Bottom-Up Parsing

Lecture 11

LR Parsing

One Parsing Algorithm
Several Ways to Build the Tables

SLR (or “Simple LR”)
- May fail to build a table for some LR grammars
- SLR Grammars $\subset$ LR Grammars
- Easiest to understand

LR (or “ Canonical LR”)
- The general algorithm
- Will work for any LR Grammar

LALR (or “ Lookahead LR”)
- Will build smaller tables
- May fail for some LR Grammars

SLR Parsing

- An LR(0) state is a set of LR(0) items
- An LR(0) item is a production with a • (dot) in the right-hand side
- Build the LR(0) DFA by
  - *Closure operation* to construct LR(0) items
  - *Goto operation* to determine transitions
- Construct the SLR parsing table from the DFA
- LR parser program uses the SLR parsing table to determine shift/reduce operations

Constructing SLR Parsing Tables

Augment the grammar with $S' \to S$

1. Construct the set $C=\{I_0,I_1,\ldots,I_n\}$ of *LR(0) items*
2. State i is constructed from I_i . Parsing state determined as follows
   a. If $[A\to\alpha\bullet a\beta] \in I_i$ and $goto(I_i,a)=I_j$ then set $action[i,a]$=shift j
   b. If $[A\to\alpha\bullet] \in I_i$ then set $action[i,a]$=reduce $A\to\alpha$ for all $a \in$ FOLLOW(A) (apply only if $A\neq S'$)
   c. If $[S'\to S\bullet]$ is in I_i then set $action[i,\$]$=accept
3. If $goto(I_i,A)=I_j$ then set $goto[i,A]=j$
4. Repeat 3-6 until no more entries added
5. The initial state i is the I_i holding item $[S'\to\bullet S]$

LR(0) Item set

Grammar:

(1) $E \rightarrow E$ **+** T
(2) $E \rightarrow T$
(3) $T \rightarrow T$ ***** F
(4) $T \rightarrow F$
(5) $F \rightarrow$ **(** E **)**
(6) $F \rightarrow$ **id**

