# Geographical Information System and Spatial Micro Data: An Introductory Socio-Technological Perspective

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## 1. Introduction

The geographic information indicates information with the relation between the position on the earth and what locates. Because the position on the earth is generally described in latitude and longitude, the geographic information might have a spatial characteristic of extending, and be called spatial data. The one that the geographic information was expressed visible is a map. The history about the map is old, and making concerning the geographic information of Japan has advanced in the Edo era when a real measurement was begun. The method of making a map has developed as cartography for a long period of time. Geographical maps are generally divided into two types; general cartography and thematic cartography. Many of certain maps are called the thematic map, and made a map for a specific theme or subject. For instance, various geographic information concerning regions and countries have been described in the atlas used by many educational institutions. It is included in a map that the description concerning the natural environment such as geographical features and climates, or the social characteristics such as population, trade, industry, and so on.

The theme of such a thematic map is called an attribute, and the spatial data related with these themes is called an attribute data. Of course, various attribute data in a map are visualized and they are also rank-ordered. It becomes possible to treat the mass data easily by the development of information technology and computing technology though it is difficult to individually collect the attribute data not so long ago because it included many things. Digitalization of mapping technology has advanced, and it becomes easy to collect, to manage, and to analyze it by the individual computer as for collecting attribute data or mapping. Therefore, in these contexts, geographic information system (GIS) can effectively aggregate many attribute data and integrate spatial micro data and variant layers of map[1].

## 2. Social concerns of special dimensions: A history of mapping

Geographical information system is mainly based on and was originally born from geography. Geography has a long history. The original meaning of geography is to describe (graph) land (geo). Land (geo) is a stage where we live, and includes not only natural environment such as geographical features, climate, and ocean but also the

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social features of economy and culture. It can be said that geo area and place are terms that indicate the extension of the concrete space and show a place where city, village, farm, and other districts are partly located. In other words, it is included in the definition of geography that locality or territoriality represents concrete space, which the technical term as space is high the abstraction level, and, therefore, understood by various meanings. The space is an aspect where we see things while extension concrete land (geo) is directed, and it can be said the concept of related to the ideal way of our recognition for spatial dimensions.

Spatial dimensions are a way in which we recognize our surrounding, and another way is time-series recognition. It becomes easy to understand the feature and the attribute of space from comparing it with the feature of time-series though these both recognition processes are indivisible for something like the both sides of the coin. Time-series recognition is one of the most fundamental ways when we acknowledge the world, and it may say that the recognition method enables us to think the relation of one thing to another as a causal relation. Moreover, a certain kind of universality is sensitive in the flow of time because all lives of mankind and artificial materials are limited and in another way they have expiration date. Our historical drama sometimes shaken our mind because all things are in flux and nothing is permanent, it is believed that lives are destined to die out eventually. Therefore, time-series recognition processes represent a kind of universality. On the other hand, our understanding of spatial dimensions is more individual or specific in general compared with universality of time-series recognition. This is deeply related with the thing that we locally recognize our surroundings with bounded rationality the famous social scientist Herbert Simon conceptualized. For instance, there is a map in what described by the aspect of the space. When we trace the history of map back, we know the first world atlas was a world atlas of Babylonia in around the seventh century B.C. and followed by Ptolemy's maps around the second century and famous TO map around tenth century. It was characteristics for the early-time mapping that the central area was concrete but the peripheral area was not. These maps depended on the editor's recognition of their surrounding until Age of Geographical Discovery came, and the experiences of many parts of the world came to be collected, and a description different in each place was performed. As remarked, it can be said that the space has an individual and specific feature compared with time-series.

Philosopher Immanuel Kant expected that geography had a central role to collect information around world and then to unite its knowledge[2]. In the 18th century when Kant played active roles, there were a lot of world maps based on the accurate measurement, and the position of geo was expressed numerically by the graticule that centered on two poles and the equator. It connects with catching the aspect of space with generality or more advance by accurate mapping. Development of geographical information system and geoscience has been alongside the history of geographic measurements in the Kant's philosophy how to generalize spatial features.

Geographic information system is a platform system designed to capture, store, manipulate, analyze, manage, and present all types of spatial data referred geographically. In the simplest terms, GIS is the complex of cartography, statistical analysis, and database technology. Therefore, Figure 1 shows GIS is developed through various academic disciplines and fields such as cartography, surveying, informatics, and computer science, which also expands in application to agriculture, environmental science, engineering, applied economics, and business management.

