

CIS 500 Software Foundations

Homework Assignment 4, version 1.1

Untyped Lambda Calculus; Basic Properties of Typing

Due: Monday, October 11, 2004, by noon

Submission instructions: Same as last time.

1 Exercise Recall the following definitions of observational and behavioral equivalence from lecture notes:

- Two terms s and t are observationally equivalent iff either both are normalizable (i.e., they reach a normal form after a finite number of evaluation steps) or both are divergent.
- Terms s and t are behaviorally equivalent iff, for every finite sequence of values v_1, v_2, \dots, v_n , the applications

$$s \ v_1 \ v_2 \ \dots \ v_n$$

and

$$t \ v_1 \ v_2 \ \dots \ v_n$$

are observationally equivalent.

Which of the following pairs of term are ~~observationally~~ behaviorally equivalent? If the terms are not equivalent, write down a sequence of values that would distinguish them.

1. $\lambda x. \lambda y. y$ and $\lambda x. \lambda y. (\lambda z. z)y$
2. $\lambda x. \lambda z. zx$ and $\lambda x. x$
3. $\lambda x. \lambda y. x$ and $\lambda x. \lambda y. y$
4. $\lambda f. (\lambda x. f(xx))(\lambda x. f(xx))$ and $\lambda f. (\lambda x. f(\lambda y. xxy))(\lambda x. f(\lambda y. xxy))$

2 Exercise Exercise 8.3.4 in TAPL

3 Exercise Exercise 8.3.6 in TAPL

4 Exercise 1. Exercise 8.3.7 in TAPL

2. Prove type safety for the big-step semantics.

5 Debriefing

1. How many hours did you spend on this assignment?
2. Would you rate it as easy, moderate, or difficult?
3. Did everyone in your study group participate?
4. How deeply do you feel you understand the material it covers (0%–100%)?

If you have any other comments, we would like to hear them; please send them cis500@cis.upenn.edu.