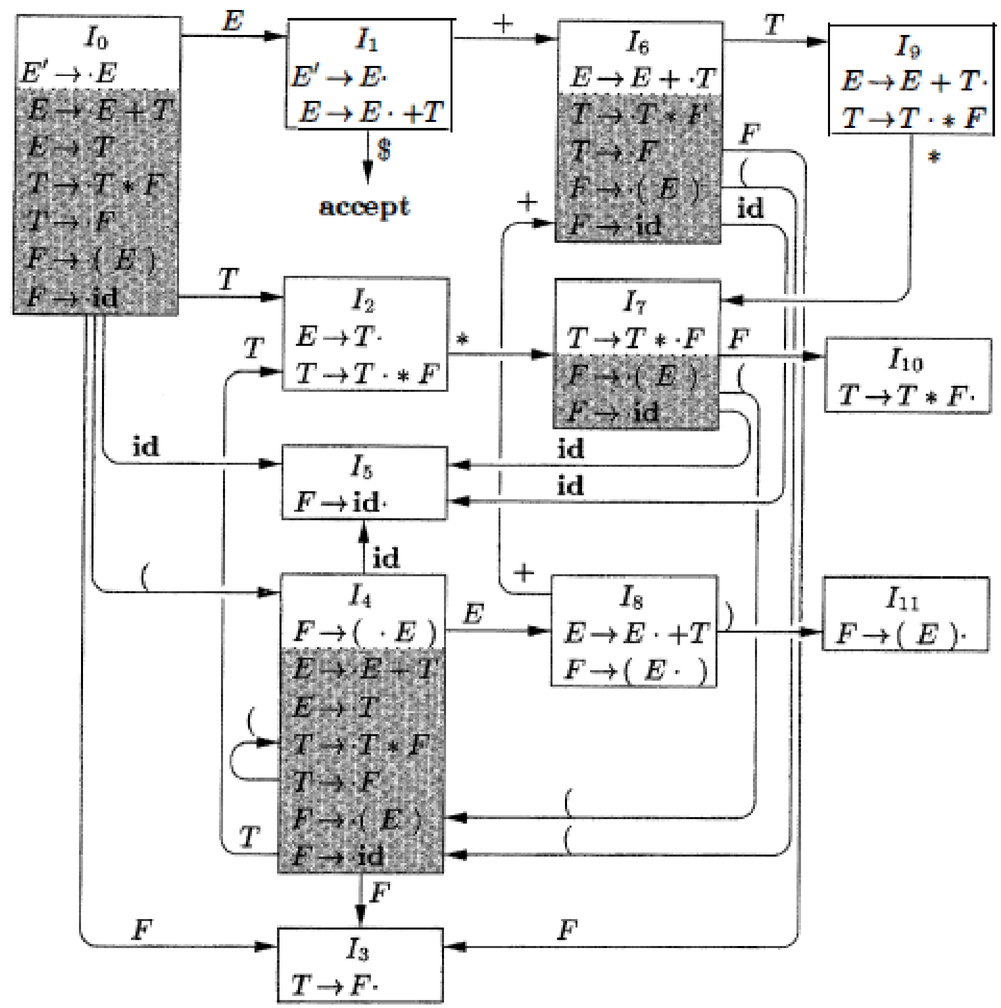

Figure 4.31: LR(0) automaton for the expression grammar (4.1)

SLR Parse Table

I_0

$[E' \rightarrow \bullet\ E]$

$[E \rightarrow \bullet\ E + T]$

$[E \rightarrow \bullet\ T]$

$[T \rightarrow \bullet\ T * F]$

$[T \rightarrow \bullet\ F]$

$[F \rightarrow \bullet\ (\ E\ )]$

$[F \rightarrow \bullet\ \mathbf{id}]\ \}$

(1) $E \rightarrow E + T$
(2) $E \rightarrow T$
(3) $T \rightarrow T * F$
(4) $T \rightarrow F$
(5) $F \rightarrow (\ E\ )$
(6) $F \rightarrow \mathbf{id}$

Action [0,(]=?

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0									
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									

I_0

[E' → • E]

[E → • E + T]

[E → • T]

[T → • T * F]

[T → • F]

[F → • (E)]

[F → • **id**] }

SLR Parse Table

(1) E → E **+** T
(2) E → T
(3) T → T * F
(4) T → F
(5) F → **(** E **)**
(6) F → **id**

Action [0,(]=s4

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0				s4					
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									

I_0

[E' → • E]
[E → • E + T]
[E → • T]
[T → • T * F]
[T → • F]
[F → • (E)]
[F → • **id**] }

SLR Parse Table

(1) E → E **+** T
(2) E → T
(3) T → T * F
(4) T → F
(5) F → **(** E **)**
(6) F → **id**

Action [0,(]=s4
Action [0,id]=s5

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0	S5			s4					
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									

I_0

[$E' \rightarrow \bullet\ E$]

[$E \rightarrow \bullet\ E$ **+** T]

[$E \rightarrow \bullet\ T$]

[$T \rightarrow \bullet\ T * F$]

[$T \rightarrow \bullet\ F$]

[$F \rightarrow \bullet$ **(** E **)**]

[$F \rightarrow \bullet$ **id**] }

SLR Parse Table

(1) E → E **+** T
(2) E → T
(3) T → T ***** F
(4) T → F
(5) F → **(** E **)**
(6) F → **id**

Action [0,(]=s4
Action [0,id]=s5

GoTo(0,E)=1

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0	S5			s4			1		
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									

SLR Parse Table

I_0

$[E' \rightarrow \bullet\ E]$
$[E \rightarrow \bullet\ E + T]$
$[E \rightarrow \bullet\ T]$
$[T \rightarrow \bullet\ T * F]$
$[T \rightarrow \bullet\ F]$
$[F \rightarrow \bullet\ (\ E\ )]$
$[F \rightarrow \bullet\ \mathbf{id}]\ \}$

(1) E → E **+** T
(2) E → T
(3) T → T * F
(4) T → F
(5) F → **(** E **)**
(6) F → **id**

Action [0,(]=s4
Action [0,id]=s5

GoTo(0,E)=1
GoTo(0,T)=2

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0	S5			s4			1	2	
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									

SLR Parse Table

I_0

[E' → • E]

[E → • E + T]

[E → • T]

[T → • T * F]

[T → • F]

[F → • (E)]

