What is Geographic Information Systems (GIS)?

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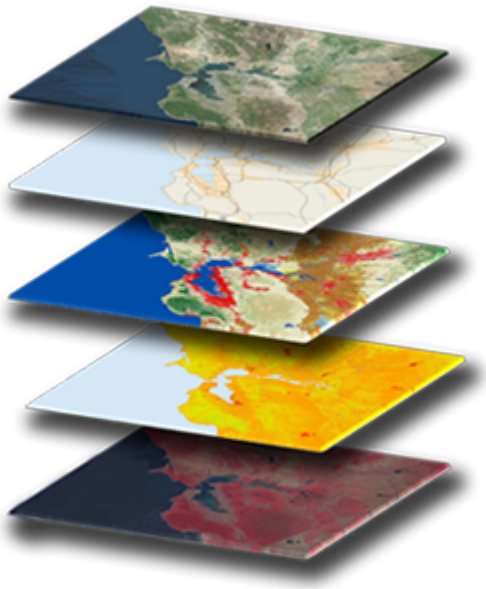
What is Geographic Information Systems (GIS)?

Geographic Information Systems (GIS) store, analyze and visualize data for geographic positions on Earth's surface. GIS is a computer-based tool that examines spatial relationships, patterns and trends. By connecting geography with data, GIS better understands data using a geographic context.

The 4 main ideas of Geographic Information Systems (GIS) are:

- **Create** geographic data.
- **Manage** it in a database.
- **Analyze** and find patterns.
- **Visualize** it on a map.



Because viewing and analyzing data on maps impacts our understanding of data, we can make better decisions using GIS. It helps us understand **what** is **where**. Analysis becomes simple. Answers become clear.

Every day, GIS powers **millions of decisions** around world. It makes a big impact in our life and you might not even realize. For example, we use GIS for:

- Pinpointing new store locations
- Reporting power outages
- Analyzing crime patterns
- Routing in car navigation
- Forecasting and predicting weather

> Because you don't fully understand your data until you see how it relates to other things in a geographic context.

Visualize Data by Making Spreadsheets Come to Life

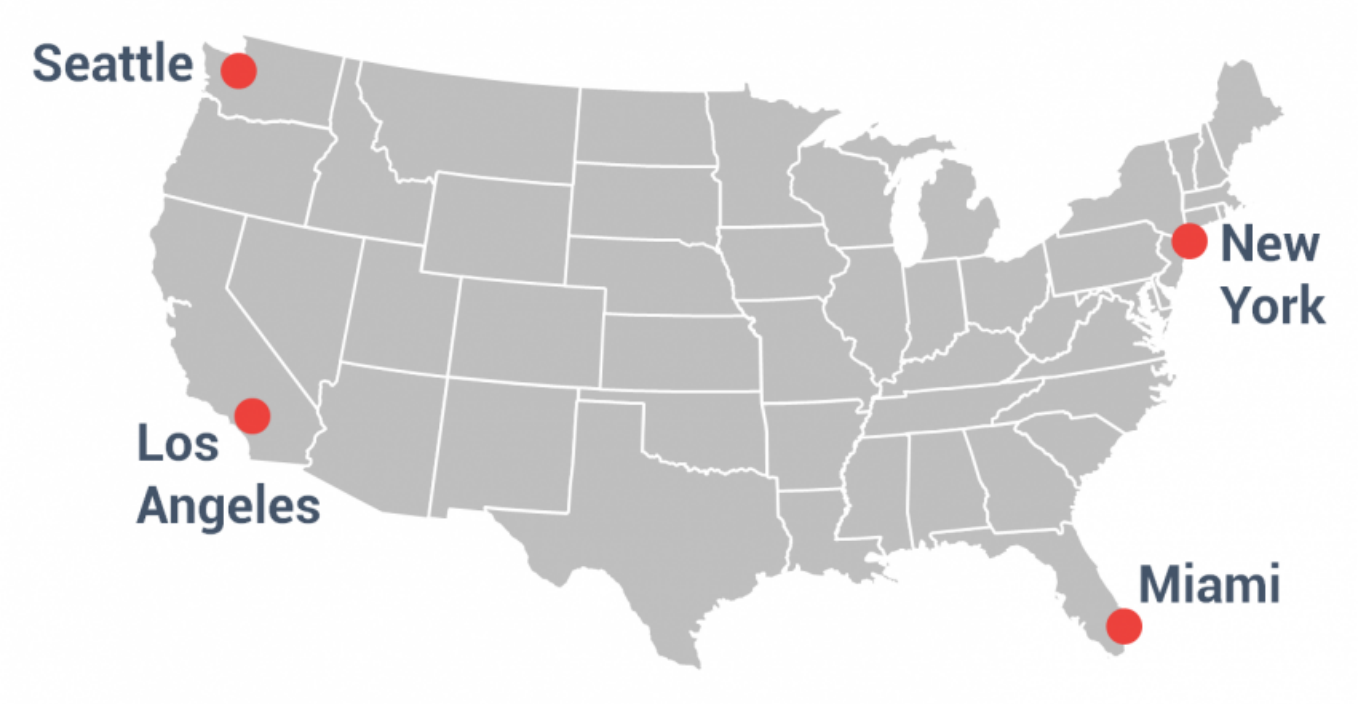
I think you'll agree:

