Shift-Reduce Conflicts

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Objectives

You should be able to ...

- Explain the circumstances that cause a shift-reduce conflict.
- Use the presence of a shift-reduce conflict to detect ambiguity.
- Explain how a shift-reduce conflict could be fixed.
- Explain what an LR parser generator will do if the shift-reduce conflict is not fixed.

The Automata, Starting

- Let's build the table for this automata.
- Can you tell that it is ambiguous right now?

$$
\begin{array}{rcl}
S & \rightarrow & a\,E\,b \\
 & | & x \\
E & \rightarrow & E\,x\,E \\
 & | & b
\end{array}
$$

The Automata, Starting

- Let's build the table for this automata.
- Can you tell that it is ambiguous right now?
- Is `b x b x b` to be parsed as `(b x b) x b` or `b x (b x b)`?

$$
\begin{array}{rcl}
S & \rightarrow & a\,E\,b \\
 & | & x \\
E & \rightarrow & E\,x\,E \\
 & | & b
\end{array}
$$

Step 1

I_0 $S \rightarrow \bullet\, a\, E\, b$
$\bullet\, a\, b\, S$

Grammar

$$
\begin{array}{lcl}
S & \rightarrow & a\, E\, b \\
 & | & a\, b\, S \\
E & \rightarrow & E\, x\, E \\
 & | & b
\end{array}
$$

Action

	a	b	x	$
0				
1				
2				
3				
4				
5				
6				

Goto

	a	b	x	$	S	E
0						
1						
2						
3						
4						
5						
6						

Step 1

I_0 $S \rightarrow \bullet\, a\, E\, b \Leftarrow$
$\bullet\, a\, b\, S \Leftarrow$

Grammar

$$
\begin{array}{rcl}
S & \rightarrow & a\,E\,b \\
 & | & a\,b\,S \\
E & \rightarrow & E\,x\,E \\
 & | & b
\end{array}
$$

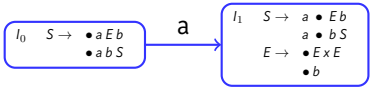
Action

	a	b	x	$
0				
1				
2				
3				
4				
5				
6				

Goto

	a	b	x	$	S	E
0						
1						
2						
3						
4						
5						
6						

Step 2

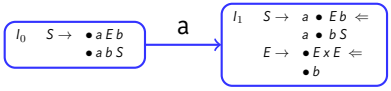


$$
\begin{aligned}
S &\rightarrow a\,E\,b \\
&\mid a\,b\,S \\
E &\rightarrow E\,x\,E \\
&\mid b
\end{aligned}
$$

	a	b	x	$
0	s			
1				
2				
3				
4				
5				
6				

	a	b	x	$	S	E
0	1					
1						
2						
3						
4						
5						
6						

Step 2

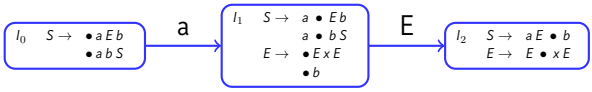


$$
\begin{aligned}
S &\rightarrow a\,E\,b \\
&\mid a\,b\,S \\
E &\rightarrow E\,x\,E \\
&\mid b
\end{aligned}
$$

	a	b	x	$
0	s			
1				
2				
3				
4				
5				
6				

	a	b	x	$	S	E
0	1					
1						
2						
3						
4						
5						
6						

Step 3

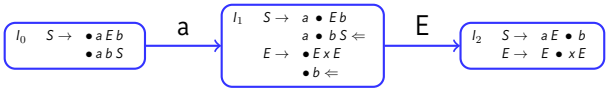


$$
\begin{aligned}
S &\to a\,E\,b \\
&\mid a\,b\,S \\
E &\to E\,x\,E \\
&\mid b
\end{aligned}
$$

