Department of Computer Science
Purdue University, West Lafayette

Fall 2009: CS 49000-020 Software Testing
Midterm Examination: Open Textbook: Solutions

Wednesday October 7, 2009 8pm-9:30pm, LWSN B151

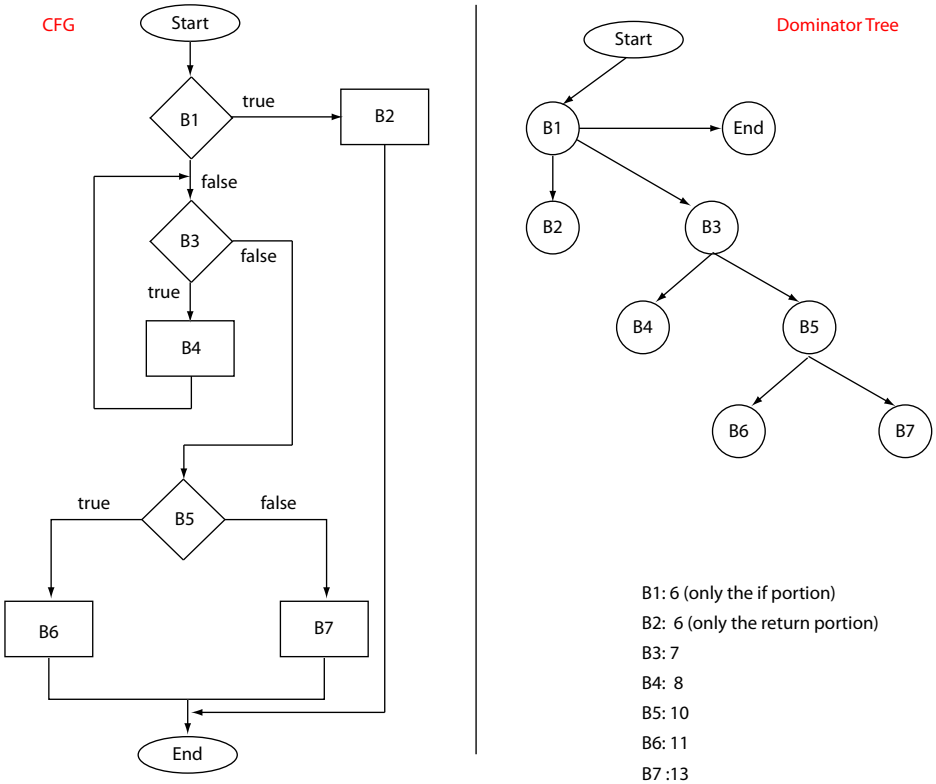
Maximum points: 100 (To be scaled down to 15 during final course grading.)

Name: Aditya Mathur

Answer all questions in the space provided. When needed, use the empty space on the back of each sheet.

Q 1 Draw the control flow graph (CFG) of `selectButton` in the following Java program. Indicate block numbers, e.g. B_1, B_2, and so on, on your CFG. Indicate the contents of each block by specifying, in a separate table, the line numbers that fall in each block.

```
1  Button save=new Button (``Save");
2  Button read=new Button (``Read");
3  Button error=new Button (``Error");
4  int  [ ] a={-19, 20, 34, 0, 32, -87};
5  public  Button selectButton(int index){
6  if(index<0 || index>=a.length) return(error);
7  while(a[index]<0){
8    index++;
9  }
10 if(index==0){
11   return(read);
12 else{
13   return(save);
14 }
```



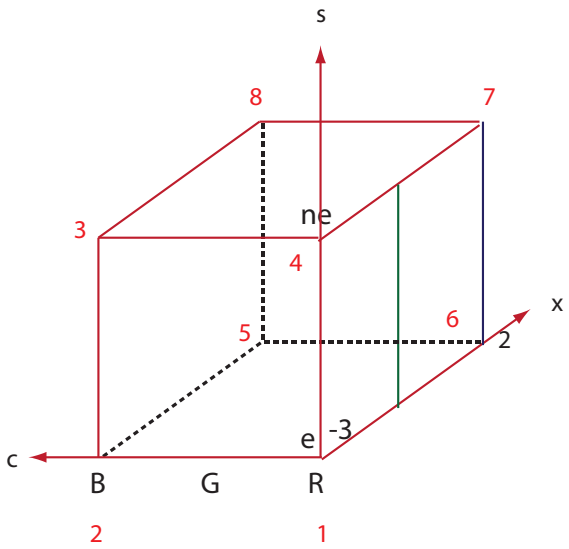
(b) Draw the dominator tree from the flow graph in (b).

