

UNIVERSITY OF ILLINOIS
 DIGITAL COMPUTER LABORATORY
 STATISTICAL LIBRARY

KBL 5.20 - 292

TITLE: Matrix Addition or Subtraction
TYPE: Entire Program
ACCURACY: 11 Decimal Places
SYMBOLS: d - decimal places input or output
 n - number of B matrices
 s - scaling integer
 i - number of rows for A and B matrices
 j - number of columns for A and B matrices

CAPACITY: $i(j + 1) \leq 10,240$
 $d \leq 12$
 n is not limited
 $\pm s \leq 12$

DESCRIPTION: This routine will form the sum,
 $A + (B_1 + B_2 + \dots) = C,$
 or the difference,
 $A - (B_1 + B_2 + \dots) = C.$ If $n = 1,$ this reduces to
 $A \pm B = C.$

The A and B matrices can be rescaled by any integer power of 10,
 $\pm s,$ during input. This can be used to prevent overflow of the
 elements of C.

METHOD OF USE:

| | <u>Stops</u> |
|------------------------------|--------------|
| 1. Master tape | 34022 |
| 2. Parameter tape | 2403N |
| 3. Data tape A | 34057 |
| 4a. Data tape B ₁ | 24057 |
| 4b. Data tape B ₂ | 24057 |
| | |
| 4n. Data tape B _n | OF000 |

To begin a new problem at stop OF, move the white switch up and
 down. The computer will then stop on 24022. Raise the black

switch to read a new parameter tape; move the white switch up and down to retain the old parameters.

THE PARAMETER TAPE: The parameter tape consists of three signed integers terminated by an N. These are in the following order:

+ d + n + s N

d is the number of decimal places in the output.

n is the number of B matrices. A positive sign indicates addition. A negative sign indicates subtraction.

s is the scaling integer. The A and B matrices are multiplied by 10^{+s} during input. If no rescaling is desired ($s = 0$), this parameter may be omitted.

If both n and s are omitted, two matrices, A + B, will be added without rescaling.

EXAMPLES:

Parameters

Operations

+4 N

The routine will form the sum $C = A + B$, and print C to 4 places.

+4 -1 N

The routine will form the difference, $C = A - B$, and print to 4 places.

+4 -3 -2 N

The routine will form the difference, $C = A - (B_1 + B_2 + B_3)$, and C will be printed to 4 places and be rescaled by 10^{-2} .

PREPARATION OF A AND B DATA TAPES:

The elements of A and B matrices are punched by rows as signed fractions with an N after each row and a J after the final N.

If instead of an N, an F is punched at the end of a row, the computer will stop. By raising the black switch, reading of the matrix is resumed.

The A and B matrices must conform; otherwise, the computer will stop (See section on Stops and Error Diagnosis).

DURATION IN SECONDS: $.005 n(d + 2) i j + .017 (d + 1) i j$

Add 20 seconds for reading the master tape.

STOPS AND ERROR DIAGNOSIS:

| STOPS | LOC | DIAGNOSIS |
|-------|-----|---|
| 34022 | 136 | Master tape read correctly; Bl. sw. to read parameter tape. |
| 2403N | 038 | End of parameter tape; Bl. sw. to read A matrix. |
| 34057 | 052 | End of tape A; Bl. sw. to read B matrix. |
| 20053 | 053 | F or L termination; Bl. sw. to continue. |
| 24061 | 060 | F or L termination; Bl. sw. to continue. |
| 24057 | 073 | End of intermediate calculation; Bl. sw. to read another B matrix. |
| 0F000 | 074 | Stop, end of calculation; Wh. sw. to next order. |
| 24022 | 074 | Bl. sw. to read new parameter tape; Wh. sw. to retain old parameters |
| FF000 | 046 | Elements of A vector overflows into B vector; wh. sw. to read another row of A. |
| FF001 | 056 | Number of elements of rows of A not equal; wh. sw. to read new A matrix. |
| FF002 | 065 | Number of elements of columns of A and B not equal; wh. sw. to read new B matrix. |
| FF003 | 071 | Number of elements of rows of A and B not equal; wh. sw. to read new B matrix. |
| FF004 | 137 | Master tape sum check failure; clear and input master again. |

