TITLE: Triangular matrix preparation subroutine for data consisting of tallies

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CLASSIFICATION: F1

ABSTRACT: Prints out and stores the summation triangular matrix of products and cross products given N records of n variables with all variables equal to zero or one (typed as some "tally" symbol), as would occur in the tabulation and cross tabulation of questionnaires, etc. The summation matrix may be put into floating point 24.0 format if desired.

DESCRIPTION:

For a series of N records each consisting of a string of n 0's and X's, the program counts how many records have X's in both the i'th and j'th positions (for every i j). This produces the summation triangular matrix of products and cross products for the data, with the tally marks "X" assigned the numerical value 1. That is, if we define x_i as 1 if there is an "X" in the i'th position in a record, and as 0 if there is a "0", then the program calculates $\Sigma x_i x_j$ (i j), the Σ sign representing summation over the N records.

In place of "X" any other character which doesn't input into the LGP-30 as zero can be used for the tally mark, since the program merely asks: zero or non-zero.

The method used is a double looping system keeping track of the row and column of the matrix that is being prepared. A test is made of the values of x_i and x_j (either a tally or a zero). If x_i is zero, an entire row is skipped. If both x_i and x_j are tallies, 1 is added to the corresponding matrix element. Otherwise, the matrix element is left unchanged.

The matrix is formed in fixed point at q=10. When the summations are completed, the matrix is converted into 24.0 floating point format, unless the computer is halted at a breakpoint stop.

On the data tape each of the N strings of 0's and X's will be preceded by a record number, which may be a serial count 1,2,...,N or anything else which is convenient, except 0. This number is treated as an additional (first) variable by the program. Since the record numbers are not zero, the first row of the matrix provides the summations Σx_j and even (in the upper left hand corner) $\Sigma 1 = N$.

The program can be used either as a complete program or as a subroutine. If it is used as a complete program, and the exit U[0000] hasn't been set otherwise, the computer returns to the Lo of the program when floating is finished, unless halted at a breakpoint stop.

Use as a subroutine:

The calling program must put initializing information into locations 6232-6236, as follows:

6232: 10 at q=29
6233: n (number of variables) at q=29
6234: N (Number of records) at q=29
6235: Lo of record
6236: Lo of matrix.

The "10" is "q of printout", the scaling at which the matrix is formed. If a scaling other than 10 is desired -- for example, if there are 1024 or more records -- this can be changed; Lo + 0149 in the program should be changed correspondingly to 1 at q of printout (now 1 at q=10).

"Lo of record" is the address of the first of a group of n+1 consecutive locations which are available for the storage of each record (preceded by the record number) in turn.

"Lo of matrix" is the address of the first of a group of (n+1)(n+2)/2 locations which are available for the storage of the matrix. The arrangement of the matrix in memory will be: first, $\Sigma 1 = N$; then the $\underline{n}$ Σx_j's; then the $n(n+1)/2$ $\Sigma x_i x_j$'s.

After this information is stored by the calling program -- possibly by a series of five Bring-Hold instruction pairs -- the linkage

```
R  (Lo + 0231)
U  (Lo)
```

can be used. When the subroutine has read the records, printed the matrix, and floated it, it will exit to the instruction following the U (Lo). The initializing information will remain unchanged.

Use as a program:

The records tape, described below, should be preceded by the initializing information arranged for storage by the program input routine into 6232-6236, and a stop-and-transfer to the program:

```
;0006232'
xz0010'
xz(n, the number of variables)'
xz(N, the Number of records)'
xz(Lo of record)'
xz(Lo of matrix'
.000(Lo of program)'
```

Data preparation:

There is a choice of input routines, and a corresponding variation in format.

If the half-track "Input Hex Characters" subroutine supplied with this program is used, prepare a data tape with the records punched consecutively in the format

record number'X_1'X_2'...'X_n'

Here "record number" may be filled in in any desireable or convenient way, except as zero. The X's are each either "0" or space or blank, or a tally symbol such as "X" or "1" or "/".