[F → • **id**] }

(1) E → E **+** T

(2) E → T

(3) T → T * F

(4) T → F

(5) F → **(** E **)**

(6) F → **id**

Action [0,(]=s4

Action [0,id]=s5

GoTo(0,E)=1

GoTo(0,T)=2

GoTo(0,F)=3

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0	S5			s4			1	2	3
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									

I$_1$

[$E' \rightarrow E \bullet$]

[$E \rightarrow E \bullet + T$]

SLR Parse Table

(1) $E \rightarrow E + T$
(2) $E \rightarrow T$
(3) $T \rightarrow T * F$
(4) $T \rightarrow F$
(5) $F \rightarrow (E)$
(6) $F \rightarrow$ **id**

Action [1,$]=acc

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0	S5			s4			1	2	3
1						acc			
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									

I_1

$[E' \rightarrow E \bullet]$

$[E \rightarrow E \bullet + T]$

SLR Parse Table

(1) E → E **+** T
(2) E → T
(3) T → T ***** F
(4) T → F
(5) F → **(** E **)**
(6) F → **id**

Action [1,$]=acc
Action [1,+]=s6

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0	S5			s4			1	2	3
1		s6				acc			
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									

SLR Parse Table

I_2

$[E \to T \bullet]$

$[T \to T \bullet * F]$

(1) E → E **+** T
(2) E → T
(3) T → T ***** F
(4) T → F
(5) F → **(** E **)**
(6) F → **id**

Follow(E)={+,),$}
Action [2,$]=
Action [2,+]=
Action [2,)]=r2

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0	S5			s4			1	2	3
1		s6				acc			
2		r2			r2	r2			
3									
4									
5									
6									
7									
8									
9									
10									
11									

I_2

$[E \rightarrow T \bullet]$

$[T \rightarrow T \bullet * F]$

SLR Parse Table

(1) E → E **+** T
(2) E → T
(3) T → T ***** F
(4) T → F
(5) F → **(** E **)**
(6) F → **id**

Follow(E)={+,),$}
Action [2,$]=
Action [2,+]=
Action [2,)]=r2
Action [2,*]=s7

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0	S5			s4			1	2	3
1		s6				acc			
2		r2	s7		r2	r2			
3									
4									
5									
6									
7									
8									
9									
10									
11									

I_3

$[T \rightarrow F \bullet]$

SLR Parse Table

(1) E → E **+** T
(2) E → T
(3) T → T * F
(4) T → F
(5) F → **(** E **)**
(6) F → **id**

Follow(T)={*,+,),$}
Action [3,$]=
Action [3,+]=
Action [3,)]=
Action [3,*]=r4

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0	S5			s4			1	2	3
1		s6				acc			
2		r2	s7		r2	r2			
3		r4	r4		r4	r4			
4									
5									
6									
7									
8									
9									
10									
11									

I_4

E' → (• E)

E → • E + T

E → • T

T → • T * F

T → • F

F → • (E)

F → • **id**

SLR Parse Table

(1) E → E **+** T
(2) E → T
(3) T → T ***** F
(4) T → F
(5) F → **(** E **)**
(6) F → **id**

Action [4,id]=s4

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0	S5			s4			1	2	3
1		s6				acc			
2		r2	s7		r2	r2			
3		r4	r4		r4	r4			
4	s4								
5									
6									
7									
8									
9									
10									
11									

SLR Parse Table

I_4

E' → (• E)

E → • E + T

E → • T

T → • T * F

T → • F

F → • (E)

F → • **id**

(1) E → E **+** T
(2) E → T
(3) T → T * F
(4) T → F
(5) F → **(** E **)**
(6) F → **id**

Action [4,id]=s4
Action [4,)]=s5

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0	S5			s4			1	2	3
1		s6				acc			
2		r2	s7		r2	r2			
3		r4	r4		r4	r4			
4	s4				s5				
5									
6									
7									
8									
9									
10									
11									

I_4

E' → (• E)

E → • E + T

E → • T

T → • T * F

T → • F

F → • (E)

