RESEARCH REPORT

SURVO 84
Interactive system for statistical computing,
graphics and text processing

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No. 51

August 1984

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SF 00100 HELSINKI 10 FINLAND

ISBN 951-45-3439-5
ISSN 0357-9778

SURVO 84 - interactive system for statistical computing, graphics and text processing

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SURVO 84 - interactive system for statistical computing, graphics and text processing

SURVO 84 is an integrated interactive statistical system for statistical computing. SURVO 84 also includes many supporting functions in text processing, graphics and mathematics for such users who need a handy workstation for various practical tasks occuring in their work.

All the activities in SURVO 84 are controlled from the SURVO 84 EDITOR which is a general text processing program. Besides standard word processing this editor provides several enhancements not encountered in typical text processing systems.

SURVO 84 can also be compared with spreadsheet programs to some extent. However, in SURVO 84 the calculations take place in the edit field which simultaneously is the basis for text processing, graphics and all other functions. In the edit field the user can control each character separately. In spreadsheet programs it is typical that some larger unit like 'number' or 'word' is the smallest representable entity.

We call our approach editorial mode. The idea of editorial mode was introduced in SURVO 76 which is an interactive statistical system for the Wang 2200 series. The present version of SURVO 84 runs on Wang PC.

Working with SURVO 84

The edit field is like a notebook for the user. He/she can write text and numbers in any place. Text and numerical tables are edited by function keys and editing commands.

Also information from various files (for instance, from any text file) can be moved to the edit field for editing and processing. Furthermore SURVO 84 provides data files for larger data sets which are needed, for example, in statistical analysis. Also many activities required in data base management are available.

The results of various computational operations are immediately displayed in the edit field, but they may also be directed to output files or to the printer.

A very essential feature in SURVO 84 is that all commands and operations are also written in the edit field. An operation is activated by moving the cursor to the operation line and by pressing the COMMAND key. Since the operations reside among the text, it is simple to edit and reactivate them. Unnecessary operations can, of course, be immediately erased.

From various commands and operations the users can build programs for their applications. We call these programs work schemes, since they get their quidance not only from operations, but also from

various keywords and specifications written around the program in the same edit field. The user maintains work schemes like any text and stores them with the edit field. Typical small work schemes will be shown at the end of this paper.

SURVO 84 operations

SURVO 84 includes now (August 1984) about 200 operations from the following areas:

1. Text editing and control of the edit field
2. Data management
3. Mathematics
   - Simple arithmetics and evaluation of numerical expressions
   - Arithmetics with numerical tables
   - Special 'Touch mode' for arithmetics and calculation with tables
   - Matrix operations (an extensive matrix interpreter)
   - Evaluation of symbolic derivatives
4. Graphics
   - Bar charts (8 different types)
   - Pie charts, Matrix diagrams, Age pyramids
   - Histograms and fitting of statistical distributions
   - Scatter diagrams (correlation diagrams)
   - Time series plots and line graphs
   - Probability plots (normal distribution)
   - Curves and families of analytic curves
   - Representation of multivariate data (Chernoff's faces, Andrews' function plots)
5. Statistical analysis
   - Basic statistics, frequency distributions and tables
   - Transformation of variables
   - Data sorting and order statistics
   - Linear and non-linear regression analysis
   - Correlations, principal components and factor analysis
   - Discriminant analysis and canonical correlations (with the matrix interpreter)
6. Simulation
   - Generating artificial data according to statistical models

Documentation

All documentation of SURVO 84 is based on a dynamic inquiry system. It is a fundamental part of SURVO 84 and always easily accessed without losing contact to the current job. During queries information and examples are displayed in a temporary window. When desired, that information may be loaded to the edit field or printed on paper.

SURVO 84 can also be used in a special tutorial mode which permits saving of each key stroke in a tutor file. Such a tutor file may be edited with the SURVO 84 EDITOR and various sessions with SURVO 84 can be repeated step by step under the control of tutors. Teaching programs for SURVO 84 and its applications can be made in tutorial mode.

Hardware requirements

The present SURVO 84 version can be run on Wang PC with a 256KB memory, a medium resolution graphics card and a 10MB Winchester. In graphics SURVO 84 supports the EPSON RX printers and SERVOGOR 281 and 284 plotters. SURVO 84 includes over 250 program modules and system files which require space over 2MB on the Winchester disk.

Examples

On the following pages 48 typical SURVO 84 applications are presented. Although we have tried to give a cross section of the current SURVO 84 functions, not all features are included. For example, some topics related to table and file management, especially 'touch mode', are not covered, since paper is too rigid a medium for showing these dynamic actions.

Each example is illustrated with two exhibits. The first one usually describes the situation in the edit field before activation of a certain operation or a series of operations. The second one tells what is seen on the screen after the operations have been completed. The activated lines are always displayed in reversed mode.

SURVO 84 EDITOR displays continuously the current date and time on the top line. In this case the time elapsed between two consecutive pictures does not tell anything about the speed, since each hard-copy took time over 6 minutes + a random time depending on the alertness of the author when preparing these examples.

The pictures are produced by the hardcopy utility of SURVO 84 on the EPSON RX-80 printer or on the SERVOGOR 281 plotter. Most of the exhibits have been reduced by 50 per cent in scale before printing. The text is printed by the PRINT operation of SURVO 84 on the same printer.

TRIM is a typical SURVO 84 operation for text editing.
When hyphenating words, the simple rules of the Finnish language
seem to work rather satisfactorily in other languages, too.
SAVE TRIM on the first line in the edit field is an operation
for saving the contents of the current edit field to file TRIM.

```
■ 9  1 SURVO 84 EDITOR  07-22-1984  15:30:56          A: 100  100  28580  0
  1 *SAVE TRIM
  2 *
  3 *
  4 *
  5 *TRIM3 55
  6 * The line length in any text can be altered by a TRIM (or T) operation.
  7 *It has various forms. We show the idea of TRIM by changing the line
  8 *legth of this chapter to 55. We use TRIM3 which allows the words to
  9 *be splitted according to the rules of the Finnish language.
 10 * In most cases the result is adequate for English, too. If not, it is
 11 *easy to make adjustments by simple editing.
 12 *
 13 *
 14 *
 15 *
 16 *
 17 *
 18 *
 19 *
 20 *
 21 *
 22 *
 23 *
```

```
■ 9  1 SURVO 84 EDITOR  07-22-1984  15:38:46          A: 100  100  29752  0
  1 *SAVE TRIM
  2 *
  3 *
  4 *
  5 *TRIM3 55
  6 * The line length in any text can be altered by a TRIM
  7 *(or T) operation. It has various forms. We show the
  8 *idea of TRIM by changing the line legth of this chapter
  9 *to 55. We use TRIM3 which allows the words to be split-
 10 *ted according to the rules of the Finnish language.
 11 * In most cases the result is adequate for English, too.
 12 *If not, it is easy to make adjustments by simple edi-
 13 *ting.
 14 *
 15 *
 16 *
 17 *
 18 *
 19 *
 20 *
 21 *
 22 *
 23 *
```

All the special display modes of the computer are supported by the SURVO 84 EDITOR. Some of them (like blinking) cannot be seen on paper.
The PRINT operation for making printouts on paper has several forms. Here the simplest one is employed. This document has been printed by using one PRINT operation.

```
■ 11  1 SURVO 84 EDITOR  08-17-1984  18:34:23          A: 100  100  27047  0
  1 *SAVE PRINT
  2 *
  3 *
  4 *
  5 *Text and tables in the edit field are printed on paper by a PRINT
  6 *operation.
  7 *
  8 *On the screen the current display mode is selected by one special
  9 *function key (F5:FORMAT), which gives in turn:
 10 *   0  normal
 11 *   1  bold              SURVO 84
 12 *   2  subscript         A1,A2,...,An
 13 *   3  superscript       X3+aX2+bx+c=0
 14 *   4  underscore        SURVO 84
 15 *   5  blinking          SURVO 84
 16 *   6  overscore
 17 *   7  reversed video    SURVO 84
 18 *
 19 *On the EPSON-RX printer also some display modes are supported.
 20 *
 21 *PRINT 5,19
 22 *
 23 *
```

Text and tables in the edit field are printed on paper by a PRINT operation.

On the screen the current display mode is selected by one special function key (F5:FORMAT), which gives in turn:

0	normal	
1	bold	SURVO 84
2	subscript	$A_1,A_2,\ldots,A_n$
3	superscript	$X^3+aX^2+bx+c=0$
4	underscore	SURVO 84
5	blinking	*SURVO 84*
6	overscore	
7	reversed video	SURVO 84

On the EPSON-RX printer also some display modes are supported.

When data in tabular form is entered, it is not necessary to keep the columns aligned. A good order can be reached any time by using a FORM operation (here on line 5) which aligns the columns according to the masks on the image line 6.

```
@ 13  1 SURVO 84 EDITOR  07-24-1984  10:33:30          A: 100  100  28957  0
  1 #SAVE FORM
  2 #
  3 #Table formatting by a FORM operation:
  4 #
  5 #FORM 11,22,6  / Lines 11-22 to be formatted according to line 6
  6 #  XXXXXXXXXX   12.1   1.12   123.1 123.1   1.1
  7 #
  8 #  Yearly consumption of various beverages per inhabitant
  9 #  Country       Coffee   Tea     Beer  Wine Spirits
 10 #                  (kg)   (kg)     (l)   (l)   (l)
 11 #Italy     3.6 0.06 13.6 106.6 2.0
 12 #Portugal 2.2 0.03 27.5 89.3 0.9
 13 #Norway    9.4 0.19 43.5 3.1 1.8
 14 #Spain     2.5 0.03 43.6 73.2 2.7
 15 #France    5.2 0.10   44.5 104.3 2.5
 16 #Finland   12.5 0.15 54.7 7.6 2.7
 17 #Sweden    12.9 0.30 58.3  7.9 2.9
 18 #Switzerland 9.1 0.25 73.5 44.9 2.1
 19 #Holland   9.2 0.58 75.5 9.7  2.7
 20 #England   1.8 3.49 113.7 5.1 1.4
 21 #Denmark   11.8 0.41 113.9 10.4 1.7
 22 #Ireland   0.2 3.73 124.5 3.8 1.9
 23 #
```

```
@ 13  1 SURVO 84 EDITOR  07-24-1984  10:41:10          A: 100  100  29765  0
  1 #SAVE FORM
  2 #
  3 #Table formatting by a FORM operation:
  4 #
  5 #FORM 11,22,6  / Lines 11-22 to be formatted according to line 6
  6 #  XXXXXXXXXX   12.1   1.12   123.1 123.1   1.1
  7 #
  8 #  Yearly consumption of various beverages per inhabitant
  9 #  Country       Coffee   Tea     Beer  Wine Spirits
 10 #                  (kg)   (kg)     (l)   (l)   (l)
 11 #  Italy          3.6    0.06    13.6 106.6   2.0
 12 #  Portugal       2.2    0.03    27.5  89.3   0.9
 13 #  Norway         9.4    0.19    43.5   3.1   1.8
 14 #  Spain          2.5    0.03    43.6  73.2   2.7
 15 #  France         5.2    0.10    44.5 104.3   2.5
 16 #  Finland       12.5    0.15    54.7   7.6   2.7
 17 #  Sweden        12.9    0.30    58.3   7.9   2.9
 18 #  Switzerland    9.1    0.25    73.5  44.9   2.1
 19 #  Holland        9.2    0.58    75.5   9.7   2.7
 20 #  England        1.8    3.49   113.7   5.1   1.4
 21 #  Denmark       11.8    0.41   113.9  10.4   1.7
 22 #  Ireland        0.2    3.73   124.5   3.8   1.9
 23 #
```

As a simple example of table management, sorting according to a certain column in the table is performed.
Here the countries are sorted in ascending order with respect to 'Wine consumption' by activating a SORT operation on line 25.
The mask '11111' on the image line tells the sort key.
To sort the countries in descending order, it is enough to change word 'SORT' to '-SORT' and activate again.

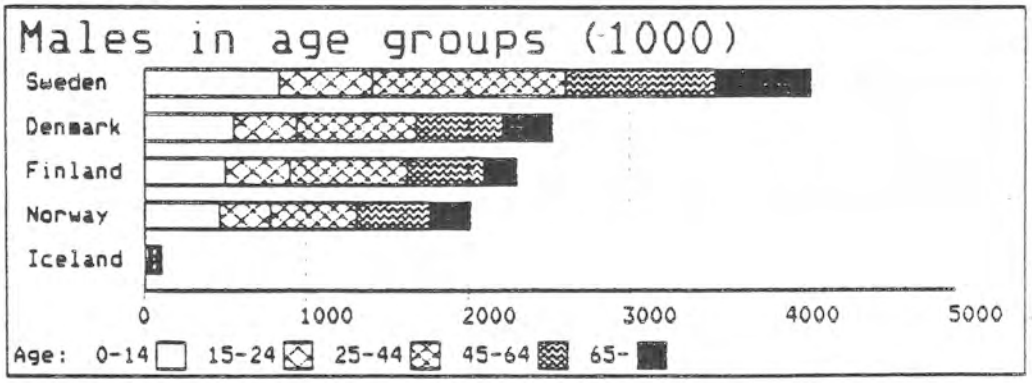
```
■ 14  1 SURVO 84 EDITOR  07-24-1984  10:50:36          A: 100  100  28468  0
  7 *
  8 *  Yearly consumption of various beverages per inhabitant
  9 *  Country       Coffee   Tea    Beer   Wine  Spirits
 10 *                (kg)    (kg)    (l)    (l)    (l)
 11 *  Italy          3.6    0.06   13.6  106.6    2.0
 12 *  Portugal       2.2    0.03   27.5   89.3    0.9
 13 *  Norway         9.4    0.19   43.5    3.1    1.8
 14 *  Spain          2.5    0.03   43.6   73.2    2.7
 15 *  France         5.2    0.10   44.5  104.3    2.5
 16 *  Finland       12.5    0.15   54.7    7.6    2.7
 17 *  Sweden        12.9    0.30   58.3    7.9    2.9
 18 *  Switzerland    9.1    0.25   73.5   44.9    2.1
 19 *  Holland        9.2    0.58   75.5    9.7    2.7
 20 *  England        1.8    3.49  113.7    5.1    1.4
 21 *  Denmark       11.8    0.41  113.9   10.4    1.7
 22 *  Ireland        0.2    3.73  124.5    3.8    1.9
 23 *                                     11111
 24 *
 25 *SORT 11,22,23  / Sorting lines 11-22 according to image line 23
 26 *
 27 *
 28 *
 29 *
```

```
■ 14  1 SURVO 84 EDITOR  07-24-1984  10:58:21          A: 100  100  29684  0
  7 *
  8 *  Yearly consumption of various beverages per inhabitant
  9 *  Country       Coffee   Tea    Beer   Wine  Spirits
 10 *                (kg)    (kg)    (l)    (l)    (l)
 11 *  Norway         9.4    0.19   43.5    3.1    1.8
 12 *  Ireland        0.2    3.73  124.5    3.8    1.9
 13 *  England        1.8    3.49  113.7    5.1    1.4
 14 *  Finland       12.5    0.15   54.7    7.6    2.7
 15 *  Sweden        12.9    0.30   58.3    7.9    2.9
 16 *  Holland        9.2    0.58   75.5    9.7    2.7
 17 *  Denmark       11.8    0.41  113.9   10.4    1.7
 18 *  Switzerland    9.1    0.25   73.5   44.9    2.1
 19 *  Spain          2.5    0.03   43.6   73.2    2.7
 20 *  Portugal       2.2    0.03   27.5   89.3    0.9
 21 *  France         5.2    0.10   44.5  104.3    2.5
 22 *  Italy          3.6    0.06   13.6  106.6    2.0
 23 *                                     11111
 24 *
 25 *SORT 11,22,23  / Sorting lines 11-22 according to image line 23
 26 *
 27 *
 28 *
 29 *
```

A typical bar chart is made from the data given in the edit field. Observe that, for example, scaling on the X axis is automatically selected by the PLOT operation on the basis of the data values. Also shadings for different age groups are chosen by the system. All these details can, of course, be determined by the user by entering proper specifications.

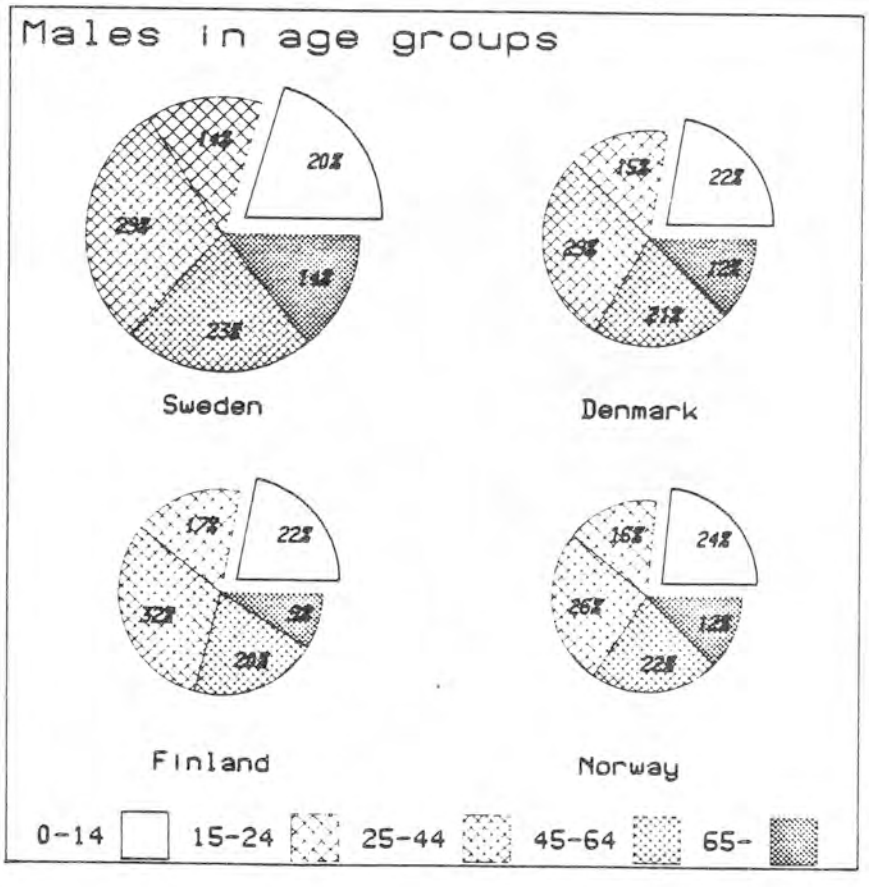
```
12  1 SURVO 84 EDITOR  07-21-1984  15:58:41          A: 100  72  31830  0
 1 * DATA NORDIC,A,8,M
 2 M Country _0-14 15-24 25-44 45-64   65-
 3 A Sweden    841   571  1188   930   585
 4 * Denmark   564   385   731   537   308
 5 * Finland   506   399   727   468   202
 6 * Norway    474   316   534   442   251
 7 B Iceland    32    22    29    20    10
 8 *
 9 *HEADER=(2,3),Males_in_age_groups_(1000) LEGEND=Age: GRID=1000 TICK=100
10 *HOME=70,0 SIZE=729,300 YDIV=70,180,50
11 *PLOT NORDIC
12 *
13 *
14 *
15 *
16 *
17 *
18 *
19 *
20 *
21 *
22 *
23 *
```

```
12  1 SURVO 84 EDITOR  07-21-1984  16:26:25          A: 100  72  33073  0
 1 * DATA NORDIC,A,8,M
 2 M Country _0-14 15-24 25-44 45-64   65-
 3 A Sweden    841   571  1188   930   585
 4 * Denmark   564   385   731   537   308
 5 * Finland   506   399   727   468   202
 6 * Norway    474   316   534   442   251
 7 B Iceland    32    22    29    20    10
 8 *
 9 *HEADER=(2,3),Males_in_age_groups_(1000) LEGEND=Age: GRID=1000 TICK=100
10 *HOME=70,0 SIZE=729,300 YDIV=70,180,50
11 *PLOT NORDIC
12 *
13 *
14 *
15 *
16 *
17 *
18 *
19 *
20 *
21 *
22 *
23 *
```



These pie charts are plotted on the SERVOGOR plotter (DEVICE=S).
The type of the graph is selected by TYPE=PIE.
The fills in various sectors are determined by SHADING where numbers in parentheses refer to pens (colors).
The parameters given in parentheses in HEADER, for example, refer to pen, letter size, letter height etc.

