CIS 500 — Software Foundations

Homework Assignment 8

Extensions of simple types

Due: Monday, November 6, 2006, by noon

Reminder: You should work *all* one-star exercises in TAPL as you are reading.

1 Exercise Answer each of the following questions either Yes or No. Additionally, for those whose answers are No, give a term `t` that demonstrates how type safety (either progress or preservation) breaks if we extend the subtype relation with this pair of types.

1. Is `{x:{}}` a subtype of `{x:Top}`?
2. Is `{}` a subtype of `{x:Top}`?
3. Is `{x:Top}` a subtype of `{x:Top→Top}`?
4. (If the system is extended to include `Ref` types as described in TAPL Section 15.5) is `Ref Top` a subtype of `Ref (Ref Top)`?
5. Is `{x: Top → (Ref Top)}` a subtype of `{x: (Ref Top) → Top}`?

2 Exercise Suppose we extend the calculus with the product type constructor $\mathtt{T}_1 \times \mathtt{T}_2$ described in TAPL Section 11.6. It is natural to add a subtyping rule

$$\frac{\mathtt{S}_1 <: \mathtt{T}_1 \qquad \mathtt{S}_2 <: \mathtt{T}_2}{\mathtt{S}_1 \times \mathtt{S}_2 <: \mathtt{T}_1 \times \mathtt{T}_2} \qquad \text{(S-ProdDepth)}$$

corresponding to S-RcdDepth for records. Would it be a good idea to add a width subtyping rule for products

$$\mathtt{S}_1 \times \mathtt{S}_2 <: \mathtt{S}_2 \times \mathtt{S}_1 \qquad \text{(S-ProdPerm)}$$

as well?

3 Exercise TAPL exercise 15.3.2.

4 Exercise TAPL exercise 15.3.6.

5 Exercise [**Required for PhD groups; optional for others.**] TAPL exercise 15.5.3.

6 Debriefing

1. Approximately how many hours (per person, on average) did you spend on this assignment?
2. Would you rate it as easy, moderate, or difficult?
3. How deeply do you feel you understand the material it covers (0%–100%)?
4. Any other comments?