# Compiler Design Project

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# Problem Statement

- Parsing DML of SQL language using LL(1) grammar
- Validates Insertion, Deletion and Select statements
- Other Features
  - Support for where, group by and order by clauses
  - Conditional and Relational operators
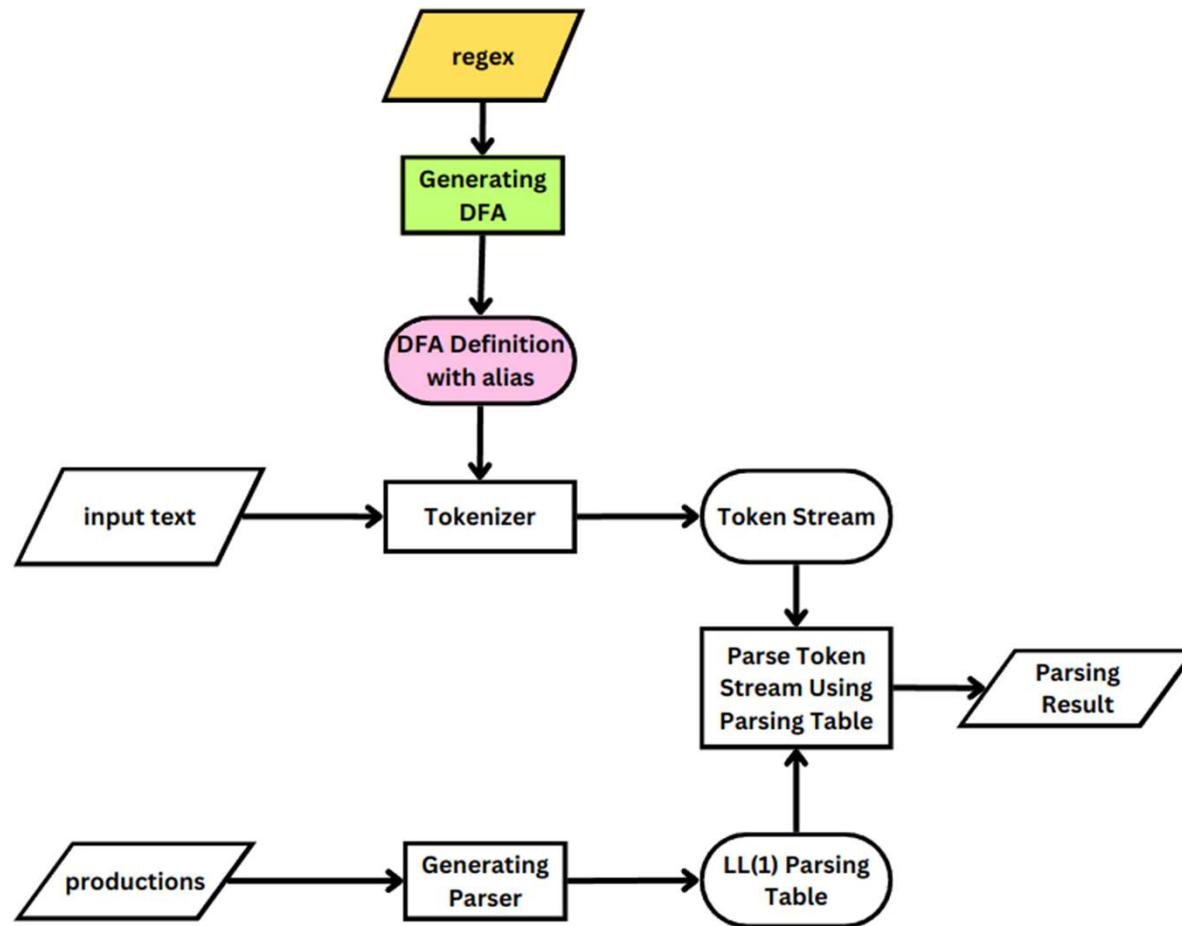  - Support for tablename.attribute notation

# Technologies Used

- Major programming language: **C++**
  - Creation of Lexical analyser
  - Creation of LL(1) parsing table
  - Validating SQL statements for syntax errors
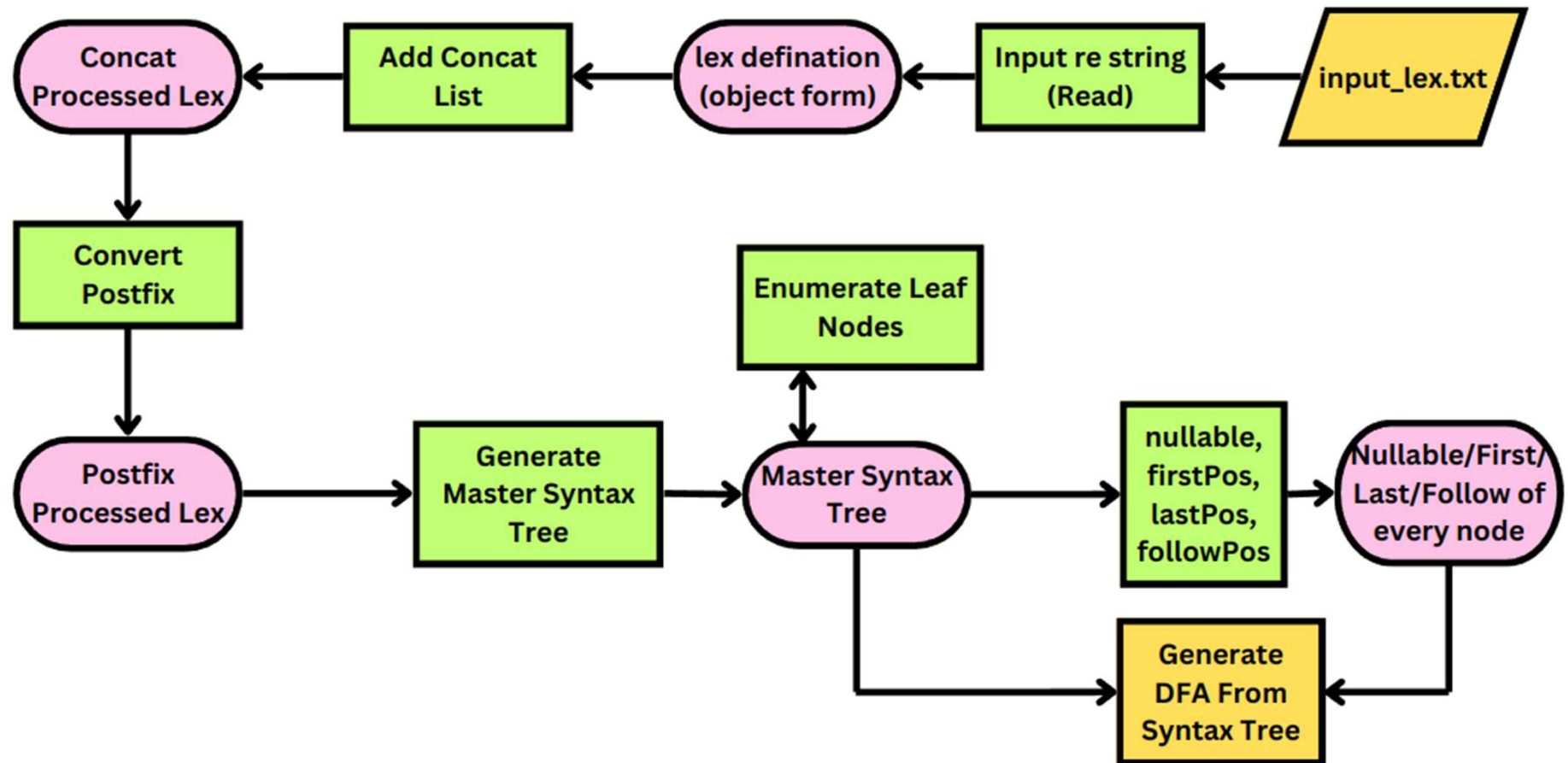- Visualisation: **Igraph** library of **python**

