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SHORT NOTE

POSTSCRIPT ROUTINES FOR DISPLAY OF WATERSHED DATA

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INTRODUCTION

Frenkel (1988) quoted Richard Weinberg: "Computing, ..., without visualization, is like assembling a jigsaw puzzle in the dark." Visualization is critical for scientific data, especially in presenting numerous grid-based data for spatial analyses. Without visualizing analysis output, a researcher has difficulty in describing the results. However, presenting such data on an A4 or letter size sheet with a general Postscript (PS) (Adobe, 1990) the laser printer is not economically attainable. Some commercial geographic information systems (GIS), although providing such a capability, generally require tedious preprocessing of data or are expensive to obtain. A GIS may pose limitations such as lack of flexibility in satisfying the researcher's requirements, limitation of the number of grids, and file incompatibility between various printers. Color output from a GIS, although impressive, is expensive to produce on a color printer and to publish in a report, document, or journal.

A researcher generally presents his/her results in black-and-white type on a sheet of paper of standard size. Finding a tool to present data easily such as both drainage directions and gray values expressing elevation for a watershed with more than 2000 grids on A4 or letter sized sheet of paper from a laser printer can be a difficult task. Therefore, in this work, PS routines are developed to present a data set with numerous grids.

Developing the PS routines stems from the author's previous attempt to prepare numerous grid-based watershed data for a research report (Kao, 1992) and a paper submitted to a journal. Although several GIS such as IDRISI (Eastman, 1992), PC ERDAS (ERDAS, 1991), GRASS (USACERL, 1993), and PC ARC/INFO (ESRI, 1990) were available to the author during preparation of the manuscripts, none could be used easily to produce the grid data set shown in Figure 1 on a generally accessible PS laser printer in a batch fashion without undertaking tedious data preprocessing for each grid data set. The flexibility provided by the PS routines enables use of some UNIX shell scripts such as PERL (Wall and Schwartz, 1992) to produce inexpensive hard copies automatically for grid-based watershed related results.

POSTSCRIPT ROUTINES

Nine major PS routines have been developed: ***box***, ***arrow***, ***arrow8***, ***pbox***, ***boxArrow***, ***showIndex***, ***nbox***, and ***dl***. These routines are described briefly below; a detailed description of routine arguments is found in the source code placed in the anonymous IAMG.ORG ftp site.

- ***box***: draw a box at a specified location in a specified size, rotated by a specified angle, and shaded according to a specified gray value.
- ***arrow***: draw a filled arrow of a specified size at a specified location; this routine is modified from a sample program provided by Adobe (1990).
- ***g arrow***: draw a general arrow and its boundary.
- ***boxArrow***: draw an arrow inside a box.
- ***arrow8***: draw an arrow, in one of eight directions, inside a box or from the current box to the center of the pointed adjacent box.
- ***pbox***: combine ***box*** and ***arrow8***; the arrow is placed at the center of a box.
- ***showIndex***: show an index inside a box; the index can be a number or a string.
- ***nbox***: combine *box* and *showIndex*. • ***dl***: draw a line between two specified points of a given width and gray value.

Routines **pbox** and ***nbox*** are written to present general grid data in a uniform format, although combination of ***box***, ***arrow***, ***g arrow***, ***arrow8***, ***showIndex***, and ***dl*** may be used to present complex or irregular grid data.

ILLUSTRATIVE EXAMPLES TO DEMONSTRATE THE USE OF THE PS ROUTINES

Figure 1 shows a sample grid data presentation generated by the PS routines. Several typical graphics are provided in the figure: shaded/unshaded box,

indexed (number and string) box (or grid), arrow and box, connectivity, and other miscellaneous presentations. These typical graphics are described briefly below with illustrative examples; detailed usage is provided in the source code placed on the IAMG.ORG ftp site.

Before the examples are described, special features of PS codes are explained. A routine call in PS differs significantly from that in another computer language. Arguments to a PS routine are provided in front of the routine name. The origin of the PS coordinate system is the lower left corner of a sheet of paper. The drawing areas of a A4 and a letter sized sheet of paper are 21 by 29.7 cm and 21.59 by 27.94 cm, respectively. For gray values used in a PS program, white is represented by gray value = 1 and black is represented by gray value = 0. A PS main program generally begins with the "newpath" statement to define a new graphical PS page and ends with the "copypage" statement to display the resulting graphical page on an output device. PS routine calls to developed routines, as demonstrated below, can be included between these two statements.

Shaded/unshaded box

Examples

1.3 2.4 0.3 ***box*** or

1.3 2.4 0 0.3 ***pbox***.

A box with a predefined size (defined by the PS variable of bSize, please refer the source code on the ftp site) is shown at the location (1.3 cm, 2.4 cm) in the PS coordinate system and shaded with a gray value equal to 0.3. Replacing 0.3 by 1 reveals an unshaded box.

Indexed box

Example

1.3 2.4 8 0.3 ***nbox***.

