

Homework 3 (20pts)

due before class Feb 11, 2009

1. Suppose we have a language that includes all the expressions over the set of terminals $\{N, +, -, **\}$, where N represents all integer numbers, and $+$, $-$, $**$ are operators that must be supported by your grammar. In particular, suppose a and b are integer numbers, the language includes all expressions composed through $a+b$ (binary addition), $-a$ (unary minus), and $a**b$ (binary exponentiation) operations. For example, $3 + 5 ** 7$ and $7 + -2 ** 3 + 34$ are both expressions in the language, but $3 + +5$ and $2 ** +2$ are not. The precedence order of the operators is $+ \ll - \ll **$; that is, $**$ has the highest precedence. The operator $+$ is left associative, and $**$ is right-associative ($2 ** 3 ** 2 = 2 ** 9$ rather than $8 ** 2$).
 - (a) Give a context-free grammar to describe the given language.
 - (b) Based on your grammar, give a parse tree and AST for the input $3 + 5 * 7$.
 - (c) Is your grammar ambiguous? If yes, rewrite your grammar to be non-ambiguous.
2. Give a context-free grammar (BNF) for a language that expresses collections of integers. The terminals of your grammar include $\{, \}, N, (,), \infty$, and $-\infty$, where N stands for all integer numbers, ∞ stands for positive infinity, and $-\infty$ stands for negative infinity. Each sentence in the language must start with $\{$, end with $\}$, and in-between $\{$ and $\}$ must include a sequence of three-integer tuples in the form of $(lb\ ub\ incr)$. Here each $(lb\ ub\ incr)$ specifies the collection of integers obtained by starting from lb and each time incrementing the previous integer by $incr$ until reaching ub . For example, “ $\{ (1\ \infty\ 2) \}$ ” specifies the set of all positive odd integers $(1,3,5,\dots)$, and “ $\{ (-3\ 3\ 1)\ (5\ 6\ 1) \}$ ” specifies the collection of integers $-3,-2,-1,0,1,2,3,5,6$. Examples of invalid specifications include “ $\{ (1\ 3) \}$ ” (the tuple $(1\ 3)$ does not include three integers) and “ $(1\ 5\ 3)$ ” (the sentence does not start with $\{$ or end with $\}$), both of which should be rejected by your grammar. Based on your grammar, give a parse tree and an abstract syntax tree for “ $\{ (-3\ 3\ 1)\ (5\ 6\ 1) \}$ ”.