Programming SURVO 84 in C

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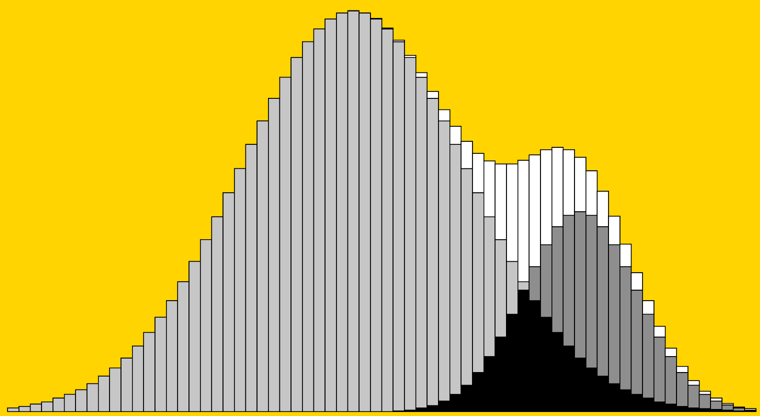

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SURVO 84C is an integrated system for statistical analysis, computing, data base management, graphics, desktop publishing, etc.
Through its unique editorial interface, SURVO 84C forms a general environment for many kinds of applications.

SURVO 84C Contributions is a series of papers devoted to various new features of the SURVO 84C system.

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SURVO 84C Contributions

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3. S.Mustonen: Programming SURVO 84 in C, 1989

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Programming SURVO 84 in C

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Programming SURVO 84 in C

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Abstract: The SURVO 84C system can be extended without any limits by new program modules written in C. In this paper, the program structure of SURVO 84C is described. Instructions for making program modules are given. The tools developed for SURVO 84C programming are presented as C library functions.

Keywords: SURVO 84C, C language, Programming tools

1. Introduction

SURVO 84C is an open system. It provides tools for making extensions in different ways. Many of the enhancements can be accomplished by means of sucros described in *"Sucros in SURVO 84C"* by Mustonen (1988). Also the matrix interpreter (MATRUN operations), the touch mode and the editorial computing mode, for example, are useful when making such extensions. Furthermore, some of the general SURVO 84C operations (like PRINT and PLOT) provide their own special programming tools.

In the most demanding tasks, the only general way for making extensions is to use the programming language C since the entire SURVO 84C system has been programmed in C.

SURVO 84C is a modular system consisting of one main program (the editor) and of numerous modules which are called by the main program when needed. Each module itself is written like any independent program, but it can be executed only as a child process when its parent process (main program) is present and delivers all input information to the module. When a SURVO 84C module terminates, it disappears from the memory and the control returns to the main program. It is up to the module how it renders its results. Usually results are printed on the screen and saved in an output file or they are displayed in the edit field. Each module in turn may have children which are written independently but receive sustenance from their mother.

An important link between the main program and the modules (and thus also between different modules) is the *edit field*, which among other things carries vital input information to the modules. The main program selects the module needed for each particular task according to the activation procedure initiated by the user. In most cases the activated line in the edit field holds that information. For example, when the user activates a line starting with the word `PRINT`, the main program 'knows' that a program !PRINT.EXE should do the job and calls it immediately. Thereafter it is the task of !PRINT.EXE to read parameters and other input information (like specifications written around the activated line).

This convention guarantees that there can be as many modules in the system as there are permitted program file names (starting with '!'). Since each module visits the central memory in turn, it is only the disk capacity that may limit the size of the system.

Instead of one large program, we have a family of smaller programs which can cooperate. Such a system is easier to maintain. For example, each module usually consists of several compilands which are compiled separately and then linked together. There is no need to link the modules to each other or to the main program. However, the environment created for the programmer guarantees that making a SURVO 84C module is like extending one large uniform system which *could be* one huge program.

When programming a new module, it is not necessary to know about the requirements of other modules (assuming that we are not using conflicting names for modules). In many cases, however, it is good to be familiar with other solutions and use ready-made tools generated earlier for similar purposes.

In fact, programming is highly simplified when various tools which have been developed earlier are employed whenever possible. The standard tools of SURVO 84C are available as libraries. The main program and all existing modules have been written in the C language. In principle, any other language producing executable program files (like Pascal, Fortran, Assembler) could be used as well, but for the time being they are lacking the SURVO 84C library support.

The main purpose of this paper is to provide information for those people who would like to make more SURVO 84C modules. We give some rules which should observed and a great deal of recommendations. Finally, we describe the tools available and give examples of their use.

Although anyone who writing a SURVO 84C compatible program can select the tools as he/she wishes, there are clear advantages to following the recommendations. Generally adopted tools create a common style in the system structure that in many ways helps the user. For example, when the user tries to test a new operation of SURVO 84C, he has the right to expect it to work according to patterns encountered earlier in similar operations. The parts of the SURVO 84C 'world' should resemble each other as much as possible, at least formally. This increases the confidence of the user to the system. On the other hand, we don't wish to spoil the joy of inventing new approaches. As an open system SURVO 84C will permit and tolerate several alternative solutions in any application area.

The prerequisities for a SURVOC 84C programmer are that he/she is able to use the C language and knows the idea and basic solutions of SURVO 84C from the user's point of view.

The current technical requirements are the *Microsoft C Compiler* (Ver. 5.10 or newer), the *SURVO 84C libraries* and the *SURVO 84C system* itself. The present implementation of SURVO 84C is for the MS-DOS operating system. Due to the origin and portability of the C language, it is obvious that versions for Unix-like operating systems at least are not difficult to develop.

2. SURVO 84C processes

The term process is described in the Microsoft C run-time library reference as follows (p.73):

The term "process" refers to a program being executed by the operating system. A process consists of the program's code and data, plus information pertaining to the status of the process, such as the number of open files. Whenever you execute a program at the MS-DOS level, you start a process. In addition you can start, stop, and manage processes from within a program by using the process control routines.

The possibility to start up another process during the program as a 'child' process is crucial in the construction of SURVO 84C. There are a few alternatives for calling child processes. The new process may overlay the parent process or the parent process may stay resident during the child's execution. Both alternatives are used in SURVO 84C, and in most cases the latter one, since the main program remains always resident until the end of the session.

As a consequence of this construction principle, we can always call other programs easily while staying in SURVO 84C in the same way as SURVO 84C calls its children. The only provision is that there is enough memory left for the new process and it can be accessed from the current directory (of SURVO 84C). Thus all MS-DOS commands may be given like any SURVO 84C command directly from the edit field by putting the ‘prompt’ symbol ‘>’ before the command and by activating it like a SURVO 84C operation. For example, `>DIR A:*.EDT` lists all edit files on disk `A:`.

Similarly we can start any executable program (.EXE or .COM) or batch file (.BAT) during the SURVO 84C session. For example, `>S` always starts a new SURVO 84C copy as a child of the current one (since S.EXE is the main program of SURVO 84C). Upon returning from child S we are back in the original SURVO 84C session.

Hence most programs without modifications may serve the SURVO 84C system as its child processes. This is very helpful for experienced users, since they can employ SURVO 84C as a natural extension of the operating system and do everything while staying in SURVO 84C.

However, to make a program a true SURVO 84C module some considerations related to input and output should be taken into account. Also the general requirements and the style of SURVO 84C programming may imply modifications in existing programs.

A formal distinction between a SURVO 84C module and a general program is that the file names of directly callable SURVO 84C modules start with ‘`!`’. Furthermore, the SURVO 84C modules receive all the input information directly from the main program (editor) so that they cannot be executed alone.

The link between the main program and a module is one address given by the main program as a parameter and pointing to an array of pointers. This array tells the addresses of the SURVO 84C system parameters and variables so that the module may use the same information as the main program does. Then, from the programmer’s point of view, the module is an integrated part of the main program. For real access to those parameters and variables, the module has to call first an initiation function (**s_init**).

During its work, the module may update various system variables (for example, write results in the edit field) so that the effects of the module can be seen immediately after returning to the main program.

The cooperation between the main program and the modules strengthens the system. The system is more than a collection of different programs. Therefore it is important to take full advantage of these possibilities for interaction when creating new modules.

3. Example of a SURVO 84C module

The idea and practice of making SURVO 84C modules is first illustrated by an example. To save space and to highlight the main principles, we shall describe coding of a simple module for calculating weighted means from statistical data.

Usually it is good to start by making a synopsis from the user's point of view and imagine how the things should look if we already had the new operation. In this case we could type following text in the edit field:

```
 13  1 SURVO 84C EDITOR Wed Feb 15 11:46:19 1989         D:\C\PROG\ 100 100 0
  1 *SAVE TEST1
  2 *
  3 *Here is our data set:
  4 *DATA TEST
  5 *Name     Sex   Test1   Test2   Test3
  6 *Karen     F     1.45    3.46     5
  7 *Charles   M     3.22    2.43     3
  8 *Anthony   M     5.00    3.27     2
  9 *Lisa      F    -0.76    4.03     3
 10 *Mike      M     1.37    1.88     3
 11 *William   M     4.65    -        2
 12 *Ann       F     2.16    4.98     2
 13 *
 14 *MASK=--AAW   / to indicate selection of variables (columns)
 15 *CASES=Sex:M  / to indicate selection of observations (lines)
 16 *
 17 *MEAN TEST,19_
 18 *
 19 * Means of variables in TEST N=4 Weight=Test3
 20 * Variable     Mean     N(missing)
 21 * Test1     3.307000       0
 22 * Test2     2.433750       1
 23 *
```

Here we have a small application where the data set is on edit lines 4-12, the MEAN operation on line 17 and results (which we hope to receive after activation of the MEAN line) on lines 19-22.

We assume that the MEAN operation has the following syntax:

`MEAN <SURVO_84C_data>,<first_line_for_the_results>`

To select variables and observations, we have used two extra specifications (on lines 14-15). There `MASK=--AAW` selects only columns #3 and #4 `(Test1,Test2)` for the analysis and column #5 `(Test3)` is used as a weight variable. `CASES=Sex:M` indicates that only observations with `Sex=M` are selected.

We shall see that there will be still more options available if the MEAN module is written according to the standards of SURVO 84C, and all this is achieved with a minimal effort by using ready-made tools of the SURVO 84C libraries.

It should also be noted that the structure of more complicated modules does not differ from that of this example.

The !MEAN module has only one compiland and its main function is listed below in several parts. The line numbers have been added for easier reference.

```
 1 /* !mean.c 21.2.1986/SM (19.3.1989)
 2 */
 3
 4 #include <stdio.h>
 5 #include <stdlib.h>
 6 #include <conio.h>
 7 #include <malloc.h>
 8 #include "survo.h"
 9 #include "survoext.h"
10 #include "survodat.h"
11
12 SURVO_DATA d;
13 double *sum;       /* sums of active variables */
14 long   *f;         /* frequencies */
15 double *w;         /* sums of weigths */
16
17 long n;
18 int weight_variable;
19 int results_line;
20
21 main(argc,argv)
22 int argc; char *argv[];
23         {
24         int i;
25
26         if (argc==1)
27             {
28             printf("This program can be used as a SURVO 84C module only.");
29             return;
30             }
31         s_init(argv[1]);
32         if (g<2)
33             {
34             init_remarks();
35             rem_pr("MEAN <data>,<output_line>        / S.Mustonen 4.3.1989");
36             rem_pr("computes means of active variables. Cases can be limited");
37             rem_pr("by IND and CASES specifications. The observations can be");
38             rem_pr("weighted by a variable activated by 'W'.");
39             wait_remarks(2);
40             return;
41             }
42         results_line=0;
43         if (g>2)
44             {
45             results_line=edline2(word[2],1,1);
46             if (results_line==0) return;
47             }
48         i=data_open(word[1],&d); if (i<0) return;
49         i=sp_init(r1+r-1); if (i<0) return;
50         i=mask(&d); if (i<0) return;
51         weight_variable=activated(&d,'W');
52         i=test_scaletypes(); if (i<0) return;
53         i=conditions(&d); if (i<0) return;  /* permitted only once */
54         i=space_allocation(); if (i<0) return;
55         compute_sums();
56         printout();
57         free(sum); free(f); free(w);
58         data_close(&d);
59         }
```

Among the include lines, 8-10 refer to special SURVO 84C include files. Lines 8-9 should always be present in modules. Line 10 (`survodat.h`) is needed especially in those modules where SURVO 84C data sets and data files are employed.

Line 12 declares the `SURVO_DATA` structure `d` which may represent either a data set in the edit field (as DATA TEST in our example) or a SURVO 84C data file or part of it or even a matrix file. The writer of the module has no need to know the actual form of the data set. By using the tools provided by the SURVO 84C library (like `data_open` on line 48), all these alternatives can be handled similarly. In rare cases where a distinction has to be made, the `d.type` member of the `SURVO_DATA` structure `d` gives the type of the data set at hand.

On lines 13-15, pointers to various arrays used in MEAN are declared. In order to make the modules general and flexible, we avoid fixed limits in arrays. Therefore all arrays whose sizes depend on application (like number of variables in the analysis) should be defined dynamically. This is done by using the standard space allocation function `malloc`. It has been employed here for all space reservations through the `space_allocation` call on line 54.

Finally, before the main function starts, certain global variables are declared on lines 17-19. To shorten the function calls, we usually prefer using static variables.

When calling the !MEAN module as a child process, the main program of SURVO 84C passes only one parameter (address of the pointer to the array of system pointers as a string). In the main function of !MEAN this parameter (`argv[1]`) is needed in the `s_init` call (line 31). It declares all important SURVO 84C system parameters and variables for !MEAN. Thereafter writing of code in !MEAN is like making more functions for the main program.

