TITLE:	Eigenvalues and Eigenvectors of a Symmetric Matrix (SADOI Only)
TYPE:	Complete program
NUMBER OF WORDS:	$176 + (R\ 1) + (N\ 12) + (P\ 16) = 280$
TEMPORARY STORAGE:	0 - 30
DURATION:	Approximately $5n^3$ milliseconds per iteration
PARAMETERS:	Four Parameters must be read in before the main routine and the matrix are read in.

S3: 00F 00gF   where $1 \leq g \leq 12$ is the number of decimal digits to be printed.

S4: 00F 00nF   where n = order of matrix.

S5: 00F 00mF   where m = 2n if eigenvalues and eigenvectors both are desired; otherwise m = n.

S6: 00F 00$(311 + n(n+1)/2)$F

SYMBOLIC ADDRESSES USED: (M26); (1); (2); (3); (4).

LIBRARY ROUTINES USED: (P16); (N12); (R1).

LIMITATIONS: If eigenvalues only are desired then n, the order of the matrix, must be ≤ 37. If eigenvectors are desired as well then $n \leq 21$.

SCALING: The elements of the matrix should be scaled so that

$$\sum_{k=1}^{n} \sum_{j=1}^{n} a_{jk}^2 < \frac{1}{2}.$$

The eigenvalues and eigenvectors will be scaled by the same factor. However, in order to prevent overflow the eigenvectors are actually scaled down by an additional factor of 10^{-1}.

METHOD OF USE:
1. Parameters must be read in first.
2. Read in Program tape; machine will stop on a $24(10J)_{SD}$.
3. Insert matrix tape in reader, the elements of the matrix being punched as signed decimal fractions, i.e., as + or - followed by up to 12 decimal digits. As only

half the off diagonal elements are needed (because of symmetry), the user need punch only a_{11}; a_{21}, a_{22}; a_{31}, a_{32}, a_{33}; etc.

i.e., we punch only

$$\begin{pmatrix} a_{11} & & & & \\ a_{21} & a_{22} & & & \\ a_{31} & a_{32} & a_{33} & & \\ \vdots & & \vdots & \ddots & \\ a_{n1} & \cdots\cdots\cdots\cdots & a_{nn} \end{pmatrix}$$

Following a_{nn} an N terminating symbol must be punched. Start with black switch.

If there has been an arithmetic failure then two F's will be punched out and the machine will come to an OF stop at location $(OLK)_{SD}$. If the user, nevertheless, wishes to continue the computations he may do so by raising and lowering the white switch.

OUTPUT FORMAT:

If there has been no arithmetic failure then the first thing punched out will be an integer - the number of iterations required for convergence. This will be followed by the column of eigenvalues. The machine will then come to a 34 stop at $(121)_{SD}$. If eigenvectors are also desired then a black switch start will cause the eigenvectors to be punched as n columns of n components each (the eigenvectors being separated from one another by an extra line feed and carriage return). The machine will then come to an OF stop at $(132)_{SD}$.

For a complete description of the mathematical method see the write-up of M25.

DATE May 6, 1959

PROGRAMMED BY W. a. Ramsler II

APPROVED BY J. N. Snyder

1r

LOCATION	ORDER	NOTES	
	00 22K		
0	00 1F		
	00 1F		
1	00 S4		
	00 S4		
2	00 (4)		
	00 (4)		
3	80 S5		
	00 S5		
4	20 F		
	00 F		
5	00 F		
	00 F		
6	40 F		
	00 F		
7	00 F		
	00 F		
8	J0 S6		
	74 S6		
(M2)	00 K		
(F16)	00 K		
(R1)	00 K		
	00 K(M26)		
0	F5 27F		
	40 27F		
1	41 20F		
	41 21F		
2	41 4F		
	41 5F		
3	L5 4F		
	L4 22F		
4	40 4F		
	L0 23F		
5	32 100L		
	50 5F		

LOCATION	ORDER			NOTES
6	L5 5F			
	74 5F			
7	00 38F			
	42 29F			
8	00 20F			
	46 29F			
9	L5 29F			
	L4 24F			
10	46 130L			
	L4 5F			
11	42 29L			
	46 94L			
12	42 95L			
	50 4F			
13	L5 4F			
	74 4F			
14	00 38F			
	42 29F			
15	00 20F			
	46 29F			
16	L5 29F			
	L4 24F			
17	42 130L			
	L4 4F			
18	46 96L			
	42 28L			
19	L0 4F			
	74 5F			
20	42 21L			
	42 22L			
21	42 96L			
	I			
22	36 97L			
	L5 F			
23	40 7F			
	L5 2 F			

LOCATION	ORDER	NOTES		
24	50 7F			
	74 7F			
25	L4 20F			
	40 20F			
26	S5 F			
	40 21F			
27	L5 7F			
	00 1F			
28	40 7F			
	L5 F			
29	40 9F			
	L5 F			
30	40 8F			
	L0 9F			
31	40 10F			
	L7 7F			
32	L2 10F			
	50 19F			
33	36 37L			
	L5 7F			
34	66 10F			
	S5 F			
35	10 1F			
	40 11F			
36	L5 26F			
	26 40L			
37	L5 10F			
	66 7F			
38	S5 F			
	10 1F			
39	40 11F			
	26 124L			
40	40 12F			
	50 11F			
41	75 11F			
	L4 26F			

