**CS 164** **Fall 2015**

# WA3

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1. (a)

$$A \to BCA'|CA'$$
$$A' \to BCA'|\epsilon$$
$$B \to int|(A)$$
$$C \to bool$$

(b)

$$L \to boolM$$
$$M \to +N|\epsilon$$
$$N \to bool|int$$

(c)

$$A \to intB$$
$$B \to +A$$
$$B \to -C$$
$$B \to \epsilon$$
$$C \to A$$
$$C \to (A)$$

2. Consider the following grammar describing a certain sort of parenthesis:

$$A \to \epsilon|A + B|C + C$$
$$B \to C|C * B$$
$$C \to (A)|int$$

(a) Left-factor this grammar.

$$A \to C + CA'|A'$$
$$A' \to +BA'|\epsilon$$
$$B \to CB'$$
$$Follow \to *B|\epsilon$$
$$C \to (A)|int$$

(b) Give the First and Follow sets for each nonterminal for the grammar in part (a).

First(A) = {(, int, +}
First($A'$) = {+}
First(B) = {(, int}
First($B'$) = {$*$}
First(C) = {(, int}

Follow(A) = $\{), \$\}$
Follow($A'$) = $\{), \$\}$
Follow(B) = $\{), +, \$\}$
Follow($B'$) = $\{), +, \$\}$
Follow(C) = $\{), +, *, \$\}$

(c) Is there a conflict in the original grammar?

Yes – besides the left recursion, theres a first/first conflict between first(A) and first(C), which are both transitions from A. Also, theres another first/first conflict on B between the two C transitions.

(d) Using the information, construct an LL parsing table for the grammar obtained in (a).

| | + | * | ( | ) | int | $ |
|---|---|---|---|---|---|---|
| A | $A'$ | | $C + CA'$ | $A'$ | $C + CA'$ | $A'$ |
| $A'$ | $+BA'$ | | | $\epsilon$ | | $\epsilon$ |
| B | | | $CB'$ | | $CB'$ | |
| $B'$ | $\epsilon$ | $*B$ | | $\epsilon$ | | $\epsilon$ |
| C | | | (A) | | int | |

(e) What would go wrong if we tried to parse the following input string?

$$((int + int) + int) + int+)$$

We'll continue to parse until our stack is $A'\$$, and our remaining input is "+)". Going forward this becomes :

$$+BA'\$, +)$$
$$BA'\$, )$$

At this point, there is no table entry for T[B,)], so we get an error on the input.

3. Complete the table below showing the trace of an LR(1) parser on the input provided.

| Stack | Input | Action |
|---|---|---|
| | $\triangleright$ x + x + + x + \$ | shift |
| x | x $\triangleright$ + x + + x + \$ | reduce ($B \to x$) |
| B | x $\triangleright$ + x + + x + \$ | shift 2 |
| B + x | x + x $\triangleright$ + + x + \$ | reduce ($B \to x$) |
| B + B | x + x $\triangleright$ + + x + \$ | shift 3 |
| B + B + + x | x + x + + x $\triangleright$ + \$ | reduce ($B \to x$) |
| B + B + + B | x + x + + x $\triangleright$ + \$ | shift 1 |
| B + B + + B + | x + x + + x + $\triangleright$ \$ | reduce ($A \to +B+$) |
| B + B + A | x + x + + x + $\triangleright$ \$ | reduce ($A \to B + A$) |
| B + A | x + x + + x + $\triangleright$ \$ | reduce ($A \to B + A$) |
| A | x + x + + x + $\triangleright$ \$ | reduce ($S \to A$) |
| S | x + x + + x + $\triangleright$ \$ | accept |