

Formal methods, Fall 2008  
Problem set 6  
Assigned: 11/20, Due: 12/2

## 1 Pumping lemmas

Please see attached sheet (from Sipser) for a model of how to present a pumping lemma proof. You do not necessarily need to give as much detail but you should use the same kind of proof structure.

[a] Show (again) that the following language isn't regular:  $\{0^n 1^m 0^n \mid m, n \geq 0\}$ . Use the pumping lemma for regular languages. If you did this right the first time you can of course repeat your proof here.

[b] (PMW 18.3a) Show (using the pumping lemma for CFLs) that the following language is not context free:  $\{a^{n^2} \mid n \geq 1\}$ .

## 2 Chomsky normal form

Do PMW 18.2.

## 3 PDAs

Construct a PDA for the language in 1a.

## 4 Type 0 grammars

A context free grammar allows only a single variable on the left side of a rule. A type 0 grammar is different in that it allows anything on the left side of the rule, e.g. "aBcd  $\rightarrow$  CD". This rule would replace the string "aBcd" with the string "CD" when applied. The rule of course can't apply unless the string "aBcd" is present. Give type 0 grammars that generate the following languages:

(i)  $\{a^n b^n c^n \mid n \geq 0\}$

(ii)  $\{ww \mid w \in \{0, 1\}^*\}$  (Everyone do this, will count more for grad students. What would a Turing machine do?)