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PREPARED FOR
Engineering Students
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CD: COMPILER DESIGN

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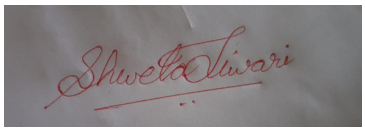


September 2022

TOPIC On : OPERATOR PRECEDENCE PARSER

OPERATOR PRECEDENCE PARSER

Operator Precedence Grammar-

A grammar that satisfies the following 2 conditions is called as **Operator Precedence Grammar**–

- There exists no production rule which contains ε on its RHS.
- There exists no production rule which contains two non-terminals adjacent to each other on its RHS.

- It represents a small class of grammar.
- But it is an important class because of its widespread applications.

Examples-

$E \rightarrow EAE \mid (E) \mid -E \mid id$

$A \rightarrow + \mid - \mid x \mid / \mid \wedge$

Operator Precedence Grammar

$E \rightarrow E + E \mid E - E \mid E \times E \mid E / E \mid E \wedge E \mid (E) \mid -E \mid id$

Operator Precedence Grammar

Operator Precedence Parser-

A parser that reads and understand an operator precedence grammar

is called an Operator **Precedence Parser**.

Designing Operator Precedence Parser-

In operator precedence parsing,

- Firstly, we define precedence relations between every pair of terminal symbols.
- Secondly, we construct an operator precedence table.

Defining Precedence Relations-

The precedence relations are defined using the following rules-

Rule-01:

- If precedence of b is higher than precedence of a, then we define a < b
- If precedence of b is same as precedence of a, then we define a = b
- If precedence of b is lower than precedence of a, then we define a > b

Rule-02:

- An identifier is always given the higher precedence than any other symbol.
- $ symbol is always given the lowest precedence.

Rule-03:

- If two operators have the same precedence, then we go by checking their associativity.

Parsing A Given String-

The given input string is parsed using the following steps-

Step-01:

Insert the following-

- $ symbol at the beginning and ending of the input string.
- Precedence operator between every two symbols of the string by referring to the operator precedence table.

Step-02:

- Start scanning the string from LHS in the forward direction until > symbol is encountered.
- Keep a pointer on that location.

Step-03:

- Start scanning the string from RHS in the backward direction until < symbol is encountered.
- Keep a pointer on that location.

Step-04:

- Everything that lies in the middle of < and > forms the handle.
- Replace the handle with the head of the respective production.

Step-05:

Keep repeating the cycle from Step-02 to Step-04 until the start symbol is reached.

Advantages-

The advantages of operator precedence parsing are-

- The implementation is very easy and simple.
- The parser is quite powerful for expressions in programming languages.

Disadvantages-

The disadvantages of operator precedence parsing are-

- The handling of tokens known to have two different precedence becomes difficult.
- Only small class of grammars can be parsed using this parser.

Important Note-

- In practice, operator precedence table is not stored by the operator precedence parsers.
- This is because it occupies the large space.
- Instead, operator precedence parsers are implemented in a very unique style.
- They are implemented using operator precedence functions.

Operator Precedence Functions-

Precedence functions perform the mapping of terminal symbols to the integers.

- To decide the precedence relation between symbols, a numerical comparison is performed.
- It reduces the space complexity to a large extent.

PRACTICE PROBLEMS BASED ON OPERATOR PRECEDENCE PARSING-

Problem-01:

Consider the following grammar-

$$E \rightarrow EAE \mid id$$

$$A \rightarrow + \mid x$$

Construct the operator precedence parser and parse the string id + id x id.

Solution-

Step-01:

We convert the given grammar into operator precedence grammar.

The equivalent operator precedence grammar is-

$$E \rightarrow E + E \mid E \, x \, E \mid id$$

Step-02:

The terminal symbols in the grammar are { id, + , x , $ }

We construct the operator precedence table as-

	id	+	x	$
id		>	>	>
+	<	>	<	>
x	<	>	>	>
$	<	<	<	

Operator Precedence Table

Parsing Given String-

Given string to be parsed is **id + id x id**.

