SPATIAL DATABASE FOR MODEL ANALYSIS METHODS

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Abstract. In the field of architectural and urban planning and design, computer education needs to move beyond basic computer literacy and have more emphasis placed on special subjects related to planning and design. How to manage spatial data is becoming an essential issue for research and education in planning and design especially in the analysis and evaluation phases. This paper discusses the importance of spatial data in planning education and shows how a common spatial database for model analysis methods was constructed at the University of Tsukuba. The database consists of many geographical and statistical data files classified under the standard region mesh codes and covers the whole country from global areas to local areas. Web-based instructions about how to use the database have also been prepared which enable students to study practical spatial analysis by themselves.

1. Introduction

1.1. COMPUTER EDUCATION FOR SPECIALIZED PURPOSES

In the 90's, the importance of computer literacy education has become to be noticed rapidly. The success of universities which started computer literacy education ahead of their time has encouraged other universities to start their own computer programs. Recently, computer literacy education has even been spreading to elementary and lower secondary education schools. This shows that information literacy education, which started in the school of information technology as a specialized skill, should be regarded as a basic skill that should

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be taught in primary education. Obviously, computer education at the university level should move beyond computer literacy and return to a specialized purpose for each application field.

1.2. COMPUTER EDUCATION IN ARCHITECTURAL AND URBAN PLANNING

There are three aspects of computer use for architectural and urban planning and design: the analysis phase, the synthesis phase, and the evaluation phase. It can also be categorized into planning theory (Model analysis methods, GIS) and design aid (CAD, CG). Most architectural and urban planning schools in Japan have focused on the synthesis phase and have already begun CAD education; whereas, there are only four schools in which GIS education for the other phases is officially taught at present. In the case of CAD education, the condition for starting it is relatively easier if enough hardware and software can be installed. Today, CAD education has been accepted in the mainstream of design education. Apparent effects in CAD are also helping to raise the motivation of students; in fact, many students have purchased a personal CAD system and have already become accustomed to using it without receiving any instruction from teachers.

1.3. EDUCATION FOR PRACTICAL PLANNING THEORY

On the other hand, since GIS education needs more than just hardware and software, it is not as easy to start as CAD education. Spatial analysis is used to evaluate the data of a present condition and plans by applying proper models to them; that is, the principal purpose of spatial analysis is not creating data itself, like design education, but using data. The other reason is that users do not have enough information and skill on how to obtain data for analysis and how to apply it to practical planning theory. Information resources and skills for spatial analysis are usually scattered into individual laboratories.
For these reasons, in order to make GIS popular in education, it is necessary to prepare a common database and instruction set which should be available to any person who is concerned with GIS education.

This paper will show:

1. How a common spatial database for practical research and GIS education was constructed and managed at the University of Tsukuba.
2. How the database is used and how instructions for the practical use of GIS is given to users especially from the view of urban planning and design.

2. Model Analysis Methods and GIS

2.1. MODEL ANALYSIS METHODS IN PLANNING

Spatial analysis is essential to architectural and urban planning and many methods for spatial analysis, such as calculating gravity by an urban facility, finding the shortest path for transportation and overlaying elevation and landuse maps, have been proposed and practiced during the last several decades. Various kind of models, such as the discrete mesh model, the network model and the geometric model, have been introduced as the representations for the space which is to be analyzed. Therefore, to use model analysis methods practically for architectural and urban planning, the spatial data sets should be prepared and should be able to be represented by a particular model in response to the intended analysis method.

2.2. THE PRESENT CONDITION OF EDUCATION

Most practical solutions for spatial analysis methods are based on computing technology. In spite of this, teachers have only taught the theoretical and mathematical aspects of these methods. Students are able to understand only the theoretical aspect of model analysis methods; thus, they are lacking in practical knowledge, especially for information processing, which is necessary when applying model analysis methods to planning theme. For example, even in a simple finding the shortest path problem, students are sometimes required to write a simple program by themselves. Moreover, in solving more difficult problems, like a salesman problem, students are required to have more advanced knowledge and skill for information processing in addition to mathematical theory in order to solve them. Since they lack this practical knowledge, this is very difficult for them to do.

