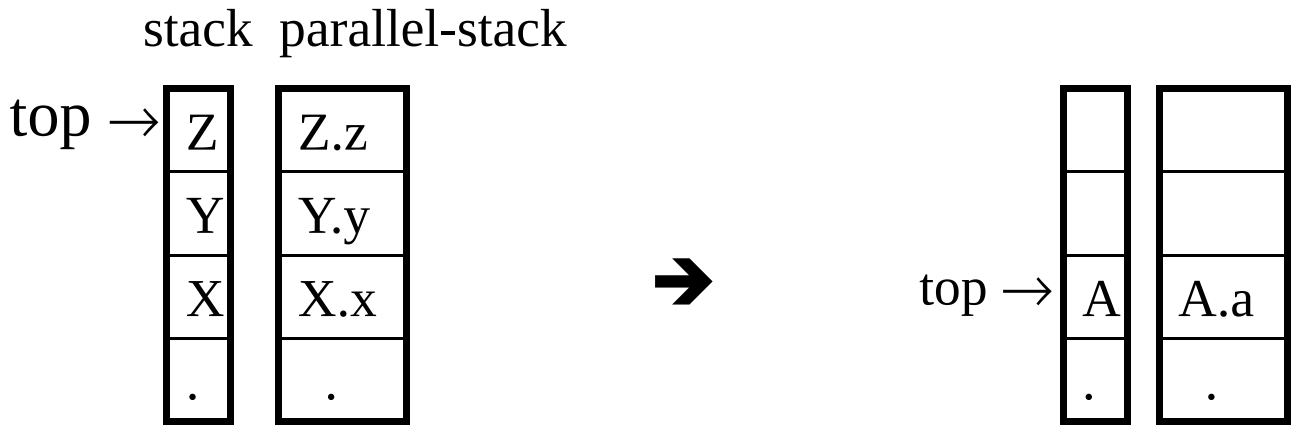
S-Attributed Definitions

- Syntax-directed definitions are used to specify syntax-directed translations.
- To create a translator for an arbitrary syntax-directed definition can be difficult.
- We would like to evaluate the semantic rules during parsing (i.e. in a single pass, we will parse and we will also evaluate semantic rules during the parsing).
- We will look at two sub-classes of the syntax-directed definitions:
  - **S-Attributed Definitions**: only synthesized attributes used in the syntax-directed definitions.
  - **L-Attributed Definitions**: in addition to synthesized attributes, we may also use inherited attributes in a restricted fashion.
- To implement S-Attributed Definitions and L-Attributed Definitions are easy (we can evaluate semantic rules in a single pass during the parsing).
- Implementations of S-attributed Definitions are a little bit easier than implementations of L-Attributed Definitions

Bottom-Up Evaluation of S-Attributed Definitions

- We put the values of the synthesized attributes of the grammar symbols into a parallel stack.
  - When an entry of the parser stack holds a grammar symbol X (terminal or non-terminal), the corresponding entry in the parallel stack will hold the synthesized attribute(s) of the symbol X.
- We evaluate the values of the attributes during reductions.

$A \rightarrow XYZ$ $\quad A.a=f(X.x,Y.y,Z.z)$ where all attributes are synthesized.

