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Interfaces Between Statistical Analysis Packages and the ESRI Geographic Information System

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Abstract

The Environmental Systems Research Institute (ESRI) geographic information system (GIS) in use at Goddard Space Flight Center provides users with the means of combining remote sensing data with ancillary data (soils maps, geologic maps, topographic maps, etc.) and performing qualitative analyses on the resulting multivariable data base. However, statistical techniques such as multiple regression, analysis of variance and spatial autocorrelation analyses are not available in the GIS. This paper describes interfaces between ESRI's GIS data files and real valued data files written to facilitate statistical analysis and display of spatially referenced multivariable data. An example of data analysis which utilized the GIS and the Statistical Analysis System (SAS) is presented to illustrate the utility of combining the analytic capability of a statistical package with the data management and display features of the GIS.

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INTERFACES BETWEEN STATISTICAL ANALYSIS PACKAGES AND THE ESRI GEOGRAPHIC INFORMATION SYSTEM

INTRODUCTION

Automated geographic information systems provide a framework in which spatially referenced data (maps and remote sensing imagery) may be manipulated, displayed and analyzed (Knapp, 1979). The utility of a geographic information system (GIS) lies in its ability to create and analyze a multivariable file derived from maps and images of a study area. Geographic information systems have been used by land planners to select sites for campgrounds in Canadian national parks (Arbour, 1980), by researchers at the National Cancer Institute to study patterns of mortality (Mason, 1980) and by geologists to examine relationships between petrologic and geophysical information on the moon (Andre et al., 1977).

The Environmental Systems Research Institute (ESRI) GIS provides the user with a tool for creating multivariable files from digitized map data and digital remote sensing data. A GIS multivariable file may be thought of as a cube made up of data cells. The horizontal axes of the cube correspond to geographic location. Along the vertical axes are the different variables in the multivariable file. Thus, each column of cells in the cube has a unique geographic location and each layer of cells in the cube corresponds to a unique thematic map variable, such as soil type, vegetation type or topographic elevations (see Figure 1). Analyses which can be performed on the multivariable files include: slope and aspect calculations, proximity analyses and the creation of qualitative models based on user supplied weights (ESRI staff, 1979). However, statistical analyses, such as multiple regression, analysis of variance and spatial autocorrelation analysis can not be performed within the GIS. Further, since observations in a GIS multivariable file are stored as sixteen bit integers, real values and integers outside the range ±32,768 can not be manipulated by the GIS.

The inability to perform statistical analyses on GIS multivariable files, precludes the development of powerful quantitative models for resource exploration or land use planning within the

GIS package. However, statistical packages, such as SAS, provide tools for performing a range of statistical analyses from the computation of simple descriptive statistics to complex multivariate techniques (Helwig and Council, 1979).

To provide a means of performing statistical analyses on variables in GIS files and to allow the results of these analyses to be merged with GIS multivariable files, interfaces between the ESRI GIS and real valued data files were created.

DESCRIPTION OF INTERFACES

SAS2GIS is a computer program which converts gridded real valued data into the single variable file (SVF) format used by the ESRI geographic information system. The data file of real values that is to be converted to an integer SVF must be sorted so that for a SVF file n rows by m columns, the real value for cell (i, j) in the SVF will correspond to entry (i*m+j) in the real valued data file. The conversion is accomplished by a linear transformation, y=ax+b, which maps a real valued variable X into an integer variable Y. The program provides the user with two options for converting the data into integer format. First, the user may supply the a and b terms of y=ax+b. Second the user may specify a range for the transformed data. The original data will be mapped into this range using the linear transformation and the transformed data will be checked to insure that the conversion did not truncate the values more than a user specified amount. After the transformed data have been written to a disk file, an additional record is added to the file which contains the a and b terms that were used to make the transformation. This record is not read by any GIS software but may be used by the interface GIS2SAS to convert the SVF file to a real valued data file.

GIS2SAS is a computer program which transforms integer data in ESRI's SVF format into real valued data with row column references. The formula used to convert integer data to real valued data is x=(y-b)/a; where x is a real value, y is an integer and a and b are constants. The user has two options for converting integers to real values. First, the user may specify a and b terms for the transformation. This is required if the SVF file was not created by SAS2GIS. Second, if no a and b values were provided by the user the program will use the a and b values in the last record written by SAS2GIS when the file was created. Program output consists of a real valued data file in a format specified by the user.

RUNNING SAS2GIS AND GIS2SAS

SAS2GIS and GIS2SAS are interactive computer programs written in FORTRAN IV. At Goddard Space Flight Center they run in the foreground on an IBM 360/91 and an IBM 360/75. Listings of these programs appear in Appendix 1. The clists (files which contain TSO commands and subcommands) used to set up and run the interfaces are presented in Appendix 1. To run a program the user types the program's name, SAS2GIS or GIS2SAS, followed by I ("input filename") and O ("output filename"). For example if the user types:

SAS2GIS I(BOTANY.DATA) O(GIS.DATA)

the program SAS2GIS will be run to create an SVF file GIS.DATA from a real valued data file BOTANY.DATA.

When the programs are running in the foreground they will prompt the user for two lines of input. The first line contains parameters used to make the transformations and the second line is the format of the real valued data file. Tables 1 and 2 summarize the input parameters for these interfaces.

Should the user wish to convert these interfaces to run in a batch environment, he must make two modifications. First, the clists must be replaced by JCL statements which assign disk files for input and output to logical units 8 and 10, as shown in Figures 2 and 3. Second, the write statements which prompt the user for input should be removed.

