

Objectives

You should be able to ...

Shift-Reduce Conflicts

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- ▶ 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?

$$\begin{array}{l}
 S \rightarrow a E b \\
 \quad | x \\
 E \rightarrow E x E \\
 \quad | b
 \end{array}$$

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 $b x (b x b)$?

$$\begin{array}{l}
 S \rightarrow a E b \\
 \quad | x \\
 E \rightarrow E x E \\
 \quad | b
 \end{array}$$

Step 1

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

$$I_0 \quad S \rightarrow a \bullet b S$$

Grammar

$$S \rightarrow a E b$$

$$S \rightarrow a b S$$

$$E \rightarrow E x E$$

$$E \rightarrow b$$

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

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

$$I_0 \quad S \rightarrow a \bullet b S \Leftarrow$$

Grammar

$$S \rightarrow a E b$$

$$S \rightarrow a b S$$

$$E \rightarrow E x E$$

$$E \rightarrow b$$

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

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

$$I_0 \quad S \rightarrow a \bullet b S$$

$$I_1 \quad S \rightarrow a \bullet E b$$

$$I_1 \quad S \rightarrow a b \bullet S$$

$$I_1 \quad E \rightarrow \bullet E x E$$

$$I_1 \quad E \rightarrow \bullet b$$

$$S \rightarrow a E b$$

$$S \rightarrow a b S$$

$$E \rightarrow E x E$$

$$E \rightarrow b$$

	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

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

$$I_0 \quad S \rightarrow a \bullet b S$$

$$I_1 \quad S \rightarrow a \bullet E b \Leftarrow$$

$$I_1 \quad S \rightarrow a b \bullet S \Leftarrow$$

$$I_1 \quad E \rightarrow \bullet E x E \Leftarrow$$

$$I_1 \quad E \rightarrow \bullet b$$

$$S \rightarrow a E b$$

$$S \rightarrow a b S$$

$$E \rightarrow E x E$$

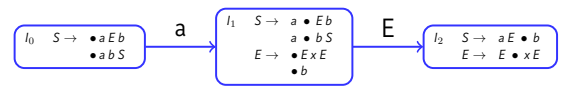
$$E \rightarrow b$$

	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



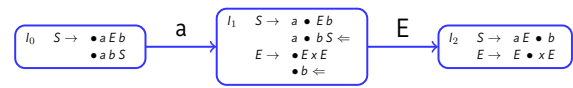
$S \rightarrow aEb$
 $\quad | abS$
 $E \rightarrow ExE$
 $\quad | b$

	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



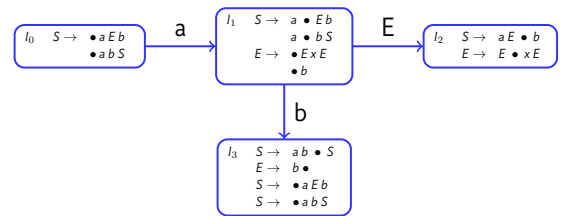
$S \rightarrow aEb$
 $\quad | abS$
 $E \rightarrow ExE$
 $\quad | b$

	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



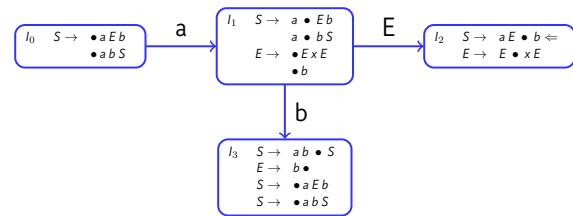
$S \rightarrow aEb$
 $\quad | abS$
 $E \rightarrow ExE$
 $\quad | b$

	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



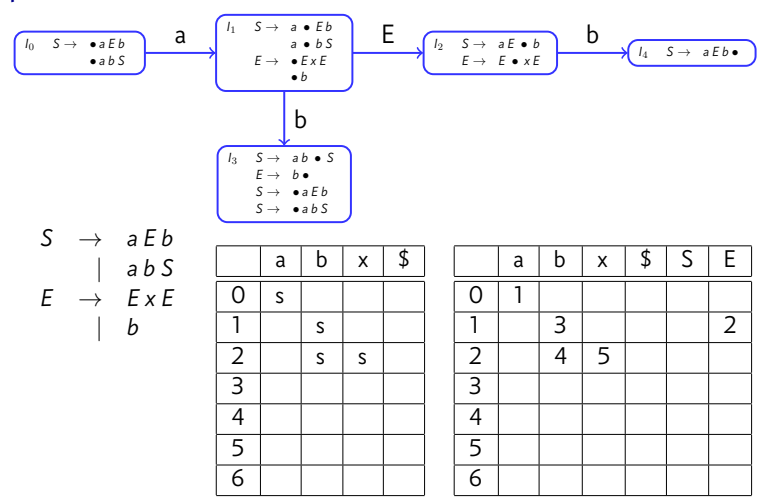
$S \rightarrow aEb$
 $\quad | abS$
 $E \rightarrow ExE$
 $\quad | b$