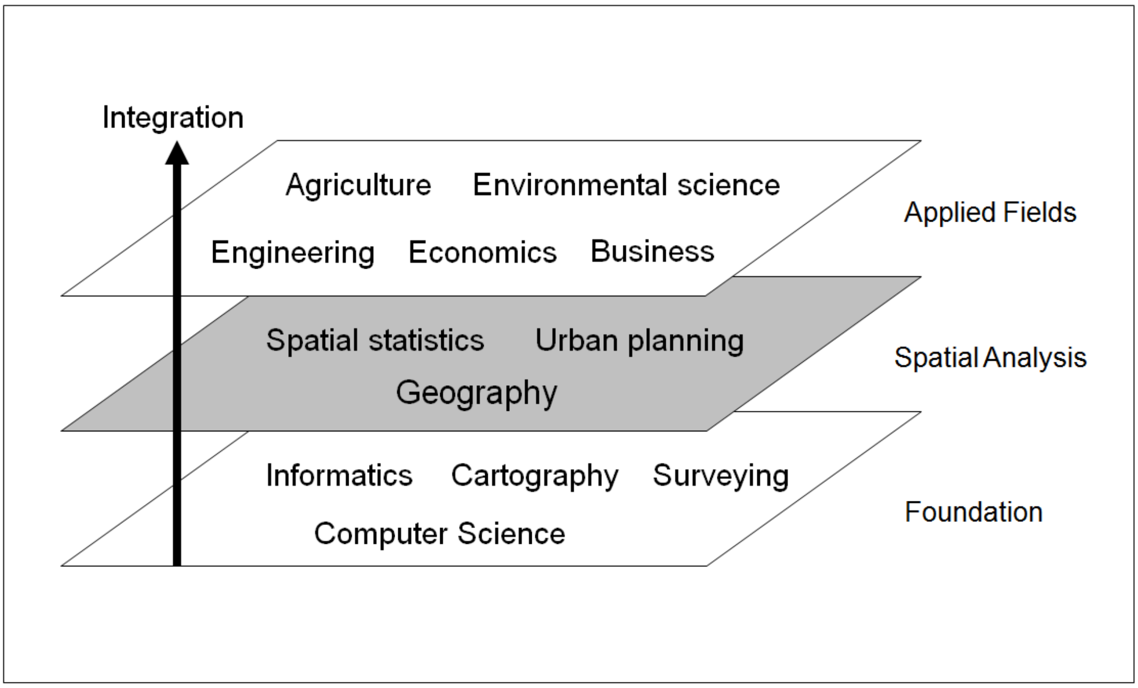


Figure 1. Geographical Information System based on academic fields

This platform system excels in integrity and functionality[3][4]. Therefore, in a general sense, it enables to integrate, store, edit, analyze, share and display geographic information for informing decision making. Also, GIS can be thought of as a system—it digitally creates and manipulates spatial areas that may be jurisdictional, purpose or application-oriented for which a specific GIS is developed. For example, the application of the Internet to GIS has been advanced, and it has a lot of web-GIS sites and clearing houses[5][6]. Thus, it can be said that the geographic information system is a strong tool to enable individual, concrete geographic information to be treated totally in the background of digitalization based on computer technology and informatics. It is important to point out that the development of geographical information system/science is consistent with the social infrastructure in using spatial micro data.

