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KSL 1.90 - 288

TITLE: Oblimax Rotation of Factors

TYPE: Entire program

SYMBOLS:
d - decimal places in results
v - number of variables
f - number of factors
x - printing directive

CAPACITY: The printing directive, X, can be any value from zero through 15 (See section on OPTIONS SPECIFIED BY THE DIRECTIVE, X).

For any X, the limits are:

$d \leq 12; \quad v \leq 128; \quad f \leq 40.$

If X = 4, 5, 6, 7, 12, 13, 14, or 15, the following additional restrictions apply:

$f \leq 20; \quad v + 4f \leq 166.$

METHOD OF USE:

A. Initial machine run	Stops
1. Master tape	2407J
2. Parameter tape	240F0
3. Factor tape, run with bl. down	OF

If the black switch is placed in mid-position, the machine will stop at 34092 at the end of each iteration. If the process has not converged, but the allotted time has run out, intermediate results can be obtained at 34092 by moving the white switch up and down. The problem can be finished subsequently using Alternative B.

To read another parameter tape to begin a new problem at stop OF, move the white switch up and down.

<u>B. Subsequent machine run with a transform</u>

1. Master tape 2407J
2. Parameter tape 240F0
3. Transform tape, move wh. sw. up and down 340L8
4. Factor tape, run with bl. down 0F

Alternative B need not be a subsequent machine run. If by some other means, a transform and reference vector structure are available, the amount of time required will be reduced depending upon how close the transform is to the one calculated by this routine.

PUNCHING OF THE RESULTS:

Each section is labeled with an appropriate heading. The first section consists of successive criterion values, one after each iteration. (See Note 2) What follows depends upon the value of the printing directive, X. The results will consist of all or part of the following:

T — Transformation matrix ($V_o T = V_r$; V_o is the factor matrix to be transformed). T will be punched either by rows or by columns depending upon X. The elements of T are punched as signed fractions scaled by 10^{-1} with an N symbol at the end of each row or column.

V_r — Reference vector structure. V_r will be punched by rows or by columns depending upon X. The elements of V_r are punched as signed fractions scaled by 10^{-1} with an N symbol at the end of each row or column and a J at the end of the matrix.

C_r — Reference vector correlations ($T'T = C_r$). C_r is symmetric and is punched in triangular form by rows. Each element is a signed fraction scaled by 10^{-1}.

C_f Primary factor correlations ($D\ C_r^{-1}\ D = C_f$). C_f is punched in triangular form by rows with each element a signed fraction scaled by 10^{-1}.

V_f Primary factor pattern ($V_o TD^{-1} = V_f$). V_f is punched by rows with an N symbol at the end of each row and a J at the end of the matrix. The elements are signed fractions scaled by 10^{-1}.

D A diagonal matrix of the reciprocals of the square roots of the diagonal elements of C_r^{-1}. D is punched as a column with the zeros omitted. An NJ is punched at the end of the column. The elements are unscaled.

D^{-1} Inverse of the diagonal matrix, D. The diagonal elements only are punched in a column with an NJ at the end of the column. Decimal points indicate the scaling.

THE TRANSFORM TAPE: If alternative B which requires a transformation is used, the transform must be punched by columns with an N at the end of each column. The elements must be punched as signed fractions scaled by 10^{-1}. In addition the transform must be consistent with V_o and V_r such that $V_o T = V_r$.

THE FACTOR TAPE: The set of factors to be rotated to oblique simple structure by this routine must be punched by columns with an N symbol at the end of each column. The elements must be punched as signed fractions scaled by 10^{-1}.

THE PARAMETER TAPE: The parameter tape consists of four unsigned integers (representing the number of decimal places, the number of variables, the number of factors, and the directive) separated by fifth-hole characters and punched in the following order:

d space v space f space X space.

The options in the results are specified by the value of X which is explained in the next section.

OPTIONS SPECIFIED BY THE DIRECTIVE, X:

X	Output will be:
0	Criterion values only.
1	T and V_r by columns. T and V_r are required by columns if the problem is to be continued subsequently using Alternative B.
2	T and V_r by rows.
3	T and V_r by both rows and columns.
4	C_r, C_f, V_f, D^{-1}, and D.
5	T and V_r by columns; C_r, C_f, V_f, D^{-1}, and D.
6	T and V_r by rows; C_r, C_f, V_f, D^{-1}, and D
7	T and V_r by both rows and columns; C_r, C_f, V_f, D^{-1}, and D.

If the values of X given above are increased by 8, the oblimax rotation process will be suppressed. Thus, if a transform, T^*, and a reference vector structure, V_r^*, are formed by some other rotation procedure, the oblimax routine can still be used to form C_r^*, C_f^*, V_f^*, D^{*-1}, and D^*. For example:

X	Output will be:
14	T^* and V_r^* by rows; C_r^*, C_f^*, V_f^*, D^{*-1}, and D^*.

THE OBLIMAX PROCEDURE: This routine transforms a set of factor vectors, g_j, to a new set, h_j, such that the function,

$$K = \frac{\Sigma\Sigma h_{ij}^4}{(\Sigma\Sigma h_{ij}^2)^2} \qquad \begin{array}{l} i = 1, 2, \ldots. v \\ j = 1, 2, \ldots. f \end{array}$$

is maximized. The purpose of this transformation is to attempt analytically to rotate the factors such that they satisfy the subjective criteria for simple structure of L. L. Thurstone. (See Multiple Factor Analysis, pp. 319-410, 1947)

The user of this routine is cautioned not to accept the results blindly, for they do not satisfy Thurstone's criteria exactly. There are occasions, moreover, when the routine fails to rotate some few of the vectors. (See Note 3)

It would be elegant to solve directly for the transformation, T, but unfortunately no solution to this problem has been found. Instead oblimax takes two vectors at a time, solves for the rotational angles, transforms these vectors, and then selects another pair until all f(f - 1) pairs have been rotated. This is called one iteration. This process is repeated iteratively until the criterion function, K, no longer increases.

It should be pointed out that maximizing all possible pairs is not the same operation as maximizing the criterion, K. For example, it is possible for a particular vector to be shifted in one direction by one pairing and to be shifted back with another pairing. It is also possible that K will become smaller as a result of a particular iteration. In general, however, the criterion K is well behaved and approaches steadily to a maximum.

For any pair of vectors, say a_i and b_i, the solution is as follows:

$$K_{ab} = \frac{\Sigma\,\Sigma(a_i\cos\phi_j + b_i\sin\phi_j)^4}{[\Sigma\,\Sigma(a_i\cos\phi_j + b_i\sin\phi_j)^2]^2} \qquad \begin{array}{l} i = 1, 2, \ldots v \\ j = 1, 2. \end{array}$$

$$= \frac{\Sigma\,\Sigma(a_i + b_i X_j)^4}{[\Sigma\,\Sigma(a_i + b_i X_j)^2]^2}$$ X_j are tangents of the rotational angles.