	a	b	x	$
0	s			
1				
2				
3				
4				
5				
6				

	a	b	x	$	S	E
0	1					
1						2
2						
3						
4						
5						
6						

Step 3

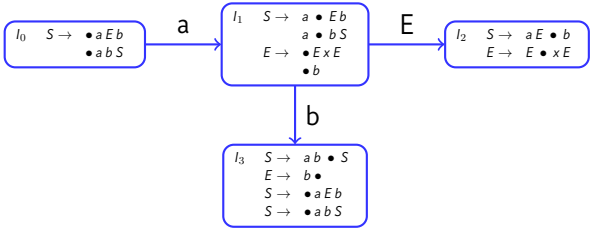


$$
\begin{aligned}
S &\to a\,E\,b \\
&\mid a\,b\,S \\
E &\to E\,x\,E \\
&\mid b
\end{aligned}
$$

	a	b	x	$
0	s			
1				
2				
3				
4				
5				
6				

	a	b	x	$	S	E
0	1					
1						2
2						
3						
4						
5						
6						

Step 4

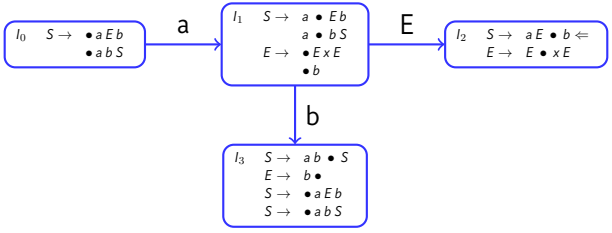


$$
\begin{aligned}
S &\to a\,E\,b \\
&\mid a\,b\,S \\
E &\to E\,x\,E \\
&\mid b
\end{aligned}
$$

	a	b	x	$
0	s			
1		s		
2				
3				
4				
5				
6				

	a	b	x	$	S	E
0	1					
1		3				2
2						
3						
4						
5						
6						

Step 4

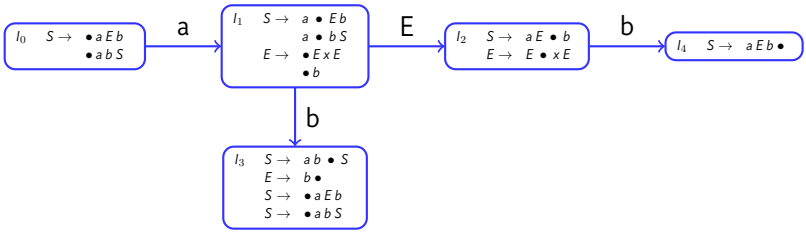


$$
\begin{aligned}
S &\to a\,E\,b \\
&\mid a\,b\,S \\
E &\to E\,x\,E \\
&\mid b
\end{aligned}
$$

	a	b	x	$
0	s			
1		s		
2				
3				
4				
5				
6				

	a	b	x	$	S	E
0	1					
1		3				2
2						
3						
4						
5						
6						

Step 5

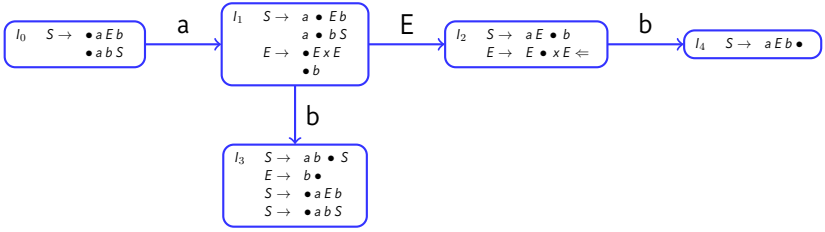


$$
\begin{aligned}
S &\to a\,E\,b \\
&\mid a\,b\,S \\
E &\to E\,x\,E \\
&\mid b
\end{aligned}
$$

	a	b	x	$
0	s			
1		s		
2		s	s	
3				
4				
5				
6				

	a	b	x	$	S	E
0	1					
1		3				2
2		4	5			
3						
4						
5						
6						

Step 5

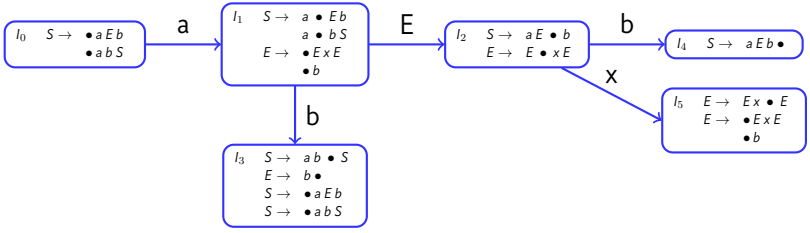


$$
\begin{aligned}
S &\rightarrow a\,E\,b \\
&\mid a\,b\,S \\
E &\rightarrow E\,x\,E \\
&\mid b
\end{aligned}
$$