However, before the `s_init` call, lines 26-30 are given in order to prevent misuse of !MEAN (direct call of !MEAN from the MS-DOS level).

After the `s_init` call we have, for example, `r`=current line on the screen and `r1`=first visible edit line on the screen. Hence `r1+r-1` is the current (activated) edit line. See the library reference of `s_init` for the the complete list of system variables which are initialized by `s_init`.

The `s_init` function also analyzes the edit line (`MEAN TEST,19`) which was activated by the user and splits it into parts `word[0]="MEAN"`, `word[1]="TEST"` and `word[2]="19"` giving the total number of ‘words’ found as `g`. (In this case `g=3`).

Lines 32-41 are for testing the completeness of the user’s call. Observe that `MEAN TEST` without an edit line for the results is allowed and thus only the case (`g<2`) (mere `MEAN` activated) leads to an error message.

In such a case, the standard modules typically give a short notice of their usage like *"Usage: MEAN <data>, L"* and the user can get more information by consulting the inquiry system of SURVO 84C.

On a new module written by the user, the inquiry system cannot provide any information. Therefore it is important to give longer explanations telling all essential features. This should be done with functions `init_remarks`, `rem_pr`, and `wait_remarks` as shown on lines 32-41.
These functions emulate the behaviour of the inquiry system. For example, the user can load the explanations appearing on the screen to the edit field.

The next section in the main function (lines 42-47) deals with output in the edit field. As pointed out earlier, the line label (or number) for the results in the edit field may be omitted (case `results_line=0`). If the line for the results is given (i.e. `g>2`), it is found by the SURVO 84C library function `edline2` (line 45). If no edit line corresponding to the user's command is found, `edline2` gives an error message and returns 0 instead of the line number.

Line 48 `i=data_open(word[1],&d); if (i<0) return;`
opens the data set and initializes several variables (members of structure `SURVO_DATA d`) describing the size and the structure of the data set.
For example, we have the following information readily available for the subsequent processing:

`d.m`	# of variables in data (type int)
`d.m_act`	# of active variables (int)
`d.n`	# of observations in data (long)
`d.l1`	first active observation (long)
`d.l2`	last active observation (long)
`d.varname[0],...,d.varname[d.m-1]`	names of variables (char **)
`d.vartype[0],...,d.vartype[d.m-1]`	types of variables (char **) byte 0: type 1,2,4,8 or S byte 1: activation byte 2: protection byte 3: scale type byte 4-: other mask bytes
`d.v[0],...,d.v[d.m_act-1]`	indices of the active variables (int *)

If the data is not available, `data_open` displays an error message and returns -1. In that case there is an immediate return to the main program of SURVO 84C.

In SURVO 84C, the operations are not only controlled by parameters written on the activated line (like TEST and 19 in our example), but the modules can also be guided by using various specifications written around the activated line anywhere in the edit field. In our example, such specifications are MASK=--AAW and CASES=Sex:M .

To take their effects into consideration, we must first read all the specifications written in the current edit field. This happens by calling the sp_init function once (line 49: sp_init(r1+r-1);) where the argument refers to the line currently activated. It implies sp_init to look for specifications primarily around that line. Later the spfind function is called repeatedly to find specifications from a list generated by sp_init.

The mask function (on line 50) has the task of analysing the VARS specification (or if it does not appear, the MASK specification) through the spfind function. If VARS or MASK exists, mask corrects the activation status of each variable accordingly. If VARS (MASK) is not given, the status of the data set itself determines which are active variables.

Line 51 checks whether any of the variables in the data set have been activated by 'W' (using the activated function). If such a variable is found (as Test3 in our example) the index of that variable is returned and it serves as a weight variable in the computations. Otherwise activated returns -1.

One of the unique features of SURVO 84C is the possibility to assess the validity of various statistical methods by checking the scale types of variables. Scale types can be declared for variables in data files only. The user has the freedom to use or not to use this facility. The test_scaletypes call on line 52 does the job in a positive case.

The observations may be restricted by the CASES and IND specifications. The conditions function (called on line 53) tests that those specifications, if used at all, are written correctly and initializes system variables which are used for scanning data during the computation (through a function called unsuitable).

After these preliminary checks, we are ready to allocate space for frequencies, sums of weights and weighted sums of observations. The dimension of these arrays must be d.m_act. This happens by calling space_allocation (line 54).

If the space is succesfully allocated (there is no negative response), the actual computations can start (compute_sums) and the results are printed (printout).

Finally (on lines 57-58), the allocated space is freed and the data set closed before returning to the main program of SURVO 84C and to the normal editing mode.

Most of the functions called by the main function of !MEAN are either in the Microsoft C run-time library or in the SURVO 84C libraries. The descriptions of the SURVO 84C library functions will be given later in this paper.

There are only 4 functions called in the main function being specific for the !MEAN module, namely `test_scaletypes`, `space_allocation`, `compute_sums`, and `printout`. Since !MEAN is a very small module, all of them are in the same compiland together with the main function.

The `test_scaletypes` function has the following form:

```
61 test_scaletypes()
62         {
63         int i,scale_error;
64
65         scales(&d);
66         if (weight_variable>=0)
67             {
68             if (!scale_ok(&d,weight_variable,RATIO_SCALE))
69                 {
70                 sprintf(sbuf,"\nWeight variable %.8s must have ratio scale!",
71                           d.varname[weight_variable]); sur_print(sbuf);
72                 WAIT; if (scale_check==SCALE_INTERRUPT) return(-1);
73                 }
74             }
75         scale_error=0;
76         for (i=0; i<d.m_act; ++i)
77             {
78             if (!scale_ok(&d,d.v[i],SCORE_SCALE))
79                 {
80                 if (!scale_error)
81                     sur_print("\nInvalid scale in variables: ");
82                 scale_error=1;
83                 sprintf(sbuf,"%.8s ",d.varname[d.v[i]]); sur_print(sbuf);
84                 }
85             }
86         if (scale_error)
87             {
88             sur_print("\nIn MEAN score scale at least is expected!");
89             WAIT; if (scale_check==SCALE_INTERRUPT) return(-1);
90             }
91         return(1);
92         }
```

The task of this function is to check the scale types of variables selected for the analysis. In small data sets written in the edit field, the scale types of the variables (columns) cannot be given and then no checks are performed; `test_scaletypes` will simply return 1 which means that everything is OK. However, in data sets saved in SURVO 84C data files, each variable can be labelled with a one character label (mask column #3) which tells the scale type. For example, variables with a ratio scale are labelled with ‘`R`’ (discrete) or with ‘`r`’ (continuous) or with ‘`F`’ (variable is a frequency). If the user omits these labels (each scale label is then ‘ ’), SURVO 84C will skip all scale checks.

In any case, at first the `scales` function is called to remove variables which have the scale type label ‘`-`’, which means that the variable in question has no scale at all. For example, ‘names’ and ‘addresses’ are typically variables (fields) without a scale. Of course, a careful user does not select such variables for computations, but it is safer to have an extra check by the `scales` function in order to avoid harmful consequences.

On lines 66-74 the program tests the scale of the weight variable (if it is used). It is done by using the `scale_ok` function which is set to require `RATIO_SCALE` for the weight variable. `RATIO_SCALE` is a predefined (in `survodat.h`) string constant `" RrF"` telling the permitted scale type alternatives.

If the scale is not OK, an error message is displayed (on lines 70-71). The continuation depends on the value of the SURVO 84C system parameter `scale_check`. This parameter can be set to 0, 1 or 2 by the user where 0 means that `scale_ok` always returns 1 and no warning error messages are given, i.e. everything is accepted. The value `scale_check=1` implies that messages are given as warnings, but the analysis can be continued. At the strictest level (value `SCALE_INTERRUPT=2`) the process is actually interrupted as we can see on line 72.

The remaining lines of `test_scaletypes` are devoted to corresponding checks for active variables which now should have a `SCORE_SCALE` at least. See how the `d.v[]` array selects the `d.m_act` variables from all `d.m` variables. (In our example `d.m=5`, `d.m_act=3` and `d.v[0]=2`, `d.v[1]=3`, `d.v[2]=4`.)

The error messages and warnings are given by producing an output string by the standard `sprintf` function (usually to a global buffer `sbuf` of max. 256 characters) and then yielding the output by `sur_print(sbuf)`.

The next function to be introduced is `space_allocation`:

```
 94 space_allocation()
 95         {
 96         sum=(double *)malloc(d.m_act*sizeof(double));
 97         if (sum==NULL) { not_enough_memory(); return(-1); }
 98         f=(long *)malloc(d.m_act*sizeof(long));
 99         if (f==NULL) { not_enough_memory(); return(-1); }
100         w=(double *)malloc(d.m_act*sizeof(double));
101         if (w==NULL) { not_enough_memory(); return(-1); }
102         return(1);
103         }
104
105 not_enough_memory()
106         {
107         sur_print("\nNot enough memory! (MEAN)");
108         WAIT;
109         }
```

This function allocates memory for arrays `sum`, `f` and `w`, which all should have `d.m_act` elements.

It is strongly recommended to use dynamic memory allocation for all working space which is dependent on the size of the data set. Then no theoretical limits appear for the number of variables, etc. In practice there are always some limits. On the 16 bit micros we typically have still the 64KB limit for a single array unless the huge memory model is used.

Since errors in memory allocation may have very surprising consequences, it is, of course, possible to start with fixed dimensions and later when all the space requirements are clear, dynamic arrays are established.

For example, the lines 13-16 in the main function could read:

```
 13 #define MAX 100
 14 double sum[MAX];       /* sums of active variables */
 15 long f[MAX];           /* frequencies */
 16 double w[MAX];         /* sums of weights */
```

and `space_allocation` is not needed at all, but this should be a temporary arrangement only.

The data set will be scanned by the `compute_sums` function:

```
111 compute_sums()
112         {
113         int i;
114         long l;
115
116         n=0L;
117         for (i=0; i<d.m_act; ++i)
118             { f[i]=0L; w[i]=0.0; sum[i]=0.0; }
119
120         sur_print("\n");
121         for (l=d.l1; l<=d.l2; ++l)
122             {
123             double weight;
124
125             if (unsuitable(&d,l)) continue;
126             if (weight_variable==-1) weight=1.0;
127             else
128                 {
129                 data_load(&d,l,weight_variable,&weight);
130                 if (weight==MISSING8) continue;
131                 }
132             ++n;
133             sprintf(sbuf,"%ld ",l); sur_print(sbuf);
134             for (i=0; i<d.m_act; ++i)
135                 {
136                 double x;
137
138                 if (d.v[i]==weight_variable) continue;
139                 data_load(&d,l,d.v[i],&x);
140                 if (x==MISSING8) continue;
141                 ++f[i]; w[i]+=weight; sum[i]+=weight*x;
142                 }
143             }
144         }
```

At first, the work space is cleared (lines 116-118) and then the rest of the function consists of a loop for active observations (from `d.l1` to `d.l2`).

In this loop the function `unsuitable` checks (line 125) whether the conditions (set by `conditions` in the main module) are met in the current observation `j`. If not, the rest of the loop is skipped.

If the observation is accepted, first the value of the possible weight variable is read by the `data_load` function (line 129). If `weight` is missing (line 130), the rest of the loop is skipped. If there is no weight variable, `weight=1.0` is selected (line 126).

Thereafter the number of cases `n` is increased by one and the order of the current observation is displayed on the screen to indicate that the run is going on (lines 132-133).

In the inner loop (lines 134-142) all the active variables are scanned and the cumulative sums updated. However, the weight variable is skipped (on line 138). Similarly, possible missing values of active variables are omitted. By comparing `n` to `f[i]` we can see the number of missing observations in each variable separately.

The final task of the !MEAN module is to give the results by calling the `printout` function:

```
146 printout()
147         {
148         int i;
149         char line[LLENGTH];
150         char mean[32];
151
152         output_open(eout);
153         sprintf(line," Means of variables in %s N=%ld%c",
154                           word[1],n,EOS);
155         if (weight_variable>=0)
156             {
157             strcat(line," Weight=");
158             strncat(line,d.varname[weight_variable],8);
159             }
160         print_line(line);
161         strcpy(line," Variable     Mean     N(missing)");
162         print_line(line);
163         for (i=0; i<d.m_act; ++i)
164             {
165             if (d.v[i]==weight_variable) continue;
166             if (w[i]==0.0)
167                 sprintf(line," %-8.8s            -  %6ld",d.varname[d.v[i]],
168                          n-f[i]);
169             else
170                 {
171                 fnconv(sum[i]/w[i],accuracy+2,mean);
172                 sprintf(line," %-8.8s %s  %6ld",d.varname[d.v[i]],
173                              mean,n-f[i]);
174                 }
175             print_line(line);
176             }
177         output_close(eout);
178         }
179
180 print_line(line)
181 char *line;
182         {
183         output_line(line,eout,results_line);
184         if (results_line) ++results_line;
185         }
```

At first the output file/device eout is opened by the output_open function. Thereafter lines can be written to eout by the output_line function (called in the function print_line on line 183). The lines are appended to the file. So no previous results are overwritten.

The SURVO 84C library function output_line writes also lines in the current edit field provided that the third argument (here results_line) gives a valid line number. Remember that the first line for the results was optional in the MEAN operation and we set results_line=0 (on line 42) if that line label was missing.

print_line (lines 180-185) is only an auxiliary function to keep an eye on the current output line in the edit field.

