

Programming Paradigms

Seminar 3

Please present the Seminar 2. Please start to work in class on Seminar 3 and complete it at home (until the deadline).

DEADLINE for Seminar 3 is in the following weeks: 8-12 November 2021 and 15-19 November 2021. If you present it in week: 22-26 November 2021 you can get maximum grade 7 on this assignment. After 27 November 2021 you will get the grade 0 for this assignment.

Exercise 1. (Finding an Element in a List) Give a definition of $\{\text{Member } Xs \ Y\}$ that tests whether Y is an element of Xs . For this assignment you have to use the truth values `true` and `false`. The equality test (that is `==`) returns truth values and a function returning truth values can be used as condition in an if-expression. For example, the call $\{\text{Member } [a \ b \ c] \ b\}$ should return `true`, whereas $\{\text{Member } [a \ b \ c] \ d\}$ should return `false`.

Exercise 2. (Taking and Dropping Elements) Write two functions $\{\text{Take } Xs \ N\}$ and $\{\text{Drop } Xs \ N\}$. The call $\{\text{Take } Xs \ N\}$ returns the first N elements of Xs whereas the call $\{\text{Drop } Xs \ N\}$ returns Xs without its first N elements. For example, $\{\text{Take } [1 \ 4 \ 3 \ 6 \ 2] \ 3\}$ returns $[1 \ 4 \ 3]$ and $\{\text{Drop } [1 \ 4 \ 3 \ 6 \ 2] \ 3\}$ returns $[6 \ 2]$.

Exercise 3. (Zip and UnZip) The operation $a \# b$ constructs a tuple with label `'#'` and fields a and b which is also known as a pair. We can use it to implement lists-of-pairs, e.g. $[a\#1 \ b\#2 \ c\#3]$. A different view of this data structure is known as a pair-of-lists, e.g. $[a \ b \ c]\#[1 \ 2 \ 3]$. Two important functions that convert list-of-pairs to pair-of-lists and vice versa are `Zip` and `UnZip`.

- Implement a function `Zip` that takes a pair $Xs\#Ys$ of two lists Xs and Ys (of the same length) and returns a pairlist, where the first field of each pair is taken from Xs and the second from Ys . For example, $\{\text{Zip } [a \ b \ c]\#[1 \ 2 \ 3]\}$ returns the pairlist $[a\#1 \ b\#2 \ c\#3]$.
- The function `UnZip` does the inverse, for example $\{\text{UnZip } [a\#1 \ b\#2 \ c\#3]\}$ returns $[a \ b \ c]\#[1 \ 2 \ 3]$. Give a specification and implementation of `UnZip`.

Exercise 4. (Finding the Position of an Element in a List) Write a function $\{\text{Position } Xs \ Y\}$ that returns the first position of Y in the list Xs . The positions in a list start with 1. For example, $\{\text{Position } [a \ b \ c] \ c\}$ returns 3 and $\{\text{Position } [a \ b \ c \ b] \ b\}$ returns 2.

Try two versions:

- one that assumes that Y is an element of Xs and
- one that returns 0, if Y does not occur in Xs .

Exercise 5. (Arithmetic Expressions Evaluation) Suppose that you are given an arithmetic expression described by a tree constructed from tuples as follows:

- An integer is described by a tuple $\text{int}(N)$, where N is an integer.
- An addition is described by a tuple $\text{add}(X \ Y)$, where both X and Y are arithmetic expressions.

3. A multiplication is described by a tuple `mul(X Y)`, where both `X` and `Y` are arithmetic expressions.

Implement a function `Eval` that takes an arithmetic expression and returns its value. For example, `add(int(1) mul(int(3) int(4)))` is an arithmetic expression and its evaluation returns 13.