



# 컴파일러 교재구성

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- ◆ 2장 : 형식언어와 오토마타
- ◆ 3장 : 어휘분석
- ◆ 4장 : Context-free 언어와  
푸시다운 오토마타
- ◆ 5장 : 구문분석

## 5.1 구문분석의 종류

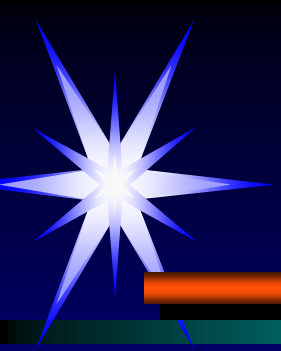
# 구문분석이란?

예)  $\text{id} + \text{id} * \text{id}$  올바른 문장인가?

$A + B * C$

$$\begin{aligned} E &\rightarrow E + E \\ &\rightarrow \text{id} + E \\ &\rightarrow \text{id} + E * E \\ &\rightarrow \text{id} + \text{id} * E \\ &\rightarrow \text{id} + \text{id} * \text{id} \end{aligned}$$


$$\begin{aligned} E &\rightarrow E + E \\ E &\rightarrow E * E \\ E &\rightarrow \text{id} \end{aligned}$$



# 구문분석의 종류/역사

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◆ **Top-Down 방법:**  
시작기호  문장