It is a practice in SURVO 84C that the numerical accuracy of the printed numbers can be controlled by the user. This happens by using the system parameter accuracy (typically set to the value 7 in SURVO.APU) which gives the desired number of significant digits and such. The writers of the modules must take the current value of accuracy into account when selecting the printout parameters. The library function fnconv is often useful in this task. Here (on line 171) it formats the means. accuracy+2 gives the total length of the resulting string mean; we must have one extra place for sign and one for the decimal point.

These 185 lines constitute the whole !MEAN module in its source form. Since several library functions were employed and there are many ‘hidden’ or optional properties included, the total amount of code after compiling and linking is about 60KB. However, if the module grows, the actual code size is not growing proportionally. For example, !MEAN can be considered a tiny special case of the !CORR module which computes standard deviations and correlations in addition to means, but the size of !CORR is only 6KB more than the size of !MEAN. Thus it is profitable to create modules with several tasks and options.

All SURVO 84C compilands of SURVO 84C modules have to be compiled in the large memory model because the SURVO 84C libraries (SURVO.LIB, SURVOMAT.LIB, etc.) are available in this model only.
Thus, the !MEAN.C file is compiled by the command

```
CL /c /AL !MEAN.C
```

and it is linked by

```
LINK !MEAN,,NUL.MAP,SURVO /STACK:4000 /NOE.
```

!MEAN was made and presented only for illustration. Source codes for selected true SURVO 84C modules are available separately.

Each module (as an .EXE file) is normally saved in the SURVO 84C system directory (typically C:\E) and activated by the user as MEAN. During the testing stage, it can be activated from any disk or path.
For example, if !MEAN.EXE is on the disk A:,

```
A:!MEAN DATA1,11
```

is a valid command in SURVO 84C.

4. Edit field

One important link between the main program of SURVO 84C and its modules is the edit field. It materializes our idea of the editorial approach.

Most of the modules read something from the edit field and write results in it. This is done by using certain global variables and library functions.

After the s_init call we have the access to the edit field through the following global variables:

```
char *z;            /* pointer to edit field */
int ed1;            /* length of edit line + control column */
int ed2;            /* number of lines in edit field */
int edshad;         /* max. # of shadow lines in edit field */
int *zs;            /* indices of shadow lines */
int r;              /* current line on the screen */
int r1;             /* first visible edit line on the screen */
int r2;             /* =ed2 */
int r3;             /* # number of edit lines on the screen */
int c;              /* current column on the screen */
int c1;             /* first visible column on the screen */
int c2;             /* =ed1-1 (length of edit line) */
int c3;             /* # of columns on the screen */
```

The edit field is simply a sequence of ed1*ed2 characters starting from a character pointed to by z. Thus the j^{th} line in the edit field consists of characters *(z+(j-1)*ed1+i), i=0,1,...,ed1-1, where the first one, *(z+(j-1)*ed1), is the control character.

Use of direct references through z should, however, be avoided, since we do not guarantee that this setup will be valid in future implementations. Therefore we recommend that the library functions edread and edwrite should always be employed in reading and writing.

Their current listings could be the following:

```
#include <stdio.h>
#include <conio.h>
#include <string.h>
#include "survo.h"

extern char *z;
extern int ed1,ed2;

edread(x,lin)
char x[];       /* result as a null terminated string */
int lin;        /* line number */
        {
        strncpy(x,z+(lin-1)*ed1,ed1);
        x[ed1]=EOS;
```

```
        }

edwrite(x,lin,col)
char x[];       /* string to be written */
int lin;        /* line number */
int col;        /* first column in writing */
        {
        int i,h;
        int len=strlen(x);

        if (len>ed1-col) len=ed1-col;
        for (i=0, h=(lin-1)*ed1+col; i<len; ++i, ++h)
            z[h]=x[i];
        }
```

The window on the screen (i.e. the visible part of the edit field) is maintained by the variables `r,r1,r3,c,c1,c3`.

The current size of the window is `r3` lines and `c3` columns (plus the control column). In that window the location of the cursor is (`r,c`), the first visible edit line is `r1` and the first column is `c1`. Hence the current position of the cursor in the edit field is line=`r1+r-1` and column=`c1+c-1`.

For example, the character indicated by the cursor can be read as follows:

```
char ch;
char x[LLENGTH];
edread(x,r1+r-1);
ch=x[c1+c-1];
```

The module can change the position of the cursor and even the position of the window by updating variables `r,c,r1,c1`. In that case the `s_end` function must be called once before the return to the main program.

For example, the following !SEEK module finds the first edit line starting with a selected word and places the cursor to the first position on that line. When necessary, the window is moved. If the word is not found, an error message is displayed and the original display restored.

```
/* !seek.c 28.3.1986/SM (28.3.1986)
**   SEEK <word>
*/

#include "survo.h"
#include "survoext.h"

main(argc,argv)
int argc; char *argv[];
    {
    int i,j;
    char x[LLENGTH];
    char *w[1];

    if (argc==1) return;
    s_init(argv[1]);

    if (g<2)
        {
        sur_print("\nUsage: SEEK <word>");
        WAIT; return;
        }
    for (j=1; j<r2; ++j)
        {
```

```
25          edread(x,j);
26          i=split(x+1,w,1);
27          if (strcmp(w[0],word[1])==0)
28              {
29              if (j<r1) r1=j;
30              else if (j>r1+r3-1)
31                  {
32                  r1=j;
33                  if (r1>r2-r3+1) r1=r2-r3+1;
34                  }
35              r=j-r1+1;
36              c1=c=1;
37              s_end(argv[1]);
38              return;
39              }
40          }
41      sprintf(sbuf,"\nWord %s not as the first word of any line!"
42                    ,word[1]);  sur_print(sbuf);
43      WAIT;
44      }
```

All the edit lines are scanned (until success) by the loop starting from line 23. The current line is read as string `x` (line 25) and the actual line (`x+1`) without the control character is divided into words by the library function `split` (line 26). Here only the first word (`w[0]`) is of interest.

On line 27 `strcmp` compares `w[0]` with `word[1]` (the word given by the user). If they are the same, a proper window for displaying the line is selected (29-36) and the module ends by updating the parameters by the `s_end` call. If the words are not the same, the search continues and in an entirely unsuccessful case an error message is displayed (on lines 41-43).

5. Shadow lines

Various display effects (color, underlining, reversed video, etc.) and other attributes related to characters and edit lines are maintained by *shadow lines*. Normally an edit line has no shadow line, but when at least one character is typed in special display mode (turned on by the `FORMAT` key, for example), the SURVO 84C system creates a shadow line for the current line. Shadow lines are as long as normal edit lines, i.e. `ed1` bytes and they are saved in the order they are created after the last normal edit line (`ed2`).

The shadow lines may contain any kind of characters. Space (blank) is the default and means normal display on the screen. Characters ‘1’, ‘2’, ...,‘7’ are reserved for the current palette of colors (or display effects). Their actual meaning can be controlled by the user (by editing the auxiliary file SURVO.APU). These and other control codes are also used in printing to produce various special effects.

The total amount of shadow lines is limited by the system parameter `edshad` (default is 20). This limit may, however, be changed by the REDIM operation. If the user tries to exceed the current limit, the system gives a warning.

If a shadow line becomes empty, the system frees it for subsequent use in the same edit field.

The shadow lines can be read and written as normal edit lines. The index of the shadow line for the j^{th} edit line is `zs[j]`. If there is no shadow line, `zs[j]=0`.

The library function `shadow_create` is used to create new shadow lines and `shadow_test` frees the shadow line if it consists of spaces only.

Normally the modules have no need to use shadow lines.

To illustrate working with shadow lines, we have made a small module !SHADOW which creates and fills all the shadow lines of specific edit lines with a selected character. For example, `SHADOW 6,10,7` turns all characters on lines 6-10 to inverse mode and `SHADOW 1,END` frees each shadow line in the current edit field.

```
 1 /* !shadow.c 28.3.1986/SM (28.3.1986)
 2     SHADOW L1,L2,<shadow_character>
 3 */
 4 #include "survo.h"
 5 #include "survoext.h"
 6
 7 main(argc,argv)
 8 int argc; char *argv[];
 9     {
10     int i,j,j1,j2;
11     char ch;
12     char shadow[LLENGTH];
13
14     if (argc==1) return;
15     s_init(argv[1]);
16     if (g<3)
17         {
18         sur_print("\nUsage: SHADOW L1,L2,<shadow_character>");
19         WAIT; return;
20         }
21
22     j1=edline2(word[1],1,1); if (j1==0) return;
23     j2=edline2(word[2],j1,1); if (j2==0) return;
24     if (g>3) ch=*word[3]; else ch=' ';
25     for (i=0; i<ed1-1; ++i) shadow[i]=ch;
26     shadow[ed1-1]=EOS;
27
28     for (j=j1; j<=j2; ++j)
29         {
30         if (zs[j]==0)
31             {
32             i=shadow_create(j);
33             if (i<0) return;
34             }
35         edwrite(shadow,zs[j],1);
36         if (ch==' ') shadow_test(j);
37         }
38     }
```

When referring to edit lines, both line numbers and line labels may be used in SURVO 84C. Line labels are one character symbols written in the control column of the edit field. Thus in modules which take line labels as their parameters (as !SHADOW above) both alternatives must be supported. This is done simply by using the library function `edline2`. It was employed twice in !SHADOW (lines 22-23).

6. Space allocation

SURVO 84C modules are usually large model programs and compiled with the /AL option of the Microsoft C compiler. Small modules could also be in small model mode, but the current SURVO 84C libraries support only the large model. In large model programs there are no limitations for the size of code and data except the total memory available. In 16 bit micros we additionally have the limit 64KB for each data item (array). We have the same limitation, too, for the code in each compiland, but this is never a real problem, since one module (if reasonably written) is divided into compilands of much smaller size.

Within these limitations each module should be written so that space is allocated according to each application separately. This means that all vectors and matrices, etc. should get their dimensions dynamically during the run.

However, temporary arrays whose sizes depend on the line length of the edit field, are typically dimensioned by using the SURVO 84C system constant `LLENGTH` and its multiplicities. The current value of `LLENGTH` is 256 and it implies the maximum line length of the edit field to be 253. Another constant is `LNAME` (current value 64) which is used for names of files (pathnames) etc.

In some cases the maximum number of columns (or maximum number of words or numbers on a single edit line) is critical for some arrays. The system constant `EP4` (current value 100) gives that limit. The counterpart of `EP4` in the SURVO.APU file is the system parameter `ep4` which may be used in dynamic space allocation for arrays related to number of columns in the edit field.

Matrices should always be defined as one-dimensional arrays and their elements should be saved columnwise. Thus the element on row `i` and column `j` of a `m*n` matrix `A` will be `A[i+n*j]` where `i=0,1,...,m-1` and `j=0,1,...,n-1`. In all arrays the base value for the indices is 0. In output, however, the base value is always 1.

Since double precision should normally used in matrix compuations, the largest square matrix (within the 64KB limit) is 90×90.

Some of the library functions make their own space reservations. For example, when a data set (`SURVO_DATA`) is opened by the `data_open` function, memory is allocated for all arrays pointed to by members of this structure.

7. Include files

Various system constants, variables and macros are defined in include files `survo.h`, `survoext.h` and `survodat.h`.

In all standard SURVO 84C compilands, `survo.h` and `survoext.h` must be included. In compilands working with SURVO 84C data (lists, tables, files, etc.) or using extra specifications, also `survodat.h` should be observed.

The most important constants defined in `survo.h` are the following (current values in parentheses):

`EP4`	Maximum number of 'words' on one edit line (100)
`LLENGTH`	Maximum length of a 'word' or a 'line' (256)
`LNAME`	Maximum length of a pathname (64)
`MAXPARM`	Maximum number of 'words' in a command (24)

The following macros, defined in `survo.h`, are available for the screen control etc.:

`WAIT`	halts the process and displays the message *'Press any key!'* until the user has pressed a key.
`CLS`	clears the screen.
`LOCATE((int)r,(int)c)`	The cursor will be located on line `r` and column `c`.
`ERASE`	erases the current line.
`BEEP`	gives a sound signal.
`CURSOR_OFF`	makes the cursor invisible.
`CURSOR_ON`	displays a normal cursor.
`CURSOR_INS`	displays an extended cursor (used in insert mode).
`CURSOR_POS((int *)prow,(int *)pcol)`	saves the current row and column of the cursor in `*prow` and `*pcol`.
`SCROLL_UP((int)lin1,(int)lin2,(int)n)`	scrolls the lines from `lin1` to `lin2` `n` steps upwards.
`SCROLL_DOWN((int)lin1,(int)lin2,(int)n)`	scrolls the lines from `lin1` to `lin2` `n` steps downwards.
`PR_UP`	moves the cursor one step upwards.
`PR_DOWN`	moves the cursor one step downwards.
`PR_RIGHT`	moves the cursor one step to the right.

PR_LEFT	moves the cursor one step to the left.
PR_ENRM	sets the normal display mode (shadow blank).
PR_EBLD	sets the bold mode (shadow 1).
PR_ESUB	sets the subscript mode (shadow 2).
PR_ESUP	sets the superscript mode (shadow 3).
PR_EUDL	sets the underlining mode (shadow 4).
PR_EBLK	sets the blinking mode (shadow 5)
PR_EOVR	sets the oblique mode (shadow 6)
PR_EINV	sets the inverse mode (shadow 7)
PR_EINV2	sets the secondary inverse mode (shadow 8)
PR_EBLD2	sets the secondary bold mode (shadow 9).

