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Homework 12

1. Describe a Turing machine accepting the language $\{ww: w \in \{a,b\}^* *\}$. The machine cannot loop. Simulate its work for the word abbabb

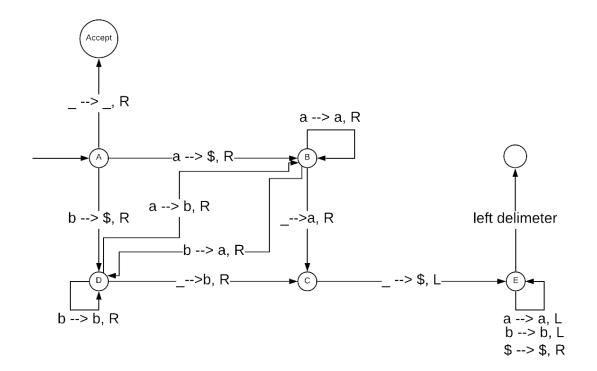
It's hard to explain the whole mechanism with words so I'lluse the diagram (state machine) Algorithm:

Dividing the tape into 2 parts (finding middle of string).

At the initial state, we shift all the symbol one place to the right, putting the symbol \$ at the beginning of string. We move the head to the right until first blank. Write the symbol \$ in this place.

Then we shift all the symbol one place to the right, putting the symbol \$ at the beginning of string We then have the new string with \$ at the beginning and ending.

We move the head to the lft until reach the left delimeter and enter stage 2.



| Sim | ulate | e its | wor | k for | r the | wor | d ab | babb |
|-----|-------|-------|-------|-------|-------|-------|--------|---------------------------------|
| а | b | b | а | b | b | _ | _ | |
| We | then | read | d fir | st le | etter | a ar | id wi | rite \$ there and move to right |
| \$ | b | b | а | b | b | _ | - | |
| We | then | read | d let | ter k | and | l wri | ite a | there and move to right |
| \$ | а | b | а | b | b | _ | _ | |
| We | then | read | d let | ter k | and | l wri | ite b | there and move to right |
| \$ | а | b | а | b | b | _ | _ | |
| We | then | read | d let | ter c | anc | l wri | ite b | there and move to right |
| \$ | а | b | b | b | b | _ | _ | |
| We | then | read | d let | ter k | and | l wri | ite a | there and move to right |
| \$ | а | b | b | а | b | _ | _ | |
| We | then | read | d let | ter k | and | l wri | ite b | there and move to right |
| \$ | а | b | b | а | b | _ | _ | |
| We | then | read | d let | ter _ | and | wri | te b | there and move to right |
| \$ | а | b | b | а | b | b | _ | |
| We | then | read | d let | ter_ | and | wri | te\$ t | here and move to left |
| \$ | а | b | b | а | b | b | \$ | |
| | | | | | | | | |

We then read and move head to the left until we see left delimeter and move to the right

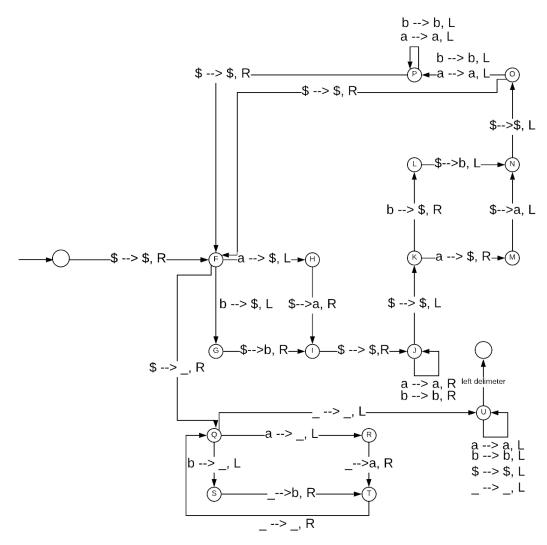
In stage 2:

We then keep interchanging the left \$ with the symbol to the right of it and right \$ with the symbol on the left of it, until there is no more symbols between them.

We delete second of two \$ and then move all symbol of the right side on step to left.

We will leave with string that have \$ in the middle.

We move back to the left until we reach left delimeter. We move to stage 3.



We read first symbol \$ and move to the right

| \$ | а | b | b | а | b | b | \$ | |
|------|------|-------|------|-------|-------|--------|-------|---------------------|
| We 1 | read | syn | ıbol | a an | d wr | ite \$ | ana | l move to the left |
| \$ | \$ | b | b | а | b | b | \$ | |
| We 1 | read | syn | ibol | \$ an | d wr | ite a | ana | l move to the right |
| а | \$ | b | b | а | b | b | \$ | |
| We 1 | read | \$ ar | nd m | ove | to th | e ri | aht.t | the same with b.b.a |

We read \$ and move to the right, the same with b, b, a, b, b,

We read symbol \$ and move to the left

We read symbol b, write \$ there and move to the right

a | \$ | b | b | a | b | \$ | \$

| u | } | Σ | 2 | 3 | Σ | 7 | ጉ | |
|------|------|-----|------|--------|-------|-----|------|---------------------|
| We 1 | read | syn | ıbol | \$, wr | ite l | the | re a | nd move to the left |
| а | \$ | b | b | а | b | \$ | b | |

We read \$ and move to the left, the same with b, a, b, b We read symbol \$ and move to the right

We read symbol b, write \$ there and move to the left

a \$ \$ b a b \$ b

| - | ۲ | + | | | | + | 1 | |
|------|------|-----|------|--------|-------|-----|------|----------------------|
| We 1 | read | syn | ıbol | \$, wr | ite l | the | re a | nd move to the right |
| а | b | \$ | b | а | b | \$ | b | |

