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DIGITAL COMPUTER LABORATORY
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KSL 2.40 - 254

TITLE: Phi's or Covariances for Dichotomous Data (SADOI Only)

TYPE: Entire program

SYMBOLS:
d decimal places in the results
S observations (persons)
n variables (items)

CAPACITY: $S \leq 2535$; $n \leq 157$

ACCURACY:
6 decimal places for phi's
9 decimal places for covariances

DURATION:
To read the data tape:
$S(.007\ n + .020)$ seconds

To calculate and punch coefficients:
$(.055 + .017\ d + .0005\ S)$ seconds per coefficient

Add 60 seconds for reading the master tape; add from 10 seconds to 90 seconds for punching the means, standard deviations, and table of positive responses depending upon the size of n.

METHOD OF USE:

	Stops
1. Master tape	34066
2. Data tape	241K4
3. Parameter tape	241K4

To read additional parameters to operate on the same data at stop 241K4, raise the black switch.
To begin a new problem with different data at stop 241K4, raise the white switch.

PREPARATION OF THE DATA TAPE:
If the responses on a set of test items cam be coded dichotomously as 1's and 0's where a 1 indicates a positive response and a 0 indicates a negative response, this routine can be used to calculate a matrix of correlations or covariances.
The data is punched on tape a person at a time with an N terminating each person. After the N for the final person, an L is punched. For example, the responses for three persons on five items might appear as follows:

10111N 01000N 11100N L

If an F is punched at the end of a person's responses instead of an N, the computer will stop on 2008J. The operator can insert another section of the data tape. By raising the black switch the reading of the data tape is continued. After the data tape which is indicated by an L has been read, the computer will print the number of items and persons as follows:

5 ITEMS 3 PERSONS

CHECKING THE DATA TAPE FOR ERRORS:

As the data tape is read, it is checked for errors. There are two kinds of errors:

1. If a character is read which is not a 0, 1, N, F, or L, the computer will stop at FF from location 0N1 and print the error. For example, suppose a positive sign is encountered at item 17 in person 28. The computer will print:

(+) ITEM 17, ERROR IN PERSON 28

2. If there are an incorrect number of items for a person (i.e., a subsequent person does not agree with person 1) the computer will stop at FF from location 0NJ and print the error as follows:

ERROR IN PERSON 28, 54 ITEMS

For either kind of error, to resume reading and checking the remainder of the tape, raise the white switch.

THE PARAMETER TAPE:

By changing the directive on the parameter tape, any of 16 options can be selected. The computer can be directed to print either a phi matrix or a covariance matrix; either a triangular matrix or a square matrix; either by rows or by columns; either the complete matrix or some submatrix of it.

If a complete matrix is desired, the directive must be an even number. In this case the parameter tape consists of but two numbers, unsigned and separated by fifth hole characters. These are d, the number of decimal places, and X, the directive.

If an incomplete matrix is desired, the directive must be an odd number. In this case four more numbers must follow the directive, X. These are the subscripts, i and j, for the first coefficient to be printed, and the subscripts, r and s, for the final coefficient to be printed.

The parameters must be in the following order:

d space X space (i space j space r space s space).

The meaning of the directive is shown in the chart:

X	Coefficient	Form	Printed	Matrix
0	Phi's	Triangular	By rows	Complete
1	Phi's	Triangular	By rows	Submatrix
2	Phi's	Square	By rows	Complete
3	Phi's	Rectangular	By rows	Submatrix
4	Covariances	Triangular	By rows	Complete
5	Covariances	Triangular	By rows	Submatrix
6	Covariances	Square	By rows	Complete
7	Covariances	Rectangular	By rows	Submatrix
8	Phi's	Triangular	By columns	Complete
9	Phi's	Triangular	By columns	Submatrix
10	Phi's	Square	By columns	Complete
11	Phi's	Rectangular	By columns	Submatrix

12	Covariances	Triangular	By columns	Complete
13	Covariances	Triangular	By columns	Submatrix
14	Covariances	Square	By columns	Complete
15	Covariances	Rectangular	By columns	Submatrix

ILLUSTRATIVE EXAMPLES: A few illustrations of parameters may be helpful. Suppose a data tape has been read which has but four items. The results printed to 3 places will appear in the following form:

