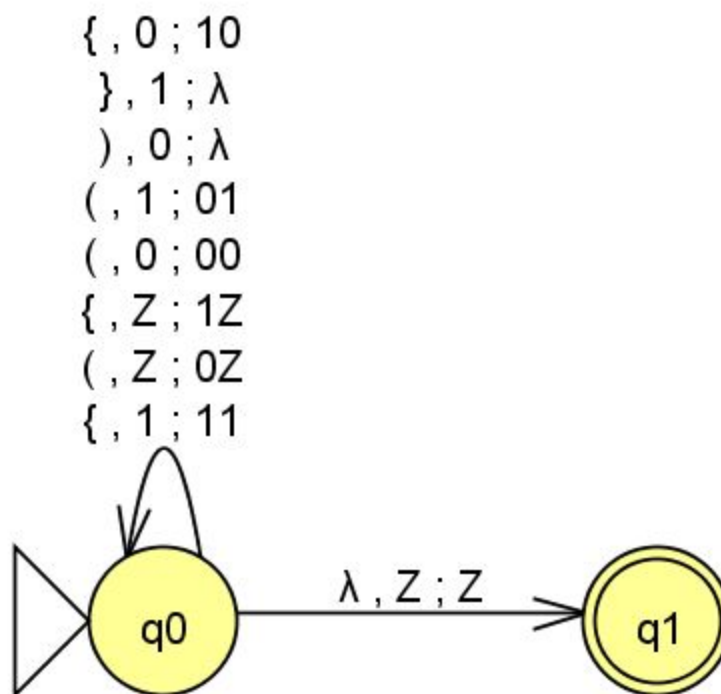


### Automata Formal Languages & Logic

#### Q&A - Pushdown Automata

- Proper nesting of parentheses and flower brackets. For example,  $\{((()))\{\{\{\}\}\}\}$ . Show how it rejects  $\{\{\}\{\{\}\}\}$ .



Solution:

It can be seen that  $\{((()))\{\{\{\}\}\}\}$  is accepted with the sequence (showing only successive stack contents):

Z, 1Z, 01Z, 001Z, 01Z, 1Z, 01Z, 1Z, 11Z, 111Z, 0111Z, 111Z, 11Z, 111Z, 11Z, 1Z, Z

The string  $\{\{\}\{\{\}\}\}$  is rejected with the sequence:

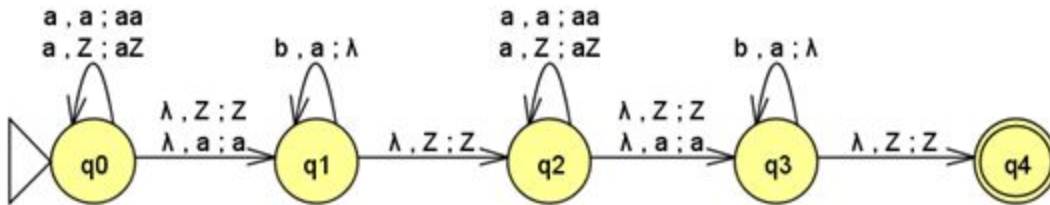
Z, 1Z, 01Z, 1Z, 11Z, 111Z, 0111Z,

At this point, there is a mismatch between the next input symbol  $\}$  and the symbol 0 on the stack and the PDA halts right there, rejecting the input.

- $a^n b^n a^m b^m$ ,  $n \geq 0$ ,  $m \geq 0$ . Show, along with two different accepting sequences of configurations, how non-determinism works to accept the string  $aaabbb$  in two different ways.

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Solution:



Accepting sequence 1 for aaabbb:

$(q_0, aaabbb, Z)$ ,  $(q_0, aabbb, aZ)$ ,  $(q_0, abbb, aaZ)$ ,  $(q_0, bbb, aaaZ)$ ,  $(q_1, bbb, aaaZ)$ ,  $(q_1, bb, aaZ)$ ,  $(q_1, b, aZ)$ ,  $(q_1, \lambda, Z)$ ,  $(q_2, \lambda, Z)$ ,  $(q_3, \lambda, Z)$ ,  $(q_4, \lambda, Z)$ .

