



地理信息科学 专业英语

ENGLISH FOR GEOGRAPHIC INFORMATION SCIENCES

李 颀 主编

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前 言

地理信息科学将地理信息视作一门科学,不仅仅是一个技术上的实现,其主要研究在应用计算机技术对地理信息进行处理、存储、提取以及管理和分析过程中提出的一系列基本问题。地理信息科学专业英语不仅是地理信息科学专业科技工作者进行学术研究与交流的重要工具,还是地理信息专业工作者提高专业文献和英语书刊阅读能力的重要途径。针对地理信息科学专业名词多,句法复杂,查阅难度大的问题,本书选取经典的地理信息科学领域文献进行解析,并对单词涵义进行专业的注释,从而引导读者在字典的帮助下独立阅读英文原版地理信息系统、遥感、全球定位系统、计算机科学、测量学、数学等方面的专业书籍,以此逐步培养阅读国际优秀文献的能力。

为保证本书内容的系统性和权威性,作者从多方面选取有代表性的原版书籍、文献、资料中的文章作为课文的信息源,每个单元涉及一个专题并自成体系。全书共分 15 个单元,内容涵盖地理信息科学专业的主要方向,其中地理信息系统 6 个单元、地图学 2 个单元、遥感 6 个单元、全球定位系统 1 个单元。

本书可以作为地理信息科学专业本科生、研究生阶段的专业英语和双语课程的课外阅读读物,也可以作为相关科技工作者、出国留学人员的参考资料。

李 颀
宁夏大学
2018 年 1 月

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Part I

Geographic Information Systems



Unit 1 GIS: An Introduction

The day-to-day necessity of dealing with space and spatial relationships represents one of the basic facets of human society, and our accumulated knowledge about the spatial form of the world in which we live has been traditionally stored in the form of maps. The emerging critical new tool of Geographic Information System (or GISystem) for the storage, analysis, and visualization of spatial data will have methodological impact on the geography, as well as, at least the spatial aspects of human society, allowing the completely different viewpoints to analyze the world phenomena. This unit aims to introduce the basic concepts and information concerning the GISystem.

1.1 Meaning of GIS

GISystem

Many definitions of GIS have been suggested over the years, such as “a container of maps in digital form”, “a computerized tool for solving geographic problems”, “a tool for performing operations on geographic data that are too tedious or expensive or inaccurate if performed by hand” (Longley, et al, Geographic Information Systems and Science, 2001). Let's look at some of the definitions given by the professional institutes:

USGS (United States Geological Survey): In the strictest sense, a GIS is a computer system capable of assembling, storing, manipulating, and displaying geographically referenced information, i.e. data identified according to their locations.

ESRI (Earth Science Research Institute): A geographic information system (GIS) integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information.

INHS (Illinois Natural History Survey): A Geographic Information System (GIS) is an organized collection of computer hardware, software, geographic data, and personnel designed to capture, store, update, manipulate, analyze, and display all forms of geographically referenced information. This system allows users to perform very difficult, time consuming, or otherwise impractical spatial analyses.

In general, we could derive the practical definition of GIS as a computerized system designed to deal with the collection, storage, manipulation, analysis, visualization and display geographic information.



GIS is a tool to perform the spatial analysis which will put insight to the activities and phenomena carrying out every day.

GIScience

Geographic Information Science (GIScience) is advocated to address a set of intellectual and scientific questions which go well beyond the technical capabilities of GIS. The concept was first advocated by Michael Goodchild.

“...There is a pressing need to recognize and develop the role of science in GIS. This is meant in two senses. The first has to do with the extent to which GIS as a field contains a legitimate set of scientific questions, the extent to which these can be expressed, and the extent to which they are generic, rather than specific to particular fields of application... The second sense has to do with the role of GIS as a toolbox in science generally - with GIS for science rather than the science of GIS.”

Thinking about the uniqueness of the spatial data, their location based characteristics, their spatial dependence, Goodchild proposed the contents for GIScience, such as data collection and measurement, spatial statistics, theories of spatial data, data structures, algorithms and processes, display and analytical tools.