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| DATE <u>March 28, 1960</u> |
| PROGRAMMED BY <u>Frank Shimamoto</u> |
| APPROVED BY <u>J. Snyder</u> |

ns

| LOCATION | | | ORDER | NOTES | PAGE 1 | KSL 5.20 |
|----------|------|-------|---------------------|-----------------------------------|--------|----------|
| ABS. | REL. | SYM. | | | | |
| | | | 00 3K | | | |
| 3 | | | 00F 00313F | Location of A vector | | |
| 4 | | | 00F 00550F | Location of B vector | | |
| 5 | | | 00F 00787F | Location of C vector | | |
| | | | 00 16K | | | |
| 16 | | (A) | 00S3 00S3 | | | |
| | | (B) | 00S4 00S4 | | | |
| | | (D1) | J0S3 501(RD) | | | |
| | | (D2) | 26(Y1) 002560F | | | |
| | | (D3) | 50S3 501(WR) | | | |
| | | (D4) | J0S5 501(RD) | | | |
| | | (N) | 40S3 L521(N12) | | | |
| | | (N1) | 40S4 L521(N12) | | | |
| | | (+) | 00F 00625000000000J | | | |
| | | (-) | 00F 00100000000000J | | | |
| | | (OP1) | L0S4 40S5 | | | |
| | | (OP2) | L4S4 40S5 | | | |
| | | (1) | 00F 001F | | | |
| | | (70) | 00F 0070F | | | |
| | | (1-1) | 001F 001F | | | |
| | | (S1) | 75F 40F | | | |
| | | (V1) | 00F 00S3 | | | |
| | | (V2) | 00F 00S4 | | | |
| | | | 00K | Read parameters | | |
| 34 | 0 | (P) | L5(OP2) 404(A2) | | | |
| | 1 | | 416F 417F | | | |
| | 2 | | 525F 502L | Read parameters "d", "n" and "s". | | |
| | 3 | | 26(N12) L55F | | | |
| | 4 | | 0020F 465(PR) | | | |
| | 5 | | 418F 508F | | | |
| | 6 | | F55F 007F | | | |
| | 7 | | 40F L5(70) | Calculate No. of ELTS/LINE | | |
| | 8 | | 66F S5F | | | |
| | 9 | | 1032F 4011F | | | |
| | 10 | | L56F 3612L | | | |

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|----------|------|------|-------------------|-------|--------|--|
| ABS. | REL. | SYM. | | | | |
| | | | L5(OP1) 404(A2) | | | |
| | | | L37F 3225L | | | |
| | | | L57F 3218L | | | |
| | | | 409F L5(-) | | | Negative scaling multiplier at Loc. 12 |
| | | | 4012F F59F | | | |
| | | | 409F 3225L | | | |
| | | | 5012F 7J(-) | | | |
| | | | 2615L 508F | | | |
| | | | L57F 0022F | | | |
| | | | 464(S) L17F | | | |
| | | | 409F L5(+) | | | Positive scaling multiplier at Loc. 12 |
| | | | 4012F F59F | | | |
| | | | 409F 3225L | | | |
| | | | 5012F 7J(+) | | | |
| | | | 2622L 2426L | | | |
| | | | L36F 4010F | | | Set counter for No. of additions/sub. |
| | | | 00K | | | |
| 61 | 0 | (A1) | L5(D1) 401(RD) | | | Initialize addresses for drum transfer |
| | 1 | | L5(D2) 402(RD) | | | |
| | 2 | | 50S3 502L | | | Read first row of A |
| | 3 | | 26(N12) L521(N12) | | | |
| | 4 | | 405F I0(N) | | | |
| | 5 | | 463(RD) 1020F | | | |
| | 6 | | 403F 4113F | | | |
| | 7 | | F5(V2) I0(V1) | | | TEST: Does ELTS. of A Vector overflow into location of B vector? |
| | 8 | | I03F 3610L | | | |
| | 9 | | FFF 26(A1) | | | FFO: Vector overflow; Wh. sw. to read another row of A. |
| | 10 | | L37F 3214L | | | |
| | 11 | | L5(A) I4(S1) | | | Set addresses for scaling row of A. |
| | 12 | | 4010(S) 423(S) | | | |
| | 13 | | 424(S) 5013L | | | Scale row of A. |
| | 14 | | 26(S) 5014L | | | Store row of A on drum. |
| | 15 | | 26(RD) L52(RD) | | | |
| | 16 | | F43F 402(RD) | | | |
| | 17 | | F513F 4013F | | | |
| | 18 | | 50S3 5018L | | | Read a row of A. |

