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Softwaretechnik

http://proglang.informatik.uni-freiburg.de/teaching/swt/2013/

Exercise Sheet 12

Exercise 1: Javascript

Given the following Javascript code snippet:

```
1 s = "some␣random␣string";
2 s.x = 42;
3 s.x;
```

1. Use the JavaScript shell from `http://www.squarefree.com/shell/shell.html` to execute the above Javascript code. Which results do you get?
2. Change the first or second line of the example, such that executing the third line (`s.x;`) prints `42`.
3. Explain the behavior you observe. What would you suggest to prevent such mysterious bugs from happening?

Exercise 2: Types and Evaluation for JAUS

1. Which of the following JAUS expressions are type correct? Give a type derivation for all type correct expressions. Assume that variable x is of type *int* and variable y is of type *boolean*.
   - $1 + \text{true}$
   - $23 + (47 - 11)$
   - !(!false)
   - $y + x$
   - $!y$
2. Evaluate the following JAUS expressions as far as possible. Which of the resulting expressions are values?
   - $23 + (47 - 11)$
   - $(1 + 1) + \text{true}$

Exercise 3: Conditional Expression

Consider the language JAUS of Java expressions.

$$\begin{array}{lllll} \mathit{Variables} & \ni & x & ::= & \ldots \\ \mathit{Numbers} & \ni & n & ::= & 0 \mid 1 \mid \ldots \\ \mathit{Truth\ Values} & \ni & b & ::= & \texttt{true} \mid \texttt{false} \\ \mathit{Expressions} & \ni & e & ::= & x \mid n \mid b \mid e + e \mid !e \end{array}$$

Extend the language with a conditional expression as known from Java, C or C++.

$$\begin{array}{lllll} \mathit{Types} & \ni & t & ::= & \texttt{int} \mid \texttt{boolean} \\ \mathit{Expressions} & \ni & e & ::= & \cdots \mid (e\ ?\ e\ :\ e) \end{array}$$

$$\mathit{Judgment}\ \vdash e : \texttt{t}$$

1. Define a typing rule (COND) for the conditional.

$$\text{(COND)}\quad \frac{\vdash e_0 : \qquad \vdash e_1 : \qquad \vdash e_2 :}{\vdash (e_0\ ?\ e_1\ :\ e_2) :}$$

2. Define evaluation rules for the conditional.

$$\mathit{Values} \quad \ni \quad v \quad ::= \quad n \mid b$$

$$\mathit{Evaluation}\ e \to e'$$

$$\text{(E-COND1)}\quad \frac{}{(e_0\ ?\ e_1\ :\ e_2) \to}$$

$$\text{(E-COND2)}\quad \frac{}{(v_0\ ?\ e_1\ :\ e_2) \to}$$

$$\text{(E-COND3)}\quad \frac{}{(v_0\ ?\ e_1\ :\ e_2) \to}$$

3. Extend the preservation proof from the lecture by treating one case for the conditional.

Exercise 4: Subtyping

Suppose we extend JAUS to distinguish the integer types `byte`, `short`, and `int`, where `byte` <: `short` and `short` <: `int` (subtypes as in Java) and the respective typing rules for constants:

$$\text{(BYTE)}\quad \frac{-128 \le n \le 127}{\vdash n : \texttt{byte}}$$

$$\text{(SHORT)}\quad \frac{-32768 \le n \le 32767}{\vdash n : \texttt{short}}$$

$$\frac{-2147483648 \leq n \leq 2147483647}{\vdash n : \texttt{int}}\ (\text{INT})$$

Argue why each of the following typing rules is sound. Provide a counterexample if a rule is unsound.

1. $$\frac{\vdash e_1 : \texttt{int} \qquad \vdash e_2 : \texttt{int}}{\vdash e_1 \cdot e_2 : \texttt{int}}\ (\text{MUL})$$

2. $$\frac{\vdash e_1 : \texttt{byte} \qquad \vdash e_2 : \texttt{byte}}{\vdash e_1 \cdot e_2 : \texttt{short}}\ (\text{MUL2})$$

3. $$\frac{\vdash e_1 : \texttt{byte} \qquad \vdash e_2 : \texttt{byte}}{\vdash e_1 / e_2 : \texttt{byte}}\ (\text{DIV})$$