8. Libraries

The ready-made tools for programming SURVO 84C modules have been collected in the following libraries:

SURVO.LIB	Functions for general system control, management of the edit field, data management, specifications, sucros, and prompts
SURVOMAT.LIB	Routines for matrix management and algebra
DISTRIB.LIB	Continuous statistical distributions (by T.Patovaara)

All the functions in these libraries have been compiled in the large memory model. The functions will now be described separately for each library.

8.1 Library SURVO.LIB

activated

Summary
```
int activated(data,character)
SURVO_DATA *data; /* pointer to data structure */
char character;   /* activation character */
```

Description
The **activated** function finds the first variable which has been activated by `character` in `data` opened by **data_open** or **data_open2**.

Return Value
activated returns # of variable or -1 if no variable has been activated by `character`.

See Also
mask, varfind

Example
```
int i;
int weight_variable;
SURVO_DATA dat;

i=data_open("TEST",&dat);
if (i<0) return;
weight_variable=activated(&dat,'W');
```

* * *

conditions

Summary
```
int conditions(data)
SURVO_DATA *data; /* pointer to data structure */
```

Description
The **conditions** function reads and tests the IND and CASES specifica-

tions according to `data` opened by **data_open** or **data_open2**.

conditions can be called only once in each SURVO 84C module and it forms the basis for data scanning where **unsuitable** is the function for eliminating those observations (records) which do not satisfy the IND and CASES restrictions.

Return Value

conditions returns 1 if IND and CASES specifications have been written correctly. In case of an error -1 is returned.

See Also

unsuitable

Example

```
int i;
SURVO_DATA dat;

i=data_open("TEST",&dat);
if (i<0) return;
i=conditions(&dat);
if (i<0) { data_close(&dat); return; }
```

* * *

create_newvar

Summary

```
int create_newvar(data,name,type)
SURVO_DATA *data; /* pointer to data structure */
char *name;       /* name of new variable */
char type;        /* type 1,2,4,8 or S of new var. */
int len;          /* length of field (S type only) */
```

Description

The **create_newvar** function creates a new variable with the name `name` and of the type `type` for data `data` which has to be opened by **data_open2** of the form `data_open2(name,data,1,0,0);` .

The length of the field in case of a string (S) variable, is given by `len`. In numeric variables the length is determined by `type` and `len` is not used.

Return Value

data_load returns the index (0,1,2,...,`data->m-1`) of the new variable and -1 if there is no room for new variables or the data representation does not permit creation of new variables.

See Also

data_save

Example

```
int i;
long j;
SURVO_DATA dat;

i=data_open2("TEST",&dat,1,0,0);
if (i<0) return;
i=create_newvar(&dat,"COUNT",'2');
if (i>=0)
    for (j=1L; j<=dat.n; ++j)
        data_save(&dat,j,3,MISSING8);

/* open TEST, create a new variable COUNT of
   integer type and save missing values in it. */
```

* * *

data_alpha_load

Summary

```
int data_alpha_load(data,j,i,string)
SURVO_DATA *data; /* pointer to data structure */
long j;           /* # of observation (record) */
int i;            /* # of variable (field) */
char *string;     /* pointer to data value */
```

Description

The **data_alpha_load** function reads the value of the `j`th observation in variable # `i` (`i=0,1,...,data->m-1`) as a null-terminated string from `data` opened by **data_open** or **data_open2**.

Only variables of string (S) type can be loaded by **data_alpha_load**.

SURVO.LIB

Return Value
data_alpha_load returns 1 if the value is found. Otherwise -1 is returned.

See Also
data_load

Example
```
int i;
long j;
char value[LLENGTH];
SURVO_DATA dat;

i=data_open("TEST",&dat);
if (i<0) return;
sprintf(sbuf,"\nValues of variable %s:",dat.varname[3]);
sur_print(sbuf);
for (j=dat.l1; j<=dat.l2; ++j)
  {
  data_alpha_load(&dat,j,3,value);
  sprintf(sbuf,
      "\nValue of var. # %d in obs. # %ld is %s",
                  i+1,j,value); sur_print(sbuf);
  }
/* open TEST and print values of var. #4 as strings */
```

* * *

data_close

Summary
```
int data_close(data)
SURVO_DATA *data; /* pointer to data structure */
```

Description
The **data_close** function closes `data` opened by **data_open** or **data_open2** and frees the space allocated for `data`.

Return Value
There is no return value.

SURVO.LIB

See Also
data_open, data_open2

Example
```
SURVO_DATA dat;
data_close(&dat);
```

* * *

data_load

Summary
```
int data_load(data,j,i,px)
SURVO_DATA *data; /* pointer to data structure */
long j;           /* # of observation (record) */
int i;            /* # of variable (field)  */
double *px;       /* pointer to data value  */
```

Description
The **data_load** function reads the value `*px` of the j^{th} observation in variable # `i (i=0,1,...,data->m-1)` from `data` opened by **data_open** or **data_open2**.
Both numeric (N) and string (S) fields can be loaded by **data_load**. In the latter case the string value is converted to double by the standard function **atof**.

Return Value
data_load returns 1 if the value is found. Otherwise -1 is returned.

See Also
data_alpha_load

SURVO.LIB

Example

```
int i;
long j;
double x;
SURVO_DATA dat;

i=data_open("TEST",&dat);
if (i<0) return;
sprintf(sbuf,"\nValues of variable %s:",dat.varname[3]);
sur_print(sbuf);
for (j=dat.l1; j<=dat.l2; ++j)
  {
  data_load(&dat,j,3,&x);
  sprintf(sbuf,
         "\nValue of var. # %d in obs. # %ld is %f",
                          i+1,j,x); sur_print(sbuf);
  }
/* open TEST and print values of var. #4 */
```

* * *

data_open

Summary

```
int data_open(name,data)
char *name;       /* name of SURVO 84C data */
SURVO_DATA *data; /* pointer to data structure */
```

Description

The **data_open** function opens the SURVO 84C data specified by `name`. `data` is a pointer to the SURVO_DATA structure. The structure type SURVO_DATA is defined in `survodat.h` as follows:

```
#define SURVO_DATA struct survodata

SURVO_DATA
 {
 SURVO_DATA_MATRIX d1; /* data matrix structure */
 SURVO_DATA_FILE d2;   /* data file structure */
 int type;             /* 1=data matrix 2=data file
                          3=data list 4=matrix file */
 char *pspace;         /* pointer to allocated space */
 int m;                /* # of variables */
 long n;               /* # of observations */
 int m_act;            /* # of active variables */
 long l1,l2;           /* selected observations */
```

```
int typelen;          /* # of attributes for variables */
int *v;               /* indices of active variables */
char **varname;       /* names of variables */
int *varlen;          /* lengths of variables */
char **vartype;       /* types etc. of variables */
int *varpos;          /* positions of variables */
} ;
```

SURVO 84C supports four different forms of data. Data may be located in the current edit field as a data matrix or a data list, or in a SURVO 84C data file or in a SURVO 84C matrix file. All forms of data can be accessed by **data_open**.

Usually, when writing SURVO 84C modules it is not necessary to know the type of the data (given by the structure member `type`).

```
data_open(name,data);
```

is equivalent to

```
data_open2(name,data,0,0,0);
```

which means that, in case of a data file, the data is opened
with space allocated for defined variables (fields) only,
with short names (of 8 bytes) for variables,
and without text information.
This is usually sufficient in statistical operations.

Return Value

data_open returns 1 if the file was succesfully opened and -1 otherwise. In the latter case an error message *SURVO 84 data 'name' not found!* is displayed.

See Also

data_open2, data_close, data_load, data_alpha_load

Example

```
int i;
SURVO_DATA dat;
i=data_open("TEST",&dat);
if (i<0) return;
```

* * *

data_open2

Summary

```
int data_open2(name,data,p1,p2,p3)
char *name;       /* name of SURVO 84C DATA */
SURVO_DATA *data; /* pointer to data structure */
int p1;           /* space for variables indicator */
int p2;           /* name length indicator */
int p3;           /* text indicator */
```

Description

The **data_open2** function opens the SURVO 84C data specified by `name`. `data` is a pointer to the SURVO_DATA structure (See **data_open**).

The parameters `p1`,`p2`,`p3` indicate various extensions when `data` is a SURVO 84C data file.

If `p1=0`, space will be allocated for defined variables (fields) only (i.e. for `data->m` variables).
Otherwise space is available for all possible variables (i.e. for `data->m1` variables).

If `p2=0`, space will be allocated for short names (of 8 bytes) of variables (fields),
otherwise space is available for full length (`data->d2.l` bytes) names of variables.

If `p3=0`, no text information is loaded.
Otherwise space is allocated for general text information saved in the data file.
The text lines are referred to by pointers `data->d2.fitext[i]`, `i=0,1,...,data->d2.textn`.

Return Value

data_open2 returns 1 if the file was succesfully opened and -1 otherwise. In the latter case the error message *SURVO 84 data 'name' not found!* is displayed.

See Also

data_open, data_close, data_load, data_alpha_load

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Example

```
int i;
SURVO_DATA dat;
i=data_open2("TEST",&dat,1,1,1);
if (i<0) return;
```

* * *

data_save

Summary

```
int data_save(data,j,i,x)
SURVO_DATA *data; /* pointer to 84 data structure */
long j;           /* # of observation (record) */
int i;            /* # of variable (field) */
double x;         /* value to be saved */
```

Description

The **data_save** function saves the value `x` of the j^{th} observation in variable # `i (i=0,1,...,data->m-1)` for `data` opened by **data_open** or **data_open2**.

Only numeric values can be saved by **data_save**. If the field for saving is a string field, value `x` is converted to a string.

Return Value

data_save returns -1 if the field for saving is protected or the data representation does not permit saving.

See Also

data_load, create_newvar

Example

```
int i;
long j;
SURVO_DATA dat;

i=data_open("TEST",&dat);
if (i<0) return;
for (j=1L; j<=dat.n; ++j)
        data_save(&dat,j,3,MISSING8);

/* open TEST and save missing values in
   all observations of field #3 */
```

* * *

edline2

Summary

```
int edline2(label,j,error)
char *label;       /* null-terminated string */
int j;             /* first edit line to be scanned */
int error;         /* display of error */
```

Description

The **edline2** function searches for the first occurrence of `label` in the control column starting from line `j` in the edit field. If the edit line is not found, message *Line 'label' not found!* is displayed. However, if `error` is 0, no message is produced.

`label` can be a line number 1,2,... or a line label consisting of one character or of the form `END`, `END-1`, `END-2`, `END+1`, etc., where `END` refers to the last non-empty line in the current edit field or of the form `CUR`, `CUR+1`, etc., where `CUR` refers to the current line. Thus **edline2** covers all the possibilities the user may employ when referring to lines in SURVO 84C operations.

Return Value

edline2 returns the index of the first edit line found with `label` and 0, if no edit line with `label` exists in the current edit field.

See Also
lastline2

Example
Assume that we have in the edit field:

```
1 *
2 *
3 *
4 A This line should be found!
5 *
```

Then

```
unsigned int j;
j=edline2("A",1,1);
```

returns `j=4`.

* * *

edread

Summary

```
int edread(x,j)
char *x;       /* storage location for input string */
unsigned int j;              /* number of edit line */
```

Description
The function **edread** reads line `j` from the current edit field to `x` as a null-terminated string. `x[0]` will be the control character of the edit line and the length of `x` is `ed1`. Thus the terminating spaces are also in `x`.
Space for `x` must be allocated before the **edread** call; it should be at least `LLENGTH` characters.

Return Value
There is no return value.

See Also
edwrite

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Example

Assume that we have in the edit field:

```
7 *
8 *PRINT 11,20
9 *
```

Then

```
char x[LLENGTH];
edread(x,8);
```

gives `x="*PRINT 11,20                                    "`
where `strlen(x)=ed1` (width of the edit field + 1).

* * *

edwrite

Summary

```
int edwrite(x,j,pos)
char *x;            /* null-terminated string */
unsigned int j;     /* number of edit line */
int pos;            /* first position on edit line */
```

Description

Function **edwrite** writes the string `x` on the line `j` in the current edit field from the column `pos` onwards. If `x` is longer than the edit line length permits, the extra characters are not written.

Return Value

There is no return value.

See Also

edread, output_line

Example

Assume that we have in the edit field:

```
7 *
8 *Result: _
9 *
```

Then

```
char x[]="123.456"
edwrite(x,8,9);
```

gives

```
    7 *
    8 *Result: 123.456
    9 *
```

Applications
edwrite is the standard tool in writing results of edit operations in the edit field. In operations producing larger output both in the edit field and in output files, **wline** is to be used instead of **edwrite.**

* * *

empty_line

Summary

```
int empty_line(s,len)
char *s;            /* string */
int len;            /* length of string */
```

Description
The **empty_line** function tests whether the string `s` consists (for the `len` first bytes) of spaces (blanks) only.

Return Value
empty_line returns 1 if the entire string `s` or its `len` first bytes are spaces and otherwise 0.

Example

```
char x[LLENGTH];
edread(x,r1+r);
i=empty_line(x+1,c2);
/* i=1, if the line after the activated line is empty
** and i=0, if it is not empty.
*/
```

* * *

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fconv

Summary

```
int fconv(number,format,string)
double number;       /* number to be converted */
char *format;        /* format to be used */
char *string;        /* string result */
```

Description

The **fconv** function converts the digits of the given `number` to a null-terminated character string and stores the result in `string`.

