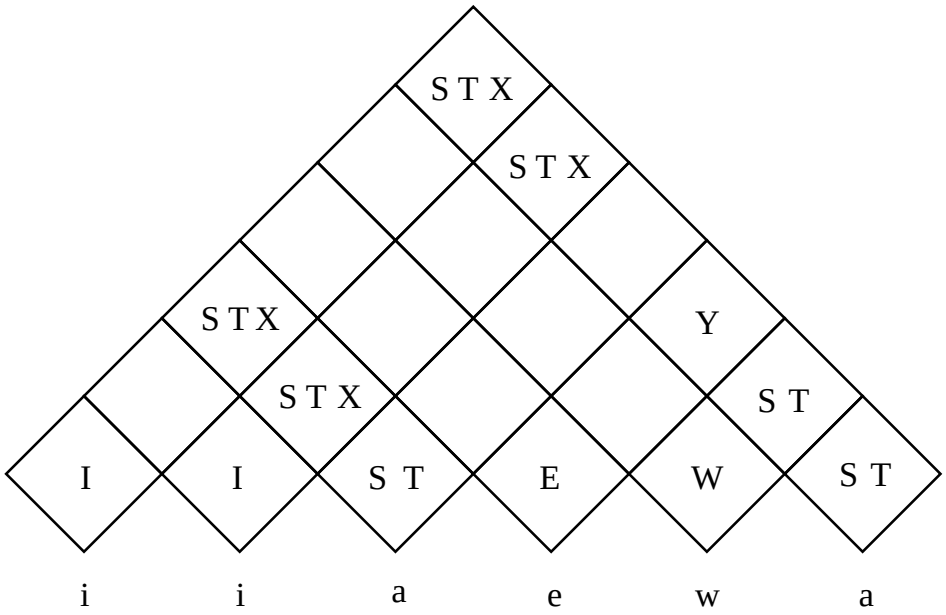
University of Nevada, Las Vegas Computer Science 456/656 Spring 2025

Answers to Assignment 6: Due Saturday March 29, 2025

1. Read the handouts CanonEnum.pdf, ComplexityI.pdf, ComplexityII.pdf, ComplexityIII.pdf, cyk.pdf, and lalrhandout1.pdf.

2. Use the CYK algorithm to prove that the language generated by the following CNF grammar, with start symbol S, contains the string $iiaewa$, by completely filling in the matrix shown below.

$S \to a$
$S \to IT$
$S \to WT$
$S \to XY$
$X \to IT$
$Y \to ET$
$T \to a$
$T \to IT$
$T \to WT$
$T \to XY$
$I \to i$
$E \to e$
$W \to w$



3. Carefully examine the Euler diagram on the last page of ComplexityIII.pdf. Then, redraw the diagram, without looking. Then check your figure. If it is not correct, draw it again. Keep going until you get it right. (You don't have to turn it in.)

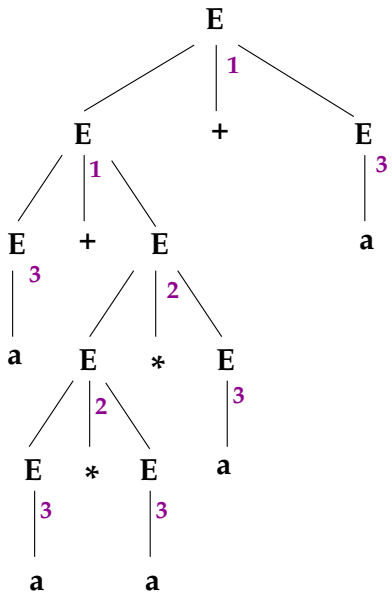
4. Work Exercises 1 and 2 on page 3 of lalrhandout1.pdf. Then work Exercises 3 and 4 on page 4.

For our second example, let the input string be $w = a+a*a*a+a$. The output is 333232131, the reverse rightmost derivation of the input. The computation of the LALR parser consists of the **id** sequence:

$\$_0$	$a+a*a*a+a\$$		
$\$_0 a_6$	$+a*a*a+a\$$		$s6$
$\$_0 E_1$	$+a*a*a+a\$$	3	$r3$
$\$_0 E_1 +_2$	$a*a*a+a\$$	3	$s2$
$\$_0 E_1 +_2 a_6$	$*a*a+a\$$	3	$s6$
$\$_0 E_1 +_2 E_3$	$*a*a+a\$$	33	$r3$
$\$_0 E_1 +_2 E_3 *_4$	$a*a+a\$$	33	$s4$
$\$_0 E_1 +_2 E_3 *_4 a_6$	$*a+a\$$	33	$s6$
$\$_0 E_1 +_2 E_3 *_4 E_5$	$*a+a\$$	333	$r3$
$\$_0 E_1 +_2 E_3$	$*a+a\$$	3332	$r2$
$\$_0 E_1 +_2 E_3 *_4$	$a+a\$$	3332	$s4$
$\$_0 E_1 +_2 E_3 *_4 a_6$	$+a\$$	3332	$s6$
$\$_0 E_1 +_2 E_3 *_4 E_5$	$+a\$$	33323	$r3$
$\$_0 E_1 +_2 E_3$	$+a\$$	333232	$r2$
$\$_0 E_1$	$+a\$$	3332321	$r1$
$\$_0 E_1 +_2$	$a\$$	3332321	$s2$
$\$_0 E_1 +_2 a_6$	$\$$	3332321	$s6$
$\$_0 E_1 +_2 E_3$	$\$$	33323213	$r3$
$\$_0 E_1$	$\$$	333232131	$r1$

HALT

1. Sketch the parse tree.



2. The grammar is ambigous, but the parser resolves ambiguities, computing a unique derivation for any string in the language. Left associativity of addition is guaranteed by the entry r1 in row 3, in the column headed by the "+". Which entry of the action table guarantees that multiplication is left associative?

r2 in row 4 col *

3. Which two entries in the action table cause multiplication to have precedence over addition?

s4 in row 3 col * and r2 in row 5 col +

4. Write the computation of the parser if the input is $a + a + a * a$. Use the same array format used for the example above.

$\$_0$	$a + a + a * a\$$		
$\$_0 a_6$	$+a + a * a\$$		$s6$
$\$_0 E_1$	$+a + a * a\$$	3	$r3$
$\$_0 E_1 +_2$	$a + a * a\$$	3	$s2$
$\$_0 E_1 +_2 a_6$	$+a * a\$$	3	$s6$
$\$_0 E_1 +_2 E_3$	$+a * a\$$	33	$r3$
$\$_0 E_1$	$+a * a\$$	331	$r1$
$\$_0 E_1 +_2$	$a * a\$$	331	$s2$
$\$_0 E_1 +_2 a_6$	$*a\$$	331	$s6$
$\$_0 E_1 +_2 E_3$	$*a\$$	3313	$r3$
$\$_0 E_1 +_2 E_3 *_4$	$a\$$	3313	$s4$
$\$_0 E_1 +_2 E_3 *_4 a_6$	$\$$	3313	$s6$
$\$_0 E_1 +_2 E_3 *_4 E_5$	$\$$	33133	$r3$
$\$_0 E_1 +_2 E_3$	$\$$	331332	$r2$
$\$_0 E_1$	$\$$	3313321	$r1$

HALT

5. The next assignment, due April 5, will include Exercises 5 through 9 on lalrhandout1, some exercises from lalrhandout2, and some proofs from CanonEnum.