Technical Report CS74028-R

THE ROLE OF AUTOMATIC DIGITIZERS IN DEMOGRAPHY

Charles M. Williams

December 1974

Department of Computer Science, Virginia Polytechnic
Institute and State University, Blacksburg, Virginia

Abstract

The incorporation of facilities for automatically digitizing maps and drawings can considerably enhance the power of the computer in demographical research. A hardware-software process is described which can rapidly, economically, and automatically digitize hard-copy maps and drawings. The resultant computer data structures are a faithful and accurate representation of both the original geometry and topology and may thus serve as a direct source of data for analysis or display. The potential uses for this system appears to be large for, though maps and drawings are of fundamental importance to demographers, their transduction into computers has historically been stymied by the problems associated with tedious, inaccurate, and incomplete manual methods.

The digital computer has provided modern demographers with a powerful mechanism for rapidly analyzing and summarizing the massive volumes of data which presently confront them. High quality maps and diagrams, however, have proven difficult and tedious to introduce into computer data bases by the manual or semi-automatic digitizing methods standardly employed. As a result excellent computer analyses of geographically distributed data are often inadequately displayed in a tabular form rather than in a far more comprehensible cartographic form graphically portraying its spatial characteristics.

The accompanying figure is an example of a digital replot of a map processed through totally automatic means. The original hard-copy document was converted into numbers by means of a Visicon automatic digitizing system [1]. These numbers were then fed to graphic collation software [2] (operating in an IBM 370/158 computer) and processed into a lineal form capable of being replotted on a digital plotter. The process is totally automatic and rapid, requiring roughly two minutes for digitizing, three minutes for graphic collation and ten minutes for replotting.

The automatic digitizer provides the demographer with a rapid and repeatably accurate method for entering graphical data into a computer. The graphic collation software then provides him with both geometrical and topological properties of the data. These geometries are a faithful representation of the original lines on the document and include (varying) line thicknesses sampled at up to 200 points per inch. The topological properties are derived by combining line descriptions with recorded positions of line terminations and junctures. The system, however, is not restricted to lineal forms and is capable of processing

arbitrarily complex graphical designs. It is written in FORTRAN II and can operate on computers which support that language.

The immediate consequences of this process are that spatially organized data may be plotted onto maps which have also been generated by the computer. If data is correlated with such coordinate information as latitude and longitude such a superposition is a straightforward task. Moreover, the computer can easily rescale or reorient both data and maps into any desired form before replotting them.

A longer range consequence of the process is that it can permit a map to act directly in the analysis process itself. The current system, for example, can isolate and identify boundaries of closed regions and thereby permit perimeter and area calculations. Moreover, the network descriptions which it can provide from (say) road maps can serve as a source of data for transportation and mobility analyses. Future versions of the system should be able to allow maps to act directly in an information retrieval capacity. It should be possible, for example, to allow maps of political subdivisions to partition existing census data by keying on positional coordinates automatically defined by graphic collation. This type of retrieval is difficult by standard techniques because of the tedium of mathematically defining the perimeters of complexly shaped regions.

In summary, the potential uses for this totally automatic digitizing system appears to be large, for though maps and drawings are of fundamental importance to demographers, their transduction into computers has historically been stymied by the problems associated with tedious, inaccurate, and incomplete manual methods.

REFERENCES

1. Broomall Industries, Inc. 682 Parkway, Broomall Pennsylvania,
    19008, U.S.A.

2. Williams, C. M. 'The Automatic Transduction of Drawings into Data
    Bases', Proceedings of AFIPS 1973 National Computer Conference
    (June 1973), pp. 635-637.