

Exercise 2. For each of the following languages L , state whether L is regular or not and prove your answer. If a language is regular, you can prove this by constructing a DFA, an NFA, or a regular expression — or give a convincing argument that one of these must exist. If the language is not regular, give an argument based on the pumping theorem for regular languages.

- b) $\{a^i b^j : i, j \geq 0 \text{ and } i - j = 5\}$.
- c) $\{a^i b^j : i, j \geq 0 \text{ and } |i - j| \equiv_5 0\}$.
- g) $\{w = xy : x, y \in \{a, b\}^* \text{ and } |x| = |y| \text{ and } \#_a(x) \geq \#_a(y)\}$.
- h) $\{w = xyz y^R x : x, y, z \in \{a, b\}^*\}$.
- j) $\{w \in \{0, 1\}^* : \#_0(w) \neq \#_1(w)\}$.
- l) $\{w \in \{a, b\}^* : \exists x \in \{a, b\}^+ \text{ such that } w = x x^R x\}$.
- q) $\{w \in \{a, b, \dots, z\}^* : \text{every letter in } w \text{ appears at least twice}\}$.
For example, *unprosperousness* is in L .

Solution.