

Vector vs Raster: What's the Difference Between GIS Spatial Data Types?



By: GIS Geography · Last Updated: July 3, 2020

What GIS data types exist?

Spatial data observations focus on locations.

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Every house, every tree, every city has its own unique **latitude and longitude coordinates**.

The two primary types of spatial data are **vector and raster data** in GIS. But what is the difference between raster and vector data?

When should we use raster and when should we use vector? Find out more on the spatial data models commonly used.

Vectors models are points, lines and polygons

Vector data is **not** made up of a grid of pixels. Instead, vector graphics are comprised of **vertices and paths**.

The three basic symbol types for vector data are points, lines and polygons (areas). Because cartographers use these symbols to represent real-world features in maps, they often have to decide based on the **level of detail** in the map.

POINTS are XY coordinates

Vector points are simply XY coordinates. Generally, they are a latitude and longitude with a **spatial reference frame**.

When features are too small to be represented as polygons, points are used. For example, you can't see city boundary lines at a global scale. In this case, maps often use points to display cities.



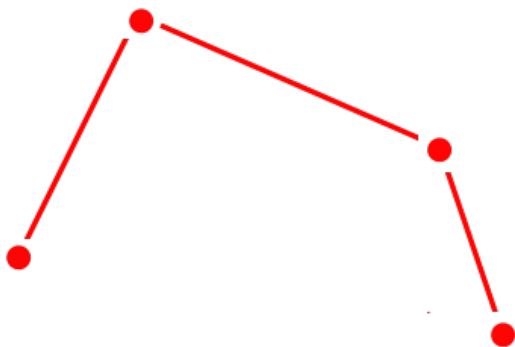
LINES connect vertices

Vector lines connect each vertex with paths. Basically, you're connecting the dots in a set order and it becomes a **vector line** with each dot representing a vertex.

Lines usually represent features that are linear in nature. For example, maps show rivers, roads and pipelines as vector lines. Often, busier highways have thicker lines than an abandoned road.

On the other hand, networks are line data sets but they are often considered to be different. This is because linear networks are **topologically connected elements**. They consist of junctions and turns with connectivity.

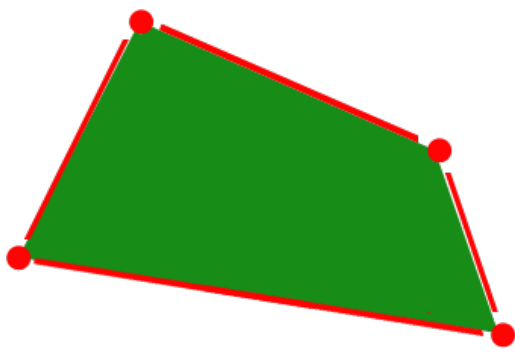
If you were to find an optimal route using a traffic line network, it would follow set rules. For example, it can restrict turns and movement on one-way streets.



POLYGONS connect vertices and closes the path

When you join a set of vertices in a particular order and close it, this is now a **vector polygon** feature. In order to create a polygon, the first and last coordinate pair are the same.

Cartographers use polygons to show boundaries and they all have an area. For example, a building footprint has a square footage and agricultural fields have acreage.



Raster Types: Discrete vs Continuous

Raster data is made up of pixels (also referred to as grid cells). They are usually regularly-spaced and square but they don't have to be. Rasters often look pixelated because each pixel has its own value or class.

For example:

Each pixel value in a **satellite image** has a red, green and blue value. Alternatively, each value in an elevation map represents a specific height. It could represent anything from rainfall to **land cover**.

Raster models are useful for storing data that varies continuously. For example, **elevation surfaces**, temperature and lead contamination.



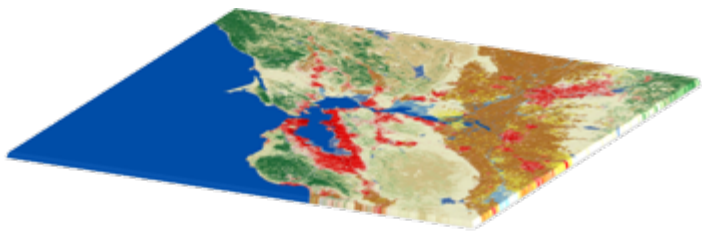
Raster data models consist of 2 categories – discrete and continuous.

DISCRETE RASTERS have distinct values

Discrete rasters have distinct themes or categories. For example, one grid cell represents a land cover class or a soil type.

In a discrete raster **land cover/use map**, you can distinguish each thematic class. Each class can be discretely defined where it begins and ends. In other words, each land cover cell is definable and it fills the entire area of the cell.

Discrete data usually consists of integers to represent classes. For example, the value 1 might represent urban areas, the value 2 represents forest and so on.



