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EDITOR
An Interactive Interface to ILLIAC IV - ARPA Network Multispectral Image Processing Systems

by

Robert M. Ray III, et al.

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E D I T O R

An Interactive Interface

to

ILLIAC IV - ARPA Network Multispectral Image Processing Systems

by

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ABSTRACT

This document presents a brief description of EDITOR -- an interactive TENEX interface to ILLIAC IV - ARPA Network multispectral image processing software under development at CAC. While conceived initially as a peripheral TENEX file-management and job-editing system for ILLIAC IV multispectral image batch processing, the scope of EDITOR functions has been widened subsequently to include procedures for direct TENEX statistical analysis of small samples of multispectral imagery in preparation for larger-scale ILLIAC IV analyses. Thus, where only small-scale image interpretations are required, and where portable terminal output is sufficient, EDITOR may be used alone on any ARPA Network TENEX computer as a self-sufficient tape-operating multispectral image analysis system. Complete records of several interactive EDITOR sessions are included to illustrate the use of the system.

CONTENTS

1. Introduction

This document provides an interim description of EDITOR -- ERTS Data Interpreter and TENEX Operations Recorder -- an interactive multispectral image interpretation system being developed at the Center for Advanced Computation of the University of Illinois at Urbana-Champaign as part of the pictorial pattern information processing research activities ongoing there.

The EDITOR system represents a component within a more extensive computer software development effort undertaken at CAC to facilitate large-scale ILLIAC IV - ARPA Network analysis of multispectral reconnaissance imagery such as that collected by the Earth Resources Technology Satellite (ERTS) of NASA and USGS/DI.[1,2] This software effort has been undertaken by CAC, in collaboration with the Laboratory for Applications of Remote Sensing (LARS) of Purdue University, in support of the ERTS/EROS programs of NASA and USGS/DI, in support of the ILLIAC IV and ARPA Network applications programs of NASA and ARPA/DOD, and in support of U. S. agricultural crop-acreage monitoring objectives of SRS/USDA. Image analysis algorithms initially implemented within these efforts follow closely software previously researched at LARS as multispectral image interpretation techniques.[3,4]

EDITOR has been conceived as an interactive job-editing and file-management interface to ERTS data analysis systems being implemented for the ILLIAC IV hardware complex at NASA's Ames Research Center (Ames) at Moffett Field, California. Nationally accessible via the ARPA Network, the EDITOR system allows portable, dial-up terminal command of ILLIAC IV image processing facilities at Ames. Multispectral image data management services within EDITOR have been designed to optimize the efficiency of ERTS data file transfers between the computers of the ILLIAC IV complex at Ames (the ILLIAC IV parallel processor, its peripheral TENEX processors, and the UNICON Data Computer) and other computers on the ARPA Network.

Since the present EDITOR system, using tape inputs, has been developed for simulation of data management systems to be implemented using the 10^{12}-bit laser memory of the UNICON Data Computer at Ames, specific data tape formating is required for all multispectral images to be processed by EDITOR. Required tape formats are described in CAC Technical Memorandum No. 19.[5]

While conceived initially as a peripheral TENEX file-management and job-editing interface to ILLIAC IV batch image interpretations, the scope of EDITOR functions has been widened subsequently to include procedures for direct TENEX interpretation of small-scale ERTS data samples in preparation for ILLIAC IV batch analyses. Thus, where only small-scale image interpretations are needed and where portable terminal output is sufficient, EDITOR may be used alone as a self-sufficient tape-operating multispectral image analysis system.

Since EDITOR has been developed as an interactive interface to ILLIAC IV image processing facilities, the system should also prove advantageous to a wider community of ARPA Network picture processing researchers. Where image disk files conform to EDITOR data file formats, the system may be used for image file management, editing, and display in conjunction with more general ILLIAC IV image processing activities. Specific file formats assumed by EDITOR are described in CAC Technical Memorandum No. 19.[5]

The EDITOR system described in this report may be executed on any ARPA Network TENEX system having 7-track or 9-track magnetic tape drives. Currently, a copy of the EDITOR system is maintained by CAC at Bolt, Beranek and Newman (BBN) in Cambridge, Massachusetts, in directory <RAY>. The BBN EDITOR can be made available to any user having access to the ARPA Network. The file <RAY>TAPES.SHARED is maintained there by CAC describing all tape imagery available at BBN for experimental system usage.

2. System Overview

The actual use of EDITOR is best described by way of examples. For this reason, complete records of example EDITOR sessions illustrating presently available features of the system have been included within this document. The following verbal description of EDITOR simply sketches major system functions. (More detailed descriptions of all presently available system procedures are given in Section 4.) A familiarity with basic multispectral image interpretation procedures is assumed.

EDITOR is implemented in modular format with each system module addressed by a single command. For each command, only that number of characters sufficient to distinguish the command from all others need be typed by the user.

The RETRIEVE command is used to create TENEX disk files containing multispectral image data from single rectangular areas of an ERTS image, or from sets of rectangular areas within an image. Use of RETRIEVE assumes that, prior to entering EDITOR, the user has requested the TENEX operator to mount a specific image tape. Analysis areas to be retrieved from tape may then be specified within EDITOR by the user in terms of image line and column coordinates and line and column sampling increments.

If, on the other hand, the user has an image file already resident on the TENEX disk and wishes to use only some portion of it for analysis, he may use the CLIP A WINDOW command. This command allows the user to construct new windows by specifying new image line and column coordinates for the subwindows desired. Additional image sampling (by additional line and column sampling increments) is also possible within CLIP.

Once image analysis areas have been selected and stored on the TENEX disk, the PRINT command within EDITOR allows a user to view the image disk files created to verify that the desired data windows have indeed been retrieved. Gray-scale displays of any of the individual spectral bands of data within an image file may be achieved by overprinting characters on the the user's terminal. A data histogramming routine is available for displaying the proportional distribution of pixel intensities within any spectral band of an image file. This feature of the system can be used for terminal display enhancement purposes. With reference to image data histograms, a user can select manually a particular range of image point intensities to be assigned to each gray-scale shade available within the character-overprinting terminal display facility.

Once a user has verified that the desired imagery has been selected, several options are available for data analysis.

The CLUSTER command within EDITOR evokes a multivariate cluster analysis of all multispectral image data points within a particular file to determine a logical partitioning or grouping of all data points into a user-specified small number of spectral clusters.[6,7] The cluster analysis procedure may be regarded as an unsupervised image interpretation procedure categorizing a set of image points into most-separable spectral classes. Also, following any cluster analysis procedure, a set of summary statistics characterizing the multivariate distributions of data within all clusters (i.e. mean vectors and variance-covariance matrices) is computed and, at the request of the user, displayed on the terminal device.

The CLASSIFY command within EDITOR allows statistical classification of all data points within a specified disk file into a particular set of spectrally-distinct categories determined by a previous cluster analysis.

This methodology of classification assumes that "ground-truth" samples will always be cluster-analyzed prior to class signature computation in order to verify the existence of spectral homogeneity within nominal terrain classes and spectral separability between classes. Where spectral properties of ground-truth samples are not homogeneous within nominal classes (i.e. multivariate distributions are non-spherical), the multiple spectral classes determined by cluster analysis for such terrain classes may be used for analysis purposes as spectrally-distinct, but nominally-synonymous, classes to be re-grouped following classification into single nominal terrain classes.

In accordance with the LARS multispectral image interpretation methodology, the statistical classification algorithm evoked by the command CLASSIFY employs the Gaussian maximum-likelihood decision rule.[3,6,8] For each data point of a file of data points to be classified, discriminant functions for all classes are computed and the point is assigned to that class for which the discriminant is largest. The parameters of the discriminant function for each class are the estimates of the means, variances and covariances of the spectral properties of all data points belonging to that class. These are the spectral class statistics computed and saved by EDITOR immediately following any cluster analysis for the set of spectral classes determined by that particular CLUSTER procedure.

The ENTER STATISTICS FILE EDITOR command provides a set of file-management procedures convenient for interactive display and editing of the spectral class statistics accumulated from previous cluster analyses. Within this mode, class signatures of different statistics files may be re-combined in any manner to produce new composite sets of signatures to be used for classification. Also within this mode, measures of spectral separability or distinctness may be computed and displayed for all pairs of signatures within any statistics file. A procedure is also implemented (again following LARS methods) for "pooling" the statistics of several different signatures into a single new composite signature.

The EXECUTE ANALYSIS ON ILLIAC IV command instructs EDITOR to use the ILLIAC IV at Ames for a particular cluster analysis or classification task specified by a user. Given this command, EDITOR immediately requires the user's I4-TENEX user code and password. If such a code can be supplied, EDITOR will automatically set up the task for ILLIAC IV processing, transmit the job via the ARPA Network to Ames, and enter the job into the ILLIAC IV batch stream. Procedures are also provided within this mode for inquiring on the status of ILLIAC IV jobs and for convenient retrieval by EDITOR of cluster analysis and classification output files resulting from previous ILLIAC IV executions. Specific ILLIAC IV multi-spectral image cluster analysis and classification procedures accessible to EDITOR users have been documented elsewhere.[9,10,11,12]

In addition to the procedures for displaying raw multispectral imagery, the PRINT command within EDITOR also provides procedures for displaying the interpreted imagery that results from either cluster analysis or classification operations. Interpreted image data files may be output as terminal printer maps where the symbols 1 - 9 and A - Z are used to represent terrain classes. Display of only selected subsets of classes is permitted. Following again the LARS methodology, provisions are included for reliability thresholding of classification results within PRINT mode. Where a particular confidence level is specified by the user, EDITOR displays only those image data points whose classification reliability meets the specified level. Also, procedures are included within PRINT mode to allow re-grouping of spectral classes into composite nominal classes, and to allow manual re-assignment of printer symbols among these nominal classes for more meaningful display of interpretations.

3. Getting Started with EDITOR and TENEX

In this section a brief description of how to run EDITOR under TENEX will be presented. TENEX is a time-sharing system running on a modified DEC SYSTEM-10 as developed by Bolt, Beranek and Newman (BBN).[13] When connecting to a TENEX system, the user should establish a character-at-a-time, full-duplex connection. Commands to TENEX may be abbreviated and if followed by ESC (ESCAPE or ALT MODE on some terminals) the remainder of the command will be typed out followed by a prompt for any parameters required. All commands should be terminated by a carriage return.

To begin an EDITOR session, one must first LOGIN. The sequence is LOG <user code> <password> <account number> followed by a carriage return. (The password will not be echoed to preserve security.) If a space is substituted for <account number>, that account number associated with the user code given will be assumed by default.

To get an ERTS image tape mounted, a request must be made to the operator who should be logged in as OPERATOR. To do this, the LINK command is used. The LINK command links two terminals together so that whatever is typed on either may be viewed on both. The syntax of the command is LINK OPERATOR. To communicate with the operator, a message should then be typed. Each line of this message must begin with a semicolon (";") to indicate to TENEX that the line is not a command. The request should be to mount a specific tape, <u>without write ring</u> (to insure that the data on the tape cannot be accidentally over-written), on a 9-track or 7-track drive. Once the operator has mounted the tape, he will inform the user of the drive. The tape drives are MTAØ:, MTA1:, etc. The drive used should be remembered, since it will be needed later in using EDITOR to read the tape. When discussion with the operator has been completed, the BREAK command should be used to break the link.

In order to secure use of the tape, two more TENEX commands must be used. The ASSIGN <tape drive> (e.g. ASSIGN MTAØ:) command assigns the tape drive to the user's job, preventing other users from accessing it. The MOUNT <tape drive> (e.g. MOUNT MTAØ:) positions the tape for reading.