It's REALLY hard to visualize **latitudes and longitudes coordinates** from a spreadsheet.

City	Latitude	Longitude
Seattle	47.5°	-122.3°
New York	40.7	-73.9°
Miami	25.8°	-80.2°

Los Angeles	33.9°	-118.2°

But when you add these positions on a map, it's like magic to the reader.



That's because maps make geographic information easier to understand. When you have geographic context, you don't only see where they are in a map. But you can:

- Calculate how far points are from each other
- Check if points are clustered for patterns and trends
- Find the optimal route between cities

Components of Geographic Information Systems

The 3 main components of Geographic Information Systems are:

1. HARDWARE: Hardware runs GIS software. It could be anything from powerful servers, mobile phones or a personal **GIS workstation**. The CPU is your workhorse and data processing is the name of the game. Dual monitors, extra storage and crisp graphic processing cards are must-haves too in GIS.

2. SOFTWARE: **ArcGIS and QGIS** are the leaders in **GIS software**. GIS software specialize in spatial analysis by using math in maps. It blends geography with

modern technology to measure, quantify and understand our world.

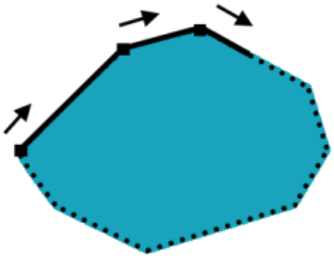
3. DATA: GIS stores location data as **thematic layers**. Each data set has an attribute table that stores information about the feature. The two main types of GIS data are **raster and vecto**r:

RASTER

Raster look like grids because they store data in rows and columns. They can be discrete or continuous. For example, land cover, temperature data and imagery are often represented as raster data.

VECTOR

Vectors are points, lines and polygons with vertices. For example, fire hydrants, contours and administrative boundaries are often vectors.



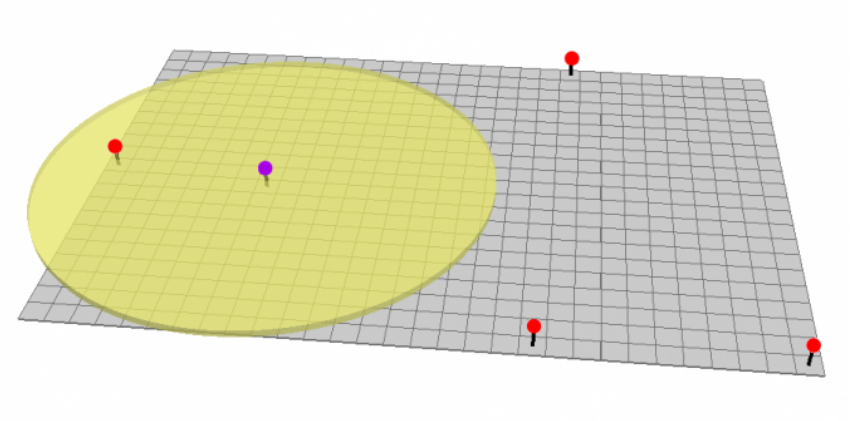
Drive Decisions with Spatial Analysis

Never before have we had more pressing issues in need of a geospatial perspective. For example, **climate change**, natural disasters and population are all geographic in nature. These global issues need location-based knowledge that can only come from a GIS.