It is known that the information science studies the fundamental issues arising from the creation, handling, storage, and use of information. So, similarly, we could infer that GIScience should also study the fundamental issues specifically arising from the special set, geographic information.

GISystem is part of the Geographic Information whole, which also includes the fundamental issues of GIScience.

GIService

GIService is the kind of services dealing with the geographic information, such as the design and development of the GIS, geographic information retrieval, analysis, etc. For example, MapQuest (www.mapquest.com) provides a routing service for people to find the best driving route between two points.

1.2 Development of GISystem

The first GIS, Canada Geographic Information System was developed in mid-1960s to identify the nation's land resources and their existing, and potential uses.

In the late 1960s, US Bureau of the Census created the DIME program (Dual Independent Map Encoding) for all US streets to support automatic referencing and aggregation of census data.

In late 1970s, Harvard University's Laboratory for Computer Graphics and Spatial Analysis developed a general-purpose GIS (ODYSSEY GIS).

The first automated cartography developments occurred in the 1960s, and by the late 1970s most

major cartographic agencies were already partly computerized.

GIS began to take off in the early 1980s, when the price of computing hardware had fallen to a level that could sustain a significant software industry and cost-effective applications.

1.3 Major Components of GISystem

According to the ESRI, the major components of GIS are hardware, software, data, people, procedure and network.

- ◎ Hardware, is the devices that the user interacts directly in carrying out GIS operations, such as the computer, digitizer, plotter, etc.

- ◎ Software, normally runs locally in the user's machine, also supports user to carry out multiple spatial analysis and management.

- ◎ Data, which is quite critical to GIS, contains either an explicit geographic reference, such as latitude and longitude coordinate, or an implicit reference such as an address, postal code, census tract name, forest stand identifier, or road name.

- ◎ People are most active components dealing with the design, programming, operation and management of GIS.

- ◎ Procedure, more related to the management aspect of GIS, is referred to lines of reporting, control points, and other mechanism for ensuring the high quality of GIS.

- ◎ Network allows rapid communication and sharing digital information. The internet has proven very popular as a vehicle for delivering GIS applications.

1.4 Data Sources of GISystem

- ◎ Digitizing and scanning of maps

Use the digitizer to transform the information from analog format, such as a paper map, to digital format, so that it can be stored and displayed with a computer. Or use scanner to convert the analog paper map to computer-readable form automatically.

- ◎ Input image data

Image data includes satellite images, aerial photographs and other remotely sensed or scanned data, which are in the raster form. Remote sensing has become a more and more important data source for GISystem.

- ◎ Direct data entry including Global Positioning System (GPS)

Surveying field data which measure the distance and angle to decide the location of other points could also be transferred into the GISystem. GPS is a set of hardware and software designed to determine accurate locations on the earth using signals received from selected satellites. Location data and associated



attribute data can be transferred to mapping and GISystem.

- ◎ Transfer data from existing sources

Data are obtained already in digital format from Government Agencies such as Australian Geological Survey Organization (<http://www.agso.gov.au>), the Australian Survey and Land Information Group (AUSLIG) (<http://www.auslig.gov.au>), and other sources.

1.5 Basic Data Model in GISystem

- ◎ Vector data model

Vector data represents the locations of the discrete objectives by points, lines and areas.

- ◎ Raster data model

Continuous numeric values, such as elevation, and continuous categories, such as vegetation types, are represented using the raster model. Raster model divides the entire study area into a regular grid of cells in specific sequence; each cell has a unique value representing different types.

1.6 Different Kinds of GISystem Software

A modern GIS software system comprises an integrated suite of software components, including end user applications, geographic tools and data access components. GIS software packages could be classified as six groups based on the functionality and type.

- ◎ Professional GIS

The distinctive features of professional GIS include data collection and editing, database administration, advanced geoprocessing and analysis, and other specialist tools, such as ESRI ArcInfo, Smallworld GIS.

