TITLE: Statistical Subroutines
Fixed Point Input

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POOL Program no. - F2-129

Compumatix Statistical Subroutines

Fixed Point Input

I. Storage Allocation

A) Standard Subroutines

Program#	Location	Description
10.4	0000-0263	Program Input
11.2	0300-0563	Data Input (Fixed)
12.1a	0600-0850	Data Output (Fixed)
25.0R	0900-1163	Float - Unfloat
24.0	1200-2163	Floating Point Interpretive
11.6-12.6	2200-2763	Floating Point Input-Output
29.0	2800-2963	Matrix Inversion

B) Statistical Subroutines:

Sample Problem	Location	Description
1	3000-3218	Fixed Point Δ Matrix Prep, Print, Float
2	3219-3263 *	Δ Matrix Scale
3	3300-3515	Calculate Means, Standard Deviations and Correlation Coefficient Δ Matrix (Print)
4a	3516-3606	Convert Δ Rij Matrix to □ Rij Matrix (Modified)

(Statistical subroutine - cont'd)

Sampe Problem	Location	Description
5	3607-3660	Invert □ Rij matrix and print
	3661	XP1600
6a	3662-4005	Compute and print: Beta Weights, Regression Coefficients; Partial Correlation Coefficient and Standard Error of the Independent Variables; the Constant Term (b_0) and its' standard error; the Sample Multiple Correlation Coefficient and Standard Error of Estimate; the Universe Multiple Correlation Coefficients and Standard Error of Estimate.
	4006	XZ0000 stop
7	4007-4060	Compute Y, Y_{cal} ($Y-Y_{cal}$) and print (Fixed Point)

C) Data and Computational Storage

Area	For	Required
4100-4131	Standard Deviations	n
4132-4163	Coefficient of Equation	n
4200-6131	Δ Data matrix and correlation) Coefficient Matrix) □ Rij matrix and inverse)	$n^2 + 2n + 1$
4201-4201+n	Means	n
6132-6163	Scale Factors	(n+1)
6200-6231	Record	(n+1)
6232-6263	Temp. and Line Set	-----

(Data and Computational Storage - Con'd)

Area	For	Required
6300-6363	Temp. for Floating Point, etc.	------

* Note: 3219 XU3300 (To skip scaling)

3219 XU3220 (To do scaling)

3220 XR1200)
3221 XU1200) Enter Floating Point

3222 XI0000 Read Scale Factors

3223 XE0000 Exit F.P.

3224 Lo Matrix scaling sub.

II. Operation:

A) Load hex tapes A and B (See storage allocation A and B for tape contents). Note exception: 10.4 is not on tape A or B.

B) Insert sample problem data tape in the typewriter and depress break points 4 and 8. Start the tape reading via a program input routine (10.0, 10.3 or 10.4). All start fill and transfers are on the tape.

C) The computer will halt on the stop and transfer instruction (.0003000'). A start compute signal will initiate the computation (or B.P. 32 could have been depressed).

D) The program will proceed to the completion of the regression analysis and then stop in location 4006 (XZ0000).

E) A start compute signal will cause an entry into the subroutine to compute the residuals, $(Y-Y_{cal})$. Although the regression equation coefficients are stored correctly by the subroutine that computes them, they are in floating point and must be entered in the correct order in fixed point before the first record of the original data is read. This information is on the sample problem data tape.

III. Format:

A) Set carriage return stop at 4.

B) Set tabs at 12, 20, 28, 36, 44, etc. n+1 tabs. (8 numbers apart).

C) For very large problems the automatic C.R. must be used or all spacing tabs in program 1 and 3 removed (see write ups) and a column type printout used.

D) Since break points separate every major phase of this group of subroutines, these spaces may be used for exits to heading printing operations or other calculations, without disrupting actual program steps.

IV. General:

A) The subroutine designated as "No. 2" (scaling) has not been used in this sample problem since then, in general, special handling would be required in the residual computation.

B) The subroutines were assembled except for locations 3219-3223 and 4006 by filling the following subroutine Lo on top of the previous subroutine L_f.

FIXED POINT DATA

COMPUMATIX, INC.

SAMPLE PROBLEM STATISTICS SUBROUTINES

;0006232'

xz0010'	q of printout
xz0003'	no. of variables
xz0005'	no. of records
xz6200'	Lo. of record
xz4200'	Lo of Δ data matrix
xz1200'	Lo. of floating point
xz4201'	Lo. of means
xz4100'	Lo. of standard deviations
xz0000'	Lo. of sq. Rij matrix
xz6132'	Lo. of scale factors
xz2800'	Lo. of matrix inversion (29.0)
xz4132'	Lo. of coefficients of regression equation

depress break points 4 and 8 for straight thru operation

to the residual computation

.0003000'

data

0+056200'1''4'1'-0000000''
0+056200'1'1'4'3'-0000000''
0+056200'1'3'3'2'-0000000''
0+056200'1'6'2'5'-0000000''
0+056200'1'8''4'-0000000''

N	ΣX_1	ΣX_2	ΣY
5.00000	18.00000	13.00000	15.00000
	ΣX_1^2	$\Sigma X_1 X_2$	$\Sigma X_1 Y$
	110.00000	25.00000	71.00000
		ΣX_2^2	$\Sigma X_2 Y$
		45.00000	32.00000
			ΣY^2
			55.00000

$\bar{X}_1$		$\bar{X}_2$		$\bar{Y}$	
.3600000	01	.2600000	01	.3000000	01
σx_1		σx_2		σy	
.3006659	01	.1496663	01	.1414213	01
r_{11}		r_{12}		r_{1y}	
.1000000	01	.9688981-	00	.7996129	00
		r_{22}		r_{2y}	
		.1000000	01	.6614376-	00
				r_{yy}	
				.1000000	01

Inverse of r_{ij} matrix

.6084443	02	.4759427	02	.1717134-	02
.4759427	02	.3900739	02	.1225603-	02
.1717134-	02	.1225603-	02	.6623824	01

$\beta x1$		b_{x1}		$r_{1y,2}$		σ_{bx1}	
.2592361	01	.1219344	01	.8553412	00	.5222230	00
$\beta x2$		b_{x2}		$r_{2y,2}$		σ_{bx2}	
.1850295	01	.1748364	01	.7624686	00	.1049098	01
		b_0				σ_{b0}	
		.5935385-	01			.3885488	00
R		σ_{EST}		$\hat{R}$		$\hat{\sigma}_{EST}$	
.9214280	00	.5494909	00	.8354996	00	.8688215	00

regression coefficients

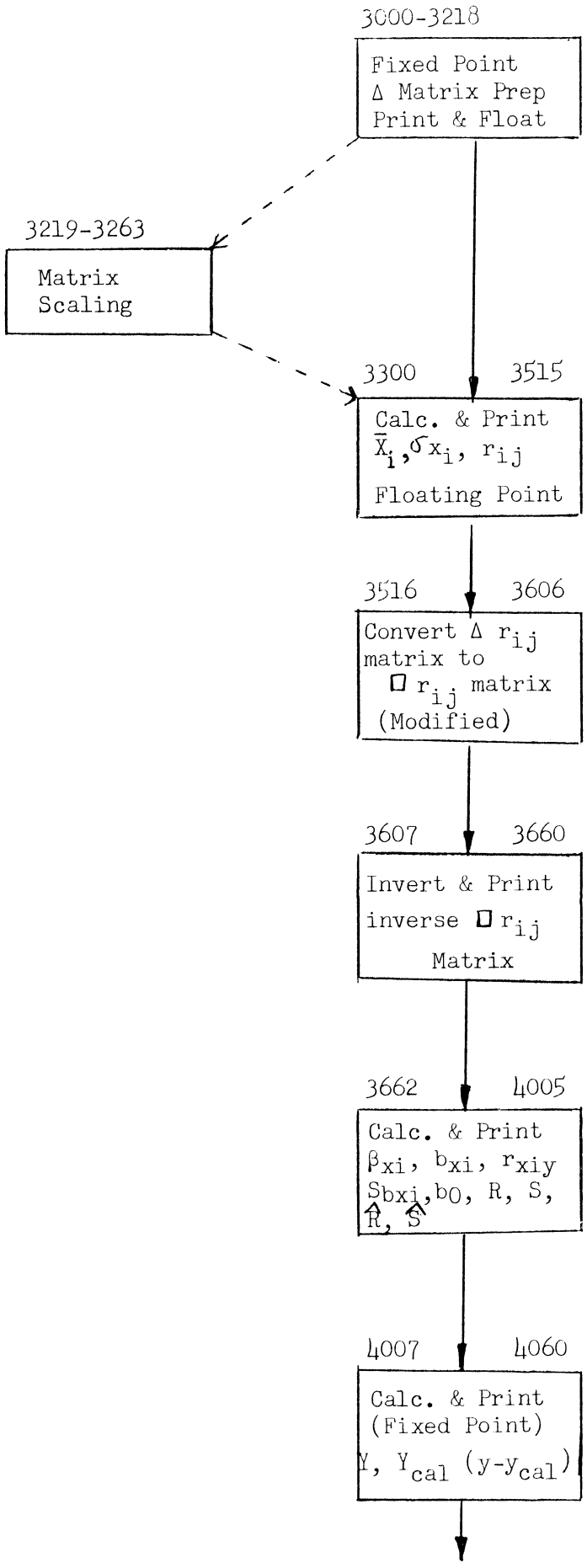
6+054132'-5935385'1219344'1748365'-0000000'

data repeated to compute residuals

printout order Y, Y_{cal}, $(Y-Y_{cal})$

	Y	Y_{cal}	$(Y-Y_{cal})$
0+056200'1''4'1'-0000000''	1.00000	1.05808	- .05808
0+056200'1'1'4'3'-0000000''	3.00000	2.27742	.72258
0+056200'1'3'3'2'-0000000''	2.00000	2.96774	- .96774
0+056200'1'6'2'5'-0000000''	5.00000	4.87741	.12259
0+056200'1'8''4'-0000000''	4.00000	3.81937	.18064

Statistics Subroutines
Fixed Point Data



TITLE: Least Squares Fixed Point Triangular Matrix Preparation

AUTHOR: William F. Burggrabe
Compumatix, Incorporated

DATE: August 31, 1961

PURPOSE: Given N records of n variables of the form 1, X_1, X_2, ... X_n, this subroutine will prepare a fixed point triangular matrix. The matrix rows are stored sequentially in the following format:

$$\begin{array}{llll} N & \Sigma X_1 & \Sigma X_2 & \cdots \quad \Sigma X_n \\ & \Sigma X_1^2 & \Sigma X_1X_2 & \cdots \quad \Sigma X_1X_n \\ & & \Sigma X_2^2 & \cdots \quad \vdots \\ & & & \Sigma X_n^2 \end{array}$$

The matrix is then put into floating point form by sub 25.OR following an optional (T.C. down - no print out) fixed point matrix print out.

RESTRICTIONS:

1) All data are assumed to be at the same q, summations are computed at twice the data q.

2) The following subroutines are required:

Linkage Location	Subroutine	Fixed Storage Location
Lo + 155 and 156	11.2	0300-0563
Lo + 56 and 57	12.1 (a)	0600-0832 (0850)
Lo + 207 and 208	25.OR	0900-1163

3) The following information must be supplied:

Location:

6232 2 x q of data
6233 number of variables
6234 number of records
6235 Lo record
6236 Lo Δ matrix

4) If any summation exceeds the maximum possible number size for 2.q, an overflow stop will occur in Lo + 105, (in general the sum of squares terms will create the most difficulty) and the problem then must be rerun with a greater data q.

5) No limit to the number of records provided no overflow is encountered; the number of variables is limited only by available machine storage.

Required storage: Data Lo to Lo + n + 1

Matrix Lo to Lo + $\frac{(n+1)\ (n+2)}{2}$

6) Data Format:

Initial record.

P + qqRRRR ' 1 ' X_1' X_2' ... X_n' -0000000''

Following records:

P + qq RRRR+1' X_1' X_2' ... X_n' -0000000''

where RRRR = Lo record as stored in (6235)

qq + Half of 2q as stored in (6232)

7) Only the record being processed is stored.

GENERAL INFORMATION ON METHOD:

Since little mathematical description need be given, a description of the program sequence will be outlined here:

1) Initialization

Clear the matrix storage area to zero

2) Semi-optimum matrix preparation.

N-records, n variables

3) Optional print out of fixed point matrix

(Transfer control up)

4) Conversion of fixed point matrix to floating point.

A break point stop separates each phase of the operation, as well as the processing of each record.

CODING INFORMATION:

A) Storage: Subroutine 2 tracks 20 sectors

External storage 6232 thru 6236 as under restriction 3 and the following ...

6260	ctr
6261	n + 1 @ 29
6262	n + 2 @ 29
6263	$\frac{(n+1)\ (n+2)}{2}$ @29

Data Lo to Lo + n + 1
Matrix Lo to Lo + $\frac{(n+1)\ (n+2)}{2}$

B) Linkage and calling sequence: Since this is one of a group of statistical subroutines, location 6232 through 6263 have been reserved for initialization information and no calling sequence is required.