# Overall Flow Diagram
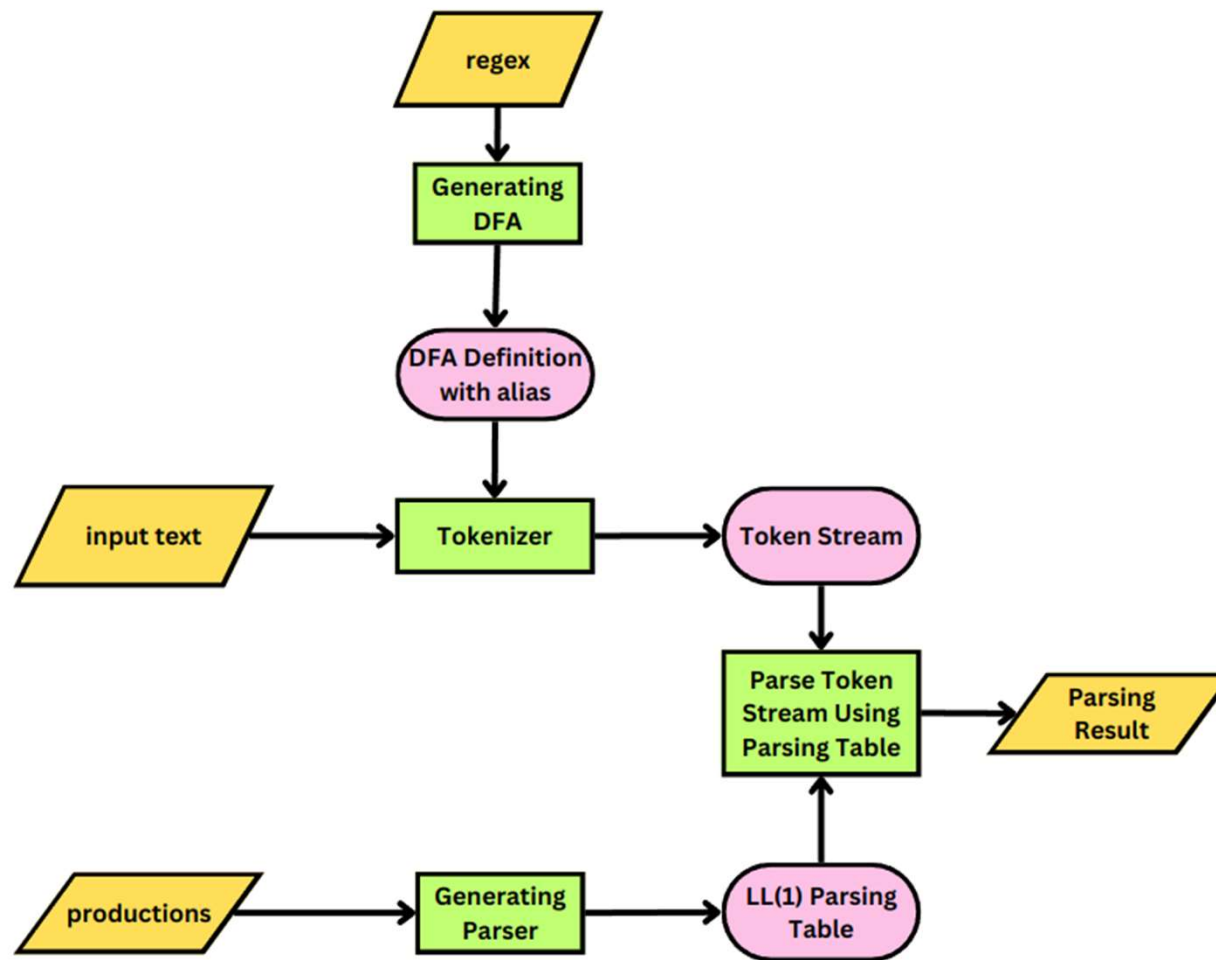
# Generating DFA

# Classes and functions for DFA creation

# Generating DFA for Lexical Analysis

- It is a multi step procedure which consists of
  - Creation of the Regular expressions
    - Concat processed lex definition
    - Postfix processed lex definition
  - Creating Master Syntax tree for the regular expressions
    - Creating syntax tree for each regular expression
  - Evaluation of nullable, first-pos, last-pos and follow-pos of every node, followed by annotation
  - Creating DFA from syntax tree (with alias)

# Regular Expressions

```
 1 DELETE    DELETE
 2 INTO      INTO
 3 INSERT    INSERT
 4 >=        >=
 5 >         >
 6 =         =
 7 <=        <=
 8 <         <
 9 \)        )
10 \(        (
11 VALUES    VALUES
12 \.        .
13 ;         ;
14 BY        BY
15 OR        OR
16 SELECT    SELECT
17 WHERE     WHERE
18 GROUP     GROUP
19 ORDER     ORDER
20 HAVING    HAVING
21 AND       AND
22 FROM      FROM
23 ,         ,
24 NOT       NOT
25 \n+\t+    SEP
26 (a+b+....+y+z)(1+2+..+8+9+0+a+b+...+y+z)*
27 ID
```

- There are 26 Regular expressions

- For each line (except the last two), the two values separated by tab indicate the **regular expression** and the **token type** returned by that regular expression

# Concat Processed Lex Definition

- Inserting Concatenation operator appropriately
- Example:

  □ $$DELETE \xrightarrow{\text{Concatenation}} D.E.L.E.T.E$$

  □ $$a+bcd+ef(gf(e+fg)*hi)jkl \xrightarrow{\text{Concatenation}} a+b.c.d+e.f.(g.f.(e+f.g)*.h.i).j.k.l$$

# Postfix Processed Lex

- Converting Infix regular expression to postfix form
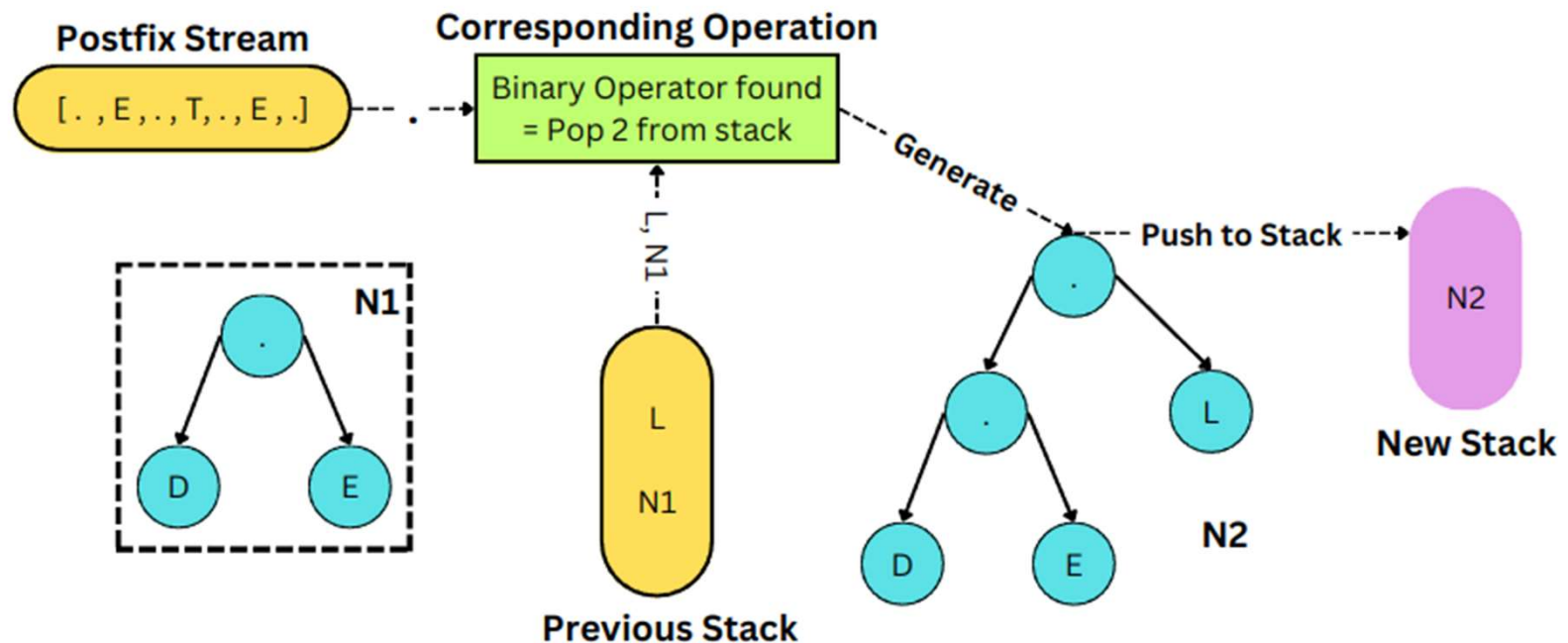- Purpose: Creating syntax tree from postfix form is easier (using Stack)

$$D.E.L.E.T.E \xrightarrow{\text{Postfix}} DE.L.E.T.E.$$

$$a+b.c.d+e.f.(g.f.(e+f.g)*.h.i).j.k.l \xrightarrow{\text{Postfix}} abc.d.+ef.gf.efg.+*.h.i..j.k.l.+$$