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

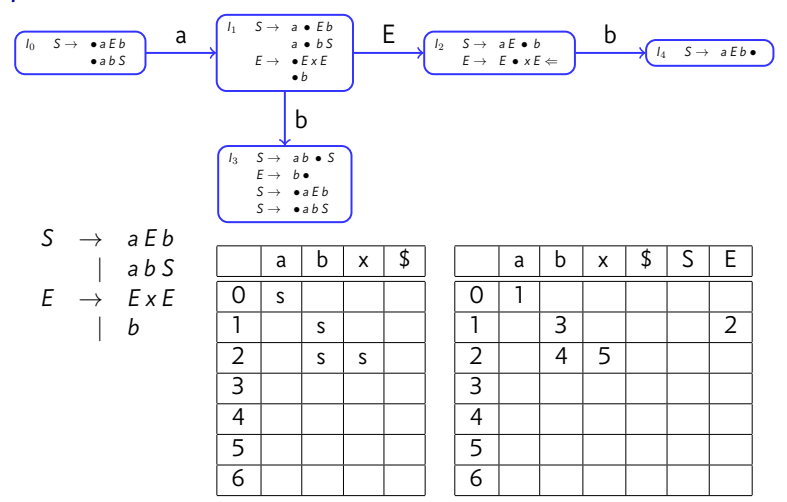
	a	b	x	\$	S	E
0	1					
1		3				2
2						
3						
4						
5						
6						



