

## LR(0) Analysis

### LR(0) Conflicts: Introduction

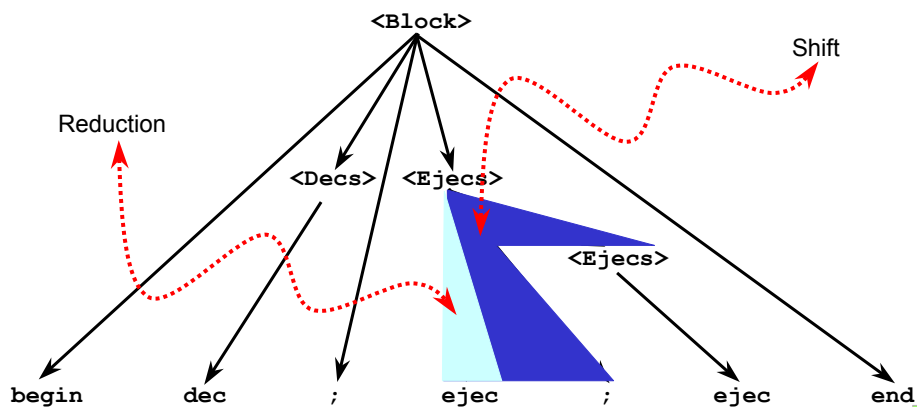
- When constructing the LR(0) analysis table described in the previous steps, it has not been possible to get a deterministic analyser, because there are several possible actions in the same cell. If this happens, we shall say that **the grammar is not LR(0)**.
- Otherwise, we shall say that **the grammar is LR(0)**.
- The existence of non-determinism is called **conflict**
- Conflicts can be of any of these two kinds:
  - **Shift / reduce conflicts:**
    - In this case there are shift and reduce actions in the same cell.
    - The last exercise contains an example of one of these conflicts.
  - **Reduce / reduce conflicts:**
    - In this case all the actions in the cell are reduce actions.
    - The conflict consists in that we do not know beforehand which rule we should reduce for accepting the input string.

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## LR(0) Analysis

### LR(0) Conflicts: Possible solutions

- Even if the grammar is not LR(0), in many cases it is not difficult to imagine a solution for the problem:
  - We shall analyse the conflict in the example: although we can find a derivation tree for the string, the ; symbol provokes that there are two possible actions.

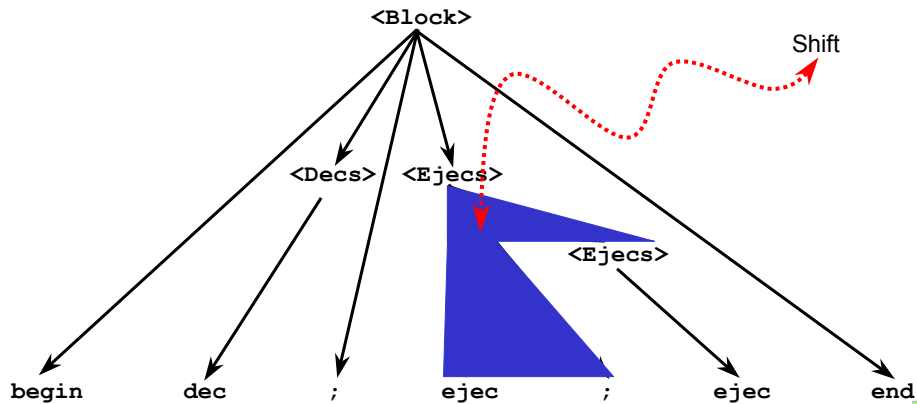


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## LR(0) Analysis

### LR(0) Conflicts: Possible solutions

- We might note, however, that the reduce operation will not permit a correct analysis if the string, because the only symbol that can follow  $\langle E\text{jecs} \rangle$  is *end*.
  - If we reduced the rule, the symbol following  $\langle E\text{jecs} \rangle$  would be *;* and, according to the grammar, that is impossible.
  - Therefore, the only possible action to take is the shift.



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## SLR(1) Analysis

### Introduction

- SLR(1) analysis is an improved version of LR(0) analysis that:
  - Shares with LR(0) the technique for creating states. Therefore,
    - It employs the same algorithm for the *closure* operation
    - It employs the same algorithm for the *go-to* operation
    - It uses the analysis table in the same way.
    - It fills in the cells with the shift operations in the same way.
  - On the other hand, it has the following difference:
    - It takes into account that reductions can only happen before terminal symbols that may follow the non-terminal in the grammar.

