

## BOTTOM-UP PARSER

- **Bottom-up parser** creates the parse tree of the given input starting from leaves towards the root.
- A bottom-up parser tries to find the right-most derivation of the given input in the reverse order.

$$S \leftarrow \dots \leftarrow \omega$$

- Bottom-up parsing is also known as **shift-reduce parsing** because its two main actions are shift and reduce.
  - At each shift action, the current symbol in the input string is pushed into a stack.
  - At each reduction step, the symbols at the top of the stack (this symbol sequence is the right side of a production) will be replaced by the non-terminal at the left side of that production.

## SHIFT-REDUCE PARSER

- A **shift-reduce parser** tries to reduce the given input string into the starting symbol.

a string  $\rightarrow$  the starting symbol  
reduced to

- At each reduction step, a substring of the input

matching to the right side of a production rule is replaced by the non-terminal at the left side of that production rule.

- If the substring is chosen correctly, the right most derivation of that string is created in the reverse order.

$$\text{Rightmost Derivation : } S \xrightarrow[*]{rm} \omega$$

$$\text{Shift-Reduce Parser finds: } S \xleftarrow{rm} \dots \xleftarrow{rm} \omega$$

Example:

$$S \rightarrow aABb$$

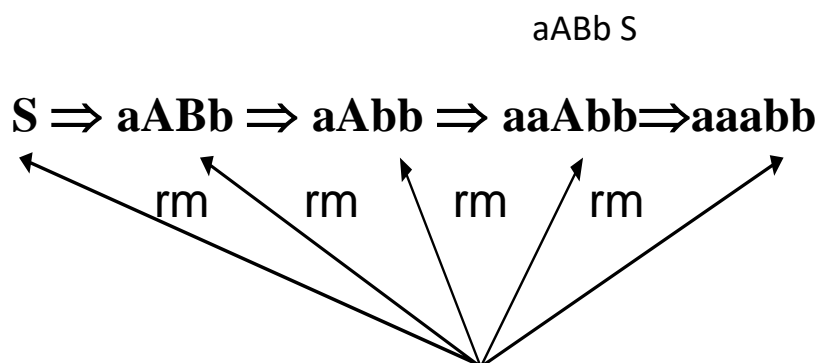
*input string: aaabb*

$$A \rightarrow aA \mid a$$

aaAbb

$$B \rightarrow bB \mid b$$

aA bb ↓reduction



## Right Sentential Forms

- In the following reduction, a **handle** of  $\alpha\beta\omega$  is the body of production  $A \rightarrow \beta$  in the position following  $\alpha$ .

$$S \xRightarrow{*} \alpha A \omega \Rightarrow \alpha \beta \omega$$

rm
rm

( $\omega$  is a string of terminals)

- A **handle** is a substring that matches the right side of a production rule.
  - But not every substring matches the right side of a production rule is a handle
  - Only that can move the reduction forward towards the start symbol in the reverse of a rightmost derivation.
- If the grammar is unambiguous, then every right-sentential form of the grammar has exactly one handle.

Example:

$$S \rightarrow aB / b$$

$$A \rightarrow a / aS / bAA$$

$$B \rightarrow aBB / bS / b$$

**Q:-What is the handle of  $aabbAb$ ?**

$S \Rightarrow aB \Rightarrow aaBB \Rightarrow aaBb \Rightarrow aabSb \Rightarrow aabbAb$

Handle is  $bA$