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Tutorial 3

Q1 Construct predictive parsing table for following grammar and verify (give moves of the parser) for the string "id + id * id".

$E \longrightarrow TE'$

$E' \longrightarrow +TE' \mid \epsilon$

$T \longrightarrow FT'$

$T' \longrightarrow *FT' \mid \epsilon$

$F \longrightarrow (E) \mid id$

Q2 Check the grammar is LL(1) or not:

1) $S \longrightarrow AaAb \mid BbBa$

$A \longrightarrow \epsilon$

$B \longrightarrow \epsilon$

2) $S \longrightarrow iEtSS'$

$S' \longrightarrow eS \mid \epsilon$

$E \longrightarrow b$

Q3 Given the grammar

$S \longrightarrow a \mid (L)$

$L \longrightarrow L, S \mid S$

i) Is the above grammar LL(1)? Justify your answer.

ii) What changes are necessary to make it suitable for LL(1) parser?

iii) Show the moves made by the LL(1) predictive parser on the input (a, (a, a)).

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Q4 Consider a grammar G as follows:

$S \rightarrow W$

$W \rightarrow ZXY \mid XY$

$Y \rightarrow c \mid \epsilon$

$Z \rightarrow a \mid d$

$X \rightarrow Xb \mid \epsilon$

Draw the LL(1) parsing table for the given grammar.

Q5 Consider the following grammar G:

$S \rightarrow Ae$

$A \rightarrow CbD$

$C \rightarrow BC \mid \epsilon$

$B \rightarrow cdD \mid acdD$

$D \rightarrow c \mid \epsilon$

In LL(1) parse table of above grammar G, How many cells are having multiple entries?

1) $E \rightarrow TE'$

$E' \rightarrow +TE' \mid \epsilon$

$T \rightarrow FT'$

$T' \rightarrow *FT' \mid \epsilon$

$F \rightarrow (E) \mid id$

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FIRST (F_i) FOLLOW (F_o)

E	(, id	$,)
E'	+, ϵ	$,)
T	(, id	$, +,)
T'	*, ϵ	$, +,)
F	(, id	$, +, *,)

$F_i(E) = F_i(TE')$
$= F_i(T)$
$= F_i(FT')$
$= F_i(F)$
$= F_i((E)) + F_i(id)$
$= (, id$

$F_i(E') = F_i(+TE') + F_i(\epsilon)$
$= +, \epsilon$

$F_i(T) = F_i(FT')$
$= (, id$

$F_i(T') = F_i(*FT') + F_i(\epsilon)$
$= *, \epsilon$

$F_i(F) = F_i((E)) + F_i(id)$
$= (, id$

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① $E \rightarrow TE'$
② $E' \rightarrow +TE'$
③ $E' \rightarrow \epsilon$
④ $T \rightarrow FT'$
⑤ $T' \rightarrow *FT'$
⑥ $T' \rightarrow \epsilon$
⑦ $F \rightarrow (E)$
⑧ $F \rightarrow id$

$F_o(E) = \$,)$

$F_o(E') = F_o(E)$

$= \$,)$

$F_o(T) = F_i(E')$

$= +, \epsilon \rightarrow +\bullet \cup F_o(E) \bullet \cup F_o(E$

$= +, \$,)$

$F_o(T') = F_o(T)$

$= +, \$,)$

$F_o(F) = F_i(T')$

$= F_i(*, \epsilon)$

$= *, F_o(T), F_o(T')$

$= *, +, \$,)$

① $E \rightarrow TE'$
② $E' \rightarrow +TE'$
③ $E' \rightarrow \epsilon$
④ $T \rightarrow FT'$
⑤ $T' \rightarrow *FT'$
⑥ $T' \rightarrow \epsilon$
⑦ $F \rightarrow (E)$
⑧ $F \rightarrow id$

$F_o(E) = \$,)$

$F_o(E') = F_o(E)$
$= \$,)$

$F_o(T) = F_i(E')$
$= +, \epsilon \rightarrow + \cup F_o(E) \cup F_o(E$
$= +, \$,)$

$F_o(T') = F_o(T)$
$= +, \$,)$

$F_o(F) = F_i(T')$
$= F_i(*, \epsilon)$
$= *, F_o(T), F_o(T')$
$= *, +, \$,)$

	id	+	*	(	)	$
E	(1)			(1)		
E'		(2)			(3)	(3)
T	(4)			(4)		
T'		(6)	(5)		(6)	(6)
F	(8)			(7)		

2) 1) $S \rightarrow AaAb \mid BbBa$

$A \rightarrow \epsilon$

$B \rightarrow \epsilon$

No Left recursion.

$Fi(S) = Fi(AaAb) \cup Fi(BbBa)$

$= a, b$

$Fi(A) = \epsilon$

$Fi(B) = \epsilon$

$Fo(S) = \$$

$Fo(A) = a, b$

$Fo(B) = a, b$

$S \rightarrow AaAb$

$S \rightarrow BbBa$

$A \rightarrow \epsilon$

$B \rightarrow \epsilon$

	$	a	b
S	(1)(2)	(1)(5)	(1)(2)
A		(3)	(3)
B		(3)	(3)

Not a LL(1) grammar

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2) $S \rightarrow iEtSS'$ ①
$S' \rightarrow eS \mid \epsilon$ ② ③
$E \rightarrow b$ ④

	First	Follow
S	i	e, $
E	b	t
E'	e, ϵ	e, $

~~S → iEtSS~~

	i	t	c	b	$
S	①		③		
E				④	
S'			②③		

∴ Conflicting grammar, not LL1

3) $S \rightarrow a \mid (L)$
$L \rightarrow L, S \mid S$

(i) Left recursion exists, so not LL1

(ii) Removing LR,
$L \rightarrow ,SL'$
$L' \rightarrow ,SL' \mid \epsilon$

iii)

	First	Follow
S	(, a	$,), a
L	(, a	)
L'	), ϵ	)

	a	,	(	)	$
S	(2)		(1)		accept
L	(3)		(3)		
L'		(4)			

∴ LL1 grammar

4) $S \rightarrow W$
$W \rightarrow ZXY \mid XY$
$Y \rightarrow c \mid \epsilon$
$Z \rightarrow a \mid d$
$X \rightarrow Xb \mid \epsilon$

Remove LR, $X \rightarrow X'$
$X' \rightarrow bX' \mid \epsilon$

	First	Follow
S	a, b, c, d, ϵ	$
W	a, b, c, d, ϵ	$
X	b, ϵ	c, b, $
Y	c, ϵ	$
Z	a, d	b, c, $

	a	b	c	d	$
S	(1)	(1)	(1)	(1)	(1)
W	(2)	(3)	(3)	(2)	(3)
X		(5) (5)	(9)		
Y			(4)		
Z	(6)			(7)	

Ambiguous grammar, not LL1

5) $S \rightarrow Ae$

$A \rightarrow CbD$

$C \rightarrow BC \mid \epsilon$

$B \rightarrow cdD \mid acdD$

$D \rightarrow c \mid \epsilon$

	First	Follow
S	a b c	$
A	a b c	e
B	c a	a b c
C	c a ϵ	b
D	c ϵ	a b c e

	a	b	c	d	e	$
S	(1)		(1)			
A	(2)	(2)	(2)			
B	(6)		(5)			
C	(4)	(5)	(4)			
D	(8)	(8)	(8) (7)		(8)	

Conflicting rules, not LL1