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Computers and the Teaching of Airphoto Interpretation

The technique described allows the computer to check the correctness of the student's interpretation.

Introduction

The assembly of a series of practical exercises in airphoto interpretation is frequently the result of trial and error over a period of years. Identifying and obtaining sets of photographs which illustrate not only the general principles of photo interpretation, but also serve to introduce the student to either a particular geographical area or field of study, or both, takes time. While available workbooks and other publications provide valuable material, one of the basic problems remains, that of checking the student's results.

Frequently a student exercise begins "Identify the objects numbered one to n. . . ." Alternatively, he may read "Compile a land use map from. . . ." The former task is useful in the initial stages of a course in that it directs attention to a particular feature and aids checking of interpretation with large classes. The latter rubric may be open-ended in which no guidance is given as to a classification system. This has merit, but at a more advanced level. Where a particular classification scheme is to be used the problem becomes one of checking. Because no two students produce identical thematic maps (under normal circumstances), an overlay helps the checking process which still remains laborious and open to error. In discussing why a particular interpretation is incorrect the problem of the positioning of boundaries also arises, and while this too is an important part of the learning process it diverts attention from the interpretation.

It is possible to overcome some of these problems by drawing up a rigid specification. This solution might be quite acceptable for in-service training but would present problems in a more general educational environment with the need to produce interpreters who would be flexible and not constrained by a particular organizational framework.

The increasing trend towards cartographic data banks and the widespread use of lineprinters to produce thematic maps led the author to experiment with the use of a computer as a means of displaying thematic maps based on air photo interpretation. The use of computers in this way allows students to be simultaneously introduced to three aspects of data collection, manipulation, and display in addition to the interpretation of the air photo. These aspects are—

- Collection of data from air photographs using regular grid sampling,
- Creation and manipulation of cartographic data banks, and
- Automated output of spatially distributed data.

In addition the method also enables the instructor to be relieved of the tedious task of correcting students' work and makes his assessment of that work more rigorous.

Data Collection

The data collection part of an exercise involves systematic sampling of the study area. Ideally, if the data are to be incorporated into a data bank, the grid used should be a national survey grid. In Australia this would be the Australian Map Grid (AMG) which is based on the Universal Transverse Mercator Grid.

For reasons of cost, simplicity, and ready availability the most acceptable system for generating graphic output is the computer lineprinter. The use of a lineprinter, however, presents problems in that the characters printed are rectangular and not square. Using the national survey grid as the basis for digitizing would produce output which, if uncorrected, would be stretched in one direction. Thus, the output could not be directly superimposed on the source document. For instruction this would be an

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important feature; for this reason it was decided that the grid to be used for digitizing would not be the national survey grid, but an arbitrary grid based on the character size of the lineprinter. With a lineprinter operating on ten characters per inch horizontally and six characters per inch vertically, a grid was established based on three characters horizontally and two characters vertically. Such a grid approximates reasonably closely to a square without producing too large a grid interval. Alternatively, a 5 by 3 set of characters is the smallest arrangement available to produce a square grid.

A further reason for not using the national survey grid is that the data are collected directly from the air photographs on which a grid is superimposed. The effects of tilt and ground relief would introduce another problem into the exercise if the national survey grid were to be used. While this is an important aspect of data collection it is an additional complication not generally welcomed in the earlier stages of an airphoto interpretation course.

Initially, students were asked to construct their own grids on the air photographs. It soon became apparent that the accuracy with which the grids were constructed varied considerably. Therefore, grids are now premarked on the photographs. Otherwise, the instructor would have to determine if a problem is due to incorrect location of the grid or incorrect interpretation. At the present time the exercises operate with stereotriplets, the grid being marked on the central photograph.