COMBINING THE GIS AND A STATISTICAL PACKAGE FOR DATA ANALYSIS

Some preliminary results in an analysis of gravity and elevation data from the Rio Grande rift are presented here to illustrate the utility of combining a package of statistical analysis programs, SAS, with the ESRI geographic information system (GIS). The objective of this study was to remove the relationship between Bouguer gravity and topographic relief which was present in a data set of elevation and gravity observations compiled by Keller and Conrad at the University of Texas.

The gravitational field measured at a given point on the earth's surface includes effects unrelated to geology. These effects are due to: variations in the distance between the earth's center and the station where the gravity field was measured and the contribution of local topography to the observed gravity (Grant and West, 1965). Once corrections for these effects have been applied to the data, the resulting values are termed Bouguer gravity data and reflect the contribution of underlying geologic structures.

At present there is no agreement on the best method for computing Bouguer gravity from the observed gravity which is measured at a station. However, Nettleton (1940) has suggested that when the corrections to reduce observed gravity to Bouguer gravity are properly applied, the correlation between station elevation and Bouguer gravity should be low. A striking similarity between the Bouguer gravity and station elevation was first observed in three dimensional plots of these two data types produced by the GIS. In order to determine the degree of correlation between the gridded elevation data from the rift (Figure 4) and gridded Bouguer data (Figure 5), the statistical analysis package SAS76 was used to compute a Pearson product moment correlation coefficient. The correlation between Bouguer gravity and elevation was high, -0.903, and a linear regression was computed to remove the variation in Bouguer gravity due to elevation. The residuals from the regression provide a better estimate of Bouguer gravity because the effect of station elevation has been removed. A plot of these residuals, Figure 6, reveals regions of high positive residuals in the North-west and South-east corners of the Rio Grande study area. This suggests that there are regional variations in rock density in the study area and that individual Bouguer gravity corrections should be calculated for each region.

In this analysis the Statistical Analysis System (SAS) and the ESRI GIS proved useful tools for examining the relationship between variables in a spatially referenced multivariable database.

With these interfaces the researcher can utilize the extensive data base management and graphics capabilities of the GIS to complement existing software in the analysis of real valued multivariate data.

Table 1
Input Parameters for SAS2GIS

Parameter	Column	Format	Function
			First Input Line
ROW	1-5	I5	Number of rows in the SVF which will be created from the input data file.
COLUMN	6-10	I5	Number of columns in SVF.
A	11-15	F5.0	Multiplicative term in y=ax+b, used to map real x into integer y.
B	16-20	F5.0	Additive term in y=ax+b, if A and B are omitted NEWMIN and NEWMAX must be specified.
MIN	26-30	F5.0	Minimum value of input data default: value calculated by the program.
MAX	26-30	F5.0	Maximum value of input data default: value calculated by program.
NEWMIN	31-37	I5	New minimum value after transformation to integers.
NEWMAX	38-44	I5	New maximum value after transformation to integers.
TOLER	45-49	F5.0	User specified tolerance for truncation resulting from conversion of real values to integer format.
MISVAL	50-55	F6.0	Value indicating missing observations in the data.
NEWVAL	56-61	F6.0	Value which will be assigned to missing observations in the SVF file, default: 0.
			Second Input Line
FMT	1-80	80A1	User supplied input format for data in real data set.

Table 2
Input Parameters for GIS2SAS

Parameter	Column	Format	Function
			First Line of Input
A	1-6	F6.0	Divisor in x=(y-b)/a used to transform integer values into real values default: use first value in last record of SVF file.
B	7-12	F6.0	b term in x=(y-b)/a used to transform integer values into real values default: use second value in last record of SVF file.
			Second Line of Input
NCOL	1-3	I3	# columns in output file.
			Third Line of Input
FMT	1-80	80A1	User supplied output format for real valued data set.

REFERENCES

1. Andre, C., M. Bielefeld, E. Eliason, L. Soderblom, I. Adler, and J. Philpotts, 1977, "Lunar surface chemistry: a new imaging technique." Science 197: 986-989.

2. Arbour, J. H., 1980, "The use of a biophysical (ecological) data base for park planning," Proceedings of the international symposium on cartography and computing: applications in health and environment, vol. 1, p. 515-523.

3. Environmental Systems Research Institute staff, 1979, ESRI geographic information software descriptions. 79 p.

4. Grant, F. and G. West, 1965, Interpretation theory in applied geophysics, McGraw-Hill, New York, 584 pp.

5. Helwig, J. T. and K. A. Council, 1979, SAS user's guide. SAS Institute, 494 p.

6. Knapp, E., 1978, "Landsat and ancillary data inputs to an automated geographic information system: Applications for urbanized area delineation." CSC T.R.-78 6019, 82 p.

7. Mason, T., 1980, "A mechanism for selecting communities at high risk for cancer." Proceedings of the international symposium on cartography and computing: applications in health and environment, vol. 1, p. 26-32.

