AN INTERACTIVE GBF CREATION AND COMPUTER MAPPING SYSTEM

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INTRODUCTION

The Office of Health Services Education and Research (OHSER), of the College of Human Medicine at Michigan State University, has been producing computer generated thematic maps since 1968. We have been utilizing them in conjunction with efforts to create continuously monitored profiles of the health status of various urban communities in the State of Michigan. In this endeavor, OHSER has served as a consultant to help local governmental agencies initiate and maintain various computer assisted statistical and cartographic systems for the processing and display of geographic information. For the most part, these services have included questionnaire development, coding and editing procedures, statistical analysis, GBF creation, and computer mapping.

Since many people with varying capabilities and divergent purposes use our facilities for computer mapping, several concerns have emerged. One of the concerns results from possible delays in creating and processing Geographic Base Files (GBF) suitable for thematic mapping. While computer maps are quick and efficient to use in the long run, their implementation may be a long and arduous process. A second problem encountered concerns a method by which users can produce computer maps. This method would have to be versatile, easily understood, have user feedback and relatively quick turnaround.

An interactive system for the creation of GBFs and computer maps has been designed in an effort to expedite both processes. The system, an integrated set of FORTRAN programs, is designed for general use in an on-line interactive mode. The first part of the system, the GBF creation process, takes a set of digitized coordinated nodes and combines it with a defined set of outline strings to produce master GBFs. Other routines are used to create GBFs in a suitable form for thematic mapping with the SYMAP,[1] CASP,[2] and CALFORM[3] computer mapping programs. The second part of the system, the interactive computer mapping preprocessor, enables users to produce computer maps from various on-line GBF files using their own data and selected parameters. The user has a choice of different sizes, class intervals, and selected legend information for each particular map. Output, in the case of SYMAP, is either sent directly to the user's terminal or routed to a line printer. CASP and CALFORM maps are sent directly to an off-line plotter. With this system, the user can make line printer maps for immediate use as "scratch" maps and plotter maps for more finished production work.

EDITOR'S NOTE: Support for this project contributed in part by funds from ECHO PROGRAM, Genesee County Health Department.

GBF CREATION PROCESS

The creation of a GBF is essential for computer mapping in that it defines the individual zones that are assigned statistical values for choropleth mapping or identified the points used to interpolate statistical surfaces for isopleth mapping. In our work, we have found that choropleth mapping has much utility for both the analysis and presentation of geographic information. Therefore, all of our GBF creation efforts have been pointed towards compiling GBFs solely for choropleth mapping.

The GBF creation process is a relatively easy to follow procedure integrating a set of digitized nodes with a set of defined node strings combined in correct order to achieve a GBF suitable for computer mapping. Other elements in the process include debugging, adjusting, and conversion techniques.

To begin the process, a suitable base map showing the configuration of the various areas is needed. Nodes, which are points on the map where lines intersect, change direction, or terminate, are marked and assigned a unique number. The base map is then put onto a digitizing table where the cartesian coordinates of each node, along with its unique node number, is recorded in sequence.

Having defined all the necessary nodes, the next step is to ascertain the node strings which define the outline of each individual area or zone. The zone node string definitions are a set of instructions expressed in tabular form, that specify, in clockwise order, every node in each zone within the GBF.

The cartesian coordinates of each node and the zone node string definitions are stored on-line in the computer and are combined through a program called MAKEMAP to produce a GBF in our central format. The central format contains a set of records for each zone in the GBF. Each record contains information for each node that is used to define a particular zone. Each record includes the X,Y coordinates of the node, the node number, and the zone number that is being defined.

At this stage error checking and debugging are carried out with the help of several pen plotter routines. There are two types of errors possible in any GBF created by the present process. The X,Y coordinates may be located inaccurately or improperly referenced. The zone node string definitions may be incorrect or incomplete. The program PLTDIG plots all of the zones of the FBF in the scale that it was originally digitized. PTPLOT plots the node number for each node of the FBF at the X,Y location of that node. By overlaying the plot from PLTDIG on the base map and referencing the plot made by PTPLOT, one can determine if the node X,Y coordinates are inaccurate or if the zone node string was incorrectly defined. Once an error has been found, it can be corrected by going back to either the zone node string definition file or the digitized X,Y coordinate node file to make necessary changes. At this point, the original GBF is then debugged or a new GBF can be constructed.