| LOCATION | | | ORDER | NOTES | PAGE 3 | KSL 5.20 |
|----------|------|------|------------------|---|--------|----------|
| ABS. | REL. | SYM. | | | | |
| | 19 | | 26(N12) 404F | | | |
| | 20 | | L34F 3222L | | | |
| | 21 | | L4(1) 34(B1) | | | |
| | 22 | | 2022L L521(N12) | | | |
| | 23 | | L05F 40F | | | |
| | 24 | | L3F 3610L | | | |
| | 25 | | FF1F 26(A1) | | | |
| | | | OOK | | | |
| 87 | 0 | (B1) | F510F 4010F | | | |
| | 1 | | 4114F L5(D3) | | | |
| | 2 | | 401(WR) L5(D2) | | | |
| | 3 | | 402(WR) L53F | | | |
| | 4 | | 0020F 463(WR) | | | |
| | 5 | | L5(D4) 401(RD) | | | |
| | 6 | | L5(D2) 402(RD) | | | |
| | 7 | | 26(B2) L34F | | | |
| | 8 | | 3610L L4(1) | | | |
| | 9 | | 3624L 2410L | | | |
| | 10 | | F514F 4014F | | | |
| | 11 | | L521(N12) L0(N1) | | | |
| | 12 | | 1020F L03F | | | |
| | 13 | | 40F L3F | | | |
| | 14 | | 3215L FF2F | | | |
| | 15 | | 261(B1) 5015L | | | |
| | 16 | | 26(WR) F53F | | | |
| | 17 | | L42(WR) 402(WR) | | | |
| | 18 | | 26(A2) L510F | | | |
| | 19 | | 3222L 5019L | | | |
| | 20 | | 26(RD) F53F | | | |
| | 21 | | L42(RD) 402(RD) | | | |
| | 22 | | 267L 5022L | | | |
| | 23 | | 26(PR) 267L | | | |
| | 24 | | L513F L014F | | | |
| | 25 | | 40F L3F | | | |
| | 26 | | 3227L FF3F | | | |
| | 27 | | 261(B1) L510F | | | |
| | | | | TEST: Are ELTS. of rows equal? | | |
| | | | | FF1: ELTS. unequal; Wh. sw. to read another A matrix. | | |
| | | | | Initialize addresses for drum transfer. | | |
| | | | | TEST: are ELTS. of rows of A and B = ? | | |
| | | | | FF2: ELTS. unequal; Wh. sw. to read new B. | | |
| | | | | Store a row of C on drum. | | |
| | | | | Print one row of C. | | |
| | | | | TEST: are ELTS. of columns of A and B = ? | | |
| | | | | FF3: ELTS. unequal; Wh. sw. to read new B. | | |

