RESEARCH REPORT

SURVO 76

A statistical data processing system

by

Seppo Mustonen

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DEPARTMENT OF STATISTICS
UNIVERSITY OF HELSINKI
SF 00100 HELSINKI 10 FINLAND

1. Principles of SURVO 76

SURVO 76 is a statistical data processing system intended to cover a wide range of activities in computational statistics. The SURVO 76 system has been designed especially for the needs of statisticians in both teaching and research work and its aims are slightly different from those of conventional statistical packages generally available for data analysis.

SURVO 76 is an interactive system and no special job describing language or code is needed. In its present form it has been implemented to a desk computer Wang 2200. This minicomputer provides suitable means for a rapid interchange of information between the system and the user which is here even more important than the computation speed. In a standard time sharing environment slowness of conversation and data communication often makes a true interactive approach almost impossible.

It is very important that the user can instantly reach any part of his data for inspection and checking. Equally important is a rapid access to the different modules (programs, subroutines) of the statistical system to get an idea of how the system works and to make temporary modifications and enlargements to the modules. Unfortunately many statistical systems are "invisible canned packages" which are difficult to see and open.

Due to interactivity an intelligent user knowing the main principles of statistical computing can learn to use SURVO 76 by just starting to use it without any previous instructions or a reference manual. No programming experience is necessary in standard application of SURVO 76 but in more advanced use

(modifications of SURVO modules) command of BASIC and main construction principles of SURVO 76 is essential.

SURVO 76 employs BASIC as a source language in a fairly extended form including many additional matrix, sort and alphanumeric statements. Using the extraordinary editing facilities of Wang 2200 the system modifications can be made easily and instantly. It can be said that SURVO 76 has been imbedded to this environment to enlarge the possibilities of this computer in the direction of computational statistics.

Even interactive systems are sometimes frustrating, since they may in their own gentle way compel the user to a long unproductive conversation without a natural exit. In SURVO 76 this dependance is avoided by splitting the programs into a lot of small modules. When the user becomes exhausted with a certain module he can interrupt the conversation and call any of the neighbouring modules by pressing one single key on the keyboard, without losing contact with previous stages of his job.

It is evident that many statisticians do not like to think in terms of computer programs. They prefer carrying out their computations in minor steps in an order they like. These preferences have been taken into consideration in the SURVO 76 system which can in many respects be used like a desk calculator having very "powerful" keys. On the Wang 2200 keyboard there are 32 special function keys (denoted here by F0,F1,...,F31) which can be defined as starting points for different modules (parts of programs). In SURVO 76 the functions of these keys vary depending on the SURVO module in use. The user not knowing

which F-key to press next, can always resort to key F0 which displays on CRT the functions of all other F-keys operative in the present situation.

Fig. 1. The CRT display and keyboard of Wang 2200.

Each F-start leads to a sequence of questions made by SURVO 76 which have to be answered by the user. The whole dialogue is displayed on CRT and allows the system to give the user many comments and hints relevant in the context without any waste of time or paper. In order to speed up the process SURVO itself volunteers with a suggestion for an answer which is printed after the question. (To give good suggestions SURVO 76 tries

to remember the previous actions of the user or even to guess what he might attempt next.) If the user agrees with the suggestion of SURVO 76 he merely presses the RETURN key. Otherwise he must write his own answer.

Each interchange of questions and answers eventually leads to a series of computations and different actions. The results are displayed on CRT. When the computations are finished the user can select another F-start. Certain F-starts are reserved for transferring the results just obtained from the screen to the printer or for saving them on disk as intermediate results for subsequent analysis with other SURVO modules. It is very important in a statistical data processing system that different modules performing various statistical analyses can co-operate and use the same original data files or intermediate results without any modifications whenever this is statistically reasonable. Each statistical method included in SURVO 76 has been split into small modules and it is the responsibility of the user to combine them in a reasonable way employing F-keys. It would, of course, be easy to connect different submodules in a fixed order but then the user would be at the mercy of the system - an undesirable but unfortunately typical feature of many statistical computing packages.

2. Operating SURVO 76

SURVO 76 can be run in Wang 2200 installations having a central processing unit with a memory of at least 20K, a CRT display, a dual removable floppy disk drive, a printer and a plotter. The size of the CRT display is sixteen 64-character lines and the speed is almost 3000 characters/sec. When the SURVO 76 system is in use one of the disk drives is reserved for the SURVO program disks and the other is for the users' data and possible additional programs. The capacity of a floppy disk is 262 K and a disk can be manually changed in a few seconds during the computations.

SURVO 76 consists of a central module and various statistical modules, of which one at a time can be in use together with the central module. The central module takes care of the co-operation between the different statistical modules and it contains system subroutines, e.g. for data transfers between the central and the disk memory. Thus the user need not worry about the location of his data during the computations.

The number of SURVO modules has not been limited in any way. Up to now (May 1977), 28 modules have been introduced into the system. New modules can be generated even in an interactive mode by consulting a half prepared SURVO module FRAME. Employing FRAME to build up a new module guarantees that the module will be compatible with the requirements of the SURVO 76 system.

When SURVO 76 is loaded from disk a list of alternative modules is displayed on CRT and the user has to select the module he wants to use next.

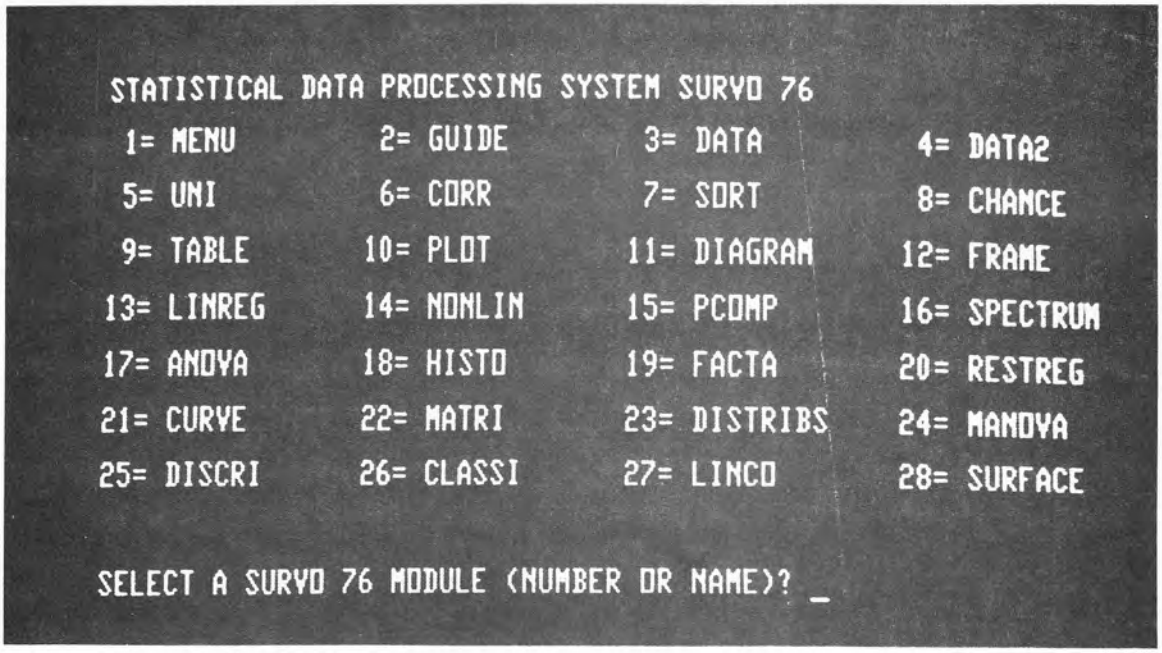


Fig.2. Display when SURVO 76 has been loaded from disk by the commands LOAD DCF "SURVO" and RUN.

If the user selects module no.1 (MENU), he gets on CRT a list of all SURVO modules with a short description of their functions. This list is reproduced in Appendix 1. A more thorough description of each module can be obtained on CRT by selecting the module in question. The module contains a presentation of its activities including a list of operative F-starts and perhaps some special instructions.

Module no.2 is a SURVO 76 teacher GUIDE which is an interactive program in itself and gives information pertinent to the SURVO 76 system during the conversation. A listing of the essential parts of GUIDE is given in Appendix 2. After consulting GUIDE the user will be ready to call any SURVO module to suit his present needs.

3. Special features of SURVO 76

It is somewhat difficult to give a concise description of various SURVO activities since the system tends to be fairly talkative. Some special features of those activities will now be characterized, however, with extracts from actual SURVO conversations.

3.1. Data analysis

SURVO 76 contains several modules for statistical data analysis which is the main field of any statistical data processing system. Until now the emphasis has been on the most traditional and elementary forms of analysis (cf. Appendix 1) which give a natural basis for the development of the system.

In SURVO 76 the problems of feeding, editing and transforming data have received special attention. The modules DATA and DATA2 have been planned to cover all conceivable activities in this field to make the system wholly self-contained in this respect. One of the basic principles in SURVO 76 is that any potentially important observations or intermediate results can be used in subsequent computations without extra modifications of the system. SURVO 76 allows both variables and observations to be labelled with alphanumeric names. This makes the results more readable and monitoring the computations easier. Each SURVO module is supposed to tell continuously on CRT what it is doing. For instance, when observations are processed the system prints on CRT the name of the observation to be dealt with next.

Appendix 3 contains a data analytical discussion with SURVO 76. The conversation customarily appearing on CRT has been transferred on paper.

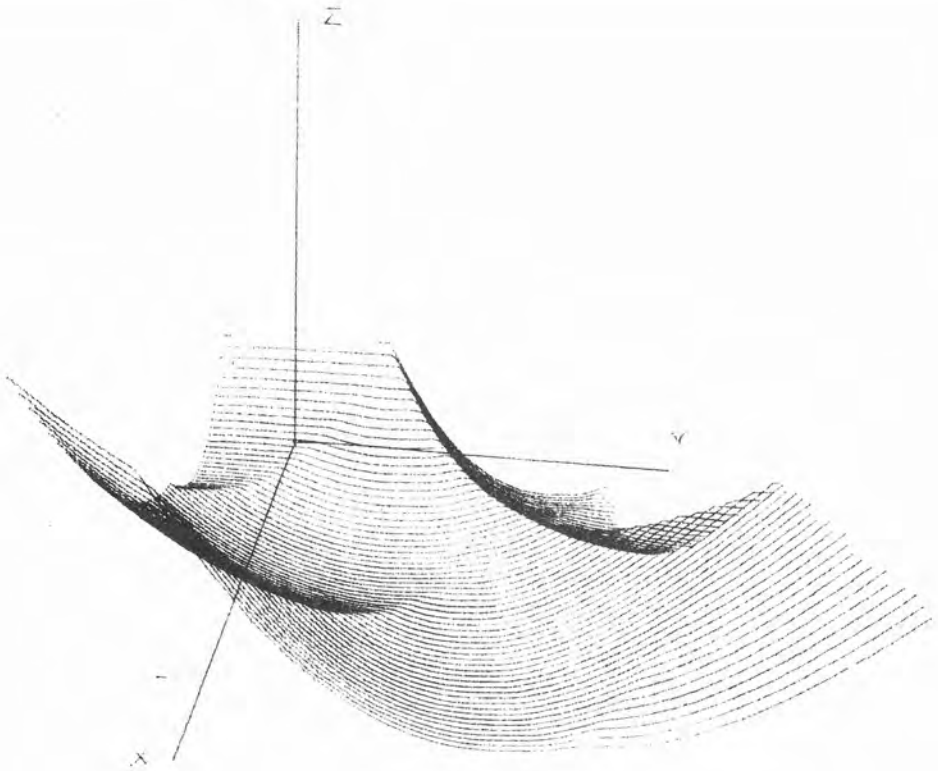


Fig.3. $z=f(x,y)=\sum_{i=1}^{3} \min((x-i)^2,(y-i)^2)$ plotted by SURFACE

3.2. Graphic representations

Both the plotter and CRT are valuable devices for visualizing statistical data or theoretical graphs.