8. Nettleton, L., 1940, Geophysical prospecting for oil, McGraw-Hill, New York.

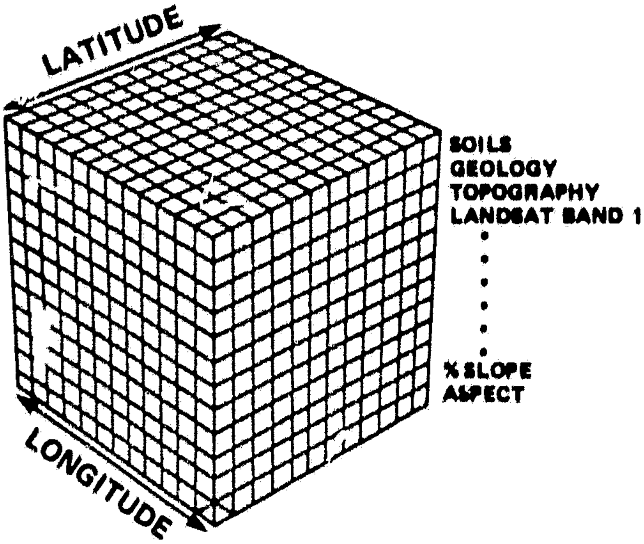
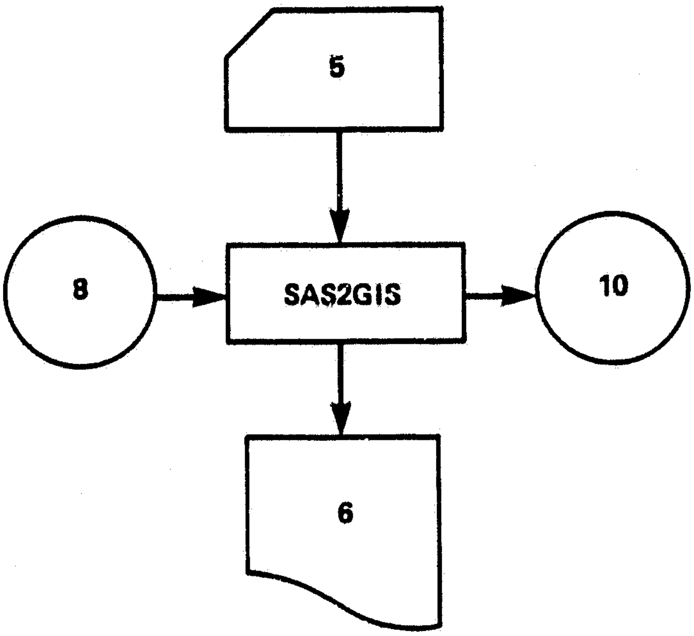
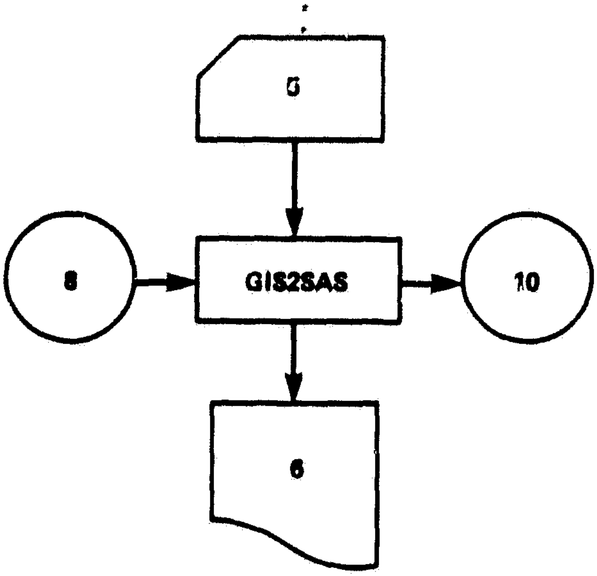


Figure 1. Structure of an ESRI GIS Multivariable File (MVF)



UNIT	STRUCTURE	COMMENT
5	CARD	USER CONTROL CARDS
6	PRINTER	JOB LISTING
8	CARD	REAL VALUED DATA FILE
10	SVF	INTEGER SINGLE VARIABLE FILE

Figure 2. Logical Units Required by SAS2GIS



UNIT	STRUCTURE	COMMENT
5	CARD	USER CONTROL CARDS
6	PRINTER	JOB LISTING
8	SVF	INTEGER SINGLE VARIABLE FILE
10	CARD	REAL VALUED DATA FILE

Figure 3. Logical Units Required by GIS2SAS

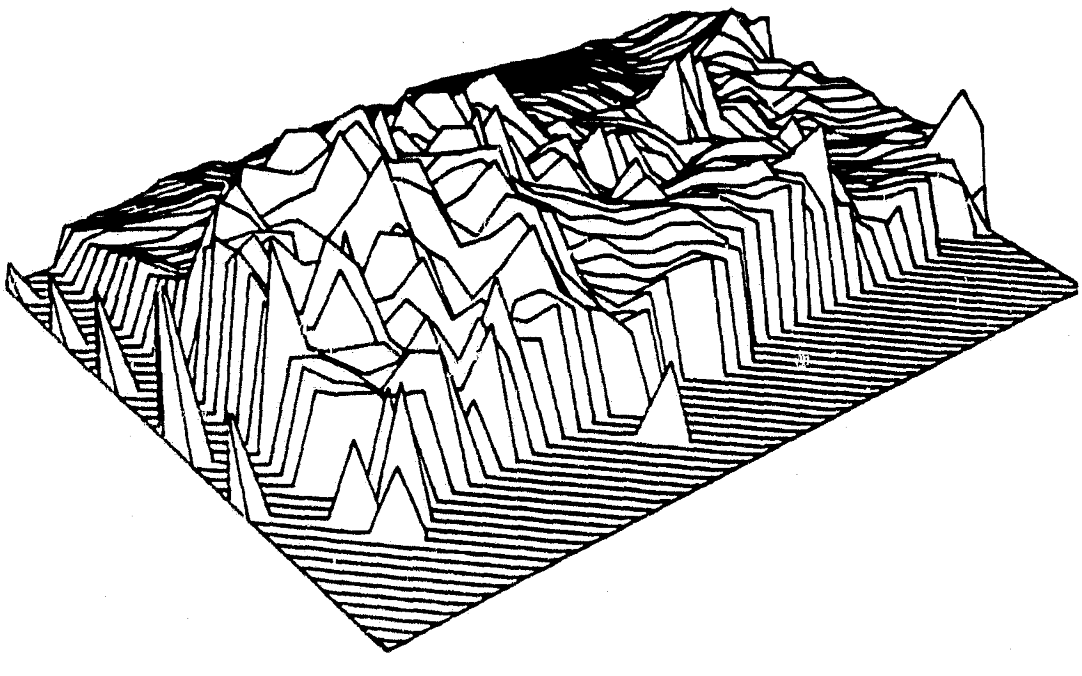


Figure 4. A Plot of Elevations in the Rio Grande Rift Study Area Produced by the ESRI GIS