Accepting sequence 2 for aaabbb:

$(q_0, aaabbb, Z)$ ,  $(q_1, aaabbb, Z)$ ,  $(q_2, aaabbb, Z)$ ,  $(q_2, aabbb, aZ)$ ,  $(q_2, abbb, aaZ)$ ,  $(q_2, bbb, aaaZ)$ ,  $(q_3, bbb, aaaZ)$ ,  $(q_3, bb, aaZ)$ ,  $(q_3, b, aZ)$ ,  $(q_3, \lambda, Z)$ ,  $(q_4, \lambda, Z)$ .

In fact, there is a third accepting sequence:

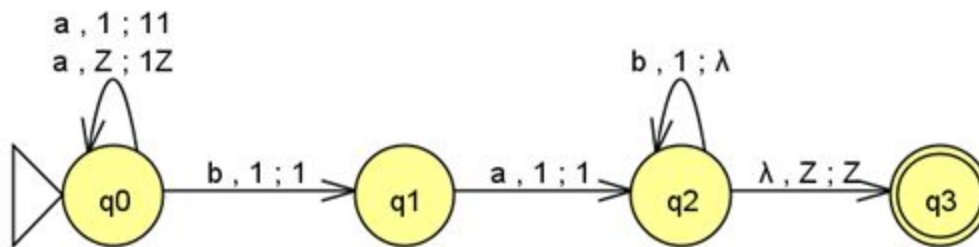
$(q_0, aaabbb, Z)$ ,  $(q_0, aabbb, aZ)$ ,  $(q_0, abbb, aaZ)$ ,  $(q_0, bbb, aaaZ)$ ,  $(q_1, bbb, aaaZ)$ ,  $(q_2, bbb, aaaZ)$ ,  $(q_3, bb, aaZ)$ ,  $(q_3, b, aZ)$ ,  $(q_3, \lambda, Z)$ ,  $(q_4, \lambda, Z)$ .

3.  $a^n bab^n$ ,  $n > 0$ . Make sure that the PDA is deterministic

Solution:

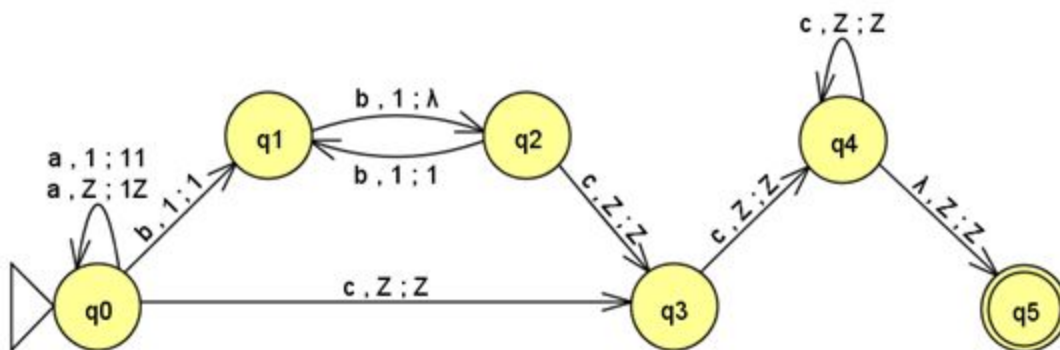
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4.  $a^n b^m c^k$  where  $2n = m$  and  $k \geq 2$ . Make sure that the PDA is deterministic.

Solution:



5. Construct a PDA for the language  $L = a^n b^m$  where  $m = n \bmod 3$ . How much stack memory do you need to handle this language?

Solution:

The stack is not needed at all; this is a regular language!

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