SURVO 76 can plot, for instance, scatter diagrams, time series, analytical curves and surfaces. To begin with, the graphs are usually plotted rapidly but inaccurately on CRT. When the user finds that a certain graph is interesting and deserves closer examination he can easily transfer it on paper in a more accurate form using the plotter or the printer. When making graphs many small nuisances like placing proper marks and indications on coordinate axes may annoy the user. Therefore it is valuable that the system can come to the rescue

of the user in problems of that kind. Thus SURVO 76 takes care of scaling of the variables if desired whenever a scatter diagram is made and it also selects "nice" marking points on the axes according to the size of the graph (determined by the user) and the range of the variables to be plotted.

It is also essential that the user can employ various plotting modules one after another for the same picture to combine graphs. It may be useful to have, for instance, a time series and some of its components in the same picture. Likewise, after making a scatter diagram the user might wish to decide what kind of model should be fitted, estimate the model and return to plot a linear or nonlinear regression curve on the same graph. This feature is apparent in the conversation with SURVO 76 in Appendix 3.

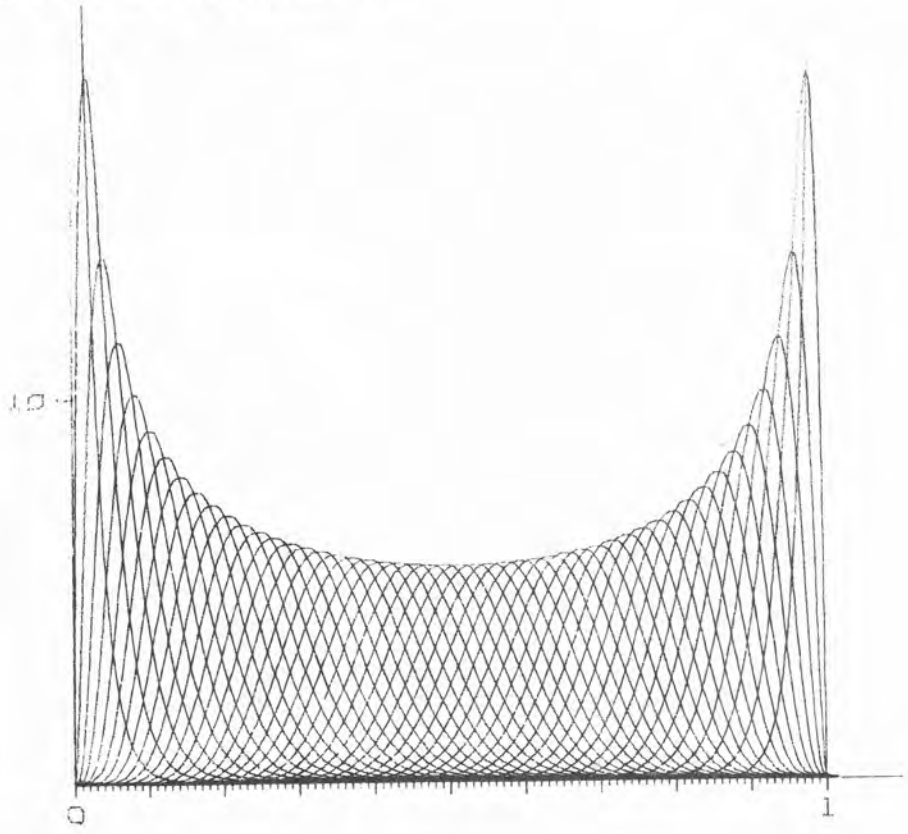


Fig.4.
The beta densities $\frac{n!}{(k-1)!(n-k)!} x^{k-1}(1-x)^{n-k}$, n=50, k=1,2,...
plotted by CURVE.

3.3. Matrix operations

One attractive feature of Wang 2200 desk computer is that various arithmetic operations can be performed and results displayed just by operating the machine like a normal calculator. To a certain extent this also applies to matrix operations.

We feel, however, that these operations as such are not sophisticated enough for the multifarious computational needs of statisticians. It is often desirable to have an opportunity to continue certain computations manually after the standard routines have been performed with SURVO modules or other programs. For this purpose the system cantains a SURVO module called MATRI. With MATRI the user can perform a wide range of matrix operations using the computer like a calculator. In MATRI all the F-keys are defined for various matrix operations including matrix inversion, eigenvalues and vectors for symmetric matrices, partitioning and combining matrices. The matrices required as an input can be keyed in manually or transferred from different SURVO files. Results can be saved in special matrix files for later operations.

In the central memory there is space for three matrices only (two operands X,Y and one result Z). An essential feature of MATRI is that the module does a lot of bookkeeping and labels each result with a name corresponding to the ordinary matrix notation. Hence, although the user has to split matrix formulae into basic operations which are carried out by single F-keys he always has on CRT labels of the latest operands and results in almost normal matrix notation.

The following "cartoon" gives a simple example of how MATRI can be used.

```
MATRI OPERATIONS:
F1:BASIC START  F2:INPUT  F3:PRINT  F10:LOAD  F19:SAVE
F4:TRANSFERRING SURVO 76 FILES IN MATRI FILES
F5:X=Z  F6:Y=Z  F20:X(-)Y,Z=X  F21:Z=X  F22:Z=Y
F7:Z=C*Z  F8:Z=X'
F9:Z=X+Y  F10:Z=X-Y  F11:Z=X*Y  F12:Z=X\ (=INV(X))
F13:Z=C  F14:Z=I  F17:Z=U(X),Y=L(X)  (X=U'LU)
F24:Z=CXIJ)  F25:CXIJ)=Z  F26:Z=d(X)  F27:Z(-)DIAG  F28:Z=P(X)
F29:REDUCTION OF MATRI FILE

F0:  X=  Y=  Z=
STOP
:
NAME OF THE MATRIX? A
NUMBER OF ROWS? 4
NUMBER OF COLUMNS? 0_          0=SYMMETRIC MATRIX
```

1. MATRI has been selected and F2 is pressed to input a symmetric 4x4 matrix A.

```
KEY ELEMENTS OF MATRIX A
 .1
 .2    .5
? _    A(3,2)  A(3,3)
A(4,1)  A(4,2)  A(4,3)  A(4,4)
```

2. The elements of A are keyed by filling a "form" on CRT.

```
CORRECTIONS BY C, OTHERWISE RETURN
 .1
 .2    .5
 .3    .4    .4
 0     .5    .5    .6
F2:  X=  Y=  Z=A
:_
```

3. All the elements of A have been keyed.

```
CORRECTIONS BY C, OTHERWISE RETURN
 .1
 .2    .5
 .3    .4    .4
 0     .5    .5    .6
F2:  X=  Y=  Z=A
:
F5:  X=A  Y=  Z=A
:
DIMENSION N? 4
F14:  X=A  Y=  Z=I
:
F6:  X=A  Y=I  Z=I
:
F9:  X=A  Y=I  Z=A+I
:_
```

4. A has been transferred to X by F5 and A+I is computed.

```
:
F5:  X=A+I  Y=I  Z=A+I
:
DET(A+I)= 2.610600000006
F12:  X=A+I  Y=I  Z=(A+I)\
:
(A+I)\=
   0.907  -0.107  -0.217   0.101
  -0.107   0.703  -0.127  -0.204
  -0.217  -0.127   0.881  -0.235
   0.101  -0.204  -0.235   0.762
F3:  X=A+I  Y=I  Z=(A+I)\
:_
```

5. $(A+I)^{-1}$ has been computed and printed on CRT.
$(A+I)^{-1}$ is denoted by $(A+I)\backslash$.

```
:
F6:  X=A+I  Y=(A+I)\  Z=(A+I)\
:
F11:  X=A+I  Y=(A+I)\  Z=(A+I)(A+I)\
:
(A+I)(A+I)\=
   1.000   0.000  -0.000   0.000
   0.000   1.000   0.000   0.000
   0.000   0.000   1.000   0.000
   0.000   0.000   0.000   1.000
F3:  X=A+I  Y=(A+I)\  Z=(A+I)(A+I)\
:_
```

6. $(A+I)^{-1}$ has been checked by multiplication.

3.4. Random data simulation

In many methodological considerations and teaching situations it is useful to analyse artificial random data whose origin is perfectly known. Planning of such experiments can be substantially facilitated by employing a SURVO module called CHANCE which is a random data generator. The user has to write the statements needed to generate a typical observation which is done according to the instructions given by CHANCE. Several subroutines are immediately available in the module to generate pseudo random variates from various distributions.

Thus it is easy even for an unexperienced "programmer" to construct random data according to a given statistical model. The simulated files can subsequently be treated as ordinary data files by means of SURVO 76. By CHANCE the form of different sample distributions can also be demonstrated on CRT. The user selects the distribution and its parameters and CHANCE starts to generate observations from that distribution. Observations are plotted on CRT one after another as a constantly growing histogram.

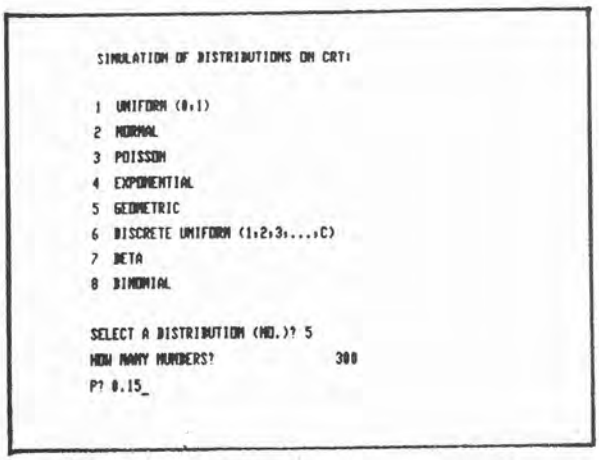


Fig.6a. Geometric distribution with p=0.15 has been selected.

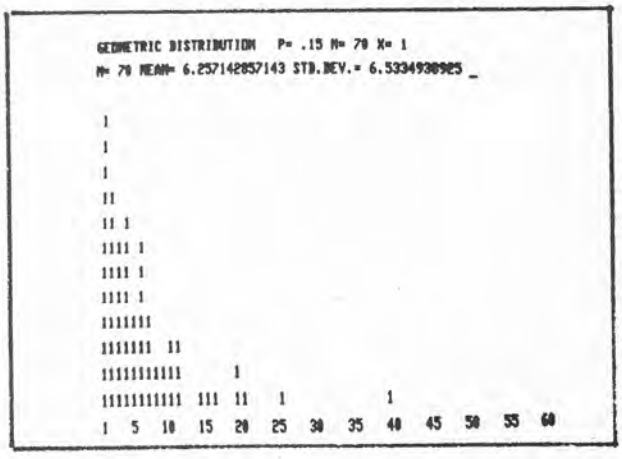
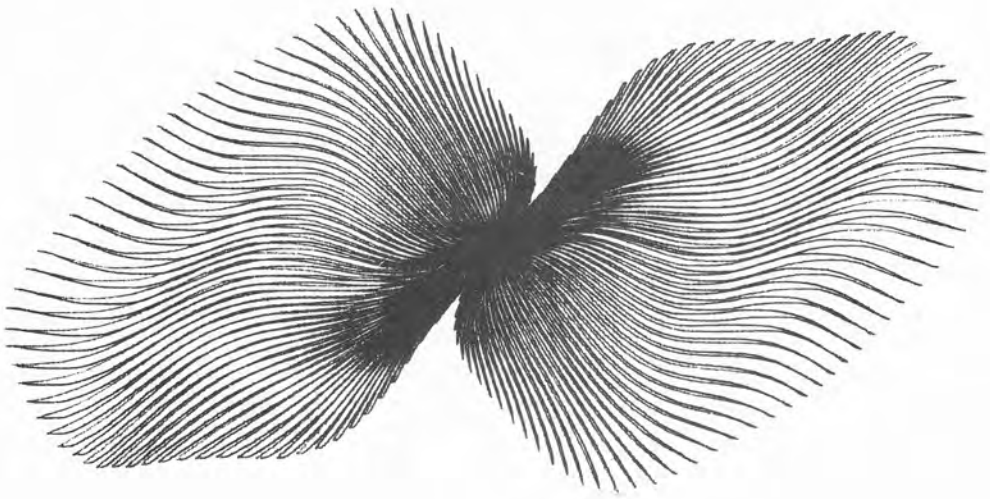


Fig.6b. Histogram is growing on CRT.