The conversion takes place according to the given `format` which is a null-terminated string of form `"1234.123"` or `"%8.3f"`.

The `format ""` means the shortest possible representation of `number` as `string`.

Return Value

fconv returns 1 if the `number` is succesfully converted and -1 if the `format` is too restrictive.

See Also

fnconv

Example

```
double x=3.14159265;
char format[]="123.123";
char result[32];
fconv(x,format,result);  /* result="  3.142" */
```

* * *

fi_create

Summary

```
fi_create(name,len,m1,m,n,f,extra,textn,textlen,text,
            varname,varlen,vartype)
char *name;      /* name of data file */
int len;         /* record length */
int m1;          /* max # of fields */
int m;           /* # of fields */
long n;          /* # of observations */
int f;           /* max field name length */
int extra;       /* field attribute length */
int textn;       /* # of comment lines */
int textlen;     /* length of comment line */
char *text[];    /* pointers to comment lines */
char *varname[]; /* names of fields */
int varlen[];    /* field lengths */
char *vartype[]; /* field attributes */
```

Description

The **fi_create** function creates a new SURVO 84C data file with a pathname `name`. If the path is not given, the current data pathname given by the global variable `edisk` is used. The default extension is .SVO.

If `n>0`, `n` missing observations will be saved.

The data file has the following structure:

		bytes	offset
Header fields: 64 bytes (46 bytes in use)			
`"SURVO 84C DATA  "`	char	16	0
record length (`len`)	int	2	16
max # of fields (`m1`)	int	2	18
# of fields (`m`)	int	2	20
# of observations (`n`)	long	4	22
max length of field name (`f`)	int	2	26
length of field attr. (`extra`)	int	2	28
# of comment lines (`textn`)	int	2	30
length of comment line (`textlen`)	int	2	32

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start of comments (`text`)	long	4	34
start of field descr. (`var`)	long	4	38
start of data (`data`)	long	4	42

Comments: `text=64`
Length of comments `textn*textlen` bytes

Field descriptions: `var=text+textn*textlen`
Following information repeated `m1` times (`f+extra` bytes for each field):

position in record (`varpos`)	int	2	0
length of field (`varlen`)	int	2	2
type (1,2,4,8,S) (`vartype`)	char	1	4
activation	char	1	5
protection	char	1	6
other mask bytes	char	`extra`-7	7
name (varname)	char	f	`extra`

Data: `data=var+m1*(f+extra)`
`=64+textn*textlen+m1*(f+extra)`
Observation `j` starts from `data+(j-1)*len`

Return Value

fi_create returns 1 if the file is succesfully created and -1 otherwise. If a data file with the same name already exists, **fi_create** asks for permission to overwrite.

Application

In practice, SURVO 84C data files are created automatically by various FILE operations. They use **fi_create** as a subroutine. A direct **fi_create** call is seldom needed.

* * *

fnconv

Summary

```
int fnconv(number,length,string)
double number;     /* number to be converted */
int length;        /* length of the result */
char *string;      /* string result */
```

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Description

The **fnconv** function converts the digits of the given `number` to a null-terminated character string and stores the result in `string`. The format of the result is selected so that the length of `string` will be `length`.

Exceptionally large numbers are converted to a floating point (exponent) form and the length of `string` may then exceed `length`.

Return Value

There is no return value.

See Also

fconv

Example

```
double x=3.14159265;
char result[32];
fnconv(x,7,result); /* result=" 3.1416" */
```

* * *

hae_apu

Summary

```
int hae_apu(s,t)
char *s;            /* keyword in SURVO.APU */
char *t;            /* value of keyword as a string */
```

Description

The **hae_apu** function searches for the keyword `s` in the system file SURVO.APU which contains the values of the SURVO 84C system parameters. The value of the keyword is copied as a null-terminated string to `t`.

Return Value

hae_apu returns 1 if the keyword `s` is found and 0 otherwise.

See Also

s_init

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Example

```
char value[16];
int ep4;
ep4=EP4;
if (hae_apu("ep4",value)) ep4=atoi(value);
```

replaces the default value `EP4` of system parameter `ep4` by a value found in SURVO.APU in the form `ep4`=value.

Applications

hae_apu does not read the file SURVO.APU itself, but rather a buffer which has been created when SURVO 84C is initialized or the SETUP command has been activated.

hae_apu is not needed very often, since most of the system parameters maintained by SURVO.APU have been read by the SURVO 84C main module and appear as global variables in any SURVO 84C module after the **s_init** call (See **s_init**).

* * *

init_remarks, rem_pr, wait_remarks

Summary

```
int init_remarks()

int rem_pr(string)
char *string;     /* output line */

int wait_remarks(type)
int type;         /* type of prompt */
```

Description

These functions are to be used in supplementary SURVO 84C modules not reported in the inquiry system. Substantially, these functions emulate the behaviour of the inquiry system of SURVO 84C. They are called when the user has activated the operation with insufficient parameters.

The **init_remarks** function initializes a temporary window for remarks to be printed on consecutive lines, possibly on several pages.

The **rem_pr** function prints one line of remarks given as `string`.

The **wait_remarks** function halts the display temporarily and gives two kinds of prompts according to `type`.

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If `type=1`, the prompt is

```
Next page by 'space'  |
Load lines by '+'  |  Interrupt by ENTER!
```

If `type=2`, the prompt is

```
Load lines by '+'  |  Interrupt by ENTER!
```

Thus `wait_remarks(1);` should be given once between pages and `wait_remarks(2);` after the last page.

Return Value

There is no return value.

* * *

lastline2

Summary

```
int lastline2()
```

Description

Function **lastline2** finds the last non-empty line in the current edit field.

Return Value

lastline2 returns the line number. There is no error return.

See Also

edline2

* * *

mask

Summary

```
int mask(data)
SURVO_DATA *data; /* pointer to data structure */
```

Description

The **mask** function reads the VAR (or VARS) specification written in the edit field or, if it does not exist, **mask** reads the MASK specification and activates variables (fields) in `data` opened by **data_open** or **data_**

open2.

The effect of **mask** is only temporary. There is no change in the activation status of files. Thus if `data` is reopened, activation due to **mask** is no longer valid.

Return Value

mask returns -1 if the VARS or MASK specification is invalid. Otherwise **mask** returns 1.

See Also

scales, activated, varfind

Example

```
int i;
SURVO_DATA dat;

i=data_open("TEST",&dat);
if (i<0) return;
mask(&dat);
```

* * *

matrix_format

Summary

```
int matrix_format(format,accuracy,A,m,n)
char *format;     /* format of type ###.#### */
int accuracy;     /* # of characters in one element */
double *A;        /* matrix */
int m,n;          /* # of rows and columns */
```

Description

The **matrix_format** function finds a common suitable `format` as a string of the form ###.#### for the elements of an `m*n` matrix `A`. The length of `format` is given by `accuracy`.

matrix_format usually precedes **matrix_print** when the suitable format is unknown for the matrix to be written.

Return Value

matrix_format always returns 1.

See Also

matrix_print, library SURVOMAT.LIB

* * *

matrix_load

Summary

```
int matrix_load(matr,A,rdim,cdim,rlab,clab,
                lr,lc,type,expr)
char *matr;   /* name of matrix file */
double **A;   /* pointer to matrix space */
int *rdim;    /* pointer to number of rows */
int *cdim;    /* pointer to number of columns */
char **rlab;  /* pointer to row labels space */
char **clab;  /* pointer to column labels space */
int *lr;      /* pointer to length of row label */
int *lc;      /* pointer to length of column label */
int *type;    /* pointer to type of matrix */
char *expr;   /* matrix expression (internal name) */
```

Description

The **matrix_load** function reads a matrix saved in a matrix file. It also allocates space (by **malloc**) for the matrix elements (of type double) and for the row and column labels. **matrix_load** does not allocate space for scalar parameters or for the matrix expression.

The elements of the matrix are read by columns in a one-dimensional double array pointed by `*A` and having the size `(*rdim)*(*cdim)*sizeof(double)`.

Each row label has the length `*lr` and they are read in a one-dimensional character array pointed by `*rlab` and having the size `(*lr)*(*rdim)`.

If `rlab` is `NULL`, no space is allocated and no row labels are read.

Each column label has length of `*lc` bytes and they are read in an one-dimensional character array pointed by `*clab` and having the size `(*lc)*(*cdim)`.

If `clab` is `NULL`, no space is allocated and no row labels are read.

`*type` will be the type of the matrix with possible values of
`*type=20` diagonal matrix,
`*type=10` symmetric matrix,
`*type=0` general matrix
and `*expr` will be the internal name of the matrix (as a matrix expression) of length 128 characters at most. Space is not allocated to `*expr` in **matrix_load**; it is the responsibility of the calling function to have 129 bytes at least for `*expr`.

Similarly space must be allocated for `rdim`,`cdim`,`lr`,`lc` and `type` before the **matrix_load** call.

Return Value

matrix_load returns -1 if matrix `matr` is not found or if space cannot be allocated for it. Upon successful completion of the function 1 is returned.

See Also

matrix_save, **matrix_print**, library SURVOMAT.LIB

Example

```
double *A;
int m,n;
char *rlab,*clab;
int lr,lc;
int type;
char expr[129];

matrix_load("MEANS",&A,&m,&n,&rlab,&clab,
            &lr,&lc,&type,expr);
```

reads an `m*n` matrix `A` from a matrix file `MEANS.MAT` on the current data disk. The labels of rows are read in character array `clab` and each label has length `lr`. The labels of columns are read in character array `rlab` and each of them has length `lc`. In most cases `lr=lc=8`. The type of matrix is `type` and its internal name is `expr`.

* * *

matrix_print

Summary

```
int matrix_print(A,m,n,rlab,clab,lr,lc,
    m2,n2,mv,nv,form,width,editline,outfile,header)
double *A;         /* matrix */
int m,n;           /* # of rows and columns */
char *rlab,*clab;  /* row and column labels */
int lr,lc;         /* lengths of row and col. labels */
int m2,n2;         /* # of selected rows/cols */
int *mv,*nv;       /* lists of selected rows/cols */
char *form;        /* format as 123.12 or %5.5g  */
int width;         /* entire printing width */
int editline;      /* first edit line for the output */
char *outfile;     /* output file/device */
char *header;      /* header text */
```

Description

The **matrix_print** function writes an `m*n` matrix `A` or an `m2*n2` submatrix of it in the current edit field and/or appends the same text in a text file `outfile`.

The matrix is written in blocks of maximal width of `width` characters. Each block will be labelled with appropriate row and column labels. The first output line will be `header`.

If `m2=m`, `n2=n` and `mv=nv=NULL`, the entire `A` matrix will be written.

If `m2<=m`, `n2<=n` and `mv=nv=NULL`, the `m2` first rows and `n2` first columns of `A` will be written.

If `mv` is not `NULL`, rows `mv[0]`,`mv[1]`,...,`mv[m2-1]` (with possible values from `0` to `m-1`) are written in this order.

If `nv` is not `NULL`, columns `nv[0]`,`nv[1]`,...,`nv[m2-1]` (with possible values from `0` to `n-1`) are written in this order.

Return Value

matrix_print always returns 1.

See Also

matrix_load, **matrix_format**, library SURVOMAT.LIB

* * *

matrix_save

Summary

```
int matrix_save(matr,A,m,n,rlab,clab,lr,lc,type,expr)
char *matr;   /* name of matrix file */
double *A;    /* pointer to matrix */
int m;        /* number of rows */
int n;        /* number of columns */
char *rlab;   /* row labels space */
char *clab;   /* column labels space */
int lr;       /* length of row label */
int lc;       /* length of column label */
int type;     /* type of matrix */
char *expr;   /* matrix expression (internal name) */
int nrem;     /* # of comment lines in edit field */
int remline;  /* first edit line for the comments */
```

Description

The **matrix_save** function saves matrix `A` and its row (`rlab`) and column (`clab`) labels in a matrix file `*matr`. `*matr` is a pathname with the default path given by the global variable `edisk` and with the default extension .MAT .

The elements of the matrix `A` are assumed to be in a one-dimensional double array pointed by `A` by columns.

Each row label has a length of `lr` bytes and they are in a one-dimensional character array `rlab` as a contiguous string.

Each column label has a length of `lc` bytes and they are in a one-dimensional character array pointed by `clab` as a contiguous string.

`type` is the type of the matrix with possible values of

`type=20` diagonal matrix,
`type=10` symmetric matrix,
`type=0` general matrix,
`type=-1` unknown type.

In the last case **matrix_save** itself determines the type.

`expr` is the internal name of the matrix (as a matrix expression) of a length of 128 characters at most.

Also `nrem` comment lines from the edit field starting from edit line `remline` can be saved in the matrix file. In case of no comment lines `nrem=remline=0`.

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The matrix file has the following structure:

Header fields: ERC bytes (ERC=128)
"MATRIX84D m n nrem lr lc type "
appearing as an ASCII string where the first 10 bytes "MATRIX84D " are for identification and the numeric parameters

# of rows (m)
# of columns (n)
# of comment lines (nrem)
row label length (lr)
column label length (lc)
type of the matrix (type)

have been converted to character strings separated by blanks.

