

## Assignment 4

### Context-Free Grammars

1. (40%) Consider the grammar

$\text{bexpr} \rightarrow \text{bexpr} \text{ or } \text{bterm} \mid \text{bterm}$

$\text{bterm} \rightarrow \text{bterm} \text{ and } \text{bfactor} \mid \text{bfactor}$

$\text{bfactor} \rightarrow \text{not } \text{bfactor} \mid ( \text{bexpr} ) \mid \text{true} \mid \text{false}$

(a) What are the terminals, nonterminals, and start symbol?

terminals: or , and , not , ( , ) , true , false

nonterminals: bexpr , bterm , bfactor

start symbol: bexpr

(b) Construct a leftmost derivation for the sentence not(true or false and true).

$\text{bexpr} \xRightarrow{\text{lm}} \text{bterm}$

$\xRightarrow{\text{lm}} \text{bfactor}$

$\xRightarrow{\text{lm}} \text{not } \text{bfactor}$

$\xRightarrow{\text{lm}} \text{not } ( \text{bexpr} )$

$\xRightarrow{\text{lm}} \text{not } ( \text{bexpr} \text{ or } \text{bterm} )$

$\xRightarrow{\text{lm}} \text{not } ( \text{bterm} \text{ or } \text{bterm} )$

$\xRightarrow{\text{lm}} \text{not } ( \text{bfactor} \text{ or } \text{bterm} )$

$\xRightarrow{\text{lm}} \text{not } ( \text{true} \text{ or } \text{bterm} )$

$\xRightarrow{\text{lm}} \text{not } ( \text{true} \text{ or } \text{bterm} \text{ and } \text{bfactor} )$

$\xRightarrow{\text{lm}} \text{not } ( \text{true} \text{ or } \text{bfactor} \text{ and } \text{bfactor} )$

$\xRightarrow{\text{lm}} \text{not } ( \text{true} \text{ or } \text{false} \text{ and } \text{bfactor} )$

$\xRightarrow{\text{lm}} \text{not } ( \text{true} \text{ or } \text{false} \text{ and } \text{true} )$

- (c) Construct a rightmost derivation for the sentence not(true or false and true).

bexpr  $\xRightarrow{rm}$  bterm

$\xRightarrow{rm}$  bfactor

$\xRightarrow{rm}$  **not** bfactor

$\xRightarrow{rm}$  **not** ( bexpr )

$\xRightarrow{rm}$  **not** ( bexpr **or** bterm )

$\xRightarrow{rm}$  **not** ( bexpr **or** bterm **and** bfactor )

$\xRightarrow{rm}$  **not** ( bexpr **or** bterm **and** **true** )

$\xRightarrow{rm}$  **not** ( bexpr **or** bfactor **and** **true** )

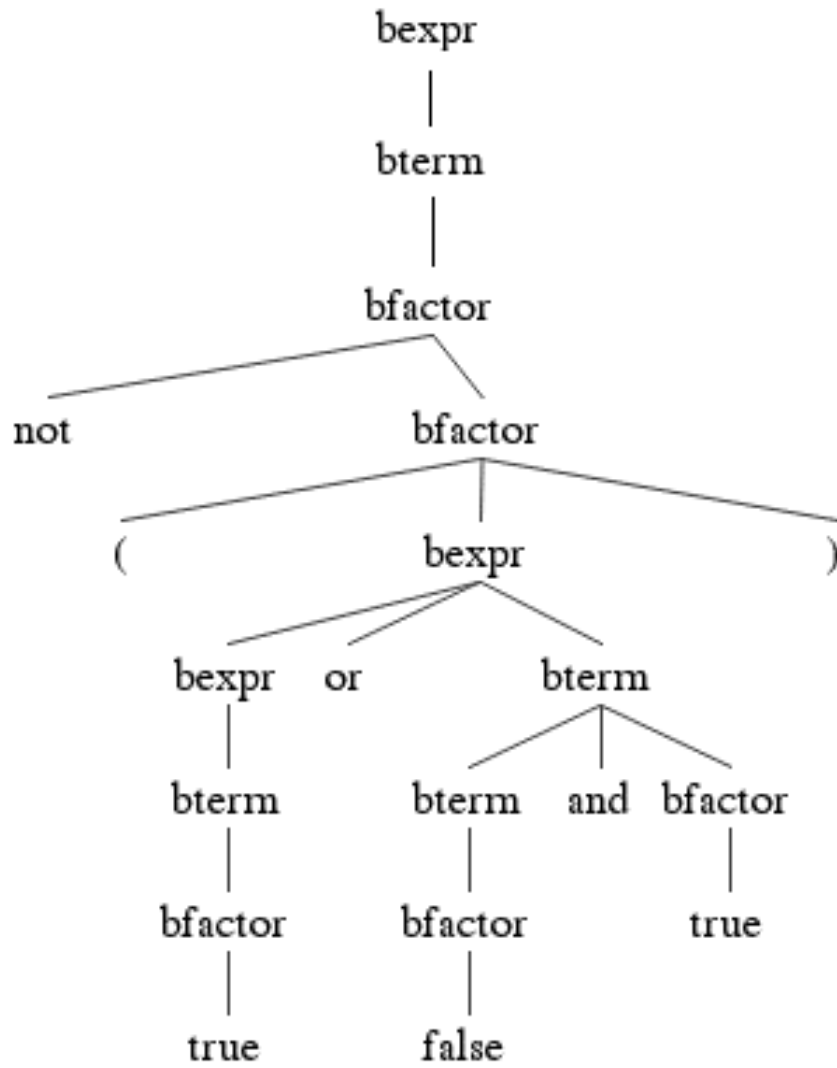
$\xRightarrow{rm}$  **not** ( bexpr **or** **false** **and** **true** )