	a	b	x	$
0	s			
1		s		
2		s	s	
3				
4				
5				
6				

	a	b	x	$	S	E
0	1					
1		3				2
2		4	5			
3						
4						
5						
6						

Step 6

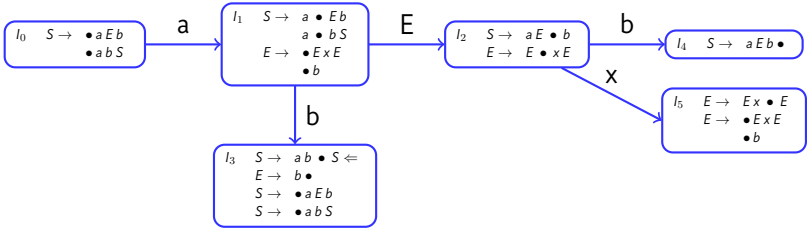


$$
\begin{aligned}
S &\to a\,E\,b \\
&\mid a\,b\,S \\
E &\to E\,x\,E \\
&\mid b
\end{aligned}
$$

	a	b	x	$
0	s			
1		s		
2		s	s	
3				
4				
5				
6				

	a	b	x	$	S	E
0	1					
1		3				2
2		4	5			
3						
4						
5						
6						

Step 6

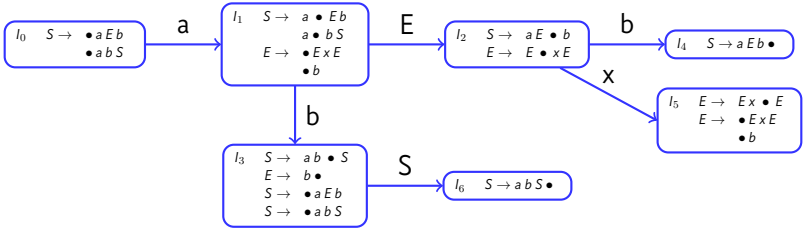


$$
\begin{aligned}
S &\to a\,E\,b \\
&\mid a\,b\,S \\
E &\to E\,x\,E \\
&\mid b
\end{aligned}
$$

	a	b	x	$
0	s			
1		s		
2		s	s	
3				
4				
5				
6				

	a	b	x	$	S	E
0	1					
1		3				2
2		4	5			
3						
4						
5						
6						

Step 7

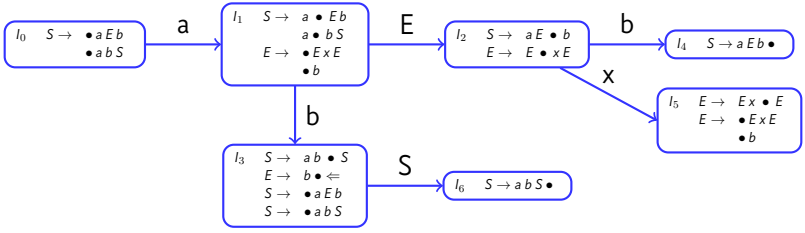


$$
\begin{aligned}
S &\to a\,E\,b \\
&\mid a\,b\,S \\
E &\to E\,x\,E \\
&\mid b
\end{aligned}
$$