- Operator Precedence: * > . > +

# Syntax Tree from Postfix R.E.

- Nodes generated by postfix evaluation using stack
- At the end of reading Postfix Expression, only one node should remain in stack, else error.
- Root Node = concatenation operator node with left child (from stack) and right child (#)

**Postfix Stream**

[ . , E , . , T , . , E , . ]

**Corresponding Operation**

Binary Operator found
= Pop 2 from stack

*Generate*

Push to Stack

N1

N2

New Stack

L, N1

L
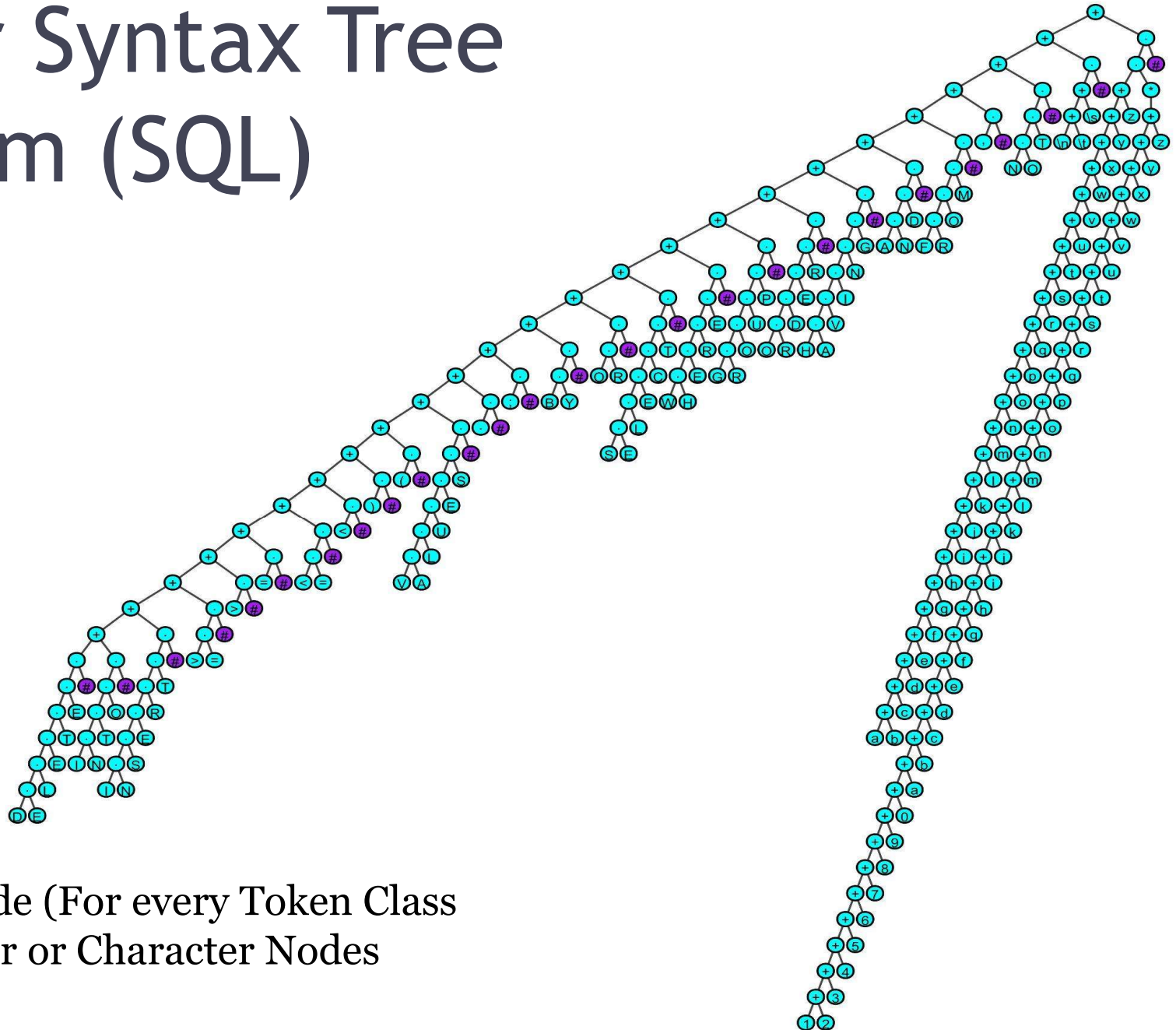N1

Previous Stack

N2

D    E

# Master Syntax Tree from Individual Trees

- All the individual syntax trees are Merged together using OR ( '|' ) operator node.
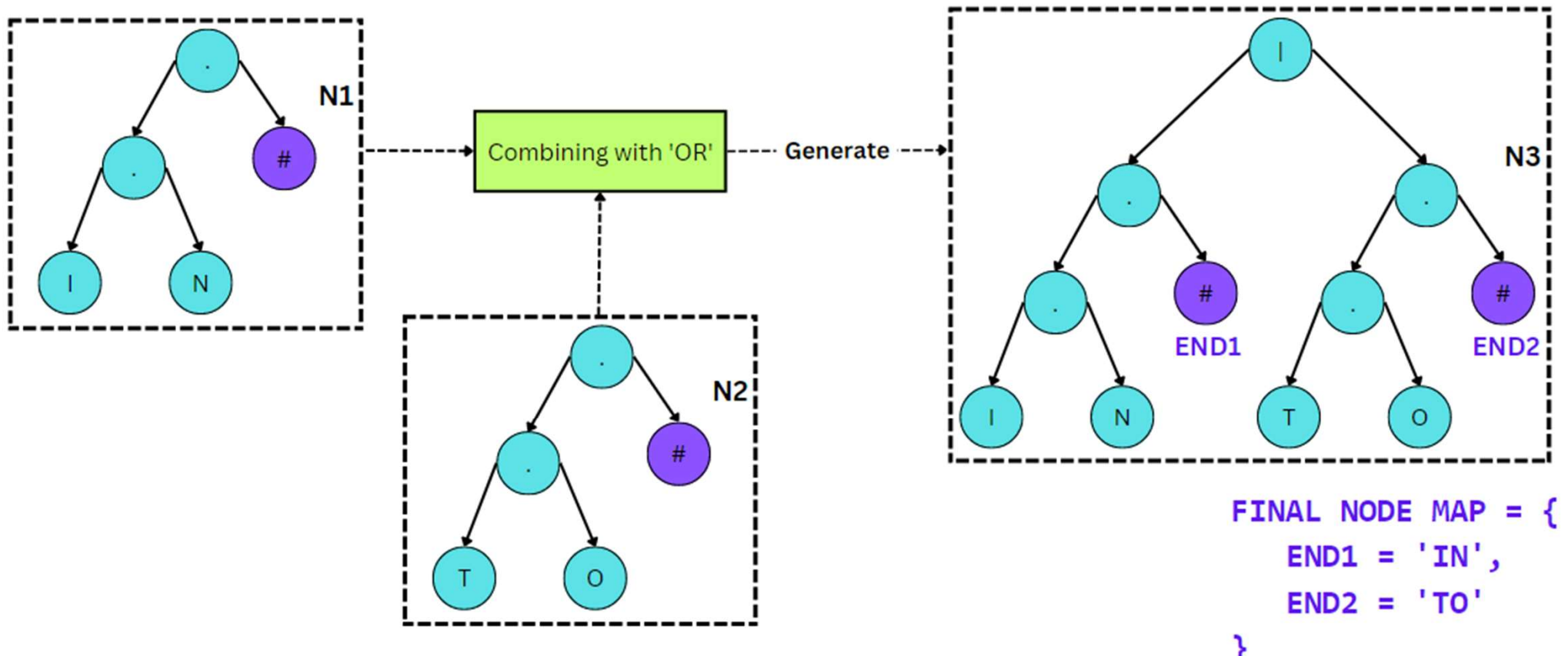
# Master Syntax Tree Diagram (SQL)