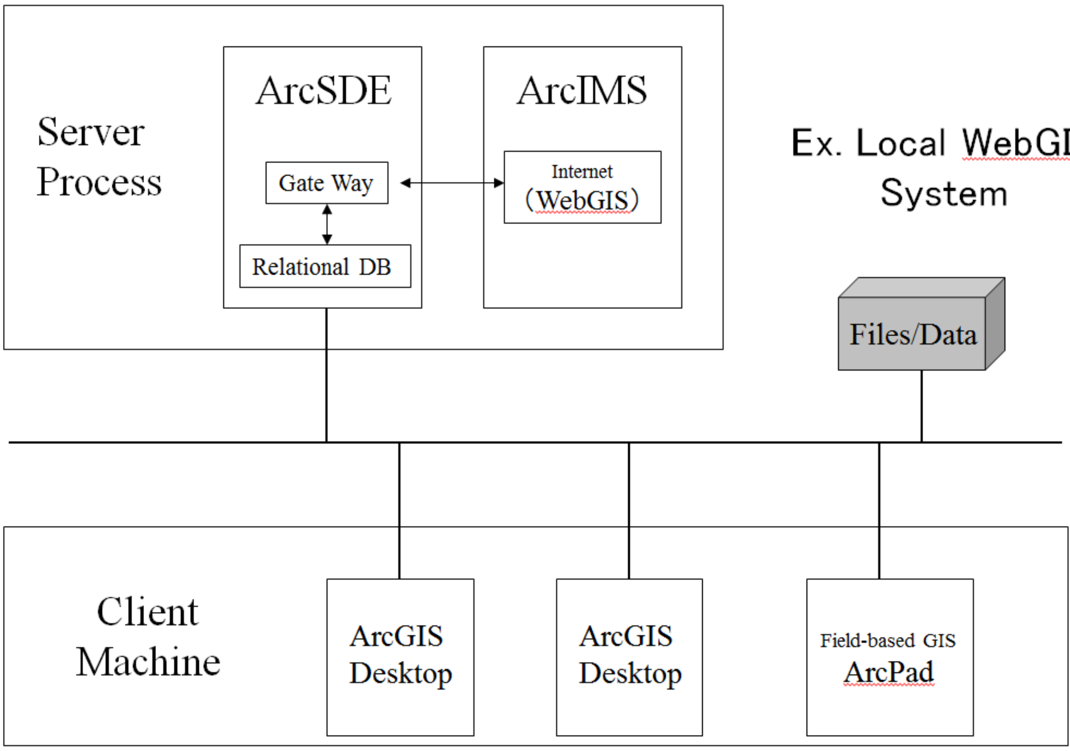


Figure 2. Local web-based GIS: An example

3. **Geotechnology matters: technological development of GIS**

Along with nanotechnology and biotechnology, geotechnology is one of the top three most important emerging fields according to the U.S. Department of Labor. In recent years, the importance of Geographical Information System in socioeconomic development has become widely recognized. Today's GIS research devotes attention not only to research and development in universities but also to the importance of constructing a national platform system of GIS that effectively connects comprehensive systems incorporating market and social needs, public sectors and private sectors. At the same time, however, various issues have arisen, such as the latent market and social needs, and the emergence of more sophisticated and complex technology.

The history of R & D in geotechnology is not that short. Its inception dates from 1960s. Subsequently, during the 1980's, some geographers expanded the classic method. In this way, the concept of geotechnology has been around for a long time, but it was not until year 2000 that the recent geoscience boom came about. Geotechnology started to draw attention when Bill Clinton, the then President of the United States, launched the "21st century Science and Technology Initiative." The United States regarded geotechnology as a technology that would trigger the next industrial revolution and decided to promote intensive investment in it.

Given these turns of events, geotechnology and related fields was given high priority in the R & D policy of the U.S. Federal Government, and it has invested more than $1 billion during the past ten years. Turning to the European Union, they thus followed the U.S. strategy and geotechnology became a major theme in each of the EU countries. Since R & D on mapping technology have progressed in parallel with the development of information technology in Japan, expectations for geotechnology were initially high in this country.

Recent times have seen the links between mapping and spatial data become less pronounced. According to recent studies of geoscience, research can be categorized into three types. These are pure basic research (mapping technology) by computer science and informatics, pure applied research by engineering and needs-inspired pure basic research by applied fields. The latter type research is recently gaining in importance, because the motives for mapping have become increasingly needs-oriented in recent years. In other words, the most advanced mapping technology cannot be realized without technology-based knowledge, and consequently, this fact affects research in universities and public research institutes. Even national platform for geographical information cannot be performed without considering social needs.

The broad aim of geotechnology is to identify geographically referred data likely to yield the greatest natural, economic, and social benefits. During the 1990s, geotechnology became much more widespread. Since 2000, most advanced geotechnologies including global positioning system have been becoming more sophisticated and complex day by day, and as such, the time and efforts inherent in the realization of geotechnologies have also increased. Many institutions and universities which had previously conducted R&D internally are now partly outsourcing their R&D tasks and the associated efforts, except for their applied field. Development of geotechnologies has reduced the distance between mapping and analyzing spatial data. In universities and national research institutes, for example, those public R&D strategies for geotechnology which were previously considered as precompetitive research have been affected by social needs and public policies. In such a circumstance, a wide range of geotechnological methods are available, some are specifically designed for future work while others are developed from management and planning. Some may not be specifically related to the social needs but are used to provide the basis for useful information sources. Some methods, like spatial multivariate analysis, which were developed by quantitate geographers, have since been borrowed by others. From the range available it is important that the chosen methods are selected as suitable for the purpose for which they are to be used. Exploring possible, probable and preferable spatial futures relies on assumptions about the situation and how we relate to it, which in turn will influence the choice of methods. However, mapping technology is the most common and available processes. Layer setting and collecting spatial data collecting are more like qualitative methods rather than quantitative.

