Problem 1 (Groups)

Each of the Turing machines that we have discussed so far has been able to move its tape head both left and right. Imagine then, a Turing machine that can only move right. Prove that these two machines are not equivalent (i.e. that they cannot “compute” the same set of numbers).

*** DISCLAIMER: The following 2 problems will be auto-graded. Read the specs carefully. ***

Problem 2

Consider a tape that initially consists of some finite pattern of 1’s and 0’s, with the tape head positioned over the first square (see figure below). Write a Turing machine (formatting guidelines on the following page) that will invert this pattern and extend it infinitely along the tape. Please submit your solution to the Gradescope autograder as P2.txt.

Problem 3

Write a Turing machine that will add 1 to a binary number that is initially written on the tape. For convenience you may assume that the tape extends infinitely to the left, and that the first cell is marked with a ‘#’. The figure below depicts 1 being added to 15 to arrive at 16. Please submit your solution to the Gradescope autograder as P3.txt.
Turing Machine Syntax

1 NAME, STATE, GAMMA, START, HALT are all one line each, are each followed by a colon (:), and must all be present.

2 States can be a sequence of printable ASCII characters that do NOT contain whitespace or quotes.
   - q0, q1, q3, q1# are all fine
   - q_Looking_for_a_one is legal, but frowned upon
   - “q state here” is illegal and will confuse the Turing Machine

3 Elements of Gamma can be a sequence of printable ASCII characters that are NOT whitespace or quotes. For clarity, do NOT reuse the names for states.
   - 0, 1, B, 1x, 0x, X, Y are all fine
   - “Crossed one out”, φ, I are all illegal and will confuse the Turing Machine

4 The blank character MUST be B. You may assume that the tape is initially filled with blanks.

5 Recall delta is \( Q \times \Gamma \rightarrow Q \times \Gamma \times \{L, R\} \)

6 Each line has one transition. Each part of the transition is separated by whitespace. L means head moves left. R means head moves right.

7 A transition to the halt state does not need to write to the tape or move the head. All other transitions do write to the tape AND move the head.

8 Any transitions not written in Delta will be treated as transitioning to the halt state.

9 Delta must end with END on a single line.

10 Anything after END will not be read by the simulator, so feel free to explain the machine and its states.

11 You may include comments in the code. A comment is on a line of its own starting with a semicolon.
NAME: Prof Monroe
STATE: q0 q1 qh
GAMMA: 0 1 B
START: q0
HALT: qh
DELTA:
q0 B q1 0 R
; This is a comment
q1 B q0 1 R
END

Comment however you like down here.
This TM computes the number .010101...