

CS581 – Theory of Computation – HW4

Tuesday, April 23, 2013
due in class Tuesday, April 30, 2013

Answer each question below. You will turn this homework in using D2L. In addition, you may also turn in a paper copy in class. In this case the TA will mark up your homework with comments and return the comments to you.

You may format your answers using some document processing software, or you may write it up with pencil and paper and scan it. In either case submit a pdf document. Be sure your submission is clearly identified as Homework 4, and contains your name and your email on the first line. The first line should look like:

CS581 HW #4

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1. Exercise 2.1 (page 128) of the Sipser text. Recall the CFG G_4 that was discussed in Example 2.4. We have renamed the variables with single letters as follows:

```
E -> E + T
E -> T
T -> T * F
T -> F
F -> ( E )
F -> a
```

Give parse trees and derivations for each string. (3 points each, 12 points total).

- a
- a+a
- a + a + a
- ((a))

2. Exercise 2.4 (page 128). Parts a. and b. and e. Give context-free grammars that generate the following languages. In all parts the alphabet Σ is $\{0, 1\}$. (5 points each, 15 points total)

- a. $\{w \mid w \text{ contains at least three 1's}\}$
 - b. $\{w \mid w \text{ starts and ends with the same symbol}\}$
 - e. $\{w \mid w = w^R, \text{ that is, } w \text{ is a palindrone}\}$
3. Exercise 2.5 (page 129). Give informal descriptions and state diagrams for pushdown automata that describe the languages of Exercise 2.4 (page 129). These are also described in question 2 immediately above. (5 points each, 15 points total)
 4. Exercise 2.14 (page 129). Convert the following CFG into an equivalent CFG in Chomsky Normal Form, using the procedure given in Theorem 2.9 (20 points)

A \rightarrow BAB
 A \rightarrow B
 A \rightarrow ""
 B \rightarrow 00
 B \rightarrow ""

In the above CFG we use "" to denote ϵ the empty string.

5. Exercise 2.11 (page 129). Convert the CFG G_4 in Exercise 2.1 (page 128) (also described in question 1 above) to an equivalent PDA, using the procedure given in theorem 2.20. (20 points)
6. Create ID-chains (instantaneous descriptions related by \vdash) showing the acceptance of the strings. (4 points each, 12 points total)
 - a
 - a+a
 - (a)
7. Show that class of context free languages is closed under the regular operations of union, concatenation, and star. (21 points)