The Theory of Computation

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Solution Manual
Chapter 4, Problem 5.7

An easy solution to this problem is to use a brute-force approach. We simulate an arbitrary Turing machine; at the beginning, we place a special symbol (not part of the machine's alphabet) on the square to the left of the input; the simulation then simply runs the simulated machine with only one safeguard: whenever the special symbol is read (with the simulated machine expecting a blank), our simulating machine enters a block of states that shifts the entire tape to the right of the special symbol by one tape square to the right, thereby creating one new tape square to the immediate right of the special symbol. This new tape square is filled with a blank and the simulation continues from there. The right-shift block is similar to that used in the decrement routine in the text.

The simulation thus takes the same amount of space on the tape as the original machine did, but it may take a lot more time: if the original machine ran in $f(n)$ time and $g(n)$ space, the simulation also runs in $g(n)$ space, but takes $O(f(n) \cdot g(n))$ time.