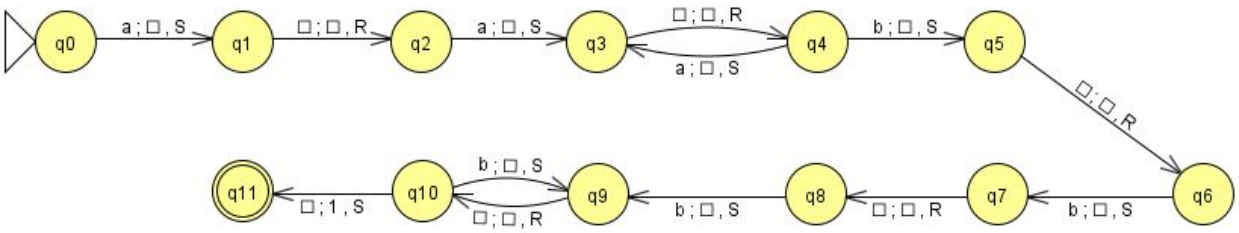
Chue Zhang and Eric Mai

CSc 30400 - Theoretical Computer Science

Turing Machine (9): $a^n b^m$ | n ≥ 2, m ≥ 3

The Turing Machine:

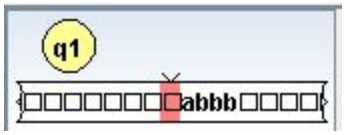


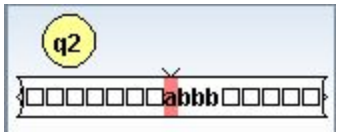
Test cases:

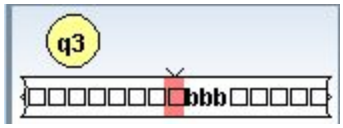
Input	Result
	Reject
a	Reject
b	Reject
ab	Reject
aab	Reject
aaab	Reject
abb	Reject
abbb	Reject
abbbb	Reject
aabbb	Accept
aabbbbb	Accept
aaaaaabb	Reject
aaaaaabbbb	Accept
aaaaabbbbb	Accept
aabbba	Reject
bbaaa	Reject

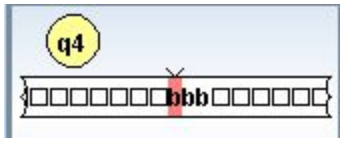
Test Case [aabbb]:

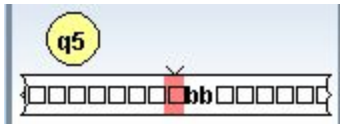

q0
aabbb

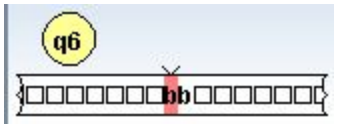

q1
abbb

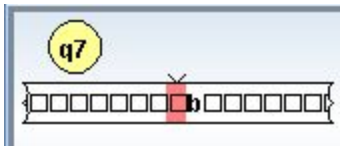

q2
abbb

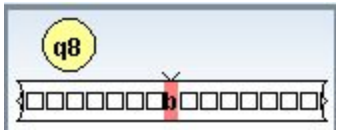

q3
bbb

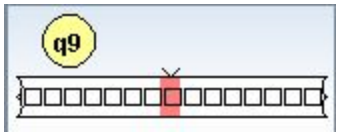

q4
bbb

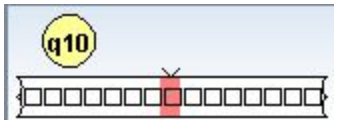

q5
bb

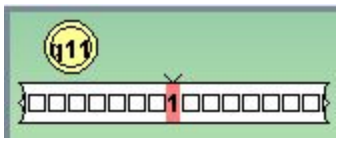

q6
bb


q7
b


q8
b


q9





Time Complexity:

The time complexity is the maximum number of steps in any terminating computation of the Turing machine for an input.

For example:

11 steps is the smallest number of steps required for the Turing Machine to reach the accepted state “q11” for the string “aabbb”.

Time complexity of the Turing Machine:

[Time to blank out an a and travel] + [Time to blank out an b and travel] + [Time to write a ‘1’]

= [2n] + [2m] + 1

$time_M(n, m) = 2n + 2m + 1 = O(n+m)$

Space Complexity:

The space complexity is the maximum number of tape squares scanned over the course of any terminating computation of the Turing machine for an arbitrary size input.

[Number of a’s] + [Number of b’s] + 1

= [n] + [m] + 1

$space_M(n, m) = n + m + 1 = O(n+m)$

Because we require there be at least 2 a's and at least 3 b's, the string must have at minimum a length of 5.

Thus, we can say that

$space_M(n, m) \geq 6$ for all valid inputs.