FORTRAN IV PROGRAMS TO DEVELOP CONTOUR MAPS OF 3-DIMENSIONAL DATA

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by

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Progress Report

FORTRAN IV PROGRAMS TO DEVELOP CONTOUR MAPS OF 3-DIMENSIONAL DATA

To: C. A. Leardats, Director
Joint Highway Research Project

From: E. L. Michael, Associate Director
Joint Highway Research Project

May 9, 1968
File No: 1-6-1
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The attached Progress Report "Fortran IV Programs to Develop Contour Maps of 3-Dimensional Data" has been prepared by Mr. A. Keith Turner, Graduate Instructor in Research, under the direction of Professor R. D. Miles.

The material in the report was developed from the current PHK-1 (5) research on "Evaluation of Numerical Surface Techniques Applied to Highway Location Analysis." This research is concerned with the graphical representation of various conceptual surfaces so that man-machine information interchanges between design engineers and electronic computers may be developed.

The need for graphical display of 3-Dimensional data exists for a wide variety of highway engineering applications, yet this capability has not been available at Purdue until the current research. It is anticipated that further refinement of these programs will become desirable, in the light of experience with their application. Further routines are still under development. Thus it is anticipated that additional reports in this area will be made.

The report is presented to the Board for the record and for review and comment. It will also be presented to the ISNC and the DPR for their review, comment and approval as partial fulfillment of the objectives of the research.

Respectfully submitted,

H. L. Michael

Attachment


Progress Report

FORTRAN IV PROGRAMS TO DEVELOP CONTOUR MAPS OF 3-DIMENSIONAL DATA

by
A. Keith Turner
Graduate Instructor in Research

Joint Highway Research Project
Project No. C-36-72A
File No. 1-6-1

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or the
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Purdue University
Lafayette, Indiana
May 9, 1968
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Progress Report

FORTRAN IV PROGRAMS TO DEVELOP CONTOUR MAPS OF 3-DIMENSIONAL DATA

This report describes a series of FORTRAN-IV subroutines used to prepare graphical displays of three-dimensional data.

Considerable work has been expended to make these programs as flexible as possible. Many are based on routines obtained from the University of Michigan Department of Geography or the Harvard University Laboratory for Computer Graphics, and are believed to be among the best routines available.

It is hoped to produce a revised version of this report during the summer of 1968 which will contain additional programs now in the developmental stage. Comments from users regarding corrections or modifications to the routines are welcome.

A. Keith Turner
Airphoto Interpretation
and Photogrammetry Laboratory
School of Civil Engineering
FORTRAN IV PROGRAMS TO DEVELOP CONTOUR
MAPS OF 3-DIMENSIONAL DATA

Joint Highway Research Project
Progress Report

PART I

INTRODUCTION
INTRODUCTION

The graphical display of three-dimensional data is important in many scientific and engineering studies. Such data form surfaces which may be of many types ranging from real surfaces such as the surface of the earth to various mathematical and functional relationships.

This manual describes an integrated series of routines which can be combined to produce various types of graphical displays of three-dimensional surfaces using either the printer or the CALCOMP plotter. Use of the printer has several advantages over the CALCOMP plotter, particularly in the early stages of a project, since the output is produced as part of the regular job output, the printer is cheap and fast (allowing many more plots to be produced), and its use does not require extra tape mounts. Due to the limited resolution of the printer which is controlled by the line and character spacing, printer displays may be distorted, although under favorable conditions distortion can be eliminated. Since the CALCOMP routines are designed to be easily compatible with the printer routines, the plotter can be used for final drafting of selected displays.

PROGRAM LANGUAGE

These routines are written in FORTRAN-IV. Most of these routines can be run on either the IBM 7094 or the CDC 6500 with only minor changes to accommodate the different word lengths on the two machines.

PROGRAM AVAILABILITY

FORTRAN-IV source decks are available for copying in the Airphoto Interpretation and Photogrammetry Laboratory, Room B-24, Civil Engineering Building and in Room G-150, Math. Sciences Building.

METHODS OF SURFACE REPRESENTATION

The three most common methods of graphically displaying three-dimensional data are:

1. perspective or isometric views of the surface
2. three-dimensional histograms
3. contour maps.

Routines presently under development will provide the capability of preparing perspective and isometric views, and three-dimensional histograms. It is hoped that these new routines will be available this summer.
This first edition of the manual describes a series of main programs and associated subroutines to perform the following functions:

a) Production of contour maps utilizing polynomial equations.
b) Interpolation of irregularly spaced to gridded data.
c) Production of contour maps of the printer.
d) Production of contour maps on the Calcomp plotter.

**BENEFITS AND LIMITATIONS OF MACHINE-COMPUTED CONTOUR MAPS**

Contouring can be extremely literal, extremely interpretative, or a compromise between the two. The routines developed here give literal contours. As such, the maps produced are not "unbiased," as is often claimed, but are in fact strongly and consistently biased toward literal interpretation of the data.

As a consequence, computer-generated contour maps developed by these routines may not be equally suitable for all applications. They are extremely useful as "quick-look" maps to give the user a general idea of his data, or to check the general validity of the data.

Furthermore, since all maps are made consistently, they can also be used for comparison purposes. Contouring several data sets by humans inevitably involves some learning processes which introduce an uncertain and subtle bias into the results rendering comparison of maps difficult. In contrast, the computer will not "learn" from one problem to the other, but will handle each data set uniformly.

**PROCEDURE**

Computer contouring of data involves two steps:

1) determination of regularly spaced (gridded) values of the dependent variable (elevation)
2) linear interpolation to locate contour lines within the grid squares.

(Obviously, if data is already in grid form, step 1 may be omitted.)

**Determination of Gridded Values**

1) By Regression Analysis

The determination of regularly spaced values can be accomplished by first developing an analytic equation to describe the data, and then evaluating this equation at a series of grid coordinates. Least squares regression procedures based on the polynomial expansion are commonly used, although double Fourier series expansion procedures have also been
developed (2). Statistical procedures allow the research to determine the ability of the various surfaces to conform to his data (1, 3). These techniques, termed Trend Surface Analysis, have long been used by geologists and geographers (3, 4, 5, 7). They have found residual maps, contour maps showing the lack of fit to the regression equations, useful in locating anomalous areas (6).

Program POLYFIT and its associated subroutines will fit polynomials up to the fifth power and produce trend surface maps. Program RESMAP will produce residual maps.

2) By Weighted Moving-Average Procedures

Weighted moving-averages or the fitting of local polynomials are two other techniques for interpolating irregularly spaced data to a uniform grid. Weighted moving averages are generally computationally easier, and therefore faster, than the fitting of local polynomials.

Subroutine GRID, based on an algorithm developed by Professor W. R. Tobler at the University of Michigan, uses a weighted moving average to determine grid values. As in all interpolation procedures some smoothing of the data results from its use. A limited amount of testing suggests that the smoothing is normally less than 2% of the data range, rising to nearly 10% of the range with extremely erratic data.

**Linear Interpolation Within Grid Squares**

Subroutines FXTCON1 and FXTCON2 perform this step on the printer; program CONTUR, performs a similar operation on the CALCOMP plotter.

FXTCON1 and FXTCON2 differ only in the type of output produced. FXTCON1 produces maps with various characters representing different contour intervals. Options allow for the printing of contour lines only, alternate contour bands, or all print positions within the map. FXTCON2 produces maps with contour intervals delineated by combinations of overprinted characters to give a graded density from light (low areas) to dark (high areas). Since the overprint carriage control is only available on the CDC 6500, this program is restricted to that machine.

The CALCOMP plotting routines are much more efficient on the IBM 7094; plotting speeds are at least twice as great, and plot tapes are written at a higher density. Under these circumstances program CONTUR has not been converted to run on the CDC 6500, although no unusual difficulties are anticipated for such a conversion.

**SUMMARY**

A series of integrated routines are available to perform machine contouring of three-dimensional data on either the printer or the CALCOMP plotter.
REFERENCES


PROCEDURES FOR MAP
CONTOURING UTILIZING
REGRESSION EQUATIONS

NOTE - Program POLYFIT (and associated subroutines) should be used if polynomial regression surfaces are to be fitted to regularly or irregularly spaced data.

Program RESMAP (and associated subroutines) should be used in conjunction with program POLYFIT to analyze residual and original data.

CONTENTS OF THIS SECTION

1) Program POLYFIT - including subroutines READ1, INVER, INVCK, POLY, EVALU, and PLOT

2) Program RESMAP
PURPOSE —

TO PERFORM TREND SURFACE ANALYSIS USING POWER SERIES EXPANSION, POLYNOMIALS UP TO FIFTH DEGREE CAN BE REQUESTED. THIS PROGRAM HAS EVOLVED FROM AN EARLIER PROGRAM OBTAINED FROM PROFESSOR R.B. JOHNSON, FORMERLY HEAD OF THE DEPARTMENT OF GEOSCIENCES, PURDUE UNIVERSITY.

PURDUE UNIVERSITY VERSION 4.2 A KEITH TURNER, CIVIL ENGINEERING, FEBRUARY, 1968.

THIS VERSION CAN FIT A SURFACE TO 1000 DATA POINTS. UP TO FOUR DIFFERENT VARIABLES CAN BE ANALYZED AT EACH POINT. DATA CARDS (ONE PER POINT) SHOULD INCLUDE IDENTIFICATION, X-COORDINATE, Y-COORDINATE, AND VARIABLES 1-4 (Z1, Z2, Z3, Z4). AN UNLIMITED NUMBER OF DATA SETS, EACH CONTAINING UP TO 1000 POINTS, CAN BE PROCESSED.

THE PROGRAM WILL (1) FIT THOSE POLYNOMIAL SURFACES REQUESTED; (2) LIST THE MATRICES USED TO DETERMINE THE COEFFICIENTS; (3) LIST THE COEFFICIENTS; (4) ESTIMATE THE ERROR IN EACH COEFFICIENT; (5) PERFORM ANALYSIS OF VARIANCE; AND (6) LIST THE ORIGINAL DATA, COMPUTED VALUES, AND RESIDUALS FOR ALL POINTS.

SUBROUTINES EVALU AND PLOT GENERATE AND MACHINE-PUNCH GRIDDED VALUES FOR SELECTED TREND SURFACES AND PRODUCE PRINTER-CONTOUR MAPS OF THESE SURFACES. A VARIETY OF CONTOUR MAPS CAN BE SPECIFIED; MULTIPLE MAPS OF ANY SURFACE MAY BE PRODUCED. THE GRIDDED VALUES MAY PRODUCE CALCOMP CONTOUR MAPS USING PROGRAM CONTR.

ALL ORIGINAL AND COMPUTED VALUES AND RESIDUALS FOR THE DATA CAN BE STORED ON A USER-DESIGNATED TAPE (TAPE 8) FOR LATER ANALYSIS.

TAPE REQUIREMENTS —

TAPE 1 IS A SCRATCH TAPE USED TO STORE AND REGENERATE DATA DESTROYED DURING THE OPERATION OF SUBROUTINES EVALU AND PLOT. NO REQUEST CARD IS NECESSARY SINCE A DISK FILE WILL AUTOMATICALLY BE GENERATED.

TAPE 8 IS USED TO STORE THE ORIGINAL INPUT VALUES, COMPUTED VALUES AND RESIDUALS FOR ALL POINTS. THE TAPE SHOULD BE WRITTEN IN BINARY AT 556 BPI. THE REQUEST CARD FORM IS —

REQUEST (TAPE8, HI) PLEASE MOUNT USERTAPENAME, FILE XXX

THE FIRST TAPE RECORD WILL CONTAIN THE NUMBER OF DATA POINTS (N) BEING ANALYZED; THERE THEN FOLLOW N RECORDS CONTAINING THE DATA ID, X, Y, Z, 1ST DEGREE ESTIMATE, 1ST DEGREE RESIDUAL, ——, 5TH DEGREE RESIDUAL.

THIS SEQUENCE WILL BE REPEATED FOR EACH VARIABLE (ONE UP TO FOUR TIMES) FOR EACH DATA SET OF 1000 POINTS OR LESS. AN END-OF-FILE IS WRITTEN AFTER THE LAST DATA SET.

IF IT IS DESIRED TO IMMEDIATELY ANALYZE THE RESIDUALS, PROGRAM RESMAP MAY BE INCLUDED UNDER THE SAME JOB CARD. IN THIS CASE NO TAPE REQUEST CARD IS REQUIRED.
ROUTINES REQUIRED —

A) MAIN PROGRAM (POLYFIT)

1) SUBROUTINES
   1) READ1 - READS THE DATA CARDS.
   2) INVER - DETERMINES INVERSE MATRIX.
   3) INVC - PRINTS OUT X-PRIME-X MATRIX.
   4) POLY - DETERMINES (ESTIMATED VALUES AND) RESIDUALS.
   5) EVALU - EVALUATES SURFACES AT GRID POINTS.
   6) PLOT - PRODUCES PRINTER CONTOUR MAPS.
   7) STATS - CALCULATES STATISTICAL MEASURES.

DESCRIPTION OF CONTROL CARDS — (REPEAT ALL CARDS FOR EACH DATA SET)

1) LARGEST CARD -
   POLYFT (COLS 1-6) CODE WORD INDICATING START OF DATA

2) MASTER CONTROL CARD -
   POLYFT (COLS 1-6)
   LIMIT (1-5) (COLS 11-15) IF LIMIT(K)=1 SURFACE OF DEGREE K FITTED.
   ISURF (1-5) (COLS 16-20) IF ISURF(K)=1 GRID VALUES FOR SURFACE K ARE CALCULATED (THESE WILL BE PUNCHED IF SPECIFIED ON CARD 9). HOWEVER NO MAP WILL BE PRINTED.
   IF ISURF(K)=2 GRID VALUES WILL BE DETERMINED AND MAP(S) OF SURFACE K WILL BE PRINTED.
   INCK (COL 25) IF INCK=1 X-PRIME-X MATRICES PRINTED.
   NLINES (COL 3) NUMBER OF GENERAL TITLE CARDS TO FOLLOW; MAXIMUM=5
   NZ (1-4) (COLS 37-40) IF NZ(KI)=1 VARIABLE K WILL BE ANALYZED.
   NRES (COL 50) IF NRES=1 RESIDUAL VALUES LISTED.
   IOUT1 (COL 60) IF IOUT1=1 DATA WRITTEN ON TAPE.

3) GENERAL TITLE CARD(S) -
   1-3 CARDS (NUMBER EQUALS NLINES), EACH CARD CONTAINS ANY ALPHA-
   NUMERIC TITLE IN COLS 1-72

4) VARIABLE IDENTIFICATION CARD -
   FOUR SETS OF ALPHANUMERIC TITLES (COLS 1-2, 21-40, 41-60, 61-80)
   WHICH WILL IDENTIFY VARIABLES Z1-Z4.
   NOTE - IF NO FURTHER IDENTIFICATION REQUIRED, INSERT BLANK CARD

5) FORMAT CARD -
   FORMAT OF DATA (COLS 7-78) SHOULD BE IN FORM (A10,5FLOATING
   POINT FIELDS(X,Y,Z1,Z2,Z3,Z4))

6) DATA CARDS -
   ONE CARD FOR EACH POINT.

7) BLANK CARD -
   BLANK CARD USED TO DISTINGUISH END OF DATA SET.
IF THE GRIDDED OR GRIDDING AND "AUTOM" OPTIONS ARE REQUESTED (IF ISURF(K)=1 OR 2) THE FOLLOWING CARDS MUST BE REPEATED FOR EACH REQUEST —

8) AREA DEFINITION CARD —
MAXIMUM AND MINIMUM VALUES OF X AND Y COORDINATES (XMAX, XMIN, YMAX, YMIN) WITH DECIMALS PUNCHED (COLS 1-10, 11-20, 21-30, 31-40)

9) GRID SPECIFICATION CARD —
ROWS (COLS 1-3) INTEGER NUMBER OF ROWS IN GRID (MAXIMUM=100).
COLS (COLS 4-6) INTEGER NUMBER OF COLUMNS IN GRID (MAXIMUM=100).
NMAP (COLS 7-9) NUMBER OF DIFFERENT MAPS OF THIS SURFACE TO BE PRINTED.
IPUN (COL 10) IF IPUN=1, GRID VALUES PUNCHED (EACH SURFACE IDENTIFIED BY PUNCH TITLE CARDS)

NOTE — A) FOR 1 INCH GRID COLS=MAP WIDTH (INCHES) + 1
ROWS=MAP LENGTH (INCHES) + 1

B) IF COLS>42, PRODUCTION OF PRINTER MAPS IS IMPOSSIBLE DUE TO LIMITED WIDTH OF PAPER (HOWEVER CALCOMP PlOTS ALLOW UP TO 100X100 ARRAYS).

REPEAT THE FOLLOWING CARD(S) FOR EACH MAP REQUESTED BY NMAP —

10) PLOT CONTROL CARD —
CON (COLS 1-2) NUMBER OF CONTOUR INTERVALS, MAXIMUM = 19
IF CON = 0, CON SET TO 6.
TOUR (COL 3) IF TOUR=0, MAX AND MIN DATA ELEVATIONS USED AS CONTOUR LIMITS.
IF TOUR=1, DESIRED TOP AND BOTTOM CONTOURS READ IN FROM SPECIAL CARD (SFF BELOW).
IF TOUR=2, VARIABLE CONTOURS READ IN (LOW TO HIGH). IN THIS CASE SET CON EQUAL TO THE NUMBER OF VALUES TO BE READ IN.
IF TOUR=3, CONTOUR INTERVAL BECOMES 1/2 STANDARD DEVIATION INCREMENTS. (MAX=+3 SIGMA, MIN=-3 SIGMA)
LINES (COL 4) IF LINES>0, CONTOUR LINES ARE PRINTED.
IF LINES=1, ALTERNATE (EVEN-VALUED) BANDS ARE PRINTED.
IF LINES=2, COMPLETE BANDS ARE PRINTED.
INCHES (COLS 5-9) WIDTH OF MAP IN INCHES, MAXIMUM = 12.

11) SPECIAL CARD(S) (REQUIRED ONLY IF TOUR = 1 OR 2)
IF TOUR=1, THIS CARD SPECIFIES MINIMUM AND MAXIMUM ELEVATION VALUES. ZMIN (COLS 1-10), ZMAX (COLS 11-20) DECIMALS PUNCHED.
IF TOUR=2, THIS CARD SPECIFIES A FORMAT (INCON) USED IN READING A SERIES OF IRREGULARLY SPACED CONTOUR VALUES. THE VALUES ARE ARRANGED FROM LOWEST TO HIGHEST ON SUBSEQUENT CARDS. SET CON= NUMBER OF LINES.
PROGRAM POLYFIT MAIN PROGRAM

PROGRAM POLYFIT(INPUT, OUTPUT, PUNCH, TAPE1, TAPE8, APE5=INPUT, TAPE6=OUTPUT)

DIMENSION XX(21,21), P(21), A(21,5), XINV(21,21,5), PAR(21), ZR(1:1), SSR(5), BB(21,4), SSQZ(4), X(1000), Y(1000), Z(1000,4), ID(1000,2), LIMIT(5), NZ(4), ERR(21), SSF(5), DEFFREE(5)
DIMENSION ISURF(5), TITL(8,5), ORDIN(4,2)
DIMENSION DUM1(3000)
COMMON X,Y,Z,ID,DUM1,XINV,A,KSOR
DATA ND0G/6HPOLYFT/
XD=0.0
YD=0.0
ZD=0.0

SEARCH THE INPUT TAPE FOR THE PARAMETER CARD WITH THE CODE POLYFT

READ (5,370) LABEL
IF (EOF,5) 510,10
10 IF (LABEL=ND0G) 5,15,5
15 READ (5,375) LABEL,LIMIT,ISURF,INCK,NLINES,NZ,NRES,IOUT1

WRITE OUT HEADING

WRITE (6,455)
DO 20 I=1,NLINES
   READ (5,32) (TITL(I,I),I=1,8)
20 WRITE (6,460) (TITL(I,I),I=1,8)
WRITE (6,380)
READ (5,465) (ORDIN(I,1),ORDIN(I,2),I=1,4)
SSQZ(1)=0.0
SSQZ(2)=0.0
SSQZ(3)=0.0
SSQZ(4)=0.0
DO 30 I=1,5
   J=6-I
   IF (:LIMIT(J)) 25,30,25
   N=((J+1)*(J+2))/2
   JMP=I
25 GO TO 35