To evoke EDITOR, the user simply types <RAY> EDITOR followed by one or two carriage returns. The two-carriage-returns form provides a shorter introductory herald and is recommended for regular users. The user is then at the top command level of EDITOR and may enter commands as detailed in the following section. A list of legitimate commands is available by entering question mark ("? ") followed by a carriage return (CR). At the top level, any command may be abbreviated -- as short as required to distinguish it from all other commands -- and followed by a carriage return or ESC. If followed by ESC, the remainder of the abbreviated command will be completed by EDITOR. In certain of the analysis modules within EDITOR, a somewhat different command structure is used in which the user is prompted for short inputs by a series of questions. To return to the top level of EDITOR from any lower-level module, an exclamation point ("!" and CR) is used instead of a command. (One is at the top level of EDITOR when one is prompted by a single exclamation point.)

Most of the EDITOR modules require TENEX disk files for input and/or output of data. The simplest form of a file designator is FILENAME.EXTENSION where FILENAME and EXTENSION are identifiers and the period is part of the file designator. Note that the period (". ") is always required between FILENAME and EXTENSION.

In entering commands through a terminal, errors will occasionally be made. To delete a single character, CONTROL-A is used and to delete an entire line, CONTROL-X is used. Similar conventions are also available at the level of TENEX commands. For example, TENEX provides CONTROL-C for terminating any program and returning to TENEX EXEC. (In some cases, two CONTROL-C characters must be entered.) It should be noted that, wherever one might be in EDITOR, the CONTROL-C completely exits EDITOR. However, this is the only way to terminate a long program, such as a large cluster or classify, which was somehow initiated erroneously.

Finally, when the EDITOR session is complete, EDITOR is exited using the QUIT EDITOR command. If a tape was used, the user should relinquish control of the tape drive. First the DEASSIGN <tape drive> (e.g., DEASSIGN MTAØ:) command is used to release exclusive control of the tape drive. Next the UNLOAD <tape drive> (e.g., UNLOAD MTAØ:) command is used to rewind the tape and position it for dismounting, hence signaling the operator that he may remove the tape and put it away. Thus, it is not necessary to LINK to the operator again at the end of an EDITOR session.

Before logging out, the user should check to see if there are any files on TENEX disk that will be no longer needed. A listing of all files in the user's directory may be obtained via the TENEX command DIRECTORY. It is prudent to delete files since all disk space used costs money, and since once a directory is filled to its allocation (the DSKSTAT command will indicate the space remaining) no new files may be created.

To delete files, the command DELETE <file name> is used. Where it is desirable to delete all files of a common FILENAME (or prefix within the FILENAME.EXTENSION convention), this may be done conveniently by using the DELETE FILENAME.* form of the DELETE command. This option for TENEX file deletion should be noted by EDITOR users since, if care is given to naming files within EDITOR sessions, file directory maintenance can be greatly simplified. In any case, if obsolete TENEX files are being deleted in order to regain disk space needed for immediate use, the TENEX EXPUNGE command should be issued by the user following all DELETEs.

When the TENEX session is complete, the LOGOUT command is used to exit the system before closing the connection. At this point, the TENEX system will report to the user the total amount of processing (CPU) time and terminal-connect time used during the complete session. Note here that time is also money.

4. Summary of EDITOR Commands

In this section, a brief description of the various EDITOR commands and the modules they evoke will be given. The use of most of these commands is illustrated in the example EDITOR sessions given in the Appendix. Several commands have already been described partially in Section 2. above. The commands are discussed here in alphabetical order to assist subsequent referencing.

4.1 CLASSIFY

The CLASSIFY command is used to perform statistical classification of an image data file using a TENEX routine. The number of channels will be requested. At present, only 4- or 8-channel data may be handled so "4" or "8" should be entered. The user will be prompted for other required inputs. For large-scale classifications, the ILLIAC IV may be used via the EXECUTE ANALYSIS ON ILLIAC IV command described below.

4.2 CLIP A WINDOW

The CLIP A WINDOW command is used to create subwindows of windows in an image file already on TENEX disk. A question mark ("? ") upon entering CLIP lists the commands. CLIP may be used for editing 4- or 8-channel raw or categorized data files. The subwindows to be created may be specified in terms of new lines and columns (contained within the input window) and/or additional image sampling. Commands within the CLIP A WINDOW module allow selection of the image window to be edited, and the new coordinates and sampling increments to be used in creating the new subwindows. After all window editing parameters have been specified, a command is available to write the output file and return to the top level of EDITOR.

4.3 CLUSTER

The CLUSTER command is used to perform cluster analysis on image data using TENEX processing. The number of channels will be requested. At present, only 4- or 8-channel data may be handled so

"4" or "8" must be entered. The user will be prompted for other required inputs. For large cluster analyses, the ILLIAC IV may be used via the EXECUTE ANALYSIS ON ILLIAC IV command (again, described below).

4.4 ENTER STATISTICS FILE EDITOR

The ENTER STATISTICS FILE EDITOR command enters the statistics editor module. Subcommands are of the form one letter followed by a carriage return. A list of commands may be displayed by typing question mark ("?") followed by carriage return. Within this module, the summary statistics for sets of spectral categories generated by cluster analyses may be displayed. Also, the statistics of individual categories of various files may be grouped in new combinations to form new statistics files. In addition, the statistics of several categories may be pooled together to create a composite spectral "signature". Finally, where a classification is to be done using the ILLIAC IV, the variance-covariance matrices of the appropriate statistics file may be inverted.

4.5 EXECUTE ANALYSIS ON ILLIAC IV

The EXECUTE ANALYSIS ON ILLIAC IV command enables automatic submission and retrieval of ILLIAC IV batch jobs from a remote TENEX site. The ARPA Network is used to submit the jobs and retrieve the results from the ILLIAC IV at NASA-Ames. To use the ILLIAC IV, the user must have a valid user code and password at I4-TENEX (the TENEX front-end subsystem of the ILLIAC IV complex). EDITOR will ask for these before allowing any commands to be entered. At present, both cluster analysis and statistical classification procedures may be performed on the ILLIAC IV remotely through EDITOR.

4.6 IDENTIFY A WINDOW

The IDENTIFY A WINDOW command displays information extracted from the header of an image file. This information includes the image file type, the line and column coordinates of all windows in the file, the line and column sampling increments used in creating all windows in the file, the number of channels of the image data, the cluster analysis parameters (DELTA or separability threshold and the NUMBER OF CLUSTERS), and certain descriptive information supplied by NASA for the ERTS image from which the data have been extracted.

4.7 INDICATE APRIORI PROBABILITIES

The INDICATE APRIORI PROBABILITIES command allows creation of a file of a priori probabilities of various categories for classification.

4.8 MODIFY WINDOW HEADER

The MODIFY WINDOW HEADER command allows insertion of necessary parameters (NUMBER OF CLUSTERS and DELTA or separability threshold) to be used for a particular cluster analysis. Also here the alpha-numeric information recorded in the header of an image file may be modified. Once all desired changes are made, the CLOSE FILE command should be issued to return to the top level of EDITOR.

4.9 PRINT A WINDOW

The PRINT A WINDOW command allows display of image windows. The display may be directed either to the user's terminal or to a back-up disk file for later printing using a conventional line printer. Raw data windows are displayed with an overprinting routine allowing up to eleven (11) levels of gray-scale. A histogram of the distribution of spectral intensities for any spectral channel may also be displayed. For categorized windows, the character assigned to each class may be selected manually as any printing character to achieve more meaningful displays. This feature facilitates the re-grouping of spectral classes by nominal categories for tabulation and display purposes.

NOTE: When PRINT A WINDOW output is directed to a terminal, the line width used for displays of windows is the line width assigned to that terminal by TENEX. The default value is 72 characters, but this may be changed by the TENEX WIDTH <number> command, where <number> is the width desired. Since WIDTH is a TENEX command it <u>must</u> be performed before entering EDITOR.

4.10 QUIT EDITOR

The QUIT EDITOR command provides for a proper exit from the top EDITOR command level back to TENEX EXEC. The QUIT command should always be used whenever possible (instead of CONTROL-C) to exit EDITOR.

4.11 RETRIEVE WINDOW FROM TAPE

The RETRIEVE WINDOW FROM TAPE command is used to copy windows from a specific tape (that has already been mounted) into a disk file. Where desired, line and column sampling increments should be supplied via the SAMPLE command. Then the coordinates of the windows to be retrieved are entered using the INSERT COORDINATES command. Additional facilities are available to allow the user to delete window coordinates entered in error.

Prior to any EDITOR analysis of a specific ERTS image, specific geographic areas of interest are known to the user, typically, only in terms of latitude and longitude boundaries. On the other hand, all image windows to be retrieved from tape by EDITOR must be specified in terms of image line and column coordinates. Therefore as a convenience to the user, there is included within the RETRIEVE module a subprocedure for transformation of window corners specified in terms of latitude and longitude coordinates into "nearest-approximation" image pixels identified by image line and column numbers. (The inverse transformation is also possible; that is, for image pixels identified by line and column coordinates, approximate latitude and longitude coordinates may be computed.)

5. Planned System Developments

The EDITOR system outlined and illustrated within this document is (hopefully) in its preliminary stages of development. While current subsystems within EDITOR now provide capabilities for interactive ARPA Network-TENEX analysis of multispectral imagery and make conveniently accessible the processing capabilities of the ILLIAC IV for specific image interpretation functions, we view the existing system primarily as a software base to which more extensive image processing subsystems can be conveniently added in the future. All additional ILLIAC IV image processing software developed at CAC will be implemented in such a manner that it can be made accessible to others via EDITOR.

Currently, efforts are underway to add to existing EDITOR subsystems interactive TENEX software to support on-line data-tablet digitizers as graphical input devices for delineation of ground-truth samples and analysis areas outlined on photographic images and maps. Procedures are also being added to allow digitization of geographic control points matched between maps and images facilitating accurate geographical registration between maps and images and between multiple images of the same geographic region taken at different points in time. These features are being developed in parallel with other ILLIAC IV - ARPA Network software systems now being completed at CAC for cost-effective geometric correction, precision-geographic registration, and multitemporal overlay of ERTS imagery.[14,15]

The utility of the EDITOR system for operational ILLIAC IV multispectral image processing applications will be greatly enhanced as the UNICON Data Computer at Ames becomes more fully operational. Alternative strategies are now being investigated for use of the 10^{12}-bit laser memory of the UNICON as the primary archival medium for storage of multispectral imagery to be processed on the ILLIAC IV. These systems will be implemented in such a manner that the EDITOR system might serve as an interactive interface to both TENEX and UNICON data management systems and ILLIAC IV interpretation procedures.

While ILLIAC IV image processing and UNICON data management systems being developed should make practical analysis of large quantities of multispectral reconnaissance imagery, the proportion of this imagery that may be displayed remotely via the ARPA Network will continue to be limited by Network data transmission rates. Further development of the EDITOR system must therefore continue to assume that only small samples of raw and interpreted reconnaissance imagery will be transmitted to and from remote users via the Network. Thus image file reformating procedures may be added to EDITOR so that larger quantities of imagery to be distributed to users may be copied from the UNICON to magnetic tape, or output graphically for distribution using image display hardware such as the DICOMED film recorder at Ames. EDITOR subsystems, however, would allow a user to sample interactively ILLIAC IV outputs prior to requests for mail transmittal of large-volume processed image files.

6. Acknowledgements

The authors wish to acknowledge the invaluable support granted them by personnel of LARS throughout the implementation of the EDITOR system. Special acknowledgements are due Dr. Philip H. Swain of LARS who influenced the design of EDITOR and who was instrumental in insuring proper implementation of specific LARSYS subroutines as TENEX and ILLIAC IV software.

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APPENDIX A

Example EDITOR Session 1.

In this first example EDITOR session, the user (Ozga) LOGINs to BBN and requests the operator to mount a specific 9-track tape labeled "KANSAS1". This tape contains ERTS multispectral imagery acquired over an agricultural region of Kansas. EDITOR is used to retrieve from the tape a small image analysis area (32 lines by 32 columns) containing a number of circular irrigation fields. Following terminal displays of spectral bands two (2) and four (4) of this analysis window, the window is cluster analyzed and summary statistics for the seven (7) resulting spectral clusters are listed. Finally, alphabetic symbols are manually assigned to all spectral clusters and a "map" of the area is printed.