If the derivative of K_{ab} is set equal to zero, this results in a quartic equation in X with the following coefficients:

X^4: $\Sigma\, ab\, \Sigma\, b^4 - \Sigma\, b^2\, \Sigma\, ab^3$

X^3: $\Sigma\, a^2\, \Sigma\, b^4 + 2\Sigma\, ab\, \Sigma\, ab^3 - 3\Sigma\, b^2\, \Sigma\, a^2b^2$

X^2: $3\Sigma\, a^2\, \Sigma\, ab^3 - 3\Sigma\, b^2\, \Sigma\, a^3b$

X^1: $3\Sigma\, a^2\, \Sigma\, a^2b^2 - 2\Sigma\, ab\Sigma\, a^3b - \Sigma\, b^2\, \Sigma\, a^4$

X^0: $\Sigma\, a^2\, \Sigma\, a^3b - \Sigma\, ab\, \Sigma\, a^4$

The four solutions to the quartic equation are tangents, two of which will maximize K_{ab}. When a value for X is found, the sign of the second derivative of K_{ab} is inspected to determine if the particular X is a maximum or a minimum. After two maxima are found, the routine forms a small transform (2 x 2). This transform must first be adjusted so that the columns of T, t_a and t_b, will remain normalized. This effectively converts the tangent transform back to a sine-cosine transform, and then the post-multiplication of the columns of T and the vector pair is performed.

The range of values for X, the solutions to the quartic equation, is from negative infinity to positive infinity. In fact, near the end of the process when some pairs have become maximized and no further movement is expected, the solutions are: -1, 0, +1, and infinity. The two maxima are zero and infinity. After normalization, this results in an identity matrix. To circumvent this scaling difficulty, there are two complete quartic solutions -- one for the tangents, X, and one for the cotangents, 1/X. Whenever the value for X begins to converge to a value greater than +1 or less than -1, the routine jumps to the other section.

It is not at all unusual for the routine to fail to find two maxima for a particular pair of vectors. When this happens, quite often a solution in the next iteration will be found, for in the meantime each vector has been changed by being paired with (f - 1) other vectors. Failures occur most often in the earlier iterations. Usually all of the vector pairs have been maximized many times by the time the criterion has reached a maximum. (See Note 3)

DURATION:

1. Read master tape: 120 sec.
2. Read data tapes: v f (.009 + .004 d) sec.
3. Approximate calculation time per iteration:
   f^2 (.230 + .007 f + .010 v) sec.
4. Printing time when X = 5 or 6:
   [5 f + .354 f^2 + .012 f^3 + .033 d (f^2 + v f)] sec.

There is no simple way to estimate the number of iterations, i, for this routine to converge. In general, i will vary from less than f to more than 3 f. For short problems, this lack of precision in time estimation will cause no concern.

For the larger problems where v and especially f are large, it is suggested that the problem be run for a definite amount of time (fixed number of iterations). If the problem has not converged, it can be interrupted (See Method of Use) and resumed on a subsequent machine run. To use Alternative B, both T and V_r are required by columns. The directive, X, should hence be an odd number.

NOTE 1: A stop on FF014 after reading the master tape indicates a sum check failure. Clear the machine and try rereading the master tape.

NOTE 2: The criterion values are unscaled. If a succeeding K value differs from the previous one by less than .0000005, the criterion function is considered to be maximized.

NOTE 3: In between successive K values a record is kept of the successes and failures in finding two maxima. A two-hole delay indicates a success and a figure shift indicates a failure. A figure shift in the same place in the sequence after each iteration indicates that a particular factor pair is never maximized. In general the figure shifts disappear in the later iterations.

NOTE 4: A stop on FF00S indicates the C_r matrix is singular. Unless some peculiar error occurs such as reading the same factor twice as part of the V_o matrix, this kind of stop should never occur.

NOTE 5: If X = 4, 5, 6, 7, 12, 13, 14, or 15, the limit on the number of factors, f, must be less than 21. A stop on FF015 indicates the limit has been exceeded. The results that have been punched on tape are correct. To begin a new problem, raise the white switch up and down.

NOTE 6: In the special case where f = 2, only 1 iteration is required for the routine to converge.

DATE February 16, 1960
PROGRAMMED BY J. W. Dickman
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ns

LOCATION Abs.	Rel.	Sym.	ORDER		NOTES PAGE 1 1.90
			006K		
6		(D)	00F 00F	by Set I	decimal places
7		(V)	00F 00F		variables
8		(F)	00F 00F		factors
9		(P)	00F 00F		directive
10		(N)	00F 00F		V + F = N
11		(A)	00691F 00691F		location of vector a
12		(B)	00857F 00857F		location of vector b
13		(DR)	8511F 004000F		drum order for store of data
14		(DS)	8611F 004000F		
15		(0)	00F 00F		
16		(AV)	00F 00F	by 171	(AV) = A + F
17		(BV)	00F 00F	by 173	(BV) = B + F
18		(1/V)	00F 00F	by 168	1/V
19		(10)	00F 0010F		
20		(193)	00F 00193F		(193) increment between vectors on drum
21		(1)	00F 00F		
22		(2)	00F 00F		
23		(3)	00F 00F		
24		(4)	00F 00F		
25		(5)	00F 00F		
26		(6)	00F 00F		
27		(7)	00F 00F		
28		(8)	00F 00F		
29		(P16)	00K		Print routine (P.16)
85		(Y1)	00K		Routine (Y 1)
			00K		
125	0	(M1)	50140F 50L	from final	Drum Set I: read parameters,
	1		26(Y1) 002560F	interlude	generate I, read factors
	2		00134F 26140F		
			00K		
128	0	(M2)	50140F 50L	from 20(N5)	Drum Set II: Main oblimax
	1		26(Y1) 002700F	in Set I	routine

LOCATION			ORDER	NOTES	PAGE 2 1.90
Abs.	Rel.	Sym.			
	2		00550F 26140F		
			00K		
131	0	(M3)	50140F 50L	from 145F	Drum Set III: Print T, V_r, C_r
	1		26(Y1) 003260F	in Set II	
	2		00230F 26140F		
			00K		
134	0	(M4)	50140F 50L	from 15(P12)	Drum Set IV: Form C_r^{-1}
	1		26(Y1) 003500F	in Set III	
	2		00160F 26140F		
			00K		
137	0	(M5)	50140F 50L	from 148F	Drum Set V: Print C_f, V_f
	1		26(Y1) 003670F	in Set IV	D, D^{-1}
	2		00210F 26140F		
			00140K		
140	0		193F 401F	from 2(M1)	Drum Set I
			L510L 426L		
			41F 814F		Read parameters:
			50F 74(10)		D, V, F, X
			S5F 40F		
			914F 363L		
			L5F 40F		
			F56L 426L		
			L51F 001F		
			401F 362L		
	10		961F 006F		Print title:
			92135F 9259F		
			92135F 92259F		
			92578F 92195F		OBLIMAX ROTATION
			92962F 92514F		
			92643F 92387F		
			92451F 92961F		
			92258F 92578F		
			92322F 92387F		

LOCATION Abs.	Rel.	Sym.	ORDER	NOTES	PAGE 3 1.90
			92322F 92514F		
160	20		92578F 92770F		
			92135F 92707F		
			9259F 92135F		
			415F L5(V)		V + F = N
			L4(F) 40(N)		
			50(0) L5(V)		
			0020F 40F		
			1918F 66F		
			S5F 40(1/V)		1/V
			L5(A) 46(N4)		
	30		465(N5) L4(F)		Set store orders
			42(AV) 428(N2)		
			L5(B) L4(F)		
			42(BV) 50(0)		Stop: 240F0/260L0
	34		24(N3) 26(N4)		Raise bl. sw. to generate I Move wh. sw. up and down to read T.
			00K		
175	0	(N2)	K5F 427L	from 12(N3), 5(N4)	
			L5(A) 422L	7(N5)	
			001F L5F		
			00F 00F		Subroutine to store vectors
			F53L 403L		on drum
			F52L 422L		
			L08L 322L		
			001F 22F		
			801F L5F	by 171,1(N5)	
	9		00F 00 1000 0000 0000J		
185		(N12)	00K		Input subroutine (N12)
			00K		
224	0	(N3)	L5(A) 424L	from 174	Generate I x 10^{-1} and store
			414F L55F		on drum
			L04F 40F		
			L3F 3615L		

