

Shift-Reduce Parsing



Definition

A shift-reduce parser attempts to construct a parse tree for an input string beginning at the leaves (the bottom) and working up towards the root (the top).

String $\xrightarrow{\text{Reduced to}}$ Start symbol

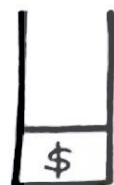
Thus, it works on the same principle of bottom-up parser.

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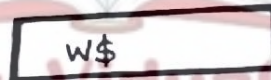
Implementation of Shift-Reduce Parser

To implement shift-reduce parser, we use a stack to hold grammar symbols and an input buffer to hold the string w to be parsed.

The initial configuration of shift reduce parser is-



stack



Input Buffer

The parser operates by shifting zero or more input symbols onto the stack until a handle β is on top of the stack.

The parser repeats this cycle until it has detected an error or until the stack contains the start symbol and the input is empty.



After entering this state/configuration, the parser halts and announces successful completion of parsing.

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Possible Actions_z

There are four possible actions that a shift-reduce parser can make -

- i) Shift:- In a shift action, the next symbol is shifted onto the top of the stack.
- ii) Reduce:- In a reduce action, the handle that appears on the top of the stack is replaced with appropriate non-terminal.
- iii) Accept:- In an accept action, the parser announces successful completion of parsing.
- iv) Error:- A situation in which parser cannot either shift or reduce the symbols and also cannot even perform the accept action.

Rule to Remember_z

☛ If the incoming operator has more priority than in stack operator, then perform shift.

If in stack operator has same or less priority than the priority of incoming operator, then perform reduce.

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Problem-01: Consider the grammar -

$$E \rightarrow E - E$$

$$E \rightarrow E * E$$

$$E \rightarrow id$$

Perform Shift-Reduce Parsing of the input string -

$id - id * id$

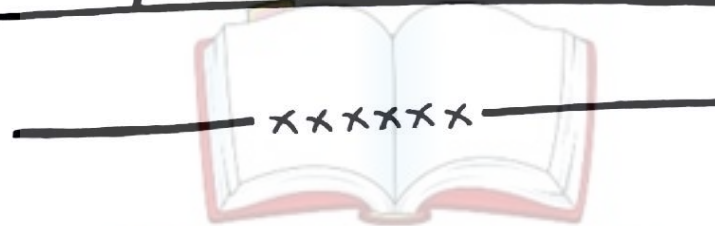
Solution:

Priority
Order:

$id > * > -$

Stack	Input Buffer	Parsing Action
\$	$id - id * id \$$	Shift
$\$ id$	$- id * id \$$	Reduce $E \rightarrow id$
$\$ E$	$- id * id \$$	Shift
$\$ E -$	$id * id \$$	Shift
$\$ E - id$	$* id \$$	Reduce $E \rightarrow id$
$\$ E - E$	$* id \$$	Shift
$\$ E - E *$	$id \$$	Shift

$\$E-E * id$	$\$$	Reduce $E \rightarrow id$
$\$E-E * E$	$\$$	Reduce $E \rightarrow E * E$
$\$E-E$	$\$$	Reduce $E \rightarrow E - E$
$\$E$	$\$$	Accept



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Problem-02: Consider the following grammar -

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

$$L \rightarrow L, S / S$$

Parse the input string $(a, (a, a))$ using shift-reduce parser.

Solution:-

Stack	Input Buffer	Parsing Action
\$	$(a, (a, a)) \$$	Shift
$\$($	$a, (a, a)) \$$	Shift
$\$(a$	$, (a, a)) \$$	Reduce $S \rightarrow a$
$\$(S$	$, (a, a)) \$$	Reduce $L \rightarrow S$
$\$(L$	$, (a, a)) \$$	Shift
$\$(L,$	$(a, a)) \$$	Shift
$\$(L,($	$a, a)) \$$	Shift
$\$(L,(a$	$, a)) \$$	Reduce $S \rightarrow a$

$\$(L, (S$	$, a)) \$$	Reduce $L \rightarrow S$
$\$(L, (L$	$, a)) \$$	Shift
$\$(L, (L,$	$a)) \$$	Shift
$\$(L, (L, a$	$) \$$	Reduce $S \rightarrow a$
$\$(L, (L, S)$	$) \$$	Reduce $L \rightarrow L, S$
$\$(L, (L$	$) \$$	Shift
$\$(L, (L)$	$) \$$	Reduce $S \rightarrow (L)$
$\$(L, S$	$) \$$	Reduce $L \rightarrow L, S$
$\$(L$	$) \$$	Shift
$\$(L)$	$\$$	Reduce $S \rightarrow (L)$
$\$S$	$\$$	Accept

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Problem-03 : Consider the following grammar -

$S \rightarrow TL;$

$T \rightarrow \text{int} / \text{float}$

$L \rightarrow L, \text{id} / \text{id}$

Parse the input string "int id, id;" using shift-reduce parser.

Solution:-

Stack	Input Buffer	Parsing Action
\$	int id, id; \$	Shift
\$int	id, id; \$	Reduce $T \rightarrow \text{int}$
\$T	id, id; \$	Shift
\$Tid	, id; \$	Reduce $L \rightarrow \text{id}$
\$TL	, id; \$	Shift
\$TL,	id; \$	Shift
\$TL, id	; \$	Reduce $L \rightarrow L, \text{id}$
\$TL	; \$	Shift

$\$TL;$	$\$$	Reduce $S \rightarrow TL;$
$\$S$	$\$$	Accept

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Problem-04:- Design shift reduce parser for the following grammar -

$$S \rightarrow OSO / 1S1/2$$

considering the string "10201"

Solution:-

Stack	Input Buffer	Parsing Action
\$	10201\$	Shift
\$1	0201\$	Shift
\$10	201\$	Shift
\$102	01\$	Reduce $S \rightarrow 2$
\$10S	01\$	Shift
\$10SO	1\$	Reduce $S \rightarrow OSO$
\$1S	1\$	Shift
\$1S1	\$	Reduce $S \rightarrow 1S1$
\$S	\$	Accept

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