We follow the following steps to parse the given string-

Step-01:

We insert $ symbol at both ends of the string as-

$ id + id x id $

We insert precedence operators between the string symbols as-

$ < id > + < id > x < id > $

Step-02:

We scan and parse the string as-

$ **<u>< id ></u>** + < id > x < id > $

$ E + **<u>< id ></u>** x < id > $

$ E + E x **<u>< id ></u>** $

$ E + E x E $

$ + x $

$ < + **<u>< x ></u>** $

$ **<u>< + ></u>** $

$ $

Problem-02:

Consider the following grammar-

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

$$L \rightarrow L , S \mid S$$

Construct the operator precedence parser and parse the string (a , (a , a)).

Solution-

The terminal symbols in the grammar are { (,) , a , , }

We construct the operator precedence table as-

	a	(	)	,	$
a		>	>	>	>
(	<	>	>	>	>
)	<	>	>	>	>
,	<	<	>	>	>
$	<	<	<	<	

Operator Precedence Table

Parsing Given String-

Given string to be parsed is **(a , (a , a))**.

We follow the following steps to parse the given string-

Step-01:

We insert $ symbol at both ends of the string as-

$ (a , (a , a)) $

We insert precedence operators between the string symbols as-

$ < (< a > , < (< a > , < a >) >) > $

Step-02:

We scan and parse the string as-

$ < (**≤ a ≥** , < (< a > , < a >) >) > $

$ < (S , < (**≤ a ≥** , < a >) >) > $

$ < (S , < (S , **≤ a ≥**) >) > $

$ < (S , **≤ (S , S) ≥**) > $

$ < (S , **≤ (L , S) ≥**) > $

$ < (S , **≤ (L) ≥**) > $

$ **≤ (S , S) ≥** $

$ **≤ (L , S) ≥** $

$ **≤ (L) ≥** $

$ **≤ S ≥** $

$ $

Problem-03:

Consider the following grammar-

$$E \rightarrow E + E \mid E \times E \mid id$$

1. Construct Operator Precedence Parser.
2. Find the Operator Precedence Functions.

Solution-

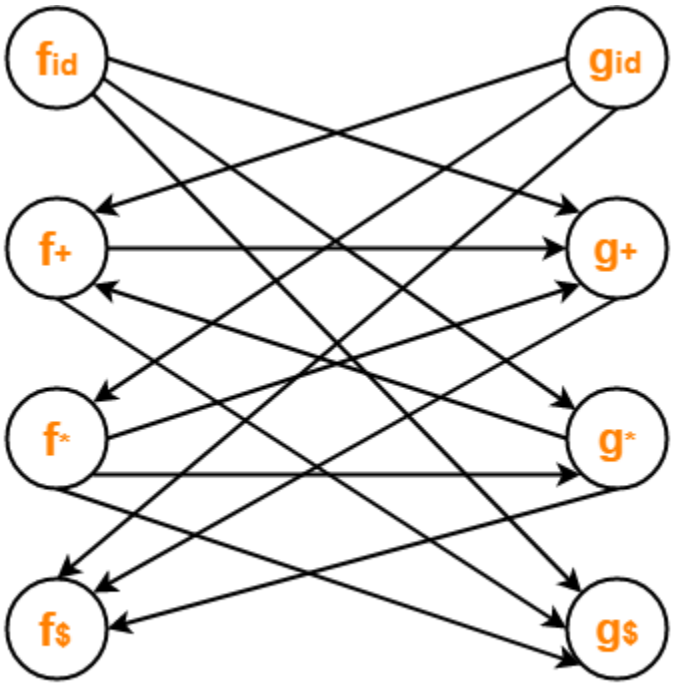
The terminal symbols in the grammar are { + , x , id , $ }

We construct the operator precedence table as-

	g →				
		id	+	x	$
f ↓	id		>	>	>
	+	<	>	<	>
	x	<	>	>	>
	$	<	<	<	

Operator Precedence Table

The graph representing the precedence functions is-



Graph Representing Precedence Functions

Here, the longest paths are-

- $f_{id} \rightarrow g_x \rightarrow f_+ \rightarrow g_+ \rightarrow f_\$$
- $g_{id} \rightarrow f_x \rightarrow g_x \rightarrow f_+ \rightarrow g_+ \rightarrow f_\$$

The resulting precedence functions are-

	+	x	id	$
f	2	4	4	0
g	1	3	5	0

To gain better understanding about Operator Precedence Parsing,

**********THE END**********