

COMS W3261: Theoretical Computer Science.

Instructor: Tal Malkin

Problem Set 5

Due: Tue, 03/03/09. **No late homework will be accepted.**

Reading: Chapter 2.1, 2.2

1. Consider the following context-free grammar (variables are marked with $\langle \dots \rangle$ and the start variable is $\langle \text{sent} \rangle$).

$\langle \text{sent} \rangle$	\longrightarrow	$\langle \text{subj} \rangle \langle \text{activity} \rangle \mid$ $\langle \text{subj} \rangle \langle \text{activity} \rangle \text{with} \langle \text{subj} \rangle$
$\langle \text{subj} \rangle$	\longrightarrow	$\langle \text{noun} \rangle \mid \langle \text{noun} \rangle \text{and} \langle \text{subj} \rangle$
$\langle \text{activity} \rangle$	\longrightarrow	$\langle \text{verb} \rangle \langle \text{obj} \rangle$
$\langle \text{obj} \rangle$	\longrightarrow	$\langle \text{noun} \rangle \mid \langle \text{noun} \rangle \text{with} \langle \text{obj} \rangle$
$\langle \text{noun} \rangle$	\longrightarrow	Alice \mid Bob \mid Carol \mid bread \mid cheese \mid cups
$\langle \text{verb} \rangle$	\longrightarrow	bought \mid ate

- (a) Give a left-most derivation for the following generated sentence: “Alice and Bob ate bread”.
 - (b) Give a derivation tree for the following generated sentence: “Carol bought cups with Alice”.
 - (c) Show that this grammar is ambiguous.
2. Consider the language $L = \{a^n b^m \mid n \geq 0, m \geq 0, n \neq m\}$ over $\Sigma = \{a, b\}$. In both the following you do not need to prove the correctness of your construction, but you do need to write in a clear manner, indicating the main idea where necessary to understand the construction.
 - (a) Give a context free grammar for L .
 - (b) Give a state diagram for a push-down automaton for L .
 3. Problem 2.13(a) (describing the language generated by a certain CFG).