# NTIN071 A&G: Tutorial 1 – Deterministic finite automaton, recognized language, regular languages

*Solve 1abcd, 2ab, 3abcd, 4ab first (the rest is for practice).*

**Problem 1** (Constructing a DFA for a given language)**.** Construct a DFA recognizing the given language.

(a) $L = \{w \in \{a,b\}^* \mid |w|_a \text{ is even}\}$

(b) $L = \{w \in \{a,b\}^* \mid |w|_a \text{ is not divisible by 3}\}$

(c) $L = \{w \in \{0,1\}^* \mid w \text{ is a binary encoding of a nonnegative integer divisible by 5}\}$

(d) $L = \{w \in \{a,b\}^* \mid 2 \text{ divides } |w|_a \text{ or 3 divides } |w|_b\}$

(e) $L = \{w \in \{a,b\}^* \mid 2 \text{ or 3 divides } |w|_a\}$

(f) $L = \{w \in \{a,b\}^* \mid |w|_b \text{ is divisible by 3}\}$

(g) $L = \{w \in \{a,b\}^* \mid 2 \text{ divides } |w|_a \text{ and 3 divides } |w|_b\}$

**Problem 2** (DFA given by a table)**.** Draw a state diagram and describe the recognized language in set notation.

(a)

| | 0 | 1 |
|---|---|---|
| → ∗ p | q | p |
| q | r | q |
| r | p | r |

(b)

| | 0 | 1 |
|---|---|---|
| → p | p | q |
| q | p | r |
| ∗ r | p | r |

(c)

| | 0 | 1 |
|---|---|---|
| → p | q | p |
| ∗ q | r | q |
| ∗ r | p | r |

(d)

| | 0 | 1 |
|---|---|---|
| → p | p | q |
| ∗ q | r | q |
| ∗ r | p | q |

**Problem 3** (Describing a language and constructing a DFA for a given property)**.** Construct a DFA accepting exactly those words over the alphabet $\Sigma = \{a,b\}$ that satisfy the given property. Describe the language in set notation.

(a) starts 'abba'

(b) ends 'abba'

(c) contains 'abba' or 'bab' as a subword

(d) has at least 2 letters and the first letter is the same as the last letter

(e) the first two letters are the same as the last two letters

**Problem 4** (Regular languages and set operations)**.** Let $L, L'$ be regular languages over the same alphabet. Show that the following is true:

(a) $\Sigma^* \setminus L$ is a regular language

(b) $L \cup L'$ is a regular language

(c) $L \cap L'$ is a regular language

(d) What if the alphabets of $L$ and $L'$ are different (but possibly sharing some symbols)?

(e) Would you be able to show that $L^R$ (i.e., words from $L$ written in reverse) is also regular?