Parameters: 3 space 0 space

ϕ_{11}

ϕ_{21} ϕ_{22}

ϕ_{31} ϕ_{32} ϕ_{33}

ϕ_{41} ϕ_{42} ϕ_{43} ϕ_{44}

Parameters: 3space 1space 2space 2space 4space 3space

ϕ_{22}

ϕ_{32} ϕ_{33}

ϕ_{42} ϕ_{43}

Parameters: 3space 3space 2space 2space 2space 3space

ϕ_{22} ϕ_{23} N

THE PRINTED RESULTS: If the matrix to be printed is triangular, no terminating symbols are punched at the end of rows or columns. If the matrix is square or rectangular, an N will be punched at the end of each row or column. If the directive specifies the results to be printed by rows, carriage returns and delays are punched at the appropriate places.
Phi coefficients are printed scaled by 10^{-1}.
Covariances, which for dichotomous data cannot exceed .25, are printed unscaled.
Following the coefficients will be printed the means and standard deviations unscaled. Finally a table showing the number of positive responses for each item will be printed.

NOTE 1: If an item has zero variance, the computer will print a zero for each coefficient involving this item and continue. The mean and standard deviation for this item will also be printed as zeros.

NOTE 2: If the computer stops on FF from location 1F8 after the master tape has been read, this indicates that the sum check has failed. Clear the machine and reread the master tape.

DATE February 4, 1959
CODED BY Kenneth Dickman
APPROVED BY J. Snyder

lgr

LOCATION			ORDER		NOTES PAGE 1
Abs.	Rel.	Sym.			
			003K		
3		(0)	00F 00F		Always zero
4		(1)	00F 001F		
5		(1-1)	001F 001F		
6		(5)	00F 005F		
7		(10)	00F 0010F		
8		(65)	00F 0065F		To increase drum address
9		(39)	00F 0039F		
10		(SC)	00F 001000 0000 0000J		
11		(=)	00F 00F		
12		(D1)	8611F 002559F		Drum orders
13		(D2)	8511F 002560F		
14		(TR1)	00F 2614(B3)		Transfer for 1st person
15		(TR2)	00F 2616(B3)		Transfer for subsequent persons
16		(N)	00F 00570F		Location for positive responses
17		(VR)	00F 00730F		Location of variances
18		(SI)	00F 00890F		Item "i"
19		(SJ)	00F 00955F		Item "j"
20		(S)	00F 00F		Sample size
21		(V)	00F 00F		Number of items
22		(W)	00F 00F		8/39 rounded up
23		(X)	00F 00F		
24		(Y)	00F 00F		
25		(Z)	00F 00F		
26		(U)	00F 00F		
27		(T1)	N0F 40F	by 2(A3)	Test constants
28		(T2)	N0F 40F	by 5(A3)	
29		(T3)	J0F J0F	by 3,5(A3)	
30		(I)	00F 00F		"i"
31		(J)	00F 00F		"j"
32		(TS0)	F0(I) 3659(C2)		Triangular matrix
33		(TS1)	L03(Q) 3258(C2)		Square matrix
34		(TS2)	00F 2642(C2)		Transfer for phi's
35		(TS3)	00F 2664(C2)		Transfer for covariances
36		(SS)	00F 00F	by 18(A3)	S^2

LOCATION			ORDER	NOTES	PAGE 2
Abs.	Rel.	Sym.			
37		(P16)	00K		Print routine
93		(R1)	00K		Square root routine
			00K		
102	0	(B)	L5(D1) 40(Y)		Beginning of a new problem
	1		41(S) 501L		
	2		26(B1) 41(W)		
	3		41(V) L5(TR1)		
	4		4213(B3) 41(=)		
	5		92135F 9259F		
	6		26(B3) 00F		
			00K		To clear from (N) to (N) + (V) and
109	0	(B1)	K5F 426L	from (B)	(U) for next problem
	1		L5(N) 423L		
	2		L4(V) 427L		
	3		41(0) 41F		
	4		F53L 423L		
	5		L07L 323L		
	6		41(U) 22F		
	7		N1(0) 41F		
			00K		To store on drum and increase drum
117	0	(B2)	K5F 429L	from 25(B3)	addresses
	1		L5(N) 424L		
	2		L4(V) 4210L		
	3		F5(Y) 405L		
	4		40(Y) L5F	by 1L	
	5		00F 00F	by 3L	
	6		L55L L4(65)		
	7		405L F54L		
	8		424L L010L		
	9		324L 22F		
	10		N0(Y) L5F		
			00K		To read data, check, transpose, and
128	0	(B3)	41(Z) L5(N)	from 6(B)	store on drum
	1		425L 426L		

