COP5621 Fall 2011 –Homework 1

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1. Consider the context-free grammar $G = \langle \{S\}, \{\mathbf{a}, -, *\}, P, S \rangle$ with productions P

$$S \rightarrow S- \mid SS* \mid \mathbf{a}$$

   (a) Show how the string $\mathbf{a} - \mathbf{a} * -\mathbf{a}*$ can be generated by G (using derivation).

   (b) Construct a parse tree for this string.

2. Consider the grammar $G = \langle \{S\}, \{\mathbf{a}, \mathbf{b}\}, P, S \rangle$ with productions P

$$S \rightarrow \mathbf{a}S\mathbf{b}S \mid \mathbf{b}S\mathbf{a}S \mid \epsilon$$

   Show that this grammar is **ambiguous** by finding an example string of terminals **a** and **b** that results in two or more parse trees.

3. Consider the grammar $G = \langle \{S\}, \{\mathbf{a}, \mathbf{b}\}, P, S \rangle$ with productions P

$$S \rightarrow \mathbf{a}S\mathbf{b}S \mid \mathbf{a} \mid \mathbf{b}$$

   (a) **Left factor** the productions.

   (b) Construct a **recursive-descent parser** for this grammar (in pseudo-code or C).

4. Consider the grammar $G = \langle \{S\}, \{\mathbf{a}, +\}, P, S \rangle$ with productions P

$$S \rightarrow S+\mathbf{a} \mid \mathbf{a}$$

   (a) By the shape of the parse trees generated from this grammar, is the + operator considered **left**- or **right-associative**? Explain why?

   (b) **Eliminate left recursion** from this grammar. What happened to operator associativity with respect to the parse tree shapes?

5. Construct a **syntax-directed translation scheme** that translates arithmetic expressions with operators $+, -, *, /$ over single-digit numbers into prefix notation. For example, $\mathbf{9 - 5 + 2}$ translates into $+ - \mathbf{952}$ and $\mathbf{9 + 5 * 2}$ translates into $+\mathbf{9} * \mathbf{52}$.