Homework # 7
due October 21

1 Reading

Please read Chapter 11 in your textbook.

2 Problems

Please do the following problems

(a) Enums can be seen as a variation on “variants”. Write new evaluation and typing rules (on paper, not SASyLF) for a type T written like \texttt{[red,green,blue]} with new syntax:

\[
  t ::= \ldots \\
  \mid n_i \text{ as } [n_1, \ldots, n_m] \quad \text{(a new kind of value)}, \\
  \mid \text{case } t \text{ of } n_1 \rightarrow t_1 \mid \ldots \mid n_m \rightarrow t_m.
\]

(b) Explain informally why these type rules should be sound. (You might wish to write the SASyLF proofs for sum types first; otherwise your explanations may not be convincing!)

3 EXTRA: Discussion

The type system for records that Pierce introduces in section 11.8 would be unsound except for a condition he states informally in the text. In other words, by itself the formal presentation of the type system is unsound. In lecture, we will attempt to prove progress and preservation of the system, but we will be unable to complete the proof.

Use the failed attempt of a proof (as well as the textual proviso) to help you find a counter-example to either progress or preservation. Make sure your counter example is an actual example (no meta-variables \texttt{t} or \texttt{T} please) that type checks in the system—give the complete type tree (again, no meta-variables!). Moving from a failed proof to a counter-example is not easy!

You may assume that the syntax and rules permit booleans as well as unit (this makes it easier to state a counter-example). You may either use the formal system from the SASyLF attempt, or the book’s formal system. This section can replace the counter-example finding part of either Homework #5 or Homework #6.

4 Proofs

Modify the proofs of type soundness of the simply-typed lambda calculus with “unit” types to add sums (See Figure 11-9). A skeleton file is available which gives the syntax. Your evaluation and types rules should follow the book as closely as possible.
5 Extra

Optionally, add type, evaluation and proof rules for products too. The syntax is defined already. Only do this if you complete the main SASyLF proofs. Then if you do better on this part than on an earlier SASyLF section, the newer score replaces the old one.

6 Graduate Students

Read Chapter 12.

Could the proofs in the this chapter be expressed in (i) Twelf, (ii) Coq or (iii) Isabelle/HOL? What about SASyLF? Explain! Give references/URLs to support your argument.

Which of the extensions in Chapter 11 (1,2,3,4,5,6,7,8,9,10,11,12) preserve normalization? For each, explain in your own words and/or give references/URLs to support your answer.