

Pumping lemma

1. Prove that the following languages are not regular (use the pumping lemma)

(a) $L_1 = \{\mathbf{a}^n \mathbf{b}^m : 0 \leq n \leq m\}$

(b) $L_2 = \{\mathbf{a}^n \mathbf{b}^m : 0 \leq m \leq n\}$

(c) $L_3 = \{\mathbf{a}^n \mathbf{b}^m : 0 \leq n \leq m \leq 2n\}$

(d) $L_4 = \{\mathbf{a}^{n!} : n \geq 1\}$

2. Let $\Sigma = \{0, 1\}$. Is the following language regular?

$$L = \{w \in \Sigma^* : \text{there are strings } x, y \in \Sigma^*, \text{ such that } |x| = |y| \text{ and } w = x0y\}$$