Exam 2 – Fall 2010 – Solution Notes


2. Create (Integer, Integer) → Array
   Assign (Array, Integer, Elem) → Array
   First (Array) → Integer
   Last (Array) → Integer
   Eval (Array, Integer) → Elem

3. pre-condition: \{N ≥ 1\}

4. \(f = (X > 0 \rightarrow X, Y := XY, 0 | \text{true} \rightarrow I)\)

5. false, true, false, true, true

6. We need to show \(P \Rightarrow wp(S, Q)\).
   
   \[
   wp(S, Q) = wp(\text{if } X < 0 \text{ then } Y := X - (2*X) \text{ end_if}, Y = |X|) \\
   = (X < 0 \land wp(Y := X - (2*X), Y = |X|)) \lor (X ≥ 0 \land Y = |X|) \\
   = (X < 0 \land -X = |X|) \lor (X ≥ 0 \land Y = X) \\
   = (X < 0) \lor (X ≥ 0 \land Y = X) \\
   = X < 0 \lor Y = X
   \]

   Does \(Y = X \Rightarrow [X < 0 \lor Y = X]?\)
   
   \(Y = X \Rightarrow ([X < 0 \lor Y = X] = [X < 0 \lor \text{true}] = \text{true})\)

   Therefore, \(P \Rightarrow wp(S, Q)\), so the assertion holds.

7. a. \(P \Rightarrow I, \{I \land b\} S \{I\}, (I \land \neg b) \Rightarrow Q\)
   b. \(P \Rightarrow I:\)
      
      Does \((x > 0 \land k = 1 \land y = x) \Rightarrow y = x(k-1)!?\)
      
      Yes, \((k = 1 \land y = x) \Rightarrow (y = x(k-1))\) since 0! = 1

      \[
      \{I \land b\} S \{I\}:
      \{ y = x(k-1)! \land k <= x \} \\
      y := y*k \\
      \{ y = xk! \land k <= x \} \\
      k := k+1 \\
      \{ y = x(k-1)! \land (k-1) <= x \} \Rightarrow \{ y = x(k-1)! \} = I
      \]

      \((I \land \neg b) \Rightarrow Q:\)
      
      Does \((y = x(k-1)! \land k = x) \Rightarrow y = x!?)\)
      
      Yes, since \(x(x-1)! = x!\).
8. Let $G$ be $Y := X - (2*X).$ Then, by observation, $g = (X,Y := X,-X).$ To prove $f = [P],$ it is sufficient to show: $f = [if \ X<0 \ then \ g].$ There are TWO correctness conditions:
(1) When $p$ is true, does $f$ equal $g$?
   $\begin{align*}
   (X<0) \Rightarrow (f &= (X,Y := X,|X|)) \\
   (X<0) \Rightarrow (g = (X,Y := X,-X) \\
   &= (X,Y := X,|X|))
   \end{align*}$
   since $-X = |X|$ when $X<0.$
   Yes.
   
   (2) When $p$ is false, does $f$ equal $I$?
   $\begin{align*}
   (X\geq 0) \Rightarrow (f &= (X,Y := X,Y) \\
   &= I)
   \end{align*}$
   Yes.
   Therefore, $f = [P].$

9. a. **transparency** issue: Should the distributed system in question appear to the user as a single (i.e., not a distributed) system, or would it be better for users to understand that the system is, in fact, distributed so they can better cope with problems that may arise?
   b. **openness** issue: Should the system in question be designed using standard, generally accepted protocols that would support the integration of components from many suppliers that can interoperate with other system components, or should more specialized (possibly more efficient, more secure, etc.) protocols be used that would restrict the designer’s freedom in this regard?

10. D, B, H, G, E, D, C, E, F, B

11. A, I, E, O, G, D, B, J, M, L

12. You can’t always tell from the source code alone where an aspect will be woven and executed. Thus, “flattening” an aspect oriented program (to make it readable from right to left and top to bottom) is problematic, as is deriving a conventional control flow graph (used in white-box testing).

13. f

14. [Diagram]

15. An **avoidance strategy** aims to reduce the **probability** that the risk will arise. A **minimization strategy** aims to reduce the **impact** of the risk (i.e., the adverse circumstance that can occur.)

16. **Process measurement**, in which attributes of the current process are measured. This provides a baseline for assessing improvements. **Process analysis**, in which bottlenecks, weaknesses, and changes aimed at improving measures are identified. **Process change**, in which changes (driven by measurable goals) are introduced.
17. The problem is that of *process recidivism* – changes being introduced and then subsequently discarded. Sommerville notes that this is particularly likely if the changes have not been universally adopted and the full benefits of the change have not yet been realized (e.g., when proposed or espoused by a single “evangelist”). The strategy recommended is “institutionalization” of the process change, whereby the change is not dependent on individual champions but instead becomes “standard practice” with company-wide support and training.

18. true, true, false, true, true