4. **Spatial data and mapping technology**

It is a need for GIS to use two types of data; GIS data (an abstraction of real object) and spatial data (statistical data on society and economy). GIS data represents real objects such as roads, land use, trees, rivers, mountains and so on with digitalization. Generally, there are two methods used to store data in GIS for both kinds of abstractions mapping references: raster images and vector. A raster data type is any type of digital image represented by reducible and enlargeable grids. It is familiar with digital photographic technology where a picture is consist of the raster graphics pixels as the smallest individual grid unit building block of an image. On the other hand, vector type data are expressed by considering those features as geometrical shapes; points, lines or polylines, and polygons. Spatial data contains geographically referred data. Also, geographically referred data is expressed as an attribute matrix. As for spatial units such as area or regions, geographical matrix is a combination of attribute matrix and interactive matrix which Brian berry designed (Figure 2).

Digital mapping technology is to visualize spatial features to be abstracted along with a spatial axis. The origin of digital mapping is derived from a public tool in governmental institutions. The development of digital mapping in public sector two important aspects in technology foresight. One is that we can apparently confirm the increase of its importance as spatial mapping system and social future vision. We can see the development of digital mapping from a public or private institution's method to an integrated system on a national level. The other is that more and more specific knowledge is needed to build a digital mapping. This originates from the advancement of technologies and diversification of social needs. The digital mapping needs to be considered as a collection of spatial data including various elements of society.

There seem to be three major reasons why digital mapping system is needed nowadays by both governments and private sectors. First, because of the rapid increase of social and economic complexity and diversification, it becomes necessary to grasp total conditions strategically based on geotechnology. In other words, more efficient and strategic management is needed to understand the global or local situations. Moreover, because of the increase of collecting digital data by high-tech tools, more selective and concentrated information system is needed. Therefore, digital mapping system increases in importance as a part of GIS.

Secondly, due to the recent digital information overloaded, it becomes more difficult to select or search useful sources individually. This results in the necessity of strategic selection and concentration of spatial data and more focusing on spatial scales, especially in socio-economic phenomenon where the rapid changes is seen. This is the reason why digital mapping and geographical information system has become more important.