See figure above.

Q 2 An application `A` takes the following inputs:

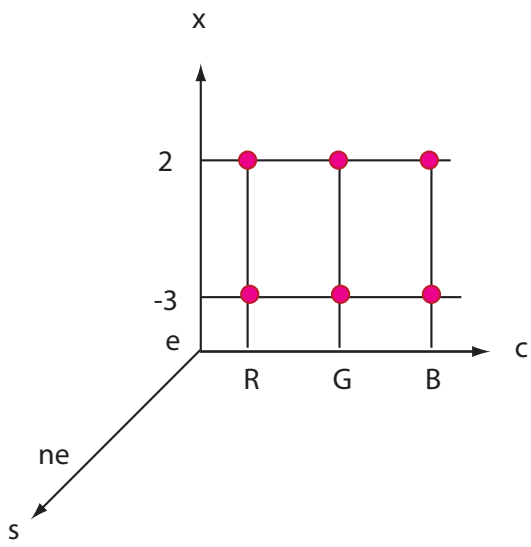
- An integer $-3 \leq x \leq 2$.
- A string `s` of lower case letters.
- An enum variable `c` that may assume values from the set $\{R, G, B\}$.

Generate a set of test inputs for `A` using boundary value analysis. All tests should be at the boundaries, or at the corners, of the input domain. You will need to determine where lie the boundaries and the corners.



3-D view

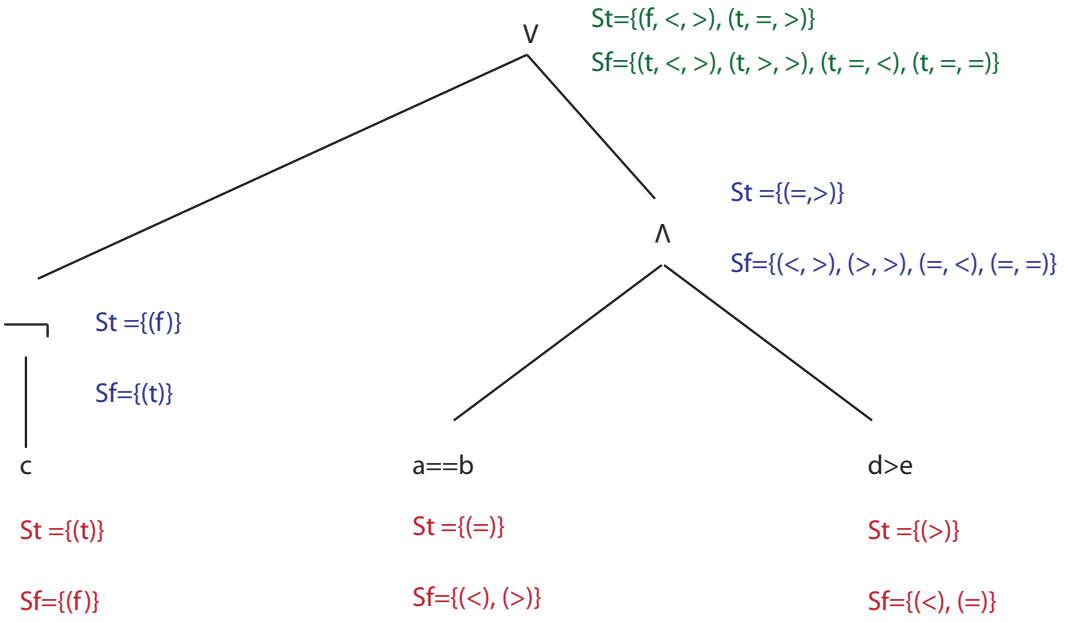
Corners ar labeled red as 1--8



a 2-D view along x-c

Tests at corners 1 through 8 (in that order)=
{(-3, e, R), (-3, e, B), (-3, ne, B), (-3, ne, R), (2, e, B), (2, e, R), (2, ne, R), (2, ne, B)}

