Regular Languages FTW?

(1) \( L = \{a^N b^N \mid N > 0\} \) // equality

(2) \( L = \{a^N b^{2N} \mid N > 0\} \) // multiplication

(3) \( L = \{a^N b^M c^{(N+M)} \mid N, M > 0\} \) // addition

Not Regular
No DFA “decides” these languages
Turing Machines

A machine $M$ that consists of:

- an alphabet $\Sigma$
- a finite set of control states, including:
  - start state
  - accepting state(s)
- transitions between states
- an infinitely large tape, which can be read or written
  - the tape is akin to memory
- a current location on the tape called the “read/write head”

Given a string $w \in \Sigma^*$, $M$ accepts $w$ if consuming $w$ causes $M$ to terminate in an accepting state.
can move left or right
What does this machine do?
$\Sigma = \{a, b\}$  \hspace{1cm} $L = \{a^N b^N\}$