

Homework # 2

due March 4, 13:00

The natural language explanations (§2) and research surveys (§4) should be turned in on paper at the *beginning* of lecture on Tuesday, March 4. The SASyLF proof (§3) should be submitted by email to scmalte@inf.ethz.ch *before* 1pm on Tuesday, March 4.

1 Reading

Please read through the end of Chapter 3 in your textbook.

2 Problems

Please do problem 3.5.13 (Funny rules). Explain your answers, but no proof (natural language or SASyLF) is required. Also answer the following question:

Which of the theorems 3.5.4, 3.5.7, 3.5.8, 3.5.11, 3.5.12 remain true after adding the rules for arithmetic expressions (Figure 3-2)? Explain!

(Ex. 3.5.14 and its solution should help, as should definition 3.5.15.)

3 Proofs

Do problem 3.5.17 and write the proof in SASyLF (**only** for the “if” sublanguage!). More precisely, prove that if $t \xrightarrow{*} t'$ and t' is a value then $t \Downarrow t'$, and conversely if $t \Downarrow t'$, then $t \xrightarrow{*} t'$. (I am not requiring you to prove that t' is a value.) You may use the solution in the back of the book (p. 498 in my edition) to help you write the proof.

When I solved this problem, I noticed I needed the following lemmas:

1. If $t \rightarrow t'$ and $t' \Downarrow v$, then $t \Downarrow v$.
2. If $t \xrightarrow{*} t'$ and $t' \Downarrow v$, then $t \Downarrow v$.
3. If $t_1 \xrightarrow{*} t'_1$ then `if t_1 then t_2 else t_3` $\xrightarrow{*}$ `if t'_1 then t_2 else t_3` .

Adding `succ`, `pred`, `iszero` doubles the size of the proof—be thankful you don’t need to handle them! We will install a “skeleton” file on the web page to get you started.

4 Application

Find three papers from journals or academic conferences in programming languages (TOPLAS, POPL, OOPSLA, ECOOP) from the last 5 years which define an operational semantics (evaluation) for a programming language. For each one, determine whether the evaluation relation is

`small-step` as with the book (with errors getting the program “stuck”);

`small-step with errors` as in Exercise 3.5.16

`big-step` as in Exercise 3.5.17

Cite each paper and explain your categorization.