University of Nevada, Las Vegas Computer Science 456/656 Spring 2020

Answers to Assignment 3: Due Thursday February 20, 2020

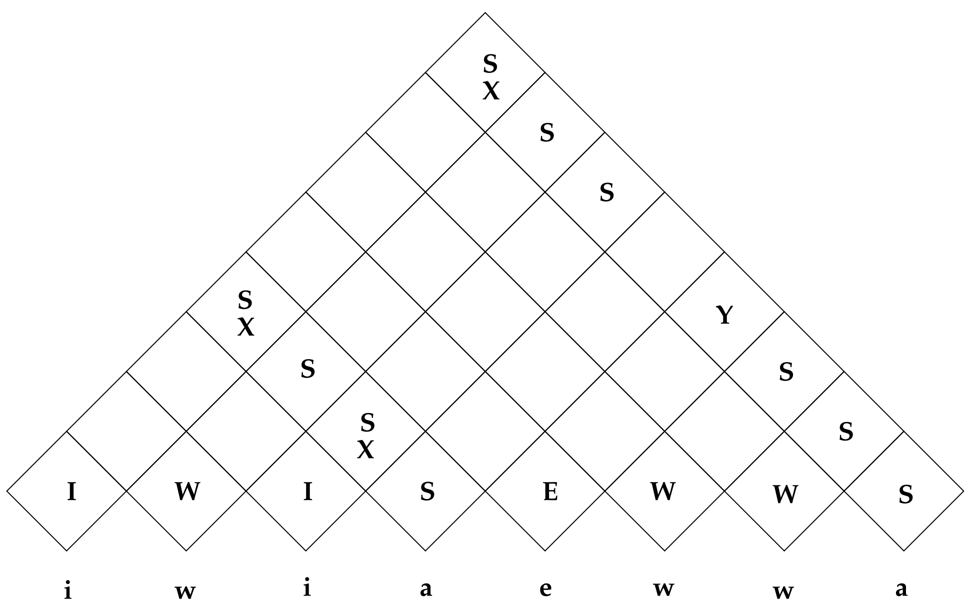
1. Consider the Chomsky Normal Form grammar G given below. $S \to IS$
   $S \to WS$
   $S \to XY$
   $X \to IS$
   $Y \to ES$
   $S \to a$
   $I \to i$
   $W \to w$
   $E \to e$

   (a) Show that G is ambiguous by giving two different **leftmost** derivations for the string $iiaea$.

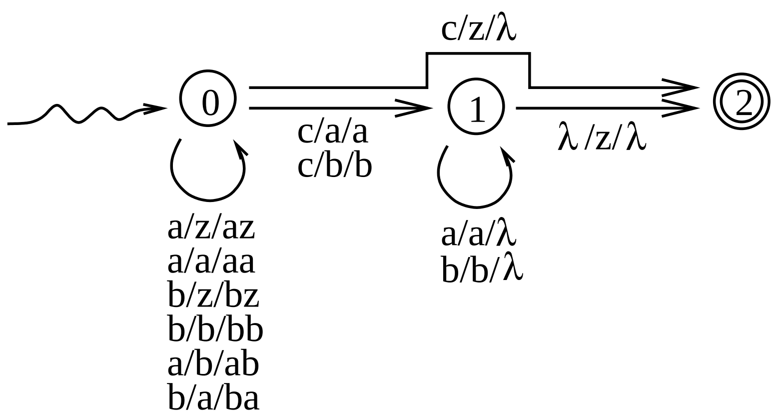
   $$S \Rightarrow IS \Rightarrow iS \Rightarrow iXY \Rightarrow iISY \Rightarrow iiSY \Rightarrow iiaY \Rightarrow iiaES \Rightarrow iiaeS \Rightarrow iiaea$$

   $$S \Rightarrow XY \Rightarrow ISY \Rightarrow iSY \Rightarrow iISY \Rightarrow iiSY \Rightarrow iiaY \Rightarrow iiSES \Rightarrow iiaES \Rightarrow iiaeS \Rightarrow iiaea$$

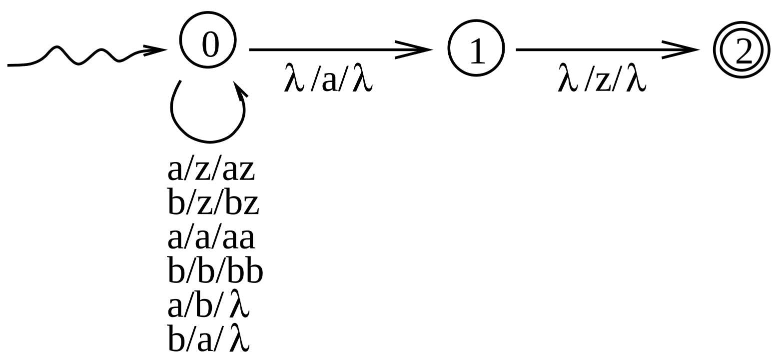
   (b) Use the CYK algorithm to prove that $iwiaewwa \in L(G)$.