Instead of "Input Hex Characters", 11.2 (Data Input Routine 3) can be used. In this case each record should be punched as

0+29(Lo of record)'record number'X_1'X_2'...'X_n'-0000000'' .

Here the address, Lo of record, is the same as that which has been stored in 6235. The -0000000'' is the standard exit code for 11.2. Record number and the X's are as before.

Output arrangement:

N	Σx_1	Σx_2	...	...	...	Σx_n
	$\Sigma x_1 x_1$	$\Sigma x_1 x_2$	...	...	...	$\Sigma x_1 x_n$
		$\Sigma x_2 x_2$	...	...	...	$\Sigma x_2 x_n$
			...	...	...	...
				...	...	...
					...	...
						$\Sigma x_n x_n$

The program types varying numbers of spaces to the left of each line to produce the triangular arrangement.

Note that the diagonal $\Sigma x_i x_i$ are the same as Σx_i, since the x's are 0 or 1.

Subroutines required:

1) EITHER "Input Hex Characters", (supplied with this program) stored Lo = 0300,

OR 11.2 Data Input No. 3, Lo = 0300.

[Both have the calling sequence xr0308'xu0300'.]

2) 12.1A Data Output No. 2 with Zero Suppression, Lo = 0600, with the following changes:

Lo + 0130: xp0309 (print space)
Lo + 0207: xz0000 (print no fractional part of number).
These locations originally contained xp2402 and xz0007 resp.

3) If the matrix is to be floated,
25.0R Float and Unfloat Subroutine, Lo = 0900.

Storage required:

Program: 2 1/2 consecutive tracks
{EITHER "Input Hex Characters": 1/2 track
{OR 11.2: 3 tracks
12.1A: 3 tracks
25.0R, if used: 3 tracks
track 62 storage: sectors 32-36, 60-63
record storage: n+1 sectors
matrix storage: (n+1)(n+2)/2 sectors

Program stops:

Lo + 0034	bkpt 4	between initialization and reading first record
Lo + 0036	bkpt 8	before printout
Lo + 0151	bkpt 4	before reading each record except the first
Lo + 0212	bkpt 4	between printout and floating of matrix
Lo + 0230	bkpt 8	after floating matrix, before exiting

Time:

The time depends on the number and position of zeroes in the records. A typical problem with 21 variables required about 18 seconds per record. The sample problem (13 records, 8 variables) takes 7 seconds for initialization, 1 minute 47 seconds for reading the records and forming the matrix, 1 minute 18 seconds for printing out the matrix, and 17 seconds for floating it: a total time of 3 minutes 29 seconds.

Tape description: The tape supplied by POOL is arranged:

Title, POOL number, date, 8 spaces, tape feed, coding of program, ;0006300'.0000000', tape feed, "Input Hex Characters" subroutine (title, 8 spaces, tape feed, coding, ;0006300'.0000000'), tape feed, sample problem data tape.

OPERATING INSTRUCTIONS:

The following is arranged for those using the program as a complete program. Those applying it as a subroutine should be able to adapt these instructions without difficulty.

1) Store the program anywhere that 2 1/2 tracks are available.

2) Store "Input Hex Characters" or 11.2, Lo = 0300.

3) Store 12.1A, Lo = 0600.

4) Change machine location 0730 to xp0309,
0807 to xz0000.
(These are changes to 12.1A.)

5) If the matrix is to be floated, store 25.0R, Lo = 0900.

6) Set switches: transfer control UP,
breakpoint 4 DOWN,
breakpoint 8 UP,
breakpoint 32 UP.

7) Place the data tape, beginning with the fill of initializing information into 6232-6236, in the typewriter tape reader.

8) Transfer to the program input routine to read the initializing information and the stop-and-transfer to the program from the tape. Computer will stop at a breakpoint 32 in the program input routine.

9) If the read-in of the records is wanted on a separate sheet, adjust the paper in the typewriter.

