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1620
Correction

11.0.042
April 6, 1965

The Source and Object decks for this program have been replaced. Attached are the listings reflecting the change in statement 208 and the addition of statement 418.

```
C       NIM              JOSEPH GREEN          1/31/64
C       HARVARD SCHOOL OF PUBLIC HEALTH
C       TYPE AS A TWO DIGIT NUMBER THE ROW AND THE NUMBER OF COUNTERS
C       SWITCH 2 ON, 1620 WINS    3 ON, 1620 STARTS    4 ON, HUMAN RETIRES
        DIMENSION IROW (4), ICOL (3), MAT (4,3)
  689   IROW(1) = 1
        IROW(2) = 3
        IROW(3) = 5
        IROW(4) = 7
        IR=0
        ISUM=0
        DO 305 I=1,4
  305   MAT(I,3) = 1
        MAT(1,1)=0
        MAT(1,2)=0
        MAT(3,2)=0
        MAT(2,1)=0
        MAT(2,2)=1
        MAT(4,2)=1
        MAT(4,1)=1
        MAT(3,1)=1
        PRINT 246
  246   FORMAT (///5HJOUEZ)
        PAUSE
  407   JT = 1
        IP = 1
        IF (SENSE SWITCH 3) 402,83
   83   ACCEPT  2,   IR, ISUM
        IF (SENSE SWITCH 2) 225,617
  617   IF (IR-4) 502,502,503
  502   IF(IR)  503,503,504
  504   IF(IROW(IR)-ISUM)    503,505,505
  505   IF (ISUM) 503,503,506
  503   PRINT1505
 1505   FORMAT  (20X ,  7HCOMMENT)
        GO TO 83
  506   ICOL(1) = 0
        ICOL(2) = 0
        ICOL(3) = 0
        IF (SENSE SWITCH 4) 83,409
    2   FORMAT (I1,I1)
  409   KT = 1
   61   IF (IROW (IR) -1) 204,205,51
  205   IP  =  IP - 1
  204   JT  =  JT - 1
   51   IROW (IR)  =  IROW (IR)  -  ISUM
        IF (IROW (IR) - 1)   206,207,210
  207   IP  =  IP  +  1
  206   JT  =  JT  +  1
  210   M  =  IROW  (IR)     +1
        GO TO (3,3,3,3,4,4,4,4), M
    3   MAT  (IR,1)  =  0
        GO TO  5
    4   MAT  (IR,1)  =  1
    5   GO TO(6,6,7,7,6,6,7,7 ),  M
    6   MAT  (IR,2)  =  0
        GO TO  8
    7   MAT (IR,2)  =  1
    8   GO TO (9,10,9,10,9,10,9,10),  M
    9   MAT  (IR,3)  =  0
```

```
      GO TO  11
   10 MAT (IR,3)  =  1
   11 GO TO  (12,13), KT
   12 IA=1
  208 IF  (JT-3)  417,211,418
  417 IB=1
      IC=1
      IF (10 * JT +IP - 41) 415,416,415
  416 PRINT  425
  425 FORMAT (5HCLUNK)
      GO TO 82
  415 DO 91 J=1,4
      IA = IA + MAT(J,1)
      IB = IB + MAT(J,2)
   91 IC = IC + MAT(J,3)
      GO TO (101, 25, 101), IA
   25 ICOL  (1)  =  1
  101 GO TO (102,26,102,26), IB
   26 ICOL  (2)  =  1
  102 GO TO (30,21,30,21,30),IC
   21 ICOL  (3)  =  1
   30 IF(ICOL(1)) 31,32,31
   31 IF (MAT(4,1))  34,33,34
   34 IR =  4
      GO TO  45
   33 IR =  3
      GO TO  45
   32 IF(ICOL(2)) 437,37,437
   37 IF (ICOL(3)) 36,402,36
  437 IF(MAT(4,2))  34,38,34
  402 ISUM = 1
      IF (IROW(4))  403,403,404
  403 IF (IROW(3)) 405,405,406
  404 IR = 4
      GO TO 501
  406 IR = 3
      GO TO 501
  405 IR = 2
  501 KT = 2
      GO TO 61
   38 IF (MAT(3,2)) 33,39,33
   39 IR =  2
      GO TO  45
   36 IF(MAT(4,3))  34,40,34
   40 IF(MAT(3,3))  33,41,33
   41 IF(MAT(2,3))  39,42,39
   42 IR =  1
   45 ISUM=ICOL(1)*4+(ICOL(2)*(4*MAT(I-,2)-2))+(ICOL(3)*(2*MAT(IR,3)-1))
      KT = 2
      GO TO 61
   13 PRINT  54, IR,  ISUM
   54 FORMAT  (I2,2X,I2)
      GO TO 83
  211 IF  (IROW (1) -1)   213,213,214
  213 IF  (IROW (2) - 1)  215,215,216
  215 IF  (IROW (3) - 1)  217,217,218
  214 IR  =  1
      GO TO 219
  216 IR  =  2
      GO TO 219
```

```
218 IR  =  3
    GO TO 219
217 IR  =  4
219 IN = IP + 1
    GO TO (221,220,221,220), IN
220 ISUM  =  IROW (IR)
    IROW (IR)  =  0
    GO TO 224
221 ISUM  =  IROW (IR) -1
    IROW (IR)  =  1
    IP  =  IP  +  1
224 PRINT 54, IR, ISUM
    IF  (IP - 1)  225,225,227
225 PRINT 231
231 FORMAT (4HHSPH)
    GO TO 82
227 ACCEPT  2, IR, ISUM
    IF(SENSE SWITCH 2)  225,621
621 IF (SENSE SWITCH 4) 227,408
408 IF(IR-4) 631,631,639
631 IF(IR) 639,639,632
632 IF(ISUM-1) 639,633,639
633 IF (IROW(IR)-1) 639,634,639
639 PRINT 1505
    GO TO 227
634 IROW(IR) =0
683 IF (IROW (1))  241,241,242
241 IF (IROW (2))  243,243,244
242 IR  =  1
    GO TO 250
244 IR  =  2
    GO TO 250
243 IR  =  3
250 ISUM=1
    PRINT  54, IR, ISUM
    PRINT 231
 82 PAUSE
    GO TO 689
418 GO TO (417,683,417,417),IP
    END
```