LOCATION			ORDER	NOTES	PAGE 3
Abs.	Rel.	Sym.			
	2		814F 103F		Read a character
	3		L0(1) 3610L		Test: + d ≥ 8
	4		012F L0(1)		
	5		36(ER1) L5F	by 1L	Character not a 0, 1
	6		001F 40F		
	7		F5(U) 42(U)		
	8		F55L 425L		
	9		426L 262L		
	10		011F L0(1)		
	11		3612L 221(ER1)		Character not a 0, 1
	12		012F L0(1)		
	13		3628L 2614L	by 4(B)	
	14		L5(U) 40(V)		
	15		L5(TR2) 4213L		
	16		L5(U) L0(V)		
	17		40F L3F		
	18		3619L 22(ER3)		Error in item count
	19		41(U) F5(S)		
148	20		40(S) F5(Z)		
	21		42(Z) L0(39)		
	22		3623L 22L		
	23		F5(W) 42(W)		
	24		50(0) 5024L		End of 39 items
153	25		26(B2) 5025L		Store data and clear locations
	26		26(B1) L3(=)		
	27		36L 26(C)		
	28		F0(1) 3229L		
	29		2013L L3(Z)		Stop for F term. symbol
	30		36(C) F5(=)		
	31		40(=) 2623L		
			00K		Print: ITEM
160	0	(IT)	K5F 424L		
	1		50F 92961F		
	2		92259F 92514F		

LOCATION			ORDER	NOTES	PAGE 4
Abs.	Rel.	Sym.			
	3		92322F 92194F		
	4		92643F 22F		
			OOK		Print: PERSON
165	0	(PN)	K5F 425L		
	1		50F 92961F		
	2		92259F 922F		
	3		92194F 92258F		
	4		92706F 92578F		
	5		92770F 22F		
			OOK		Print:
171	0	(ER2)	K5F 425(PN)		ERROR IN PERSON X
	1		92259F 92194F		
	2		92262F 92578F		
	3		92258F 92961F		
	4		92514F 92770F		
	5		221(PN) OOF		
			OOK		Error in characters
177	0	(ER1)	L4(1) 001F	from 5,11(B3)	
	1		222L F5(1)		
	2		002F 40(X)		
	3		92195F L5(X)		
	4		0036F 824F		
	5		92387F 50(0)		
	6		92961F 506L		
	7		26(IT) 92707F		
	8		50F F5(U)		
	9		J24F 509L		
	10		26(P16) 92323F		
	11		92961F 5011L		
	12		26(ER2) 92707F		
	13		50F F5(S)		
	14		J24F 5014L		
	15		26(P16) 92135F		
193	16		FFF 262(B3)		Stop. White to continue

LOCATION			ORDER	NOTES	PAGE 5
Abs.	Rel.	Sym.			
			00K		Error in item count
194	0	(ER3)	00F 50L	from 18(B3)	
	1		26(ER2) 92707F		
	2		F5(S) 40(S)		
	3		J24F 503L		
	4		26(P16) 92323F		
	5		F5(Z) 42(Z)		
	6		92961F L5(U)		
	7		J23F 507L		
	8		26(P16) 508L		
	9		26(IT) 92706F		
	10		92707F 41(U)		
	11		92135F FFF		Stop. White to continue
	12		262(B3) 262(B3)		
			00K		
207	0	(C)	L5(N) 4219L	from 27,30(B3)	
	1		L5(VR) 4224L		
	2		41(U) L5(SI)		
	3		429L 4213L		Calculate n_i, number of positive
	4		L4(W) 42(T1)		responses
	5		4230L 50(U)		
	6		75(65) L5(D2)		
	7		S4F 408L		
	8		00F 00F		Drum address
	9		40F 40F	by 3L	
	10		F58L 408L		
	11		F59L 429L		
	12		L0(T1) 368L		
	13		41(Y) 50F		
	14		011F L4(Y)		
	15		40(Y) S3F		
	16		3617L 2614L		
	17		F513L 4213L		
	18		L030L 3213L		
	19		L5(Y) 40F	by 0L	