Q 3(a) Let $p : \neg c \vee a == b \wedge d > e$, where a, b, d, e are integers and c is Boolean. Derive a BRO constraint set S for p. Precedence of Boolean operators (from high to low) is: $\neg, \wedge$, and $\vee$. Clearly show the syntax tree used to derive S.



(b) Use S to derive a sample set T of test inputs.

ID	Constraint	Test	p	p_1	p_2
T1	$(f, <, =)$	$(c = \texttt{false}, a = 1, b = 2, d = 2, e = 2)$	`true`	`false`	`true`
T2	$(t, =, >)$	$(c = \texttt{true}, a = 1, b = 1, d = 5, e = 4)$	`true`	`true`	`true`
T3	$(t, <, >)$	$(c = \texttt{true}, a = 1, b = 2, d = 3, e = 2)$	`false`	`true`	`true`
T4	$(t, >, >)$	$(c = \texttt{true}, a = 3, b = 2, d = 4, e = 2)$	`false`	`true`	`true`
T5	$(t, =, <)$	$(c = \texttt{true}, a = 2, b = 2, d = 0, e = 2)$	`false`	`true`	`true`
T6	$(t, =, =)$	$(c = \texttt{true}, a = -1, b = -1, d = 12, e = 12)$	`false`	`true`	`true`

(c) For each of the erroneous versions of p listed below, is there at least one test case in T that reveals the error?

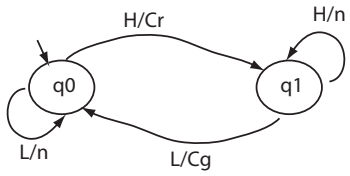
$p_1 : c \vee a == b \wedge d > e$: Yes, tests T1, T3, T4, T5, and T6 detect the error.

$p_2 : \neg c \vee a == b \vee d > e$. Yes, Tests T3, T4, T5, and T6 detect the error.

Q 4 A simple program P controls a furnace temperature indicator. The indicator is either Green or Red. Upon start, P sets the indicator to Green. At any instant, P could receive one of two signals from the furnace temperature sensor: an L indicating that the furnace temperature is low and an H indicating the furnace temperature is high. P responds to these two signals as follows depending on the current state of the indicator.

- An H signal changes the indicator color from Green to Red; the color does not change if it is already Red.
- An L signal changes the color of the indicator from Red to Green; there is no change in the color if the indicator is already Green.

(a) Draw a finite state machine (FSM) that captures the state behavior of P as described above. Your FSM should be complete and strongly connected.



(b) Assume that X and Y denote, respectively, sets of inputs and outputs of P. In your FSM in (a), what are X and Y?

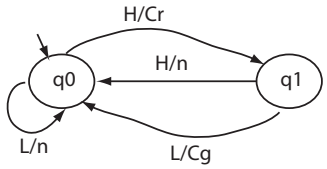
$X = \{L, H\}$

$Y = \{n, Cr, Cg\}$

(c) Develop a minimal test set that covers all transitions in your FSM in (a). Show each test case as an input-output pair.

$T = \{(LHHL, n\ Cr\ n\ Cg)\}$

(d) Redraw your FSM from (a) so that it has exactly one transfer error.



(e) Is your your test set T able to detect the transfer error in the FSM in (d)? If so, then how?

Yes.

Expected response: n Cr n Cg

Actual response: n Cr n n

Note: If we assume that in q_0 the indicator is green and red in state q_1 then the error is detected only if we know the actions performed. If we rely solely on the color of the indicator, then the error is not detected as the color has changed to green, as expected, by some internal operation that is not part of the design as indicated in the correct FSM.

End of Solutions.