

CSEN 1003 Compiler, Spring Term 2020
Practice Assignment 9

Exercise 9-1

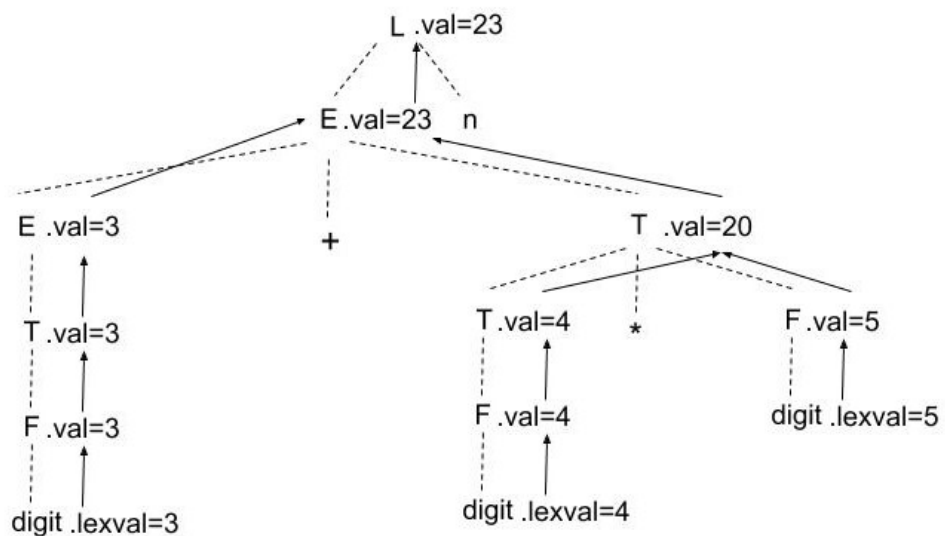
Consider the following SDD:

Production	Semantic Rule
1) $L \rightarrow E \mathbf{n}$	$L.val = E.val$
2) $E \rightarrow E_1 + T$	$E.val = E_1.val + T.val$
3) $E \rightarrow T$	$E.val = T.val$
4) $T \rightarrow T_1 * F$	$T.val = T_1.val * F.val$
5) $T \rightarrow F$	$T.val = F.val$
6) $F \rightarrow (E)$	$F.val = E.val$
7) $F \rightarrow \mathbf{digit}$	$F.val = \mathbf{digit.lexval}$

Give the dependency graphs of the annotated parse trees for the following expressions

