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SOME THOUGHTS ON AN ARCHAEOLOGIST'S TOOLKIT

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Abstract

The interactive use of computers has been gaining in popularity for some time. This style of computing brings with it the possibility of using the machine as a tool for thinking. Nevertheless, the degree of interaction of much of the available software remains limited and the style of interaction, using a conventional display screen and keyboard, remains primitive. Modern microcomputers and, in particular, the more powerful personal workstations, provide us with a good alternative method. In addition to their basic processing capabilities, many of these machines provide extensive graphical and word-processing facilities which may be combined in an integreated approach to analysis and report preparation. This paper explores some aspects of the established software tools approach and discusses how a more integrated use of computers can result from the adoption of a style of computing based on thinking tools.

Introduction

Archaeologists use a wide variety of tools. In the field there are excavation and surveying tools. In the library there are books, journals and catalogues. In the laboratory there are yet more tools for the examination and conservation of artefacts. Of a less physical nature are the conceptual and theoretical tools which inform the everyday practice of archaeology.

This paper is concerned with another group of tools which is becoming increasingly relevant to the working activities of archaeologists: computers and the software which runs on them. My intention is, in part, to draw attention to the wide range of tools which are available on existing computer systems, and so to reinforce the comments of Irwin Scollar (1982: 196) at an earlier Computer Applications in Archaeology conference when he cautioned against attempts to 're-invent hexagonal wheels which bump down the problem road as if nothing has ever been done before'.

It is often remarked that the typical computer user is not interested in the hardware and software per se, only in using them as tools to simplify or assist in the practice of their trade. A thorough appreciation of existing software can help such users to make optimum use of available resources. However, there will always be applications to which existing tools are not suited. Equally, there will always be a number of individuals both within and around the fringes of Archaeology who maintain an interest in the development of new tools to solve problems arising from their own and their colleagues' research. It is equally important that this group appreciates both the range of existing tools and the algorithms upon which they are based.

This paper reviews three types of computing tool which may be grouped under the following headings:

Software Tools
Graphical Tools
Thinking Tools

The use of existing tools will be examined using the analysis of archaeological stratigraphy as an example task.

Software Tools

The term Software Tools is frequently used to describe both the tools themselves and the methodology that underlies their development and use (Kernigan & Plauger 1976). Historically this approach arose amongst computing scientists who required a tool that could be used in the development of software. They needed tools which could be used to make other tools.

Software Tools are programs which:
- are simple and easy to use
- are flexible
- help to do things by machine rather than by hand
- help in producing other programs
- work together

The software tools approach is exemplified in the design of the UNIX operating system and its utility programs. In general the tools are designed to perform a single task and are given only a limited range of options to control their operation. Many of them can be used with a pipe mechanism which allows the output of one program to be passed directly to the input of filters. Examples of this use include the various filters which may be used with the text processing and typesetting software (nroff, troff) to process bibliographic material (bib, refer), diagrams (pic), tables (tbl) and mathematical expressions (eqn).

Other typical UNIX tools include:
- GREP: search a file for a pattern
- UNIQ: report repeated lines in a file
- COMM: select or reject lines common to two sorted files
- SORT: sort or merge files
- TSORT: topological sort
- JOIN: relational database operator
- AWK: pattern scanning and processing address

Although these examples are taken from a typical UNIX system, it should be readily apparant that many similar functions are provided by other operating systems and utility libraries. Not all UNIX tools achieve the criteria outlined above. New users may be forgiven for assuming that AWK is short for awkward. For although this program is extremely powerful and flexible, it can hardly be claimed to be simple to learn or easy to use.

It is not immediately apparent that the TSORT program should have archaeological applications. Its usual application is in ordering the contents of subroutine or function libraries in order to avoid forward references. In practice, however, this is an application of the more general topological sorting problem which aims to order the members of a partially ordered set. As John Haigh (this volume) points out, this is similar to, but not identical with, the problem of solving the ordering of stratigraphic contexts. In practice, the differences which he outlines have no effect on solutions generated by the algorithm used in TSORT.