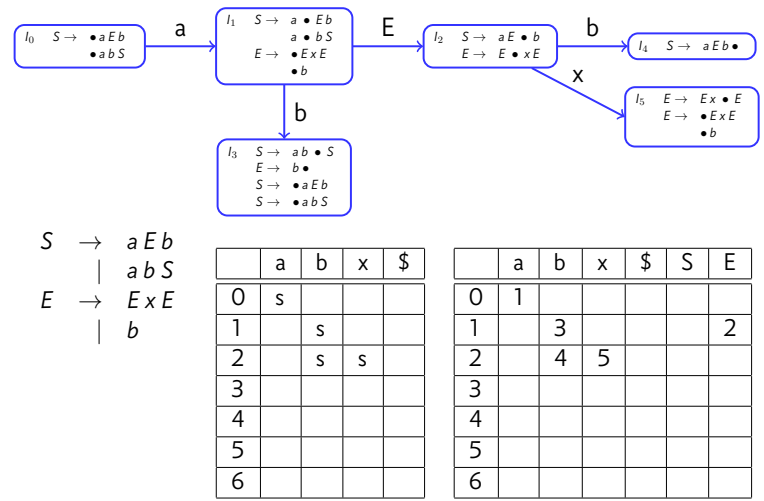
Step 5



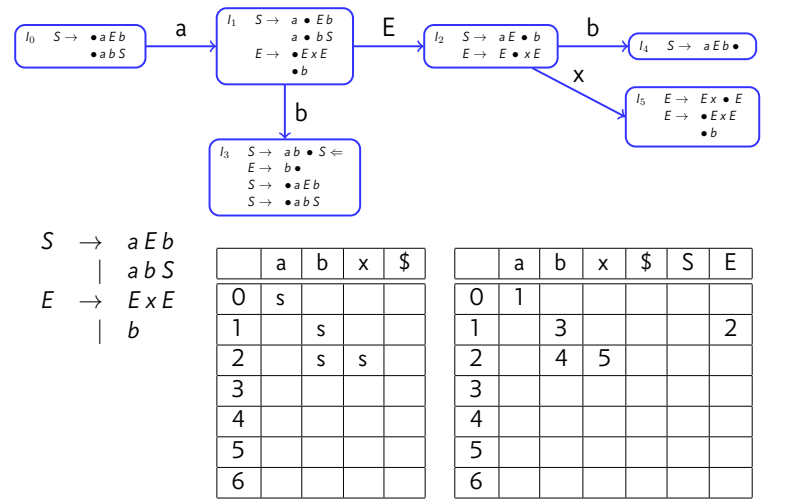
Step 5



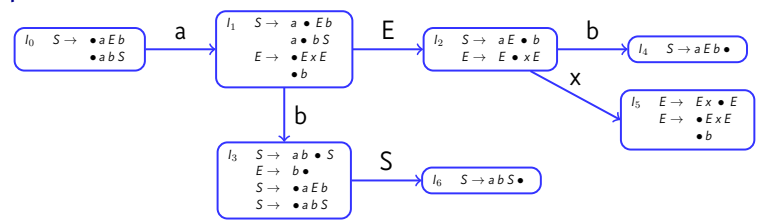
Step 6



Step 6



Step 7



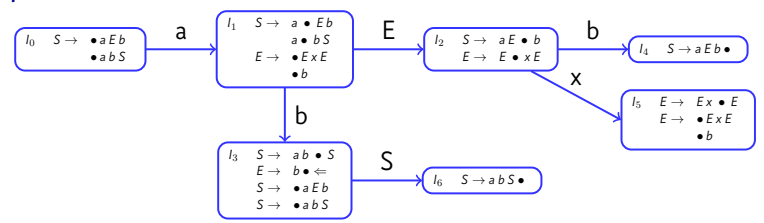
$S \rightarrow aEb$
 $\quad | abS$
 $E \rightarrow ExE$
 $\quad | b$

	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



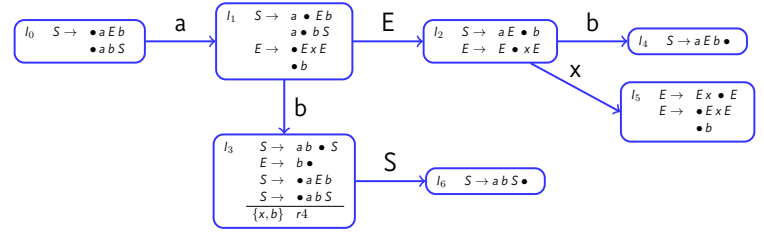
$S \rightarrow aEb$
 $\quad | abS$
 $E \rightarrow ExE$
 $\quad | b$

	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



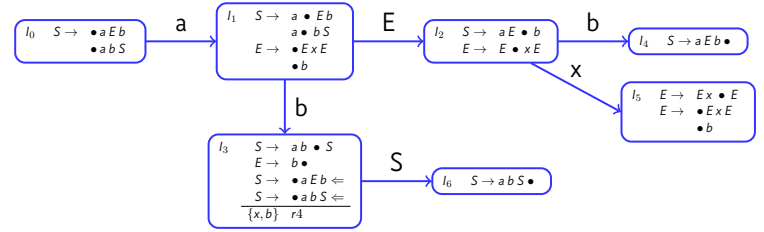
$S \rightarrow aEb$
 $\quad | abS$
 $E \rightarrow ExE$
 $\quad | b$

	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



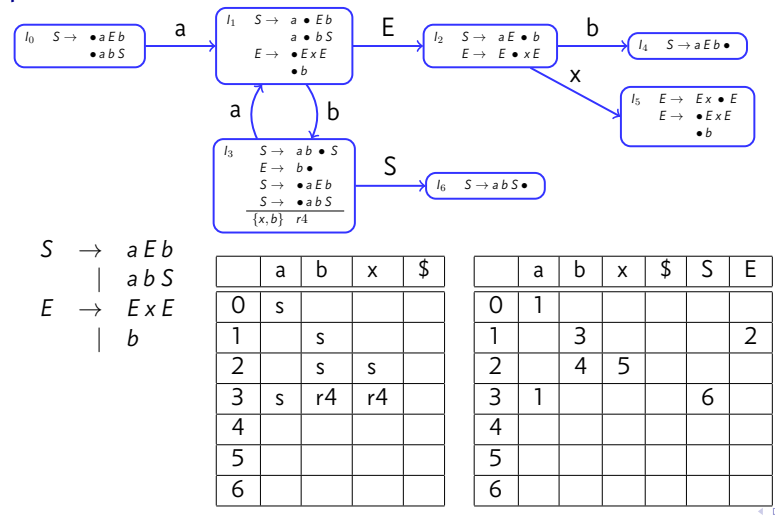
$S \rightarrow aEb$
 $\quad | abS$
 $E \rightarrow ExE$
 $\quad | b$

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

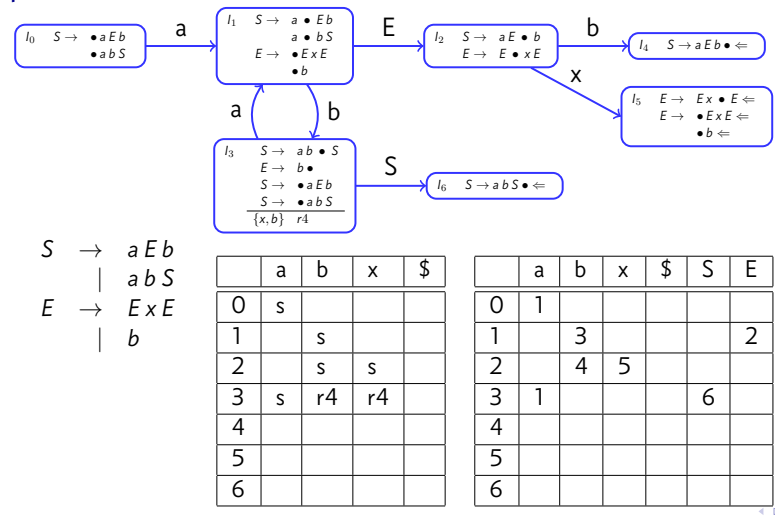
	a	b	x	\$	S	E
0	1					
1		3				2
2		4	5			
3					6	
4						
5						
6						



