| Last name | |
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| First name | |
| Group | |

Algorithmics Midterm Exam 1 - Part 1

Undergraduate 1^{st} year S1

Epita

9 Nov. 2020 - 8:30

 \Box This is the part 1 of the subject - You have to give back the two parts!

- \Box You must answer on this subject.
 - Answer within the provided space. Answers outside will not be marked.
 - Penciled answers will not be marked.
- \Box 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

| empty list | : | \rightarrow list |
|------------|---|---|
| head | : | $\mathrm{list}\to\mathrm{box}$ |
| contents | : | $\mathrm{box} \to \mathrm{element}$ |
| first | : | $\mathrm{list} \to \mathrm{element}$ |
| cons | : | $\mathrm{element}\times\mathrm{list}\rightarrow\mathrm{list}$ |
| tail | : | $\mathrm{list} \to \mathrm{list}$ |
| next | : | $box \to box$ |

PRECONDITIONS

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

AXIOMS

$$\begin{split} first(cons(e,\lambda)) &= e\\ tail(cons(e,\lambda)) &= \lambda\\ contents(head(\lambda)) &= first(\lambda)\\ next(head(\lambda)) &= head(tail(\lambda)) \end{split}$$

WITH

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

 $\begin{array}{l} \textit{ispresent}: \text{ element} \times \text{ list} \rightarrow \text{boolean} \\ \textit{search}: \text{ element} \times \text{ list} \rightarrow \text{box}. \end{array}$

concatenate : liste × list \rightarrow 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.