

# SML - PRACTICE EXERCISES

## Exercise 1

Explain what is wrong in the following expressions and propose a correction.

```
hd([]);
explode(["toto"]);
implode("a","b");
["t"] :: ["o","p"];
6 @ 10;
```

## Exercise 2

(3,4) and (3,4,5) have the same type? [3,4] and [3,4,5] have the same type?

## Exercise 3

Consider the following definitions:

```
fun fact n = if n=0 then 1
             else n * fact(n-1);

fun new_if (a,b,c) = if a then b else c;
```

Write a function **new\_fact** using **new\_if**.

Explain why **new\_fact** does not compute the factorial.

Note: What is the evaluation of recursive function in SML?

## Exercise 4

Link the variable  $x$  to the value 0 when constructing forms to match the following expressions.

For example given the expression **(false,"bonjour",0)** the form  $(\_,\_,x)$  permits us to link  $x$  to 0 when we write: `val (_,_,x) = (false,"bonjour",0)`.

```
{a=3,b=0,c=false} - record.
[~2,~1,0,1,2] - ~ unary minus.
[(3,1),(0,9)]
```

## Exercise 5

Write a function `power_of_two` that tests if an int is a power of 2.

Write each steps of the evaluation of (`power_of_two 8`).

## Exercise 6

What is the type of the following function , justify your answer.

```
fun f (x,y,z,t) =  
  if x=y then z+1  
    else if x > y then z else y+t;
```

## Exercise 7

Write 2 functions `odd` and `even` that define if an int is even or odd using mutual recursion.

## Exercise 8

What are the results of the following declarations and expression. Each one is independent.

```
val x = 2 and y = x+1;
```

```
val x = 1; local val x = 2 in val y = x+1 end; val z = x + 1;
```

```
let val x = 1 in let val x = 2 and y = x in x + y end end ;
```

## Exercise 9

What are the results of the following expressions evaluations.

```
val x = 1 and y = 2 and z = 3;
```

```
let val x = x+1 and z=x+4 in x+z end;
```

```
let val t = x+1 in let val x = x+1 in x end end;
```

## Exercise 10

Write a function `insert` that inserts an int in a (ascending) sorted list.

## Exercise 11

Write a function `interclass` that interclasses 2 lists of (ascending) sorted int.

## Exercise 12

Write a function `insertion_sort` that implements insertion sorting.

## Exercise 13

### Bubble sort

1. Define a function `iteration` that repeat the treatment of a data while a condition on this data is not true.
2. Define a function `is_sorted` that returns true if a list is sorted, false otherwise.
3. Write a function `bubble` that implements the Bubble sort.

## Exercise 14

Write a function that computes the subsets of a set. How to represent a set?

## Exercise 15

What is the type of C:

```
fun C f g x = f (g x);
```

## Exercise 16

1. Write a function  $F$  that takes 2 parameters: a function  $O$  and a list  $l$  and processes the following way:  
$$F(O, l) = O(a_1, O(a_2, O(a_3, \dots, O(a_{n-1}, a_n) \dots))$$
 où  $l = [a_1, \dots, a_n]$ .  
The list  $l$  has 2 or more elements.
2. Write a function  $G$  that returns the elements of a list  $l$  that satisfy the condition  $cond$ . What is the type of  $G$ ? Why?
3. Using  $F$  and the function  $max$  that returns the maximum of 2 integers (write `max`) what is the maximum of a list of int, for example `[2, 6, 3, 15, 18, 1, 55, 22]`?
4. Using  $F$  and the function  $conc$  that returns the concatenation of 2 strings (write `conc`) what is the concatenation of all the strings of a list, for example `["a", "b", "c", "d"]`?
5. Consider the function  $fold$ . What is its type?

```
fun fold F nil y = y
  | fold F (x::l) y = F(x, (fold F l y));
```

## Exercise 17

Consider the function  $f$ :

```
fun f (x,nil) = nil
| f (x,a::aa) = if x(a) then a::f(x,aa) else f(x,aa);
```

Let  $T_e$  be the type of an expression  $e$ . We construct using  $f$  the following system of equations.

- (1)  $T_f = 'a \rightarrow 'b$
- (2)  $'a = T_x * T_{\{nil\}}$
- (3)  $'a = T_x * T_{\{a::aa\}}$
- (4)  $'b = T_{\{nil\}}$
- (5)  $'b = T_{\{f(x,aa)\}}$
- (6)  $T_{\{x(a)\}} = bool$

1. Justify each line of this system of equations.
2. Compute the type of  $f$ .

## Exercise 18

Let consider  $f$ :

```
fun f (x,nil) = nil
| f (x,a::aa) = if x(a) then x(a)::f(x,aa) else f(x,aa);
```

Let  $T_e$  be the type of an expression  $e$ . We construct a set of equations from the definition of  $f$ .

Write this system and compute the type of  $f$ .

## Exercise 19

1. Write a *datatype* **COORDS** that defines the coordinates of a point in 3D.
2. Give examples of the use of **COORDS**.
3. Using **COORDS** write a function *distance* that computes the distance between 2 points.
4. Give an examples of the use of *distance*.

## Exercise 20

Create a datatype **PERSON** that defines a person defined by its name, fname, age and datebirth.

## Exercise 21

1. Create a reference variable  $i$  whose value is a reference to 10.
2. Increment the value of  $i$  of 1.
3. Decrement the value of  $i$  of 1.
4. Change the value of  $i$  to 20.

## Exercise 22

while  $\langle expression \rangle$  do  $\langle expression \rangle$  has the following semantics in SML:

- a. Evaluate the first expression.
- b. If the first expression is false, exit. Else, evaluate the second expression and go to step a.

We want to code the following algorithm in SML:

```
i = 1
while i <= 10
do
afficher i
i= i+1
end
```

1. Why is the use of references needed?
2. Write the SML code.

## Exercise 23

Write a function *factorial* that returns:

- 1 for factorial(0)
- generates an exception for a negative parameter and return 0
- $n!$  for a strictly positive parameter.