- ◎ Desktop GIS

Desktop GIS focus on data use, rather than data creation, and provide excellent tools for making maps, reports, and charts. Well-known examples include ESRI ArcView, Intergraph GeoMedia, MapInfo professional, Clark Lab's IDRISI, etc.

- ◎ Hand-held GIS

Hand-held GIS are lightweight systems designed for mobile and field use, such as Autodesk Onsite, ESRI ArcPad, and Smallworld Scout.

- ◎ Component GIS

Component GIS are tool kits and used by knowledgeable programmers to create focused applications. Examples include Blue Marble Geographic GeoObjects, and MapInfo MapX.

- ◎ GIS viewer

GIS viewer are able to display and query popular file formats, such as ESRI ArcExplorer,

Intergraph's GeoMedia, and MapInfo's ProViewer.

◎ Internet GIS

Internet GIS focus on display and query applications, as well as mapping. Examples include Autodesk MapGuide, ESRI ArcIMS, Intergraph GeoMedia Web Map, and MapInfo MapXtreme.

词汇

facet	<i>n.</i> (事物的)面,方面	aspect	<i>n.</i> 方位,朝向
reference	<i>n.</i> 参照 <i>vt.</i> 以…为参照	visualization	<i>n.</i> 可视化
algorithm	<i>n.</i> 算法	encoding	<i>n.</i> 编码
forest stand	<i>n.</i> 林分,林段	identifier	<i>n.</i> 标识符
aerial	航空的	vector	<i>n.</i> 矢量
raster	<i>n.</i> 栅格	field data	<i>n.</i> 外业数据

阅读材料

Introduction to Geographic Information Systems

A Geographical Information System (GIS) is defined as a system for entering, storing, manipulating, analyzing, and displaying geographic or spatial data. The word geographic implies that locations of the data items are known, or can be calculated, in terms of geographic coordinates (latitude, longitude). The word information implies that the data in a GIS are organized to yield useful knowledge, often as colored maps and images, but also as statistical graphics, tables, and various on-screen responses to interactive queries. The word system implies that a GIS is made up from several interrelated and linked components with different functions.

A GIS consists of a package of computer programs with a user interface that provides access to particular functions. GIS are designed to bring together spatial data from diverse sources into a unified database, often employing a variety of digital data structures, and representing spatially varying phenomena as a series of data, all of which are in spatial register, meaning that they overlap correctly at all locations.

The acronym "GIS" has come to mean much more than a type of computer program. GIS implies the science of geographic information management and analysis. In many countries, there are now academic institutes devoted to all aspects of GIS. GIS courses are now part of the academic curriculum in many universities and technical colleges. There are a large number of GIS periodicals, many of them commercially -orientated, but some entirely for the publication of scientific papers, such as the International Journal of Geographical Information Systems. Numerous conferences are devoted to GIS,



catering to the needs of those working in GIS in academia, government and business.

GIS is invaluable for collecting, maintaining and using spatial data in a database management role, as well as for producing both standardized and customized cartographic products. Application of GIS achieves these major goals through one or more of the following activities with spatial data: organization, visualization, query, combination, analysis and prediction.

Purpose of GIS

The ultimate purpose of GIS is to provide support for making decisions based on spatial data. Of course, GIS is invaluable for collecting, maintaining and using spatial data in a database management role, as well as for producing both standardized and customized cartographic products. Application of GIS achieves these major goals through one or more of the following activities with spatial data: organization, visualization, query, combination, analysis and prediction.

Organization

Data can be arranged in many different ways, schemes for organizing data are sometimes called data models. The principal characteristic for organizing GIS data is spatial location. GIS data are also organized according to non-spatial characteristics. Data models must, therefore, organize observations both by spatial and non-spatial attributes.

Visualization

Visual display is normally carried out using the video monitor or color printers for hardcopy displays. Humans have an extraordinary ability to understand complex spatial relationships visually, whereas the same information may be quite unintelligible when presented as a table of numbers.

