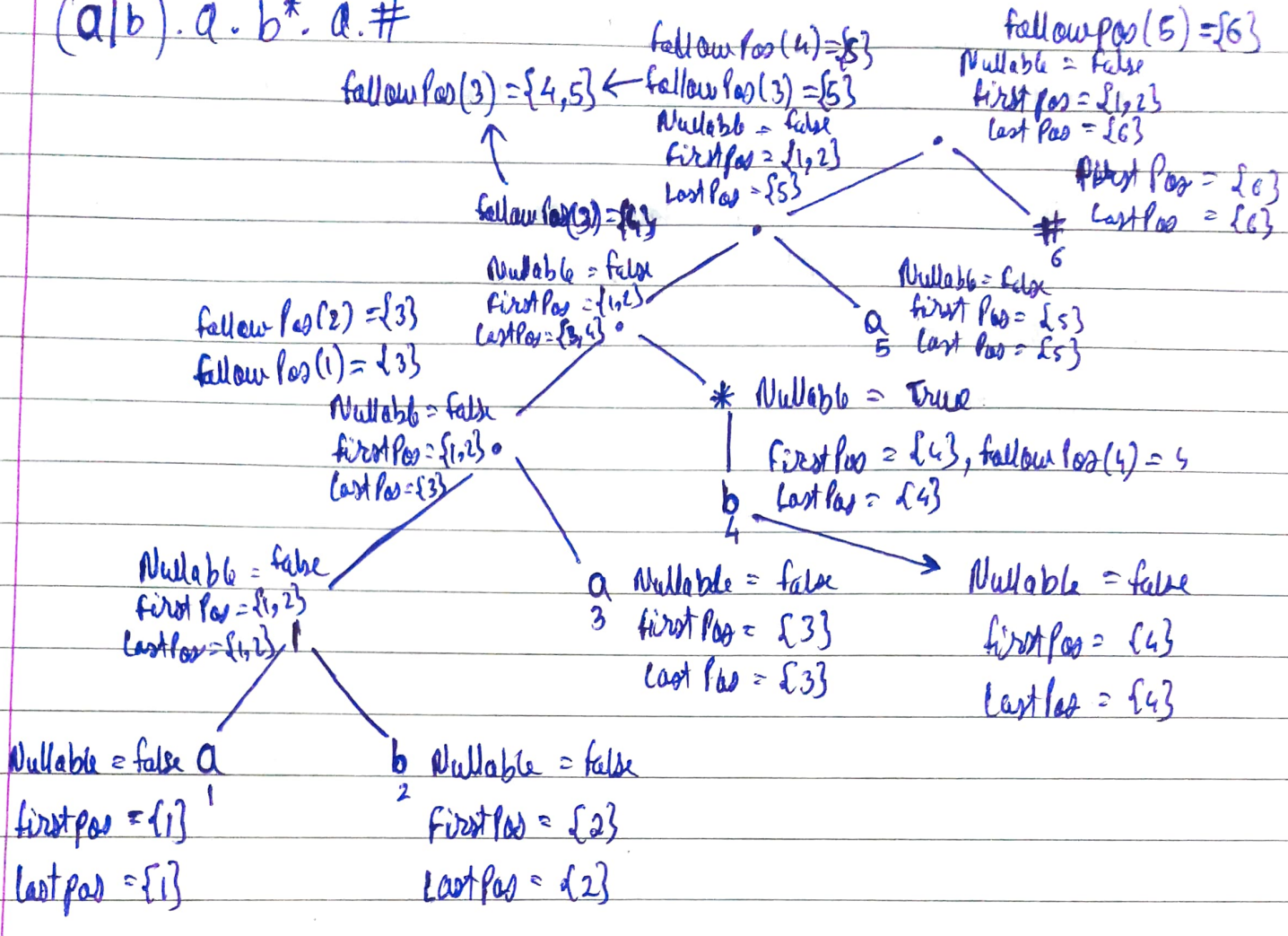
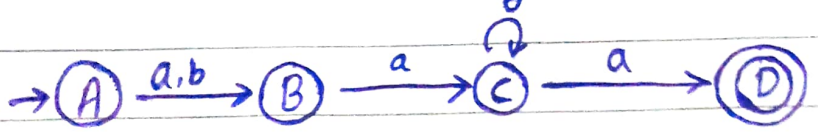
$(a|b).a.b^*.a.\#$



followPos(1) = {3}
followPos(2) = {3}
followPos(3) = {4,5}
followPos(4) = {4,5}
followPos(5) = {6}

firstPos of root Node = {1,2} = A
DFA[A, a] = followPos(1) = {3} = B
DFA[A, b] = followPos(2) = {3} = B
DFA[B, a] = followPos(3) = {4,5} = C
DFA[C, a] = followPos(5) = {6} = D
DFA[C, b] = followPos(4) = {4,5} = C

