Library Routine   H 4 - 84

TITLE:	Minimization of a Function of Four Variables (DOI or SADOI)
TYPE:	Closed subroutine with two auxiliary routines.
NUMBER OF WORDS:	75 words
DURATION:	Time depends upon function and mesh size.
PURPOSE:	To find a relative minimum of $f(x, y, z, t)$
DESCRIPTION:	Given a mesh size δ and starting values for x, y, z, and t the routine finds the minimum of $f(x, y, z, t)$. It uses a closed subroutine at S 9 to calculate f. After finding min. f it transfers control to S 8 and the programmer can supply any routine he wishes (e.g., print x, y, z, t, and min f) before transferring back to this routine. The mesh δ is then reduced to $\alpha \delta$ and the process repeats until $\alpha^N \delta < \epsilon$.
ACCURACY:	Depends upon the condition of the function.
TEMPORARY STORAGE:	15 words at S3 to 4S3, S4 to 4S4, and S5 to 4S5.
METHOD OF USE:	Enter with initial values for x, y, z, t, δ in 1S3, 2S3, 3S3, 4S3, S4 respectively. Use standard entry

p	50 pF
p + 1	26 qF

RESULT:	The values of f, x, y, z, t for the minimum at each δ are placed in S3, 1S3, 2S3, 3S3, 4S3, respectively, and control is transferred to the left side of S 8. After obtaining any desired results the programmer **must** return control to the left side of q + 69. If no intermediate results are wanted S 8 should contain 00F 00 (q + 69)F during read-in. The routine is finally left with the best values of f, x, y, z, t in S3, 1S3, 2S3, 3S3, 4S3.
PRESET PARAMETERS:	S3 00F 00 aF location of f, x, y, z, t
	S4 00F 00 bF location of δ and variants
	S5 00F 00 cF temporary storage
	S6 00F 00 cJ mesh reduction factor

S7	00F 00 eJ	lower mesh limit
S8	00F 00 rF	location of intermediate transfer out
S9	00F 00 sF	location of closed subroutine for f.

NOTES:

1. The closed subroutine at S 9 must take x from 1S5, y from 2S5, z from 3S5, and t from 4S5 and place f(x, y, z, t) in A.

2. The current mesh size is always in S4.

3. By neglecting t in the closed subroutine functions of 3 variables may be minimized. Use routine H 3 for 1 or 2 variables.

lgr

LOCATION	ORDER	NOTES
	00 K(H4)	
0	S5 F	Plant link
	L4 35L	
1	42 71L	
	L5 1S3	
2	40 1S5	x_0, t_0, y_0, z_0 to 1S5 – 4S5
	L5 2S3	
3	40 2S5	
	L5 3S3	
4	40 3S5	
	L5 4S3	
5	40 4S5	
	50 5L	$f(x_0, y_0, z_0, t_0)$ to S3
6	26 S9	
	40 S3	
7	L5 19L	Set switch for failure on first try
	42 61L	
8	L5 1S3	
	L4 S4	
9	40 1S5	$f(x + \delta, y, z, t)$
	L5 2S3	
10	40 2S5	to 1S4
	L5 3S3	
11	40 3S5	
	L5 4S3	
12	40 4S5	
	50 12L	
13	26 S9	
	40 1S4	
14	L5 1S3	
	L0 S4	
15	40 1S5	$f(x - \delta, y, z, t)$ in R_1
	50 15L	
16	26 S9	
	L0 1S4	
17	40 1S4	f_x to 1S4
	L5 1S3	

(Note: "From 61 and 71" appears beside location 7, between the ORDER and NOTES columns.)

LOCATION	ORDER	NOTES
18	40 1S5	
	L5 2S3	
19	L4 S4	
	50 S8	
20	40 2S5	
	50 20L	
21	26 S9	f_y to 2S4
	40 2S4	
22	L5 2S3	
	L0 S4	
23	40 2S5	
	50 23L	
24	26 S9	
	L0 2S4	
25	40 2S4	
	L5 2S3	
26	40 2S5	
	L5 3S3	
27	L4 S4	
	50 7L	
28	40 3S5	
	50 28L	f_z to 3S4
29	26 S9	
	40 3S4	
30	L5 3S3	
	L0 S4	
31	40 3S5	
	50 31L	
32	26 S9	
	L0 3S4	
33	40 3S4	
	L5 3S3	
34	40 3S5	
	L5 4S3	
35	L4 S4	
	50 1F	

LOCATION	ORDER	NOTES
36	40 4S5	
	50 36L	
37	26 S9	
	40 4S4	
38	L5 4S3	f_t to 4S4
	L0 S4	
39	40 4S5	
	50 39L	
40	26 S9	
	L0 4S4	
41	40 4S4	
	19 38F	
42	L6 1S4	
	L6 2S4	$\sum \left| f_i \right|$ or $1 - 2^{-39}$
43	L6 3S4	
	L6 4S4	to S5
44	36 45L	
	L5 74L	
45	40 S5	
	L5 1S4	
46	66 S5	
	7J S4	$\delta_x = \delta \dfrac{f_x}{\sum \left| f_i \right|}$ to 1S4
47	40 1S4	
	L5 2S4	
48	66 S5	
	7J S4	δ_y to 2S4
49	40 2S4	
	L5 3S4	
50	66 S5	
	7J S4	δ_z to 3S4
51	40 3S4	
	L5 4S4	δ_t to 4S4
52	66 S5	
	7J S4	
53	40 4S4	
	L5 1S3	From 68

LOCATION	ORDER		NOTES
54	L4 1S4		
	40 1S5		
55	L5 2S3		$f(x + \delta_x,\ y + \delta_y,\ z + \delta_z,\ t + \delta_t)$
	L4 2S4		
56	40 2S5		
	L5 3S3		to S5
57	L4 3S4		
	40 3S5		
58	L5 4S3		
	L4 4S4		
59	40 4S5		
	50 59L		
60	26 S9		
	40 S5		$(f - f_{before})$ in R_1
61	LO S3		
	36 ( )F	By 7 and 67	
62	L5 S5		
	40 S3		
63	L5 1S5		
	40 1S3		Replace old f and arguments by the new.
64	L5 2S5		
	40 2S3		
65	L5 3S5		
	40 3S3		
66	L5 4S5		
	40 4S3		
67	L5 27L		Set switch for failure after 1st try.
	42 61L		
68	22 53L		
	00 F		Waste
69	50 72L		
	7J S4		Form δ_{i+1} and test against ϵ
70	40 S4		
	LO 73L		
71	36 7L		
	22 ( )F	By 1	Link

LOCATION	ORDER		NOTES
72	00 F		$= \alpha$
	00 S6		
73	00 F		$= \epsilon$
	00 S7		
74	7L 4095F		$= 1 - 2^{-39}$
	LL 4095F		