LOCATION Abs.	Rel.	Sym.	ORDER	NOTES	
			41F 40F		
			F54L 424L		
			F54F 424F		
			L0(F) 328L		
			221L 505F		
			75(193) S5F		
	10		L4(DS) 403(N2)		
			50(0) 5011L		
			26(N2) F55F		
			425F L0(F)		
			36(N5) 26L		
	15		L59(N2) 224L		
			00K		
240	0	(N4)	50F 50L	from 174	Read T x 10^{-1} by columns
			26(N12) 50(5)		and store on drum
			75(193) S5F		
			L4(DS) 403(N2)		
			50(0) 504L		
			26(N2) F55F		
			425F L0(F)		
	7		34(N5) 22L		Stop: 340L8
			00K		
248	0	(N5)	415F L5(A)	from 14(N3),7(N4)	Read F x 10^{-1} by columns
			L4(V) 428(N2)		and store on drum
			505F 75(193)		
			S5F L4(F)		
			L4(DS) 403(N2)		
			50F 505L		
			26(N12) 506L		
			26(N2) F55F		
			425F L0(F)		
			3610L 262L		
	10		L5(P) 103F		
			50(0) 101F		

LOCATION			ORDER		NOTES PAGE 5 1.90
Abs.	Rel.	Sym.			
			S3F 50(0)		
			3614L 26(M3)		Test directive: if X $\geq$ 8, skip to
			92259F 92835F		drum Set III
			92258F 92514F		Print: CRITERION
			92322F 92194F		
			92258F 92514F		
			92578F 92770F		
			92707F 92135F		
268	20		26(M2) 00F		
			00850K		
850	0		L5F 404L		Interlude to put Set I
			J0140F 501L		on drum
			26(Y1) 002560F		
			00134F 26999F		
			26850N		
			00140K		
140	0		L5(AV) L4(V)	from 2(M2)	Drum Set II
	1		42(C2) 421(C2)		
	2		41(K2) 502L		Test criterion
	3		26(C3) L5(K1)		
	4		L0(K2) L0(TK)		
	5		346L 26(M3)		Stop: 34092
	6		L5(K1) 40(K2)		Bl. sw. for iteration;
	7		50(0) 507L		Move wh. sw. up and down
	8		26(C4) 222L		for output.
			00K		
149	0	(C2)	N0F 40F	by 141	
	1		J03L 75F		
	2		00F 002F		
	3		00F 00 6250 0000 0000J	10' x 2^{-4}	
			00K		
153	0	(K1)	00F 00F		K_{i+1}
		(K2)	00F 00F		K_i

LOCATION			ORDER		NOTES
Abs.	Rel.	Sym.			
		(I)	00F 00F		
		(J)	00F 00F		
		(AD)	00F 00F		
		(IS)	00F 00F		
		(JS)	00F 00F		
		(A4)	00F 00F		Quartic coefficients:
		(A3)	00F 00F		(A4), (A3), (A2), (A1), (A0)
		(A2)	00F 00F		
		(A1)	00F 00F		
		(A0)	00F 00F		
		(R)	00F 00F		(R) tally maxima
		(T1)	00F 00F		
		(T2)	00F 00F		
		(T3)	00F 00F		Transform
		(T4)	00F 00F		
		(1/2)	40F 00F		
		(B0)	00F 00F		Quartic coefficients:
		(B1)	00F 00F		(B4), (B3), (B2), (B1), (B0)
		(B2)	00F 00F		
		(B3)	00F 00F		
		(B4)	00F 00F		
		(B5)	00F 00F		
		(B6)	00F 00F		Cubic coefficients:
		(B7)	00F 00F		(B8), (B7), (B6), (B5)
		(B8)	00F 00F		
		(B9)	00F 00F		
		(B10)	00F 00F		Quadratic coefficients:
		(B11)	00F 00F		(B11), (B10), (B9)
		(B12)	00F 00F		
		(B13)	00F 00F		Linear coefficients: (B13),(B12)
		(R2)	00F 00 0000 3906 2500J	10^{-2}	x 2^{-8}
		(TR1)	00F 0020F		trials per set
		(TR2)	00F 0010F		Sets
		(TK)	00F 00 0000 0050 0000J		Tolerance on criterion

LOCATION			ORDER		NOTES PAGE 7 1.90
Abs.	Rel.	Sym.			
189		(TX)	00F 00 0000 0000 1000J		Tolerance on root
			00K		
190	0	(C3)	K5F 4235L	from 143	Evaluate and print criterion, K
			41(I) 41(2)		
			41(3) 50(I)		
			75(193) S5F		
			L4(F) L4(DR)		
			407L L5(AV)		
			428L 4213L		
			00F 00F		f x 10^{-1} at (AV)
			40F 40F		
			F57L 407L		
	10		F58L 428L		
			L0(C2) 367L		
			414F 415F		
			503(C2) 75F		
			002F 40F		
			50F 75F		
			401F 104F		
			L44F 404F		
			501F 751F		
			L45F 405F		
210	20		F513L 4213L		
			L01(C2) 3613L		
			504F 75(1/V)		
			004F L4(2)		
			40(2) 505F		
			75(1/V) L4(3)		
			40(3) F5(I)		
			42(I) L0(F)		
			3629L 222L		
			50(2) 75(2)		
	30		40(4) 50(3)		
			75(1/V) 66(4)		

LOCATION Abs.	Rel.	Sym.	ORDER	NOTES	PAGE 8 1.90
			S5F 40(K1)		
			5010F 5033L		Print $K = \frac{\Sigma \Sigma f_{ij}^4}{[\Sigma \Sigma f_{ij}^2]^2}$
			26(P16) 92131F		
	35		50(0) 22F		
			00K		
226	0	(DRD)	K5F 4211L	from 5(C4),8(C4)	Subroutine to read vector i from drum
			L5(AD) 427L		
			L4(N) 4212L		
			50(0) 50(I)		
			75(193) S5F		
			L4(DR) 406L		$f_{ij} \times 10^{-1}$
			00F 00F		
			40F 40F		
			F56L 406L		
			F57L 427L		
	10		L012L 366L		
			50(0) 22F		
238	12		N0F 40F		
			00K		
239	0	(DRS)	K5F 4210L	from 10(C4)	Subroutine to store vector i on drum
			L5(AD) 425L	16(C4)	
			14(N) 4211L		
			50(I) 75(193)		
			S5F L4(DS)		
			406L L5F		
			00F 00F		store $f_{ij} \times 10^{-1}$
			F56L 406L		
			F55L 425L		
			L011L 325L		
	10		50(0) 22F		
	11		N06L L5F		
			00K		
251	0	(C4)	K5F 4218L	from 148	Select column pairs
			41(IS) F5(IS)		