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## SLR(1) Analysis

### Construction of SLR(1) Analysis tables

- Concerning **shifts** and **reductions**,
  - Shift actions in the table:**
    - They are done exactly as in LR(0)**
    - They are obtained by following the transitions in the “automaton”.
    - In other words, if there is a transition in the automaton from  $s_i$  to  $s_j$  with the symbol  $x$ , then we add the action
      - $\text{Table}[i, x] = \begin{cases} sj & \text{if } x \in \Sigma_T \\ j & \text{if } x \in \Sigma_N \end{cases}$
  - Reductions in the table:**
    - For each of the states which contain a reduction configuration (one of the type  $A \rightarrow \gamma \bullet$ ) we have to add the rule  $A \rightarrow \gamma$  **only in the columns** for the terminal **symbols that can follow** the non-terminal at the left-hand side of the rule ( $A$ ).
    - Therefore, this step is **different to LR(0)**

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## SLR(1) Analysis

### Construction of SLR(1) Analysis tables

- Acceptation:**
  - It is the same as in LR(0)**
  - If a state  $s_i$  has a transition, with the terminal  $\$$  to the state with the reduction of the new rule  $\text{axiom}' \rightarrow \text{axiom}\$ \bullet$ 
    - Then we add to  $\text{Table}[i, \$]$  the action **accept**
  - There exist variations of this approach.
- Error:**
  - It is the same as in LR(0)**
  - All the remaining cells have associated the action **error**
  - The most common is to leave them empty.

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## SLR(1) Analysis

### Construction of SLR(1) Analysis tables

- The following is the analysis table for the exercise

It is easy to check that, in this grammar,

(0)  $B' \rightarrow B\$$

(1)  $B \rightarrow bD; Ef$

(2)  $D \rightarrow d$

(3)  $D \rightarrow D; d$

(4)  $E \rightarrow e$

(5)  $E \rightarrow e; E$

The following terminal symbols can follow each non-terminal.

- $\text{next}(B) = \{\$ \}$
- $\text{next}(D) = \{ ; \}$
- $\text{next}(E) = \{ f \}$

E	$\Sigma_T$						$\Sigma_N$		
	d	e	b	;	f	\$	B	D	E
0			s2				1		
1						acc			
2	s3							4	
3				r2					
4				s5					
5	s8	s7							6
6					s9				
7				s10	r4				
8				r3					
9						r1			
10		s7							11
11					r5				
Action							Go-to		

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## SLR(1) Analysis

### Construction of SLR(1) Analysis tables

- Check that the table is correct with the following example programs:

- Correct:**  

```
begin
    dec;
    ejec;
    ejec
end
```

- Incorrect:**  

```
begin
    dec;
    ejec;
end
```

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## SLR(1) Analysis

		$\Sigma_T$						$\Sigma_N$		
E		d	e	b	;	f	\$	B	D	E
0				s2				1		
1							acc			
2	s3								4	
3					r2					
4					s5					
5	s8	s7								6
6						s9				
7					s10	r4				
8					r3					
9							r1			
10		s7								11
11					r5					
Action								Go-to		

b	d	;	e	;	e	f	\$				
0											

(0)  $B' \rightarrow B\$$   
 (1)  $B \rightarrow bD; Ef$   
 (2)  $D \rightarrow d$   
 (3)  $D \rightarrow D; d$   
 (4)  $E \rightarrow e$   
 (5)  $E \rightarrow e; E$

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## SLR(1) Analysis

		$\Sigma_T$						$\Sigma_N$		
E		d	e	b	;	f	\$	B	D	E
0				s2				1		
1							acc			
2	s3								4	
3					r2					
4					s5					
5	s8	s7								6
6						s9				
7					s10	r4				
8					r3					
9							r1			
10		s7								11
11					r5					
Action								Go-to		

b	d	;	e	;	e	f	\$				
2											
b	0										

(0)  $B' \rightarrow B\$$   
 (1)  $B \rightarrow bD; Ef$   
 (2)  $D \rightarrow d$   
 (3)  $D \rightarrow D; d$   
 (4)  $E \rightarrow e$   
 (5)  $E \rightarrow e; E$