1620 USERS GROUP PROGRAM REVIEW AND EVALUATION

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. Please list any suggestions to improve the usefulness of the program. These will be passed on to the author for his consideration.
   Comment _____

Please return to:

Mr. Robert J. Robinson (PREP)
Marquette University
Computing Center
1515 W. Wisconsin Avenue
Milwaukee 3, Wisconsin

Your Name _____

Company _____

Address _____

User Group Code _____

THIS REVIEW FORM IS PART OF THE 1620 USER GROUP ORGANIZATION'S PROGRAM REVIEW AND EVALUATION PROCEDURE. NONMEMBERS ARE CORDIALLY INVITED TO PARTICIPATE IN THIS EVALUATION.

N I M

Author: Joseph Green
Data Processing Center
Department of Biostatistics
Harvard School of Public Health
1 Shattuck Street
Boston 15, Massachusetts

Users Group Code 1337
July 31, 1964

Modifications or revisions to this program, as they occur, will be announced in the appropriate Catalog of Programs for the IBM Data Processing Systems. If such announcement indicates a change to the program decks or tapes, a complete new program, if needed, should be requested from the Program Distribution Center.

c

Table of Contents

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1620 USERS GROUP LIBRARY
PROGRAM ABSTRACT

1. TITLE (If subroutine, state in Title): N I M
Subj. Class. 11.0
2. Author; Organization: Joseph Green, Data Processing Center, Department of Biostatistics, Harvard School of Public Health
Date: 8/1/64 Users Group Membership Code: 1337
3. Direct Inquiries to Name: Joseph Green, Data Processing Center, Harvard School of Public Health, 1 Shattuck St., Boston Phone: RE 4 3300, Ex.592
4. Description/Purpose: (5. Method; 6. Restriction/Range; When Applicable)
This demonstration program pits the computer against a human in a game far more interesting than Tic-Tac-Toe or Blackjack.