2.3. SPATIAL DATABASE FOR GIS

GIS (Geographic Information System) has been developed as an application software for making model analysis methods to be practiced effectively. GIS allows users to perform complex regional analysis with the combination of simple commands. However, the effectiveness of GIS depends on the quality and quantity of data. Indeed, although various GIS databases have been constructed in the field of research, such databases are not practical enough for education because of their difficult accessibility. Therefore, for urging practical GIS education, it is necessary to have enough data and to have a common spatial database which should be available to every user.

3. Data for Model Analysis Methods

3.1. COLLECTING GEOGRAPHICAL AND STATISTIC DATA

In Japan, the Geographical Survey Institute, which falls under the Ministry of Construction's jurisdiction, has prepared official atlases of Japan, and the National Land Agency has provided the digital archives for the atlases. The Management and Coordination Agency has also provided the national census archives. Currently, WWW technology enables us to overview these up-to-date abstractions. The University of Tsukuba has collected these digital data sets yearly for the purpose of research. The department of policy and planning sciences has managed these data sets on the common file server. These data sets are generally too expensive to be collected by a small unit like a laboratory of a school. However, the amount and variation of the data sets directly reflect how well model analysis methods can be practiced; therefore, collecting data sets is an essential issue for GIS education.

3.2. PROBLEMS IN USING DATA

Although the department of policy and planning science had enough data resources, it was not enough for students to use practically. The problem was that the archives for this data always had specific data formats for each agency respectively and could not be used directly for model analysis methods. Due to this, the original data sets had to be converted and a spatial database at a local site for individual education and research activities had to be constructed. Besides this, the procedure for converting the raw data into a practical database required advanced skill and a lot of effort. For example, the landuse mesh data of Japan in digital archive was provided in a condensed image data format like FORTRAN and its size was sometimes more than 100M bytes. Because of this, students were required to purse data structure and to write a converting program to use only a part of the data in addition to having knowledge of model analysis methods. If students did not have enough knowledge and skill for one of these procedures, they were forced to give up using the data.

Generally, the data sets for GIS are various in kind, expensive to collect, large in size and not ready to be directly used as mentioned above. Taking all this into consideration, a common database needs to be prepared by an organization that has the knowledge, skill and budget to get this done. In the case of the University of Tsukuba, we had already collected a certain amount of data sets; thus, our concentration was mainly on how to construct a common spatial database to be used for education.

4. Constructing A Common Spatial Database for Model Analysis Methods

4.1. FACILITIES

The department of policy and planning sciences at the University of Tsukuba is in charge of computer education. The computer facilities have been carefully maintained and solely managed by the department since its establishment. The facility includes personal computers for information processing, file servers and a network system. In addition to this, in 1994, the Regional Information System was introduced exclusively to be used for the education of GIS, CAD, and CG consisting of networked workstations and personal computers installed with special software for its use. Particularly, GIS software (ARC/INFO) is not only licensed to be available from a specific place but it can also be used in every laboratory of the department via local network. Since these facilities were capable of providing a large database, a common spatial database for education was constructed.

4.2. SPATIAL DATA SETS

The present contents of the spatial database are as follows:

TABLE 1. The present contents of the database.

National digital maps (old)	land elevation, topographical classification, landuse, details of specific areas
National digital maps	specific areas, geographical features mesh, land prices, landuse mesh, roads, railways, administrative boundaries, cultural assets, public facilities, agricultural census mesh, rivers
Other digital maps	administrative boundaries of specific area, detail of metropolitan areas
Digital data of national census	regional statistics mesh, regional population and households

Each data was converted from the original archive data into a basic data unit of ARC/INFO which is called "coverage". The converting program was written mainly in C and each converting procedure needed special skill such as changing byte order. Although, some of the attributes in the original data sets

could be saved by utilizing the relational data structure, all the attributes were kept as schemes of coverage and no special data structure was introduced in constructing the database. Although this made the database structure relatively redundant the primary order was kept to inform users how the original data sets were regarded.

4.3. INSTRUCTIONS FOR USERS

In order to help users practice model analysis with this database, two web based instruction sets were prepared; one is for all users and the other is for students taking classes. Both instruction sets are available via network so that the database can be used anywhere in the school. The former one provides information about the data itself on the common spatial database and the latter one illustrates how to practice model analysis methods using GIS. These instruction sets enable users to learn and practice model analysis methods by themselves. Figure 1 and 2 are examples from the instruction pages.