Linkage R Lo + 219

U Lo

C) Input: As described under restriction 3 and 6

D) Output: The computed matrix is stored sequentially beginning in the specified location. It may be printed out in fixed point in the following format:

as per 12.1a				
N	ΣX_1	ΣX_2	...	ΣX_n

as per 12.1a				
Tab	ΣX_1^2	ΣX_1X_2	...	ΣX_1X_n
Tab	Tab	ΣX_2^2	...	ΣX_2X_n etc.

(See sample problem)

The tabs may be suppressed by changing Lo + 0049 to U (Lo + 55).

E) Location of constants:

Lo + 110	1 @ 3
Lo + 114	1 @ 29
Lo + 115	1 @ 29
Lo + 116	3wwj
Lo + 117	3wwj
Lo + 123	1 @ 29

F) The actual matrix preparation time is approximately:

$$\frac{[(n+1)^2]}{12} \text{ N sec: compute time, } + \frac{(n)}{3} \text{ N sec.}$$

Data read time (Photo reader).

G) Program Stops:

Lo + 34 (Break Point 4) after initialization

Lo + 37 (Break Point 8) after completion of matrix prep.

Lo + 154 (Break Point 4) after each record is processed.

Lo + 200 (Break Point 4) after print out of matrix

Lo + 218 (Break Point 8) after floating matrix.

FIXED POINT MATRIX PREPARATION

Operating Procedure:

Prepare data tape as per instructions under input and fill the required storage locations in 6232-6236 as under restriction 3. Insert data tape in reader and transfer to routine Lo or use a main program with the required linkage.

After inialization a stop (BP 4) in Lo + 34 will occur. Depression of start compute will cause the reading of the first record, the necessary computations for that record and an exit to (BP 4) in Lo + 154 prior to reading the next record. (This feature allows for machine stoppage on very large problems).

After all records have been processed, the program will halt on BP 8 in Lo + 37. If it is desired to eliminate the fixed point matrix print out, depress transfer control before continuing the program. This causes a transfer to Lo + 200 (BP 4) the end of the print sequence. (NOTE: Depression of the transfer control switch during the printing operation will cause an exit from the print routine at the end of the particular line being printed).

A start compute signal will then cause the fixed point numbers to be floated. On completion of the float sequence, a terminal stop on BP 8 in Lo + 218 is executed, and a start compute signal will transfer control back to the main program.

SAMPLE PROBLEM FIXED POINT Δ MATRIX PREP.

```
;0006232'xz0010'      print q
;0006233'xz0003'      no. variables
;0006234'xz0005'      no. records
;0006235'xz6200'      Lo record
;0006236'xz5000'      Lo Δ matrix
```

External Storage

.0003000' transfer to matrix prep. data follows

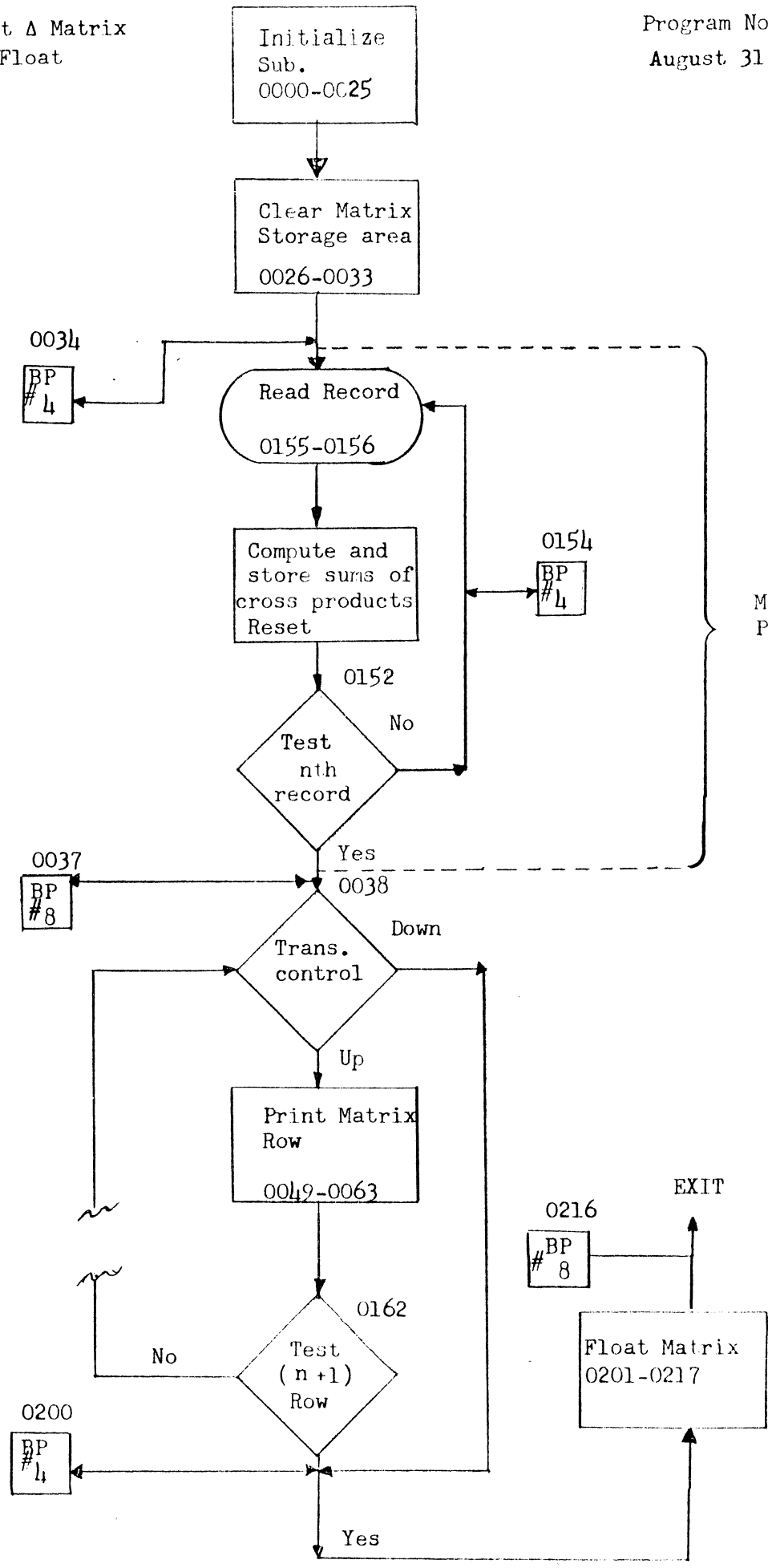
```
0+056200'1''4'1'-0000000''
0+056200'1'1'4'3'-0000000''
0+056200'1'3'3'2'-0000000''
0+056200'1'6'2'5'-0000000''
0+056200'1'8''4'-0000000''
```

Data

```
 5.00000      18.00000      13.00000      15.00000
             110.00000      25.00000      71.00000
                            45.00000      32.00000
                                          55.00000
```

TITLE: Fixed Point Δ Matrix Prep. and Float

Program No. - F2-129-1
August 31, 1959



LGP-30 CODING SHEET

PREPARED FOR: LGP-30, RPC-4000 Users' Organization - POOL — PAGE 1 / 5

JOB NO. | PROGRAM NO. F2-129 | PROGRAM PREPARED BY: Burggrabe | PROGRAM CHECKED BY: POOL Review | DATE 4-18-59

PROBLEM: Given: N records of n variables; prepare Δ Fixed point matrix & Float. — TRACK 00

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	/						
	/	☒					
		0 0 0 0	X B	6 2 3 3	/	n @ 29	n= (No. of variables)
		0 0 0 1	A	0 1 1 4	/	1 @ 29	
		0 0 0 2	X H	6 2 6 1	/	(n+1) @ 29	
		0 0 0 3	A	0 1 1 4	/	☒ 1 @ 29	
		0 0 0 4	X H	6 2 6 2	/	(n+2) @ 29	
		0 0 0 5	X N	6 2 6 1	/	(n+1) @ 29	gives (n+1)(n+2) @ 27
		0 0 0 6	M	0 1 1 0	/	1 @ 3	give $\frac{(n+1)(n+2)}{2}$ @ 29
		0 0 0 7	X C	6 2 6 3	/	☒ $\frac{(n+1)(n+2)}{2}$ @ 29	
		0 0 0 8	X B	6 2 3 5	/	Lo Record	
		0 0 0 9	Y	0 1 0 0	/		} (Init. Matrix Prep.)
		0 0 1 0	Y	0 1 0 1	/		
		0 0 1 1	Y	0 1 1 3	/	☒	
		0 0 1 2	X A	6 2 6 1	/	(n+1) @ 29	→ Record L_f + 1
		0 0 1 3	Y	0 1 1 1	/		
		0 0 1 4	X B	6 2 3 6	/	Lo Δ Matrix	
		0 0 1 5	Y	0 1 0 5	/	☒	} (Init. Matrix Prep.)
		0 0 1 6	Y	0 1 0 6	/		
		0 0 1 7	Y	0 1 1 8	/		
		0 0 1 8	Y	0 0 2 7	/		(Init. Clear Drum)
		0 0 1 9	Y	0 0 5 5	/	☒	(Init. Print)
		0 0 2 0	Y	0 2 0 6	/		} Init. Float
		0 0 2 1	Y	0 2 1 0	/		
		0 0 2 2	X A	6 2 6 3	/	$\frac{(n+1)(n+2)}{2}$ @ 29	
		0 0 2 3	X C	6 2 6 0	/	☒ Temp (Matrix L_f +1) @ 29	
		0 0 2 4	X S	6 2 3 4	/	No records @ 29	} Init. Matrix
		0 0 2 5	C	0 1 2 1	/	Matrix Prep ctr.	} Prep. counter
		0 0 2 6	B	0 0 4 6	/	0	} Clear storage area
		0 0 2 7	C	[ ]	/	☒ Matrix area	
		0 0 2 8	B	0 0 2 7	/	Add in matrix	
		0 0 2 9	A	0 1 1 4	/	1 @ 29	
		0 0 3 0	Y	0 0 2 7	/		
		0 0 3 1	E	0 1 1 7	/	☒ XZ 6363	Mask

☒ CARRIAGE RETURN

FORM LP-10

ROYAL McBEE J13841X

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JOB NO. | PROGRAM NO. F2-129 | PROGRAM PREPARED BY: Burggrabe | PROGRAM CHECKED BY: POOL Review | DATE 4-18-59

PROBLEM: Δ Fixed point Matrix and Float | TRACK 00

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	/				/		
	/	☒					
		00312	XS	62600	/		Matrix L_f +1
		313	T	00026	/		
		314	XZ	04000	/		BP 4 - stop after initialization
		315	R	01244	/	☒	Δ Matrix Prep.
		316	U	01555	/		Linkage
		317	XZ	08000	/		BP 8 - stop after matrix prep.
		318	8 9 0 T	02000	/		→ skip matrix print out
		319	XB	62611	/	☒	(n+1) @ 29
		320	XC	62600	/		temp 1 - no. of numbers to print
		321	XB	62600	/		" " " " "
		322	N	00522	/		1@ 25
		323	XA	62322	/	☒	print q gives XZ[NNqq]
		324	Y	00588	/		set up Z inst.
		325	XP	16000	/		cr.
		326	XZ	00000	/		delay & zero (0026)
		327	XB	62600	/	☒	temp 1 no. of no.s to print
		328	XS	62611	/		(n+1) @ 29
		329	T	00511	/		→ print tab
		330	U	00555	/		exit tab loop
		331	XP	24000	/	☒	tab
		332	XZ	00116	/		delay & 1 @ 25 (0042)
		333	A	01114	/		1 @ 29
		334	U	00499	/		loop
		335	B	[ ]	/	☒	Lo first no. in row
		336	XR	06055	/		
		337	XU	06000	/		
		338	XZ	[ ]	/		no & q
		339	XB	62600	/	☒	temp 1 no. of no.s printed
		340	A	00555	/		
		341	Y	00555	/		
		342	XB	62600	/		temp 1 no. of no.s printed
		343	U	01559	/	☒	over matrix prep.

FORM LP-12

☒ CARRIAGE RETURN

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JOB NO.

PROGRAM NO. F2-129

PROGRAM PREPARED BY: Burggrabe

PROGRAM CHECKED BY: POOL Review

DATE 4-18-59

PROBLEM: Given: N records of n variables: prepare Δ Fixed point matrix & float.