D.F.A for given R.E.



$S \to aB \mid BC$
$A \to Aa \mid Ac \mid b$
$B \to b$

$\alpha_1 = a \quad \alpha_2 = c \quad \beta_1 = b$

$A \to b A'$
$A' \to aA' \mid cA' \mid \varepsilon$

Unit2Q1

* $S \to ACB \mid CbB \mid Ba$
$A \to da \mid BC$
$B \to g \mid \varepsilon$
$C \to h \mid \varepsilon$

Calculate First Set

First(S) = First(ACB) ∪ First(CbB) ∪ (First Ba) → ①
First(ACB) = First(A) → ②
First(A) = First(da) ∪ First(BC)
First(da) = {d}
First(BC) = First(B) → ③
First(B) = First(g) ∪ First(ε)
= {g, ε} ⇒ Next Rule
First(BC) = First(B) − {ε} ∪ First(C) → ④
First(C) = {h, ε}
First(BC) = {g, ε} − {ε} ∪ {h, ε}
First(A) = {d} ∪ {g, h, ε} = {d, g, h, ε}

$first(ACB) = first(A) - \{\varepsilon\} \cup first(CB)$

$first(CB) = first(C) = \{h, \varepsilon\}$

$first(CB) = first(C) - \{\varepsilon\} \cup first(B)$

$first(CB) = \{h, g, \varepsilon\} - \{\varepsilon\} \cup \{g, \varepsilon\}$

$= \{g, h, \varepsilon\}$

$first(ACB) = \{d, g, h, \varepsilon\} - \{\varepsilon\} \cup \{g, h, \varepsilon\}$

$= \underline{\{d, g, h, \varepsilon\}}$

$first(CbB) = first(C) = \{h, \varepsilon\}$

$first(C, b, B) = first(C) - \{\varepsilon\} \cup first(b, B)$

$= \{h, \varepsilon\} - \{\varepsilon\} \cup \{b\}$

$= \underline{\{b, h\}}$

$\underline{first(Ba) = \{g, a\}}$

$first(S) = \{a, b, d, g, h, \varepsilon\}$

* Examples on Left Recursion

1) $A \rightarrow Aa \mid b$

$B \rightarrow c$

Considering : $A \rightarrow Aa \mid b$

$\alpha = a$

$\beta = b$

$\Rightarrow A \rightarrow bA'$

$A' \rightarrow aA' \mid \varepsilon$

Final Production Rules :

$A \rightarrow bA'$

$A' \rightarrow aA' \mid \varepsilon$

$B \rightarrow c$

2) $A \rightarrow AaAa \mid AbBb \mid c$

$B \rightarrow c$

Considering : $A \rightarrow AaAa \mid AbBb \mid c$

$\alpha_1 = aAa \quad \alpha_2 = bBb$

$\beta = c$

$\Rightarrow A \rightarrow cA'$

$A' \rightarrow aAaA' \mid bBbA' \mid \varepsilon$

Final Production Rules :

$A \rightarrow cA'$

$A' \rightarrow aAaA' \mid bBbA' \mid \varepsilon$

$B \rightarrow c$

3)

$A \rightarrow Aa \mid Ab \mid Bc \mid Bd$

$B \rightarrow Ba \mid d$

Considering : $A \rightarrow Aa \mid Ab \mid Bc \mid Bd$

$\alpha_1 = a \quad \alpha_2 = b$

$\beta_1 = Bc \quad \beta_2 = Bd$

$\Rightarrow A \rightarrow BcA' \mid BdA'$

$A' \rightarrow aA' \mid bA' \mid \varepsilon$

Considering : $B \rightarrow Ba \mid d$

$\alpha = a$

$\beta = d$

$B \rightarrow dB'$

$B' \rightarrow aB' \mid \varepsilon$

Final Production Rules :