◆ **Bottom-Up 방법:**  
문장  시작기호

# Top-down 구문분석



# Top down 방법과 좌단유도

(예)  $id+id*id$  좌단유도 하라

문법

$$E \rightarrow E + E$$

$$E \rightarrow E * E$$

$$E \rightarrow id$$

# 좌단유도 과정

id + id \* id

E

→ E + E

$E \rightarrow E + E$

$E \rightarrow E * E$

$E \rightarrow id$

# 좌단유도 과정

id + id \* id

E

→ E + E

→ id + E

$E \rightarrow E + E$

$E \rightarrow E * E$

$E \rightarrow id$



# 좌단유도 과정

id + id \* id

E

→ E + E

→ id + E

→ id + E \* E

$E \rightarrow E + E$

$E \rightarrow E * E$

$E \rightarrow id$

# 좌단유도 과정

id + id \* id

E

→ E + E

→ id + E

→ id + E \* E

→ id + id \* E

$E \rightarrow E + E$

$E \rightarrow E * E$

$E \rightarrow id$

# 좌단유도 과정

id + id \* id

E

→ E + E

→ id + E

→ id + E \* E

→ id + id \* E

→ id + id \* id

$E \rightarrow E + E$

$E \rightarrow E * E$

$E \rightarrow id$