Figure 1. An example of one of the instruction pages for a digital map. The instruction pages cannot be seen outside the department because of a license contract.

Figure 2. An example of one of the instruction pages for learning how to use the data.

5. Education Programs

5.1. FOR UNDERGRADUATE STUDENTS

At the University of Tsukuba, GIS education for undergraduate students is practiced as a part of basic information processing education for urban planning. This class is practiced in the last semester of their senior year and the main purpose of the class is to teach students how to manage geometric features in urban and architectural planning with the use of CAD and GIS applications. Students are taught how to use the GIS application to help them make geographical data of certain urban areas, add attributes to geographical data and how to make statistical maps from this data in order to learn basic skills. Students must make a geographical database of their hometown in the third of five exercises. This exercise is linked to CAD education and students practice simulating a 3D urban scene with the database in the last exercise. All information for the class, such as the class schedule, course work in the class, instructions for exercises and follow up are provided on web pages. All students' work for each year are also displayed on the web page of the class. Although the original purpose of showing the students' work on the web page

was to critique students' work at the end of the class, it has become an indispensable tool which has helped to raise students' motivation and will help next year's students. Figure 3 shows part of their work submitted at the end of the class.

Figure 3. Examples of undergraduate students' work. This picture is of a statistical map from the database of student's hometown.

5.2. FOR GRADUATE STUDENTS

The class for graduate students is aimed at learning practical urban and regional analysis with model analysis methods and various spatial data. Based on basic skills which are taught in the undergraduate years, students learn about database structure, how to convert data, algorithms for spatial analysis, about model analysis methods, and how to practice model analysis methods with spatial databases. The most important thing that is taught is for the student to learn how to apply everything that they have learned in all the classes to solve specific problems in planning theory. During the class, students use the common spatial database of the department and learn topics from the view of both information processing and urban planning. As the requirement for the class, students have to practice model analysis methods on the themes which are related to their own research, make a digital map of them and then submit a paper on their findings. Figure 4 shows part of their work.

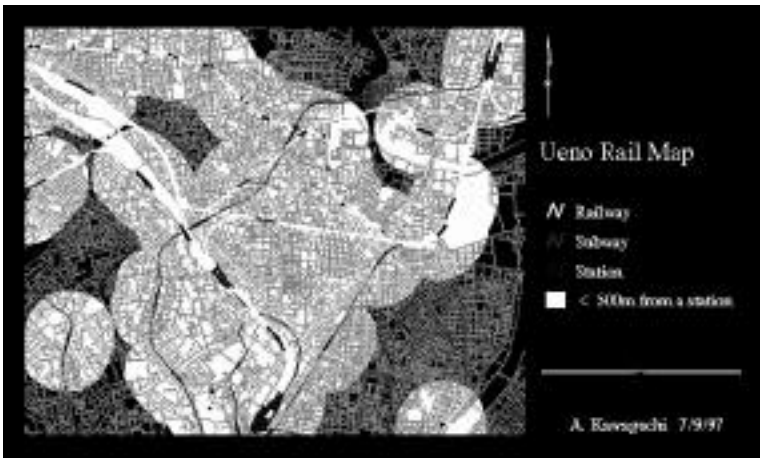

Figure 4. An example of graduate students' work. This digital map was made to analyze the railway network and 500m areas from each station in the area.

6. Conclusion

Computer literacy and use, such as sending e-mail and making home pages, has been accepted by universities for research and education. However, practical use of the computer for specialized purposes in each special research field and education is still under development in many fields. In the field of architectural and urban planning, CAD has already been accepted; whereas, practical use and education of GIS is still under development and the reasons for this are the lack of data, knowledge and skill for GIS even though demands for GIS definitely exist. In order to meet the supply and demand for computer aided planning theory, we prepared a common spatial database and instruction set for it and started practical education programs for it. As a result, graduate students are starting to apply proper model analysis to their own research; moreover, undergraduate students are beginning to apply model analysis using GIS to their own interests.

Future computer education in the architectural and urban planning field should be aimed not only to teach various knowledge and skill but also to educate the student so that they can combine this knowledge and skill in order to run urban policy, planning and management of architectural and urban design projects. How to collect and accumulate existing data should be regarded as an essential issue for organizations and how to manage this data should be regarded as an essential condition for individuals involved with urban and architectural planning and design.

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