$A \rightarrow BcA' \mid BdA'$

$A' \rightarrow aA' \mid bA' \mid \varepsilon$

$B \rightarrow dB'$

$B' \rightarrow aB' \mid \varepsilon$

4) $A \rightarrow AabB \mid AbcB \mid b \mid c$

$B \rightarrow c$

Considering : $A \rightarrow AabB \mid AbcB \mid b \mid c$

$\alpha_1 = abB \quad \alpha_2 = bcB$

$\beta_1 = b \quad \beta_2 = c$

$\Rightarrow A \rightarrow bA' \mid cA'$

$A' \rightarrow abBA' \mid bcBA' \mid \varepsilon$

Final Production Rules : $A \rightarrow bA' \mid cA'$

$A' \rightarrow abBA' \mid bcBA' \mid \varepsilon$

$B \rightarrow c$

5)

$A \rightarrow Aabc \mid ABac \mid Bac \mid baB$

$B \rightarrow b$

Considering : $A \rightarrow Aabc \mid ABac \mid Bac \mid baB$

$\alpha_1 = abc \quad \alpha_2 = Bac$

$\beta_1 = Bac \quad \beta_2 = baB$

$\Rightarrow A \rightarrow BacA' \mid baBA'$

$A' \rightarrow abcA' \mid BacA' \mid \varepsilon$

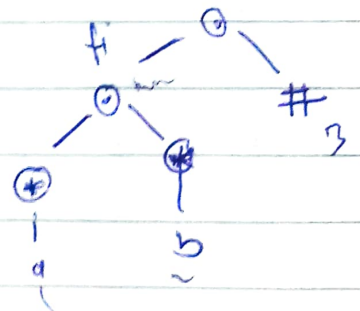
Final Production Rules :

$A \rightarrow BacA' \mid baBA'$

$A' \rightarrow abcA' \mid BacA' \mid \varepsilon$

$B \rightarrow b$

$a^* b^*$



$a^* b^*$

ab

Q1.

$S \to aBDh$
$B \to Bb \mid c$
$D \to EF$
$E \to g \mid \varepsilon$
$F \to f \mid \varepsilon$

$\Rightarrow$

$S \to aBDh$
$B \to cB'$
$B' \to bB' \mid \varepsilon$
$D \to EF$
$E \to g \mid \varepsilon$
$F \to f \mid \varepsilon$

$first(S) = first(aBDh) = \{a\}$
$first(B) = \{c\}$
$first(B') = \{b, \varepsilon\}$
$first(D) = first(EF) = first(E) - \{g \mid \varepsilon\}$
$first(D) = first(E) - \{\varepsilon\} \cup first(F)$
$= \{g, \varepsilon\} - \{\varepsilon\} \cup \{f, \varepsilon\}$
$= \{g, f, \varepsilon\}$
$first(E) = \{g, \varepsilon\}$
$first(F) = \{f, \varepsilon\}$

Q.

$A \to BCc \mid gDB$
$B \to bCDE \mid \varepsilon$
$C \to DaB \mid c$
$D \to \varepsilon \mid dD$
$E \to Eaf \mid c \to E \to cE'$
$E' \to afE' \mid \varepsilon$

$first(B) = \{b, \varepsilon\}$
$first(D) = \{d, \varepsilon\}$
$first(E) = \{c\}$
$first(E') = \{a, \varepsilon\}$

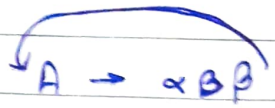
$first(A) = first(BCc) \cup first(gDB)$
$first(BCc) = first(B) = \{b, \varepsilon\}$
$= first(B) - \{\varepsilon\} \cup first(cc)$
$= \{a, b, c, d\}$

$first(A) = \{a, b, c, d, g\}$

$first(c) =$
$first(c)$
$= first(DaB) \cup first(ca)$
$first(DaB) = first(D)$
$= \{d, \varepsilon\}$
$= \{d, \varepsilon\} - \{\varepsilon\} \cup first(aB)$
$= \{a, d\}$
$first(cc) = \{a, c, d\}$

② Follow Information.

