

## An Introduction to Grammars: -

Grammar is a set of rules for constructing correct sentences in any language.

There are two aspects to studying grammar:

1. Syntax: - The set of sentences.
2. Semantics: - Which specifies the meaning of language.

We are interested in the first one. To analyze a sentence, it means to parse it to produce a parse tree by which we can see whether the sentence to syntax correct or not.

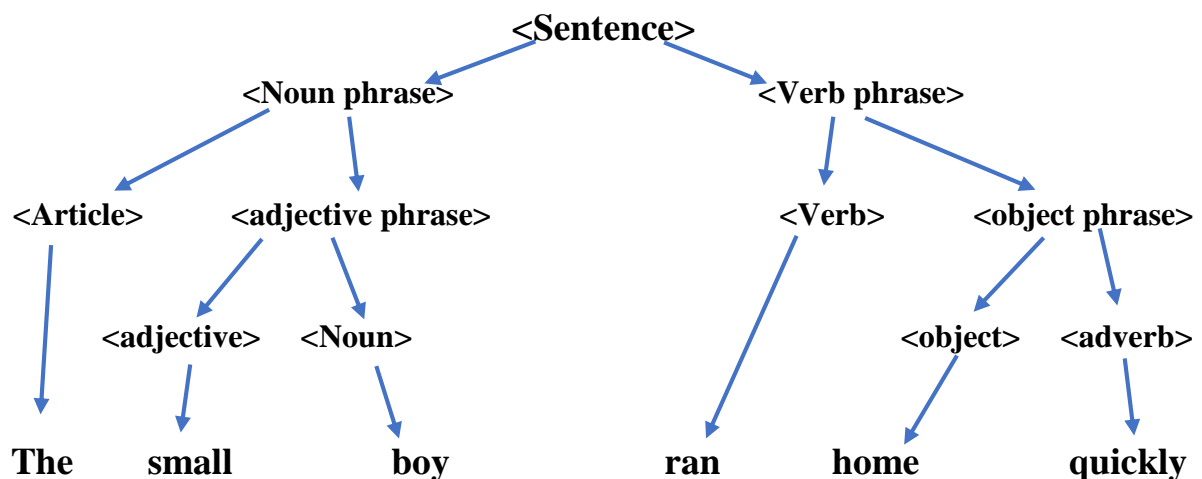
There are many types of parsing:

- Top-down parsing.
- Bottom-up parsing.

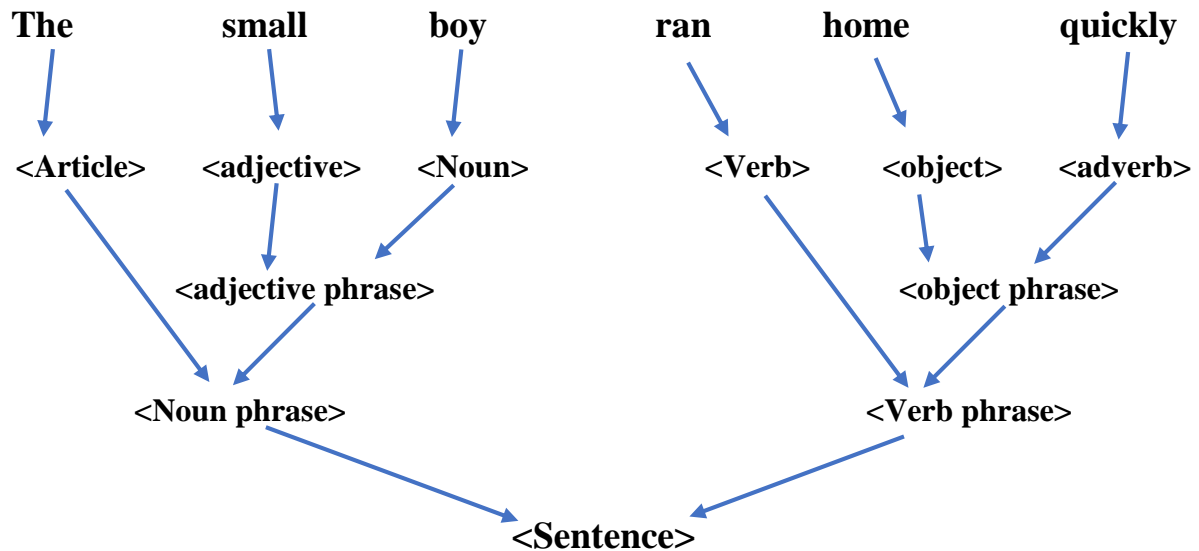
### 1. Top-down parsing or (parsing tree)

#### Example

" The small boy ran home quickly"



## 2. - Bottom-up parsing or (parsing tree)



The syntax of the sentence " The small boy ran home quickly" in English language:

< sentence> → <noun phrase> <verb phrase>

<noun phrase> → <article> <adjective phrase>

<adjective phrase> → <adjective> <noun>

<verb phrase> → <verb> <object phrase>

<object phrase> → <object> <adverb>

<article> → The

< adjective> → small

<noun> → boy

<verb> → ran

<object> → home

< adjective> → quickly

In 1960 Backus-Naur wrote the syntax rules in a form called BNF notation.