LOCATION			ORDER	NOTES	PAGE 9 1.90
Abs.	Rel.	Sym.			
			40(JS) L5(IS)		
			40(I) L5(A)		
			40(AD) 504L		
			26(DRD) L5(JS)		
			40(I) L5(B)		
			40(AD) 507L		
			26(DRD) 50(0)		
			26(C5) 509L	from 56(TRM)	
	10		26(DRS) F5(JS)	from 88(C5), 6(VT), 9(LT)	
			42(JS) L0(F)		
			3213L 225L		
			00F L5(IS)		
			40(I) L5(A)		
			40(AD) 5015L		
			26(DRS) F5(IS)		
			42(IS) F4(0)		
			L0(F) 32F		
	19		221L 00F		
			00K		
271	0	(C5)	L5(AV) 426L	from 9(C4)	Form quartic coefficients
			L5(BV) 428L		
			415F 41(1)		
			41(2) 41(3)		
			41(4) 41(5)		
			41(6) 41(7)		t.s. 0: $a \times 2^{-2}$
			41(8) 50F		1: $b \times 2^{-2}$
			75(10) 0037F		2: $a^2 \times 2^{-4}$
			40F 50F		3: $b^2 \times 2^{-4}$
			75(10) 0037F		4: $ab \times 2^{-4}$
	10		401F 50F		5: tally
			75F 402F		
			501F 751F		
			403F 50F		
			751F 404F		

LOCATION			ORDER	NOTES	PAGE 10	1.90
Abs.	Rel.	Sym.				
			F56L 426L			
			F58L 428L			
			L52F 103F			
			L4(1) 40(1)			
290	19		L53F 103F			
291	20		L4(2) 40(2)	t.s.	(1) $\Sigma\, a^2$	
			L54F 103F		(2) $\Sigma\, b^2$	
			L4(3) 40(3)		(3) $\Sigma\, ab$	
			504F 754F		(4) $\Sigma\, a^2b^2$	$\times\, 2^{-7}$
			001F L4(4)		(5) $\Sigma\, a^3b$	
			40(4) 502F		(6) $\Sigma\, ab^3$	
			754F 001F		(7) $\Sigma\, a^4$	
			L4(5) 40(5)		(8) $\Sigma\, b^4$	
			503F 754F			
			001F L4(6)			
	30		40(6) 502F			
			752F 001F			
			L4(7) 40(7)			
			503F 753F			
			001F L4(8)			
			40(8) F55F			
			425F L0(V)			
			3638L 226L			
			50(1) 75(1/V)			
			007F 40(1)			
311	40		50(2) 75(1/V)			
			007F 40(2)			
			50(3) 75(1/V)			
			007F 40(3)			
			50(8) 75(3)			
			003F 40F			
			50(6) 71(2)			
			003F L4F			
			40(A4) 40(B4)	$A_4 = [\Sigma\, ab\, \Sigma\, b^4 - \Sigma\, b^2\, \Sigma\, ab^3] \times 1/V \times 2^{-4}$		

LOCATION Abs.	Rel.	Sym.	ORDER	NOTES PAGE 11 1.90
			50(8) 75(1)	
	50		003F 40F	
			50(6) 75(3)	
			004F 401F	
			50(4) 71(2)	
			003F 402F	
			001F L42F	
			L41F L4F	
			40(A3) 40(B3)	
			50(6) 75(1)	$A_3=[\Sigma a^2 \Sigma b^4+2\Sigma ab \Sigma ab^3-3\Sigma b^2\Sigma a^2b^2]$
			003F 40F	$\times 1/V \times 2^{-4}$
331	60		50(5) 71(2)	
			003F L4F	
			401F 001F	
			L41F 40(A2)	$A_2=3[\Sigma ab^3 \Sigma a^2-\Sigma a^3b \Sigma b^2] \times 1/V \times 2^{-4}$
			40(B2) 50(4)	
			75(1) 003F	
			401F 001F	
			L41F 402F	
			50(5) 71(3)	
			004F L42F	
	70		403F 50(7)	
			71(2) 003F	
			L43F 40(A1)	$A_1=[3\Sigma a^2 \Sigma a^2b^2-2\Sigma ab \Sigma a^3b-\Sigma b^2\Sigma a^4]$
344	73		40(B1) 50(7)	$\times 1/V \times 2^{-4}$
345	74		71(3) 003F	
			404F 50(5)	
			75(1) 003F	
			L44F 40(A0)	$A_o=[\Sigma a^2 \Sigma a^3b-\Sigma ab \Sigma a^4] \times 1/V \times 2^{-4}$
			40(B0) L12(C2)	
			40(R) L5(1/2)	
351	80		40(T1) 40(T2)	Set transform
			40(T3) 40(T4)	
			41(1) 41(2)	
			41(3) L7(A4)	
			102F 40F	Tests: $\lvert A_4\rvert \neq C$,

LOCATION Abs.	Rel.	Sym.	ORDER	NOTES	
			L7(A0) 102F		$\lvert A_0 \rvert \neq 0$,
			401F L4F		$\lvert A_4 \rvert + \lvert A_0 \rvert \neq 0$
			402F L32F		
			3210(C4) 415F		
			L3F 3617(QC)		
	90		L31F 3617(QT)		
	91		26(QT) 00F		
			00K		
363	0	(NT)	K5F 425L	from 2 QT,QC	Replace X with X x 2^{23}
			F5(2) 42(2)	CT,CC	after 20 trials
			L0(TR2) 366L	QUT,QUC	
			41(1) L55F		
			0023F 405F		
			50(0) 22F		
	6		921F 2210(C4)		Punch 5th hole delay for failure after 10 sets of 20 trials.
			00K		
370	0	(X)	K5F 425L	from QT,QC	
			505F 755F	CT,CC	5: X
			404F 504F	QUT,QUC	4: X^2 $\lvert X \rvert > .001$
			755F 403F	LT	3: X^3
			504F 754F		2: X^4
	5		402F 22F		
			00K		
376	0	(DVT)	K5F 429L	from QT,	Tangent derivative
			503F 75(A4)	CT,	
			002F L4(A1)	QUT	
			401F 50(A3)	LT	$(4) = 4A_4X^3 + 3A_3X^2 + 2A_2X + A_1$
			754F 40F		
			001F L4F		
			L41F 401F		
			505F 75(A2)		
			001F L41F		
	9		40(4) 22F		

LOCATION			ORDER		NOTES PAGE 13 1.90
Abs.	Rel.	Sym.			
			00K		
386	0	(DVC)	K5F 429(DVT)	from QC	
			503F 75(A0)	CC	Cotangent derivative
			002F L4(A3)	QUC	
			401F 50(A1)	LT	$(4)=4A_oy^3 + 3A_1y^2 + 2A_2y^2 + A_3$
390	4		754F 224(DVT)		
			00K		
391	0	(NR)	K5F 426L	from QT,QC	Form new root at (5)
			50(0) L5(3)	CT,CC	
			66(4) S5F	QUT,QUC	$\lvert r_i \rvert - \lvert r_{i+1} \rvert$ at (6)
			40(5) L75F	LT	
			L2(5) 40(6)		
			L5(5) 405F		
	6		50(0) 22F		
			00K		
398	0	(TN)	K5F 426L	from QT	Store a tangent
			L59L 425L	CT	
			L42(C2) 428L	QUT	
			F5(R) 42(R)	LT	
			327L L55F		
			101F 40F		Store if first root, r x 2^{-1}, is max.
			50(0) 22F		
			00F L55F		
			101F 40F		
	9		26(TRM) 00(T1)		Store if second root, r x 2^{-1}, is max.
			00K		
408	0	(COT)	K5F 426(TN)	from QC	Store a cotangent
	1		F59(TN) 221(TN)	CC	
				QUC	
				LT	
			00K		
410	0	(EX)	K5F 425L	from QT,QC	Change from tan Θ to cot Θ,
			L5(4) 366L	CT,CC	or from cot Θ to tan Θ
			F4(0) 40F	QUT,QUC	