CONTINUE
GO TO 305

READ THE DATA POINTS

CALL READ1 (NCARDS)
COMPUTE THE COEFFICIENT MATRIX

\begin{verbatim}
PAR(1) = 0.0
DO 45 I = 1, N
   DO 40 J = 1, N
   40 XX(I, J) = 0.0
   BB(I, 1) = 0.0
   BB(I, 2) = 0.0
   BB(I, 3) = 0.0
   45 BB(I, 4) = 0.0
   DO 95 K = 1, NCARDS
   XD = X(K)
   YD = Y(K)
   PAR(2) = XD
   PAR(3) = YD
   GO TO (50, 50, 50, 50, 70, 70), JUMP
   PAR(4) = XD * XD
   PAR(5) = XD * YD
   PAR(6) = YD * YD
   GO TO (55, 55, 55, 55, 70, 70), JUMP
   PAR(7) = PAR(4) * XD
   PAR(8) = PAR(4) * YD
   PAR(9) = PAR(6) * XD
   PAR(10) = PAR(6) * YD
   GO TO (60, 60, 70, 70, 70, 70), JUMP
   PAR(11) = PAR(7) * XD
   PAR(12) = PAR(7) * YD
   PAR(13) = PAR(4) * PAR(6)
   PAR(14) = PAR(10) * XD
   PAR(15) = PAR(10) * YD
   GO TO (65, 70, 70, 70, 70, 70), JUMP
   PAR(16) = PAR(11) * XD
   PAR(17) = PAR(11) * YD
   PAR(18) = PAR(7) * PAR(6)
   PAR(19) = PAR(10) * PAR(4)
   PAR(20) = PAR(15) * XD
   PAR(21) = PAR(15) * YD
   70 DO 75 I = 1, N
   75 J = I, N
   XX(I, J) = XX(I, J) + PAR(I) * PAR(J)
C COMPUTE THE P VECTORS FOR EACH Z TO BE FITTED.
C
   DO 90 JIM = 1, 4
      IF (NZ(JIM)) 80, 90, 80
   80 ZD = Z(K, JIM)
      DO 85 I = 1, N
   85 BB(I, JIM) = BB(I, JIM) + ZD * PAR(I)
      SSQZ(JIM) = SSQZ(JIM) + ZD * ZD
   90 CONTINUE
95 CONTINUE
\end{verbatim}
WRITE (6,325)
DO 100 I=1,N
   WRITE (6,330) I, (XX(I,J), J=1,N)
100   CONTINUE
WRITE (6,335)
DO 105 JIM=1,4
   IF (NZ(JIM) .EQ. 0) GC TO 105
DO 105 I=1,N
   WRITE (6,340) I, BB(I, JIM)
105   CONTINUE
NM1=N-1
DO 110 I=1,NM1
   IP1=I+1
DO 110 J=IP1,N
110   XX(J,I)=XX(I,J)
WRITE (6,345)
DO 115 I=1,N
   WRITE (6,330) I, (XX(I,J), J=1,N)
115   CONTINUE
DO 145 K=1,5
   IF (LIMIT(K)) 125, 140, 120
120   MTERMS=1*(K+1)*(K+2)/2
   KS0B=0
   CALL INVER (XX, XINV, MTERMS, K)
   IF (KSOB) 125, 130, 125
125   WRITE (6,385) K
   LIMIT(K)=0
130   CONTINUE
   IF (INCK) 135, 140, 135
135   CALL INVCK (XX, XINV, K)
140   CONTINUE
REWIND 1
C 
C THE JIM DO LOOP RUNNING TO STATEMENT 300 CONTROLS WHICH Z IS BEING 
C FITTED.
C 
DO 300 JIM=1,4
   IF (NZ(JIM)) 145, 300, 145
145   DO 150 I=1,NCARDS
150   READ (1) ID(I), X(I), Y(I), Z(I,1), Z(I,2), Z(I,3), Z(I,4)
   SSZ=SSQZ(JIM)
   DO 155 I=1,N
155   B(I)=BB(I, JIM)
C 
C COMPUTE COEFFICIENTS
C 
DO 170 K=1,5
   IF (LIMIT(K)) 165, 170, 160
160   MTERMS=1*(K+1)*(K+2)/2
DO 165 I=1, NTERMS
   A(I,K)=0.0
DO 165 J=1, NTERMS
165   A(I,K)=A(I,K)+XINV(I,J,K)*B(J)
170 CONTINUE
WRITE (6,455)
DO 175 I=1, NNLINES
175   WRITE (6,460) (TITL(I,I), I=1,8)
WRITE (6,395) ORDN(JIM,1), ORDN(JIM, 2)
WRITE (6,390) NCARDS
DO 185 K=1, 5
185   WRITE (LIMIT(K)) 180, 185, 180
180   NTERMS=((K+1)*(K+2))/2
   WRITE (6, 430) K, (A(I,K), I=1, NTERMS)
185 CONTINUE
C
C ANALYSIS OF VARIANCE
C ERROR ESTIMATES FOR COEFFICIENTS
C
ZSUM=0.0
DO 190 K=1, NCARDS
190   ZSUM=ZSUM+Z(K,JIM)
ZBAR=ZSUM/FLOAT(NCARDS)
SSZBAR=ZSUM*ZBAR
SSZ=SSZ-SSZBAR
WRITE (6,405)
DO 210 K=1, 5
195   NTERMS=((K+1)*(K+2))/2
SSR(K)=0.0
DO 200 J=1, NTERMS
200   SSR(K)=SSR(K)+A(J,K)*B(J)
SSR(K)=SSR(K)-SSZBAR
SSE(K)=SSZ-SSR(K)
DFREF(K)=NCARDS-NTERMS-1
SIGMAE=SQR(T(SSE(K)/DFREE(K))
DO 205 J=1, NTERMS
205   ERR(J)=SIGMAE*SQR(T(XINV(J,J,K))
   WRITE (6, 410) K, (ERR(J), J=1, NTERMS)
210 CONTINUE
C
C ANALYSIS OF VARIANCE
C
WRITE (6,455)
DO 215 I=1, NNLINES
215   WRITE (6,460) (TITL(I,I), I=1,8)
WRITE (6,470) ORDN(JIM,1), ORDN(JIM,2)
WRITE (6,415) NDF=NCARDS-1
WRITE (6,350) NDF, SSZBAR
DO 225 K=1,5
   IF (LIMIT(K)) 225,225,220
220  NTERMS=((K+1)*(K+2))/2
    XSE=SSE(K)/DFREE(K)
    XSR=SSR(K)/FLOAT(NTERMS)
    F=XSR/XSE
    NDF=DFREE(K)
    WRITE (6,420) K,NTERMS,NDF,SSR(K),XSR,SSE(K),XSF,F
225  CONTINUE
    JACK=6-JUMP
    WRITE (6,355) SSZ
    WRITE (6,360)
    DO 230 K=1,5
      II (LIMIT(K)) 230,235,230
      RR=SSR(K)/SSZ
      PCENT=PR*100.0
      R=SQR(RR)
      WRITE (6,365) K,PCENT,RR,R
235  CONTINUE
    WRITE (6,425) JACK
    KSWT=1
    DO 255 K=1,5
      IF (LIMIT(K)) 240,255,240
240  NTERMS=((K+1)*(K+2))/2
      GO TO (245,250), KSWT
245  KSWT=2
      NTERMS=NTERMS-1
      XMSQ=SSR(K)/FLOAT(NTERMS)
      F=XMSQ/(SSE(JACK)/DFREE(JACK))
      WRITE (6,430) K,NTERMS,SSR(K),XMSQ,F
      NTE=NTERMS+1
      J=K
      GO TO 255
C
250    DF=NTERMS-NTE
      SSQ=SSR(K)-SSR(J)
      XMSQ=SSQ/DF
      F=XMSQ/(SSE(JACK)/DFREE(JACK))
      NDF=DF
      WRITE (6,430) K,NDF,SSQ,XMSQ,F
      J=K
      NTE=NTERMS
255  CONTINUE
    IF (NRES) 260,300,260
260  WRITE (6,455)
    DO 265 I=1,NLINES
265  WRITE (6,460) (TITL(I),I=1,8)
    WRITE (6,435) ORDIN(JIM,1),ORDIN(JIM,2)
    WRITE (6,440)
DO 270 I=1,1C
ZR(I)=0,0
IF (IOUT1*NE.1) GO TO 275
WRITE (8) NCARDS
275 DO 285 I=1,NCARDS
XD=X(I)
YD=Y(I)
ZD=Z(I,JIM)
CALL POLY (ZR,LIMIT,XD,YD,ZD)
WRITE (6,445) ID(I),X(I),Y(I),Z(I,JIM),(ZR(K),K=1,10)
IF (IOUT1*NE.1) GO TO 280
WRITE (8) ID(I),X(I),Y(I),Z(I,JIM),(ZR(K),K=1,10)
280 CONTINUE
285 CONTINUE
DO 295 I=1,5
IF (ISURF(I)*NE.1.AND.ISURF(I)*NE.2) GO TO 290
CALL EVALU (A,I,ISURF,TITL,NLINES,ORDIN,JIM)
290 CONTINUE
REWIND 1
295 CONTINUE
300 CONTINUE
GO TO 5
C C
305 WRITE (6,450)
GO TO 5
C C
310 CONTINUE
IF (IOUT1*NE.1) GO TO 315
END FILE 8
REWIND 8
315 CONTINUE
STOP
C C
320 FORMAT (8A10)
325 FORMAT (1H1,13HTHE XX MATRIX;///4H ROW)
330 FORMAT (1H0,I3,2X,11E16.3,/,6X,10E10.3)
335 FORMAT (1H1,13HTHE BB MATRIX;///4H ROW)
340 FORMAT (1H0,I3,2X,E16.4)
345 FORMAT (1H1,21HTHE REVISED XX MATRIX;///4H ROW)
350 FORMAT (1H0,12H MEAN 1\,\,I4\,F17.8)
355 FORMAT (///50X,47HCORRECTED TOTAL SS= TOTAL SS - SS DUE TO MEAN =\,1F20.6)
360 FORMAT (///,1X,81HPERCENT SS EXPLAINED BY REGRESSION=MULTIPLE CORR
IELATION COEFFICIENT ( R-SQUARED )///,54H DEGREE PERCENT VARIATI
2ON EXPLAINED R-SQUARED R)
365 FORMAT (1H0,I4,15X,F10.3,10X,F7.5,3X,F7.5)
FORMAT (A6)
FORMAT (A6,4X,5I1,5I1,4X,11,3X,12,6X,4I1,9X,11,9X,11)
FORMAT (1H0,///,5X,52HTREND SURFACE ANALYSIS USING POWER SERIFS EX
PANSION,///,5X,48HPOLYNOMIALS UP TO FIFTH DEGREE CAN BE REQUESTED/2)
FORMAT (46H THE COEFFICIENT MATRIX FOR THE FIT OF DEGREE ,11,70H I
IS MACHINE SINGULAR. THE PROGRAM WILL TRY THE OTHER FITS ASKED FOR
2. )
FORMAT (1H0,15X,39H THE NUMBER OF POINTS IN THIS GROUP IS,15,///<
1)
FORMAT (1H0,25X,78HTREND SURFACE EQUATIONS FOR 2A10,/
181HTHE COEFFICIENTS, WITH THE CONSTANT TERM LISTED FIRST. THE FOR
2M OF THE POLY IS //12H Z=A1+A2X+A3Y+A4X2+A5XY+A6Y2+A7X3+A8X2Y+
3A9XY2+A10Y3+A11X4+A12X3Y+A13X2Y2+A14+XY3+A15Y4+A16X5+A17X4Y+A18X3Y
42+ ... ETC. //1X,7H DEGREE)
FORMAT (1H0,4,3X,7E16.7///E24.7,6E16.7///E24.7,6E16.7)
FORMAT (///51H ESTIMATE OF ERROR IN THE COEFFICIENTS OF THE POLYS/
1/10H DEGREE)
FORMAT (///16X*7Fl£,27//F24,2?//F24,2?//F24.2)
FORMAT (///45H ANALYSIS OF VARIANCES FOR ALL REGRESSION
2M///1X,99H SOURCE D.F. SS DUE REG. MS DUE REG. F-RATIO )
FORMAT (1H0,7HDEGREE ,11,13,1H,14,1E17,8,E16,8,E19,8,F18,5,F14,3)
FORMAT (///34H ANALYSIS OF VARIANCE FOR ,11,12H DEGREE PO
1LY///75H DEGREE OF SOURCE D.F. SUM OF SQUARES MEAN SQUA
RE F-RATIO )
FORMAT (7X,11,12X,12,F20.6,E20.8,F17.5)
FORMAT (1H0,18X,82HCOORDINATES,ORIGINAL AND COMPUTED VALUES,AND RE
1SIDUALS FOR ALL SURFACES REQUESTED,///40X,12HDATA IS FOR ,2A10,/
27/)
FORMAT (1H0,6X,115HID X Y Z Z-LINEAR RES-L
1 Z-QUAD RES-QD Z-CUBIC RES-C Z-QUAR. RES-GQ Z-QUINT RES-
2QT/1X)
FORMAT (1H ,A10,2F8.2,F9.3,5|F9.3|F9.3))
FORMAT (104HTHE LIMIT PARAMETER IS ZERO FOR THIS GROUP. THIS MEANS
1 NO FIT WAS ASKED FOR. GOING ON TO NEXT GROUP. )
FORMAT (1H1)
FORMAT (1H ,2X,8A10)
FORMAT (8A10)
FORMAT (1H0,3,X,9HDATA FOR ,2A10/) END
SUBROUTINE READ1

PURPOSE -

TO READ ID,X,Y,Z1,Z2,Z3,Z4 DATA FROM THE DATA CARDS.

THE DATA CARDS SHOULD BE PRECEDED BY A FORMAT CARD (COLS 7-78)
AND BE FOLLOWED BY A BLANK CARD. THE SUBROUTINE DETERMINES THE NUM-
BER OF POINTS IN THE DATA SET BY SEARCHING FOR A CARD CONTAINING
BLANKS IN COLUMNS 1-10.

USAGE -

CALL READ1(NCARDS)

NCARDS - THE NUMBER OF DATA POINTS BEING ANALYZED. THIS IS DETER-
MINED BY READ1.

SUBROUTINE READ1 (NCARDS)
DIMENSION X(1:CO), Y(1:CO), Z(10:0,4), ID(1000)
DIMENSION FMT(12)
COMMON X,Y,Z,ID
DATA NBLANK/10H / 
I=1
READ (5,20) FMT
5 READ (5,FMT) ID(I),X(I),Y(I),Z(I+1),Z(I+2),Z(I+3),Z(I+4)
WRITE (1) ID(I),X(I),Y(I),Z(I+1),Z(I+2),Z(I+3),Z(I+4)
IF (ID(I)-NBLANK) 10,15,20
10 I=I+1
GO TO 5
15 NCARDS=I-1
RETURN
20 FORMAT (6X,12A6)
END
SUBROUTINE INVER

PURPOSE -
TO INVERT THE XX MATRICES FOR ALL SURFACES BEING FITTED.

USAGE -
CALL INVER(XX,XINV,K,NDEGRF)

XX - MATRIX FOR WHICH INVERSIF IS REQUIRED.
XINV - THE CALCULATED INVERSIF.
K - NUMBER OF TERMS IN EQUATION BEING DETERMINED=SIZE OF MATRIX.
NDEGRF - DEGREE OF EQUATION BEING DETERMINED.

SUBROUTINE INVER (XX,XINV,K,NDEGRF)
DIMENSION XX(21,21), XINV(21,21,5), AM(21,22)
DIMENSION N(21), DUMMY(12310)
COMMON DUMMY,KSOB
DO 5 I=1,K
DO 5 J=1,K
AM(I,J)=XX(I,J)
KK=K+1

DO 15 I=1,K
N(I)=0
DO 85 J=1,K
II=I-1
JJ=J-1
15 DO 20 L=1,II
IF (N(L)-I) 20,25,20
20 CONTINUE
IF (AM(I,II)) 35,25,35
I=I+1
IF (K-I) 30,15,15
30 KSOB=1
RETURN
35 AMA=ABS(AM(I,II))
40 I=II
II=II+1
45 DO 50 IZ=1,J
IF (N(IZ)-II) 50,40,50
50 CONTINUE
AMB=ABS(AM(II,1))

TEST FOR MAXIMAL SIZE PIVOTAL ELEMENT.

IF (AMA-AMB) 55,40,40
AMA=AMB
I=II
GO TO 40.
N(J) = I

ADJOIN THE CORRECT IDENTITY COLUMN VECTOR.

DO 65 IZ = 1, K
   AM(IZ, KK) = 0.0
   AM(I, KK) = 1.0
   DA = AM(I, 1)

NORMALIZE THE PIVOTAL ROW.

DO 70 IZ = 2, KK
   AM(I, IZ-1) = AM(I, IZ) / DA

DO 85 IZ = 1, K
   IF (IZ = 1) 75, 85, 75
   DR = AM(IZ, 1)

ZERO OUT NON-PIVOTAL COLUMN ELEMENTS.

DO 80 JZ = 2, KK
   AM(IZ, JZ-1) = AM(IZ, JZ) - AM(I, JZ-1) * DA

CONTINUE

DO 100 I = 1, K
   DO 90 J = 1, K
      IF (N(J) = I) 90, 95, 90

CONTINUE

LL = N + L

XINV(L, NDEGRE) = AM(LL, J)

RETURN

END
SUBROUTINE INVCK

PURPOSE -
TO DETERMINE AND PRINT OUT THE PRODUCT OF THE XX AND XX INVERSE
MATRICES FOR ALL SURFACES BEING FITTED. THIS SUBROUTINE CALLED ONLY
WHEN INCK (COL 25 = MASTER CONTROL CARD) IS SET EQUAL TO 1 (SEE DES-
CRIPTION OF CONTROL CARDS PAGE ).

THESE LISTINGS CAN BE EXAMINED TO DETERMINE IF STRONG DISCREP-
ANCIES FROM AN IDENTITY MATRIX OCCUR FOR ANY SURFACE. IF DISCREP-
ANCIES OCCUR, THE COEFFICIENTS SHOULD BE REGARDED WITH SUSPICION.

USAGE -
CALL INVCK(A,B,K)

A - ORIGINAL XX MATRIX.
B - INVERSE MATRICES FOR EACH DEGREE SURFACE.
K - NUMBER OF TERMS IN EQUATION OF EACH SURFACE = SIZE OF IDENTITY
AND OTHER MATRICES.

SUBROUTINE INVCK(A,B,K)
DIMENSION A(21,21), B(21,21,5), C(21)
N=(((K+1)*(K+2))/2)
WRITE (6,15) K
DO 10 I=1,N
  DO 5 J=1,N
    C(J)=0.0
  DO 5 L=1,N
    C(J)=A(I,L)*B(L,J,K)+C(J)
10 WRITE (6,20) I,C(J),J=1,N
RETURN

15 FORMAT (1H1,77H THE PRODUCT OF THE COEFFICIENT MATRIX AND ITS INVE
IRSE FOR THE FIT OF DFREF ///4H ROW)
20 FORMAT (1H0,13,2X,11F10.7,7X,10F10.7)
END
SUBROUTINE POLY

PURPOSE -
TO EVALUATE THE EQUATIONS OF THE REQUESTED SURFACES AT EACH
OBSERVED DATA LOCATION IN ORDER TO DETERMINE THE ESTIMATED VALUES
AND THE RESIDUALS FOR EACH DATA POINT.

USAGE -
CALL POLY(ZR,LIMIT,XDD,YDD,ZDD)

ZR - UP TO TEN VALUES WHICH ARE THE CALCULATED AND RESIDUAL VALUES
FOR THIS DATA POINT FOR ALL SURFACES REQUESTED.
LIMIT - PARAMETER SPECIFYING WHICH SURFACES ARE BEING FITTED.
XDD - X COORDINATE OF THIS DATA POINT.
YDD - Y COORDINATE OF THIS DATA POINT.
ZDD - Z COORDINATE OF THIS DATA POINT.

DIMENSION A(21,5), ZR(10), XD(1), YD(1), ZD(1), PT(1)
DIMENSION XDD(1), YDD(1), ZDD(1)
DIMENSION LIMIT(5), DUMMY(12205)
COMMON DUMMY, A
XD=XDD
YD=YDD
ZD=ZDD
DO 40 K=1,5
  IF (LIMIT(K)) 5,40,5
  GO TO (10,15,20,25,30), K
10 PT=A(1,K)+XD*A(2,K)+YD*A(3,K)
  GO TO 35
20 PT=A(1,2)+XD*A(2,2)+YD*A(3,2)+XD*XD*A(4,2)+XD*YD*A(5,2)+YD*YD*A
  (6,2)
  GO TO 35
30 XD2=XD*XD
    YD2=YD*YD
    PT=A(1,3)+XD*A(2,3)+YD*A(3,3)+XD2*A(4,3)+XD*YD*A(5,3)+YD2*A(6,3)+
      XD2*XD*A(7,3)+XD2*YD*A(8,3)+XD*YD2*A(9,3)+YD2*YD*A(10,3)
  GO TO 35
40 XD3=XD*XD
    XD2=XD2*XD
    YD3=YD*YD
    PT=A(1,4)+XD*A(2,4)+YD*A(3,4)+XD2*A(4,4)+XD*YD*A(5,4)+YD2*A(6,4)+
      XD3*A(7,4)+XD2*YD*A(8,4)+XD*YD2*A(9,4)+YD3*A(10,4)+XD2*XD2*A
        (1,5)
  GO TO 35
50}

GO TO 35
C
30 XD2=XD*XD
XD3=*D2*XD
XD4=*D3*XD
YD2=YD*YD
YD3=YD2*YD
YD4=YD3*YD
PT=A{(1,5)}+XD*A{(2,5)}+YD*A{(3,5)}+XD2*A{(4,5)}+XD*YD*A{(5,5)}+YD2*A{(6,5)}
1 +XD3*A{(7,5)}+XD2*YD*A{(8,5)}+XD*YD2*A{(9,5)}+YD3*A{(10,5)}
PT=PT+XD4*A{(11,5)}+XD3*YD*A{(12,5)}+XD2*YD2*A{(13,5)}+XD*YD3*A{(14,5)}
1 +YD4*A{(15,5)}+XD4*YD*A{(16,5)}+XD*YD4*A{(17,5)}+XD2*YD2*A{(18,5)}+YD2*YD2*YD4*
2 YD3*YD4*(19,5)+XD*YD4*A{(20,5)}+YD*YD4*A{(21,5)}
35 ZR(2*k-1)=PT
ZR(2*k)=ZD-PT
40 CONTINUE
RETURN
END
SUBROUTINE EVALU

PURPOSE -
TO EVALUATE THE EQUATIONS OF THE SURFACES AT A SERIES OF EQUALLY SPACED (GRIDDED) LOCATIONS SO THAT CONTOUR MAPS OF THE SURFACES CAN BE PREPARED.

