Homework 5. Programming Language Design & Analysis (CSE 497)

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Due date: Sept. 29th in class.

1. (2 points) For each one of the following typing statements in Simply Typed Lambda Calculus, either show a typing derivation of the statement, or argue that there is no typing derivation for it.

(a) \( f : \text{Bool} \to \text{Bool} \vdash (\lambda x : \text{Bool}. f \ x) : \text{Bool} \to \text{Bool} \)

(b) \( \vdash (\lambda x : \text{Bool} \to \text{Bool}. x \ x) : (\text{Bool} \to \text{Bool}) \to \text{Bool} \)

(c) \( f : (\text{Bool} \to \text{Bool}) \to \text{Bool} \vdash (\lambda x : \text{Bool}. f \ x) : \text{Bool} \to \text{Bool} \)

(d) \( f : \text{Bool} \to \text{Bool} \to \text{Bool} \vdash (\lambda x : \text{Bool}. f \ x) : \text{Bool} \to \text{Bool} \to \text{Bool} \)

2. (2 points) Prove theorem 11.3.1 in the textbook

3. (3 points) In this problem, we consider Simply Typed Lambda Calculus together with pairs. That is, it is the calculus in Fig. 11-5 of the textbook. Prove progress and preservation theorems for this calculus. You need to show only the new cases with respect to the proofs for Simply Typed Lambda Calculus. (You may need to show some auxiliary lemmas first).