

# 7 things you should know about...

## Geolocation

### Scenario

For her senior project, Joanna participated in a cross-departmental research project to study the penstemon plant, popularly called the beard-tongue. Joanna, a biology major with a focus on botany, teamed with an environmental studies senior and a junior from the geography department to investigate how changes in the environment affect the plant and its bloom cycle. To do this, they tracked the dates and locations of blooms and correlated that information with data about local weather and other environmental conditions. So that the project would represent a range of environmental and weather factors, the team recruited middle school teachers and students from several states to go into their local communities, take digital pictures of the plants as soon as they began to flower, and send those photos to the research group. All of the photos were geotagged with highly specific latitude and longitude coordinates. Date and time information, as well as elevation, were also included.

With more than a thousand photos submitted, the first step was for Joanna to look closely at each picture and eliminate those that the students had mistaken for penstemons. Those that remained were loaded into a database along with the metadata about location, date, and altitude. Joanna and her research partners plotted the locations of the photos on a mapping application, onto which they could then overlay images of weather patterns, both historical and current, as well as data about environmental conditions including CO<sub>2</sub> levels, groundwater pollution, and soil contaminants. This visual representation of the data provided an engaging, multidimensional context that facilitated simpler, more thorough analysis. Each student brought expertise—as well as access to large databases of relevant, location-based data—from his or her academic discipline. The research team was able to show that at a given location, variances in water quality, air quality, and weather patterns either forestalled or accelerated the flowering season and also affected its duration. Because all of their data were correlated with specific locations, they could easily control for multiple variables with an extremely high degree of geographical precision. Having each team member approach the research with a different background and with somewhat distinct research questions resulted in a more thoughtful, comprehensive report, and because their data were geotagged, their results could be verified by other researchers or used as the basis for a longitudinal study over a number of years.

### What is it?

Geolocation, also called geotagging, is the practice of associating a digital resource with a physical location. Location information is typically given in terms of latitude and longitude coordinates, which can pinpoint any place on the planet with a high degree of precision. If a photographer includes the coordinates for where a picture was taken, for instance, the value of the photograph is increased, for both the photographer and others who have access to the photo and its metadata. Other sorts of digital artifacts—such as videos, podcasts, and news stories—similarly benefit from being tagged with location data. With this new layer of information, users have new abilities to search and organize content, discern correlations between related material, and take greater advantage of the growing interconnectedness of computing systems. At the same time, the idea of geolocation is increasingly being applied to infrastructure components and end-user devices for the purpose of knowing where people are. Various systems use location data from devices such as wireless access points or cell phones to discern, or at least estimate, where users are. In the same way that some in-car GPS systems alert drivers with up-to-the-minute traffic conditions, location-based systems might notify users about weather, nearby landmarks, places of interest, or where their friends are.

### Who's doing it?

Many photo-sharing websites have long included the ability to geotag photos. Users can click on the coordinates for a photo to access an interactive mapping application that shows the location where the photo was taken, as well as nearby locations that have been associated with other photos. In the same vein, some video-sharing sites have begun allowing users to indicate where a video was recorded, giving users similar access to mapping tools that open the door to further exploration of a geographical area. Alternatively, users can begin with a location, find that spot in a mapping application, and view online resources that have been associated with that place. Since Google's acquisition of geotagging site Panoramio, for example, anyone using Google Maps can choose to activate the photo layer, which dynamically shows all Panoramio photos on Google Maps. From the map, users can click on a photo to see a larger version of it and to link to that photographer's other photos. Users can then comment on a photo, search for similar photo streams, and otherwise interact with the content and other users.

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Wikipedia also now allows users to geotag entries with location coordinates. If you read the Wikipedia article on Devil's Tower National Monument, for example, you find that the coordinates of this rock formation are 44° 35' 25" N, 104° 42' 55" W. Clicking on those coordinates opens a page with links to numerous map systems that will display that location on an interactive map. If you view the Google Map of this location, you can see Panoramio photos that have been tagged with those coordinates.

## How does it work?

The JPEG photo format includes a placeholder for location data. Digital cameras that have GPS capability can automatically include latitude and longitude coordinates in JPEGs, and mapping and other tools can access those coordinates in the metadata. From there, representing a location is a simple process of plotting those coordinates on a map. For users whose cameras do not include GPS, photo-manipulation tools provide the ability to manually add coordinates to photos, either individually or in batches. In these cases, users must have access to a separate GPS unit or other tool and manually record the coordinates for particular locations. Whether location information is generated automatically or recorded manually, once those data are associated with a digital resource, applications can then relate that resource with other place-based services and data, such as real-estate information or bus schedules.

Some services associate physical locations with network hardware such as wireless access points. By monitoring a set of access points and seeing which users are connecting through individual access points—using laptops, cell phones, or other mobile devices—these services can identify users' locations and their movements. This sort of "awareness" brings another dimension to location-based social networks by automatically supplying details about where users are.

## Why is it significant?

For many kinds of resources, an additional layer of location data can make that resource much more useful to a broader range of users. A photo or video takes on a new dimension when you can pinpoint its location on a map and quickly access other media from the same or nearby places. As web applications become increasingly interconnected, users have more opportunities to meet people with similar interests, and geolocation can bring together people who live in the same area or who have visited the same place and posted geolocated pictures online. A number of location-based social networking sites have appeared, which use place as the organizing principle for building communities. Knowing where something took place—or will take place in the future—and being able to relate that place to its surroundings can provide not only a deeper understanding of the geographical context but also of environmental, social, or political factors. The result is a deeper understanding of and engagement with subject material.

## What are the downsides?

To the extent that growing numbers of users geotag digital resources, the opportunities increase for broader access to greater amounts of information. At some point, however, this benefit becomes a drawback, as people and systems begin to suffer from data overload. Imagine if everyone who visited the Eiffel Tower took a picture of it and uploaded it to a photo-sharing site whose content was represented by an online mapping application. Tens of thousands of Eiffel Tower photos on a map quickly become unmanageable. Moreover, geolocation that is done manually is prone to mistakes, and these inaccuracies are difficult to root out and correct.

As geolocation efforts increasingly focus on pinpointing people, important questions arise over privacy. The technology and infrastructure to keep tabs on people is becoming more sophisticated and commonplace, and clear policies are needed to help users understand what information is being collected about them and how it is used. Geolocation services and tools should recognize this concern and give users control over how and when their location information is shared.

## Where is it going?

As awareness increases, users will more regularly include location information in their digital resources and will increasingly expect other resources to include it as well. Expanding the practice of geotagging will lead to new tools for searching and organizing information. Mobile devices will be able to locate more users, more often, supplying information both *to* and *about* users. This exchange of information potentially dovetails with emergent cyberinfrastructure projects designed to create new connections between users, myriad forms of content and data, and sophisticated applications.

## What are the implications for teaching and learning?

Students, faculty, and researchers across the disciplines stand to benefit from adding a layer of location information to data and systems. For a sociologist studying dispersion of domestic violence by neighborhood, an epidemiologist tracking outbreaks of illness, or an MBA student looking into regional purchasing trends, location data provide opportunities to see obscure patterns and gain a deeper insight into the topic of study. Learning activities that formerly required taking a field trip might be accomplished through technologies that use location data to coordinate information and resources. Geolocation also provides students another avenue to contribute to the body of knowledge used by professionals in their discipline.