NOTE: Throughout all of the example EDITOR sessions that follow, all user inputs (commands, answers, file names, etc.) are underlined. It should be understood that each user-supplied input has been terminated either with a carriage return (CR) or with an escape (ESC). Where only part of an EDITOR command is underlined, it should be understood that the user has employed the command abbreviation and ESC option as described in Section 3. above.

```
BBN-TENEX 1.33.11, BBN-SYSTEM-C EXEC 1.53.38
@LOG OZGA
JOB 35 ON TTY26 16-JUN-75 15:04
PREVIOUS LOGIN: 16-JUN-75 15:03
@LINK OPERATOR

LINK FROM OZGA, JOB 35, TTY 26
@;PLEASE PUT UP TAPE KANSAS1 ON A 9-TRACK DRIVE, NO RING.
;OK ...ON MYXYTA0:, NO RING, UNL WHEN DONE
!BRE
@ASS MTA0:
@MOUNT MTA0:
@ RAY EDITOR
```

WELCOME TO

* * * * * * * EDITOR * * * * * * *

AN INTERACTIVE INTERFACE
TO
ILLIAC IV - ARPA NETWORK IMAGE PROCESSING SYSTEMS

DEVELOPED BY

THE CENTER FOR ADVANCED COMPUTATION
UNIVERSITY OF ILLINOIS
URBANA, ILLINOIS 61801
(217)-333-0925

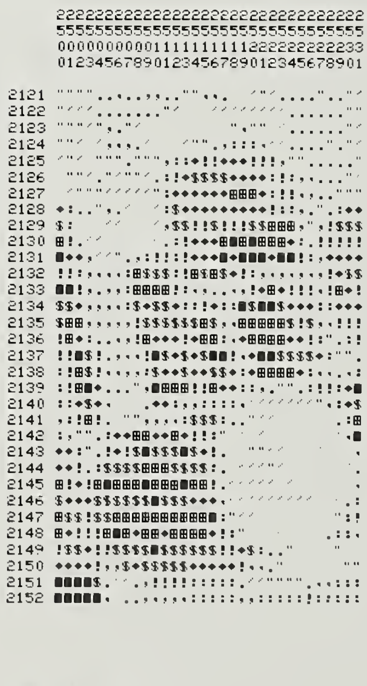
TERMINATE COMMANDS WITH CAR RET. TYPE ? FOR A LIST OF AVAILABLE COMMANDS.

```
!?
HELP
RETRIEVE WINDOW FROM TAPE
PRINT A WINDOW
IDENTIFY A WINDOW
MODIFY WINDOW HEADER
REFORMAT A WINDOW FILE
CLUSTER A WINDOW
ENTER STATISTICS FILE EDITOR
INDICATE APRIORI PROBABILITIES
CLASSIFY A WINDOW
EXECUTE ANALYSIS ON ILLIAC IV
CLIP A WINDOW
PLOT A CLASSIFIED WINDOW
CLOSE DISK FILES
DELETE A DISK FILE
QUIT EDITOR
```

```
!RETRIEVE WINDOW FROM TAPE
2!INSERT COORDINATES
SAMPLING IS SET AT 1,1
3!2121,2500,2152,2531
3!WRITE OUT TO WINDOW
9 TRACK TAPE DRIVE=MTA0:
 [OK]
OUTPUT DISK FILE=EXAMPLE1.WIN
 [NEW VERSION]
WAIT................................
2!!
!IDENTIFY A WINDOW
DISK FILE=EXAMPLE1.WIN
 [OLD VERSION]
TYPE=0
CATEGORIES IN=0
CATEGORIES OUT=0
DELTA=0
NUMBER OF LONG ROWS=8
NUMBER OF WINDOWS=1
SAMPLING IS SET AT 1,1
2121,2500,2152,2531,1024
NUMBER OF CHANNELS=0
CHANNELS IN USE= 1
ASCII HEADER INFORMATION:
12AUG73 C N38-50/W101-28 N N38-49/W101-19              SUN EL
55 AZ125 190-5368- -1-  D-    NASA ERTS E1385-1656300 3 4P
!PRINT A WINDOW
OUTPUT DEVICE?(? FOR LIST) ?
T FOR TI SILENT 700 TERMINAL,
G FOR GE TERMINET,
B FOR BACKUP PRINT FILE,
O FOR SOME OTHER TERMINAL TYPE.
OUTPUT DEVICE?(? FOR LIST) T

INPUT WINDOW FILE=EXAMPLE1.WIN

FILE TYPE= 0, CATEGORIES ASKED= 0, CATEGORIES OUTPUT= 0
DELTA= 0.00, LONG ROWS=     8, NUMBER OF WINDOWS=  1
CHANNELS=4, ROW COL SAMPLING=  1  1
WINDOWS:
 #  NORTH WEST       SOUTH EAST       NUMBER OF POINTS
  1:(2121,2500)     (2152,2531)              1024

WHICH CHANNEL?(1 THRU 4) 2

MIN PIXEL VALUE= I4  MAX PIXEL VALUE= 58

DISPLAY HISTOGRAM?(Y, N, OR ONLY) Y
```

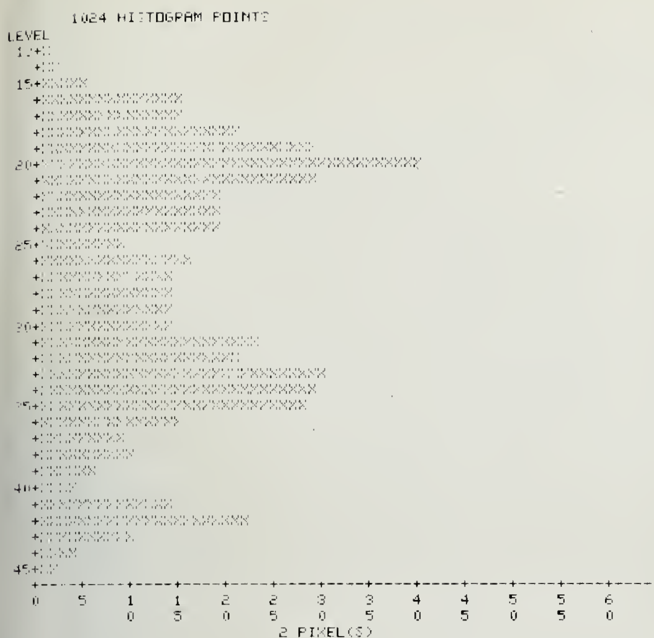
1024 HISTOGRAM POINTS


```
HOW MANY GREY LEVELS?(1 TO 11) 11
WANT AUTOMATIC SCALING?(Y OR N) Y
EQUIPROBABLE OR LINEAR?(E OR L) E
```

