## L1: Recursive programming in Lisp (1)

## Write recursive Lisp functions for the following problems:

1.

- a) Write a function to return the n-th element of a list, or NIL if such an element does not exist.
- b) Write a function to check whether an atom E is a member of a list which is not necessarily linear.
- c) Write a function to determine the list of all sublists of a given list, on any level.

A sublist is either the list itself, or any element that is a list, at any level. Example:

(1 2 (3 (4 5) (6 7)) 8 (9 10)) => 5 sublists:

( (1 2 (3 (4 5) (6 7)) 8 (9 10)) (3 (4 5) (6 7)) (4 5) (6 7) (9 10) )

d) Write a function to transform a linear list into a set.

2

a) Write a function to return the product of two vectors.

https://en.wikipedia.org/wiki/Dot\_product

- b) Write a function to return the depth of a list. Example: the depth of a linear list is 1.
- c) Write a function to sort a linear list without keeping the double values.
- d) Write a function to return the intersection of two sets.

3.

- a) Write a function that inserts in a linear list a given atom A after the 2nd, 4th, 6th, ... element.
- b) Write a function to get from a given list the list of all atoms, on any level, but reverse order. Example:

(((A B) C) (D E)) ==> (E D C B A)

- c) Write a function that returns the greatest common divisor of all numbers in a nonlinear list.
- d) Write a function that determines the number of occurrences of a given atom in a nonlinear list.

4.

- a) Write a function to return the sum of two vectors.
- b) Write a function to get from a given list the list of all atoms, on any level, but on the same order. Example:

```
(((A B) C) (D E)) ==> (A B C D E)
```

c) Write a function that, with a list given as parameter, inverts only continuous sequences of atoms. Example:

```
(a b c (d (e f) g h i)) ==> (c b a (d (f e) i h g))
```

d) Write a list to return the maximum value of the numerical atoms from a list, at superficial level.

5.

- a) Write twice the n-th element of a linear list. Example: for (10 20 30 40 50) and n=3 will produce (10 20 30 40 50).
- b) Write a function to return an association list with the two lists given as parameters. Example: (A B C) (X Y Z) --> ((A.X) (B.Y) (C.Z)).
- c) Write a function to determine the number of all sublists of a given list, on any level. A sublist is either the list itself, or any element that is a list, at any level. Example:

(1 2 (3 (4 5) (6 7)) 8 (9 10)) => 5 lists:

(list itself, (3 ...), (4 5), (6 7), (9 10)).

d) Write a function to return the number of all numerical atoms in a list at superficial level.

6

- a) Write a function to test whether a list is linear.
- b) Write a function to replace the first occurence of an element E in a given list with an other element
- c) Write a function to replace each sublist of a list with its last element.

A sublist is an element from the first level, which is a list.

Example: (a (b c) (d (e (f)))) ==> (a c (e (f))) ==> (a c (f)) ==> (a c f)(a (b c) (d ((e) f))) ==> (a c ((e) f)) ==> (a c f)

d) Write a function to merge two sorted lists without keeping double values.

7.

- a) Write a function to eliminate the n-th element of a linear list.
- b) Write a function to determine the successor of a number represented digit by digit as a list, without transforming the representation of the number from list to number. Example: (1 9 3 5 9 9) --> (1 9 3 6 0 0)
- c) Write a function to return the set of all the atoms of a list.

```
Exemplu: (1 (2 (1 3 (2 4) 3) 1) (1 4)) ==> (1 2 3 4)
```

d) Write a function to test whether a linear list is a set.

8.

- a) Write a function to return the difference of two sets.
- b) Write a function to reverse a list with its all sublists, on all levels.
- c) Write a function to return the list of the first elements of all list elements of a given list with an odd number of elements at superficial level. Example:

$$(1\ 2\ (3\ (4\ 5)\ (6\ 7))\ 8\ (9\ 10\ 11)) \Longrightarrow (1\ 3\ 9).$$

d) Write a function to return the sum of all numerical atoms in a list at superficial level.

9.

- a) Write a function that merges two sorted linear lists and keeps double values.
- b) Write a function to replace an element E by all elements of a list L1 at all levels of a given list L.
- c) Write a function to determines the sum of two numbers in list representation, and returns the corresponding decimal number, without transforming the representation of the number from list to number.
- d) Write a function to return the greatest common divisor of all numbers in a linear list.

10.

- a) Write a function to return the product of all the numerical atoms from a list, at superficial level.
- b) Write a function to replace the first occurrence of an element E in a given list with an other element O.
- c) Write a function to compute the result of an arithmetic expression memorised in preorder on a stack. Examples:

```
(+13) ==> 4 (1+3)

(+*243) ==> 11 [((2*4)+3)

(+*24-5*22) ==> 9 ((2*4)+(5-(2*2))
```

d) Write a function to produce the list of pairs (atom n), where atom appears for n times in the parameter list. Example:

```
(A B A B A C A) --> ((A 4) (B 2) (C 1)).
```

11.

- a) Determine the least common multiple of the numerical values of a nonlinear list.
- b) Write a function to test if a linear list of numbers has a "mountain" aspect (a list has a "mountain" aspect if the items increase to a certain point and then decreases.

Eg. (10 18 29 17 11 10). The list must have at least 3 atoms to fullfil this criteria.

- c) Remove all occurrences of a maximum numerical element from a nonlinear list.
- d) Write a function which returns the product of numerical even atoms from a list, to any level.

12.

- a) Write a function to return the dot product of two vectors. https://en.wikipedia.org/wiki/Dot\_product
- b) Write a function to return the maximum value of all the numerical atoms of a list, at any level.
- c) All permutations to be replaced by: Write a function to compute the result of an arithmetic expression memorised

in preorder on a stack. Examples:

```
(+13) ==> 4 (1+3)
(+*243) ==> 11 [((2*4)+3)
(+*24-5*22) ==> 9 ((2*4)+(5-(2*2))
```

d) Write a function to return T if a list has an even number of elements on the first level, and NIL on the contrary case, without counting the elements of the list.

13.

- a) A linear list is given. Eliminate from the list all elements from N to N steps, N-given.
- b) Write a function to test if a linear list of integer numbers has a "valley" aspect (a list has a valley aspect if the items decrease to a certain point and then increase. Eg. 10 8 6 17 19 20). A list must have at least 3 elements to fullfill this condition.
- c) Build a function that returns the minimum numeric atom from a list, at any level.
- d) Write a function that deletes from a linear list of all occurrences of the maximum element.

14.

- a) Write a function to return the union of two sets.
- b) Write a function to return the product of all numerical atoms in a list, at any level.
- c) Write a function to sort a linear list with keeping the double values.
- d) Build a list which contains positions of a minimum numeric element from a given linear list.

15.

- a) Write a function to insert an element E on the n-th position of a linear list.
- b) Write a function to return the sum of all numerical atoms of a list, at any level.
- c) Write a function to return the set of all sublists of a given linear list. Ex. For list  $((1\ 2\ 3)\ ((4\ 5)\ 6)) => ((1\ 2\ 3)\ ((4\ 5)\ 6))$
- d) Write a function to test the equality of two sets, without using the difference of two sets.