CS310

Context Free Languages and Grammars

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Context Free Grammar

- Another way to represent a language
  - Can represent more languages than FA
- Produces a "Context Free Language"
- Pushdown Automata: machine that recognizes a context free language
- Trivia:
  - First used to describe human languages
  - Now used to parse computer languages (C, C++)

Context Free Grammar

- Example

  A -> 0A1

  A -> B

  B -> #

  Variables: A, B (may appear on LHS and RHS)

  Terminals: 0, 1, # (only appear on the RHS)

  Start variable: Variable on LHS of top rule

  Language:

  Example:

Example

- A –> –> 00#11
  - derivation
  - write u –*> v if there is a derivation of the string v from u using the grammar, where u and v are strings of terminals and variables

    0A1 –*> 00#11
  - Parse Tree

Exercise

R -> XRX | S

S -> aTb | bTa

T -> XTX | X | ε

X -> a | b

Variables, terminals of G?

Start variable?

True or false? T -*> aba

Formal Definition

- A context free grammar (CFG) G is a 4-tuple (V, Σ, R, S)
  - V finite set of variables
  - Σ finite set of terminals
  - R set of rules of form:
    - variable `->` (string of variables and terminals)
  - S ϵ V, start variable
  - The language of the grammar is:
  - L(G) = { w ϵ Σ* | S `-*>` w}
    - what?

Example

$L = \{ w \in \{a, b\}^* \mid aa \text{ is a substring} \}$

Find a grammar that generates this language

Example

- Grammar G_2 on page 101
- Show derivation for “a boy sees a flower”
  - Notice how this statement is non-creepy?

- Show the parse tree

Ambiguous Grammar

- E **->** E + E | E x E | E | a
- Find parse tree for: a + a x a