Exam 2 – Fall 2011 – Solution Notes


2. The other example was “SECTOR,” which specified an object corresponding to a controlled sector of airspace used in an air traffic control system.

3. pre-condition: \( \{X>0 \land Y>0\} \)
   post-condition: \( \{Z=XY \land UNCH(X,Y)\} \)  (Note: see Pre- and Post-Condition Specification Exercises, problem 9)

4. \( f = (X \neq 0 \rightarrow X, Y := X-2X, X+Y \mid true \rightarrow I) = (X, Y := -X, X+Y) \)

5. How can a system be constructed so as to deliver a high quality service (QoS) as demands on the system increase? Systems can be designed to “scale-up” by replacing resources with more powerful ones, and/or “scale-out” by adding additional resources.


7. a. Giving each user the impression of being the sole system user, and allowing the efficient sharing of the system’s resources.
   
b. The system must be designed so that there is an absolute separation between the system functionality and the system state. (Thus, all operations should be “stateless”.)

   
   Cross: “Security reqmts” and “Recovery reqmts”

   b. Tangling would occur, for example, when the component that implements “New customer reqmts” also includes code for the two cross-cutting concerns, “Security reqmts” and “Recovery reqmts.”

   c. Scattering would occur, for example, when cross-cutting concern, “Security reqmts” is implemented in all three of the components implementing the core concerns.

9. a. Assess (1) the probability and (2) the seriousness (in terms of consequences) of each risk.
   
b. Develop a strategy to manage each risk using (1) avoidance strategies to reduce risk probability, and/or (2) minimization strategies to reduce risk impact by developing contingency plans.

10. d

11. f

12. a
13. true, true, false, true

14. true, true, false, true, true

15. We need to show $P \implies wp(S,Q)$ where $P$ is $\{y=17\}$ and $wp(S,Q) = \wp(if \ y>0 \ then \ y := y-5, y\geq0)$

$$\begin{align*}
wp(if \ y>0 \ then \ y := y-5, y\geq0) &= (y>0 \land wp(y := y-5, y\geq0)) \lor (y\leq0 \land y\geq0) \\
&= (y>0 \land y-5\geq0) \lor y=0 \\
&= (y>0 \land y\geq5) \lor y=0 \\
&= (y\geq5 \lor y=0)
\end{align*}$$

Does $y=17 \implies (y\geq5 \lor y=0)$?

Yes, since $y=17 \implies [(y\geq5 \lor y=0) = (17\geq5 \lor 17=0) = (true \lor false) = true]$

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

16. a. $P \implies I$, $\{I \land b\} \ S \ {I}$, $\{I \land \neg b\} \ \Rightarrow \ Q$

b. $P \implies I$:

Does $(true \land x=11) \implies x\geq5$? Yes, if $x=11$ then $x$ is obviously $\geq5$.

$\{I \land b\} \ S \ {I}$:

$\{ x\geq5 \land x>5 \} \equiv \{ x>5 \}$

$x := x-1$

${x+1 > 5} = \{ x>4 \} = \{ x\geq5 \} = I$

$(I \land \neg b) \ \Rightarrow \ Q$:

Does $[(x\geq5) \land (x\leq5)] \implies x=5$? Yes, if $x\geq5$ and $x\leq5$ then $x=5$.

17. Let $G$ be $y := x+3; \ x := x-3$. Then, by observation,

$$g = (x,y := x-3,y) \circ (x,y := x,x+3).$$

Thus, $g = (x,y := x-3,x+3)$ by composition of functions.

To prove $f = [P]$, it is therefore sufficient to show: $f = [if \ x>0 \ then \ g]$. To do so, we must show: (1) $p \implies (f = g)$ and (2) $(\neg p) \implies (f = I)$...

(1) When $p$ is true does $f$ equal $g$?

$(x>0) \implies (f = (x,y := x-3,x+3))$

$(x>0) \implies (g = (x,y := x-3,x+3))$

Yes.
17. (cont’d)

(2) When \( p \) is \textit{false} does \( f \) equal \( I \)?

\[(x \leq 0) \Rightarrow (f = (x, y := x, y) = I)\]

\(\text{Yes.}\)

\textit{Therefore,} \( f = [P] \).

18. D, A, F, C, E, B

19. In the context of application frameworks, IoC refers to framework objects controlling the execution of application-specific methods in response to (exceptional) events recognized by the framework objects from the user interface, database, etc. The application-specific methods then respond to the events in an appropriate way. (This represents an “inversion” or reversal of the normal flow of control whereby application-specific methods would be expected to control reusable methods.).

For example, a framework object that handles mouse clicks would invoke a “hook method” that must be configured by the developer to call the appropriate application method to handle this event.


\[\text{Histogram of Raw Scores}\]