To avoid problems which involve a subjective judgement, the use of the grid cell itself as the basic unit was abandoned in favor of using the grid intersection. It might be argued that by using the grid cell that the major components of the area are recorded and this ought to be the method used. This paper does not attempt to review the arguments in favor of one system or another in general terms. In the context of planning this particular project the main objective was to eliminate as far as possible errors other than those arising from incorrect interpretation. Two possible situations are shown in Figure 1. A decision as to which category each square should be assigned will clearly be subjective. For example, classes A and B cover 50 percent of the area of each of the top two grid cells, while in the two lower cells there is a three way split between A, B, and C. If each grid cell can only be recorded as a single class, then there is no unique answer and assessment of the student's work is very subjective. The location of the grid intersection, on the other hand, is objective and the student has only to interpret the feature at that point. This is not to say one method is better than the other for general use. The nature of the data being interpreted and their intended use will affect the choice of method.

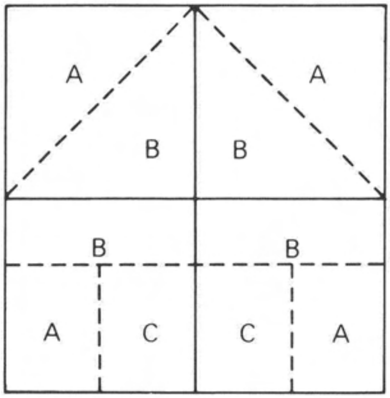


FIG. 1. Hypothetical land use map (dashed lines) with grid (solid lines).

This objectivity is important when checking students' work because the computer is able to calculate a percentage correct figure which refers to the correctness of the student's interpretation of the air photograph and does not incorporate variables such as grid location or a dubious decision as to which feature covers more than 50 percent of a grid cell.

Data Processing

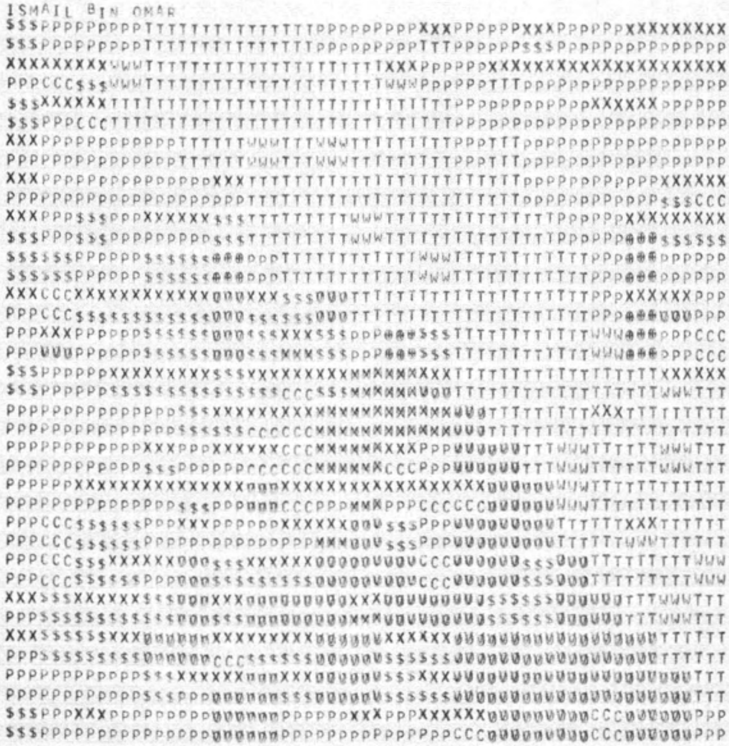
Even with clear instructions regarding the collection and presentation of the data, errors continue to be made. To reduce the frequency of these errors a separate program was written to operate on a minicomputer (PDP-11T34) to which students have direct access on a cafeteria system. This allows students to input their data and produce a simple lineprinter map. If the data set does not have the correct dimensions (e.g., a row missing), the computer rejects the data and the student needs to look for the source of the problem.

