

# Types and Programming Languages, Exercise 3

Philip Wadler

Issued: Monday 4 February 2008. Due: Monday 11 February 2008.

TAPL refers to *Types and Programming Languages* by Benjamin Pierce.

1. Update your answer to Exercise 2.1 [a–c] ('Using your implementation . . . write and test the following') to simply-typed lambda calculus. Since you have not yet implemented simply-typed lambda calculus, use a typed functional language such as O'Caml or Haskell to test and debug your solutions.

Hint: The type of the Church numerals may vary depending on how they are used. For example, depending on the definitions you use, addition may have type  $C \rightarrow C \rightarrow C$ , while multiplication may have type  $C_2 \rightarrow C_2 \rightarrow C_2$ , where  $C = (N \rightarrow N) \rightarrow N \rightarrow N$ , and  $C_2 = (C \rightarrow C) \rightarrow C \rightarrow C$ , and  $N$  is the type of the naturals.