$\xRightarrow{rm}$  **not** ( bterm **or** **false** **and** **true** )

$\xRightarrow{rm}$  **not** ( bfactor **or** **false** **and** **true** )

$\xRightarrow{rm}$  **not** ( **true** **or** **false** **and** **true** )

(d) Construct the parse tree for the sentence not(true or false and true).



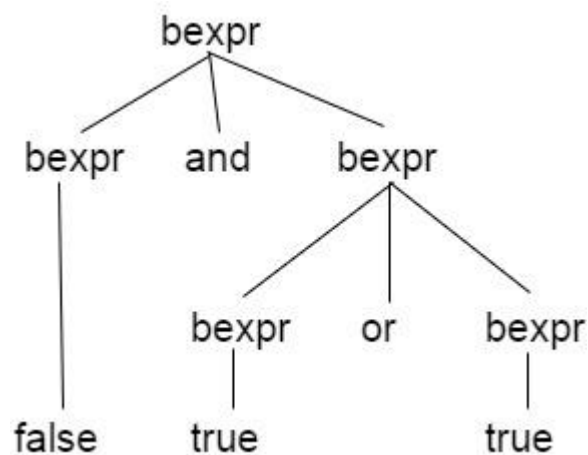
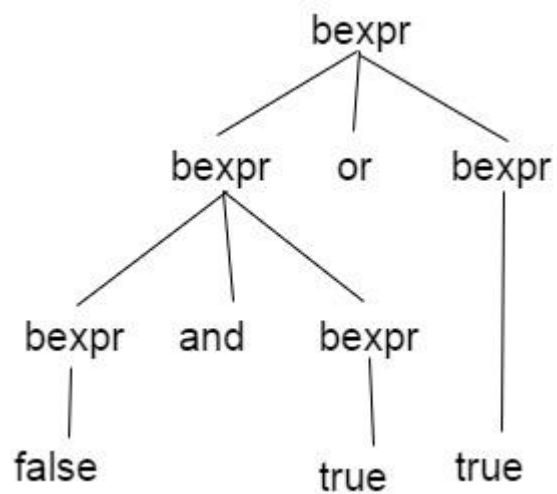
2. (20%) Consider the grammar

$\text{bexpr} \rightarrow \text{bexpr} \text{ or } \text{bexpr} \mid \text{bexpr} \text{ and } \text{bexpr} \mid \text{not bexpr}$   
 $\mid ( \text{bexpr} ) \mid \text{true} \mid \text{false}$

Show that this grammar is ambiguous.

Show that this grammar is ambiguous by constructing two different parse trees for a sentence.

For Example : **false and true or true**



So the grammar is ambiguous.

3.(40%) Design a context-free grammar for each of the following languages.

- (a) The set of all strings of 0's and 1's such that every 0 is immediately followed by at least one 1.

$$S \rightarrow 01S \mid 1S \mid \varepsilon$$

- (b) The set of all strings of 0's and 1's with an equal number of 0's and 1's.

$$S \rightarrow 0S1S \mid 1S0S \mid \varepsilon$$