	a	b	x	$
0	s			
1		s		
2		s	s	
3				
4				
5				
6				

	a	b	x	$	S	E
0	1					
1		3				2
2		4	5			
3					6	
4						
5						
6						

Step 7

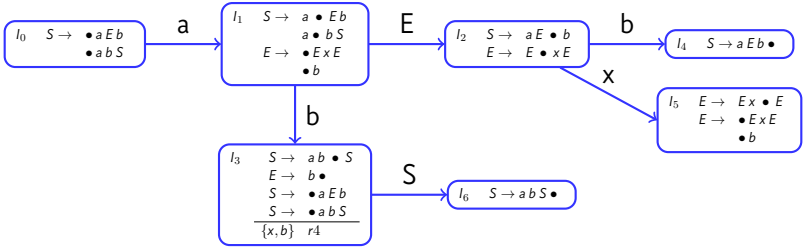


$$
\begin{aligned}
S &\to a\,E\,b \\
&\mid a\,b\,S \\
E &\to E\,x\,E \\
&\mid b
\end{aligned}
$$

	a	b	x	$
0	s			
1		s		
2		s	s	
3				
4				
5				
6				

	a	b	x	$	S	E
0	1					
1		3				2
2		4	5			
3					6	
4						
5						
6						

Step 7

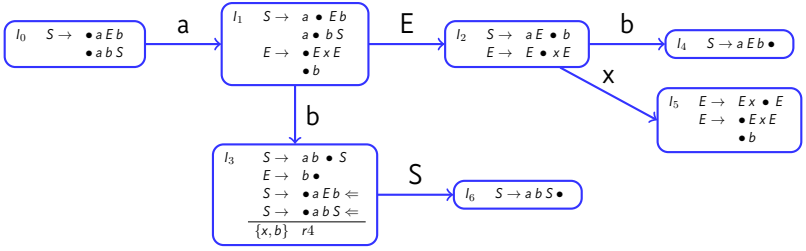


$$
\begin{aligned}
S &\to a\,E\,b \\
&\mid a\,b\,S \\
E &\to E\,x\,E \\
&\mid b
\end{aligned}
$$

	a	b	x	$
0	s			
1		s		
2		s	s	
3		r4	r4	
4				
5				
6				

	a	b	x	$	S	E
0	1					
1		3				2
2		4	5			
3					6	
4						
5						
6						

Step 7

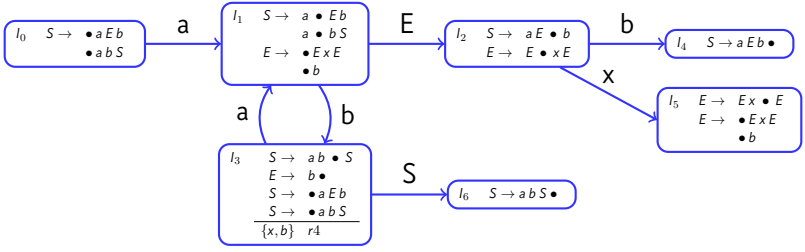


$$
\begin{aligned}
S &\to a\,E\,b \\
&\mid a\,b\,S \\
E &\to E\,x\,E \\
&\mid b
\end{aligned}
$$

	a	b	x	$
0	s			
1		s		
2		s	s	
3		r4	r4	
4				
5				
6				

	a	b	x	$	S	E
0	1					
1		3				2
2		4	5			
3					6	
4						
5						
6						

Step 8

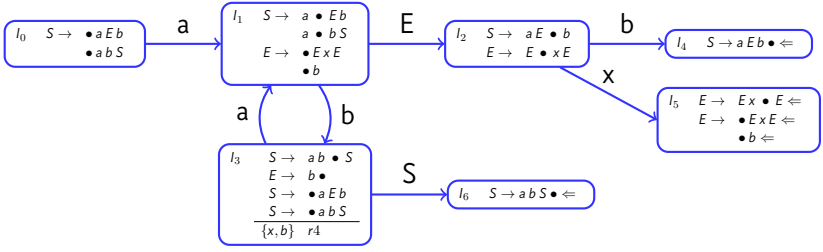


$$
\begin{aligned}
S &\to a\,E\,b \\
&\mid a\,b\,S \\
E &\to E\,x\,E \\
&\mid b
\end{aligned}
$$