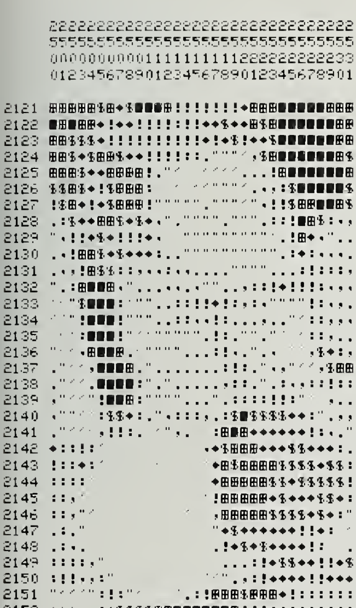



```
CONTINUE WITH THIS FILE?(Y OR N) Y
WHICH CHANNEL?(1 THRU 4) 4

MIN PIXEL VALUE= 13  MAX PIXEL VALUE= 45

DISPLAY HISTOGRAM?(Y, N, OR ONLY) Y
```

```
     1024 HISTOGRAM POINTS
LEVEL
```




```
HOW MANY GREY LEVELS?(1 TO 11) 11
WANT AUTOMATIC SCALING?(Y OR N) Y
EQUIPROBABLE OR LINEAR?(E OR L) E
```




```
CONTINUE WITH THIS FILE?(Y OR N) N
ANOTHER FILE?(Y OR N) N
!MODIFY WINDOW HEADER
2!NUMBER OF CATEGORIES DESIRED
DISK FILE=EXAMPLE1.WIN
 [OLD VERSION]
NUMBER OF CLUSTERS=8
2!DELTA OR SEPARABILITY THRESHOLD
DELTA=.5
2!CLOSE FILE AND QUIT
!IDENTIFY A WINDOW
DISK FILE=EXAMPLE1.WIN
 [OLD VERSION]
TYPE=1
CATEGORIES IN=8
CATEGORIES OUT=0
DELTA=.5
NUMBER OF LONG ROWS=8
NUMBER OF WINDOWS=1
SAMPLING IS SET AT 1,1
2121,2500,2152,2531,1024
NUMBER OF CHANNELS=0
CHANNELS IN USE= 1
ASCII HEADER INFORMATION:
12AUG73 C N38-50/W101-28 N N38-49/W101-19              SUN EL
55 AZ125 190-5368- -1-  D-   NASA ERTS E1385-1656300 3 4P
```

```
!CLUSTER A WINDOW
NUMBER OF CHANNELS=4

INPUT WINDOW FILE=EXAMPLE1.WIN

CATEGORIES ASKED= 8, DELTA= 0.50, ROW COL SAMPLING= 1 1
CHANNELS=4, TOTAL NUMBER OF POINTS= 1024


MINIMUM NUMBER OF CATEGORIES AFTER MERGING (1 TO  8) 4
WHAT PERCENT CONVERGENCE?(0.001-100.0) 100.0

ENTER MAXIMUM NUMBER OF ITERATIONS TO BE PERFORMED
 (-1 TO PERFORM AS MANY AS NEEDED TO ATTAIN DESIRED CONVERGENCE)
=-1

PERCENT CONVERGENCE=  0.00
PERCENT CONVERGENCE= 50.39
PERCENT CONVERGENCE= 83.59
PERCENT CONVERGENCE= 93.46
PERCENT CONVERGENCE= 97.17
PERCENT CONVERGENCE= 97.75
PERCENT CONVERGENCE= 98.54
PERCENT CONVERGENCE= 97.66
PERCENT CONVERGENCE= 97.75
PERCENT CONVERGENCE= 97.95
PERCENT CONVERGENCE= 98.24
PERCENT CONVERGENCE= 98.44
PERCENT CONVERGENCE= 99.02
PERCENT CONVERGENCE= 99.51
PERCENT CONVERGENCE= 99.32
PERCENT CONVERGENCE= 99.51
PERCENT CONVERGENCE= 99.71
PERCENT CONVERGENCE= 99.80
PERCENT CONVERGENCE= 99.90
PERCENT CONVERGENCE=100.00
  20 ITERATION(S).
NUMBER OF POINTS IN EACH CLUSTER:
  95  144  113  259   84  138   74  117

CATEGORIES  2 AND  8 ARE MERGED. DISTANCE  0.50   DELTA.
PERCENT CONVERGENCE= 86.72
PERCENT CONVERGENCE= 99.22
PERCENT CONVERGENCE= 99.22
PERCENT CONVERGENCE= 99.61
PERCENT CONVERGENCE= 99.71
PERCENT CONVERGENCE=100.00
  26 ITERATION(S).
NUMBER OF POINTS IN EACH CLUSTER:
 115  222  114  259  102  138   74

FINAL CLASSIFICATION

NUMBER OF POINTS IN EACH CLUSTER:
 115  222  114  259  102  138   74
```

```
             :CLUSTERING CLASSIFICATION:

          22222222222222222222222222222222
          55555555555555555555555555555555
          00000000001111111111222222222233
          01234567890123456789012345678901

2121 22221115511115555522222111111112
2122 11225555555522222222222211111111
2123 11225555222222222225552221111122
2124 22222111522222557777672211111112
2125 21222251155777666666774521111111
2126 22225522225666666444447431111112
2127 22255222225744444444447331111115
2128 43552552222344444444474335115344
2129 44222222222364444444444443153444
2130 44522222222544444444444443534444
2131 44432225334433444444444444324444
2132 44311113444443444444333553353444
2133 44411113444443355533344477733444
2134 44431113444443344334444477633444
2135 44431111444444444433444446667344
2136 44431111444447444334444466675534
2137 44444111144444444443334444666752 1
2138 47444111134444444444334444433353 3
2139 37444511134444444443335555777344
2140 77467722254473337731222222257744
2141 77767725577777446351522222222534
2142 33555766666666777522222222222234
2143 33355666666666667522212222222223
2144 43357666666666667522222222222225
2145 43476666666666666652222222222223
2146 44476666666666666672222222222257
2147 44446666666666666675222222222577
2148 44477666666666666435222222225777
2149 34443766666666666677443552222522
2150 33344576666666666674435552222225
2151 46444525776666743311122222555333 3
2152 66666325551111111111333333333333 3


WANT TO SEE STATISTICS?(Y OR N) Y

                  SEPARABILITY MATRIX

 1 + 1.00
 2 + 0.73 1.00
 3 + 1.27 1.95 1.00
 4 + 2.22 3.35 0.75 1.00
 5 + 0.70 0.83 0.87 1.67 1.00
 6 + 3.48 4.70 1.65 1.06 2.41 1.00
 7 + 2.05 2.19 0.81 0.65 1.20 0.80 1.00
     +    +    +    +    +    +    +
     1    2    3    4    5    6    7
```

```
GROUP              MEANS                                VARIANCES
  1      33.73  33.09  36.41  17.14          6.32  17.66   8.61    2.44
  2      40.32  44.35  45.25  20.68          6.18  11.15  12.55    3:28
  3      30.40  24.80  49.31  27.17          3.41   6.60   8.60    4.87
  4      26.96  18.72  54.27  33.07          2.05   3.32   7.70    4.29
  5      36.37  35.51  47.02  23.18          3.84   8.13  13.62    7.28
  6      28.29  18.14  66.94  41.09          2.00   2.47   9.11    4.51
  7      31.07  24.28  60.45  34.34          6.50  12.86   8.63    7.27

CREATE A CATEGORIZED WINDOW FILE?(Y OR N) Y

CATEGORIZED WINDOW FILE=EXAMPLE1.CAT

CREATE A STATISTICS FILE?(Y OR N) Y

OUTPUT STATISTICS FILE=EXAMPLE1.STAT


!PRINT A WINDOW
OUTPUT DEVICE?(? FOR LIST) T

INPUT WINDOW FILE=EXAMPLE1.CAT

FILE TYPE= 2, CATEGORIES ASKED= 8, CATEGORIES OUTPUT= 7
DELTA= 0.50, LONG ROWS=    8, NUMBER OF WINDOWS=  1
CHANNELS=4, ROW COL SAMPLING=  1  1
WINDOWS:
 #  NORTH WEST      SOUTH EAST      NUMBER OF POINTS
  1:(2121,2500)    (2152,2531)              1024

WANT TO GROUP CATEGORIES?(Y OR N) Y
ENTER EACH GROUPING AS <O>←<I>. <O> IS THE OUTPUT GROUP,
AND MAY BE ANY PRINTING CHARACTER.
 I  IS A STRING OF INPUT CATEGORIES FROM 1 THRU
7(A=10) TO BE MAPPED TO <O>; <I> MUST NOT CONTAIN ANY
SPACES. A SPACE AND A COMMENT MAY FOLLOW <I>. END WITH
ONLY CAR RET ON A LINE.
A←12
B←3
C←47
D←5
E←6
_

MAPPING USED:AABCDEC
OK?(Y OR N) Y
WANT COUNT OF GROUPS?(Y OR N) Y



     22222222222222222222222222222222
     55555555555555555555555555555555
     00000000001111111111222222222233
     01234567890123456789012345678901

2121 AAAAAAADDAAAAADDDDAAAAAAAAAAAAAA
2122 AAAADDDDDDDDAAAAAAAAAAAAAAAAAAAA
2123 AAAADDDDAAAAAAAAAAADDDAAAAAAAAAA
2124 AAAAAAAADAAAAAADDCCCCECAAAAAAAAA
2125 AAAAAADAADDCCCEEEEEEECCCDAAAAAAA
2126 AAAADDAAAAADEEEEEEECCCCCCBAAAAAA
2127 AAADDAAAAAADCCCCCCCCCCCCBBAAAAAD
2128 CBDDADDAAAABCCCCCCCCCCCBBDAADBCC
2129 CCAAAAAAAAAABECCCCCCCCCCCCBADBCCC
2130 CCDAAAAAAAAADCCCCCCCCCCCCCBDBCCCC
2131 CCCBAAADBBCCBBCCCCCCCCCCCCBBCCCC
2132 CCBAAAABCCCCCBCCCCCCBBBDDBBDBCCC
2133 CCCAAAABCCCCCBBDDDBBBCCCCCCBBCCC
2134 CCCBAAABCCCCCBBCCBBCCCCCCCEBBCCC
2135 CCCBAAAACCCCCCCCCBBCCCCCEEECBCCC
2136 CCCBAAAACCCCCCCCCBBCCCCCEEECDDBC
2137 CCCCCAAAACCCCCCCCCBBBCCCCEEEECDAA
2138 CCCCCAAAABCCCCCCCCCBBCCCCCCBBBDBB
2139 BCCCCDAAABCCCCCCCCCBBBDDDDCCCBCC
2140 CCCECCAAADCCCBBBCCBAAAAAAAADCCCC
2141 CCCECCADDCCCCCCCEBDADAAAAAAAADBC
2142 BBDDDCEEEEEEEEECCCDAAAAAAAAAAAABC
2143 BBBDDEEEEEEEEEEEECDAAAAAAAAAAAAAB
2144 CBBDCEEEEEEEEEEEECDAAAAAAAAAAAAAD
2145 CBCCEEEEEEEEEEEEEEDAAAAAAAAAAAAAB
2146 CCCCEEEEEEEEEEEEEECAAAAAAAAAAAADC
2147 CCCCEEEEEEEEEEEEEEECDAAAAAAAAAADCC
2148 CCCCCEEEEEEEEEEEEECBDAAAAAAAADCCC
2149 BCCCBCEEEEEEEEEEEECCCCBDDAAAAADAA
2150 BBBCCDCEEEEEEEEEEEECCCBDDDAAAAAAD
2151 CECCCDADCCEEEECCBBAAAAAAADDDDBBBB
2152 EEEEEBADDDAAAAAAAAAAABBBBBBBBBBB



  1024 TOTAL VALID POINTS.

GROUP    COUNT   PERCENT
  A       337     32.91
  B       114     11.13
  C       333     32.52
  D       102      9.96
  E       138     13.48



CONTINUE WITH THIS FILE?(Y OR N) N
ANOTHER FILE?(Y OR N) N
!QUIT EDITOR
TAPE REWINDING, PLEASE WAIT
?
```

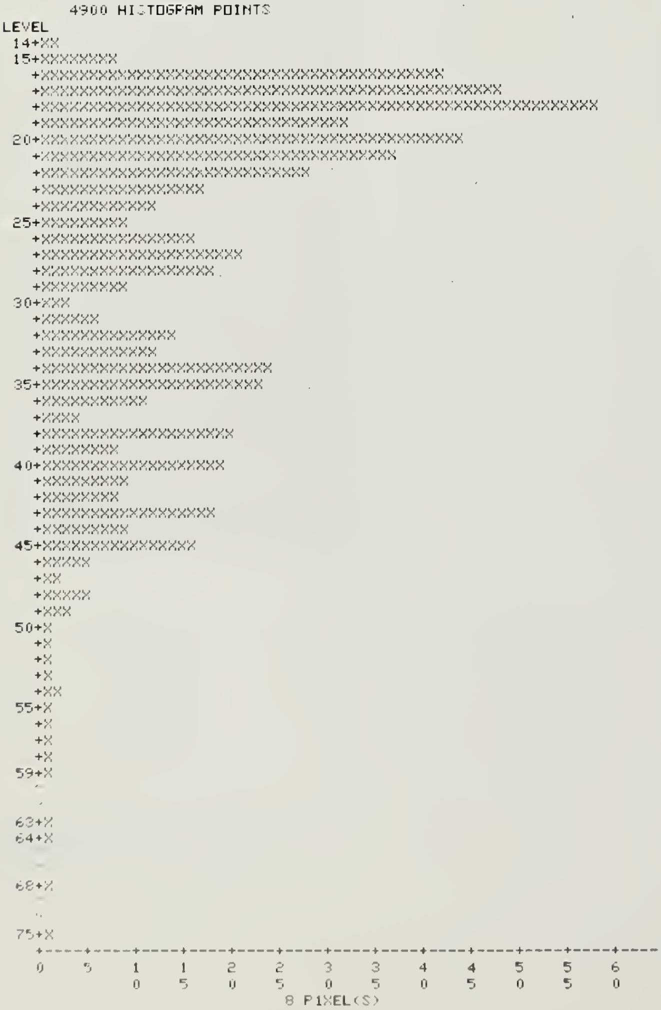
APPENDIX B

Example EDITOR Session 2.

This second example EDITOR session continues with image tape KANSAS1 still mounted on tape drive MTAØ:. A larger agricultural window is retrieved and displayed. Using the CLIP A WINDOW module within EDITOR, a one-quarter (1/4) sample of the larger analysis area is taken to create a new sub-window file. This smaller, sampled window is then clustered into eight (8) spectral classes. The summary statistics of these classes are edited to compile a new statistics file corresponding to six (6) classes considered to be spectrally distinct. This new statistics file is then used in classifying the original un-sampled window file.

```
$WIDTH 78
@ RAY EDITOR

EDITOR  VERSION 2.5  MARCH 25, 1975
!RETRIEVE WINDOW FROM TAPE
2!INSERT COORDINATES
SAMPLING IS SET AT 1,1
3!2111,2466,2180,2535
3!WRITE OUT TO WINDOW
9 TRACK TAPE DRIVE=MTA0:
 [OK]
OUTPUT DISK FILE=EXAMPLE2.WIN
 [NEW VERSION]
WAIT..........................................................
2!!
!IDENTIFY A WINDOW
DISK FILE=EXAMPLE2.WIN
 [OLD VERSION]
TYPE=0
CATEGORIES IN=0
CATEGORIES OUT=0
DELTA=0
NUMBER OF LONG ROWS=39
NUMBER OF WINDOWS=1
SAMPLING IS SET AT 1,1
2111,2466,2180,2535,4900
NUMBER OF CHANNELS=0
CHANNELS IN USE= 1
ASCII HEADER INFORMATION:
12AUG73 C N38-50/W101-28 N N38-49/W101-19             SUN EL
55 AZ125 190-5368- -1-  D-    NASA ERTS E1385-1656300 3 4P
!PRINT A WINDOW
OUTPUT DEVICE?(? FOR LIST) T

INPUT WINDOW FILE=EXAMPLE2.WIN

FILE TYPE= 0, CATEGORIES ASKED= 0, CATEGORIES OUTPUT= 0
DELTA= 0.00, LONG ROWS=   39, NUMBER OF WINDOWS=  1
CHANNELS=4, ROW COL SAMPLING=  1  1
WINDOWS:
 #  NORTH WEST       SOUTH EAST       NUMBER OF POINTS
  1:(2111,2466)     (2180,2535)              4900

WHICH CHANNEL?(1 THRU 4) 2

MIN PIXEL VALUE= 14  MAX PIXEL VALUE= 75

DISPLAY HISTOGRAM?(Y, N, OR ONLY) Y
```