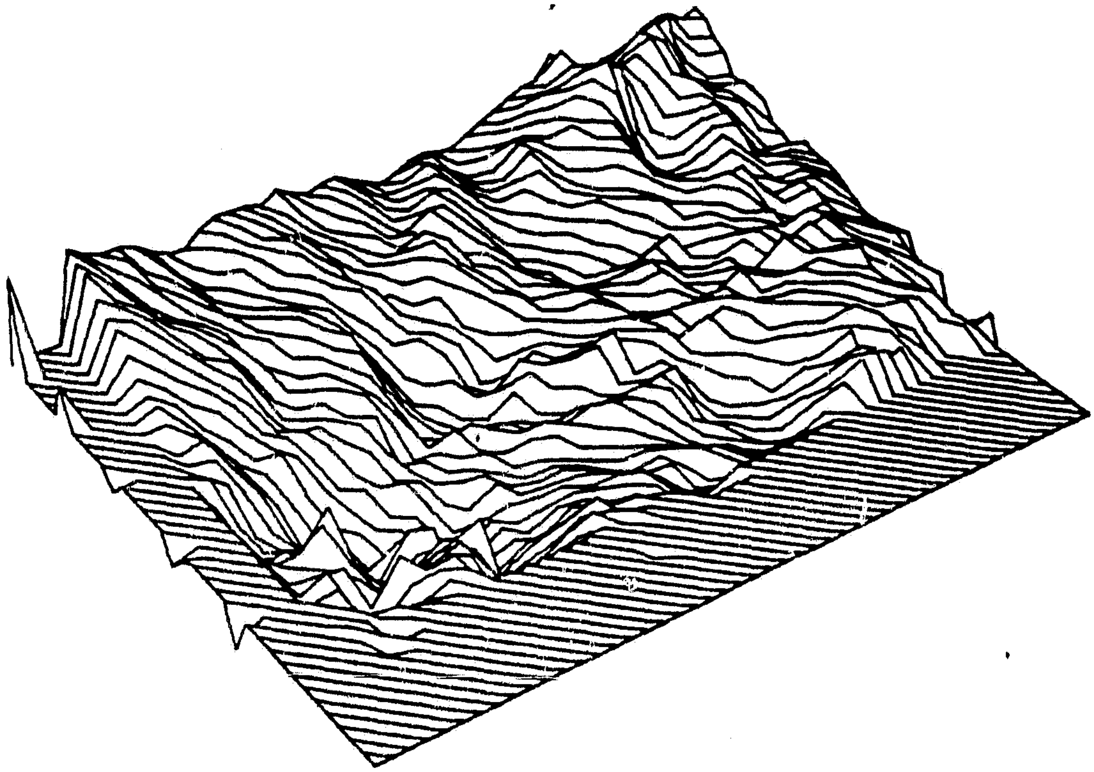


Figure 5. Bouguer Gravity Values from the Rio Grande Rift Study Area

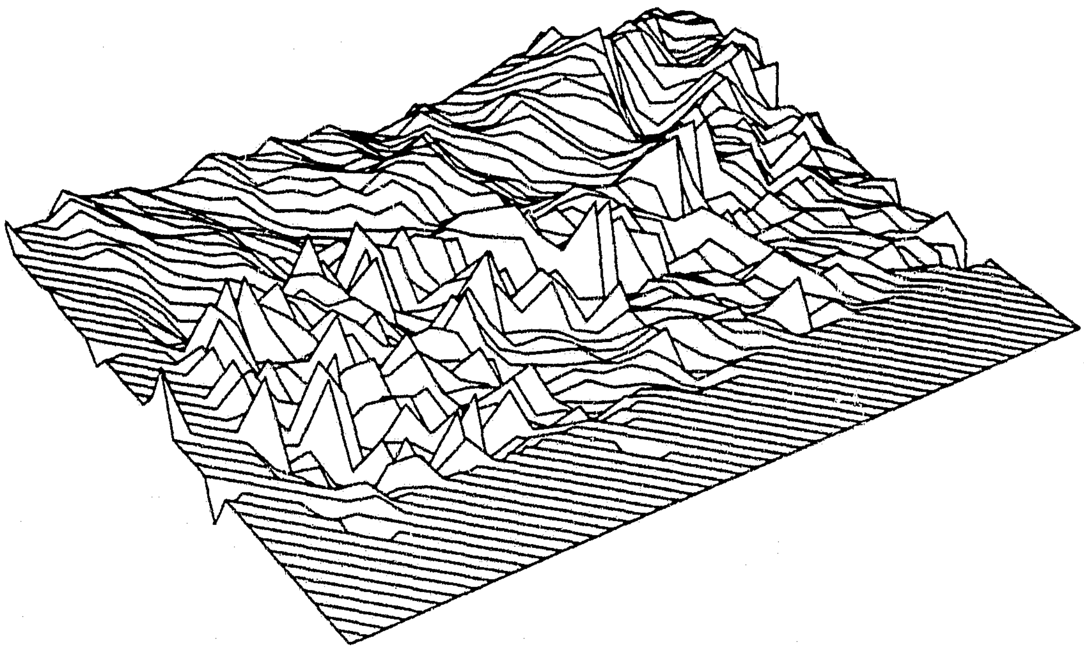


Figure 6. Residuals from a Regression of Elevation and Bouguer Gravity

APPENDIX 1

PROGRAM LISTINGS OF THE INTERACTIVE INTERFACES BETWEEN REAL VALUED DATA SETS AND THE ESRI GEOGRAPHIC INFORMATION SYSTEM

A. SAS2GIS PROGRAM LISTING

```
C       ***************************************************************
C       *                                                             *
C       *     TITLE:  INTERFACE FOR REAL VALUED DATA AND              *
C       *     ESRI GIS SINGLE VARIABLE FILES (SVF'S)                  *
C       *     PROGRAMMER:  EDWARD MASUOKA                             *
C       *     DATE:  AUGUST 1, 1979                                   *
C       *                                                             *
C       *                                                             *
C       *     THIS PROGRAM TRANSFORMS REAL VALUED DATA SETS           *
C       *     INTO INTEGER*2 DATA IN GIS FORMAT IN 3 STEPS:           *
C       *                                                             *
C       *     1.  PROMPTS USER FOR FORMAT OF INPUT DATA AND           *
C       *         PARAMETERS USED TO MAP REAL VALUES                  *
C       *         INTO INTEGERS                                       *
C       *                                                             *
C       *     2.  MAPS REAL VALUES INTO INTEGER*2                     *
C       *         WITHIN THE RANGE -32,768 TO +32,768                 *
C       *         WITH A LINEAR TRANSFORMATION                        *
C       *                                                             *
C       *     3.  WRITES THE ESRI/GIS FILE AND INFORMATION            *
C       *         REQUIRED TO TRANSFORM THE GIS FILE TO               *
C       *         REAL VALUED DATA, AS THE LAST RECORD                *
C       *         OF THE SVF FILE.                                    *
C       *                                                             *
C       *                                                             *
C       *      USER INPUT:                                            *
C       *                                                             *
C       *      CARD 1 1-5   NROW # ROWS IN INPUT FILE                 *
C       *             5-10  NCOL # COLUMNS IN INPUT FILE              *
C       *             11-15 A    MULTIPLICATIVE TERM IN Y=AX+B        *
C       *                        USED TO MAP REAL X                   *
C       *                        INTO INTEGER Y                       *
C       *             16-20 B    ADDITIVE TERM IN Y=AX+B              *
C       *             21-25 MIN  MINIMUM VALUE OF INPUT DATA          *
C       *                        DEFAULT:  CALCULATED                 *
C       *             26-30 MAX  MAXIMUM VALUE IN INPUT DATA          *
C       *                        DEFAULT:  CALCULATED                 *
C       *             31-37 NEWMIN INTEGER MINIMUM AFTER              *
C       *                        TRANSFORMATION                       *
C       *             38-44 NEWMAX INTEGER MAXIMUM AFTER              *
C       *                        TRANSFORMATION                       *
C       *             45-49 TOLER USER SPECIFIED TOLERANCE            *
C       *                        FOR TRUNCATION RESULTING FROM        *
C       *                        THE TRANSFORMATION OF REAL           *
C       *                        VALUES TO INTEGERS                   *