We read \$ and move to the right, the same with b, a, b We read symbol \$ and move to the left

We read symbol b, write \$ there and move to the right

| VV C 1 | cuu | 3 9 11 | ibui | D, WI | 111 | P CITC | i c u | |
|--------|-----|--------|------|-------|-----|--------|-------|--|
| а | \$ | b | b | а | \$ | \$ | b | |

| We | read | sym | ıbol | \$, wr | ite l | b the | re a | nd move to the leftt |
|-----|------|-------|------|--------|--------|---------|--------|-------------------------------------------------------------------------------|
| а | b | \$ | b | а | \$ | b | b | |
| We | read | \$ ar | ıd m | love | to th | ie lej | ft, th | ne same with a, b |
| We | read | sym | ıbol | \$ an | d mo | ove t | o the | e right |
| We: | read | sym | ıbol | b, wı | ite \$ | \$ the | re a | nd move to the left |
| а | b | \$ | \$ | а | \$ | b | b | |
| We: | read | sym | ıbol | \$, w1 | ite l | b the | re a | nd move to the right |
| а | b | b | \$ | а | \$ | b | b | |
| We | read | \$ ar | ıd m | love | to th | ie riį | ght, t | the same with a |
| | | | | | | | | e left |
| We | read | sym | ıbol | a, wi | rite S | \$ the | ere a | nd move to the right |
| а | b | b | \$ | \$ | \$ | b | b | |
| We: | read | sym | ıbol | \$, w | ite c | a the | ere a | nd move to the left |
| а | b | b | \$ | \$ | а | b | b | |
| We | read | \$ ar | ıd m | love | to th | ie le j | ft, w | e read \$ and move to the right.We read \$ and write thereand move to right |
| а | b | b | \$ | | а | b | b | |
| We | read | sym | ıbol | a, wi | rite _ | the | re aı | nd move to the left |
| а | b | b | \$ | | | b | b | |
| We | read | svn | ıbol | .wr | ite a | the | re aı | nd move to the right |
| а | b | b | \$ | a | | b | b | |
| We | read | svn | ibol | and | d mo | ve t | o the | right |
| | | | | | | | | nd move to the left |
| а | b | b | \$ | а | | | b | |
| We | read | sym | ıbol | , wr | ite b | the | re ar | nd move to the right |
| а | b | b | \$ | a | b | | b | |
| We | read | sym | ıbol | an | d mo | ve t | o the | eright |
| | | | | | | | | nd move to the left |
| а | b | b | \$ | а | b | | | |
| We | read | sym | ibol | _, wr | ite b | the | re ar | nd move to the right |
| а | b | b | \$ | a | b | b | | |
| We | read | SVM | hol | and | d mo | 110 ti | n the | right. |
| | | | | | | | | left we make the same was entill we may be left delimator |

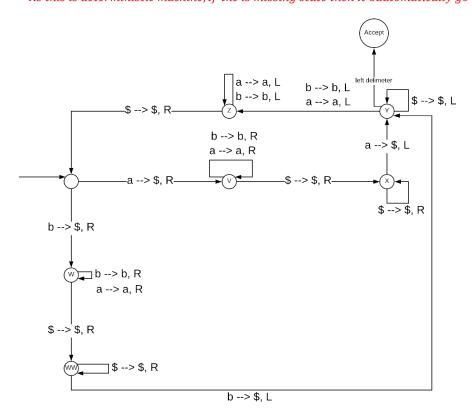
 $We \ read \ symbol \ _and \ move \ to \ the \ left, we \ move \ the \ same \ way \ untill \ we \ reach \ left \ delimator.$

In stage 3:

We check if the letter reading from left delimeter is matching the one reading from first $\$ in the middle. We then replace those letter with symbol $\$

Until there is no more letter between two block of \$, then we can end and accept the word..

As this is deterministic machine, if the is missing state then it's automatically go to reject state.



We read symbol a, write \$ there and move to the right.

| \$ | b | b | \$ | а | b | b | _ |
|----|---|---|----|---|---|---|---|
|----|---|---|----|---|---|---|---|

We read other symbol b, b and don't change them until we reach \$.read and move to right We check if symbol is a, write \$ there and move to the left.

| \$ b | b | \$ \$ | b | b | - 1 |
|---------|---|----------|---|---|-----|

We read \$ and move to left, the same with b, b until we reach \$, we read it and move to right. We read symbol b, write \$ there and move to the right.

| \$ \$ | b | \$ \$ | b | b | _ |
|-------|---|----------|---|---|---|

We read b and move to right, the same with next \$,\$

We check if symbol is b, write \$ there and move to the left.

| | 0.000. | | 9 | 0000 | 0 2). | | 4 0 | |
|----|--------|---|----|------|-------|---|-----|--|
| \$ | \$ | b | \$ | \$ | \$ | b | _ | |

We read \$ and move to left, the same with \$, b until we reach \$, we read it and move to right. We read symbol b, write \$ there and move to the right.

| | 0 0000 | 0) | 0000 | ~, | , 0.00 | |
|----|--------|----|------|----|------------|--|
| \$ | \$ | \$ | \$ | \$ | \$ b | |

We read \$ and move to right, the same with next \$,\$

We check if symbol is b, write \$ there and move to the left.

| \$ \$ | \$ \$ | \$ \$ | \$ - |
|----------|----------|----------|---------|

We read \$ and move to left, until we reach left delimeter and to accept state.