Calculated for Non Terminal symbols of RHS



follow (B) = first(β)

if first (β) contains ε

follow (B) = first(β) − {ε} ∪ follow (A)

S → aBDh
B → cB'
B' → bB' | ε
D → EF
E → g | ε
F → f | ε

	First	Follow
S	{a}	{$}
B	{c}	{g, f, h}
B'	{b, ε}	{g, f, h}
D	{g, f, ε}	{h}
E	{g, ε}	{f, h}
F	{f, ε}	{h}

* Design of LL(1) Parser

Ex(1) : Grammar → (String)
↳ Parser →

$S \to PQR$
$P \to aB|b|C$
$Q \to q|rP$

Step 1 (FIRST)

$First(S) = First(PQR) = First(P)$
$First(P) = First(aP) \cup First(b) \cup First(c) = \{a, b, c\} = First(S)$
$First(Q) = First(q) \cup First(rP) = \{q, r\}$

Step 2 (Follow)

$Follow(S) = \{\$\}$
$Follow(P) = First(Q,R) = First(q) = \{q, r\}$
$Follow(Q) = First(R) = \{R\}$
$Follow(P) = Follow(P) = \{q, r\} = \{q, r\}$
$Follow(P) = Follow(Q) = \{R\} =$

Step 3 First - follow Table

NT	First	Follow
S	{a, b, c}	{$}
P	{a, b, c}	{q, r}
Q	{q, r}	{R}

Step 4 Parser

NT \ T	a	b	c	q	r	$
S	S → PQR	S → PQR	S → PQR			
P	P → aP	P → b	P → c			
q				q → q	q → rP	

String → acrbr

Buffer	Stack	Action
$rbrc@	(S)$	S → PQR
$rbrc@	(P)Qr$	P → aP
$rbrc@	@PQr$	Matched
$rbrc	(P)Qr$	P → c
$rbrc	(c)Qr$	Matched
$rb@	(Q)r$	Q → rP
$rb	(r)P r ($)	Matched
$rb	(P)r$	P → b
$r	(b)r$	Matched
$r	(r)$	Matched
$	$	Accepted

Example 2:

$S \rightarrow Abc \mid ad$

$A \rightarrow es \mid Cr \mid \varepsilon$

$C \rightarrow f \mid p \mid \varepsilon$

First(Abc) = {e, f, p, r, b}

First(Cr) = {p, f, r}

	First	Follow
S	{a, b, e, f, p, r}	{b, $}
A	{e, f, p, r, ε}	{b}
C	{f, p, ε}	{r}

	a	b	e	f	p	r	$
S		S→Abc	S→Abc	S→Abc	S→Abc	S→Abc	
A		A→ε	A→eS	A→Cr	A→Cr	A→Cr	
C				C→f	C→p	C→ε	

String → frbc

Buffer	Stack	Action
$ cbrf	$S	S→Abc
$cbrf	Abc$	A→Cr
$cbrf	Crbc$	C→f
$cbrf	frbc$	Matched
$cbr	rbc$	Match
$cb	bc$	Match
$c	c$	Match
$	$	Accepted