# 좌단유도 과정

id + id \* id

E

→ E + E

→ id + E

→ id + E \* E

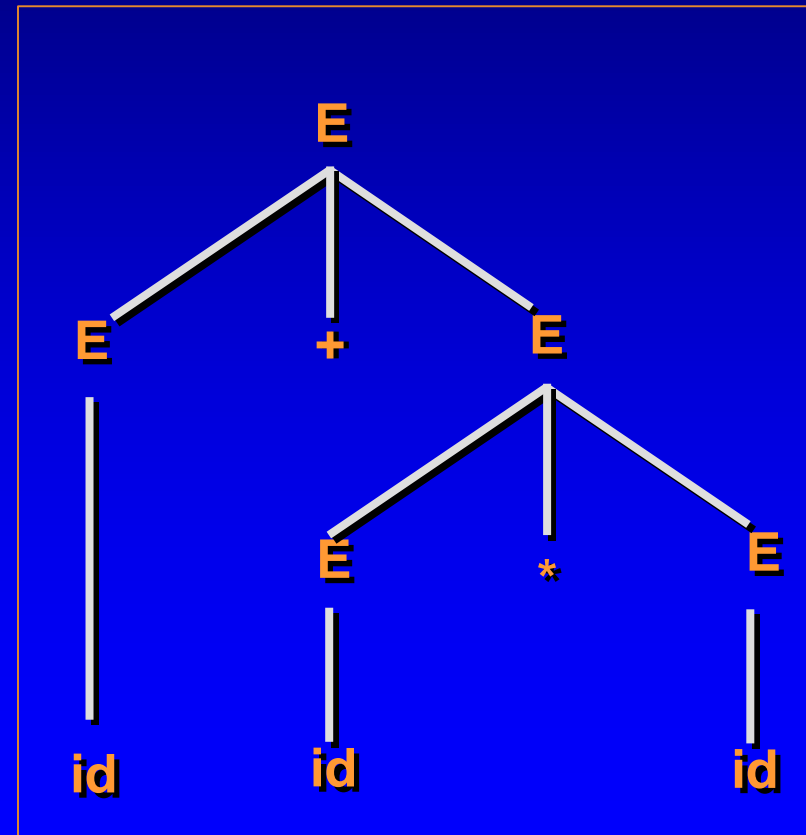
→ id + id \* E

→ id + id \* id

$E \rightarrow E + E$

$E \rightarrow E * E$

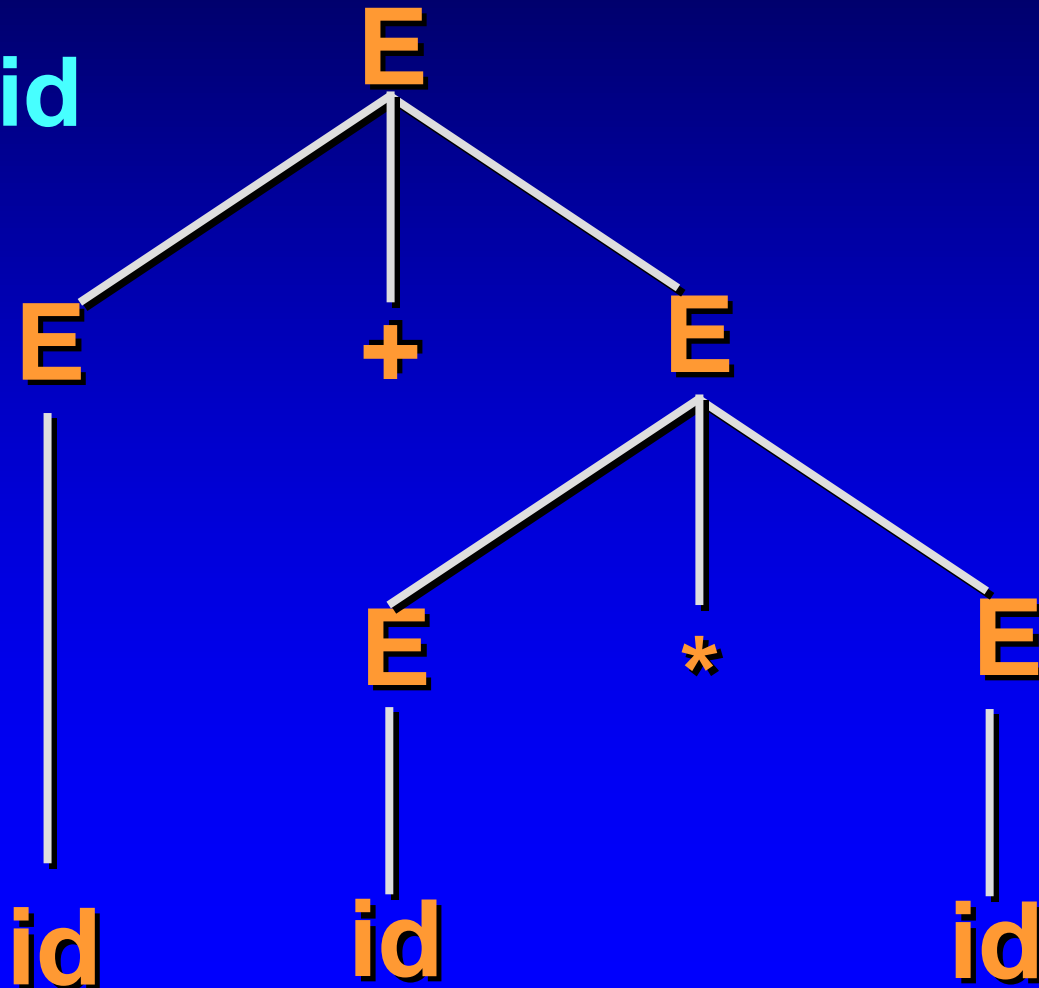
$E \rightarrow id$





# Top Down 구문분석

id + id \* id

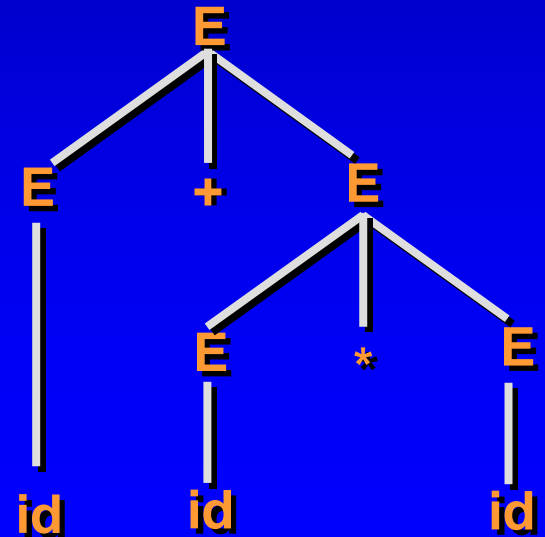


## **5.2 Bottom-up 구문분석**

# Bottom-Up 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow \text{id}$$

id + id \* id shift

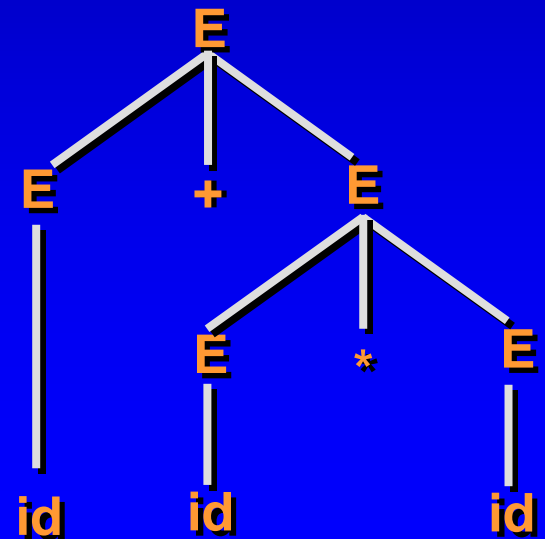


# Bottom-Up 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

**id** + id \* id

reduce  $\rightarrow$  **E** + id \* id

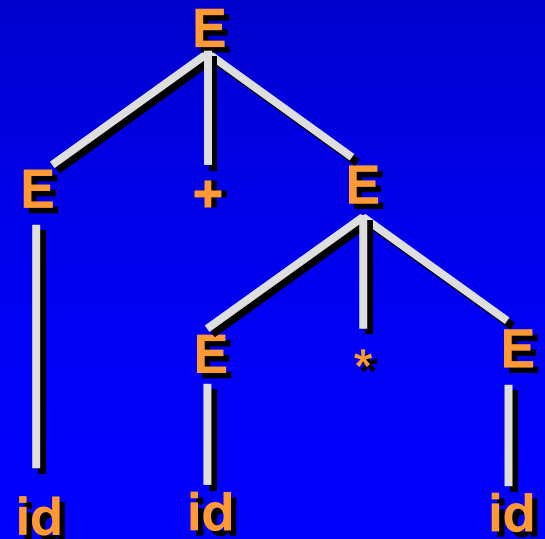




# Bottom-Up 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow \text{id}$$

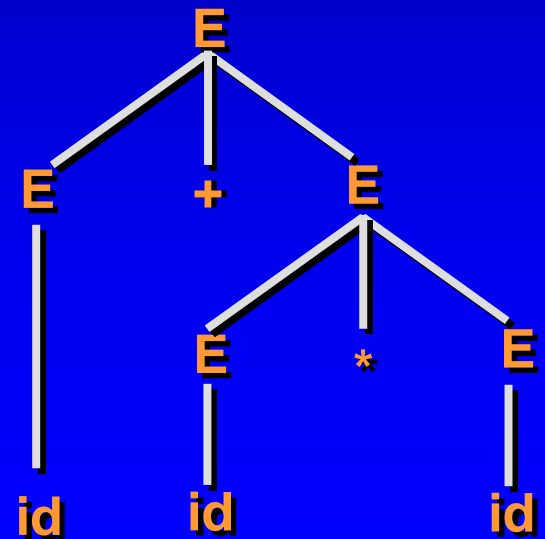
id + id \* id  
→ E + id \* id **shift**



