Parul® University

COMPILER DESIGN
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CHAPTER-4

Syntax-directed definitions

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Syntax Directed Definitions

- We can associate information with a language construct by attaching attributes to the grammar symbols.

- A syntax directed definition specifies the values of attributes by associating semantic rules with the grammar productions.

Production	Semantic Rule
E->E1 + T	E.code=E1.code=T.code

Syntax Directed Definitions

- A SDD is a context free grammar with attributes and rules.
- Attributes are associated with grammar symbols and rules with productions.
- Attributes may be of many kinds: numbers, types, table references, strings, etc.

Syntax Directed Definitions

Synthesized attributes:

A synthesized attribute at node N is defined only in terms of attribute values of children of N and at N it.

Inherited attributes:

An inherited attribute at node N is defined only in terms of attribute values at N's parent, N itself and N's siblings

Synthesized attributes

- A synthesized attribute at node N is defined only in terms of attribute values of children of N and at N it.
- Each of the non-terminals has a single synthesized attribute, called val.
- An SDD that involves only synthesized attributes is called S-attributed.
- Each rule computes an attribute for the non-terminal at the head of a production from attributes taken from the body of the production.

SDD for expression grammar with Synthesized attribute

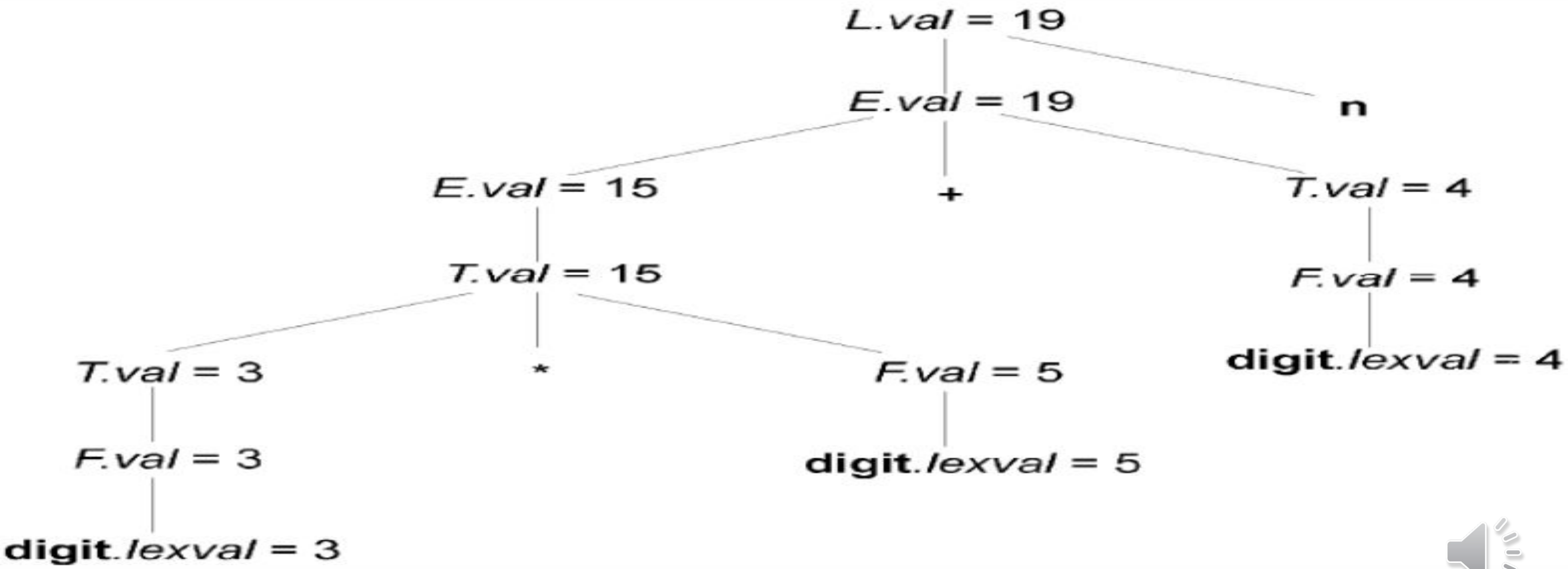
Production	Semantic Rules
1) L -> E n	L.val = E.val
2) E -> E1 + T	E.val = E1.val + T.val
3) E -> T	E.val = T.val
4) T -> T1 * F	T.val = T1.val * F.val
5) T -> F	T.val = F.val
6) F -> (E)	F.val = E.val
7) F -> digit	F.val = digit.lexval

Evaluating an SDD at the Nodes of a Parse Tree

- A parse tree, showing the value(s) of its attribute(s) is called an annotated parse tree.