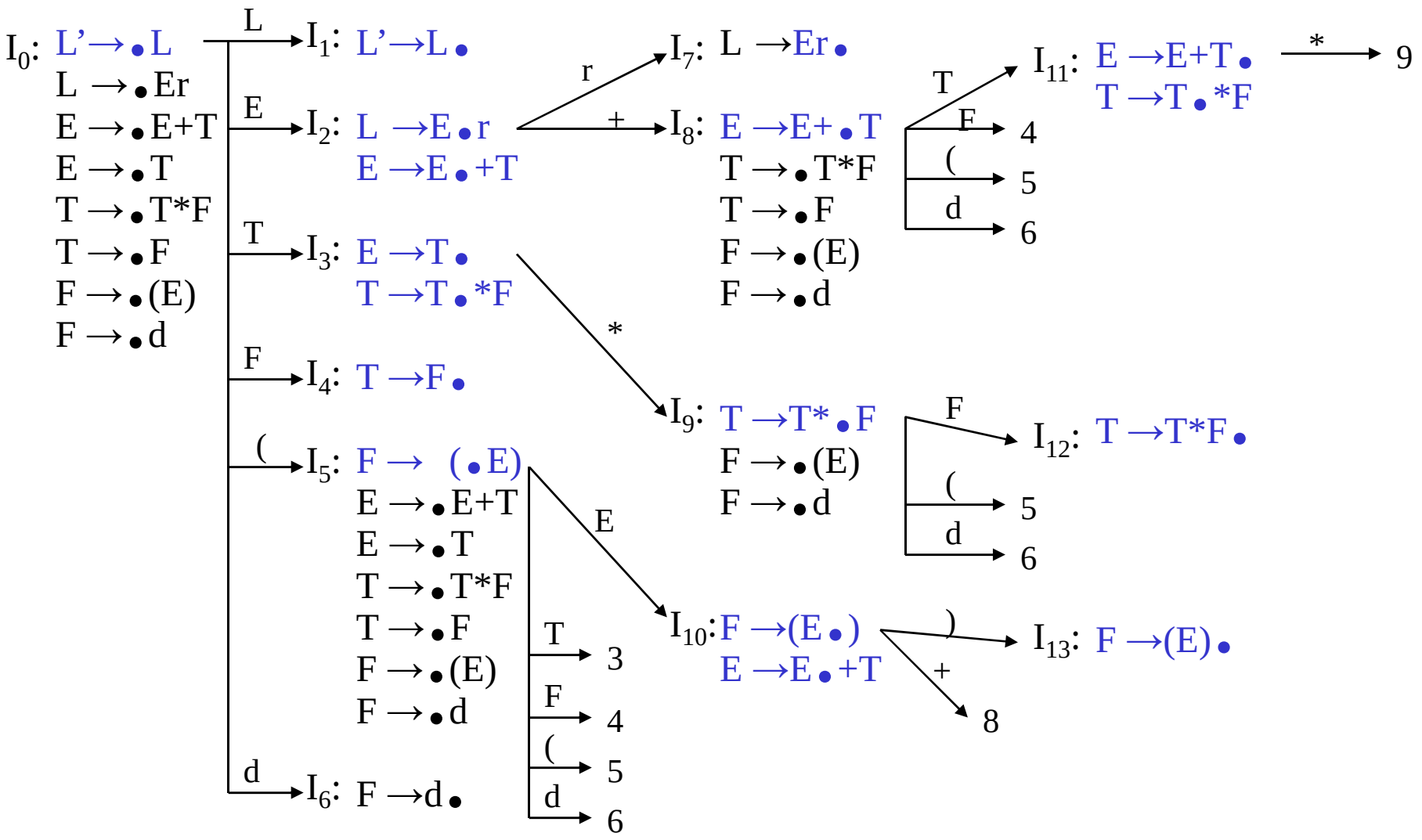


Bottom-Up Eval. of S-Attributed Definitions (cont.)

Production	**Semantic Rules**
L → E **return**	print(val[top-1])
$E \rightarrow E_1 + T$	val[ntop] = val[top-2] + val[top]
E → T	
$T \rightarrow T_1 * F$	val[ntop] = val[top-2] * val[top]
T → F	
F → (E)	val[ntop] = val[top-1]
F → **digit**	

- At each shift of **digit**, we also push **digit.lexval** into *val-stack*.
- At all other shifts, we do not put anything into *val-stack* because other terminals do not have attributes (but we increment the stack pointer for *val-stack*).

Canonical LR(0) Collection for The Grammar



Bottom-Up Evaluation -- Example

- At each shift of **digit**, we also push **digit.lexval** into *val-stack*.

stack	val-stack	input	action	semantic rule
0		5+3*4r	s6	d.lexval(5) into val-stack
0d6	5	+3*4r	F→d	F.val=d.lexval – do nothing
0F4	5	+3*4r	T→F	T.val=F.val – do nothing
0T3	5	+3*4r	E→T	E.val=T.val – do nothing
0E2	5	+3*4r	s8	push empty slot into val-stack
0E2+8	5-	3*4r	s6	d.lexval(3) into val-stack
0E2+8d6	5-3	*4r	F→d	F.val=d.lexval – do nothing
0E2+8F4	5-3	*4r	T→F	T.val=F.val – do nothing
0E2+8T11	5-3	*4r	s9	push empty slot into val-stack
0E2+8T11*9	5-3-	4r	s6	d.lexval(4) into val-stack
0E2+8T11*9d6	5-3-4	r	F→d	F.val=d.lexval – do nothing
0E2+8T11*9F12	5-3-4	r	T→T*F	$T.val=T_1.val*F.val$
0E2+8T11	5-12	r	E→E+T	$E.val=E_1.val*T.val$
0E2	17	r	s7	push empty slot into val-stack
0E2r7	17-	$	L→Er	print(17), pop empty slot from val-stack
0L1	17	$	acc	