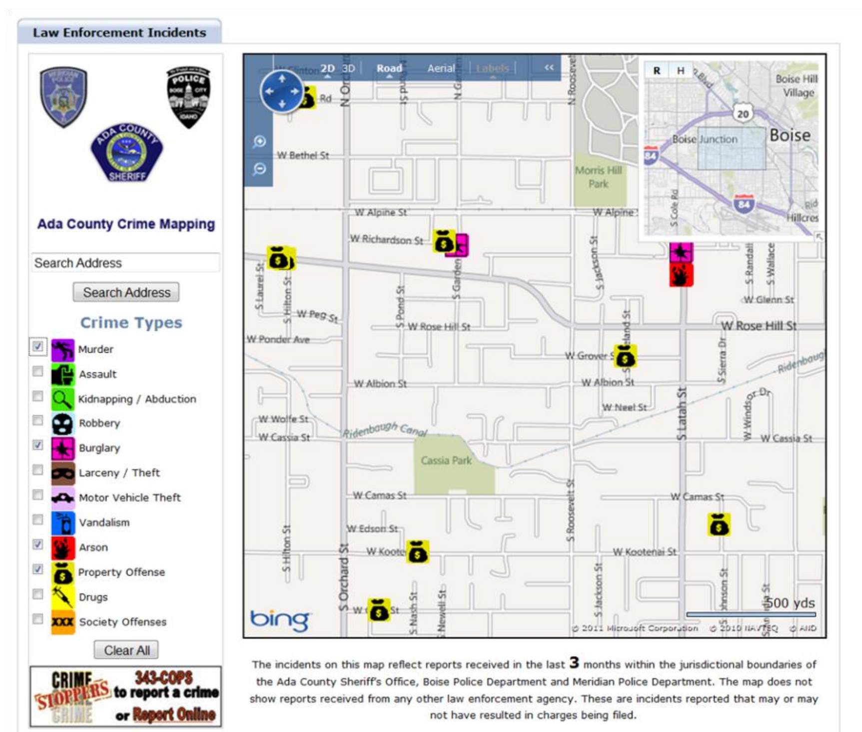



*Figure 1.6. Ada County uses GIS to map their crime statistics and share this information with the public.*

Everything that happens happens somewhere. Knowing *where* something happens can be critically important