Spatial Query

Visualization reveals spatial pattern amongst collections of organized data items. However, visualization is not so helpful for answering questions about special instances in the data, such as the value of particular data items. Spatial query is a complementary activity to data visualization.

GIS provides tools for two types of interactive query. The first type is the question “What are the characteristics of this location?” The second type is “Whereabouts do these characteristics occur?” Other kinds of questions may be related to distance, orientation, and conditions of adjacency or containment. Such questions require not only efficient search of data items, but also the capability for deriving their geometric and topological attributes. The term topology refers those characteristics of a data object, like adjacency and containment, which are not affected by spatial transformations.

Combination

The ability to merge spatial datasets from quite different sources and display and manipulate combinations can often lead to an understanding and interpretation of spatial phenomena that are simply not apparent when individual spatial data types are considered in isolation. The process of combining layers of spatial data is sometimes called data integration, and can be carried out either by visualizing

composite displays of various kinds, or with integration models that effectively create a new map from two or more existing maps. Integration models are symbolic mathematical models, using arithmetic and logical operations to combine layers of data together.

The algebraic statement that operates on maps are usually written in a programming language, sometimes known as “map algebra”, specific to the GIS. One of the really powerful features of GIS is the ability to link several map algebra statements together to form more complex algorithms. Several maps and tables of attribute data can be combined in a single processing step. The process of combining maps together is often called map or cartographic modelling.

Analysis

Analysis is the process of inferring meaning from data. Analysis is often carried out visually in a GIS, as already indicated. Analysis in a GIS can also be carried out by measurements, statistical computations, fitting models to data values and other operations.

Spatial analysis in a GIS sense means simply the analysis of spatial data. In the statistical literature, however, spatial analysis often means analysis specifically involving spatial location. For example, trend surface analysis is a method of fitting a mathematical surface to observed data values, and explicitly uses the spatial coordinates in the calculations.

Prediction

The purpose of a GIS study is often for prediction. For example, a number of data layers indicative of gold deposits might be combined together to predict the favorability for gold as a new map. Such a map may then be used as a basis for making exploration decisions, or land-use decisions. Prediction is sometimes a research exercise to explore the outcome of making a particular set of assumptions, often with the purpose of examining the performance of a model. The modeling tools of GIS provide the means to apply spatial data in problem solving, and take spatial data beyond simply the retrieval and display of information.

GIS and Related Computer Software

There are a number of computer software products developed for handling spatial data, as illustrated in Figure 1-1. Many of these are computer programs that are similar to GIS in some, but not all, respects. Even amongst the products that qualify as full-fledged GIS, there is a great range in functional capabilities, some excelling at making cartographic products, some being good for map modelling, others offering superior database management, and so on. The following paragraphs provide a cursory survey of some of the software categories. This helps to clarify what is, and what is not, a GIS, and also illustrates some of the factors that have influenced the development of GIS.

Computer Aided Drawing

CAD systems were originally developed for engineering drawings. They employ a vector data structure for representing points, lines and graphical symbols, which means that a point in a drawing is defined by a pair of spatial coordinates (rather than a single number or scalar), and that lines are built up



by a series of ordered points. Areas are represented by boundary lines, also held digitally as strings of connected points. The digital data defining a drawing consists of a large number of coordinate pairs. CAD systems are excellent for the digital representation, spatial transformation and display of drawings, including maps. However, CAD systems on their own are not designed to handle non-spatial attributes, except in a basic manner, and are unsuitable for manipulating digital images. They are therefore not good for handling data tables or gridded data, nor are they able to provide the analytical functions of a GIS. Many of the original GIS were developed with vector data structures for handling spatial data, but later added database management and functional capabilities for analysis and modelling.