S → e x bc bc

$

* S → iLuETa
L → LS | ε → Left Recursion
E → b
T → d_e | ε

L → LS | ε

L → εL' ⇒ L → L'
L' → SL' | ε

⇒

S → iLuEUETa
L → SL | ε
E → b
T → de | ε

First(S) = {i, a}
First(L) = {i, a, ε}
First(E) = {b}
First(T) = {d, ε}

Follow(S) = {$$, i, a, u}
Follow(L) = {u}
Follow(E) = {d, e, $, i, a, u, $}

Tutorial Question on LL(1) Parsing Technique

Q1: $S \to cTuYZ \mid a$

$T \to TS \mid c$

$Y \to b \mid \varepsilon$

$Z \to dTe \mid \varepsilon$

Rule with left Recursion

$T \to TS \mid c$

Removing left Recursion

$T \to cT'$

$T' \to ST' \mid \varepsilon$

New Production Rules

$S \to cTuYZ \mid a$

$T \to cT'$

$T' \to ST' \mid \varepsilon$

$Y \to b \mid \varepsilon$

$Z \to dTe \mid \varepsilon$

$First(S) = First(cTuYZ) \cup First(a)$

$= \{c\} \cup \{a\}$

$= \{c, a\}$

$First(T) = First(cT')$

$= \{c\}$

$First(T') = First(ST') \cup First(\varepsilon)$

$= First(S) \cup \{\varepsilon\}$

$= \{c, a, \varepsilon\}$

First (Y) = {b, ε}
First (Z) = {d, ε}

Follow (S) = {$}

Follow (T) = First (u Y Z)
= {u} - {U, e}

Follow (T') = Follow (T)
= {u} = {U, e}

Follow (Y) = First (Z)
= {d, ε}
= {d, ε} - {ε} ∪ Follow (S)
= {d, $}

Follow (Z) = Follow (S)
= {$} ∪ {c, a, U, ε}

Follow (T) = {e} = {e, u}

Follows (S) = First (T') - ε ∪ Follow (T')
= {c, a, ε} - {ε} ∪ {U, e}
= {c, a, U, ε}

Non Terminal	First Set	Follow Set
S	{c, a}	{c, a, U, e, c, $}
T	{c}	{U, e}
T'	{c, a, ε}	{U, e}
Y	{b, ε}	{c, a, U, e, d, $}
Z	{d, ε}	{c, a, U, e, $}

Q2.

NT	a	b	c	d	e	v	$
S	$S \to a$		$S \to cTvY\varepsilon$				
T			$T \to cT'$				
Y	$Y \to \varepsilon$	$Y \to b$	$Y \to \varepsilon$	$Y \to \varepsilon$	$Y \to \varepsilon$	$Y \to \varepsilon$	$Y \to \varepsilon$
Z	$Z \to \varepsilon$		$Z \to \varepsilon$	$Z \to dTe$	$Z \to \varepsilon$	$Z \to \varepsilon$	$Z \to \varepsilon$
T'	$T' \to ST'$		$T' \to ST'$		$T' \to \varepsilon$	$T' \to \varepsilon$	

LR Parser

SLR - Simple LR
- LR (0)

Construct - Parser
"Canonical"

Steps: 1] Grammar Augmentation
2] DOT addition
3] Closure : String $\left(\frac{NT}{T}\right)$ or

Ex. Grammar

$E \to E+T$
$E \to T$
$T \to T*F$
$T \to F$
$F \to (E)$
$F \to id$

$\Rightarrow$

I_0
$E' \to .E$
$E \to .E+T$ ①
$E \to .T$ ②
$T \to .T*F$ ③
$T \to .F$ ④
$F \to .(E)$ ⑤
$F \to .id$ ⑥

$Goto(I_0, E) = I_1$
$E' \to E.$
$E \to E.+T$

$Goto(I_0, T) = I_2$
$E \to T.$
$T \to T.*F$

$Goto(I_0, F) = I_3$
$T \to F.$

$Goto(I_0, id) = I_5$
$F \to id.$

$Goto(I_0, ( ) = I_4$
$F \to (.E)$
$E \to .E+T$
$E \to .T$
$T \to .T*F$
$T \to .F$
$F \to .(E)$
$F \to .id$

$Goto(I_4, E) = I_8$
$F \to (E.)$
$E \to E.+T$

$Goto(I_4, T) = I_2$
$Goto(I_4, F) = I_3$
$Goto(I_4, ( ) = I_4$
$Goto(I_4, id) = I_5$

$Goto(I_8,)) = I_{11}$
$F \to (E).$

$Goto(I_8, +) = I_6$

$Goto(I_9, *) = I_7$

$Goto(I_6, F) = I_3$
$Goto(I_6, ( ) = I_4$
$Goto(I_6, id) = I_5$

$Goto(I_6, T) = I_9$
$E \to E+T.$
$T \to T.*F$

$Goto(I_1, +) = I_6$
$E \to E+.T$
$T \to .T*F$
$T \to .F$ $F \to .(E)$ $F \to .id$

