Time Complexity (TM)

For any M, its <u>time complexity</u>

$$tc_M : \mathbb{N} \longrightarrow \mathbb{N} \quad \text{s.t.} \quad tc_M(n)$$

is the maximum number of transitions taken by a computation ("run") of M on an input of length n.

$t_{c_M} : \mathbb{N} \longrightarrow \mathbb{N}$

input length

max transitions taken

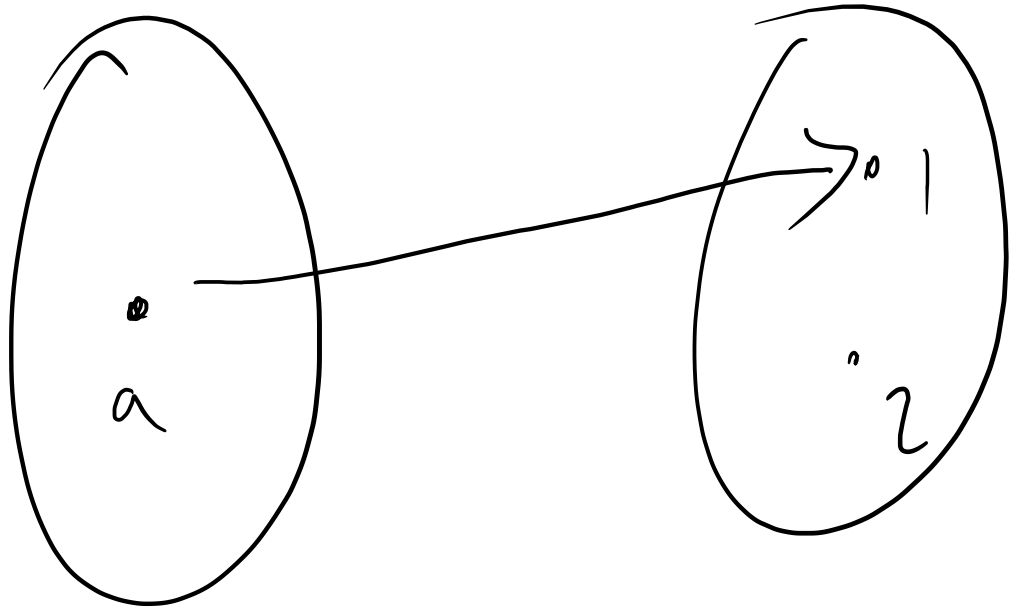
$t_{c_M}(n)$

$\left(f(n) \in O(n^2) \right)$

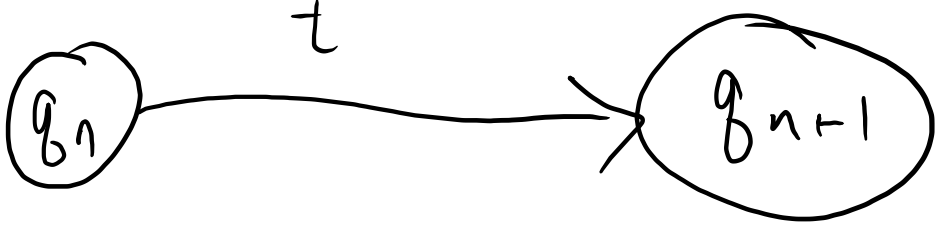
TM is deterministic if

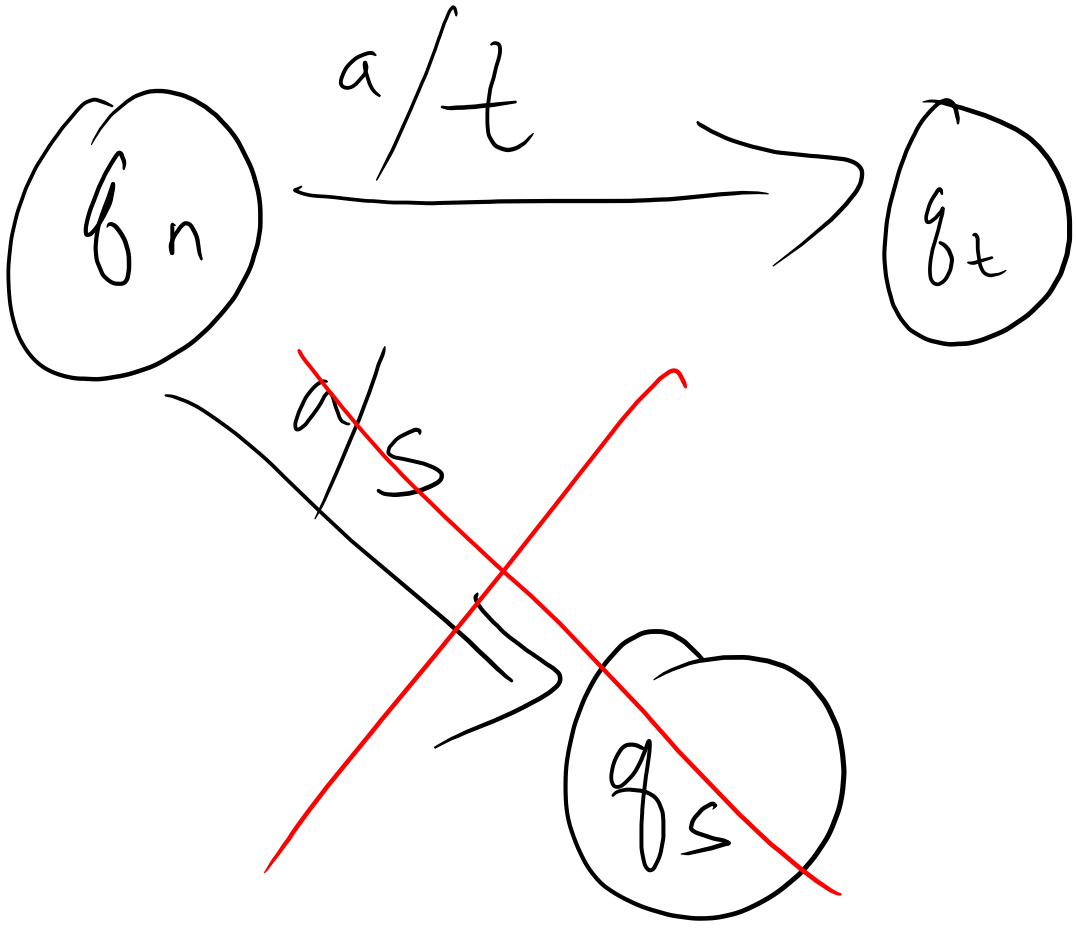
δ is a (partial) function.

Intuitively, this means for any state and symbol read from the tape, there is exactly one transition.



deterministic machine




a/t
qn
qt
a/s
qs