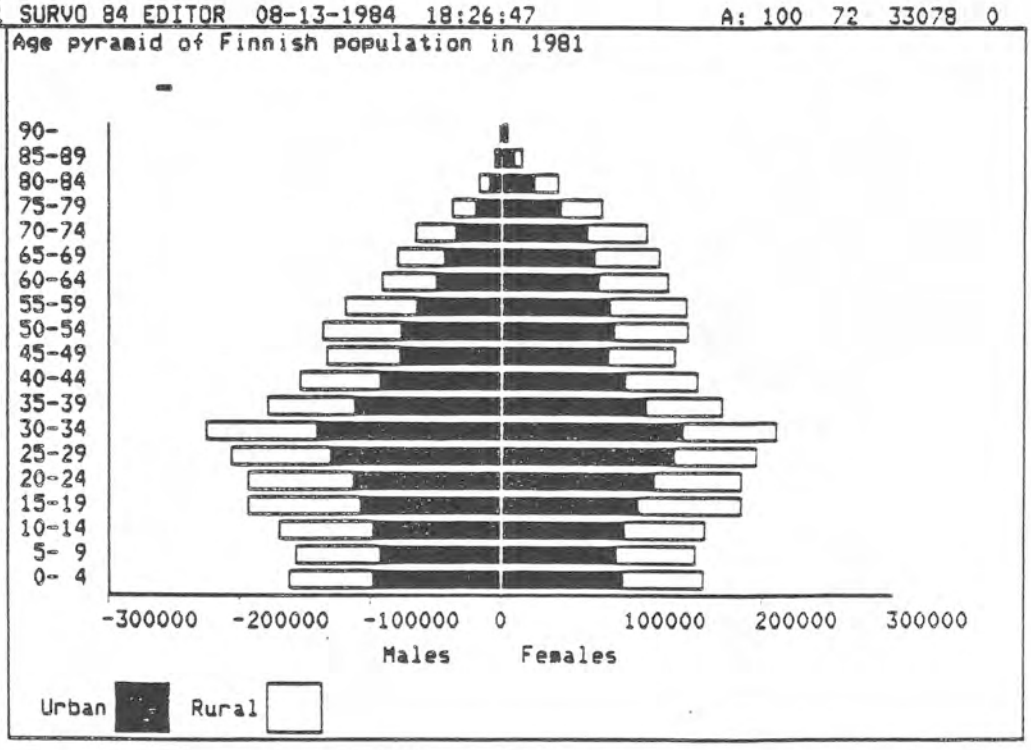
```
■ 15  1 SURVO 84 EDITOR  08-20-1984  14:15:37          A: 100  100  29804  0
  1 *
  2 *
  3 *DATA COUNTRIES,A,B,M
  4 M COUNTRY _0-14 15-24 25-44 45-64   65-
  5 A Sweden    841   571  1188   930   585
  6 * Denmark   564   385   731   537   308
  7 * Finland   506   399   727   468   202
  8 B Norway    474   316   534   442   251
  9 *
 10 *PLOT COUNTRIES
 11 *TYPE=PIE SHADING=0(1)P,2(2),4(2),6(2),8(2)
 12 *VALUES=(1,30,25,1,2),##%,7
 13 *HEADER=(1,50,60,0,3),Males_in_age_groups
 14 *DEVICE=S PEN=1,35,35,0,3
 15 *
 16 *
 17 *
 18 *
 19 *
 20 *
 21 *
 22 *
 23 *
```



One special form of bar charts in an age pyramid (TYPE=PYRAMID).

```
■ 13  1 SURVO 84 EDITOR  08-13-1984  18:15:54          A: 100  72  31839  0
  69 #HEADER=Age_pyramid_of_Finnish_population_in_1981
  70 #PLOT FINLAND_ / TYPE=PYRAMID
  71 #TEXT=SEX SEX=Males_____Females,275,70
  72 #SHADING=0,10,10,0 HOME=70,0 SIZE=729,576 LEGEND=_  XDIV=79,600,100
  73 #DATA FINLAND,X,Y,Z
  74 *          Males                 Females
  75 Z Age      Urban       RuraI     Urban       Rural
  76 X _0-_4    98297       64141     94036       61476
  77 * _5-_9    92198       64997     87882       61428
  78 * 10-14    97692       71849     94557       62239
  79 * 15-19   107942       84661    105762       79183
  80 * 20-24   113227       79993    116625       67403
  81 * 25-29   129741       76574    132092       64212
  82 * 30-34   140428       84486    138585       72422
  83 * 35-39   111781       66638    110621       58569
  84 * 40-44    92445       61069     94446       55852
  85 * 45-49    77049       55753     81436       51374
  86 * 50-54    76963       59786     85871       57149
  87 * 55-59    65116       53909     83273       58700
  88 * 60-64    49770       41449     74286       53148
  89 * 65-69    43081       36557     70859       50219
  90 * 70-74    34993       30922     65574       45777
  91 * 75-79    19771       18630     45057       32336
```

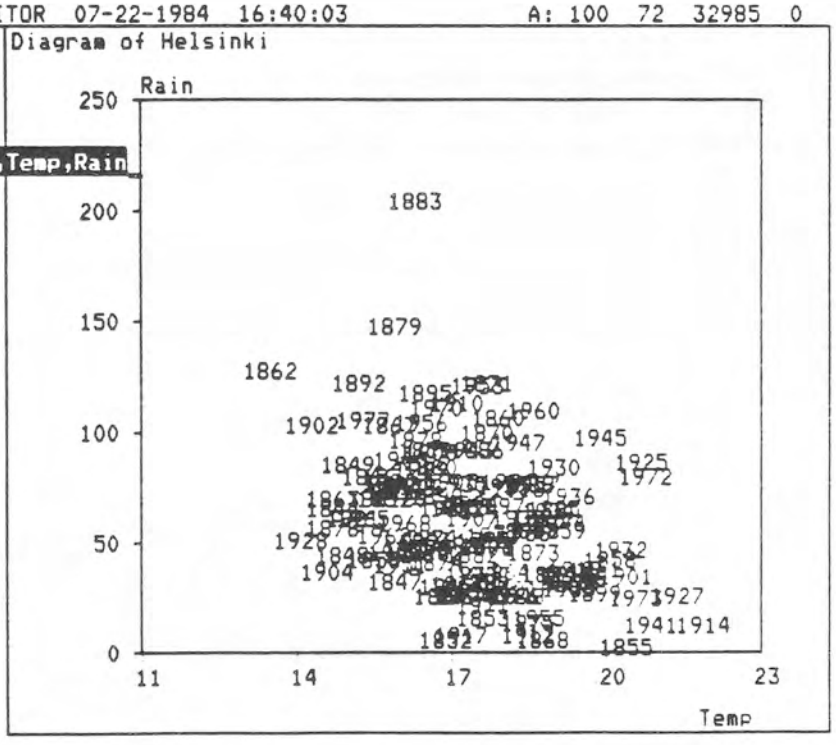
```
■ 13  1 SURVO 84 EDITOR  08-13-1984  18:26:47          A: 100  72  33078  0
```



A typical scatter diagram of two variables:
The correlation between rainfall and mean temperature in July for 135 consecutive years is displayed. Due to the specification POINT=Year each point in this scatter diagram is annotated by 'Year' thus giving possibility to detect exceptional years immediately. For example, summer of 1883 must have been extremely wet in Helsinki. The scalings are selected by the system.

```
■ 24  1 SURVO 84 EDITOR  07-22-1984  16:30:34          A: 100  72  31063  0
 24 *
 25 *
 26 *
 27 *
 28 *PLOT Helsinki,Temp,Rain
 29 *POINT=Year
 30 *
 31 *
 32 *
 33 *
 34 *
 35 *
 36 *
 37 *
 38 *
 39 *
 40 *
 41 *
 42 *
 43 *
 44 *
 45 *
 46 *
```

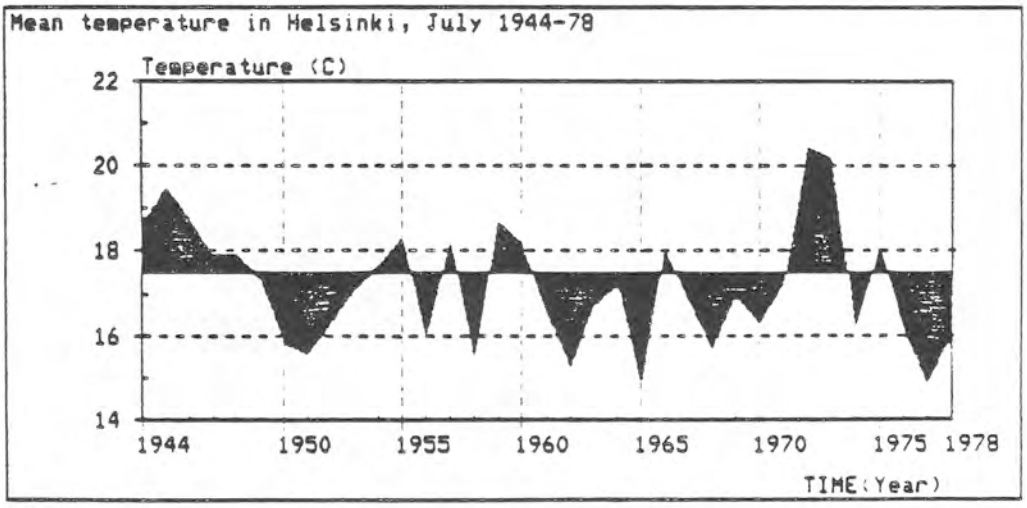
```
■ 24  1 SURVO 84 EDITOR  07-22-1984  16:40:03          A: 100  72  32985  0
 24 *
 25 *
 26 *
 27 *
 28 *PLOT Helsinki,Temp,Rain
 29 *POINT=Year
 30 *
 31 *
 32 *
 33 *
 34 *
 35 *
 36 *
 37 *
 38 *
 39 *
 40 *
 41 *
 42 *
 43 *
 44 *
 45 *
 46 *
```



The mean temperature of July in Helsinki is plotted as a time series. The oscillations of the curve around a long term average (17.5 C) are characterized by a shading which is determined by the extra specification FILL.

```
■ 31  1 SURVO 84 EDITOR  07-23-1984  19:02:08          A: 100  72  32551  0
 51 *
 52 *PLOT Helsinki2,TIME(Year),Temp_
 53 *DATA Helsinki2 IN Helsinki,101,135
 54 *HEADER=Mean_temperature_in_Helsinki,_July_1944-78
 55 *HOME=70,0 SIZE=729,400 YLABEL=Temperature_(C)
 56 *LINE=1 GRID=XY XSCALE=1,7(5)32,35
 57 *FILL=1,1,35,17.5 TICK=1,1
 58 *
 59 *
 60 *
 61 *
 62 *
 63 *
 64 *
 65 *
 66 *
 67 *
 68 *
 69 *
 70 *
 71 *
 72 *
 73 *
```

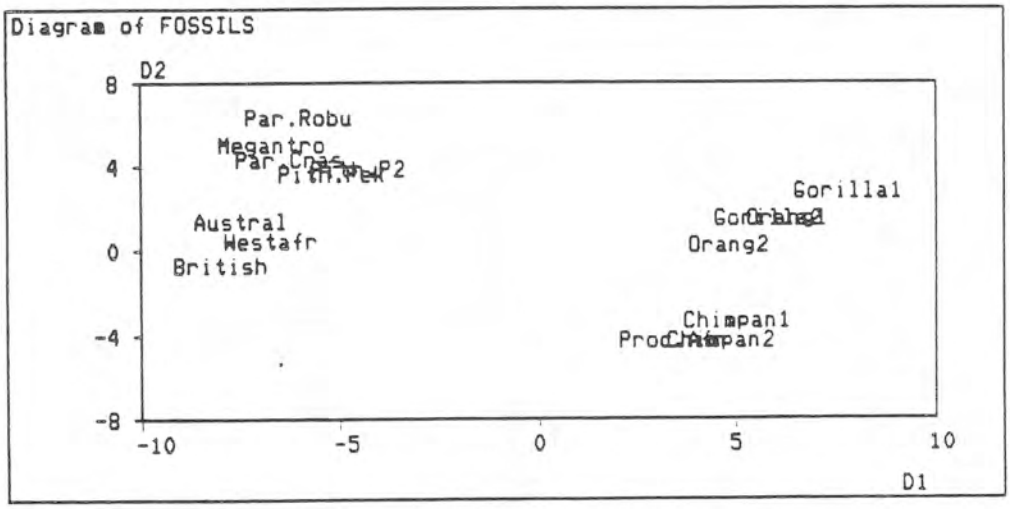
```
■ 31  1 SURVO 84 EDITOR  07-23-1984  19:12:17          A: 100  72  33000  0
 51 *
 52 *PLOT Helsinki2,TIME(Year),Temp_
 53 *DATA Helsinki2 IN Helsinki,101,135
 54 *HEADER=Mean_temperature_in_Helsinki,_July_1944-78
 55 *HOME=70,0 SIZE=729,400 YLABEL=Temperature_(C)
 56 *LINE=1 GRID=XY XSCALE=1,7(5)32,35
 57 *FILL=1,1,35,17.5 TICK=1,1
 58 *
 59 *
 60 *
 61 *
 62 *
 63 *
 64 *
 65 *
 66 *
 67 *
 68 *
 69 *
 70 *
 71 *
 72 *
 73 *
```



This and next two examples show, how interrelationships and structural differences in multidimensional data can be visualized. We have a data set of fossils, human races and apes. There are 8 measurements of the skull and teeth which have been transformed into 8 new variables by means of multiple discriminant analysis. First a simple scatter diagram of the two first discriminant functions D1,D2 is made. See how it separates apes and human races.

```
■ 19  1 SURVO 84 EDITOR  08-13-1984  19:41:14          A: 100  72  30285  0
  1 *SAVE MULTI
  2 *
  3 *Plotting a scatter diagram
  4 *PLOT FOSSILS,D1,D2 / POINT=Species HOME=70,0 SIZE=729,400
  5 *
  6 *DATA FOSSILS,X,Y,Z
  7 Z Species   D1    D2    D3    D4    D5    D6    D7    D8     Label
  8 X Westafr  -8.09  0.49  0.18  0.75 -0.06 -0.04  0.04  0.03   H1
  9 * British  -9.37 -0.68 -0.44 -0.37  0.37  0.02 -0.01  0.05   H2
 10 * Austral  -8.87  1.44  0.36 -0.34 -0.29 -0.02 -0.01 -0.05   H3
 11 * Gorilla1  6.28  2.89  0.43 -0.03  0.10 -0.14  0.07  0.08   A1
 12 * Gorilla2  4.28  1.52  0.71 -0.06  0.25  0.15 -0.07 -0.10   A2
 13 * Orang1    5.11  1.61 -0.72  0.04 -0.17  0.13  0.03  0.05   A3
 14 * Orang2    3.60  0.28 -1.05  0.01 -0.03 -0.11 -0.11 -0.08   A4
 15 * Chimpan1  3.46 -3.37  0.33 -0.32 -0.19 -0.04  0.09  0.09   A5
 16 * Chimpan2  3.05 -4.21  0.17  0.28  0.04  0.02 -0.06 -0.06   A6
 17 * Pith.Pek -6.73  3.63  1.14  2.11 -1.90  0.24  1.23 -0.55   F1
 18 * Pith.P2  -5.90  3.95  0.89  1.58 -1.56  1.10  1.53  0.58   F2
 19 * Par.Robu -7.56  6.34  1.66  0.10 -2.23 -1.01  0.68 -0.23   F3
 20 * Par.Cras -7.79  4.33  1.42  0.01 -1.80 -0.25  0.04 -0.87   F4
 21 * Megantro -8.23  5.03  1.13 -0.02 -1.41 -0.13 -0.28 -0.13   F5
 22 Y Proc.Afr  1.86 -4.28 -2.14 -1.73  2.06  1.80  2.61  2.48   F6
 23 *
```

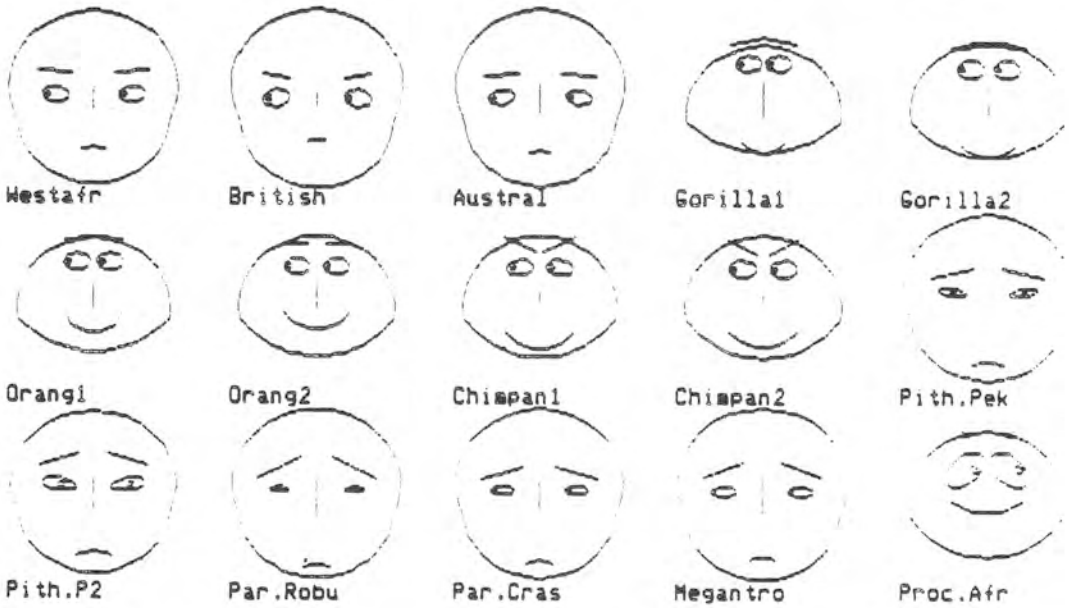
```
■ 19  1 SURVO 84 EDITOR  08-13-1984  19:50:32          A: 100  72  32815  0
  1 *SAVE MULTI
  2 *
  3 *Plotting a scatter diagram
  4 *PLOT FOSSILS,D1,D2 / POINT=Species HOME=70,0 SIZE=729,400
  5 *
```