$Goto(I_2, *) = I_7$
$T \to T*.F$
$F \to .(E)$
$F \to .id$

$Goto(I_7, F) = I_{10}$
$T \to T*F.$

$Goto(I_7, ( ) = I_4$
$Goto(I_7, id) = I_5$

Parsing table

- Shift
- Reduce

Two Parts

Action → Terminal

go to → Non-terminal

State	Action						go To		
	id	+	*	(	)	$	E	T	F
I_0	S_5			S_4			1	2	3
I_1		S_6				Accept			
I_2		R_2	S_7		R_2	R_2			
I_3		R_4	R_4		R_4	R_4			
I_4	S_5			S_4			8	2	3
I_5		R_6	R_6		R_6	R_6			
I_6								9	3
I_7	S_5			S_4					10
I_8		S_6			S_{11}				
I_9		R_1	S_7		R_1	R_1			
I_{10}		R_3	R_3		R_3	R_3			
I_{11}		R_5	R_5		R_5	R_5			

↓

No Multiple Entries

⇒ Valid LR(0) / SLR

Follow(E) = {$, +,)}

Follow (T) = {$, +,), *}

Follow (F) = {$, +,), *}

Ex.

$S \to AxB \mid Bc$

$A \to yA \mid z$

$B \to xB \mid \varepsilon$

Step 1:

$S' \to .S$ ⓪

$S \to .AxB$ ①

$S \to .Bc$ ②

$A \to .yA$ ③

$A \to .z$ ④

$B \to .xB$ ⑤

$B \to .$ ⑥

Step 2:

Closure $(S' \to .S) = I_0$

$S' \to .S$

$S \to .AxB$

$S \to .Bc$

$A \to .yA$

$A \to .z$

$B \to .xB$

$B \to .$

Follow(S) = {$}

Follow(B) = {$, c}

Follow(A) = {x}

Goto $(I_0, S) = I_1$

$S' \to S.$

Goto $(I_0, A) = I_2$

$S \to A.xB$

Goto $(I_0, y) = I_4$

$A \to y.A$

$A \to .yA$

$A \to .z$

Goto $(I_0, z) = I_5$

$A \to z.$

Goto $(I_0, x) = I_6$

$B \to x.B$

$B \to x.B$

$B \to .$

Goto $(I_2, x) = I_7$

$S \to Ax.B$

$B \to .xB$

$B \to .$

Goto $(I_3, c) = I_8$

$S \to Bc.$

Goto $(I_4, A) = I_9$

$A \to yA.$

Goto $(I_4, y) = I_4$

Goto $(I_4, z) = I_5$

Goto $(I_6, B) = I_{10}$

$B \to xB.$

Goto $(I_6, x) = I_6$

Goto $(I_7, B) = I_{11}$

$S \to AxB.$

Goto $(I_7, x) = I_6$

-

	x	y	z	c	$	S	A	B
I_0	S_6	S_4	S_5	r_6	r_6	1	2	3
I_1					Accept			
I_2	S_7							
I_3				S_8				
I_4		S_4	S_5					
I_5	r_4							
I_6	S_6			r_6	r_6			
I_7	S_6			r_6	r_6			

- String Parser Using Stack

String $w = yzxx$

$w = yzxx\$$

Number ⇒ state ⇐ Stack	Buffer	Action
0	$yzxx\$$	Table(0, y) = S4
0y4	$zxx\$$	Table(4, z) = S_5
0y4z5	$xx\$$	Table(5, x) = r_4
0y4A9	$xx\$$	Table(9, x) = r_3
0A2	$xx\$$	Table(2, x) = S7
0Ax7	$x\$$	Table(7, x) = S6
0A2x7x6	$\$$	Table(6, $) = r_6
0A2x7B11	$\$$	Table(11, $) = r_1
0S1	$\$$	Accept

Given Production Rules

$E \rightarrow E+T$ ①
$E \rightarrow T$ ②
$T \rightarrow T*F$ ③
$T \rightarrow F$ ④
$F \rightarrow (E)$ ⑤
$F \rightarrow id$ ⑥

Parser Table

State	Action						Goto		
	id	+	*	(	)	$	E	T	F
0	S5			S4			1	2	3
1		S6				Accept			
2		R2	S7		R2	R2			
3		R4	R4		R4	R4			
4	S5			S4			8	2	3
5		R6	R6		R6	R6			
6	S5			S4				9	3
7	S5			S4					10
8		S6			S11				
9		R1	S7		R1	R1			
10		R3	R3		R3	R3			
11		R5	R5		R5	R5			