LOCATION			ORDER	NOTES	PAGE 6
Abs.	Rel.	Sym.			
227	20		L5(S) L0(Y)		
	21		40F 50(Y)		
	22		75F S5F		Calculate standard deviations,
	23		0015F 5023L		$\sqrt{n_i(S - n_i)} \times 2^{-12}$
	24		26(R1) 40F	by 1L	
	25		F519L 4219L		
	26		F524L 4224L		
	27		F5(U) 42(U)		
	28		L0(V) 3229L		
	29		222L 26(C1)		
	30		N1(Y) 50F		
			OOK		Print: X ITEMS
238	0	(C1)	92135F L5(V)	from 29(C)	Y PERSONS
	1		J23F 501L		
	2		26(P16) 502L		
	3		26(IT) 92706F		
	4		92707F L5(S)		
	5		J25F 505L		
	6		26(P16) 506L		
	7		26(PN) 92706F		
	8		92707F 921001F		Stop.
	9		92135F 24(A)		Read parameters
			OOK		Calculation routine
248	0	(C2)	L5(Q) 40(I)	from 20(A3)	
	1		L5(TS0) 4053L		Set 1st row
	2		L59(P) 364L		Triangular or square
	3		L5(TS1) 4053L		
	4		L5(N) L4(I)		
	5		0020F 4637L		
	6		L5(VR) L4(I)		
	7		0020F 4645L		
	8		41(Z) L5(SI)		
	9		4213L 50(I)		"i" off drum
	10		75(65) L5(D2)		
	11		S4F 4012L		

LOCATION			ORDER	NOTES	PAGE 7
Abs.	Rel.	Sym.			
	12		00F 00F	by 11L	
	13		40F 40F	by 9L	
	14		F512L 4012L		
	15		F513L 4213L		
	16		L0(T1) 3612L		
	17		L51(Q) 40(J)		Begin first column
	18		L5(SJ) 4223L		
	19		4229L 50(J)		
268	20		75(65) L5(D2)		
	21		S4F 4022L		"j" off drum
	22		00F 00F	by 21L	
	23		40F 40F	by 18L	
	24		F522L 4022L		
	25		F523L 4223L		
	26		L0(T2) 3622L		
	27		L5(SI) 0020F.		
	28		4629L 41(Y)		
	29		50F J0F	by 18L	Extract n_{ij}; joint set of 1's
	30		011F L4(Y)		
	31		40(Y) S3F		
	32		3633L 2630L		
	33		L529L L4(1-1)		
	34		4029L L0(T3)		
	35		3629L L5(N)		
	36		L4(J) 4237L		
	37		50F 75F	by 5,36L	$n_i n_j$ at 0F
	38		S1F 40F		
287	39		50(Y) 75(S)		$(S_{n_{ij}} - n_i n_j)$ at 1F
288	40		S5F L4F		
	41		401F 2642L	by 20(A3)	
	42		L5(VR) L4(J)		
	43		4245L L51F		
	44		0014F 401F		
	45		50F 75F	by 7,43L	$\sqrt{n_i(S - n_i)\, n_j(S - n_j)} \times 2^{-24}$