4900 HISTOGRAM POINTS




```
HOW MANY GREY LEVELS?(1 TO 11) 11
WANT AUTOMATIC SCALING?(Y OR N) Y
EQUIPROBABLE OR LINEAR?(E OR L) E
```

```
CONTINUE WITH THIS FILE?(Y OR N) N
ANOTHER FILE?(Y OR N) N
!CLIP A WINDOW

SUBWIN (DISK TO DISK SUBWINDOW PROGRAM), VERSION 3.0

INPUT WINDOW FILE=EXAMPLE2.WIN [OLD VERSION]
TYPE=0
CATEGORIES IN=0
CATEGORIES OUT=0
ROW SAMPLE=1
COLUMN SAMPLE=1
NUMBER OF CHANNELS=4
CHANNELS IN USE: 1 2 3 4
NUMBER OF WINDOWS=1
1: 2111,2466,2180,2535,4900
2!SAMPLE
ADDITIONAL ROW SAMPLING=2
ADDITIONAL COLUMN SAMPLING=2
2!COORDINATES
ENTER COORDINATES OF SUBWINDOWS OF WINDOW 1
USE ESC FOR THE FULL COORDINATES OF THE WINDOW
TERMINATE WITH CARRIAGE RETURN ONLY ON A LINE
*2111,2466,2180,2535
*
2!DISPLAY WINDOWS
NUMBER OF INPUT WINDOWS=1
1: 2111,2466,2180,2535
```

```
NUMBER OF OUTPUT WINDOWS=1
1: 2111,2466,2180,2535 FROM INPUT WINDOW 1
2!WRITE
NUMBER OF WINDOWS=1
2111,2466,2180,2535
ADDITIONAL SAMPLING, ROW=2, COLUMN=2
OUTPUT FILE=EXAMPLE2.SWIN [NEW VERSION]
!MODIFY WINDOW HEADER
2!NUMBER OF CATEGORIES DESIRED
DIT FILE=EXAMPLE2.SWIN
 [OLD VERSION]
NUMBER OF CLUSTERS=8
2!DELTA OF SEPARABILITY THRESHOLD
DELTA=.5
2!CLOSE FILE AND QUIT
!CLUSTER A WINDOW
NUMBER OF CHANNEL =4

INPUT WINDOW FILE=EXAMPLE2.SWIN

CATEGORIES ASKED= 8, DELTA= 0.50, ROW COL SAMPLING= 2 2
CHANNELS=4, TOTAL NUMBER OF POINTS= 1225

MINIMUM NUMBER OF CATEGORIES AFTER MERGING (1 TO  8) 4
WHAT PERCENT CONVERGENCE?(0.001-100.0) 100.0

ENTER MAXIMUM NUMBER OF ITERATIONS TO BE PERFORMED
 (-1 TO PERFORM AS MANY AS NEEDED TO ATTAIN DESIRED CONVERGENCE)
#-1

PERCENT CONVERGENCE=  0.00
PERCENT CONVERGENCE= 41.39
PERCENT CONVERGENCE= 81.06
PERCENT CONVERGENCE= 94.61
PERCENT CONVERGENCE= 96.65
PERCENT CONVERGENCE= 96.73
PERCENT CONVERGENCE= 96.16
PERCENT CONVERGENCE= 97.80
PERCENT CONVERGENCE= 98.78
PERCENT CONVERGENCE= 98.37
PERCENT CONVERGENCE= 98.20
PERCENT CONVERGENCE= 98.53
PERCENT CONVERGENCE= 98.37
PERCENT CONVERGENCE= 98.53
PERCENT CONVERGENCE= 98.78
PERCENT CONVERGENCE= 98.86
PERCENT CONVERGENCE= 99.02
PERCENT CONVERGENCE= 99.18
PERCENT CONVERGENCE= 99.51
PERCENT CONVERGENCE= 99.67
PERCENT CONVERGENCE= 99.92
PERCENT CONVERGENCE=100.00
  22 ITERATION(S).
NUMBER OF POINTS IN EACH CLUSTER:
 140  193  111  324   91  224   99   43

FINAL CLASSIFICATION

NUMBER OF POINTS IN EACH CLUSTER:
 140  193  111  324   91  224   99   43.


       :CLUSTERING CLASSIFICATION:

     22222222222222222222222222222222222
     44444444444444444555555555555555555
     66777778888899999000001111122222333
     68024680246802468024680246802468024

2111 888885666666111117566666658827856662
2113 84443423255715666643313312275654465
2115 84444311111115433372112112275545543
2117 665664311112221133466222227735772222
2119 446764411111215666666222277711111222
2121 4445444311122175722271711177822111222
2123 4664464311117565222222788882222111222
2125 644453774466643722222217666665211122
2127 657277773466644348272274444445311227
2129 31177777746646444488282644444414454
2131 64577717734615443442254544444454444
2133 66677777734613655441144437334663444
2135 78277772216626645461144444344667444
2137 75652222117611663544114444344465273
2139 66677227344651664564114444437254444
2141 66656666444661664566875546722228544
2143 66665333344463153477666666222222244
2145 72222733244343464446666666222222244
2147 277336666644444644466666662222288654
2149 53333366666444346445666666547222222
2151 665333666666444564648566653122275332
2153 77344466622254446666111111133337222
2155 53322226632224444464511111111122822
2157 45522222222825337446331111112222111
2159 665222222228822221655631111111773544
2161 73332221222822221166641113345334464
2163 13338881444328766665442284555454444
2165 173434444444456666666662885522444444
2167 11237344444444666644344887678343433
2169 44444444444444666652774354472744664
2171 444444444443372222227746566452244366
2173 4444645771228222111117544664444463136
2175 44441111112222733434445434444443134
2177 66661127544444444444444654464444464
2179 45446666466546666444444445572884533


WANT TO SEE STATISTICS?(Y OR N) N
CREATE A CATEGORIZED WINDOW FILE?(Y OR N) Y

CATEGORIZED WINDOW FILE=EXAMPLE2.SCAT

CREATE A STATISTICS FILE?(Y OR N) Y

OUTPUT STATISTICS FILE=EXAMPLE2.STAT
```

```
!ENTER STATISTICS FILE EDITOR

INPUT STATISTICS FILE=EXAMPLE2.STAT

NUMBER OF CATEGORIES= 8 NUMBER OF CHANNELS=4

TYPE "?" FOR LIST OF COMMANDS

#?

COMMANDS ARE:
C=>DISPLAY CORRELATIONS
D=>DELETE CATEGORIES
E OR !=>EXIT
G=>GENERATE NEW STATISTICS FILE FROM OUTPUT BUFFER
I= INVERT CATEGORIES TO OUTPUT BUFFER
M=>DISPLAY MEANS
N=>DISPLAY NUMBER OF POINTS
O=>OPEN NEW INPUT FILE
P=>POOL CATEGORIES AND WRITE TO OUTPUT BUFFER
S=>DISPLAY SEPARABILITY MATRIX
U=>UN-DELETE CATEGORIES
V=>DISPLAY VARIANCES
W=>WRITE CATEGORIES TO OUTPUT BUFFER

#M

MEANS:
```

CAT#	CHANNELS 1	2	3	4
1	33.34	32.44	36.14	17.00
2	38.49	41.90	43.46	20.23
3	30.09	24.45	46.78	25.67
4	26.60	18.39	53.43	32.52
5	31.12	24.84	54.84	30.97
6	27.63	18.19	63.67	38.23
7	35.49	33.90	46.17	23.35
8	44.70	49.44	53.56	24.86

```
#V

VARIANCES:
```

CAT#	CHANNELS 1	2	3	4
1	6.05	18.25	9.38	3.22
2	2.64	6.51	6.87	2.41
3	4.12	7.00	7.06	5.62
4	1.81	3.27	9.11	4.98
5	3.33	9.29	8.34	5.05
6	3.07	5.25	14.77	6.41
7	3.05	4.03	11.00	5.27
8	13.03	32.25	25.97	6.84

```
#C

CHANNEL CORRELATION MATRIX, (UPPER TRIANGULAR):
```

CAT#	CHANNELS 1	2	3	4
1	1.000	0.813	0.398	0.173
		1.000	0.432	0.212
			1.000	0.835
				1.000
2	1.000	0.617	0.470	0.371
		1.000	0.445	0.274
			1.000	0.807
				1.000
3	1.000	0.765	0.066	-0.217
		1.000	-0.039	-0.274
			1.000	0.744
				1.000
4	1.000	0.525	0.225	0.004
		1.000	-0.013	-0.287
			1.000	0.651
				1.000
5	1.000	0.743	0.219	0.090
		1.000	0.042	-0.072
			1.000	0.685
				1.000
6	1.000	0.711	0.414	0.146
		1.000	0.111	-0.047
			1.000	0.542
				1.000
7	1.000	0.637	0.272	-0.001
		1.000	0.176	-0.061
			1.000	0.807
				1.000
8	1.000	0.840	0.677	0.497
		1.000	0.507	0.261
			1.000	0.887
				1.000

```
:S

SEPARABILITY MATRIX:
```

