

# CSCI 447 – Summer 2003

## Context-Free Grammars

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**Due Date:** Tuesday, July 1<sup>st</sup>, 2003

1. Given the grammar  $A \rightarrow AA \mid (A) \mid \epsilon$ 
  - a. Describe the language it generates.
  - b. Show that this grammar is ambiguous.
  - c. Write an unambiguous grammar that generates the same language
2. The following grammar generates all regular expressions over the alphabet of letters

$rex$        $\rightarrow$      $rex \mid rex$   
              $\rightarrow$      $rex \mid rex$   
              $\rightarrow$      $rex \mid *$   
              $\rightarrow$      $( \mid rex \mid )$   
              $\rightarrow$     **letter**

- a. Show that this grammar is ambiguous
  - b. Rewrite the above grammar to establish correct precedence of operators. Parentheses are given highest precedence, then Kleene closure (\*), then concatenation (no operator symbol), then alternation (|).
  - c. What associativity does your answer in (b) give to operators and why?
3. Write a grammar for Boolean expressions that include the constants **true** and **false**, identifiers, the operators **and**, **or**, **not**, and parentheses. Be sure to give **or** a lower precedence than **and** and **and** a lower precedence than **not** and to allow repeated **not**'s. The associativity of **or** and **and** is left-to-right, while the associativity of **not** is right-to-left. Be sure that your grammar is not ambiguous.
  4. The following grammar has been proposed to remedy the **else** ambiguity in **if** statements:

$stmt$        $\rightarrow$      $matched \mid unmatched$   
 $matched$   $\rightarrow$     **if**  $expr$  **then**  $matched$  **else**  $stmt$   
 $matched$   $\rightarrow$      $other-stmt$   
 $unmatched$   $\rightarrow$     **if**  $expr$  **then**  $stmt$

Show that this grammar is still ambiguous

5. a. Write a regular expression that generates the same language of the grammar:

$A \rightarrow aA \mid B \mid \epsilon$   
 $B \rightarrow bB \mid A$

- b. Write a regular grammar for:  $(a \mid c \mid ba \mid bc)^*(b \mid \epsilon)$ .