TRACK 0 1

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	/						
	/	☒					
		0100	B[ ]		/	$X_i(k+1)$ @ q	$0 \leq k \leq n-1$
		01	M[ ]		/	$X_j(k+1)$ @ q	$0 \leq k \leq n-1$
		02	U	0105	/		
		03			/	☒	
		04			/		
		05	A[ ]		/	$\sum_{k+1}^{k} X_i X_j$ @2q	
		06	C[ ]		/	$\sum X_i X_j$ @2q	
		07	B	0106	/	☒	
		08	A	0123	/	1 @ 29	
		09	U	0126	/		
,0000 0016	/	10	1000	0000	/	1 @ 3	
		11			/	☒ Data Lo + n + 1 = Data L_f + 1	
		12			/		
		13			/	Data Lo	
		14		4	/	1@ 29	
		15		4	/	☒ 1@ 29	
		16		3www j	/	XZ 6363 Mask	
		17		3www j	/	" "	
		18			/	Δ Matrix Lo	
		19			/	☒	
		20			/		
		21			/	-n (Records @ 29)	
		22	P	1000	/	c.r. (Hex)	
		23		4	/	☒ 1 @ 29 & delay	
		24	U	0000	/	Exit matrix prep ← R here	
		25			/		
		26	Y	0105	/		
		27	Y	0106	/	☒	
		28	B	0100	/		
		29	A	0115	/	1 @ 29	
		30	E	0116	/	3www j	
		31	Y	0100	/	☒	

☒ CARRIAGE RETURN

FORM LP-10

ROYAL McBEE J13641X

LGP-30 CODING SHEET

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JOB NO. | PROGRAM NO. F2-129 | PROGRAM PREPARED BY: Burggrabe | PROGRAM CHECKED BY: POOL Review | DATE 4-18-59

PROBLEM: Δ Fixed point matrix and float | TRACK 01

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	/				/		
	/	☒			/		
		01 32	S	0111	/	data L_f +1	
		33	T	0100	/	(Back to complete row)	
		34	B	0101	/		
		35	A	0114	/ ☒	1 @ 29	
		36	Y	0101	/		
		37	Y	0100	/		
		38	E	0117	/	3wwj	
		39	S	0111	/ ☒	Data L_f +1	
		40	T	0100	/	(Begin new row)	
		41	B	0113	/	Data Lo	Initiallze for new record
		42	Y	0100	/		
		43	Y	0101	/ ☒		
		44	U	0146	/		
		45			/		
		46	B	[0118]	/	Δ Matrix Lo	
		47	Y	0105	/ ☒		
		48	Y	0106	/		
		49	B	0121	/	-n @ 29	
		50	A	0115	/	1 @ 29	
		51	H	0121	/ ☒		
		52	T	0154	/		
		53	U	0122	/	matrix prep exit →	
		54	XZ	0400	/	BP 4 stop after each record	
		55	XR	0308	/ ☒	← U here	
		56	XU	0300	/		
		57	U	0100	/		
		58			/		
		59	S	0114	/ ☒	1 @ 29	
		60	XH	6260	/	temp no. of no.s to print	
		61	S	0114	/	1 @ 29	
		62	800T	0200	/	exit print out of matrix	
		63	U	0041	/ ☒	back to print new line	

☒ CARRIAGE RETURN

FORM LP-12

LGP-30 CODING SHEET

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JOB NO. | PROGRAM NO. F2-129 | PROGRAM PREPARED BY: Burggrabe | PROGRAM CHECKED BY: POOL Review | DATE 4-18-59

PROBLEM: Δ Fixed Point Matrix and Float | TRACK 02

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	/						
	/	☒					
		0200	XZ	0400	/	BP 4 stop	
		01	XB	6232	/	2q @29	
		02	Y	0209	/		
		03	XB	6236	/	☒ Δ Matrix Lo	
		04	XA	6263	/	$\frac{(n+1)(n+2)}{2}$ @ 29	
		05	XC	6260	/	ctr	
		06	B	[ ]	/	$\Sigma X_i X_j$ @2q	
		07	XR	0925	/	☒ } 25.OR	
		08	XU	0900	/	}	
		09	Z	[ ]	/	q of no. to float.	
		10	C	[ ]	/	floated no. store	
		11	B	0206	/	☒	
		12	A	0114	/	1 @ 29	
		13	Y	0206	/		
		14	Y	0210	/		
		15	E	0117	/	☒ 3wwj Mask	
		16	XS	6260	/	Matrix L_f + 1	
		17	T	0206	/		
		18	XZ	0800	/	BP 8 stop after float.	
		19	U	[ ]	/	☒ Exit sub.	
		20			/	open ↓	
		21			/		
		22			/		
		23			/	☒	
		24			/		
		25			/		
		26			/		
		27			/	☒	
		28			/		
		29			/		
		30			/		
		31			/	☒	

☒ CARRIAGE RETURN

TITLE: Triangular Matrix Scaling

AUTHOR: William F. Burggrabe
Compumatix, Incorporated

DATE: September 4, 1959

PURPOSE: Given a matrix in floating point of the form ...

$$\begin{matrix} N & \Sigma \frac{X_1}{C_1} & \Sigma \frac{X_2}{C_2} & \cdots & \Sigma \frac{X_n}{C_n} \\ \Sigma\left(\frac{X_1}{C_1}\right)^2 & \Sigma \frac{X_1}{C_1} \times \frac{X_2}{C_2} & \cdots & \Sigma \frac{X_1}{C_1} \times \frac{X_n}{C_n} & \\ & \vdots & & & \\ & \Sigma \left(\frac{X_n}{C_n}\right)^2 & & & \end{matrix}$$

and scale factors 1, C_1, C_2 ... C_n compute the matrix.

$$\begin{matrix} N & \Sigma X_1 & \Sigma X_2 & \Sigma X_3 & \cdots & \Sigma X_n \\ \Sigma X_1^2 & \Sigma X_1 X_2 & & \cdots & \Sigma X_1 X_n & \\ & & & & \vdots & \\ & & & & \Sigma X_n^2 & \end{matrix}$$

RESTRICTIONS:

1) The following locations must contain:

6236	Lo matrix
6237	Lo floating point 24.0
6241	Lo scale factors
6261	(n+1) @ 29 - matrix order

2) The scale factors in floating point must be stored in the same order as the matrix components.

3) Normal limitations of 24.0, 11.6-12.6.

4) All scale factors must be stored, (i.e.) where a scale factor is unity it must be stored

$$(1 \times 1 \times N = N,\ 1 \times C_1 \times \frac{X_1}{C_1} = X_1 \text{ , etc.}$$

CODING INFORMATION:

A) Subroutine storage - 41 sectors

External Storage	6236	Lo Δ matrix
	6237	Lo floating point
	6241	Lo scale factors
	6260	Temp storage
	6261	(n+1) @ 29*

B) Linkage

R Lo + 40

U Lo

C) Input - the following must be stored in memory

1) Δ matrix in floating point

2) Scale factors in floating point

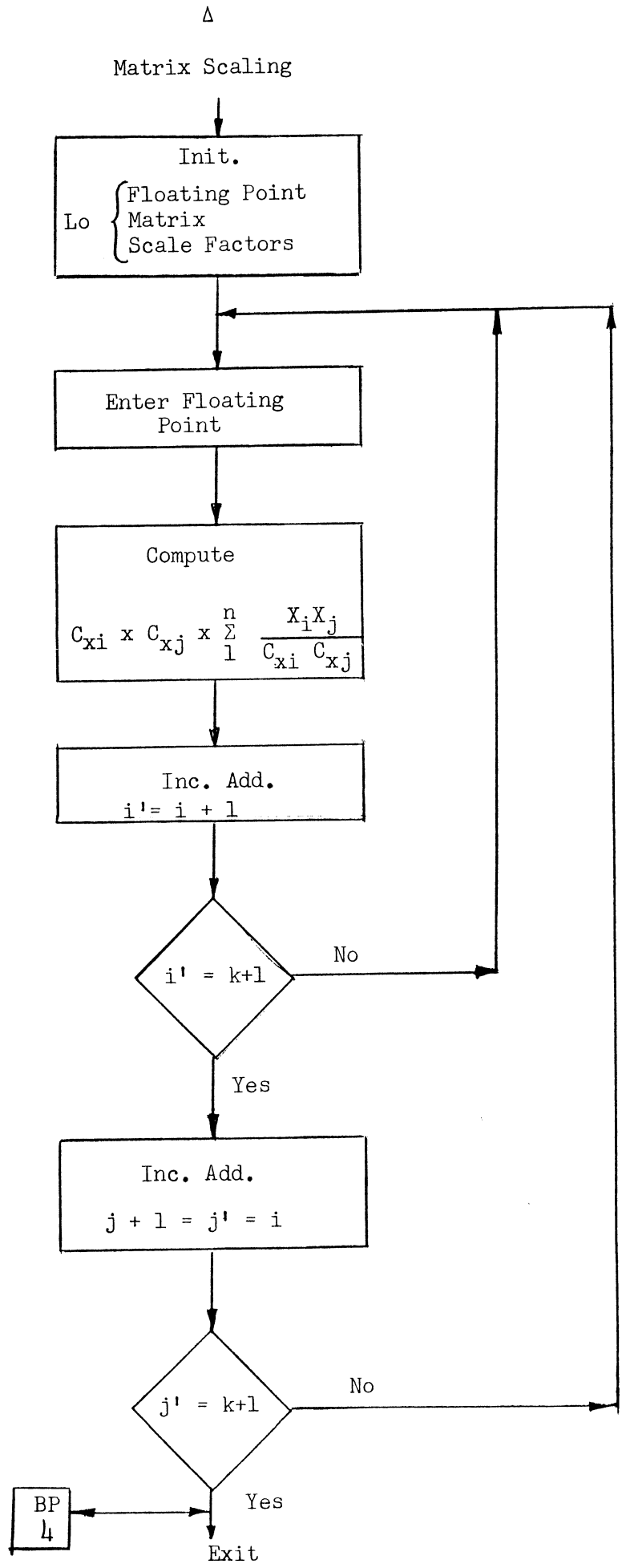
D) Output scaled Δ matrix. Stored in the same location as unscaled matrix.

E) Constants

Lo + 30	XZ6363 mask
Lo + 31	1 @ 29

F) Timing (n+1)(n+2) x .65 sec.

*From CI Δ matrix prep. routines


Δ
Matrix Scaling
Init.
Lo
Floating Point
Matrix
Scale Factors
Enter Floating Point
Compute
$C_{xi} \times C_{xj} \times \sum_{1}^{n} \frac{X_i X_j}{C_{xi} C_{xj}}$
Inc. Add.
i'= i + 1
i' = k+1
No
Yes
Inc. Add.
j + 1 = j' = i
j' = k+1
No
Yes
BP 4
Exit

LGP-30 CODING SHEET

PREPARED FOR: LGP-30, RPC-4000 Users' Organization - POOL

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JOB NO.	PROGRAM NO.	PROGRAM PREPARED BY:	PROGRAM CHECKED BY:	DATE
	F2-129	Burggrabe	POOL Review	10-4-59

PROBLEM: Matrix Scale

TRACK: 00

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	/				/		
	/	☒					
		0 0 0 0	X B	6 2 3 7	/	Lo F. P.	
		0 1	Y	0 0 1 1	/		
		0 2	Y	0 0 1 2	/		
		0 3	X B	6 2 3 6	/	☒ Lo Matrix	
		0 4	Y	0 0 1 3	/		
		0 5	Y	0 0 1 7	/		
		0 6	X B	6 2 4 1	/	Lo Scale Factors	
		0 7	Y	0 0 1 4	/	☒	
		0 8	Y	0 0 1 6	/		
		0 9	X A	6 2 6 1	/	(n+1) @ 29 →	L_f +1 (Scale Factors)
		1 0	X Y	6 2 6 0	/		
		1 1	R	[ ]	/	☒ F.P. Linkage	
		1 2	U	[ ]	/		
		1 3	P	[ ]	/	$\Sigma X_i X_j$	
		1 4	M	[ ]	/	Cx_i	
		1 5	X U	0 0 0 0	/	☒ Acc → Mult	
		1 6	M	[ ]	/	Cx_j	
		1 7	H	[ ]	/	$Cx_i\ Cx_j\ \Sigma X_i X_j$	
		1 8	X E	0 0 0 0	/	Exit F.P.	
		1 9	B	0 0 1 3	/	☒ Add of $\Sigma X_i X_j$	
		2 0	A	0 0 3 1	/	1 @ 29	
		2 1	Y	0 0 1 3	/		
		2 2	Y	0 0 1 7	/		
		2 3	B	0 0 1 4	/	☒ Add. of Cx_i	
		2 4	A	0 0 3 1	/	1 @ 29	
		2 5	Y	0 0 1 4	/		
		2 6	E	0 0 3 0	/	mask	
		2 7	X S	6 2 6 0	/	☒ L_f +1 of C_x's	
		2 8	T	0 0 1 1	/	loop	
		2 9	U	0 0 3 2	/		
		3 0	X Z	6 3 6 3	/	mask	
		3 1	X Z	0 0 0 1	/	☒ 1 @ 29	

☒ CARRIAGE RETURN

LGP-30 CODING SHEET

PREPARED FOR: LGP-30, RPC-4000 Users' Organization - POOL

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JOB NO.