To get an overall picture of the entire set of 8 variables D1-D8, the face technique of Chernoff (1973) is used.
The variables D1-D8 are now connected to various features of the face according to the list given below the PLOT operation.
See how the fossils resemble humans. The only exception is the mysterious 'Proconsul Africanus'.
The specification TYPE=FACES implies plotting of faces.

```
 13  1 SURVO 84 EDITOR  07-21-1984  16:49:46          A: 100  72  31038  0
 49 *HOME=0,0 SIZE=799,576 XDIV=0,799,0 YDIV=0,480,96
 50 *PLOT FOSSILS / TYPE=FACES LABEL=Species FSIZE=160
 51 *Specifications for Chernoff's faces of data FOSSILS
 52 *VARIABLES: xmin      xmax     Features                    fmin fmax
 53 * -         0         0        Radius_to_corner_of_face_OP  0.6  1.0
 54 * -         0         0        Angle_of_OP_to_horizontal    0.0  0.6
 55 *01        6.28      -9.37     Vertical_size_of_face_OU     0.6  1.0
 56 * -         0         0        Eccentricity_of_upper_face   0.5  1.5
 57 * -         0         0        Eccentricity_of_lower_face   0.5  1.5
 58 *02        -4.28     6.34     Length_of_nose               0.1  0.5
 59 *03        -2.14     1.66     Vertical_position_of_mouth   0.2  0.8
 60 *01        -9.37     6.28     Curvature_of_mouth_1/R      -4.0  4.0
 61 *01        -9.37     6.28     Width_of_mouth               0.2  1.0
 62 *01        -9.37     6.28     Vertical_position_of_eyes    0.0  0.4
 63 *01        6.28      -9.37    Separation_of_eyes           0.3  0.8
 64 *04        -1.73     2.11     Slant_of_eyes               -0.5  0.5
 65 *05        -2.23     2.06     Eccentricity_of_eyes         0.3  1.0
 66 *06        -1.01     1.8      Size_of_eyes                 0.1  0.2
 67 *07        -.28      2.61     Position_of_pupils          -0.1  0.1
 68 *08        -.87      2.48     Vertical_position_of_eyebrows 0.2 0.4
 69 *02        -4.28     6.34     Slant_of_eyebrows           -0.5  0.5
 70 *03        -2.14     1.66     Size_of_eyebrows             0.1  0.5
 71 *END of plotting specifications
```

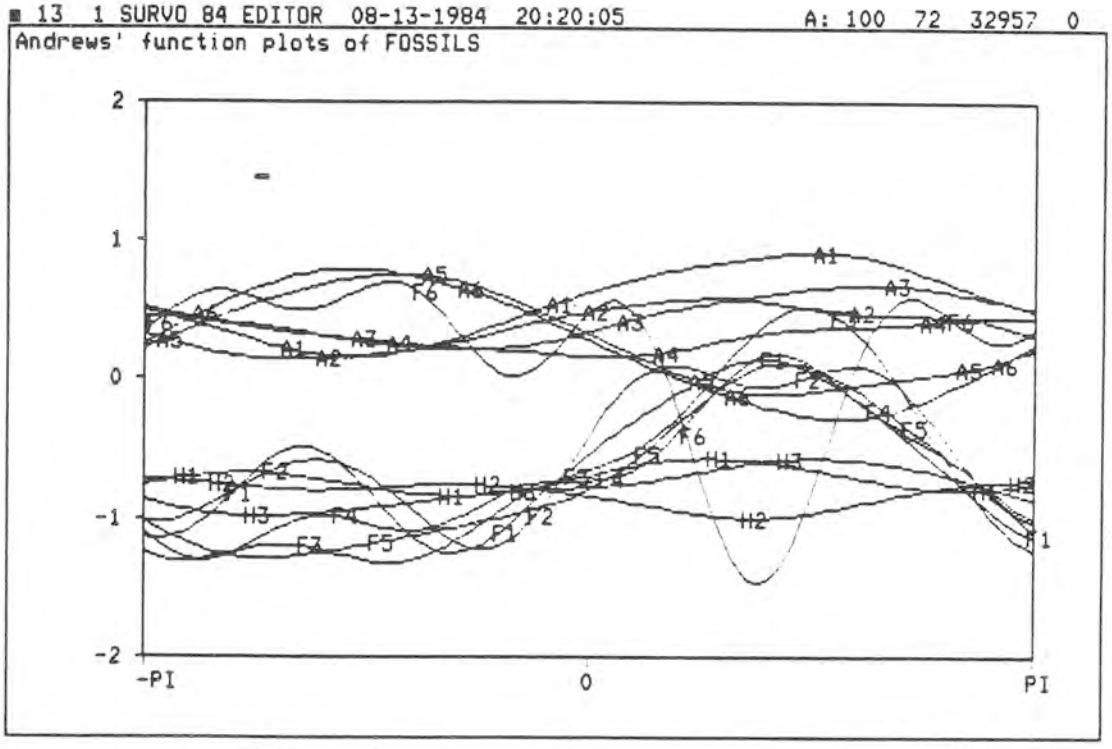
```
  1  1 SURVO 84 EDITOR  07-21-1984  17:01:38          A: 100  72  33023  0
Chernoff's faces of FOSSILS
```



Andrews' (1972) function plots for the same data.
Each observation D1,D2,...,D8 is represented by the function
f(t)=D1/sqr(2)+D2*sin(t)+D3*cos(t)+D4*sin(2t)+...
Due to the LABEL specification the curves can be labelled in
regular intervals by selected names (here variable 'Label').

```
■ 13  1 SURVO 84 EDITOR  08-13-1984  19:58:48          A: 100  72  32331  0
 72 *
 73 *
 74 *
 75 *HOME=0,0 SIZE=799,576 CLEAR=TEXT
 76 *PLOT FOSSILS / TYPE=ANDREWS SCALING=0,1 LABEL=Label
 77 *Specifications for Andrews' function plots of data FOSSILS
 78 *Transformed variables X'=(X-A)/B
 79 *VARIABLES: A          B         Term
 80 *D1         0          1         1/sqr(2)
 81 *D2         0          1         sin(t)
 82 *D3         0          1         cos(t)
 83 *D4         0          1         sin(2t)
 84 *D5         0          1         cos(2t)
 85 *D6         0          1         sin(3t)
 86 *D7         0          1         cos(3t)
 87 *D8         0          1         sin(4t)
 88 *END of plotting specifications
 89 *
 90 *
 91 *
 92 *
 93 *
 94 *
```

```
■ 13  1 SURVO 84 EDITOR  08-13-1984  20:20:05          A: 100  72  32957  0
```



Data files are created by a FILE CREATE scheme and the data values are saved and edited by the FILE EDIT operation.
The fields can have long names (8 first characters are used as a reference) and the name may include technical information like the output format and the numerical range.
FILE EDIT automatically generates a format for data input according to the structure of the data file.

```
■ 16  1 SURVO 84 EDITOR  08-11-1984  15:35:53          D: 100  100  29600  0
  1 *
  2 *
  3 *FILE CREATE WORLD,1,30,64
  4 *  Source: Selected Demographic Indicators by Country, 1950-2000:
  5 *          Demographic  estimates  and projections as assessed in 1978
  6 *          United Nations, New York 1980
  7 *          Projections and estimates for 1985  (medium variant)
  8 *
  9 *FIELDS:
 10 *   1 S  26  Country    Name of the country
 11 *   2 N   1  Page       Page number in the source  (###)      {16,198}
 12 *   3 S   8  Area       Major area
 13 *   4 S   8  Region
 14 *   5 N   4  Popul      Population, total in 1000  (########) {1,1010000}
 15 *   6 N   4  Males      Population, males in 1000  (########) {1,520000}
 16 *   7 N   4  Ages4      Pop. ages  0-4  to total %  (##.#)     {5,30}
 17 *   8 N   4  Ages14     Pop. ages  5-14 to total %  (##.#)     {10,40}
 18 *   9 N   4  Ages64     Pop. ages 15-64 to total %  (##.#)     {40,75}
 19 *  10 N   4  Old        Pop. ages 65-   to total %  (##.#)     {2,20}
 20 *  11 N   4  Med.age    Median age (years)          (##.#)     {14,40}
 21 *END
 22 *
 23 *FILE EDIT WORLD
```

```
 14  1 SURVO 84 EDITOR  08-11-1984  15:45:45          100  100  27351
DATA FILE: WORLD       Record # 1                              N= 0
Country ◀Finland                ▶
Page    ◀164▶ Area    ◀Europe  ▶ Region  ◀Northern▶
Popul   ◀4907         ▶ Males   ◀2374          ▶
Ages4   ◀6.8          ▶ Ages14  ◀13.0          ▶
Ages64  ◀68.3         ▶ Old     ◀              ▶
Med.age ◀             ▶
```

To stop, press F8:EXIT

More fields in the data file are defined by the FILE UPDATE scheme which has the same structure as FILE CREATE. Also the file and field descriptions may be edited by the FILE UPDATE scheme.

The active fields for subsequent operations with the data file are selected from a display which gives one line for each field.
The active fields are indicated here by 'A's.
The activation process is started and terminated by control-Z.

```
■ 18  1 SURVO 84 EDITOR  08-12-1984  13:17:26            D: 100  100  30088  0
  1 *
  2 *
  3 *
  4 *FILE UPDATE WORLD
  5 *  Source: Selected Demographic Indicators by Country, 1950-2000:
  6 *          Demographic  estimates  and projections as assessed in 1978
  7 *          United Nations, New York 1980
  8 *          Projections and estimates for 1985  (medium variant)
  9 *
 10 *FIELDS:
 11 *  12 N   4  Urban     Proportion of urban population % (##.#) {0,99.9}
 12 *  13 N   2  Density   Population density (per sqr.km.) (####) {1,5100}
 13 *  14 N   4  Growth    Rate of growth %           (##.##)   {-0.3,5}
 14 *  15 N   4  Age_mal   Life expectancy, males   (years) (##.#) {40,80}
 15 *  16 N   4  Age_fem   Life expectancy, females (years) (##.#) {40,80}
 16 *END
 17 *
 18 *
 19 *
 20 *
 21 *
 22 *
 23 *


Data file: WORLD  M1= 30  M= 16   N= 150   REC/OBS= 1
N(active fields)= 5 , N(protected fields)= 0
   1 -- Country   Name of the country                                    S 26
   2 -- Page      Page number in the source  (###)     {16,198}          N  1
   3 -- Area      Major area                                            S  8
   4 -- Region                                                          S  8
   5 -- Popul     Population, total in 1000  (########) {1,1010000}     N  4
   6 -- Males     Population, males in 1000  (########) {1,520000}      N  4
   7 -- Ages4     Pop. ages  0-4  to total % (##.#)    {5,30}           N  4
   8 -- Ages14    Pop. ages  5-14 to total % (##.#)    {10,40}          N  4
   9 -- Ages64    Pop. ages 15-64 to total % (##.#)    {40,75}          N  4
  10 -- Old       Pop. ages 65-   to total % (##.#)    {2,20}           N  4
  11 -- Med.age   Median age (years)          (##.#)    {14,40}          N  4
  12 A- Urban     Proportion of urban population % (##.#) {0,99.9}      N  4
  13 A- Density   Population density (per sqr.km.) (####) {1,5100}      N  2
  14 A- Growth    Rate of growth %           (##.##)   {-0.3,5}         N  4
  15 A- Age_mal   Life expectancy, males   (years) (##.#) {40,80}       N  4
  16 A- Age_fem   Life expectancy, females (years) (##.#) {40,80}       N  4

Indicate active (A,X,Y etc.) and passive (-) fields!
To protection column, press →


To stop, press F8:EXIT  or ctl-Z
```

Usually FILE UPDATE is preceded by a FILE STATUS operation which displays the current structure of the file in the edit field in the same form. This set-up works as a basis for creating new files with a similar structure or for updating the current one.

Now FILE EDIT has been activated again and the user may enter values for the active fields.

```
■ 16  1 SURVO 84 EDITOR  08-12-1984  13:34:03          D: 100  100  30052  0
  1 *
  2 *
  3 *
  4 *FILE UPDATE WORLD
  5 *  Source: Selected Demographic Indicators by Country, 1950-2000:
  6 *          Demographic  estimates  and projections as assessed in 1978
  7 *          United Nations, New York 1980
  8 *          Projections and estimates for 1985  (medium variant)
  9 *
 10 *FIELDS:
 11 *  12 N   4  Urban     Proportion of urban population % (##.#) {0,99.9}
 12 *  13 N   2  Density   Population density (per sqr.km.) (####) {1,5100}
 13 *  14 N   4  Growth    Rate of growth %          (##.##)   {-0.3,5}
 14 *  15 N   4  Age_mal   Life expectancy, males   (years) (##.#) {40,80}
 15 *  16 N   4  Age_fem   Life expectancy, females (years) (##.#) {40,80}
 16 *END
 17 *
 18 *
 19 *FILE EDIT WORLD_
 20 *
 21 *
 22 *
 23 *


 10  1 SURVO 84 EDITOR  08-12-1984  13:42:13              100  100  27550
DATA FILE: WORLD       Record # 1          Finland              N= 150
Urban    466.9       ▶ Density 415    ▶ Growth  4.3          ▶
Age_mal 469.3 _      ▶ Age_fem 4            ▶
```

To stop, press F8:EXIT

FILE EDIT can also be used for various searches in the current data file. When the cursor is located in a certain field and the SRCH key is pressed, a prompt for starting a search for a specific value of this field is displayed.
Here two searches (one for 'Country' and another for 'Growth') are shown.

```
 10  1 SURVO 84 EDITOR  08-11-1984  16:04:39                100  100  22534
DATA FILE: WORLD       Record # 102        Paraguay              N= 150
Country ◀Paraguay                ▶
Page    ◀101▶ Area     ◀America ▶ Region  ◀Tr.South▶
Popul   ◀3546          ▶ Males   ◀1774          ▶
Ages4   ◀16.7          ▶ Ages14  ◀26.9          ▶
Ages64  ◀52.9          ▶ Old     ◀3.5           ▶
Med.age ◀18            ▶ Urban   ◀41.5          ▶ Density ◀9      ▶
Growth  ◀2.81          ▶ Age_mal ◀64.9          ▶
Age_fem ◀68.6          ▶

Record to be found ( number or  =,<,> Country )? Paraguay
                                                  102



To stop, press F8:EXIT
```

```
 10  1 SURVO 84 EDITOR  08-11-1984  16:16:29                100  100  25638
DATA FILE: WORLD       Record # 31         Kenya                 N= 150
Country ◀Kenya                   ▶
Page    ◀19 ▶ Area     ◀Africa  ▶ Region  ◀Eastern ▶
Popul   ◀19864         ▶ Males   ◀9881          ▶
Ages4   ◀20.4          ▶ Ages14  ◀29.7          ▶
Ages64  ◀47.5          ▶ Old     ◀2.5           ▶
Med.age ◀15            ▶ Urban   ◀16.7          ▶ Density ◀34     ▶
Growth  ◀3.72 _        ▶ Age_mal ◀58.6          ▶
Age_fem ◀62.3          ▶

Record to be found ( number or  =,<,> Growth  )? >3
                                                  31



To stop, press F8:EXIT
```

Variables in the data file are transformed and new variables defined by a VAR operation.
The data file can be sorted according to any set of variables by the FILE SORT operation.
The active fields are displayed in the edit field by the FILE LOAD operation.
Thus more extensive searches in data files can be conducted by a sequence of commands and operations.

```
■ 22  1 SURVO 84 EDITOR  08-11-1984  17:05:00          A: 100  100  28869  0
  1 *
  2 *Where females have the greatest life expectancy
  3 *when compared with males?
  4 *
  5 *Original variables in file WORLD:
  6 *  15 N   4  Age_mal   Life expectancy, males   (years) (##.#) {40,80}
  7 *  16 N   4  Age_fem   Life expectancy, females (years) (##.#) {40,80}
  8 *
  9 *VAR Ageratio=Age_fem/Age_mal TO WORLD
 10 *FILE SORT WORLD BY -Ageratio TO WORLD2
 11 *
 12 *FILE LOAD WORLD2,1,10
 13 *
 14 *
 15 *
 16 *
 17 *
 18 *
 19 *
 20 *
 21 *
 22 *
 23 *
```

```
■ 22  1 SURVO 84 EDITOR  08-11-1984  17:13:54          D: 100  100  29538  0
  1 *
  2 *Where females have the greatest life expectancy
  3 *when compared with males?
  4 *
  5 *Original variables in file WORLD:
  6 *  15 N   4  Age_mal   Life expectancy, males   (years) (##.#) {40,80}
  7 *  16 N   4  Age_fem   Life expectancy, females (years) (##.#) {40,80}
  8 *
  9 *VAR Ageratio=Age_fem/Age_mal TO WORLD
 10 *FILE SORT WORLD BY -Ageratio TO WORLD2
 11 *
 12 *FILE LOAD WORLD2,1,10
 13 *DATA WORLD2*,16;25,14
 14 *Country                    Ageratio
 15 *
 16 *USSR                         1.1394
 17 *Finland                      1.1183
 18 *USA                          1.1165
 19 *Czechoslovakia               1.1066
 20 *Luxemburg                    1.1034
 21 *Poland                       1.1032
 22 *Chile                        1.1031
 23 *France                       1.1020
```

FILE STATUS displays the active fields of the data file in the edit field and thus gives general information. It also provides a natural basis for FILE UPDATE and FILE CREATE.

