

Last name	
First name	
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Grade	/ 5
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Algorithmics
Midterm Exam 1 - Part 1
 Undergraduate 1st year S1
 EPITA
 9 Nov. 2020 - 8 : 30

- ☐ This is the part 1 of the subject - You have to give back the two parts!
- ☐ You must answer on **this subject**.
 - Answer within the provided space. **Answers outside will not be marked.**
 - Penciled answers will not be marked.
- ☐ The presentation is marked.

Exercise 1 (Abstract Types: Recursive lists – 5 points)

Consider the algebraic abstract type *recursive list* seen in class and recalled below.

TYPES

list, box

USES

element

OPERATIONS

$emptylist : \rightarrow list$
 $head : list \rightarrow box$
 $contents : box \rightarrow element$
 $first : list \rightarrow element$
 $cons : element \times list \rightarrow list$
 $tail : list \rightarrow list$
 $next : box \rightarrow box$

PRECONDITIONS

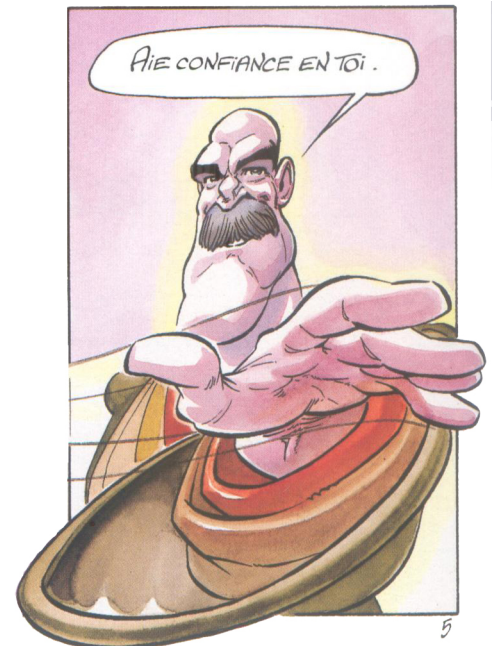
$head(\lambda)$ **is-defined-iaoi** $\lambda \neq emptylist$
 $tail(\lambda)$ **is-defined-iaoi** $\lambda \neq emptylist$
 $first(\lambda)$ **is-defined-iaoi** $\lambda \neq emptylist$

AXIOMS

$first(cons(e, \lambda)) = e$
 $tail(cons(e, \lambda)) = \lambda$
 $contents(head(\lambda)) = first(\lambda)$
 $next(head(\lambda)) = head(tail(\lambda))$

WITH

list λ
 element e



We propose to extend the properties of this type allowing it:

- to search for an element in a list
- to concatenate two lists.

The search for an item in a list will return the corresponding box to the element only if it exists. Then we have two operations for the search, the one which determines the existence of the element and the other one which determines the box for the latter, if it exists. As for the concatenation, it requires no auxiliary operation. We then consider the three following operations:

OPERATIONS $ispresent : \text{element} \times \text{list} \rightarrow \text{boolean}$ $search : \text{element} \times \text{list} \rightarrow \text{box.}$ $concatenate : \text{liste} \times \text{list} \rightarrow \text{list}$

1. Give the axioms allowing one to deduce a value for the search for an element e in a *recursive list* λ . Specify the PRECONDITIONS if there are any.

2. Give the axioms allowing one to deduce a value for the concatenation of two *recursive lists* λ and λ_2 . Specify the PRECONDITIONS if there are any.
