

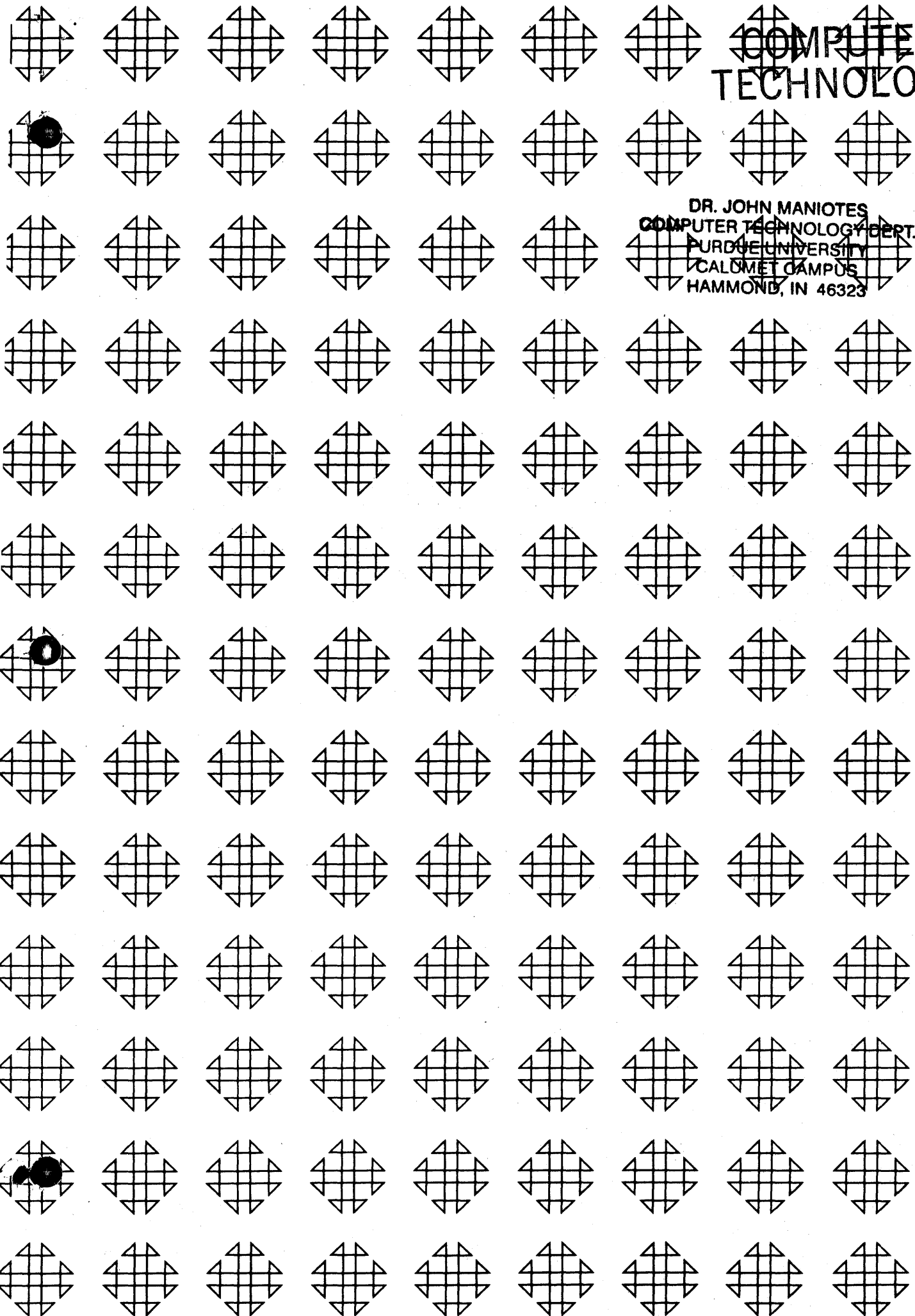
**COMPUTER
TECHNOLOGY**

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1620 GENERAL PROGRAM LIBRARY

Evaluation of a Determinant

5.0.019



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1620 USERS GROUP PROGRAM REVIEW AND EVALUATION

(fill out in typewriter or pencil, do not use ink)