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## SLR(1) Analysis

		$\Sigma_T$						$\Sigma_N$		
E		d	e	b	;	f	\$	B	D	E
0				s2				1		
1							acc			
2	s3								4	
3					r2					
4					s5					
5	s8	s7								6
6						s9				
7					s10	r4				
8					r3					
9							r1			
10		s7								11
11					r5					
		Action						Go-to		

b	d	;	e	;	e	f	\$				
---	---	---	---	---	---	---	----	--	--	--	--

3	d	2	b	0						
---	---	---	---	---	--	--	--	--	--	--

(0)  $B' \rightarrow B\$$

(1)  $B \rightarrow bD; Ef$

(2)  $D \rightarrow d$

(3)  $D \rightarrow D; d$

(4)  $E \rightarrow e$

(5)  $E \rightarrow e; E$

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## SLR(1) Analysis

		$\Sigma_T$						$\Sigma_N$		
E		d	e	b	;	f	\$	B	D	E
0				s2				1		
1							acc			
2	s3								4	
3					r2					
4					s5					
5	s8	s7								6
6						s9				
7					s10	r4				
8					r3					
9							r1			
10		s7								11
11					r5					
		Action						Go-to		

b	d	;	e	;	e	f	\$			
---	---	---	---	---	---	---	----	--	--	--

4	D	2	b	0					
---	---	---	---	---	--	--	--	--	--

(0)  $B' \rightarrow B\$$

(1)  $B \rightarrow bD; Ef$

(2)  $D \rightarrow d$

(3)  $D \rightarrow D; d$

(4)  $E \rightarrow e$

(5)  $E \rightarrow e; E$

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## SLR(1) Analysis

E	$\Sigma_T$						$\Sigma_N$		
	d	e	b	;	f	\$	B	D	E
0			s2				1		
1						acc			
2	s3							4	
3				r2					
4				s5					
5	s8	s7							6
6					s9				
7				s10	r4				
8				r3					
9						r1			
10		s7							11
11				r5					
Action							Go-to		

b	d	;	e	;	e	f	\$			
---	---	---	---	---	---	---	----	--	--	--

5	;	4	D	2	b	0			
---	---	---	---	---	---	---	--	--	--

(0)  $B' \rightarrow B\$$   
 (1)  $B \rightarrow bD; Ef$   
 (2)  $D \rightarrow d$   
 (3)  $D \rightarrow D; d$   
 (4)  $E \rightarrow e$   
 (5)  $E \rightarrow e; E$

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## SLR(1) Analysis

E	$\Sigma_T$						$\Sigma_N$		
	d	e	b	;	f	\$	B	D	E
0			s2				1		
1						acc			
2	s3							4	
3				r2					
4				s5					
5	s8	s7							6
6					s9				
7				s10	r4				
8				r3					
9						r1			
10		s7							11
11				r5					
Action							Go-to		

b	d	;	e	;	e	f	\$			
---	---	---	---	---	---	---	----	--	--	--

7	e	5	;	4	D	2	b	0		
---	---	---	---	---	---	---	---	---	--	--

(0)  $B' \rightarrow B\$$   
 (1)  $B \rightarrow bD; Ef$   
 (2)  $D \rightarrow d$   
 (3)  $D \rightarrow D; d$   
 (4)  $E \rightarrow e$   
 (5)  $E \rightarrow e; E$

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## SLR(1) Analysis

E	$\Sigma_T$						$\Sigma_N$		
	d	e	b	;	f	\$	B	D	E
0			s2				1		
1						acc			
2	s3							4	
3					r2				
4					s5				
5	s8	s7							6
6						s9			
7					s10	r4			
8					r3				
9							r1		
10		s7							11
11					r5				
Action							Go-to		

b	d	;	e	;	e	f	\$			
---	---	---	---	---	---	---	----	--	--	--

10	;	7	e	5	;	4	D	2	b	0
----	---	---	---	---	---	---	---	---	---	---

- (0)  $B' \rightarrow B\$$
- (1)  $B \rightarrow bD; Ef$
- (2)  $D \rightarrow d$
- (3)  $D \rightarrow D; d$
- (4)  $E \rightarrow e$
- (5)  $E \rightarrow e; E$

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## SLR(1) Analysis

E	$\Sigma_T$						$\Sigma_N$		
	d	e	b	;	f	\$	B	D	E
0			s2				1		
1						acc			
2	s3							4	
3					r2				
4					s5				
5	s8	s7							6
6						s9			
7					s10	r4			
8					r3				
9							r1		
10		s7							11
11					r5				
Action							Go-to		

b	d	;	e	;	e	f	\$			
---	---	---	---	---	---	---	----	--	--	--

7	e	10	;	7	e	5	;	4	D	2
b	0									

- (0)  $B' \rightarrow B\$$
- (1)  $B \rightarrow bD; Ef$
- (2)  $D \rightarrow d$
- (3)  $D \rightarrow D; d$
- (4)  $E \rightarrow e$
- (5)  $E \rightarrow e; E$