A three-dimensional contingency table is formed by a TAB operation. A classification can be defined for both string fields and numerical variables.
Multidimensional tables are displayed in the natural nested form.

```
■ 14  1 SURVO 84 EDITOR  08-11-1984  10:37:26            D: 100  100  29064  0
  1 *SAVE TABLE
  2 *
  3 *FILE STATUS WORLD2
  4 *  Source: Selected Demographic Indicators by Country, 1950-2000:
  5 *          Demographic  estimates  and projections as assessed in 1978.
  6 *          United Nations, New York 1980
  7 *          Projections and estimates for 1985  (medium variant)
  8 *
  9 *FIELDS:  (active)
 10 *   3 S   8  Area      Major area
 11 *  11 N   4  Med.age   Median age (years)          (##.#)
 12 *  14 N   4  Growth    Rate of growth %            (##.##)
 13 *END
 14 *
 15 *TAB WORLD2,21
 16 *VARIABLES=Area,Med.age,Growth
 17 *Area=/Europe,/Asia,/America,/-(other)
 18 *Med.age=0,25(Low),30(Medium),40(High)
 19 *Growth=-0.5,1,2,5
 20 *
 21 *
 22 *
 23 *
```

```
■ 14  1 SURVO 84 EDITOR  08-11-1984  10:45:11            D: 100  100  29670  0
 11 *  11 N   4  Med.age   Median age (years)          (##.#)
 12 *  14 N   4  Growth    Rate of growth %            (##.##)
 13 *END
 14 *
 15 *TAB WORLD2,21
 16 *VARIABLES=Area,Med.age,Growth
 17 *Area=/Europe,/Asia,/America,/-(other)
 18 *Med.age=0,25(Low),30(Medium),40(High)
 19 *Growth=-0.5,1,2,5
 20 *
 21 *TABLE WORLD21,22,32,F   N=150
 22 *                Area       /Europe    /Asia /America    other
 23 *Med.age Growth ********
 24 *Low      1                       0        0        0        4
 25 *         2                       1        3        2       11
 26 *         5                       0       26       15       47
 27 *Medium   1                       3        1        1        1
 28 *         2                       0        3        1        3
 29 *         5                       0        0        0        0
 30 *High     1                      23        1        1        1
 31 *         2                       0        0        1        1
 32 *         5                       0        0        0        0
 33 *
```

After a slight modification in the TAB scheme (see the colon in the VARIABLES=Area:Med.age,Growth specification) the same scheme gives several two-dimensional tables with 'Area' as a common background variable.

```
# 14  1 SURVO 84 EDITOR  08-11-1984  10:57:30          D: 100  100  29628  0
  1 #SAVE TABLE
  2 #
  3 #FILE STATUS WORLD2
  4 #  Source: Selected Demographic Indicators by Country, 1950-2000:
  5 #          Demographic  estimates  and projections as assessed in 1978
  6 #          United Nations, New York 1980
  7 #          Projections and estimates for 1985  (medium variant)
  8 #
  9 #FIELDS:  (active)
 10 #   3 S   8  Area      Major area
 11 #  11 N   4  Med.age   Median age (years)          (##.#)
 12 #  14 N   4  Growth    Rate of growth %            (##.##)
 13 #END
 14 #
 15 #TAB WORLD2,21
 16 #VARIABLES=Area:Med.age,Growth
 17 #Area=/Europe,/Asia,/America,/-(other)
 18 #Med.age=0,25(Low),30(Medium),40(High)
 19 #Growth=-0.5,1,2,5
 20 #
 21 #
 22 #
 23 #
```

```
# 14  1 SURVO 84 EDITOR  08-11-1984  11:06:14          D: 100  100  29651  0
 11 #  11 N   4  Med.age   Median age (years)          (##.#)
 12 #  14 N   4  Growth    Rate of growth %            (##.##)
 13 #END
 14 #
 15 #TAB WORLD2,21
 16 #VARIABLES=Area:Med.age,Growth
 17 #Area=/Europe,/Asia,/America,/-(other)
 18 #Med.age=0,25(Low),30(Medium),40(High)
 19 #Growth=-0.5,1,2,5
 20 #
 21 #TABLE WORLD21,22,26,F   N=150
 22 #         Area       /Europe    /Asia /America    other
 23 #Med.age  ********
 24 #Low                     1        29       17       62
 25 #Medium                  3         4        2        4
 26 #High                   23         1        2        2
 27 #
 28 #TABLE WORLD22,29,33,F   N=150
 29 #         Area       /Europe    /Asia /America    other
 30 #Growth   ********
 31 #1                      26         2        2        6
 32 #2                       1         6        4       15
 33 #5                       0        26       15       47
```

The CELL=Growth,##.### specification implies the means and standard deviations of 'Growth' to be computed in classes defined by the other specifications. The results are displayed according to the format given in CELL.

```
■ 14  1 SURVO 84 EDITOR  08-11-1984  11:17:18          D: 100  100  29622  0
  1 *SAVE TABLE
  2 *
  3 *FILE STATUS WORLD2
  4 *  Source: Selected Demographic Indicators by Country, 1950-2000:
  5 *          Demographic  estimates  and projections as assessed in 1978
  6 *          United Nations, New York 1980
  7 *          Projections and estimates for 1985  (medium variant)
  8 *
  9 *FIELDS:  (active)
 10 *   3 S   8  Area      Major area
 11 *  11 N   4  Med.age   Median age (years)          (##.#)
 12 *  14 N   4  Growth    Rate of growth %           (##.##)
 13 *END
 14 *
 15 *TAB WORLD2,21
 16 *VARIABLES=Area,Med.age
 17 *Area=/Europe,/Asia,/America,/-(other)
 18 *Med.age=0,25(Low),30(Medium),40(High)
 19 *CELL=Growth,##.###
 20 *
 21 *
 22 *
 23 *
```

```
■ 14  1 SURVO 84 EDITOR  08-11-1984  11:30:17          D: 100  100  29652  0
 11 *  11 N   4  Med.age   Median age (years)          (##.#)
 12 *  14 N   4  Growth    Rate of growth %           (##.##)
 13 *END
 14 *
 15 *TAB WORLD2,21
 16 *VARIABLES=Area,Med.age
 17 *Area=/Europe,/Asia,/America,/-(other)
 18 *Med.age=0,25(Low),30(Medium),40(High)
 19 *CELL=Growth,##.###
 20 *
 21 *TABLE WORLD21,22,32,FMS   N=150 Mean and SD of Growth
 22 *         Area       /Europe    /Asia /America    other
 23 *Med.age ********
 24 *Low                      1       29       17       62
 25 *         Mean         1.930    2.551    2.685    2.472
 26 *         SD               -    0.576    0.522    0.761
 27 *Medium                   3        4        2        4
 28 *         Mean         0.897    1.185    0.935    1.138
 29 *         SD           0.101    0.474    0.134    0.231
 30 *High                    23        1        2        2
 31 *         Mean         0.334    0.500    0.955    0.950
 32 *         SD           0.285        -    0.092    0.141
 33 *
```

Variables for a regression model are selected by activating them with specific labels. For example, the regressand is indicated by 'Y', the regressors by 'X' and the residual by 'R'.
The whole set-up may be compressed in the edit field in a MASK specification. Whenever a MASK line is activated, the selection of variables with complete descriptions will be seen temporarily. LINREG DECA,7 computes the regression model defined by MASK and gives the results from line 7 onwards in the edit field.

```
Data file: DECA  M1= 30  M= 15   N= 48   REC/OBS= 1
N(active fields)= 7 , N(protected fields)= 0
   1 -- Name     Name of athlete                                  S  8
   2 Y- Points   Total score              (####) (7000,9000)     N  2
   3 X- 100m     100 meters run           (####) (500,1200)      N  2
   4 X- L_jump   Long jump                (####) (500,1200)      N  2
   5 X- Shot_put                          (####) (500,1200)      N  2
   6 X- Hi_jump  High jump                (####) (500,1200)      N  2
   7 X- 400m     100 meters run           (####) (500,1200)      N  2
   8 -- Hurdles  110 meters hurdles       (####) (500,1200)      N  2
   9 -- Discus                            (####) (500,1200)      N  2
  10 -- Pole_vlt Pole vault               (####) (500,1200)      N  2
  11 -- Javelin                           (####) (500,1200)      N  2
  12 -- 1500m    1500 meters run          (####) (400,1200)      N  2
  13 -- Height   in centimeters           (###)  (160,210)       N  2
  14 -- Weight   in kilograms             (###)  (50,120)        N  2
  15 R- RES                                                      N  8

Indicate active (A,X,Y etc.) and passive (-) fields!
To protection column, press ←

To stop, press F8:EXIT  or ctl-Z
```

```
■ 14  1 SURVO 84 EDITOR  08-11-1984  17:55:21          D: 100  100  30128  0
   1 *
   2 *
   3 *MASK=-YXXXXX-------R
   4 *LINREG DECA,7
   5 *
   6 *
   7 *Linear regression analysis: Data DECA, Regressand Points   N=48
   8 *Variable  Regr.coeff.   Std.dev.        t      beta
   9 *100m      .5425684      .3063601       1.77   0.199
  10 *L_jump    1.361467      .3024766       4.50   0.427
  11 *Shot_put  1.17146       .2589412       4.52   0.448
  12 *Hi_jump   .9223284      .2616502       3.53   0.370
  13 *400m      1.327236      .3632046       3.65   0.409
  14 *constant  3559.491
  15 *Variance of regressand Points  = 26132       DF=47
  16 *Residual variance=10607.98  DF=42
  17 *R=0.79828  R↑2=0.63725
  18 *
  19 *
  20 *
  21 *
  22 *
  23 *
```

The CORR operation computes the means, standard deviations and correlations for all active fields pointed out by the MASK specification. If MASK is not given, all active fields selected previously (by FIELD ACTIVATE for example) are used.
The results are also saved (without rounding) in a special file SURVO.COR on the current data disk. This file may be renamed, if necessary, and used as a starting point for regression and principal components analysis, for example.

```
■ 13  1 SURVO 84 EDITOR  08-11-1984  18:07:05            D: 100  100  29603  7
  1 *
  2 *
  3 *MASK=-YXXXXX-------R
  4 *LINREG DECA,7
  5 *
  6 *
  7 *Linear regression analysis: Data DECA, Regressand Points   N=48
  8 *Variable  Regr.coeff.   Std.dev.          t      beta
  9 *100m      .5425684      .3063601         1.77   0.199
 10 *L_jump    1.361467      .3024766         4.50   0.427
 11 *Shot_put  1.17146       .2589412         4.52   0.448
 12 *Hi_jump   .9223284      .2616502         3.53   0.370
 13 *400m      1.327236      .3632046         3.65   0.409
 14 *constant 3559.491
 15 *Variance of regressand Points  = 26132       DF=47
 16 *Residual variance=10607.98  DF=42
 17 *R=0.79828  R↑2=0.63725
 18 *
 19 *CORR DECA,20
 20 *
 21 *
 22 *
 23 *
```

```
■ 13  1 SURVO 84 EDITOR  08-11-1984  18:15:14            D: 100  100  29651  0
 18 *
 19 *CORR DECA,20
 20 *Means, std.devs and correlations of DECA N= 48
 21 *Variable       Mean          Std.dev.
 22 *Points      7843.47917      161.65395
 23 *100m         828.18750       59.30256
 24 *L_jump       840.18750       50.72859
 25 *Shot_put     740.77083       61.82757
 26 *Hi_jump      805.85417       64.80511
 27 *400m         813.50000       49.80216
 28 *RES            0.00000       97.36257
 29 *Correlations:
 30 *        Points 100m   L_jump Shot_p Hi_jum 400m   RES
 31 *Points   1.000  0.294  0.499  0.364  0.221  0.295  0.602
 32 *100m     0.294  1.000  0.172 -0.028 -0.412  0.456  0.000
 33 *L_jump   0.499  0.172  1.000 -0.034 -0.003  0.133  0.000
 34 *Shot_put 0.364 -0.028 -0.034  1.000  0.163 -0.304  0.000
 35 *Hi_jump  0.221 -0.412 -0.003  0.163  1.000 -0.339  0.000
 36 *400m     0.295  0.456  0.133 -0.304 -0.339  1.000  0.000
 37 *RES      0.602  0.000  0.000  0.000  0.000  0.000  1.000
 38 *
 39 *
 40 *
```

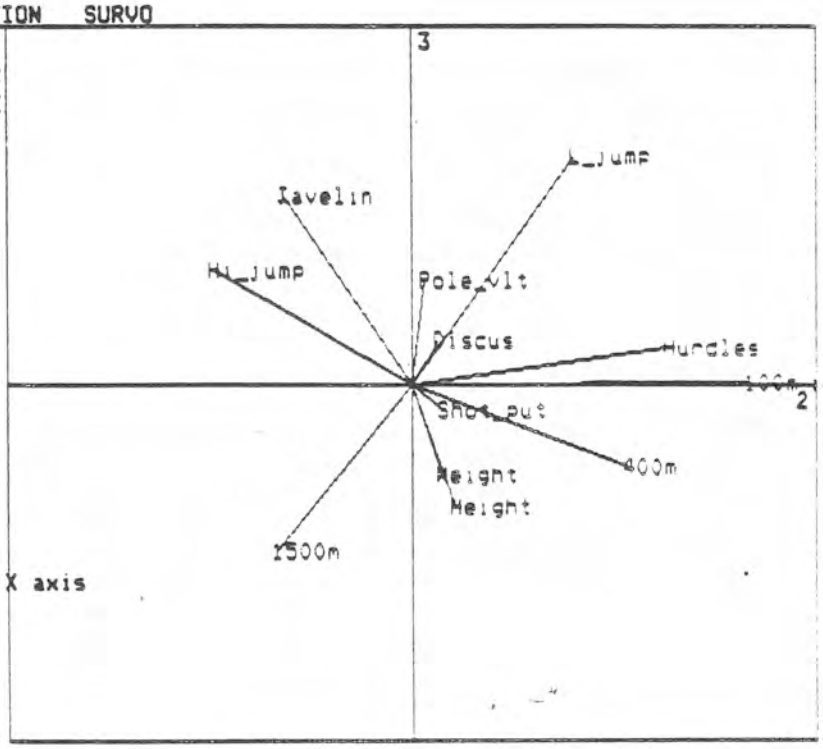
These two exhibits tell a story of making principal components and factor rotation.
First correlations are computed (CORR). Then four (#COMP=4) principal components are extracted (PCOMP).
Finally an interactive and iterative rotation procedure is started by a ROTATE command.
The user can control rotation step by step and consult some analytic criteria when selecting proper rotation angles.

```
# 19  1 SURVO 84 EDITOR  08-20-1984  16:40:45          A: 100  100  28581  0
  1 #
  2 #MASK=--AAAAAAAAAAAA- / Selecting variables
  3 #CORR DECA  / Means, std.devs and correlations, results in SURVO.COR
  4 ##COMP=4
  5 #PCOMP DECA;SURVO.7  / Principal components from DECA with SURVO.COR
  6 #                     Results also in file SURVO.PCO
  7 #Principal components: Data DECA
  8 #              1      2      3      4
  9 #100m      -0.128  0.836  0.008 -0.158
 10 #L_jump    -0.010  0.405  0.642  0.304
 11 #Shot_put   0.843  0.077 -0.067 -0.117
 12 #Hi_jump    0.336 -0.485  0.320  0.142
 13 #400m      -0.478  0.537 -0.230  0.337
 14 #Hurdles    0.153  0.639  0.103  0.249
 15 #Discus     0.847  0.068  0.128 -0.136
 16 #Pole_vlt -0.355  0.030  0.295 -0.681
 17 #Javelin    0.087 -0.315  0.529  0.453
 18 #1500m     -0.590 -0.334 -0.467  0.311
 19 #Height     0.808  0.109 -0.338  0.199
 20 #Weight     0.883  0.074 -0.251  0.016
 21 #Eigenval. 3.723  2.035  1.361  1.152
 22 #
 23 #ROTATE SURVO  / Rotating SURVO.PCO
```

SURVO 84: FACTOR ROTATION SURVO

Item select: SPACE BAR
BACKSPACE
or Initials

Angle of rotation
Rotate
Next pair of axes
Varimax
Quartimax
Factor matrix
Printout (on LPT)
Exit



Indicate direction of X axis
by + and - keys!

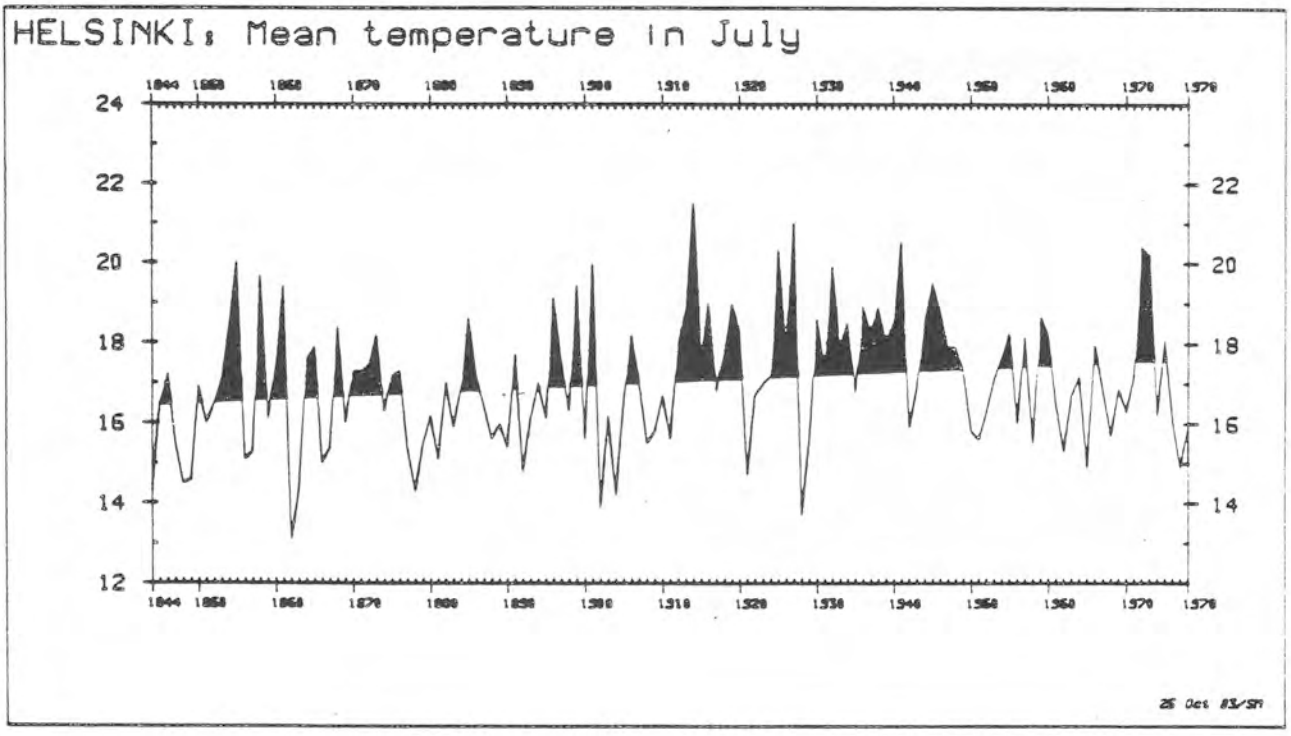
Computing a linear trend for the mean temperature for 135 consecutive years.
Before the regression analysis a new variable (Trend) is defined by the FILE UPDATE scheme.
The MASK=XY-P indicates the variables (XY) to be selected in the regression model and the variable (P) for the predicted values (Trend). This trend will be employed in the next example.

```
■ 19  1 SURVO 84 EDITOR  08-13-1984  16:31:38            D: 100  100  27662  0
  1 *SAVE HEL2
  2 *
  3 *FILE UPDATE HELSINKI
  4 *  Mean temperature (C) and rainfall (mm)
  5 *  Helsinki, July 1844-1978
  6 *
  7 *FIELDS:  (active)
  8 *   1 S   4  Year
  9 *   2 N   4  Temp    Mean temperature (C) in July (##.#)
 10 *   3 N   1  Rain    Rainfall (mm) in July (###)
 11 *   4 N   4  Trend   Trend of temperature (##.#)
 12 *END
 13 *
 14 *MASK=XY-P
 15 *LINREG HELSINKI,16_
 16 *
 17 *
 18 *
 19 *
 20 *
 21 *
 22 *
 23 *
```

```
■ 19  1 SURVO 84 EDITOR  08-13-1984  16:49:53            D: 100  100  29610  0
  1 *SAVE HEL2
  2 *
  3 *FILE UPDATE HELSINKI
  4 *  Mean temperature (C) and rainfall (mm)
  5 *  Helsinki, July 1844-1978
  6 *
  7 *FIELDS:  (active)
  8 *   1 S   4  Year
  9 *   2 N   4  Temp    Mean temperature (C) in July (##.#)
 10 *   3 N   1  Rain    Rainfall (mm) in July (###)
 11 *   4 N   4  Trend   Trend of temperature (##.#)
 12 *END
 13 *
 14 *MASK=XY-P
 15 *LINREG HELSINKI,16_
 16 *Linear regression analysis: Data HELSINKI, Regressand Temp     N=135
 17 *Variable  Regr.coeff.   Std.dev.          t      beta
 18 *Year     8.761096E-03  3.568748E-03      2.45   0.208
 19 *constant .3049534
 20 *Variance of regressand Temp    = 2.709079    DF=134
 21 *Residual variance=2.611127  DF=133
 22 *R=0.20821  R↑2=0.04335
 23 *
```

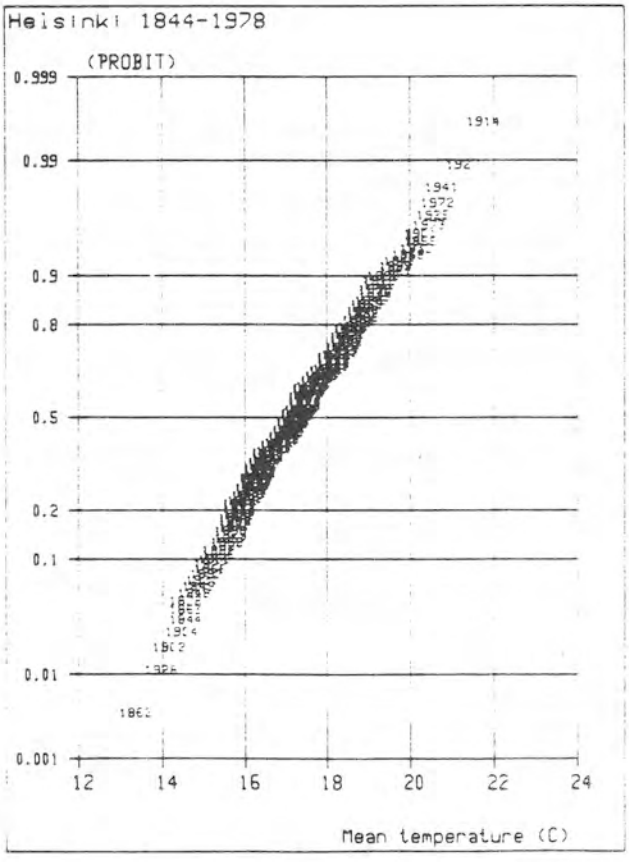
The mean temperature of July in Helsinki is plotted for 135 consecutive years on the SERVOGOR plotter (DEVICE=S). The FILL specifications indicate that the deviations from 'Trend' (computed in the previous example) should shaded using different pens (pen #1 'black' for positive and pen #0 'white' for negative deviations).

