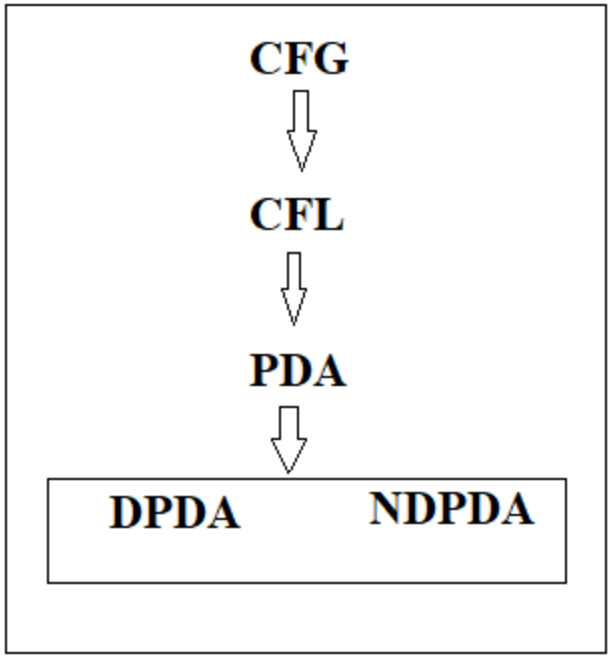
Theory of Computation
CS-202

Outline

- Push Down Automata
  - Deterministic Push Down Automata
  - Non Deterministic Push Down Automata

Context free Grammar, Language and PDA



Pumping Lemma for Context free Language

The pumping lemma is a way to show that certain languages are not context free.

Just like we used the pumping lemma to show certain languages are not regular.

Pumping Lemma for Context free Language

Let L be an infinite Context free language then there exist some positive Number m such that any $w \in L$ with $|w| \geq m$ can be decomposed as:

$$w = uvxyz$$

with $|vxy| \leq m$

& $|vy| \geq 1$

Such that $uv^ixy^iz \in L$, $i = 1,2\ldots\ldots$

Example

Let L be the language $\{ a^n b^n c^n \mid n \geq 1 \}$. Show that this language is not a CFL.

Let m=3

w=aaabbbccc

Let m=3

w=a a a b b bccc

u v x y z

$w = uvxyz$

$|vxy| \leq m$

& $|vy| \geq 1$

$uv^i xy^i z \notin L$

Here, $|vy|=2$

$|vxy|=3=m$

For i=2

⇒ aa aa b bb bccc $\notin L$

Hence the given language is not Context free

Closure Properties of Context free Language

The **CFL**'s are closed under union, Concatenation, star **closure** , reversal, homomorphism.

CFL's are not closed under intersection and complementation.

For the Grammar G=(V, T, S, P)

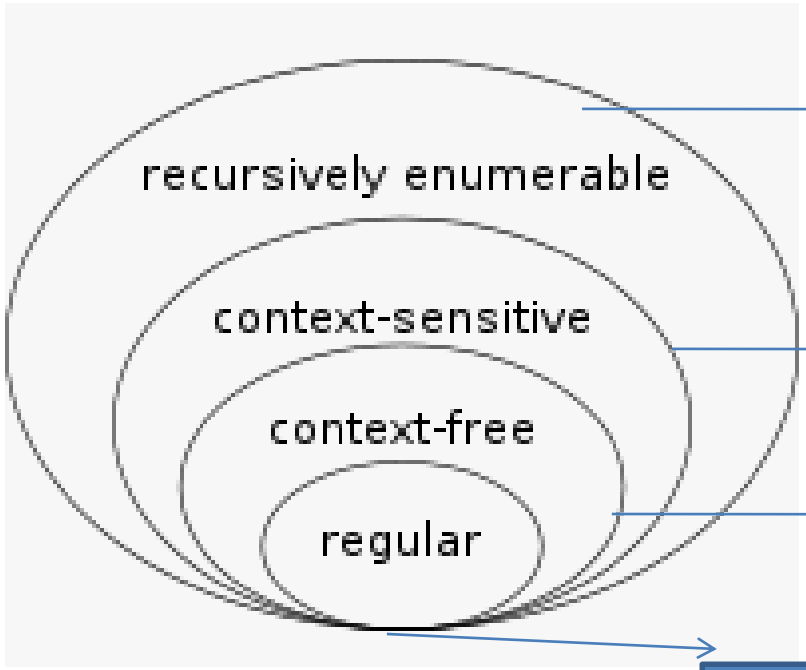
Regular Language
Recognized by
Finite Automata

Regular Grammar
$\alpha \rightarrow \beta$
Where,
$\alpha \in V$
$\beta \in VT^* | T^*$
Or $\beta \in T^* V | T^*$

Context free Language
Recognized by
Push Down Automata

Context free Grammar
$\alpha \rightarrow \beta$
Where,
$\alpha \in V$
$\beta \in (VUT)^*$

Grammar Hierarchy



Recognized by
Turing Machine

Recognized by
Linear Bounded Automata

Recognized by
Push Down Automata

Recognized by
Finite Automata

Context Sensitive Grammar (CSG)

Context Sensitive Grammar (CSG)

A Grammar G=(V, T, S, P) is said to be context sensitive if all productions are of the form:

$\alpha \rightarrow \beta$

Where, $\alpha \in (V \cup T) * V (V \cup T) *$

$\beta \in (V \cup T)^{+}$

$|\alpha| \leq |\beta|$

$\Rightarrow$It does not incorporate ε productions.

Note: Add $S \rightarrow \varepsilon$ such that S should not occur twice on the R. H.S of any production.

Suggested readings

1. An introduction to FORMAL LANGUAGES and AUTOMATA by PETER LINZ.
2. Introduction to Automata Theory, Languages, And Computation by JOHN E. HOPCROFT, RAJEEV MOTWANI, JEFFREY D. ULLMAN
3. Theory of computer science: automata, languages and computation **by** K.L.P MISHRA