7. Specifications (Check or fill in appropriate spaces):
a. Storage used by program: About 16 K
b. Equipment required by program:
Card System X ; Magnetic Tape System ; No. of Tapes ;

Paper Tape System ; Disk File System ; No. of Packs ;

TNS, TNF, MF ; Auto divide ; Indirect addressing ;Floating point hardware ;

Other (specify)

Can program be used on lesser Machine? No . Specify which requirements can be easily removed
c. Programming type (Check appropriate spaces):

Fortran without Format ; Fortran with Format X ;

Fortran II ; Mainline, Complete X ; Subroutine or function subprogram(S or F) ;

Is the program a library (ie, SPS) function to the Fortran system checked? ;

SPS ; SPS - 1620/1710 ;

Mainline, Complete ; Macro ; Subroutine ;

Other programming language: ; Give details
d. Language used in the writeup: Fortran with Format Version 2
8. Additional Remarks:

6-63

DECK KEY

1. Source deck
2. Object deck

Program Description

N I M

Joseph Green
Data Processing Center
Department of Biostatistics
Harvard School of Public Health
1 Shattuck Street, Boston, Mass.

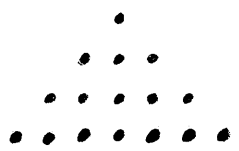
August 1, 1964

RE 43300, Ext. 592

Users Group Code 1337

This program was written in 1620 Fortran with Format and compiled on a 40K machine with automatic divide and indirect addressing and without floating point hardware or TNS, TNF, MF. But the compiler was set to compile the program and symbol table within 20 K. There are no "divide" instructions and no relocatable subroutines are used. Fortran with Format does not assume indirect addressing. The object program has been altered slightly to shift the typewriter into numeric mode during execution of the "accept" statements.

The game of NIM, which gained prominence in the movie "Last Year at Marienbad", is played as follows. There are four rows of counters initially arranged:

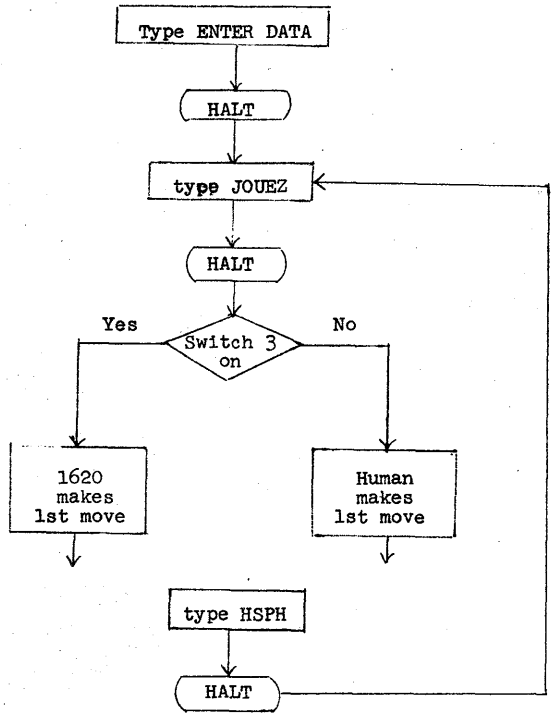


row 1
row 2
row 3
row 4

Two players alternate moves, each player taking one or more than one counter from a single row. The player obliged to remove the last counter loses. A typical game would be: 1) Player One removes all the counters in the fourth row, 2) Player Two removes three of the five counters in the third row, 3) Player One removes the three counters in the second row, 4) Player Two removes the two remaining counters in the third row, and, since there is but one counter left, Player Two has won. The above is the third game on the sample sheet.

The computer is prepared to move first or second, depending on the setting of sense switch 3. Moves are entered at the typewriter as two digit numbers; the first digit is the number of the row, and the second digit is the number of counters to be removed from that row. The computer checks the validity of each of its opponent's moves; if the move is not permissable, the computer asks in French "comment" and branches to reaccept the move. If the player wishes to correct a typing error, he must turn switch 4 on before pressing R-S; the computer then branches to reaccept the move. If the player wishes to resign a game in the middle, he must turn switch 2 on and press R-S.