The header is followed by:

	offset
Comments: nrem*ERC bytes	ERC
Internal name (expr): ERC bytes	(nrem+1)*ERC
Column labels (*clab): n*lc bytes	(nrem+2)*ERC
Rows of the matrix: lr+8*n bytes each	n*lc+(nrem+2)*ERC

If the matrix is symmetric (type=10), only the elements of the lower triangular part are saved by rows, each row preceded by its label of lr bytes.
If the matrix is diagonal (type=20), only the diagonal elements, each preceded by the row label, are saved.
The total size of the matrix file is
m*(lr+8*n)+n*lc+(nrem+2)*ERC bytes for type=0,
m*(lr+8*(m+1)/2)+m*lc+(nrem+2)*ERC bytes for type=10,
m*(lr+8)+m*lc+(nrem+2)*ERC bytes for type=20.

Return Value
matrix_save returns -1 if matrix matr cannot be saved. Otherwise 1 will be returned.

See Also
matrix_load, library SURVOMAT.LIB

Example
```
double *A;
int m,n;
char *rlab,*clab;
int lr,lc;
int type;
char expr[129];

matrix_save("MEANS",A,m,n,rlab,clab,8,8,-1,expr,0,0);
```

saves an `m*n` matrix `A` in a matrix file `MEANS.MAT` on the current data disk. The labels of rows are in character array `clab` and each label has length 8. The labels of columns are in character array `rlab` and each of them has length 8. The type of matrix is -1 (unknown) and its internal name is `expr`. No comment lines are saved from the edit field.

* * *

nextch

Summary
```
int nextch(display_text)
char *display_text      /* prompt text */
```

Description
The **nextch** function prompts the user to press some key by displaying `display_text` on the bottom line of the screen.
nextch works also under tutorial mode (reading key strokes from the sucro file).

Return Value
nextch returns the SURVO 84C key code of the key pressed.

See Also
tut_init, prompt

Example

```
int m;
m=0;
while (m!=CODE_RETURN)
    m=nextch("Press ENTER!");
/* The program waits until ENTER is pressed */
```

* * *

output_open, output_line, output_close

Summary

```
int output_open(file)
char *file;      /* name of output file */

int output_line(string,file,editline)
char *string;    /* output string */
char *file;      /* name of output file */
int editline;    /* current output line in edit field */

int output_close(file)
char *file;      /* name of output file */
```

Description

The **output_open** function opens `file` to be used as an output file for SURVO 84C results.

The **output_line** function appends the given `string` to `file`, replacing `string`'s terminating null character (`EOS`) with a newline character (`'\n'`) in `file`.

Simultaneously `string` will be copied to `editline` in the current edit field, if `1<=editline<=r2`. When `editline` overrides those limits, no error message is given, but copying is prohibited. Thus `editline=0` suppresses printing in the edit field.

The **output_close** function closes `file`.

Return Value

output_open returns 1 if the file was successfully opened and -1 otherwise. There is no return value for **output_line** and **output_close**.

See Also

edwrite

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Application

The global SURVO 84C variable `eout` gives the name of the output file/device the user has selected (by OUTPUT command, for example).

Normally `eout` is opened once by

```
int i;
i=output_open(eout);
if (i<0) return;
```

Then each output line is written by

```
int ed_output_line;
     /* initialized according to situation */
char line[LLENGTH];
     /* filled with information to be written */
output_line(line,eout,ed_output_line++);
```

Finally, after all results have been written `eout` is closed by

```
output_close(eout);
```

* * *

prompt

Summary

```
int prompt(question,answer,maxlength)
char *question; /* prompt text */
char *answer;   /* default/final answer */
int maxlength;  /* max length of the answer */
```

Description

The **prompt** function presents a `question` on the screen giving a default `answer` and letting the user edit it or type a new answer within the limit given by `maxlength`.

The place for the prompt can be selected by `LOCATE(row,column);` .

prompt works also under tutorial mode (reading the user's answers from the sucro file).

Return Value

There is no return value. The user's answer will be in `answer` as a null-terminated string.

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See Also
tut_init, nextch

Example
```
char filename[LNAME];

strcpy(filename,"TEST");
LOCATE(r3+2,1); /* bottom line on the screen */
prompt("Name of file? ",filename,LNAME-1);
```

* * *

s_end

Summary
```
int s_end(address)
char *address;       /* address of SURVO 84C pointers
                        as a string */
```

Description
The **s_end** function copies the SURVO 84C system parameters which have been altered in current module back to the main module.
s_end should be called once before returning to the main program in those modules which change any of the scalar parameters
`r,r1,c,c1,etu,etu1,etu2,etu3,tutpos,erun,edisp`.
For example, `edisp` may be changed from its default value 1 to to avoid redisplay of the entire screen after return.
Normally **s_end** is not needed at all.

See Also
s_init

Example
See also **s_init**.
```
s_end(argv[1]);
```

* * *

s_init

Summary

```
int s_init(address)
char *address;       /* address of SURVO 84C pointers
                        as a string */
```

Description

The **s_init** function copies the SURVO 84C system parameters from the SURVO 84C main module (parent process) to the current module (child process).

The 4-byte address of pointers is passed from the parent to the child in a form of a string `address` and in practice always replaced by `argv[1]`.

After the **s_init** call, which should take place once in the beginning of each SURVO 84C module the following variables and parameters are available with their current values:

```
char *z;            /* pointer to edit field */
int ed1;            /* length of edit line + control column */
int ed2;            /* number of lines in edit field */
int edshad;         /* max. # of shadow lines in edit field */
int r;              /* current line on the screen */
int r1;             /* first visible edit line on the screen */
int r2;             /* =ed2 */
int r3;             /* # number of edit lines on the screen */
int c;              /* current column on the screen */
int c1;             /* first visible column on the screen */
int c2;             /* =ed1-1 (length of edit line) */
int c3;             /* # of columns on the screen */
char *edisk;        /* current data disk (path) */
char *esysd;        /* SURVO 84C system disk (path) */
char *eout;         /* output file/device */
int etu;            /* tutorial mode indicator */
char *etufile;      /* current sucro file (when etu>0) */
int etu1,etu2,etu3; /* tutorial mode parameters */
long tutpos;        /* pointer to sucro file */
int *zs;            /* indices of shadow lines */
int zshn;           /* # of shadow lines */
int erun;           /* run mode indicator (1=run mode on) */
int edisp;          /* display mode after exit from current module */
char *sapu;         /* buffer for SURVO.APU parameters */
char *info;         /* string for information between modules */
char **key_label;   /* key label pointers */
char *key_lab;      /* key label buffer */
char *survo_id;     /* owner of the SURVO 84C copy */
char **disp_string; /* display string pointers */
int speclist;       /* size of buffer for specifications */
int specmax;        /* max # of specifications */
char *active_data;  /* current SURVO 84C DATA */
int scale_check;    /* scale type checking level */
int accuracy;       /* accuracy for printouts */
int scroll_line;    /* first scroll line for temporary displays */
int space_break;    /* break indicator for space bar (1=on) */
int sdisp;          /* current shadow character (display mode) */
```

SURVO.LIB

Return Value

There is no return value.

See Also

hae_apu, s_end, tut_init

Example

A typical start of the main function in a SURVO 84C module is:

```
main(argc,argv)
int argc; char *argv[1];
        {
        if (argc==1) return;
        s_init(argv[1]);
/*  ..........  */
        }
```

* * *

scale_ok

Summary

```
int scale_ok(data,i,scale)
SURVO_DATA *data; /* pointer to data structure */
int i;            /* # of variable */
char *scale; /* list of allowed scales as a string */
```

Description

The **scale_ok** function tests whether the scale type of variable # `i` in `data` opened by **data_open** or **data_open2** belongs to the given list `scale` of scale types.

In `survodat.h` the following scale types are predefined:

```
#define ORDINAL_SCALE       " DOoSsIiRrF"
#define SCORE_SCALE         " DSsIiRrF"
#define INTERVAL_SCALE      " DIiRrF"
#define RATIO_SCALE         " RrF"
#define DISCRETE_VARIABLE   " DNOSIRF"
#define CONTINUOUS_VARIABLE " osir"
```

where the different scale types are denoted as follows:

`-`	no scale	
	(blank)	scale unknown
`D`	Dichotomy	(two distinct numeric values)
`N`	Nominal	
`O`	Ordinal	(discrete)
`o`	Ordinal	(continuous)
`S`	Score	(discrete)
`s`	Score	(continuous)
`I`	Interval	(discrete)
`i`	Interval	(continuous)
`R`	Ratio	(discrete)
`r`	Ratio	(continuous)
`F`	Frequency	

Return Value

scale_ok returns 1 if the scale of variable # `i` is found in `scale`. Otherwise 0 is returned. If the system parameter `scale_check` is 0, then scale is not checked at all and 1 is returned. However, if the scale of variable # `i` is '-', 0 is returned irrespective of `scale` and the value of `scale_check`.

See Also

scales

Example

```
int i;
int weight_variable;
SURVO_DATA dat;

i=data_open("TEST",&dat);
if (i<0) return;
weight_variable=activated(&dat,'W');
```

```
if (weight_variable>=0)
 {
 if (!scale_ok(&dat,weight_variable,RATIO_SCALE))
   {
   printf("\nWeight variable %.8s must have ratio scale!",
               dat.varname[weight_variable]);
   WAIT; if (scale_check==SCALE_INTERRUPT) return;
   }
 }
```

* * *

scales

Summary

```
int scales(data)
SURVO_DATA *data; /* pointer to data structure */
```

Description

The **scales** function removes all variables with the scale type '-' (no scale) from the list `data->v` of active variables.

`data` must be opened by **data_open** or **data_open2**.

scales is usually called after **mask** in statistical SURVO 84C modules to remove fields without scale from the analysis irrespective of the user's selection. **scales** thus updates `data->m_act` and selection vector `data->v`.

Return Value

There is no return value.

See Also

mask

Example

```
int i;
SURVO_DATA dat;

i=data_open("TEST",&dat);
if (i<0) return;
mask(&dat);   /* select variables according to MASK */
scales(&dat); /* remove variables without scale */
```

* * *

shadow_create

Summary

```
int shadow_create(j)
int j;              /* edit line */
```

Description

The **shadow_create** function creates a shadow line consisting of `ed1` spaces for the `j`th line (`1<=j<=ed2`) in the edit field. After the **shadow_create** call `zs[j]` is the index of the new shadow line.

If there is no more space for a new shadow line (`edshad` is the max. number), an error message *Not space anymore for special display lines!* is displayed.

Return Value

shadow_create returns 1 if the shadow line has been created and -1 otherwise.

See Also

shadow_test

Example

```
char x[LLENGTH];
int i;
for (i=0; i<c2; ++i) x[i]='7';
if (zs[10]==0)
    {
    i=shadow_create(10);
    if (i<0) return;
    }
edwrite(x,zs[10],1);
/* turns all characters on edit line 10
   into reversed video (shadow value 7) */
```

* * *

shadow_test

Summary

```
int shadow_test(j)
int j;             /* edit line */
```

Description

The **shadow_test** function frees the shadow line of the `j`th edit line if it consists of spaces (blanks) only.

Return Value

There is no return value.

See Also

shadow_create

Example

```
int j;
for (j=1; j<=r2; ++j)
    if (zs(j)>0) shadow_test(j);
/* frees all unnecessary shadow lines
   in the current edit field. */
```

* * *

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sp_init

Summary

```
int sp_init(editline)
int editline;          /* # of edit line */
```

Description

The **sp_init** function finds all the specifications from the subfield around `editline` and secondarily from the `*GLOBAL*` subfield.

sp_init forms the arrays char `**spa`,`**spb` consisting of the names (`**spa` on the left-hand side) and values (`**spb` on the right-hand side) of the specifications of the form

`<name>=<value>`

After the **sp_init** call the function **spfind** can be used to find the values of the specifications.

Return Value

sp_init returns 1 if there is enough space for all specifications. Otherwise -1 is returned.

See Also

spfind

Example

```
int i;

i=sp_init(r1+r-1);
    /* r1+r-1 is the current line in the edit field */
if (i<0) return;
```

* * *

spfind

Summary

```
int spfind(name)
char *name;      /* specification to be found */
```

Description

The **spfind** function searches for the specification `name` from the `**spa` list which has been created by the **sp_init** function earlier.

Return Value

If `name` is found, **spfind** returns the index (say `i`) of `name` in the `**spa` list. `spb[i]` is then the pointer to the value of `name`. If `name` is not found, -1 is returned.

See Also

sp_init

Example

```
int i,k;
int x_home,y_home;
char x[LLENGTH]; *px[2];

i=sp_init(r1+r-1);
    /* r1+r-1 is the current line in the edit field */
if (i<0) return;

i=spfind("HOME");
if (i>=0)
  {
  strcpy(x,spb[i]);
  k=split(x,px,2);
  if (k<0)
    {
    sprintf(sbuf,"\nError in spec. HOME=%s",spb[i]);
    sur_print(sbuf); WAIT; return;
    }
  x_home=atoi(px[0]);
  y_home=atoi(px[1]);
  }
else
  x_home=y_home=0;
```

* * *

SURVO.LIB

split

Summary

```
int split(s,word,max)
char *s;          /* null-terminated string */
char *word[];     /* pointers to words of string */
int max;          /* max number of words to be found */
```

Description

The **split** function splits string `s` into tokens (words) `word[0]`, `word[1]`, ...,`word[max-1]` interpreting spaces and commas as delimiters. Since **split** writes an `EOS` character in place of every word ending with a space or a comma in `s`, the original contents of `s` are destroyed during the **split** call. After the call, the pointers `word[0]`,`word[1]`,... indicate the starting positions of the words in `s`.

Please note that the words will be destroyed if the contents of `s` are altered after the **split** call.

