

01204213: Homework 4

Due: 23pm, 2 Aug 2021.

1. (Sipser 2.1) Consider the following CFG for expressions.

$$\begin{aligned} E &\rightarrow E + T | T \\ T &\rightarrow T \times F | F \\ F &\rightarrow (E) | a \end{aligned}$$

Give parse trees and derivations for each string.

- (a) **a**
 - (b) **a + a**
 - (c) **a + a + a**
 - (d) **a + a × a**
 - (e) **((a))**
2. (Sipser 2.4) Give context-free grammars that generate the following languages. In all parts $\Sigma = \{1, 0\}$.
 - (a) $\{w \mid w \text{ starts and ends with the same symbol}\}$
 - (b) $\{w \mid \text{the length of } w \text{ is odd}\}$
 - (c) $\{w \mid w = w^R, \text{ that is } w \text{ is a palindrome}\}$
 - (d) The empty set
 3. (Sipser 2.5) Give informal descriptions and state diagrams of pushdown automata for the languages in question 2.
 4. (Sipser 2.8) Consider the simplified English grammar from class.

$$\begin{aligned} S &\rightarrow NP VP \\ NP &\rightarrow CN | CN PP \\ VP &\rightarrow CV | CV PP \\ PP &\rightarrow PREP CN \\ CN &\rightarrow ART N \\ CV &\rightarrow V | V NP \\ ART &\rightarrow a | the \\ N &\rightarrow boy | girl | flower \\ V &\rightarrow touches | likes | sees \\ PREP &\rightarrow with \end{aligned}$$

Show that the string **the girl touches the boy with the flower** has two different leftmost derivations in the grammar. Describe in English the two different meanings of this sentence.

5. (Sipser 2.11) Convert CFG in question 1 to an equivalent PDA, using the procedure discussed in class.