PROGRAM NO. F2-129

PROGRAM PREPARED BY: Burggrabe

PROGRAM CHECKED BY: POOL Review

DATE 10-4-59

PROBLEM: Matrix Scale

TRACK 00

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	/				/		
	/	☒					
		0032	B	0016	/		
		33	A	0031	/	1 @ 29	
		34	Y	0014	/		
		35	Y	0016	/	☒	
		36	E	0030	/		
		37	XS	6260	/		
		38	T	0011	/	loop	
		39	XZ	0400	/	☒	BP 4 stop after scaling
		40	U	[ ]	/		
		41			/		
		42			/		
		43			/	☒	
		44			/		
		45			/		
		46			/		
		47			/	☒	
		48			/		
		49			/		
		50			/		
		51			/	☒	
		52			/		
		53			/		
		54			/		
		55			/	☒	
		56			/		
		57			/		
		58			/		
		59			/	☒	
		60			/		
		61			/		
		62			/		
		63			/	☒	

☒ CARRIAGE RETURN

/ = CONDITIONAL STOP CODE

FORM LP-12

Royal McBee Corporation
DATA PROCESSING DIV.
PORT CHESTER, NEW YORK

TITLE: Calculation of Means, Standard Deviations and Correlation Coefficient Triangular Matrix

AUTHOR: William F. Burggrabe, Jr.
Compumatix, Incorporated

DATE: September 23, 1959

PURPOSE: Given a floating point Δ matrix as prepared by either the fixed or floating point Δ matrix preparation subroutine, compute the means, standard deviation and the all simple correlation coefficients.

n = Number variables

N = Number records

The Rij matrix replaces all cross product terms in the original matrix. The means and standard deviations (n values each) will be stored in the correct order starting in the Lo specified. Each value is printed out in normal floating point form as computed. (See sample problem)

RESTRICTIONS:

1) Normal restrictions of 24.0, 11.6-12.6

2) Required computational storage

mean Lo thru Lo + (n-1)

σ x Lo thru Lo + (n-1)

Δ Data matrix Lo thru Lo + $\frac{(n+1)\ (n+2)}{2}$ -1

Δ Rij matrix replaces all but first row of Δ data matrix

3) The following information must be supplied:

Location 6233 n @ 29
6236 Lo Δ data matrix
6237 Lo floating point
6238 Lo means
6239 Lo standard deviations

6258)
6259) Temp. storage area
6260)

6261 n + 1 @ 29*

*Supplied by Compumatix, Inc. Δ Matrix Prep. Progs.

4) Output: 24.0 - 12.6 format

GENERAL INFORMATION ON METHOD:

The equations used are:

1) $\bar{X}_i = \frac{\Sigma X_i}{N}$

2) Standard deviation

$$\sigma_{x_i} = \sqrt{\frac{\Sigma X_i^2}{N} - (\bar{X})^2}$$

3) Correlation coefficient

$$R_{ij} = \frac{\frac{\Sigma X_i X_i}{N} - \bar{X}_i \bar{X}_j}{\sigma_{x_i} \sigma_{x_j}}$$

CODING INFORMATION:

A) Storage - subroutine 2 tracks and 17 sectors

Calculated storage as described above under "restrictions" 2 and 3

B) No calling sequence required.

Linkage (R Lo + 216
(U Lo

C) Input: None

D) Output: Format of 24.0 - 12.6

All answers are printed as computed. The correct number of tabs preceeds the printing of each diagonal element of Rij matrix (See sample problem). The tabs may be eliminated by changing t[0209] in 0207 to u[0208] or u0127.

E) Constants 0024 1 @ 29
0201 XZ6363 Mask

and areas mentioned under Restriction (3).

F) Timing: The approximate times including printing are:

Means: 3 n sec.

Standard Deviations: 4 n sec.

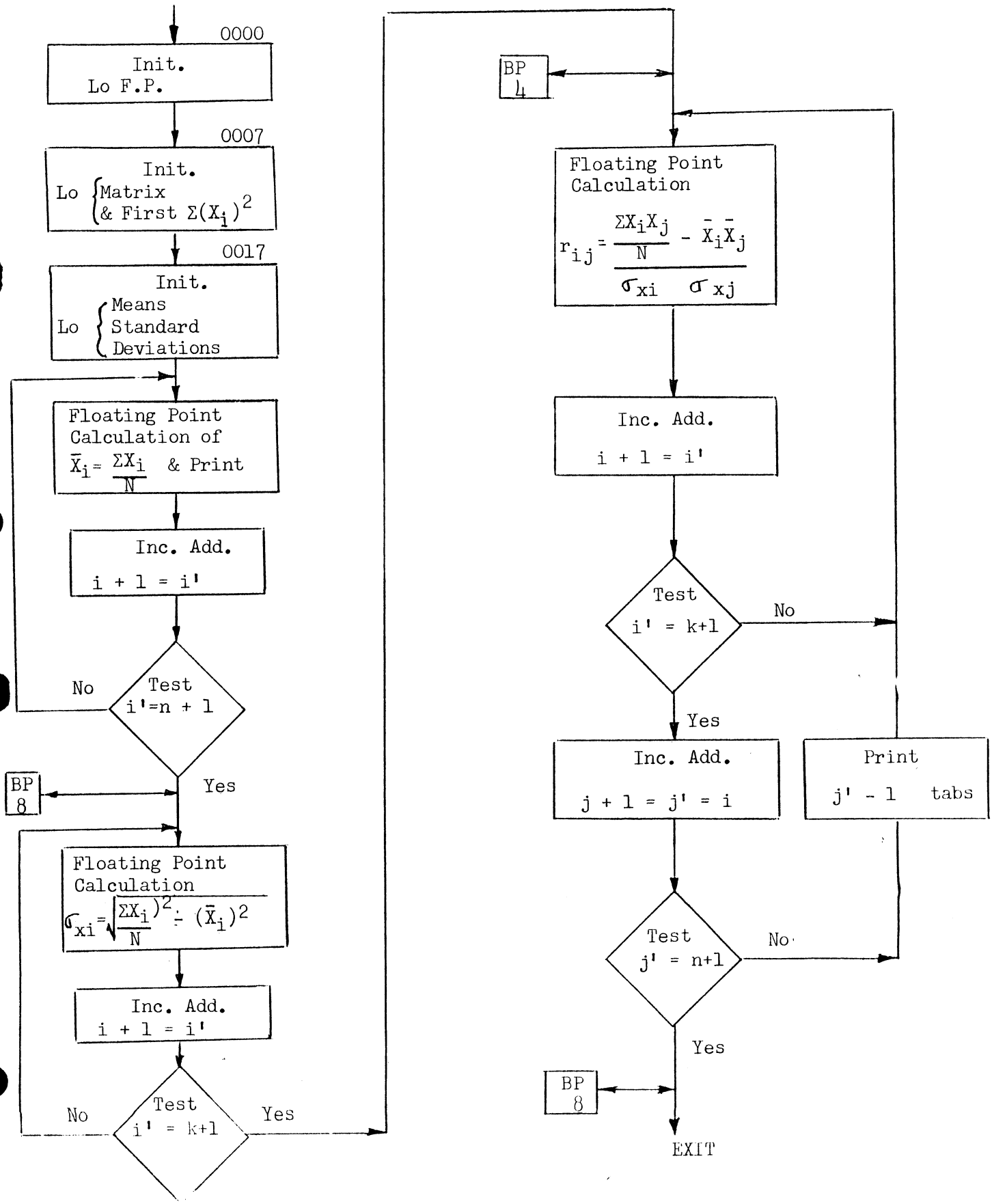
Rij matrix: n(n+1) x 2.25 sec.

Where n is the total number of variables.

G) Program stops:

0051	Breakpoint 8	$\bar{X}_i$ calculations complete
0022	Breakpoint 4	σ_{x_i} calculation complete
0215	Breakpoint 8	Rij calculation complete

Flow Diagram
Calculation of Means, Standard Deviations and Correlation Coefficient Triangular Matrix
Floating Point



LGP-30 CODING SHEET

PREPARED FOR:				PAGE / OF
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JOB NO.	PROGRAM NO.	PROGRAM PREPARED BY:	PROGRAM CHECKED BY:	DATE
	F2-129	Burggrabe	POOL Review	4-20-59
PROBLEM:				TRACK
Given: Δ Matrix; Compute & Print $\bar{X}_i$, σx_i , Rij Matrix (F.P.)				00

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	/						
	/	☒					
		0000	XB	6237	/	Lo Floating Point	
		0001	Y	0033	/	mean } sub	
		0002	Y	0034	/	mean }	
		0003	Y	0055	/	☒ σx_i } sub	
		0004	Y	0056	/	σx_i }	
		0005	Y	0127	/	rij } sub	
		0006	Y	0128	/	rij }	
		0007	XB	6236	/	☒ Lo Δ Matrix	
		0008	Y	0036	/	mean	
		0009	Y	0061	/	σ }	Lo of N
		0010	Y	0133	/	rij	
		0011	A	0024	/	☒ 1 @ 29	
		0012	Y	0035	/	Lo first $\Sigma(X_i)$ (for mean)	
		0013	XA	6233	/	gives Lo first $\Sigma(X_i)^2$ (n @ 29)	
		0014	Y	0060	/	σx_i sub	
		0015	Y	0132	/	☒ rij } sub	
		0016	Y	0137	/	rij }	
		0017	XB	6238	/	Lo mean	
		0018	Y	0037	/	mean sub	
		0019	Y	0057	/	☒ σx_i } sub	
		0020	Y	0058	/	σx_i }	
		0021	Y	0129	/	rij	
		0022	Y	0130	/	rij	
		0023	XP	1600	/	☒ cr.	
		0024	XZ	0001	/	delay & 1 @ 29	
		0025	XB	6239	/	Lo standard deviations	
		0026	Y	0100	/	σx_i sub	
		0027	Y	0135	/	☒	
		0028	Y	0136	/		
		0029	XB	6236	/	Lo Δ Matrix	
		0030	XA	6261	/	n + 1 @ 29	
		0031	XC	6260	/	☒ mean L_f +1	to test out

FORM LP-10

☒ CARRIAGE RETURN

ROYAL McBEE J13541X

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JOB NO.	PROGRAM NO.	PROGRAM PREPARED BY:	PROGRAM CHECKED BY:	DATE
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PROBLEM: Given: Δ Matrix· Compute & Print $\bar{X}_i$, σx_i, Rij Matrix

TRACK: 00

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	/						
	/	☒					
		00 32	XP	1600	/	cr.	
		33	R	[ ]	/	} F. Point	
		34	U	[ ]	/		
		35	B	[ ]	/	☒ $\sum_{n} X_i$	
		36	D	[ ]	/	No. of records	
		37	H	[ ]	/	$\bar{X}_i$	
		38	XP	0000	/	Print $\bar{X}_i$	
		39	XE	0000	/	☒ Exit floating point	
		40	B	0037	/	Add $\bar{X}_i$	
		41	A	0024	/	1 @ 29	
		42	Y	0037	/		
		43	B	0035	/	☒ Add ΣX_i	
		44	A	0024	/	1 @ 29	
		45	Y	0035	/		
		46	E	0201	/	3wwj mask	
		47	XS	6260	/	☒	
		48	T	0033	/	loop back n times	
		49	XP	1600	/	cr.	
		50	XZ	0000	/	delay	
		51	XZ	0800	/	☒ BP 8 stop after means	
		52	XB	6261	/	(n+1) @ 29	
		53	XC	6260	/	Temp 1 (Ctr)	
		54	XP	1600	/	Δ Matrix Lr + 1(Set for σx_i)(Temp 1)	
		55	R	[ ]	/	☒ F.P.	
		56	U	[ ]	/		
		57	P	[ ]	/	$\bar{X}_i$	
		58	M	[ ]	/	$\bar{X}_i$	
		59	XH	6259	/	☒ Temp 2 $(\bar{X}_i)^2$	
		60	B	[ ]	/	$\sum_{n} X_i^2$	
		61	D	[ ]	/	No of records	
		62	XS	6259	/	$\bar{X}_i^2$	
		63	XR	0000	/	☒ √	

☒ CARRIAGE RETURN

FORM LP-12

METAL M Bell 113541X

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JOB NO.	PROGRAM NO.	PROGRAM PREPARED BY:	PROGRAM CHECKED BY:	DATE
	F2-129	Burggrabe	POOL Review	4-20-59
PROBLEM: Given: Δ Matrix; Compute & Print X_i, σx_i, Rij matrix (F. P.)				TRACK 01

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	/						
	/	☒					
		0100	H [ ]		/		Standard Deviation
		0101	XP	0000	/		Print Stan. Dev.
		0102	XE	0000	/		
		0103	B	0057	/	☒	Add. of $\bar{X}_i$
		0104	A	0024	/		1 @ 29
		0105	Y	0057	/		
		0106	Y	0058	/		
		0107	B	0100	/	☒	Add. of σx_i
		0108	A	0024	/		1 @ 29
		0109	Y	0100	/		
		0110	XB	6260	/		Temp 1 (n+1,n,n-1,etc.)
		0111	S	0024	/	☒	1 @ 29
		0112	XH	6260	/		Temp 1
		0113	A	0060	/		Add. of ΣX_i^2
		0114	Y	0060	/		
		0115	B	0024	/	☒	1 @ 29
		0116	XS	6260	/		Temp 1 (Test out when = 1)
		0117	T	0055	/		loop back (n times)
		0118	XP	1600	/		cr.
		0119	XZ	0000	/	☒	
		0120	XP	1600	/		cr.
		0121	XZ	0000	/		
		0122	XZ	0400	/		BP 4 stop after σx_i scale
		0123	XB	6238	/	☒	Lo mean
		0124	XA	6233	/		n @ 29
		0125	XC	6260	/		mean L_f + 1 (Temp 1)
		0126	XC	6259	/		Tab counter (Temp 2)
		0127	R [ ]		/	☒	F.P.
		0128	U [ ]		/		
		0129	P [ ]		/		$\bar{X}_i$
		0130	M [ ]		/		$\bar{X}_j$
		0131	XH	6258	/	☒	Temp 3 ($\bar{X}_i \bar{X}_j$)