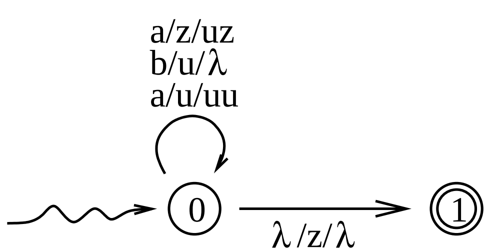
2. Work problem 6(b) on page 189 of the sixth edition, 4(b) in Section 7.1 of the fifth edition. XXXXX



3. Work problem 6(g) on page 189 of the sixth edition, 4(g) in Section 7.1 of the fifth edition.



4. Let L be the language accepted by the PDA diagrammed below. What is L? You can either describe L in a **few** words, or give a context-free grammar for L.

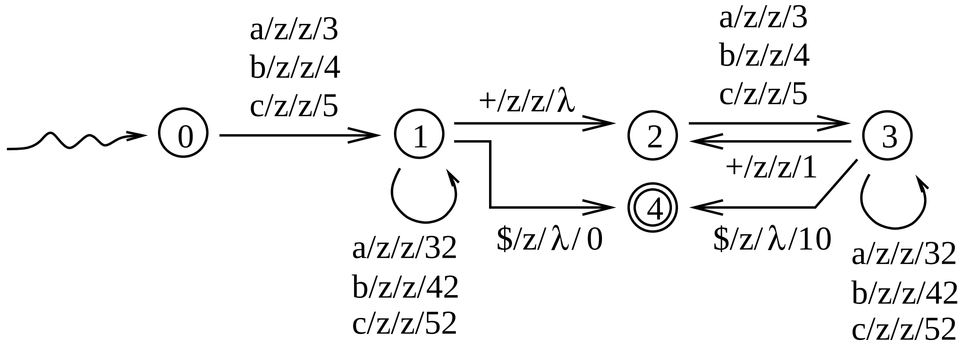


The Dyck language, where a and b denote left and right parentheses, respectively. One unambiguous context-free grammar for L is:

$S \to aSbS \mid \lambda$

5. Let L be the language generated by the following context-free grammar, G. The DPDA, which we call P, shown is actually a parser for G. Its output is a derivation of its input string. Each arc has four labels: "read/pop/push/output." The input alphabet is $\{a, b, c, +, \$\}$, where "\$" is basically an end-of-file symbol, so that the parser can tell that it's reached the end of the input string.

0. $S \to E$
1. $E \to E + E$
2. $E \to EE$
3. $E \to a$
4. $E \to b$
5. $E \to c$



(a) Show that G is ambiguous.

There are two leftmost derivations for $x + yz\$$:

$$S \Rightarrow E\$ \Rightarrow E + E\$ \Rightarrow x + E\$ \Rightarrow x + EE\$ \Rightarrow x + yE\$\$ \Rightarrow x + yz\$$$

$$S \Rightarrow E\$ \Rightarrow EE\$ \Rightarrow E + EE\$ \Rightarrow x + EE\$ \Rightarrow x + yE\$ \Rightarrow x + yz\$$$

The first derivation is the one found by the parser.

(c) Despite the ambiguity of G, P is deterministic and will build a unique parse tree for any $w \in L$. Draw the parse tree for the input a+abc+bc\$.

(b) Walk through the computation of P with input b+abc+bc\$. Here is what your answer should look like. I've filled in the first few lines. The output stream grows while the input stream shrinks.

read	pop	push	input	output	state
			$b + abc + bc\$$		0
b	z	z	$+abc + bc\$$	4	1
$+$	z	z	$abc + bc\$$	4	2
a	z	z	$bc + bc\$$	43	3
b	z	z	$c + bc\$$	4342	3
c	z	z	$+bc\$$	434252	3
$+$	z	z	$bc\$$	4342521	2
b	z	z	$c\$$	43425214	3
c	z	z	$\$$	4342521452	3
$\$$	z	z		434252145210	4