Program No. _____

Date _____

Program Name: _____

1. Does the abstract adequately describe what the program is and what it does? Yes ___ No ___
Comment _____
2. Does the program do what the abstract says? Yes ___ No ___
Comment _____
3. Is the Description clear, understandable, and adequate? Yes ___ No ___
Comment _____
4. Are the Operating Instructions understandable and in sufficient detail? Yes ___ No ___
Comment _____
Are the Sense Switch options adequately described (if applicable)? Yes ___ No ___
Are the mnemonic labels identified or sufficiently understandable? Yes ___ No ___
Comment _____
5. Does the source program compile satisfactorily (if applicable)? Yes ___ No ___
Comment _____
6. Does the object program run satisfactorily? Yes ___ No ___
Comment _____
7. Number of test cases run _____. Are any restrictions as to data, size, range, etc. covered adequately in description? Yes ___ No ___
Comment _____
8. Does the Program Meet the minimal standards of the 1620 Users Group? Yes ___ No ___
Comment _____
9. Were all necessary parts of the program received? Yes ___ No ___
Comment _____
10. Please list on the back any suggestions to improve the usefulness of the program. These will be passed onto the author for his consideration.

Please return to:

Mr. Richard L. Pratt
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EVALUATION

OF A

D E T E R M I N A N T

by

Reginald T. Harling
Associate Professor of Mathematics

AIR FORCE INSTITUTE OF TECHNOLOGY
Wright-Patterson AFB, Ohio

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Modifications or revisions to this program, as they occur, will be announced in the appropriate Catalog of Programs for IBM Data Processing Systems. When such an announcement occurs, users should order a complete new program from the Program Information Department.

DECK KEY

1. Determinant Source Deck
2. Determinant Object Deck

AFIT 20
November, 1962

EVALUATION OF A DETERMINANT

R. T. Harling
Programmer

ABSTRACT

TITLE: Evaluation of a Determinant

SUBJECT CLASSIFICATION: 5.0

AUTHOR; ORGANIZATION: Reginald T. Harling, Air Force Institute of Technology, Wright-Patterson, AFB, Ohio

DIRECT INQUIRIES TO:

NAME: Reginald T. Harling - Address: Math Department,
AFIT, Wright-Patterson, AFB, Ohio

PHONE: CL3-7111, Extension 29115

PURPOSE: This program will evaluate a determinant of order 40 or less.

METHOD: The method used is that of Chio, and is described in Kunz, "Numerical Analysis," McGraw-Hill, 1957, Chap 10.

RESTRICTIONS, RANGE: Round-off error decrease the accuracy of the answer as the order of the determinant increases.

STORAGE REQUIREMENTS: 20K

EQUIPMENT SPECIFICATIONS: IBM 1620, with 20,000 digits of memory, card input-output. No additional features are needed.

ADDITIONAL REMARKS: The source program was written in SPS language, having macro-ops for the input and output conversion of floating point numbers. The present program differs from 5.0.005 principally in that, in the present program, all conversions of numbers, between external and internal forms, are done by the machine.

Purpose: This program will evaluate a determinant of order 40 or less.

Equipment Needed: IBM 1620, 20,000 digits of memory, and input-output. No additional features are needed.

Method: The method used is that of Chio, and is fully described in Kunz, "Numerical Analysis." McGraw-Hill, 1957, Chapter 10. Briefly, the procedure is as follows:

a) Each element of the top row of the determinant is divided by its first element, A_{11} , so that the new A_{11} is unity. (In case $A_{11} = 0$, two columns are interchanged to make A_{11} non-zero.)

b) A new array is formed by the rule

$$A_{1j} \quad A_{1l} \quad * \quad A_{lj} \quad \rightarrow \quad A_{lj}$$

c) Column 1 and row 1 are removed from the array. What remains is a determinant of order one less than the original.

d) The reduction in order is repeated until a determinant of order two can be evaluated by cross multiplication.

e) If, at any stage, the top row of the determinant should contain only zero elements, the value of the determinant is at once reported as being zero. This situation can be recognized by the fact that the word ZERO, rather than a numeric representation, is typed.

Program Language: The program was written in SPS language, having macro-ops for the input and output conversion of floating point numbers.

Data Input: The first data card must carry N , the order of the determinant, as a two-digit fixed point number (e.g., 03, 09, 25, etc) in card columns 1 and 2.

The second, third, etc., data cards must carry the elements of the determinant, commencing with those of row 1, and continuing to lower rows. These numbers must be in any external floating point form acceptable to the INC routine. They may be presented one per card, or any number per card, the numbers being separated by one or more blanks or commas. It is not necessary to follow the last number on a card by a record mark. If more than N^2 elements are presented, only the first N^2 of them will be read.

Operation:

1. Set the overflow switch to PROGRAM, others to STOP.
2. Put the SPS object deck of this program into the read hopper and press LOAD. Press READER START to read in the last two cards.

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3. Place the data cards in the read hopper and press START and READER START. It will again be necessary to press READER START to read in the last two cards.

4. The machine will evaluate the determinant and type out

"DETERMINANT IS -----

followed by its value.

