

Department of Computer Science Columbia University
Sample Midterm – COMS W4115
Programming Languages and Translators
Wednesday, March 24, 2010

Closed book, no aids. Do questions 1–5. Each question is worth 20 points. Question 5(c) is extra credit, 10 points.

1. Briefly explain the essential difference between
 - a) Call-by-value and call-by-reference. How are parameters passed in C and Java?
 - b) Static scope and dynamic scope. How is scoping done in C and Java?

2. Java compilation.
 - a) Draw a block diagram showing how programs are compiled and executed in Java.
 - b) What is a Java just-in-time compiler?

3. Let L be the set of strings of the form $abxba$ where x is a string of a 's, b 's, and c 's that does not contain ba as a substring.
 - a) Write a regular expression for L .
 - b) Show how your regular expression generates the string $ababcba$.
 - c) Construct a deterministic finite automaton for L .
 - d) Show how your automaton processes the input $ababcba$.

4. Consider the context-free grammar $G: S \rightarrow S + S \mid S * S \mid a$.
 - a) Show that G is ambiguous by constructing all parse trees for $a + a * a$.
 - b) Construct an unambiguous grammar for $L(G)$ in which $+$ is left associative, $*$ is nonassociative and of higher precedence than $+$. Draw the parse tree in your grammar for the input string $a + a * a$.
 - c) Prove that your grammar is unambiguous by constructing an SLR(1) parser for it.

5. Syntax-directed translation.
 - a) Construct an SDTS that maps postfix expressions containing the digits $0, 1, \dots, 9$ and the binary arithmetic operators $+$ and $*$ into equivalent infix expressions.
 - b) Show how your SDTS translates the expression $123+*$.
 - c) [Extra credit, 10 pts] Modify your SDTS so that it uses the fewest possible number of parentheses in the output.