Abs.	Rel.	Sym.	ORDER		NOTES
			L5(3) 40(4)	LT	
			L5F 40(3)		
			50(0) 22F		
	6		F0(0) 222L		
			00K		
417	0	(QT)	F5(1) 42(1)	from 91(C5)	Tangent quartic solution
			L0(TR1) 501L	32(QC)	
			36(NT) 502L		
			26(X) 503L		
			26(DVT) 50(B4)		
			752F 40F		
			001F L4F		
			40(3) 50(B3)		
			753F 001F		
			L4(3) 40(3)		
	10		50(B2) 754F		
			L0(B0) L4(3)		
			40(3) L7(3)		
			L2(4) 3230L		If $X_t \geq 1$ go to cotangent solution
			50(0) 5014L		
			26(NR) L7(6)		
			L2(TX) 36L		
			L5(B4) 40(B8)	from 90(C5)	If $\lvert X_t = X_{t-1} \rvert \leq$ (TX), reduce to cubic
			50(B8) 755F		
436	19		L4(B3) 40(B7)		
437	20		50(B7) 755F		
			L4(B2) 40(B6)		
			50(B6) 755F		
			L4(B1) 40(B5)		
			50(0) 5024L		
			26(X) 5025L		
			26(DVT) L5(4)		Test 2nd derivative, if neg., it is a maximum
			3228L 5027L		
			26(TN) 41(1)		

LOCATION Abs.	Rel.	Sym.	ORDER		NOTES
			41(2) 26(CC)		
	30		00F 5030L	from 13L	
			26(EX) 5031L		
	32		26(NR) 26(QC)		
			00K		
450	0	(QC)	F5(1) 42(1)	from 32(QT)	cotangent quartic solution
			L0(TR1) 501L		
			36(NT) 502L		
			26(X) 503L		
			26(DVC) 50(B0)		
			752F 40F		
			001F L4F		
			40(3) 50(B1)		
			753F 001F		
			L4(3) 40(3)		
	10		50(B2) 754F		
			L0(B4) L4(3)		
			40(3) L7(3)		
			L2(4) 3230L		If $Y_t \geq 1$, go to tangent solution
			50(0) 5014L		
			26(NR) L7(6)		
			L2(TX) 36L		If $\lvert Y_t - Y_{t-1} \rvert \leq$ (TX) reduce to cubic
			L5(B0) 40(B5)	from 89(C5)	
			50(B5) 755F		
			L4(B1) 40(B6)		
470	20		50(B6) 755F		
			L4(B2) 40(B7)		
			50(B7) 755F		
			L4(B3) 40(B8)		
			50(0) 5024L		
			26(X) 5025L		
			26(DVC) L1(4)		Test 2nd derivative; if pos.,it is
			3228L 5027L		a maximum.
			26(COT) 41(1)		

LOCATION Abs.	Rel.	Sym.	ORDER	NOTES	PAGE 16 1.90
			41(2) 26(CT)		
	30		00F 5030L	from 13L	
			26(EX) 5031L		
	32		26(NR) 26(QT)		
			00K		
483	0	(CT)	F5(1) 42(1)	from 29(QC)	Tangent cubic solution
			L0(TR1) 501L	31(CC)	
			36(NT) 502L		
			26(X) 50(B8)		
487	4		753F 001F		
488	5		40(3) 50(B7)		
			754F L4(3)		
			L0(B5) 40(3)		
			50(B8) 754F		
			40F 001F		
	10		L4F 40(4)		
			50(B7) 755F		
			001F L4(B6)		
			L4(4) 40(4)		
			L7(3) L2(4)		If $X_t \geq 1$, go to cubic cotangent solution
			3229L 5015L		
			26(NR) L7(6)		
			L2(TX) 36L		If $\lvert X_t - X_{t-1} \rvert \leq (TX)$, reduce to quadratic
			L5(B8) 40(B11)		
			50(B11) 755F		
403	20		L4(B7) 40(B10)		
			50(B10) 755F		
			L4(B6) 40(B9)		
			50(0) 5023L		
			26(X) 5024L		
			26(DVT) L5(4)		Test 2nd derivative; if neg., it is a maximum
			3227L 5026L		
			26(TN) 41(1)		
			41(2) 26(QUC)		

LOCATION			ORDER		NOTES PAGE 17 1.90
Abs.	Rel.	Sym.			
			00F 5029L	from 15L	
	30		26(EX) 5030L		
	31		26(NR) 26(CC)		
			00K		
415	0	(CC)	F5(1) 42(1)	from 29(QT)	Cotangent cubic solution
			L0(TR1) 501L	31(CT)	
			36(NT) 502L		
			26(X) 50(B5)		
			753F 001F		
			40(3) 50(B6)		
			754F L4(3)		
			L0(B8) 40(3)		
			50(B5) 754F		
			40F 001F		
	10		L4F 40(4)		
			50(B6) 755F		
			001F L4(B7)		
			L4(4) 40(4)		
			L7(3) L2(4)		If $Y_t \geq 1$, go to cubic tangent
			3229L 5015L		solution
			26(NR) L7(6)		
			L2(TX) 36L		If $\lvert Y_t - Y_{t-1} \rvert \leq$ (TX), reduce to
			L5(B5) 40(B9)		quadratic
			50(B9) 755F		
435	20		L4(B6) 40(B10)		
			50(B10) 755F		
			L4(B7) 40(B11)		
			50(0) 5023L		
			26(X) 5024L		
	25		26(DVC) L1(4)		Test 2nd derviative; if pos., it is a max
441	26		3227L 5026L		
			26(COT) 41(1)		
			41(2) 26(QUT)		
			00F 5029L	from 15L	

LOCATION Abs.	Rel.	Sym.	ORDER		NOTES
	30		26(EX) 5030L		
	31		26(NR) 26(CT)		
			00K		
447	0	(QUT)	F5(1) 42(1)	from 28(CC)	Tangent quadratic solution
			L0(TR1) 501L	22(QUC)	
			36(NT) 502L		
			26(X) 50(B11)		
			754F L0(B9)		
			40(3) 50(B11)		
			755F 001F		
			L4(B10) 40(4)		
			L7(3) L2(4)		If $X_t \geq 1$, go to quadratic cot.
			3220L 509L		solution
	10		26(NR) L7(6)		
			L2(TX) 36L		
			L5(B11) 40(B13)		Reduce to linear
			50(B13) 755F		
			L4(B10) 40(B12)		
			50(0) 5015L		
			26(X) 5016L		
			26(DVT) L5(4)		Test 2nd derivative; if pos., it
			3219L 5018L		is a max.
			26(TN) 26(LT)		
457	20		00F 5020L		
			26(EX) 5021L	from 9L	
	22		26(NR) 26(QUC)		
			00K		
460	0	(QUC)	F5(1) 42(1)	from 28(CT)	Cotangent quadratic solution
			L0(TR1) 501L	22(QUT)	
			36(NT) 502L		
			26(X) 50(B9)		
			754F L0(B11)		
			40(3) 50(B9)		
			755F 001F		