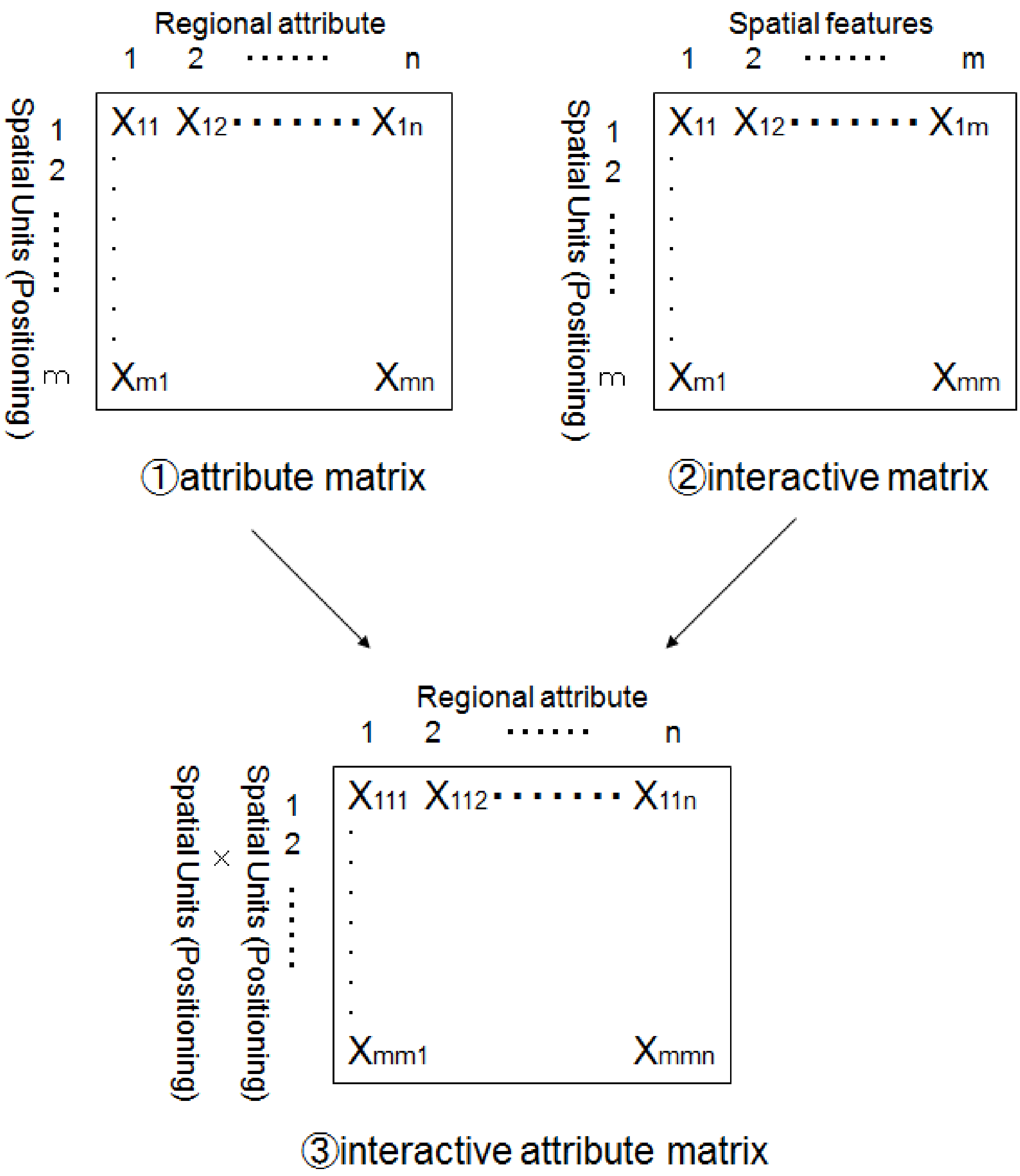


Figure 3. Structure of Geographical matrix

Geographically mapping is based on specific technological knowledge. As technological complexity increases, the search range of technology seeds becomes wider, which means it is necessary to gather not only open information sources such as academic or public research institution, but also closed information such as know-how and implicit knowledge in the related fields. There would be, however, still some amount of difficulties to construct a huge GIS platform. According to the factors of the digital mapping above, the formula, shapes and components deeply depend on the purposes of mapping. National governments, consortia of academic institutions could be the builders of a GIS platform, and they have various GIS platform (see Figure 4). If a government or public community build a GIS platform, they would have to consider national conditions and reasonableness of public services, and eventually it should be a long-term digital mapping rather than short-term[7][8].


Figure 4. Public GIS platform: An example

Sources: http://portal.cyberjapan.jp/index.html

5. **Concluding Remarks**

It is now required for governmental and private contributions in geotechnology to see whether expectations for the geoscience field create matching social value and needs upon spatial integration. Sufficiently social effective results are now demanded from GIS platform. The field of geotechnology has been in the limelight in recent years, because the possibility has emerged that it will bring about not only innovations in geography and engineering but also radically remake ordinary information tools. A pioneering example is fullerene, which is used widely in fields from car navigation system to mobile GPS tools. As far as the future potential of geotechnology in industrial technology is concerned, geotechnology has created high expectations as a technological seed that brings about explosive innovation. However, huge investments and strategic inputs of resources are required to realize it.

Taking the field of geographical information system as an example, this paper points out the importance of a viewpoint that takes a series of processes from mapping to social platform as a single information system. Positioned at the center of this system is Geographical Information System. As a tool that helps develop a combination among spatial features such as nature, environment, society, economy, and so on, and prioritized allocation of efforts and human resources, a geotechnology is also being developed for GIS also in the USA and EU countries. Although a GIS brings about a comprehensive vision, however, there are some problems with technology characterized by quantitative methods such as collecting spatial data. Research and Development of GIS in the amounts of cost is required to reach integration of spatial micro data in the field of geotechnology. The path to integration is extremely unclear, and, furthermore, technological establishment does not necessarily match social needs. Under these circumstances, a geographical information system that functions sufficiently for developing a collection of spatial micro data, be it for the government or a private sector. In this sense, one can also say that the field of geotechnology is an experimental field for various purposes and extremely cutting-edge cases.

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