$\langle \text{sentence} \rangle ::= \langle \text{noun phrase} \rangle \langle \text{verb phrase} \rangle$   
 $\langle \text{noun phrase} \rangle ::= \langle \text{article} \rangle \langle \text{adjective phrase} \rangle$   
 $\langle \text{adjective phrase} \rangle ::= \langle \text{adjective} \rangle \langle \text{noun} \rangle$   
 $\langle \text{verb phrase} \rangle ::= \langle \text{verb} \rangle \langle \text{object phrase} \rangle$   
 $\langle \text{object phrase} \rangle ::= \langle \text{object} \rangle \langle \text{adverb} \rangle$   
 $\langle \text{article} \rangle ::= \text{The}$   
 $\langle \text{adjective} \rangle ::= \text{small}$   
 $\langle \text{noun} \rangle ::= \text{boy}$   
 $\langle \text{verb} \rangle ::= \text{ran}$   
 $\langle \text{object} \rangle ::= \text{home}$   
 $\langle \text{adverb} \rangle ::= \text{quickly}$

**Example 1/** Find BNF notation for "Integer"

**Answer**

$\langle \text{Integer} \rangle ::= \langle \text{digit} \rangle / \langle \text{Integer} \rangle \langle \text{digit} \rangle$   
 $\langle \text{digit} \rangle ::= 0 / 1 / 2 / \dots / 9$

**Example:** integer = 9657

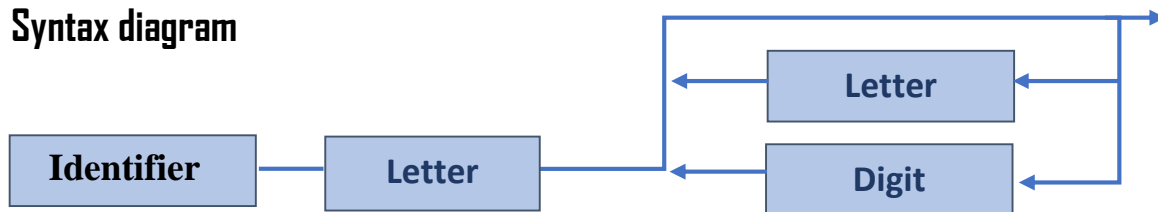
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 $::= 9 \langle \text{digit} \rangle \langle \text{digit} \rangle \langle \text{digit} \rangle$   
 $::= 9 6 \langle \text{digit} \rangle \langle \text{digit} \rangle$   
 $::= 9 6 5 \langle \text{digit} \rangle$   
 $::= 9 6 5 7$

**Example 2/ Find BNF notation for "Identifier"****Answer**

$\langle \text{Identifier} \rangle ::= \langle \text{letter} \rangle \{ \langle \text{letter} \rangle / \langle \text{digit} \rangle \}^*$

$\langle \text{letter} \rangle ::= a / b / \dots / z / A / B / \dots / Z$

$\langle \text{digit} \rangle ::= 0 / 1 / 2 / \dots / 9$

**Syntax diagram****Example 3/ Write BNF notation for "Bexp"****Answer**

$\langle \text{Bexp} \rangle ::= \langle \text{Exp} \rangle \langle \text{Op} \rangle \langle \text{Exp} \rangle / \langle \text{id} \rangle / \langle \text{integer} \rangle$

$\langle \text{Exp} \rangle ::= \langle \text{id} \rangle \langle \text{Op} \rangle \langle \text{id} \rangle / \langle \text{id} \rangle \langle \text{Op} \rangle \langle \text{integer} \rangle / \langle \text{integer} \rangle \langle \text{Op} \rangle \langle \text{id} \rangle / \langle \text{integer} \rangle \langle \text{Op} \rangle \langle \text{integer} \rangle$

$\langle \text{Op} \rangle ::= > | < | \geq | \leq | < > | + | - | / | *$

**Example 4/ Write BNF notation for "Statement"****Answer**

$\langle \text{Statement} \rangle ::= \langle \text{State} \rangle / \langle \text{compound-Statement} \rangle$

$\langle \text{compound-Statement} \rangle ::= \langle \text{If-Statement} \rangle / \langle \text{For-Statement} \rangle / \langle \text{While-Statement} \rangle / \dots$

$\langle \text{State} \rangle ::= \langle \text{assign-Statement} \rangle$

$\langle \text{assign-Statement} \rangle ::= \langle \text{id} \rangle \langle \text{S} \rangle \langle \text{Bexp} \rangle$

**Example 5/ Write BNF notation for "If-Statement" in C++ language****Answer**

$\langle \text{If-Statement} \rangle ::= \text{If} \langle \text{Bexp} \rangle \langle \text{Statement} \rangle \{ \text{else} \langle \text{Statement} \rangle \}$