LOCATION			ORDER	NOTES	PAGE 8
Abs.	Rel.	Sym.			
	46		40F L71F		
	47		LOF 3667L		
	48		L51F 66F		
	49		75(SC) 001F		$\phi_{ij} = \dfrac{S_{n_{ij}} - n_i n_j}{\sqrt{n_i(S - n_i)\, n_j(S - n_j)}} \times 10^{-1}$
	50	(PR)	50F 5050L	by 14(A)	
	51		26(P16) 001F		
	52		F5(J) 42(J)		
	53		L03(Q) 3258L	by 1,3L	Test: End of row
	54		F5(Z) 42(Z)		
	55		L07(P) 3618L		Test: End of page
	56		92131F 92515F		
	57		41(Z) 2618L		
	58		00F 92770F		
	59		92135F 92515F		
308	60		F5(I) 42(I)		
	61		L02(Q) 3262L		
	62		264L 92135F		End of matrix
	63		92515F 26(C3)		$Cov_{ij} = \dfrac{S_{n_{ij}} - n_i n_j}{S^2}$
	64		50(0) L51F		
	65		66(SS) S5F		
	66		2250L 00F		
	67		41F 2250L		Variance = zero
			00K		Print: MEANS, STANDARD DEVIATION
316	0	(C3)	92259F 92643F	from 63(C2)	
	1		92194F 92387F		
	2		92770F 92706F		
	3		92707F 92323F		
	4		92961F 92259F		
	5		92706F 92322F		
	6		92707F 92643F		
	7		92961F 92259F		
	8		9267F 92194F		
	9		92323F 92707F		
	10		92643F 92131F		
	11		9259F 92131F		

LOCATION			ORDER	NOTES	PAGE 9
Abs.	Rel.	Sym.			
			OOK		
328	0	(C4)	50(0) L5(S)	from 11(C3)	Calculate means
	1		0027F 40(X)		and standard deviations
	2		L5(N) 424L		
	3		L5(VR) 429L		
332	4		41(U) L5F	by 2L	$\frac{n_i}{S}$ = mean
	5		L0(S) 3618L		
	6		L4(S) 50(0)		
	7		66(S) S5F		
	8	(PR1)	50F 508L	by 14(A)	$\frac{\sqrt{n_i(S - n_i)}}{S}$ = St. Dev.
	9		26(P16) L5F	by 3L	
	10		66(X) S5F		
	11	(PR2)	50F 5011L	by 15(A)	
	12		26(P16) 92131F		
	13		92515F F54L		
	14		424L F59L		
	15		429L F5(U)		
	16		42(U) L0(V)		
	17		3619L 224L		
	18		41F 228L		
	19		92770F 92131F		
	20		9259F 92131F		
			OOK		
349	0	(C5)	92259F 92135F	from 20(C4)	Print: POSITIVE RESPONSES
	1		92981F 922F		
	2		92578F 92706F		
	3		92514F 92322F		
	4		92514F 92323F		
	5		92194F 92961F		
	6		92258F 92194F		
	7		92706F 922F		
	8		92578F 92770F		
	9		92706F 92194F		
	10		92706F 92707F		

LOCATION			ORDER	NOTES	PAGE 10
Abs.	Rel.	Sym.			
	11		92131F 92515F		
	12		92131F 26(C6)		
			OOK		
362	0	(C6)	L5(V) L0(1)	from 12(C5)	Set-up for page output
	1		40(U) 41(X)		
	2		F5(X) 42(X)		
	3		L5(U) L0(5)		
	4		40(U) 362L		
	5		41(Y) 41(Z)		
	6		F5(0) 40(U)		
	7		L5(N) 423(C7)		
			OOK		
370	0	(C7)	41(I) L5(U)	from 7(C6)	Print page of n_i
	1		J24F 501L		
	2		26(P16) 92835F		
	3		50(0) L5F	by 7(C6)	
	4		525F 504L	11,15(C7)	
	5		26(P16) F5(Z)		
376	6		42(Z) L0(5)		
	7		3612L L5(U)		
	8		L4(X) 42(U)		
	9		F0(V) 3612L		
	10		L53L L4(X)		
	11		423L 22L		
	12		41(Z) F5(Y)		
	13		42(Y) L4(1)		
	14		40(U) L0(1)		
	15		L4(N) 423L		
	16		F5(I) 42(I)		
	17		L0(X) 3219L		
	18		92131F 92519F		
	19		22L 9259F		
	20		92131F 92131F		Stop: Black, new parameter white, read data
	21		24(A) 26(B)		

