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May 1, 1983

Dear Bob Fabris,

Below is a listing in AstroBASIC of the "Jailer Problem" in the June 1983 issue of Popular Computing, page 211.

Line 3 and 5, below, are equivalent to 3IF K/J=INT(K/J) THEN S=S+1, and 5IF S/2=INT(S/2) THEN 7.

THE JAILER PROBLEM
adapted for AstroBasic

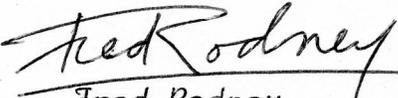
```
1 CLEAR;NT=0;SM=4;C=0;K=1;GOSUB 9
2 FOR K=2 TO 100;S=0;FOR J=1 TO K
*3 N=K/J;IF RM=0 S=S+1
4 NEXT J
*5 N=S/2;IF RM=0 GOTO 7
6 GOSUB 9
7 NEXT K
*8 PRINT "  →",#2,C," CELLS",;GOSUB 10;STOP
*9 PRINT "  CELL #",#3,K,;GOSUB 10;C=C+1;RETURN
*10 PRINT "  WILL BE OPEN";RETURN
```

*K/J is the same as $K \div J$

*_ is the same as (SPACE)

The Astrocade takes about 2.75 minutes to complete this program. I figure that the Astrocade does about 485 computations. That equals about 176 computations per minute or 33 per second. Each computation takes about 333 milliseconds.

Sincerely,


Fred Rodney

enc:1

Listing 1: A BASIC program that solves the eccentric jailer problem.

```

10 PRINT TAB(18) "THE ECCENTRIC JAILER"
20 PRINT TAB(15) "(C) 1983 POPULAR COMPUTING"
30 PRINT
40 PRINT "CELL #1 WILL BE OPEN"
50 FOR K=2 TO 100: REM TRY ALL CELL NO'S FROM 2 TO 100
60 S=0
70 FOR J=1 TO K: REM TRY ALL POSSIBLE DIVISORS OF J
80 IF K/J=INT(K/J) THEN S=S+1: REM COUNT THEM IN S
90 NEXT J
100 IF S/2=INT(S/2) THEN 120: REM IS S ODD OR EVEN?
110 PRINT "CELL #" K "WILL BE OPEN"
120 NEXT K

```

In the first case, we use powers of 2. In the second, powers of 10. For the third case, the coefficients are equal to one of the numbers from 0 to 1 less than the chosen base.

Now, just as we do not write base 10 numbers in expanded form, for example, $134 = 4 + (3 \times 10) + (1 \times 100)$, we do not write base 2 or binary numbers in expanded form. Instead, we write 25 in base 2 as 11001. The 1 on the extreme left indicates a 16, the next 1 indicates an 8, and the 1 on the right indicates a 1. As an exercise, you might try writing 17 in base 2 form. Figure out the expansion, then pack it into a string of 1s and 0s as we did above.

So, the base 2 trick has led us to an explanation of binary numbers!

The Jailer Problem

To recap from last month: an eccentric jailer makes a complicated amnesty offer to his 100 inmates. Every second, he reverses the status of certain cell doors from open to closed or vice versa. After one second, he switches cells whose numbers are multiples of 1 (all of them are opened). After two seconds, cells whose numbers are multiples of 2 (even-numbered cells) are switched. After three seconds, he switches cells whose numbers are multiples of 3, and so on. He repeats this process for 100 seconds. If a cell door is open after the last switch, the con in that cell goes free.

Now, as we asked last month,

which inmates will benefit from this amnesty offer?

The key to the solution of the problem is the recognition that a cell is switched once for each number that divides evenly into the cell number. For example, cell number 6 will be switched at seconds 1 (open), 2 (closed), 3 (open), and 6 (closed)—these are the divisors of 6. If a cell number has an even number of divisors, then that cell will be closed when all the switching is over. Only cells whose numbers have an odd number of divisors will be open after all is said and done.

The program in listing 1 finds and lists all the cells that will be open after the 100-second switching process. Why not type it in and try it out before continuing?

Did you notice the rather striking pattern to the cells that are open? Next time I'll offer an elementary mathematical explanation of why we get such an elegant result.

If you have questions or ideas for recreational games, send them directly to me (enclose a stamped, self-addressed envelope if you wish a reply):

Michael W. Ecker
Contributing Editor
Popular Computing
129 Carol Dr.
Clarks Summit, PA 18411

Until next month, happy recreational computing! □

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Puzzle The May 83 issue of Popular Computing asked a puzzling question,
Assume 100 ^{closed} cells, numbered 1-100. Every second, the status of the boxes is
changed according to this pattern: At second 1, all cell numbers that are divisible
by 1 are opened, at second 2, all cell numbers that are divisible by 2 are closed, at second
3 all cell numbers that are divisible by 3 are opened, etc. The question is, which cells
are open after second 100? The magazine provided a BASIC solution in their
June issue, & Fred Bodony counted that program as ASTRO BASIC for us, as
follows.