# Bottom-Up 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow \text{id}$$

id + id \* id  
 $\rightarrow E + \text{id} * \text{id}$  shift



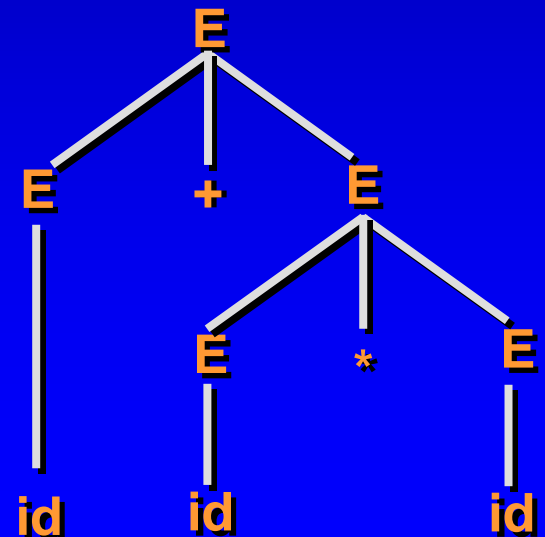
# Bottom-Up 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

id + id \* id

→ E + id \* id

reduce → E + E \* id



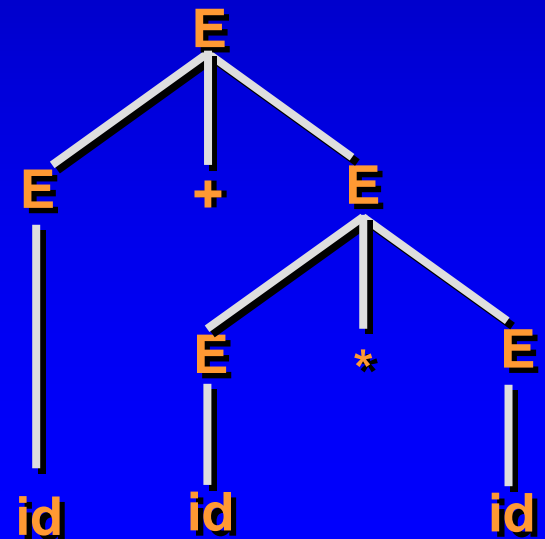
# Bottom-Up 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

id + id \* id

→ E + id \* id

→ E + E \* id **shift**



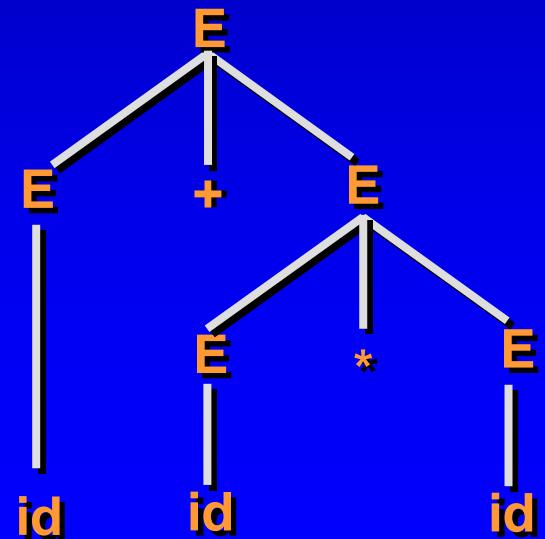
# Bottom-Up 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

id + id \* id

→ E + id \* id

→ E + E \* id **shift**



# Bottom-Up 구문분석

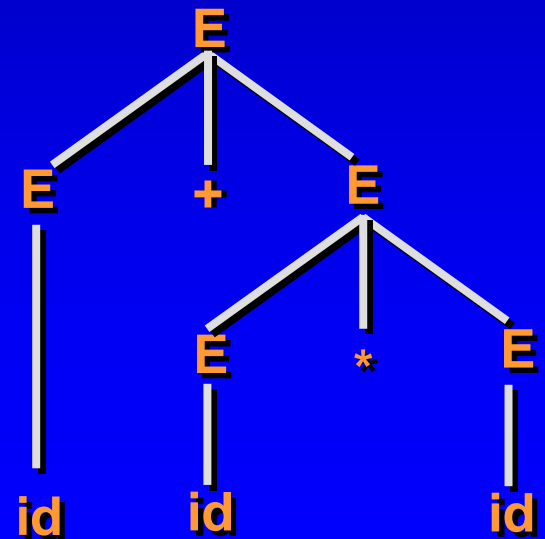
$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

