CS 241 – Week 7 Tutorial

Languages: NFAs and CFGs

Spring 2015

Summary

- Non-Deterministic Finite Automata
- Context-free Languages

Regluar Language Review

Non-Deterministic Finite Automaton (NFA)

A Non-Deterministic Finite Automaton (NFA) is a 5-tuple $(\Sigma, Q, q_0, \mathcal{A}, \delta)$ where:
Σ – the input alphabet
Q – finite set of states
$q_0 \in Q$ – a starting state in the set of states
$\mathcal{A} \subseteq Q$ – set of accepting states
$\delta : Q \times \Sigma \to 2^Q$ – the transition relation that allows multiple transitions from a state on the same input

NFA Problems

Draw an NFA diagram for the following language:

1. The language of strings over $\Sigma = \{a, b, c\}$ that end in abc or cab.
2. Convert the previous NFA to a DFA.

Context-Free Languages

1. Generate a CFG that recognizes the same language as the previous NFA.
2. Generate a CFG for the language with n 0's followed by the same number of 1's.
3. Generate a CFG that recognizes words with the same number of a's and b's.

4. Below is a context-free grammar. The strings it generates look like an application of a one-parameter function called f or a two-parameter function called g, where the arguments can either be variables called x or y or another application of f or g.

$$S \to f(A)$$
$$S \to g(A, A)$$
$$A \to x$$
$$A \to y$$
$$A \to S$$

For example, the strings $f(x)$, $g(y, f(y))$ and $f(g(g(x, y), f(x)))$ are generated by this grammar.

Find a left-canonical (left-most) derivation for the string $g(f(x), g(x, y))$ and draw the corresponding parse tree.

5. Given the context-free grammar, which recognizes sequences of balanced parenthesis:

$$S \to (S)$$
$$S \to SS$$
$$S \to \epsilon$$

Write psuedocode for a program that reads a derivation of a string generated by this grammar represented as a parse tree (for example in the .cfg file format). The program should output the maximum level of nesting in the string.