LOCATION			ORDER	NOTES	PAGE 11
Abs.	Rel.	Sym.			
			00K		Subscripts for first and last
392	0	(Q)	00F 00F		coefficients i - 1
	1		00F 00F	by (A3)	j - 1
	2		00F 00F		r
	3		00F 00F		s
			00K		Store of parameters
396	0	(P)	00F 00F		d
	1		00F 00F		x
	2		00F 00F	by 7(A1)	i
	3		00F 00F		j
	4		00F 00F		r
	5		00F 00F		s
	6		00F 00F		
	7		80F 00F	by 2, 12(A)	
	8		00F 00(P)		Number elements per row
	9		00F 00F	by 3, 22(A)	triangular or square
	10		00F 00F	by 3, 26(A)	complete or incomplete
	11		00F 00F	by 4, 19(A)	phi or covariance
			00K		Input parameters
408	0	(A1)	K5F 4211L	from 5,25(A1)	
	1		41F 914F		
	2		324L 221L		
	3		914F 324L		
	4		267L 50F		
	5		74(10) S5F		
	6		40F 263L		
	7		L5F 40F	by 1,6(A)	Store d, x, (i, j, r, s)
	8		F57L 427L		
	9		L51F L41F		
	10		401F 361L		
419	11		50(0) 22F		
			00K		Read parameters
420	0	(A)	191F 401F	from 9(C1)	
	1		L58(P) 427(A1)	21(C7)	
	2		L5(1) 427(P)		

LOCATION			ORDER	NOTES	PAGE 12
Abs.	Rel.	Sym.			
	3		419(P) 4110(P)		
	4		4111(P) 504L		
	5		26(A1) F57(A1)		
	6		427(A1) L51(P)		
	7		L028L 3627L		
	8		50(0) F5(P)		
	9		007F 40F		
	10		L5(65) 66F		
	11		S5F 1032F		
	12		427(P) 2613L		
	13		L5(P) 0020F		
	14		46(PR) 46(PR1)		
	15		46(PR2) 50(0)		
	16		L51(P) 102F		
	17		L0(1) 3218L		
	18		2219L L57(P)		
	19		4011(P) 011F		
440	20		L0(1) 3221L		
	21		2222L L57(P)		
	22		409(P) S3F		
	23		3226L 193F		
	24		401F 5024L		
	25		26(A1) L57(P)		
	26		4010(P) 26(A2)		
	27		401(P) 2613L	from 7L	
448	28		00F 008F		
			00K	from 26(A)	Title:
449	0	(A2)	9259F 92135F		PHI COEFFICIENTS
	1		92259F L511(P)		or
	2		368L 92835F		COVARIANCES
	3		92578F 92323F		
	4		92387F 92258F		
	5		92514F 92387F		
	6		92770F 92835F		

LOCATION			ORDER	NOTES	PAGE 13
Abs.	Rel.	Sym.			
	7		92194F 2615L		
	8		922F 92771F		
	9		92514F 92961F		
	10		92835F 92578F		
	11		92194F 92902F		
	12		92514F 92835F		
	13		92514F 92194F		
	14		92770F 92322F		
	15		92706F 92135F		
465	16		92707F 26(A3)		
			00K		Interpret parameters
466	0	(A3)	9259F 9259F	from 16(A2)	
	1		92135F L5(SI)		
	2		L4(W) 42(T1)		Set test constants
	3		0020F 46(T3)		
	4		L5(SJ) L4(W)		
	5		42(T2) 42(T3)		
	6		L510(P) 3613L		Set i, j, r, s in (Q)
	7		L53(P) L0(1)		
	8		40(Q) L55(P)		
	9		402(Q) L54(P)		
	10		L0(1) 401(Q)		
	11		L56(P) 403(Q)		
	12		2215L 00F		
	13		41(Q) 401(Q)		
	14		L5(V) 402(Q)		
	15		403(Q) L511(P)		
	16		3219L 50(S)		For S^2
	17		75(S) S5F		
	18		40(SS) L5(TS3)		
	19		2620L L5(TS2)		
486	20		4241(C2) 26(C2)		
			00K		
487	0		L3F 34(B)		Sum check and stop

LOCATION			ORDER	NOTES	PAGE 14
Abs.	Rel.	Sym.			
	1		FFF 26(B)		
	2		NS0800F FF3052F		
490	3		26L 261N		