id + id \* id

→ E + id \* id

→ E + E \* id

reduce → E + E \* E



# Bottom-Up 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

id + id \* id

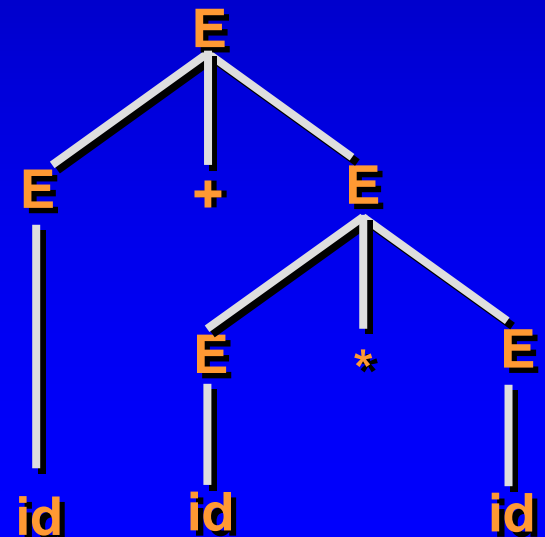
$\rightarrow E + id * id$

$\rightarrow E + E * id$

$\rightarrow E + E * E$

reduce

$\rightarrow E + E$



# Bottom-Up 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

id + id \* id

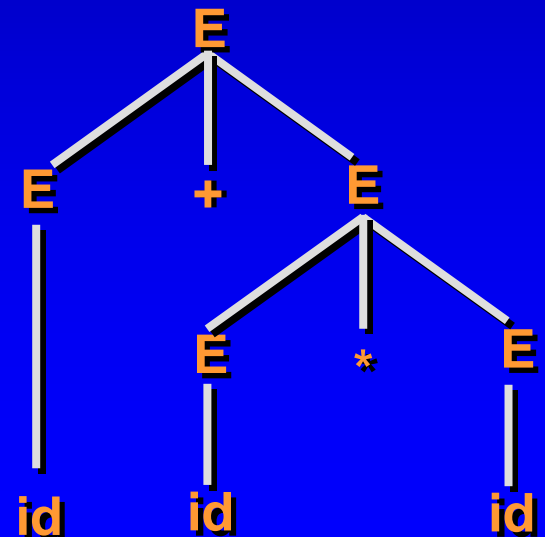
→ E + id \* id

→ E + E \* id

→ E + E \* E

→ E + E

reduce → E





# Bottom-Up 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

handle

**id** + id \* id

**id**

reduce  $\rightarrow E + \mathbf{id} * id$

**id**

reduce  $\rightarrow E + E * \mathbf{id}$

**id**

reduce  $\rightarrow E + \mathbf{E} * E$

**E \* E**

reduce  $\rightarrow \mathbf{E} + E$

**E + E**

reduce  $\rightarrow \mathbf{E}$

# Bottom-Up 구문분석

## 우단유도

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

**id** + id \* id

reduce  $\rightarrow E + \text{id} * id$

reduce  $\rightarrow E + E * id$

reduce  $\rightarrow E + E * E$

reduce  $\rightarrow E + E$

reduce  $\rightarrow E$

**E**

$\rightarrow E + E$

$\rightarrow E + E * E$

$\rightarrow E + E * id$