A simple example of the use of this program will illustrate its application to the stratigraphic problem. Using the following input data from part of a hypothetical site, which should be understood to represent 'x is above y' relationships:

a b
g h
e h
c d
f g
a c
b e
a f
d e

TSORT produces the following results:

a b c d e f g h

Although this is a correct solution to the partially ordered set problem it is not presented in a form with which archaeologists are particularly familiar. Specifically, the linear solution hides information about parallel stratigraphic sequences. In the example shown here, it is not apparent, for example, that layers b, c and f are all sealed by a. What is needed is an indication of links as well as the simple order of nodes in the network. This suggests that a graphical display would be more appropriate.

Graphical Tools

The term graphical tools is used here simply to indicate those tools which produce some form of graphical output. The increasing use of microcomputers, both as independent processors and as terminals to mini and mainframe computers, means that graphics are no longer the preserve of those fortunate enough to have access to special terminals. As a result, graphical tools are becoming more widely available.

Some existing tools may quite easily be enhanced by the addition of graphical output. This, of course, presupposes access to source code. In many cases this is not possible, but there is an ever growing body of public domain software available for a variety of operating systems. UNIX users are particularly well served in this respect. In addition they may be fortunate in working at a site which has a source licence, thus enabling use to be made of utility software sources, subject of course to the conditions of the licence.

The TSORT program can be adapted for general graph/network representation simply by the additon of a few lines of code mostly comprising calls to a library of graphics functions. The result is a simple graphical tool with potential applications in a wide range of areas including the analysis of program structure, social networks and archaeological stratigraphy. Figure 1 shows the results obtained from the input used in the previous example. The graphical output format is considerably more meaningful to an archaeologist.

It would be quite simple to enhance this program further to improve the layout of the display and to minimise the number of crossing links. The result would be a useful tool that was capable of isolating inconsistencies in the data and producing intelligible displays. As such it would be equivalent to previous developments in this field such as STRATA (Wilcock 1981) and its derivatives.

However, I would suggest that this approach is somewhat limited. In the remainder of this paper I will discuss one possible route for future developments in the computer-assisted analysis of stratigraphy.

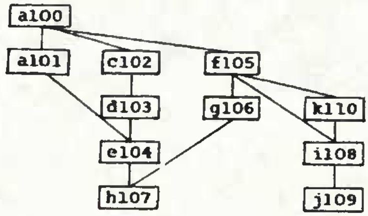

Figure 1: Example of modified output from TSORT

Thinking Tools

The tools discussed so far are deterministic in the sense that only one possible output may result from a given combination of input data and options. In general this is, of course, the desired effect, but in many applications there is a wide range of possible outcomes. The graphical tool for analysing stratigraphy is one of these. Although it will produce a logically correct solution to the problem, it is unlikely that in the form described here it would ever produce wholly satisfactory diagrams.

A major aim in the graphical presentation of data is to communicate information. When producing diagrams, whether in the course of data exploration, or to communicate information to others, in publications or as lecture slides for example, it will invariably be necessary to simplify in order to gain clarity. This requires facilities to manipulate and edit the diagrams which could be achieved by either a general purpose graphics editor or by introducing user mediation into the tool itself.

The interactive thinking tool concept presupposes that the user will employ professional skills in using the program so that diagrams may be manipulated in order to illustrate important information clearly. Such tools should tailor the general functions of the software tools approach to specific user needs by the provison of an interactive interface. The interface should present information to the user in a form which reflects standard practice in the application area. In other words, a stratigraphic sequence should be presented in classic Harris (1979) form, not as a table of numbers or as an arbitrary representation of a network. Thus the general applicability of the underlying algorithmic tools may be extended to a wider user community. This approach could be followed in order to produce a highly interactive tool for both thinking about and analysing archaeological stratigraphy. As an added bonus, it also would be capable of producing illustrations to publication standard.