	a	b	x	$
0	s			
1		s		
2		s	s	
3	s	r4	r4	
4				
5				
6				

	a	b	x	$	S	E
0	1					
1		3				2
2		4	5			
3	1				6	
4						
5						
6						

Step 8

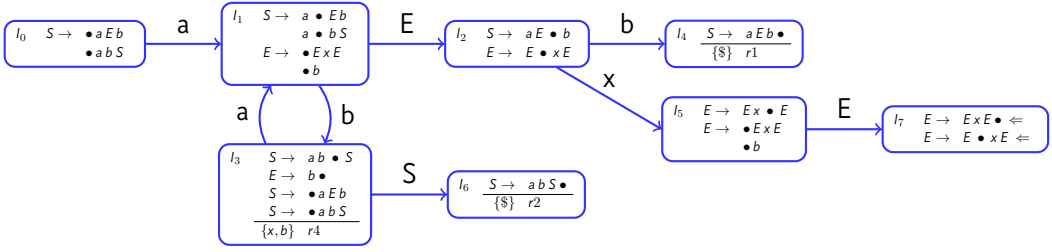


$$
\begin{aligned}
S &\to a\,E\,b \\
&\mid a\,b\,S \\
E &\to E\,x\,E \\
&\mid b
\end{aligned}
$$

	a	b	x	$
0	s			
1		s		
2		s	s	
3	s	r4	r4	
4				
5				
6				

	a	b	x	$	S	E
0	1					
1		3				2
2		4	5			
3	1				6	
4						
5						
6						

Step 9

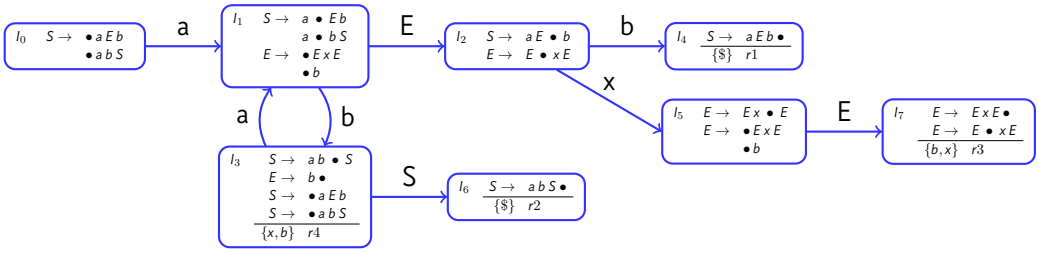


$$
\begin{aligned}
S &\to a\,E\,b \\
&\mid a\,b\,S \\
E &\to E\,x\,E \\
&\mid b
\end{aligned}
$$

	a	b	x	$
0	s			
1		s		
2		s	s	
3	s	r4	r4	
4				r1
5		s		
6				r2

	a	b	x	$	S	E
0	1					
1		3				2
2		4	5			
3	1				6	
4						
5						7
6						

Step 10

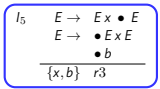


$$
\begin{aligned}
S &\to a\,E\,b \\
&\mid a\,b\,S \\
E &\to E\,x\,E \\
&\mid b
\end{aligned}
$$

	a	b	x	$
0	s			
...	...	...	...	...
5		s		
6				r2
7		r3	s/r3	

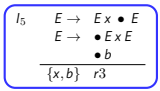
	a	b	x	$	S	E
0	1					
...	...	...	...	...	...	...
5						7
6						
7			5			

Shift-Reduce Conflicts



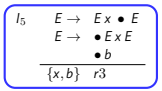
- The FIRST set of E says “shift.”
- The FOLLOW set of E says “reduce.”
- Fix this by changing precedence or associativity.
- What if you don’t fix this?

Shift-Reduce Conflicts



- The FIRST set of E says "shift."
- The FOLLOW set of E says "reduce."
- Fix this by changing precedence or associativity.
- What if you don't fix this?
- Consider the "dangling else" problem:
  `if x then if y then z • else q`

Shift-Reduce Conflicts



- The FIRST set of E says "shift."
- The FOLLOW set of E says "reduce."
- Fix this by changing precedence or associativity.
- What if you don't fix this?
- Consider the "dangling else" problem:
  `if x then if y then z • else q else w`