**Purple**: # Node (For every Token Class
**Blue**: Operator or Character Nodes

# Nullable, First-pos, Last-pos, Follow-pos,

| Node $n$ | $nullable(n)$ | $firstpos(n)$ | $lastpos(n)$ |
|---|---|---|---|
| Leaf $\varepsilon$ | true | $\emptyset$ | $\emptyset$ |
| Leaf $i$ | false | $\{i\}$ | $\{i\}$ |
| $\begin{array}{c} \mid \\ / \ \backslash \\ c_1 \quad c_2 \end{array}$ | $nullable(c_1)$ or $nullable(c_2)$ | $firstpos(c_1)$ $\cup$ $firstpos(c_2)$ | $lastpos(c_1)$ $\cup$ $lastpos(c_2)$ |
| $\begin{array}{c} \bullet \\ / \ \backslash \\ c_1 \quad c_2 \end{array}$ | $nullable(c_1)$ and $nullable(c_2)$ | **if** $nullable(c_1)$ **then** $firstpos(c_1) \cup$ $firstpos(c_2)$ **else** $firstpos(c_1)$ | **if** $nullable(c_2)$ **then** $lastpos(c_1) \cup$ $lastpos(c_2)$ **else** $lastpos(c_2)$ |
| $\begin{array}{c} * \\ \mid \\ c_1 \end{array}$ | true | $firstpos(c_1)$ | $lastpos(c_1)$ |



F(C1) **C1** L(C1)     F(C2) **C2** L(C2)

followpos

followpos

F(n)  **\***  L(n)
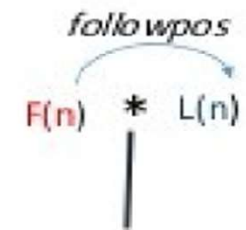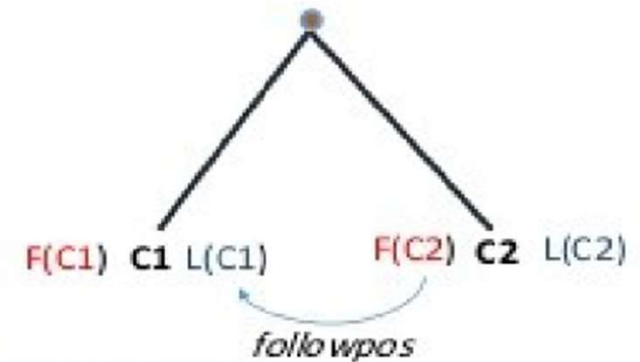
```
#104 -->
Nullable: False,
First Pos: 104,
Last Pos: 104,
Follow Pos: 154, 162, 137, 135, 155, 136, 151, 153, 132, 147, 164, 165, 156, 133, 131, 152,
150, 160, 158, 134, 130, 146, 143, 144, 159, 140, 163, 149, 145, 138, 139, 129, 141, 142,
148, 161, 157,
```
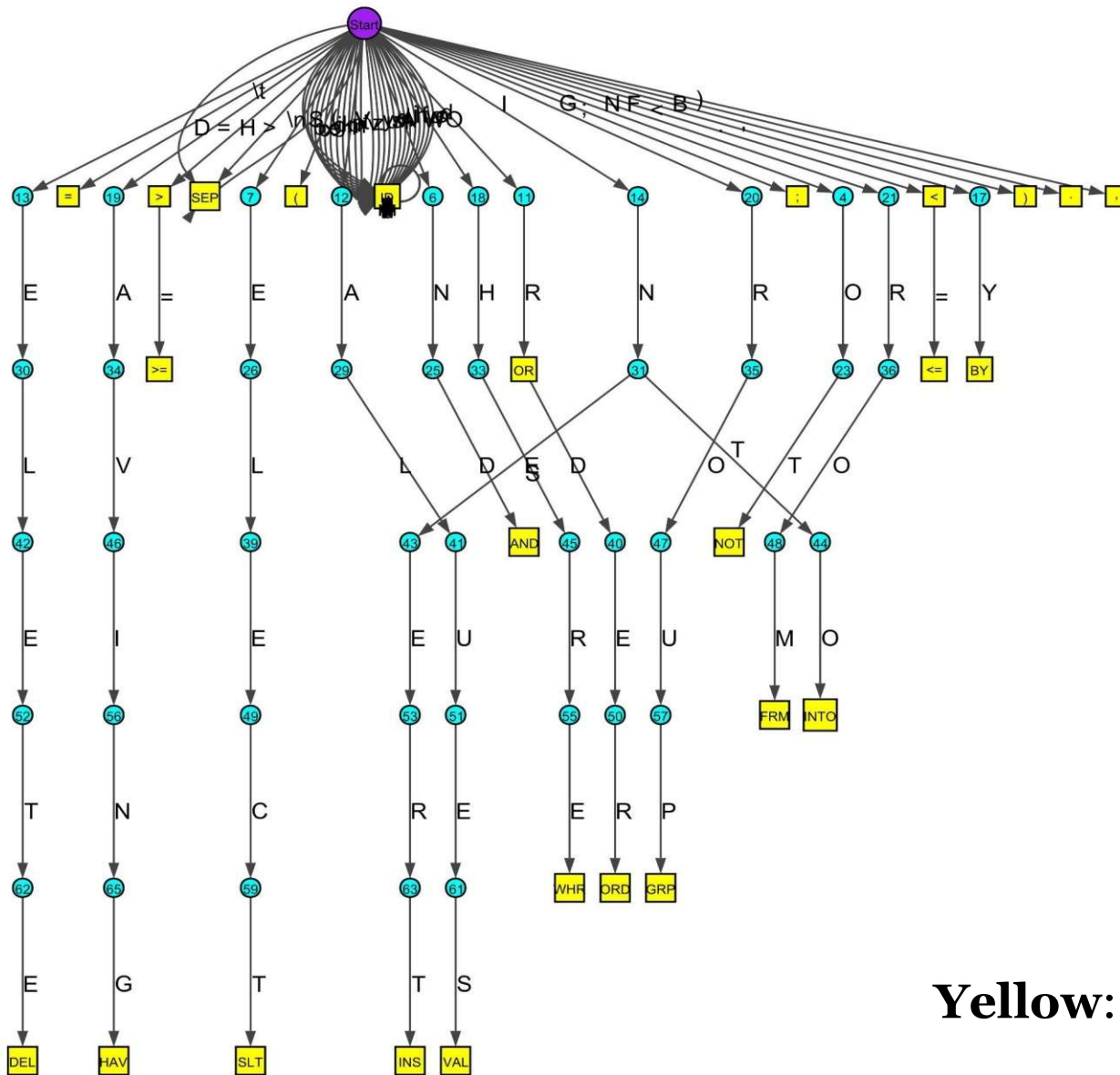
# DFA from Master Syntax Tree

- Initialize Dstates to contain only the unmarked state $firstpos(n_o)$, where $n_o$ is the root of syntax tree T for ( r ) #

- while ( there is an unmarked state S in Dstates ) {

    mark  S;

    for ( each input symbol a ) {

        let  U be the union of followpos(p)  for all p in S

        that correspond to a;

        if ( U is not in Dstates )

            add U as an unmarked state to Dstates; Dtran[S, a] = U;

        }

    }

# DFA Diagram

Size: 72

Alias -->
#0 -> 126 ,108 ,107 ,113 ,123 ,112
,104 ,110 ,121 ,103 ,116 ,106 ,88 ,93
,35 ,22 ,125 ,114
,29 ,33 ,105 ,99 ,95 ,44 ,26 ,100 ,101
,52 ,119 ,12 ,0 ,122 ,120 ,71 ,7 ,65
,42 ,84 ,59 ,24
,124 ,109 ,31 ,127 ,46 ,115 ,49 ,77
,117 ,111 ,19 ,128 ,118 ,

#1 -> 157 ,165 ,133 ,156 ,155 ,153
,132 ,147 ,151 ,135 ,137 ,154 ,162
,152 ,131 ,136 ,164
,150 ,160 ,158 ,134 ,130 ,146 ,143
,144 ,159 ,140 ,163 ,149 ,145 ,138
,139 ,129 ,141 ,142
,148 ,161 ,

#2 -> 34 ,
#3 -> 32 ,
#4 -> 96 ,
#5 -> 27 ,30 ,
...
...
#69 -> 6 ,
#70 -> 18 ,
#71 -> 83 ,

