Programming Project

Due: November 12, 2024

Contents

Implement the simply typed λ calculus in Haskell. The following are the required steps.

1. Implement the data type for λ terms. You may use `['a'..]` to generate the list of all possible Haskell characters, which you can use as variables. [15]
2. Express the following λ terms in your syntax. [5]
   (a) $(\lambda c.cc)$
   (b) $(\lambda c.cd)$
   (c) $(\lambda x.xy)(\lambda y.xy)$
   (d) $(\lambda y.x)y$
   (e) $(\lambda y.x)a$
3. By deriving `Show`, provide a pretty printing routine for λ terms. [10]
4. Implement the algorithm to perform substitution. Ensure that you handle the variable capture case. [15]
5. Implement β reduction using the substitution mechanism. For this question, you can assume that the terms will be given with distinct variables so that α renaming is not required. [15]
6. Implement α reduction. [15]
7. Ensure that β reduction works with α renaming. [10]