••• **P4.8** *The game of Nim.* This is a well-known game with a number of variants. The following variant has an interesting winning strategy. Two players alternately take marbles from a pile. In each move, a player chooses how many marbles to take. The player must take at least one but at most half of the marbles. Then the other player takes a turn. The player who takes the last marble loses.

You will write a program in which the computer plays against a human opponent. Generate a random integer between 10 and 100 to denote the initial size of the pile. Generate a random integer between 0 and 1 to decide whether the computer or the human takes the first turn. Generate a random integer between 0 and 1 to decide whether the computer plays *smart* or *stupid*. In stupid mode the computer simply takes a random legal value (between 1 and $n/2$) from the pile whenever it has a turn. In smart mode the computer takes off enough marbles to make the size of the pile a power of two minus 1—that is, 3, 7, 15, 31, or 63. That is always a legal move, except when the size of the pile is currently one less than a power of two. In that case, the computer makes a random legal move.

You will note that the computer cannot be beaten in smart mode when it has the first move, unless the pile size happens to be 15, 31, or 63. Of course, a human player who has the first turn and knows the winning strategy can win against the computer.

•• **Business P5.18** *Postal bar codes.* For faster sorting of letters, the United States Postal Service encourages companies that send large volumes of mail to use a bar code denoting the zip code (see Figure 9).

Figure 9 A Postal Bar Code

The encoding scheme for a five-digit zip code is shown in Figure 10. There are full-height frame bars on each side. The five encoded digits are followed by a check digit, which is computed as follows: Add up all digits, and choose the check digit to make the sum a multiple of 10. For example, the zip code 95014 has a sum of 19, so the check digit is 1 to make the sum equal to 20.
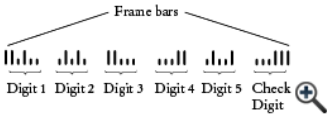

Figure 10 Encoding for Five-Digit Bar Codes

Each digit of the zip code, and the check digit, is encoded according to the following table where 0 denotes a half bar and 1 a full bar.

Digit	Bar 1 (weight 7)	Bar 2 (weight 4)	Bar 3 (weight 2)	Bar 4 (weight 1)	Bar 5 (weight 0)
1	0	0	0	1	1
2	0	0	1	0	1
3	0	0	1	1	0
4	0	1	0	0	1
5	0	1	0	1	0
6	0	1	1	0	0
7	1	0	0	0	1
8	1	0	0	1	0
9	1	0	1	0	0
0	1	1	0	0	0

The digit can be easily computed from the bar code using the column weights 7, 4, 2, 1, 0. For example, 01100 is $0 \times 7 + 1 \times 4 + 1 \times 2 + 0 \times 1 + 0 \times 0 = 6$. The only exception is 0, which would yield 11 according to the weight formula.

Write a program that asks the user for a zip code and prints the bar code. Use : for half bars, | for full bars. For example, 95014 becomes

||:|:::|:|:||:::::::||:|::|:::|||