

Werkcollege Compilerconstructie
Vrijdag 3 november 2017

1. (Part of problem 4 at the exam of 15 December, 2014)

When generating three-address code for boolean expressions and *flow-of-control* instructions, we can use labels for addresses that Goto-instructions must jump to. During translation, we can pass both the code generated and the labels as attributes of the variables in the grammar.

Consider the following part of a syntax-directed definition for generating this three-address code:

Production	Semantic Rules
$P \rightarrow S$	$S.next = newlabel()$ $P.code = S.code \ \ label(S.next)$
$S \rightarrow \mathbf{while} (B) S_1$	$begin = newlabel()$ $B.true = newlabel()$ $B.false = S.next$ $S_1.next = begin$ $S.code = label(begin) \ \ B.code \ \ label(B.true)$ $\ \ S_1.code \ \ gen('goto' \ begin)$
$B \rightarrow B_1 \&\& B_2$	$B_1.true = newlabel()$ $B_1.false = B.false$ $B_2.true = B.true$ $B_2.false = B.false$ $B.code = B_1.code \ \ label(B_1.true) \ \ B_2.code$
$B_1 \rightarrow \mathbf{id}_1 \ \mathbf{rel} \ \mathbf{id}_2$	$B_1.code = gen('if' \ \mathbf{id}_1.addr \ \mathbf{rel.op} \ \mathbf{id}_2.addr \ 'goto' \ B_1.true)$ $\ \ gen('goto' \ B_1.false)$
$S_1 \rightarrow \mathbf{id}_1 = \mathbf{id}_2 \ \mathbf{binop} \ \mathbf{num}$	$S_1.code = gen(\mathbf{id}_1.addr = \mathbf{id}_2.addr \ \mathbf{binop.op} \ \mathbf{num.val})$

Both P , S and B have an attribute *code*, In addition, S has an attribute *next*, and B has attributes *true* and *false*.

- (a) Draw the parse tree in the above grammar (with start symbol P) for the following ‘program’:

```
while (x!=y && x<max)
  x = x*2
```

- (b) Use the syntax-directed definition above to annotate the parse tree, i.e., to determine values for the attributes *code*, *next*, *true* and *false* of the variables in the tree (of course only the attributes that each variable has). Use names $L1, L2, \dots$ for the labels you introduce.

2. (Derived from Exercise 6.7.1(a) from the book)

Consider the following boolean expression:

`a==b && (c==d || e==f)`

- (a) Construct the parse tree for the boolean expression.
- (b) Use the translation scheme of Fig. 6.43 to annotate the parse tree. Give the resulting translation of the boolean expression into three-address code.
You may assume that the address of the first instruction generated is 100.

3. (Extension of Exercise 6.7.1(a) from the book)

Consider the following ‘program’:

`{ if (a==b && (c==d || e==f)) x=1; y=42; }`

- (a) Construct the parse tree for the program.
- (b) Use the translation scheme of Fig. 6.43 and Fig. 6.46 to annotate the parse tree. Give the resulting translation of the program into three-address code.
You may assume that the address of the first instruction generated is 100.