This routine call to ***nbox*** displays a box at the location (1.3, 2.4 cm), shaded with gray value equa to 0.3, with the number 8 at the center of the box

Example:

1.3 2.4 (pp) 0.3 ***nbox***.

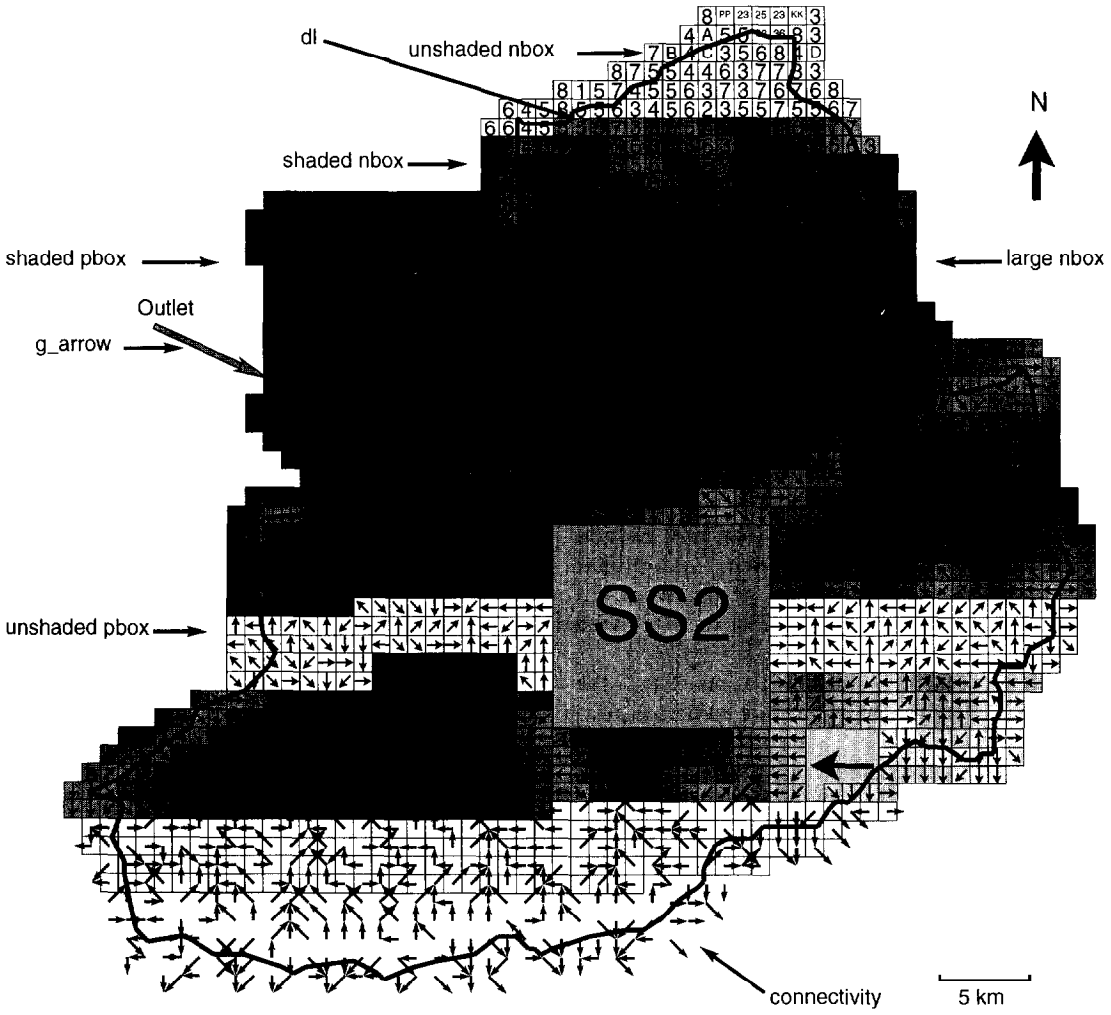

Figure 1. Sample grid data presentation for watershed.

This routine call shows the string "pp" as the index instead.

Arrow and box

Example

1.3 2.4 3 0.5 ***pbox***.

This routine call to ***pbox*** displays a box at the location (1.3, 2.4 cm), shaded with a gray value equal to 0.5, with an arrow at the center of the box pointing left, east. The third argument is a direction number between 1 and 8 (1-north, 2-northeast, 3-east, 4-southeast, 5-south, 6-southwest, 7-west, and 8-northwest).

Connectivity

Showing a drainage direction inside a grid according to the above pbox example does not clearly reveal the connectivity of the drainage pattern. The connectivity is shown more clearly according to the following PS routine calls.

Example

1.3 2.4 0.8 ***box***

1.3 2.4 4 0 ***arrow8***

These routine calls first display a shaded (gray value = 0.8) box at (1.3 cm, 2.4 cm) and then display an arrow from the center of the current box to the center of the southeast adjacent box. If the fourth argument to ***arrow8*** has 0 replaced by 1, these two routines are equivalent to the following ***pbox*** routine call.