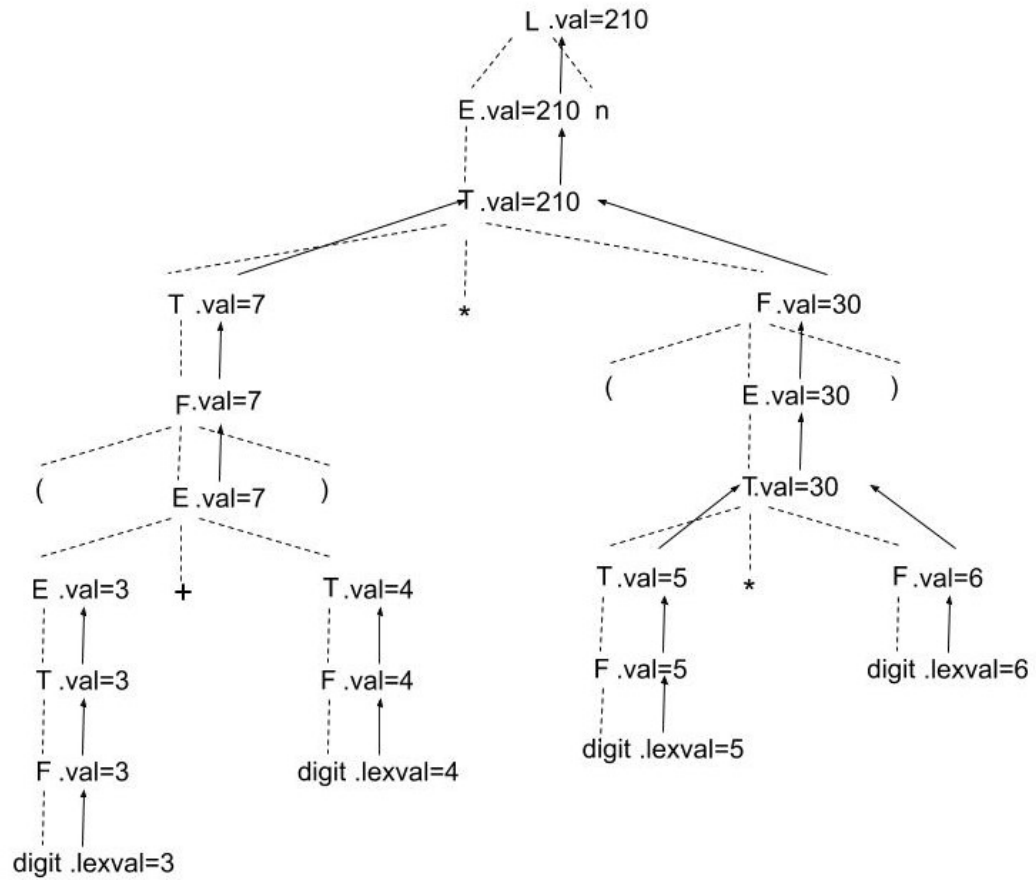
a) $3 + 4 * 5 \mathbf{n}$

Solution:



b) $(3 + 4) * (5 * 6) n$

Solution:



Exercise 9-2

Extend the following SDD to handle expressions as in SDD given in Exercise 9-1.

Production	Semantic Rule
1) $T \rightarrow F T'$	$T'.inh = F.val$ $T.val = T'.syn$
2) $T' \rightarrow * F T'_1$	$T'_1.inh = T'.inh * F.val$ $T'.syn = T'_1.syn$
3) $T' \rightarrow \epsilon$	$T'.syn = T'.inh$
4) $F \rightarrow \mathbf{digit}$	$F.val = \mathbf{digit.lexval}$

Solution:

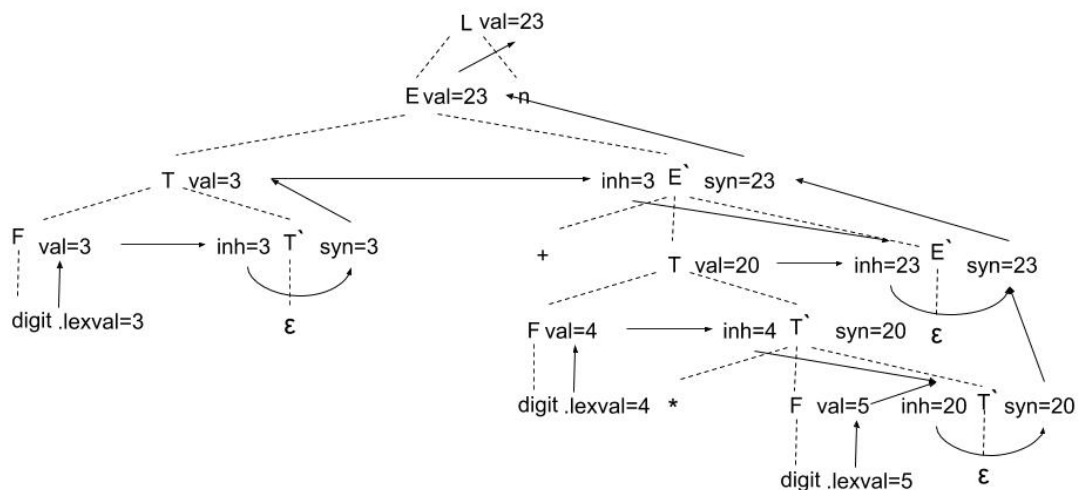
Note: *.syn* and *.val* are different names for the same synthesized attributes of the grammar variables.

Production	Semantic Rule
1) $L \rightarrow E \mathbf{n}$	$L.val = E.syn$
2) $E \rightarrow T E'$	$E.syn = E'.syn$ $E'.inh = T.val$
3) $E' \rightarrow + T E'_1$	$E'_1.inh = E.inh + T.val$ $E.syn = E'_1.syn$
4) $E' \rightarrow \epsilon$	$E'.syn = E'.inh$
5) $T \rightarrow F T'$	$T'.inh = F.val$ $T.val = T'.syn$
6) $T' \rightarrow * F T'_1$	$T'_1.inh = T'.inh * F.val$ $T'.syn = T'_1.syn$
7) $T' \rightarrow \epsilon$	$T'.syn = T'.inh$
8) $F \rightarrow (E)$	$F.val = E.val$
9) $F \rightarrow \mathbf{digit}$	$F.val = \mathbf{digit}.lexval$

Give the dependency graphs of the annotated parse trees for the following expressions

a) $3 + 4 * 5 \mathbf{n}$

Solution:



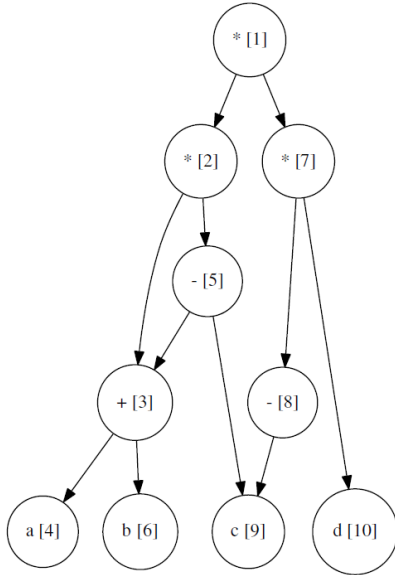
b) $(3 + 4) * (5 * 6) \mathbf{n}$

Solution:

Do it yourself.