When there is but one counter remaining, or when the opponent has resigned, the computer announces its victory by typing "HSPH" (Harvard School of Public Health). If defeated, it emits a metallic gasp. At the end of the game, the computer halts before branching to the beginning. The accompanying flow chart shows the initial and final steps of the program.




```
C     NIM              JOSEPH GREEN          7/31/64                    001
C     HARVARD SCHOOL OF PUBLIC HEALTH                                   002
C     TYPE AS A TWO DIGIT NUMBER THE ROW AND THE NUMBER OF COUNTERS     003
C     SWITCH 2 ON, 1620 WINS     3 ON, 1620 STARTS     4 ON, HUMAN RETYPES 004
      DIMENSION IROW (4), ICOL (3), MAT (4,3)                           005
  689 IROW(1) = 1                                                       006
      IROW(2) = 3                                                       007
      IROW(3) = 5                                                       008
      IROW(4) = 7                                                       009
      IR=0                                                              010
      ISUM=0                                                            011
      DO 305 I=1,4                                                      012
  305 MAT(I,3) = 1                                                      013
      MAT(1,1)=0                                                        014
      MAT(1,2)=0                                                        015
      MAT(3,2)=0                                                        016
      MAT(2,1)=0                                                        017
      MAT(2,2)=1                                                        018
      MAT(4,2)=1                                                        019
      MAT(4,1)=1                                                        020
      MAT(3,1)=1                                                        021
      PRINT 246                                                         022
  246 FORMAT (///5HJOUEZ)                                               023
      PAUSE                                                             024
  407 JT = 1                                                            025
      IP = 1                                                            026
      IF (SENSE SWITCH 3) 402,83                                        027
   83 ACCEPT  2,   IR, ISUM                                             028
      IF (SENSE SWITCH 2) 225,617                                       029
  617 IF (IR-4) 502,502,503                                             030
  502 IF(IR)  503,503,504                                               031
  504 IF(IROW(IR)-ISUM)    503,505,505                                  032
  505 IF (ISUM) 503,503,506                                             033
  503 PRINT1505                                                         034
 1505 FORMAT  (20X ,  7HCOMMENT)                                        035
      GO TO 83                                                          036
  506 ICOL(1) = 0                                                       037
      ICOL(2) = 0                                                       038
      ICOL(3) = 0                                                       039
      IF (SENSE SWITCH 4) 83,409                                        040
    2 FORMAT (I1,I1)                                                    041
  409 KT = 1                                                            042
   61 IF (IROW (IR) -1) 204,205,51                                      043
  205 IP  =  IP - 1                                                     044
  204 JT  =  JT - 1                                                     045
   51 IROW (IR)  =  IROW (IR)  -  ISUM                                  046
      IF (IROW (IR) - 1)   206,207,210                                  047
  207 IP  =  IP  + 1                                                    048
