Prof. P. Thiemann, S. Wehr Summer Term 2009

Concepts of Programming Languages

`http://proglang.informatik.uni-freiburg.de/teaching/konzepte/2009ss/`

Exercise Sheet 2

2009-04-30

Hint: Use SchemeUnit as on exercise sheet 1 for writing test cases.

Exercise 1 (4 points)
Implement the environment interface presented in the lecture using the *association-list* representation. An association-list is a list of pairs `(cons k v)` where `k` is some kind of key and `v` is the value associated with the key.

For convenience, we repeat the type signatures of the operations of the environment interface:

empty-env : $() \to Env$
extend-env : $Var \times SchemeVal \times Env \to Env$
apply-env : $Env \times Var \to SchemeVal$

Exercise 2 (4 points)
We now extend the environment interface with two operations:

empty-env? : $Env \to Bool$
has-binding? : $Env \times Var \to Bool$

The operation `empty-env?` simply checks whether the given environment is empty. The operation `has-binding?` checks whether the given environment contains the variable given.

Extend your environment implementation from the preceding exercise with these two operations.

Exercise 3 (4 points)
Here is a binary tree representation using the `define-datatype` construct presented in the lecture:

```
(define-datatype bintree bintree?
  (leaf-node
   (num integer?))
  (interior-node
   (left bintree?)
   (right bintree?)))
```

Write a procedure `bintree->list` that takes a binary tree and returns a list of the values in the leaf nodes. The ordering of the list should reflect the ordering in the binary tree; for example,

```
(bintree->list (interior-node (leaf-node 0)
                              (interior-node (leaf-node 1) (leaf-node 2))))
```

should return the list `'(0 1 2)`.

Exercise 4 (4 points)
Solve exercise 2.31 on page 55 of the "Essentials of Programming Languages" book.

Submission
Via email to `wehr@informatik.uni-freiburg.de`. Please submit in pairs of two. Your code must not raise errors when pressing DrScheme's "Run" bottom. The strict submission deadline is **2009-05-07, 2 pm.**