LOCATION Abs.	Rel.	Sym.	ORDER		NOTES
			L4(B10) 40(4)		
			L7(3) L2(4)		If $Y_t \geq 1$, go to quadratic tan.
			3220L 509L		solution
	10		26(NR) L7(6)		
			L2(TX) 36L		Reduce to linear
			L5(B9) 40(B12)		
			50(B12) 755F		
			L4(B10) 40(B13)		
			50(0) 5015L		
			26(X) 5016L		
			26(DVC) L1(4)		Test 2nd derivative; if neg., it
			3219L 5018L		is a maximum.
			26(COT) 26(LT)		
480	20		00F 5020L	from 9L	
			26(EX) 5021L		
	22		26(NR) 26(QUT)		
			00K		
483	0	(LT)	L1(B12) 40(3)	from 19(QUT)	Linear solution
			L5(B13) 40(4)	19(QUC)	
			L7(3) L2(4)		If $X_t \geq 1$, go to 9L
			329L 503L		
			26(NR) 504L		
			26(X) 505L		
			26(DVT) L5(4)		Test 2nd derivative; if pos., it is max.
			328L 507L		
			26(TN) 92707F		Fig. shift: two max. not found.
			2210(C4) 509L	from 3L	
	10		26(EX) 5010L		
			26(NR) 5011L		
			26(X) 5012L		
			26(DVC) L1(4)		Test 2nd derivative; if neg., it is max
			3215L 5014L		
	15		26(COT) 228L		
499		(R1)	00K		

LOCATION			ORDER	NOTES	PAGE 20 1.90
Abs.	Rel.	Sym.			
			OOK		
508	0	(TRM)	L5(A) 427L	from 9(TN)	Transformation section
			4211L 4238L		
			4248L 4243L		
			L5(B) 429L		
			4212L 4240L		
			4245L 4247L		
			415F 41(7)		
			41(8) 50F		
			75(T2) 40F		
			50(T1) 75F		
	10		L4F 401F		
			50(T4) 75F		
			402F 50F		
			75(T3) L42F		
			403F 501F		
			751F L4(7)		Calculate normalization
			40(7) 503F		constants, k_1 and k_2
			753F L4(8)		
			40(8) F57L		
			427L 4211L		
528	20		F59L 429L		
			4212L F55F		
			425F L0(F)		
			3624L 227L		
			50(0) L5(R2)		
			66(7) 41F		
			S5F 5026L		
			26(R1) 40(7)		$k_1 \times 2^{-3}$ at (7)
			50(0) L5(R2)		
			66(8) 41F		
	30		S5F 5030L		
			26(R1) 40(8)		$k_2 \times 2^{-3}$ at (8)
			50(7) 75(T1)		
541	33		40(T1) 50(7)		

LOCATION Abs.	Rel.	Sym.	ORDER		NOTES
542	34		75(T2) 40(T2)		Normalize transform
			50(8) 75(T3)		
			40(T3) 50(8)		
			75(T4) 40(T4)		
			415F 50F		
			75(T2) 004F		Post multiply 2 columns of
548	40		40F 50F		T and 2 factor vectors
			75(T1) 004F		by normalized transform.
			L4F 402F		
			50(T4) 75F		
			004F 401F		
			50(T3) 75F		
			004F L41F		
			50(0) 40F		
			L52F 40F		
			F538L 4238L		
	50		4248L 4243L		
			F540L 4240L		
			4245L 4247L		
			F55F 425F		
			L0(N) 3255L		
			2238L 92515F		Punch 2-hole delay for successful
564	56		229(C4) 00F		solution
			00855K		
855	0		L5F 404L		Interlude to place Set II on
			J0140F 501L		drum
			26(Y1) 002700F		
	3		00550F 26999F		
			26855N		
			00140K		
140	0		L5(A) 40(7)	from 2(M3)	Drum Set III
			92139F 50(0)		
			L5(P) 101F		Test directive: if odd, print
			S3F 36(P5)		T and V_r by columns

LOCATION			ORDER	NOTES	PAGE 22 1.90
Abs.	Rel.	Sym.			
			92259F 92195F		
			92386F 92961F		
			92835F 92578F		
			92962F 92450F		
			92643F 92770F		
			92706F 509L		
	10		26(P2) 41(1)		Print title
			L5(D) 0020F		
			464(P4) 41(2)		
			L5(AV) 4211(P3)		
			4213(P4) F5(0)		
			40(3) 5015L		
			26(P4) 9259F		Print T x 10^{-1} by columns
			92135F 41(1)		
			L5(F) 40(2)		
	19		L5(A) L4(V)		
160	20		4211(P3) 4213(P4)		
			92131F 5021L		
			26(P4) 92834F		Print V_r x 10^{-1} by columns
	23		9259F 26(P5)		
			OOK		
164	0	(P2)	K5F 4224L	from 150,13(P5)	Print title:
			92135F 92515F		A TRANSFORM
			92387F 92965F		B REFERENCE VECTOR
			92322F 92258F		STRUCTURE
			92387F 92770F		
			92706F 92898F		
			92578F 92258F		
			92643F 92131F		
			92515F 92195F		
			92965F 92258F		
	10		92194F 92898F		
			92194F 92258F		
			92194F 92770F		

LOCATION			ORDER	NOTES	PAGE 23 1.90
Abs.	Rel.	Sym.			
			92835F 92194F		
			92961F 92323F		
			92194F 92835F		
			92322F 92578F		
			92258F 92961F		
			92706F 92322F		
			92258F 92450F		
184	20		92835F 92322F		
			92450F 92258F		
			92194F 92135F		
			92707F 9259F		
	24		9259F 22F		
			00K		
189	0	(P3)	K5F 4210L	from 3(P4),3(P6)	Subroutine to take a row
			L5(7) 426L	10,15(P8)	or a column from the drum
			50(1) 75(193)		
			S5F L4(2)		
			L4(DR) 405L		
			00F 00F		
			40F 40F		
			L55L L4(3)		
			405L F56L		
			426L L011L		
	10		365L 22F		
	11		N0F 40F	by 153, 160,16(P5),8,12(P8)	
			00K		
201	0	(P4)	K5F 4212L	from 156, 162	Printing subroutine for cols.
			L5(7) 423L		
			92135F 502L		
			26(P3) L5F		
			50F 504L		
			26(P16) 92131F		
			92515F F53L		
208	7		423L L013L		

LOCATION			ORDER		NOTES PAGE 24 1.90
Abs.	Rel.	Sym.			
209	8		323L 92770F		
			9211F F5(1)		
	10		42(1) L0(F)		
			3612L 261L		
			9259F 22F		
	13		K6(P3) L5F		
			00K		
215	0	(70)	00F 0070F		No. characters per line of teletype
		(1-1)	001F 001F		
		(P11)	00F 00 6250 0000 0000J		10×2^{-4}
		(21)	00F 0021F		Max. no. of factors for inversion
			00K		
219	0	(P5)	50(0) F5(D)	from 143,163	
			007F 40(8)		
			L5(70) 66(8)		
			S5F 1032F		
			40(8) L5(P)		(8) No. numbers per row
			101F 50(0)		
			101F S3F		
			36(P7) 92139F		Test directive: if $a^{38}=1$, print
			92259F 92195F		T and V_r by rows
			92386F 92961F		
	10		92258F 92578F		
			92130F 92706F		
			41(1) 5012L		
			26(P2) L5(D)		Print title
			0020F 464(P6)		
			41(2) L5(AV)		
			4211(P3) 4217(P6)		
			L5(F) 40(5)		
			L5(193) 40(3)		
			50(0) 5019L		
239	20		26(P6) 9259F		Print $T \times 10^{-1}$ by rows