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## SLR(1) Analysis

E	$\Sigma_T$						$\Sigma_N$		
	d	e	b	;	f	\$	B	D	E
0			s2				1		
1						acc			
2	s3							4	
3				r2					
4				s5					
5	s8	s7							6
6					s9				
7				s10	r4				
8				r3					
9						r1			
10		s7							11
11				r5					
Action							Go-to		

b	d	;	e	;	e	f	\$			
---	---	---	---	---	---	---	----	--	--	--

11	E	10	;	7	e	5	;	4	D	2
b	0									

- (0)  $B' \rightarrow B\$$
- (1)  $B \rightarrow bD; Ef$
- (2)  $D \rightarrow d$
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- (4)  $E \rightarrow e$
- (5)  $E \rightarrow e; E$

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## SLR(1) Analysis

E	$\Sigma_T$						$\Sigma_N$		
	d	e	b	;	f	\$	B	D	E
0			s2				1		
1						acc			
2	s3							4	
3				r2					
4				s5					
5	s8	s7							6
6					s9				
7				s10	r4				
8				r3					
9						r1			
10		s7							11
11				r5					
Action							Go-to		

b	d	;	e	;	e	f	\$			
---	---	---	---	---	---	---	----	--	--	--

6	E	5	;	4	D	2	b	0		
---	---	---	---	---	---	---	---	---	--	--

- (0)  $B' \rightarrow B\$$
- (1)  $B \rightarrow bD; Ef$
- (2)  $D \rightarrow d$
- (3)  $D \rightarrow D; d$
- (4)  $E \rightarrow e$
- (5)  $E \rightarrow e; E$

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## SLR(1) Analysis

		$\Sigma_T$						$\Sigma_N$		
E		d	e	b	;	f	\$	B	D	E
0				s2				1		
1							acc			
2	s3								4	
3					r2					
4					s5					
5	s8	s7								6
6						s9				
7					s10	r4				
8					r3					
9							r1			
10		s7								11
11					r5					
		Action						Go-to		

b	d	;	e	;	e	f	\$			
---	---	---	---	---	---	---	----	--	--	--

9	f	6	E	5	;	4	D	2	b	0
---	---	---	---	---	---	---	---	---	---	---

(0)  $B' \rightarrow B\$$

(1)  $B \rightarrow bD; Ef$

(2)  $D \rightarrow d$

(3)  $D \rightarrow D; d$

(4)  $E \rightarrow e$

(5)  $E \rightarrow e; E$

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## SLR(1) Analysis

		$\Sigma_T$						$\Sigma_N$		
E		d	e	b	;	f	\$	B	D	E
0				s2				1		
1							acc			
2	s3								4	
3					r2					
4					s5					
5	s8	s7								6
6						s9				
7					s10	r4				
8					r3					
9							r1			
10		s7								11
11					r5					
		Action						Go-to		

b	d	;	e	;	e	f	\$			
---	---	---	---	---	---	---	----	--	--	--

1	B	0								
---	---	---	--	--	--	--	--	--	--	--

(0)  $B' \rightarrow B\$$

(1)  $B \rightarrow bD; Ef$

(2)  $D \rightarrow d$

(3)  $D \rightarrow D; d$

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(5)  $E \rightarrow e; E$

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## SLR(1) Analysis

E	$\Sigma_T$						$\Sigma_N$		
	d	e	b	;	f	\$	B	D	E
0			s2				1		
1						acc			
2	s3							4	
3				r2					
4				s5					
5	s8	s7							6
6					s9				
7				s10	r4				
8				r3					
9						r1			
10		s7							11
11				r5					
Action							Go-to		

b	d	;	e	;	e	f	\$						
---	---	---	---	---	---	---	----	--	--	--	--	--	--

1	B	0											
---	---	---	--	--	--	--	--	--	--	--	--	--	--

- (0)  $B' \rightarrow B\$$
- (1)  $B \rightarrow bD; Ef$
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## SLR(1) Analysis