Image Processing Systems

On the other hand, IP systems were developed for manipulating and visualizing digital images in raster format, originally images generated principally from satellite sensors and also medical imaging sensors. A raster is simply a lattice of pixels (picture elements) similar to those on a TV screen. Each pixel is like a cell in a rectangular grid. The terms raster and grid are used interchangeably in the GIS literature. Spatial locations of pixels are not stored explicitly with each pixel value, but are stored implicitly by the sequence in which the pixel data is held digitally. IP systems are very strong for the display and analysis of digital images, and the gridded data structure makes the overlap and combination of spatial datasets simpler to compute than in vector systems. However, pure IP systems are often weak at handling vector data and they lack the linkages to tables containing non-spatial attribute data. They are not generally suitable for producing high quality maps, because the boundaries of map units are jagged, although some high-resolution digital images are of map quality. Some of the original GIS were based on a raster data structure and treated all spatial data as a series of gridded layers, like an IP system. When the data being analyzed is spatially distributed over earth's surface (as opposed to images of thin section of rocks, or images of human insides), an IP system is the same as a GIS. Many of the more advanced IP systems have improved their vector handling, can add cartographic annotation to the hardcopy of images, and possess analytical and modelling capabilities.

3-D GIS

GIS designed specifically for 3-dimension characterize the location of each data object in space with three spatial coordinates (x , y for horizontal and z for vertical position). This allows two or more objects that occur at the same (x , y) location to be distinguished by their z value. For geographic data where objects at one (x , y) location only have a single z value, two-dimensional GIS is adequate. Most 2-D GIS have facilities for perspective display of surfaces that are single-valued (not more than one value per location). This is often referred to as a two-and-a-half dimensional capability. The "height" of the surface can be any attribute, not simply elevation. For projects that involve three-dimensional geographic, 3-D GIS are needed.

Database Management Systems

Another important relative of GIS is DBMS, which stands for database management system. DBMS

are computer systems for handling any kind of digital data. Some form of database management system lies at the heart of any GIS, and many commercial GIS are explicitly linked to a particular DBMS. Many of the data collected are stored as tables of numbers and text, with the rows being the instances, and the columns being the attributes. When the location of each site is recorded by a pair of spatial coordinates (i. e. a vector), such tables comprise one of the most important inputs to a GIS. Where a CAD system is used in conjunction with a DBMS, many of the data handling and vector functions of a GIS can be implemented, although the data structures are usually not sufficiently complex for the more advanced analysis and modelling operations.

Desktop Mapping Systems

These are systems mainly for display and query of spatial data. Often they use databases that have already been assembled in a GIS or DBMS. They are less expensive and are easier to learn than a full GIS. They are suitable for users of spatial data that need to visualize and explore an existing database, without getting into database creation or advanced analysis and modelling.

Contouring and Surface Mapping Packages

Where data is organized as a table, with each row being the record of data sampled at a geographic location, the immediate goal of data analysis is often to make contour maps of one or more of the variables, stored as columns of the table. Surface mapping is a more general term for the estimation of surface characteristics from irregularly -spaced point data, not simply expressing the result as contour lines, but also as gridded or triangulated data structures. Some surface mapping systems offer sophisticated analysis, such as the handling of faults in surfaces, permit operations between multiple mapped surfaces, provide visualization and modelling tools, and approach full GIS functionality.

Geostatistics Programs

Geostatistics is the branch of statistics dealing with regionalized variables. A regionalized variable is a quantity whose value changes with spatial location, and whose behavior is somewhere between a truly random variable and one that is deterministic. The behavior of regionalized variables is studied with variograms, which depict the average squared difference between data values as a function of distance and orientation between data locations. Variograms are used in kriging, a method of estimating the value of a regionalized variable from scattered data points. Kriging is a popular method of spatial interpolation for contouring and surface mapping. Geostatistics program packages are normally designed to handle point location data, similar to contouring and surface mapping programs, and can generate co-variograms and co-kriging estimates based on the spatial co-variation of pairs of variables.

Other software

Other programs often used in association with GIS for specialized tasks are spreadsheets, statistical analysis programs, particularly for multivariate analysis, and expert system shells.