- With synthesized attributes, evaluate attributes in bottom-up order.

Annotated Parse Tree for 3*5+4



L.val = 19

E.val = 19

n

E.val = 15

+

T.val = 4

T.val = 15

F.val = 4

T.val = 3

*

F.val = 5

digit.lexval = 4

F.val = 3

digit.lexval = 5

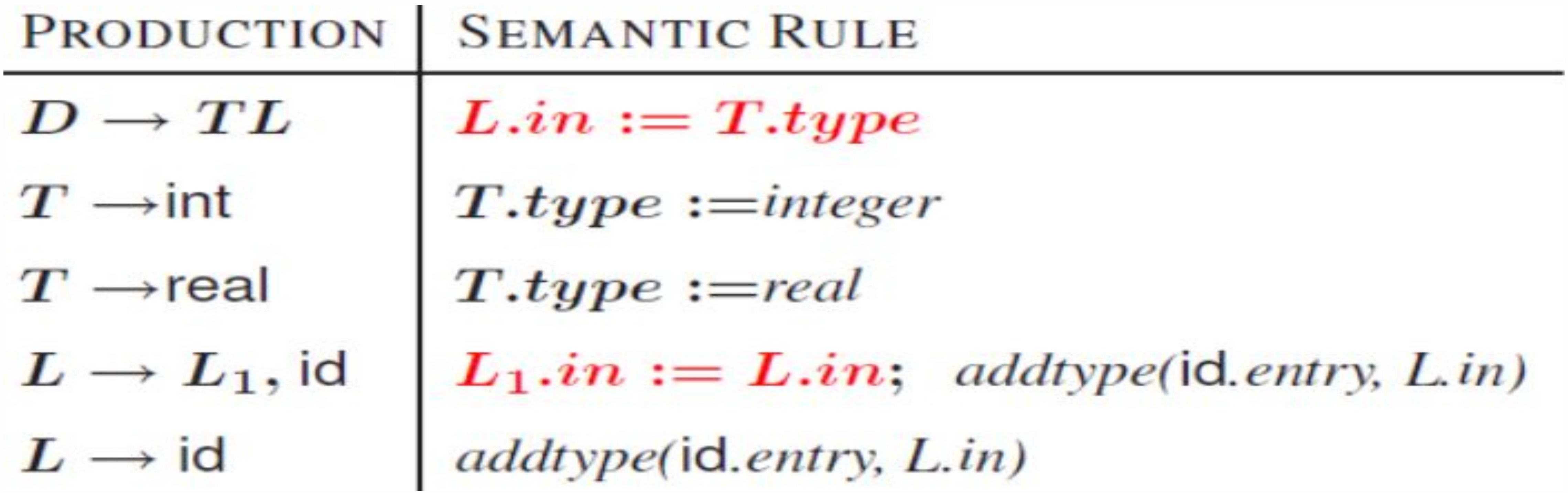
digit.lexval = 3

Inherited Attributes

- An INHERITED ATTRIBUTE for a non-terminal B at a parse-tree node N is defined by a semantic rule associated with the production at the parent of N. The production must have B as a symbol in its body.