CAT:	1	2	3	4	5	6	7	8
1	1.00	0.67	1.08	2.06	1.63	2.49	0.70	0.96
2		1.00	1.60	2.95	1.86	3.09	0.90	0.58
3			1.00	0.79	0.60	1.33	0.84	1.35
4				1.00	0.67	0.64	1.84	2.30
5					1.00	0.89	1.05	1.48
6						1.00	2.03	2.41
7							1.00	0.85
8								1.00

```
:W

LOW CATEGORY, HIGH CATEGORY=1,1

INPUT CATEGORY  1 TO OUTPUT CATEGORY  1

:P

ENTER LIST OF CATEGORIES TO BE POOLED:2,8

INPUT CATEGORIES  2  8
POOLED TO OUTPUT CATEGORY  2

:W

LOW CATEGORY, HIGH CATEGORY=4,4

INPUT CATEGORY  4 TO OUTPUT CATEGORY  3

:P

ENTER LIST OF CATEGORIES TO BE POOLED:3,5

INPUT CATEGORIES  3  5
POOLED TO OUTPUT CATEGORY  4

:W

LOW CATEGORY, HIGH CATEGORY=6,7

INPUT CATEGORY  6 TO OUTPUT CATEGORY  5
INPUT CATEGORY  7 TO OUTPUT CATEGORY  6

:G

OUTPUT STATISTICS FILE=EXAMPLE2.STATF

DO YOU WISH TO CONTINUE (Y OR N)N


!CLASSIFY A WINDOW
NUMBER OF CHANNELS=4

INPUT STATISTICS FILE=EXAMPLE2.STATF

FILE TYPE=4, CATEGORIES OUTPUT= 6, CHANNELS=4

WANT TO USE APPIORI PROBIBILITIES?(Y OR N) N

INPUT WINDOW FILE=EXAMPLE2.WIN

FILE TYPE=0, ROW COL SAMPLING=  1  1, CHANNELS=4
NUMBER OF WINDOWS=  1

CATEGORIZED WINDOW FILE=EXAMPLE2.CAT

PLEASE USE "PRINT" TO SEE CLASSIFICATION.


!PRINT A WINDOW
OUTPUT DEVICE?(? FOR LIST) T

INPUT WINDOW FILE=EXAMPLE2.CAT

FILE TYPE= 2, CATEGORIES ASKED= 0, CATEGORIES OUTPUT= 6
DELTA= 0.00, LONG ROWS=   39, NUMBER OF WINDOWS=  1
CHANNELS=4, ROW COL SAMPLING=  1  1
WINDOWS:
  #   NORTH WEST      SOUTH EAST      NUMBER OF POINTS
  1:(2111,2466)    (2180,2535)          4900

MINIMUM RELIABILITY TO DISPLAY?(0.0 TO 1.0) 0
WANT TO GROUP CATEGORIES?(Y OR N) N

MAPPING USED:123456
WANT COUNT OF GROUPS?(Y OR N) Y
```

```
     2222222222222222222222222222222222222222222222222222222222222222
     4444444444444444444444444444444444555555555555555555555555555555
     6666777777777788888888889999999999000000000011111111112222222222
     6789012345678901234567890123456789012345678901234567890123456789

2111 22222222264555555555555531111111664445555555555555462222266666455
2112 226666443344444645555554164443555555555555344334446222635544444
2113 2333333333422441644446111455555555553344411444411622226444554443
2114 2433333334346661111111111145554444444444461122211162226444554444
2115 2433333333421111111111111143444444446611211122211622622654643444
2116 4354465553334111111111112264666111111164666226662224444424335
2117 5554465553334111111111122122111444435555422222226222634446646662
2118 5354464553334111111111121116435555555555562222222622261611111122
2119 3535556455333311111111112211455555555555562222226666661111111111
2120 3335556455333311111111211226555555446622266666111116644611111
2121 3333354435333341111111111111644661222216666111126666222221111121
2122 3555554435533341111111111226111121122266666662222222222221111
2123 3355553435533341111166444554222122222266222222222222262222111111
2124 4355555535534446644355555544621222222221116222226644455422111111
2125 5533333344466666333555555334446622222222211264555555555534621111
2126 5446666266662666433535355335534442222266222265555553333344441111
2127 5346622666666666433553555555334334222662222264333333333344411111
2128 5541166666666666633555555555333333346626662222453333333335344611
2129 44111166666646626335555533553333333322222222224533333333333341163
2130 3346666666662666664335533445533343333622222222643333333333334643
2131 5334466666666666666433554444553333333342226443443333333333333443
2132 5554466666666666666433334116353344433411114333344333333344466446
2133 5555566666666666666433354164444446433334111433333446664443335544
2134 5555566666666666666645546265555364455541114335334433443333355544
2135 6222216666666662211145551265555344455341114333333334433333355544
2136 2222216222222212111455561635553444335411113533333334433337555426
2137 6445554222222221111165551113555544433341111333333333344333335554
2138 5555554222222221111116555611455554444333111143333333334433333444
2139 5555546666222226444333555416455553644553611143333333333444662645
2140 5544426644445553333335554114555554445554222633444444441222222644
2141 5555554455555553333335555616555534455562264444433546122222222226
2142 5555555455555444333333555616455334446264555555555542222222222222
2143 5555555544444444433333355541144444344665555555555556222222222222
2144 5555544666444444443334444444443533344465555555555556222222222222
2145 6622222222664444444433344433433555333434555555555555622222222222
2146 1222222226443555555553433333355533335555555555555542222222222222
2147 2266644444555555555553333333335533333355555555555554222222222226
2148 4444444444435555555555333333433553333445555555555554462222222226
2149 4444444444435555555555333333343555433345555555555555433466222222
2150 5534444444444455555555555533443344555444346455555555553446622222222
2151 5554444444444455555555555433334444553555362244555544411622222266644
2152 5554444444435555555544622243333334555555542666111111111114444444444
2153 6664433333335555554222222633333335555555311111111111114444444666
2154 6644444446666455554222222633333335553553361111111111111466111122
2155 4444442222222455534222222633333333555533441111111111111111111122
2156 4444442222222644662222222633333333444444441111111111111111112222
2157 3444462222222222222222222243344664343554444111111111111121111222
2158 4444462222222222222222222222112145553444411111111111111111162666
2159 5554462222222222222222222221616554443534111111111111116666644
2160 4464462222222222222222222221122645555553111111111111114444443333
2161 6644444222222212222222222222221116455555534111111444433444443333
2162 1644444222222216433334222222264443555555553416224444444434443333
2163 1144444622222214333333462222645555555554333342222244444444433433
2164 1264444626644444433333334222226453555555553422222444446664433333
2165 1264444444443333333333333344555555555555555532222226446222643333
2166 1164444444444434443333333333555555553355535555322222235422224333433
2167 1111144464444433333333333333555555555333334433362222263536222433333
2168 1166664443333333333333333333333555555555344626644622226336222633346
2169 33333333333333333333333333333355555555446666266434444333336222633335
2170 333333333333333333333333333355446622266662455345555333422226333333
2171 333333333333333333333334446622222222222666635534555533342222433344
2172 333333333333333355462222222222211222222262455335555333466443535333
2173 33333334553354466212222222222211111111664333335533333333333333553411
2174 3333333466222211111222222226111111144443333444444333333333335341
2175 33333334111111211111222222226644443333333333343334333333333333341
2176 335555531111111221216644433333433333333333353343333333335553411
2177 5555555311122664433343333333333333333333333355344333533333333333
2178 555553444335553355553333333333445543333333333334344433554444643343
2179 334334335355553355353334555555555333333333333333334446662222224344
2180 3355555555555555555555335355555555543333333333333342222222222226466
```

4900 TOTAL VALID POINTS.

GROUP	COUNT	PERCENT
1	561	11.45
2	861	17.57
3	1225	25.00
4	866	17.67
5	904	18.45
6	483	9.86

```
CONTINUE WITH THIS FILE?(Y OR N) N
ANOTHER FILE?(Y OR N) N
!QUIT EDITOR
TAPE REWINDING, PLEASE WAIT
@DEASS MTA0:
@UNL MTA0:
@
```

APPENDIX C

Example EDITOR Session 3.

This third example EDITOR session illustrates the use of ground truth information in compiling statistics files (or "spectral signatures") for TENEX and ILLIAC IV classifications. Here, the CLIP module is used to extract from the analysis window retrieved previously (in Appendix B) rectangular image areas known to correspond to pasture and wasteland agricultural terrains. The samples selected for both terrain types are clustered into two (2) spectral categories, although reference to the cluster separability information reported suggests that the samples of both terrain types are spectrally homogeneous and hence, one signature per terrain type should have been sufficient. The statistics files resulting from these ground truth cluster analyses are then merged with statistics files already existing for sugar-beets and corn terrain samples to create a new composite statistics file to be used for classification of the complete analysis area. Following classification, the nine (9) spectral clusters are manually re-grouped into four (4) nominal categories and assigned the symbols "S", "C", "P", and "W" (representing sugar-beets, corn, pasture and wasteland respectively) for crop-area tabulation and mapping purposes.