5. The program may then be restarted by placing new data cards in the read hopper and returning to 3 above.

6. To recommence the program before it has printed an answer press in turn,

INST. STOP, RESET, INSERT, RELEASE, START,

and return to 3 above.

Comments: A tenth order determinant is evaluated in about 20 seconds. A thirtieth order determinant requires 12 minutes. Round-off error decreases the accuracy as the order increases. A determinant of order 30 was computed with an accuracy of five significant figures.

* EVALUATION OF A DETERMINANT

START	TDM	401,1	00402	15	00401	00001
	TF	FACT,ØNE	00414	26	02279	02269
	TF	FACT-2,ØNE-2	00426	26	02277	02267
	RNCD	N-1	00438	36	02280	00500
	SF	N-1	00450	32	02280	00000
	M	N,N	00462	23	02281	02281
	SF	97	00474	32	00097	00000
	TF	NSQ,99	00486	26	18444	00099
	TFM	CNT,0,9	00498	16	18447	00000
	TFM	ABC+23,ARRAY	00510	16	00641	02451
CAB	RACD	AREA	00522	37	02283	00500
	TFM	PQ+11,AREA+157	00534	16	00557	02440
PQ	BD	PQ2,	00546	43	00582	00000
	SM	PQ+11,2,10	00558	12	00557	00002
	B	PQ	00570	49	00546	00000
PQ2	TF	PQ1+6,PQ+11	00582	26	00612	00557
	AM	PQ1+6,3,10	00594	11	00612	00003
PQ1	TFM		00606	16	00000	00000
	DC	2,@,*	00617		00002	
ABC	INC	,AREA	00618	16	18657	00641
			00630	49	18606	00000
			00637		00005	00000
			00642		00005	02283
			00648	11	00641	00010
	AM	ABC+23,10,10	00660	11	18447	00001
	AM	CNT,1,10	00672	24	18444	18447
	C	NSQ,CNT	00684	46	00720	01200
	BE	AAB	00696	45	00618	02283
	BNR	ABC,AREA	00708	49	00522	00000
	B	CAB	00720	13	02281	00010
AAB	MM	N,10,10	00732	32	00097	00000
	SF	97	00744	26	18492	00099
	TF	TN,99	00756	26	18447	02281
	TF	CNT,N	00768	12	18447	00002
	SM	CNT,2,10	00780	46	01030	01100
	BP	TUFF	00792	46	00898	01200
	BZ	EASY	00804	34	00000	00102
PRINT	RCTY		00816	39	18449	00100
	WATY	MESS1	00828	16	18657	00851
	ØUTC	AREA,ARRAY,01608	00840	49	18626	00000
			00847		00005	02283
			00852		00005	02451
			00857		00005	01608

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	WATY AREA	00862 39 02283 00100
	H	00874 48 00000 00000
	B START+12	00886 49 00414 00000
EASY	FM ARRAY,ARRAY+30	00898 16 18657 00921
		00910 49 18546 00000
		00917 00005 02451
		00922 00005 02481
	FM ARRAY+10,ARRAY+20	00928 16 18657 00951
		00940 49 18546 00000
		00947 00005 02461
		00952 00005 02471
	FS ARRAY,ARRAY+10	00958 16 18657 00981
		00970 49 18526 00000
		00977 00005 02451
		00982 00005 02461
	FM ARRAY,FACT	00988 16 18657 01011
		01000 49 18546 00000
		01007 00005 02451
		01012 00005 02279
		01018 49 00804 00000
TUFF	B PRINT	01030 16 01065 02442
	TFM BBB+11,ARRAY-9	01042 16 18447 00001
	TFM CNT,1,10	01054 43 01186 00000
BBB	BD NZ,	01066 24 18447 02281
	C CNT,N	01078 46 01126 01200
	BE PRIN	01090 11 18447 00001
	AM CNT,1,10	01102 11 01065 00010
	AM BBB+11,10,10	01114 49 01054 00000
	B BBB	01126 34 00000 00102
PRIN	RCTY	01138 39 18449 00100
	WATY MESS1	01150 39 18479 00100
	WATY MESS2	01162 48 00000 00000
	H	01174 49 00414 00000
	B START+12	01186 12 18447 00001
NZ	SM CNT,1,10	01198 46 01522 01200
	BZ A23	01210 16 01334 02451
A22	TFM B24+28,ARRAY	01222 16 01359 02451
	TFM B25+23,ARRAY	01234 16 01364 02451
	TFM B25+28,ARRAY	01246 16 01389 02451
	TFM B26+23,ARRAY	01258 13 18447 00010
	MM CNT,10,10	01270 21 01364 00099
	A B25+28,99	01282 21 01389 00099
	A B26+23,99	01294 16 18447 00001
B24	TFM CNT,1,10	01306 16 18657 01329
	TFLS TEMP,	01318 49 18586 00000
		01325 00005 18502
		01330 00005 00000
B25	TFLS ,	01336 16 18657 01359