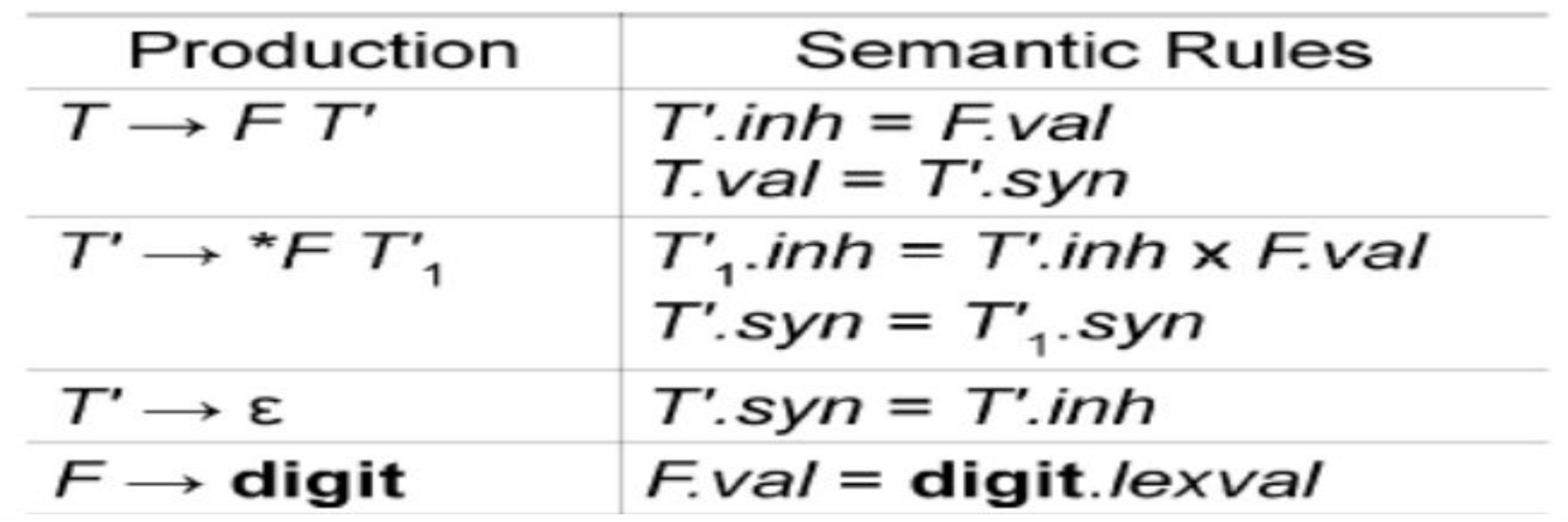
- An inherited attribute at node N is defined only in terms of attribute values at N's parent, N itself, and N's siblings

SDD for expression grammar with inherited grammar



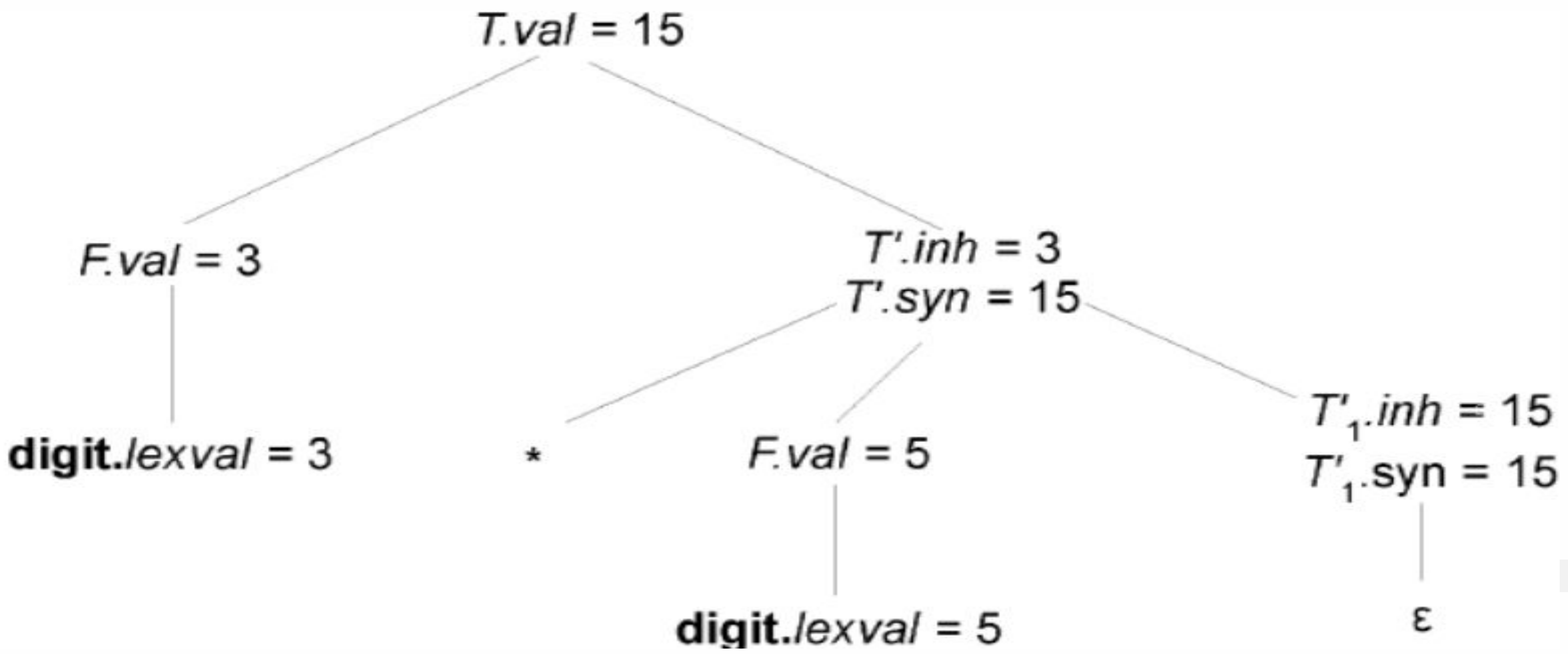
PRODUCTION	SEMANTIC RULE
$D \rightarrow TL$	$L.in := T.type$
$T \rightarrow$ int	$T.type := integer$
$T \rightarrow$ real	$T.type := real$
$L \rightarrow L_1$, id	$L_1.in := L.in$; $addtype($id$.entry, L.in)$
$L \rightarrow$ id	$addtype($id$.entry, L.in)$