Acknowledgements

The planning of the original Finnish-speaking version of SURVO 76 has been supported by the Academy of Finland and the economic planning department of ALKO. I am also indebted to the staff of the Department of Statistics for a fine co-operation.

My special thanks for valuable contributions are attributed to Markku Rahiala for SPECTRUM and PLOT, Pekka Hakkarainen for MANOVA and DISCRI, Erkki Nykyri for DISTRIBS, Osmo Soininvaara for RESTREG, Juni Palmgren for UNI and Kimmo Linnilä.



APPENDIX 1

LIST OF SURVO 76 MODULES 29.4.1977:

GUIDE:	SURVO 76 TEACHER
DATA:	DATA INPUT, SAVING, EDITING AND TRANSFORMATIONS
DATA2:	TRANSFERRING AND COMBINING DATA FILES
UNI:	UNIVARIATE STATISTICS
CORR:	MEANS, STANDARD DEVIATIONS AND CORRELATIONS
SORT:	DATA SORTING AND ORDER STATISTICS
TABLE:	2-DIMENSIONAL CLASSIFIED FREQUENCY TABLES, TABLES FOR MEANS AND STANDARD DEVIATIONS, TABLE EDITING ON CRT, CHI^2 AND T TESTS, 1-AND 2-WAY ANALYSIS OF VARIANCE
HISTO:	UNIVARIATE CLASSIFIED FREQUENCY DISTRIBUTIONS, HISTOGRAMS
PLOT:	PLOTTING A TIME SERIES OR SCATTER DIAGRAM (MAX 170 OBSERVATIONS, AUTOMATIC SCALING)
DIAGRAM:	PLOTTING A TIME SERIES OR SCATTER DIAGRAM (UNLIMITED NUMBER OF OBSERVATIONS, SCALING IS AUTOMATIC OR DETERMINED BY THE USER)
CURVE:	CURVE PLOTTING
SURFACE:	SURFACE PLOTTING IN CENTRAL PROJECTION
CHANCE:	RANDOM DATA GENERATOR, SIMULATION OF VARIOUS DISTRIBUTIONS ON CRT
FRAME:	HALF PREPARED SURVO MODULE FOR INTERACTIVE COMPOSING OF NEW SURVO MODULES
LINREG:	MULTIPLE LINEAR REGRESSION ANALYSIS
RESTREG:	MULTIPLE LINEAR REGRESSION ANALYSIS WITH LINEAR PARAMETER CONSTRAINTS
NONLIN:	NONLINEAR REGRESSION ANALYSIS AND NONLINEAR OPTIMIZATION
PCOMP:	ANALYSIS OF PRINCIPAL COMPONENTS, PRINCIPAL AXES SOLUTION FOR FACTOR ANALYSIS
FACTA:	ORTHOGONAL ROTATIONS IN FACTOR ANALYSIS ON CRT, GRAPHICAL, VARIMAX AND QUARTIMAX ROTATIONS
SPECTRUM:	AUTO- AND CROSS-CORRELATIONS, SPECTRAL ANALYSIS
MATRI:	MATRIX OPERATIONS ON MATRICES IN SURVO FILES OR MATRICES GIVEN BY THE USER
DISTRIBS:	VALUES OF THEORETICAL DENSITY AND DISTRIBUTION FUNCTIONS
DISCRI:	MULTIPLE DISCRIMINANT ANALYSIS
CLASSI:	CLASSIFICATION OF OBSERVATIONS USING MAHALANOBIS D^2 AND BAYES PROBABILITIES
LINCO:	LINEAR COMBINATIONS OF VARIABLES, PRINCIPAL COMPONENT, FACTOR AND DISCRIMINANT SCORES

APPENDIX 2: INFORMATION ON SURVO 76 GIVEN BY "GUIDE"

SURVO 76 HAS BEEN DEVELOPED BY PROF. SEPPO MUSTONEN AND
HIS RESEARCH GROUP AT THE UNIVERSITY OF HELSINKI.
THE WORK HAS BEEN SUPPORTED BY THE ACADEMY OF FINLAND AND
THE ECONOMIC PLANNING DEPARTMENT OF ALKO.

SURVO 76 HAS BEEN PLANNED ESPECIALLY FOR THE NEEDS OF
STATISTICIANS IN BOTH TEACHING AND RESEARCH WORK.

IN STANDARD APPLICATIONS NO PROGRAMMING EXPERIENCE IS NEEDED.
IN ADVANCED USE COMMAND OF THE "BASIC" LANGUAGE IS NECESSARY.

SURVO 76 IS AN INTERACTIVE SYSTEM.

IT MAKES QUESTIONS WHICH YOU HAVE TO ANSWER BY PRESSING
NORMAL TYPEWRITER KEYS ON THE KEYBOARD.

IN ORDER TO GIVE REASONABLE ANSWERS YOU HAVE TO MASTER
THE KEYBOARD.

ON THE KEYBOARD THERE ARE FOUR TYPES OF KEYS:
1) REGULAR TYPEWRITER KEYS,
2) NUMERIC ENTRY KEYS (ON THE RIGHT SIDE),
3) KEYS FOR ENTRY AND SYSTEM CONTROL (RETURN, LOAD, RUN, ETC.)
4) 16 SPECIAL FUNCTION KEYS (ON THE TOP ROW)

THE QUESTIONS OF THE SURVO 76 SYSTEM ARE ALWAYS ANSWERED
BY USING REGULAR TYPEWRITER KEYS.

THE ANSWER MUST BE TERMINATED BY PRESSING RETURN(EXEC) KEY.

OFTEN SURVO 76 ITSELF SUGGESTS AN ANSWER
WHICH IT THINKS IS REASONABLE.

SUCH A SUGGESTION IS USUALLY PRINTED AFTER THE QUESTION.
IF YOU CANNOT BUT AGREE, MERELY PRESS RETURN.

OTHERWISE WRITE YOUR OWN ANSWER AND PRESS RETURN.

THE 16 (SPECIAL) FUNCTION KEYS LOCATED ON THE TOP ROW
WILL BE DENOTED BY F0, F1, F2, F3, . . .

IN FACT THERE ARE 32 KEYS, SINCE
EACH KEY HAS A LOWER SHIFT(F0-F15) AND AN UPPER SHIFT(F16-F31).
THE UPPER SHIFT WILL BE EMPLOYED BY CONSTANTLY PRESSING
THE SHIFT KEY.

USING F-KEYS YOU CAN MAKE INITIATIVES DURING THE CONVERSATION
AND STEER THE ACTIVITIES OF SURVO 76.

USING F15 (THE RIGHTMOST KEY IN THE LOWER SHIFT)
YOU CAN SELECT THE PRINTER AS THE OUTPUT DEVICE INSTEAD OF CRT.

USING F16 (THE LEFTMOST KEY IN THE UPPER SHIFT)
YOU CAN EXIT FROM THE SURVO MODULE AT HAND AND SELECT A NEW ONE.

THE F0 KEY IS VERY IMPORTANT IN SURVO 76.
BY PRESSING F0 A LIST OF F-KEYS ACTIVE IN THE PRESENT MODULE
WILL APPEAR ON THE SCREEN.

IN SURVO 76 SOME F-KEYS (F0, F11, F12, F15, F16) HAVE CONSTANT TASKS
INDEPENDENT OF THE MODULE SELECTED.
IT IS USEFUL TO KEEP THEM IN MIND.

WHEN A SURVO MODULE HAS BEEN SELECTED
A NORMAL ORDER OF ACTIVITIES IS F1, F2, F3, . . .

YOU CAN OF COURSE CHANGE THIS ORDER, SKIP ACTIVITIES OR RETURN
TO PREVIOUS ONES WHENEVER YOU FIND IT NECESSARY AND REASONABLE

THUS IN MANY CASES YOU CAN DECIDE FOR YOURSELF
WHICH ARE THE ACTIVITIES YOU NEED AND WHAT IS THEIR PROPER ORDER

THE STRUCTURE OF SURVO 76 AND LOADING OF THE SYSTEM:

SURVO 76 CAN BE USED IN WANG 2200 INSTALLATIONS HAVING AT LEAST
20K MEMORY, 2 DISK DRIVES AND MATRIX ROM.
PLOTTER 2212 AND SORT ROM ARE OPTIONAL.

ALL PROGRAMS INCLUDED IN SURVO 76 ARE ON THE SURVO 76 DISK WHICH
HAS TO BE MOUNTED IN THE LEFT (OR FIXED) DISK DRIVE (310).

THE STATISTICAL DATA OF THE USER ARE ON ANOTHER DISK WHICH
HAS TO BE MOUNTED IN THE RIGHT (OR REMOVABLE) DISK DRIVE (B10).

THE DATA VALUES ARE SAVED ON DISK USING A SURVO MODULE
CALLED "DATA". (F3-KEY GIVES INFORMATION ON THE DATA MODULE.)

SURVO 76 CONSISTS OF A CENTRAL MODULE CALLED "SURVO" AND
SEVERAL SURVO 76 MODULES WHICH PERFORM VARIOUS
STATISTICAL COMPUTATIONS AND RELATED TASKS.

THE SURVO 76 SYSTEM WILL BE LOADED AS FOLLOWS:

1) CLEAR RETURN (THIS CLEARS THE MEMORY)
2) MOUNT DISK SURVO 76 IN THE LEFT DISK DRIVE (310)
3) MOUNT YOUR DATA DISK IN THE RIGHT DISK DRIVE (B10)
4) LOAD DCF"SURVO" RETURN (THE CENTRAL MODULE IS LOADED)
5) RUN RETURN

SURVO 76 IS THEN READY FOR USE.
ONCE LOADED THE SYSTEM NEED NOT BE RELOADED
FOR EACH SUCCESSIVE USER SEPARATELY.

WORKING WITH DATA FILES IN THE SURVO 76 SYSTEM

IN SURVO 76 BOTH VARIABLES AND OBSERVATIONS WILL HAVE
ALPHANUMERIC NAMES (MAX. 8 CHARACTERS) GIVEN BY THE USER.

DATA ARE ARRANGED IN THE FORM OF A DATA MATRIX AND
DATA MATRICES ARE SAVED ON DISK AS DATA FILES.

BEFORE THE DATA VALUES ARE SAVED THE USER HAS TO
CREATE A DATA FILE ON DISK USING THE SURVO MODULE "DATA".

"DATA" IS AN IMPORTANT MODULE WHICH CAN BE USED FOR
1) CREATING DATA FILES,
2) ENTERING DATA VALUES INTO DATA FILES,
3) EDITING AND TRANSFORMING DATA.

WHEN A DATA FILE IS CREATED IT IS POSSIBLE TO RESERVE SPACE
FOR ADDITIONAL VARIABLES AND OBSERVATIONS
CONSIDERED NECESSARY AT A LATER STAGE OF COMPUTATIONS.

ON THE OTHER HAND IT IS WISE TO AVOID TOO LARGE RESERVATIONS.

USING ANOTHER SURVO MODULE "DATA2" IT IS POSSIBLE
TO EXPAND AND COMBINE DIFFERENT DATA FILES.

IN EACH SURVO MODULE PERFORMING DATA ANALYSIS
ONE OR TWO OF THE DATA FILES ARE OPEN (IN USE).

THE SURVO 76 CENTRAL MODULE OPENS THE DATA FILE NEEDED.
AT THAT MOMENT ALL THE DATA ARE IN USE.

HOWEVER, THE SET OF VARIABLES AND OBSERVATIONS IN USE CAN BE
LIMITED BY KEYS F11 AND F12 AND THE LIMITATIONS WILL REMAIN
VALID UNTIL ANOTHER DATA FILE IS OPENED.