F → • **id**

SLR Parse Table

(1) E → E **+** T
(2) E → T
(3) T → T * F
(4) T → F
(5) F → **(** E **)**
(6) F → **id**

Action [4,id]=s4
Action [4,)]=s5

GoTo(4,E)=8

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0	S5			s4			1	2	3
1		s6				acc			
2		r2	s7		r2	r2			
3		r4	r4		r4	r4			
4	s4				s5		8		
5									
6									
7									
8									
9									
10									
11									

I$_4$

E' → (• E)

E → • E + T

E → • T

T → • T * F

T → • F

F → • (E)

F → • **id**

SLR Parse Table

(1) E → E **+** T
(2) E → T
(3) T → T * F
(4) T → F
(5) F → **(** E **)**
(6) F → **id**

Action [4,id]=s4
Action [4,)]=s5

GoTo(4,E)=8
GoTo(4,T)=2

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0	S5			s4			1	2	3
1		s6				acc			
2		r2	s7		r2	r2			
3		r4	r4		r4	r4			
4	s4				s5		8	2	
5									
6									
7									
8									
9									
10									
11									

I_4

E' → (• E)

E → • E + T

E → • T

T → • T * F

T → • F

F → • (E)

F → • **id**

SLR Parse Table

(1) E → E **+** T
(2) E → T
(3) T → T * F
(4) T → F
(5) F → **(** E **)**
(6) F → **id**

Action [4,id]=s4
Action [4,)]=s5

GoTo(4,E)=8
GoTo(4,T)=2
GoTo(4,F)=3

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0	S5			s4			1	2	3
1		s6				acc			
2		r2	s7		r2	r2			
3		r4	r4		r4	r4			
4	s4				s5		8	2	3
5									
6									
7									
8									
9									
10									
11									

I_5

$F \rightarrow \mathbf{id} \bullet$

SLR Parse Table

(1) E → E **+** T
(2) E → T
(3) T → T * F
(4) T → F
(5) F → **(** E **)**
(6) F → **id**

Follow(F)=Follow(T)
=\{+*,)$\}

Action(5,+)=
Action(5,*)=
Action(5,))=
Action(5,$)=r6

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0	S5			s4			1	2	3
1		s6				acc			
2		r2	s7		r2	r2			
3		r4	r4		r4	r4			
4	s4				s5		8	2	3
5		r6	r6		r6	r6			
6									
7									
8									
9									
10									
11									

I_6

$E \rightarrow E + \bullet T$

$T \rightarrow \bullet T * F$

$T \rightarrow \bullet F$

$F \rightarrow \bullet (E)$

$F \rightarrow \bullet \mathbf{id}$

SLR Parse Table

(1) $E \rightarrow E + T$

(2) $E \rightarrow T$

(3) $T \rightarrow T * F$

(4) $T \rightarrow F$

(5) $F \rightarrow (E)$

(6) $F \rightarrow \mathbf{id}$

Action(6,id)=s5

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0	S5			s4			1	2	3
1		s6				acc			
2		r2	s7		r2	r2			
3		r4	r4		r4	r4			
4	s4				s5		8	2	3
5		r6	r6		r6	r6			
6	s5								
7									
8									
9									
10									
11									

I_6

$E \rightarrow E + \bullet\ T$

$T \rightarrow \bullet\ T * F$

$T \rightarrow \bullet\ F$

$F \rightarrow \bullet\ (\ E\ )$

$F \rightarrow \bullet\ \mathbf{id}$

SLR Parse Table

(1) E → E **+** T
(2) E → T
(3) T → T ***** F
(4) T → F
(5) F → **(** E **)**
(6) F → **id**

Action[6,id]=s5
Action[6,(] =s4

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0	S5			s4			1	2	3
1		s6				acc			
2		r2	s7		r2	r2			
3		r4	r4		r4	r4			
4	s4				s5		8	2	3
5		r6	r6		r6	r6			
6	s5			s4					
7									
8									
9									
10									
11									

I_6
E → E + • T
T → • T * F
T → • F
F → • (E)
F → • **id**

SLR Parse Table

(1) E → E **+** T
(2) E → T
(3) T → T ***** F
(4) T → F
(5) F → **(** E **)**
(6) F → **id**

Action[6,id]=s5
Action[6,(] =s4

GoTo(6,T)=9

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0	S5			s4			1	2	3
1		s6				acc			
2		r2	s7		r2	r2			
3		r4	r4		r4	r4			
4	s4				s5		8	2	3
5		r6	r6		r6	r6			
6	s5			s4				9	
7									
8									
9									
10									
11									

