

Homework 1 (25pts)

due before class Feb 8, 2012

1. Describe the syntax of each of the following languages using BNF.

(a) Strings of length five or more over the set of terminals $\{p, q, r\}$.

$$S \rightarrow BBBBA$$

$$A \rightarrow BA \mid \varepsilon$$

$$B \rightarrow q \mid p \mid r$$

(b) Strings over $\{a, b, c, d\}$ that start with ab and end with cd .

$$S \rightarrow abAcd$$

$$A \rightarrow aA \mid bA \mid cA \mid dA \mid \varepsilon$$

(c) Strings over $\{0, 1, 2\}$ that contain an even number of tokens, e.g., 2011 and 12 are in the language, but 121 is not.

$$S \rightarrow AAS \mid \varepsilon$$

$$A \rightarrow 0 \mid 1 \mid 2$$

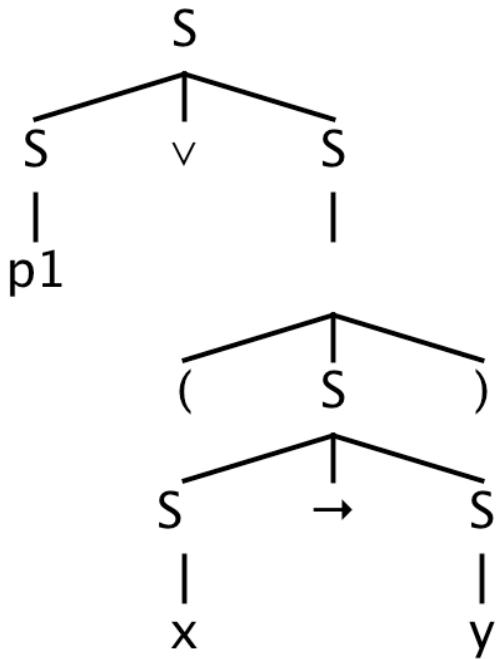
2. The set of well-formed propositional logic formulas can be considered as a language over the set of terminals $\{p, \neg, \vee, \wedge, \rightarrow, (,)\}$, where p is a propositional variable and can be mapped to an arbitrary identifier (i.e., variable name), \neg is the negation unary operator, and $\vee, \wedge, \rightarrow$ are binary operators representing or, and, implication relations respectively. For example, expression $p1 \wedge p2 \vee p3$ means $p1$ and $p2$ or $p3$, and expression $p1 \vee (x \rightarrow y)$ means $p1$ or (if x then y).

(a) Use Backus-Naur Form (BNF) to describe the syntax of the given language.

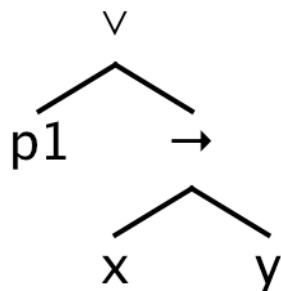
$$S \rightarrow S \vee S \mid S \wedge S \mid S \rightarrow S \mid \neg S \mid (S) \mid p$$

(b) Based on your BNF, give a parse tree and an AST (Abstract Syntax Tree) for the input $p1 \vee (x \rightarrow y)$.

Parse tree:



AST :



- (c) Is your grammar ambiguous? If yes, rewrite your grammar to be non-ambiguous by enforcing that \wedge has higher precedence than \vee , \vee has higher precedence than \rightarrow , and all binary operators are left associative.

Yes, this grammar is ambiguous, because it has more than one parse tree.

Non-ambiguous grammar:

$$\begin{aligned}
 A &::= A \rightarrow B \mid B \\
 B &::= B \vee C \mid C \\
 C &::= C \wedge D \mid D \\
 D &::= (A) \mid p
 \end{aligned}$$