10) Press START. Computer will initialize constants and clear the matrix area. Then the records will read in, one by one. Breakpoint 4 can be raised to stop the computer before reading in the next record, if necessary.

11) When all the records have read in (and simultaneously the matrix has been completed) there will be a breakpoint 8 stop. If the matrix printout is wanted on a separate sheet, adjust the paper in the typewriter.

12) Raise breakpoint 4 if floating is not desired, and press START. The printing will commence.

13) (If transfer control is depressed at any time, all remaining printing will be skipped following completion of the current line.)

14) When the matrix printing is finished there will be a breakpoint 4 stop if the switch was raised in Step 12. For many applications this is the end of the program. However, if the matrix is to be floated in memory (that is, if each element, now in fixed point at q=10, is to be replaced in memory by its 24.0 floating point equivalent) press START. After floating the matrix the computer will stop at a breakpoint 8. Another START takes the program to the exit U[0000].

RELATIONSHIP TO F2-129:

If the data consists of 0's and 1's only, this program can be used in place of "Least Squares Fixed Point Triangular Matrix Preparation", the first of the seven subroutines comprising POOL program F2-129. The allocation of space for the subroutines and for the track 62 information is the same. There will be a considerable saving of time, especially when there are many 0's in the data, and when "Input Hex Characters" is used.

There are, however, two points to be noted.

1) F1-139 is twelve sectors longer than subroutine 1 in F2-129. If the suggested storage scheme of F2-129 is retained, giving this program Lo = 3000, it overlaps the beginning of subroutine 2, "Triangular Matrix Scaling". This is not as serious as it may seem, since subroutine 2 would never be used with "tally" data since all the variables are already normalized. (Subroutine 2 is not used in the sample problem of F2-129 either.)

2) Subroutine 7 of F2-129, calculating the last variable according to the regression plane, requires the input to be of true 0's and 1's (not an arbitrary "tally" symbol such as "x"), and needs the number 1 where we have put the record number. It also uses 12.1A in its standard form, not modified to "cram" the line as in F1-139. But it is unlikely that Subroutine 7 will often be used when the data consists of tallies, so these difficulties will not in fact arise.

ASSOCIATED SUBROUTINE:

Input Hex Characters and store at q=29

Purpose: To input zeros or hex characters (i.e. X's, etc.), shift to q=29, and store. n+1 values starting at the Lo specified in 6235 (Lo of record) are stored in sequence.

Coding information:

1) The following information must be supplied:

   6233: n at q=29
   6235: Lo of record

2) Linkage: R (Lo + 0008)
   U (Lo)

3) Storage:

subroutine:	32 consecutive sectors
records:	n+1 sectors
track 62:	sectors 33 and 35

The coding is reproduced in this manual following that of the triangular matrix preparation subroutine itself.

SAMPLE PROBLEM:

The data for the sample problem is punched for the program starting in 3000, and using "Input Hex Characters". Note that the changes required in 12.1A are punched on the data tape for convenience.

On the next page is reproduced the computer run of the problem, from the read-in of the data tape through the printout of the matrix. The floating of the matrix was included in this computer run, but since floating produces no output this can't be seen from the printout.

As was stated before, on one particular computer-flexowriter combination the run took a total of 3 minutes 29 seconds, from the transfer to 3000 through the floating of the matrix.

```
;0003000'/0003000'      store program

;0000300'/0000300'      store INPUT HEX CHARACTERS

;0000600'/0000600'      store 12.1A

;0000900'/0000900'      store 25.0R
```