I_6

$E \rightarrow E + \bullet T$

$T \rightarrow \bullet T * F$

$T \rightarrow \bullet F$

$F \rightarrow \bullet (E)$

$F \rightarrow \bullet \mathbf{id}$

SLR Parse Table

(1) $E \rightarrow E + T$
(2) $E \rightarrow T$
(3) $T \rightarrow T * F$
(4) $T \rightarrow F$
(5) $F \rightarrow (E)$
(6) $F \rightarrow \mathbf{id}$

Action[6,id]=s5
Action[6,(] =s4

GoTo(6,T)=9
GoTo(6,F)=3

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0	S5			s4			1	2	3
1		s6				acc			
2		r2	s7		r2	r2			
3		r4	r4		r4	r4			
4	s4				s5		8	2	3
5		r6	r6		r6	r6			
6	s5			s4				9	3
7									
8									
9									
10									
11									

I_7

$T \rightarrow T * \bullet F$

$F \rightarrow \bullet (E)$

$F \rightarrow \bullet$ **id**

SLR Parse Table

(1) E → E **+** T
(2) E → T
(3) T → T ***** F
(4) T → F
(5) F → **(** E **)**
(6) F → **id**

Action[7,id]=s5

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0	S5			s4			1	2	3
1		s6				acc			
2		r2	s7		r2	r2			
3		r4	r4		r4	r4			
4	s4				s5		8	2	3
5		r6	r6		r6	r6			
6	s5			s4				9	3
7	s5								
8									
9									
10									
11									

I_7

$T \rightarrow T * \bullet F$

$F \rightarrow \bullet (E)$

$F \rightarrow \bullet$ **id**

SLR Parse Table

(1) E → E **+** T
(2) E → T
(3) T → T ***** F
(4) T → F
(5) F → **(** E **)**
(6) F → **id**

Action[7,id]=s5
Action[7,(] =s4

GoTo(7,F)=10

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0	S5			s4			1	2	3
1		s6				acc			
2		r2	s7		r2	r2			
3		r4	r4		r4	r4			
4	s4				s5		8	2	3
5		r6	r6		r6	r6			
6	s5			s4				9	3
7	s5			s4					
8									
9									
10									
11									

I_7

$T \rightarrow T * \bullet F$
$F \rightarrow \bullet (E)$
$F \rightarrow \bullet$ **id**

SLR Parse Table

(1) E → E **+** T
(2) E → T
(3) T → T ***** F
(4) T → F
(5) F → **(** E **)**
(6) F → **id**

Action[7,id]=s5
Action[7,(] =s4

GoTo(7,F)=10

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0	S5			s4			1	2	3
1		s6				acc			
2		r2	s7		r2	r2			
3		r4	r4		r4	r4			
4	s4				s5		8	2	3
5		r6	r6		r6	r6			
6	s5			s4				9	3
7	s5			s4					10
8									
9									
10									
11									

I_8

$E \rightarrow E \bullet + T$

$F \rightarrow (E \bullet)$

SLR Parse Table

(1) $E \rightarrow E + T$
(2) $E \rightarrow T$
(3) $T \rightarrow T * F$
(4) $T \rightarrow F$
(5) $F \rightarrow (E)$
(6) $F \rightarrow$ **id**

Action[8,+] =s6

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0	S5			s4			1	2	3
1		s6				acc			
2		r2	s7		r2	r2			
3		r4	r4		r4	r4			
4	s4				s5		8	2	3
5		r6	r6		r6	r6			
6	s5			s4				9	3
7	s5			s4					10
8		s6							
9									
10									
11									

I_8

$E \rightarrow E \bullet + T$

$F \rightarrow (E \bullet)$

SLR Parse Table

(1) $E \rightarrow E + T$
(2) $E \rightarrow T$
(3) $T \rightarrow T * F$
(4) $T \rightarrow F$
(5) $F \rightarrow (E)$
(6) $F \rightarrow$ **id**