**Purple:** Start State
**Blue**: Intermediate State
**Yellow**: Final State (For a token class)

**Alias**: Set of tree nodes representing the DFA state

# Tokenizing Input SQL Statements
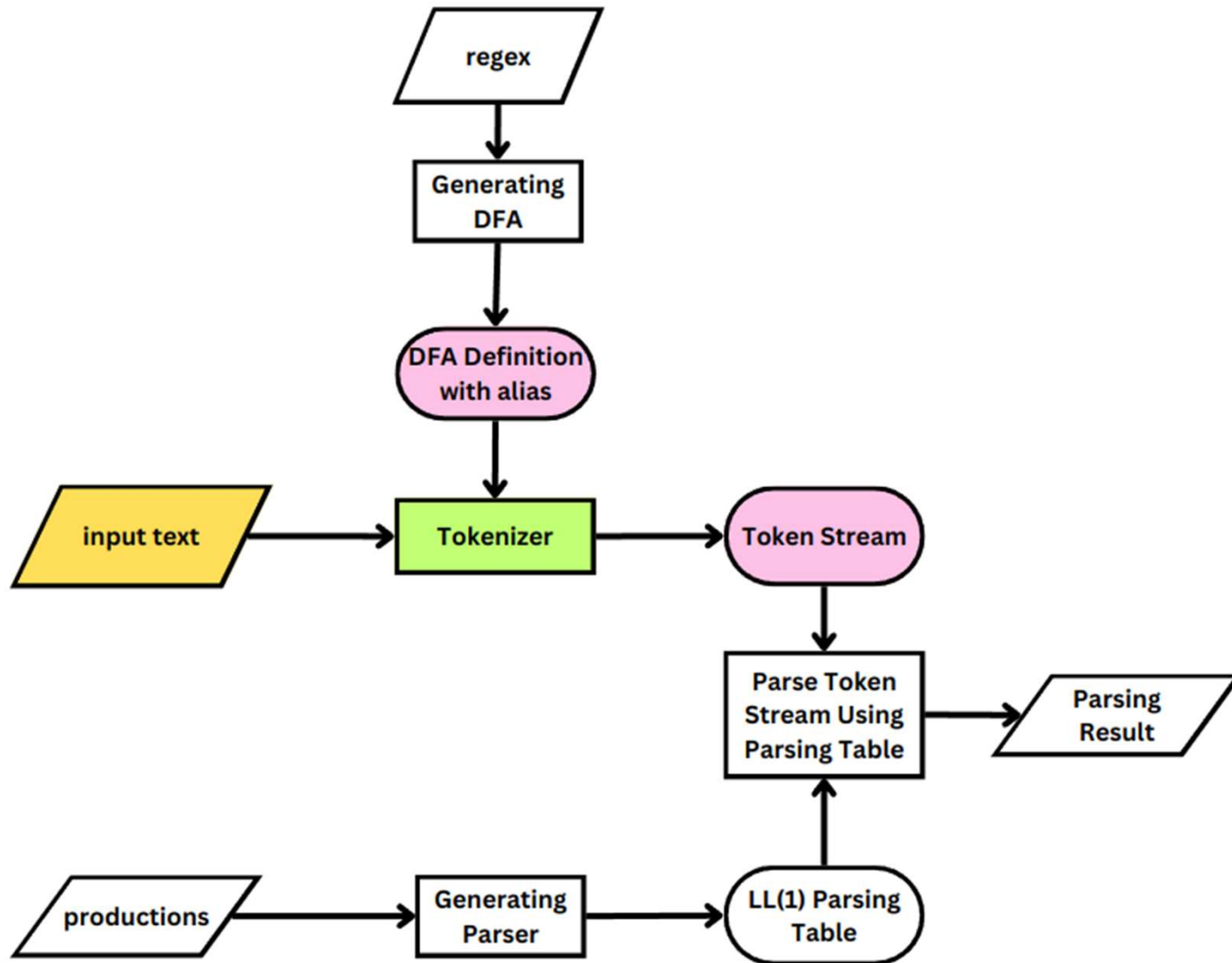
# Flow diagram of Tokenizing
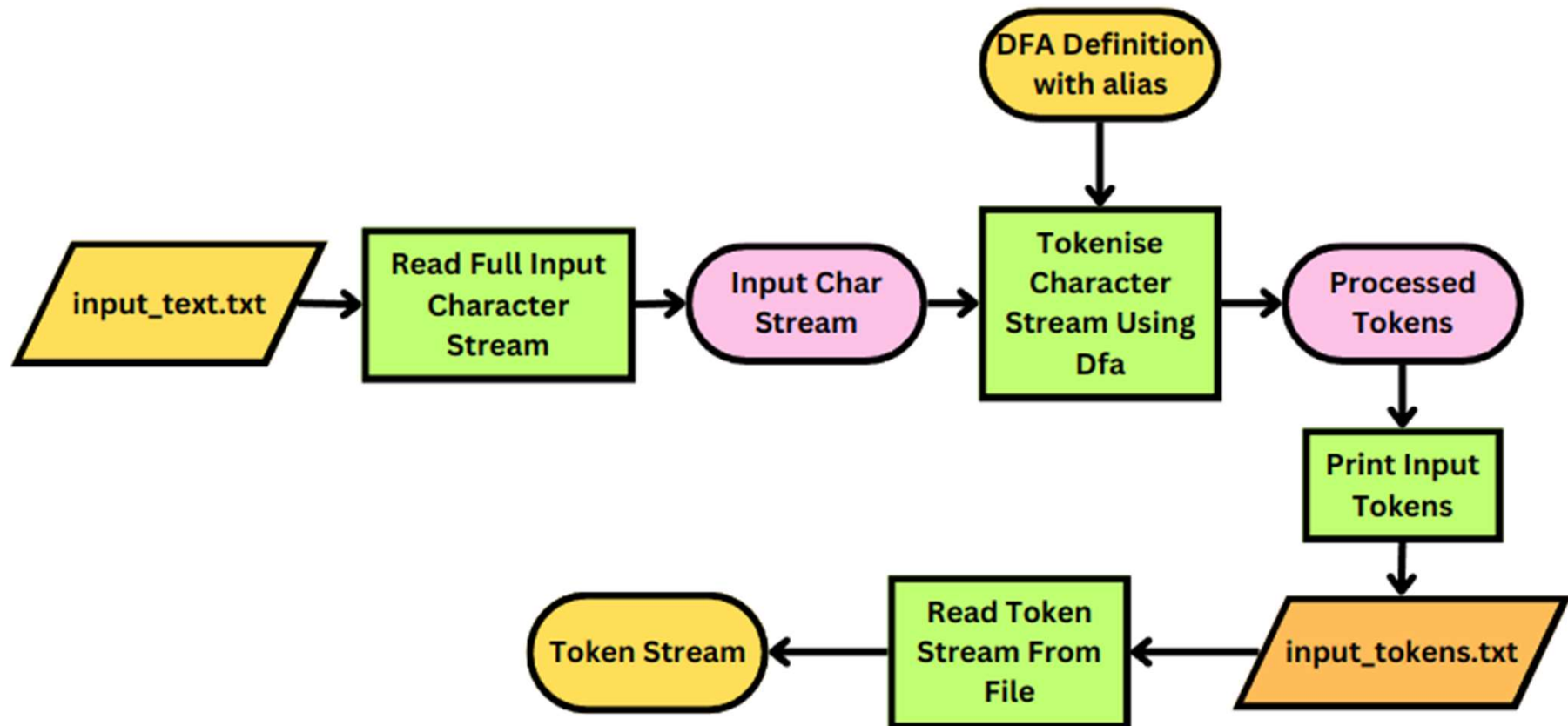
# Tokenizing Rule

- While creating the token, if DFA current state is not final, extend.
- If currently in final state, keep transitioning till new state is also final, else return current token class
- If input stream ends and left lexeme has no token class or invalid transition (can't transition for that state and character), return INVALID.

