Stay-put

Instead of just Left and Right, we also have Stay-put option
Two-way-infinite tape TM

Given a two-way-infinite tape TM, construct an equivalent one-way infinite tape TM.

Represent tape contents with:

For each transition in original machine:

Multiple tapes

Let our TM have $k$ tapes with a transition function:

- $\delta : Q \times \Sigma^k \rightarrow Q \times \{L, R, \text{Stay}\}^k$

Write a new single-tape TM that represents the $k$ tapes with:

Convert each transition into a set of states and transitions in the single-tape TM that:
Closure properties of Turing-decidable languages

Union

Intersection

Concatenation

Reverse

Closure properties of Turing-recognizable languages

Union

Intersection

Concatenation

Reverse
Non-deterministic TM

Transition function maps to set of:
- state
- new tape symbol
- Left or Right

Computation is a tree

TM accepts if:

TM rejects if:

Any Non-det TM has an equivalent Det TM

Given:
- M, a nondeterministic one-way-infinite one-tape TM

Compute
- M' which simulates M

Idea:
- 3 tapes:
  - Tape 1 contains w, the input
  - Tape 2 contains a copy of M's tape (on some non-deterministic branch)
  - Tape 3 contains record of non-deterministic choices
    - Will be generated deterministically. Consists of #,##,##,# where each # is in range 1..maxBranchingFactorOfM
- 4 stages of M':
  - Stage 1: Tape 2 and 3 are blank
  - Stage 2: Copy w to tape 2
  - Stage 3: Use tape 2 to simulate M. On every step of M, consult tape 3 to determine
    which choice to make of the allowable transitions. If illegal, or no more symbols in tape 3, goto stage 4. If M accepts, accept.
  - Stage 4: Replace string on tape 3 with lexicographically next string. Simulate next branch by going to stage 2.