by hand

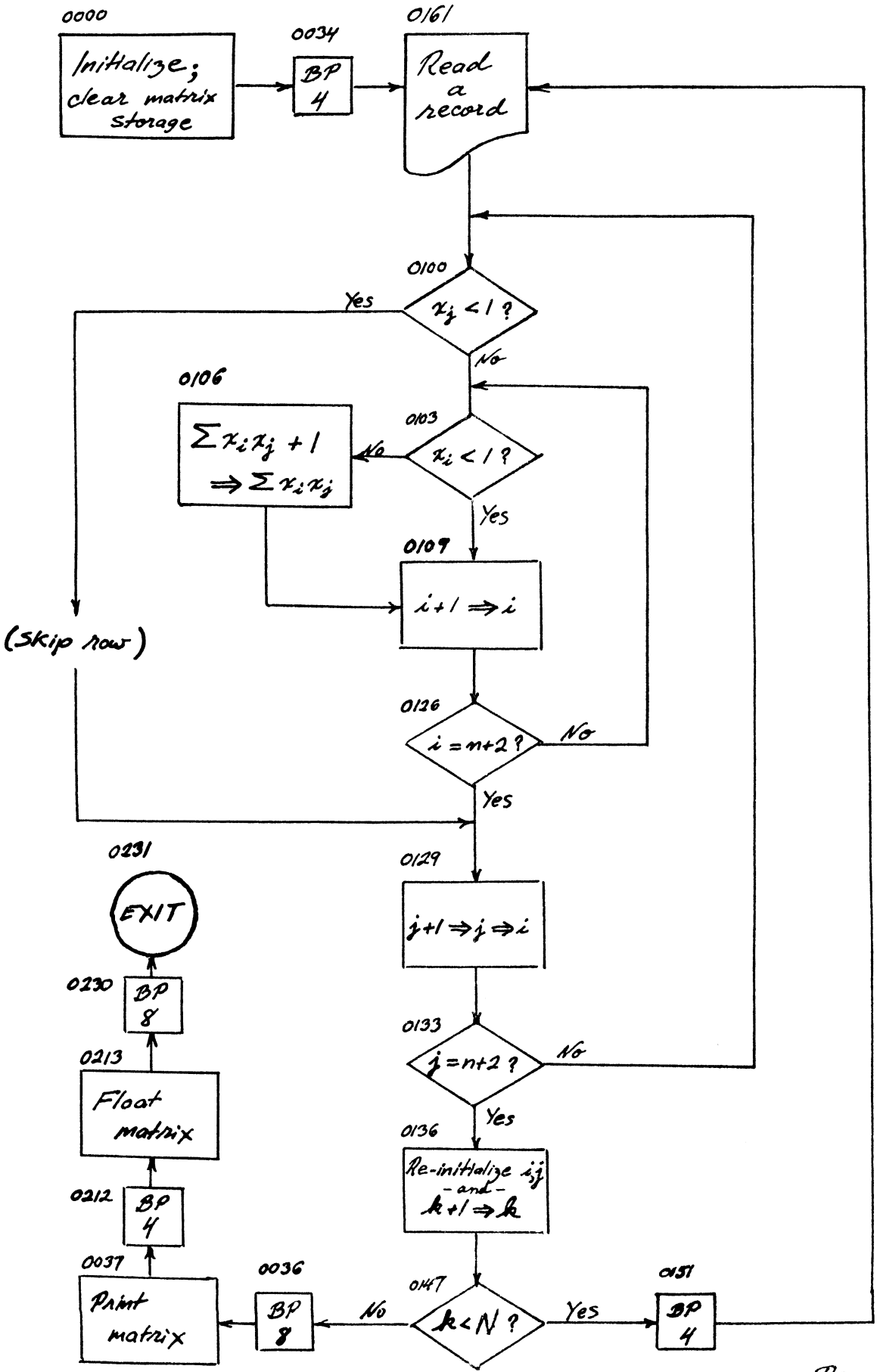
```
DATA TAPE FOR SAMPLE PROBLEM FOR F1-139

;0000730'xp0309'  modifications in 12.1A
;0000807'xz0000'

;0006232'
xz0010'  q of printout
xz0008'  no. of variables
xz0013'  no. of records
xz6200'  Lo of record
xz4000'  Lo of matrix

.0003000'

R1 '0'0'x'0'x'x'x'0'
R2 'x'x'0'0'x'x'0'0'
R3 '0'x'0'0'0'x'x'x'
R4 '0'0'0'0'0'0'0'0'
R5 'x'x'x'0'0'x'x'x'
R6 '0'x'0'0'x'x'x'0'
R7 'x'x'0'0'0'0'x'0'
R8 '0'0'x'0'0'0'0'0'
R9 '0'0'x'0'0'0'0'0'
R10'x'0'x'0'x'0'x'x'
R11'x'x'x'0'0'0'0'0'
R12'x'0'0'0'0'0'0'0'
R13'0'x'0'0'x'x'x'x'
```

