

HOMEWORK 1

1 Definition of languages

1. Give the prefix and postfix notations of $a * (b + c) * d$.
2. Postfix notation: Exercise 2.8 page 49
3. Exercise 2.14 a. page 51
4. Exercise 2.7 for expressions c and d of exercise 2.6
5. What are the terminals and the nonterminals of the following BNF grammar?

```
<goal> ::= <letter> | <letter> <next>
<next> ::= ,<letter>
<letter> ::= A
```

Describe the language described by the previous BNF grammar.

6. Write a BNF grammar that describes the structure of US telephone numbers, which can either be $(xxx)xxx - xxxx$ or $xxx - xxxx$, where x is a digit from 0 to 9.
7. Write a BNF grammar for identifiers that consist of an arbitrarily long string of letters and digits, the first one of which must be a letter.

2 Recursion, functional language programming and SML

1. Describe in 5 lines one of the industrial application of functional language programming (use the web and books).
2. Write a recursive function to compute 2^n for $n \geq 0$ (Write an algorithm or the JAVA code).
3. Write the **Fibonacci** function in JAVA and compute $Fibonacci(10)$, $Fibonacci(40)$, $Fibonacci(80)$, $Fibonacci(800)$???
4. Consider the function f such that:

$$f(n) = \begin{cases} x - 1 & \text{if } x > 0 \\ f(f(n + 2)) & \text{otherwise} \end{cases}$$

Compute $f(0)$ and $f(10)$.

5. What are the results and the types of the following expressions:

```
hd([6,1,2]);
tl [7,2,3];
hd [1];
tl [6];
explode ("abcd");
"f" :: ["a","c","i","l","e"];
["m","e","t"] @ ["a"," ", "l","a","n","g","a","g","e"];
```

6. What are the type of the following expressions:

```
((1,2),3);
(1,(2,3));
(1,2,3);
(1.2,("2",[4,5]));
[[3,4],[],[5]];
[(9,3,5),(1,2,1),(9,4,2)];
(["b","a"],[nil,[1,2,3]]);
```

7. Give examples of expressions of the following types:

```
int list list list
int * string list
(int * string) list
(string list * (int * (real * string))) * int
(((int * int) * (string list) * real) * (real * string))
```

Note: In the types parentheses are sometimes used for clarifying the problem.

8. Write a function **max4** that computes the maximum of 4 integers. What is the type of this function?
9. Define a function **circumference** and a function **area** that compute the circumference and the area of a circle with respect to its radius. You will use $\pi = 3.14159$. What are the types of your functions?
10. Write a function **Move** that given a list $[a_1, a_2, \dots, a_n]$, returns $[a_2, \dots, a_n, a_1]$. What is the type of your function?