USAGE -
CALL EVALU(A,K,ISURF,TITL,NLINES,ORDIN,JIM)
A - MATRIX CONTAINING POLYNOMIAL COEFFICIENTS
K - COUNTER USED TO IDENTIFY SURFACES IN MAP TITLES.
ISURF - PARAMETER USED TO SPECIFY MAPPING OR GRIDDING OPTIONS.
TITL - GENERAL ALPHANUMERIC TITLE(S), NUMBER SPECIFIED BY NLINES
NLINES - NUMBER OF TITLE LINES (NUMBER OF CARDS), MAXIMUM = 5
ORDIN - SPECIFIC ALPHANUMERIC TITLES USED TO IDENTIFY VARIABLES.
JIM - COUNTER USED TO IDENTIFY WHICH VARIABLE (1-4) BEING ANALYZED

SUBROUTINE EVALU(A,K,ISURF,TITL,NLINES,ORDIN,JIM)
INTEGER COLS, ROWS
DIMENSION ISURF(5),
DIMENSION A(21,100), C(100,100), DUMMY(2205),
DIMENSION TITL(8,5), ORDIN(4*2),
COMMON C,DUMMY, A
READ (5,9) XMAX,XMIN,YMAX,YMIN
READ (5,95) ROWS,COLS,NMAP,IPUN
XINC=(XMAX-XMIN)/FLOAT(COLS-1)
YINC=(YMAX-YMIN)/FLOAT(ROWS-1)

ZERO C ARRAY

DO 5 KK=1,95
DO 5 JJ=1,95
C(JJ,KK)=0.0

DEFINE STARTING X AND Y

XD=XMIN
YD=YMAX
DO 45 JJ=1,ROWS
   DO 44 KK=1,COLS
      GO TO (10,15,20,25,30), K
   10 PT=A(1,1)+XD*A(2,1)+YD*A(3,1)
      GO TO 35
   15 PT=A(1,2)+XD*A(2,2)+YD*A(3,2)+XD*XD*A(4,2)+XD*YD*A(5,2)+YD*YD*A(6,2)
      GO TO 35

C
XD2 = XD * XD
YD2 = YD * YD
PT = A(1, 3) + XD * A(2, 3) + YD * A(3, 3) + XD2 * A(4, 3) + YD * YD * A(5, 3) + XD * YD * A(6, 3) + XD2 * XD * A(7, 3) + YD * YD2 * A(8, 3) + XD * YD2 * A(9, 3) + YD2 * YD * A(10, 3)
GO TO 33

XD2 = XD * XD
XD3 = XD2 * XD
YD2 = YD * YD
YD3 = YD2 * YD
PT = A(1, 4) + XD * A(2, 4) + YD * A(3, 4) + XD2 * A(4, 4) + YD * YD * A(5, 4) + YD2 * A(6, 4) + XD3 * A(7, 4) + XD2 * YD * A(8, 4) + XD * YD3 * A(9, 4) + YD2 * YD * A(10, 4) + XD * XD2 * A(11, 4) + YD * YD2 * A(12, 4) + XD * YD2 * A(13, 4) + XD2 * YD * A(14, 4) + YD2 * YD * A(15, 4)
GO TO 35

XD2 = XD * XD
XD3 = XD2 * XD
XD4 = XD3 * XD
YD2 = YD * YD
YD3 = YD2 * YD
YD4 = YD3 * YD
PT = A(1, 5) + XD * A(2, 5) + YD * A(3, 5) + XD2 * A(4, 5) + XD * YD * A(5, 5) + YD2 * A(6, 5) + XD3 * A(7, 5) + XD2 * YD * A(8, 5) + XD * YD2 * A(9, 5) + YD3 * A(10, 5) + PT + XD4 * A(11, 5) + XD3 * YD * A(12, 5) + XD2 * YD2 * A(13, 5) + XD3 * YD3 * A(14, 5) + YD4 * A(15, 5) + XD4 * XD * A(16, 5) + XD * YD4 * A(17, 5) + XD2 * YD2 * A(18, 5) + YD4 * YD2 * A(19, 5) + XD4 * YD4 * A(20, 5) + YD4 * YD2 * A(21, 5)
C(JJ, KK) = PT

XD = XD + XINC
XD = XMIN

YD = YD - YINC
WRITE (6, 130)
DO 50 I = 1, NLINES
WRITE (6, 135) (TITL(I), I = 1, 8)
WRITE (6, 145) ORDIN(JIM, 1), ORDIN(JIM, 2)
WRITE (6, 100) K, COLS, ROWS
WRITE (6, 10) XMAX, XMIN, YMAX, YMIN
DO 55 JJ = 1, ROWS
WRITE (6, 110) C(JJ, KK), KK = 1, COLS)
55 WRITE (6, 120)
IF (IPUN) WRITE (6, 75) 60 DO 65 I = 1, NLINES
65 PUNCH 1.0, (TITL(I), I = 1, 8)
PUNCH 1.0, ORDIN(JIM, 1), ORDIN(JIM, 2)
PUNCH 1.0, K, COLS, ROWS
DO 70 J = 1, ROWS
PUNCH 125, (C(J, KK), KK = 1, COLS)
70 CONTINUE
CONTINUE
IF (ISURF(K) NE 2 OR COLS GT 42) GO TO 85
DO 80 I = 1, NMAP
80 CALL PLOT (C, ROWS, COLS, K, TITL, NLINE, ORDIN, JIM)
85 CONTINUE
RETURN
C
C
90 FORMAT (4F10.3)
95 FORMAT (3I3, 11)
100 FORMAT (1H0, 36HGRIDDED VALUES OF SURFACE OF DEGREE $I1$, 9H Grid is 113, 12H Columns by $I3$, 6H Rows$)
105 FORMAT (3X, 36HGRIDDED VALUES OF SURFACE OF DEGREE $I1$, 9H Grid is 113, 12H Columns by $I3$, 6H Rows$)
110 FORMAT (1H0, 55HMAXIMUM AND MINIMUM COORDINATE VALUES READ IN ARE IMF, 9H XMIN = $F10.3$, 6H YMIN = $F10.3$, 6H YMAX = $F10.3$)!
115 FORMAT (1H0, 12F10.3)
120 FORMAT (1H0)
125 FORMAT (8F10.3)
130 FORMAT (1H1)
135 FORMAT (1H0, 1X, 13HANALYSIS FOR $2A10$)!
140 FORMAT (8A10)
145 FORMAT (1H0, 1X, 13HANALYSIS FOR $2A10$)!
150 FORMAT (2X, 2A10)
SUBROUTINE PLOT (Z,ROWS, COLS, KOLD, TITL, N LINES, ORDIN, JJM)

DIMENSION SYMTAB(200), SYM(131), ICON(101), DRANG(25), ZFREQ(171)
1 SYM(121), 2(100, 100), TITL(3, 5), ORDIN(4, 2)
INTEGER ROWS, COLS, CONTOUR, COLMAX, DJL, SYMPS, GRID, SYMBLANK, PLUS,
MINUS, START, SYMTAB, STOP, STOP
REAL MINZ, MAXZ, INCHES, INCM
DATA (SYMTAB); jI=1,1H0,1H1,1H2,1H3,1H4,1H5,1H6,1H7,1H8,1H9,1H0
1,1H1,1HC,1HF,1HC,1HF,1HC,1HF,1HC,1HF,1HC,1HF,1HC,1HF,1HC,1HF,1HC,1HF,1HC
2MUS/1H7/ START/1H7
READ (5, 170) CONTOUR, LINES, INCHES
JJ=0
MI=0
N=ROWS*KOLS
N = NUMBER OF DATA POINTS
WRITE (6, 17B)
10 I=1, N LINES
WRITE (6, 180) TITL(I), I=1, 8
WRITE (6, 185) ORDIN(JJ), JJ=1, 2
WRITE (6, 190) COLS, COLS, ROWS
CALL STATS (ROWS, COLS, 10, 100, 7, 2BAR, XP, ZSIG, MAXZ, MINZ)
**DETERMINE CONTROL LINE PLACEMENTS**

**TOUR VALUE DETERMINES METHOD USED IN DEFLATING CONTOURS**

```
IF (TOUR.GT.3 .OR. TOUR.LT.0) GO TO 30
GO TO (15, 20, 25), TOUR
WRITE (6, 195)
READ (5, 215)
IF (ZMAX .GT. 2.0) ZMAX = ZMAX
GO TO 35
READ (5, 215)
WRITE (6, 205)
READ (5, 215)
MIN = DRANG(I)
MAX = DRANG(J)
GO TO 35
ZMIN = ZMIN .PLUS. 3.0 .PLUS. ZSIG
ZMAX = ZMAX .PLUS. 3.0 .PLUS. ZSIG
WRITE (6, 225)
GO TO 35
WRITE (6, 215)
WRITE (6, 225)
WRITE (6, 225)
```

**CALCULATE GRID WIDTH IN CHARACTERS (COL)**

```
IF (INCHES.LT.0.0) COL = 10
IF (INCHES.GT.12.7) COL = 127
IF (INCHES.GT.12.7 .AND. DEGREES.LE.12.7) COL = INCHES*10.0
PS = (COL-COLS)/ (COLS-1)
```

**TEST GRID SIZE — IF GRID SMALLER THAN 2 CHARACTERS BETWEEN COLUMNS, AN ERROR STATEMENT IS PRINTED AND PLOT ABORTED.**

```
IF (PS .LT. 1) GO TO 40
WRITE (6, 215)
GO TO 165
```

**CALCULATE REQUIRED CONSTANTS**

```
COLMAX = PS * (COLS - 1) + COLS
```
YINC=1.0/((FLOAT(PS+1))*0.6)
GRID=PS+1
XINC=1.0/FLOAT(GRID)
RANGZ=ZMAX-ZMIN
RHIGH=ZMAX+RANGZ
RLOW=ZMIN-RANGZ
IF (CON.EQ.0.OR.CON.GT.19) CON=5
FCON=CON
CI=RANGZ/FCON
IF (TOUR.EQ.2) GO TO 50
JJJ=CON+1
DO 45 I=1,JJJ
45 DRANG(I)=ZMIN+FLOAT(I-1)*CI
CONTINUE
WRITE (6,235)
WRITE (6,240) ZMIN,ZMAX,CI,GRID,XINC,YINC,CON,PS,COLMAX

WRITE OUT CONTOUR SYMBOL TABLE

WRITE (6,245)
IF (LINES.EQ.1) WRITE (6,250)
WRITE (6,255)
IF (LINES.NE.0) GO TO 55
WRITE (6,260)
WRITE (6,265) (SYMTAB(I),DRANG(I),I=1,CON)
WRITE (6,270)
GO TO 60

WRITE (6,275)
WRITE (6,280) (SYMTAB(I),DRANG(I),DRANG(I+1),I=1,CON)
WRITE (6,285) DRANG(CON+1)

WRITE (6,290) (SYMTAB(I),I=1,N)
XSTOP=GRID
GRID=COLS-1
COL=3
DO 75 J=1,GRID
   DO 70 I=2,XSTOP
      SYM(COL)=ELANK
70   COL=COL+1
      SYM(COL)=PLUS
75   COL=COL+1
   N=COLMAX+2
   SYM(2)=PLUS
   SYM(1)=BLANK
   SYM(N)=BLANK
WRITE (6,290) (SYM(I),I=1,N)
*ESTIMATE VALUE OF ALL PRINTING POSITIONS ON MAP*

**LOOP THROUGH MAP LENGTH, ROW BY ROW**

```
ITOP=1
IROW=RPS+1
DO 160 IM=2,1ROW
   YSTOP=1./YINC+5
   IF (MN.EQ.IROW) YSTOP=1
   M=M-1
   YP=0.
   PSYM(1)=PLUS
   PSYM(N)=PLUS
   DO 160 KJ=1,YSTOP
      COL=1
      Z1=YP*(Z(M,J)+Z(M+1,J)+Z(M,J+1))
      I=1
      DO 130 J=1,I
         Z2=YP*(Z(M,J)-Z(M,J+1)+Z(M+1,J))
         ZDELTA=Z2-Z1
         XP=W+D
         DO 130 KK=1,XSTOP
            JLFT=JLFT-1
            COL=COL+1
            ZEST=XP*ZDELTA+Z1
            IF (ZEST.LE.ZMIN.AND.ZEST.LT.ZMAX) GO TO 95
            IF (ZEST.GE.ZMIN.AND.\( ITOP+FG+1\) OR IM.EQ.IROW OR JLFT.EQ.1) \( 1\) ) GO TO 80
            IF (ZEST.GT.ZMAX.AND.\( ITOP+EQ+1\) OR IM.EQ.IROW OR JLFT.EQ.1) \( 1\) ) GO TO 85
            PSYM(COL)=BLANK
            ZPREV(COL)=ZEST
            ZLAST=ZEST
            GO TO 130
          160
          130  IF (ZEST.LE.ZLOW) GO TO 90
          PSYM(COL)=MINUS
          ZPREV(COL)=ZEST
          ZLAST=ZEST
          GO TO 130
```
IF (ZEST .GE. RHIGH) GO TO 90
PSYM(COL) = PLUS
ZPREV(COL) = ZEST
ZLAST = ZEST
GO TO 130

C

PSYM(COL) = STAP
ZPREV(COL) = ZEST
ZLAST = ZEST
GO TO 130

C

I = ((ZEST-ZMIN)/CL)+1
LVAL = LINES+1
IF (ITOP.EQ.1 .OR. MM.EQ.IROW .OR. JLFT.EQ.1) LVAL = 3
GO TO (100, 120, 125), LVAL

100 DO 105 I = 1, CON
   ZSTEP = DRANG(I)
   SW1 = 1.
   SW2 = 1.
   SW3 = 1.
   SW4 = 1.
   IF (ZSTEP .GE. ZLAST .OR. ZSTEP .GE. ZPREV(COL)) SW1 = 0.
   IF (ZSTEP .LE. ZEST) SW2 = 0.
   IF (ZSTEP .LT. ZLAST .OR. ZSTEP .LT. ZPREV(COL)) SW3 = 0.
   IF (ZSTEP .GE. ZEST) SW4 = 0.
   IF ((SW1 .EQ. 0 .AND. SW2 .EQ. 0) .OR. (SW3 .EQ. 0 .AND. SW4 .EQ. 0)) GO TO 110

105 CONTINUE
PSYM(COL) = BLANK
GO TO 115

C

PSYM(COL) = SYMTAB(I)
115 ZLAST = ZEST
ZPREV(COL) = ZEST
GO TO 130

C

K = I/2
IF ((K*2).NE.1) PSYM(COL) = SYMTAB(I)
IF ((K*2).EQ.1) PSYM(COL) = BLANK
GO TO 130

C

125 PSYM(COL) = SYMTAB(I)
ZPREV(COL) = ZFST
130 XP = XP + XINC
Z1 = Z2
135 JLFT = 0
COL = COL + 1
IF (Z(M+COLS).GE.ZMIN . AND. Z(M+COLS).LE.ZMAX) GO TO 150
IF (Z(M+COLS).GT.ZMAX) GO TO 140
IF (Z(M+COLS).LE.RLOW) GO TO 145
PSYM(COL) = MINUS
GO TO 155
IF (Z(M, COLS) .GE. RHIGH) GO TO 145
PSYM(COL) = PLUS
GO TO 155

PSYM(COL) = STAR
GO TO 155

I = ((Z(M, COLS) - ZMIN) / CI) + 1.
PSYM(COL) = SYMTAB(I)
WRITE (6, 290) (PSYM(L), L = 1, N)
YP = YP + YINC
PSYM(1) = BLANK
PSYM(N) = BLANK

ITOP = 0
WRITE (6, 290) (SYM(L), L = 1, N)
CONTINUE
RETURN

FORMAT (I2, 2I1, F4.0)
FORMAT (1H1)
FORMAT (1I6)
FORMAT (1H0, 10X, 8A10)
FORMAT (1H0, 10X, 21H ANALYSIS OF DATA FOR 2A10, ////)
FORMAT (1H0, 33H CONTOUR MAP OF SURFACE OF DEGREE 1137
THE EQUATION HAS BEEN EVALUATED AT 14, 21 LOCATION ON A GRID
29NS BY 13, 6 H ROWS, //)
FORMAT (25H CONTOUR LEVELS SPECIFIED)
FORMAT (2F10.0)
FORMAT (1H0)
FORMAT (10A6)
FORMAT (1H0, 10X, 21H VARYING CONTOUR INTERVALS SPECIFIED)
FORMAT (3H0, 10H CONTOUR INTERVAL = UI/2 SIGMA)
FORMAT (26H CONTOUR LEVELS CALCULATED)
FORMAT (14H GRIDDED DATA, 42H LINEAR INTERPOLATION WITHIN GRID
1ARES, //, 17H OBSERVED VALUES, //, 8H ROWS = 13, 10H COLS = 13, 8
2H ZBAR = 1F10.3, 10H ZSIG = 1F10.3, 10H MAXZ = 1F10.3, 10H MINZ
3 = 1F10.3)
FORMAT (25H TOO MANY COLUMNS IN GRID)
FORMAT (1H0, 16H VALUES EMPLOYED)
FORMAT (8H ZMIN = 1F10.3, 10H ZMAX = 1F10.3, 8H CI = 1F10.3, 8H
1GRID = 1I5, 10H XINC = 1F10.3, 10H YINC = 1F10.3, 7H CON = 1I5, 8
2H PS = 1I5, 12H COLMAX = 1I5)
FORMAT (35H4 CONTINUOUS SYMBOL TABLE IS AS FOLLOWS)
FORMAT (43H0 (ONLY EVEN SYMBOLS PRINTED IN BODY OF MAP))
FORMAT (7H0, SYMBOL, 11X, 5H VALUE)
FORMAT (5H0, *6X, 7H0, DATA, 15H, 5H, 4X, 10H BELOW LOW)
FORMAT (4X, A, 2X, F12.4)
FORMAT (4X, 1H+, 4X, 10H ABOVE HIGH)
FORMAT (5H0, *5X, 7H0, DATA, 15H, 5H, 23X, 10H BELOW LOW)
FORMAT (4X, A, 2X, F12.4, 6H TO F12.4)
FORMAT (4X, 1H+, 2X, F12.4, 10H OR OVER)
FORMAT (I9, 129A1)
END
JOB CONTROL CARDS NECESSARY TO RUN POLYFIT AND RESMAP AS ONE JOB

COL 1

ACCT, NAME, T800, CM70:00, PRIORITY
RUN(S, 77777)
REQUEST(TAPE8, HI) USER TAPE IDENTIFICATION (THIS CARD OPTIONAL)
LGO.
REFL(7U...0)
REWIND(LGO)
RUN(S, 77777)
LGO.

7-8-9 CARD PROGRAM POLYFIT SOURCE DECK
7-8-9 CARD POLYFIT CONTROL AND DATA CARDS (SEE BELOW)
7-8-9 CARD PROGRAM RESMAP SOURCE DECK
7-8-9 CARD RESMAP CONTROL CARDS
6-7-8-9 CARD
PROGRAM POLYFIT - SAMPLE DATA CARDS

NOTE: THESE CARDS WILL FIT TRENDS 1-4, PRODUCE PRINTER MAPS, PUNCH GRIDDED TREND VALUES FOR A 1/2 INCH GRID, AND STORE DATA FOR RESMAP. FOUR DIFFERENT VARIABLES WILL BE ANALYZED.

THE DATA REPRESENTS WATER WELL OBSERVATIONS DURING THE LAST FOUR MONTHS OF 1967 IN BARTHOLOMEW COUNTY, INDIANA.

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1.0 16.0 C.0

100111.2

1.0 16.0 C.0

100111.2
PROGRAM RESMAP SHOULD FOLLOW IMMEDIATELY
PROGRAM RESMAP - GENERAL INSTRUCTIONS

PURPOSE -
TO BE USED IN CONJUNCTION WITH PROGRAM POLYFIT. THIS PROGRAM ANALYZES THE ORIGINAL AND RESIDUAL VALUES STORED ON TAPE8 BY PROGRAM POLYFIT. GRIDDED VALUES AND PRINTER CONTOUR MAPS ARE PRODUCED BY SUBROUTINES GRID AND PLTCON1 OR PLTCON2. A VARIETY OF CONTOUR MAPS MAY BE SPECIFIED, MULTIPLE MAPS OF ANY DATA MAY BE PRODUCED. THE GRIDDED VALUES MAY PRODUCE CALCOP CONTOUR MAPS USING PROGRAM CONTOUR.

PURDUE UNIVERSITY VERSION 2.0 A. KEITH TURNER
CIVIL ENGINEERING,
FEBRUARY, 1968.

TAPE REQUIREMENTS -
TAPE8 IS USED TO STORE DATA DEVELOPED BY PROGRAM POLYFIT.

SUBROUTINES REQUIRED -
1) GRID - TO GRID THE IRREGULARLY SPACED DATA
2) PRTCON1 - TO PRODUCE PRINTER CONTOUR MAPS
   OR
   PRTCON2 - TO PRODUCE GRADED DENSITY PRINTER CONTOUR MAPS
3) STATS - TO CALCULATE CERTAIN STATISTICAL VALUES

NOTE 1 - GRID CONTROL CARDS ARE REQUIRED FOR EACH ANALYSIS REQUESTED. SEE SECTION III.
NOTE 2 - PRTCON1 OR PRTCON2 CONTROL CARDS REQUIRED FOR EACH MAP REQUESTED (NUMBER OF MAPS = NUMBER OF MAPS PER REQUEST TIMES NUMBER OF ANALYSES REQUESTED). SEE SECTION IV.
PROGRAM RESMAP - MAIN PROGRAM

PROGRAM RESMAP(INPUT,OUTPUT,TAPE5,PUNCH,TAPE6=INPUT,TAPE5=OUTPUT)
DIMENSION X(1000),Y(1000),Z(1000),IVAL(6),TITL(8)

READ(5,65) TITL
IF(EOF(5),55,6)
READ(5,85) (IVAL(I),I=1,6)
DO 50 I=1,6
IF(IVAL(I).NE.1) GO TO 50
READ(8) NUM
IF(EOF(8),55,10)
WRITE(6,60) NUM
WRITE(6,70) TITL
GO TO (20,21,22,23,24,25),I
DO 10 N=1,NUM
11 READ(8) ID,X(N),Y(N),Z(N),ZC1,ZR1,ZC2,ZR2,ZC3,ZR3,ZC4,ZR4,ZC5,ZR5
GO TO 45
DO 12 N=1,NUM
12 READ(8) ID,X(N),Y(N),ZD,ZC1,Z(N),ZC2,ZR2,ZC3,ZR3,ZC4,ZR4,ZC5,ZR5
GO TO 45
DO 13 N=1,NUM
13 READ(8) ID,X(N),Y(N),ZD,ZC1,ZR1,ZC2,Z(N),ZC3,ZR3,ZC4,ZR4,ZC5,ZR5
GO TO 45
DO 14 N=1,NUM
14 READ(8) ID,X(N),Y(N),ZD,ZC1,ZR1,ZC2,ZR2,ZC3,Z(N),ZC4,ZR4,ZC5,ZR5
GO TO 45
DO 15 N=1,NUM
15 READ(8) ID,X(N),Y(N),ZD,ZC1,ZR1,ZC2,ZR2,ZC3,ZR3,ZC4,Z(N),ZC5,ZR5
GO TO 45
DO 16 N=1,NUM
16 READ(8) ID,X(N),Y(N),ZD,ZC1,ZR1,ZC2,ZR2,ZC3,ZR3,ZC4,ZR4,ZC5,Z(N)
45 REWIND 8
CALL GRID NUM,X,Y,Z)
50 CONTINUE
GO TO 5
STOP
60 FORMAT(1H1,10X,32H NUMBER OF POINTS TO BE READ IN 14,//)
65 FORMAT(8A10)
70 FORMAT(1H1,5X,8A10)
85 FORMAT(6I1)
END
PROGRAM REMAP - SAMPLE DATA CARDS

NOTE - THESE CARDS ARE DESIGNED TO ANALYZE DATA PRODUCED BY PROGRAM POLYFIT FROM THE SAMPLE DATA SHOWN THERE. THESE CARDS REQUEST THE PRODUCTION OF ORIGINAL AND FOUR DIFFERENT RESIDUAL MAPS FOR THE SAME FOUR MONTHS. PUNCHED CARD OUTPUT FOR THE GRIDDED VALUES WILL ALSO BE PRODUCED.