THE SURVO 76 CENTRAL MODULE TAKES CARE OF THE DATA FILES AND
AUTOMATICALLY SEARCHES THE DATA FROM THE DISK.

SMALL DATA MATRICES (NOT EXCEEDING 500 DATA VALUES)
ARE LOADED INTO THE MEMORY AS A WHOLE.

LARGER DATA FILES ARE DIVIDED INTO PAGES (MAX 500 VALUES EACH).
ONLY ONE PAGE CAN BE IN THE MEMORY AT A TIME.

YOU GET MORE INFORMATION ABOUT THE DATA FILES AND
THEIR USE BY CONSULTING THE MODULES "DATA" AND "DATA2".

Appendix 3.

A conversation with SURVO 76

This is a short data analytical conversation with SURVO 76. The conversation normally displayed on CRT has now been transferred to paper. Unfortunately some of the typical dynamic features are lost on paper and the whole conversation looks perhaps too rigid and redundant. Nevertheless we hope that the reader can imagine how the things look in the real situation.

In the discussion all the answers and actions of the user are underlined and the F-starts are indicated by (F1), (F2), etc. Explanations and remarks are usually written on the right hand side.

In the discussion a small data matrix (containing data on the best athletes of the world in decathlon in 1973) will be keyed and saved and later enlarged with some additional variables. In the analysis a few descriptive modules of SURVO 76 will be employed at first. Then data analysis will be performed using linear regression analysis and factor analysis.

```
:CLEAR

READY
:LOAD DCF"SURVO"
:RUN

STATISTICAL DATA PROCESSING SYSTEM SURVO 76
 1= MENU         2= GUIDE        3= DATA         4= DATA2
 5= UNI          6= CORR         7= SORT         8= CHANCE
 9= TABLE       10= PLOT        11= DIAGRAM     12= FRAME
13= LINREG      14= NONLIN      15= PCOMP       16= SPECTRUM
17= ANOVA       18= HISTO       19= FACTA       20= RESTREG
21= CURVE       22= MATRI       23= DISTRIBS    24= MANOVA
25= DISCRI      26= CLASSI      27= LINCO       28= SURFACE

SELECT A SURVO 76 MODULE (NUMBER OR NAME)? 3
SURVO 76: DATA INPUT, SAVING, EDITING AND TRANSFORMATIONS/SM
F1: CREATING NEW DATA FILE
F2: DATA INPUT AND SAVING
F3: DATA CHECKING AND EDITING
F4: DEFINING NEW VARIABLES
F5: DATA INPUT AND SAVING FOR SELECTED VARIABLES
F6: DATA PRINTOUT
F7: VARIABLE TRANSFORMATIONS  F23:LAG OPERATIONS
F8: CHANGING NAME OF DATA FILE
F9: CHANGING NAMES OF VARIABLES
F10:DATA FILE REDUCTION

STOP (F1)
:
CREATION OF NEW DATA FILE:
NAME OF NEW DATA FILE? DECA
MAXIMUM NUMBER OF VARIABLES IN FILE? 20
NUMBER OF VARIABLES NOW TO BE DEFINED? 11
MAXIMUM NUMBER OF OBSERVATIONS IN FILE? 60
NAMES OF VARIABLES
VARIABLE 1 ? POINTS
VARIABLE 2 ? 100M
VARIABLE 3 ? BR.JUMP
VARIABLE 4 ? SHOT PUT
VARIABLE 5 ? HI JUMP
VARIABLE 6 ? 400M
VARIABLE 7 ? HURDLES
VARIABLE 8 ? DISCUS
VARIABLE 9 ? POLE VLT
VARIABLE 10 ? JAVELIN
VARIABLE 11 ? 1500M
DATA FILE DECA     CREATED.

STOP DATA INPUT: PRESS F2
:
```

The memory is cleared and the SURVO 76 central module is loaded.

RUN command initiates the execution.

The module DATA is selected.
DATA gives on CRT a list of available F-starts.

F1 is pressed.
The data file DECA containing space for 20 variables and
60 observations is created.
At this stage 11 variables are defined.

POINTS=total points in decathlon
Other variables correspond to the points in various events.

```
(F2)
DATA INPUT:
NAME OF DATA FILE?                DECA
SURVO 76 FILE DECA
M= 11  M(MAX)= 20  N= 0  N(MAX)= 60  L= 20
VARIABLES:      X( 1 )=POINTS   X( 2 )=100M     X( 3 )=BR.JUMP
X( 4 )=SHOT PUT X( 5 )=HI JUMP  X( 6 )=400M     X( 7 )=HURDLES
X( 8 )=DISCUS   X( 9 )=POLE VLT X( 10 )=JAVELIN X( 11 )=1500M


 IN USE:        X( 1 )=POINTS   X( 2 )=100M     X( 3 )=BR.JUMP
X( 4 )=SHOT PUT X( 5 )=HI JUMP  X( 6 )=400M     X( 7 )=HURDLES
X( 8 )=DISCUS   X( 9 )=POLE VLT X( 10 )=JAVELIN X( 11 )=1500M

KEY OBSERVATION VALUES 1
NAME OF OBSERVATION? SKOURONE     TO STOP, PRESS . (FULL STOP)
POINTS  ? 9206                    0
100M    ? 853                     0
BR.JUMP ? 931                     0
SHOT PUT? 725                     0
HI JUMP ? 857                     0
400M    ? 838                     0
HURDLES ? 903                     0
DISCUS  ? 772                     0
POLE VLT? 931                     0
JAVELIN ? 918                     0
1500M   ? 528                     0
KEY OBSERVATION VALUES 2
NAME OF OBSERVATION? HEDMARK      TO STOP, PRESS . (FULL STOP)
POINTS  ? 9138                    9206
100M    ?                         853
BR.JUMP ? 853                     931
SHOT PUT? 81                      725
HI JUMP ? 769                     857
400M    ? 833                     838
HURDLES ? 914                     903
DISCUS  ? 855                     772
POLE VLT? 884                     931
JAVELIN ? 975                     818
1500M   ? 438                     528
-------------------------------------------
KEY OBSERVATION VALUES 48
NAME OF OBSERVATION? DZHUROV      TO STOP, PRESS . (FULL STOP)
POINTS  ? 7649                    7651
100M    ? 747                     759
BR.JUMP ? 793                     871
SHOT PUT? 935                     722
HI JUMP ?                         689
400M    ? 792                     810
HURDLES ? 789                     799
DISCUS  ? 757                     658
POLE VLT?                         909
JAVELIN ? 726                     765
1500M   ? 504                     669
KEY OBSERVATION VALUES 49
NAME OF OBSERVATION? .            TO STOP, PRESS . (FULL STOP)

STOP OBSERVATIONS SAVED
:
```

Keying observations is started by F2.
SURVO 76 suggests DECA which is accepted.
The structure of the data file is presented.

The values of the precedent observation are suggested by SURVO 76.

After the keying and saving operations the contents of the data file or parts of it can be listed by F6 (not included here) and errors can be corrected by F3.

An obvious error in observation 2 will now be corrected.

(F3)

```
DATA CHECKING AND EDITING:
NAME OF DATA FILE?                DECA
SURVO 76 FILE DECA
M= 11  M(MAX)= 20  N= 48  N(MAX)= 60  L= 20
VARIABLES:       X( 1 )=POINTS   X( 2 )=100M      X( 3 )=BR.JUMP
X( 4 )=SHOT PUT X( 5 )=HI JUMP  X( 6 )=400M      X( 7 )=HURDLES
X( 8 )=DISCUS   X( 9 )=POLE VLT X( 10 )=JAVELIN X( 11 )=1500M


 IN USE:         X( 1 )=POINTS   X( 2 )=100M      X( 3 )=BR.JUMP
X( 4 )=SHOT PUT X( 5 )=HI JUMP  X( 6 )=400M      X( 7 )=HURDLES
X( 8 )=DISCUS   X( 9 )=POLE VLT X( 10 )=JAVELIN X( 11 )=1500M

                OBSERVATIONS 1 - 48
NO. OF OBSERVATION? 2      1
NO. : NAME      POINTS          100M            BR.JUMP
SHOT PUT        HI JUMP         400M            HURDLES
DISCUS          POLE VLT        JAVELIN         1500M

 2 : HEDMARK     8188            853             853
 31              769             833             914
 855             884             975             438

CORRECTIONS BY PRESSING C. OTHERWISE RETURN
SELECT: 1=ALL KINDS OF CORRECTIONS
        2=ONLY SOME VARIABLES TO BE CORRECTED
? 1
OBS.NAME=HEDMARK  NEW NAME?
OBS.NO.= 2   NEW NO.?
POINTS= 8188 POINTS?
100M= 853 100M?
BR.JUMP= 853 BR.JUMP?
SHOT PUT= 81 SHOT PUT? 814
HI JUMP= 769 HI JUMP?
400M= 833 400M?
HURDLES= 914 HURDLES?
DISCUS= 855 DISCUS?
POLE VLT= 884 POLE VLT?
JAVELIN= 975 JAVELIN?
1500M= 438 1500M?
NO. OF OBSERVATION? 0      3

STOP IMPOSSIBLE OBS.NO.
:
```

(F4)

Two additional variables are to be included.

```
DEFINING NEW VARIABLES:
NAME OF DATA FILE?                DECA
SURVO 76 FILE DECA
M= 11  M(MAX)= 20  N= 48  N(MAX)= 60  L= 20
VARIABLES:       X( 1 )=POINTS   X( 2 )=100M      X( 3 )=BR.JUMP
X( 4 )=SHOT PUT X( 5 )=HI JUMP  X( 6 )=400M      X( 7 )=HURDLES
X( 8 )=DISCUS   X( 9 )=POLE VLT X( 10 )=JAVELIN X( 11 )=1500M


 IN USE:         X( 1 )=POINTS   X( 2 )=100M      X( 3 )=BR.JUMP
X( 4 )=SHOT PUT X( 5 )=HI JUMP  X( 6 )=400M      X( 7 )=HURDLES
X( 8 )=DISCUS   X( 9 )=POLE VLT X( 10 )=JAVELIN X( 11 )=1500M

                OBSERVATIONS 1 - 48
HOW MANY NEW VARIABLES? 2
NAMES OF NEW VARIABLES:
VARIABLE 12 ? HEIGHT
VARIABLE 13 ? WEIGHT

STOP VALUES FOR THE NEW VARIABLES CAN BE KEYED BY F5.
:
```

(F5)

```
DATA INPUT FOR SELECTED VARIABLES:
NAME OF DATA FILE?                DECA
SURVO 76 FILE DECA
M= 13  M(MAX)= 20  N= 48  N(MAX)= 60  L= 20
VARIABLES:       X( 1 )=POINTS   X( 2 )=100M      X( 3 )=BR.JUMP
X( 4 )=SHOT PUT X( 5 )=HI JUMP  X( 6 )=400M      X( 7 )=HURDLES
X( 8 )=DISCUS   X( 9 )=POLE VLT X( 10 )=JAVELIN X( 11 )=1500M
X( 12 )=HEIGHT  X( 13 )=WEIGHT


 IN USE:         X( 1 )=POINTS   X( 2 )=100M      X( 3 )=BR.JUMP
X( 4 )=SHOT PUT X( 5 )=HI JUMP  X( 6 )=400M      X( 7 )=HURDLES
X( 8 )=DISCUS   X( 9 )=POLE VLT X( 10 )=JAVELIN X( 11 )=1500M
X( 12 )=HEIGHT  X( 13 )=WEIGHT
                OBSERVATIONS 1 - 48
NUMBER OF FIRST OBSERVATION TO BE KEYED (1)?
VARIABLES TO BE KEYED AND SAVED (0=NO SAVING)
POINTS? 0          1
100M? 0            1
BR.JUMP? 0         1
SHOT PUT? 0        1
HI JUMP? 0         1
400M? 0            1
HURDLES? 0         1
DISCUS? 0          1
POLE VLT? 0        1
JAVELIN? 0         1
1500M? 0           1
HEIGHT?            1
WEIGHT?            1
OBS.NO.= 1       OBS.NAME=SKOWRONE
HEIGHT= 0 HEIGHT? 184
WEIGHT= 0 WEIGHT? 81
OBS.NO.= 2       OBS.NAME=HEDMARK
```