Most people think GIS is only about “making maps”. But we harness the power of GIS because of the insights of **spatial analysis**. We use spatial analysis through math in maps. Spatial analysis is difficult with paper maps so that’s why we need GIS. Here are examples of spatial analysis:

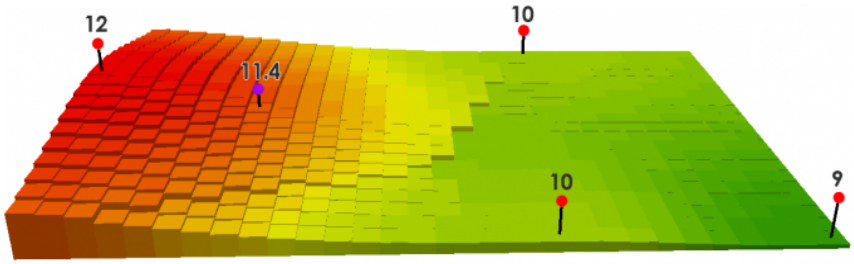
BUFFER:

The **buffer tool** generates a polygon around features at a set distance. By creating buffers, you can find the surrounding features that are within buffers.



HOT SPOT:

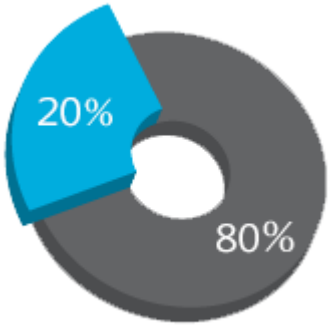
Hot spots highlights areas that have clusters of points. Whereas cold spots have a small density of points.



Build Your Career in Geomatics

> 80% of the informational needs of local government are related to geographic location.

This quote means that if you take 80% of all government data, 80% has a geographic context. This quote originated from Robert Williams in his paper “Selling a geographical information system to government policy makers.”[1]



But recently, researchers have **cut this percent to 60%** in 2012.[2] Either way, geography is a big component of data.

From planning a pipeline to navigating ships, spatial problems need spatial thinkers. This is why Geographic Information Systems has expanded into countless disciplines. GIS careers are booming for:

- **CARTOGRAPHERS** create maps. In fact, the origin of **"cartographer"** comes from charta which means "tablet or leaf of paper" and graph "to draw"
- **DATABASE MANAGERS** store and extract information from structured sets into **spatial databases**.
- **PROGRAMMERS** write code and automate redundant GIS processes. For example, **GIS programming** languages includes Python, SQL, C++, Visual Basic and JavaScript.
- **REMOTE SENSING SPECIALISTS** use aerial, **satellite imagery** and **remote sensing software**.
- **SPATIAL ANALYSTS** use **geoprocessing tools** to manipulate, extract, locate and analyze geographic data.
- **LAND SURVEYORS** measure the 3-dimensional coordinates on the land.

READ MORE: **GIS Salary Expectations: Climb the GIS Career Ladder**

GIS All Started by Mapping Cholera

In 1854, cholera hit the city of London, England. No one knew where the disease started. So, British physician John Snow started mapping the outbreak. It wasn't just the disease. But he also mapped out roads, property boundaries and water lines.

When he added these features to a map, something interesting happened. He noticed that cholera cases were only along one water line. This was a major breakthrough that connected geography to public health safety. But it wasn't only the beginning of spatial analysis. It also marked the start epidemiology, the study of the spread of disease.

In 1968, a man by the name of Roger Tomlinson started piecing together modern computing with maps. In fact, he first coined the term "GIS" in his paper "**A Geographic Information System for Regional Planning**".[3] At this moment, GIS truly

became a computer-based tool for storing map data. In 2014, Roger Tomlinson later passed away and will always be remembered as the “father of GIS”.

READ MORE: **The Remarkable History of GIS**

Great discoveries and improvements invariably involve the cooperation of many minds. I may be given credit for having blaze the trail of GIS. But when I look at the subsequent development, I feel the credit is due to others rather than just myself.
-Roger Tomlinson

GIS Uses and Applications

Geographic Information Systems is jam-packed with example use cases. For example, we’ve found over **1000 GIS uses and applications**. Here are some examples below.