BARTHOLOMEW COUNTY WATER SURFACE ANALYSIS FOR SEPTEMBER 1967
11111
33 23 101 1
BARTHOLOMEW COUNTY GROUND WATER-ORIGINAL WELL ELEV. DATA, SEPTEMBER 1967
11.0 0.0 16.0 0.0
100111.2
33 23 101 1
BARTHOLOMEW COUNTY GROUND WATER- 1ST DEGREE RESIDUALS, SEPTEMBER 1967
11.0 0.0 16.0 0.0
100111.2
33 23 101 1
BARTHOLOMEW COUNTY GROUND WATER- 2ND DEGREE RESIDUALS, SEPTEMBER 1967
11.0 0.0 16.0 0.0
100111.2
33 23 101 1
BARTHOLOMEW COUNTY GROUND WATER- 3RD DEGREE RESIDUALS, SEPTEMBER 1967
11.0 0.0 16.0 0.0
100111.2
33 23 101 1
BARTHOLOMEW COUNTY GROUND WATER- 4TH DEGREE RESIDUALS, SEPTEMBER 1967
11.0 0.0 16.0 0.0

BARTHOLOMEW COUNTY WATER SURFACE ANALYSIS FOR OCTOBER 1967
11111
33 23 101 1
BARTHOLOMEW COUNTY GROUND WATER-ORIGINAL WELL ELEV. DATA, OCTOBER 1967
11.0 0.0 16.0 0.0
100111.2
33 23 101 1
BARTHOLOMEW COUNTY GROUND WATER- 1ST DEGREE RESIDUALS, OCTOBER 1967
11.0 0.0 16.0 0.0
100111.2
33 23 101 1
BARTHOLOMEW COUNTY GROUND WATER- 2ND DEGREE RESIDUALS, OCTOBER 1967
11.0 0.0 16.0 0.0
100111.2
33 23 101 1
BARTHOLOMEW COUNTY GROUND WATER- 3RD DEGREE RESIDUALS, OCTOBER 1967
11.0 0.0 16.0 0.0
100111.2
23 23 101 1
BARTHOLOMEW COUNTY GROUND WATER- 4TH DEGREE RESIDUALS, OCTOBER 1967

11.0  0.0  16.0  0.0

100111.2

BARTHOLOMEW COUNTY WATER SURFACE ANALYSIS FOR NOVEMBER 1967

11111

33 23  101 1

BARTHOLOMEW COUNTY GROUND WATER-ORIGINAL WELL ELEV. DATA, NOVEMBER 1967

11.0  0.0  16.0  0.0

100111.2

33 23  101 1

BARTHOLOMEW COUNTY GROUND WATER-1ST DEGREE RESIDUALS, NOVEMBER 1967

11.0  0.0  16.0  0.0

100111.2

33 23  101 1

BARTHOLOMEW COUNTY GROUND WATER-2ND DEGREE RESIDUALS, NOVEMBER 1967

11.0  0.0  16.0  0.0

100111.2

33 23  101 1

BARTHOLOMEW COUNTY GROUND WATER-3RD DEGREE RESIDUALS, NOVEMBER 1967

11.0  0.0  16.0  0.0

100111.2

33 23  101 1

BARTHOLOMEW COUNTY GROUND WATER-4TH DEGREE RESIDUALS, NOVEMBER 1967

11.0  0.0  16.0  0.0

100111.2

BARTHOLOMEW COUNTY WATER SURFACE ANALYSIS FOR DECEMBER 1967

11111

33 23  101 1

BARTHOLOMEW COUNTY GROUND WATER-ORIGINAL WELL ELEV. DATA, DECEMBER 1967

11.0  0.0  16.0  0.0

100111.2

33 23  101 1

BARTHOLOMEW COUNTY GROUND WATER-1ST DEGREE RESIDUALS, DECEMBER 1967

11.0  0.0  16.0  0.0

100111.2

33 23  101 1

BARTHOLOMEW COUNTY GROUND WATER-2ND DEGREE RESIDUALS, DECEMBER 1967

11.0  0.0  16.0  0.0

100111.2

33 23  101 1

BARTHOLOMEW COUNTY GROUND WATER-3RD DEGREE RESIDUALS, DECEMBER 1967

11.0  0.0  16.0  0.0

100111.2

33 23  101 1

BARTHOLOMEW COUNTY GROUND WATER-4TH DEGREE RESIDUALS, DECEMBER 1967

11.0  0.0  16.0  0.0
PART III

PROCEDURES FOR ASSIGNING
IRREGULARLY SPACED (RANDOM) DATA
TO A SQUARE GRID

NOTE - This procedure must precede any attempt to machine-contour irregularly spaced data. Since potential users may wish to clearly understand the underlying principles used in subroutine GRID, a description of the algorithm is included.

CONTENTS OF THIS SECTION

1) Description of Interpolation Algorithm

2) SUBROUTINE GRID

3) SUBROUTINE STATS
AN INTERPOLATION ALGORITHM FOR GEOGRAPHICAL DATA

The documentation for this algorithm and a MAD language program were obtained from Professor W. R. Tobler, Geography Department, University of Michigan. The MAD language program formed the basis of the Subroutine GRID. The algorithm involves a weighted moving average procedure, and appears to give results which are comparable to those obtained by the fitting of local polynomials, but is computationally much simpler. Following considerable (empirical) testing, the main disadvantage appears to be a slight dampening (or smoothing) effect on the data. This approaches 10% of the data range for extremely erratic data, but for commonly encountered data distributions is much less. Competing schemes are described in the references cited.

The following discussion was obtained from Tobler:

Definitions:

An observation is recorded as \( x_i, y_i, z_i; i = 1, \ldots, N \), where \( x, y \) are locational coordinates and \( z \) is a value at \( x, y \).

Lattice points are labelled \( jk \) in standard matrix notation (\( j = \) row subscript, and \( K = \) column subscript). The problem is to estimate \( z_{jk} \).

Procedure:

(1) Calculate \( A \), the area of the rectangle bounded by the maximum and minimum of the coordinate values \( x \) and \( y \).

(2) Let the grid size, \( G \), equal the square root of the area divided by the number of observations,

\[
G = \left( \frac{A}{N} \right)^{1/2}
\]

(3) The number of rows in the matrix is computed as the (truncated) integer part of

\[
R = \left( \frac{\Delta y}{G} \right) + 1.5
\]
and the number of columns as the integer part of
\[ C = \lceil \Delta X / G \rceil + 1.5 \]

This yields a matrix which has approximately \( N \) entries.

(4) In general, because of truncation,
\[ (C - 1) \cdot G \neq \Delta X \]
\[ (R - 1) \cdot G \neq \Delta Y \]

Split the difference, letting
\[ \Delta^i X = \frac{(\Delta X - (C - 1) \cdot G)}{2} \]
\[ \Delta^i Y = \frac{(\Delta Y - (R - 1) \cdot G)}{2} \]

and assign \( X \) and \( Y \) coordinates to positions in the matrix. For example the \( j^\text{th} \) row and the \( k^\text{th} \) column will have the coordinates
\[ X_k = X_\text{min} + \Delta^i X + (k - 1) \cdot G \]
\[ Y_j = Y_\text{max} - \Delta^i Y - (j - 1) \cdot G \]

(5) For each position in the matrix calculate the square of the distance to each observation using
\[ D_i^2 = (X_k - X_i)^2 + (Y_j - Y_i)^2 \]

and rank the points in order of increasing distance from the \( jk^\text{th} \) lattice point as they are computed, saving the results for only the nearest six points, except if \( D_i^2 < \epsilon \) in which case set \( Z_{jk} = Z_i \) and proceed to the next position in the matrix since the assignment has been completed. (We have taken \( \epsilon = G/25 \), but this is arbitrary).
(6) Assign a value to the $j^k$th position by using a weighted mean of the value at the nearest point with the weighted mean of the nearest six points. Symbolically, using the notation $D_i\alpha$ to denote the rank $\alpha$ of the distance from the $j^k$th position to the point $i$ and $z_{i\alpha}$ for the observed value at the nearest point, this can be written as

$$z_{jk} = \frac{\sum_{\alpha=1}^{6} \frac{z_{i\alpha}}{D_i\alpha}}{\sum_{\alpha=1}^{6} \frac{1}{D_i\alpha}}$$

References:


SUBROUTINE GRID

PURPOSE -
TO ASSIGN SCATTERED OBSERVATIONS TO A SQUARE GRID. THE PROGRAM INVOLVES A WEIGHTED MOVING AVERAGE TECHNIQUE AND LINEAR INTERPOLATION WITHIN GRID SQUARES.

PURDUE UNIVERSITY VERSION 20.0
A. KEITH TURNER,
CIVIL ENGINEERING,
FEBRUARY 1968.

USAGE — CALL GRID (N, X, Y, W)

DESCRIPTION OF PARAMETERS —
N — NUMBER OF SCATTERED OBSERVATIONS
X — X CO-ORDINATES OF SCATTERED OBSERVATIONS
Y — Y CO-ORDINATES OF SCATTERED OBSERVATIONS
W — ELEVATION (Z CO-ORDINATE) VALUES OF SCATTERED OBSERVATIONS

DESCRIPTION OF CONTROL CARDS —

1) GRID SPECIFICATION CARD —
ROWS (COLS 1-3) NUMBER OF ROWS IN GRID
COLS (COLS 4-6) NUMBER OF COLUMNS IN GRID
GSIZE (COLS 7-10) SIZE OF GRID IN X-Y INPUT DATA UNITS
BND (COL11) IF BND = 0, GRID BOUNDARIES CALCULATED FROM DATA
IF BND = 1, GRID BOUNDARIES SPECIFIED ON CARD 3
LIST (COL12): IF LIST = 1, INPUT DATA IS LISTED
IF LIST = 2, INTERPOLATED VALUES ARE LISTED
IF LIST = 3, BOTH INPUT AND INTERPOLATED VALUES ARE LISTED
IPUN (COL13): IF IPUN = 1, GRID VALUES ARE PUNCHED
NWAP (COL14-15) NWAP = NUMBER OF DIFFERENT MAPS DESIRED
IPL0T (COL16) IF IPL0T = 1, GRID CALLS SUBROUTINE PRTC0N1
IF IPL0T = 2, GRID CALLS SUBROUTINE PRTC0N2
NOTE — IF ANY ONE OF ROWS, COLS, OR GSIZE SPECIFIED, PROGRAM WILL COMPUTE THE OTHERS. IF NONE ARE SPECIFIED, PROGRAM SELECTS A GRID SIZE.

2) TITLE CARD —
ANY ALPHANUMERIC TITLE IN COLS 1-72

3) BOUNDARY SPECIFICATION CARD (OPTIONAL-REQUIRED ONLY IF BND = 1)
MAXIMUM AND MINIMUM X-Y COORDINATE VALUES (XMAX, XMIN, YMAX, YMIN) IN COLS 1-10, 11-20, 21-30, 31-40 WITH DECIMALS PUNCHED

REQUIRED SUBROUTINES —

1) SUBROUTINE STATS

2) MAPPING SUBROUTINES (IF NWAP GREATER THAN ZERO)
IF IPL0T = 1, SUBROUTINE PRTC0N1 (PRODUCES BANDS OR LINES)
IF IPL0T = 2, SUBROUTINE PRTC0N2 (PRODUCES SHADDED DENSITY MAPS)
SUBROUTINE GRID (N, X, Y, W)

DIMENSION X(1000), Y(1000), W(1000), Z(1000), D(20), M(20), FO

DIMENSION X(IOOO), Y(IOOO), W(IOOO), D(20), NK20, FO

DIMENSION T(12), A(6), B(6), C(6)

REAL MAXX, MINX, MAXY, MINY, MAXW, MINW, MAXZ, MNZ

INTEGER TAPE, YES, BND, ROWS, COLS

READ (5, 110) ROWS, COLS, GSIZE, BND, LIST, IPUN, NMAP, I PLOT

READ (5, 115) (T(I), I = 1, 12)

IF (LIST .LT. 1 OR LIST .GT. 3) GO TO 5

IF (LIST .NE. 2) WRITE (6, 120) (T(I), I = 1, 12)

5 IF (IPUN .EQ. 0) PUNCH 125 (* TITL(I) )

WRITE (6, 130) (T(I), I = 1, 12), N

IF (BNDNE .EQ. 0.) GO TO 15

WRITE (6, 140)

READ (5, 145) XMAX, XMIN, YMAX, YMIN

GO TO 20

10 IF (LIST .EQ. 1 OR LIST .EQ. 3) WRITE (6, 130) I, X(I), Y(I), W(I)

CALL STATS (N, 1, 1000, 1, X, XBAR, DUM, XSIG, MAXX, MINX)

CALL STATS (N, 1, 1000, 1, Y, YBAR, DUM, YSIG, MAXY, MINY)

CALL STATS (N, 1, 1000, 1, W, WBAR, DUM, WSIG, MAXW, MINW)

WRITE (6, 135) (T(I), I = 1, 12), N

IF (BND .NE. 1.) GO TO 15

WRITE (6, 140)

READ (5, 145) XMAX, XMIN, YMAX, YMIN

GO TO 20

15 WRITE (6, 150)

XMAX = MAXX

XMIN = MINX

YMAX = MAXY

YMIN = MINY

20 FN = MAXW - MINW

WMAX = FN + MAXW

WMIN = MINW - FN

MAXZ = MAXW

MINZ = MINW

WRITE (6, 155) NMAP, LIST, BND, TAPE

M = 0

FN = M * 0

DX = XMAX - XMIN

DY = YMAX - YMIN

AREA = DX * DY

BEST = SORT (ARE A / FN)

AVEDIS = BEST * 1.07346

WRITE (6, 160) XBAR, XSIG, MAXX, MINX, YBAR, YSIG, MAXY, MINY, WBAR, WSIG, MA

1, XW, XMINW, AREA, AVERDIS, BEST, GSIZE, ROWS, COLS

IF (GSIZE .LE. 0.) GO TO 25

COLS = (1.5 + DX / GSIZE)

ROWS = (1.5 + DY / GSIZE)

M = 1

GO TO 45

25 IF (COLS .LE. 1.) GO TO 35

30 GSIZE = DX / FLOAT (COLS - 1)
ROWS = (1.5 + DY / GSIZE)  
M = 1  
GO TO 45

C  
35 IF (ROWS .LE. 1) GO TO 4C  
GSIZE = DY / FLOAT(ROWS - 1)  
COLS = (1.5 + DX / GSIZE)  
M = 1  
GO TO 45

C  
40 GSIZE = BEST  
COLS = (1.5 + DX / GSIZE)  
ROWS = (1.5 + DY / GSIZE)  
CONTINUE  
45 IF (COLS .LE. 1) GO TO 50  
COLS = 100  
GO TO 30

C  
50 WRITE (6, 165)  
IF (M .EQ. 1) WRITE (6, 167)  
IF (M .NE. 1) WRITE (6, 175)  
WRITE (6, 180) XM, XM, YMAX, YMIN, GSIZE, ROWS, COLS  
IF (LIST .EQ. 2 .OR. LIST .EQ. 3) WRITE (6, 185) (TITL(I), I = 1, 12)  
DY = (DY - (ROWS - 1s) + GSIZE) / 2.0  
DX = (DX - (COLS - 1s) + GSIZE) / 2.0  
YMAX = YMAX - DY  
XMIN = XMIN + DX  
HGRID = GSIZE / 25.0  
FN = (WMAX - MAXW) / 2.s C  
MAXX = MAXW + FN  
MINX = MINW - FN  
DO 90 M = 1, ROWS  
YP = YMAX - (FLOAT(M - 1) * GSIZE)  
DO 90 J = 1, COLS  
XP = XMIN + (FLOAT(J - 1)) * GSIZE  
DO 55 I = 1, N  
D(I) = 1.E10  
N1(I) = 1  
N1(2) = 1  
DO 75 I = 1, N  
DIST = ((XP - X(I)) **) 2 + (YP - Y(I)) **) 2  
IF (DIST .GE. HGRID) GO TO 50  
Z(M, J) = W(I)  
GO TO 85

C  
60 YES = MINO(I, 8)  
DO 70 K = 1, YES  
IF (DIST .GE. D(K)) GO TO 70  
DO 65 JJ = K, YES  
KK = YES + K - JJ  
MN = KK + 1  
D(MN) = D(KK)  
65 N1(MN) = N1(KK)
D(K) = DIST
N1(K) = I
GO TO 75

CONTINUE
70 CONTINUE
75 CONTINUE
DUM1 = 0.0
PSUM = 0.0
DO 80 I = 1, 6
   YES = N1(I)
   MAXW = 1.0 / (SORT(D(I)))
   PSUM = PSUM + MAXW
80 DUM1 = DUM1 + W(YES) * MAXW
DUM6 = DUM1 / PSUM
N11 = N1(1)
DUM2 = W(N11)
DUM = (DUM2 + DUM6) / 2.0
IF (DUM > MAXW .AND. DUM < MINW) Z(M, J) = DUM
IF (DUM > MAXW .AND. DUM > MINW) Z(M, J) = DUM
CONTINUE
85 CONTINUE
90 CONTINUE
IF (LIST .EQ. 2) OR LIST .EQ. 3) WRITE (6, 190) Z(M, I), I = 1, COLS
IF (IPU .EQ. 1) PUNCH 195, (Z(M, I), I = 1, COLS)
95 CONTINUE
NEWTOT = ROWS * COLS
CALL STATS (ROWS, COLS, 100, 100, ZBAR, XP, ZSIG, ZMAX, ZMIN)
YMIN = YP
WRITE (6, 200) NEWTOT, XMIN, YMIN, ZMAX, ZMIN, ZBAR, ZSIG
WRITE (6, 205)
IF (NMAP .LT. 1) GC TO 1C5
DO 100 JNUM = 1, NMAP
   IF (JIPLC .EQ. 1) CALL PRTCON1(Z, ROWS, COLS, TITL)
   IF (IPLC .EQ. 2) CALL PRTCON2(Z, ROWS, COLS, TITL)
100 CONTINUE
105 CONTINUE
RETURN
C
110 FORMAT (2I3, 2F4.0, 3I12, 1I1)
115 FORMAT (12A6)
120 FORMAT (1H1, 12A6, /, 3X, 24H COORDINATE OBSERVATIONS)
125 FORMAT (6X, 12A6)
130 FORMAT (5X, 4H I =, I3, 7H X(I) =, F10.3, 7H Y(I) =, F10.3, 7H W(I) =, F10.3, 13)
135 FORMAT (1H1, 12A6, /, 3X, 15, 13H OBSERVATIONS, /)
140 FORMAT (3X, 25H BOUNDARIES PREDETERMINED)
145 FORMAT (4F10.0)
150 FORMAT (3X, 32H BOUNDARIES CALCULATED FROM DATA)
155 FORMAT (3X, 6HNMAP =, I3, 7H LIST =, I3, 6H 3ND =, I2, 7H TAPE =, I3)
155 FORMAT (3X,28H REAL BIT d10.3, OK GRID SIZE)
175 FORMAT (3X,21H CALCULATED FROM DATA)
180 FORMAT (3X,16H VALUES EMPLOYED 3X,7H X=AX = F10.3, 3X,7H Y=AY = F10.3, 3X,7H YMAX = F10.3, 3X,7H YMIN = F10.3, 3X,7H CSA = F10.3, 3X,7H RXS = F10.3, 3X,7H COLS = 14)
185 FORMAT (1H1,12A6,/,3X,9H INTERPOLATED VALUES)
190 FORMAT (1HCs(10F10.3))
195 FORMAT (8F10.3)
200 FORMAT (1HC3X,3HM = 13:6HXXMIN = F10.3, 3X,6HXXMAX = F10.3, 3X,6HYYMIN = F10.3, 3X,6HYYMAX = F10.3, 3X,6HZMIN = F10.3, 3X,6HZMAX = F10.3, 3X,6HZSIG = F10.3)
205 FORMAT (13H1 END OF DATA)
END
PURPOSE -
TO CALCULATE STATISTICAL MEASURES OF ONE OR TWO DIMENSIONAL DATA
ARRAYS. MEASURES DETERMINED ARE 1) MEAN, 2) VARIANCE, 3) STANDARD DEVIATION,
4) MAXIMUM VALUE, 5) MINIMUM VALUE.

USAGE -
CALL STATS(ROWS, COLS, II, JJ, XBAR, XR, XVAR, XSIG, XMAX, XMIN)

ROWS - NUMBER OF ROWS IN ARRAY BEING ANALYZED.
COLS - NUMBER OF COLUMNS IN ARRAY BEING ANALYZED.
II - MAXIMUM NUMBER OF ROWS ALLOWED FOR ARRAY BEING ANALYZED.
JJ - MAXIMUM NUMBER OF COLUMNS ALLOWED FOR ARRAY BEING ANALYZED.
X - DATA ARRAY BEING ANALYZED.
XBAR - MEAN OF ARRAY.
XVAR - VARIANCE OF ARRAY.
XSIG - STANDARD DEVIATION OF ARRAY.
XMAX - MAXIMUM VALUE OF ARRAY.
XMIN - MINIMUM VALUE OF ARRAY.