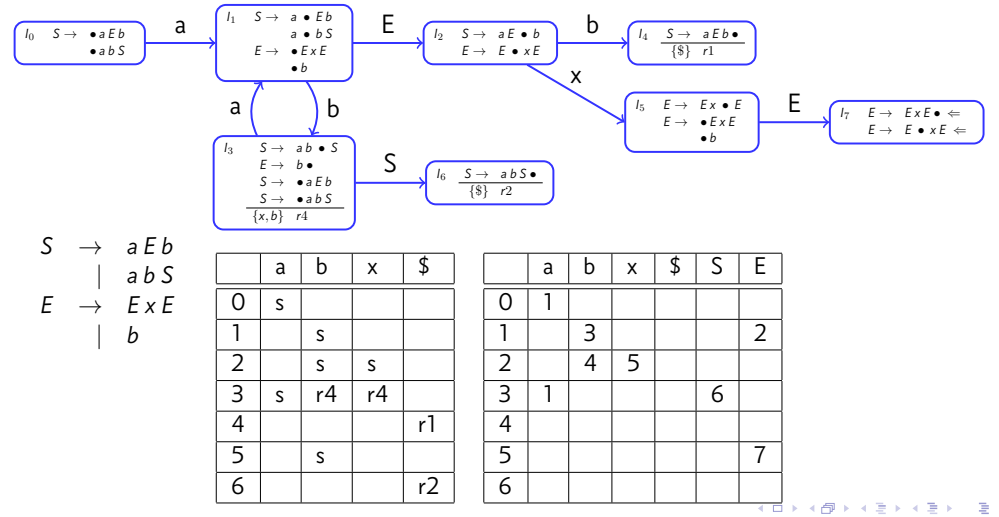
Step 8



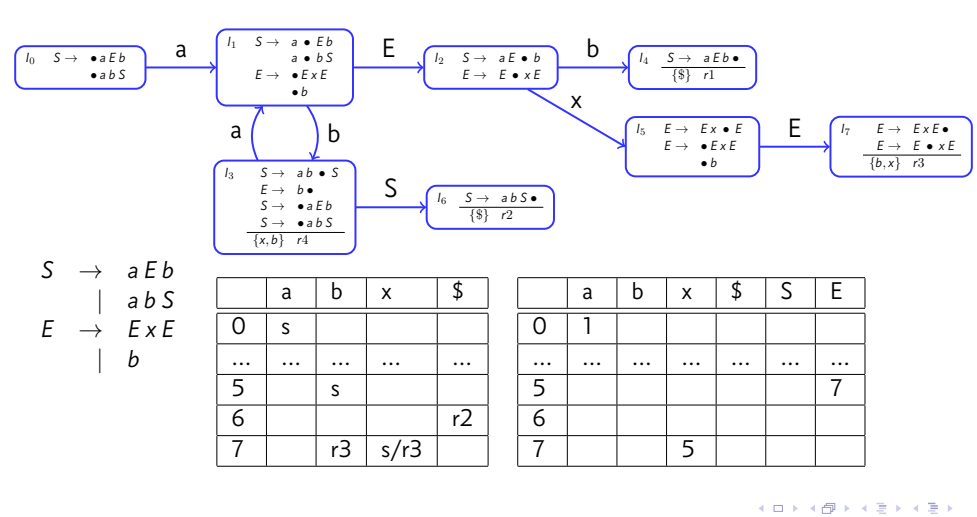
Step 8



Step 9



Step 10



Shift-Reduce Conflicts

$$\begin{array}{l}
 I_5 \quad E \rightarrow E x \bullet E \\
 \quad \quad E \rightarrow \bullet E x E \\
 \quad \quad \quad \bullet b \\
 \hline
 \{x, b\} \quad r3
 \end{array}$$

- ▶ 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

$$\begin{array}{l}
 I_5 \quad E \rightarrow E x \bullet E \\
 \quad \quad E \rightarrow \bullet E x E \\
 \quad \quad \quad \bullet b \\
 \hline
 \{x, b\} \quad r3
 \end{array}$$

- ▶ 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

$$\begin{array}{l}
 I_5 \quad E \rightarrow E x \bullet E \\
 \quad \quad E \rightarrow \bullet E x E \\
 \quad \quad \quad \bullet b \\
 \hline
 \{x, b\} \quad r3
 \end{array}$$

- ▶ 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

