

CSE 30151 Theory of Computing: Homework 5

CFGs, CFLs, PDAs

Version 1: Sept. 27, 2017

Instructions

- Unless otherwise specified, all problems from “the book” are from Version 3. When a problem in the International Edition is different from Version 3, the problem will be listed as V3:x.yy/IE:x.zz, where x.zz is the equivalent number. When Version 2 has a different number, it will be listed as V3:x.yy/V2:x.zz. If either IE or V2 does not have a matching number, the problem text will be duplicated.
- You can prepare your solutions however you like (handwriting, L^AT_EX, etc.), but you must submit them in **legible PDF**. You can scan written solutions in the library or using a smartphone (with a scanner app like CamScanner). It is up to you to ensure that submissions are legible. REMEMBER THAT IF WE CAN’T READ IT OR SCAN IS CUT OFF, YOU DON’T GET A GRADE FOR IT.
- Please give every PDF file a unique filename.
 - If you’re making a complete submission (all problems), name your PDF file `netid-hw5.pdf`, where `netid` is replaced with your **NetID**.
 - If you’re submitting some problems now and other problems later, name your file `netid-hw5-123.pdf`, where `123` is replaced with just the problems you are submitting now.
 - If you use the same filename twice, only the most recent version will be graded.
 - The time of submission is the time the most recent file was uploaded.
- If you use L^AT_EX and want to draw something like a state diagram, consider using the `tikz` package. A reference document is on the website under “Assignments”.
- You may also find the website <http://madebyevan.com/fsm/> a useful tool for drawing state diagrams via drop and drag. It will output both .png image files and latex in the tikz format.
- Submit your PDF file in Sakai. Don’t forget to click the Submit (or Resubmit) button!

Practice Problems

These problems are from the book, and most have solutions listed for them. They are listed here for you to practice on as needed and any answers you generate **should not** be submitted. You are free to discuss these with others, but you are not allowed to post solutions to any public forum.

1. 2.1 Parse Trees
2. 2.3 Parts of a CFG
3. 2.4a,d V3-V3:(2.21, 2.22, 2.23, 2.24, 2.29)(Not in IE) Writing a CFG
4. 2.8, V3,V2:2-29 V3:2.27 IE:2.39 Ambiguous grammar
5. V3:2.18;IE:2.30 Properties of CFLs

Book Exercises

These problems are found in the text book and are to be answered and submitted by each student. You are to solve them yourself. Use of solution manuals from any source or shared solutions is a violation of the ND

Honor Code. You are also not allowed to show your solutions to another student.

1. (5 points - CFG and PDA) 2.4b Give the grammar and then develop a PDA.
2. (5 points - CFG) 2.6d
3. (10 points - Properties of CFLs) 2.16. Hint: build new PDAs from known ones (as was do for regexs)
4. (10 points - CFG and PDA) V3:2.47;IE2.58. (Problem is not in V2) Let $\Sigma = \{0, 1\}$ and $B = \{uv|u \text{ in } \Sigma^*, v \text{ in } \Sigma^*1\Sigma^*, |u| \geq |v|\}$. That is, there is at least one 1 in the second half. Hint: do the CFG first.

Non-book Problems

The following problems are not found in the text book. You are to solve them yourself. Use of any resource you used other than the text book or class notes must be cited. You are also not allowed to show your solutions to another student.

5. (15 points) (Derivations and Induction) Consider the following CFG G:

$$\begin{aligned} S &\rightarrow abB \\ A &\rightarrow aaBb \mid \varepsilon \\ B &\rightarrow bbAa \end{aligned}$$

- (a) (5 points) Draw a parse tree for $w = abbbaabbaba$ rooted at S and list a left-most derivation.
 - (b) (5 points) Draw a PDA for the grammar. You do not need to show any transitions to trap states. You may either draw a state diagram or a table (I suggest the state diagram). You do not need to list all the state names if you draw a diagram. Hint: consider the procedure of Fig. 2.24. Show all states; don't use the shorthand that has multiple stack pushes on one arc. How many states did you need?
 - (c) (5 points) Then prove by induction that any string of the form $ab(bbaa)^i bba(ba)^i, i \geq 0$ is also a member of $L(G)$ (i.e. this string really is pumpable). Make sure you explicitly state all three steps of the induction (prove basis, state hypothesis, prove hypothesis) Suggestion: use your derivation or parse tree and look where the pattern starts to emerge to guide your proof.
6. (10 points - PDA to CFG) Convert the PDA of Fig.2.17 back into a CFG using the approach of Lemma 2.27.