SOEN 331 (Section): Introduction to Formal Methods for Software Engineering

Assignment 3 on Temporal Logic

Name(s)

`Email(s)`

Date

Problem 1 (20 pts): Analyzing program behavior

1. (10 pts) Visualize all models of behavior.

2. (3 pts) Specify conditions (model of behavior), if any exist, under which the program can terminate.

3. (7 pts) For the expressions below, indicate (true/false) whether there exists a model where the expression holds. When true, cross reference your particular model:

PROPERTY	**TRUE/FALSE**
$(a \wedge c) \rightarrow \Diamond\Box(g \wedge h)$	
$h \; \mathcal{U} \; m$	
$h \; \mathcal{U} \; (k \wedge g)$	
$(b \wedge c) \rightarrow \Box\Diamond(b \wedge c)$	
$(k \wedge \bigcirc(k \wedge g)) \rightarrow \bigcirc m$	
$h \; \mathcal{S} \; c$	
$((g \wedge h) \wedge \bigcirc d) \rightarrow \bigcirc^2(g \wedge h)$	
$e \; \mathcal{R} \; h$	
The program has the following stability property: $\Diamond\Box(b \wedge \; c \wedge h)$	
The program has the following response property: $\Box\Diamond(b \wedge \; c \wedge h)$	
$(g \wedge h)$ is an invariant property of the program.	
There is a guarantee that $(g \wedge k \wedge h)$	
The program has the following response property: $(b \wedge c \wedge h) \rightarrow \Diamond(b \wedge c \wedge h)$.	
The program has the following precedence property: $(b \wedge c \wedge h) \rightarrow ((g \wedge h) \; \mathcal{U} \; b \wedge c \wedge h))$	

Problem 2 (20 pts) : Visualizing temporal expressions

1. $\Box(\phi \rightarrow \bigcirc^2\psi)$

   If ϕ is true at some moment, then ψ is true at the next next moment.

   $\bullet - \bullet - \bullet - \bullet - \bullet - \bullet - \bullet$

   $\phi - \circ - \psi - \circ - \circ - \circ - \circ$

   or

   $\bullet - \bullet - \bullet - \bullet - \bullet - \bullet - \bullet$

   $\circ - \circ - \circ - \circ - \phi - \circ - \psi$

   etc...

2. $\Box\phi \rightarrow \bigcirc\psi$

   If ϕ is globally true it implies that next ψ is true.

   $\bullet - \bullet - \bullet - \bullet - \bullet - \bullet$

   $\phi - \phi - \phi - \phi - \phi - \phi$

   $\circ - \psi - \circ - \circ - \circ - \circ$

3. $\phi \rightarrow \bigcirc\Diamond\Box\psi$

   ϕ implies ψ becomes globally true at some point in time starting i+1.

   $\bullet - \bullet - \bullet - \bullet - \bullet - \bullet$

   $\phi - \psi - \psi - \psi - \psi - \psi$

   or

   $\bullet - \bullet - \bullet - \bullet - \bullet - \bullet$

   $\phi - \circ - \circ - \psi - \psi - \psi$

   etc...

4. $(\phi \wedge \bigcirc\psi) \rightarrow \bigcirc^2\Diamond\Box\omega$

   ϕ and next ψ implies that ω becomes globally true at some point in time starting i+2.

   $\bullet - \bullet - \bullet - \bullet - \bullet - \bullet$

   $\phi - \psi - \omega - \omega - \omega - \omega$

or

$\bullet - \bullet - \bullet - \bullet - \bullet - \bullet - \bullet$

$\phi - \psi - \circ - \circ - \omega - \omega - \omega$

etc...

5. $\Box((\phi \wedge \bigcirc\psi) \rightarrow \bigcirc^2\Diamond\Box\omega)$

   If ϕ and ψ next is true at some moment, then ω becomes globally true at some point in time at the next next moment.

   $\bullet - \bullet - \bullet - \bullet - \bullet - \bullet$

   $\phi - \psi - \omega - \omega - \omega - \omega$

   or

   $\bullet - \bullet - \bullet - \bullet - \bullet - \bullet - \bullet$

   $\phi - \psi - \circ - \circ - \omega - \omega - \omega$

   or

   $\bullet - \bullet - \bullet - \bullet - \bullet - \bullet$

   $\circ - \circ - \phi - \psi - \omega - \omega$

   etc...

6. $(\phi \wedge \bigcirc\psi) \rightarrow \tau \ \mathcal{R} \ \upsilon$

7. $(\phi \wedge \bigcirc\psi) \rightarrow \bigcirc(\tau \ \mathcal{R} \ \upsilon)$

8. $(\phi \wedge \bigcirc\psi) \rightarrow \bigcirc(x \ \mathcal{U} \ \tau)$

9. $(\phi \wedge \Box\psi) \rightarrow \bigcirc^2\Diamond\omega$

10. $(\phi \wedge \bigcirc^2\psi) \rightarrow \bigcirc\Box\omega$