When the data have been checked, the card decks are handed to the instructor who runs them on a larger computer. His program checks each student's data matrix with the correct data matrix, and computes the percentage correct and the percentage of each land use category (or whatever is being interpreted). In addition, an error matrix indicating the ways in which each point has been interpreted or misinterpreted is produced. While each exercise is being checked, a running total of the error matrix is also calculated. This allows the instructor to check if a particular error in interpretation is common to the whole class or only to a few individuals. The program* is written in FORTRAN as a series of subroutines which can be called up in varying combinations to produce single map outputs, compare changes in land use, and so on.

Data Output

As the system is currently arranged each student receives three maps:

(1) A map showing his interpretation and where he has made a mistake in interpretation (Figure 2). This is done by putting XXX in the top row of the appropriate grid cell and the student's interpretation beneath. Beneath this map is an indication of the percentage area covered by



LAND USE	KEY	PERCENTAGE
WATER	WWW	3.5
URBAN/RESIDENTIAL	MMM	3.0
COMMUNICATIONS	CCC	5.0
RECREATION	@@@	1.5
FOREST	TTT	25.1
ARABLE	$$$	16.0
PASTURE	PPP	30.8
ORCHARDS/VINEYARDS	UUU	15.0

PERCENTAGE CORRECT 75.7

FIG. 2. Student map with corrections.

* Copies of the program may be obtained from the author who makes no claims to being anything other than an amateur in this field.

each land use and a statement of the percentage of data points correctly interpreted. The percentage land use figures are based on all the grid cells and include mistakes.

(2) The second map (Figure 3) shows the student's uncorrected version as it would normally appear together with the key.

(3) The third map (Figure 4) shows the instructor's version and the key together with an error matrix indicating where the student has gone wrong.

By using the maps and data the student can directly relate the maps to the air photo and see his errors of interpretation. If he consistently misinterprets a particular land use type and usually assigns it to another, then there is a fundamental error in interpretation being made. On the other hand, a random distribution of errors normally indicates the usual problems faced by a student in learning air photo interpretation. The student and instructor are thus able to direct their attention to specific problems of interpretation without the need to worry if they are looking at different points.