A language L is accepted in deterministic time, if there is a single-tape deterministic Turing machine for the language.

$$t_{c_M} \in O(f(n))$$

↑ complexity class.

Example: Palindrome Example (script)

palindrome: forward-reading = backward-reading

racecar

a's and b's

a a

a b a

a b b a

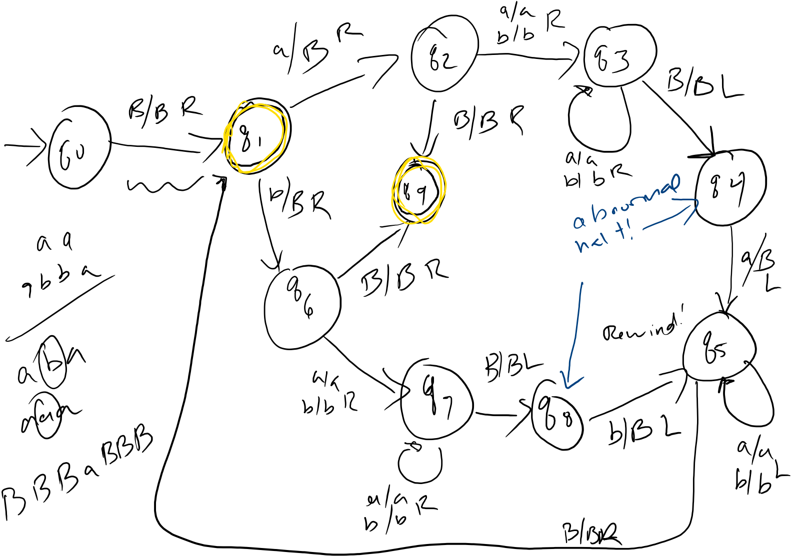
a b a b a

" " — trivial palindrome

a a or b b

a u a

b u a where u is a palindrome.



q0
B/B R
q1
a/B R
q2
a/a
b/b R
q3
a/a
b/b R
B/B L
q4
a/B L
q5
a/a
b/b L
Rewind!
B/B R
b/B L
q8
B/B L
q7
a/a
b/b R
q6
b/B R
B/B R
q9
abnormal halt!
a a
a b b a
a b a
B B B a B B B

$$4+3+2+1$$

$$\sum_{i=0}^{n} i = \frac{n^2+n}{2}$$

$$n^2+n+1$$

exact complexity

$$tc_m = n^2+n+1 \in O(n^2)$$