data tape

```
 13.    6.    7.    6.     .    5.    6.    7.    4.
        6.    4.    3.     .    2.    2.    3.    2.
              7.    2.     .    3.    5.    5.    3.
                    6.     .    2.    2.    3.    2.
                           .     .     .     .     .
                                 5.    4.    4.    2.
                                       6.    5.    3.
                                             7.    4.
                                                   4.
```

output

FLOW CHART ---------- for POOL Program No. F1-139



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JOB NO.	PROGRAM NO.	PROGRAM PREPARED BY:	PROGRAM CHECKED BY:	DATE
	F1-139	AGR & WFB	POOL review	9/30/59

PROBLEM: Triangular Matrix Prep. for data consisting of tallies | TRACK

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
;0000(40)	'						
/0000(40)	'	☒					
		000	XB	62333	'	n @ 29	(n = no. of variables)
		001	A	01118	'	1 @ 29	
		002	XH	62611	'	(n+1) @ 29	
		003	A	01118	'	☒ 1 @ 29	
		004	XH	62622	'	(n+2) @ 29	
		005	XN	62611	'	(n+1) @ 29	
		006	M	01400	'	1 @ 3	
		007	XC	62633	'	☒ $\frac{(n+1)(n+2)}{2}$ @29	
		008	XB	62355	'	Lo record	Initialize matrix preparation
		009	Y	01000	'		
		010	Y	01033	'		
		011	Y	01155	'	☒	
		012	XA	62611	'	(n+1) @ 29	
		013	Y	01133	'		
		014	XB	62366	'	Lo matrix	
		015	Y	02188	'	☒	Initialize float
		016	Y	02222	'		
		017	Y	00488	'		Initialize print
		018	Y	00277	'		Initialize clear matrix area
		019	Y	01200	'	☒	Initialize matrix preparation
		020	Y	01088	'		
		021	Y	01077	'		
		022	XA	62633	'	$\frac{(n+1)(n+2)}{2}$ @29	
		023	XC	62600	'	☒ Matrix Lf+1	
		024	XS	62344	'	N @ 29	
		025	C	01177	'	Counter k	
		026	B	00444	'	0	Clear matrix storage area to 0
		027	C	[ ]	'	☒	
		028	B	01144	'	1 @ 29	
		029	A	00277	'		
		030	Y	00277	'		
		031	E	01122	'	☒ xz6363	

FORM LP-10
SC 0516

☒ CARRIAGE RETURN
' CONDITIONAL STOP CODE

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JOB NO. | PROGRAM NO.: F1-139 | PROGRAM PREPARED BY: AGR & WFB | PROGRAM CHECKED BY: POOL review | DATE: 9/30/59