ENVIRONMENT: By far, the heaviest users are for the environment. For example, conservationists use GIS for climate change, groundwater studies and impact assessments.

MILITARY AND DEFENSE: Military are heavy users for GIS. They use it for location intelligence, logistics management and **spy satellites**.

AGRICULTURE: Farmers use it for precision farming, **soil mapping** and crop productivity.

FORESTRY: Foresters manage timber, **track deforestation** and inventory forest stands with GIS.

BUSINESS: More on the business side of things, GIS is for **site selection**, consumer profiling and customer prospecting.

REAL ESTATE: Examples in real estate include market analysis, home valuations and zoning.

PUBLIC SAFETY: GIS shows the **spread of disease**, disaster response and public health.

What Can GIS Do For You?

Geographic Information Systems better answer questions about location, patterns and trends. For example:

1. Where are land features found? If you need to find the closest gas station, GIS can show you the way. GIS can find optimal location by connecting traffic volumes, zoning information and demographics.

2. What geographical patterns exist? In conservation, we want to know animal habitat using GPS collars and **land cover**. By knowing animal

locations, we can correlate preferred land types with GPS locations. In the end, we have a massive database with all types of species of animals.

3. What changes have occurred over a given period of time? Time is the missing element to study change. For example, we understand change through **remote sensing of the environment**. Also, we better predict disasters by finding change over time.

4. What are the spatial implications? If a company wants to build a new project, GIS excels in storing environment data. Most environmental assessments use GIS to understand impact of projects in the landscape.

What is Geographic Information Science (GISc)?

How will GIS grow in upcoming years? This is a question that is Geographic Information Science understands best.

Geographic Information Science provides all the **building blocks** for Geographic Information Systems. It draws from computer science, mathematics, geography, statistics, cartography, and **geodesy**.

While Geographic Information Systems

GIScience incorporates the knowledge from these fields into Geographical Information Systems.

- Geographic Information Systems connects ***what*** with the ***where***.
- Geographic Information Science discovers ***how***.

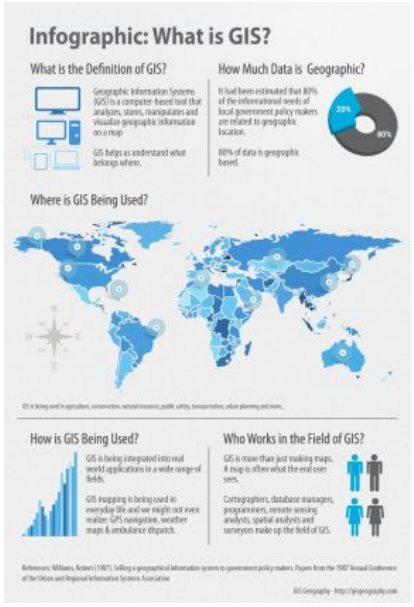
answers “what” and “where”, Geographic Information Science (GIScience) is concerned with the “how” and its development.

Summary: What is Geographic Information Systems?

You might ask yourself: Haven’t geographers been answering these questions for centuries? Yes, they have. But geographers can answer these questions much better with Geographic Information Systems.

When we first started recording inventories on paper maps, it was quite a tedious process. But what did we really need? We needed a GIS to record and store observations. Also, we needed a **table to store attributes** about the data.

What’s the bottom line? Geographic information systems (GIS) let us interpret data understanding relationships, patterns, and trends. Then, viewing and analyzing data geographically impacts our understanding of the world we live in.



Click to enlarge infographic

- **What is Geofencing?**
- **What is Remote Sensing? The Definitive Guide**
- **What is the Difference Between Geomatics and GIS?**

References:

1. Williams, Robert (1987), Selling a geographical information system to government policy makers. Papers from the 1987 Annual Conference of the Urban and Regional Information Systems Association.

2. Stefan Hahmann & Dirk Burghardt. How much information is geospatially referenced? Networks and cognition (Pages 1171-1189). Received 27 Jun 2012, Accepted 21 Oct 2012, Published online: 23 Nov 2012.

3. R. F. Tomlinson. A Geographic Information System for Regional Planning. Department of Forestry and Rural Development. Government of Canada, Published 1969.