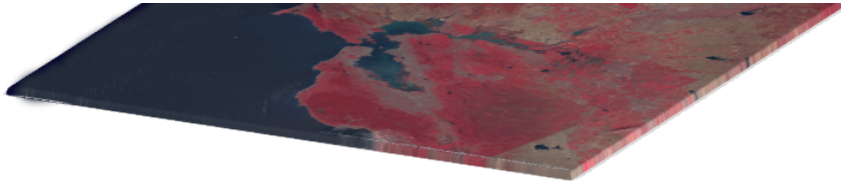
CONTINUOUS RASTERS have gradual change

Continuous rasters (non-discrete) are grid cells with gradual changing data such as elevation, temperature or an aerial photograph.

A continuous raster surface can be derived from a **fixed registration point**. For example, digital elevation models use sea level as a registration point. Each cell represents a value above or below sea level. As another example, **aspect cell values** have fixed directions such as north, east, south or west.

Phenomena can gradually vary along a continuous raster from a **specific source**. In a raster depicting an oil spill, it can show how the fluid moves from high concentration to low concentration. At the source of the oil spill, concentration is higher and diffuses outwards with diminishing values as a function of distance.





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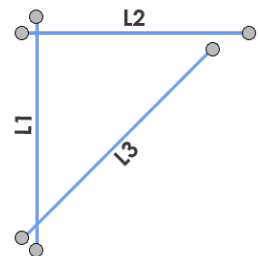
Vector data advantages and disadvantages

What are advantages of using vector data?

Because vector data have vertices and paths, this means that the graphical output is generally more aesthetically-pleasing. Furthermore, it gives higher geographic accuracy because data isn't dependent on grid size.

Topology rules can help data integrity with vector data models. Not only that, network analysis and proximity operations use vector data structures.

Did you know?



Spaghetti Data Model

The **spaghetti data model** was one of the first conceptual models to

What are disadvantages of using vector data?

Continuous data is poorly stored and displayed as vectors. In order to display continuous data as a vector, it would require substantial generalization.

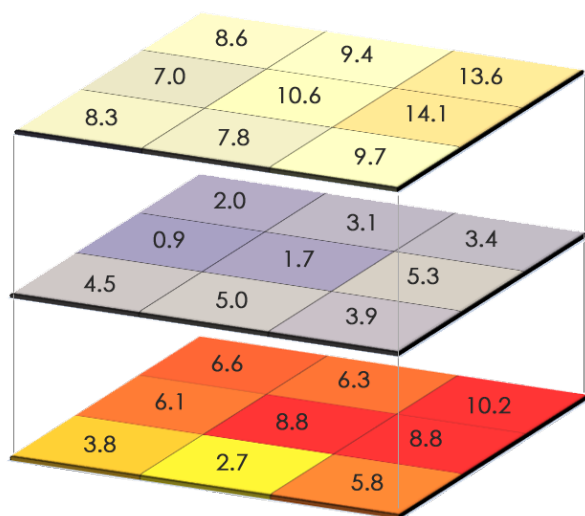
structure features in a GIS. It was a simple GIS model where lines may cross without intersecting or topology without attributes.

Although topology is useful for vector data, it is often processing intensive. Any feature edits requires updates on topology. With a lot of features, vector manipulation algorithms are complex.

What are the advantages of raster?

Raster grid format is data model for satellite data and other **remote sensing** data. For raster positions, it's simple to understand cell size.

Map algebra with raster data is usually quick and easy to perform. Overall, quantitative analysis is intuitive with discrete or continuous rasters.



What are the disadvantages of raster?

Because cell size contributes to graphic quality, it can have a pixelated look and feel. To illustrate, linear features and paths are difficult to display.

You cannot create network datasets or perform **topology rules** on rasters. Also, you don't have the flexibility with raster data attribute tables.

Raster datasets can become potentially very large because they record values for each cell in an image. As resolution increases, the size of the cell decreases. But this comes at a cost for speed of processing and data storage.

Vector vs Raster: Spatial Data Types

It's not always straight-forward which spatial data type you should use for your maps.

In the end, it really comes down to the way in which the cartographer conceptualizes the feature in their map.

- **Do you want to work with pixels or coordinates?** Raster data works with pixels. Vector data consists of coordinates.
- **What is your map scale?** Vectors can scale objects up to the size of a billboard. But you don't get that type of flexibility with raster data
- **Do you have restrictions for file size?** Raster file size can result larger in comparison with vector data sets with the same phenomenon and area.

Spatial data structures

Spatial data types provide the information that a computer requires to reconstruct the spatial data in digital form.

In the raster world, we have grid cells representing real world features. In the vector

world, we have points, lines and polygons that consist of vertices and paths.

Vector and raster data both have their advantages and disadvantages.

But don't sweat it:

Because you can convert vector to raster. And vice versa.

Do you have anything to add? Let me know with a comment below.

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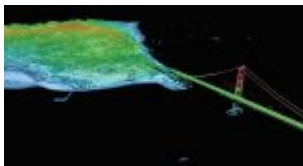
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