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☒ CARRIAGE RETURN

ROYAL McBEE J13541X

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JOB NO. | PROGRAM NO. F2-129 | PROGRAM PREPARED BY: Burggrabe | PROGRAM CHECKED BY: POOL Review | DATE 4-20-59

PROBLEM: Given: Δ Matrix; Compute & Print X_i, σ_{x_i}, Rij Matrix (F.P.) | TRACK 01

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	/				/		
	/	☒					
		01 32	B	[ ]	/	$\Sigma X_i X_j$	
		33	D	[ ]	/	No of records	
		34	XS	6258	/	Temp 3	
		35	D	[ ]	/	☒ σx_i	
		36	D	[ ]	/	σx_j	
		37	H	[ ]	/	rij	
		38	XP	0000	/	Print rij	
		39	XE	0000	/	☒ Exit F.P.	
		40	B	0132	/	add $\Sigma X_i X_j$	
		41	A	0024	/	1 @ 29	
		42	Y	0132	/		
		43	Y	0137	/	☒	
		44	B	0136	/	add σx_j	
		45	A	0024	/	1 @ 29	
		46	Y	0136	/		
		47	B	0130	/	☒ add $\bar{X}_j$	
		48	A	0024	/	1 @ 29	
		49	Y	0130	/		
		50	E	0201	/	3wwj mask	
		51	XS	6260	/	☒ mean L_f +1	
		52	T	0127	/		
		53	B	0135	/	add σx_i	
		54	A	0024	/	1 @ 29	
		55	Y	0135	/	☒	
		56	Y	0136	/		
		57	B	0129	/	add $\bar{X}_i$	
		58	A	0024	/	1 @29	
		59	Y	0129	/	☒	
		60	Y	0130	/		
		61	E	0201	/	3wwj mask	
		62	XS	6260	/	mean L_f +1	
		63	T	0202	/	☒	

FORM LP-12

☒ CARRIAGE RETURN

ROYAL M 011 J13541X

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	F2-129	Burggrabe	POOL Review	4-20-59
PROBLEM:				TRACK
Given: Δ Matrix; Compute & Print X_i, σx_i, Rij Matrix (F. P.)				02

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	/						
	/	☒					
		9200	U	0213	/	Exit Path	→
		01	XZ	6363	/	Mask for extract's	
		02	XP	1600	/	cr.	
		03	XB	6259	/	☒ tab ctr.	
		04	A	0024	/	1 @ 29	increase tab ctr by one
		05	XC	6259	/		
		06	XS	6259	/	make acc. negative	
		07	T	0209	/	☒ Print tab	
		08	U	0127	/	Exit tab loop	
		09	XZ	0000	/	delay	
		10	XP	2400	/	tab	
		11	A	0024	/	☒ 1 @ 29	
		12	U	0207	/	loop	
		13	XP	1600	/	cr.	
		14	XZ	0000	/		
		15	XZ	0800	/	☒	
		16	U	[ ]	/		
		17			/		
		18			/		
		19			/	☒	
		20			/		
		21			/		
		22			/		
		23			/	☒	
		24			/		
		25			/		
		26			/		
		27			/	☒	
		28			/		
		29			/		
		30			/		
		31			/	☒	

☒ CARRIAGE RETURN

TITLE: Convert Triangular Rij matrix to a square Rij matrix - modified.

AUTHOR: William F. Burggrabe, Jr.
Compumatix, Incorporated

DATE: October 13, 1959

PURPOSE: Given a triangular matrix as prepared by the subroutine "Calculation of Means, Standard Deviations and Δ Correlation Coefficient Matrix", convert the Δ correlation coefficient portion to a square Rij matrix with the initial location of Δ Rij equal to the initial location of the □ Rij. This routine also sets automatically location 6240 to the correct address.

RESTRICTIONS:

A) The Lo Δ Rij matrix = Lo □ Rij matrix

B) The entire subroutine is in fixed point and will operate on both fixed and floating point format matricies, but will not operate on matricies in an extended range format.

C) External storage as on attached sheet.

METHOD: The subroutine takes advantage of the symmetry of the matrix and sets cell ij = cell ji. A looping process builds both the row and column cells of the square matrix while stepping through the matrix from the bottom.

CODING INFORMATION:

A) Storage: 56 sectors

B) Constants: Lo + 51 1 @2
Lo + 52 1@29
Lo + 53 Mask

C) Linkage: R [Lo + 55]
U [Lo]

D) Stops: Break point 4 at end of conversion

E) Timing: Approximately $\frac{n(n+1)}{6}$ seconds

LGP-30 CODING SHEET

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JOB NO. | PROGRAM NO. F2-129 | PROGRAM PREPARED BY: Burggrabe | PROGRAM CHECKED BY: POOL Review | DATE 10-10-59

PROBLEM: External Storage Δ → □ Rij Modified | TRACK 62

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	/						
	/	☒					
		62 32			/		
		33	X Z [	]	/	n @ 29	No variables *
		34			/		
		35			/	☒	
		36	X Z [	]	/	Lo Δ data Matrix	*
		37			/		
		38			/		
		39			/	☒	
		40	X Z [	]	/	Lo □ rij matrix	
		41			/		
		42			/		
		43			/	☒	
		44			/	Note: * These locations	
		45			/	must be filled prior to	
		46			/	entry into the subroutine	
		47			/	☒	
		48			/		
		49			/	Note : ✓ These locations	
		50			/	normally filled by Δ Matrix	
		51			/	☒ Prep. sub.	
		52			/		
		53			/		
		54			/		
		55			/	☒	
		56			/		
		57			/		
		58			/		
		59			/	☒ Temp. storage	
		60			/		
		61			/	n + 1@ 29	* ✓
		62			/		
		63			/	☒ $\frac{(n+1)(n+2)}{2}$ @ 29	* ✓
						☒ CARRIAGE RETURN	

FORM LP-12

ROYAL M DEE J13541X

LGP-30 CODING SHEET

PREPARED FOR: LGP-30, RPC-4000 Users' Organization - POOL

PAGE 1 / 2

JOB NO.

PROGRAM NO. F2-129

PROGRAM PREPARED BY: Burggrabe

PROGRAM CHECKED BY: POOL Review

DATE 10-10-59

PROBLEM: Δ rij $\rightarrow \square$ rij Matrix Conversion

TRACK 00

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
;0 0 0 Lo	/						
/0 0 0 Lo	/	☒					
		0000	XB	6236	/	Lo Δ data matrix	
		0001	XA	6263	/	$\frac{(n+1)(n+2)}{2}$ @ 29	
		0002	S	0052	/	1 @ 29	
		0003	Y	0017	/	☒ B[ ]	L_f Δdata matrix
		0004	XB	6236	/	Lo Δ data matrix	
		0005	XA	6261	/	n + 1 @ 29	
		0006	XC	6240	/	Lo Δrij matrix & Lo $\square$rij matrix	
		0007	XC	6260	/	☒ Temp 1 → 0	
		0008	XC	6259	/	Temp 2 → 0	Init. ctr's
		0009	XC	6258	/	Temp 3 → 0	
		0010	XB	6233	/	n @ 29	
		0011	XN	6233	/	☒ n @ 29	
		0012	M	0051	/	1 @ 2 →	n^2 @ 29
		0013	XA	6240	/	Lo $\square$ rij matrix	
		0014	S	0052	/	1 @ 29 →	L_f $\square$ rij matrix
		0015	Y	0018	/	☒ H [ ]	
		0016	Y	0019	/	C [ ]	
		0017	B	[ ]	/	rij Δ matrix	
		0018	H	[ ]	/	rij $\square$ (row)	
		0019	C	[ ]	/	☒ rji $\square$ (col)	
		0020	B	0017	/	B [ ]	
		0021	S	0052	/	1 @ 29	
		0022	Y	0017	/	B [ ]	
		0023	B	0018	/	☒ H [ ]	
		0024	S	0052	/	1 @ 29	
		0025	Y	0018	/	H [ ]	
		0026	XY	6258	/	Temp 3	
		0027	B	0019	/	☒ C [ ]	
		0028	XS	6233	/	n @ 29	
		0029	Y	0019	/	C [ ]	
		0030	E	0053	/	3wwj	mask
		0031	XS	6258	/	☒ Temp 3	

☒ CARRIAGE RETURN

FORM LP-10

ROYAL McBEE, J13541X

LGP-30 CODING SHEET

PREPARED FOR: LGP-30, RPC-4000 Users' Organization - POOL | PAGE 2 / 2

JOB NO. | PROGRAM NO. F2-129 | PROGRAM PREPARED BY: Burggrabe | PROGRAM CHECKED BY: POOL Review | DATE 1-10-61

PROBLEM: Δ rij → □ rij Matrix Conversion | TRACK 00

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	/				/		
	/	☒			/		
		0032	T	0034	/	test out	
		33	U	0017	/	loop	
		34	B	0019	/	C[ ]	
		35	XA	62599	/	☒ temp 2	0,1,2,...n-1
		36	Y	0018	/	H[ ]	
		37	XB	62599	/	Temp 2	}
		38	A	00522	/	1@ 29	inc. ctr 2
		39	XC	62599	/	☒ temp 2	}
		40	XB	62588	/	= old H[ ]	
		41	XA	62600	/	temp 1	0,n,2n,...(n-1)n
		42	Y	00199	/	C[ ]	
		43	XB	62600	/	☒ temp 1	}
		44	XA	62333	/	n @ 29	inc. ctr 1
		45	XC	62600	/	temp 1	}
		46	B	0018	/	H[ ]	
		47	E	00533	/	☒ 3wwj	mask
		48	XS	62400	/	Lo □rij matrix	
		49	T	00544	/	test out	
		50	U	0017	/	loop →	
,0000 0003	'	51	20000	00000	/	☒ 1 @ 2	
		52		4	/	1 @ 29	
		53		3www j	/	mask	
		54	XZ	04000	/	BP 4 stop after conversion	
		55	U	[ ]	/	☒ exit	
.0000 0000	'	56			/		
		57			/		
		58			/		
		59			/	☒	
		60			/		
		61			/		
		62			/		
		63			/	☒	

FORM LP-12

☒ CARRIAGE RETURN

METAL MARK J13541X

TITLE: Compute and Print Matrix Inverse

AUTHOR: William F. Burggrabe, Jr.
Compumatix, Incorporated

DATE: April 24, 1959

PURPOSE: A) Initialize and transfer control to the matrix inversion routine (29.0).

B) Printout the inverse if it is desired (Transfer control up)

RESTRICTIONS:

1) Normal restrictions of 24.0, 12.6 and 29.0

2) See attached sheet for external information that must be supplied.

3) Output - 12.6 format

CODING INFORMATION:

A) Storage: 55 sectors and under two above.

B) Linkage: R (Lo + 54)

U (Lo)

C) Input: None

D) Output: 12.6 format with a carriage return after each row.

NOTE: Transfer control down skips printing to Lo + 53.

E) Constants:

Lo + 28	1 @ 29
Lo + 29	14 @ 29
Lo + 30	XZ0149
Lo + 31	1 @ 14

F) Timing:

Inversion: Approximately 1.08 n^3 seconds

Printout: Approximately 2 n^2 seconds

G) Program Stops:

Lo + 15*	B.P. 8 inversion complete
Lo + 53	B.P. 4 printing complete

*Depression of transfer control before continuing causes a transfer to Lo + 53, thus eliminating the printing phase of the program.

LGP-30 CODING SHEET

PREPARED FOR: LGP-30, RPC-4000 Users' Organization - POOL

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JOB NO.

PROGRAM NO.: F2-129

PROGRAM PREPARED BY: Burggrabe

PROGRAM CHECKED BY: POOL Review

DATE: 4-24-59

PROBLEM: External Storage

TRACK: 62

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	/						
	/	☒					
		6232			/		
		33	XZ	[ ]	/	n@ 29 = Matrix Order	*
		34			/		
		35			/	☒	
		36			/		
		37	XZ	[ ]	/	Lo floating Point	*
		38			/		
		39			/	☒	
		40	XZ	[ ]	/	Lo □ rij matrix	*
		41			/		
		42	XZ	[ ]	/	Lo inversion sub. 29.0	*
		43			/	☒	
		44			/		
		45			/	* Note: These locations	
		46			/	must be filled prior	
		47			/	☒ to entry into subroutine	
		48			/		
		49			/		
		50			/		
		51			/	☒	
		52			/		
		53			/		
		54			/		
		55			/	☒	
		56			/		
		57			/		
		58			/		
		59	[	]	/	☒ Temp & ctr	
		60	[	]	/	Temp & ctr	
		61			/		
		62			/		
		63			/	☒	

FORM LP-11

☒ CARRIAGE RETURN

ROYAL MCBEE J13541X

LGP-30 CODING SHEET

PREPARED FOR: LGP-30, RPC-4000 Users' Organization - POOL

PAGE 1 / 2

JOB NO.

PROGRAM NO. F2-129

PROGRAM PREPARED BY: Burggrabe

PROGRAM CHECKED BY: POOL Review

DATE 4-24-59

PROBLEM: Call-in, Compute & Print - Inverse (Rice F.P.M.I.)