SUBROUTINE STATE (for COLS)
DO 1 J=1, COLS
  XR(J) = XBAR(J)
  XVAR(J) = XR(J) - XBAR(J)**2
  XSIG(J) = SQRT(XVAR(J))
  XMAX(J) = MAX(X(J,1), X(J,JJ))
  XMIN(J) = MIN(X(J,1), X(J,JJ))
1 CONTINUE
RETURN
END
PART IV

PRODUCTION OF CONTOUR MAPS ON THE PRINTER

CONTENTS OF THIS SECTION

1) Subroutine P4CON 1
2) Subroutine P4CON 2
3) Subroutine LYPSO
4) Program MAPPER
5) SAMPLE DATA
SUBROUTINES PRTCON1 AND PRTCON2 — GENERAL INSTRUCTIONS

THESE PROGRAMS ARE BASED ON A MAD LANGUAGE PROGRAM OBTAINED
FROM PROFESSOR W. R. TOBLER, DEPT. OF GEOGRAPHY, UNIVERSITY OF
MICHIGAN, ANNA BAR. BOTH SUBROUTINES PRODUCE CONTOUR MAPS OF GRIDDED
DATA ON THE PRINTER USING LINEAR INTERPOLATION WITHIN THE GRID
SQUARES. HOWEVER PRTCON1 ASSIGNS A SINGLE CHARACTER TO EACH CONTOUR
INTERVAL (ALLOWING A MAXIMUM OF 19 INTERVALS) WHILE PRTCON2 USES
THE OVERPRINT OPTION TO PRODUCED PATTERNS FOR EACH INTERVAL THAT
ARE LIGHT FOR LOW AREAS AND DARK FOR HIGH AREAS (A MAXIMUM OF 10
CONTOUR INTERVALS IS POSSIBLE). PRTCON1 HAS THREE OPTIONS — CONTOUR
LINES MAY BE PRINTED, ALTERNATE CONTOUR BANDS MAY BE PRINTED, OR ALL
PRINT POSITIONS ON THE MAP MAY BE PRINTED. PRTCON2 HAS TWO OPTIONS —
THE MAPS MAY BE PRINTED WITH OR WITHOUT WHITE BORDERS SEPARATING THE
CONTOUR INTERVALS.

BOTH SUBROUTINES CAN CONTOUR IRREGULARLY SHAPED AREAS IF THE
GRID POINTS FALLING OUTSIDE THE AREA OF INTEREST ARE GIVEN
ARBITRARILY VERY HIGH OR LOW VALUES (VALUES MUST BE ONE DATA ELEVATION RANGE BELOW LOW OR ABOVE HIGH).

THE SUBROUTINES PREPARE A FREQUENCY TABLE SHOWING THE PERCENT
MAP AREA (OR PERCENT AREA OF INTEREST FOR IRREGULAR AREAS) BY NUMERICAL INTEGRATION. THE VALUES MAY BE FURTHER ANALYZED BY SUBROUTINE
HYPSO WHICH PERFORMS HYPSOMETRIC (AREA-ALTITUDE) ANALYSIS.

SPECIAL NOTE —

THE MAXIMUM MAP WIDTH IS 12.7 INCHES. THE WIDTH OF THE PAPER. THE MAXIMUM NUMBER
OF COLUMNS OF INPUT DATA IS A FUNCTION OF THE SPECIFIED MAP WIDTH.
IF PS=(COL-COLS)/(COLS-1) (SEE DEFINITIONS BELOW) IS LESS THAN 2, FEWER
THAN 2 PRINTING POSITIONS WOULD BE ASSIGNED TO EACH COLUMN SPACE AND SO AN
UNSATISFACTORY MAP WOULD RESULT. THUS THE PROGRAM WILL NOT PLOT A MAP IF PS IS
LESS THAN 2, AND ACCORDINGLY THE MAXIMUM NUMBER OF COLUMNS FOR A MAP OF
MAXIMUM WIDTH IS 42. IF MORE COLUMNS ARE REQUIRED THE MAP MUST BE MADE IN
SECTIONS BY USING ONLY PART OF THE DATA IN EACH PASS. THE NUMBER OF COLUMNS
SHOULD BE THE SAME IN EACH PASS FOR THE MAPS TO BE AT THE SAME SCALE. TO DO
THIS IT MAY BE NECESSARY, AND IS ADVISABLE, TO REPEAT SOME COLUMNS.
SUBROUTINE PPTCON1

PURPOSE -
TO PRODUCE CONTOUR MAPS ON THE PRINTER.

USAGE -
CALL PPTCON1(Z,ROWS,COLS,TITL)
Z = ARRAY OF GRIDDED ELEVATION VALUES (MAXIMUM = 100 X 100).
ROWS = NUMBER OF ROWS IN Z ARRAY.
COLS = NUMBER OF COLUMNS IN Z ARRAY.
TITL = ALPHANUMERIC TITLE 1-72 CHARACTERS.

Purdue University Version 2.0
A. Keith Turner,
Civil Engineering,
February 1968.

CONTROL CARD ORDER -

1) MASTER CONTROL CARD -
CON (COLS 1-2) THE NUMBER OF CONTOUR INTERVALS (MAXIMUM = 19).
(T CON = DATA RANGE / DESIRED CONTOUR INTERVAL).

TOUR (COL 3) IF TOUR = 0, PROGRAM USES MAXIMUM AND MINIMUM FROM
DATA FOR UPPER AND LOWER CONTOUR LIMITS.
IF TOUR = 1, DESIRED TOP AND BOTTOM CONTOURS READ
IN FROM SPECIAL PROGRAM CARD (SEE BELOW).
IF TOUR = 2, VARIABLE CONTOURS READ IN (LOW TO
HIGH). IN THIS CASE SET CON EQUAL TO THE NUMBER
OF VALUES TO BE READ IN.
IF TOUR = 3, CONTOUR INTERVAL BECOMES 1/2 STANDARD
DEVIATION (MAX = +3 SIGMA, MIN = -3 SIGMA).

LINES (COL 4) IF LINES = 0, CONTOUR LINES ARE PRINTED.
IF LINES = 1, ALTERNATE (EVEN VALUED) CONTOUR BANDS
ARE PRINTED.
IF LINES = 2, ALL BANDS PRINTED (ALL PRINT POSNS).

INCHES (COLS 5-8) INCHES IS MAP WIDTH IN INCHES, IF GREATER THAN
12.7 OR BLANK, SET TO 10.0.
(COL = MAP WIDTH IN CHARACTERS=INCHES #10.0)

IHYPSO (COL 10) IF IHYPSO = 1, SUBROUTINE HYPSO CALLED.

2) SPECIAL CARD(S) -
REQUIRED ONLY WHEN TOUR = 1 OR 2
IF TOUR = 1, THIS CARD SPECIFIES MINIMUM AND MAXIMUM ELEVATION
VALUES: -- ZMIN (COLS 1-10) AND ZMAX (COLS 11-20).
IF TOUR = 2, THIS CARD SPECIFIES A FORMAT (INCON) TO BE USED IN
READING IN A SERIES OF IRREGULARLY SPACED CONTOUR LINES. THE
VALUES ARE ARRANGED FROM LOWEST TO HIGHEST ON SUBSEQUENT CARDS.
SUBROUTINE PRTCON1(Z,ROWS,COLS,TITL)
DIMENSION FORM(17),TITL(12),SYMTAB(21),SYM(131),Z(100,100),
1 INCON(10),DRANG(25),TABE(25),ZPREV(131),SYM(131)
DIMENSION CUMH(27)
INTEGER ROWS,COLS,CON,TOUR,COLMAX,COL,PSYM,PS,GRID,TOUT,TLOW,
1 SYM,FLANK,PLUS,MINUS,STAR,SYMTAB
INTEGER XSTOP,YSTOP
REAL MINZ,MAXZ,INCHES,INCON
DATA (SYMTAB(I))=I=1,21)/1H0,1H1,1H2,1H3,1H6,1H9,1H9,1H8,1H7,1H6,1H5,1H4,1H3,1H2,1H1,1H0,1H9,1H8,1H7,1H6,1H5,1H4,1H3,1H2,1H1,1H0,1H9,1H8,1H7,1H6,1H5,1H4,1H3,1H2,1H1,1H0,1H9,1H8,1H7,1H6,1H5,1H4,1H3,1H2,1H1,1H0,1H9,1H8,1H7,1H6,1H5,1H4,1H3,1H2,1H1,1H0,1H9,1H8,1H7,1H6,1H5,1H4,1H3,1H2,1H1,1H0,1H9,1H8,1H7,1H6,1H5,1H4,1H3,1H2,1H1,1H0,1H9,1H8,1H7,1H6,1H5,1H4,1H3,1H2,1H1,1H0,1H9,1H8,1H7,1H6,1H5,1H4,1H3,1H2,1H1,1H0,1H9,1H8,1H7,1H6,1H5,1H4,1H3,1H2,1H1,1H0,1H9,1H8,1H7,1H6,1H5,1H4,1H3,1H2,1H1,1H0,1H9,1H8,1H7,1H6,1H5,1H4,1H3,1H2,1H1,1H0,1H9,1H8,1H7,1H6,1H5,1H4,1H3,1H2,1H1,1H0,1H9,1H8,1H7,1H6,1H5,1H4,1H3,1H2,1H1,1H0,1H9,1H8,1H7,1H6,1H5,1H4,1H3,1H2,1H1,1H0,1H9,1H8,1H7,1H6,1H5,1H4,1H3,1H2,1H1,1H0,1H9,1H8,1H7,1H6,1H5,1H4,1H3,1H2,1H1,1H0,1H9,1H8,1H7,1H6,1H5,1H4,1H3,1H2,1H1,1H0,1H9,1H8,1H7,1H6,1H5,1H4,1H3,1H2,1H1,1H0
100 FORMAT(12I2I,F4.0,2X,11)
C ZERO COUNTERS AND ARRAYS USED IN FREQUENCY TABLE
C
JJ=0
MM=0
SUM=0.0
TLOW=0
TOUT=0
DO 5 I=1,25
5 TABLE(I)=0.0
N=ROWS*COLS
C
N = NUMBER OF DATA POINTS
C
WRITE(6,1030) TITL,N,ROWS,COLS
1030 FORMAT(1H1,12A6//,22H MAP IS DEVELOPED FROM,13,30H GRIDDED VALUES,13,6H ROWS,/) CALL STATS(ROWS,COLS,N,Z,100,Z3AR,XP,ZSIG,MAXZ,MINZ)
C
C DETERMINE CONTOUR LINE ELEVATIONS
C
TOUR VALUE DETERMINES METHOD USED IN DEFINING CONTOURS
C
IF (TOUR *GT* 3 .OR. TOUR *LE* 0) GO TO 60
GO TO (30,40,50) TOUR
30 WRITE (6,1060)
1060 FORMAT (25H CONTOUR LEVELS SPECIFIED)
READ (5,1070) ZMIN,ZMAX
1070 FORMAT (2F10.0)
GO TO 70
40 READ (5,1020) INCON
1020 FORMAT (1UA6)
WRITE (6,1080)
1080 FORMAT (37H VARIABLE CONTOUR INTERVALS SPECIFIED)
READ (5,1090) (DRANG(I),I=1,CON)
ZMIN=DRANG(1)
ZMAX=DRANG(CON)
GO TO 70
50 ZMIN=Z3AR-3.0*ZSIG
ZMAX=Z3AR+3.0*ZSIG
CON=13
WRITE (6,1090)
1090 FORMAT (36H CONTOUR INTERVAL = U1/2 SIGMA)
GO TO 70
60 WRITE (6,1100)
1100 FORMAT (26H CONTOUR LEVELS CALCULATED)
ZMIN=MINZ
ZMAX=MAXZ
70 WRITE(6,1110) ROWS,COLS,ZBAR,ZSIG,ZMAX,ZMIN
111- FORMAT (13H GRIDDED DATA/,42H LINEAR INTERPOLATION WITHIN GRID SQU
1ARES /,17H OBSERVED VALUES /, 8H ROWS = #13,10H COLS = #
213,/,8H ZBAR = #F10.3,10H ZSIG = #F10.3,10H MAXZ = #F10.3,10H
3 MINZ = #F10.3)
C
******Calendar of Precision (CALCULATE MAP WIDTH IN CHARACTERS (COL))
C
IF (INCHES.LE.0.0) COL=100
IF (INCHES.GT.12.7) COL=127
IF (INCHES.0.GT.0. AND .INCHES.LE.12.7) COL=INCHES*10.0
PS=(COL-COLS)/(COLS-1)
C
******Calendar of Precision (TEST GRID SIZE—IF GRID SMALLER THAN 2 CHARACTERS BETWEEN COLUMNS, AN ERROR STATEMENT IS PRINTED AND PLOT ABORTED)
C
IF (PS.GT.1) GO TO 80
WRITE (6,1120)
1120 FORMAT (25H TOO MANY COLUMNS IN GRID)
GO TO 999
C
C
CALCULATE REQUIRED CONSTANTS
C
80 COLMAX=PS*(COLS-1)+COLS
YINC=1./((FLOAT(P)+1))*0.6
GRID=PS+1
XINC=1./FLOAT(GRID)
RANGZ=ZMAX-ZMIN
RHIGH=ZMAX+RANGZ
RLOW=ZMIN-RANGZ
IF (CON.EQ.0. OR CON.GT.19) CON=5
FCON=CON
CI=RANGZ/FCON
IF (TOUR.EQ.2) GO TO 100
JJJ=CON+1
DO 90 I=1,JJJ
90 DRANG(I)=ZMIN+FLOAT(I-1)*CI
CONTINUE
WRITE (6,1130)
1130 FORMAT (1H 16H VALUES EMPLOYED)
WRITE (6,1140) ZMIN,ZMAX,CI,GRID,XINC,YINC,CON,PS,COLMAX
1140 FORMAT (8H ZMIN = #F10.3,10H ZMAX = #F10.3,PH CI = #F10.3,8H
GRID = #15,10H XINC = #F10.3,10H YINC = #F10.3,7H CON = 15,
2 BH PS = #15,12H COLMAX = #15)
**WRITE OUT CONTOUR SYMBOL TABLE**

WRITE (6,1150)
1150 FORMAT (35HCONTOUR SYMBOL TABLE IS AS FOLLOWS)
IF (LINES.LE.1) WRITE (6,1160)
1160 FORMAT (43HONLY EVEN SYMBOLS PRINTED IN BODY OF MAP)
WRITE (6,1170)
1170 FORMAT (7H0SYMBOL, 11X, 5HVALUE)
IF (LINES.NE.0) GO TO 110
WRITE (6,1180)
1180 FORMAT (5HO6X, 7HNO DATA, 5H-6X, 10HBELOW LOW)
WRITE (6,1190) (SYMTAB(I),DRANG(I),I=1,CON)
1190 FORMAT (4X,A1,2X,F12.4)
WRITE (6,1200)
1200 FORMAT ('4X,1H+, 4X, 10HABOVE HIGH')
GO TO 120
120 WRITE (6,1210)
1210 FORMAT (5HO, 6X, 7HNO DATA, 5H-25X, 10HBELOW LOW)
WRITE (6,1220) (SYMTAB(I),DRANG(I),DRANG(I+1),I=1,CON)
1220 FORMAT (4X,A1,2X,F12.4,6H TO, F12.4)
WRITE (6,1230) DRANG(CON+1)
1230 FORMAT (4X,1H+, 2X, F12.4, 10H OR OVER?)
120 WRITE (6,1240) TITLE, N, COLS, ROWS
XSTOP = GRID
GRID = COLS - 1
COL = 3
DO 140 J=1,GRID
DO 130 I = 2*XSTOP
SYM(COL) = BLANK
130 COL = COL + 1
SYM(COL) = PLUS
140 COL = COL + 1
N = COL MAX + 2
SYM(2) = PLUS
SYM(1) = BLANK
SYM(N) = BLANK
WRITE (6,1240) (SYM(I), I=1,N)
1240 FORMAT (1H9, 129A1)

**ESTIMATE VALUE OF ALL PRINTING POSITIONS ON MAP**

**LOOP THROUGH MAP LENGTH, ROW BY ROW**

ITOP = 1
IROW = ROWS + 1
DO 340 MM = 2*IROW
YSTOP = 1/YINC + .5
IF (MM.EQ.IROW) YSTOP = 1
M = MM - 1
145  YP=0.0
PSYM(1) = PLUS
PSYM(N) = PLUS
DO 340 KJ=1,YSTOP
150  COL=1
   Z1 = YP*(Z(MM,1)-Z(M,1))+Z(M,1)
   C
   LOOP THROUGH MAP WIDTH,COLUMN BY COLUMN
   C
190  II=COLS-1
   JLFT=2
   DO 330 J=1,II
   JJ=J+1
   Z2=YP*(Z(MM,JJ)-Z(M,JJ))+Z(M,JJ)
   ZDELT=Z2-Z1
   XP=0.0
   DO 480 KK = 1,XSTOP
   JLFT=JLFT-1.
195  COL=COL+1
   ZEST=XP*ZDELT+Z1
200  IF( ZEST .GE. ZMIN .AND. ZEST .LE. ZMAX) GO TO 325
   IF( ZEST .GT. ZMAX) GO TO 203
   IF( ZEST .LE. RLOW) GO TO 206
   IF( ITOP .EQ. 1 .OR. MM .EQ. IROW .OR. JLFT .EQ. 1) GO TO 201
   PSYM(COL) = BLANK
   GO TO 202
201  PSYM(COL) = MINUS
202  TLOW=TLOW+1
   ZPREV(COL)=ZEST
   ZLAST=ZEST
   GO TO 124
203  IF( ZEST .GE. RHIGH) GO TO 206
   IF( ITOP .EQ. 1 .OR. MM .EQ. IROW .OR. JLFT .EQ. 1) GO TO 204
   PSYM(COL) = BLANK
   GO TO 205
204  PSYM(COL) = PLUS
205  TABE(CON+1)=TABE(CON+1)+1.0
   ZPREV(COL)=ZEST
   ZLAST=ZEST
   GO TO 124
206  IF( ITOP .EQ. 1 .OR. MM .EQ. IROW .OR. JLFT .EQ. 1) GO TO 207
   PSYM(COL) = BLANK
   GO TO 208
207  PSYM(COL) = STAR
208  TOUT=TOUT+1
   ZPREV(COL)=ZEST
   ZLAST=ZEST
   GO TO 480
325  I=((ZEST-ZMIN)/CI)+1.
   TABE(I)=TABE(I)+1.0
   LVAL=LINES+1
IF(ITOP.EQ.1 OR ITMM.EQ.1 OR JLT.EQ.1)LVAL=3
GO TO (326,327,328) LVAL
326 DO 309 I=1,CON
ZSTEP=DRANG(I)
SW1=1.
SW2=1.
SW3=1.
SW4=1.

IF (ZSTEP.EQ.ZLAST OR ZSTEP.EQ.ZPREV(COL)) SW1=0.
IF (ZSTEP.LE.ZEST) SW2=0.
IF (ZSTEP.LT.ZLAST OR ZSTEP.LT.ZPREV(COL)) SW3=0.
IF (ZSTEP.GE.ZEST) SW4=0.
IF((SW1.EQ.0 AND SW2.EQ.0 AND SW3.EQ.0 AND SW4.EQ.0)) GO TO 310
CONTINUE
309 PSYM(COL)=BLANK
GO TO 320
310 PSYM(COL)=SYMTAB(I)
320 ZLAST=ZEST
ZPREV(COL)=ZEST
GO TO 124
327 K=I/2
IF((K*2).NE.I) PSYM(COL)=SYMTAB(I)
IF((K*2).EQ.I) PSYM(COL)=BLANK
GO TO 124
328 PSYM(COL)=SYMTAB(I)
ZPREV(COL)=ZEST
124 SUM=SUM+1.0
480 XP=XP+XINC
Z1=Z2
330 JLT=0
COL=COL+1
IF(Z(M,3)LE.ZMIN AND Z(M,3)LE.ZMAX) GO TO 333
IF(Z(M,3)GT.ZMAX) GO TO 335
IF(Z(M,3)LE.RLOW) GO TO 336
PSYM(COL)=MINUS
TLOW=TLOW+1.
GO TO 334
335 IF(Z(M,3)GE.RHIGH) GO TO 336
PSYM(COL)=PLUS
TAKE(CON+1)=TAKE(CON+1)+1.0
GO TO 334
336 PSYM(COL)=STAR
TOUT=TOUT+1
GO TO 332
333 I=((Z(M,3)-ZMIN)/C1)+1.
TAKE(I)=TAKE(I)+1.0
PSYM(COL)=SYMTAB(I)
334 SUM=SUM+1.0
332 WRITE (6,1240) (PSYM(L),L=1,N)
YP=YP+YINC
PSYM(1)=BLANK
PSYM(N)=BLANK
340 ITOP=0
WRITE (6,1240) (SYM(L),L=1,N)
C ################################################################################
C CALCULATE AND PRINT FREQUENCY TABLE
C ################################################################################
WRITE (6,1250) TOUT
1250 FORMAT (16H1FREQUENCY TABLE,12X,8HINTERVAL,16X,5HUNITS,6X,10HPERCENTAGE,4X,10HCUMULATIVE,16X,7HNO DATA,11X,13)
PTAB=(FLOAT(TLOW)/SUM)*100.0
CTAB=0
WRITE (6,1260) TLOW,PTAB,CTAB
1260 FORMAT (16H1FREQUENCY TABLE,12X,8HINTERVAL,16X,5HUNITS,6X,10HPERCENTAGE,4X,10HCUMULATIVE,16X,7HNO DATA,11X,13)
DO 350 I=1,CON
VALUE=DRANG(I)
VAL1=DRANG(I+1)
VAL2=DRANG(I+1)
PTAB=(TABEL(I)/SUM)*100.0
CTAB=CTAB+PTAB
350 WRITE (6,1270) VALUE,VAL1,TABEL(I),PTAB,CTAB
1270 FORMAT (14X,9HBELOW,11X,18,2(3X,F12.4))
I=CON+1
PTAB=(TABEL(I)/SUM)*100.0
CTAB=CTAB+PTAB
WRITE (6,1280) VALUE,TABEL(I),PTAB,CTAB,SUM,CTAB,CTAB
1280 FORMAT (11X,18,2(3X,F12.4))
C IF IHYPSO = 1 , PERFORM HYPSOMETRIC ANALYSIS
C IHYPSO = 1
IF (IHYSO) 450,999,450
450 CALL HYPSO(DRANG, ZMAX, ZMIN, CON, SUMH, TITL)
999 CONTINUE
RETURN
END
SUBROUTINE PRTCON2

PURPOSE -
TO PRODUCE GRADED DENSITY CONTOUR MAPS ON THE PRINTER

USAGE -
CALL PRTCON2(Z,ROWS,COLS,TITL)
Z - ARRAY OF GRIDDED ELEVATION VALUES (MAXIMUM = 100 X 100)
ROWS - NUMBER OF ROWS IN Z ARRAY
COLS - NUMBER OF COLUMNS IN Z ARRAY
TITL - ALPHANUMERIC TITLE 1-72 CHARACTERS

Purdue University Version 1.0
A. Keith Turner
Civil Engineering
February 1968

CONTROL CARD ORDER -

1) MASTER CONTROL CARD -
   CON (COLS 1-2) THE NUMBER OF CONTOUR INTERVALS (MAXIMUM=10)
   (CON = DATA RANGE / DESIRED CONTOUR INTERVAL)
   TOUR (COL 3) IF TOUR=0, PROGRAM USES MAXIMUM AND MINIMUM FROM
   DATA FOR UPPER AND LOWER CONTOUR LIMITS
   IF TOUR=1, DESIRED TOP AND BOTTOM CONTOURS READ
   IN FROM SPECIAL PROGRAM CARD (SEE BELOW)
   IF TOUR=2, VARIABLE CONTOURS READ IN (LOW TO
   HIGH). IN THIS CASE SET CON equal to the number
   OF VALUES TO BE READ IN
   LINES (COL 4) IF LINES=0, BLANK BORDERS ARE PLACED BETWEEN
   CONTOUR INTERVALS.
   IF LINES=1, BLANK BORDERS NOT DEVELOPED.
   INCHES (COLS 5-8) INCHES IS MAP WIDTH IN INCHES. IF GREATER THAN
   12.0, SET TO 10.0
   IF HYPSO=1, SUBROUTINE HYPSO CALLED.

