SE 4367 Homework #8, BRO

Generate a BRO-adequate test set T_{BRO} for
p_r: (a<0) ∨ (b=1) ∧ (c>2) ∨ D ∨ !E

Show all the steps in generating T_{BRO}.

Draw the abstract syntax tree (AST) and label the nodes N_1 to N_m.

Explicitly list the true and false constraint sets for <u>each</u> node in the AST.

Remember to generate a test set T_{BRO} corresponding to the root node in the AST.

Grading Rubric

Setting up the AST wrong, -10 points
- common problem: doing OR before AND in this tree
- try to use their AST for the rest of the problem

Using the wrong BRO formulas for a node, -5 points
- common problem: getting ONTO product or $\{t_x\}$ wrong

Not explicitly listing the true and false constraint sets for a node, -5 points
- for N1-N5, 5 points total

Getting the wrong (true or false) constraint set for a node, -5 points each
- try to use their set for the rest of the problem

Not generating the T_{BRO} test set, -5 points
- don't care what specific values are used for a,b,c

There are legitimate alternatives for ONTO product and for $\{t_x\}$ or $\{f_x\}$ in this problem (highlighted in red in this solution).

Using one of the alternatives is legitimate. I have suggested conventions that make it easier to grade, but if you went a different (legal) way, that's acceptable.

Conventions
- order <, =, > in initial sets
- match corresponding ONTO terms until reaching the end of the shorter set; then continue matching with the last item in the shorter set
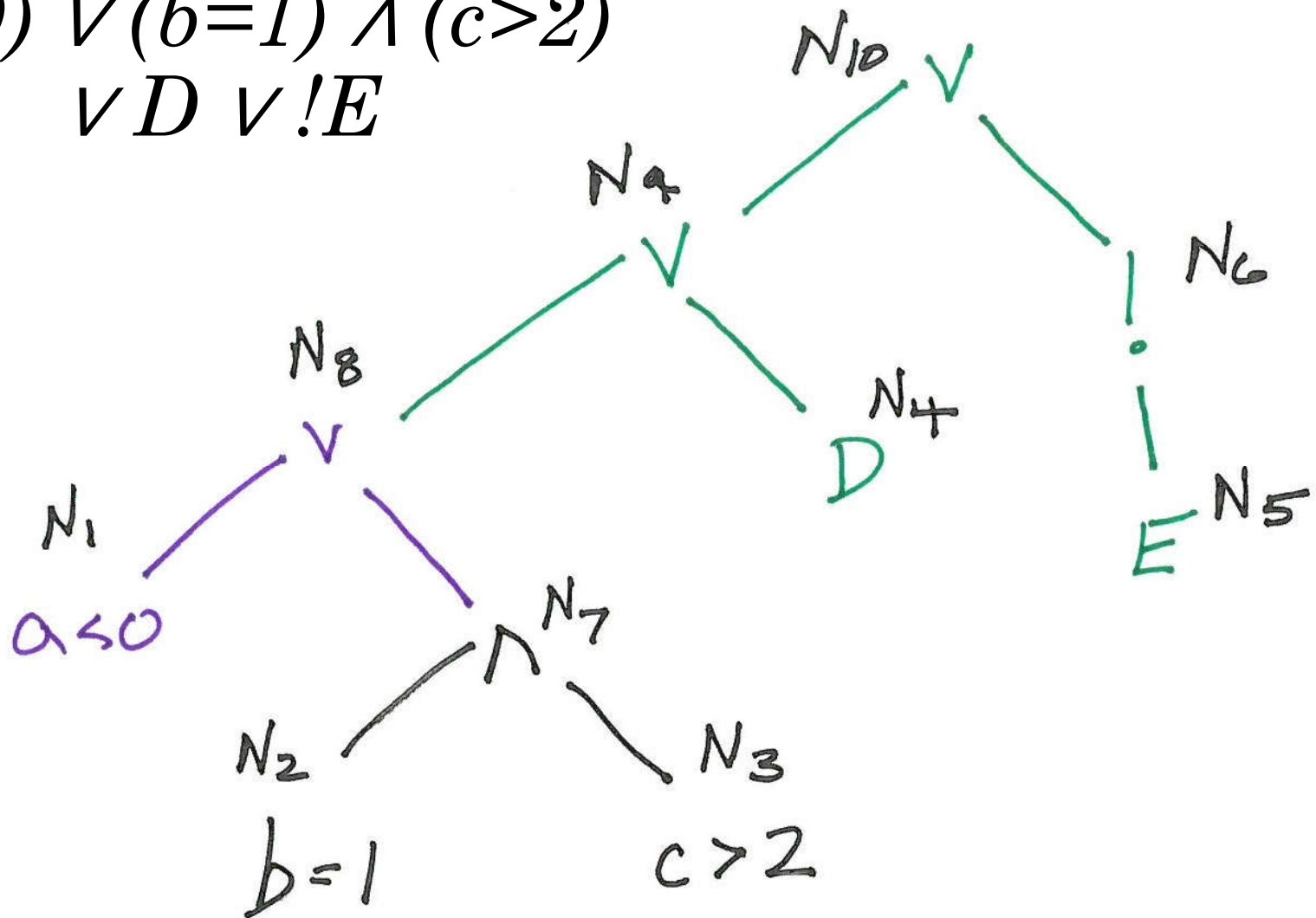- pick the first item for a $\{t_x\}$ or $\{f_x\}$

Formatting Submissions

In the file name, include:
  - **class**
  - **assignment identifier**
  - **your name (or team's name)**
    - e.g., SE4367a01jdoe

In the file (or hardcopy) submitted, include the class, assignment, and name information at the top.