$\rightarrow E + id * id$

$\rightarrow id + id * id$

# 우단유도와 핸들

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

**E**

$\rightarrow E + E$

$\rightarrow E + E * E$

$\rightarrow E + E * id$

$\rightarrow E + id * id$

$\rightarrow id + id * id$

**handle**

**E+E**

**E \* E**

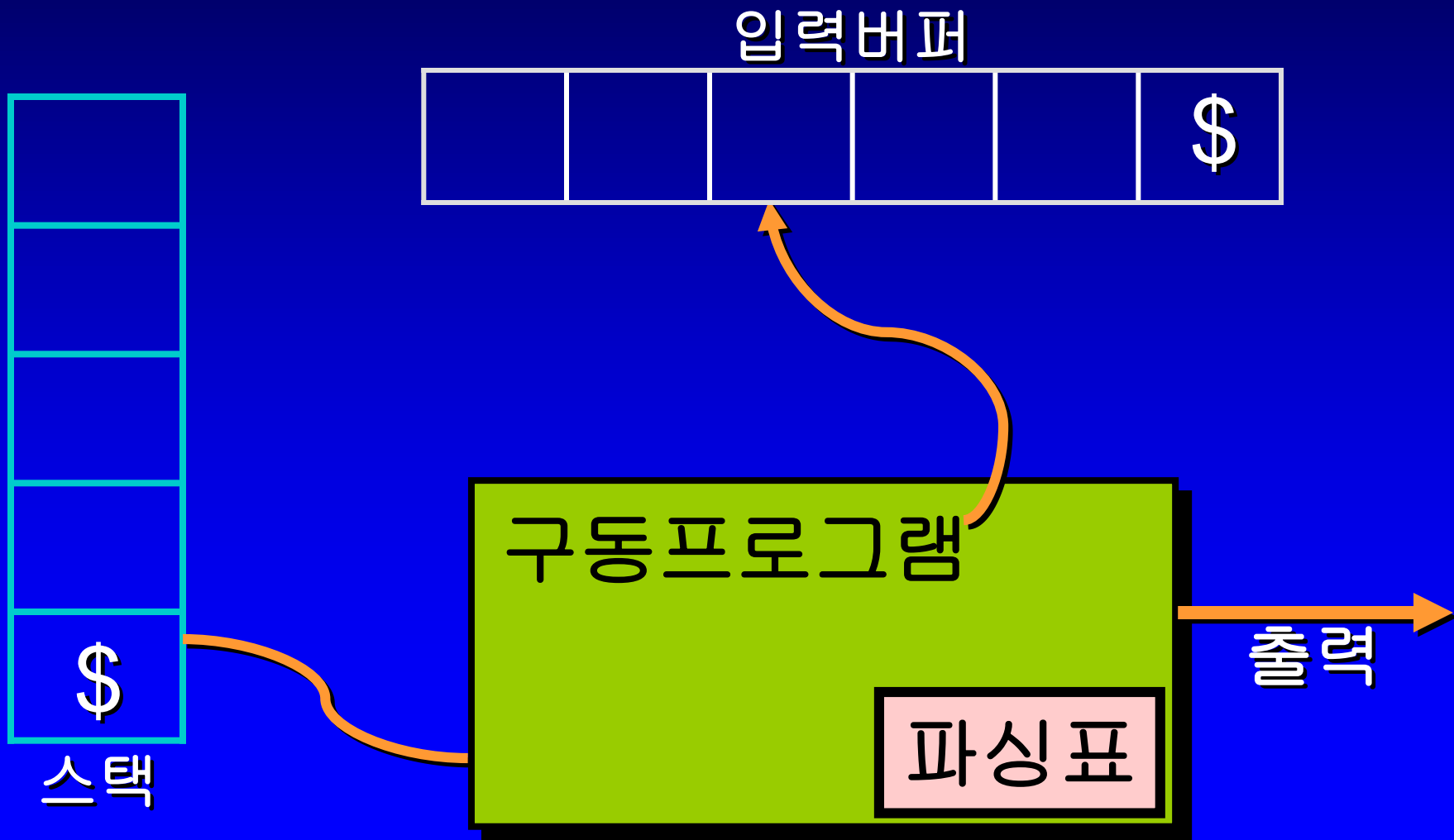
**id**

**id**

**id**

# Shift-Reduce 구문분석

# Shift-Reduce 구문분석



# Shift-Reduce 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

(예)  $id+id*id$

단계	스택	입력	구문분석행동
0	\$	$id+id*id$ \$	

# Shift-Reduce 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

(예)  $id+id*id$

단계	스택	입력	구문분석행동
0	\$	$id+id*id$ \$	shift id

# Shift-Reduce 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

(예)  $id+id*id$

단계	스택	입력	구문분석행동
0	\$	$id+id*id$ \$	shift id
1	\$ id	$+id*id$ \$	



# Shift-Reduce 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

(예)  $id+id*id$

단계	스택	입력	구문분석행동
0	\$	$id+id*id$ \$	shift $id$
1	\$ $id$	$+id*id$ \$	reduce $E \rightarrow id$

# Shift-Reduce 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

(예)  $id+id*id$

단계	스택	입력	구문분석행동
0	\$	$id+id*id$ \$	shift id
1	\$ id	$+id*id$ \$	reduce $E \rightarrow id$
2	\$ E	$+id*id$ \$	