2) SPECIAL CARD(S) -
   REQUIRED ONLY WHEN TOUR = 1 OR 2
   IF TOUR=1, THIS CARD SPECIFIES MINIMUM AND MAXIMUM ELEVATION
   VALUES - ZMIN (COLS 1-10) AND ZMAX (COLS 11-20)
   IF TOUR=2, THIS CARD SPECIFIES A FORMAT (INCON) TO BE USED IN
   READING IN A SERIES OF IRREGULARLY SPACED CONTOUR LINES. THE
   VALUES ARE ARRANGED FROM LOWEST TO HIGHEST ON SUBSEQUENT CARDS.
SUBROUTINE (PRTC0N2(Z,ROWS, COLS, TITL)  
DIMENSION FORM(10), TITL(12), Z(100, 100), DRANG(25), SYM(131)  
DIMENSION ZPREV(131), CON, TABE(25), CUMH(27)  
INTEGER ROWS, COLS, CON, COLMAX, COL, PSYM, PS, GRID, SYM, BLANK, PLUS,  
SYM, XTSTOP, YSTOP  
INTEGER TOUR, STAR  
INTEGER MINUS, DOT, OWF, EYE, LPAR, RPAR, SLASH, EGGS, EQUAL  
REAL INCHES, MINZ, MAXZ, INCON  
DATA BLANK/1H /, PLUS/1H+/, MINUS/1H-/, DOT/1H. /, OWF/1HO/, EYE/1HI/  
1 EGGS/1HX/, EQUAL/1H=/, SLASH/1H//, LPAR/1H(, RPAR/1HV/*STAR/1H*/  
SYMTAB(1, 1) = DOT  
SYMTAB(1, 2) = BLANK  
SYMTAB(2, 1) = LPAR  
SYMTAB(2, 2) = BLANK  
SYMTAB(3, 1) = OWE  
SYMTAB(3, 2) = OWE  
SYMTAB(4, 1) = EGGS  
SYMTAB(4, 2) = EGGS  
SYMTAB(5, 1) = LPAR  
SYMTAB(5, 2) = RPAR  
SYMTAB(6, 1) = OWE  
SYMTAB(6, 2) = MINUS  
SYMTAB(7, 1) = EYE  
SYMTAB(7, 2) = EQUAL  
SYMTAB(8, 1) = EGGS  
SYMTAB(8, 2) = MINUS  
SYMTAB(9, 1) = OWE  
SYMTAB(9, 2) = SLASH  
SYMTAB(10, 1) = OWE  
SYMTAB(10, 2) = STAR  
READ (5, 1000) CON, TOUR, LINES, INCHES, IHYPSEO  
1000 FORMAT (12, 2I1, F4.0, 2X, 1)  
C******************************************************************  
C ZERO COUNTERS AND ARRAYS USED IN FREQUENCY TABLE  
C******************************************************************  
JJ = 0  
MM = 0  
SUM = 0  
LOW = 0  
TOUT = 0  
DO 5 1 = 1, 25  
5  
TABE(I) = 0.0  
N = ROWS*COLS  
C******************************************************************  
C N = NUMBER OF DATA POINTS  
C******************************************************************  
WRITE(6, 1030) TITL, N, COLS, ROWS  
1030 FORMAT (1HI, 12A6/) , 22H MAP IS DEVELOPED FROM, 15, 30H GRIDDED VALUES  
1, CONSISTING OF, 13, 12H COLUMNS BY, 13, 6H ROWS, /)  
CALL STATS(ROWS, COLS, 1.0, 100, Z, ZBAR, XP, ZSIG, MAXZ, MINZ)
**DETERMINE CONTOUR LINE ELEVATIONS**

**TOUR VALUE DETERMINES METHOD USED IN DEFINING CONTOURS**

IF (TOUR.GT.2.0 OR TOUR.LE.0) GO TO 60
GO TO (30*40)*TOUR

WRITE (6,1060)
1060 FORMAT (25H CONTOUR LEVELS SPECIFIED)
READ (5,1070) ZMIN,ZMAX

WRITE (6,1020)
1020 FORMAT (1A6)
READ (5,1020) INCON

WRITE (6,1080)
1080 FORMAT (37H VARIABLE CONTOUR INTERVALS SPECIFIED)
READ (5,1090) (INCON(I), I=1,INCON)
ZMIN=DRANG(INCON(I))
ZMAX=DRANG(INCON(CON))
GO TO 70

WRITE (6,1100)
1100 FORMAT (26H CONTOUR LEVELS CALCULATED)
ZMIN=MINZ
ZMAX=MAXZ

WRITE(6,1110) ROWS,COL,PS,ZBAR,ZSIG,MAXZ,MINZ
1110 FORMAT (13H GRIDDED DATA/,42H LINEAR INTERPOLATION WITHIN GRID soc)
1ARES / 17H OBSERVED VALUES / 8H ROWS = 13,10H COLS = ,
213, / 8H ZBAR = ,F10*3,1OH ZSIG = ,F10*3,1OH MAXZ = ,F10*3,1OH
3 MINZ = ,F10*3

CALCULATE MAP WIDTH IN CHARACTERS (COL)

IF (INCHES.LE.0.0) COL=100
IF (INCHES.GT.12.7) COL=127
IF (INCHES.GT.0.0 AND INCHES.LE.12.7) COL=INCHES/10.0
PS=(COL-COLS)/(COLS-1)

TEST GRID SIZE—IF GRID SMALLER THAN 2 CHARACTERS BETWEEN COLUMNS,
AN ERROR STATEMENT IS PRINTED AND PLOT ABORTED

IF (PS.GT.1) GO TO 80
WRITE (6,1120)
1120 FORMAT (25H TOO MANY COLUMNS IN GRID)
GO TO 999

CALCULATE REQUIRED CONSTANTS

40 COLMAX=PS*(COLS-1)+COLS
YINC=1.0/((FLOAT(P S+1))**0.6)
GRID=PS+1
XINC=1.0/FLOAT(GRID)
RANGZ=ZMAX-ZMIN
RHIGH=ZMAX+RANGZ
RLOW=ZMIN-RANGZ
IF (CON.EQ.0.OR.CON.GT.10) CON=5
FCON=CON
CI=RANGZ/FCON
IF (TOUR.EQ.2) GO TO 100
JJJ=CON+1
DO 90 I=1,JJJ
90 DRANG(I)=ZMIN+FLOAT(I-1)*CI
100 CONTINUE
WRITE (6,1130)
1130 FORMAT (1H /,16H VALUES EMPLOYED)
WRITE (6,1140) ZMIN,ZMAX,CI,GRID,XINC,YINC,CON,PS,COLMAX
1140 FORMAT (8H ZMIN = ,F10.3,10H ZMAX = ,F10.3,8H CI = ,F10.3/8H 1GRID = ,I5,10H XINC = ,F10.3,10H YINC = ,F10.3,7H CON = I5,
2 8H PS = ,I5,12H COLMAX = ,I5)
C ****************************
C WRITE OUT CONTOUR SYMBOL TABLE
C ****************************
WRITE (6,1150)
1150 FORMAT (35H CONTOUR SYMBOL TABLE IS AS FOLLOWS)
WRITE (6,1170)
1170 FORMAT (7H SYMBOL,11X,5H VALUE)
110 WRITE (6,1210)
1210 FORMAT (SHO,25X,7HNO DATA,/,5H =,23X,10HE BELOW LOW)
DO 450 I=1,CON
WRITE (6,1221) SYMTAB(I,2)
450 CONTINUE
WRITE (6,1220) SYMTAB(I,1),DRANG(I),DRANG(I+1)
1220 FORMAT (IH ,4X,A1,2X,F12.4,6H TO ,F12.4)
450 CONTINUE
WRITE (6,1230) DRANG(CON+1)
1230 FORMAT (4X,1H+,2X,F12.4,10H OR OVER)
120 WRITE (6,1030) TITL,N,COLS,ROWS
XSTOP = GRID
GRID=COLS-1
COL=3
DO 140 J=1,GRID
DO 13 I = 2,XSTOP
SYM(J)="BLANK"
130 COL=COL+1
SYM(COL)="PLUS"
140 COL=COL+1
N=COLMAX+2
SYM(2)="PLUS"
SYM(1)="BLANK"
SYM(N)="BLANK"
WRITE (6,1240) (SYM(I),I=1,N)
1240 FORMAT (IH9,129A1)
ESTIMATE VALUE OF ALL PRINTING POSITIONS ON MAP

LOOP THROUGH MAP LENGTH, ROW BY ROW

ITOP=1
IROW = ROWS + 1
DO 340 MM = 2: IROW
YSTOP = 1: YINC + .5
IF {MM EQ IROW) YSTOP=1
M=MM-1

YP=0.0
PSYM(1,1)=PLUS
PSYM(1,2)=BLANK
PSYM(M,1)=PLUS
PSYM(N+2)=BLANK
DO 340 K = I, YSTOP

COL=1
Z1 = YP*(Z(M+1)-Z(M,1)+Z(M,1))

LOOP THROUGH MAP WIDTH, COLUMN BY COLUMN

II=COl-S-1
JLFT=I
DO 33 J=1,II
JJ=J+1
Z2=YP*(Z(M,JJ)-Z(M,JJ)+Z(M,JJ))
ZDELT=Z2-Z1
XP=0.0
DO 480 KK = I, XSTOP
JLFT=JLFT-1

COL=COL+1

ZEST=XP*ZDELT-Z1
IF (ZEST GE ZMIN AND ZEST LE ZMAX) GO TO 32E
IF (ZEST GT ZMAX) GO TO 203
IF (ZEST LT ZMIN) GO TO 203
IF (ITOP EQ 1 OR MM EQ IROW OR JLFT EQ 1) GO TO 201
PSYM(COL+1)=BLANK
GO TO 202

PSYM(COL+2)=MINUS
202 PSYM(COL+2)=BLANK
TLOW=TLOW+1
ZPREV(COL)=ZEST
ZLAST=ZEST
GO TO 124

IF (ZEST GE ZHIGH) GO TO 205
IF (ITOP.EQ.1 .OR. MM.EQ.1 .OR. ROW.EQ.1 .OR. JLFT.EQ.1) GO TO 204
PSYM(COL,1)=BLANK
GO TO 205
204 PSYM(COL,1)=PLUS
205 PSYM(COL,2)=BLANK
TABE(CON+1)=TABE(CON+1)+1.0
ZPREV(COL)=ZEST
ZLAST=ZEST
GO TO 124
206 IF (ITOP.EQ.1 .OR. MM.EQ.1 .OR. ROW.EQ.1 .OR. JLFT.EQ.1) GO TO 207
PSYM(COL,1)=BLANK
GO TO 208
207 PSYM(COL,1)=STAR
208 PSYM(COL,2)=BLANK
TOUT=TOUT+1
ZPREV(COL)=ZEST
ZLAST=ZEST
GO TO 480
325 CONTINUE
LVAL=LINES+1
IF (ITOP.EQ.1 .OR. MM.EQ.1 .OR. ROW.EQ.1 .OR. JLFT.EQ.1) LVAL=2
GO TO (326,327), LVAL
326 DO 309 I=1,CON
ZSTEP=DRANG(I)
SW1=1.
SW2=1.
SW3=1.
SW4=1.
IF (ZSTEP.GE.ZLAST .OR. ZSTEP.GE.ZPREV(COL)) SW1=0.
IF (ZSTEP.LE.ZEST) SW2=0.
IF (ZSTEP.LT.ZLAST .OR. ZSTEP.LT.ZPREV(COL)) SW3=0.
IF (ZSTEP.GE.ZEST) SW4=0.
IF ((SW1.EQ.0 .AND. SW2.EQ.0 .AND. SW3.EQ.0 .AND. SW4.EQ.0)) GO TO 310
309 CONTINUE
327 I=((ZEST-ZMIN)/CI)+1.
PSYM(COL,1)=SYMTAB(I,1)
PSYM(COL,2)=SYMTAB(I,2)
TABE(I)=TABE(I)+1.0
GO TO 920
310 PSYM(COL,1)=BLANK
PSYM(COL,2)=BLANK
TABE(I)=TABE(I)+1.0
320 ZLAST=ZEST
ZPREV(COL)=ZEST
124 XSUM=XSUM+1.0
480 XP=XP+XINC
Z1=Z2
330 JLFT=1
COL = COL + 1
IF(Z(M,2OLS).GE.ZMIN .AND. Z(M,2OLS).LE.ZMAX) GO TO 333
IF(Z(M,2OLS).GT.ZMAX) GO TO 335
IF(Z(M,2OLS).LE.ZLOW) GO TO 336
PSYM(COL,1)=MINUS
PSYM(COL,2)=BLANK
TLOW=TLOW+1
GO TO 332
IF(2(M, COLS) GE RHIGH) GO TO 336
PSYM(COL, 1) = PLUS
PSYM(COL, 2) = BLANK
TABE(CON + 1) = TABE(CON + 1) + 1.0
GO TO 332
PSYM(COL, 1) = STAR
PSYM(COL, 2) = BLANK
TOUT = TOUT + 1
GO TO 334
I = (2(M, COLS) - ZMIN)/CI + 1.
PSYM(COL, 1) = SYMTAB(I, 1)
PSYM(COL, 2) = SYMTAB(I, 2)
SUM = SUM + 1.0
WRITE(6, 1241) (PSYM(L, 2), L=1, N)
1241 FORMAT(1H+, 12HAI)
WRITE(6, 1240) (PSYM(L, 1), L=1, N)
YP = YP + YINC
PSYM(1, 1) = BLANK
PSYM(1, 2) = BLANK
PSYM(N, 1) = BLANK
PSYM(N, 2) = BLANK
332
333
334
333
WRITE(6, 1241) (PSYM(L, 2), L=1, N)
1241 FORMAT(1H+, 12HAI)
WRITE(6, 1240) (PSYM(L, 1), L=1, N)
YP = YP + YINC
PSYM(1, 1) = BLANK
PSYM(1, 2) = BLANK
PSYM(N, 1) = BLANK
PSYM(N, 2) = BLANK
332
333
334
C
C CALCULATE AND PRINT FREQUENCY TABLE
C
WRITE (6, 1250) TOUT
1250 FORMAT (16H1FREQUENCY TABLE, /, 12X, 8HINTERVAL, 16X, 5HUNIT'S, 6X, 10HP
ERECTION, 4X, 10HCUMULATIVE, /, 16X, 7HNO DATA, 11X, I8)
PTAB = (FLOAT(TLOW)/SUM)*100.0
CTAB = PTAB
WRITE (6, 1260) TLOW, PTAB, CTAB
1260 FORMAT (14X, 9HBELOW LOW, 11X, I8, 2(3X, F12.4))
DO 35 J = 1, CON
VALUE = DRANG(J)
VAL1 = DRANG(J + 1)
VAL2 = DRANG(J + 1)
PTAB = (TABE(J)/SUM)*100.0
CTAB = CTAB + PTAB
350
WRITE (6, 1277) VALUE, VAL1, TABF(J), PTAB, CTAB
1277 FORMAT (1X, F12.4, 6H TO, F12.4, 3X, F8.0, 2(3X, F12.4))
I = CON + 1
PTAB = (TABF(J)/SUM)*100.0
CTAB = CTAB + PTAB
WRITE (6, 1280) VAL1, TABF(J), PTAB, CTAB, SUM, CTAB, CTAB
1280 FORMAT (1X, F12.4, 4H OR OVER, 911X, F8.0, 2(3X, F12.4), /, 18X, 5HTOTAL
L, 11X, F8.0, 2(3X, F12.4))
C
C IF IHYPISO = 1, PERFORM HYPSONEMETRIC ANALYSIS
C
IF (IHYPISO) 450, 999, 45C
450 CALL HYPISO( DRANG, ZMAX, ZMIN, CON, CUMH, TITL)
999 CONTINUE
RETURN
END
SUBROUTINE HYPSO

PURPOSE = TO PERFORM HYPSOMETRIC (AREA-ALTITUDE) ANALYSIS.

REFERENCE:
PAGES 1117-1142.

USAGE -
CALL HYPSO(DRANG, ZMAX, ZMIN, CON, CUMH, TITL)
DRANG - ARRAY CONTAINING CONTOUR LEVELS
ZMAX - MAXIMUM ELEVATION VALUE
ZMIN - MINIMUM ELEVATION VALUE
CON - NUMBER OF CONTOUR INTERVALS
CUMH - ARRAY CONTAINING CUMULATIVE PCT AREAS BELOW EACH CONTOUR
TITL - ALPHANUMERIC TITLE (1-72 CHARACTERS)

SUBROUTINE HYPSO(DRANG, ZMAX, ZMIN, CON, CUMH, TITL)
DIMENSION IROW(49, 81), RELH(25), RELA(25)
DIMENSION TITL(12), CUMH(27), DRANG(27)
DATA DOT, BLANK, STAR/1H, 1H, 1H*/
REAL IROW
INTEGER CON

INTEGER CON

MAKE PLOT ALL BLANKS, DRAW BORDERS WITH DOTS, AND PLOT A STAR AT TOP LEFT AN BOTTOM RIGHT CORNERS

DO 2 M=1, 49
DO 2 N=1, 81
2 IROW(M, N)=BLANK
IROW(1, 1)=STAR
DO 3 N=2, 81
3 IROW(1, N)=DOT
IROW(49, 81)=STAR
DO 4 N=1, 80
4 IROW(49, N)=DOT
DO 5 M=2, 48
5 IROW(M, 1)=DOT
IROW(M, 81)=DOT

DETERMINE POSITIONS OF STARS WITHIN THE PLOT

K=CON+1
DO 20 I=1, K

20 CONTINUE
```

RELH(I) = (DRANGE(I) - ZMIN) / (ZMAX - ZMIN)
RELAD(I) = 1 - (CUMH(I) - CUMH(1)) / (CUMH(1) - CUMH(I))
M = (49 * RELH(I) * 49.0) / (ZMAX - ZMIN) + 0.5
N = RELAD(I) * 81.0 / (ZMAX - ZMIN) + 0.5

DO 20 IROW(M, N) = STAR
C
C PRINT OUT ALL THE PLOT SEQUENTIALLY
C
WRITE (6, 1000) TITL
1000 FORMAT (1H1, 22H: HYPSOMETRIC CURVE FOR 12A6)
WRITE (6, 1001)
1001 FORMAT (1H8, REL, HT, /)
WRITE (6, 1002)
1002 FORMAT (1H8X, 3H0, 037X: H0, 5, 37X: 3H1, 0)
WRITE (6, 1003)
1003 FORMAT (1H8X, 9X, 1H+, 39X, 1H-, 39X, 1H+)
WRITE (6, 1004) (IROW(I, N), I = 1, 81)
1004 FORMAT (1H8X, 9X, 4X, 5H1, +, 3H1, 5H+ 1, 0)
DO 100 M = 2, 24
100 WRITE (6, 1005) (IROW(M, N), I = 1, 81)
1005 FORMAT (1H8X, 9X, 9X, 81A1)
WRITE (6, 1006) (IROW(25, N), N = 1, 81)
1006 FORMAT (1H8X, 4X, 5H0, 5+, 81A5, 5H+ 0, 5)
DO 101 M = 26, 48
101 WRITE (6, 1007) (IROW(M, N), I = 1, 81)
WRITE (6, 1008)
1008 FORMAT (1H8X, 13H: RELATIVE AREA /)
C
C CALCULATE AREA BELOW THE CURVE USING DECIMAL VALUES OF POINTS FOR
C THE REST OBTAINABLE ACCURACY.
C
AREA = 0.0
DO 200 I = 1, CON
A = ((RELH(I) + RELH(I + 1)) * (RELAD(I) - RELAD(I + 1))) / 2.0
200 AREA = AREA + A
WRITE (6, 1010) AREA
1010 FORMAT (1H7, 7H: THE HYPSOMETRIC INTEGRAL FOR THE ABOVE CURVE ( THE
ARE A BELOW THE CURVE ) IS 0.0)
C
C WRITE OUT COORDINATES OF HYPSOMETRIC CURVE
C
WRITE (6, 2001)
2001 FORMAT (1H8, 50H: CALCULATED VALUES OF HYPSOMETRIC CURVE COORDINATES,
1/5X: 12H POINT NUMBER, 5X: 0FA - AXIS, 10X: 6HH - AXIS )
DO 21 I = 1, CON
21 WRITE (6, 2000) (RELAD(I), RELH(I))
2000 FORMAT (1H8, 10X, 12, 10X, 08, 4, 10X, 5, 4)
RETURN
END
```
PROGRAM MAPPER

PURPOSE -
A SIMPLE PROGRAM TO READ IN GRIDDED DATA FOR CONTOURING.

