CS311 – Computational Structures – HW6

Thursday, November 1, 2012
due in class Thursday, November 8, 2012

Answer each question below. Write your answers neatly on paper. Be sure your name is on the paper, and the paper is clearly identified as Homework 6.

1. **Language description to PDA** (30 points). Find a pushdown automata for each of the following languages. (10 points each)

   - all strings over $\{a, b\}$ with the same number of a's and b's.
   - the palindromes of odd length over $\{a, b\}$.
   - $\{a^i b^j a^k | k = i + j\}$.

2. **The regular languages are a subset of the context free languages** (40 points). Argue that the regular languages are a subset of the context free languages. Do this by

   - Pick a formalism (other than regular grammars) that describes the regular languages. (4 points)
   - Write down the formal description (or definition) of that formalism. (6 points)
   - Using just the pieces available from the definition, give an algorithm that transforms the pieces into a context free grammar. Be as precise as you can, list individual steps, identify where you use loops or repetition, identify where you make a choice or case split, use indentation, flow charts, or other lexical features to make the structure of your algorithm clear. (16 points)
   - Give one (small but not trivial) example, transforming a concrete instance of your formalism into a concrete context free grammar. Your example should describe an infinite language. (8 points)
   - Finally, make a persuasive argument that the concrete context free grammar recognizes the same set of strings as the concrete formalism (6 points)

3. **CFG to PDA** (30 points). Consider the grammar for balanced parenthesis:

$$
\begin{aligned}
S &\rightarrow \Lambda \\
S &\rightarrow (S) \\
S &\rightarrow SS
\end{aligned}
$$

   (a) Apply the construction given in Hein, Algorithm 12.7, to construct a PDA from a grammar. (If you prefer you can follow another construction, but please give a reference identifying what algorithm you are using.)
   (b) Give a leftmost derivation for the string $((())())$ in the grammar.
   (c) Show that the PDA accepts this string by giving a complete calculation of the steps it follows. Note that this calculation has a similar structure to the leftmost derivation.