PROBLEM: Triangular Matrix Prep. for data consisting of tallies | TRACK

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	1						
	1	☒					
		32	XS	6260	1	Matrix Lf+1	
		33	T	0026	1		
		34	XE	043	1	BP#4 stop after initialization	
		35	U	0161	1	☒ → to matrix preparation	
		36	XZ	0808	1	BP#8 stop after matrix prep.	
		37	XB	6261	1	(n+1) @ 29	Construct 12.1A code word
		38	XC	6260	1	# of nos. to print	
		39	XB	6260	1	☒ "	
		40	N	0200	1	1 @ 25	
		41	XA	6232	1	# of printout	
		42	Y	0051	1	XZ[NN99]	
		43	XP	1600	1	☒	carriage return delay
		44	XZ	0000	1		
		45	XB	6260	1	# of nos. to print	
		46	XS	6261	1	(n+1) @ 29	
		47	T	0205	1	☒ → print spaces	
		48	B[	]	1	to first number in row	
		49	XR	0605	1		12.1A linkage
		50	XU	0600	1		
		51	XZ[	]	1	☒	XZ[NN88]
		52	XB	6260	1	# of nos. to print	
		53	A	0048	1		
		54	Y	0048	1		
		55	XB	6260	1	☒ "	
		56	S	0114	1	1 @ 29	
		57	XH	6260	1		
		58	S	0118	1		
		59	8 00 T	0212	1	☒ → exit printout of matrix	
		60	U	0053	1		
		61	E	0112	1	XZ6363	
		62	XS	6260	1	Matrix Lf+1	
		63	U	0229	1	☒	

FORM LP-12 — 2

☒ CARRIAGE RETURN

1 CONDITIONAL STOP CODE

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PREPARED FOR: LGP-30, RPC-4000 USERS ORGANIZATION - POOL

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JOB NO.	PROGRAM NO.	PROGRAM PREPARED BY:	PROGRAM CHECKED BY:	DATE
	F1-139	AGR & WFB	POOL review	9/30/59

PROBLEM: Triangular Matrix Prep. for data consisting of tallies

TRACK:

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	'						
	'	☒					
		0100	B[ ]		'	x_j @29	
		01	S	0116	'	1 @29	
		02	T	0153	'	→ (skip row)	
		03	B[ ]		' ☒	x_i @29	
		04	S	0119	'	1 @29	
		05	T	0109	'	→ (skip element)	
		06	B	0149	'	1 @10	
		07	A[ ]		' ☒	$\Sigma x_i x_j$ @29	
		08	C[ ]		'	"	
		09	B	0107	'		
		10	A	0160	'	1@29	
		11	U	0121	' ☒		
		12	XZ	6363	'		Address mask
,00000008	'	13	[ ]		'		L_{fr1} x_i
		14		4	'		1@29
		15	[ ]		' ☒		L_o x_j
		16		4	'		1@29
		17	[ ]		'		counter k (starts -N@29)
		18		4	'		1@29
		19		4	' ☒		1@29
		20	[ ]		'		L_o matrix
		21	Y	0107	'		
		22	Y	0108	'		
		23	B	0159	' ☒	1@29	
		24	A	0103	'	B[x_i]	
		25	Y	0103	'		
		26	E	0112	'	xz6363	
		27	S	0113	' ☒	L_{fr1} x_i	
		28	T	0103	'		
		29	B	0100	'	B[x_j]	
		30	A	0159	'	1@29	
		31	Y	0103	' ☒		

☒ CARRIAGE RETURN

' = CONDITIONAL STOP CODE

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JOB NO. | PROGRAM NO. F1-139 | PROGRAM PREPARED BY: AGR & WFB | PROGRAM CHECKED BY: POOL review | DATE 9/30/59

PROBLEM: Triangular Matrix Prep. for data consisting of tallies | TRACK

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	'						
	'	☒					
		01 32	Y	01100	'		
		33	E	01112	'	xz6363	
		34	S	01113	'	Lf+1 x_i	
		35	T	01100	'	☒	
		36	B	01115	'	Lo x_i	
		37	Y	01100	'		
		38	Y	01103	'		
		39	U	01141	'	☒	
,00000001	'	40	10000000		'		1@3
		41	B	01120	'	Lo matrix	
		42	Y	01107	'		
		43	Y	01108	'	☒	
		44	B	01159	'	1@29	
		45	A	01117	'	counter k	
		46	H	01117	'	"	
		47	T	01151	'	☒	
		48	XP	16210	'		carriage return
,00000001	'	49	20	00000	'	delay and	1@10 (=1@ of printout)
		50	U	00036	'	→ to matrix printout	
		51	XZ	04021	'	☒ BP #4	stop after each record
		52	U	01161	'		
		53	B	01107	'	A[$\Sigma x_i x_j$]	
		54	S	01100	'	B[x_i]	
		55	A	01113	'	☒ Lf+1	record
		56	Y	01107	'		
		57	Y	01108	'		
		58	U	01129	'		
		59	XZ	00011	'	☒	1@29
		60	XZ	00011	'		1@29
		61	XR	03038	'		Data Input
		62	XU	03000	'		
		63	U	01000	'	☒	

