SNS COLLEGE OF ENGINEERING

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

19CS502- Automata Theory and Compiler Design

III YEAR / V SEMESTER

UNIT – 3 : Semantics and Context Sensitive Features

Topic   : **1. Context Sensitive Features**

2. Chomsky hierarchy of languages

and recognizers

1.Context-sensitive grammar

- Definition
- General rules
- Example

2. Chomsky hierarchy of languages and recognizers

Context Sensitive Grammar - definition

- Context Sensitive Grammar is defined by 4 Tuples as (V,T,P,S)

- In the grammar (V,T,P,S)

> Where V is a set of all Variable,
> T is a set of all Terminal
> P is a set of all Production
> S is the start Symbol

X -> Y
- x and y are combination of variables and terminals
- The grammar type-1 grammar is called Context Sensitive Grammar (CFG) .
- The language Generated by Type -1 Grammar is called CSL.
- The machine which Accepts the CSL is called Linear Bounded Automata (LBA

Context Sensitive Grammar – General Rules

1) Take a production X -> Y
2) X, Y belongs to (V U T)^+
3) X, Y is a string of terminals and non-terminals.
4) The symbol + says at least one symbol is considered.

1)|X| <=|Y|
2)The length of the left side of production should be less than or equal to the length of the right side of the production.
3)Example: aAb – abb
         aAc – abcD
         aA – c
The last production is not context-sensitive grammar because the length of the left side is greater.

Why is the name context-sensitive?

Example: aAb –> aaa

aA –> b

- We are applying A based on the Context.
- We define the production Based on the before and after symbols.
- If the before symbol is a and the after symbol is b, we apply aaa.
- We do not consider the Context in context-free grammar.
- A –> aA | aB
- Whenever we see production A, we apply. CFG is a subset of context-sensitive grammar.

Example Question: What is language generated by the following CSG

S→abc/aAbC

Ab→bA

AC→Bbcc

bB→Bb

aB→aa/aaA

Solution:

$\qquad$ S→aAbC

$\qquad$ →abAC (Ab→bA)

$\qquad$ →abBbcc (AC→Bbcc)

$\qquad$ →aBbbcc (bB→Bb)

$\qquad$ →aabbcc (aB→aa)

So Language Generated By above grammar is a ^n b^ n c ^n

Chomsky hierarchy of languages and recognizers

Chomsky Hierarchy represents the class of languages that are accepted by the different machine. The category of language in Chomsky's Hierarchy is as given below:

1. Type 0 known as Unrestricted Grammar.
2. Type 1 known as Context Sensitive Grammar.
3. Type 2 known as Context Free Grammar.
4. Type 3 Regular Grammar.