CONTROL CARD ORDER -

1) SPECIFICATION CARD -
   ROWS(COLS1-3) NUMBER OF ROWS IN GRID. (MAX=100)
   COLS(COLS4-6) NUMBER OF COLS IN GRID. (MAX=100)
   LIST(COL 7) IF LIST=1, LIST INPUT DATA
   NMAP(COLS8-9) NUMBER OF MAPS REQUESTED FOR THIS DATA SET.

2) TITLE CARD -
   ANY ALPHANUMERIC TITLE IN COLUMNS 1-72.

3) FORMAT CARD -
   SPECIFIES FORMAT OF INPUT DATA (COLS 1-60)

4) DATA CARDS

    PROGRAM MAPPER(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)
    DIMENSION FORM(10),TITL(12),Z(100,100)
    INTEGER ROWS,COLS
    1 READ (5,1000) ROWS,COLS,LIST,NMAP
    1000 FORMAT (2I3,I12)
    IF (EOF,5) 999,Z
    2 IF (NMAP.LT.1) NMAP=1
    READ (5,1010) TITL
    1010 FORMAT (12A6)
    READ (5,1020) FORM
    1020 FORMAT (10A6)
    DO 7 1=1,ROWS
    7 READ (5,FORM) (Z(I,J),J=1,100)
    IF (LIST.EQ.1) GO TO 20
    WRITE (6,1030) TITL
    1030 FORMAT (1H1,12A6,/) WRITE(6,1025)
    1025 FORMAT(1H0,25X,22HLISTING OF INPUT DATA.
    DO 10 I=1,ROWS
    10 WRITE (6,1040) (Z(I,J),J=1,100)
    1040 FORMAT(1H0,10F10.3,/1X,10F10.3)
    20 DO 25 I=1,NMAP
    25 CALL PRTC0N1(Z,ROWS,COLS,TITL)
    GO TO 1
    999 STOP
    END
SAMPLE DATA FOR PROGRAM MAPPER, SUBROUTINE PRCON1.

DRAINAGE BASIN: VERDUGO HILLS, CALIFORNIA.

(16F4.0)

99999999999999999999999999999999999999991715170017751800999999999999999999999999

999999999999999999999999999999999999999915751575150152515751621638171217509999

99999999999999999999999999999999999999991531550152315014881475152515251620168017001712

999999999999999999999999999999999999999914901483146014514251440145015501625160016301675

99999999999999991475142514501423140137513801500157515601555155516189999

9999999999999999144140013851375137013251400151214801475153299999999

999999999999999913913751325132013123125141214251412141821512129999999

999999999999999913801340130012751255132513251325136014401475999999999999

9999999999999999140134512801255122012251265132513901450999999999999999999999999

9999999999999999136013001250120011851250132513801425999999999999999999999999

99999999999999991332127512121751208129013801395999999999999999999999999

9999999999999999132311551166125013259999999999999999999999999999999999999999999999999

999999999999999913126011701125120612751325999999999999999999999999999999999999999999

999999999999999912511251125120126299999999999999999999999999999999999999999999999

999999999999999911751120110011759999999999999999999999999999999999999999999999999999

999999999999999999999910809999999999999999999999999999999999999999999999999999999999

161010.0

1080

161110.0

1080

161210.0

1080
CONTOUR MAP OF DRAINAGE BASIN IN VERDUGO HILLS, STRAHLER FIG 15.

320 OBSERVATIONS

CONTOUR LEVELS SPECIFIED
GRIDDED DATA
LINEAR INTERPOLATION WITHIN GRID SQUARES
OBSERVED VALUES

ROWS = 20  COLS = 16
ZBAR = 6145.009  ZSIG = 4262.532  MAXZ = 9999.000  MINZ = 1080.000

VALUES EMPLOYED
ZMIN = 1080.000  ZMAX = 1880.000  CI = 50.000
GRID = a  XINC = 0.167  YINC = 0.278
CON = 16  PS = 5  COLMAX = 91
CONTOUR SYMBOL TABLE IS AS FOLLOWS
(ONLY EVEN SYMBOLS PRINTED IN BODY OF MAP)

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1080.0000 TO 1130.0000</td>
</tr>
<tr>
<td>1</td>
<td>1130.0000 TO 1180.0000</td>
</tr>
<tr>
<td>2</td>
<td>1180.0000 TO 1230.0000</td>
</tr>
<tr>
<td>3</td>
<td>1230.0000 TO 1280.0000</td>
</tr>
<tr>
<td>4</td>
<td>1280.0000 TO 1330.0000</td>
</tr>
<tr>
<td>5</td>
<td>1330.0000 TO 1380.0000</td>
</tr>
<tr>
<td>6</td>
<td>1380.0000 TO 1430.0000</td>
</tr>
<tr>
<td>7</td>
<td>1430.0000 TO 1480.0000</td>
</tr>
<tr>
<td>8</td>
<td>1480.0000 TO 1530.0000</td>
</tr>
<tr>
<td>9</td>
<td>1530.0000 TO 1580.0000</td>
</tr>
<tr>
<td>A</td>
<td>1580.0000 TO 1630.0000</td>
</tr>
<tr>
<td>B</td>
<td>1630.0000 TO 1680.0000</td>
</tr>
<tr>
<td>C</td>
<td>1680.0000 TO 1730.0000</td>
</tr>
<tr>
<td>D</td>
<td>1730.0000 TO 1780.0000</td>
</tr>
<tr>
<td>E</td>
<td>1780.0000 TO 1830.0000</td>
</tr>
<tr>
<td>F</td>
<td>1830.0000 TO 1880.0000</td>
</tr>
<tr>
<td>*</td>
<td>1880.0000 OR OVER</td>
</tr>
</tbody>
</table>

FREQUENCY TABLE

<table>
<thead>
<tr>
<th>INTERVAL</th>
<th>NO DATA</th>
<th>UNITS</th>
<th>PERCENTAGE</th>
<th>CUMULATIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1080.0000 TO 1130.0000</td>
<td>39.</td>
<td>1.7751</td>
<td>1.7751</td>
<td></td>
</tr>
<tr>
<td>1130.0000 TO 1180.0000</td>
<td>98.</td>
<td>4.4606</td>
<td>6.2358</td>
<td></td>
</tr>
<tr>
<td>1180.0000 TO 1230.0000</td>
<td>171.</td>
<td>7.7833</td>
<td>14.0191</td>
<td></td>
</tr>
<tr>
<td>1230.0000 TO 1280.0000</td>
<td>184.</td>
<td>8.3751</td>
<td>22.3942</td>
<td></td>
</tr>
<tr>
<td>1280.0000 TO 1330.0000</td>
<td>223.</td>
<td>10.1502</td>
<td>32.5444</td>
<td></td>
</tr>
<tr>
<td>1330.0000 TO 1380.0000</td>
<td>230.</td>
<td>10.4688</td>
<td>43.0132</td>
<td></td>
</tr>
<tr>
<td>1380.0000 TO 1430.0000</td>
<td>230.</td>
<td>10.4688</td>
<td>53.4820</td>
<td></td>
</tr>
<tr>
<td>1430.0000 TO 1480.0000</td>
<td>213.</td>
<td>9.6950</td>
<td>63.1771</td>
<td></td>
</tr>
<tr>
<td>1480.0000 TO 1530.0000</td>
<td>182.</td>
<td>8.2840</td>
<td>71.4611</td>
<td></td>
</tr>
<tr>
<td>1530.0000 TO 1580.0000</td>
<td>146.</td>
<td>6.6454</td>
<td>78.1065</td>
<td></td>
</tr>
<tr>
<td>1580.0000 TO 1630.0000</td>
<td>136.</td>
<td>6.1903</td>
<td>84.2968</td>
<td></td>
</tr>
<tr>
<td>1630.0000 TO 1680.0000</td>
<td>88.</td>
<td>4.0055</td>
<td>88.3022</td>
<td></td>
</tr>
<tr>
<td>1680.0000 TO 1730.0000</td>
<td>84.</td>
<td>3.8234</td>
<td>92.1256</td>
<td></td>
</tr>
<tr>
<td>1730.0000 TO 1780.0000</td>
<td>67.</td>
<td>3.0496</td>
<td>95.1752</td>
<td></td>
</tr>
<tr>
<td>1780.0000 TO 1830.0000</td>
<td>34.</td>
<td>1.5476</td>
<td>96.7228</td>
<td></td>
</tr>
<tr>
<td>1830.0000 TO 1880.0000</td>
<td>17.</td>
<td>0.7738</td>
<td>97.4966</td>
<td></td>
</tr>
<tr>
<td>1880.0000 OR OVER</td>
<td>55.</td>
<td>2.5034</td>
<td>100.0000</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>2197.</td>
<td>100.0000</td>
<td>100.0000</td>
<td></td>
</tr>
</tbody>
</table>
PROGRAM CONTUR - GENERAL INSTRUCTIONS

PURPOSE -
TO PLOT CONTOUR MAPS OF GRIDDED DATA ON THE CALCOMP PLOTTERT.
THIS PROGRAM IS BASED ON A FORTRAN II PROGRAM WRITTEN BY FRANK J.
RENS, UNIVERSITY OF MICHIGAN DEPARTMENT OF GEOGRAPHY.

PURDUE UNIVERSITY VERSION 1.2
PROGRAMMED BY -- SANDRA L. TURNER, A. KEITH TURNER,
COMPUTER SCIENCE, CIVIL ENGINEERING,
FEBRUARY 1968.

THIS PROGRAM CAN PRODUCE MAPS TO ANY SCALE WITHIN THE LIMITS
OF THE PLOTTER PAPER WIDTH (MAXIMUM = 28 INCHES).

MANY OPTIONS ARE AVAILABLE AND CAN BE SPECIFIED THROUGH THE USE
OF CONTROL CARDS. THE USER MAY SPECIFY CONTOURS AT REGULAR OR IRREG-
ULAR INTERVALS, AND MAY TRANSFORM MAP COORDINATES BY TRANSLATION OR
ROTATION ABOUT ANY OF THE THREE MAJOR AXES (X, Y, OR Z).

THE PROGRAM CAN PRODUCE ISOMETRIC BLOCK DIAGRAMS OF THE CONTOUR
MAPS BY ROTATING THE DATA ABOUT ALL THREE AXES BEFORE PLOTTING. THE
USF OF A PERSPECTIVE OPTION IN COMBINATION WITH TRANSLATION WILL
ALLOW THE PLOTTING OF LEFT AND RIGHT VIEWS FOR STEREOSCOPIC (3-D)
EFFECTS.

THE PROGRAM IS CAPABLE OF PLOTTING A NUMBER OF DIFFERENT MAPS
OF A SINGLE SET OF DATA, EACH INVOLVING DIFFERENT MAP SCALES, CONTOUR
INTERVALS, ROTATIONS OR TRANSLATIONS, WITHOUT REREADING THE DATA.
VALUES OF CONTOUR LINE COORDINATES ARE CALCULATED AND STORED ON A
SCRATCH TAPE. THESE VALUES ARE MODIFIED AND PLOTTED FOR EACH MAP
REQUESTED SO THAT THE CALCULATIONS ARE MINIMIZED AND THE PLOTTING
OF MULTIPLE MAPS IS EFFICIENT.

TAPE REQUIREMENTS -
1) A SCRATCH TAPE (TAPE 3) IS USED TO STORE CONTOUR COORDINATES
PRIOR TO PLOTTING.
2) A PLOT TAPE IS REQUIRED.
SINCE TWO TAPES ARE USED, REASSIGNMENT OF TAPE UNITS IS REQUIRED
THIS IS ACCOMPLISHED BY A MAP ROUTINE INCLUDED IN THE LISTING.

ROUTINES REQUIRED -
A) MAIN PROGRAM (CONTUR) PERFORMS OPERATIONS ACCORDING TO CONTROL
CARD SPECIFICATIONS.
B) SUBROUTINES -
1) SCAN - SCANS DATA TO LOCATE CONTOURS.
2) TRACE - TRACES OUT CONTOUR LINE.
3) CALC - PERFORMS INTERPOLATION.
4) DRAFT - PERFORMS ROTATIONS AND TRANSLATIONS, WRITES PLOT TAPE.
5) PROJ - DUMMY SUBROUTINE TO ALLOW ADDITION OF USER-DEVELOPED
MODIFICATIONS.
DESCRIPTION OF CONTROL CARDS AND THEIR OPERATIONS -

Each control card contains a control integer (NCON) in columns 1-2. Some operations require input data in the form of variables and/or data on additional cards. Any variables required should be placed in columns 3-12, 13-22, 23-32, 33-42, etc. with decimal points punched. When the control integer indicates that additional cards are necessary for a complete operation, these cards should follow immediately.

<table>
<thead>
<tr>
<th>NCON</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>OPERATION - READ AND CONTOUR DATA MATRIX</td>
</tr>
<tr>
<td></td>
<td>VARIABLES - 1) NUMBER OF ROWS</td>
</tr>
<tr>
<td></td>
<td>2) NUMBER OF COLUMNS</td>
</tr>
<tr>
<td></td>
<td>3) WIDTH OF MAP IN INCHES</td>
</tr>
<tr>
<td></td>
<td>4) SCALE FACTOR FOR Z VALUES (Z=Z/ZSCALE) (IF BLANK=1)</td>
</tr>
<tr>
<td></td>
<td>ADDL CARDS - THE DATA MATRIX IS READ IN ROW BY ROW FROM TOP TO BOTTOM (EACH ROW IS SCANNED FROM LEFT TO RIGHT). THE MATRIX IS READ ACCORDING TO A PREVIOUSLY DEFINED FORMAT (SEE NCON=19). MAXIMUM SIZE IS 100X100.</td>
</tr>
<tr>
<td>02</td>
<td>OPERATION - ROTATE THE VIEWING POSITION OF THE SURFACE THETA DEGREES IN THE X DIRECTION.</td>
</tr>
<tr>
<td></td>
<td>VARIABLES - 1) THETA IN DEGREES.</td>
</tr>
<tr>
<td></td>
<td>ADDL CARDS - NONE</td>
</tr>
<tr>
<td>03</td>
<td>OPERATION - ROTATE THE VIEWING POSITION OF THE SURFACE THETA DEGREES IN THE Y DIRECTION.</td>
</tr>
<tr>
<td></td>
<td>VARIABLES - 1) THETA IN DEGREES.</td>
</tr>
<tr>
<td></td>
<td>ADDL CARDS - NONE</td>
</tr>
<tr>
<td>04</td>
<td>OPERATION - ROTATE THE VIEWING POSITION OF THE SURFACE THETA DEGREES IN THE Z DIRECTION.</td>
</tr>
<tr>
<td></td>
<td>VARIABLES - 1) THETA IN DEGREES.</td>
</tr>
<tr>
<td></td>
<td>ADDL CARDS - NONE</td>
</tr>
<tr>
<td>05</td>
<td>OPERATION - CALL SUBROUTINE PROJ FOR USER-DEFINED MODIFICATIONS.</td>
</tr>
<tr>
<td></td>
<td>VARIABLES - NONE</td>
</tr>
<tr>
<td></td>
<td>ADDL CARDS - NONE</td>
</tr>
<tr>
<td>06</td>
<td>OPERATION - PLOT USERS NAME AND ACCOUNT NUMBER ON PLOT.</td>
</tr>
<tr>
<td></td>
<td>VARIABLES - NONE</td>
</tr>
<tr>
<td></td>
<td>ADDL CARDS - NAME AND ACCOUNT NUMBER</td>
</tr>
<tr>
<td>08</td>
<td>OPERATION - PLOT CONTOURS WITH PERSPECTIVE TRANSFORMATION TO PRODUCE LEFT OR RIGHT STERO MODELS.</td>
</tr>
<tr>
<td></td>
<td>VARIABLES - 1) DISTANCE TO PERSPECTIVE PLANE.</td>
</tr>
<tr>
<td></td>
<td>2) DISTANCE TO OBJECT PLANE.</td>
</tr>
<tr>
<td></td>
<td>ADDL CARDS - NONE</td>
</tr>
<tr>
<td>10</td>
<td>OPERATION - TRANSLATION OF CONTOUR COORDINATES.</td>
</tr>
<tr>
<td></td>
<td>VARIABLES - 1) TRANSLATION OF X IN INCHES (NOT SCALED, TRUE MEASURE)</td>
</tr>
<tr>
<td></td>
<td>2) TRANSLATION OF Y IN INCHES (NOT SCALED, TRUE MEASURE)</td>
</tr>
<tr>
<td></td>
<td>3) TRANSLATION OF Z IN INCHES (NOT SCALED, TRUE MEASURE)</td>
</tr>
<tr>
<td></td>
<td>ADDL CARDS - NONE</td>
</tr>
</tbody>
</table>
11 OPERATION- DEFINE PLOTTER TAPE AS OTHER THAN NORMAL NUMBER.
  VARIABLES- PLOTTER TAPE NUMBER
  ADDL CARDS- NONE

12 OPERATION- READ TITLE FOR PLOT (PLOTTED AT TOP OF MAP).
  VARIABLES- NONE
  ADDL CARDS- TITLE PUNCHED IN COLUMNS 1-48

13 OPERATION- TERMINATE PLOT TAPE
  VARIABLES- NONE
  ADDL CARDS- NONE

14 OPERATION- READ LABELS AND COORDINATES (MAX. PER PLOT = 10).
  VARIABLES- X, Y, Z, HEIGHT OF LABEL LETTERS
  ADDL CARDS- A LABEL PUNCHED IN COLUMNS 1-36

15 OPERATION- DEFINE REGULARLY SPACED CONTOURS.
  VARIABLES- STARTING CONTOUR, CONTOUR INTERVAL, FINAL (HIGHEST) CONTOUR
  ADDL CARDS- NONE

16 OPERATION- REDEFINE CONTOUR INTERVALS FOR SAME DATA.
  VARIABLES- SAME AS FOR NCON=15

17 OPERATION- DEFINE IRREGULARLY SPACED CONTOURS.
  VARIABLES- NUMBER OF CONTOURS
  ADDL CARDS- FORMAT OF CONTOURS

18 OPERATION- SPECIFY WIDTH OF PAPER (11 OR 28 INCHES)
  VARIABLES- WIDTH OF PAPER
  ADDL CARDS- NONE

19 OPERATION- SPECIFY FORMAT OF DATA
  VARIABLES- NONE
  ADDL CARDS- FORMAT OF DATA MATRIX IN COLUMNS 1-72

20 OPERATION- PLOT MAP ACCORDING TO ALL CONTROLS GIVEN SINCE LAST CALL TO PLOT (LAST NCON=20)
  VARIABLES- NONE
  ADDL CARDS- NONE

21 OPERATION- CHANGE WIDTH OF PLOTTED MAP (CHANGE SCALE)
  VARIABLES- NEW WIDTH IN INCHES
  ADDL CARDS- NONE

COMMENTS AND RESTRICTIONS
PRIOR TO READING IN DATA MATRIX, THE FORMAT (NCON=19) AND CONTOUR INTERVALS (NCON=15 OR 17) MUST BE DEFINED.
BEFORE CALL TO PLOT (NCON=20) PAPER WIDTH (NCON=18) AND ACCOUNT CODE (NCON=06) MUST BE DEFINED.
PLOTTING THE MAP RESETS ALL CONTROLS TO PLOT A NEW SET OF DATA USE NCON=1 WITH OR WITHOUT A NEW FORMAT OR CONTOURING CONTROLS.
DIMENSION AM(100,100),REC(800),X(1500),Y(1500),IPT(3,3),INX(8),
1 IY(8),IOP(20),XL(10),YL(10),ZL(10),LAB(10,6),DX(2),DY(2),DZ(2),
2 HT(15),CTHETA(4),STHETA(4),TEMP(6),FMT(12),Z(1500),TIT(8),
3 CFMT(12),VCON(20),WORK(1024)

DIMENSION USER(8)

COMMON MT,NT,N,I,X,Y,IDX,ITY,ISP,IV,NP,NJ,T,PY,REC,CV,X,Y,IPT,
1 INX,INY,DL,A,IOP,DP,D0,ILAB,XL,YL,ZL,LAB,DX,SY,DZ,XMAX,HT,SCALE,
2 YMAX,CTHETA,STHETA,FM2,FNN,NN,CL,D,NLINES,NCURV,Z,TIT,WORK

COMMON MAXX,MAXY,MINX,MINY

REAL MAXX,MAXY,MINX,MINY

NPLION=1

IOP(1)=0

NLINFS=0

ISTAP=5

D=0.

9999 ILAB=0

REWIND 3

DO 9981 I=2,20

9981 IOP(I)=0

NBOUND=0

1000 READ (5,1U0) NCON,(TEMP(I),I=1,6)

100 FORMAT (I2,6F10.0)

WRITE (6,1001) NCON,(TEMP(I),I=1,6)

1001 FORMAT (3X,15,6F10.3)

IF(NCON.LE.0 .OR. NCON.GT.21) GO TO 30

GO TO (1,2,2,2,5,6,30,8,8,10,11,12,13,14,15,16,17,18,19,20,21)

1 NCON

C

C NCON=1

1

M=TEMP(1)

NN=TEMP(2)

TEMP(1)=TEMP(2)-1.

SCALE=TEMP(1)/TEMP(3)

IF (TEMP(4).EQ.0.0) TEMP(4)=1.

ZSCALE=TEMP(4)

FM2=FLOAT(M)/2.

FNN=FLOAT(NN)/2.

YMAX=(FM2/SCALE)+2.5

XMAX=(FNN/SCALE)+2.5

MAXX=0.

MAXY=0.