TRACK 00

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
; 0 0 0 Lo	/						
/ 0 0 0 Lo	/	☒					
		0 0 0 0	X B	6 2 3 3	/	n @ 29	
		0 1	D	0 0 3 1	/	1 @ 14	
		0 2	X A	6 2 4 0	/	Lo □ rij matrix	
		0 3	C	0 0 1 4	/	☒	
		0 4	X B	6 2 4 2	/	Lo matrix Inversion sub. (Rice M.I.)	
		0 5	Y	0 0 1 3	/		
		0 6	A	0 0 2 9	/	XZ 0 0 1 4	
		0 7	Y	0 0 1 2	/	☒	
		0 8	A	0 0 3 0	/	XZ 0 1 4 9	
		0 9	Y	0 0 1 1	/		
		1 0	X B	6 2 3 7	/	Lo Floating Point	
		1 1	Y	[ ]	/	☒ (Matrix Inversion Lo + 163)	
		1 2	R	[ ]	/	} Matrix Inversion Linkage	
		1 3	U	[ ]	/		
		1 4	[	]	/	Code word	
		1 5	X Z	0 8 0 0	/	☒ BP 8 stop after inversion	
		1 6	X C	6 2 6 0	/	Clear acc.	
		1 7	8 0 0 T	0 0 5 3	/	Skip inverse print-out	
		1 8	X C	6 2 6 0	/	ctr 1 → 0	
		1 9	X C	6 2 5 9	/	☒ ctr 2 → 0	
		2 0	X B	6 2 3 7	/	Lo Floating Point }	
		2 1	Y	0 0 3 2	/	} Init.Print	
		2 2	Y	0 0 3 3	/		
		2 3	X B	6 2 4 0	/	☒ Lo □ Rij Matrix Inverse	
		2 4	Y	0 0 3 4	/		
		2 5	X P	1 6 0 0	/	C.R.	
		2 6	X Z	0 0 0 0	/	delay	
		2 7	U	0 0 3 2	/	☒ transfer over constants	
		2 8	X Z	0 0 0 1	/	1 @ 29	
		2 9	X Z	0 0 1 4	/	14 @ 29	
		3 0	X Z	0 1 4 9	/	Used to set up { Lo + 163 in Rice F.P.M.I.	
		3 1	X Y	0 0 0 0	/	☒ 1 @ 14	

☒ CARRIAGE RETURN

FORM LP-10

ROYAL McBEE, J13541X

LGP-30 CODING SHEET

PREPARED FOR: LGP-30, RPC-4000 Users' Organization - POOL

PAGE 2 OF /2

JOB NO.	PROGRAM NO.	PROGRAM PREPARED BY:	PROGRAM CHECKED BY:	DATE
	F2-129	Burggrabe	POOL Review	4-24-59

PROBLEM: Call-in, Compute & Print - Inverse (Rice F.P.M.I.)

TRACK 00

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	'						
	'	X					
		32	R	[ ]	'		F.P. Linkage
		33	U	[ ]	'		
		34	B	[ ]	'		No. to print
		35	XP	0000	'	X	Print No.
		36	XE	0000	'		Exit F.P.
		37	B	0034	'		add. of no. printed
		38	A	0028	'		1 @ 29
		39	Y	0034	'	X	
		40	XB	6260	'		ctr 1
		41	A	0028	'		1 @ 29
		42	XH	6260	'		ctr 1
		43	XS	6233	'	X	n @ 29
		44	T	0032	'		loop n times
		45	XP	1600	'		cr.
		46	XC	6260	'		ctr 1 → 0
		47	XB	6259	'	X	ctr 2
		48	A	0028	'		1 @ 29
		49	XH	6259	'		ctr 2
		50	XZ	0000	'		delay
		51	XS	6233	'	X	n @ 29
		52	T	0032	'		loop n times
		53	XZ	0400	'		BP 4 stop after printing
		54	U	[ ]	'		exit
		55			'	X	
		56			'		
		57			'		
		58			'		
		59			'	X	
		60			'		
		61			'		
		62			'		
		63			'	X	

X CARRIAGE RETURN

FORM LP-12

ROYAL MCBEE J13541X

TITLE: Calculation of Beta Weights, Regression Coefficients; Partial Correlation Coefficient and Standard Error of the Independent Variables; the Constant Term (b_o) and its Standard Error; the Sample Multiple Correlation Coefficient and Standard Error of Estimate; the Universe Multiple Correlation Coefficient and Standard Error of Estimate.

AUTHOR: William F. Burggrabe, Jr.
Compumatix, Incorporated

DATE: May 26, 1960.

PURPOSE: Given the inverse of the correlation coefficient matrix, the means and standard deviations of the variables; compute and printout the above.

RESTRICTIONS:

1) The last row and column of the matrix contain elements corresponding to the dependent variable. (Explanation under "Method").

2) Normal restrictions of 24.0 and 12.6.

3) See attached sheet for external storage of information that must be supplied.

4) 25.OR in 0900.

METHOD:

A) Given a correlation coefficient matrix of the form:

	X_1	X_2	X_3	...	Y
X_1	R_{11}	R_{12}	R_{13}	...	R_{1y}
X_2	R_{21}	R_{22}	R_{23}	...	R_{2y}
X_3	R_{31}	R_{32}	R_{33}	...	R_{3y}
.	.	.	.		.
.	.	.	.		.
.	.	.	.		.
Y	R_{y1}	R_{y2}			R_{yy}

An inverse of the (Rij) matrix is computed yielding:

	X_1	X_2	...	Y
X_1	$\frac{1}{V_{1,23 \ldots y}}$	$-\frac{\beta_{21,34 \ldots}}{V_{2,13 \ldots y}}$	...	$-\frac{\beta_{y1,23 \ldots}}{V_{y,123 \ldots}}$
X_2	$-\frac{\beta_{12,34 \ldots}}{V_{1,23 \ldots y}}$	$\frac{1}{V_{2,13 \ldots y}}$	...	$-\frac{\beta_{y2,13 \ldots}}{V_{y,123 \ldots}}$
.	.	.		.
.	.	.		.
.	.	.		.
Y	$-\frac{\beta_{1y,23 \ldots}}{V_{1,23 \ldots y}}$	$-\frac{\beta_{2y,13 \ldots}}{V_{2,13 \ldots y}}$	...	$\frac{1}{V_{y,123 \ldots}}$

B) Where:

1. The β's, Beta weights, are equal to the coefficients of the equation:

$$\frac{y'-\bar{y}}{\sigma_y} = \beta_1 \frac{(x-\bar{x})_1}{\sigma_{x1}} + \beta_2 \frac{(x-\bar{x})_2}{\sigma_{x2}} + \ldots + \beta_{n-1} \frac{(x-\bar{x})_{n-1}}{\sigma_{xn-1}}$$

Y' = Predicted Value
$\beta_1 = \beta_{y1,23 \ldots}$
$\beta_2 = \beta_{y2,13 \ldots}$
$\bar{x}i$, $\bar{y}$ = means
σ_{xi}, σ_y = standard deviations

The β's are obtained by dividing each column element by the principle diagonal element in that column.

NOTE: All β's for <u>all</u> multiple regression equations (i.e.,
are available in the inverse.

2. The regression coefficients are obtained from the Beta weights as follows:

$$b_0 = \bar{Y} - \bar{X}_1 \frac{\sigma_y}{\sigma_{x1}} \beta_1 - \bar{X}_2 \frac{\sigma_y}{\sigma_{x2}} \beta_2 - \bar{X}_3 \frac{\sigma_y}{\sigma_{x3}} \beta_3 \ldots$$

$$b_1 = \beta_1 \frac{\sigma_y}{\sigma_{x1}}$$

$$b_2 = \beta_2 \frac{\sigma_y}{\sigma_{x2}} \quad , \text{ etc.}$$

3. The partial correlation coefficients are obtained by:

$$r^2_{ab,cde\ldots} = \frac{\left(\frac{\beta_{ab,cde\ldots}}{V_{a,bcde\ldots}}\right) \cdot \left(\frac{\beta_{ba,cde\ldots}}{V_{b,acde\ldots}}\right)}{\left(\frac{1}{V_{a,bcde\ldots}}\right) \cdot \left(\frac{1}{V_{b,acde\ldots}}\right)}$$

However, because of the symmetry of the inverse,

$$\frac{\beta_{ab,cde\ldots}}{V_{a,bcde\ldots}} = \frac{\beta_{ba,cde\ldots}}{V_{b,acde\ldots}}$$

There, each partial correlation coefficient may be obtained by dividing the corresponding off principal diagonal element by the square root of the product of the row, column elements of the principal diagonal.

4. Standard error of regression coefficient --

$$S_{bi} = \hat{S} \cdot \sqrt{\frac{(1-r^2_{iy,123\ldots})}{N\sigma^2_i\ (1-R^2_{i,23\ldots})}}$$

5. The regression multiple correlation coefficients for the n equations are computed as follows:

$$R^2_{a,bcde} = 1 - \frac{1}{\text{ath diag. element}}$$

or --

$$R = \sqrt{1 - \frac{1}{\left(\frac{1}{V_{y,123\ldots}}\right)}}$$

Etc.

6. The standard error of estimate is:

$$S = \sigma_y \sqrt{1 - R^2}$$

7. Universe multiple correlation coefficient --

$$\hat{R} = \sqrt{1 - (1-R^2)\left(\frac{N-1}{N-n}\right)}$$

8. Universe standard error of estimate --

$$\hat{S} = \sigma_y \sqrt{(1-\hat{R}^2)\left(\frac{N}{N-1}\right)}$$

C) The program that has been written assumes the dependent variable cells to occupy the last column and/or row. However, a routine could be written for any other designation, or since the program does not alter the inverse, rows and columns could be interchanged, to put the correct elements in the proper locations for this program.

CODING INFORMATION:

A) Storage 3 tracks 10 sectors plus external storage on attached sheet.

B) Linkage R (Lo + 309)
U (Lo)

C) Input None

D) Output 12.6 - format (See sample problem)

Order: β_1, b_1, $R_{1y,2}$ ... S_{b1} C.R.

β_2, b_2, $R_{2y,1}$ ... S_{b2} C.R.

etc.

Bn-1, bn-1, Rn-1y,1 ... C.R.

Tab b_0 Tab S_{b0} C.R.

C.R.

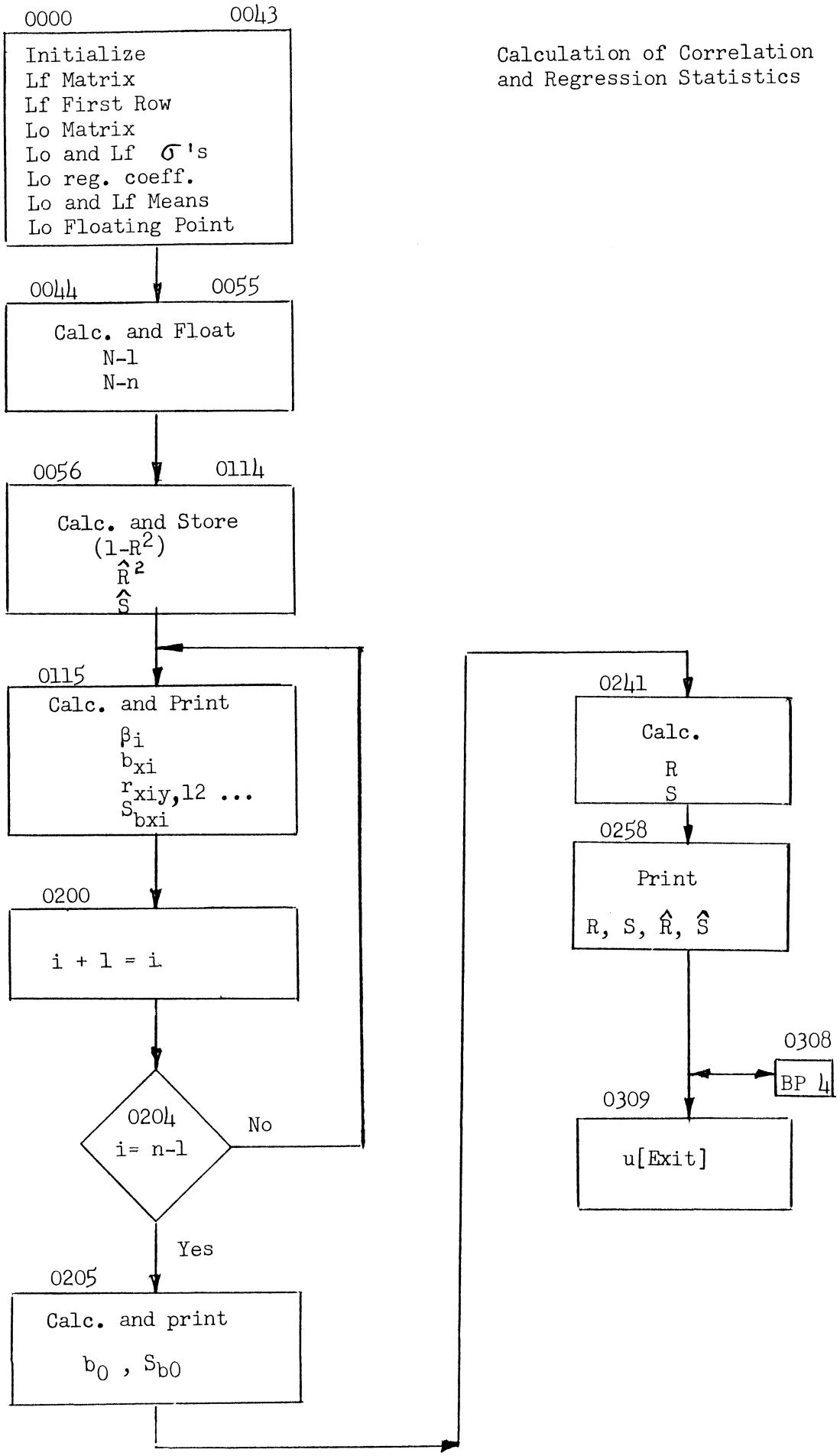
R, , S , $\hat{R}$, $\hat{S}$

E) Constants Lo + 226 1 @ 29
Lo + 240 1 @ 2
Lo + 148 Floating Point "1"