C       *                        DEFAULT:  .0001                      *
C       *             50-55 MISVAL VALUE FOR MISSING                  *
C       *                        OBSERVATIONS                         *
C       *                        DEFAULT: -9999.                      *
C       *             56-61 NEWVAL VALUE ASSIGNED TO MISSING          *
C       *                        OBSERVATIONS IN SVF FILE             *
C       *                        DEFAULT:  0                          *
C       *                                                             *
C       *      LINE 2 1-80  FMT  USER SUPPLIED FORMAT  (20A4)         *
```

```
C      *                            EX.  (1X,6F10.5)                       *
C      *                                                                   *
C      *********************************************************************
C
       REAL*4 FMT(20),DATA(500),AB(2),MAX,MIN,MISVAL/-9999./,NEWVAL/0./
       REAL*4 RANGE/0./,NEWMIN/-32500./,NEWMAX/32500./,TOLER/.00001/
       INTEGER*2 ROWCOL(2),ROW(500)
       EQUIVALENCE (AB(1),A), (AB(2),B)
C
C      *********************************************************************
C      *                                                                   *
C      *  READ USER SUPPLIED PARAMETERS FOR THE TRANSFORMATION             *
C      *                                                                   *
C      *********************************************************************
C
       WRITE (6,111)
  111  FORMAT(/1H0,'INPUT:  ROW COLUMN A B MIN MAX NEW_MIN NEW_MAX'/
      1' TOLERANCE MISS_VAL NEW_VAL USING:'/
      2,' (2I5,2F5.0,2F5.0,2F7.0,F5.0,2F6.0)'//
      3' ....5...10...15...20...25...30...35...40...45...50...55...60'/
      4'      +    +    +    +    +    +    +    +    +    +    +    +')
       READ(5,1) (ROWCOL(I),I=1,2),A,B,MIN,MAX,NEWMIN,NEWMAX,TOLER,
      1  MISVAL,NEWVAL
    1  FORMAT(2I5,2F5.0,2F5.0,2F7.0,F5.0,2F6.0)
       NROW=ROWCOL(1)
       NCOL=ROWCOL(2)
C
C      ECHO NUMBER OF ROWS AND COLUMNS IN INPUT AND SVF FILES
C
       WRITE(6,8) NROW,NCOL,A,B
    8  FORMAT(/1H0,T10,'ROWS=',T22,I5/1X,T10,'COLUMNS=',T22,I5/
      .1X,T10,'SLOPE=',T19,F9.3/1X,T10,'INTERSEPT=',T21,F9.3/)
C
C      READ AND ECHO USER SPECIFIED FORMAT FOR DATA INPUT
C
       WRITE (6,991)
  991  FORMAT (1H ,'PLEASE INPUT FORMAT OF REAL VALUED DATA')
       READ(5,2)FMT
    2  FORMAT(20A4)
       IF (A .GT. 0) GO TO 999
C
C      *********************************************************************
C      *                                                                   *
C      *      SCALE DATA BETWEEN NEWMIN AND NEWMAX                         *
C      *                                                                   *
C      *********************************************************************
C
C      FIND MIN AND MAX OF DATA IF NOT SUPPLIED
C
       IF(MIN .NE. MAX) GO TO 300
       MAX=-999.0
       MIN=999.0
       DO 22 I=1,NROW
       READ(8,FMT) (DATA(J),J=1,NCOL)
```

```
      DO 22 J=1,NCOL
      IF(DATA(J) .LT. MIN) MIN=DATA(J)
      IF(DATA(J) .GT. MAX) MAX=DATA(J)
 22   CONTINUE
      IF (MIN .GT. NEWVAL .OR. MIN .EQ. MISVAL) MIN=NEWVAL
      IF (MAX .LT. NEWVAL .OR. MAX .EQ. MISVAL) MAX=NEWVAL
      REWIND 8
C
C     CALCULATE A AND B FOR SCALING FUNCTION Y=AX+B
C
  300 RANGE=NEWMAX+1.-NEWMIN
      IF(NEWMAX+NEWMIN .LT. ABS(NEWMAX+NEWMIN))RANGE=RANGE-1.
      A=RANGE/(MAX-MIN)
      B=RANGE-A*MAX
C
C     ***************************************
C     *                                     *