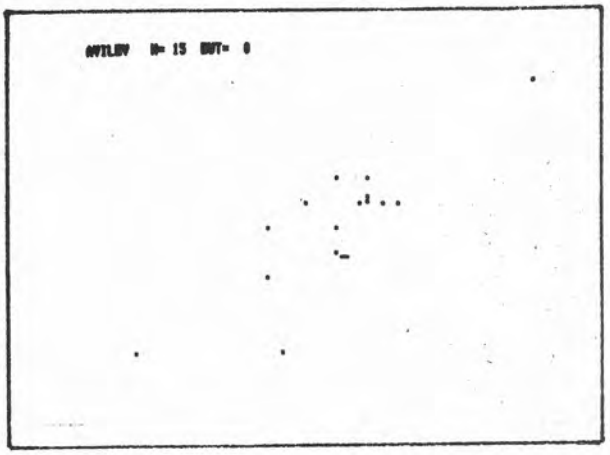
```
OBS.NO.= 48      OBS.NAME=DZHUROV
HEIGHT= 0 HEIGHT? 194
WEIGHT= 0 WEIGHT? 93

STOP ADDITIONAL OBSERVATIONS MAY BE KEYED BY F2.
:
```

(F16)

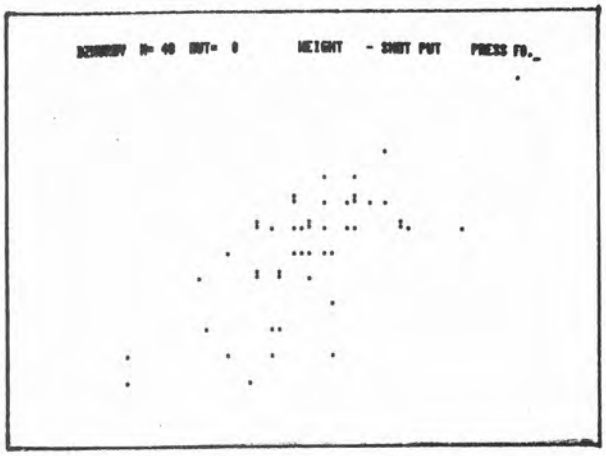
```
STATISTICAL DATA PROCESSING SYSTEM SURVO 76
 1= MENU          2= GUIDE         3= DATA          4= DATA2
 5= UNI           6= CORR          7= SORT          8= CHANCE
 9= TABLE        10= PLOT         11= DIAGRAM      12= FRAME
13= LINREG       14= NONLIN       15= PCOMP        16= SPECTRUM
17= ANOVA        18= HISTO        19= FACTA        20= RESTREG
21= CURVE        22= MATRI        23= DISTRIBS     24= MANOVA
25= DISCRI       26= CLASSI       27= LINCO        28= SURFACE

SELECT A SURVO 76 MODULE (NUMBER OR NAME)? 11
SURVO 76: DIAGRAM/SM
F1: BASIC START
F2: NEW PRINTOUT (ALSO ON PAPER)
F3: NEW PRINTOUT ON CRT (POSSIBILITY TO MOVE CURSOR)
F4: NEW DIAGRAM
F5: DIAGRAM ON PLOTTER (AFTER F1)

TO PROCEED PRESS F1.
IF YOU NEED ADDITIONAL INSTRUCTIONS PRESS RETURN.
   RETURN
"DIAGRAM" PLOTS A SCATTER DIAGRAM OF TWO VARIABLES.

THE DIAGRAM WILL APPEAR ONE OBSERVATION AT A TIME ON CRT.
IT CAN BE TRANSFERRED TO PLOTTER BY F5 OR TO PRINTER BY F15,F2.

   BY F3 YOU CAN MOVE CURSOR IN THE DIAGRAM.
   ON THE UPPERMOST ROW YOU HAVE THE COORDINATES OF THE CURSOR.
   CURSOR CAN BE MOVED BY KEYS: L=LEFT, R=RIGHT, U=UP, D=DOWN.
   TO FIND OBSERVATIONS CORRESPONDING TO THE PRESENT POSITION
   OF CURSOR, PRESS ?
   TEXT IN QUATITION MARKS CAN BE WRITTEN AND IT WILL BE
   PRINTED TOGETHER WITH THE DIAGRAM ON PAPER BY F2.

STOP .  TO PROCEED PRESS F1.
: (F1)
SURVO 76: DIAGRAM/SM
NAME OF DATA FILE?                DECA
SURVO 76 FILE DECA
M= 13  M(MAX)= 20  N= 48  N(MAX)= 60  L= 29
VARIABLES:      X( 1 )=POINTS   X( 2 )=100M     X( 3 )=BR.JUMP
X( 4 )=SHOT PUT X( 5 )=HI JUMP  X( 6 )=400M     X( 7 )=HURDLES
X( 8 )=DISCUS   X( 9 )=POLE VLT X( 10 )=JAVELIN X( 11 )=1500M
X( 12 )=HEIGHT  X( 13 )=WEIGHT

 IN USE:        X( 1 )=POINTS   X( 2 )=100M     X( 3 )=BR.JUMP
X( 4 )=SHOT PUT X( 5 )=HI JUMP  X( 6 )=400M     X( 7 )=HURDLES
X( 8 )=DISCUS   X( 9 )=POLE VLT X( 10 )=JAVELIN X( 11 )=1500M
X( 12 )=HEIGHT  X( 13 )=WEIGHT.
                OBSERVATIONS 1 - 48
```

```
DIAGRAM SEARCHES, IF NEEDED, MINIMUM AND MAXIMUM VALUES
OF THE VARIABLES TO BE ANALYSED AND SELECTS
APPROPRIATE SCALINGS FOR THEM (AUTOMATIC SCALING).
AUTOMATIC SCALING (1=YES,0=NO)?                  1
SELECT ALL VARIABLES AND OBSERVATIONS YOU INTEND TO USE:

SELECT VARIABLES:(1=YES,0=NO)
 POINTS  ?0 100M    ?1 BR.JUMP ?0 SHOT PUT?1 HI JUMP ?1
 400M    ?0 HURDLES ?0 DISCUS  ?0 POLE VLT?0 JAVELIN ?0
 1500M   ?0 HEIGHT  ?1 WEIGHT  ?1
 IN USE:        X( 2 )=100M     X( 4 )=SHOT PUT X( 5 )=HI JUMP
X( 12 )=HEIGHT  X( 13 )=WEIGHT
                OBSERVATIONS 1 - 48
LIMITING OF OBSERVATIONS:
FIRST OBSERVATION?          1
LAST  OBSERVATION?          48
MINIMUM AND MAXIMUM VALUES OF THE VARIABLES WILL BE SEARCHED...
SKOURONE        HEDMARK         LE ROY          ZEILBAUE
ZIGERT          BENNETT         BLINJAJE        KATUS
BERENDSE        GORBACHO        KISELJEV        GOUGH
SHERBATI        GHESQUIR        AVILOV          KRATKY
SCHREYER        LINKMANN        THIEMIG         PERNICA
STROOT          BUGAY           EVANS           TSELNOKO
IVANOV          JANCZENK        DEMMIG          SCHULZE
ANDRES          GEORGE          JENNER          SWOBODA
APT             HERBRAND        TREGUBJE        KOZAKIEW
JACHMIEN        POLD            NIKITIN         ORMANOV
BRIGHAM         HOISCHEN        WANAMAKE        NOVIK
SAMARA          SCHOEBEL        BOGDAN          DZHUROV
PLOTTING STARTS...

 IN USE:        X( 2 )=100M     X( 4 )=SHOT PUT X( 5 )=HI JUMP
X( 12 )=HEIGHT  X( 13 )=WEIGHT
                OBSERVATIONS 1 - 48
VARIABLE ON HORIZONTAL AXIS (NO.)? 13     0 (0=TIME)
VARIABLE ON VERTICAL   AXIS (NO.)? 4      0

GIVE LIMITS OF THE VARIABLES: (LOWER LIMIT,UPPER LIMIT)
SUGGESTIONS CORRESPOND TO AUTOMATIC SCALING.
WEIGHT?                     63.5 , 105.5
SHOT PUT?                   575 , 950
LIMITING OF OBSERVATIONS:
FIRST OBSERVATION?          1
LAST  OBSERVATION?          48
```

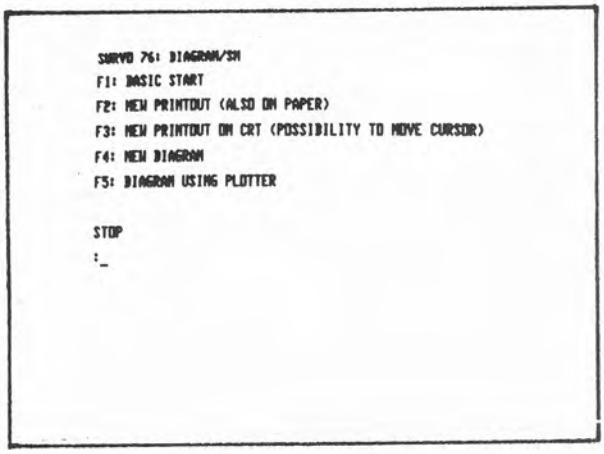
The "cartoon" on the next page illustrates what is happening on CRT.



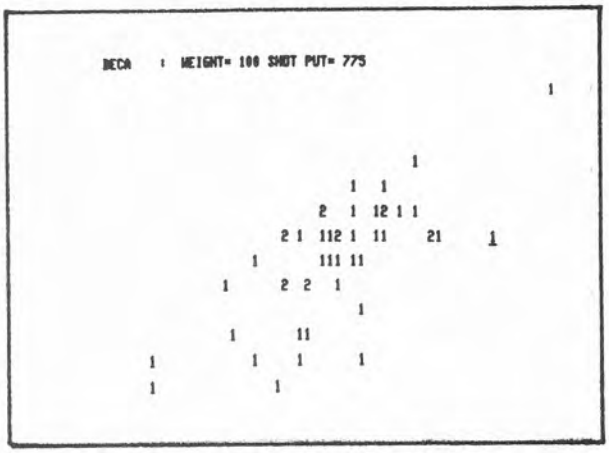
1. 15 observations have been plotted on CRT.



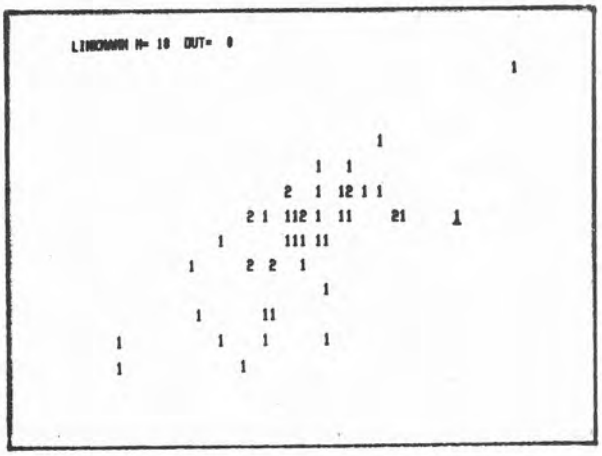
2. All the observations have been plotted.



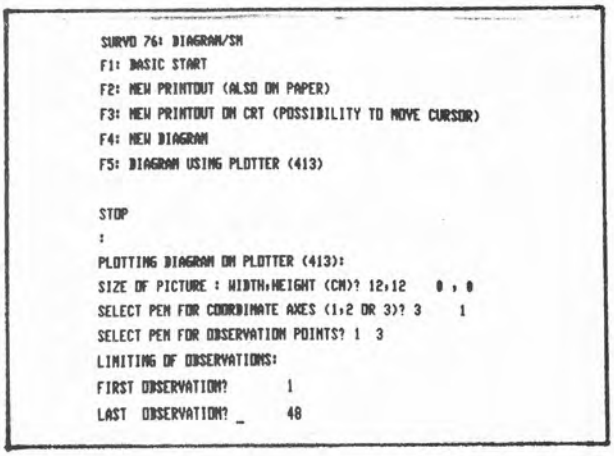
3. F0 has been pressed to find a possible continuation.



