

Homework 4

CS 441
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1 Given the following SDD:

Productions	Semantic Rules
$L \rightarrow L S$	
$L \rightarrow \varepsilon$	
$S \rightarrow W C \text{ loop } L \text{ end loop } ;$	writeln ('GOTO top'); write ('end: ');
$S \rightarrow \text{id} := E ;$	writeln ('STORE', id#lexeme);
$W \rightarrow \text{while}$	write ('top: ');
$C \rightarrow E < E$	writeln ('COMP'); writeln ('BGE end');
$E \rightarrow E + T$	writeln ('ADD');
$E \rightarrow T$	
$T \rightarrow T * F$	writeln ('MUL');
$T \rightarrow F$	
$F \rightarrow (E)$	
$F \rightarrow \text{id}$	writeln ('LOAD', id#lexeme);
$F \rightarrow \text{literal}$	writeln ('LC', literal#value);

Draw the annotated parse tree for the following sentence and evaluate the attributes in the annotated parse tree.

```
x := 0;
while x < 5 loop
  x := x+1;
end loop;
```

2 Consider the following CFG G which generates a language of tours:

```
Tour  → ε | Tour Move ;
Move  → rotate literal | walk literal
```

Construct an S-attributed attribute grammar from the underlying CFG G which computes the final (x, y) -coordinates of a Tour beginning at $(0, 0)$ facing the positive x -axis and consisting of Moves which **rotate** the tourist literal#value degrees counterclockwise or **walk** the tourist literal#value units forward.

3 Consider the following CFG G which generates strings representing polynomials in x :

E	\rightarrow	$E_1 + T \mid T$
T	\rightarrow	$T_1 * F \mid F$
F	\rightarrow	$x \mid C$
C	\rightarrow	$0 \mid 1 \mid \dots \mid 9$

Recall the rules for differentiating sums E , products T , and constants C :

$$\frac{dE}{dx} = \frac{dE_1}{dx} + \frac{dT}{dx},$$

$$\frac{dT}{dx} = T_1 * \frac{dF}{dx} + F * \frac{dT_1}{dx},$$

$$\frac{dC}{dx} = 0.$$

- a) Construct an S-attributed syntax-directed definition from the underlying CFG G which performs “symbolic differentiation”. For each nonterminal A , let $A\#poly$ and $A\#deriv$ be attributes whose values are strings representing the polynomial and its derivative with respect to x , respectively. The semantic functions need not simplify the resulting expressions.
- b) Draw the annotated parse tree for the sentence $x * x + 3 * x$ and evaluate the attributes.