C     *      PRINT INTERMEDIATE RESULTS     *
C     *                                     *
C     ***************************************
C
      WRITE(6,6) MIN,MAX
    6 FORMAT(1H ,'MIN=',F10.5/' MAX=',F10.5)
      WRITE(6,9) A,B
    9 FORMAT(1H ,10X,'A=',F12.5/1H ,10X,'B=',F12.5//)
C
C     *************************
C     *                       *
C     *     WRITE THE SVF     *
C     *                       *
C     *************************
C
C     CHECK TO INSURE THAT THE TRANSFORMED VALUES HAVE NOT
C     BEEN TRUNCATED MORE THAN A USER SPECIFIED TOLERANCE
C
      CALL CHKTOL(DATA,NCOL,A,B,TOLER)
C
C     WRITE ROW AND COLUMN INFORMATION ON THE GIS FILE
C
  999 WRITE(10)ROWCOL
C
C     SCALE THE DATA FROM + RANGE TO - RANGE
C
      DO 30 I=1,NROW
      READ(8,FMT,END=99) (DATA(J),J=1,NCOL)
      DO 40 J=1,NCOL
      IF(DATA(J) .EQ. MISVAL) DATA(J)=NEWVAL
      ROW(J)=(A*DATA(J)+B)
   40 CONTINUE
C
C     WRITE THE TRANSFORMED OBSERVATIONS A ROW AT A TIME
C
      CALL WRITRC(ROW,NCOL)
```

```
   3C CONTINUE
C
C     WRITE THE COEFFICENTS USED TO MAKE THE TRANSFORMATION
C     AND THE FORMAT OF THE REAL VALUED DATA SET
C     AS THE LAST RECORDS OF THE TRANSFORMED FILE
C
      WRITE (10) AB
      WRITE(10) FMT
      WRITE(6,11)
  11  FORMAT(1H0//'++++ SUCCESSFUL CONVERSION TO ESRI SVF FILE +++++')
      STOP 1
C
C     ERROR MESSAGES FOR INCORRECT CONTROL CARDS
C
   99 WRITE(6,3)
    3 FORMAT(1H ,'TOO FEW OBSERVATIONS ')
      STOP 2
      END
C
C     ******************************************
C     *                                        *
C     *   THIS SUBROUTINE WRITES THE INTEGERS  *
C     *   AS A SINGLE VARIABLE FILE            *
C     *                                        *
C     ******************************************
C
      SUBROUTINE WRITEC(RCW,NCOL)
      INTEGER*2 RCW(NCOL)
      WRITE(10) RCW
      RETURN
      END
C
C     *********************************************************
C     *                                                       *
C     *   THIS SUBROUTINE COMPARES THE ORIGINAL REAL VALUED   *
C     *   DATA FILE WITH THE REAL VALUED FILE WHICH WILL BE   *
C     *   PRODUCED IF THE SVF IS TRANSFORMED BACK TO A REAL   *
C     *   VALUES IF THE DIFFERENCE  BETWEEN                   *
C     *   ENTRIES IN THESE FILES EXCEEDS A USER SPECIFIED     *
C     *   TOLERANCE AN ERROR MESSAGE IS WRITTEN AND THE JOB   *
C     *   IS ABORTED.                                         *
C     *                                                       *
C     *********************************************************
C
      SUBROUTINE CHKTOL(DATA,NCOL,A,B,TOLER)
      INTEGER*4 NCOL
      REAL*4 DATA(NCOL),A,B,TOLER,RDAT
      INTEGER*2  IDAT
C
C     CALCULATE EFFECT OF TRANSFORMATION ON
C     VALUES OF THE INPUT DATA
C
      DO 10 I=1,NCOL
      IDAT=DATA(I)*A+B
```

```
      RDAT=IDAT
      RDAT=(RDAT-B)/A
C
C     *************************************************************
C     *  COMPARE ORIGINAL REAL VALUE WITH REAL VALUE              *
C     *  WHICH RESULTS FROM TRANSFORMING GIS FILE BACK            *
C     *  TO A REAL FILE USING SLOPE AND INTERSEPT CALUCULATED     *
C     *  FROM THE USER SPECIFIED RANGE FOR TRANSFORMED DATA       *
C     * TOLERANCE CREATE THE GIS FILE                             *
C     *************************************************************
C
      IF (ABS(RDAT-DATA(I)) .LT. TOLER) GO TO 10
C
C     ELSE WRITE AN ERROR MESSAGE AND STOP
C
      WRITE(6,1)
 1    FORMAT(1H ,'************  TOLERANCE EXCEEDED DURING TRANSFORMATION'
     1 ,'  ************')
      STOP 2
 10   CONTINUE
      RETURN
      END
```