LOCATION	ORDER	NOTES
42	40 1F	
	S5 F	
43	40 F	
	50 43L	
44	22 (R1)	
	40 14F	
45	L3 12F	
	50 19F	
46	66 14F	
	S1 F	
47	40 13F	
	22 118L	
48	40 1F	
	41 F	
49	22 49L	
	50 49L	
50	22 (R1)	
	L5 12F	
51	L0 26F	
	32 56L	
52	L5 12F	
	36 54L	
53	L1 26F	
	22 54L	
54	L5 26F	
	50 19F	
55	66 14F	
	S5 F	
56	22 58L	
	19 1F	
57	50 11F	
	74 13F	
58	00 1F	
	40 14F	
59	66 2F	
	S5 F	

LOCATION	ORDER	NOTES
60	40 3F	
	41 11F	
61	27 70L	
	L5 11F	
62	L0 23F	
	36 100L	
63	L4 23F	
	40 131L	
64	L5 5F	
	L0 11F	
65	32 67L	
	L5 4F	
66	L0 11F	
	32 68L	
67	22 69L	
	L5 22F	
68	46 131L	
	L5 22F	
69	42 131L	
	L5 131L	
70	L4 130L	
	40 130L	
71	46 74L	
	46 78L	
72	46 83L	
	42 76L	
73	42 80L	
	42 81L	
74	50 F	
	73 2F	
75	40 10F	
	S5 F	
76	50 3F	
	74 F	
77	L4 10F	
	40 F	

LOCATION	ORDER	NOTES
78	50 F	
	79 3F	
79	40 10F	
	S5 F	
80	50 2F	
	74 F	
81	L4 10F	
	40 F	
82	22 82L	
	L5 F	
83	40 F	
	L5 11F	
84	L4 22F	
	40 11F	
85	L0 25F	
	32 61L	
86	LJ 13F	
	40 F	
87	L9 13F	
	40 1F	
88	50 7F	
	7J 14F	
89	40 10F	
	S5 F	
90	50 8F	
	74 F	
91	L4 10F	
	40 10F	
92	S5 F	
	50 9F	
93	74 1F	
	L4 10F	
94	40 F	
	L5 8F	
95	L4 9F	
	L0 F	

LOCATION	ORDER		NOTES		
96	40 F				
	41 F				
97	L5 5F				
	L4 22F				
98	40 5F				
	L0 4F				
99	32 2L				
	22 5L				
100	27 63L				
	41 15F				
101	41 16F				
	L5 24F				
102	42 104L				
	46 104L				
103	22 103L				
	L5 16F				
104	50 F				
	74 F				
105	L4 15F				
	40 15F				
106	S5 F				
	40 16F				
107	L5 104L				
	L4 22F				
108	40 104L				
	L0 30F				
109	32 103L				
	L5 18F				
110	L0 16F				
	L0 39F				
111	L4 17F				
	L0 15F				
112	36 (2)				
	L5 128L				
113	26 126L				
	19 34F				

LOCATION	ORDER	NOTES	
114	L2 F		
	36 116L		
115	92 904F		
	OF F		
116	L5 15F		
	40 17F		
117	L5 16F		
	40 18F		
118	26 L		
	L5 13F		
119	L0 123L		
	36 121L		
120	LJ 13F		
	26 48L		
121	LJ 123L		
	40 2F		
122	22 50L		
	00 F		
123	3L 4095F		
	LL 4095F		
124	F5 11F		
	10 1F		
125	26 40L		
	00 F		
126	40 112L		
	L5 129L		
127	40 113L		
	26 116L		
128	36 (2)		
	L4 20F		
129	40 F		
	19 34F		
130	00 F		
	00 F		
131	00 F		
	00 F		

LOCATION	ORDER	NOTES
132	00 F	
	00 (3)	
133	00 F	
	00 F	
	00 K(1)	
0	50 (4)	
	50 L	
1	26 (N12)	
	L5 21(N12)	
2	10 20F	
	42 133(M26)	
3	42 6L	
	42 12(2)	
4	L5 4F	
	L0 5F	
5	36 (M26)	
	26 6L	
6	L5 28F	
	40 F	
7	L5 6L	
	L4 13L	
8	40 6L	
	F5 12L	
9	40 12L	
	L0 11L	
10	36 6L	
	26 (M26)	
11	80 F	
	00 S4	
12	00 F	
	00 F	
13	00 F	
	00 1S4	
	00 K(2)	
0	22 L	
	L5 27F	

LOCATION	ORDER		NOTES	
1	52 3F			
	50 1L			
2	26 (P16)			
	92 131F			
3	92 515F			
	F5 19F			
4	40 19F			
	L4 132(M26)			
5	40 132(M26)			
	42 7L			
6	L0 133(M26)			
	34 10L			
7	22 7L			
	L5 F			
8	50 S3			
	50 8L			
9	26 (P16)			
	22 2L			
10	92 135F			
	92 515F			
11	F5 12L			
	40 24L			
12	50 25L			
	7J F			
13	50 S3			
	50 13L			
14	26 (P16)			
	92 131F			
15	92 515F			
	L5 12L			
16	L4 12(1)			
	40 12L			
17	F5 27L			
	40 27L			
18	L0 12(1)			
	32 19L			

LOCATION	ORDER
19	26 12L
	L5 24L
20	40 12L
	41 27L
21	F5 26L
	40 26L
22	LO 12(1)
	32 23L
23	26 10L
	OF F
24	00 F
	00 F
25	00 F
	00 2000 0000 0000J
26	00 F
	00 F
27 (3)	00 F
	00 F
	00 K(4)
	2. (1)
	26 1N