TITLE — A search for the Real Roots of $f(x) = 0$ (DOI or SADOI)

TYPE — Closed

NUMBER OF WORDS — 80

TEMPORARY STORAGE — 7 to 16 inclusive

PARAMETERS — Several Program parameters must be set.

ACCURACY — Depends upon the function $f(x)$ and the error in the routine which computes it. Possible error inherent in this routine is about 2^{-38}.

DURATION — $[2 + (2.33 + 2t)n + (6 + t)ir]$ ms where t is the duration in ms of the routine which computes $f(x)$. n is the number of intervals examined for roots, i is the average number of iterative linear interpolations necessary to find a root, and r is the number of roots found.

READ AROUND — Depends upon routine used to compute $f(x)$, whose duration is denoted by t(ms). RAR adjacent to routine is $22.5/(2.33 + 2t)$ or $22.5/(6+t)$ whichever is greater. Next to the temporary store it may be 8 times as great.

DESCRIPTION — This routine is a combination of Code H1 (Inverse Interpolation), Code P2 (Decimal Fraction Print), plus orders which examine an arbitrary range of the independent variable for roots of $f(x) = 0$. In n steps of length h, the routine examines the interval $x_0 < x \le x_0 + nh$ for roots. The ith interval is regarded as $x_0 + (i-1)h < x \le x_0 + ih$. If such an interval contains an even number of roots. (e.g., 0) none will be found, if it contains an odd number of roots (e.g., 1) one will be found. This means the programmer must have sufficient information about $f(x)$ to choose x_0, n, and h compatible with both economy of time and the finding of all the roots. Multiple

roots are treated as single roots.

The routine is entered with x_0 in R_1 and the orders:

p	JO kF or 50 rF
	50 pF
p+1	26 qF
	00 nF
p+2	00 F
	00 hJ
p+3	00 aF
	-- --

where q is the address of this routine, n is the number of intervals to be examined, h is the length of an interval, and a is the address of the closed subroutine which replaces x in R_1 by f(x) in R_1. If the first parameter is JO kF, the roots will be printed with sign in a column to k decimal digits. If it is 50 rF, the roots will be stored sequentially starting at memory position r. If x_i be the roots found, then ,..., $< x_{i-1} < x_i < x_{i+1} <$,..., always. Control will be returned to the right side of p+3 after the n intervals have been examined.

NOTES

If it is never desired to print the roots, the last 18 words of this routine (62 - 79) may be overwritten. Further, if for other purposes it is desired to use Code P2 (Decimal Fraction Print), the one incorporated in this program may be utilized in the usual fashion by merely transferring control to the left hand side of the 62nd word.

lgr

LOCATION	ORDER		NOTES	PAGE 1	H 2
	00 K(H2)				
0	40 10F		Store x_0		
	S5 F		Move in link		
1	L4 61L		Plant n's address		
	42 10L				
2	L4 61L		Plant h's address		
	42 12L				
3	L4 61L		Plant call for auxiliary routine		
	42 8L		address		
4	42 16L		Plant link address		
	36 7L				
5	46 59L				
	L5 57L		Set store or print orders		
6	42 53L				
	22 8L				
7	46 55L	From 4			
	L5 54L				
8	42 53L				
	L5 (p+3)F	By 3	From 6		
9	46 18L				
	46 21L				
10	46 32L				
	L5 (p+1)F	By 1			
11	10 20F		Plant step counter		
	01 20F				
12	40 8F				
	L5 (p+2)F	By 2	h to 9		
13	40 9F				
	L4 10F		Set first interval end points		
14	40 12F				
	L5 8F	From 53, 57, 60			
15	L0 61L		Test for end		
	40 8F				
16	36 17L				

LOCATION	ORDER		NOTES
	22 (p+3)F	By 4	Link
17	L5 10F	From 16	
	50 17L		
18	26 ( )F	By 9	
	10 1F		
19	40 11F		
	L5 12F		
20	40 7F		
	50 20L		
21	26 ( )F	By 9	
	10 1F		
22	40 13F		
	L3 13F		
23	36 49L		
	50 13F		
24	75 11F		
	36 48L		
25	L5 11F	From 45	
	L0 13F		
26	40 14F		
	50 10F		
27	75 13F		
	40 16F		Search for a root
28	S1 F		
	50 12F		
29	74 11F		
	L0 16F		
30	66 14F		
	S5 F		
31	40 14F		
	50 31L		
32	26 ( )F	By 10	
	10 1F		
33	40 15F		

LOCATION	ORDER		NOTES
	L3 15F		
34	36 47L		
	L5 10F		
35	L0 12F		
	40 16F		
36	51 22L		
	00 2F		
37	L2 16F		
	36 47L		
38	50 15F		
	75 11F		
39	32 41L		
	L5 11F		
40	10 1F		
	40 11F		
41	22 43L		
	L5 12F	From 39	
42	40 10F		
	L5 13F		
43	40 11F		
	L5 14F	From 41	
44	40 12F		
	L5 15F		
45	40 13F		
	26 25L		
46	80 F		
	00 F		= -1
47	L5 14F	From 34,37	
	22 49L		
48	L5 46L	From 24	
	22 49L		
49	L5 12F	From 23	
	40 16F		Result in 16

LOCATION	ORDER		NOTES
50	L5 7F		
	40 10F		Advance test interval
51	L4 9F		
	40 12F		
52	L7 16F		Test result, if < 0 repeat
	32 53L		
53	22 14L		
	26 ( )F	By 6, 8	From 50
54	L5 16F	From 53	Store root and advance address of
	50 54L		store order
55	40 ( )F	By 7	
	L5 55L		
56	L4 28L		
	46 55L		
57	22 14L		
	00 58L		
58	92 129F	From 53	
	L5 16F		Line feed and print root
59	50 ( )F	By 5	
	50 59L		
60	26 62L		
	22 14L		
61	00 F		
	00 1F		Unit of count
62-79			Code P2, Decimal Fraction Print