B. GIS2SAS PROGRAM LISTING

```
C      ************************************************************
C      *                                                          *
C      *    TITLE:  INTERFACE BETWEEN ESRI GEOGRAPHIC             *
C      *            INFORMATION SYSTEM SVF DATA SETS              *
C      *            AND REAL VALUED DATA SETS USED BY             *
C      *            STATISTICAL PACKAGES                          *
C      *                                                          *
C      *    PROGRAMMER:  EDWARD MASUOKA                           *
C      *                                                          *
C      *    DATE:  AUGUST 1, 1979                                 *
C      *                                                          *
C      *                                                          *
C      *   THIS PROGRAM TRANSFORMS GIS FILES IN INTEGER*2         *
C      *   INTO THE ORIGINAL REAL VALUED DATA IN 3 STEPS:         *
C      *                                                          *
C      *   1.  READS ROW COLUMN INFORMATION FROM RECORD 1         *
C      *                                                          *
C      *   2.  TRANSFORMS INTEGERS TO REAL VALUES USING           *
C      *       A LINEAR TRANSFORMATION: REAL=(INTEGER-B)/A        *
C      *                                                          *
C      *   3.  WRITES THE REAL DATA TO A FILE WITH A              *
C      *       USER SUPPLIED FORMAT                               *
C      *                                                          *
C      *                                                          *
C      *      VARIABLE         FUNCTION                           *
C      *                                                          *
C      *      DATA             STORES REAL DATA                   *
C      *      ROWCOL           STORES # OF ROWS AND COLUMNS       *
C      *                       IN THE INPUT FILE                  *
C      *      ROW              # OF ROWS IN DATA AND GIS FILE     *
C      *      COLUMN           # COLUMNS IN DATA & GIS FILE       *
C      *      AB               STORES LINEAR TRANSFORM PARAMS     *
C      *      SLOPE            SLOPE OF LINEAR FUNCTION USED      *
C      *                       TO TRANSFORM REAL DATA             *
C      *      INTER            INTERCEPT OF LINEAR TRANSFORM      *
C      *      IROW             STORES A ROW OF THE TRANSFORMED*
C      *                       DATA                               *
C      *                                                          *
C      *      FMT              USER SUPPLIED FORMAT FOR REAL      *
C      *                       VALUED DATA SET                    *
C      *                                                          *
C      ************************************************************
C
       REAL*4 DATA(150),AB(2),SLOPE,INTER
       INTEGER*2 ROWCOL(2),IROW(150)
       INTEGER*4 ROW,COLUMN,FMT(20),BLNK/'    '/
       LOGICAL*1 BUFFER(80)
       EQUIVALENCE (AB(1),SLOPE),(AB(2),INTER),(BUFFER(1),FMT(1))
C
C      READ USER SUPPLIED OUTPUT FORMAT AND PARAMETERS
C
       WRITE(6,4)
     4 FORMAT(1H0,T10,'PLEASE INPUT A (F5.0) B(F5.0) TERMS'/
     .       1H ,T10,'WHICH WILL BE USED TO MAKE THE TRANSFORMATION'/
```

```
     .      1H ,'(DEFAULT: IF ZERO, PROGRAM WILL USE LAST RECORD OF SVF)'/
     .      1H ,'      A      B'/
     .      1H ,'-----+-----+')
      READ(5,11) SLOPE,INTER
   11 FORMAT(2F5.0)
      WRITE(6,2)
    2 FORMAT(/' PLEASE INPUT # OF COLUMNS FOR OUTPUT DATA SET: (I3)'/
     . ' DEFAULT: IF ZERO, PROGRAM WILL USE # COLUMNS IN SVF')
      READ(5,6)NCOL
    6 FORMAT(I3)
      WRITE(6,8)
    8 FORMAT(/' PLEASE INPUT FORMAT FOR REAL VALUED DATA SET: (80A1)',
     ./1H0,' DEFAULT: LAST RECORD OF SVF WILL BE USED')
      READ(5,1)FMT
    1 FORMAT(80A1)
C
C     READ AND ECHO # ROWS AND COLUMNS IN GIS FILE
C
      READ (8) ROWCOL
      ROW=ROWCOL(1)
      COLUMN=ROWCOL(2)
      WRITE(6,3) ROW,COLUMN
    3 FORMAT(1H0/T10,'ROWS=',T22,I5/1X,T10,'COLUMNS=',T22,I5)
      IF (SLOPE .NE. 0 .OR. INTER .NE. 0) GO TO 40
C
C     SPACE PAST TRANSFORMED DATA
C
      DO 30 I=1,ROW
   30 CALL READC(IROW,COLUMN,8)
C
C     READ AND ECHO PARAMETERS USED TO TRANSFORM ORIGINAL REAL DATA
C
      READ (8) AB
   40 WRITE(6,5)SLOPE,INTER
    5 FORMAT(1H ,T10,'SLOPE=',T19,F8.3/1X,T10,'INTERSEPT=',T21,F8.3)
C
C     CHECK FOR USER SPECIFIED FORMAT
C
      DO 50 I=1,20
      IF (FMT(I) .NE. BLNK) GO TO60
   50 CONTINUE
C
C     NONE FOUND USE LAST RECORD OF SVF
C
      READ(8,END=99) FMT
   60 REWIND 8
C
C
C     TRANSFORM THE DATA INTO ORIGINAL VALUES
C     A ROW AT A TIME
C
      IF (NCOL .EQ. 0) NCOL=COLUMN
      READ (3) ROWCOL
      DO 10 I=1,ROW
```

```
      CALL READC(IROW,COLUMN,8)
      DO 20 J=1,COLUMN
   20 DATA(J)=(IROW(J)-INTER)/SLOPE
C
C     WRITE THE REAL VALUED DATA FILE
C
   10 CALL WRITEC(DATA,NCOL,FMT,10)
      WRITE(6,12)
   12 FORMAT(/1H0,'++++ SUCCESSFUL CONVERSION TO REAL VALUED FILE ++++'
     .//)
      STOP 1
   99 WRITE(6,100)
  100 FORMAT(1H0,T10,'***** FATAL ERROR:   NO FORMAT SPECIFIED',
     .' BY USER AND NO FORMAT ON SVF *****')
      STOP 2
      END
C
C     ************************************************************
C     *                                                          *
C     *   THIS SUBROUTINE READS A SVF FORMAT FILE                *
C     *                                                          *
C     ************************************************************
C
      SUBROUTINE READC(IROW,COLUMN,LUNIT)
      INTEGER*4 COLUMN
      INTEGER*2 IROW(COLUMN)
      READ(LUNIT)IROW
      RETURN
      END
C
C     ****************************************************
C     *                                                  *
C     *   THIS SUBROUTINE WRITES THE REAL VALUED DATA    *
C     *   WITH A USER SPECIFIED FORMAT                   *
C     *                                                  *
C     ****************************************************
C
      SUBROUTINE WRITEC(DATA,COLUMN,FMT,LUNIT)
      INTEGER*4 COLUMN
      REAL*4 DATA(COLUMN),FMT(20)
      WRITE(LUNIT,FMT)DATA
      RETURN
      END
```