Minus 5 points per violation. Potentially 30 points off for formatting mistakes!

AST of
(a<0) ∨ (b=1) ∧ (c>2)
∨ D ∨ !E

Note that you do the AND before the OR in going from bottom to top of the AST.

$$S^t_{N_1} = \{ < \}$$

$$S^f_{N_1} = \{ =, > \}$$

$$S^t_{N_2} = \{ = \}$$

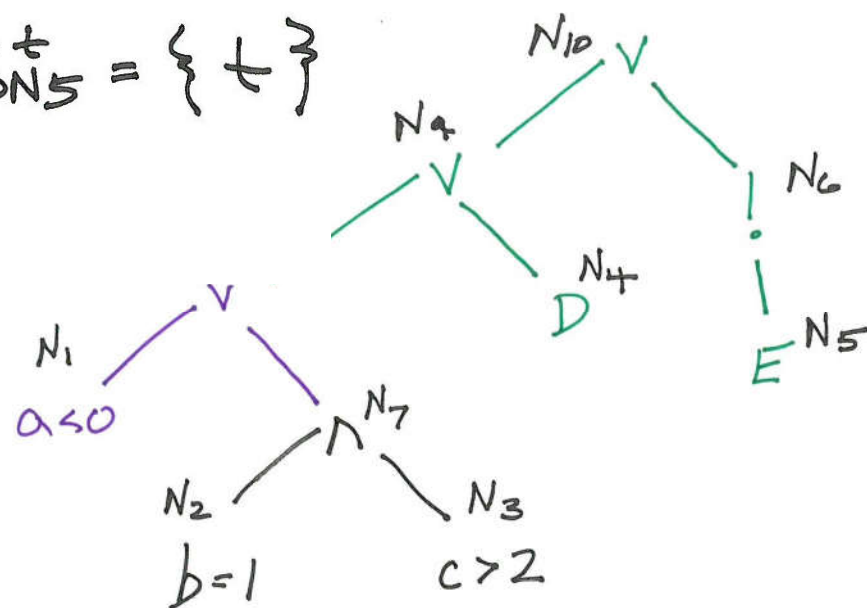$$S^f_{N_2} = \{ <, > \}$$

$$S^t_{N_3} = \{ > \}$$

$$S^f_{N_3} = \{ <, = \}$$

$$S^t_{N_4} = \{ t \}$$

$$S^f_{N_4} = \{ f \}$$

$$S^t_{N_5} = \{ t \}$$

$$S^f_{N_5} = \{ f \}$$

$$S^t_{N_6} = S^f_{N_5} = \{ f \} \qquad S^f_{N_6} = S^t_{N_5} = \{ t \}$$

AND (b,c)

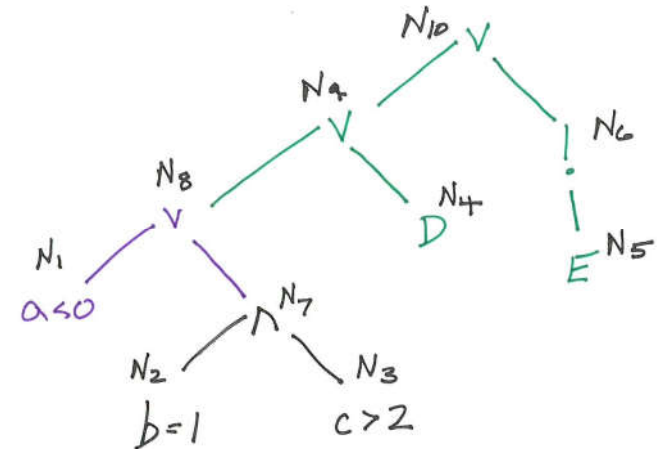$$S_{N7}^{t} = S_{N2}^{t} \otimes S_{N3}^{t}$$

$$= \{(=)\} \otimes \{(>)\} = \{(=,>)\}$$

$$S_{N7}^{f} = \left(S_{N2}^{f} \times \{t_{N3}\}\right) \cup \left(\{t_{N2}\} \times S_{N3}^{f}\right)$$

$$= \left(\{<,>\} \times \{(>)\}\right) \cup \left(\{(=)\} \times \{<,=\}\right)$$

$$= \{(<,>),(>,>)\} \cup \left(\{(=,<),(=,=)\}\right)$$

$$= \{(<,>),(>,>),(=,<),(=,=)\}$$

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OR (a,b,c)