Also illustrated within this appendix is the use of certain TENEX commands available for file directory maintenance. Following this EDITOR session, the user requests a listing of all files within his directory and selects a number of files to be deleted. Following all DELETEs, the EXPUNGE command is used to cause immediate deletion of all specified files. The DSKSTAT command is then used to obtain a status report on all disk space currently being charged to the user.

```
.RAY:EDITOR

EDITOR  VERSION 2.5  MARCH 25, 1975
!CLIP

SUBWIN (DISK TO DISK SUBWINDOW PROGRAM), VERSION 3.0

INPUT WINDOW FILE=EXAMPLE2.WIN [OLD VERSION]
TYPE=0
CATEGORIES IN=0
CATEGORIES OUT=0
ROW SAMPLE=1
COLUMN SAMPLE=1
NUMBER OF CHANNELS=4
CHANNELS IN USE: 1 2 3 4
NUMBER OF WINDOWS=1
1: 2111,2466,2180,2535,4900
2!COORDINATES
ENTER COORDINATES OF SUBWINDOWS OF WINDOW 1
USE ESC FOR THE FULL COORDINATES OF THE WINDOW
TERMINATE WITH CARRIAGE RETURN ONLY ON A LINE
*2128,2472,2134,2481
*_
2!WRITE
NUMBER OF WINDOWS=I
2128,2472,2134,2481
ADDITIONAL SAMPLING, ROW=1, COLUMN=1
OUTPUT FILE=PASTURE.WIN [NEW VERSION]
!MODIFY WINDOW HEADER
2!NUMBER OF CATEGORIES DESIRED
DISK FILE=PASTURE.WIN
 [OLD VERSION]
NUMBER OF CLUSTERS=4
2!DELTA OR SEPARABILITY THRESHOLD
DELTA=.8
2!CLOSE FILE AND QUIT
!CLUSTER A WINDOW
NUMBER OF CHANNELS=4

INPUT WINDOW FILE=PASTURE.WIN

CATEGORIES ASKED= 4, DELTA= 0.80, ROW COL SAMPLING= 1 I
CHANNELS=4, TOTAL NUMBER OF POINTS=   70


MINIMUM NUMBER OF CATEGORIES AFTER MERGING (1 TO  4) 2
WHAT PERCENT CONVERGENCE?(0.001-100.0) 100.0

ENTER MAXIMUM NUMBER OF ITERATIONS TO BE PERFORMED
 (-1 TO PERFORM AS MANY AS NEEDED TO ATTAIN DESIRED CONVERGENCE)
:-1

PERCENT CONVERGENCE=  0.00
PERCENT CONVERGENCE= 88.57
PERCENT CONVERGENCE= 92.86
PERCENT CONVERGENCE= 95.7I
PERCENT CONVERGENCE= 98.57
PERCENT CONVERGENCE=100.00
   6 ITERATION(S).
NUMBER OF POINTS IN EACH CLUSTER:
   8   31   17   I4

CATEGORIES  2 AND  3 ARE MERGED. DISTANCE  0.56 < DELTA.
PERCENT CONVERGENCE= 57.14
PERCENT CONVERGENCE= 98.57
PERCENT CONVERGENCE=100.00
   9 ITERATION(S).
NUMBER OF POINTS IN EACH CLUSTER:
   8   46   16

CATEGORIES  2 AND  3 ARE MERGED. DISTANCE  0.67 < DELTA.
PERCENT CONVERGENCE= 65.71
PERCENT CONVERGENCE= 90.00
PERCENT CONVERGENCE= 94.29
PERCENT CONVERGENCE= 98.57
PERCENT CONVERGENCE= 95.71
PERCENT CONVERGENCE= 97.14
PERCENT CONVERGENCE= 97.14
PERCENT CONVERGENCE= 98.57
PERCENT CONVERGENCE= 98.57
PERCENT CONVERGENCE=100.00
  19 ITERATION(S).
NUMBER OF POINTS IN EACH CLUSTER:
  37   33

FINAL CLASSIFICATION

NUMBER OF POINTS IN EACH CLUSTER:
  37   33

        :CLUSTERING CLASSIFICATION:

     2222222222
     4444444444
     7777777788
     2345678901

2128 2222212121
2129 2222222221
2130 2121111111
2131 2211111111
2132 111111111I
2133 212I1111I21
2134 2222222222


WANT TO SEE STATISTICS?(Y OR N) Y

                  SEPARABILITY MATRIX

 1 + 1.00
 2 + 0.56 1.00
   +    +    +
        1    2
```

```
GROUP              MEANS                                VARIANCES
  I     35.78  33.89  43.22  21.16        0.95   2.60   1.5
  2     36.76  34.27  46.I2  22.00        1.44   2.02   1.4

CREATE A CATEGORIZED WINDOW FILE?(Y OR N) Y

CATEGORIZED WINDOW FILE=PASTURW.CAT

CREATE A STATISTICS FILE?(Y OR N) Y

OUTPUT STATISTICS FILE=PASTURE.STAT


!MODIFY WINDOW HEADER
2!NUMBER OF CATEGORIES DESIRED
DISK FILE=WASTE.WIN
 [OLD VERSION]
NUMBER OF CLUSTERS=4
2!DELTA OR SEPARABILITY THRESHOLD
DELTA=.8
2!CLOSE FILE AND QUIT
!CLUSTER A WINDOW
NUMBER OF CHANNELS=4

INPUT WINDOW FILE=WASTE.WIN

CATEGORIES ASKED= 4, DELTA= 0.80, ROW COL SAMPLING= 1 1
CHANNELS=4, TOTAL NUMBER OF POINTS=   70


MINIMUM NUMBER OF CATEGORIES AFTER MERGING (1 TO  4) 2
WHAT PERCENT CONVERGENCE?(0.00I-I00.0) 100.0

ENTER MAXIMUM NUMBER OF ITERATIONS TO BE PERFORMED
 (-I TO PERFORM AS MANY AS NEEDED TO ATTAIN DESIRED CONVE
:-I

PERCENT CONVERGENCE=  0.00
PERCENT CONVERGENCE= 91.43
PERCENT CONVERGENCE= 92.86
PERCENT CONVERGENCE= 95.71
PERCENT CONVERGENCE= 98.57
PERCENT CONVERGENCE= 95.71
PERCENT CONVERGENCE= 91.43
PERCENT CONVERGENCE= 95.71
PERCENT CONVERGENCE= 98.57
PERCENT CONVERGENCE=100.00
  10 ITERATION(S).
NUMBER OF POINTS IN EACH CLUSTER:
  12   20   26   12

CATEGORIES  1 AND  3 ARE MERGED. DISTANCE  0.60 < DELTA.
PERCENT CONVERGENCE= 47.14
PERCENT CONVERGENCE= 92.86
PERCENT CONVERGENCE= 92.86
PERCENT CONVERGENCE= 92.86
PERCENT CONVERGENCE= 94.29
PERCENT CONVERGENCE= 92.86
PERCENT CONVERGENCE= 95.7I
PERCENT CONVERGENCE= 97.I4
PERCENT CONVERGENCE=I00.00
  19 ITERATION(S).
NUMBER OF POINTS IN EACH CLUSTER:
  16   33   2I

CATEGORIES  1 AND  3 ARE MERGED. DISTANCE  0.72 < DELTA.
PERCENT CONVERGENCE= 65.71
PERCENT CONVERGENCE= 90.00
PERCENT CONVERGENCE= 9I.43
PERCENT CONVERGENCE= 95.71
PERCENT CONVERGENCE= 95.71
PERCENT CONVERGENCE=100.00
  25 ITERATION(S).
NUMBER OF POINTS IN EACH CLUSTER:
  19   51

FINAL CLASSIFICATION

NUMBER OF POINTS IN EACH CLUSTER:
  19   51

        :CLUSTERING CLASSIFICATION:

     2222222222
     5555555555
     111111I1I1
     0123456789

2154 2222222222
2155 2222222222
2156 122211I222
2157 12I1111222
2158 1211222212
2159 2I22I22222
2160 III2222222


WANT TO SEE STATISTICS?(Y OR N) Y

                  SEPARABILITY MATRIX

 1 + 1.00
 2 + 0.59 1.00
   +    +    +
        1    2

GROUP              MEANS                                VARIANCES
  1     30.84  26.53  30.47  14.63        1.36   1.60   3.60
  2     30.86  26.86  34.47  16.49        2.00   1.52   1.49

CREATE A CATEGORIZED WINDOW FILE?(Y OR N)_
CREATE A CATEGORIZED WINDOW FILE?(Y OR N) Y
```

```
CATEGORIZED WINDOW FILE=WASTE.CAT

CREATE A STATISTICS FILE?(Y OR N) Y

OUTPUT STATISTICS FILE=WASTE.STAT


!CL NOT UNIQUE
!CLIP A WINDOW

SUBWIN (DISK TO DISK SUBWINDOW PROGRAM), VERSION 3.0

INPUT WINDOW FILE=EXAMPLE2.WIN [OLD VERSION]
TYPE=0
CATEGORIES IN=0
CATEGORIES OUT=0
ROW SAMPLE=1
COLUMN SAMPLE=1
NUMBER OF CHANNELS=4
CHANNELS IN USE: 1 2 3 4
NUMBER OF WINDOWS=1
1: 2111,2466,2180,2535,4900
2!COORDINATES
ENTER COORDINATES OF SUBWINDOWS OF WINDOW 1
USE ESC FOR THE FULL COORDINATES OF THE WINDOW
TERMINATE WITH CARRIAGE RETURN ONLY ON A LINE
*2154,2510,2160,2519
*
2!WRITE
NUMBER OF WINDOWS=1
2154,2510,2160,2519
ADDITIONAL SAMPLING, ROW=1, COLUMN=1
OUTPUT FILE=WASTE.WIN [NEW VERSION]
!ENTER STATISTICS FILE EDITOR

INPUT STATISTICS FILE=SUGAR-BEETS.STAT


NUMBER OF CATEGORIES= 3 NUMBER OF CHANNELS=4

TYPE "?" FOR LIST OF COMMANDS


:W

LOW CATEGORY, HIGH CATEGORY=1,3

INPUT CATEGORY  1 TO OUTPUT CATEGORY  1
INPUT CATEGORY  2 TO OUTPUT CATEGORY  2
INPUT CATEGORY  3 TO OUTPUT CATEGORY  3


:O

INPUT STATISTICS FILE=CORN.STAT


NUMBER OF CATEGORIES= 2 NUMBER OF CHANNELS=4


:W

LOW CATEGORY, HIGH CATEGORY=1,2

INPUT CATEGORY  1 TO OUTPUT CATEGORY  4
INPUT CATEGORY  2 TO OUTPUT CATEGORY  5


:O

INPUT STATISTICS FILE=PASTURE.STAT


NUMBER OF CATEGORIES= 2 NUMBER OF CHANNELS=4


:W

LOW CATEGORY, HIGH CATEGORY=1,2

INPUT CATEGORY  1 TO OUTPUT CATEGORY  6
INPUT CATEGORY  2 TO OUTPUT CATEGORY  7


:O

INPUT STATISTICS FILE=WASTE.STAT


NUMBER OF CATEGORIES= 2 NUMBER OF CHANNELS=4


:W

LOW CATEGORY, HIGH CATEGORY=1,2

INPUT CATEGORY  1 TO OUTPUT CATEGORY  8
INPUT CATEGORY  2 TO OUTPUT CATEGORY  9


:G

OUTPUT STATISTICS FILE=EXAMPLE3.STAT


DO YOU WISH TO CONTINUE (Y OR N)N

!CLASSIFY A WINDOW
NUMBER OF CHANNELS=4

INPUT STATISTICS FILE=EXAMPLE3.STAT

FILE TYPE=4, CATEGORIES OUTPUT= 9, CHANNELS=4

WANT TO USE APPIORI PROBIBILITIES?(Y OR N) N

INPUT WINDOW FILE=EXAMPLE2.WIN

FILE TYPE=0, ROW COL SAMPLING=  1  1, CHANNELS=4
NUMBER OF WINDOWS=  1

CATEGORIZED WINDOW FILE=EXAMPLE3.CAT


PLEASE USE "PRINT" TO SEE CLASSIFICATION.

!PRINT A WINDOW
OUTPUT DEVICE?(? FOR LIST) T

INPUT WINDOW FILE=EXAMPLE3.CAT



FILE TYPE= 2, CATEGORIES ASKED= 0, CATEGORIES OUTPUT= 9
DELTA= 0.00, LONG ROWS=   39, NUMBER OF WINDOWS=  1
CHANNELS=4, ROW COL SAMPLING=  1  1
WINDOWS:
 #  NORTH WEST      SOUTH EAST      NUMBER OF POINTS
 1:(2111,2466)     (2180,2535)            4900

MINIMUM RELIABILITY TO DISPLAY?(0.0 TO 1.0) 0.05
WANT TO GROUP CATEGORIES?(Y OR N) N

MAPPING USED:123456789
WANT COUNT OF GROUPS?(Y OR N) Y


     2222222222222222222222222222222222222222222222222222222222222222222222
     4444444444444444444444444444444444555555555555555555555555555555555555
     6666777777777788888888889999999999000000000011111111112222222222333333
     6789012345678901234567890123456789012345678901234567890123456789012345

2111 ...........122221211211.............111221212111.......6.....111111...
2112 ........44.......111111.......11111111111.........6.....11....111111...
2113 ..55544..44.66...6.........111111111.4............66.......11.......11..
2114 .....5544...76..........9..111.............6...................11.........
2115 .....44.44...........................66.............6.7..7..7.5.......5...
2116 ......11.44.................7.776........6.677..777..........5...1....7.
2117 111...111455...........................51111........66.7...17...........
2118 1..11...1545..............8....11111111111.......66...6.6...............
2119 .1.......154...................211111111111........76677.8898..........
2120 4..111....5445.................111111....6.67.766..99.66..699..........
2121 5....1..5.545...................6.......6.66.....767....................
2122 511111..5.1555..............76.........677.777..........................
2123 ..1111..511555.......67...11..........66..............66................
2124 ..1111115..4...7....5....5...6..........99.7..........111...............
2125 115555......7766.54........5...76..................113333331..7.........
2126 1.....7..6766766.551.....5...5.........77.....3322.15.........9.........
2127 15.....777676666.44..........55.44....67.....7....54455............6....
2128 1..887777777767774...........5.44544.777..........555555551...7..6.4..44.
2129 ..9...777777.776....1....5..5....45.............15..5...55555..6.45.....
2130 55.77776766666666.5...5.....554.54447...........4...45.5455..6.444.....
2131 .....7776666666666.54........54..4444.......4...44455.54555...44..44.4
2132 1.1..7666666666666.45.....6..55.........8..4544..44454....77....4......1
2133 1111177676666667666.44....6..1...........88..544....76...445111..4.....5
2134 1.....7777777777676.........11.4...111..99.55.55......44545.11..4.444..
2135 ......666777766.....331...12115....11...8...5555544..4555533...4.4.5..
2136 ......6...............3316.6.111.......1....94.555.455..44544131.66..44..
2137 ...111....................331....11.............89455445455..44544..1.6..6...
2138 333333..................7133....1111............9.44.44.45...4544........4444
2139 33311..6.6....6...444133.......1.......5.....5454..4.......7...11.444444
2140 31....77...1111444554133....111.....111.....45......................444544
2141 331111..12222135455555133....1111...1111..........451.6.................45444
2142 1111111.11111...44554.3337.6.1154.......2222222211..................44444
2143 11111111..........445444111.................133222222217.................4445