# Tokenized Stream SQL Preview

- **Input**

```
INSERT INTO mytable(atr1 ,atr2 ,atr3 ,atr4) VALUES ( bren , pro , op , super );
INSERT INTO mytable2 VALUES ( bruh2 , pro2 , op2 , super2 );
INSERT INTO mytable3 (atr1 ,atr2 ,atr3 ,atr4) VALUES ( bruh , pro , op , super );

DELETE FROM mytable;
DELETE FROM mytable WHERE age >= agetemp AND name = myname OR pro < toopro;


SELECT atr, op FROM gtbl;
SELECT atr, op FROM gtbl, btbl;
SELECT atr, gtbl.op FROM gtbl;
SELECT gtbl.atr, btbl.op FROM gtbl, btbl;
```

- **Tokenized Stream**

```
Size = 459

INSERT INSERT
INTO INTO
ID mytable
( (
ID atr1
, ,
ID atr2
, ,
ID atr3
, ,
```

# Generating LL(1) Parser
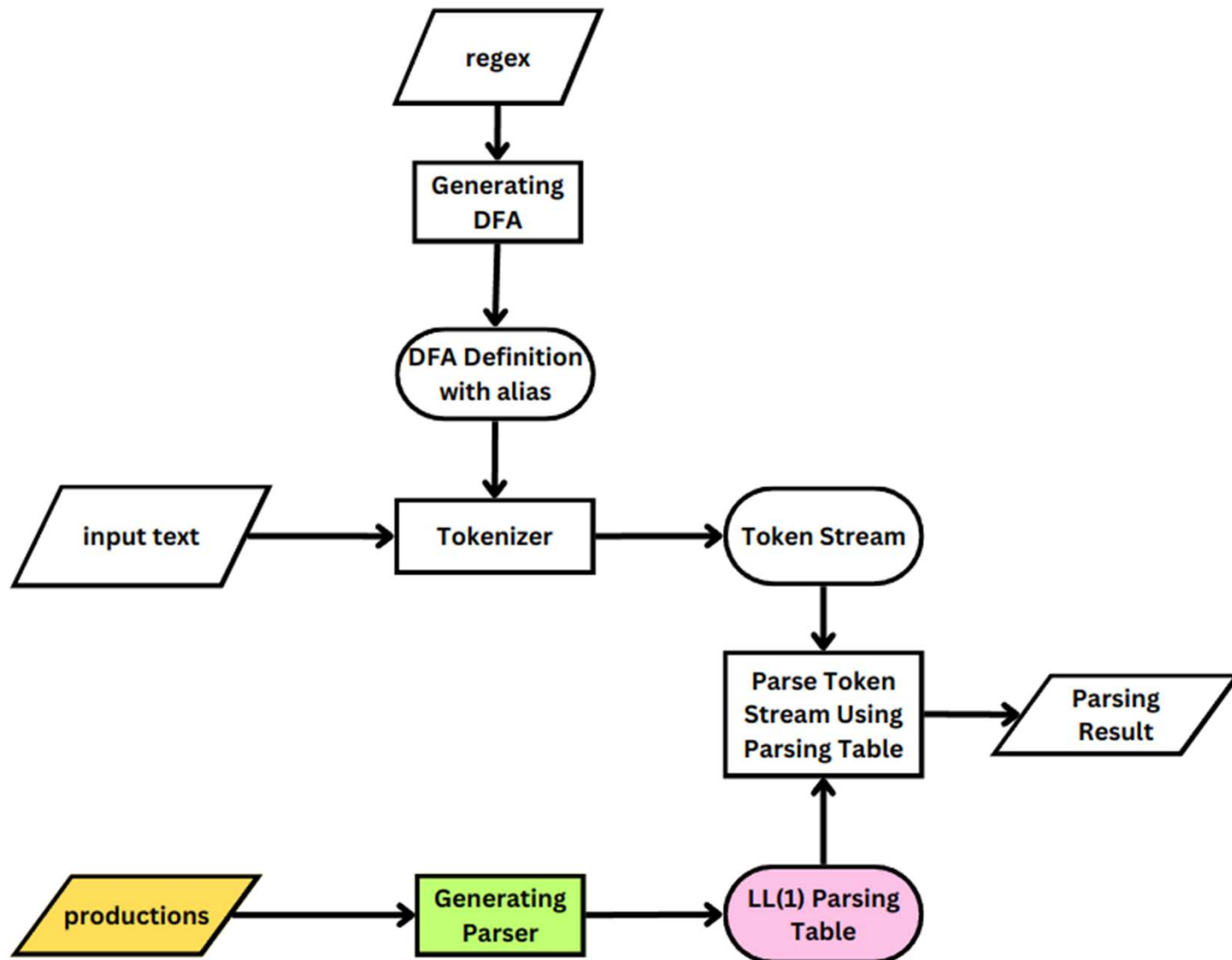
# Classes and Functions for LL(1) generation
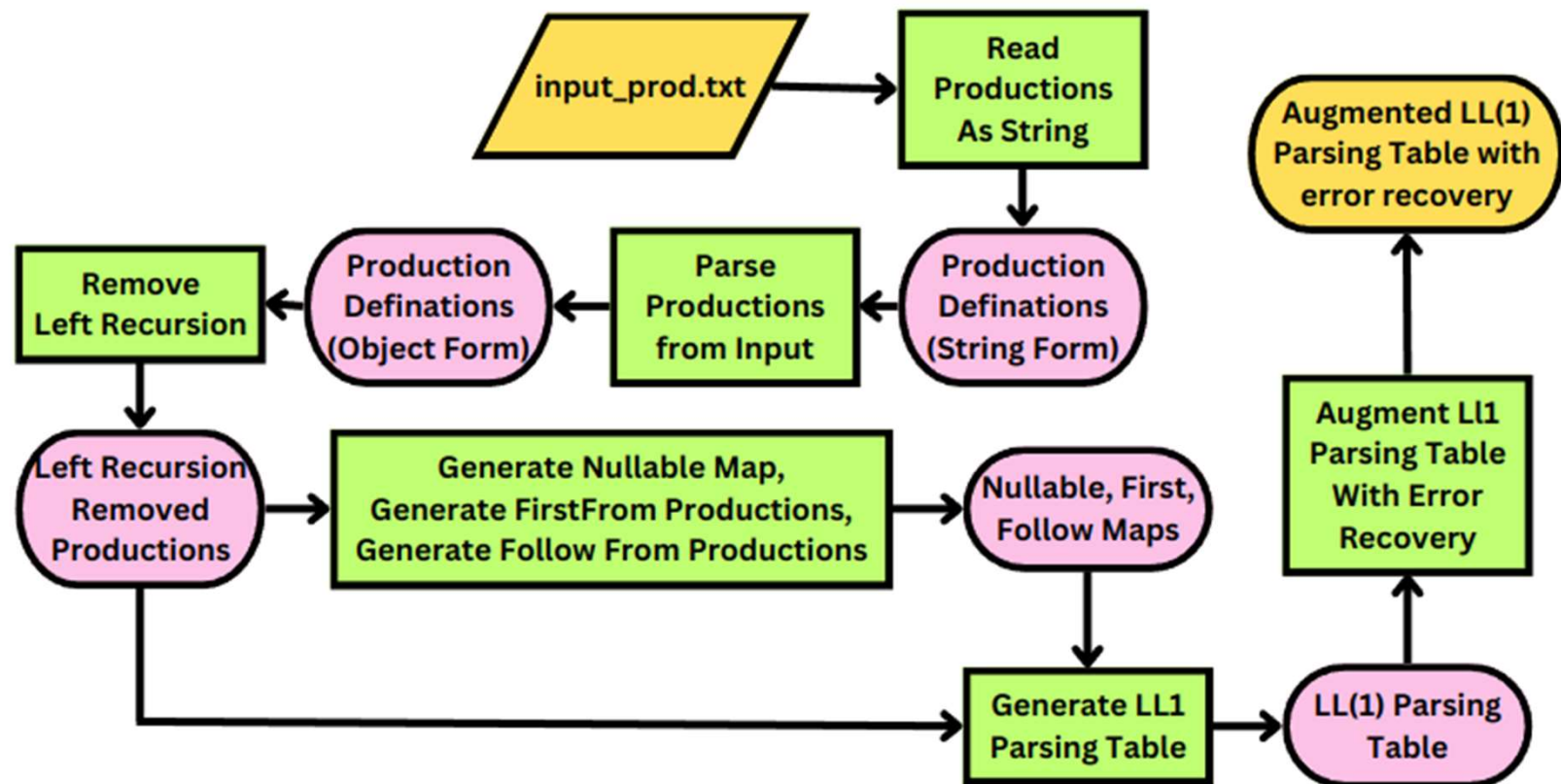
# Generating LL(1) Grammar for Parsing

- Pre Processing Productions for recognizing symbols
- Left Recursion Removal
- Left Factoring
- Generating Nullable, First and Follow of each Non terminals
- Generating LL(1) Parsing Table
- Augmenting LL(1) Parsing Table (pop and scan)