Action[8,+] =s6
Action[8,)] =s11

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0	S5			s4			1	2	3
1		s6				acc			
2		r2	s7		r2	r2			
3		r4	r4		r4	r4			
4	s4				s5		8	2	3
5		r6	r6		r6	r6			
6	s5			s4				9	3
7	s5			s4					10
8		s6			s11				
9									
10									
11									

I_9

$E \rightarrow E + T \bullet$

$T \rightarrow T \bullet * F$

SLR Parse Table

(1) $E \rightarrow E$ **+** T
(2) $E \rightarrow T$
(3) $T \rightarrow T$ ***** F
(4) $T \rightarrow F$
(5) $F \rightarrow$ **(** E **)**
(6) $F \rightarrow$ **id**

Follow(E) ={+,),$}

Action[8,$] =
Action[8,+] =
Action[8,)] =r1

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0	S5			s4			1	2	3
1		s6				acc			
2		r2	s7		r2	r2			
3		r4	r4		r4	r4			
4	s4				s5		8	2	3
5		r6	r6		r6	r6			
6	s5			s4				9	3
7	s5			s4					10
8		s6			s11				
9		r1			r1	r1			
10									
11									

I_9

$E \rightarrow E + T \bullet$

$T \rightarrow T \bullet * F$

SLR Parse Table

(1) $E \rightarrow E$ **+** T
(2) $E \rightarrow T$
(3) $T \rightarrow T$ ***** F
(4) $T \rightarrow F$
(5) $F \rightarrow$ **(** E **)**
(6) $F \rightarrow$ **id**

Follow(E) ={+,),$}

Action[8,$] =
Action[8,+] =
Action[8,)] =r1
Action[8,*] =s7

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0	S5			s4			1	2	3
1		s6				acc			
2		r2	s7		r2	r2			
3		r4	r4		r4	r4			
4	s4				s5		8	2	3
5		r6	r6		r6	r6			
6	s5			s4				9	3
7	s5			s4					10
8		s6			s11				
9		r1	s7		r1	r1			
10									
11									

I_{10}

$T \to T * F \bullet$

SLR Parse Table

(1) $E \to E + T$
(2) $E \to T$
(3) $T \to T * F$
(4) $T \to F$
(5) $F \to (E)$
(6) $F \to id$

Follow(T) ={*,+,),$}

Action[8,$] =
Action[8,*]=
Action[8,+] =
Action[8,)] =r3

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0	S5			s4			1	2	3
1		s6				acc			
2		r2	s7		r2	r2			
3		r4	r4		r4	r4			
4	s4				s5		8	2	3
5		r6	r6		r6	r6			
6	s5			s4				9	3
7	s5			s4					10
8		s6			s11				
9		r1	s7		r1	r1			
10		r3	r3		r3	r3			
11									

I_{11}

$F \rightarrow (E) \bullet$

SLR Parse Table

(1) $E \rightarrow E + T$
(2) $E \rightarrow T$
(3) $T \rightarrow T * F$
(4) $T \rightarrow F$
(5) $F \rightarrow (E)$
(6) $F \rightarrow id$

Follow(F) =
Follow(T) ={*,+,),$}

Action[8,$] =
Action[8,*]=
Action[8,+] =
Action[8,)] =r5

State	Action						GOTO		
	id	+	*	(	)	$	E	T	F
0	S5			s4			1	2	3
1		s6				acc			
2		r2	s7		r2	r2			
3		r4	r4		r4	r4			
4	s4				s5		8	2	3
5		r6	r6		r6	r6			
6	s5			s4				9	3
7	s5			s4					10
8		s6			s11				
9		r1	s7		r1	r1			
10		r3	r3		r3	r3			
11		r5	r5		r5	r5			

SLR and Ambiguity

- Every SLR grammar is unambiguous, but **not** every unambiguous grammar is SLR
- Consider for example the unambiguous grammar

$$S \to L \;\mathbf{=}\; R \mid R$$
$$L \to \mathbf{*}\; R \mid \mathbf{id}$$
$$R \to L$$

(1) $S \to L \;\mathbf{=}\; R$
(2) $S \to R$
(3) $L \to \mathbf{*}\; R$
(4) $L \to \mathbf{id}$
(5) $R \to L$