E	$\Sigma_T$						$\Sigma_N$		
	d	e	b	;	f	\$	B	D	E
0			s2				1		
1						acc			
2	s3							4	
3				r2					
4				s5					
5	s8	s7							6
6					s9				
7				s10	r4				
8				r3					
9						r1			
10		s7							11
11				r5					
Action							Go-to		

b	d	;	e	;	\$								
---	---	---	---	---	----	--	--	--	--	--	--	--	--

0													
---	--	--	--	--	--	--	--	--	--	--	--	--	--

- (0)  $B' \rightarrow B\$$
- (1)  $B \rightarrow bD; Ef$
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- (3)  $D \rightarrow D; d$
- (4)  $E \rightarrow e$
- (5)  $E \rightarrow e; E$

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## SLR(1) Analysis

E	$\Sigma_T$						$\Sigma_N$		
	d	e	b	;	f	\$	B	D	E
0			s2				1		
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3				r2					
4				s5					
5	s8	s7							6
6					s9				
7				s10	r4				
8				r3					
9						r1			
10		s7							11
11					r5				
Action							Go-to		

b	d	;	e	;	\$						
---	---	---	---	---	----	--	--	--	--	--	--

2	b	0									
---	---	---	--	--	--	--	--	--	--	--	--

(0)  $B' \rightarrow B\$$

(1)  $B \rightarrow bD; Ef$

(2)  $D \rightarrow d$

(3)  $D \rightarrow D; d$

(4)  $E \rightarrow e$

(5)  $E \rightarrow e; E$

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## SLR(1) Analysis

E	$\Sigma_T$						$\Sigma_N$		
	d	e	b	;	f	\$	B	D	E
0			s2				1		
1						acc			
2	s3							4	
3				r2					
4				s5					
5	s8	s7							6
6					s9				
7				s10	r4				
8				r3					
9						r1			
10		s7							11
11					r5				
Action							Go-to		

b	d	;	e	;	\$						
---	---	---	---	---	----	--	--	--	--	--	--

3	d	2	b	0							
---	---	---	---	---	--	--	--	--	--	--	--

(0)  $B' \rightarrow B\$$

(1)  $B \rightarrow bD; Ef$

(2)  $D \rightarrow d$

(3)  $D \rightarrow D; d$

(4)  $E \rightarrow e$

(5)  $E \rightarrow e; E$

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## SLR(1) Analysis

E	$\Sigma_T$						$\Sigma_N$		
	d	e	b	;	f	\$	B	D	E
0			s2				1		
1						acc			
2	s3							4	
3				r2					
4				s5					
5	s8	s7							6
6					s9				
7				s10	r4				
8				r3					
9						r1			
10		s7							11
11					r5				
Action							Go-to		

b	d	;	e	;	\$						
4	D	2	b	0							

- (0)  $B' \rightarrow B\$$
- (1)  $B \rightarrow bD; Ef$
- (2)  $D \rightarrow d$
- (3)  $D \rightarrow D; d$
- (4)  $E \rightarrow e$
- (5)  $E \rightarrow e; E$

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## SLR(1) Analysis

E	$\Sigma_T$						$\Sigma_N$		
	d	e	b	;	f	\$	B	D	E
0			s2				1		
1						acc			
2	s3							4	
3				r2					
4				s5					
5	s8	s7							6
6					s9				
7				s10	r4				
8				r3					
9						r1			
10		s7							11
11					r5				
Action							Go-to		

b	d	;	e	;	\$						
5	;	4	D	2	b	0					

- (0)  $B' \rightarrow B\$$
- (1)  $B \rightarrow bD; Ef$
- (2)  $D \rightarrow d$
- (3)  $D \rightarrow D; d$
- (4)  $E \rightarrow e$
- (5)  $E \rightarrow e; E$

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## SLR(1) Analysis

		$\Sigma_T$						$\Sigma_N$		
E		d	e	b	;	f	\$	B	D	E
0				s2				1		
1							acc			
2	s3								4	
3					r2					
4					s5					
5	s8	s7								6
6						s9				
7					s10	r4				
8					r3					
9							r1			
10		s7								11
11					r5					
		Action						Go-to		

b	d	;	e	;	\$					
---	---	---	---	---	----	--	--	--	--	--

7	e	5	;	4	D	2	b	0		
---	---	---	---	---	---	---	---	---	--	--

(0)  $B' \rightarrow B\$$

(1)  $B \rightarrow bD; E f$

(2)  $D \rightarrow d$

(3)  $D \rightarrow D; d$

(4)  $E \rightarrow e$

(5)  $E \rightarrow e; E$

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## SLR(1) Analysis

		$\Sigma_T$						$\Sigma_N$		
E		d	e	b	;	f	\$	B	D	E
0				s2				1		
1							acc			
2	s3								4	
3					r2					
4					s5					
5	s8	s7								6
6						s9				
7					s10	r4				
8					r3					
9							r1			
10		s7								11
11					r5					
		Action						Go-to		

