4.3.46) Z-stack PDA's = TMs

figure out how to encode TM type in Z stacks
(can use bottom of stack markers)

4.4.4) how does reply mess up poly-time simulation of RATM
- pay attention!

4.6.2a) new 2 approaches: 1) generate word
reverse word

2) for ex: for aabagaba
generate aaabbbbaa
renumerate

6) a^n think of as repeated doublings
c) Idea: take advantage of $1 = 1 \quad 4 = 1 + 3 \quad 9 = 1 + 3 + 5 \quad n^2 = \sum_{k=1}^{n}(2k+1)

produce \quad a, \quad aaaa, \quad aaaa, \quad aaaa

S \rightarrow e \quad \{special\ \cases{\text{cases}}\}
S \rightarrow a 
S \rightarrow \text{aC}$
$\text{aC} \rightarrow \text{CaA}$ \quad \text{make A for a}
$\text{aA} \rightarrow \text{aA}$ \quad \text{mark A's to right of a's}
$\text{eC} \rightarrow \text{eD}$ \quad \text{put marker between groups}
$\text{eD} \rightarrow \text{eT}$ \quad \text{E erases 0's}
$\text{eA} \rightarrow \text{eT}$ \quad \text{E erases 0's}
$\text{T} \rightarrow \text{aT}$ \quad \text{T replaces A by a}
$\text{T} \rightarrow \text{aC}$ \quad \text{T replaces A by a}
$\text{T} \rightarrow \text{aA}$ \quad \text{T replaces A by a}
$\text{T} \rightarrow \text{aE}$ \quad \text{T replaces A by a}
$\text{E} \rightarrow \text{eA}$ \quad \text{E erases E}

\begin{align*}
\text{if do } @ \text{ wrong time, can't erase all a's} & \\
\text{if do } @ \text{ wrong time, can't transform all A's} & \\
\end{align*}
Random Access TM
- tape for each reg
- tape for input/output
- tape with \((c, T[a])\) pairs for tape states with -2000 contents
- write a temp tape

If RATOM computes \(f\) in poly time, then \(f\) is a standard TM that computes \(f\) in poly time.

\[
\begin{align*}
R_o & \quad 0 \; 14 \\
R_i & \quad 1 \; 3 \\
tape & \quad (1, 100); (2, 10); (4, \_); (3, 1); (4, 100)
\end{align*}
\]

simulating one step scans tape; how long to scan tape depends on length \(0(\text{m})\)

how fast can tape grow?
for $i = 1$ to $\infty$  
step $i$ adds $\log_{10} (i+10)$ chars to tape

$T[i] = 100000$

at each step, tape grows at most by (size of largest value in reg or on tape)

$T[i] = 2^{i \cdot \text{pow}}$

largest value on tape or in reg can increase at most by a constant at each step

$\text{pow} = \text{pow} + \text{pow}$

$\text{size of largest value is } O(\text{Oct})$

$\text{tape increases by } O(\text{Oct})$ at each step

$\text{size of tape is } O(\text{Oct})$

Each of $t$ steps takes $O(\text{Oct})$ to simulate
Simulating $T$ steps takes $O(T^3)$ time.

**Nondeterministic TMs**

transition relation must have $(q, a, z)$ and $(p, b)$

$((q, a), (s, \rightarrow))$

$M$ accepts a string $w$ if at least one computation path halts on $w$ (recognizes $L$ if $M$ accepts $w \iff w \in L$)

$M$ decides a language (or computes $f$) iff

1. no computation path takes longer $N$ steps ($N$ depends on input)
2. every computation path ends in $y$ if $w \in L$
   or $y'$ if $w \notin L$
   (every path ends $w|f(w)$ on type)