After all errors are found in the GBF and it has been verified, it needs to be adjusted to a standardized form matching the other GBFs in our library. A routine that rotates the entire GBF to prescribed angle, adjusts all node X,Y coordinates to a 0,0 origin, and scales the GBF to a standard format is utilized to make these changes. Simple line plots are used to verify these changes after they have been made.

We use three different mapping programs; SYMAP, CASP, and CALFORM, each

requiring a GBF in a slightly different format. The central format GBF needs to be converted to a format suitable for use in these three computer mapping programs. The GBF is converted into each of the other formats and entered into the MAPSET interactive computer mapping system.

It should be noted that we also have routines that convert any of the three mapping programs GBFs back to the central format. Thus if we receive a GBF from an outside source in either SYMAP, CASP or CALFORM formats, we can convert it to our central format and adjust it for entry into the system.

One aspect of our method of creating GBFs that adds to its flexibility is the ability to produce several different GBFs from a single set of digitized nodes. By defining all the nodes needed, different zone node string definitions can be used to create several GBFs. This can be useful when more than one GBF is needed for a particular place. For example, GBFs of census tracts, police precincts and school attendance areas can be constructed from one set of digitized nodes and the properly enumerated zone node string definitions.

INTERACTIVE COMPUTER MAPPING SYSTEM

As our library of GBFs grew and demands for computer generated maps increased, we found it difficult to remember what GBF corresponded with what data set and which parameters were used in each appropriate situation. Further, much of our time was taken up in just producing maps which did not allow us adequate time to study in-depth the data being mapped. Turnaround time was also very slow since we were operating in a batch mode. What we needed was in integrated system that would combine the previously created GBFs with data under the constraints of certain needed parameters to produce computer maps interactively and so simply that any user with a minimal amount of training could produce his own maps. This system would prove expecially useful in our workings with users in local community governmental offices in their needs for the cartographic display of information.

MAPSET is such a preprocessor system for making computer maps. MAPSET acts as an interface between the interactive user and the batch oriented computer mapping programs. It allows anyone with a minimum of computer mapping knowledge or knowledge about computers to make a computer generated map. One can enter data and save it as a permanent file, or use data already on a permanent file, specify several different cartographic parameters, and obtain a SYMAP, CASP, or CALFORM computer choropleth map for any GBF in the MAPSET system library, all interactively by using a computer initiated question-answer routine.

A computer initiated question-answer routine was developed in an attempt to lead users through the process of creating a computer map. The user is prompted through "menu selection" for the information needed to bring together a GBF, data, and several cartographic specifications. Receiving responses from the user, the system checks for valid replies, takes appropriate action, and prompts for a new response. The entire process terminates when the user has finished producing one or more computer maps.

Our maps are produced for two main purposes: for use in publication and for immediate study of geographic data. We included SYMAP in the MAPSET system to allow the user to produce low quality line printer maps at a computer terminal

in about ten minutes. The SYMAP maps are used as "scratch" maps for the immediate interpretation and analysis of geographic information and for making decisions about the choice of appropriate cartographic parameters (shadings, class intervals, etc.) for more finished work. These are quick to produce but too low quality for publication. For publication purposes, we found that CASP and CALFORM maps were of a high enough quality for reproduction and printing. However, they have to be disposed to a pen plotter extending turnaround time to about one day.

CONCLUSIONS

The interactive GBF creation and computer mapping system has been utilized in health planning and urban policy in a variety of situations. The bulk of our work has been in published reports of various urban communities on such topics as social indicator mapping, environmental deficiency reporting, and health and medical care status. Individual researchers have used the system for their own varied research directions in analyzing geographic data. Instructors at the College of Human Medicine have used maps produced by the system for their teaching needs. The simplicity, flexibility, and rapidity of the system has enabled many individuals to use computer maps, opening up this form of graphic presentation to a wider audience. The overall role of the interactive GBF creation and computer mapping system in a daily work schedule has been to decrease the turnaround time of both GBF creation and computer mapping as well as allowing easy access for general users needing mapped information in a relatively short period of time.

REFERENCES

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