b	d	;	e	;	\$					
---	---	---	---	---	----	--	--	--	--	--

10	;	7	e	5	;	4	D	2	b	0
----	---	---	---	---	---	---	---	---	---	---

(0)  $B' \rightarrow B\$$

(1)  $B \rightarrow bD; E f$

(2)  $D \rightarrow d$

(3)  $D \rightarrow D; d$

(4)  $E \rightarrow e$

(5)  $E \rightarrow e; E$

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## SLR(1) Analysis

E	$\Sigma_T$						$\Sigma_N$		
	d	e	b	;	f	\$	B	D	E
0			s2				1		
1						acc			
2	s3							4	
3				r2					
4				s5					
5	s8	s7							6
6					s9				
7				s10	r4				
8				r3					
9						r1			
10		s7							11
11				r5					
Action							Go-to		

b	d	;	e	;	\$					
---	---	---	---	---	----	--	--	--	--	--

10	;	7	e	5	;	4	D	2	b	0
----	---	---	---	---	---	---	---	---	---	---

(0)  $B' \rightarrow B\$$

(1)  $B \rightarrow bD ; E f$

(2)  $D \rightarrow d$

(3)  $D \rightarrow D ; d$

(4)  $E \rightarrow e$

(5)  $E \rightarrow e ; E$

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## SLR(1) Analysis

### Concepts

- When building the SLR(1) analysis table, as described in the previous points, it may be the case that we cannot obtain a deterministic grammar (because there is more than one action in some cell). In this case, we shall say that **the grammar is not SLR(1)**
- Otherwise, we shall say that **the grammar is SLR(1)**.

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## Other analysis algorithms

### Introductory example

- Build the SLR(1) analysis table for the following grammar:

$$\{xb, a^nxb^n \mid n \geq 0\}$$

- (1)  $S \rightarrow A$
- (2)  $S \rightarrow xb$
- (3)  $A \rightarrow aAb$
- (4)  $A \rightarrow B$
- (5)  $B \rightarrow x$

- The first thing to do is to extend the grammar:

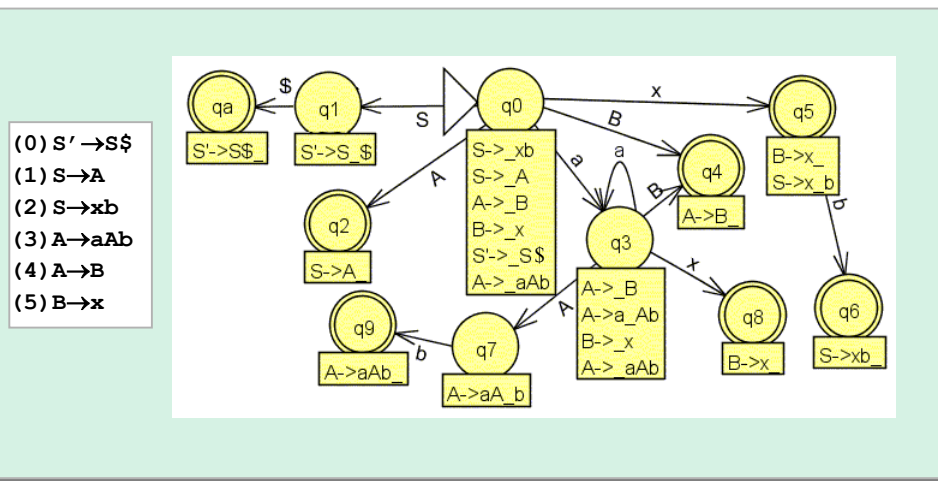
- (0)  $S' \rightarrow S\$$
- (1)  $S \rightarrow A$
- (2)  $S \rightarrow xb$
- (3)  $A \rightarrow aAb$
- (4)  $A \rightarrow B$
- (5)  $B \rightarrow x$

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## Other analysis algorithms

### Introductory example

- We calculate the diagram with the states and transitions of the SLR(1) parser



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## Other analysis algorithms

### Introductory example

- And the SLR(1) analysis table

- (0)  $S' \rightarrow S\$$
- (1)  $S \rightarrow A$
- (2)  $S \rightarrow xb$
- (3)  $A \rightarrow aAb$
- (4)  $A \rightarrow B$
- (5)  $B \rightarrow x$

