ECE653 Software Testing, Quality Assurance, and Maintenance Assignment 2

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Question 1

a) The program has 4 syntactic paths.

(1) 1, 2, 3, 4, 8, 9, 10, 11, 15

(2) 1, 2, 5, 6, 7, 8, 9, 10, 11, 15

(3)1, 2, 3, 4, 8, 9, 12, 13, 14, 15

(4) 1, 2, 5, 6, 7, 8, 9, 12, 13, 14, 15

b)

Stmt	PV	PC
1-2	x $\rightarrow$ X_0 y $\rightarrow$ Y_0	true
2-3	x $\rightarrow$ X_0 y $\rightarrow$ Y_0	$X_0+Y_0 <= 20$
3-4	x $\rightarrow$ X_0-1 y $\rightarrow$ Y_0	$X_0+Y_0 <= 20$
4-8	x $\rightarrow$ X_0-1 y $\rightarrow$ Y_0+2	$X_0+Y_0 <= 20$
9-10	x $\rightarrow$ X_0-1 y $\rightarrow$ Y_0+2	$X_0+Y_0 <= 20 \wedge$ $2\times(X_0+Y_0+1)<40$
10-11	x $\rightarrow$ $2\times(X_0-1)$ y $\rightarrow$ Y_0+2	$X_0+Y_0 <= 20 \wedge$ $2\times(X_0+Y_0+1) <40$
11-15	x $\rightarrow$ $2\times(X_0-1)$ y $\rightarrow 2\times(Y_0+2)$	$X_0+Y_0 <= 20 \wedge$ $2\times(X_0+Y_0+1) <40$

c) The path is feasible.ie: $X_0=0,\ Y_0=0$

Question 2

a) $\neg a1 \wedge \neg a2$ $\neg a1 \wedge \neg a3$ $\neg a1 \wedge \neg a4$ $\neg a2 \wedge \neg a3$ $\neg a2 \wedge \neg a4$ $\neg a3 \wedge \neg a4$

b) The formula Path(G; V; vinit ; vend) can be defined as:

$\neg a_u \vee a_v$, $a_{int} \wedge a_{end}$

So the constraint of the right graph can be:

$\neg a_{int} \vee a_1 \vee a_2$, $a_{int} \wedge a_{end}$, $a_1 \vee a_2 \vee \neg a_{end}$, $\neg a_1$, $\neg a_2$

This is unsatisfied as $\neg a_{int} \vee a_1 \vee a_2$ and $\neg a_1$, $\neg a_2$

the constraint of the left graph can be:

$\neg a_{int} \vee a_1 \vee a_2$, $a_{int} \wedge a_{end}$, $\neg a_1 \vee a_{end}$, $\neg a_2 \vee a_{end}$

Possible assignment is: $a_{int} \rightarrow 1, a_{end} \rightarrow 1,\ a_1 \rightarrow 0,\ a_2 \rightarrow 1$

Question 5

a) valid.

Proof by contradiction:

Assume that there is a model M, $M \models (\forall x . \exists y . P(x) \vee Q(y))$ and $M \not\models (\forall x . P(x)) \vee (\exists y. Q(y))$

In this example, let the domain be integers.

P(x) is true if x is an even number. Q(y) is true if y is an odd number

$\forall x . P(x) \vee \exists y. Q(y)$ is true, $P(x) \vee Q(y)$ is all integers, all even numbers are intergers. So both side are true. Same theory in opposite direction.

b) Invalid. Assume there's a model M{a,b,P(a,b),Q(a,b)}

If $M \models$ the right side, the universe is S={a,b}, then $\exists b. (P(a) \vee Q(a))$ is true

But $M \not\models \exists b. P(a)$, $M \not\models \exists b. Q(a)$

c) $\exists x . \exists y. P(x, y) \Rightarrow \exists x . P(x,y) \vee \exists y. P(x,y)$

d) Array(A) ^ ($\forall$i .0 <i < len(A)/2) ^ $A[i] = m$ => m >A[i]) ^ ($\forall$i .len(A)/2< i < len(A))

e) Array(A) ^ $\forall$I, j. 0 $\leqslant$ i < j < len(A) => A[i] $\neq$ A[j]