# Regular expressions

**1.** Consider the alphabet $\Sigma = \{0,1\}$. Prove that

    a) $0^*(0+1)^* = (0+10^*)^*$.

    b) $(10)^+(0^*1^* + 0^*) = (10)^*10^+1^*$.

**2.** Consider the alphabet $\Sigma = \{0,1\}$. Prove that each of the following regular expressions is equivalent to $(0+1)^*$.

    a) $\epsilon + 0(0+1)^* + 1(1+0)^*$

    b) $0^* + 0^*1(0+1)^*$

    c) $0^*(10^*)^*$

**3.** For each of the following languages, give two strings that are members and two strings that are not members. Assume the alphabet is $\Sigma = \{a,b\}$.

    a) $a(ba)^*b$

    b) $(a+b)^*a(a+b)^*b(a+b)^*a(a+b)$

    c) $(a+ba+bb)(a+b)^*$

**4.** For each of the following languages in $\{0,1\}^*$, describe an equivalent regular expression

    a) Strings that contain at least three 1s.

    b) Strings that contain the substring 010.

    c) Strings that contain the subsequence 010.

    d) Strings with length at least 3 such that the third symbol is a 0.

    e) Strings that start with 0 and have odd length or strings that start with 1 and have even length.

f)  Strings that have 1 on every odd position.

g)  All strings not containing the substring 110.

h)  All strings not containing the substring 101.

i)  Strings containing an even number of 0's.

j)  The set containing the binary expansions of integers that are powers of 4.