Return Value

split returns the number of words found which is `max` at most. Thus if the number of words in `s` is greater than `max`, the excessive words will not be found. There is no error return.

See Also

edread

Example

```
char x[]="PRINT 11,20";
char *word[3];
int i,k;

k=split(x,word,3);
for (i=0; i<k; ++i)
    printf("\nword[%d]=%s",i,word[i]);
```

prints:

```
word[0]=PRINT
word[1]=11
word[2]=20
```

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Applications

split is the common tool when analyzing edit lines. A typical combination is, for example:

```
edread(x,j);
k=split(x+1,word,10);
    /* x+1=jth edit line without a control character */
```

* * *

sur_print

Summary

```
int sur_print(string)
char *string;        /* null-terminated string */
```

Description

The **sur_print** function prints `string` in the window below the line defined by the global variable `scroll_line`. The output of `sur_print` will be scrolled automatically in that window.

sur_print is used mainly for temporary printouts with a 256 byte global string `sbuf`.

Return Value

There is no return value.

See Also

write_string

Example

```
double result;
char str[LLENGTH];

fnconv(result,str,accuracy+2);
sprintf(sbuf,"\nResult=%s",str);
sur_print(sbuf);
```

* * *

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sur_wait

Summary

```
int sur_wait(time,display,break)
long time;        /* waiting time in ms */
int (*display)(); /* display function during wait */
int break;        /* 1: possible to break by any key */
                  /* 0: not possible to break */
```

Description

The **sur_wait** function creates a wait lasting `time` milliseconds. During the wait the `display` function is called once every second (to indicate the time elapsed, for example). If `break=1`, the wait can be interrupted by pressing any key.

Return Value

sur_wait returns -1 if the wait has been interrupted by a key. Otherwise 0 is returned.

Example

```
#include <stdio.h>
int sec=0;
main()
        {
        extern seconds();
        sur_wait(20000L,seconds,1);
        }
seconds()
        {
        printf(" %d",++sec);
        }
/* This program counts to 20 seconds */
```

* * *

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tut_init, tut_end

Summary

```
int tut_init()

int tut_end()
```

Description

The **tut_init** function opens the tutorial file, if the current module is run under tutorial mode (system parameter `etu>0`).

tut_init is called once immediately after **s_init** in those modules which operate at least partially in conversational mode (by using the **prompt** and **nextch** functions).

Thus **tut_init** is not needed in modules which simply carry out their task without any prompts for the user. Error messages ending with `WAIT` do not require **tut_init** either.

If **tut_init** has been called, the functions **tut_end** and **s_end** must be called (in this order) before the exit from the module.

Return Value

There is no return value.

See Also

s_init, s_end, prompt, nextch

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Example

A typical construction in a SURVO 84C module is:

```
#include "survo.h"
#include "survoext.h"

main(argc,argv)
int argc; char *argv[1];
        {
        if (argc==1) return;
        s_init(argv[1]);
        tut_init();
/*  ..........  */
        tut_end();
        s_end(argv[1]);
        }
```

* * *

unsuitable

Summary

```
int unsuitable(data,j)
SURVO_DATA *data; /* pointer to data structure */
long *j;          /* # of observation (record) */
```

Description

The **unsuitable** function tests whether observation `j` in `data` opened by **data_open** or **data_open2** satifies the restrictions imposed by IND and CASES specifications. Each module must call the **conditions** function once before the calls of **unsuitable**.

Return Value

unsuitable returns 1 if the conditions are **not** fulfilled and 0 otherwise.

See Also

conditions

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Example

```
int i;
long j;
SURVO_DATA dat;

i=data_open("TEST",&dat);
if (i<0) return;
i=conditions(&dat);
if (i<0) { data_close(&dat); return; }
for (j=dat.l1; j<=dat.l2; ++j)
        {
        if (unsuitable(&dat,j)) continue;
        printf(" %ld",j);
        }
/* Numbers of observations satisfying
   the conditions are printed. */
```

* * *

varfind

Summary

```
int varfind(data,name)
SURVO_DATA *data; /* pointer to data structure */
char *name;       /* name of variable */

int varfind2(data,name,error_display)
SURVO_DATA *data; /* pointer to data structure */
char *name;       /* name of variable */
int error_display;/* 1=on 0=off */
```

Description

The **varfind** function finds the index corresponding to the given `name` of a variable (field) in `data` opened by **data_open** or **data_open2**.

Comparisons between names are performed by using the first 8 characters only. Trailing blanks are not counted. **varfind** is case-sensitive. Thus `"Weight"` is different from `"weight"`.

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Return Value

varfind returns # of variable or -1 if no variable corresponding to `name` is found. In the latter case an error message is displayed.

varfind2 works as **varfind**, but in case of an error (variable not found) no error message is displayed if `error_display=0`.

See Also

mask, activated

Example

```
int i;
SURVO_DATA dat;

i=data_open("TEST",&dat);
if (i<0) return;
i=varfind(&dat,"Weight");
```

* * *

wfind

Summary

```
int wfind(word1,word2,j)
char *word1;        /* first word */
char *word2;        /* second word */
int j;              /* first edit line to be scanned */
```

Description

The **wfind** function searches the first line starting with the words `word1 word2`. The first line to be checked is `j`. Extra spaces before and between the words are not counted.

Return Value

wfind returns the index of the line and -1 if the line is not found.

Example

```
int k;
char name[]="ABC";
k=wfind("DATA",name,1);
```

finds the first line in the current edit field starting with the words DATA ABC.

* * *

write_string

Summary

```
int write_string(x,len,shadow,row,col)
char *x;        /* string to be written */
int len;        /* max # of bytes to be written */
char shadow;    /* shadow (attribute) character */
int row,col;    /* row and column of first character */
```

Description

The **write_string** function displays the `len` first bytes of `x` using the attribute given by `shadow` and starting from position (`row`,`col`).

Return Value

There is no return value.

See Also

sur_print

Example

A message for the user on the bottom line of the screen is produced typically by:

```
write_string(space,c3+8,' ',r3+2,1);
            /* Erase bottom line r3+2 */
write_string("Press any key!",14,'1',r3+2,1);
            /* Give message in 'red' */
```

* * *

8.2 Library SURVOMAT.LIB

Matrix functions are tools for making SURVO 84C operations for linear models, multivariate analysis, etc. For example, the matrix interpreter employs the library functions through the MAT operations.

The matrix operands and results are referred to by pointers of the double type. To enable dynamic space allocation, the matrices are always stored as one-dimensional arrays. The elements of the matrices (of type double) are saved columnwise. All computations are carried out in double precision.

For example, the function **mat_transp** is written as

```
mat_transp(T,X,m,n)
double *T,*X;
int m,n;
    {
    register int i,j;

    for (i=0; i<m; ++i) for (j=0; j<n; ++j)
        T[j+n*i]=X[i+m*j];
    return(1);
    }
```

It transposes a `m*n` matrix `X` and gives the result as a `n*m` matrix `T`. The elements of `X` are `X[i+m*j]` with row indices `i=0,1,...,m-1` and column indices `j=0,1,...,n-1`.

The matrix functions do not allocate space for result matrices. For example, if the function above is called, space for the result T must have been reserved by

```
T=(double *)malloc(m*n*sizeof(double));
if (T==NULL) { not_enough_space(); return(-1); } .
```

If the matrix operation is successful, 1 is returned. Otherwise 0 or a negative integer is returned. In many cases the return value `-i` indicates that the operation has failed on row/column `i` of the matrix.

Matrix input and output

The SURVOMAT.LIB library does not support the matrix input and output directly. The SURVO.LIB library, however, includes the functions **matrix_load** and **matrix_save** functions for matrix files of the type used in MAT operations, for example. These functions should be used in all SURVO 84C operations which read and write matrices.

For example, the following SURVO 84C module transposes the matrix in matrix file A and saves the result in matrix file B, when the command

```
MTRANSP A TO B
```

is given in SURVO 84C. The operation is equivalent to

```
MAT B=A'
```

```
 1 /* !mtransp.c 30.10.1986/SM  (24.6.1989) */
 2 #include "survo.h"
 3 #include "survoext.h"
 4 #include <stdio.h>
 5 #include <string.h>
 6 #include <malloc.h>
 7
 8 double *A,*B;         /* pointers to matrices */
 9 int m,n;              /* dimensions of A */
10 char *rlab,*clab;     /* row and column labels */
11 int rlen,clen;        /* lengths of labels */
12 int type;             /* type of matrix (not used) */
13 char expr[LLENGTH];   /* internal matrix name */
14 char newexpr[LLENGTH];
15
16 main(argc,argv)
17 int argc; char *argv[];
18     {
19     int i;
20
21     if (argc==1) return;
22     s_init(argv[1]);
23     if (g<4)
24         {
25         sur_print("\nUsage: MTRANSP A TO B");
26         WAIT; return;
27         }
28     i=matrix_load(word[1],&A,&m,&n,&rlab,&clab,
29                   &rlen,&clen,&type,expr);
30     B=(double *)malloc(m*n*sizeof(double));
31     if (B==NULL)
32         {
33         sur_print("\nNot enough memory!");
34         WAIT; return;
35         }
36     mat_transp(B,A,m,n);
37     strcpy(newexpr,"("); strcat(newexpr,expr);
38     strcat(newexpr,")'");
39     matrix_save(word[3],B,n,m,clab,rlab,
40                 clen,rlen,0,newexpr,0,0);
41     }
```

The **matrix_load** call (28-29) also allocates space for matrix `A` and its row and column labels `rlab`,`clab`. Space is allocated for the transpose `B` on lines 30-35 and after transposing the label of the matrix is updated on lines 37-38. Finally the **matrix_save** call (39-40) saves `B` in a matrix file. For additional information on **matrix_load** and **matrix_save** functions, see their descriptions in the SURVO.LIB library.

Functions in library SURVOMAT.LIB

`survomat.h` must be included for these functions.

mat_add

```
int mat_add(T,X,Y,m,n)
double *T,*X,*Y;
int m,n;
```

computes `T=X+Y`, where `X` and `Y` are `m*n` matrices.
mat_add always returns 1.

* * *

mat_sub

```
int mat_sub(T,X,Y,m,n)
double *T,*X,*Y;
int m,n;
```

computes `T=X-Y`, where `X` and `Y` are `m*n` matrices.
mat_sub always returns 1.

* * *

mat_mlt

```
int mat_mlt(T,X,Y,m,n,r)
double *T,*X,*Y;
int m,n,r;
```

computes `T=X*Y`, where `X` is an `m*n` and `Y` is an `n*r` matrix.
mat_mlt always returns 1.

* * *

mat_inv

```
int mat_inv(T,X,n,pdet)
double *T,*X;
int n;
double *pdet;
```

computes matrix `T` as the inverse matrix of an `n*n X` by the Gauss-Jordan elimination method. As a by-product, determinant of `X` will be `*pdet`. If any of the pivot elements are less than `1e-15`, `X` is considered singular and no `T` is computed; `-i` will then be returned where `i` is the current row index of the pivot element (`i=0,1,...,n-1`). In non-sigular cases, 1 is returned. **Warning**: The matrix `X` to be inverted is not preserved during the `mat_inv` call.

* * *

mat_transp

```
int mat_transp(T,X,m,n)
double *T,*X;
int m,n;
```

transposes an `m*n` matrix `X` to an `n*m` matrix `T`.
mat_transp always returns 1.

* * *

mat_mtm

```
int mat_mtm(T,X,m,n)
double *T,*X;
int m,n;
```

computes `T=X'X`, where `X` is an `m*n` matrix.
mat_mtm always returns 1.

* * *

mat_mmt

```
int mat_mmt(T,X,m,n)
double *T,*X;
int m,n;
```

computes `T=XX'`, where `X` is an `m*n` matrix.
mat_mmt always returns 1.

* * *

mat_dmlt

```
int mat_dmlt(T,X,Y,m,n)
double *T,*X,*Y;
int m,n;
```

computes `T=X*Y`, where `X` is an `m*m` diagonal matrix and `Y` is an `m*n` matrix. **mat_dmlt** always returns 1.

* * *

mat_mltd

```
int mat_mltd(T,X,Y,m,n)
double *T,*X,*Y;
int m,n;
```

computes `T=X*Y`, where `X` is an `m*n` matrix and `Y` is an `n*n` diagonal matrix. **mat_mltd** always returns 1.

* * *

mat_center

```
int mat_center(T,X,m,n)
double *T,*X;
int m,n;
```

centers an `m*n` matrix `X` by computing the means of the `X` columns as an `n` element `T` vector and subtracting them from the corresponding columns. **mat_center** always returns 1.

* * *

mat_nrm

```
int mat_nrm(T,X,m,n)
double *T,*X;
int m,n;
```

normalizes the columns of an `m*n` matrix `X` to length 1. The original column lengths (square root of sum of squares) will be stored as an `n` element vector `T`. Columns of length=0 are not changed.
mat_nrm always returns 1.

* * *

mat_sum

```
int mat_sum(T,X,m,n)
double *T,*X;
int m,n;
```

computes the column sums of an `m*n` matrix `X` as an `n` element vector `T`.
mat_sum always returns 1.

* * *

mat_chol

```
int mat_chol(T,X,n)
double *T,*X;
int n;
```

performs the Cholesky decomposition of an `n*n` positive definite matrix `X`. Hence an `n*n` lower triangular matrix `T` satisfying `X=TT'` will be computed. If `X` is not positive definite, **mat_chol** returns `-i`, where `i` (`i=0,1,...,n-1`) represents the column index where this assumption fails. If decomposition is successful, 1 is returned.