Exercise 9-3**Topological sort of a dependency graph**

Give a topological sort for the following dependency graph:

**Solution:**

Post-order traversal: 4, 6, 3, 9, 5, 2, 8, 10, 7, 1

Topological sort: 1, 7, 10, 8, 2, 5, 3, 6, 4, 9

Exercise 9-4

Suppose that we have a production $A \rightarrow BCD$. Each of the four nonterminals A, B, C , and D have two attributes: s is a synthesized attribute, and i is an inherited attribute. For each of the sets of rules below, tell whether (i) the rules are consistent with an S-attributed definition (ii) the rules are consistent with an L-attributed definition, and (iii) whether the rules are consistent with any evaluation order at all?

- $A.s = B.i + C.s$.
- $A.s = B.i + C.s$ and $D.i = A.i + B.s$.
- $A.s = B.s + D.s$.
- $A.s = D.i$, $B.i = A.s + C.s$, $C.i = B.s$, and $D.i = B.i + C.i$.

Solution:

- Consistent with an L-attributed definition, since the value of the synthesized attribute $A.s$ of the node is computed from that of the inherited attribute ($B.i$) and synthesized attribute ($C.s$) of its children nodes.
- Consistent with an L-attributed definition, since the value of the inherited attribute $D.i$ is computed from the attributes of a parent node ($A.i$) and a sibling node that appears to its left ($B.s$).

- c) Consistent with an S-attributed definition, since the value of the synthesized attribute ($A.s$) of the node is computed from that of the attributes of its children nodes $C.s$ and $D.s$.
- d) Neither, since the inherited attribute ($B.i$) is computed from the attribute $C.s$ of a sibling node that appears to its right in the production, which is inconsistent with the L-attributed definition. Moreover, the value of the inherited attribute of B ($B.i$) is dependent on a synthesized attribute of the parent which is also inconsistent with the L-attribute definition.

Exercise 9-5

The following grammar generates binary numbers with a “decimal” point:

$$\begin{aligned}
 S &\rightarrow L.L \mid L \\
 L &\rightarrow LB \mid B \\
 B &\rightarrow 0 \mid 1
 \end{aligned}$$

Design an L-attributed SDD to compute $S.val$, the decimal-number value of an input string. For example, the translation of string 101.101 should be the decimal number 5.625.

Solution:

$$\begin{aligned}
 S &\rightarrow L_1.L_2 & L_1.f = 1; L_1.p = 1; L_2.f = 0.5; L_2.p = 0.5 \\
 & & S.val = L_1.val + L_2.val \\
 S &\rightarrow L & L.f = 1; L.p = 1; S.val = L.val \\
 L &\rightarrow L_1B & L_1.f = L.f \times L.p; L_1.p = L.p \\
 & & L.min = L_1.min; L.val = 2 \times L_1.val + L.min \times B.val \\
 L &\rightarrow B & L.min = L.f; L.val = L.min \times B.val \\
 B &\rightarrow 0 & B.val = 0 \\
 B &\rightarrow 1 & B.val = 1
 \end{aligned}$$

Exercise 9-6

Convert your SDD from Exercise 9-2 to an SDT.

Solution:

Production	
1)	$L \rightarrow E \mathbf{n} \{L.val = E.syn\}$
2)	$E \rightarrow T \{E'.inh = T.val\} E' \{E.syn = E'.syn\}$
3)	$E' \rightarrow + T \{E'_1.inh = E.inh + T.val\} E'_1 \{E.syn = E'_1.syn\}$
4)	$E' \rightarrow \varepsilon \{E'.syn = E'.inh\}$
5)	$T \rightarrow F \{T'.inh = F.val\} T' \{T.val = T'.syn\}$
6)	$T' \rightarrow * F \{T'_1.inh = T.inh * F.val\} T'_1 \{T'.syn = T'_1.syn\}$
7)	$T' \rightarrow \varepsilon \{T'.syn = T'.inh\}$
8)	$F \rightarrow (E) \{F.val = E.val\}$
9)	$F \rightarrow \mathbf{digit} \{F.val = \mathbf{digit.lexval}\}$