String $w =$ id * id + id $

CLR Parsing / LR(1) Parsing

Canonical L R Stack

LR(1) → Extension of LR(0)

G → Not LR(0) | Conflict - Shift + Reduce
→ LR(1) | - Reduce + Reduce

LR(1) → optimise LR(0) Shift - Red. Conflict
operator overloading

* S → CC
C → eC | d

Sol^n: Step 1 - Augmented

S' → .S ⓪
S → .CC ①
C → .eC ②
C → .d ③

Step 2:

Closure of [S' → .S, $] = I_0

S' → .S , $
S → .C C , $ First(C) = {e, d}
C → .eC , e/d
C → .d , e/d

Goto (I_0, S) = I_1

S' → S. , $

Goto (I_0, C) = I_2

S → C.C , $
C → .eC, $
C → .d, $

goto $(I_0, e) = I_3$

$C \to e.C$, e/d

$C \to .eC$, e/d

$C \to .d$

goto $(I_0, d) = I_4$

$C \to d.$, e/d

goto $(I_2, e) = I_6$

$C \to eC.$, $

$C \to .eC$, $

$C \to .d$

goto $(I_2, C) = I_5$

$S \to CC.$, $

goto $(I_2, d) = I_7$

$C \to d.$, $

goto $(I_3, C) = I_8$

$C \to eC.$ e/d

goto $(I_3, e) = I_3$

goto $(I_3, d) = I_4$

goto $(I_6, C) = I_9$

$C \to eC.$, $

goto $(I_6, e) = I_6$

goto $(I_6, d) = I_7$

State	e	d	$	S	C
I_0	S_3	S_4		1	2
I_1			Accept		
I_2	S_6	S_7			5
I_3	S_3	S_4			8
I_4	R_3	R_3			
I_5			R_1		
I_6	S_6	S_7			9
I_7			R_3		
I_8	R_2	R_2			
I_9			R_2		

- LALR
  - ↳ Look Ahead

I_{36}

$C \to e.C$ e/d/$

$C \to .eC$ e/d/$

$C \to .d$ e/d/$

I_{47}

$C \to d.$ e/d/$

I_{89}

$C \to d.$ e/d/$

Ex:

$A \to aCDg \mid aBg \mid \epsilon$

$D \to d \mid \epsilon$

$B \to e \mid \epsilon$

$C \to Ct \mid p \mid BD \mid rAB \mid \epsilon$

$A' \to A$

$A \to .aCDg$ (1)

$A \to .aBg$ (2)

$A \to .$ (3)

$D \to .d$ (4)

$D \to .$ (5)

$B \to .e$ (6)

$B \to .$ (7)

$C \to .Ct$ (8)

$C \to .p$ (9)

$C \to .BD$ (10)

$C \to .rAB$ (11)

$C \to .$ (12)

Closure of $A' \to .A, \$ = I_0$

$A' \to .A, \$$

$A \to .aCDg, \$$

$A \to .aBg, \$$

$A \to ., \$$

Goto $(I_0, A) = I_1$

$A' \to A., \$$

goto $(I_0, a) = I_2$

$A \to a.CDq$, \$
$A \to a.Bg$, \$
$B \to .e$, g, d, q, t
$B \to .$, g, d, q, t
$C \to .Ct$, d, q, t
$C \to .p$, d, q, t
$C \to .BD$, d, q, t
$C \to .rAB$, d, q, t
$C \to .$, d, q, t

