Programming Languages

Homework 1 (updated 2009-3-18)

Due 2:20 pm, March 11, 2009

1. Read Section *6.3.2. Pairs and lists* of *Revised^5 Report on the Algorithmic Language Scheme.* Implement `append` and `reverse` in such a way that:

   - Evaluation of the expression (`append` u v) will only take time $O(m)$ where m is the length of the list u.
   - Likewise, the evaluation of (`reverse` u) only takes time $O(m)$, where m is the length of the list u.

   Hint: You can implement `reverse` using `append` in a naive way, but it will take time $O(m^2)$. Why?

2. Implement a function `mirror` in Scheme such that it returns the mirror image of its argument. That is,

$$\begin{array}{rcl} \texttt{(mirror '(a))} & \Longrightarrow & \texttt{(a)} \\ \texttt{(mirror '(a b c))} & \Longrightarrow & \texttt{(c b a)} \\ \texttt{(mirror '(a (b c) (((d) e f) g) ())} & \Longrightarrow & \texttt{(() (g (f e (d))) (c b) a))} \end{array}$$

   What is the time complexity of your implementation? Hint: Implement `mirror` using `reverse`.

3. Implement a function `upto` in Scheme such that (`upto` n) returns all the natural numbers up to n for all $n \geq 0$. That is,

$$\begin{array}{rcl} \texttt{(upto -1)} & \Longrightarrow & \texttt{()} \\ \texttt{(upto 0)} & \Longrightarrow & \texttt{(0)} \\ \texttt{(upto 5)} & \Longrightarrow & \texttt{(0 1 2 3 4 5)} \end{array}$$

   What does the following expression do?

```
(mirror (map upto (upto 5))
```

4. Exercise 3.1 (p. 40).

5. Exercise 3.2 (p. 40).

6. Exercise 3.4 (p. 40). Note: The text book uses Lisp syntax which may differ from Scheme syntax. However, this shall not affect your judgment.

1 PLEASE NOTE, NO EXCEPTION

- Homework is due **before the class begins** on March 11, 2008. Late homework will not be accepted.
- For programming assignments, you must hand in **printout of the code, as well as the testing data and result**. Programs must be accompanied by their documentations. For other assignments, you must hand in **typeset hardcopy**.
- You are expected to do the homework by yourself. Discussion among peers is encouraged but **copying from others is a shame**.