# SQL Grammar

- Number of productions: 41
- Starting symbol: s

```
1  s -> stmt ; s
2  s -> E
3  stmt -> selst
4  stmt -> insst
5  stmt -> delst
6  ide -> ID ide'
7  ide' -> . ID
8  ide' -> E
9  selst -> SELECT idlste FROM idlist wherecl grpbycl ordercl
10 idlist -> ID idlnul
11 idlnul -> , ID idlnul
12 idlnul -> E
13 idlste -> ide idlnle
14 idlnle -> , ide idlnle
15 idlnle -> E
16 wherecl -> WHERE cond
17 wherecl -> E
18 grpbycl -> GROUP BY idlste havngcl
19 grpbycl -> E
20 havngcl -> HAVING cond
```

```
21 havngcl -> E
22 ordercl -> ORDER BY idlste
23 ordercl -> E
24 cond -> unitcd cond'
25 cond' -> cdjoin unitcd cond'
26 cond' -> E
27 cdjoin -> AND
28 cdjoin -> OR
29 unitcd -> NOT ( unitcd )
30 unitcd -> ide compop ide
31 compop -> =
32 compop -> >
33 compop -> <
34 compop -> >=
35 compop -> <=
36 insst -> INSERT INTO ID insst1
37 insst1 -> VALUES ( idlist )
38 insst1 -> ( ID insst' ID )
39 insst' -> , ID insst' ID ,
40 insst' -> ) VALUES (
41 delst -> DELETE FROM ID wherecl
```

# Pre-processing Productions

- Reading the productions from file and identification of Terminals and Non terminals
- Achieved in 2 passes
  - **Pass 1**: Recognizing Non Terminals from LHS of Productions (stored in a set)
  - **Pass 2**: Annotating every element in RHS as terminal or non terminal

```
READ PRODUCTIONS [ Start Symbol = S(s) ] -->
S(delst) -> T(DELETE) T(FROM) T(ID) S(wherecl)
S(insst) -> T(INSERT) T(INTO) T(ID) S(insst1)
S(unitcd) -> T(NOT) T(() S(unitcd) T()) | S(ide) S(compop) S(ide)
S(idlist) -> T(ID) S(idlnul)
S(insst') -> T(,) T(ID) S(insst') T(ID) T(,) | T()) T(VALUES) T(()
S(ide') -> T(.) T(ID) | T(E)
S(s) -> S(stmt) T(;) S(s) | T(E)
S(selst) -> T(SELECT) S(idlste) T(FROM) S(idlist) S(wherecl) S(grpbycl) S(ordercl)
```

# Left Recursion Removal

- Immediate Left Recursion Removal

$$S \rightarrow S\,a_1 \mid \ldots \mid S\,a_n \mid b_1 \mid \ldots \mid b_m$$

$$\xRightarrow{\text{left recurssion removal}} S \rightarrow b_1\,S' \mid \ldots \mid b_m\,S', \qquad S' \rightarrow a_1\,S' \mid \ldots \mid a_n\,S' \mid \varepsilon$$

- Non Immediate Left Recursion Removal

```
1 FOR i = 1 to n:
2     FOR j in 1 to i-1:
3         replace each production Ai -> Ajy by
4         productions         Ai → δ1γ| δ2γ| … … . . |δKγ
5         where Aj → δ1|δ2| … … . |δK
6     END FOR
7     remove immediate left recursion among Ai productions
8 END FOR
9
```

# Left Factoring Removal

- It is done to avoid ambiguity while parsing based on one terminal occuring in first set of multiple productions

$$S \rightarrow aB \mid aC \xrightarrow{\;left\; factoring\;} S \rightarrow aD, D \rightarrow B|C$$

# Generating Nullable, First and Follow of each Non terminals

For production **S -> S1 S2 … Si … Sn**

- Nullable:
  - all of $S_i$ (i = 1 to n) are nullable
  - If a symbol S directly derives EPSILON (S -> E).
- First Map:
  - first(S) = first($S_1$) ∪ (if nullable($S_1$) then first($S_2$)) ∪ … ∪ (if nullable($S_1$) && nullable($S_2$) && … && nullable($S_{n-1}$) then first($S_n$))
- Follow Map:
  - follow($S_i$) = first($S_{i+1}$) ∪ (if nullable($S_{i+1}$) then first($S_{i+2}$)) ∪ … ∪ (if nullable($S_{i+1}$) && nullable($S_{i+2}$) && … && nullable($S_n$) then follow(S))).

# Generating LL(1) parsing Table

- Row Head: **Non Terminals**
- Column Head: **Terminals**

- A production of the form `S->S1 S2 … Si … Sn`, is placed in the position (S, First($S_1$ $S_2$ … $S_i$ … $S_n$)) in the LL(1) parsing table. If S is nullable, then the production is also placed in the position (S, Follow(S))
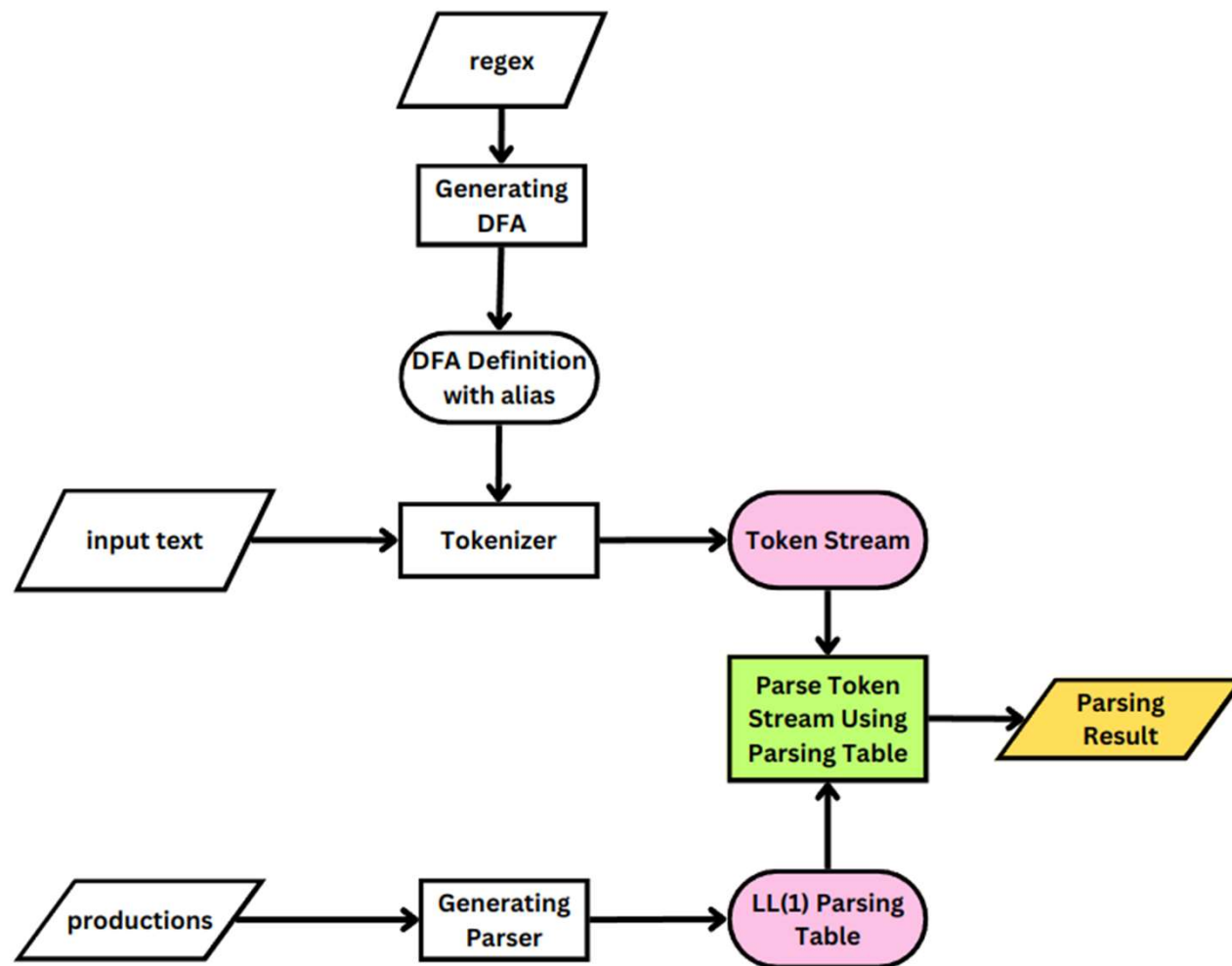
# Augmenting LL(1) Parsing Table

- Pop and Scan are inserted in empty spaces
- **POP**:
  - terminal of the index of the table is end terminal ('$')
  - the terminal is present in the follow set of the symbol
- **SCAN**:
  - Everywhere else