		01348 49 18586 00000
		01355 00005 00000
		01360 00005 00000
		01366 16 18657 01389
		01378 49 18586 00000
		01385 00005 00000
		01390 00005 18502
		01396 24 18447 02281
		01408 46 01492 01200
		01420 11 18447 00001
		01432 21 01334 18492
		01444 21 01359 18492
		01456 21 01364 18492
		01468 21 01389 18492
		01480 49 01306 00000
		01492 16 18657 01515
		01504 49 18546 00000
		01511 00005 02279
		01516 00005 18512
		01522 16 18657 01545
		01534 49 18546 00000
		01541 00005 02279
		01546 00005 02451
		01552 26 18522 02451
		01564 26 18520 02449
		01576 16 01623 02451
		01588 16 18447 00000
		01600 16 18657 01623
		01612 49 18566 00000
		01619 00005 00000
		01624 00005 18522
		01630 11 18447 00001
		01642 11 01623 00010
		01654 24 18447 02281
		01666 47 01600 01300
		01678 16 18524 00001
		01690 16 01832 02461
		01702 16 01802 02451
		01714 21 01802 18492
		01726 16 01887 02451
		01738 21 01887 18492
		01750 11 01887 00010
		01762 16 18447 00001
		01774 16 18657 01797
		01786 49 18586 00000
		01793 00005 02293
		01798 00005 00000
		01804 16 18657 01827
		01816 49 18586 00000

FM CØN,AREA+10
 B30 FS ,CØN
 AM B29+28,10,10
 AM B30+23,10,10
 AM CNT,1,10
 C CNT,N
 BL B28
 A B28+28,TN
 TFM B29+28,ARRAY+10
 AM B30+23,10,10
 AM 1,1,10
 C 1,N
 BL B28-12
 TFM 1,1,10
 TFM B31+23,ARRAY
 TFM B31+28,ARRAY
 A B31+28,TN
 AM B31+28,10,10
 TFM CNT,1,10
 B31 TFLS ,
 AM B31+23,10,10
 AM B31+28,10,10
 AM CNT,1,10
 C CNT,N
 BL B31
 AM B31+28,10,10
 AM 1,1,10
 C 1,N
 BL B31-12
 SM N,1,10
 B AAB
 DC 8,10000000
 ØNE DC 2,01
 FACT DS 10
 N DS 2
 AREA DAS 80
 ARRAY DSB 10,1600
 NSQ DS 3

01823 00005 T8522
 01828 00005 00000
 01834 16 18657 01857
 01846 49 18546 00000
 01853 00005 T8522
 01858 00005 02293
 01864 16 18657 01887
 01876 49 18526 00000
 01883 00005 00000
 01888 00005 T8522
 01894 11 01832 00010
 01906 11 01887 00010
 01918 11 18447 00001
 01930 24 18447 02281
 01942 47 01774 01300
 01954 21 01802 18492
 01966 16 01832 02461
 01978 11 01887 00010
 01990 11 18524 00001
 02002 24 18524 02281
 02014 47 01762 01300
 02026 16 18524 00001
 02038 16 02121 02451
 02050 16 02126 02451
 02062 21 02126 18492
 02074 11 02126 00010
 02086 16 18447 00001
 02098 16 18657 02121
 02110 49 18586 00000
 02117 00005 00000
 02122 00005 00000
 02128 11 02121 00010
 02140 11 02126 00010
 02152 11 18447 00001
 02164 24 18447 02281
 02176 47 02098 01300
 02188 11 02126 00010
 02200 11 18524 00001
 02212 24 18524 02281
 02224 47 02086 01300
 02236 12 02281 00001
 02248 49 00720 00000
 02267 00008
 02269 00002
 02279 00010
 02281 00002
 02283 00080
 02451 00010 01600
 18444 00003

CNT DS 3
 MESS1 DAC 15, DETERMINANT 1S@
 MESS2 DAC 6, ZERØ@
 TN DS 3
 TEMP DS 10
 DC 8,-10000000
 MØNE DC 2,01
 CØN DS 10
 I DS 2
 DEND START
 LØAD SUBRØUTINES

18447 00003
 18449 00015
 18479 00006
 18492 00003
 18502 00010
 18510 00008
 18512 00002
 18522 00010
 18524 00002
 00402