goto $(I_2, C) = I_3$

$A \to aC.Dq$, \$
$C \to C.t$, d, q, t
$D \to .d$, q
$D \to .$, q

goto $(I_2, B) = I_4$

$A \to aB.g$, \$
$C \to B.D$, d, q, t
$D \to .d$, d, q, t
$D \to .$, d, q, t

goto $(I_2, e) = I_5$

$B \to e.$, g, d, q, t

goto $(I_2, p) = I_6$

$C \to p.$, d, q, t

goto $(I_2, r) = I_7$

$C \to r.AB$, d, q, t
$A \to .aCDq$, e, d, q, t
$A \to .aBg$, e, d, q, t

goto $(I_3, D) = I_8$

$A \to aCD.q$, \$

goto $(I_3, t) = I_9$

$C \to Ct.$, d, q, t

goto $(I_3, d) = I_{10}$

$D \to d.$, q

goto $(I_4, g) = I_{11}$

$A \to aBg.$, \$

goto $(I_4, D) = I_{12}$

$C \to BD.$, d, q, t

goto $(I_4, d) = I_{13}$

$D \to d.$, d, q, t

goto $(I_7, 2) = I_{14}$

$C \to 2A \cdot B$, d, q, t

$B \to \cdot e$, d, q, t

$B \to \cdot$, d, q, t

goto $(I_7, a) = I_{15}$

$A \to a \cdot CDq$ e, d, q, t

$A \to a \cdot Bg$ e, d, q, t

$B \to \cdot e$ g, d, q, t

$B \to \cdot$ g, d, q, t

$C \to \cdot Ct$ d, q, t

$C \to \cdot P$ d, q, t

$C \to \cdot BD$ d, q, t

$C \to \cdot 2AB$ d, q, t

$C \to \cdot$ d, q, t

goto $(I_8, q) = I_{16}$

$A \to aCDq \cdot$, $

goto $(I_{14}, B) = I_{17}$

$C \to 2AB \cdot$, d, q, t

goto $(I_{15}, C) = I_{18}$

$A \to aC \cdot Dq$, e, d, q, t

$D \to \cdot d$, q

$D \to \cdot$, q

goto $(I_{15}, B) = I_{19}$

$A \to aB \cdot g$ e, d, q, t

$C \to B \cdot D$ d, q, t

$D \to \cdot d$ d, q, t

$D \to \cdot$ d, q, t

goto $(I_{15}, e) = I_5$

goto $(I_{15}, P) = I_6$

goto $(I_{15}, 2) = I_7$

goto $(I_{18}, D) = I_{20}$

$A \to aCD \cdot q$, e, d, q, t

goto $(I_{18}, d) = I_{10}$

goto $(I_{19}, g) = I_{21}$

$A \to aBg \cdot$, e, d, q, t

goto $(I_{19}, D) = I_{12}$

goto $(I_{19}, d) = I_{13}$

goto $(I_{20}, q) = I_{22}$

~~$A \to aCDq \cdot$, e, t, q, t~~

$A \to aCDq \cdot$, e, d, q, t

For LALR parser sets are

$I_2 = I_{15} \Rightarrow I_{215}$

$A \to a \cdot CDq$	$\$, e, d, q, t$
$A \to a \cdot Bg$	$\$, e, d, q, t$
$B \to \cdot e$	g, d, q, t
$B \to \cdot$	g, d, q, t
$C \to \cdot Ct$	d, q, t
$C \to \cdot p$	d, q, t
$C \to \cdot BD$	d, q, t
$C \to \cdot zAB$	d, q, t
$C \to \cdot$	d, q, t

$I_3 = I_{18} = I_{318}$

$A \to aC \cdot Dq$	$\$, e, d, q, t$
$D \to \cdot d$	q
$D \to \cdot$	q

$I_4 = I_{19} = I_{419}$

$A \to aB \cdot g$	$\$, e, d, q, t$
$C \to B \cdot D$	d, q, t
$D \to \cdot d$	d, q, t
$D \to \cdot$	d, q, t

$I_8 = I_{20} = I_{820}$

$A \to QCD \cdot q$	$\$, e, d, q, t$

$I_{16} = I_{24} = I_{1622}$

$A \to aCDq \cdot$	$\$, e, d, q, t$

Parser Table

State	a	q	g	d	e	t	p	r	$	A	B	C	D
0	S215								r3	1			
1									Accept				
215		r7,r12	r7	r7,r12	S5	r7,r12	S6	S7			48	318	
318		r5		S10		S9					4		820
419		r5,	S11	r5		r5							12
5		r6	r6	r6		r6							
6		r9		r9		r9							
7	S225							S14					
820		S1622											
9		r8		r8		r8							
10		r4											
11									r2				
12		r10		r10		r10							
13		r4		r4		r4							
14		r7		r7		r7					17		
1622		r1		r1		r1			r1				
17		r11		r11		r11							
21		r2		r2	r2	r2							