# Augmented LL(1) parsing table

| | T($) | T(DELETE) | T(INTO) | T(INSERT) | T(>=) | T(<) | T(>) | T(=) | T(()) | T(VALUES) | T(E) | T(.) | T(;) | T(<=) | T(BY) | T(OR) | T(SELECT) | T(WHERE) | T(GROUP) | T(ORDER) | T(HAVING) | T(AND) | T(FROM) | T(,) | T(NOT) | T(ID) | T(()) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S(delst) | POP | 41 | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | POP | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN |
| S(insst) | POP | SCAN | SCAN | 36 | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | POP | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN |
| S(unitcd) | POP | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | POP | SCAN | SCAN | SCAN | POP | SCAN | SCAN | POP | SCAN | SCAN | POP | POP | SCAN | POP | SCAN | SCAN | 29 | 30 | SCAN |
| S(idlist) | POP | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | POP | SCAN | SCAN | SCAN | POP | SCAN | SCAN | SCAN | SCAN | POP | POP | POP | SCAN | SCAN | SCAN | SCAN | SCAN | 10 | SCAN |
| S(insst') | POP | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | 40 | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | 39 | SCAN | POP | SCAN |
| S(ide') | POP | SCAN | SCAN | SCAN | 8 | 8 | 8 | 8 | 8 | SCAN | SCAN | 7 | 8 | 8 | SCAN | 8 | SCAN | SCAN | 8 | 8 | 8 | 8 | 8 | 8 | SCAN | SCAN | SCAN |
| S(s) | 2 | 1 | SCAN | 1 | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | 1 | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN |
| S(selst) | POP | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | POP | SCAN | SCAN | SCAN | 9 | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN |
| S(insst1) | POP | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | 37 | SCAN | SCAN | POP | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | 38 |
| S(cdjoin) | POP | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | 28 | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | 27 | SCAN | SCAN | POP | POP | SCAN |
| S(ide) | POP | SCAN | SCAN | SCAN | POP | POP | POP | POP | POP | SCAN | SCAN | SCAN | POP | POP | SCAN | POP | SCAN | SCAN | POP | POP | POP | POP | POP | POP | SCAN | 6 | SCAN |
| S(compop) | POP | SCAN | SCAN | SCAN | 34 | 33 | 32 | 31 | SCAN | SCAN | SCAN | SCAN | SCAN | 35 | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | POP | SCAN |
| S(stmt) | POP | 5 | SCAN | 4 | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | POP | SCAN | SCAN | SCAN | 3 | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN |
| S(idlnul) | POP | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | 12 | SCAN | SCAN | SCAN | 12 | SCAN | SCAN | SCAN | SCAN | 12 | 12 | 12 | SCAN | SCAN | SCAN | 11 | SCAN | SCAN | SCAN |
| S(cond) | POP | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | POP | SCAN | SCAN | SCAN | SCAN | SCAN | POP | POP | SCAN | SCAN | SCAN | SCAN | 24 | 24 | SCAN |
| S(idlnle) | POP | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | 15 | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | 15 | 15 | SCAN | 15 | 14 | SCAN | SCAN | SCAN |
| S(grpbycl) | POP | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | 19 | SCAN | SCAN | SCAN | SCAN | SCAN | 18 | 19 | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN |
| S(wherecl) | POP | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | 17 | SCAN | SCAN | SCAN | SCAN | 16 | SCAN | 17 | 17 | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN |
| S(havngcl) | POP | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | 21 | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | 21 | 20 | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN |
| S(idlste) | POP | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | POP | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | POP | POP | SCAN | POP | SCAN | SCAN | 13 | SCAN |
| S(ordercl) | POP | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | 23 | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | 22 | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN |
| S(cond') | POP | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | SCAN | 26 | SCAN | SCAN | 25 | SCAN | SCAN | 26 | 26 | SCAN | 25 | SCAN | SCAN | SCAN | SCAN | SCAN |

# Validating SQL statements

# Validating Using LL(1) Parser

- **Components:**
  - Parsing Table
  - Token Stream (containing tokens ,i.e., terminals)
  - Parsing Stack (containing symbols and terminals)
- **Rules:**
  - Parsing Stack starts with the value "S $" (where S is starting symbol)
  - If both terminals at top of stack and token stream match, they are popped, else throw fatal error
  - Else if the top of stack has a symbol, decide the action by looking from the corresponding Parsing Table entry
- **Parsing History was also saved**

## TEST CASE 3 ⇒

- **Input**

```
SELECT gtbl.atr, btbl.op FROM gtbl, btbl HAVING btbl.op > opwin;
```

- **Output**

```
READ TOKEN STREAM -->
[{T(SELECT): SELECT}, {T(ID): gtbl}, {T(.): .}, ..., {T(;): ;}, {T($): $}]
_____

PARSING RESULT: FALSE
PARSING ERROR INFO: Recovered Error

Parsing Stack: S(s), T($)
Token Stream: {T(SELECT): SELECT}, ..., {T(;): ;}, {T($): $}
Action: A(PRODUCE[ S(s) -> S(stmt) T(;) S(s) ])

Parsing Stack: S(stmt), T(;), S(s), T($)
Token Stream: {T(SELECT): SELECT}, ..., {T(;): ;}, {T($): $}
Action: A(PRODUCE[ S(stmt) -> S(selst) ])

...
...
```

```
Parsing Stack: T(ID), S(idlnul), S(wherecl), S(grpbycl), S(ordercl), T(;), S(s), T($)
Token Stream: {T(ID): btbl}, {T(HAVING): HAVING}, {T(ID): btbl}, {T(.): .}, {T(ID): op},
{T(>): >}, {T(ID): opwin}, {T(;): ;}, {T($): $}
Action: A(MATCH_TOKEN)


Parsing Stack: S(idlnul), S(wherecl), S(grpbycl), S(ordercl), T(;), S(s), T($)
Token Stream: {T(HAVING): HAVING}, {T(ID): btbl}, {T(.): .}, {T(ID): op}, {T(>): >},
{T(ID): opwin}, {T(;): ;}, {T($): $}
Action: A(SCAN)


Parsing Stack: S(idlnul), S(wherecl), S(grpbycl), S(ordercl), T(;), S(s), T($)
Token Stream: {T(ID): btbl}, {T(.): .}, {T(ID): op}, {T(>): >}, {T(ID): opwin}, {T(;): ;},
{T($): $}
Action: A(SCAN)


...
...
...


Parsing Stack: T(;), S(s), T($)
Token Stream: {T(;): ;}, {T($): $}
Action: A(MATCH_TOKEN)


Parsing Stack: S(s), T($)
Token Stream: {T($): $}
Action: A(PRODUCE[ S(s) -> T(E) ])


Parsing Stack: T($)
Token Stream: {T($): $}
Action: A(MATCH_TOKEN)
```

## TEST CASE 1 ⇒

- **Input**

```
INSERT INTO mytable(atr1 ,atr2 ,atr3 ,atr4) VALUES ( bren , pro , op , super );
INSERT INTO mytable2 VALUES ( bruh2 , pro2 , op2 , super2 );
INSERT INTO mytable3 (atr1 ,atr2 ,atr3 ,atr4) VALUES ( bruh , pro , op , super );


DELETE FROM mytable;
DELETE FROM mytable WHERE age >= agetemp AND name = myname OR pro < toopro;



SELECT atr, op FROM gtbl;
SELECT atr, op FROM gtbl, btbl;
SELECT atr, gtbl.op FROM gtbl;
SELECT gtbl.atr, btbl.op FROM gtbl, btbl;
```

- **Output**

```
READ TOKEN STREAM -->
[{T(INSERT): INSERT}, {T(INTO): INTO}, {T(ID): mytable}, ... ,  {T(;): ;}, {T($): $}]

_____


PARSING RESULT: TRUE
PARSING ERROR INFO: No Error

Parsing Stack: S(s), T($)
Token Stream: {T(INSERT): INSERT}, ..., {T(;): ;}, {T($): $}
Action: A(PRODUCE[ S(s) -> S(stmt) T(;) S(s) ])

Parsing Stack: S(stmt), T(;), S(s), T($)
Token Stream: {T(INSERT): INSERT}, ..., {T($): $}
Action: A(PRODUCE[ S(stmt) -> S(insst) ])

Parsing Stack: S(insst), T(;), S(s), T($)
Token Stream: {T(INSERT): INSERT}, ..., {T($): $}
Action: A(PRODUCE[ S(insst) -> T(INSERT) T(INTO) T(ID) S(insst1) ])

...
...
...


Parsing Stack: T(;), S(s), T($)
Token Stream: {T(;): ;}, {T($): $}
Action: A(MATCH_TOKEN)

Parsing Stack: S(s), T($)
Token Stream: {T($): $}
Action: A(PRODUCE[ S(s) -> T(E) ])

Parsing Stack: T($)
Token Stream: {T($): $}
Action: A(MATCH_TOKEN)
```

# Thank You

Any Questions?