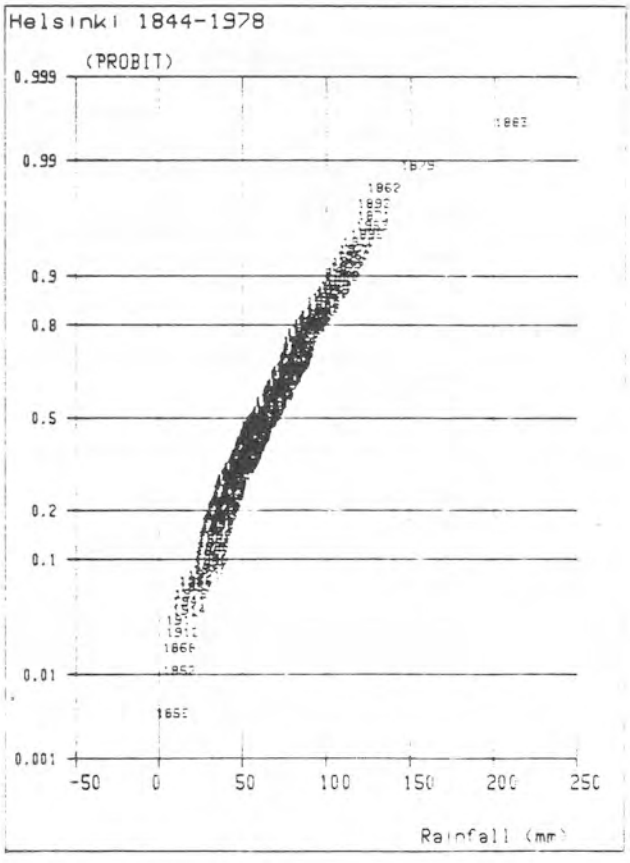
```
# 30  1 SURVO 84 EDITOR  08-20-1984  15:43:58          D: 100  100  29640  0
 24 *
 25 *
 26 *
 27 *HEADER=(1,50,50,0,3),HELSINKI:_Mean_temperature_in_July
 28 *PLOT HELSINKI,TIME(Year),Temp_
 29 *XSCALE=(1,20,20,0,1),1,7(10)127,135 TICK=1,1
 30 *XSCALE2=(1,20,20,0,1),XSCALE TICK2=1,1
 31 *YSCALE=(1,30,30),12(2)24 YSCALE2=(1,30,30),14(2)22
 32 *XLABEL= YLABEL= TEXT=(1,20,20,1,1),A A=25_Oct_83/SM,2400,50
 33 *DEVICE=S HOME=0,400 SIZE=2650,1500
 34 *PEN=1,42,42,0,2 LINE=(1),1 FILL=(1),2,1,135,Trend FILL-=(0),1
 35 *
 36 *
 37 *
 38 *
 39 *
 40 *
 41 *
 42 *
 43 *
 44 *
 45 *
 46 *
```



When several schemes have common specifications, a *GLOBAL* subfield in the edit field can be used for them.
The subfields are separated from each other by dotted border lines (8 and 15 below).
The precedence order of specifications is: local>global>default.
The data set HELSINKI is sorted at first with respect to 'TEMP' and then with respect to 'RAIN'. In both cases the ordered sample is plotted on normal probability paper.

```
■ 26  1 SURVO 84 EDITOR  08-14-1984  17:10:31            D: 100  100  29331  0
  1 *
  2 *  *GLOBAL* specifications
  3 *   DEVICE=S SIZE=1300,1800
  4 *   GRID=XY TICK=0,1
  5 *   YSCALE=(1,24,18),PROBIT,0.001,0.01,0.1,0.2,0.5,0.8,0.9,0.99,0.999
  6 *   HEADER=(2,30,30,0,2),Helsinki_1844-1978
  7 *   PEN=1,30,24 XDIV=150,1050,100 YDIV=200,1450,150
  8 *.....................................................................
  9 *FILE SORT HELSINKI BY Temp TO HELSORT
 10 *PLOT HELSORT,Temp,PROBIT
 11 *
 12 *XSCALE=12(2)24 POINT=(2,18,18),Year
 13 *XLABEL=Mean_temperature_(C)
 14 *
 15 *.....................................................................
 16 *FILE SORT HELSINKI BY Rain TO HELSORT2
 17 *PLOT HELSORT2,Rain,PROBIT
 18 *
 19 *HOME=1350,0
 20 *XSCALE=-50(50)250 POINT=(2,18,18),Year
 21 *XLABEL=Rainfall_(mm)
 22 *
 23 *
```

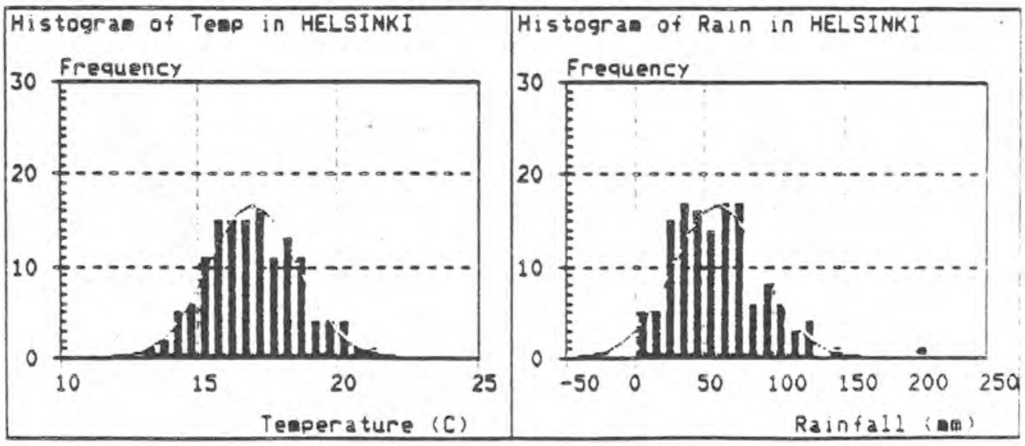




HISTO is a SURVO 84 operation for making of histograms and for fitting of univariate statistical distributions to the data. In this example the mean temperature and the rainfall of Helsinki in July are studied for 135 consecutive years. Both variables are fitted by a normal distribution. By using proper HOME and SIZE specifications several pictures can be displayed simultaneously. HISTO also perfoms a goodness-of-fit test (not displayed here). HELSINKI is a SURVO 84 data file on the current data disk.

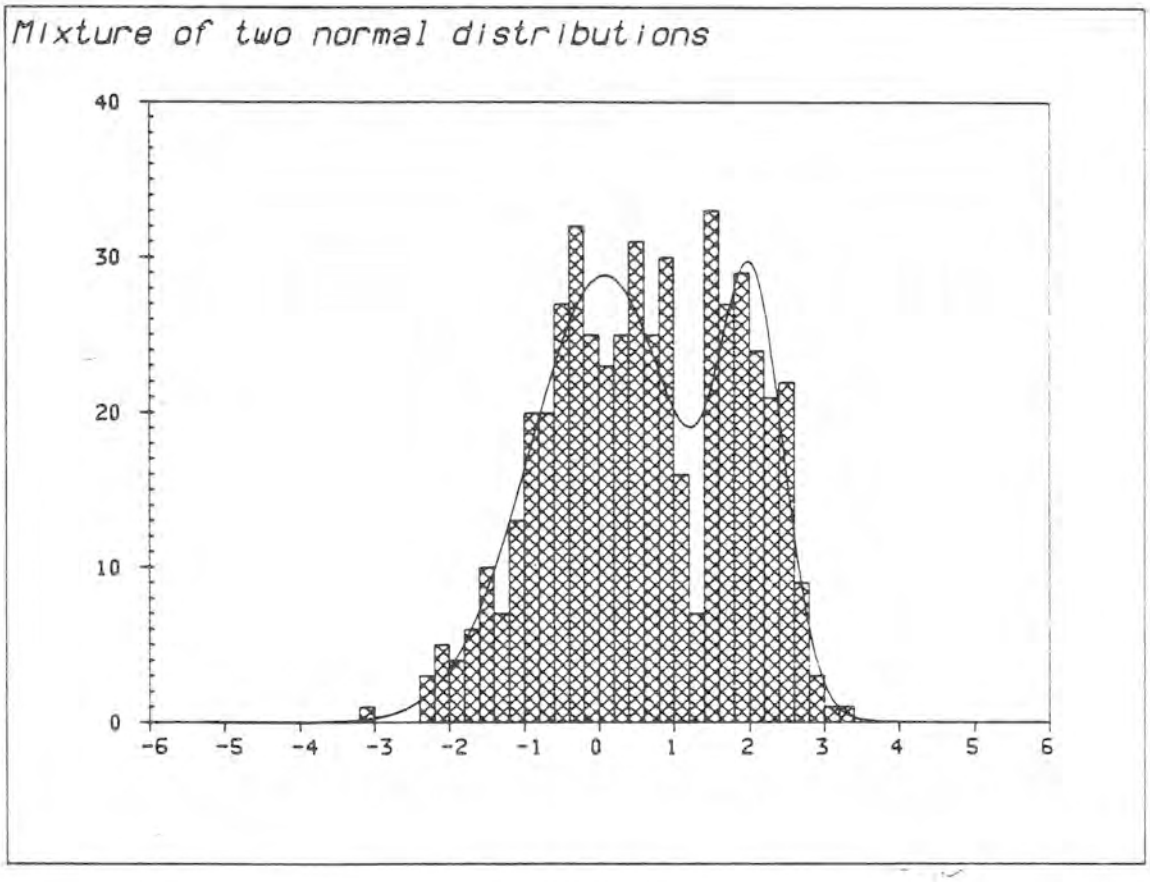
```
■ 20  1 SURVO 84 EDITOR  07-21-1984  20:10:37            A: 72  72  34105  0
*
*   Mean temperature and rainfall in Helsinki, July 1865-1978
*HISTO HELSINKI,Temp_
*Temp=10(0.50)24 XSCALE=10(5)25 FIT=NORMAL XLABEL=Temperature_(C)
*HOME=70,0 SIZE=365,350 XDIV=40,300,25 GRID=XY TICK=0.5,1
*■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■
*HISTO HELSINKI,Rain
*Rain=-50(10)250 XSCALE=-50(50)250 FIT=NORMAL XLABEL=Rainfall_(mm)
*HOME=434,0 SIZE=365,350 XDIV=40,300,25 GRID=XY TICK=10,1
```

```
■ 20  1 SURVO 84 EDITOR  07-21-1984  20:33:53            A: 72  72  34453  0
*
*   Mean temperature and rainfall in Helsinki, July 1865-1978
*HISTO HELSINKI,Temp
*Temp=10(0.50)24 XSCALE=10(5)25 FIT=NORMAL XLABEL=Temperature_(C)
*HOME=70,0 SIZE=365,350 XDIV=40,300,25 GRID=XY TICK=0.5,1
*■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■
*HISTO HELSINKI,Rain_
*Rain=-50(10)250 XSCALE=-50(50)250 FIT=NORMAL XLABEL=Rainfall_(mm)
*HOME=434,0 SIZE=365,350 XDIV=40,300,25 GRID=XY TICK=10,1
```



Estimating parameters of a mixture of two normal distributions.
In this experiment a data file SIMUDATA is created (FILE CREATE) and 500 observations from a certain mixture are generated by a VAR operation.
Finally the parameters are re-estimated by the HISTO operation which also plots the frequency distribution and the fitted density function.

```
■ 26  1 SURVO 84 EDITOR  08-20-1984  14:59:45          D: 100  100  27387  0
  1 *
  2 *FILE CREATE SIMUDATA,1*4,10,64,500
  3 *     Sample (N=500) from a mixture of two normal distributions
  4 *FIELDS:
  5 * 1 N 4 Mixnorm
  6 *END
  7 *■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■
  8 *VAR TO SIMUDATA
  9 *BASIC
 10 *          W=%Uniform(0,1):IF W<0.7 THEN Popul2!
 11 *          Mixnorm=%Normal(2,0.25):GOTO END
 12 *Popul2!   Mixnorm=%Normal(0,1)
 13 *END
 14 *■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■
 15 *HISTO SIMUDATA,Mixnorm,25_ / HOME=200,0 SIZE=2400,1800
 16 *HEADER=(1,50,40,1,3),Mixture_of_two_normal_distributions
 17 *Mixnorm=-6(0.2)6 XSCALE=-6(1)6 YSCALE=0(10)40 TICK=0,1
 18 *DEVICE=S PEN=1,30,30,0,2 SHADING=4
 19 *FIT=MIXNORM INIT=0.5,2,0.5,0,1  STEP=0.1
 20 *
 21 *DENSITY MIXNORM(p,m1,s1,m2,s2)
 22 *Y=0.39894226*(p/s1*EXP(-0.5*((X-m1)/s1)↑2)+(1-p)/s2*EXP(-0.5*((X-m2)/s2)↑
 23 *END
```



(Continuation)
Besides the graphical output HISTO displays numerical results in the edit field (if a line label is given in the HISTO operation). The estimated parameters as well as their standard errors and correlations are produced. Furthermore a table of observed and expected frequencies and the X^2 statistic is printed.

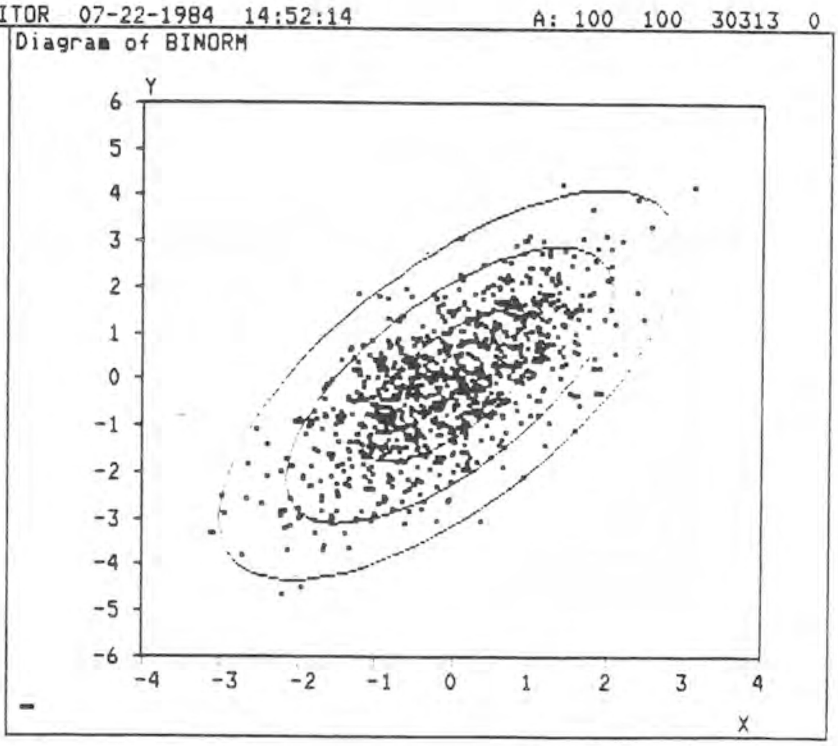
```
1  1 SURVO 84 EDITOR  08-12-1984  21:01:06          D: 100  100  29589  0
 24 *_
 25 *HISTO: Estimated parameters of MIXNORM
 26 *p=0.271094 (0.033635)
 27 *m1=2.047 (0.054054)
 28 *s1=0.428125 (0.039643)
 29 *m2=0.076563 (0.086999)
 30 *s2=1.008 (0.059888)
 31 *Correlations:
 32 *         p      m1      s1      m2      s2
 33 *p        1.000 -0.457  0.460 -0.645 -0.602
 34 *m1      -0.457  1.000 -0.436  0.380  0.265
 35 *s1       0.460 -0.436  1.000 -0.381 -0.319
 36 *m2      -0.645  0.380 -0.381  1.000  0.608
 37 *s2      -0.602  0.265 -0.319  0.608  1.000
 38 *LOG(L)=-791.320    NF= 381
 39 *Frequency distribution of Mixnorm in SIMUDATA: N=500
 40 *                                                  min e=5
 41 *Class midpoint   f    %   Sum    %      e      e    f     X+2
 42 * (     -3.1      0   0.0    0   0.0    0.2
 43 *       -3.1      1   0.2    1   0.2    0.2
 44 *       -2.9      0   0.0    1   0.2    0.4
 45 *       -2.7      0   0.0    1   0.2    0.7
 46 *       -2.5      0   0.0    1   0.2    1.1
```

```
1  1 SURVO 84 EDITOR  08-12-1984  21:11:44          D: 100  100  29845  0
 58 *_      -0.1     25   5.0  173  34.6   28.3  28.3  25     0.4
 59 *        0.1     23   4.6  196  39.2   28.8  28.8  23     1.2
 60 *        0.3     25   5.0  221  44.2   28.1  28.1  25     0.3
 61 *        0.5     31   6.2  252  50.4   26.4  26.4  31     0.8
 62 *        0.7     25   5.0  277  55.4   24.0  24.0  25     0.0
 63 *        0.9     30   6.0  307  61.4   21.4  21.4  30     3.5
 64 *        1.1     16   3.2  323  64.6   19.5  19.5  16     0.6
 65 *        1.3      7   1.4  330  66.0   19.5  19.5   7     8.0
 66 *        1.5     33   6.6  363  72.6   21.9  21.9  33     5.6
 67 *        1.7     27   5.4  390  78.0   26.0  26.0  27     0.0
 68 *        1.9     29   5.8  419  83.8   29.2  29.2  29     0.0
 69 *        2.1     24   4.8  443  88.6   28.6  28.6  24     0.7
 70 *        2.3     21   4.2  464  92.8   23.6  23.6  21     0.3
 71 *        2.5     22   4.4  486  97.2   16.1  16.1  22     2.2
 72 *        2.7      9   1.8  495  99.0    9.0   9.0   9     0.0
 73 *        2.9      3   0.6  498  99.6    4.2
 74 *        3.1      1   0.2  499  99.8    1.6
 75 *        3.3      1   0.2  500 100.0    0.6
 76 * )      3.3      0   0.0  500 100.0    0.3   6.7   5     0.4
 77 *Mean=0.611600 Std.dev.=1.248
 78 *Fitted by MIXNORM(0.271094,2.047,0.428125,0.076563,1.008) distribution
 79 *Chi-square=28.2 df=19 P=0.9211
 80 *
```