Fig: Chomsky Hierarchy
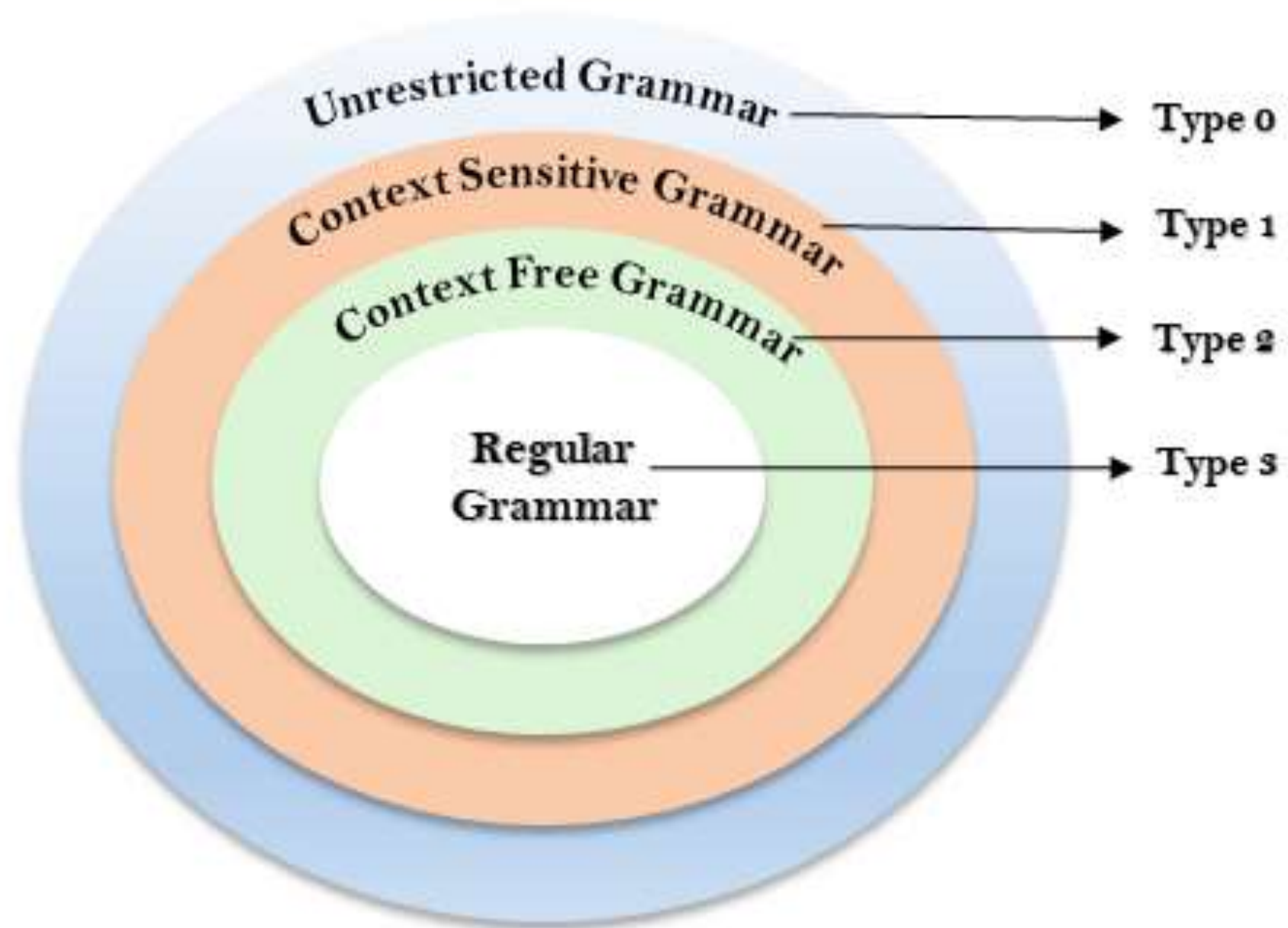
This is a hierarchy. Therefore every language of type 3 is also of type 2, 1 and 0. Similarly, every language of type 2 is also of type 1 and type 0, etc.

Type 3 Grammar:

- Type 3 Grammar is known as Regular Grammar. Regular languages are those languages which can be described using regular expressions.
- These languages can be modeled by NFA or DFA.
- Type 3 is most restricted form of grammar. The Type 3 grammar should be Type 2 and Type 1. Type 3 should be in the form of

$$1. \rightarrow \quad T^*V \: / \: T^*$$

Type 2 Grammar:

Type 2 Grammar is known as Context Free Grammar. Context free languages are the languages which can be represented by the context free grammar (CFG). Type 2 should be type 1. The production rule is of the form

1.A → α

Where A is any single non-terminal and is any combination of terminals and non-terminals.

For example:

1.A → aBb

2.A → b

3.B → a

Type 1 Grammar:

Type 1 grammar is known as Context Sensitive Grammar. The context sensitive grammar is used to represent context sensitive language. The context sensitive grammar follows the following rules:

• The context sensitive grammar may have more than one symbol on the left hand side of their production rules.

• The number of symbols on the left-hand side must not exceed the number of symbols on the right-hand side.

• The rule of the form A → ε is not allowed unless A is a start symbol. It does not occur on the right-hand side of any rule.

• The Type 1 grammar should be Type 0. In type 1, Production is in the form of V → T

Where the count of symbol in V is less than or equal to T.

For example:

1. S → AT
2. T → xy
3. A → a

Type 0 Grammar:

Type 0 grammar is known as Unrestricted grammar. There is no restriction on the grammar rules of these types of languages. These languages can be efficiently modeled by Turing machines.

For example:

1.bAa → aa

2.S → s