* * *

mat_cholinv

```
int mat_cholinv(A,n)
double *A;
int n;
```

inverts an `n*n` positive definite matrix `A` by the Cholesky method and writes the inverted matrix `B` partially on `A` according to the following scheme:

Before **mat_cholinv**: (Here n=5 assumed)

	0	1	2		n-1	n
0	a_{00}	a_{01}	a_{02}	a_{03}	a_{04}	*
1	a_{10}	a_{11}	a_{12}	a_{13}	a_{14}	*
2	a_{20}	a_{21}	a_{22}	a_{23}	a_{24}	*
	a_{30}	a_{31}	a_{32}	a_{33}	a_{34}	*
n-1	a_{40}	a_{41}	a_{42}	a_{43}	a_{44}	*

After **mat_cholinv**:

	0	1	2		n-1	n
0	a_{00}	b_{00}	b_{01}	b_{02}	b_{03}	b_{04}
1	a_{10}	a_{11}	b_{11}	b_{12}	b_{13}	b_{14}
2	a_{20}	a_{21}	a_{22}	b_{22}	b_{23}	b_{24}
	a_{30}	a_{31}	a_{32}	a_{33}	b_{33}	b_{34}
n-1	a_{40}	a_{41}	a_{42}	a_{43}	a_{44}	b_{44}

Please note that the elements are assumed to be saved columnwise.

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To have enough space for B, at least $n*(n+1)$ elements (of type double) must have been allocated for A before the **mat_cholinv** call.

If A is not positive definite, `-i` (where `i` is the first column dependent on previous ones) is returned. In a successful case 1 is returned.

* * *

mat_cholmove

To overwrite A by its inverse completely, use **mat_cholmove**(A,*n*) after **mat_cholinv**(A,*n*) to obtain

	0	1	2		n-1	n
0	b_{00}	b_{01}	b_{02}	b_{03}	b_{04}	b_{04}
1	b_{10}	b_{11}	b_{12}	b_{13}	b_{14}	b_{14}
2	b_{20}	b_{21}	b_{22}	b_{23}	b_{24}	b_{24}
	b_{30}	b_{31}	b_{32}	b_{33}	b_{34}	b_{34}
n-1	b_{40}	b_{41}	b_{42}	b_{43}	b_{44}	b_{44}

* * *

mat_gram_schmidt

```
int mat_gram_schmidt(S,U,X,m,n,tol)
double *S,*U,*X;
int m,n;
double tol;
```

computes the Gram-Schmidt decomposition `X=S*U` for an `m*n` matrix `X` (with rank(`X`)=`n<=m`), where `S` is an `m*n` matrix with orthonormal columns and `U` is `n*n` upper triangular.

The accuracy in checking the linear independency of columns is given by `tol`. The value `tol=1e-15` is recommended.

Return value `-i` indicates that column `i` (`i=0,1,...,n-1`) is linearly dependent on previous ones. After a successful decomposition, 1 is returned.

* * *

mat_p

```
int mat_p(X,n,k)
double *X;
int n,k;
```

transforms the n*n matrix X by the pivotal operation by using the diagonal element k (k=0,1,...,n-1) as the pivot.

* * *

mat_svd

```
int mat_svd(X,D,V,m,n,eps,tol)
double *X,*D,*V;
int m,n;
double eps,tol;
```

makes the singular value decomposition X=U*diag(D)*V' for an m*n matrix X with m>=n. After the **mat_svd** call X will be overwritten by an m*n matrix U which is columnwise orthogonal. D will be an n element vector consisting of singular values and V an n*n orthogonal matrix.

eps and tol are tolerance constants (See the source cited below). Suitable values are eps=1e-16 and tol=(1e-300)/eps.

mat_svd has been written using the ALGOL procedure by G.H.Golub and C.Reinsch as the basis. See *Handbook for Automatic Computation*, Volume II, edited by J.H.Wilkinson and C.Reinsch, pp. 134-151 (Springer 1971).

* * *

mat_tred2

```
int mat_tred2(d,e,A,n,tol)
double *d,*e,*A;
int n;
double tol;
```

reduces an n*n symmetric matrix A to tridiagonal form using Householder's reduction. The diagonal of the result is stored as an n element vector d and the sub-diagonal as the last n-1 elements of an n element vector e.

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A will be overwritten by the transformation matrices. tol is an accuracy constant (see **mat_svd**).

Space for d and e (n elements each of type double) must be allocated before **mat_tred2** is called.

To get the eigenvalues and vectors after mat_tred2(d,e,A,n,tol), function **mat_tql2** has to be called.

* * *

mat_tql2

```
int mat_tql2(d,e,A,n,eps,maxiter)
double *d,*e,*A;
int n;
double eps;
int maxiter;
```

finds the eigenvalues and vectors of the n*n tridiagonal matrix A obtained by **mat_tred2**. Matrix A will be overwritten by the eigenvectors and the eigenvalues will be saved in descending order as an n element vector d.

eps in an accuracy constant (see **mat_svd**). Maximum number of iterations for one eigenvalue is maxiter. maxiter=30 is recommended. In case of no convergence within maxiter iterations, -1 is returned. If the eigenvalues and vectors are obtained, 1 is the return value.

mat_tred2 and **mat_tql2** have been written using the ALGOL procedures *tred*2 and *tql*2 as the basis. See *Handbook for Automatic Computation*, Volume II, edited by J.H.Wilkinson and C.Reinsch, (Springer 1971).

* * *

solve_upper, solve_lower, solve_diag

```
int solve_upper(X,A,B,m,k,eps)
double *X,*A,*B;
int m,k;
double eps;
```

solves the system of linear equations AX=B where A is an m*m upper triangular matrix and B is an m*k matrix. Before calling **solve_upper**, space must also be allocated to the m*k solution matrix X.

If any of the pivot elements is smaller than eps, **solve_upper** returns -i where i=0,1,...,m-1 is the current column. After a successful solution, 1 is returned.

solve_lower works as **solve_upper** but with an m*m lower triangular matrix A.

solve_diag works as **solve_upper** but with an m*m diagonal matrix A.

* * *

solve_symm

```
int solve_symm(X,A,B,m,k,eps)
double *X,*A,*B;
int m,k;
double eps;
```

solves the system of linear equations AX=B where A is an m*m positive definite matrix and B is an m*k matrix. Before calling **solve_symm**, space must also be allocated to the m*k solution matrix X.

If any of the pivot elements is smaller than eps, **solve_symm** returns -i, where i=0,1,...,m-1 is the current column. After a successful solution, 1 is returned. If A is not positive definite, **solve_symm** calls **ortholin1**.

solve_symm is based on the ALGOL procedures *choldet*1 and *cholsol*1 in *Handbook for Automatic Computation*, Volume II, edited by J.H.Wilkinson and C.Reinsch, (Springer 1971).

* * *

ortholin1

```
int ortholin1(A,n,m,B,k,eps,X,improvement)
double *A;
int n,m;
double *B;
int k;
double eps;
double *X;
int improvement;
    /* iterative improvement 1=yes 0=no */
```

gives least squares solutions for AX=B, where A is an n*m matrix, B an n*k matrix and n>=m.

eps is the maximal relative rounding error (typically eps=1e-15).

ortholin1 is based on the ALGOL procedure *ortholin1* in *Handbook for Automatic Computation*, Volume II, edited by J.H.Wilkinson and C. Reinsch, (Springer 1971).

* * *

sis_tulo

```
double sis_tulo(a,b,sa,sb,n)
double *a,*b;
int sa,sb,n;
```

is an assembler routine (written by Timo Patovaara) for computation of the inner product

```
a[0]*b[0]+a[sa]*b[sb]+a[2*sa]*b[2*sb]+...
                          +a[(n-1)*sa]*b[(n-1)*sb]
```

To speed up computations, many of the SURVOMAT.LIB functions use **sis_tulo** for scalar products.

* * *

8.3 Library DISTRIB.LIB

Many statistical operations give test statistics with appropriate *P* values obtained from standard distributions. To provide such *P* values and other numerical characteristics related to theoretical distributions, a set of C routines for density, distribution and inverse distribution functions of the common continuous distributions have been written by **T. Patovaara**. These functions are presented in the DISTRIB.LIB library.

The sources for the algorithms used are:

Abramowitz and Stegun: *Handbook of Mathematical Functions with Formulas, Graphs and Mathematical Tables*, Dover 1970.
Griffiths and Hill: *Applied Statistical Algorithms*, Horwood 1985.
Kennedy and Gentle: *Statistical Computing*, Dekker 1980.

Functions in library DISTRIB.LIB

cdf_std

```
double cdf_std(x)
double x;
```

returns the cumulative distribution function of the standardized normal distribution with the accuracy of the machine.

* * *

inv_std

```
double inv_std(p)
double p;
```

returns $x = \text{inv\_F}(p)$ for a given value of p ($0 < p < 1\text{-}1.0\text{E-}15$), where inv_F is the inverse distribution function of the standardized normal distribution.

Accuracy:

$0 < p \le$ 1-1E-4:	the accuracy of the machine
1-1E-4 $< p \le$ 1-1E-8:	13-10 significant digits
1-1E-8 $< p \le$ 1-1E-11:	9-5 significant digits
1-1E-11 $< p \le$ 1-1E-15:	4-2 significant digits

* * *

pdf_t

```
double pdf_t(x,n)
double x,n;
```

returns the Student's density function for a value x with n ($n > 0$) degrees of freedom with the accuracy of the machine.

* * *

cdf_t

```
double cdf_t(x,n)
double x,n;
```

returns the cumulative distribution function of the Student's distribution for a value x with n ($n > 0$) degrees of freedom.
Accuracy: 10-14 significant digits for $|x| \ge$ 1E-7 .

* * *

inv_t

```
double inv_t(p,n)
double p,n;
```

returns x = inv_F(p,n) for a given value of p ($0 < p \leq$ 1-1E-15), where inv_F is the inverse distribution function of the Student's distribution for n ($n > 0$) degrees of freedom.
Accuracy:

0.5+1E-4 ≤ p < 1-1E-7:	over 10 significant digits
1-1E-7 ≤ p < 1-1E-9:	10-9 significant digits
1-1E-9 ≤ p < 1-1E-12:	8-5 significant digits
1-1E-12 < p ≤ 1-1E-15:	4-2 significant digits

Similar accuracy for $0 < p < 0.5$.

* * *

pdf_chi2

```
double pdf_chi2(x,n)
double x,n;
```

returns the χ^2 density function for a value x with n ($n > 0$) degrees of freedom with the accuracy of the machine.

* * *

cdf_chi2

```
double cdf_chi2(x,n,rel_error)
double x,n,rel_error;
```

returns the cumulative distribution function of the χ^2 distribution for a value x with n ($n > 0$) degrees of freedom.
Accuracy: determined by `rel_error` (1E-15 ≤ `rel_error` < 0.5) .

* * *

DISTRIB.LIB

inv_chi2

```
double inv_chi2(p,n)
double p,n;
```

returns x = inv_F(p,n) for a given value of p ($1E\text{-}6 \le p < 1\text{-}1E\text{-}6$), where inv_F is the inverse distribution function of the χ^2 distribution for n ($n > 0$) degrees of freedom.
Accuracy: over 10 significant digits.

* * *

pdf_beta

```
double pdf_beta(x,a,b)
double x,a,b;
```

returns the Beta density function for a value x and parameters a,b ($a,b > 0$) with the accuracy of the machine.

* * *

cdf_beta

```
double cdf_beta(x,a,b,rel_error)
double x,a,b,rel_error;
```

returns the cumulative distribution function of the Beta distribution for a value x and parameters a,b ($a,b > 0$).
Accuracy: determined by `rel_error` (1E-15 ≤ `rel_error` < 0.5) .

* * *

inv_beta

```
double inv_beta(p,a,b,s_digits)
double p,a,b;
int s_digits;
```

returns x = inv_F(p,a,b) for a given value of p ($0 < p \leq$ 1-1E-15), where inv_F is the inverse distribution function of the Beta distribution with parameters a,b.
Accuracy: The number of significant digits is determined by `s_digits` (2 ≤ `s_digits` ≤ 14).

* * *

pdf_f

```
double pdf_f(x,n1,n2)
double x,n1,n2;
```

returns the F density function for a value x and n_1 and n_2 (n_1,$n_2 > 0$) degrees of freedom with the accuracy of the machine.

* * *

cdf_f

```
double cdf_f(x,n1,n2,rel_error)
double x,n1,n2,rel_error;
```

returns the cumulative distribution function of the F distribution for a value x and n_1 and n_2 (n_1,$n_2 > 0$) degrees of freedom.
Accuracy: same as in t distribution if $n_1 = 1$ or $n_2 = 1$.
Otherwise determined by `rel_error` (1E-15 ≤ `rel_error` < 0.5) .

* * *

inv_f

```
double inv_f(p,n1,n2,s_digits)
double p,n1,n2;
int s_digits
```

returns x = inv_F(p,n_1,n_2) for a given value of p ($0 < p < 1$), where inv_F is the inverse distribution function of the F distribution for n_1 and n_2 ($n_1,n_2 > 0$) degrees of freedom.
Accuracy: same as in t distribution if $n_1 = 1$ or $n_2 = 1$.
Otherwise the number of significant digits is determined by `s_digits` (2 ≤ `s_digits` ≤ 14).

* * *

lg_gamma

```
double lg_gamma(x)
double x;
```

returns the natural logarithm of the gamma function with the accuracy of the machine.

* * *

Index to SURVO 84C library functions