☒ CARRIAGE RETURN

' = CONDITIONAL STOP CODE

FORM LP-12

ROYAL MCBEE J13541X

PORT CHESTER, NEW YORK

PREPARED FOR: LGP-30, RPC-4000 USERS ORGANIZATION – POOL

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JOB NO. | PROGRAM NO. F1-139 | PROGRAM PREPARED BY: AGR & WFB | PROGRAM CHECKED BY: POOL review | DATE 9/30/59

PROBLEM: Triangular Matrix Prep. for data consisting of tallies | TRACK

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	1						
	1	☒					
		0200	XZ	0016	1		delay & 1@25
		01	T	0209	1	→ print spaces	
		02	B	0117	1		
		03	A	0118	1	☒	
		04	U	0047	1	→ test for another word	
		05	C	0117	1	# of words to space	
		06	S	0228	1	6, # of spaces/word	
		07	U	0201	1	☒	
		08			1		
		09	XP	0352	1		"space"
		10	A	0160	1	1@29	
		11	U	0200	1	☒	
		12	XZ	0400	1	BP #4 stop before floating matrix	
		13	XB	6232	1	q of printout @29	
		14	Y	0221	1		
		15	XB	6236	1	☒	
		16	XA	6263	1		
		17	XC	6260	1		
		18	B	[ ]	1		
		19	XR	0925	1	☒	25.0R Float subroutine
		20	XU	0900	1		
		21	XZ	[ ]	1		xz [8]
		22	C	[ ]	1		
		23	B	0218	1	☒	
		24	A	0114	1	1@29	
		25	Y	0218	1		
		26	Y	0222	1		
		27	U	0061	1	☒	
		28	XZ	0006	1		6@29, # of spaces/word
		29	T	0218	1		
		30	XZ	0800	1	BP #8 stop before exiting	
		31	U	[0000]	1	☒	EXIT

FORM LP-10

☒ CARRIAGE RETURN

1 : CONDITIONAL STOP CODE

PREPARED FOR: LGP-30, RPC-4000 USERS ORGANIZATION - POOL

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JOB NO. | PROGRAM NO.: USED WITH FI-139 | PROGRAM PREPARED BY: WPB | PROGRAM CHECKED BY: POOL review | DATE: 8/15/59

PROBLEM: Input Hex Characters (and store at q = 29) | TRACK: 0300

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
;0000300	'						
/0000300	'	☒					
		00	XB	6235	'	Lo of record	← "U" here
		01	Y	0011	'		
		02	XA	6233	'	n @ 29	
		03	A	0025	'	☒ 1 @ 29	
		04	H	0031	'	Lf+1 record	
		05	C	0020	'	dump	loop
		06	XP	0028	'		
		07	U	0009	'	☒	
		08	U[	]	'		← EXIT, "R" here
		09	XI	0000	'		
		10	N	0025	'	1@29	
		11	C[	]	'	☒	store word
		12	B	0011	'		
		13	A	0028	'	1@29	
		14	Y	0011	'		
		15	E	0030	'	☒ xz6363	
		16	S	0031	'	Lf+1 record	
		17	T	0005	'	loop	
		18	U	0008	'	→ to exit	
		19			'	☒	
		20	[	]	'		dump
		21			'		
		22			'		
		23			'	☒	
		24			'		
		25	XZ	0001	'		1@29
		26			'		
		27			'	☒	
		28	XZ	0001	'		1@29
		29			'		
		30	XZ	6363	'		Address mask
		31	[	]	'	☒	Lf+1 record

FORM LP-10

☒ = CARRIAGE RETURN

' = CONDITIONAL STOP CODE