Conclusions

Although the method described fails to

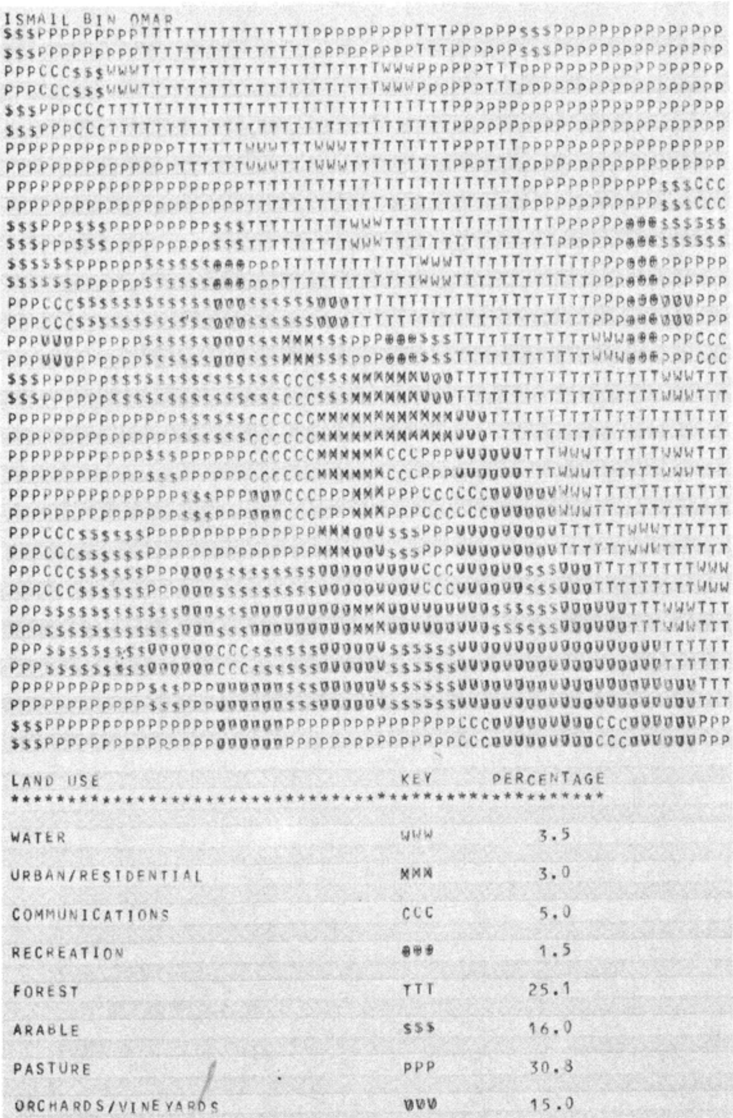
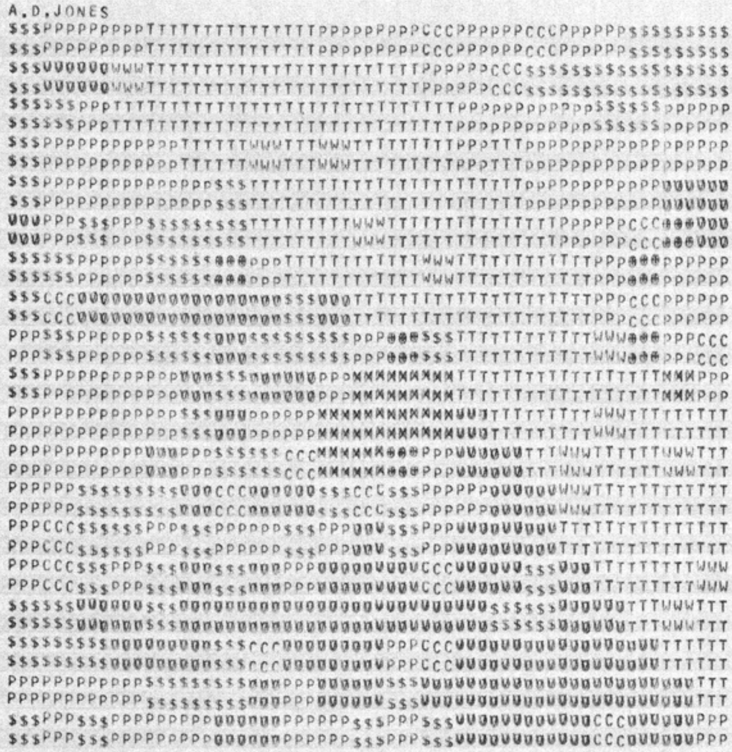


Fig. 3. Student map without corrections.



LAND USE	KEY	PERCENTAGE
WATER	WWW	3.0
URBAN/RESIDENTIAL	MMM	2.5
COMMUNICATIONS	CCC	4.0
RECREATION	###	1.5
FOREST	TTT	24.6
ARABLE	$$$	17.8
PASTURE	PPP	25.8
ORCHARDS/VINEYARDS	UUU	20.8

ERROR MATRIX DOWN A.D.JONES ACROSS ISMAIL BIN OMAR

	1	2	3	4	5	6	7	8
1	11	0	0	0	1	0	0	0
2	1	8	0	0	0	0	0	1
3	0	1	7	2	2	3	1	0
4	0	0	1	4	0	1	0	0
5	2	0	0	0	96	0	0	0
6	0	1	2	0	0	32	34	2
7	0	1	5	0	1	7	88	1
8	0	1	5	0	0	21	0	56

FIG. 4. Instructor's map with error matrix.

use a standardized grid system, this is more than countered by the advantages of being able to directly relate back to a single photograph. It has been operating for three years and it is hoped that most of the problems have been encountered. The transition to the problems of data input based on national survey grids, at a later stage, is made easier, if this is required. Further refinements are clearly possible, but the aim here is to produce a simple system which allows the checking of air photo interpretation *per se* without all the other problems usually presented in land use mapping and the like.

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