$$S^t_{N8} = \left(S^t_{N1} \times \{f_{N7}\}\right) \cup \left(\{f_{N1}\} \times S^t_{N7}\right)$$

$$= \left(\{(<)\} \times \{(<,>)\}\right) \cup \left(\{(=)\} \times \{(=,>)\}\right)$$

$$= \{(<,<,>)\} \cup \{(=,=,>)\}$$

$$= \{(<,<,>),(=,=,>)\}$$

$$S^f_{N8} = S^f_{N1} \otimes S^f_{N7}$$

$$= \{(=),(>)\} \otimes \{(<,>),(>,>),(=,<),(=,=)\}$$

$$= \{(=,<,>),(>,>,>),(>,=,<),(>,=,=)\}$$

Tree diagram with nodes: $N_{10}\ \vee$, $N_9\ \vee$, $N_6\ !$, $N_8\ \vee$, $N_4\ D$, $N_5\ E$, $N_1\ a<0$, $N_7\ \wedge$, $N_2\ b=1$, $N_3\ c>2$

$$OR(a, b, c, D)$$

$$S_{N9}^t = (S_{N8}^t \times \{f_{N4}\}) \cup (\{f_{N8}\} \times S_{N4}^t)$$

$$= (\{(<, <, >), (=, =, >)\} \times \{(f)\}) \cup$$

$$(\{(=, <, >)\} \times \{(t)\})$$

$$= \{(<, <, >, f), (=, =, >, f)\} \cup$$

$$\{(=, <, >, t)\}$$

$$= \{(<, <, >, f), (=, =, >, f), (=, <, >, t)\}$$
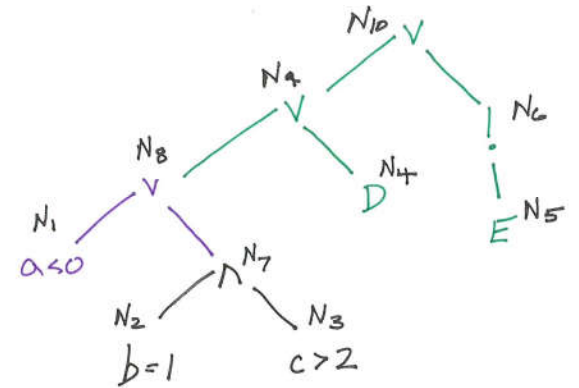
$$S_{N9}^f = S_{N8}^f \otimes S_{N4}^f$$

$$= \{(=, <, >), (>, >, >), (>, =, <), (>, =, =)\}$$

$$\otimes \{(f)\}$$

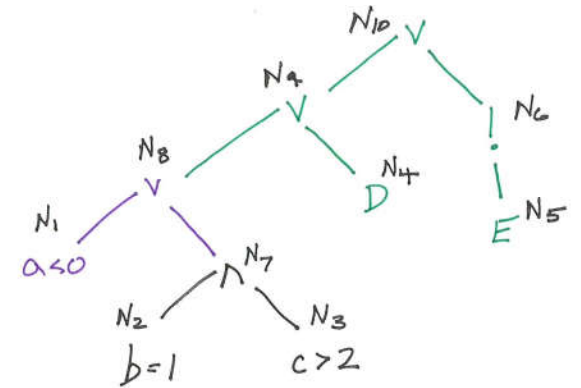$$= \{(=, <, >, f), (>, >, >, f), (>, =, <, f),$$

$$(>, =, =, f)\}$$

$$OR(a, b, c, D, E)$$

$$S_{N10}^{t} = \left(S_{N9}^{t} \times \{f_{N6}\} \right) \cup \left(\{f_{N9}\} \times S_{N6}^{t} \right)$$

$$= \left(\{ (<, <, >, f), (=, =, >, f), (=, <, >, t) \} \right.$$
$$\left. \times \{(t)\} \right) \cup \left(\{ (=, <, >, f) \} \times \{(f)\} \right)$$

$$= \{ (<, <, >, f, t), (=, =, >, f, t),$$
$$(=, <, >, t, t) \} \cup \{ (=, <, >, f, f) \}$$

$$= \{ (<, <, >, f, t), (=, =, >, f, t),$$
$$(=, <, >, t, t), (=, <, >, f, f) \}$$

$$S_{N10}^{f} = S_{N9}^{f} \otimes S_{N6}^{f}$$

$$= \{ (=, <, >, f), (>, >, >, f), (>, =, <, f),$$
$$(>, =, =, f) \} \otimes \{(t)\}$$

$$= \{ (=, <, >, f, t), (>, >, >, f, t),$$
$$(>, =, <, f, t), (>, =, =, f, t) \}$$

	a	b	c	D	E
t_1	-1	0	3	f	t
t_2	0	1	3	f	t
t_3	0	0	3	t	t
t_4	0	0	3	f	F
t_5	0	0	3	f	t
t_6	1	2	3	f	t
t_7	1	1	1	f	t
t_8	1	1	2	f	t