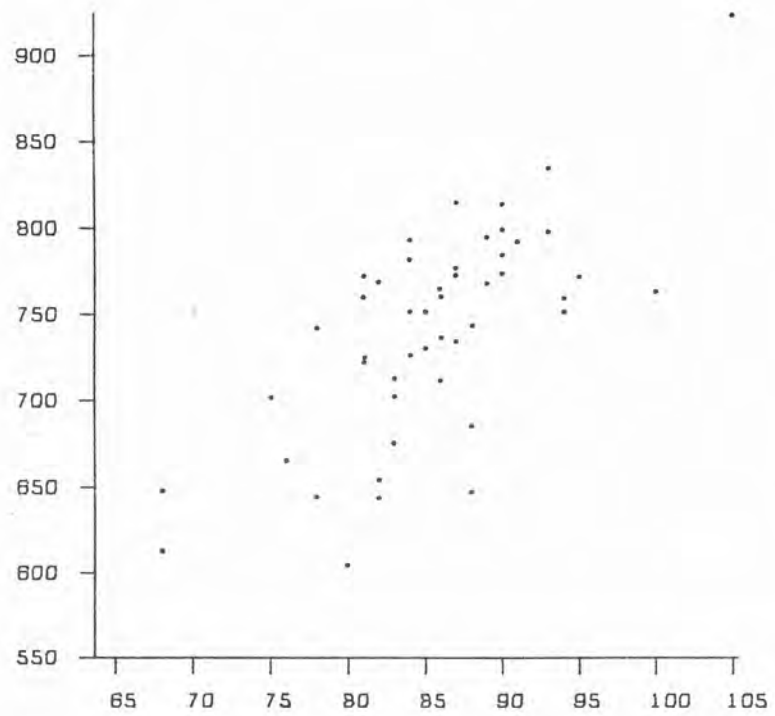
4. F3 has been pressed and the cursor has been moved to point at the observation (100,775).



5. The observation pointed at by the cursor has been identified by pressing ?



6. F5 has been pressed to transfer the same graph to plotter.



F16

```
STATISTICAL DATA PROCESSING SYSTEM SURVO 76
 1= MENU          2= GUIDE         3= DATA          4= DATA2
 5= UNI           6= CORR          7= SORT          8= CHANCE
 9= TABLE        10= PLOT         11= DIAGRAM      12= FRAME
13= LINREG       14= NONLIN       15= PCOMP        16= SPECTRUM
17= ANOVA        18= HISTO        19= FACTA        20= RESTREG
21= CURVE        22= MATRI        23= DISTRIBS     24= MANOVA
25= DISCRI       26= CLASSI       27= LINCO        28= SURFACE

SELECT A SURVO 76 MODULE (NUMBER OR NAME)? S
SURVO 76: MEANS, STANDARD DEVIATIONS AND CORRELATIONS/SM
F1: BASIC START
F2: NEW PRINTOUT
F3: SAVING CORRELATION MATRIX ON DISK
F4: LOADING CORRELATION MATRIX FROM DISK
F5: MANUAL INPUT OF CORRELATION MATRIX

CHOICE CRITERIA FOR OBSERVATIONS CAN BE WRITTEN ON LINES 450-500

STOP
:
```

F1

```
SURVO 76: MEANS,STANDARD DEVIATIONS AND CORRELATIONS/SM
NAME OF DATA FILE?                DECA
SURVO 76 FILE DECA
M= 13  M(MAX)= 20  N= 48  N(MAX)= 50  L= 20
VARIABLES:      X( 1 )=POINTS   X( 2 )=100M     X( 3 )=BR.JUMP
X( 4 )=SHOT PUT X( 5 )=HI JUMP  X( 6 )=400M     X( 7 )=HURDLES
X( 8 )=DISCUS   X( 9 )=POLE VLT X( 10 )=JAVELIN X( 11 )=1500M
X( 12 )=HEIGHT  X( 13 )=WEIGHT

 IN USE:        X( 2 )=100M     X( 4 )=SHOT PUT X( 5 )=HI JUMP
X( 12 )=HEIGHT  X( 13 )=WEIGHT
                OBSERVATIONS 1 - 48
                                                (0=NO WEIGHTS)
OBSERVATIONS TO BE WEIGHED WITH VARIABLE (NO.) ? 0

SELECT VARIABLES:(1=YES,0=NO)
 POINTS  ?1 100M    ?1 BR.JUMP ?1 SHOT PUT?1 HI JUMP ?1
 400M    ?1 HURDLES ?1 DISCUS  ?1 POLE VLT?1 JAVELIN ?1
 1500M   ?1 HEIGHT  ?1 WEIGHT  ?1
 IN USE:        X( 1 )=POINTS   X( 2 )=100M     X( 3 )=BR.JUMP
X( 4 )=SHOT PUT X( 5 )=HI JUMP  X( 6 )=400M     X( 7 )=HURDLES
X( 8 )=DISCUS   X( 9 )=POLE VLT X( 10 )=JAVELIN X( 11 )=1500M
X( 12 )=HEIGHT  X( 13 )=WEIGHT
                OBSERVATIONS 1 - 48
LIMITING OF OBSERVATIONS:
FIRST OBSERVATION?          1
LAST  OBSERVATION?          48
```

```
COMPUTATION OF MEANS: (OBSERVATIONS WITH * WILL BE PROCESSED)
SKOURONE*       HEIMARK*        LE ROY*         ZEILBAUE*
ZIGERT*         BENNETT*        BLINJAJE*       KATUS*
BERENDSE*       GORBACHO*       KISELJEV*       GOUGH*
SHERBATI*       GHESQUIR*       AVILOV*         KRATKY*
SCHREYER*       LINKMANN*       THIEMIG*        PERNICA*
STROOT*         BUGAY*          EVANS*          TSELNOKO*
IVANOV*         JANCZENK*       DEMMIG*         SCHULZE*
ANDRES*         GEORGE*         JENNER*         SWOBODA*
APT*            HERBRAND*       TREGUBJE*       KOZAKIEW*
JACHMIEN*       POLD*           NIKITIN*        ORMANOV*
BRIGHAM*        HOISCHEN*       WANAMAKE*       NOVIK*
SAMARA*         SCHOEBEL*       BOGDAN*         DZHUROV*

COMPUTATION OF CORRELATIONS:
SKOURONE*       HEIMARK*        LE ROY*         ZEILBAUE*
ZIGERT*         BENNETT*        BLINJAJE*       KATUS*
BERENDSE*       GORBACHO*       KISELJEV*       GOUGH*
SHERBATI*       GHESQUIR*       AVILOV*         KRATKY*
SCHREYER*       LINKMANN*       THIEMIG*        PERNICA*
STROOT*         BUGAY*          EVANS*          TSELNOKO*
IVANOV*         JANCZENK*       DEMMIG*         SCHULZE*
ANDRES*         GEORGE*         JENNER*         SWOBODA*
APT*            HERBRAND*       TREGUBJE*       KOZAKIEW*
JACHMIEN*       POLD*           NIKITIN*        ORMANOV*
BRIGHAM*        HOISCHEN*       WANAMAKE*       NOVIK*
SAMARA*         SCHOEBEL*       BOGDAN*         DZHUROV*


DATA FILE: DECA OBSERVATIONS: SKOURONE-DZHUROV  N= 48

MEANS AND STD.DEVS
POINTS       7843.4791       161.6539
100M          823.1875        59.3925
BR.JUMP       840.1875        50.7285
SHOT PUT      749.7708        61.3275
HI JUMP       895.8541        64.3951
400M          813.5000        49.3021
HURDLES       852.8750        54.2047
DISCUS        747.4583        62.2321
POLE VLT      900.2708        63.0429
JAVELIN       760.0208        63.9369
1500M         554.6250        75.6724
HEIGHT        186.9583         5.0904
WEIGHT         85.5625         6.3476
```

CORRELATION MATRIX

	POINTS	100M	BR.JUM	SHOT P	HI JUM	400M	HURDLE
POINTS	1.000	0.294	0.499	0.363	0.220	0.295	0.445
100M	0.294	1.000	0.171	-0.027	-0.411	0.456	0.315
BR.JUMP	0.499	0.171	1.000	-0.034	-0.003	0.133	0.298
SHOT PUT	0.363	-0.027	-0.034	1.000	0.162	-0.303	0.086
HI JUMP	0.220	-0.411	-0.003	0.162	1.000	-0.338	-0.038
400M	0.295	0.456	0.133	-0.303	-0.338	1.000	0.175
HURDLES	0.445	0.315	0.298	0.086	-0.038	0.175	1.000
DISCUS	0.386	0.014	0.020	0.727	0.216	-0.344	0.047
POLE VLT	0.160	0.054	0.061	-0.204	-0.117	0.096	-0.073
JAVELIN	0.320	-0.221	0.153	0.023	0.149	-0.104	-0.148
1500M	-0.153	-0.291	-0.206	-0.446	-0.146	0.302	-0.224
HEIGHT	0.223	-0.110	-0.049	0.617	0.125	-0.164	0.225
WEIGHT	0.142	-0.082	-0.054	0.708	0.161	-0.322	0.130

	DISCUS	POLE V	JAVELI	1500M	HEIGHT	WEIGHT
POINTS	0.386	0.160	0.320	-0.153	0.223	0.142
100M	0.014	0.054	-0.221	-0.291	-0.110	-0.082
BR.JUMP	0.020	0.061	0.153	-0.206	-0.049	-0.054
SHOT PUT	0.727	-0.204	0.023	-0.446	0.617	0.708
HI JUMP	0.216	-0.117	0.149	-0.146	0.125	0.161
400M	-0.344	0.096	-0.104	0.302	-0.164	-0.322
HURDLES	0.047	-0.073	-0.148	-0.224	0.225	0.130
DISCUS	1.000	-0.181	0.135	-0.573	0.587	0.635
POLE VLT	-0.181	1.000	-0.129	0.012	-0.350	-0.313
JAVELIN	0.135	-0.129	1.000	-0.065	-0.035	-0.066
1500M	-0.573	0.012	-0.065	1.000	-0.237	-0.400
HEIGHT	0.587	-0.350	-0.035	-0.237	1.000	0.852
WEIGHT	0.635	-0.313	-0.066	-0.400	0.852	1.000

```
STOP CORRELATIONS COMPUTED.  NEW PRINTOUT: F2, SAVING: F3
: (F3)
SAVING CORRELATION MATRIX ON DISK:
NAME OF CORRELATION FILE? DECORR
IS FILE NEW(=0) OR OLD(=1)? 0
CREATION OF NEW CORRELATION FILE  DECORR
MAXIMUM NUMBER OF VARIABLES IN CORRELATION FILE? 15

STOP CORRELATION MATRIX SAVED.
:
```

```
:  (F16)
STATISTICAL DATA PROCESSING SYSTEM SURVO 76
 1= MENU          2= GUIDE         3= DATA          4= DATA2
 5= UNI           6= CORR          7= SORT          8= CHANCE
 9= TABLE        10= PLOT         11= DIAGRAM      12= FRAME
13= LINREG       14= NONLIN       15= PCOMP        16= SPECTRUM
17= ANOVA        18= HISTO        19= FACTA        20= RESTREG
21= CURVE        22= MATRI        23= DISTRIBS     24= MANOVA
25= DISCRI       26= CLASSI       27= LINCO        28= SURFACE

SELECT A SURVO 76 MODULE (NUMBER OR NAME)? 13
SURVO 76: LINEAR REGRESSION ANALYSIS/SM
F1: BASIC START (NO CORRELATION FILE)
F2: BASIC START (CORRELATION FILE ON DISK)
F3: CORRELATIONS OF ESTIMATED COEFFICIENTS
F7: NEW PRINTOUT
F8: RESIDUALS
F11:SELECTING VARIABLES
F12:LIMITING OF OBSERVATIONS
F24:SAVING RESIDUALS IN DATA FILE

MAXIMUN NUMBER OF REGRESSORS IS  11 PLUS A CONSTANT.
MAXIMUM NUMBER OF VARIABLES IN CORRELATION FILE IS 20.

STOP
:  (F2)
LINEAR REGRESSION ANALYSIS/SM
NAME OF CORRELATION FILE? DECORR
CORRELATION FILE DECORR    OBS. SKOWRONE-DZHUROV
 CONTAINS VARIABLES:
X( 1 )=POINTS   X( 2 )=100M     X( 3 )=BR.JUMP  X( 4 )=SHOT PUT
X( 5 )=HI JUMP  X( 6 )=400M     X( 7 )=HURDLES  X( 8 )=DISCUS
X( 9 )=POLE VLT X( 10 )=JAVELIN X( 11 )=1500M   X( 12 )=HEIGHT
X( 13 )=WEIGHT
REGRESSAND (DEPENDENT VARIABLE), (NO.)? 4
SELECT REGRESSORS (INDEPENDENT VARIABLES) (1=INCLUDE,0=EXCLUDE):
POINTS? 0          1
100M? 0            1
BR.JUMP? 0         1
HI JUMP? 0         1
400M? 0            1
HURDLES? 0         1
DISCUS? 0          1
POLE VLT? 0        1
JAVELIN? 0         1
1500M? 0           1
HEIGHT? 0          1
WEIGHT?            1
```

Basic start F2 can be used, since means, standard deviations and correlations are already on disk.

