Lecture 7

Syntax Analysis

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Take aways from the last class

- Overview of Syntax Analysis

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- Derivation of string from a grammer

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- Parse Tree

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- Recursive Descent Parsing

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  - k stands for number of lookahead token

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also Predictive Parser is a Recursive descent parser with no backtracking.

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- It removes backtracking by fixing one production for every non- terminal and input token(s)
- Predictive parsers accept LL(k) languages
  - First L stands for left to right scan of input
  - Second L stands for leftmost derivation
  - k stands for number of lookahead token
  - In practice LL(1) is used

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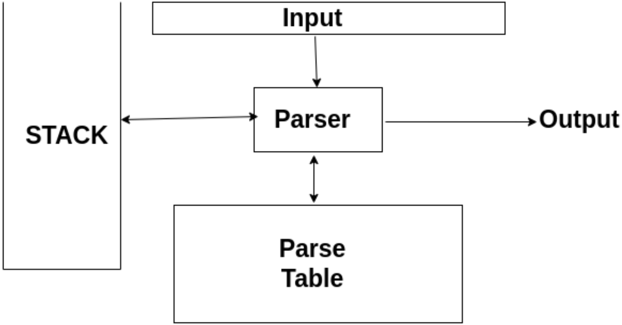

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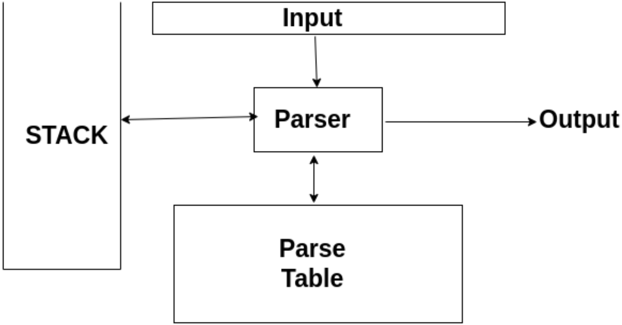

Parse table is a two dimensional array $M[X, a]$ where "X" is a non terminal and "a" is a terminal of the grammar

Example

Consider the following grammar:

$$E \rightarrow TE'$$
$$E' \rightarrow +TE'|\epsilon$$
$$T \rightarrow FT'$$
$$T' \rightarrow *FT'|\epsilon$$
$$F \rightarrow (E)|id$$

Parse table for the grammar

	id	+	*	(	)	$
E	$E \rightarrow TE^{'}$			$E \rightarrow TE^{'}$		
E'		$E^{'} \rightarrow +TE^{'}$			$E^{'} \rightarrow \epsilon$	$E^{'} \rightarrow \epsilon$
T	$T \rightarrow FT^{'}$			$T \rightarrow FT^{'}$		
T'		$T^{'} \rightarrow \epsilon$	$T^{'} \rightarrow *FT^{'}$		$T^{'} \rightarrow \epsilon$	$T^{'} \rightarrow \epsilon$
F	$F \rightarrow id$			$F \rightarrow (E)$		

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T'		$T^{'} \rightarrow \epsilon$	$T^{'} \rightarrow *FT^{'}$		$T^{'} \rightarrow \epsilon$	$T^{'} \rightarrow \epsilon$
F	$F \rightarrow id$			$F \rightarrow (E)$		

Blank entries are error states.

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$ is not considered part of grammar

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  ```
      then begin pop(X); push(W,V,U)
  end
  else error
  ```

push W, then V and then U

Example

initially, the stack will contain \$ and above it will be the start symbol.

Stack	Input	Action
\$E	id+id*id \$	expand by $E \rightarrow TE'$

Example

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$E'T'id	id+id*id $	pop id and ip++
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$E'	+id*id $	expand by $E' \rightarrow +TE'$

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$E'T'id	id+id*id $	pop id and ip++
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$E'	+id*id $	expand by $E' \to +TE'$
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$E'T'	$	expand by $T' \rightarrow \epsilon$
$E'	$	expand by $E' \rightarrow \epsilon$
$	$	halt

Constructing Parse table

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- Table can be constructed if for every non terminal, every lookahead symbol can be handled by at most one production

what are the cases in which there can be more than one production in any entry??
If multiple entries,
1. Grammar is ambiguous
2. If grammar is not ambiguous, then parser is not strong enough.
    a. Grammar may be left recursive or left factored.

LL(K) is more powerful than LL(1) => If we are doing LL(1), and given that grammar is ambiguous and multiple entries arise, then increase the value of K.

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- **First(a)** for a string of terminals and non terminals *a* is Set of symbols that might begin the fully expanded (made of only tokens) version of *a*

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- Table can be constructed if for every non terminal, every lookahead symbol can be handled by at most one production
- **First(a)** for a string of terminals and non terminals *a* is Set of symbols that might begin the fully expanded (made of only tokens) version of *a*
- **Follow(X)** for a non terminal X is set of symbols that might follow the derivation of X in the input stream

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- If ϵ is in $First(Y_1) \cdots First(Y_k)$ then ϵ is in $First(X)$

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- For the expression grammar
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- $First(E) = First(T) = First(F) = (, id$

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