	$\Sigma_T$				$\Sigma_N$		
E	a	b	x	\$	S	A	B
0	s3		s5		1	2	4
1				acc			
2				r1			
3	s3		s8			7	4
4		r4		r4			
5		r5/s6		r5			
6				r2			
7							
8		r5		r5			
9		r3		r3			
	Action				Go-to		

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## Other analysis algorithms

### Introduction

- There are high-level programming with grammars which are not SLR(1)
- In these cases, it is possible to use more powerful algorithms.
- We are going to see the following two:
  - LR(k),  $k \geq 1$
  - LALR(1)

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## Other analysis algorithms

### Example

- Build the SLR(1) analysis table of the following ambiguous grammar that generates arithmetic expressions:

- (1)  $E \rightarrow E + E$
- (2)  $E \rightarrow E * E$
- (3)  $E \rightarrow i$

- The first thing to do is to augment the grammar:

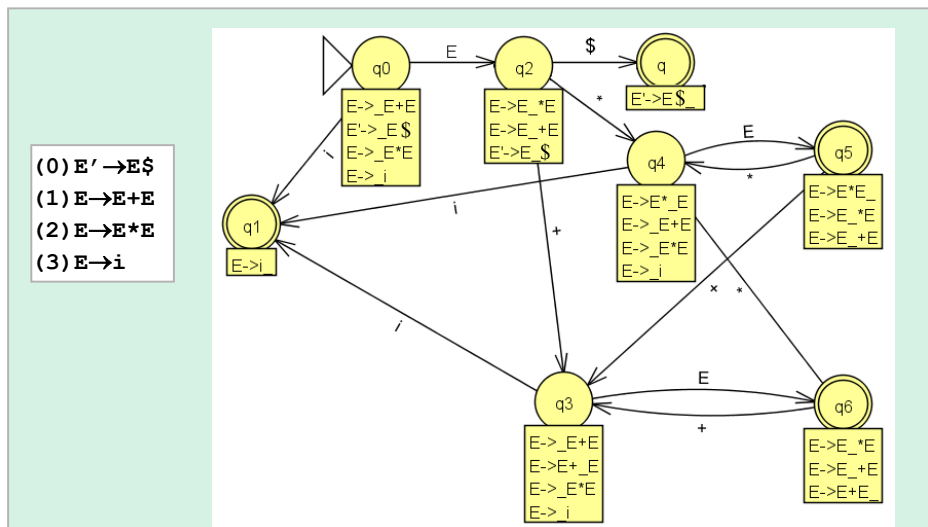
- (0)  $E' \rightarrow E \$$
- (1)  $E \rightarrow E + E$
- (2)  $E \rightarrow E * E$
- (3)  $E \rightarrow i$

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## Other analysis algorithms

### Example

- We calculate the SLR(1) diagram with the transitions between states



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## Other analysis algorithms

### Example

- And the SLR(1)

- (0)  $E' \rightarrow E\$$
- (1)  $E \rightarrow E+E$
- (2)  $E \rightarrow E * E$
- (3)  $E \rightarrow i$

	$\Sigma_T$				
E	*	+	i	\$	B
0			s1		2
1	r3	r3		r3	
2	s4	s3		acc	
3			s1		6
4			s1		5
5	r2/s4	r2/s3		r2	
6	r1/s4	r1/s3		r1	
Action					

- This grammar is not SLR(1)

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## Other analysis algorithms

### Example: possible solutions

- The problem was originated by the following ambiguity:  
 $(i+i)*i$  or  $i+(i*i)?$
- If this happens, a possible solution is to force one decision among the several that may be in the cells.
- Bear in mind that the decision taken will affect the precedence of the operators:

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## Other analysis algorithms

### Example: possible solutions

- If we shift with '+' and reduce with '\*'...