LOCATION			ORDER		NOTES PAGE 25 1.90
Abs.	Rel.	Sym.			
			92139F L5(N)		
			40(5) 5022L		
			26(P6) 9259F		Print $V_r \times 10^{-1}$ by rows
	24		92135F 26(P7)		
			00K		
244	0	(P6)	K5F 4218L	from 20,23(P5)	Printing subroutine for rows
			L5(7) 423L		
			41(6) 502L		
			26(P3) L5F		
			50F 504L		
			26(P16) 50(0)		
			F53L 423L		
			L017L 3212L		
			F5(6) 42(6)		
			L0(8) 3210L		
	10		223L 92131F		
			92519F 41(6)		
			223L 92770F		
			92131F 92519F		
	14		F5(2) 42(2)		
259	15		L0(5) 3618L		
			261L 00F		
			26(P3) L5F		
	18		92834F 22F		
			00K		
263	0	(P10)	K5F 428L	from 20(P8)	Routine to store rows of C_r on drum
			L5(BV) 423L		
			L5(DS) L4(5)		
			404L L5F		
			00F 00F		
			L54L L4(193)		
			404L F53L		
			423L L09L		
			323L 22F		

LOCATION			ORDER		NOTES PAGE 26 1.90
Abs.	Rel.	Sym.			
	9		N04L L5F	by 3(P8)	
			00K		
273	0	(P7)	L5(P) 102F	from 7,24(P5)	Test directive: if $a^{37} = 1$,
			50(0) 101F		
			S3F 3618L		
			92259F 92258F		Print REF. VECTOR CORRELATIONS
			92194F 92898F		
			92707F 92643F		
			92259F 92961F		
			92323F 92194F		
			92835F 92322F		
			92578F 92258F		
			92961F 92835F		
	10		92578F 92262F		
			92194F 92962F		
			92387F 92322F		
			92514F 92578F		
			92770F 92706F		
			92135F 92515F		
			92707F 26(P8)		
	18		0FF 26(M1)	from 2L	
			00K		
292	0	(P9)	K5F 4214L	from 16(P8)	Subroutine to form scaler product of two vectors
			L5(A) 465L		
			L5(B) 425L		
			414F 415F		
			2L5L S5F		
			50F 74F		
			L44F 404F		
			L55L L4(1-1)		
			405L F55F		
			425F L0(F)		
	10		3611L 224L		
			504F 75(P11)		

LOCATION			ORDER	NOTES	PAGE 27 1.90
Abs.	Rel.	Sym.			
			004F 40F	preset to (BV)	C_r x 10^{-1}
			F512L 4212L		
	14		001F 22F		
			00K		
207	0	(P8)	F5(0) 40(3)	from 17(P7)	Form C_r, store on drum and
	1		41(2) L5(N)		print C_r
209	2		40(5) L5(BV)		
			L4(F) 429(P10)		
			L5(D) 0020F		
			4624L 41(4)		
			50(0) L5(A)		
			40(7) L4(F)		
			4211(P3) L5(4)		
			40(1) 509L		
	10		26(P3) L5(B)		Vector a from drum
			40(7) L4(F)		
			4211(P3) 41(1)		
			L5(BV) 4212(P9)		
			4223L 5014L		
			26(P3) 5015L		Vector b from drum
			26(P9) F5(1)		
			42(1) L0(F)		
			3619L 2214L		
			415F 5019L		
227	20		26(P10) F5(4)		Store row of C_r on drum
			42(4) F5(5)		
			42(5) 50(0)		
			41(6) L5F		
			50F 5024L		
			26(P16) F523L		Print C_r in triangular form
			4223L F55F		
			425F L0(4)		
			3232L F5(6)		
			42(6) L0(8)		

LOCATION Abs.	Rel.	Sym.	ORDER		NOTES
	30		3631L 2223L		
			92131F 92515F		
			2623L 92131F		
			92515F L5(4)		
			L0(F) 3235L		
			226L 92139F		
			L5(F) L0(21)		Test: No. of factors < 21.
			3638L 26(P12)		
	38		FF21F 26(M1)		FF015: f $\geq$ 21
			00K		
246	0	(P12)	9259F 92259F	from 37(P8)	Print: PRIMARY FACTOR CORRELATIONS.
			922F 92258F		
			92514F 92643F		
			92387F 92258F		
			92386F 92961F		
			92898F 92387F		
			92835F 92322F		
			92578F 92258F		
			92961F 92835F		
			92578F 92262F		
	10		92194F 92962F		
			92387F 92322F		
			92514F 92578F		
			92770F 92706F		
			92135F 92707F		
260	15		92519F 26(M4)		
			00860K		Interlude to place Set III on drum.
860	0		L5F 404L		
			J0140F 501L		
			26(Y1) 003260F		
	3		00230F 26999F		
			26860N		
			00140K		Set IV

LOCATION Abs.	Rel.	Sym.	ORDER		NOTES
140	0		41(1) 41(2)	from 3(M4)	
			L58L L4(F)		
			42(Q4) F4(0)		
			421(Q4) L5(F)		
			427L 0020F		
			466L 50(0)		
			JOF L56L		
			26(M14) 00F		
	8		26(M5) 00115(M14)		
			00K		
149	0	(Q2)	L510L 425L		Auxiliary I for M14
			50(1) 75(193)		
			K5F L4(N)		
			L4(DR) 404L		
			00F 00F		Read a row of C_r from drum
			40F 40F		
			F54L 404L		
			F55L 425L		
			L0(Q4) 364L		
			F5(1) 42(1)		
	10		2221(M14) 00115(M14)		
			00K		
160	0	(Q3)	L510(Q2) 424L		Auxiliary II for M14
			40(2) 75(193)		
			S5F L4(N)		
			L4(DS) 405L		
			001F L5F		
			00F 00F		Store a column C_r^{-1} on drum
			F55L 405L		
			F54L 424L		
			L01(Q4) 324L		
			F5(2) 42(2)		
	10		26106(M14) 00F		

LOCATION			ORDER		NOTES PAGE 30 1.90
Abs.	Rel.	Sym.			
			00K		
171	0	(Q4)	N0F 40F	by 142	
			801F L5F	by 143	
			00K		
173	0	(Q5)	92135F 92259F		Print: SING.
			92706F 92514F		and stop on FF00S
			922770F 92579F		
			92707F 92643F		
	4		FF11F 26(M1)		
178	0	(M14)	00K		
			Insert M14 revised		
			00865K		
865	0		L5F 404L		Interlude to place Set IV
			J0140F 501L		on drum
			26(Y1) 003500F		
869	3		00160F 26999F		
			26865N		
			00140K		Drum Set V
140	0		L5(B) 426L	from 3(M5)	
			L4(F) 42(Q7)		
			4213L L5(DR)		
			L4(N) 405L		
			L4(F) 4012L		
			00F 00F		Read diagonals of C_r^{-1} at B
			40F 40F		
			F55L L4(193)		
			405L F56L		
			426L L0(Q7)		
	10		365L L5(Q7)		
			L4(F) 42(Q7)		
			00F 00F		Read scalers of C_r^{-1} at BV
			40F 40F		