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|----------|------|------|----------------|--|--------|----------|
| ABS. | REL. | SYM. | | | | |
| | 28 | | 3629L 24(B1) | Stop on 24057; Bl. sw. to read next B. | | |
| | 29 | | OFF 24(P) | Stop on OF; Wh. sw. to a stop 24022; | | |
| | 30 | | 2626(P) OOF | Bl. sw. to read new parameter tape or | | |
| | | | OOK | Wh. sw. to retain old parameters. | | |
| 118 | 0 | (A2) | L5(OP2) 464L | | | |
| | 1 | | 424L L5(A) | | | |
| | 2 | | 423L 419F | | | |
| | 3 | | 223L L5S3 | Form addition/subtraction on corresponding | | |
| | 4 | | L4S4 40S5 | ELTS. of A and B. | | |
| | 5 | | F53L 423L | | | |
| | 6 | | L54L L4(1-1) | | | |
| | 7 | | 404L F59F | | | |
| | 8 | | 409F L03F | | | |
| | 9 | | 3218(B1) 223L | | | |
| | | | OOK | | | |
| 128 | 0 | (B2) | 50S4 50L | Read a row of B | | |
| | 1 | | 26(N12) 404F | | | |
| | 2 | | L37F 326L | | | |
| | 3 | | L5(B) L4(S1) | Set addresses for scaling a row of B. | | |
| | 4 | | 4010(S) 423(S) | | | |
| | 5 | | 424(S) 505L | Scale ELTS. of a row of B. | | |
| | 6 | | 26(S) 227(B1) | | | |
| | | | OOK | | | |
| 135 | 0 | (S) | K5F 428L | | | |
| | 1 | | L13F 409F | | | |
| | 2 | | L17F 329L | | | |
| | 3 | | 5012F 75F | Scale with a positive multiplier | | |
| | 4 | | OOF 40F | | | |
| | 5 | | F53L 403L | | | |
| | 6 | | F54L 404L | | | |
| | 7 | | F59F 328L | | | |
| | 8 | | 221L 22F | | | |
| | 9 | | 50F 5012F | Scale with a negative scaling multiplier. | | |
| | 10 | | 75F 40F | | | |

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|----------|------|-------|---------------|-------|--------|---|
| ABS. | REL. | SYM. | | | | |
| | 11 | | L510L L4(1-1) | | | |
| | 12 | | 4010L 267L | | | |
| | | | OOK | | | |
| 148 | 0 | (PR) | K5F 4218L | | | |
| | 1 | | L5(OP1) 424L | | | Set addresses and counters for printing a row of C. |
| | 2 | | F58F 408F | | | |
| | 3 | | 223L 419F | | | |
| | 4 | | 4115F L5F | | | |
| | 5 | | 50F 505L | | | Print one ELT. of C. |
| | 6 | | 26(P16) F54L | | | |
| | 7 | | 424L F59F | | | |
| | 8 | | 429F L03F | | | |
| | 9 | | 3213L F515F | | | |
| | 10 | | 4215F L011F | | | |
| | 11 | | 3612L 224L | | | |
| | 12 | | 92131F 92515F | | | Punch line feed/carriage return and delay. |
| | 13 | | 264L 92770F | | | Print N. |
| | 14 | | L58F L013F | | | |
| | 15 | | 3616L 2217L | | | |
| | 16 | | 92834F 418F | | | Print J. |
| | 17 | | 92147F 92131F | | | 6 carriage returns and line feeds delay. |
| | 18 | | 92515F 22F | | | |
| | | | OOK | | | |
| 167 | 0 | (RD) | K5F 423L | | | Store a row of A or C on drum. |
| | | | JOF 501L | | | |
| | | | 26(Y1) OOF | | | |
| | | | OOF 22F | | | |
| | | | OOK | | | |
| 171 | 0 | (WR) | K5F 423L | | | Place a row of A or C in WM., from drum. |
| | | | 50F 501L | | | |
| | | | 26(Y1) OOF | | | |
| | | | OOF 22F | | | |
| 175 | | (P16) | OOK | | | Print routine (P16) |

LOCATION

ORDER

NOTES

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| ABS. | REL. | SYM. | | |
|------|------|-------|---------------|-----------------------------------|
| 231 | | (N12) | OOK | Input routine (N12) |
| 270 | | (Y1) | OOK | Drum transfer routine (Y1) |
| | | | OOK | |
| 310 | 0 | | L3F 34(P) | |
| | 1 | | FF4F 26(P) | FF4: Read failure on master tape. |
| | 2 | | L1868F 4N779F | |
| | | | 26L 261N | |