- (0)  $E' \rightarrow E\$$   
 (1)  $E \rightarrow E+E$   
 (2)  $E \rightarrow E * E$   
 (3)  $E \rightarrow i$

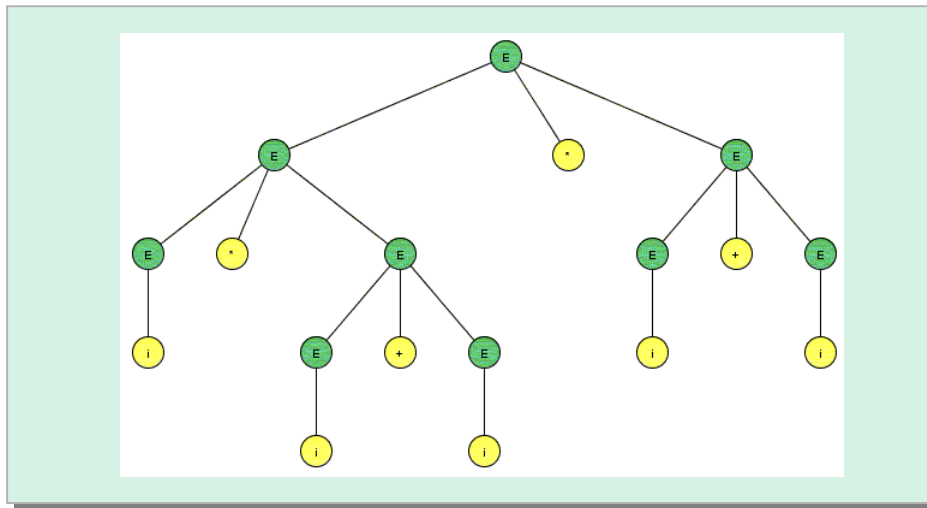
	$\Sigma_T$				
E	*	+	i	\$	B
0			s1		2
1	r3	r3		r3	
2	s4	s3		acc	
3			s1		6
4			s1		5
5	r2	s3		r2	
6	r1	s3		r1	
Action					

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## Other analysis algorithms

### Example: possible solutions

- This would be the analysis of the following string 'i\*i+i+i'



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## Other analysis algorithms

### Example: possible solutions

- IF we shift with '\*' and reduce with '+'...

- (0)  $E' \rightarrow E\$$   
 (1)  $E \rightarrow E+E$   
 (2)  $E \rightarrow E * E$   
 (3)  $E \rightarrow i$

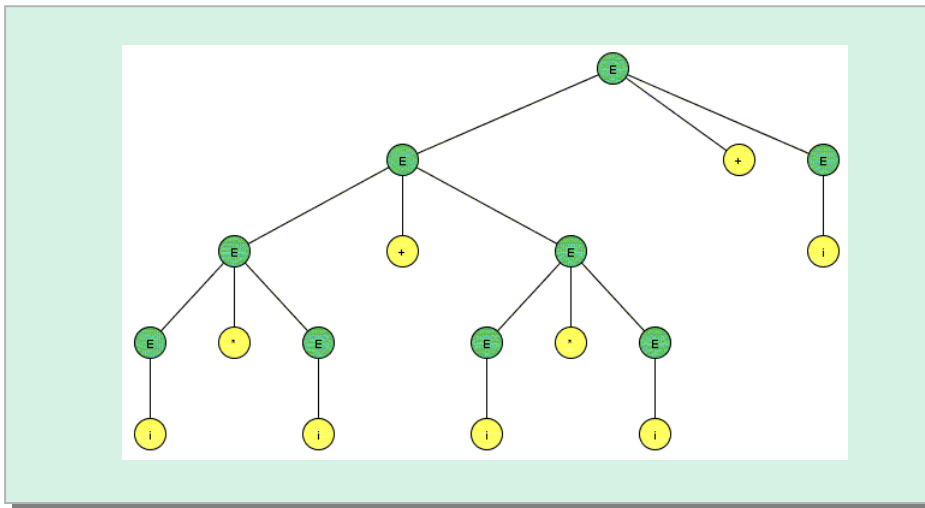
	$\Sigma_T$				
E	*	+	i	\$	B
0			s1		2
1	r3	r3		r3	
2	s4	s3		acc	
3			s1		6
4			s1		5
5	s4	r2		r2	
6	s4	r1		r1	
	Action				

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## Other analysis algorithms

### Example: possible solutions

- This is the analysis of 'i\*i+i\*i+i'



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## Bottom-up Analysis

### Glossary

- **LR(k):**
  - Technique for bottom-up syntactic analysis
  - Examines the entry *left-to-right*
  - Builds a *right-most derivation* of the entry
  - It uses the k tokens in the input that follow the current symbol.
- **SLR:**
  - Technique for bottom-up analysis which is a simplification of LR(k).
  - Acronym for *Simple Left-to-Right*
- **LALR:**
  - Bottom-up technique, similar to LR, which uses “anticipation symbols”.
  - Acronym for *Look-Ahead Left-to-Right*.

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## Syntactic Analysis

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