

# COMP 350 — Theory

## Lecture Notes 02

### Chapter 2 Summary

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Very brief summary of the key points in chapter 2.

- We're introduced to a new class of languages known as *Context-Free Languages* or CFLs.
- A CFL can be DERIVED from a *Context-Free Grammar* which is a simple recursive grammar composed of variables, terminals, and SUBSTITUTION/PRODUCTION rules for replacing variables. Such a derivation can be represented as a parse tree where internal nodes are variables, leaves are terminals, and rules are represented by parent-child relationships.
- Grammars can be *ambiguous* in that they allow multiple parse trees for a given string. There is no guarantee that an unambiguous grammar exists for a given CFL.
- *Chomsky Normal Form* is a restricted form for Context-Free grammars in which rules either produce terminals or a pair of variables. Theorem 2.9 states that all CFLs can be expressed in Chomsky normal form.
- A non-deterministic *Pushdown Automaton* (PDA) is a new machine model that incorporates stack-based memory into the finite state machine model. Theorem 2.20 asserts that the PDA machine model and the CFG model are equivalent such that every context-free language can be derived by a CFG and accepted by a PDA.
- There is a pumping lemma for context-free languages that is analogous to the pumping lemma for regular languages. It is given in theorem 2.34. For context-free languages, strings can be written as  $uvxyz$  such that  $uv^ixy^iz$  remains in the language for all values of  $i$ . The key constraints are that the substring  $vxy$  is not longer than the pumping length for the language and that the combined length of  $v$  and  $y$  cannot be zero.
- The class of regular languages is a proper subset of the class of context-free languages.