WEIGHT will be the only regressor.

The results will be displayed on CRT. They can be transferred to paper by F15,F2.

```
CORRELATION FILE: DECORR    'OBS. SKOWRONE-DZHUROV
DATA FILE: DECA  N= 48 DECORR     OBS. SKOWRONE-DZHUROV

VARIABLE         MEAN              STD.DEV.
SHOT PUT       740.770833         61.827570
WEIGHT          95.562500          6.847500
CORRELATIONS      1
WEIGHT    1  1.000
SHOT PUT     0.708
DET(R)= 1
VARIABLE      REGR.COEFF.       STD.ERROR    T      BETA PARTIAL R
WEIGHT          6.394912         0.939913    6.80  0.708   0.708
CONSTANT      193.606155        90.664568    2.40
VARIANCE OF REGRESSAND SHOT PUT = 3822.648492852 DF= 47
RESIDUAL VARIANCE= 1946.51700256 DF= 46
R=0.708256  R^2=0.501627  F= 46.3004930996

STOP F3: CORRELATIONS OF ESTIMATED COEFFICIENTS,  F8: RESIDUALS
:  (F8)
RESIDUALS:
SURVO 76 FILE DECA
M= 13  M(MAX)= 20  N= 48  N(MAX)= 60  L= 20
VARIABLES:      X( 1 )=POINTS   X( 2 )=100M     X( 3 )=BR.JUMP
X( 4 )=SHOT PUT X( 5 )=HI JUMP  X( 6 )=400M     X( 7 )=HURDLES
X( 8 )=DISCUS   X( 9 )=POLE VLT X( 10 )=JAVELIN X( 11 )=1500M
X( 12 )=HEIGHT  X( 13 )=WEIGHT

 IN USE:        X( 1 )=POINTS   X( 2 )=100M     X( 3 )=BR.JUMP
X( 4 )=SHOT PUT X( 5 )=HI JUMP  X( 6 )=400M     X( 7 )=HURDLES
X( 8 )=DISCUS   X( 9 )=POLE VLT X( 10 )=JAVELIN X( 11 )=1500M
X( 12 )=HEIGHT  X( 13 )=WEIGHT
                OBSERVATIONS 1 - 48
OBS.NAME      SHOT PUT        F          SHOT PUT - F
SKOWRONE      725.0000      711.5940       13.40595
HEDMARK       814.0000      769.1482       44.85174
LE ROY        799.0000      769.1482       29.85174
ZEILBAUE      793.0000      730.7787       62.22121
-------------------------------------------------------
HUISCHEN      712.0000      724.3839      -12.38387
WANAMAKE      685.0000      756.3584      -71.35843
NOVIK         742.0000      692.4093       49.59069
SAMARA        604.0000      705.1991     -101.19913
SCHOEBEL      647.0000      756.3584     -109.35843
BOGDAN        722.0000      711.5940       10.40595
DZHUROV       835.0000      788.3329       46.66700
R=0.7982563 R^2=0.5016277
TOTAL VARIANCE= 3822.648492979 DF= 47
RESIDUAL VARIANCE = 1946.517002604 DF= 46
COEFFICIENT OF DETERMINATION = .5016277797919
SKEWNESS=-.6121829860023 EXCESS=-.293091055517
DURBIN-WATSON= 1.422616220663

STOP
:
```

CURVE will be selected to plot the regression line on the previous scatter diagram.

The equation of the regression line is to be written as a subroutine on line 100.

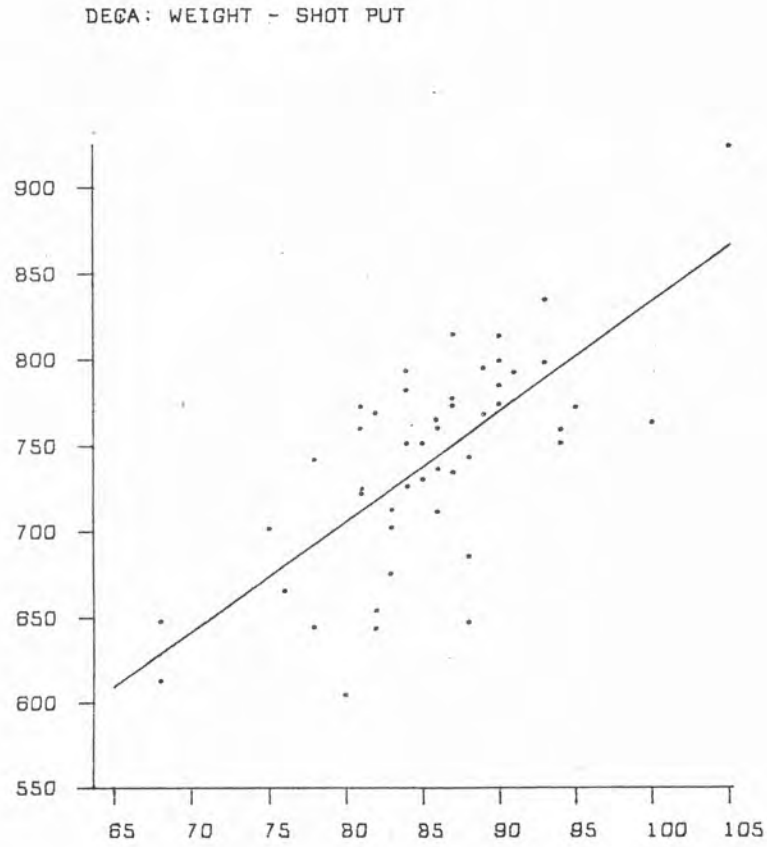
(F16)

```
STATISTICAL DATA PROCESSING SYSTEM SURVO 76
 1= MENU          2= GUIDE         3= DATA          4= DATA2
 5= UNI           6= CORR          7= SORT          8= CHANCE
 9= TABLE        10= PLOT         11= DIAGRAM      12= FRAME
13= LINREG       14= NONLIN       15= PCOMP        16= SPECTRUM
17= ANOVA        18= HISTO        19= FACTA        20= RESTREG
21= CURVE        22= MATRI        23= DISTRIBS     24= MANOVA
25= DISCRI       26= CLASSI       27= LINCO        28= SURFACE

SELECT A SURVO 76 MODULE (NUMBER OR NAME)? 21
CURVE/SM, CURVE PLOTTING ON PLOTTER 2212:
THE EQUATION OF THE CURVE MUST BE WRITTEN AS A SUBROUTINE
ON THE LINES 100-129 IN A PARAMETRIC FORM
100 X=X(T):Y=Y(T):RETURN

F1: BASIC START (COORDINATE AXES ALREADY PLOTTED BY "DIAGRAM")
F2: BASIC START (NO COORDINATE AXES PLOTTED)
F10:WRITING ADDITIONAL TEXT IN THE GRAPH

IF F2 HAS BEEN USED AS THE BASIC START,
COORDINATE AXES CAN BE PLOTTED USING F-KEYS AS FOLLOWS:
F12: X-AXIS ON THE RIGHT,    F13: X-AXIS ON THE LEFT,
F28: Y-AXIS UPWARDS,         F29: Y-AXIS DOWNWARDS.
STOP
:100 X=T:Y=5.395*X+193.606:RETURN
:
```

(F1)

```
FOR PLOTTING CERTAIN ADDITIONAL INFORMATION IS NEEDED:

LIMITS OF THE PARAMETER T:
LOWER LIMIT, UPPER LIMIT? 55,105                0 , 0


CHOOSE APPROPRIATE MINIMUM AND MAXIMUM STEP LENGTHS
FOR THE PEN WHEN PLOTTING:
MINIMUM, MAXIMUM (UNIT 0,1 MM)? 300,1000        3 , 30
SELECT A PEN (1,2 OR 3)? 3                      0
```

For a straight line long steps can be used.



(F16)

```
STATISTICAL DATA PROCESSING SYSTEM SURVO 76
 1= MENU          2= GUIDE         3= DATA          4= DATA2
 5= UNI           6= CORR          7= SORT          8= CHANCE
 9= TABLE        10= PLOT         11= DIAGRAM      12= FRAME
13= LINREG       14= NONLIN       15= PCOMP        16= SPECTRUM
17= ANOVA        18= HISTO        19= FACTA        20= RESTREG
21= CURVE        22= MATRI        23= DISTRIBS     24= MANOVA
25= DISCRI       26= CLASSI       27= LINCO        28= SURFACE

SELECT A SURVO 76 MODULE (NUMBER OR NAME)? 15
SURVO 76: PRINCIPAL COMPONENT ANALYSIS/SM
F1: BASIC START
F2: PRINTOUT
F3: SAVING PRINCIPAL COMPONENT MATRIX ON DISK
F4: MANUAL INPUT AND SAVING OF PRINCIPAL COMPONENT MATRIX

A CORRELATION FILE MUST HAVE BEEN PREVIOUSLY CREATED BY "CORR".

STOP
:
```

(F1)

```
SURVO 76: PRINCIPAL COMPONENT ANALYSIS/SM
NAME OF CORRELATION FILE? DECORR
CORRELATION FILE: DECORR     OBS. SKOWRONE-DZHUROV VARIABLES:
X( 1 )=POINTS   X( 2 )=100M      X( 3 )=BR.JUMP  X( 4 )=SHOT PUT
X( 5 )=HI JUMP  X( 6 )=400M      X( 7 )=HURDLES  X( 8 )=DISCUS
X( 9 )=POLE VLT X( 10 )=JAVELIN X( 11 )=1500M   X( 12 )=HEIGHT
X( 13 )=WEIGHT
SELECT VARIABLES (1=YES,0=NO):
POINTS? 0          1
100M?              1
BR.JUMP?           1
SHOT PUT?          1
HI JUMP?           1
400M?              1
HURDLES?           1
DISCUS?            1
POLE VLT?          1
JAVELIN?           1
1500M?             1
HEIGHT? 0          1
WEIGHT? 0          1
STARTING POINT FOR THE ANALYSIS:
1: CORRELATION MATRIX
2: CORRELATION MATRIX (MAX R ON THE DIAGONAL)
3: VARIANCE-COVARIANCE MATRIX
SELECT 1,2 OR 3? 2
EIGENVALUES AND VECTORS WILL BE COMPUTED:
HOW MANY PRINCIPAL COMPONENTS? 4
CONSTANT OF ACCURACY?          0.0001
```

To compute the eigenvalues and vectors a submodule EIGEN of SURVO 76 is employed.