2144 111.....77.........444.........5........12222222222217..............7.444
2145 .7.......76........4.......4.4...........22222.2222217.................4444
2146 .........7..........5.....4..........1232322222222....................455
2147 ..666.....1..........554455..4........5.2222222222221..............11.544
2148 ......................54444...4....5...122222222222..7..........1...7..
2149 ........................44445..4..........222222322221.44.76...........
2150 ........................54..4..............2122222211....7.........6.7..
2151 11.......................1..444...................1111....9.....67..........
2152 1............1.......77.7.544444...........776..99999989...................7..
2153 .77...55444.1...............444544.222.....9999998999999..........7.......
2154 7........776..................454444.1.15....69999999999999.66..............75
2155 ............6....5..........4444455.....5...9999999999999.................7
2156 ..................7...........44445.5..........8889988889899.................6
2157 ..........................4....6....1......8.9888889999..........99.9.6
2158 .....7...........................................989889999999999.77.76.9....
2159 111...............................11....1..998998999.999.66666....555.
2160 .....7............................6..211115.8888999999999......44.5554.5
2161 77.............................................999999....4......44555....
2162 .6..............6.4444........67.....12111.1...6....................5111.554
2163 ...................444444.........1...1111...5.........................54444444
2164 ..6......77.....44444444.........1.1111..11............................4444.44
2165 ..6........4444.4444444....1211221211.11111.................444.44444444
2166 ..6.................444444445222.2.1.5111.11............1......444.44444444
2167 ..................4544444444441......1555.5.............75..6....444.44.....
2168 ..666....4454444444444444444511.22.11....6.7........6.5......444.........
2169 .444444445544444444.4444444441222221..76...7.4.....5554....744.4......5.
2170 444444555554444444.445444444411.......77777.....1111.55....7.444..5.11.
2171 44444444555444455444444...766...........777....5.1111555.6....44......222
2172 444444444445555..11....6....................676.5..4.11115.5.77....5.4.5.1..
2173 44444.4.11.....76..6.......................7..44.4.11.444444.4..5.998....
2174 5.55555..6..........6......................455......4444.4...45...888....
2175 5555555......................7.....444.4.4445...44.44444444444555..88....
2176 .5...................7.............444444445554....4555544444.....8.....
2177 .........9...77....55.444.4444444.5.5555555......5..545111.555.....5...5.
2178 ...11.........55.......4.4.4....11.55555544454.4...55.1.......4....45.4.
2179 .........1......55.......4.1..3.311145555544555 4.4.......................
2180 .111111111................1513..11111.54544454.544......................11.
```

```
 4900 TOTAL VALID POINTS.

GROUP    COUNT  PERCENT
  .      2989    61.00
  1       400     8.16
  2       132     2.69
  3        49     1.00
  4       523    10.67
  5       309     6.31
  6       172     3.51
  7       170     3.47
  8        42     0.86
  9       114     2.33


CONTINUE WITH THIS FILE?(Y OR N) Y
MINIMUM RELIABILITY TO DISPLAY?(0.0 TO 1.0) 0.05
WANT TO GROUP CATEGORIES?(Y OR N) Y
ENTER EACH GROUPING AS <O>+<I>. <O> IS THE OUTPUT GROUP,
AND MAY BE ANY PRINTING CHARACTER.
 I> IS A STRING OF INPUT CATEGORIES FROM 1 THRU
9(A=10) TO BE MAPPED TO <O>; <I> MUST NOT CONTAIN ANY
SPACES. A SPACE AND A COMMENT MAY FOLLOW <I>. END WITH
ONLY CAR RET ON A LINE.
S+123  SUGAR BEETS
C+45   CORN
P+67   PASTURE
W+89   WASTELAND


MAPPING USED:SSSCCPPWW
OK?(Y OR N) Y
WANT COUNT OF GROUPS?(Y OR N) Y



     2222222222222222222222222222222222222222222222222222222222222222222222
     4444444444444444444444444444444444555555555555555555555555555555555555
     6666777777777788888888889999999999000000000011111111112222222222333333
     6789012345678901234567890123456789012345678901234567890123456789012345

2111 ...........SSSSSSSSSSSS.............SSSSSSSSSSSS.......P.....SSSSSS...
2112 ........CC.......SSSSSS......SSSSSSSSSSSS........P.....SS....SSSSSS...
2113 ..CCCCC..CC.PP...P.........SSSSSSSSS.C...........PP.......SS......SS..
2114 .....CCCC...PP............W..SSS...........P................SS.........
2115 .....CC.CC.........................PP.............P.P..P..P.C......C...
2116 ......SS.CC.................P.PPP........P.PPP..PPP..........C...S....P.
2117 SSS...SSSCCC........................CSSSS.........PP.P...SP.............
2118 S..SS...SCCC..............W....SSSSSSSSSSS.......PP...P.P...............
2119 .S.......SCC..................SSSSSSSSSSSS........PPPPP.WWWW............
2120 C..SSS....CCCC..................SSSSSS....P.PP.PPP..WW.PP..PWW..........
2121 C....S..C.CCC.......................P......P.PP......PPP.................
2122 CSSSSS..C.SCCC..............PP.........PPP.PPP...........................
2123 ..SSSS..CSSCCC.......PP...SS...........PP.............PP.................
2124 ..SSSSSSC..C...P....C....C...P.........WW.P..........SSS.................
2125 SSCCCC......PPPP.CC.........C...PP.................SSSSSSSSS..P..........
2126 S......P..PPPPPPP.CCS.....C...C.........PP.....SSSS.SC.........W.........
2127 SC.....PPPPPPPPP.CC..........CC.CC....PP.....P....CCCCC............P....
2128 S..WWPPPPPPPPPPPPPC...........C.CCCCC.PPP.........CCCCCCCCS...P..P.C..CC.
2129 ..W...PPPPPP.PPP....S....C..C.....CC..............SC..C...CCCCC..P.CC.....
2130 CC.PPPPPPPPPPPPPP.C...C......CCC.CCCCP...........C...CC.CCCC..P.CCC.....
2131 .....PPPPPPPPPPPPP.CC..........CC..CCCC........C...CCCCC.CCCCC...CC..CC.C
2132 S.S..PPPPPPPPPPPPP.CC.....P..CC.........W..CCCC..CCCCC....PP.....C......S
2133 SSSSSPPPPPPPPPPPPP.CC....P..S...........WW..CCC....PP...CCCSSS..C......C
2134 S.....PPPPPPPPPPPPP..........SS.C...SSS..WW.CC.CC......CCCCC.SS..C.CCC..
2135 ......PPPPPPPPP.....SSS...SSSSC....SS...W...CCCCCCC..CCCCCSS...C.C..C..
2136 ......P...............SSSP.P.SSS......S....WC.CCC.CCC..CCCCCSSS.PP..CC..
2137 ...SSS..................SSS....SS...........WWCCCCCCCCC..CCCCC..S.P..P...
2138 SSSSSS..................PSSS....SSSS...........W.CC.CC.CC...CCCC.......CCCC
2139 SSSSS..P.P....P...CCCSSS.......S.......C.....CCCC..C.......P...SS.CCCCCC
2140 SS....PP...SSSSCCCCCCSSS....SSS.....SSS.....CC.....................CCCCCC
2141 SSSSSS..SSSSSSSCCCCCCSSS....SSSS...SSSS.........CCS.P..............CCCCC
2142 SSSSSSS.SSSSS...CCCCC.SSSP.P.SSCC.......SSSSSSSSSSS..................CCCCC
2143 SSSSSSSS..........CCCCCCSSS.................SSSSSSSSSSSSSP............CCCC
2144 SSS.....PP.........CCC........C.........SSSSSSSSSSSSSSP.............P.CCC
2145 .P.......PP........C.......C.C..........SSSSS.SSSSSSSP................CCCC
2146 .........P.............C.....C..........SSSSSSSSSSSSSSS.................CCC
2147 ..PPP.....S...........CCCCCC..C........C.SSSSSSSSSSSSSSS..............SS.CCC
2148 ........................CCCCC...C....C...SSSSSSSSSSSSSS..P.........S....P..
2149 ..........................CCCCC..C..........SSSSSSSSSSSSS.CC.PP...........
2150 ..........................CC..C.............SSSSSSSSSSS....P.........P.P..
2151 SS......................S..CCC......................SSSS....W......PP..........
2152 S............S........PP.P.CCCCCC...........PPP..WWWWWWWW...............P..
2153 .PP...CCCCC.S................CCCCCC.SSS.....WWWWWWWWWWWWW..........P.......
2154 P.........PPP................CCCCCC.S.SC....PWWWWWWWWWWWWW.PP............PC
2155 .............P....C.........CCCCCCC.....C...WWWWWWWWWWWWW..................P
2156 ...................P.........CCCCC.C..........WWWWWWWWWWWW................P
2157 ..............................C....P....S......W.WWWWWWWWWW.........WW.W.P
2158 .....P.........................................WWWWWWWWWWWWWWW.PP.PP.W....
2159 SSS..............................SS....S..WWWWWWWWW.WWW.PPPPP....CCC.
2160 .....P...........................P..SSSSSC.WWWWWWWWWWWW......CC.CCCC.C
2161 PP.............................................WWWWWW....C......CCCCC....
2162 .P...............P.CCCC........PP.....SSSSS.S...P...................CSSS.CCC
2163 ..................CCCCCC........S...SSSS...C...........................CCCCCCCC
2164 ..P......PP.....CCCCCCCC........S.SSSS..SS............................CCCC.CC
2165 ..P........CCCC.CCCCCCC....SSSSSSSSSS.SSSSS..................CCC.CCCCCCCC
2166 ..P...............CCCCCCCCCSSS.S.S.CSSS.SS..........S......CCC.CCCCCCCC
2167 ................CCCCCCCCCCCCS......SCCC.C...........PC..P....CCC.CC.....
2168 ..PPP....CCCCCCCCCCCCCCCCCCCSS.SS.SS....P.P.......P.C......CCC.........
2169 .CCCCCCCCCCCCCCCCCC.CCCCCCCCCSSSSSSSS..PP...P.C.....CCCC....PCC.C......C.
2170 CCCCCCCCCCCCCCCCCCC.CCCCCCCCCSS.......PPPPP.....SSSS.CC....P.CCC..C.SS.
2171 CCCCCCCCCCCCCCCCCCCCCC...PPP...........PPP....C.SSSSCCC.P.....CC.....SSS
2172 CCCCCCCCCCCCC..SS....P...................PPP.C..C.SSSSC.C.PP....C.C.C.S..
2173 CCCCC.C.SS.....PP..P......................P..CC.C.SS.CCCCCC.C..C.WWW....
2174 C.CCCCC..P.........P.......................CCC......CCCC.C....CC...WWW....
2175 CCCCCCC.........................P.....CCC.C.CCCC...CC.CCCCCCCCCCCCC..WW....
2176 .C...................P.............CCCCCCCCCCC....CCCCCCCCCC.....W.....
2177 .........W...PP....CC.CCC.CCCCCCC.C.CCCCCCC.....C..CCCSSS.CCC.....C....C.
2178 ...SS.........CC......C.C.C....SS.CCCCCCCCCCCC.C....CC.S.......C.....CC.C.
2179 .........S.......CC.......C.S..S.SSSSCCCCCCCCCCCC.C........................
2180 .SSSSSSSSS.................SCSS..SSSSS.CCCCCCCC.CCC........................SS.
```

```
 4900 TOTAL VALID POINTS.

GROUP    COUNT  PERCENT
  .      2989    61.00
  C       832    16.98
  P       342     6.98
  S       581    11.86
  W       156     3.18


CONTINUE WITH THIS FILE?(Y OR N) N
ANOTHER FILE?(Y OR N) N
!QUIT EDITOR


@DIRECTORY

   <OZGA>
 CORN.WIN;1
    .CAT;3
    .STAT;3
 EXAMPLE1.WIN;4
    .CAT;2
    .STAT;2
 EXAMPLE2.WIN;3
    .SWIN;3
    .SCAT;3
    .STAT;3
    .STATF;4
    .CAT;4
 EXAMPLE3.STAT;3,2
    .CAT;3,2
 MESSAGE.TXT;1
 PASTURE.WIN;2,1
    .CAT;3
    .STAT;3,2
 PASTURW.CAT;1
 SUGAR-BEETS.WIN;1
    .STAT;2
    .CAT;1
 WASTE.WIN;2,1
    .STAT;4,3
    .CAT;3,2
 ]ARCHIVE-DIRECTORY[.;1


 @DELETE EXAMPLE1.*
  EXAMPLE1.WIN;4
  EXAMPLE1.CAT;2
  EXAMPLE1.STAT;2
 @DELETE EXAMPLE2.CAT
 @DELETE EXAMPLE2.STAT
 @DELETE EXAMPLE3.CAT
 @EXPUNGE


 @DIRECTORY

   <OZGA>
  CORN.WIN;1
     .CAT;3
     .STAT;3
  EXAMPLE2.WIN;3
     .SWIN;3
     .SCAT;3
     .STATF;4
  EXAMPLE3.STAT;3,2
     .CAT;3
  MESSAGE.TXT;1
  PASTURE.WIN;2,1
     .CAT;3
     .STAT;3,2
  PASTURW.CAT;1
  SUGAR-BEETS.WIN;1
     .STAT;2
     .CAT;1
  WASTE.WIN;2,1
     .STAT;4,3
     .CAT;3,2
 ]ARCHIVE-DIRECTORY[.;1

  @DSKSTAT
  46 TOTAL PAGES IN USE - 600 ALLOWED, 46 UNDELETED,
  SYSTEM TOTAL: 129817 PAGES LEFT, 95618 USED

  @LOGOUT
  KILLED JOB 33, USER OZGA, ACCT 111641, TTY 2, AT
    USED 0:2:8 IN 1:25:1
```