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LCP

Software Engineering II, Part 1a

Full question

A Web browser is a complicated program. It must deal with many types of data (images, sound, etc.), support various network services and handle the many constructs of HTML (the language in which Web pages are written). Your manager asks you to lead a small group of programmers in implementing a Web browser. Describe top-down refinement; is it appropriate for your task? [6 marks]

Your manager further states that it is essential that your browser should almost never crash. What how would you go about meeting this requirement? [6 marks]

Consider the following two ML functions:

```
fun sumfiv [] = 0
  | sumfiv (x::xs) = 5*x + sumfiv xs;

fun summing z [] = z
  | summing z (x::xs) = summing (z + x) xs;
```

Use structural induction to prove that `sumfiv xs` can be replaced by `5 * summing 0 xs`. [8 marks]

Model Answer

Refinement is described in the notes, Lecture 1. It consists of first coding a top-level main routine, leaving lower-level modules as 'stubs' that do nothing. Incrementally, these stubs are implemented, leaving in turn the things they call as 'stubs.' The Web browser is particularly suitable, since it can offer a limited service even while major parts (e.g. images) remain unimplemented. It tends to give a clean, modular design, though only if the division into modules is done carefully.

Fault avoidence is covered in Lecture 3. The first strategic decision is to try to use a high-level language instead of C, e.g. Java or Ada. Further suggestions include making the most of libraries instead of writing new code; turning on maximum warnings in your compiler; loading the code with assertion checking; inserting active checks that key data structures are consistent. (An answer such as 'prove the Web browser to be correct' won't do very well.)

The induction formula is $\forall z\, 5 \times \mathit{summing}\, z\, xs = \mathit{sumfiv}(xs) + 5 \times z$. In the base case, both sides collapse to $5 \times z$. For the induction step we get

$$\begin{aligned} 5 \times \mathit{summing}\, z\, (x :: xs) &= 5 \times \mathit{summing}\, (z + x)\, xs \\ &= \mathit{sumfiv}(xs) + 5 \times (z + x) \\ &= \mathit{sumfiv}(x :: xs) + 5 \times z \end{aligned}$$