APPENDIX 2

CLISTS

A. CLIST FOR SAS2GIS

```
PROG O INFILE (REAL.DATA) OUTFILE (SAS.GIS)
CALLOC DA (&INFILE.) F(FT08F001)
ALLOC DA (&OUTFILE.) N SP (10, 1) TR U (GIS)
CALLOC DA (&OUTFILE.) F (FT10F001)
DO SAS2SVF LIB (PROG.LOAD)
```

B. CLIST FOR GIS2SAS

```
PROG O INFILE (SAS.GIS) OUTFILE (REAL.DATA)
CALLOC DA (&INFILE.) F (FT08F001)
CALLOC DA (&OUTFILE.) N SP (10, 10) TR U (FORT)
CALLOC DA (&OUTFILE.) F (FT10F001)
ALLOC DA (*) F (FT05F001)
ALLOC DA (*) F (FT06F001)
DO SVF2SAS LIB (PROG.LOAD)
```

APPENDIX 3

AN EXAMPLE OF THE OUTPUT FROM THE INTERACTIVE PROGRAMS, SAS2GIS AND GIS2SAS. PROGRAM OUTPUT IS IN UPPERCASE AND USER INPUT IS IN LOWERCASE LETTERS.

A. EXAMPLE OF RUNNING SAS2GIS

```
sas2gis infile (real.data) outfile (elev2.svf)

INPUT:  ROW COLUMN A B MIN MAX NEW_MIN NEW_MAX
TOLERANCE MISS_VAL NEW_VAL USING.
(2I5, 2F5.0, 2F5.0, 2F7.0, F5.0, 2F6.0)

....5...10...15...20...25...30...35...40...45...50...55...60

    +    +    +    +    +    +    +    +    +    +    +
   36   48   1.   0.

          ROWS =          36
          COLUMNS =       48
          SLOPE =      1.000
          INTERSEPT =    0.0

PLEASE INPUT FORMAT OF REAL VALUED DATA
(10f8.0)

+++ SUCCESSFUL CONVERSION TO ESRI SVF FILE +++++
IH0002I STOP         1
CONDITION CODE = 01
```

B. EXAMPLE OF RUNNING GIS2SAS

```
gis2sas infile (elev.svf) outfile (real.data)
          PLEASE INPUT A (F5.0) B (F5.0) TERMS WHICH WILL BE USED TO MAKE
          THE TRANSFORMATION
(DEFAULT:  IF ZERO, PROGRAM WILL USE LAST RECORD OF SVF)
    A    B
....+....+
   1.   0.

PLEASE INPUT # OF COLUMNS FOR OUTPUT DATA SET: (I3)
DEFAULT:  IF ZERO, PROGRAM WILL USE # COLUMNS IN SVF

PLEASE INPUT FORMAT FOR REAL VALUED DATA SET:  (80A1)
DEFAULT:  LAST RECORD OF SVF WILL BE USED
(10f8.0)
```

```
        ROWS =           36
        COLUMNS =        48
        SLOPE =        1.000
        INTERSEPT =      0.0

++++ SUCCESSFUL CONVERSION TO REAL VALUED FILE ++++

IH0002I STOP           1
CONDITION CODE = 01
```