This example tells, how easily artificial data can be generated and rather complicated experiments performed.
The orbits around this galaxy are concentration ellipses on probability levels given by CONTOUR=0.5,0.9,0.99. Since N=1000, the expected number of cases lying outside the largest orbit is 10. Now we have 8 or 9, which is plausible.

```
■ 16  1 SURVO 84 EDITOR  07-22-1984  14:35:58              A: 100  100  29486  0
*SAVE BINORM
*
*Generating a sample of 1000 observations from a two-dimensional
*normal distribution:
*
*Creating data file BINORM:
*FILE CREATE BINORM,1*8,2,64,1000
*FIELDS:
* 1 N 4  X         X is N(0,1)
* 2 N 4  Y         Y=X+W, where W is N(0,1)
*END
*■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■
*
*Generating the sample:
*VAR TO BINORM
*BASIC
*X=%Normal(0,1)
*W=%Normal(0,1):Y=X+W
*END
*■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■
*
*Plotting the bivariate sample:
*PLOT BINORM,X,Y_ / XSCALE=-4(1)4 YSCALE=-6(1)6 CONTOUR=0.5,0.9,0.99
```

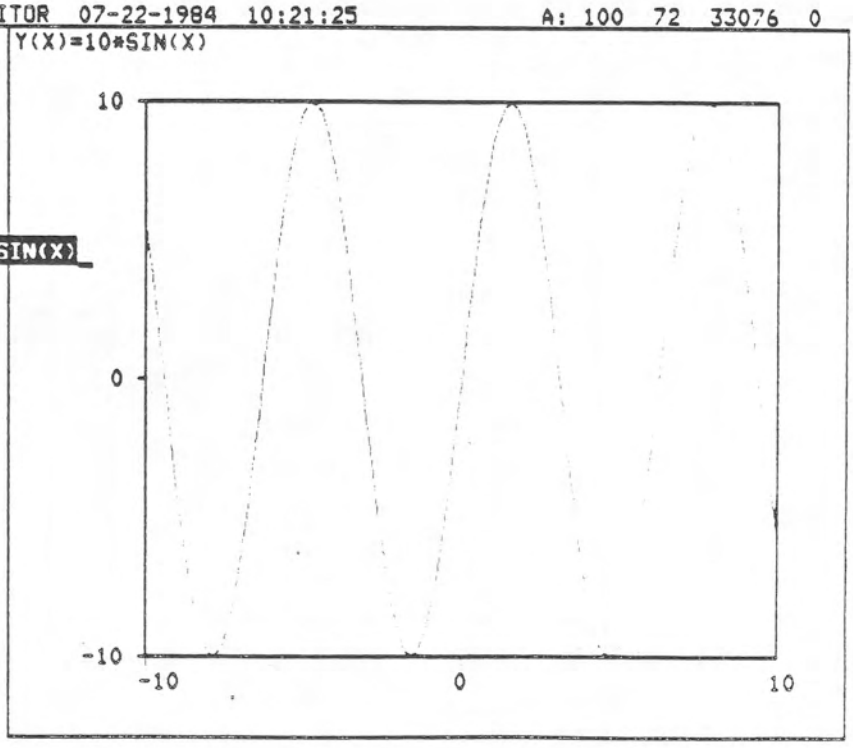
■ 16 1 SURVO 84 EDITOR 07-22-1984 14:52:14   A: 100 100 30313 0



Simple curve plotting without any extra specifications.
After plotting the edit field may be freely scrolled over the graph.

```
■ 20  1 SURVO 84 EDITOR  07-22-1984  10:13:58          A: 100  72  32912  0
  1 *
  2 *
  3 *
  4 *
  5 *
  6 *
  7 *
  8 *PLOT Y(X)=10*SIN(X)
  9 *
 10 *
 11 *
 12 *
 13 *
 14 *
 15 *
 16 *
 17 *
 18 *
 19 *
 20 *
 21 *
 22 *
 23 *
```

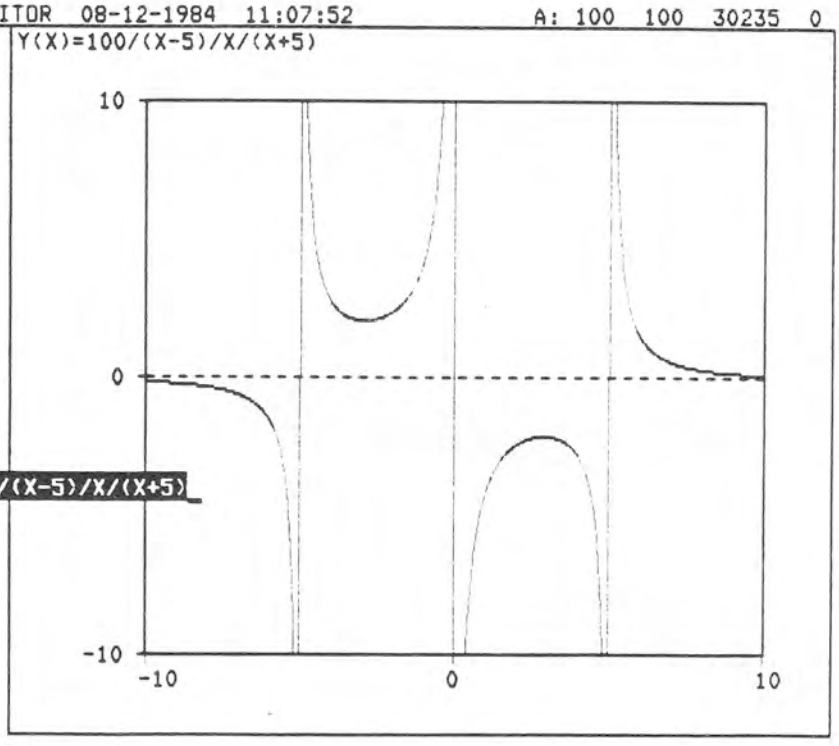
```
■ 20  1 SURVO 84 EDITOR  07-22-1984  10:21:25          A: 100  72  33076  0
  1 *
  2 *
  3 *
  4 *
  5 *
  6 *
  7 *
  8 *PLOT Y(X)=10*SIN(X)
  9 *
 10 *
 11 *
 12 *
 13 *
 14 *
 15 *
 16 *
 17 *
 18 *
 19 *
 20 *
 21 *
 22 *
 23 *
```



A rational function with 3 points of discontinuity is plotted. Observe that, due to a small step length (0.02), the vertical asymptotes are plotted automatically when jumping from one edge to another.

```
■ 28  1 SURVO 84 EDITOR  08-12-1984  10:56:41          A: 100  100  29860  0
  11 *
  12 *
  13 *
  14 *
  15 *
  16 *
  17 *
  18 *
  19 *
  20 *
  21 *
  22 *
  23 *
  24 *
  25 *
  26 *PLOT Y(X)=100/(X-5)/X/(X+5)
  27 *X=-10,10,0.02
  28 *GRID=Y
  29 *
  30 *
  31 *
  32 *
  33 *
```

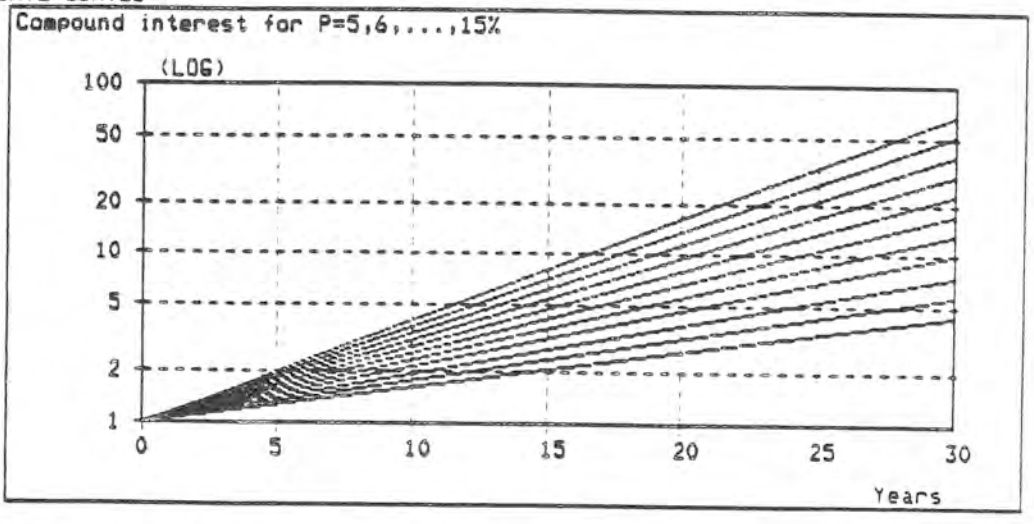
```
■ 28  1 SURVO 84 EDITOR  08-12-1984  11:07:52          A: 100  100  30235  0
  11 *
  12 *
  13 *
  14 *
  15 *
  16 *
  17 *
  18 *
  19 *
  20 *
  21 *
  22 *
  23 *
  24 *
  25 *
  26 *PLOT Y(X)=100/(X-5)/X/(X+5)
  27 *X=-10,10,0.02
  28 *GRID=Y
  29 *
  30 *
  31 *
  32 *
  33 *
```



A curve family telling about compound interest for various interest rates is plotted.
LOG in the YSCALE specification selects the logarithmic scale which transforms an exponential growth to a linear one.

```
■ 22  1 SURVO 84 EDITOR  07-22-1984  12:24:45          A: 100  72  31822  0
  1 *SAVE CURVES
  2 *
  3 *
  4 *
  5 *
  6 *
  7 *
  8 *
  9 *
 10 *
 11 *
 12 *
 13 *
 14 *
 15 *
 16 *
 17 *
 18 *
 19 *
 20 *PLOT Y(X)=(1+P/100)^X
 21 *HEADER=Compound_interest_for_P=5,6,...,15% XLABEL=Years GRID=XY
 22 *XSCALE=0(5)30 YSCALE=LOG,1,2,5,10,20,50,100
 23 *P=5,15,1 X=0,30,30 HOME=70,150 SIZE=729,400
```

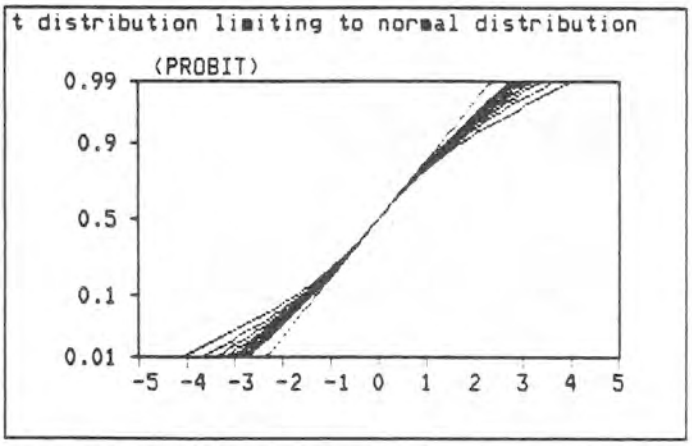
```
■ 22  1 SURVO 84 EDITOR  07-22-1984  12:32:42          A: 100  72  32943  0
  1 *SAVE CURVES
  2 *
  3 *
  4 *
  5 *
  6 *
  7 *
  8 *
  9 *
 10 *
 11 *
 12 *
 13 *
 14 *
 15 *
 16 *
 17 *
 18 *
 19 *
 20 *PLOT Y(X)=(1+P/100)^X
 21 *HEADER=Compound_interest_for_P=5,6,...,15% XLABEL=Years GRID=XY
 22 *XSCALE=0(5)30 YSCALE=LOG,1,2,5,10,20,50,100
 23 *P=5,15,1 X=0,30,30 HOME=70,150 SIZE=729,400
```



The cumulative distribution functions of standard normal and t distributions with n=2,3,...,10 degrees of freedom are plotted on normal probability paper. 'PROBIT' in the YSCALE specification selects the probit scale. PLOT INTEGRAL implies that the integral function is to be plotted and INTEGRAL=1 that the function should be scaled so that its integral is 1 in the plotting range.

```
■ 33  1 SURVO 84 EDITOR  08-12-1984  09:37:10          A: 100  100  29602  0
  1 *
  2 *
  3 *
  4 *
  5 *
  6 *
  7 *
  8 *
  9 *
 10 *
 11 *
 12 *
 13 *
 14 *
 15 *
 16 *
 17 *HEADER=t_distribution_limiting_to_normal_distribution
 18 *HOME=100,200 SIZE=500,350
 19 *INTEGRAL=1 XSCALE=-5(1)5 YSCALE=PROBIT,0.01,0.1,0.5,0.9,0.99
 20 *
 21 *PLOT INTEGRAL Y(X)=exp(-0.5*X↑2)
 22 *PLOT INTEGRAL Y(X)=(1+X↑2/n)↑(-(n+1)/2)  /  n=2,10,1
 23 *
```

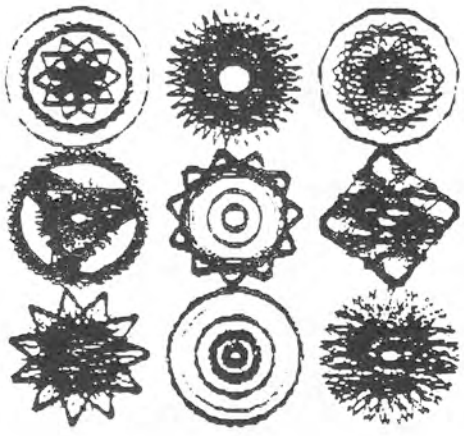
```
■ 40  1 SURVO 84 EDITOR  08-12-1984  09:50:47          A: 100  100  30122  0
  1 *
  2 *
  3 *
  4 *
  5 *
  6 *
  7 *
  8 *
  9 *
 10 *
 11 *
 12 *
 13 *
 14 *
 15 *
 16 *
 17 *HEADER=t_distribution_limiting_to_normal_distribution
 18 *HOME=100,200 SIZE=500,350
 19 *INTEGRAL=1 XSCALE=-5(1)5 YSCALE=PROBIT,0.01,0.1,0.5,0.9,0.99
 20 *
 21 *PLOT INTEGRAL Y(X)=exp(-0.5*X↑2)
 22 *PLOT INTEGRAL Y(X)=(1+X↑2/n)↑(-(n+1)/2)  /  n=2,10,1
 23 *
```



This curve plotting example emphasizes the fact that not so much information is required for producing varied forms and shapes. All information SURVO 84 needs for this picture, can be seen on lines 48-52. A slight modification in parameters would lead to totally different patterns.

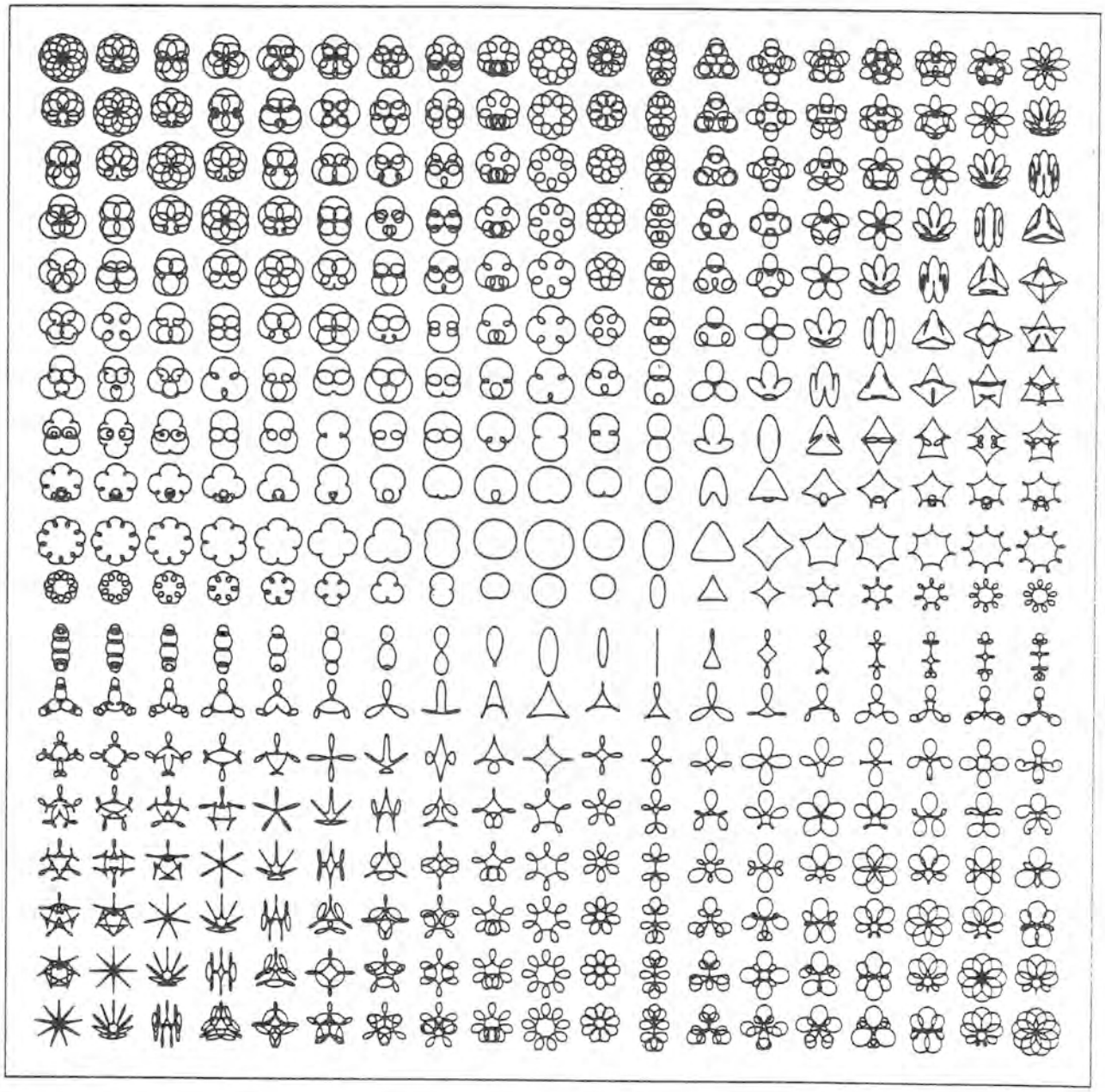
```
■ 1  1 SURVO 84 EDITOR  07-22-1984  11:28:14          A: 100  72  32603  0
 47 *
 48 *HEADER= HOME=200,0 SIZE=450,450
 49 *XSCALE=0,4 YSCALE=0,4 XDIV=0,1,0 YDIV=0,1,0
 50 *t=0,50,1 r=.1,.5,.1 n=0,8,1 FRAME=0
 51 *PLOT X(t)=0.9*r*cos((8*r+n)*t)+int(n/3)+1,
 52 *      Y(t)=r*sin((8*r+n)*t)+n+1-3*int(n/3)
 53 *
 54 *
 55 *
 56 *
 57 *
 58 *
 59 *
 60 *
 61 *
 62 *
 63 *
 64 *
 65 *
 66 *
 67 *
 68 *
 69 *
```

```
■ 1  1 SURVO 84 EDITOR  07-22-1984  11:45:05          A: 100  72  33017  0
 47 *
 48 *HEADER= HOME=200,0 SIZE=450,450
 49 *XSCALE=0,4 YSCALE=0,4 XDIV=0,1,0 YDIV=0,1,0
 50 *t=0,50,1 r=.1,.5,.1 n=0,8,1 FRAME=0
 51 *PLOT X(t)=0.9*r*cos((8*r+n)*t)+int(n/3)+1,
 52 *_     Y(t)=r*sin((8*r+n)*t)+n+1-3*int(n/3)
 53 *
 54 *
 55 *
 56 *
 57 *
 58 *
 59 *
 60 *
 61 *
 62 *
 63 *
 64 *
 65 *
 66 *
 67 *
 68 *
 69 *
```