1.3 2.4 0.8 ***pbox***

Miscellaneous graphics

Figure annotation, caption, direction, and scale generally are required for a grid data presentation. These presentations are provided with a few basic PS routines such as ***moveto*** (specify where to show) and ***show*** (show a string), and ***arrow***, ***g arrow***, or ***arrow8*** can be used to draw various arrows on a figure. Several samples of these general presentations are provided in the sample code placed on the ftp site.

A PERL PROGRAM

A simple PERL program is developed here to convert grid-based data into a Postscript file for producing a desired graphical output. The program can be executed by the following command

genPS **[*-n*| *-N* |*-c*] [*-h* #] [*-w* #] *-m maskFile***

[*-a attributeFile*] [*-d directionFile*] [*-g grayFile*]

where genPS is the program name; ***-n*** is an option to show the values specified in the ***attributeFile***; ***-N*** is an option to show the grid indexes, numbered from left to right and top to bottom; ***-c*** is an option to show the connectivity plot based on the directions specified in the directionFile; ***-h*** is an option to specify the height, in cm, of the page area for presenting the data set, default value is 20 cm; ***-w*** is an option to specify the width of the page area, default is 16 cm; ***maskFile*** is a required file to specify the grids to be shown; ***attributeFile*** is an optional file to provide the value of an attribute of each grid; [bdi]directionFile is an optional file to specify the drainage direction of each grid; and ***grayFile*** is an optional file to specify the gray value of each grid. A sample drainage direction file is provided in Appendix A. The formats for ***maskFile***, ***attributeFile***, and ***grayFile*** are similar to those found in Appendix A. However, values for ***maskFile*** must be either 1 (marked) or 0, values for attributeFile can be any value, and values for ***grayFile*** must be between 0 (black) and 1.0 (white). The source code of this PERL program is also put on the anonymous ftp site.

CONCLUSION

The PS routines provide an inexpensive alternative to presenting a data set with numerous grids for watershed related information. A PS file is accepted widely by many output devices. Although the routines are developed originally for a watershed data set, other data in a similar grid-based format can utilize also the routines to produce various graphical outputs. The user has flexibility in combining the provided routines to present a data set in the described grid-based format. Any unnecessary routine can be removed from the program without causing any problem. The complete listing of the program and data sets used to generate Figure 1 and the PERL program described can be obtained from the anonymous IAMG.ORG ftp site.

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APPENDIX A

Sample drainage direction file

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0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 8 8 2 2 8 8 8 8 2 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 8 8 8 2 2 8 8 8 8 2 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 8 8 1 1 2 1 1 1 8 8 2 2 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 8 8 1 1 1 1 1 2 8 8 8 2 2 0 0 0 0 0 0 0
0 0 0 0 0 8 8 8 8 1 1 2 1 2 8 8 2 2 2 2 2 0 0 0 0 0 0
0 0 0 0 8 8 8 8 8 1 1 2 1 8 8 2 2 2 2 2 2 2 0 0 0 0 0
0 0 0 8 8 8 8 8 8 8 2 2 2 8 8 2 2 2 2 2 2 2 0 2 0 0 0
0 0 0 8 8 8 8 8 8 8 2 2 2 8 2 2 2 2 2 2 2 2 2 2 2 0 0
0 0 0 8 8 8 8 8 8 8 1 1 1 1 2 2 2 2 2 2 2 2 2 2 2 0 0
0 0 8 8 8 8 8 8 8 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 2 0 0
0 0 8 8 8 8 8 8 8 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 0
0 0 0 8 8 8 8 8 8 1 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 0 0
0 0 0 0 8 8 8 8 8 1 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 0
0 0 0 0 0 8 8 8 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 0
0 0 0 0 0 8 8 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 2 0 0
0 0 0 0 0 8 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 2 0 0
0 0 0 0 0 2 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 0 0 0
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 0 0 0 0
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 0 0 0 0
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 0 0 0 0
0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 0 0 0 0
0 0 0 0 0 0 0 0 2 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 0 0
0 0 0 0 0 0 0 0 0 2 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 0 0
0 0 0 0 0 0 0 0 2 2 2 1 1 2 1 1 1 1 1 1 1 2 2 2 0 0 0
0 0 0 0 0 0 0 0 0 2 2 2 2 2 2 1 1 1 1 1 1 2 2 2 0 0 0
0 0 0 0 0 0 0 0 0 0 0 2 2 2 2 2 1 1 1 1 2 2 2 2 0 0 0
0 0 0 0 0 0 0 0 0 0 0 2 2 2 2 2 2 1 1 1 1 2 2 0 0 0 0
0 0 0 0 0 0 0 0 0 0 2 2 2 2 2 2 2 1 1 1 1 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 2 2 2 2 2 2 1 1 1 1 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 2 2 1 1 1 1 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 1 1 1 1 1 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 2 1 1 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 1 1 1 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 2 1 1 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 2 2 1 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 2 1 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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