Syntax Analysis - Exercise 1

Consider the following language:

$$L = \{(r\ a^*\ i^*)^n\ (t\ i^*)^n \mid n >= 0\}$$

where the alphabet is A={r, a, i , t}.

1. Define an unambiguous context-free grammar for the language
2. Define an LR grammar for the language and give a table for the bottom-up parser
3. Define an LL grammar for the language and give the corresponding table for the top-down parser

Solution

Exercise 1.1

The following is a non-ambiguous grammar for the language L.

S ::= r A I S t I | ε
A ::= a A | ε
I ::= i I | ε

Exercise 1.2

Let's augment the same grammar and check if it is SLR(1):

S'::= S
S::= r A I S t I
A::= a A | ε
I::= i I | ε

The following is the collection of the items LR(0):

I0 = Clos(S'->.S)	{S'->.S, S->.rAIStI, S-> .}
I1 = G(0,S)	{S'->S.}
I2 = G(0,r) = G(5,r)	{S->r.AIStI, A->.aA, A->.}
I3 = G(2,A)	{S->rA.IStI, I->.iI, I->.}
I4 = G(2,a) = G(4,a)	{A->a.A, A->.aA, A->.}
I5 = G(3,I)	{S->rAI.StI, S->.rAIStI, S-> .}
I6 = G(3,i) = G(6,i) = G(10,i)	{I->i.I, I->.iI, I->.}
I7 = G(4,A)	{A->aA.}
I8 = G(5,S)	{S->rAIS.tI}

I9 = G(6,I)	{I->iI.}
I10 = G(8,t)	{S->rAISt.I, I->.iI, I->.}
I11 = G(10,I)	{S->rAIStI.}

We should check now the presence of conflicts. The states in which possible conflicts can arise are the following: I2 (check follow(A)), I3 (check follow(I)), I4 (check follow(A)), I6 (check follow(I)), I10 (check follow(I)):

Follow	S	{$,t}
	A	{i,r,t}
	I	{r,$,t}

There are no conflicts. The following is the table SLR(1) (productions are numbered from 1 to 6):

Action	r	t	a	i	$	Goto	S	A	I
I0	S/2	R/2	---	---	R/2		I1	---	---
I1	---	---	---	---	accept		---	---	---
I2	R/4	---	S/4	R/4	---		---	I3	---
I3	R/6	R/6	---	S/6	R/6		---	---	I5
I4	R/4	---	S/4	R/4	---		---	I7	---
I5	S/2	R/2	---	---	R/2		I8	---	---
I6	R/6	R/6	---	S/6	R/6		---	---	I9
I7	R/3	---	---	R/3	---		---	---	---
I8	---	S/10	---	---	---		---	---	---
I9	R/5	R/5	---	---	R/5		---	---	---
I10	R/6	R/6	---	S/6	R/6		---	---	I11
I11	---	R/1	-	---	R/1		-	-	---

Exercise 1.3

Let's check if the original grammar is also LL(1):

S::= r A I S t I | ε
A::= a A | ε
I::= i I | ε

FIRST & FOLLOW

FIRST	rAIStI	{r}	**FOLLOW**	S	{t,$}
	aA	{a}		A	{i,r,t}
	ε	{ε}		I	{r,t,$}
	iI	{i}			

Table:

	r	t	a	i	$
S	0	1	---	---	1
A	3	3	2	3	---
I	5	5	---	4	5

The table is not multiply-defined thus the grammar is LL(1).