

For each machine, determine how many operations are performed on each step, on an input string of length n , and give a big-Oh upper bound on the total number of operations performed.

Group 1:

On input string w :

1. Scan across the tape and reject if a 0 is found to the right of a 1.
2. Repeat if both 0s and 1s remain on the tape:
 3. Scan across the tape, crossing off a single 0 and a single 1.
4. If 0s still remain after all the 1s have been crossed off, or if 1s still remain after all the 0s have been crossed off, reject. Otherwise, if neither 0s nor 1s remain on the tape, accept.

Group 2:

On input string w :

1. Scan across the tape and reject if a 0 is found to the right of a 1.
2. Repeat as long as some 0s and some 1s remain on the tape:
3. Scan across the tape, checking whether the total number of 0s and 1s remaining is even or odd. If it is odd, reject.
4. Scan again across the tape, crossing off every other 0 starting with the first 0, and then crossing off every other 1 starting with the first 1.
5. If no 0s and no 1s remain on the tape, accept. Otherwise, reject.

Group 3:

On input string w :

1. Scan across tape 1 and reject if a 0 is found to the right of a 1.
2. Scan across the 0s on tape 1 until the first 1. At the same time, copy the 0s onto tape 2.
3. Scan across the 1s on tape 1 until the end of the input. For each 1 read on tape 1, cross off a 0 on tape 2. If all 0s are crossed off before all the 1s are read, reject.
4. If all the 0s have now been crossed off, accept. If any 0s remain, reject.