UNIVERSITY OF ILLINOIS

DIGITAL COMPUTER

LIBRARY ROUTINE H6 - 86

TITLE	Minimization of a Function of n Variables by Treating One Variable at a Time (DOI or SADOI)
TYPE	Closed
NUMBER OF WORDS	46
TEMPORARY STORAGE	n+1 words at S3 1 word at S4 n+1 words at S5
ACCURACY	Depends upon the condition of the function. In general the ultimate error in the position of the minimum will be less than the last mesh size used. (See description)
DURATION	Depends upon the condition of the function. In general the duration will only be a trivial amount longer than the time to compute the function $f(x_1, x_2, \ldots, x_n)$ the great number of times necessary using this crude (see description) approach.
READ AROUND	Depends upon the condition of the function and the routine used to compute it. The read around will be a little less than that of the function subroutine when used continuously.
PRESET PARAMETERS	S3 - SS

S3	00F 00 aF	Where a, a+1, ..., a+n are the addresses of $f(x_1, \ldots, x_n)$
S4	00F 00 bF	$x_1, x_2, \ldots, x_n$ on entry and exit;
S5	00F 00 cF	b is the address of δ, the current mesh size;
S6	00F 00 αJ	c, c+1, ..., c+n are working spaces;
S7	00F 00 ϵJ	α is a factor by which the mesh size is decreased;
S8	00F 00 sF	ϵ is an end constant such that only mesh sizes larger than ϵ will be used;
S9	00F 00(a+n)F	s is the address of a closed subroutine which takes x_1 from c+1(1S5), x_2 from c+2(2S5), ..., x_n from c+n(nS5) and places $f(x_1, x_2, \ldots, x_n)$ in R_1;
SK	00F 00 (2b)F	n is the number of variables.
SS	00F 00(c+n)F	

ENTRY

$x_1^o, x_2^o, \ldots, x_n^o$ the initial values of $x_1, x_2, \ldots, x_n$ are to be loaded in 1S3, 2S3,...,nS3. δ_o, the initial value of δ, is to be in R_1, and the main program should contain:

p	50 rF
	50 pF
p+1	26 qF

where q is the address of this routine and r is the address to the left hand side of which control will be transferred before every decrease in mesh size. At this address the programmer may place a routine to assess or print intermediate results. This routine should return control to the left hand side of (q+32). This can be done automatically since when control is transferred to r(L.H.) the appropriate return address will be in the right hand address position of R_2 and can be utilized by S5, 42 into a 26 at the end of the programmer's interlude routine. The best current values of $f(x_1, \ldots, x_n)$, x ,...,x_n are always in S3, 1S3,..., nS3. If it is not desired to leave this code, set $r \equiv q+32$. The routine is finally left with the best values of $f(x_1, x_2, \ldots, x_n)$, x_1, $x_2, \ldots, x_n$ in S3, 1S3, 2S3,...,nS3.

METHOD

1- The routine examines $f(x_1, \ldots, x_n)$ at $x_1 \pm \delta$ going in the decreasing direction until f is minimized as a function of x_1.

2- Step 1 is repeated for $x_2, x_3, \ldots, x_n$ in sequence.

3- We then return to x_1, then x_2, etc. until no improvement would be obtained for $x_1 \pm \delta$, $x_2 \pm \delta$,..., $x_n \pm \delta$.

4- Control is then transferred to the interlude.

5- Upon returning to the routine, the current mesh size, δ_i, is replaced by $\delta_{i+1} \equiv \alpha \delta_i$ where α is the number entered in S6 during read-in. Steps 1-4 are then repeated.

6- Steps 1-6 will be repeated (N+1) times where N is the largest integer for which $\alpha^N \delta_o > \epsilon$. ϵ is to be entered in S7 during read-in.

NOTE A function, poorly conditioned (e.g.) in having a very small gradient with respect to some argument, can deceive a method of steepest descent routine in that this coordinate of the minimum will be very poorly found. If the programmer suspects that such a condition exists, Code 85 can be used for roughing and this code, a brute force approach to the minimum by varying one argument at a time may be used for finishing. All parameters (except SK and SN), entry, and contents of storage location of this code and Code 85 are identical, so that they may be used at the same time in the machine for the above purpose.

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LOCATION	ORDER		NOTES
	00K (H6)		
0	40 S4		Store δ
	S5 32L		Link in
1	46 13L		Plant interlude address
	L4 35L		
2	42 34L		Plant link address
	L5 38L		Set transfer
3	40 4L		Orders for initial entry
	50 21I		
4	L5 F	From 43	$x_1^o, x_2^o, \ldots, x_n^o$ to 1S5,...,nS5
	40 F	By 3,6	
5	L5 4L		Advance transfer orders
	L4 35L		
6	40 4L		
	L5 39L		
7	L0 4L		Test for i = n
	26 43L		
8	L5 40L	From 31,34	
	42 13L	and 45	Set routine to process x_1
9	42 24L		
	46 15L		
10	46 25L		
	40 19L		
11	L5 13L		Close switch for complete failure with
	46 31L		given mesh size
12	L5 3L	From 30	Close switch for failure in one direction
	42 17L		
13	50 F	By 1	Interlude address
	L5 F	By 8,27 from 24	Form $x_i \pm \delta$
14	L0 S4	By 22	
	50 F		
15	40 F	By 9,28	$f(,\ldots,x_i \pm \delta ,\ldots,)$ to S5
	50 15L		
16	26 S8		
	40 S5		
17	L0 S3		f - f (before)
	32 F	By 12,23	Directional failure switch

LOCATION	ORDER		NOTES PAGE 2
18	L5 S5		Replace old values by new ones
	40 S3		
19	L5 F	By 10, 26	
	40 F		
20	L5 34L		Open mesh size
	46 31L		failure switch
21	26 23L		
	L5 42L	From 17	Replace + by - or - by +
22	L0 14L		
	40 14L		
23	L5 31L	From 21	Open directional failure switch
	42 17L		
24	22 13L	From 17	
	L5 F	By 9, 27	Replace failing values
25	40 F	By 10, 28	
	L5 19L		
26	L4 35L		
	40 19L		Advance addresses for treatment of
27	42 13L		
	42 24L		x_{i+1}
28	46 15L		
	46 25L		
29	L5 41L		Test for $i = n$
	L0 19L		
30	36 12L		
	50 L		Set up link address
31	26 F	By 11, 20	Mesh size failure switch
	00 24L		
32	50 S4		Form $\delta_{i+1} = \alpha\ \delta_i$ and test against ϵ
	7J 36L		
33	40 S4		
	L0 37L		
34	36 8L		
	22 F	By 2	Link Address
35	00 1F		
	00 1F		Advancer

LOCATION	ORDER	NOTES
36	00 F	= α
	00 S6	
37	00 F	
	00 S7	= ϵ
38	L5 1S3	Starting constant
	40 1S5	
39	L5 S9	End constant
	40 SS	
40	L5 1S5	Starting constant
	40 1S3	
41	L5 SS	
	40 S9	End constant
42	F4 SK	
	KO F	(+) + (-)
43	36 4L	
	50 43L	$f(x_1^o,\ldots,x_n^o)$ to S3
44	26 S8	
	40 S3	
45	26 8L	
	00 F	