**GRAMMAR**

* Grammar is a standard way of representing a language.
* Grammar is a set of rules of a language.
* Grammar G is defined as a quadruple i.e., G= {V, T, P, S}, where V is variable, T is terminal, P is production rule, and S is starting variable.
* Context free means that there is no restriction for the right-side of a production rule.

**AMBIGUITY**

* A grammar is said to be ambiguous if there exist two left-most derivation trees for a string.
* For example, w=a+a\*b.
* **INHERENT AMBIGUITY:** When all the grammars for a language are ambiguous, the language is called inherently ambiguous. If either of the grammars is unambiguous, the language is unambiguous.

**CHOMSKY NORMAL FORM**

* The RHS has a restriction i.e., a production rule can either have a single terminal or two variables on the RHS. For example,

S -> a

S -> ABs

**GREIBACH NORMAL FORM**

* The productions are of the form

S -> a

S -> aB1B2 … Bn

**CLOSURE PROPERTIES OF CFL**

* Closed under union, concatenation and Kleene star closure.
* Not closed under intersection and complement.

**DECISION PROPERTIES OF CFL**

* **EMPTINESS:** If after reducing a CFG, no string can be generated from it, it is said to be empty.
* **FINITENESS:** If the language can generate infinite number of strings, it is said to be a finite language i.e., recursive production rules lead to infiniteness.
* **MEMBERSHIP:** If a given string is part of a language i.e., it can be derived from the provided grammar of that language, the string is said to have acquired the membership of that language. Can be checked using derivation trees.

**PUSHDOWN AUTOMATA**

* Transition function is defined by 7 tuples, 5 of which are same as in FA.
* The other two tuples are:
  + **Tau** symbol which represents the elements of the stack.
  + **Z0** which represents the element present in the stack initially.
* Transition function is defined as:

**(Q x (SET\_OF\_ALPHABETS U EPSILLON) x TAU) = (TRANSITION\_STATE x TAU\*)**

* Pushdown automata considers epsilons to be present between all characters in the string, i.e., for a string abba, it considers it as E a E b E b E a E.
* Instantaneous description is defined using a triplet (q, w, Z) where q is the current state, w is the input to be read, and Z is the stack’s top element.

**TURING MACHINES**

* Accepts two types of languages Recursive languages and Recursive enumerable languages.
* RL are those for which the TM always halts whether it accepts or rejects.
* REL are those for which the TM halts only if it accepts, else it goes into infinite loop.
* Based on whether a language is RL or REL, it is said if a language is decidable or partially decidable.
* In case it is neither RL or REL, it is an undecidable language.

**CHURCH THESIS**

* Any real-world computation can be translated into an equivalent turning machine computation problem.