  206 JT  =  JT  + 1                                                    049
  210 M  =  IROW  (IR)    +1                                            050
      GO TO (3,3,3,3,4,4,4,4), M                                        051
    3 MAT  (IR,1)  =  0                                                 052
      GO TO  5                                                          053
    4 MAT  (IR,1)  =  1                                                 054
```

```
    5 GO TO(6,6,7,7,6,6,7,7 ),  M
    6 MAT  (IR,2)  =  0
      GO TO  8
    7 MAT (IR,2)  =  1
    8 GO TO (9,10,9,10,9,10,9,10),  M
    9 MAT  (IR,3)  =  0
      GO TO  11
   10 MAT (IR,3)  =  1
   11 GO TO  (12,13), KT
   12 IA=1
  208 IF  (JT-3)  417,211,417
  417 IB=1
      IC=1
      IF (10 * JT +IP - 41) 415,416,415
  416 PRINT  425
  425 FORMAT (5HCLUNK)
      GO TO 82
  415 DO 91 J=1,4
      IA = IA + MAT(J,1)
      IB = IB + MAT(J,2)
   91 IC = IC + MAT(J,3)
      GO TO (101, 25, 101), IA
   25 ICOL  (1)  =  1
  101 GO TO (102,26,102,26), IB
   26 ICOL  (2)  =  1
  102 GO TO (30,21,30,21,30),IC
   21 ICOL  (3)  =  1
   30 IF(ICOL(1)) 31,32,31
   31 IF (MAT(4,1))  34,33,34
   34 IR =  4
      GO TO  45
   33 IR =  3
      GO TO  45
   32 IF(ICOL(2)) 437,37,437
   37 IF (ICOL(3)) 36,402,36
  437 IF(MAT(4,2))  34,38,34
  402 ISUM = 1
      IF (IROW(4))  403,403,404
  403 IF (IROW(3)) 405,405,406
  404 IR = 4
      GO TO 501
  406 IR = 3
      GO TO 501
  405 IR = 2
  501 KT = 2
      GO TO 61
   38 IF (MAT(3,2)) 33,39,33
   39 IR =  2
      GO TO  45
   36 IF(MAT(4,3))  34,40,34
   40 IF(MAT(3,3))  33,41,33
   41 IF(MAT(2,3))  39,42,39
   42 IR =  1
   45 ISUM=ICOL(1)*4+(ICOL(2)*(4*MAT(IR,2)-2))+(ICOL(3)*(2*MAT(IR,3)-1))
```



```
      KT = 2
      GO TO 61
   13 PRINT  54, IR,  ISUM
   54 FORMAT  (I2,2X,I2)
      GO TO 83
  211 IF  (IROW (1) -1)  213,213,214
  213 IF  (IROW (2) - 1)  215,215,216
  215 IF  (IROW (3) - 1)  217,217,218
  214 IR  =  1
      GO TO 219
  216 IR  =  2
      GO TO 219
  218 IR  =  3
      GO TO 219
  217 IR  =  4
  219 IN = IP + 1
      GO TO (221,220,221,220), IN
  220 ISUM  =  IROW (IR)
      IROW (IR)  =  0
      GO TO 224
  221 ISUM  =  IROW (IR) -1
      IROW (IR)  =  1
      IP  =  IP  +  1
  224 PRINT 54, IR, ISUM
      IF  (IP - 1)  225,225,227
  225 PRINT 231
  231 FORMAT (4HHSPH)
      GO TO 82
  227 ACCEPT  2, IR, ISUM
      IF(SENSE SWITCH 2)  225,621
  621 IF (SENSE SWITCH 4) 227,408
  408 IF(IR-4) 631,631,639
  631 IF(IR) 639,639,632
  632 IF(ISUM-1) 639,633,639
  633 IF (IROW(IR)-1) 639,634,639
  639 PRINT 1505
      GO TO 227
  634 IROW(IR) =0
  683 IF (IROW (1))  241,241,242
  241 IF (IROW (2))  243,243,244
  242 IR  =  1
      GO TO 250
  244 IR  =  2
      GO TO 250
  243 IR  =  3
  250 ISUM  =  1
      PRINT  54, IR, ISUM
      PRINT 231
   82 PAUSE
      GO TO 689
      END
```

Modification of the Object Program

During compilation, statements 83 and 227 were both followed by Two Pause instructions. The five resulting machine language instructions (BT,BTM,BTM, H,H) were replaced by the machine language equivalent of

```
RCTY
RNTY    * + 10
TD      IR, * - 2
TD      ISUM, * - 13
NOP
```

IR is located at 19639

ISUM is located at 19619


```
JOUEZ
32RS
 4   6
11RS
 4   1
21RS
 3   1
22RS
 3   1
HSPH
```

```
JOUEZ
 4   1
42RS
 2   3
45RS
44RS
 3   5
HSPH
```

1620 moved FIRST

COMMENT 45 was invalid.

```
JOUEZ
47RS
 3   3
23RS
 3   2
HSPH
```

Operating Instructions

1. Load program (deck 2)
2. At "ENTER DATA" press START
3. The machine types "JOUEZ." Set Switch 3 and press START
4. When the typewriter shifts into numeric, type the desired move
5. After the message of victory or defeat, the computer halts. To begin another game, press START. Go to Step 3.
6. The origin of the program is 08300.
7. Switch 1 is not used

   Switch 2 permits a player to resign a game

   Switch 3 determines who goes first

   Switch 4 permits a player to correct a typing error.