The full potential of thinking tools can only be realised by using a powerful microcomputer or personal workstation with a bit-mapped screen and multiple window display facilities. The fundamental characteristic of such a program which distinguishes it from its antecedents lies in the manner of interaction between user and data which can be exploited with such machines. The majority of interactive software works in response to commands typed on the keyboard. Commands may be selected from a displayed menu, or the user is expected to memorise them. In practice, most systems which employ the latter approach

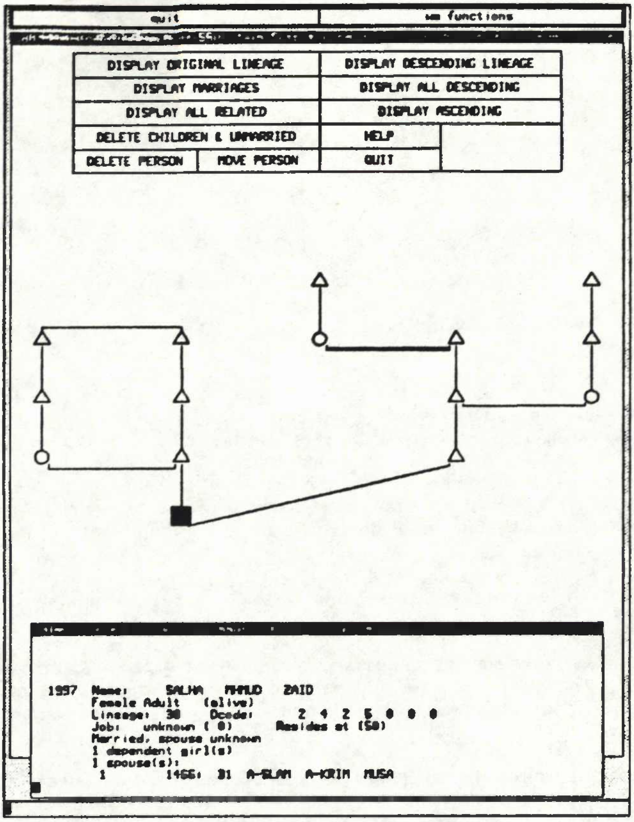

Figure 2: Example display from the GTREE genealogical tool.

provide some form of help commnand to obviate the need for frequent recourse to a printed manual. In contrast, the user's interaction with a bit-mapped screen is largely graphical, use of the keyboard being minimised. A pointing device, referred to as a mouse or puck, is used both for direct input of graphical information in the form of x-y coordinates, and to move a cursor around the display. It may be used to point at and select from displayed items. This ability can be used to retrieve any stored information concerning the selected item. A similar mechanism could be employed to ask questions. For example, what is the relationship between two given items?

The range of functions provided in an interactive stratigraphic thinking tool would be as follows:

- read data and build stratigraphic network
- calcualte display positions
- display network
- select and option:
  - display network
  - display earlier contexts
  - display later contexts
  - display all adjacent contexts
  - edit diagram:
    - move context
    - remove context
    - expand feature
    - compress feature
  - help
  - quit

The program as described is concerned solely with display and analysis of networks of stratigraphic relationships. Possible extensions might include the ability to include other relationships defined by attributes of the stratigraphic contexts, such as the link between those in which a particular artefact type has been found. In this way it would be possible, for example, to examine the distribution of artefacts against the background of stratigraphic relationships.

Finally, in order to show how such a program might appear to the user I include an example of a similar tool which was developed to aid the analysis and examination of kinship relations by Social Anthropologists. Essentially, this is also a problem of the display and manipulation of a network of related nodes. Figure 2 shows one possible display from this tool. The available options appear in the menu box above the diagram in the main window, and information about selected individuals is displayed in the small window towards the bottom of the screen. The design and operation of this program will be described in detail elsewhere (Ryan 1985).

Conclusion

Considerable time and effort may be saved in the production of specialised software in areas such as archaeology by an understanding of existing tools, many of which have applications far beyond those for which they were originally intended. Where the solutions offered by these tools are not appropriate it may often be possible to achieve the desired results by minor modifications to the source code, or by a study of the alogrithms employed. The examples discussed in this paper have ranged from the everyday tools of the computing scientists to a specialised thinking tool which addressed a specific task within Social Anthropology. The ease with which such tools may be adapted demonstrates how a clear understanding of the underlying problem helps to avoid re-inventing the wheel.

The design for an interactive stratigraphic thinking tool outlined above represents a potentially valuable tool which, given wider availablity of appropriate hardware, could reduce the burden of mechanical tasks involved in analysing stratigraphy. It provides an example of the kind of tool which might be used in the integrated text and graphics production environment which can now be provided on the more powerful microcomputers and personal workstations. The ability to display different structural views of data also suggests potential applications to teaching.

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