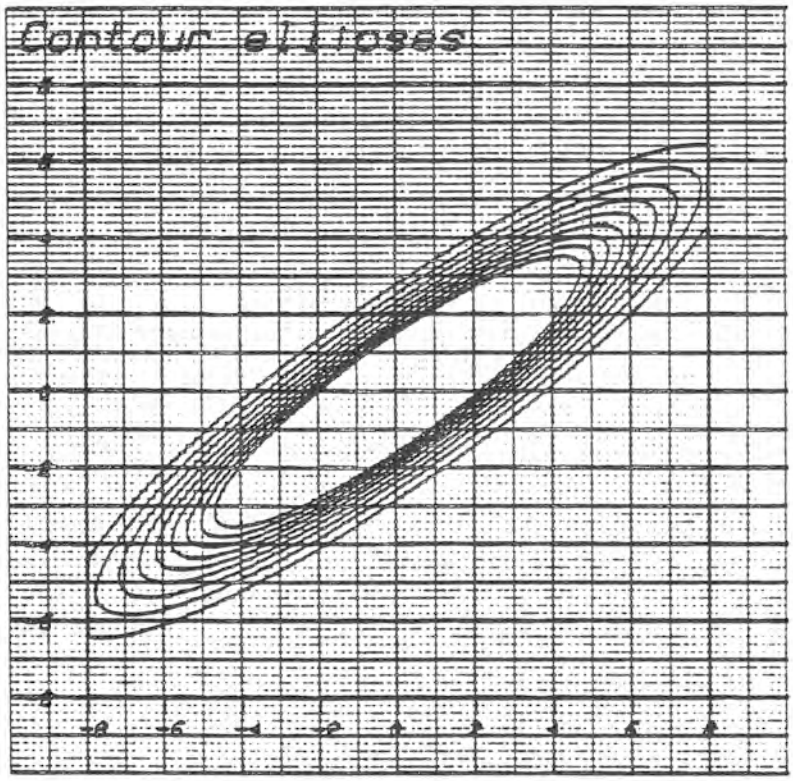
Another family of curves yielding diverse shapes.
All forms in this picture could be interpreted as
variations of a simple circle appearing in the middle
and thus representing 'the origin of species'.
See, how systematically the patterns are developing
in different directions.

```
■ 56  1 SURVO 84 EDITOR  08-18-1984  20:14:02          A: 100  100  29373  0
  1 *
  2 *XDIV=0,1,0 YDIV=0,1,0 SIZE=2650,2650 HEADER= FRAME=1
  3 *A=-8,10,1      B=-8,10,1       T=0,6.3,0.03
  4 *XSCALE=-9,11   YSCALE=-9,11    DEVICE=S
  5 *
  6 *PLOT X(T)=A+0.225*COS(T)+0.139*COS(A*T)+0.086*COS(B*T),_
  7 *      Y(T)=B+0.225*SIN(T)+0.139*SIN(A*T)+0.086*SIN(B*T)
  8 *
  9 *
 10 *
```



Plotting a graph paper and curves on it.
Firstly a 100 mm x 100 mm grid of parallel lines is drawn by using a single pen with a 0.12 mm tip. The thicker lines are produced in 3 or 5 passes. The series of six PLOT operations does the job automatically.
Then a family of contour ellipses from a two-dimensional normal distribution is plotted. Parameter eps controls the confidence level. (The graph is presented in original scale.)

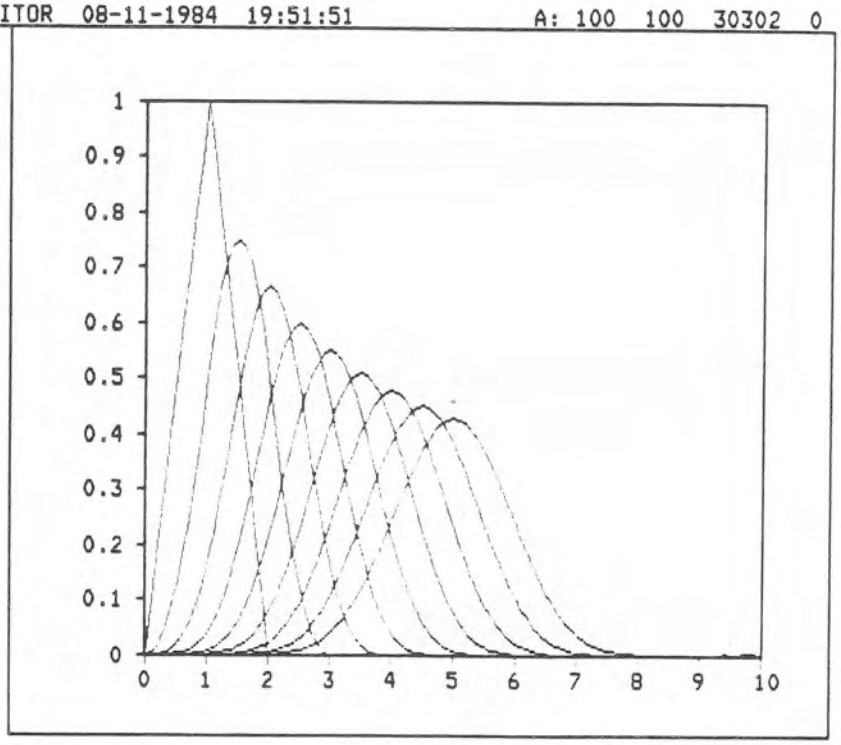
```
■ 40  1 SURVO 84 EDITOR  08-17-1984  18:24:35          A: 100  100  28185  0
  1 *
  2 *XDIV=0,1,0 YDIV=0,1,0 SIZE=1000,1000
  3 *HEADER= FRAME=0 DEVICE=S PEN=2
  4 *XSCALE=0,1000 YSCALE=0,1000 HOME=250,50
  5 *t10=0,1000,100 t5=50,950,100 t=0,1000,10
  6 *eps10=-2,2,1   eps5=-1,1,1   u=0,1000,100
  7 *
  8 *PLOT Y(u)=t10+eps10          / X lines 10 mm, thickness 5
  9 *PLOT Y(u)=t5+eps5            / X lines  5 mm, thickness 3
 10 *PLOT Y(u)=t                  / X lines  1 mm, thickness 1
 11 *PLOT X(u)=t10+eps10,Y(u)=u   / Y lines 10 mm, thickness 5
 12 *PLOT X(u)=t5+eps5,Y(u)=u     / Y lines  5 mm, thickness 3
 13 *PLOT X(u)=t,Y(u)=u           / Y lines  1 mm, thickness 1
 14 *■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■
 15 *
 16 *PLOT X(t)=s1*sqr(-2*log(1-eps))*cos(t),
 17 *      Y(t)=s2*sqr(-2*log(1-eps))*sin(t+atn(rho/sqr(1-rho*rho)))
 18 *
 19 *HEADER=(1;36;36,1,2),Contour_ellipses DEVICE=S
 20 *s1=4 s2=3 rho=0.9 t=0,6.2832 eps=0.5,0.9,0.05
 21 *XDIV=1,8,1 YDIV=1,8,1 SIZE=1000,1000 HOME=250,50 FRAME=1
 22 *XSCALE=(1,20,20,1),-8(2)8 YSCALE=(1,20,20,1),-8(2)8
 23 *
```



The equations of more complicated curves may be written as 'BASIC' programs in the edit field.
Observe that the statement lines may have symbolic labels (like REPEAT!, OLD! etc.).

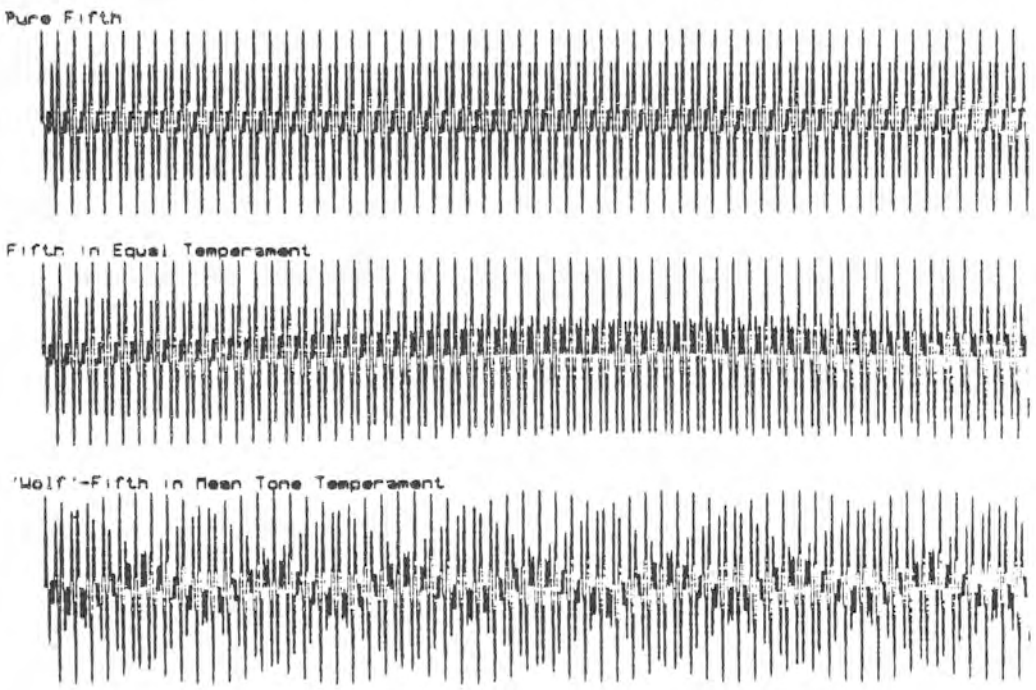
```
■ 10  1 SURVO 84 EDITOR  08-11-1984  19:41:04          A: 100  100  29372  0
  1 *SAVE UNIFORM
  2 *
  3 *
  4 *
  5 *
  6 *         Plotting the density functions of the sum of n independent
  7 *         variables uniformly distributed over (0,1)
  8 *
  9 *XSCALE=0(1)10 YSCALE=0(0.1)1 n=2,10,1
 10 *PLOT F(X)
 11 *         IF X>0 THEN OLD! ELSE WFACTORIAL=1:WTERM=1
 12 *REPEAT!  WTERM=WTERM+1:IF WTERM>n-1 THEN OLD!
 13 *         WFACTORIAL=WFACTORIAL*WTERM:GOTO REPEAT!
 14 *OLD!     Y=0:IF X>n THEN READY!
 15 *         WCOEFF=1:WIND=0
 16 *SUM!     Y=Y+WCOEFF*(X-WIND)↑(n-1)
 17 *         WIND=WIND+1:IF X<=WIND THEN READY!
 18 *         WCOEFF=-(n-WIND+1)/WIND*WCOEFF:GOTO SUM!
 19 *READY!   Y=Y/WFACTORIAL
 20 *END
 21 *
 22 *
 23 *
```

```
■ 10  1 SURVO 84 EDITOR  08-11-1984  19:51:51          A: 100  100  30302  0
```



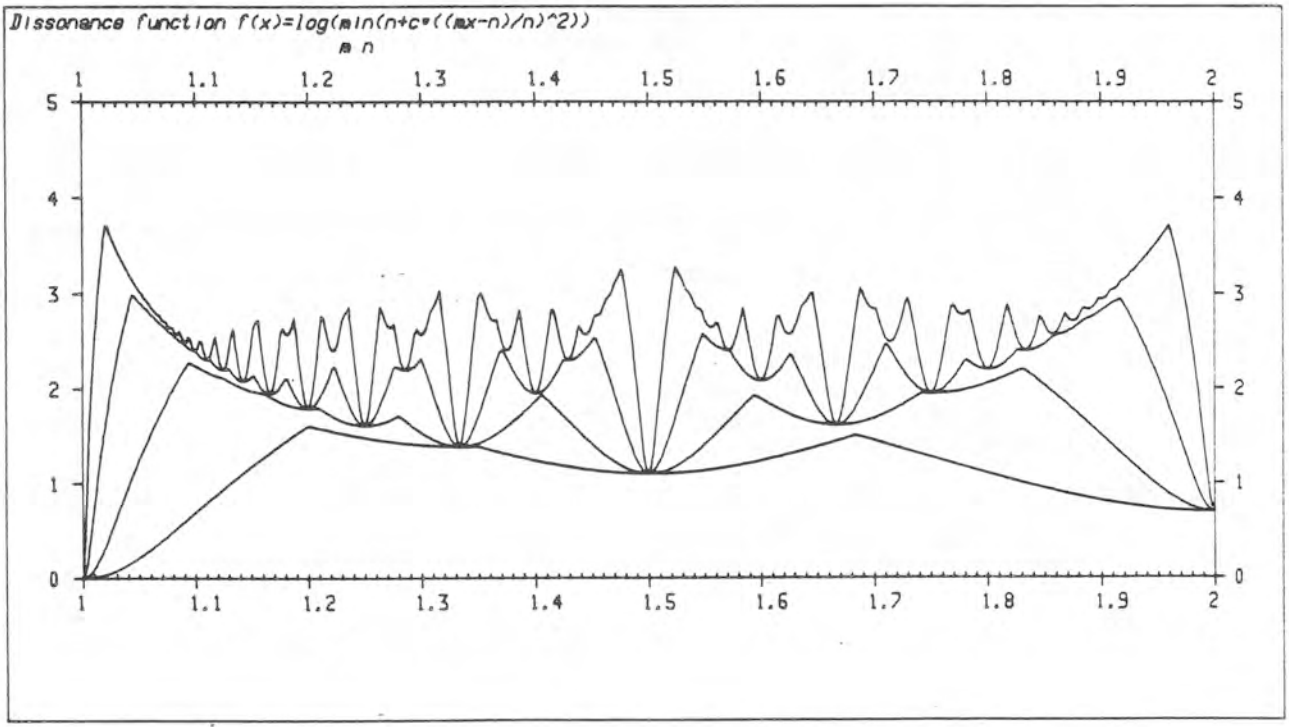
Oscillograms for certain musical intervals are plotted.
This kind of a representation clearly reveals the beats which indicate the impureness of the sound as long cycle oscillations.
The howling of the extremely dissonant 'Wolf' fifth in the ancient mean tone temperament is striking.
To gain more accuracy, these graphs are made on the SERVOGOR plotter (specification DEVICE=S)

```
S 34  1 SURVO 84 EDITOR  07-22-1984  19:54:38          A: 100  100  27319  0
 67 *
 68 *       Musical intervals in different temperaments
 69 *
 70 *HEADER=Pure_Fifth
 71 *PLOT Y(X)=(SIN(20*X)+SIN(30*X))/2
 72 *YSCALE=-1,0,1
 73 *XSCALE=0,37.699/12*PI X=0,37.699,0.001
 74 *HOME=0,1200 SIZE=2650,600 YDIV=50,500,50 XDIV=100,2500,50
 75 *DEVICE=S  PEN=1,30,30 FRAME=0
 76 *=============================================================================
 77 *HEADER=Fifth_in_Equal_Temperament              20*2↑(7/12)=29.96614
 78 *PLOT Y(X)=(SIN(20*X)+SIN(29.96614*X))/2
 79 *YSCALE=-1,0,1
 80 *XSCALE=0,37.699/12*PI X=0,37.699,0.001
 81 *HOME=0,600  SIZE=2650,600 YDIV=50,500,50 XDIV=100,2500,50
 82 *DEVICE=S  PEN=1,30,30 FRAME=0
 83 *=============================================================================
 84 *HEADER='Wolf'-Fifth_in_Mean_Tone_Temperament  20*128*5↑(-11/4)=30.62476
 85 *PLOT Y(X)=(SIN(20*X)+SIN(30.62476*X))/2
 86 *YSCALE=-1,0,1
 87 *XSCALE=0,37.699/12*PI X=0,37.699,0.001
 88 *HOME=0,0    SIZE=2650,600 YDIV=50,500,50 XDIV=100,2500,50
 89 *DEVICE=S  PEN=1,30,30 FRAME=0
```



Hermann Helmholz (1821-1894) in his great treatise 'On The Sensations of Tone' has presented a graph on the degree of harmoniousness of consonances. It is based on his theory of physiological acoustics (see pp.192-3 and App.XV).
Here another (and simpler) proposal is introduced. The assumption behind our model is that each (impure) interval x is conceived as a simple ratio n/m. The ear likes to keep n and the beat (mx-n)/n as small as possible simultaneously.
The balance between these two conflicting factors is controlled by parameter c which represents the sensitivity of the ear.
The dissonance curve has been plotted for 4 different ears.
Observe that the PLOT scheme finds the minimum with respect to n for each x separately before moving the pen.

```
■ 10  1 SURVO 84 EDITOR  08-20-1984  16:32:24          A: 100  100  29445  0
  1 *
  2 *
  3 *Degree of dissonance for intervals from Unison to Octave
  4 *
  5 *HEADER=(1,30,24,1),Dissonance_function_f(x)=log(min(n+c*((mx-n)/n)↑2))
  6 *TEXT=A A=(1,30,24,1),m_n,720,1420
  7 *XSCALE=(1,30,24),1(0.1)2  YSCALE=(1,30,24),0(1)5
  8 *XSCALE2=(1,30,24),XSCALE YSCALE2=(1,30,24),YSCALE
  9 *X=1,2,0.002 TICK=0.01 TICK2=TICK
 10 *DEVICE=S SIZE=2690,1500 XDIV=100,1500,90
 11 *The sensitivity of the ear: ACCURACY=2,5,1
 12 *
 13 *PLOT F(X)
 14 *         WF=1E10:WM=0:WA=10↑ACCURACY
 15 *NEW!     WM=WM+1:WN=INT(WM*X):WDISS=WM*X-WN:IF WDISS<0.5 THEN CONT!
 16 *         WDISS=1-WDISS:WN=WN+1
 17 *CONT!    WB=WDISS/WN:WB=WN+WA*WB*WB:IF WF<=WB THEN TEST!
 18 *         WF=WB:WMM=WM:WNN=WN
 19 *TEST!    IF WN<WF THEN NEW!
 20 *         Y=LOG(WF)
 21 *END
 22 *
 23 *
```