LOCATION Abs.	Rel.	Sym.	ORDER	NOTES	
			L512L L4(193)		
			4012L F513L		
			4213L L0(Q7)		
	17		3612L 26(Q8)		
158	0	(Q6)	00K		Square root subroutine R1
			Insert (R1)		
			00K		
167	0	(Q7)	N0F 40F	by 141,151,2,39(Q9)	
			J02(Q7) 7JF	by 3,40(Q9)	
			00F 00 1000 0000 0000J		
			N1(6) 50F	by 3(Q11)	
			00K		
171	0	(Q8)	L5(F) L4(F)	from 157	
	1		40(2) 41(1)		
173	2		L5(B0) 424L		
			L4(2) 426L		
			41F L5F		
			50(0) 505L		
			26(Q6) 40F		Form square roots of diagonals
			F54L 424L		of C_r^{-1} and scalers at
			F56L 426L		B + 2F and B + 3F
			F5(1) 42(1)		
	10		L0(2) 36(Q9)		
	11		264L 00F		
			00K		
183	0	(Q9)	L5(D) 0020F	from 10(Q8)	Routine to print $C_f \times 10^{-1}$
			4629L 41(1)		triangular form
			F5(A) 42(Q7)		
			421(Q7) L5(BV)		
			4224L L4(F)		
			4223L L4(F)		
			4222L L5(A)		
			4212L 4219L		

LOCATION Abs.	Rel.	Sym.	ORDER	NOTES
			50(1) 75(193)	
			S5F L4(N)	
	10		L4(DR) 4011L	
			00F 00F	
			40F 40F	
			F511L 4011L	
			F512L 4212L	
			L0(Q7) 3611L	
			L5(BV) L4(F)	
			4225L L4(F)	
			4220L 41(6)	
			502(Q7) 7JF	
203	20		40(3) 50F	
			7J(3) 40(3)	
			50(3) 7JF	
			40(3) 50F	(3) $\sqrt{s_{ii}}$ $C_r^{ij}\sqrt{s_{sj}} \times 10^{-1}$
			2224L 7JF	
			40(4) 50F	
			7J(4) 40(4)	(4) $\sqrt{C^{ii}}$ $s_i\sqrt{C^{jj}}$
			50(0) L5(3)	
			66(4) S5F	
			50F 5029L	
	30		26(P16) F525L	Print $C_f \times 10^{-1}$
			4225L F520L	
			4220L F519L	
			4219L L01(Q7)	
			3643L 2635L	
			92131F 92519F	
			F522L 4222L	
			F523L 4223L	
			F524L 4224L	
			F5(Q7) 42(Q7)	
223	40		421(Q7) F5(1)	
			42(1) L0(F)	

LOCATION Abs.	Rel.	Sym.	ORDER		NOTES
			36(Q10) 226L		
			F5(6) 42(6)		
	44		L0(8) 3245L		
228	45		2619L 92131F		
	46		92519F 2218L		
			00K		Print:
230	0	(Q10)	92139F 9211F	from 42(Q9)	PRIMARY FACTOR PATTERN
	1		92259F 922F		
			92258F 92514F		
			92643F 92387F		
			92258F 92386F		
			92961F 92898F		
			92387F 92835F		
			92322F 92578F		
			92258F 92961F		
			922F 92387F		
	10		92326F 92194F		
			92258F 92770F		
			92135F 92515F		
	13		92707F 26(Q11)		
			00K		
244	0	(Q11)	L5(D) 0020F	from 13(Q10)	
			4619L L5(F)		
			40(1) L5(AV)		
			42(Q7) 423(Q7)		
			L5(A) 428L		
			4215L L5(DR)		
			L4(1) 407L		
			00F 00F		Read row of V_r from drum
			40F 40F		
			L57L L4(193)		
	10		407L F58L		
			428L L0(Q7)		
			367L L5(BV)		

LOCATION Abs.	Rel.	Sym.	ORDER	NOTES	PAGE 34 1.90
			L4(F) 4216L		
			L4(F) 4217L		
			41(6) 50F		
			2216L 7JF		
			50(0) 66F		
			2218L S5F		
			50F 5019L		
264	20		26(P16) F516L		$V_f = V_r \dfrac{\sqrt{C^{ii}}}{\sqrt{S_{ii}}}$
			4216L F517L		
			4217L F515L		
			4215L L03(Q7)		
			3625L 2629L		
			F5(6) 42(6)		
			L0(8) 3227L		
			2215L 92131F		
			92519F 2615L		
			92770F 92131F		
	30		92519F F5(1)		
			42(1) L0(N)		
			3633L 264L		
			92834F 9259F		
			92135F 92259F		Print· INVERSE OF D
			92514F 92770F		
280	36		92323F 92194F		
281	37		92258F 92706F		
			92194F 92961F		
			92578F 92898F		
	40		92961F 9267F		
			9259F 92707F		
	42		92131F 26(Q13)		
			00K		
287	0	(Q12)	00F 00 0100 0000 0000J		
			N21L 50F	by 3(Q13)	
			N0(1) L5F	by 3(Q14)	

LOCATION Abs.	Rel.	Sym.	ORDER	NOTES	
			OOK		
290	0	(Q13)	92131F L5(BV)	from 42(Q11)	
			L4(F) 423L		
			L4(F) 425L		
			421(Q12) 50F		
			75(Q12) 40(1)		
			92515F L5F		
			40(2) L5(1)		
			L0(2) 3624L		
			50(0) L5(1)		
			66(2) S5F		
	10		54208F 5010L		
			26(P16) 92131F		$\frac{\sqrt{c^{ii}}}{\sqrt{s_{ii}}} \times 10^{-2}$
			F55L 425L		
			F53L 423L		
			L01(Q12) 323L		
			92770F 92834F		
			9259F 92135F		
			92259F 9267F		Print: D-VALUES
			92707F 92706F		
			92259F 92323F		
310	20		92387F 92962F		
			92450F 92194F		
			92706F 92707F		
			9259F 26(Q14)		
			50(1) 75(Q12)	from 7L	
			66(2) S5F		
			54410F 5026L		
	27		26(P16) 2211L		$\frac{\sqrt{c^{ii}}}{\sqrt{s_{ii}}} \times 10^{-4}$
			OOK		
318	0	(Q14)	92135F L5(BV)	from 23(Q13)	
			L4(F) 424L		
			L4(F) 423L		
			422(Q12) L5F		

LOCATION Abs.	Rel.	Sym.	ORDER		NOTES	PAGE 36 1.90
			40(1) L5F			
			40(2) L5(1)			
			L0(2) 3617L			
			50(0) L5(1)			
			66(2) S5F			
			508F 509L			
	10		26(P16) 92131F		$\frac{\sqrt{S_{ii}}}{\sqrt{C^{ii}}}$	
			92515F F53L			
			423L F54L			
			424L L02(Q12)			
	14		323L 92770F			
333	15		92834F 921001F			
			92139F 2621L			
			50(1) 75(Q12)	from 6L		
			66(2) S5F			
			54208F 5019L			
	20		26(P16) 2210L		$\frac{\sqrt{S_{ii}}}{\sqrt{C^{ii}}} \times 10^{-2}$	
339	21		OFF 26(ML)		Stop on OF	
			00870K		Interlude to put Set V on	
870	0		L3F 362L		drum and sum check	
			FF20F 262L			
			J0140F 502L			
			26(Y1) 003670F			
			00210F 24(ML)		Stop: 2407J	
	5		J92771F 692771F			
			26870N			