

COMP 410
Spring 2018
Midterm Practice Exam #1

Abstract Syntax Trees

In Boolean expressions, \neg has the highest precedence, followed by \wedge and \vee . With this in mind, write out the ASTs corresponding to each of the following Boolean expressions:

1.) $\neg a \wedge b \vee c$

2.) $(a \vee b) \wedge c$

3.) $\neg(a \wedge b) \wedge (b \vee c)$

Arithmetic expressions can be used to form Boolean expressions with the help of arithmetic comparisons (e.g., $<$, \leq , $>$, \geq , $==$). These comparisons have the lowest possible precedence. With this in mind, write out the ASTs corresponding to each of the following expressions:

4.) $1 * 2 + 3 == 4$

5.) $(2 + 2 < 4) \wedge \neg a$

Semantic Tableau

For each of the following Boolean formulas, write out the complete semantic tableau tree. **Circle** the nodes in the tree representing solutions. If a tree has no solutions, say so. **Be sure to write all steps.**

6.) $\neg a \wedge a$

$$7.) (a \vee \neg a) \wedge a$$

$$8.) (\neg x \wedge \neg y) \vee (x \wedge y)$$

Prolog - Modeling the World

9.a)

For this problem, you need to write a clause database encapsulating pricing information for a convenience store. Write Prolog code accurately reflecting the following:

- Soda costs \$2
- Chips cost \$3
- Hot dogs cost twice as much as soda (do not hardcode \$4)
- Soda chips, and hot dogs are food
- Pencils and pens are office supplies
- All office supplies cost \$2
- Cold medicine costs \$7

Using the clause database you previously wrote, write queries to determine the following:

9.b.) Which items cost exactly \$2?

9.c.) Which items cost more than \$3?

9.d.) Which foods cost less than \$3?

9.e.) Which foods are also office supplies?

Prolog - Recursion

10.) Consider the following mathematical definition of a recursive function:

$$f_n = \begin{cases} 2 & \text{if } n = 0 \\ 3 & \text{if } n = 1 \\ (3 \times f_{n-1}) + (4 \times f_{n-2}) & \text{otherwise} \end{cases}$$

Write an equivalent definition in Prolog.

11.) Write a procedure named `evensBetween`, which will nondeterministically produce all the even numbers within an inclusive range. As a hint, a number `N` is even if and only if the clause `0 is mod(N, 2)` is true. An example query is below:

```
?- evensBetween(1, 4, Even).  
Even = 2 ;  
Even = 4.
```