F) Timing: Approximately 10 n seconds

G) Stops: Lo + 308 B.P. 4 stop at completion of program

Calculation of Correlation and Regression Statistics



LGP-30 CODING SHEET

PREPARED FOR: LGP-30, RPC-4000 Users' Organization

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JOB NO.	PROGRAM NO.	PROGRAM PREPARED BY:	PROGRAM CHECKED BY:	DATE
	F2-129	Burggrabe	POOL Review	1-15-60

PROBLEM: External Storage

TRACK 62

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	/						
	/	☒					
		6232			/		
		33	X Z	[ ]	/	n @ 29	Order of Inverse *
		34	X Z	[ ]	/	N @ 24	No of Records *
		35			/	☒	
		36			/		
		37	X Z	[ ]	/	Lo Floating	Point *
		38	X Z	[ ]	/	Lo Means	*
		39	X Z	[ ]	/	☒ Lo Standard Deviations	*
		40	X Z	[ ]	/	Lo Inverse	(□ rij Matrix) *
		41			/		
		42			/		
		43	X Z	[ ]	/	☒ Lo Regression Coefficients	*
		44			/		
		45			/		
		46			/	* Note:	These locations must
		47			/	☒	be filled prior to entering
		48			/		into subroutine.
		49			/		
		50			/		
		51			/	☒	
		52			/		
		53			/		
		54			/		
		55			/	☒	
		56			/		
		57			/		
		58	[ ]		/	Temp	
		59	[ ]		/	☒ Temp	
		60	[ ]		/	Temp	
		61	[ ]		/	n + 1 @ 29	*
		62			/		
		63			/	☒	

☒ CARRIAGE RETURN

FORM LP-12

ROYAL M 011 J13541X

LGP-30 CODING SHEET

PREPARED FOR: LGP-30, RPC-4000 Users' Organization - POOL

PAGE 1 / 7

JOB NO.

PROGRAM NO. F2-129

PROGRAM PREPARED BY: Burggrabe

PROGRAM CHECKED BY: POOL Review

DATE 1-15-60

PROBLEM: β_{xi}, b_{xi}, Partial Corr. Coeff, S_{bxi}, b_o, & est, R, σ est, $\hat{R}$, $\hat{\sigma}$ est

TRACK 00

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	/						
	/	☒					
		0000	XB	6233	/	n @ 29	
		001	XN	6233	/	n @ 29	
		002	M	0240	/	1 @ 2	
		003	S	0226	/	☒ 1 @ 29	
		004	XA	6240	/	Lo □ Matrix Inverse	
		005	Y	0060	/	Add $[1/V_n]$	
		006	XB	6233	/	n @ 29	
		007	S	0226	/	☒ 1 @ 29	
		008	XH	6254	/	Temp	ctr
		009	XA	6240	/	Lo □ Matrix Inverse	
		010	Y	0117	/	$-\beta_i/V_n$	
		011	Y	0131	/	☒	
		012	XB	6240	/	Lo □ Matrix Inverse	
		013	Y	0127	/	Add $1/V_i$	
		014	XB	6239	/	Lo σ's	
		015	Y	0123	/	☒ Add $[\sigma x_i]$	
		016	Y	0140	/	"	
		017	Y	0141	/	"	
		018	XA	6254	/	n-1 @ 29	
		019	Y	0112	/	☒ Add $[\sigma y]$	
		020	Y	0122	/	"	
		021	Y	0252	/	"	
		022	XB	6243	/	Lo reg. Coeff.	
		023	Y	0231	/	☒ Add $[b_o]$	
		024	A	0226	/	1 @ 29	
		025	Y	0124	/	Add $[b_{xi}]$	
		026	Y	0210	/		
		027	XB	6238	/	☒ Lo Means	
		028	Y	0209	/		
		029	XA	6254	/	n-1 @ 29	
		030	Y	0229	/	Add $\bar{Y}$	
		031	XB	6237	/	☒ Lo Floating Point	

FORM LP-10

☒ CARRIAGE RETURN

ROYAL McBEE J13541X

LGP-30 CODING SHEET

PREPARED FOR: LGP-30, RPC-4000 Users' Organization - POOL

PAGE 2 OF 7

JOB NO.

PROGRAM NO. F2-129

PROGRAM PREPARED BY: Burggrabe

PROGRAM CHECKED BY: POOL Review

DATE 1-15-60

PROBLEM: β_{xi}, b_{xi}, Partial Corr. Coeff, S_{bxi}, b_o, & est, R, σ est, $\hat{R}$, $\hat{\sigma}$ est

TRACK 00

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	/						
	/	X					
		0032	Y	0057	/		
		33	Y	0058	/		
		34	Y	0115	/		
		35	Y	0116	/	X	
		36	Y	0207	/		
		37	Y	0208	/		
		38	Y	0227	/		
		39	Y	0228	/	X	
		40	Y	0241	/		
		41	Y	0242	/		
		42	Y	0258	/		
		43	Y	0259	/	X	
		44	XB	6234	/	n @ 29	
		45	S	0226	/	1 @ 29	
		46	XR	0925	/	float	25.OR
		47	XU	0900	/	X	
		48	XZ	0029	/		
		49	XC	6257	/	n-1	
		50	XB	6234	/	n @29	
		51	XS	6233	/	X n @ 29	
		52	XR	0925	/	float	25.OR
		53	XU	0900	/		
		54	XZ	0029	/		
		55	XC	6258	/	X n-P	
		56	XC	6253	/	Temp → 0	
		57	R	[ ]	/	24.0	
		58	U	[ ]	/		
		59	B	0148	/	X "1"	
		60	D	[ ]	/	$1/V_n$	
		61	XH	6259	/	$(1-R^2)$	
		62	XD	6258	/		
		63	XH	6258	/	X	$\frac{(1-R^2)}{N-1}$

FORM LP-12

X CARRIAGE RETURN

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JOB NO. | PROGRAM NO. F2-129 | PROGRAM PREPARED BY: Burggrabe | PROGRAM CHECKED BY: POOL Review | DATE 1-15-60

PROBLEM: B_{xi}, b_{xi}, Partial Corr. Coeff, S_{bxi}, b_o, & est, R, σest, $\hat{R}$, $\hat{\sigma}$ est | TRACK 01

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	/						
	/	☒					
		0100	XU	00000	/	Acc. → M	
		01	XM	62577	/	(N-1) →	$(1-\hat{R}^2)$
		02	XY	00000	/	change signs →	$-1+\hat{R}^2$
		03	A	01488	/	☒ "1" →	$\hat{R}^2$
		04	XH	62600	/		
		05	XB	62577	/	N-1	
		06	A	01488	/	1	
		07	XH	62555	/	☒ →	n
		08	XU	00000	/		
		09	XM	62588	/	$\frac{1-\hat{R}^2}{(N-1)}$ → $\sqrt{}$	$\frac{(1-\hat{R})^2 N}{N-1}$
		10	XR	00000	/		
		11	XU	00000	/	☒	
		12	M[ ]		/	σ_y	
		13	XH	62588	/	$\hat{S}$	
		14	XE	00000	/	Exit	F.P.
		15	R[ ]		/	☒ 24.0	
		16	U[ ]		/		
		17	P[ ]		/	$-\beta/V_n$	
		18	XM	62599	/	V_n	
		19	XY	00000	/	☒ Change Signs	
		20	XP	00000	/	Print β_i	
		21	XU	00000	/	Acc → M	
		22	M[ ]		/	σ_y	
		23	D[ ]		/	☒ σ_{xi}	
		24	H[ ]		/	b_{xi}	
		25	XP	00000	/		
		26	B	01488	/	"1"	
		27	D[ ]		/	☒ $1/V_i$	
		28	XH	62577	/	$(1-R_i^2)$	
		29	XM	62577	/	$\beta_i \cdot V_i$	
		30	XU	00000	/		
		31	M[ ]		/	☒ $-\beta_i/V_i$	$-\beta_{iy} \cdot \beta_{yi}$

☒ CARRIAGE RETURN

FORM LP-10

ROYAL McBEE J13541X

PREPARED FOR: LGP-30, RPC-4000 Users' Organization - POOL | PAGE 4 / 7

JOB NO. | PROGRAM NO. F2-129 | PROGRAM PREPARED BY: Burggrabe | PROGRAM CHECKED BY: POOL Review | DATE 1-15-60

PROBLEM: β_{xi}, b_{xi}, Partial Corr. Coeff, S_{bxi}, b_o, & est, R, σ est, $\hat{R}$, $\hat{\sigma}$ est | TRACK 01

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	/						
	/	☒					
		0132	XY	0000	/		
		33	XH	6256	/	$rij^2 \cdot xxx$	Partial
		34	XR	0000	/	$\sqrt{}$	$rij \cdot xxx$
		35	XP	0000	/	☒	
		36	B	0148	/	"1"	
		37	XS	6256	/	r^2	
		38	XD	6257	/	$(1-R_i^2)$	
		39	XD	6255	/	☒ N	
		40	D	[ ]	/	σ_{xi}	
		41	D	[ ]	/	σ_{xi}	$(1-r^2)/N\sigma(1-R_i^2)$
		42	XR	0000	/	$\sqrt{}$ →	$\sqrt{C_{ij}}$
		43	XU	0000	/	☒ Acc → M	
		44	XM	6258	/	$\hat{\sigma}$ est	
		45	XP	0000	/	Print	(S_{bxi})
		46	XE	0000	/		
		47	XP	1600	/	☒	
,0000 0001	'	48	4000	0002	/	F.P. "1" & delay	
		49	B	0117	/	Add $[-\beta_i/V_n]$	
		50	XA	6233	/	n @ 29	
		51	Y	0117	/	☒	
		52	Y	0131	/		
		53	B	0123	/	$D[\sigma_{xi}]$	
		54	A	0226	/	1 @ 29	
		55	Y	0123	/	☒	
		56	Y	0140	/		
		57	Y	0141	/		
		58	B	0124	/	$H[b_{xi}]$	
		59	A	0226	/	☒ 1 @ 29	
		60	Y	0124	/		
		61	B	0127	/	$D[1/V_i]$	
		62	XA	6261	/	(n+1) @ 29	
		63	Y	0127	/	☒	

FORM LP-12

☒ CARRIAGE RETURN

LGP-30 CODING SHEET

PREPARED FOR: LGP-30, RPC-4000 Users' Organization - POOL

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JOB NO.