MINX=1.E15

MINY=1.E15
IF (IOP(1) .EQ. 0) GO TO 5027
IOP(15)=1
IOP(19)=1

5027 IOP(1)=1
IF (IOP(19) .EQ. 0) GO TO 902
DO 2026 I=1,M

2026 READ (ISTAP,FMT) (AM(J,I),J=1,NN)
WRITE (6,FMT) ((AM(J,I),J=1,NN),I=1,M)
IF (IOP(15) .EQ. 0) GO TO 903
IF (IOPV .EQ. 0) GO TO 2065

C
C VARIABLE CONTOURS
2027 DO 2069 I=1,NVCON
   CL=VCON(I)
   CV=CL
   CALL SCAN
2069 CONTINUE
GO TO 200

C
C REGULAR CONTOURS
2065 CV=CBGN
   NLINES=0
2066 CL=CV
   CALL SCAN
   CV=CV+CINC
   IF (CV .LE. CEND) GO TO 2066
200 END FILE 3
2068 REWIND 3
   GO TO 1000

C
C NCON=2,3,4
C DEFINE THETA FOR ROTATION
2 IOP(NCON)=1
   NBOUND=1
   THETA=-TEMP(1)/57.295795
   STHETA(NCON)=SIN(THETA)
   CTHETA(NCON)=COS(THETA)
   GO TO 1000

C
C NCON=5
5 IOP(NCON)=1
   GO TO 1000
C
C NCON=6
6   IOP(NCON)=1
    READ (5,6000) (USER(I),I=1,8)
    6000 FORMAT (8A6)
    GO TO 1000
C
C NCON=8,9
C DEFINE PERSPECTIVE CONSTANTS
8   IOP(NCON)=1
    IF (NCON-8) 7083,7084,7083
7084 NBOUND=1
7083 CONTINUE
   DP=TEMP(1)
   DO=TEMP(2)
   GO TO 1000
C
C NCON=10
C DEFINE TRANSLATION
10   DX(1)=TEMP(1)
    DY(1)=TEMP(2)
    DZ(1)=TEMP(3)
    IOP(NCON)=1
    GO TO 1000
C
C NCON=11
11   ISTAP=TEMP(1)
    GO TO 1000
C
C NCON=12
12   IOP(12)=1
    READ (5,556) (TIT(I),I=1,8)
    WRITE (6,1008) (TIT(I),I=1,8)
    556 FORMAT (8A6)
    GO TO 1000
    1008 FORMAT (1H0,12A6)
C
C NCON=13
C END PLOT TAPE
13   CALL PLOT (0,0,999)
    STOP
C
C NCON=14
C READ LABELS AND THEIR CORRESPONDING COORDINATES
14    IOP(14)=1
      ILAB=ILAB+1
      XL(ILAB)=TEMP(1)
      YL(ILAB)=TEMP(2)
      IF (ZSCALE) 92,96,92
96    ZL(ILAB)=TEMP(3)
      GO TO 94
94    ZL(J)=TEMP(3)/ZSCALE
      IT(ILAB)=TEMP(4)
      READ (5*)IOU2 (LAB(I,ILAB),I=1,6)
102   FORMAT (6A6)
      GO TO 1000
C
C NCON=15
C DEFINE CONTOUR INCREMENTS
15    CBGN=TEMP(1)
      CINC=TEMP(2)
      CEND=TEMP(3)
      IOP(15)=1
      IOPV=0
      GO TO 1000
C
C NCON=16
16    CBGN=TEMP(1)
      CINC=TEMP(2)
      CEND=TEMP(3)
      IOPV=0
     REWIND 3
      GO TO 2065
C
C NCON=17
17    NVCON=TEMP(""
      IOP(15)=1
      IOPV=1
      READ (5*,15) (TFMT(I),I=1,12)
      READ (5*,FMT) (VCON(I),I=1,NVCON)
      GO TO 1000
C
C NCON=18
18    IOP("J")=1
      SIZ'=TEMP(1)
      GO TO 1000
C NCON=19
C READ FORMAT FOR MATRIX
19 READ (5,105) (FMT(I),I=1,12)
105 FORMAT (12A6)
   IOP(19)=1
   GO TO 105
C
C NCON=20
C BEGIN PLOTTING
20 IF (IOP(2).EQ.1) GO TO 953
   IF (IOP(6).EQ.0) GO TO 6001
   CALL PLOTS (WORK(1),1024,0)
   CALL SYMBOL(0,0,2,USER,90,68)
   CALL PLOT(1,0,-3)
   IOP(20)=1
953 IF (IOP(8).EQ.0) IOP(9)=1
   IF (IOP(18).EQ.0) GO TO 954
   XCEN=(MAXX+MINX)/2.
   YCEN=(MAXY+MINY)/2.
   YCEN1=YCEN
   XCIN1=XCEN
   IF (IOP(17).EQ.0) GO TO 955
   CBGN=VCON(1)
   CEND=VCON(NVCON)
955 IF (IOP(2).EQ.0) GO TO 956
   YCEN1=CTHETA(2)*YCEN-CBGN*STHETA(2)/ZSCALE
   YCEN=CTHETA(2)*YCEN-CEND*STHETA(2)/ZSCALE
956 IF (IOP(3).EQ.3) GO TO 957
   XCEN1=CTHETA(3)*XCEN+CBGN*STHETA(3)/ZSCALE
   XCEN=CTHETA(3)*XCEN+CEND*STHETA(3)/ZSCALE
957 IF (IOP(3).EQ.0) GO TO 958
   XCEN1=CTHETA(4)*XCEN-STHETA(4)*YCEN1
   XCEN=CTHETA(4)*XCEN-STHETA(4)*YCEN
958 XCEN=(XCEN1+XCEN)/2.
   XCFN=XCEN/SCALE+XMAX
   XMAX=XMAX-XCEN+SIZE/2.
954 IF (IOP(1).EQ.0) GO TO 904
C
C CALL DRAFT TO PLOT
   CBGN=-53139.E15
   NCURV=0
   NCOUNT=U
   NCMAX=0
   IF (NLINES) 23,23,25
25 READ(3) N,CV
   IF (CBGN.EQ.-53139.E15) CBGN=CV/SCALE-0.5
   READ (3) (X(I),Y(I),I=1,N)
   NCURV=NCURV+1
   NCOUNT=NCOUNT+N
IF (N-NCMAX) 7337,7338,7338
7338 NCMAX=N
CLMAX=CV
7337 CV=CV/ZSCALE
CALL DRAFT
IF (NCURV-NLINES) 25,22,22
23 CRGN=0.
22 N=5
CV=CBGN
X(1)=FNN
X(2)=-X(1)+1.
X(3)=X(2)
X(4)=X(1)
X(5)=X(1)
Y(1)=FM2
Y(2)=Y(1)
Y(3)=-Y(2)+1.
Y(4)=Y(3)
Y(5)=Y(1)
CALL DRAFT
XNEW=YMAX*2.
28 CALL PLOT(XNEW,0.,-3)
GO TO 1000
C C NCON=21
C CHANGE SCALE
21 SCALE =FLOAT(M)-1.)/TEMP(1)
GO TO 1000
6001 WRITE (6,6002)
6002 FORMAT (41H0****PLOT USER IDENTIFICATION NOT DEFINED)
GO TO 920
902 WRITE (6,402)
402 FORMAT (32H0****FORMAT NOT DEFINED FOR DATA)
GO TO 920
903 WRITE (6,403)
403 FORMAT (31H0****CONTOUR LEVELS NOT DEFINED)
GO TO 920
904 WRITE (6,404)
404 FORMAT (12H0****NO DATA)
GO TO 920
30 WRITE (6,531) NCON
531 FORMAT (27H0****NCON NOT LEGAL, NCON =,I5)
920 WRITE (6,6003)
6003 FORMAT (20H0****PLOT TERMINATED)
STOP
END
$IBFTC SCANS DECK
SUBROUTINE SCAN

DIMENSION AM(100,100), REC(800), X(100), Y(100), Z(1500), IPT(3,3), INX(8),
1 INY(8), IOP(20), XL(10), YL(10), LAB(10), DX(2), DY(2), DZ(2),
2 HT(10), CTHETA(4), STHETA(4), Z(1500), TIT(8), WORK(1024)
COMMON MT, NT, NI, IX, IY, IDY, IDY, ISS, IT, IV, NP, JT, NP, SY, REC, CV, X, Y, IPT,
1 INX, INY, DL, AN, IOP, DP, DO, LAB, XL, YL, LAB, DY, DYN, 7 YMAX, HT, SCALE,
2 YMAX, CTHETA, STHETA, FM2, FNN, NN, CL, DL, NLINES, NCURV, Z, TIT, WORK
IZX=1
NP=0
DL=D
MT=NN
MT=NN
IF (IZX) 3,3,1
1 IPT(1,1)=8
IPT(1,2)=1
IPT(1,3)=2
IPT(2,1)=7
IPT(2,3)=3
IPT(3,1)=6
IPT(3,2)=5
IPT(3,3)=4
INX(1)=-1
INX(2)=-1
INX(3)=U
INX(4)=1
INX(5)=1
INX(6)=1
INX(7)=U
INX(8)=-1
INY(1)=U
INY(2)=1
INY(3)=1
INY(4)=1
INY(5)=U
INY(6)=-1
INY(7)=-1
INY(8)=-1
IZX=C
3 XT=MT
DO 58 J=1,800
58 REC(J)=U
ISS=0
MT1=MT-1
DO 110 I=1,MT1
IF (AM(I,1)-CV) 55,110,11
55 IF (AM(I+1,1)-CV) 110,57,57
57 IX=I+1
IY=1
IDX=-1
IDY=0
CALL TRACE

CONTINUE
NT1=NT-1
DO 20 I=1,NT1
IF (AM(MT,I)-CV) 15,20,20
15 IF (AM(MT,I+1)-CV) 20,17,17
17 IX=MT
IY=I+1
IDX=0
IDY=-1
CALL TRACE
20 CONTINUE
22 DO 30 I=1,MT1
MT2=MT+1-I
IF (AM(MT2,NT)-CV) 25,30,30
25 IF (AM(MT2+1,NT)-CV) 30,27,27
27 IX=MT2-1
IY=NT
IDX=1
IDY=0
CALL TRACE
30 CONTINUE
DO 40 I=1,NT1
NT2=NT+1-I
IF (AM(I,NT2)-CV) 35,40,40
35 IF (AM(I,NT2-1)-CV) 40,37,37
37 IX=1
IY=NT2-1
IDX=0
IDY=1
CALL TRACE
40 CONTINUE
ISS=1
NT1=NT-1
MT1=MT-1
DO 10 J=2,NT1
DO 10 I=1,MT1
IF (AM(I,J)-CV) 5,10,10
5 IF (AM(I+1,J)-CV) 10,7,7
7 COM=100*U(I+1)+J
IF (NP) 12,11,12
12 DO 9 IN=1,NP
IF (REC(IDJ-COM) 9,10,9
9 CONTINUE
11 IX=I+1
IY=J
IDX=-1
IDY=0
CALL TRACE
10 CONTINUE
RETURN
END
SUBROUTINE TRACE

DIMENSION AM(100, 100), REC(100), X(1500), Y(1500), IPT(3, 3), INX(8)
1 INY(8), IOP(20), XL(10), YL(10), ZL(10), LAB(10, 6), DX(2), DY(2), DZ(2)
2 HT(I0), CTHETA(4), STHETA(4), Z(1500), TIT(8), WORK(1024)

COMMON MT, NT, NI, IX, IY, IDX, IDY, ISS, IT, IV, NP, N, JT, PY, REC, CV, X, Y, IPT
1 INX, INY, DL, AM, IOP, DP, DO, ILAB, XL, YL, ZL, LAB, DX, DY, DZ, XMAX, HT, SCALE
2 YMAX, CTHETA, STHETA, FM2, FNN, NN, M, CL, DLINES, NCURV, Z, TIT, WORK

COMMON MAXX, MAXY, MINX, MINY, SIZE
REAL MAXX, MAXY, MINX, MINY
PY=0.0

501 JT=0
N=0
IX0=IX
IY0=IY
IX=IDX+2
IY=IDY+2
IS=IPT(IX, IY)
JTB=0
ISO=IS
IF(ISO-8) 18, 18, 17
17 ISO=ISO-8
18 JT=0

5 CALL CALC
N2=N
N=NZ
IF (IT+JT-1) 49, 49, 47

47 XS=X(N-1)
YS=Y(N-1)
X(N-1)=X(N)
Y(N-1)=Y(N)
X(N)=XS
Y(N)=YS
49 IS=IS+1
JT=IT
9 IF (IS-9) 8, 7, 7
7 IS=IS-8
8 IDX=INX(IS)
IDY=INY(IS)
IX2=IX+IDX
IY2=IY+IDY
JTB=JTB+1
IF (JTB-1500) 51, 51, 308

308 WRITE (6, 103) CV

103 FORMAT (21HO A CONTOUR AT LEVEL JF6, 2) WAS TERMINATED.)
RETURN
51 IF (ISS) 10, 10, 20
20 IF (IX-IX0) 12, 21, 12
21 IF (IY-IY0) 12, 22, 12
22 IF (IS-ISO) 12, 23, 12
23 CALL CALC
GO TO 73
10 IF(IX2) 13, 50, 13
13 IF (IX2-MT) 19, 19, 50
19 IF(IY2) 11, 50, 11
11 IF (IY2-NT) 12, 12, 50
12 IF ((CV-AM(IX2, IY2)) 206, 206, 5
206 IF (IDX**2+IDY**2-1) 213, 213, 213
213 DCP=(AM(IX, IY)+AM(IX2, IY)+AM(IX, IY2)+AM(IX2, IY2))/4*0
217 IF (INX(IS-1)) 214, 215, 214
214 IX=IX+IDX
IDX=-IDX
PY=2.0
CALL CALC
IX=IX+IDX
GO TO 6
215 IY=IY+IDY
IDY=-IDY
PY=2.0
CALL CALC
IY=IY+IDY
6 IF (AM(IX-1, IY)-CV) 306, 16, 16
306 NP=NP+1
REC(NP)=100*IX+IY
16 IS=IS+5
IX=IX2
IY=IY2
GO TO 9
50 XT=MT
IF (AM(IX-1, IY)-CV) 307, 73, 73
307 NP=NP+1
REC(NP)=100*IX+IY
73 NLINES=NLINES+1
DO 135 K=1, N
X(K)=X(K)-FNN
Y(K)=Y(K)-FM2
135 CONTINUE
C
C STORE CURVE ON TAPE 3 (A4)
IF (N) 2072, 2072, 2071
2071 WRITE (3) N, CL
071 WRITE (3) (X(I), Y(I), I=1, N)
WRITE (6, 104) CV
104 FORMAT (16HOCONTOR LEVEL =, F6.2)
WRITE (6, 105) (X(I), Y(I), I=1, N)
105 FORMAT (2X, 6F10.3)
IF (IOP(18) .GT. 0) GO TO 2072
DO 72 I=1, N
IF (X(I) .GT. MAXX) MAXX=X(I)
72 IF (Y(I) .LT. MINY) MINY=Y(I)
72 IF (Y(I) .LT. MINY) MINY=Y(I)
2072 N=-1
RETURN
END
SUBROUTINE CALC
DIMENSION AM(100,100), REC(80U), X(1500), Y(1500), IPT(3,3), INX(8),
1 INY(8), IOP(20), XL(10), YL(10), ZL(10), LAB(10,6), DX(2), DY(2), DZ(2),
2 HT(IU), CTHETA(4), STHETA(4), Z(1500), TIT(8), WORK(1024)
COMMON MT, NT, NI, IX, IY, IDX, IDY, ISS, IT, IV, NP, NT, PY, REC, CV, X, Y, IPT,
1 INX, INY, DL, AM, IOP, DP, DO, ILAB, XL, YL, ZL, LAB, DX, DY, DZ, XMAX, HT, SCALE,
2 YM, INX, IY, DL, AM, IOP, DP, DO, ILAB, XL, YL, ZL, LAB, DX, DY, DZ, XMAX, HT, SCALE,
IT=0
N=N+1
IF (IDX**2+IDY**2<1) 20,1,20
1 IF (IDX) 10,2,10
2 X(N)=IX
Z=IY
IY2=IY+IDY
DY=IDY
41 Y(N)=((AM(IX, IY)-CV)/(AM(IX, IY)-AM(IX, IY2)))*DY+Z
RETURN
10 Y(N)=IY
W=IX
DX=IDX
IX2=IX+IDX
44 X(N)=((AM(IX, IY)-CV)/(AM(IX, IY)-AM(IX2, IY)))*DX+W
RETURN
20 IX2=IX+IDX
IY2=IY+IDY
W=IX
Z=IY
DX=IDX
DY=IDY
DCP=(AM(IX, IY)+AM(IX2, IY)+AM(IX, IY2)+AM(IX2, IY2))/40
IF (PY=2.0) 24,21,24
24 IF (DCP-<CV) 21,24
21 AL=AM(IX, IY)-DCP
22 V=0.5*(AL+DCP-CV)/AL
23 X(N)=V*DX+W
Y(N)=V*DY+Z
PY=O.0
RETURN
25 IT=1
AL=AM(TX2, TY)-DCP
33 V=0.5*(AL+DCP-CV)/AL
28 X(N)=-V*DX+W+DX
Y(N)=-V*DY+Z+DY
RETURN
END
SUBROUTINE DRAFT

DIMENSION AM(100,100),REC(800),X(1500),Y(1500),IPT(3,3),INX(8),
1 INY(8),IOP(20),XL(10),YL(10),ZL(10),LAB(1C,6),DX(2),DY(2),DZ(2),
2 HT(10),CTHETA(4),STHETA(4),Z(1500),TIT(8),WORK(1024)

COMMON HT,NT,NI,IX,IY,IDX,ITY,ISS,IT,IV,NP,N,JT,PY,REC,CX,XY,Y, IPT,
1 INX,INY,DL,AM,IOP,DP,D0,ILAB,XL,YL,ZL,LAB,DX,DY,DZ,XMAX,HT,SCALE,
2 YMAX,CTHETA,STHETA,FM2,FNN,NM,CL,DLINES,NCURV,Z,TIT,WORK

COMMON MAXX,MAXY,MINX,MINY,SIZE

COMMON ZSCALE

REAL MAXX,MAXY,MINX,MINY

303 KTYPE=3

DO 80 I=2,14
IF (IOP(I)) 80,80,81
81 GO TO (101,101,102,103,80,80,8,8,1,8,80,80,80,14),I
C
C ROTATION ABOUT X

101 D1=1.
D2=0.
D3=0.
D4=0.
D5=CTHETA(2)
D8=STHETA(2)
D7=0.
D6=-D8
D9=D5
GO TO 106
C
C ROTATION ABOUT Y

102 D1=CTHETA(3)
D2=0.
D3=STHETA(3)
D4=0.
D5=1.
D6=0.
D7=-D3
D8=0.
D9=D1
GO TO 106
C
C ROTATION ABOUT Z

103 D1=CTHETA(4)
D4=STHETA(4)
D3=0.
D2=-D4
D5=D1
D6=0.
D7=0.
D8=0.
D9=1.
C
C ROTATE
106  CVD3=CV*D3
     CVD6=CV*D6
     CVD9=CV*D9
     DO 20  J=1,N
     XX=D1*X(J)+D2*Y(J)+CVD3
     YY=D4*X(J)+D5*Y(J)+CVD6
     Z(J)=D7*X(J)+D8*Y(J)+CVD9
     X(J)=XX
20  Y(J)=YY
     GO TO 80
C
C PRINT HEADING INFORMATION
8  TITCOD=ITC0D9
     IF (ITCODE<8) 401,401,301
401  NN1=2
     WRITE (6,1010) DP,DO
1010 FORMAT (24H0 DISTANCE TO PLANE =,F9.2,22H, DISTANCE TO OBJECT =
     1,F9.2)
     GO TO 86
301  NN1=1
86  IF (IOP(12)) 565,566,565
565  CALL SYMBOL (TITCOD=3,14,TIT90,TI90,48)
566  IOP(8)=0
     IOP(9)=0
     GO TO 80
C PLOT LABEL ON GRAPH
14  DO 935  J=1,ILA8
     GO TO (751,752)*NN1
752  E=(DO-ZL(J))/DP*SCALE
     F=(DO/DP)*SCALE
     C1=(XL(J)-FIN)/E+XMAX
     C2=(YL(J)-FIN)/E+YMAX
     GO TO 934
751  C1=XL(J)/SCALE+XMAX
     C2=YL(J)/SCALE+YMAX
     F=SCALE
934  HT(J)=HT(J)/F
935  IOP(14)=0
893  GO TO 80
C TRANSLATE DATA
10  DO 602  J=1,N
     X(J)=X(J)+DX(1)
80  Y(J)=Y(J)+DY(1)
602  Z(J)=Z(J)+DZ(1)
C PLOT PLANE OR PERSPECTIVE VIEW OF SURFACE

80 CONTINUE
IOPC=IOP(2)+IOP(3)+IOP(4)
405 DO 300 J=1,N
   IF (IOPC) 894,894,892
894 Z(J)=CV
892 GO TO (402,403)*NN1
402 C1=X(J)/SCALE+XMAX
   C2=Y(J)/SCALE+YMAX
   GO TO 406
403 E=(DO-Z(J))/DP*SCALE
   C1=X(J)/E+XMAX
   C2=Y(J)/E+YMAX
406 IF (IOP(5)) 933,933,930
930 CALL PROJ(C1,C2)
933 IF (C1.GT.SIZE.OR.C1.LT.-1.) GO TO 936
   CALL PLOT (C2,C1,KTYPE)
   IF(KTYPE.EQ.2) GO TO 304
   CVV=CV*ZSCALE
   CALL NUMBER (C2,C1,.07,CVV,90.,2)
   CALL PLOT (C2,C1,3)
   CB1=C1
   CB2=C2
304 KTYPE=2
   GO TO 300
936 KTYPE=3
300 CONTINUE
   IF(CB2.EQ.C2.AND.CB1.EQ.C1) GO TO 305
   CALL NUMBER (C2,C1,.07,CVV,90.,2)
305 CONTINUE
RETURN
END
SIBFTC PROJS DECK
SUBROUTINE PROJ(X,Y)
X=1.
Y=1.
RETURN
END

SIBMAP INPUT
ENTRY UNU8.
UNU8 PZF UNIT08
UNIT08 FILE A,READY,INPUT,BLK=22,HIGH,BCD
END
### DATA

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**H DEGREE TREND SURFACE, APRIL 1967**

**RINNER 3402**

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**PROGRAM CONTOUR - SAMPLE DATA CARDS**
SAMPLE OUTPUT FROM PROGRAM CONTUR

4TH DEGREE TREND SURFACE, APRIL 1967