About the functions of modern maps

Georg GARTNER

Research Group Cartography, TU Wien, Wien · georg.gartner@tuwien.ac.at

Abstract

Much digital data generated today has a spatial component. Depicting, analysing and communicating this spatial data has been a cartographic concern for decades. Many methods, tools and technologies have been developed in cartography to effectively communicate this data to humans to support orienting in the environment, understanding (complex) natural and social phenomena, as well as making social, political and economic decisions. In recent years, with the advent of the information age and the growing volume of this data, cartography as a discipline has become even more important and has gained much interest from expert and novice map users. This has an impact on how maps are used, perceived and applied, thus the functions of maps are increasing.

1 Key influences on modern cartography

Cartographic communication processes and maps (or map-like products) are the keys to enable humans to efficiently deal with all kinds of spatial data. To provide effective and efficient communication of spatial data, cartographic products should be user-centered, and adapted to users' needs, contexts, preferences and constraints. We argue that there are three primary aspects that must be considered when designing cartographic products: data; technology; and design. For example, with data, cartographers need to identify which data are relevant to users' needs and the contexts, which level of detail, which form of abstraction, which classification, etc. And, with respect to technology, cartographers need to investigate appropriate interface technologies (for example, paper, computer screen, smartphone, wearable device) are suitable, the interaction modalities and interactive functions to be provided, or even which of the human senses to use (sight, hearing, touch). The final primary aspect is design, which has been considered as being the "most fundamental, challenging and creative aspect of the cartographic process" (De Lucia 1974: 83). It needs to identify which visualization techniques to use (2D, 3D, virtual reality and augmented reality), which styles to choose, which symbolization to apply, which graphical composition to employ, and so on.

- Map design plays a fundamental role in cartography. Different techniques, methods and tools have been developed for map design, especially related to the aspects of symbolization, labelling, coloring, map projection, and so on. Additionally, much empirical research has been undertaken in order to better understand the effectiveness and efficiency of different map designs. Recently, research on map design shifted focus from static maps to dynamic, interactive, personalized and mobile maps (Griffin and Fabrikant 2012). In terms of empirical studies, many researchers have utilised physiological devices (for example, electroencephalogram

EEG, magnetic resonance imaging MRI, and galvanic skin response GSR) and eye-tracking devices, combined with traditional empirical methods, to not only study how well a particular map design works, but also understand why, how, and in what context the design works.

- Cartographic heritage and history play important roles in contemporary cartography and GIScience, as they enable us to better understand foundational information about the discipline and to study more effectively the evolution of the natural and social aspects of the world (Cartwright and Ruas 2015). In recent years, many methodologies, techniques and tools have been and are being developed to digitize, geo-reference and analyze and interpret historic maps and map-like products. The challenge here is on how to intersect the analysis of historical maps with their cultural contexts, considering the inaccuracy, uncertainty and incompleteness of these sources.

- Geovisual analytics and spatial analysis are powerful tools for deriving pattern and knowledge from complex, voluminous and heterogeneous data, understanding complex phonemes, as well as decision making. Recently, the increasing availability of data about the world and society ('big data') has triggered a much stronger research interest in geovisual analytics and spatial analysis, not only in the discipline of cartography and GIScience, but also in other disciplines like computer science. This is not surprising, as maps and map-like products are powerful abstraction and communication tools, and can help to convert these data into usable information that enable us to gain new knowledge about the world and society.

- Web maps have become the most common cartographic products that the general public encounters daily. Many Web mapping APIs (Applications Programming Interfaces) like Google Maps APIs have been developed to enable normal users to implement their own Web maps. Recently there has been a trend toward more interactive and cartographically pleasing Web maps. Due to its powerful communication capacity, maps published on the Web are being increasingly used in different media (news services, magazines) for storytelling. And, in recent years there has also been a strong interest in personalising Web maps, by tailoring Web maps to best suit an individual user's characteristics, preferences and needs.

- The rapid advances in mobile communication and the ubiquity of mobile devices have triggered a trend toward Location-Based Services (LBS). This emerging field in cartography and GIScience brings many challenges to the discipline. For example, compared to users of traditional maps, LBS users are often the general public, and not expert map users. Their knowledge, abilities, preferences and needs are diverse. As well, LBS are often used in a mobile environment, which requires LBS to be context-aware, and adapt to the context in which the user operates. Additionally, in LBS, the devices to render maps or communicate spatial information are diverse, ranging from smartphones and tablets to wearable devices (smart watches and digital glasses) and public displays. All these changes in users, map use contexts, and devices challenge the discipline of cartography to define and provide (improved or new) principles, rules, and techniques that can be used to design usable LBS applications meeting users' information needs (Huang 2015).

2   Functions of maps

Modern cartography is everything we do in our daily life as a cartographer or GI Scientist in order to produce maps, or to be more precise to design cartographic communication processes. The role of the map has changed. Maps used to be artifacts, they had to look beautiful, well-designed, they had to store information for a long time because it needed to be used over a long period of time. In modern cartography there is an increasing number of functions to a map. Besides its old function of an artifact, a modern map is also an interface that gives human users access to information stored in the map and beyond the map in databases. The map has therefore the function of a table, structuring information through spatial attributes. And if a modern map is such an interface, giving access to structured information, then the concept of modern cartography in one sentence would be 'efficient communication of geospatial information'.

In this sense we can distinguish functions of maps as

- the cognitive function encompassing all processes and operations and all models which generate and enhance spatial knowledge. This can include processes of map analysis, transformations, generalization, simulations, animations.

- the communication function, which includes demonstration, encompasses all processes and operations of spatial knowledge transfer from a map maker to a user. It may be divided into several sub-functions according to the extent of transferred knowledge, the level of pre-knowledge, and the form and means of knowledge transfer. Educational communication, mass media communication, academic communication, administrative communication represent the dimensions of this function.

- the decision support function encompasses all processes and operations which result in spatial decisions and spatial actions. Examples of these types of functions include navigation, planning, and persuasion.

- the social function encompasses all processes which result not in spatial, but in social behavior and actions. One form of this involves the professional map maker in relation to other persons in the mapping process, including the users. Maps can also be seen as tools of social power, exercised through the access or the denial of access to spatial information, through copyrights or the monopoly on mapping equipment. Then there is the ability to consider mapping as a cultural activity.

In this sense we can summarize main functions as follows, without claiming to see this as a full list:

- to order, link and relate spatial and spatialized information
- to enable exploration and detecting of spatial and spatialized information and their relations
- to tell stories
- to entertain
- to allow to interactively express spatial and spatialized information and relations
- to allow to interact with those expressions
- to respond to queries and spatial questions
- to make spatially aware

Summary

Modern Cartography is dramatically changing the way maps can be used and thus which functions they can offer. To better understand this potential and the arising opportunites will allow for a better tailoring of maps and map-based applications.