

# Sets and tuples

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## Regular expressions

$(0.0|1.1).(0.1)^*.(0.0|1.1)$

- Regular expressions are strings that represent patterns of text.
- The strings can contain special characters.
- Brackets can be used to group characters together.
- Regular expressions are used to search other strings for patterns.

### Special characters

- means *concatenate*. So,  $a.b$  means an  $a$  followed by a  $b$ .
- | means *or*. So,  $a|b$  means an  $a$  or a  $b$ .
- \* means *zero or more times*. So,  $a^*$  means zero or more  $a$ 's.

## Examples of regular expressions

$a.b.c$  – a single  $a$  followed by a single  $b$  followed by a single  $c$ .

$a.b.c^*$  – an  $a$  followed by a  $b$  followed by zero or more  $c$ 's.

$a|b.c$  – an  $a$ , or a  $b$  followed by a  $c$ .

$(a|b).c$  – an  $a$  or a  $b$ , followed by a  $c$ .

$0.0.(0|1)^*$  – all strings of 0's and 1's that begin with two zeros.

$1^*$  – any number of 1's (including empty string).

# Precedence

1. Always apply  $*$  first.
2. Apply  $.$  after  $*$  but before  $|$ .
3. Apply  $|$  last.
4. Treat bracketed groups as individual characters.

## Languages of regular expressions

This is a list of regular expressions over an alphabet  $A$  and the languages they define.

$\emptyset$  – the empty language ( $\{\}$ ).

$\epsilon$  – the language containing the empty string ( $\{\epsilon\}$ ).

$a$  – the language containing any symbol  $a$  from  $A$  ( $\{a\}$ ).

$r.s$  – the concatenation of the languages defined by regular expressions  $r$  and  $s$ .

$r|s$  – the union of the languages of regular expressions  $r$  and  $s$ .

$r^*$  – the star of the language defined by regular expression  $r$ .

## Infix and postfix

It is sometimes convenient to re-write expressions in postfix. This applies to lots of different expressions, not just regular expressions.

### Example

Convert an infix mathematical expression (left) to postfix (right):

$$(3 + 4) \times 5 \quad \rightarrow \quad 3\ 4\ +\ 5\ \times$$

### Example

Converting an infix regular expression (left) to postfix (right):

$$a.(b.b)^*.a \quad \rightarrow \quad abb.^*.a.$$

Note we often omit the  $.$  in infix notation: “ $a(bb)^*a$ ” but can’t in postfix. However, the brackets aren’t needed in postfix.