Some simple applications of editorial arithmetics: Any expression like 2+2=_ can be evaluated by moving the cursor to the position after = and by pressing the activation key COMMAND.
The last example shows, how (after activation of FV=_) the system is able to find definitions and formulas from the edit field and how it calculates the activated expression on the basis of these formulas. Thus no 'program' in the normal sense is needed for these computations.

```
■ 11  1 SURVO 84 EDITOR  07-22-1984  17:25:12          A: 100  72  31382  0
  24 *************************************************************************
  25 *
  26 *Arithmetics:
  27 *
  28 *      2+2=_   (23*17-67)/(1900-78)=
  29 *
  30 *      2↑12=        SQR(49)=
  31 *
  32 *      A=3 B=A+1 C=SQR(A*A+B*B) C+1=
  33 *
  34 *************************************************************************
  35 *
  36 *Computing compound interest:
  37 *
  38 *Let N be number of years,
  39 *    PMT the present value,
  40 *    FV the future value and
  41 *    P the interest rate.
  42 *Then FV=PMT*r↑N where r=1+P/100.
  43 *
  44 *If N=10 , PMT=2000 and P=12 ,
  45 *then FV=
  46 *
```

```
■ 9  1 SURVO 84 EDITOR  07-22-1984  17:33:49          A: 100  72  32232  0
  24 *************************************************************************
  25 *
  26 *Arithmetics:
  27 *
  28 *      2+2=4   (23*17-67)/(1900-78)=0.1778265642151482
  29 *
  30 *      2↑12=4096    SQR(49)=7
  31 *
  32 *      A=3 B=A+1 C=SQR(A*A+B*B) C+1=6
  33 *
  34 *************************************************************************
  35 *
  36 *Computing compound interest:
  37 *
  38 *Let N be number of years,
  39 *    PMT the present value,
  40 *    FV the future value and
  41 *    P the interest rate.
  42 *Then FV=PMT*r↑N where r=1+P/100.
  43 *
  44 *If N=10 , PMT=2000 and P=12 ,
  45 *then FV=6211.696147918701
  46 *
```

Evaluating formal derivatives of mathematical functions is a feature in SURVO 84 which enables making of more intelligent programs. For example, in nonlinear regression analysis the derivatives of the model function play an essential role.

```
■ 14  1 SURVO 84 EDITOR  07-22-1984  16:56:57          A: 100  72  31749  0
  1 *SAVE DER
  2 *
  3 *DER (function of variable x),(variable x)
  4 *forms the analytical derivative of the function with respect to
  5 *(variable x) and writes the result on the next two lines in the edit
  6 *field. For example,
  7 *
  8 *DER (X+A)↑X X
  9 *
 10 *
 11 *
 12 *DER F(G(LOG(x)))
 13 *
 14 *
 15 *
 16 *DER SIN(G(t)/t) t
 17 *
 18 *
 19 *
 20 *SURVO 84 employs itself analytical derivatives in the ESTIMATE operation
 21 *for linear and nonlinear regression models and for general Maximum
 22 *likelihood problems.
 23 *
```

```
■ 18  1 SURVO 84 EDITOR  07-22-1984  17:05:03          A: 100  72  32560  0
  1 *SAVE DER
  2 *
  3 *DER (function of variable x),(variable x)
  4 *forms the analytical derivative of the function with respect to
  5 *(variable x) and writes the result on the next two lines in the edit
  6 *field. For example,
  7 *
  8 *DER (X+A)↑X X
  9 * Derivative of (X+A)↑X with respect to X is
 10 *     (X+A)↑X*(LOG(X+A)+X/(X+A))
 11 *
 12 *DER F(G(LOG(x)))
 13 * Derivative of F(G(LOG(x))) with respect to x is
 14 *     F'(G(LOG(x)))*G'(LOG(x))*1/x
 15 *
 16 *DER SIN(G(t)/t) t
 17 * Derivative of SIN(G(t)/t) with respect to t is
 18 *     COS(G(t)/t)*(t*G'(t)-G(t))/t↑2
 19 *
 20 *SURVO 84 employs itself analytical derivatives in the ESTIMATE operation
 21 *for linear and nonlinear regression models and for general Maximum
 22 *likelihood problems.
 23 *
```

Linear and nonlinear regression models can be estimated by the ESTIMATE operation which is able to analyze the form of the model function by means of the derivatives. For example, when seeing that the second derivatives with respect to the unknown parameters are zero (as in the case we have here) the system knows that the model is linear and selects the numerical algorithm accordingly.

```
■ 28  1 SURVO 84 EDITOR  07-22-1984  18:03:01          A: 100  100  29775  0
  1 *SAVE EST
  2 *
  3 *DATA COUNTRIES,A,8,C
  4 C  Country       Coffee   Tea    Beer  Wine Spirits
  5 *
  6 A  Italy           3.6   0.06   13.6 106.6   2.0
  7 *  Portugal        2.2   0.03   27.5  89.3   0.9
  8 *  Norway          9.4   0.19   43.5   3.1   1.8
  9 *  Spain           2.5   0.03   43.6  73.2   2.7
 10 *  France          5.2   0.10   44.5 104.3   2.5
 11 *  Finland        12.5   0.15   54.7   7.6   2.7
 12 *  Sweden         12.9   0.30   58.3   7.9   2.9
 13 *  Switzerland     9.1   0.25   73.5  44.9   2.1
 14 *  Holland         9.2   0.58   75.5   9.7   2.7
 15 *  England         1.8   3.49  113.7   5.1   1.4
 16 *  Denmark        11.8   0.41  113.9  10.4   1.7
 17 B  Ireland         0.2   3.73  124.5   3.8   1.9
 18 *
 19 *MODEL Beer1
 20 *log(Beer)=constant+coeff*log(Tea)
 21 *
 22 *ESTIMATE COUNTRIES,Beer1,24
 23 *
```

```
■ 28  1 SURVO 84 EDITOR  07-22-1984  18:10:20          A: 100  100  29810  0
 10 *  France          5.2   0.10   44.5 104.3   2.5
 11 *  Finland        12.5   0.15   54.7   7.6   2.7
 12 *  Sweden         12.9   0.30   58.3   7.9   2.9
 13 *  Switzerland     9.1   0.25   73.5  44.9   2.1
 14 *  Holland         9.2   0.58   75.5   9.7   2.7
 15 *  England         1.8   3.49  113.7   5.1   1.4
 16 *  Denmark        11.8   0.41  113.9  10.4   1.7
 17 B  Ireland         0.2   3.73  124.5   3.8   1.9
 18 *
 19 *MODEL Beer1
 20 *log(Beer)=constant+coeff*log(Tea)
 21 *
 22 *ESTIMATE COUNTRIES,Beer1,24
 23 *
 24 *Estimated parameters of model Beer1
 25 *constant=4.488964 (.156575)
 26 *coeff=.3276288 (7.527091E-02)
 27 *Correlations:
 28 *         consta coeff
 29 *constant 1.000  0.687
 30 *coeff    0.687  1.000
 31 *RSS=1.553654  R↑2=.6545251
 32 *
```

As an example of true nonlinear estimation problem, the location and the radius of a circle are determined on the basis of 20 points in the X-Y plane.
Firstly a data file is created and simulated data values generated. Then the least squares estimates for the parameters are computed by using model C starting from 'wrong' initial values.

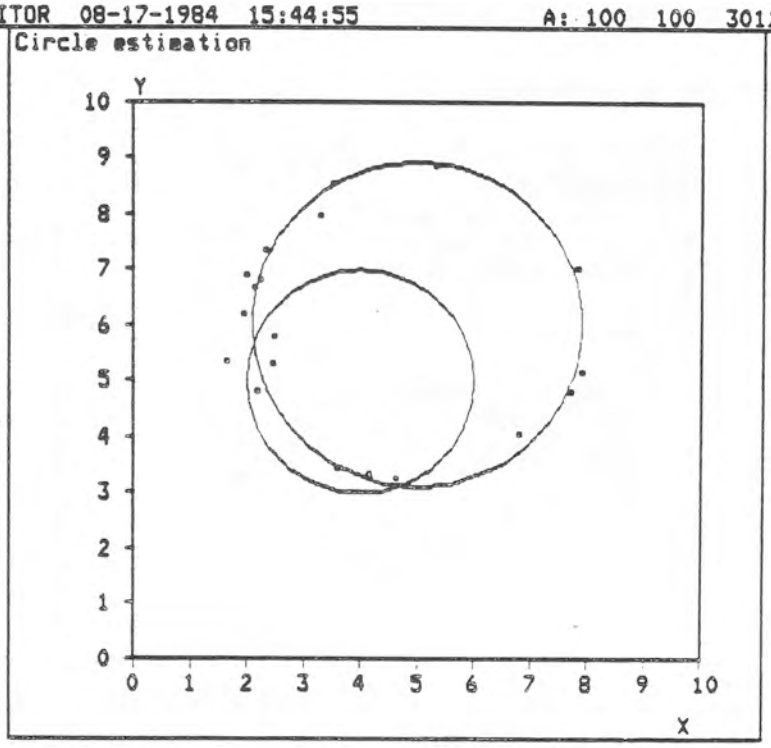
```
■ 14  1 SURVO 84 EDITOR  08-17-1984  15:17:06              A: 100  100  27264  0
*SAVE CIRCLE
*
*
*FILE CREATE CIRCLE,1,10,64,20
*    20 points (X,Y) approximately on the circumference of the circle
*    (X-X0)↑2+(Y-Y0)↑2=R↑2, where X0=5, Y0=6 and R=N(3,0.2↑2)
*FIELDS:
*  1 N 4 X
*  2 N 4 Y
*END
*■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■
*
*Generating 20 points (X,Y):
*
*VAR TO CIRCLE_
*BASIC
*WR=%Normal(3,0.04)
*WT=%Uniform(0,6.2832)
*X=5+WR*COS(WT):Y=6+WR*SIN(WT)
*END
*■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■
*
*
```

```
■ 21  1 SURVO 84 EDITOR  08-17-1984  15:25:07              A: 100  100  27385  0
*
*MODEL C
*SQR((X-X0)↑2+(Y-Y0)↑2)=R
*
*INIT=4,5,2 / Initial values for X0,Y0,R
*ESTIMATE CIRCLE,C,30_
*Estimated parameters of model C
*X0=5.005461 (7.120773E-02)
*Y0=6.028773 (8.152406E-02)
*R=2.903806 (5.650576E-02)
*Correlations:
*         X0     Y0     R
*X0      1.000  0.192  0.493
*Y0      0.192  1.000  0.234
*R       0.493  0.234  1.000
*RSS=.7994619
*
*
*
*
*
*
*
```

(Continuation)
Finally the data and two circles (one with initial values and another with estimated ones) are plotted.

```
■ 39  1 SURVO 84 EDITOR  08-17-1984  15:33:03          A: 100  100  27364  0
 24 *
 25 *MODEL C
 26 *SQR((X-X0)↑2+(Y-Y0)↑2)=R
 27 *
 28 *INIT=4,5,2 / Initial values for X0,Y0,R
 29 *ESTIMATE CIRCLE,C,30
 30 *Estimated parameters of model C
 31 *X0=5.005461 (7.120773E-02)
 32 *Y0=6.028773 (8.152406E-02)
 33 *R=2.903806 (5.650576E-02)
 34 *Correlations:
 35 *          X0      Y0      R
 36 *X0         1.000   0.192   0.493
 37 *Y0         0.192   1.000   0.234
 38 *R          0.493   0.234   1.000
 39 *RSS=.7994619
 40 *
 41 *HEADER=Circle_estimation
 42 *XSCALE=0(1)10 YSCALE=0(1)10
 43 *PLOT CIRCLE,X,Y
 44 *PLOT X(T)=4+2*COS(T),Y(T)=5+2*SIN(T)
 45 *PLOT X(T)=X0+R*COS(T),Y(T)=Y0+R*SIN(T)
 46 *T=0,6.2832
```

```
■ 1  1 SURVO 84 EDITOR  08-17-1984  15:44:55          A: 100  100  30120  0
```



The matrix interpreter of SURVO 84 permits various matrix operations to be performed in the edit field.
In this example a 4x4 matrix A is inverted.

```
■ 11  1 SURVO 84 EDITOR  07-22-1984  18:42:52          A: 100  100  28947  0
  1 *SAVE MAT
  2 *        Matrix operations in SURVO 84
  3 *
  4 *Computing inverse of A:
  5 *
  6 *MATRIX A ///
  7 *      12.5   4.2  11.0  -8.1
  8 *       0.0  -1.3   5.6   2.4
  9 *       5.2  10.4  -9.3   0.3
 10 *       1.0   3.5   2.4  12.9
 11 *
 12 *MAT SAVE A
 13 *MAT B=INV(A)
 14 *MAT LOAD B,16
 15 *
 16 *
 17 *
 18 *
 19 *
 20 *
 21 *
 22 *
 23 *
```

```
■  1  1 SURVO 84 EDITOR  07-22-1984  18:52:03          A: 100  100  29031  0
  1 *SAVE MAT
  2 *        Matrix operations in SURVO 84
  3 *
  4 *Computing inverse of A:
  5 *
  6 *MATRIX A ///
  7 *      12.5   4.2  11.0  -8.1
  8 *       0.0  -1.3   5.6   2.4
  9 *       5.2  10.4  -9.3   0.3
 10 *       1.0   3.5   2.4  12.9
 11 *
 12 *MAT SAVE A
 13 *MAT B=INV(A)                    / *B~INV(A) 4*4
 14 *MAT LOAD B,16
 15 *
 16 *MATRIX B
 17 *INV(A)
 18 *///            1       2       3       4
 19 *  1       0.1776 -0.9609 -0.2918  0.2971
 20 *  2      -0.1268  0.9541  0.3560 -0.2654
 21 *  3      -0.0416  0.5206  0.1242 -0.1259
 22 *  4       0.0284 -0.2812 -0.0971  0.1499
 23 *
```

Canonical analysis on two sets of variables X,Y on the same observations is performed by using a series of MAT operations. Observe that the computations are essentially based on the singular value decomposition.
The results are loaded at the end of the of the operations. This is an example of a 'matrix program' for multivariate statistical analysis.

```
■ 17  1 SURVO 84 EDITOR  07-22-1984  19:03:21          A: 100  100  26930  0
  24 *
  25 *    Canonical correlations
  26 *
  27 *MAT X'=CENTER(X)                 / *X!~CENTER(DECA) 48*5
  28 *MAT Y!=CENTER(Y)                 / *Y!~CENTER(DECA) 48*5
  29 *MAT GRAM-SCHMIDT DECOMPOSITION OF X TO QX,RX
  30 *MAT GRAM-SCHMIDT DECOMPOSITION OF Y TO QY,RY
  31 *MAT W=QX'                        / *W~GS(X)' 5*48
  32 *MAT W=W*QY                       / *W~GS(X)'*GS(Y) 5*5
  33 *MAT SINGULARVALUE DECOMPOSITION OF W TO U,LAMBDA,V
  34 *MAT SOLVE ALPHA FROM RX*ALPHA=U     / *Upper triangular
  35 *MAT SOLVE BETA  FROM RY*BETA=V      / *Upper triangular
  36 *MAT ALPHA!=NRM(ALPHA)            / *ALPHA!~NRM((ALPHA_from_RX*ALPHA=U)) 5*5
  37 *MAT BETA!=NRM(BETA)              / *BETA!~NRM((BETA_from_RY*BETA=V)) 5*5
  38 *MAT LAMBDA=VD(LAMBDA)            / *LAMBDA~VD(Qsvd(GS(X)'*GS(Y))) 5*1
  39 *MAT LAMBDA!=LAMBDA'              / *LAMBDA!~LAMBDA 1*5
  40 *MAT LOAD LAMBDA,END+2
  41 *MAT LOAD ALPHA,END+2
  42 *MAT LOAD BETA,END+2
  43 *
  44 *
  45 *
  46 *Results on the next page!

■  1  1 SURVO 84 EDITOR  07-22-1984  19:15:59          A: 100  100  28623  0
  47 *
  48 *MATRIX LAMBDA
  49 *///            U1      U2      U3      U4      U5
  50 *Diag       0.7894  0.5284  0.3306  0.2823  0.0972
  51 *
  52 *MATRIX ALPHA
  53 *///            U1      U2      U3      U4      U5
  54 *100m      -0.4631  0.7126  0.3823  0.3025  0.2574
  55 *Br_jump   -0.1403  0.4297 -0.6201 -0.4593 -0.2937
  56 *Shot_put  -0.7471 -0.3920 -0.2396  0.2995 -0.1706
  57 *Hi_jump   -0.1805  0.1065 -0.0784 -0.0724  0.8592
  58 *400m       0.4185 -0.3775 -0.6370  0.7763  0.2830
  59 *
  60 *MATRIX BETA
  61 *///            V1      V2      V3      V4      V5
  62 *Hurdles   -0.1200  0.3912 -0.7545  0.4979 -0.1728
  63 *Discus    -0.8919 -0.6855 -0.2195  0.1943 -0.4581
  64 *Pole_vlt   0.0837  0.1561  0.0024 -0.2574 -0.8142
  65 *Javelin    0.1444  0.0004 -0.5062 -0.7343  0.0691
  66 *1500m      0.4028 -0.5938 -0.3555  0.3301 -0.3043
  67 *
  68 *
  69 *
```

The SURVO 84 matrix interpreter also provides operations for large supermatrices. In this example a 100*100 matrix consisting of 25*25 parts is inverted. The matrix has a simple structure: All diagonal elements are 1 and other elements are 0.8.
The structures of the supermatrices R%,S% are given in the edit field and the parts A,B are formed by MAT operations.
Finally R% is inverted by MAT S%=INV(R%). After inversion the result is examined and compared with known theoretical values.

```
■ 15  1 SURVO 84 EDITOR  08-18-1984  11:27:54          A: 100  100  26679  0
  1 *
  2 *            Inverting partitioned 100*100 matrix
  3 *MATRIX R%
  4 *A B B B
  5 *B A B B
  6 *B B A B
  7 *B B B A
  8 *
  9 *MATRIX S%
 10 *S11 S12 S13 S14
 11 *S21 S22 S23 S24
 12 *S31 S32 S33 S34
 13 *S41 S42 S43 S44
 14 *
 15 *n=25 r=0.8 s=0.2
 16 *
 17 *MAT B=CON(n,n)
 18 *MAT B!=r*B                    / *B!((B S25*25
 19 *MAT A=IDN(n)
 20 *MAT A=s*A                    / *A((s*I D25*25
 21 *MAT A!=A+B                   / *A!((A S25*25
 22 *MAT S%=INV(R%)
 23 *
```

```
■ 44  1 SURVO 84 EDITOR  08-18-1984  11:36:18          A: 100  100  28721  0
 25 *************************************************************************
 26 *n=25 r=0.8  N=4*n
 27 *x=(1+(N-2)*r)/q   q=1+(N-2)*r-(N-1)*r*r
 28 *y=-r/q
 29 *x=4.950124688279302
 30 *y=-4.9875311720698260-02
 31 *
 32 *MAT LOAD S11(1:3,1:3),##.################,33
 33 *MATRIX S11
 34 *INV(A)-INV(A)*B*INV(A-B*INV(A)*B)*(-B*INV(A))-(INV(A)*B-INV(A)*B*INV(A-B*
 35 *///                        1                    2                    3
 36 *  1       4.950124688279277 -0.049875311720723 -0.049875311720723
 37 *  2      -0.049875311720723  4.950124688279277 -0.049875311720723
 38 *  3      -0.049875311720722 -0.049875311720723  4.950124688279278
 39 *
 40 *MAT LOAD S44(1:3,1:3),##.################,41
 41 *MATRIX S44
 42 *INV(A-B*INV(A)*B-(B-B*INV(A)*B)*INV(A-B*INV(A)*B)*(B-B*INV(A)*B)-(B-B*INV
 43 *///                        1                    2                    3
 44 *  1       4.950124688279299 -0.049875311720701 -0.049875311720701
 45 *  2      -0.049875311720701  4.950124688279299 -0.049875311720701
 46 *  3      -0.049875311720701 -0.049875311720701  4.950124688279299
 47 *************************************************************************
```