PROGRAM NO. F2-129

PROGRAM PREPARED BY: Burggrabe

PROGRAM CHECKED BY: POOL Review

DATE 1-15-60

PROBLEM: β_{xi}, b_{xi}, Partial Corr. Coeff, S_{bxi}, b_o, & est, R, σ est, $\hat{R}$, $\hat{\sigma}$ est

TRACK 02

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	/						
	/	☒					
		000	XB	6253	/	Ctr	
		001	A	0226	/	1 @ 29	
		002	XH	6253	/	Ctr	
		003	XS	6254	/	☒ n - 1 @ 29	
		004	T	0115	/		
		005	XC	6253	/	Ctr	
		006	XC	6256	/	Σ Area	
		007	R	[ ]	/	☒ 24.0	
		008	U	[ ]	/		
		009	P	[ ]	/	$\bar{X}_i$	
		010	M	[ ]	/	b_{xi}	
		011	XA	6256	/	☒ Σ	
		012	XH	6256	/	Σ	
		013	XE	0000	/	Exit F.P.	
		014	B	0209	/	P[$\bar{X}_i$]	
		015	A	0226	/	☒ 1@ 29	
		016	Y	0209	/		
		017	B	0210	/		
		018	A	0226	/	1@ 29	
		019	Y	0210	/	☒	
		020	XB	6253	/	ctr	
		021	A	0226	/	1@ 29	
		022	XH	6253	/	ctr	
		023	XS	6254	/	☒ (n-1)@ 29	
		024	T	0207	/		
		025	XP	2400	/	tab	
		026	XZ	0001	/	1@ 29 & delay	
		027	R	[ ]	/	☒ 24.0	
		028	U	[ ]	/		
		029	B	[ ]	/	$\bar{Y}$	
		030	XS	6256	/	Σ	
		031	H	[ ]	/	☒ b_o	

FORM LP-10

ROYAL McBEE J13541X

☒ CARRIAGE RETURN

/ = CONDITIONAL STOP CODE

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	F2-129	Burggrabe	POOL Review	1-15-60
PROBLEM: β_{xi}, b_{xi}, Partial Corr. Coeff, S_{bxi}, b_o, & est, R, σ est, $\hat{R}$, $\hat{\sigma}$ est				TRACK 02

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	/						
	/	☒					
		02 32	XP	0000	/		
		33	XB	6255	/	N	
		34	XR	0000	/	$\sqrt{}$ →	$\sqrt{N}$
		35	XH	6255	/	☒	
		36	XB	6258	/	$\hat{S}$ est	
		37	XD	6255	/	$\sqrt{N}$	
		38	XE	0000	/	Exit F.P.	
		39	XP	2400	/	☒ tab	
,0000 0001	/	40	2000	0000	/	1@ 2 and delay	
		41	R[	]	/		
		42	U[	]	/		
		43	XP	0000	/	☒ Sb_o	
		44	XB	6259	/	$1-R^2$	
		45	S	0148	/	"1"	
		46	XY	0000	/	Change signs	R^2
		47	XR	0000	/	☒ $\sqrt{}$	R
		48	XH	6257	/	R	
		49	XB	6259	/	$1-R^2$	
		50	XR	0000	/	$\sqrt{}$	
		51	XU	0000	/	☒ Acc → M	
		52	M[	]	/	σ y →	S est
		53	XH	6259	/	S est	
		54	XE	0000	/		
		55	XP	1600	/	☒ cr.	
		56	XZ	0000	/		
		57	XP	1600	/	cr.	
		58	R[	]	/		
		59	U[	]	/	☒	
		60	XB	6257	/	R	
		61	XP	0000	/	Print	
		62	XB	6259	/	S est	
		63	XP	0000	/	☒ Print	

FORM LP-12

☒ CARRIAGE RETURN

/ = CONDITIONAL STOP CODE

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JOB NO.

PROGRAM NO. F2-129

PROGRAM PREPARED BY: Burggrabe

PROGRAM CHECKED BY: POOL Review

DATE 1-15-60

PROBLEM: β_{xi}, b_{xi}, Partial Corr. Coeff, S_{bxi}, b_o, & est, R, σ est, $\hat{R}$, $\hat{\sigma}$ est

TRACK 03

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	/						
	/	☒					
		0300	XB	6260	/	$\hat{R}^2$	
		01	xR	0000	/		
		02	XP	0000	/		
		03	XB	6258	/	☒ $\hat{S}$ est	
		04	XP	0000	/		
		05	XE	0000	/		
		06	XP	1600	/	cr.	
		07	XZ	0000	/	☒ delay	
		08	XZ	0400	/	Stop	BP 4
		09	U[	]	/	Exit	
		10			/		
		11			/	☒	
		12			/		
		13			/		
		14			/		
		15			/	☒	
		16			/		
		17			/		
		18			/		
		19			/	☒	
		20			/		
		21			/		
		22			/		
		23			/	☒	
		24			/		
		25			/		
		26			/		
		27			/	☒	
		28			/		
		29			/		
		30			/		
		31			/	☒	

ROYAL McBEE J13541X

FORM LP-10

☒ CARRIAGE RETURN

/ = CONDITIONAL STOP CODE

TITLE: Calculation of Y^1 and $(y-y^1)$ given a set of coefficients $(B_0, B_1, \ldots B_n)$ and a set of records $(1, X_1, X_2 \ldots X_n)$

AUTHOR: Allen G. Renz
Compumatix, Incorporated

DATE: October 8, 1959

PURPOSE: To read in a set of records, each record containing values for $X_1, X_2, \ldots X_n$ and Y, and calculate a predicted value of Y, Y^1, using a set of coefficients stored in the machine. Also calculate $(y-y^1)$ and print out Y, Y^1, and $(y-y^1)$.

RESTRICTIONS:

A) Normal restrictions of 11.2 and 12.1

B) Coefficients must be stored in machine prior to entering subroutine in order, (i.e., b_0, b_{x1}, ..., b_{xn}) in fixed point @ q of variables.

C) The number of variables is limited only by machine storage available.

CODING INFORMATION:

A) Storage

1) Program - 54 sectors

2) External storage - 6232 to 6263 (See attached sheet)

3) 11.2 data input - 0300-0563

4) 12.1 data output - 0600-0763

B) No calling sequence is required.

Linkage: R (Lo + 50)

U (Lo + 00)

C) Input is in 11.2 data input format in the following sequence:

First record

P ± qq (Lo record) ' 1' X_1' X_2 ' ... X_n' Y' -0000000''

Following Records:

P ± qq (Lo record +1)' X_1' X_2' ... X_n' Y' -0000000''

D) Output: Output is in 12.1 fixed point data output format. Three colums are printed out:

Y_1 Y^1 and $(y-y^1)$ at ZQ of variables (X_1 ... X_n)

E) Location of constants:

Lo + 36 1@ 29

Lo + 51 XZ 0300

Lo + 52 XZ 6363

Lo + 53 Temp storage

F) Timing: 5 sec/15 X's/ record + input and print time

G) Program stops:

Lo + 45 B.P. 4 after print out

Lo + 49 B.P. 8 after completion

H) Storage Requirement(External)

6232 - Two times the data q @ q = 29

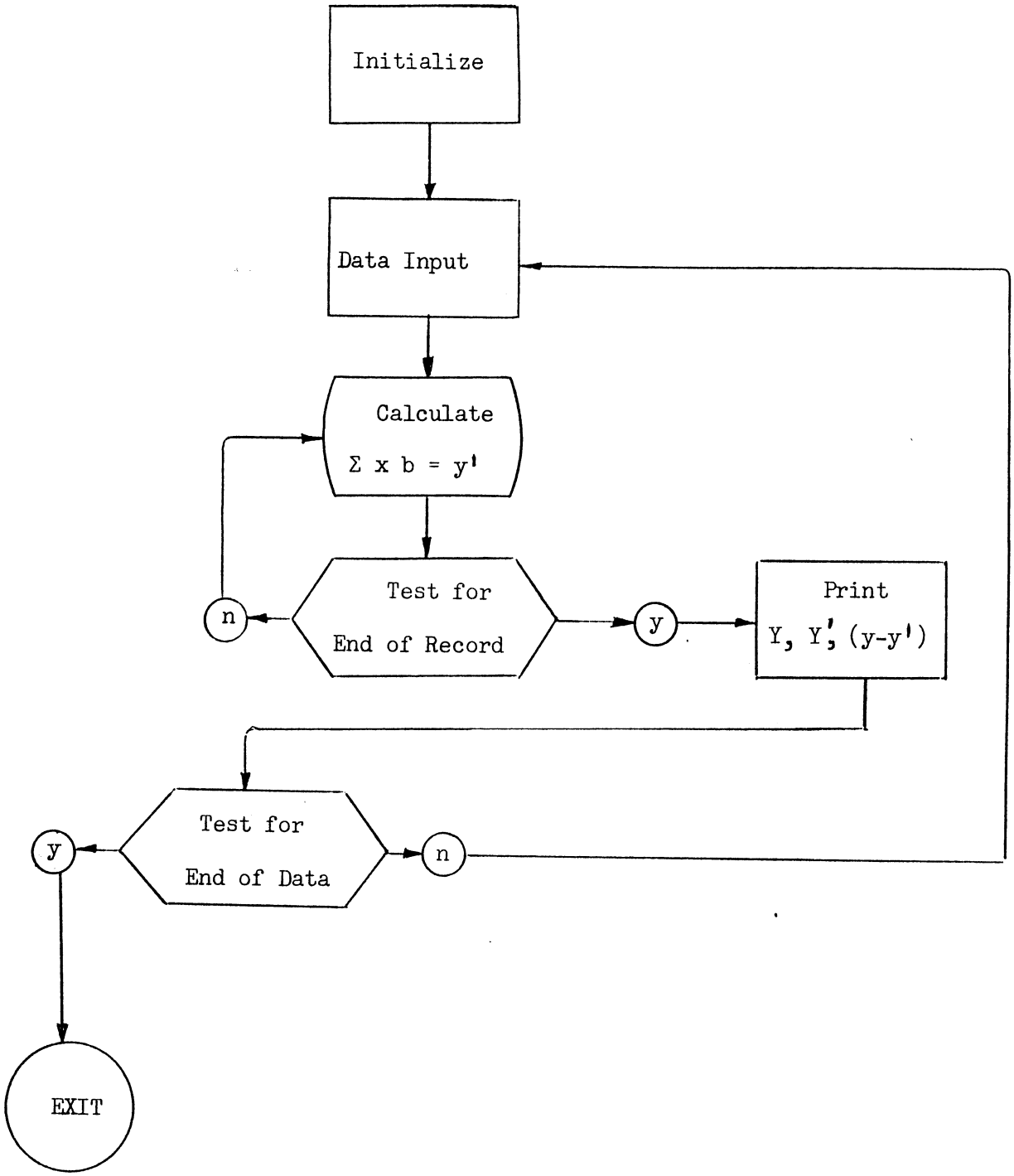
6233 - n, no. of variables @ q = 29

6234 - N, no. of records @ q = 29

6235 - Lo of the record

6243 - Lo of the coefficients

Calculation of Y^1 and $(y-y^1)$



LGP-30 CODING SHEET

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JOB NO.	PROGRAM NO.	PROGRAM PREPARED BY:	PROGRAM CHECKED BY:	DATE
	F2-129	Burggrabe	POOL Review	10-6-59
PROBLEM:				TRACK
Calc. & Print Y, Y' (Y-Y') Fixed Point				00

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	/						
	/	☒					
		0000	XB	6235	/	Lo Record	
		0001	Y	0018	/		
		0002	Y	0030	/		
		0003	XA	6233	/	☒ n @ 29	no variables
		0004	Y	0031	/		L_f Record
		0005	Y	0053	/		
		0006	XB	6243	/	Lo of coefficients	
		0007	Y	0017	/	☒	
		0008	B	0051	/	XZ0300	
		0009	XA	6232	/	Q of printout	
		0010	Y	0040	/		
		0011	XC	6260	/	☒ Acc → 0	
		0012	XS	6234	/	N @ 29	Number of records
		0013	XC	6260	/	ctr	
		0014	XC	6258	/	Σ storage	
		0015	XR	0308	/	☒ read record	
		0016	XU	0300	/		
		0017	B	[ ]	/	b_{xi}	
		0018	M	[ ]	/	x_i	
		0019	XA	6258	/	☒ $\Sigma(b \cdot X)_i$	
		0020	XC	6258	/	$\Sigma(b \cdot X)_{i+1}$	
		0021	B	0017	/	B [ ] b_{xi}	
		0022	A	0036	/	1 @ 29	
		0023	Y	0017	/	☒	
		0024	B	0018	/	M [ ] x_i	
		0025	A	0036	/	1 @ 29	
		0026	Y	0018	/		
		0027	E	0052	/	☒ XZ 6363	
		0028	S	0053	/	L_f record	
		0029	T	0017	/		
		0030	B	[ ]	/	1 @ q	
		0031	M	[ ]	/	☒ y @ q	y @ 2q

FORM LP-10

ROYAL McBEE, J13541X

☒ CARRIAGE RETURN

/ CONDITIONAL STOP CODE

LGP-30 CODING SHEET

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JOB NO.	PROGRAM NO.	PROGRAM PREPARED BY:	PROGRAM CHECKED BY:	DATE
	F2-129	Burggrabe	POOL Review	10-6-59
PROBLEM:				TRACK
Calc. & Print Y, Y' (Y-Y') Fixed Point				00

PROGRAM INPUT CODES	STOP	LOCATION	INSTRUCTION OPERATION	INSTRUCTION ADDRESS	STOP	CONTENTS OF ADDRESS	NOTES
	/						
	/	☒					
		00032	X H	6257	/	Y	} @ Q
		33	X S	6258	/	Y'	
		34	X C	6259	/	Y-Y'	
		35	X P	1600	/	☒ cr.	
		36	X Z	0001	/	delay & 1 @ 29	
		37	X B	6257	/	Lo print area	
		38	X R	0605	/	12.1a	
		39	X U	0600	/	☒	
		40	X Z	[ ]	/	NNQQ	
		41	X B	6235	/	Lo record	
		42	Y	0018	/		
		43	X B	6243	/	☒ Lo coeff.	
		44	Y	0017	/		
		45	X Z	0400	/	BP 4 after each record	
		46	X B	6260	/		
		47	A	0036	/	☒ 1 @ 29	
		48	T	0013	/		
		49	X Z	0800	/	BP 8	At completion
		50	U	[ ]	/	Exit	
		51	X Z	0300	/	☒ for print code (12.1a)	
		52	X Z	6363	/	mask	
		53	X Z	0000	/	L_f Record	
		54			/		
		55			/	☒	
		56			/		
		57			/		
		58			/		
		59			/	☒	
		60			/		
		61			/		
		62			/		
		63			/	☒	

FORM LP-12

☒ CARRIAGE RETURN

/ = CONDITIONAL STOP CODE