I_0:
$S' \to \bullet S$
$S \to \bullet L{=}R$
$S \to \bullet R$
$L \to \bullet {*}R$
$L \to \bullet \mathbf{id}$
$R \to \bullet L$

I_1:
$S' \to S \bullet$

I_2:
$S \to L \bullet {=}R$
$R \to L \bullet$

I_3:
$S \to R \bullet$

I_4:
$L \to {*}\bullet R$
$R \to \bullet L$
$L \to \bullet {*}R$
$L \to \bullet \mathbf{id}$

I_5:
$L \to \mathbf{id} \bullet$

I_6:
$S \to L{=}\bullet R$
$R \to \bullet L$
$L \to \bullet {*}R$
$L \to \bullet \mathbf{id}$

I_7:
$L \to {*}R \bullet$

I_8:
$R \to L \bullet$

I_9:
$S \to L{=}R \bullet$

SLR and Ambiguity

- Every SLR grammar is unambiguous, but **not** every unambiguous grammar is SLR
- Consider for example the unambiguous grammar

$$S \rightarrow L = R \mid R$$
$$L \rightarrow * R \mid \textbf{id}$$
$$R \rightarrow L$$

(1) S → L **=** R
(2) S → R
(3) L → ***** R
(4) L → **id**
(5) R → L

I_0:
$S' \rightarrow \bullet S$
$S \rightarrow \bullet L{=}R$
$S \rightarrow \bullet R$
$L \rightarrow \bullet {*}R$
$L \rightarrow \bullet \textbf{id}$
$R \rightarrow \bullet L$

I_1:
$S' \rightarrow S \bullet$

I_2:
$S \rightarrow L \bullet {=}R$
$R \rightarrow L \bullet$

$action[2,=]=s6$

I_3:
$S \rightarrow R \bullet$

I_4:
$L \rightarrow {*}\bullet R$
$R \rightarrow \bullet L$
$L \rightarrow \bullet {*}R$
$L \rightarrow \bullet \textbf{id}$

Has no SLR parsing table

I_5:
$L \rightarrow \textbf{id} \bullet$

I_6:
$S \rightarrow L{=}\bullet R$
$R \rightarrow \bullet L$
$L \rightarrow \bullet {*}R$
$L \rightarrow \bullet \textbf{id}$

I_7:
$L \rightarrow {*}R \bullet$

I_8:
$R \rightarrow L \bullet$

I_9:
$S \rightarrow L{=}R \bullet$

SLR and Ambiguity

- Every SLR grammar is unambiguous, but **not** every unambiguous grammar is SLR
- Consider for example the unambiguous grammar

$$S \rightarrow L = R \mid R$$
$$L \rightarrow * R \mid \mathbf{id}$$
$$R \rightarrow L$$

Follow(L) = Follow (R)

=Follow(S)

$S \rightarrow L{=}R$

$S \rightarrow {*}R{=}R$

(1) $S \rightarrow L = R$
(2) $S \rightarrow R$
(3) $L \rightarrow * R$
(4) $L \rightarrow \mathbf{id}$
(5) $R \rightarrow L$

I_0:
$S' \rightarrow \bullet S$
$S \rightarrow \bullet L{=}R$
$S \rightarrow \bullet R$
$L \rightarrow \bullet {*}R$
$L \rightarrow \bullet \mathbf{id}$
$R \rightarrow \bullet L$

I_1:
$S' \rightarrow S \bullet$

I_2:
$S \rightarrow L \bullet {=}R$
$R \rightarrow L \bullet$

I_3:
$S \rightarrow R \bullet$

I_4:
$L \rightarrow {*} \bullet R$
$R \rightarrow \bullet L$
$L \rightarrow \bullet {*}R$
$L \rightarrow \bullet \mathbf{id}$

I_5:
$L \rightarrow \mathbf{id} \bullet$

I_6:
$S \rightarrow L{=} \bullet R$
$R \rightarrow \bullet L$
$L \rightarrow \bullet {*}R$
$L \rightarrow \bullet \mathbf{id}$

I_7:
$L \rightarrow {*}R \bullet$

I_8:
$R \rightarrow L \bullet$

I_9:
$S \rightarrow L{=}R \bullet$

$action[2,=]=s6$

$action[2,=]=r5$

no

Has no SLR parsing table

Thank You