EIGEN gives continuously on CRT information of the computations. This information is not included here.

```
DATA FILE: DECA   OBSERVATIONS 1 - 48
PRINCIPAL COMPONENT MATRIX: (MAX R)
                1       2       3       4
100M     -0.139  0.731 -0.104 -0.046
BR.JUMP   0.028  0.334  0.467  0.037
SHOT PUT 0.781  0.127 -0.269  0.141
HI JUMP  0.377 -0.377  0.292  0.038
400M     -0.519  0.415 -0.040  0.270
HURDLES   0.050  0.492  0.197  0.088
DISCUS    0.839  0.142 -0.117  0.054
POLE VLT-0.198  0.032  0.028 -0.419
JAVELIN   0.169 -0.197  0.295  0.182
1500M    -0.628 -0.392 -0.150  0.246
EIG.VAL   2.215  1.435  0.553  0.371

STOP
:
```

(F3)

```
SAVING OF PRINCIPAL COMPONENT MATRIX ON DISK:
NAME OF FILE FOR THE PRINCIPAL COMPONENT MATRIX? DECOMP
IS THE FILE NEW(=0) OR OLD(=1)? 0
A NEW MATRIX FILE DECOMP WILL BE CREATED:
MAXIMUM NUMBER OF ELEMENTS? 100

STOP PRINCIPAL COMPONENT MATRIX SAVED.
:
```

(F16)

```
STATISTICAL DATA PROCESSING SYSTEM SURVO 76
 1= MENU          2= GUIDE         3= DATA          4= DATA2
 5= UNI           6= CORR          7= SORT          8= CHANCE
 9= TABLE        10= PLOT         11= DIAGRAM      12= FRAME
13= LINREG       14= NONLIN       15= PCOMP        16= SPECTRUM
17= ANOVA        18= HISTO        19= FACTA        20= RESTREG
21= CURVE        22= MATRI        23= DISTRIBS     24= MANOVA
25= DISCRI       26= CLASSI       27= LINCO        28= SURFACE

SELECT A SURVO 76 MODULE (NUMBER OR NAME)? 19
FACTOR ANALYSIS: ORTHOGONAL ROTATIONS/SM
F1: BASIC START
F2: ROTATION CONTINUES
F3: PRINTOUT
```

```
BY "FACTA" OTHOGONAL ROTATIONS CAN BE PERFORMED ON CRT.
    THE FACTOR MATRIX TO BE ROTATED MUST BE PREVIOUSLY EVALUATED
    AND SAVED IN A MATRIX FILE USING "PCOMP".
ROTATION IS CARRIED OUT AS A SERIES OF 2-DIMENSIONAL ROTATIONS.
EACH 2-DIMENSINAL ROTATION IS PERFORMED ON CRT BY MOVING
THE CURSOR TO THE DESIRED POSITION OF A NEW FACTOR AXIS.
THEN ROTATION TAKES PLACE BY PRESSING KEY . (FULL STOP)
CURSOR CAN BE MOVED BY KEYS U=UP, D=DOWN, L=LEFT, R=RIGHT.
SUGGESTIONS FOR ROTATIONS ARE GIVEN BY  X=VARIMAX, Q=QUARTIMAX.
STOP
:
```

(F1)

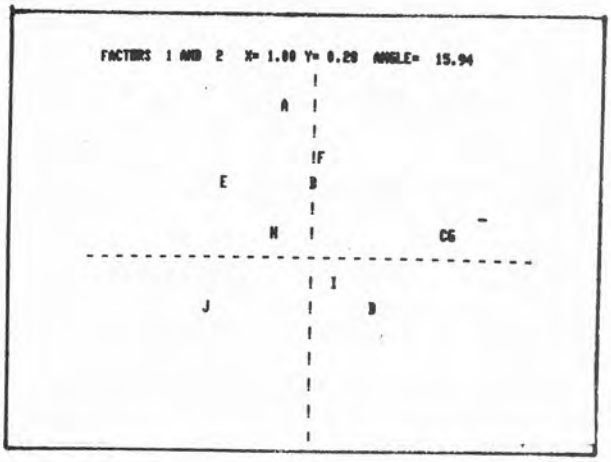
```
MATRIX FILE CONTAINING THE FACTOR MATRIX TO BE ROTATED? DECOMP
FACTOR MATRIX TO BE ROTATED:
                1       2       3       4      H↑2
100M      A -0.139   0.731  -0.104  -0.046   0.567
BR.JUMP   B  0.023   0.334   0.467   0.037   0.333
SHOT PUT  C  0.781   0.127  -0.269   0.141   0.719
HI JUMP   D  0.377  -0.377   0.292   0.038   0.372
400M      E -0.519   0.415  -0.040   0.279   0.517
HURDLES   F  0.050   0.492   0.197   0.088   0.291
DISCUS    G  0.839   0.142  -0.117   0.054   0.742
POLE VLT  H -0.198   0.032   0.028  -0.410   0.209
JAVELIN   I  0.169  -0.197   0.295   0.182   0.188
1500M     J -0.628  -0.392  -0.150   0.246   0.632
HOW MANY FACTORS IN ROTATION? 3        4

                1       2       3      H↑2
100M      A -0.139   0.731  -0.104   0.565
BR.JUMP   B  0.023   0.334   0.467   0.331
SHOT PUT  C  0.781   0.127  -0.269   0.699
HI JUMP   D  0.377  -0.377   0.292   0.370
400M      E -0.519   0.415  -0.040   0.444
HURDLES   F  0.050   0.492   0.197   0.284
DISCUS    G  0.839   0.142  -0.117   0.739
POLE VLT  H -0.198   0.032   0.028   0.041
JAVELIN   I  0.169  -0.197   0.295   0.154
1500M     J -0.628  -0.392  -0.150   0.571
SELECT 2 FACTOR AXES ?                    1 , 2
```

FACTA has been selected for factor rotation.
The "cartoon" on the next page shows
how the rotation can be carried out on CRT.

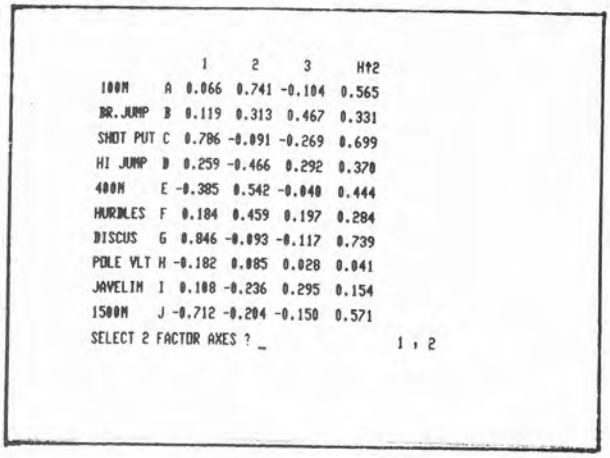
The final result according to Varimax criterion:

(F3)

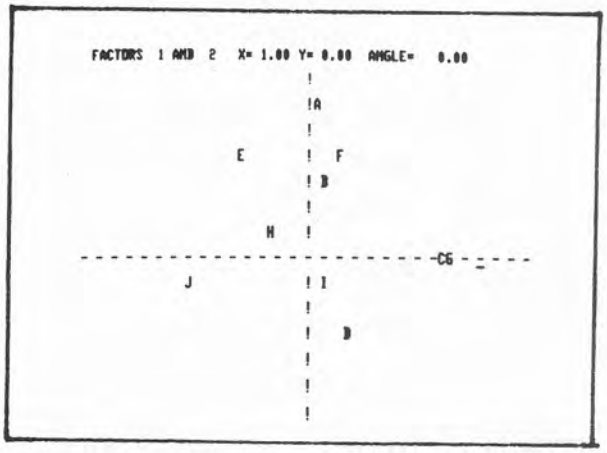
```
DATA FILE: DECA  OBSERVATIONS 1 - 48
ROTATED FACTOR MATRIX:

                1       2       3      H↑2
100M      A  0.039   0.610   0.437   0.565
BR.JUMP   B -0.055  -0.088   0.566   0.331
SHOT PUT  C  0.835  -0.014  -0.027   0.699
HI JUMP   D  0.190  -0.577  -0.033   0.370
400M      E -0.393   0.489   0.223   0.444
HURDLES   F  0.078   0.185   0.493   0.284
DISCUS    G  0.845  -0.123   0.093   0.739
POLE VLT  H -0.187   0.073   0.025   0.041
JAVELIN   I  0.028  -0.384   0.078   0.154
1500M     J -0.612   0.055  -0.439   0.571

ROTATION MATRIX:
                1       2       3
        1   0.931  -0.352   0.087
        2   0.188   0.573   0.714
        3  -0.310  -0.649   0.694
```



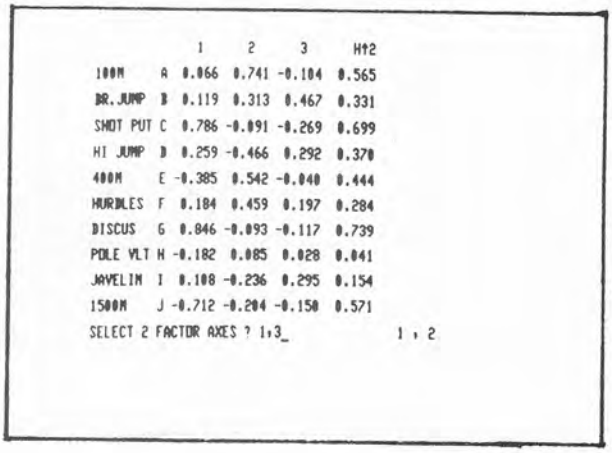
1. Factors 1 and 2 have been selected and the cursor has been moved to indicate the new position of x-axis.



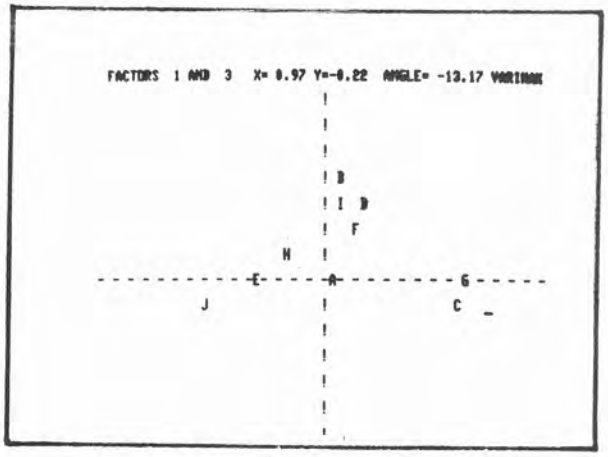
2. Key . has been pressed to perform the indicated rotation. The rotated factor matrix is displayed.



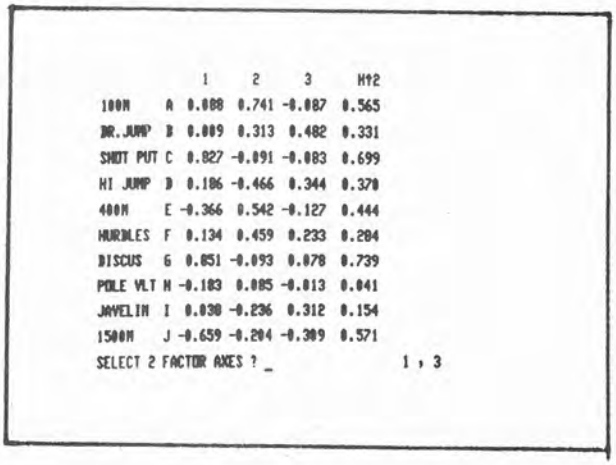
3. RETURN pressed to show the rotated axes.



4. RETURN has been pressed again to select factors 1 and 3.



5. X has been pressed to show the position of x-axis suggested by Varimax.



6. Key . has been pressed to perform the rotation according to Varimax. The rotated matrix is displayed.