SDD for expression grammar with inherited grammar



Production	Semantic Rules
$T \rightarrow F\ T'$	$T'.inh = F.val$ $T.val = T'.syn$
$T' \rightarrow {*F}\ T'_1$	$T'_1.inh = T'.inh \times F.val$ $T'.syn = T'_1.syn$
$T' \rightarrow \varepsilon$	$T'.syn = T'.inh$
$F \rightarrow \textbf{digit}$	$F.val = \textbf{digit}.lexval$

Annotated Parse Tree for 3*5



Evaluation Orders for SDD's

- Dependency graphs‟ tool for determining an evaluation order for the attribute instances in a given parse tree.

- annotated parse tree shows the values of attributes, a dependency graph helps to determine how those values can be computed.

Dependency graphs

- Edges express constraints implied by the semantic rules.
- Each attribute is associated to a node
- If a semantic rule associated with a production p defines the value of synthesized attribute
  A.b in terms of the value of X.c, then graph has an edge from X.c to A.b.
- If a semantic rule associated with a production p defines the value of inherited attribute
  B.c in terms of value of X.a, then graph has an edg

Topological Sort

- A dependency graph characterizes the possible order in which we can evaluate the attributes at various nodes of a parse tree.

- If there is an edge from node M to N, then attribute corresponding to M first be evaluated before evaluating N.

- Thus the allowable orders of evaluation are N1, N2, ...,Nk such that if there is an edge from
  Ni to Nj then i < j.

Topological Sort

- Such an ordering embeds a directed graph into a linear order, and is calle
  a topological
  sort of the graph.

- If there is any cycle in the graph, then there are no topological sorts.

S-Attributed

- If every attribute is synthesized.
- S-attributed SDD can be evaluated in bottom up order of the nodes of the parse tree.

L-Attributed

- Synthesized, or Inherited, but with the rules limited as follows. Suppose that there is a production A -> XIX2 · ..Xn , and that there is an inherited attribute Xi·a computed by
  a rule associated with this production.
- Inherited attributes associated with the head A.
- Either inherited or synthesized attributes associated with the occurrences of symbols XI ,
  X2 , ••• ,Xi-l located to the left of Xi.
- Inherited or synthesized attributes associated with this occurrence of Xi itself, but only in
  such a way that there are no cycles in a dependenc
  attributes of
  this Xi

Recursive Descent Parser

- Top-down parsing strategy, for LL(1) grammars.
- One procedure per nonterminal.
- Stack contents embedded in recursive call sequence
- Each procedure “commits” to one production, based on the next input symbol, and the
   select sets.
- It uses back- tracking. So, it is not usefull.
- Good technique for hand-written parsers