# Shift-Reduce 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

(예)  $id+id*id$

단계	스택	입력	구문분석행동
0	\$	$id+id*id$ \$	shift $id$
1	\$ $id$	$+id*id$ \$	reduce $E \rightarrow id$
2	\$ $E$	$+id*id$ \$	shift $+$

# Shift-Reduce 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

(예)  $id+id*id$

단계	스택	입력	구문분석행동
0	\$	$id+id*id$ \$	shift $id$
1	\$ $id$	$+id*id$ \$	reduce $E \rightarrow id$
2	\$ $E$	$+id*id$ \$	shift $+$
3	\$ $E+$	$id*id$ \$	

# Shift-Reduce 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

(예)  $id+id*id$

단계	스택	입력	구문분석행동
0	\$	$id+id*id$ \$	shift $id$
1	\$ $id$	$+id*id$ \$	reduce $E \rightarrow id$
2	\$ $E$	$+id*id$ \$	shift $+$
3	\$ $E+$	$id*id$ \$	shift $id$

# Shift-Reduce 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

(예)  $id+id*id$

단계	스택	입력	구문분석행동
0	\$	$id+id*id$ \$	shift $id$
1	\$ $id$	$+id*id$ \$	reduce $E \rightarrow id$
2	\$ $E$	$+id*id$ \$	shift $+$
3	\$ $E+$	$id*id$ \$	shift $id$
4	\$ $E+id$	$*id$ \$	

# Shift-Reduce 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

(예)  $id+id*id$

단계	스택	입력	구문분석행동
0	\$	$id+id*id$ \$	shift $id$
1	\$ $id$	$+id*id$ \$	reduce $E \rightarrow id$
2	\$ $E$	$+id*id$ \$	shift $+$
3	\$ $E+$	$id*id$ \$	shift $id$
4	\$ $E+id$	$*id$ \$	reduce $E \rightarrow id$

# Shift-Reduce 구문분석

$$E \rightarrow E + E$$

$$E \rightarrow E * E$$

$$E \rightarrow id$$

(예)  $id+id*id$

단계	스택	입력	구문분석행동
0	\$	$id+id*id$ \$	shift $id$
1	\$ $id$	$+id*id$ \$	reduce $E \rightarrow id$
2	\$ $E$	$+id*id$ \$	shift $+$
3	\$ $E+$	$id*id$ \$	shift $id$
4	\$ $E+id$	$*id$ \$	reduce $E \rightarrow id$
5	\$ $E+E$	$*id$ \$	



# Shift-Reduce 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

(예)  $id+id*id$

단계	스택	입력	구문분석행동
0	\$	$id+id*id$ \$	shift $id$
1	\$ $id$	$+id*id$ \$	reduce $E \rightarrow id$
2	\$ $E$	$+id*id$ \$	shift $+$
3	\$ $E+$	$id*id$ \$	shift $id$
4	\$ $E+id$	$*id$ \$	reduce $E \rightarrow id$
5	\$ $E+E$	$*id$ \$	shift $*$

# Shift-Reduce 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

(예)  $id+id*id$

단계	스택	입력	구문분석행동
6	\$ E+E*	id \$	

# Shift-Reduce 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

(예)  $id+id*id$

단계	스택	입력	구문분석행동
6	\$ E+E*	id \$	shift id

# Shift-Reduce 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

(예)  $id+id*id$

단계	스택	입력	구문분석행동
6	\$ E+E*	id \$	shift id
7	\$ E+E*id	\$	

# Shift-Reduce 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

(예)  $id+id*id$

단계	스택	입력	구문분석행동
6	\$ E+E*	id \$	shift id
7	\$ E+E*id	\$	reduce $E \rightarrow id$

# Shift-Reduce 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

(예)  $id+id*id$

단계	스택	입력	구문분석행동
6	\$ E+E*	id \$	shift id
7	\$ E+E*id	\$	reduce $E \rightarrow id$
8	\$ E+E*E	\$	

# Shift-Reduce 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

(예)  $id+id*id$

단계	스택	입력	구문분석행동
6	\$ E+E*	id \$	shift id
7	\$ E+E*id	\$	reduce $E \rightarrow id$
8	\$ E+E*E	\$	reduce $E \rightarrow E * E$

# Shift-Reduce 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

(예)  $id+id*id$

단계	스택	입력	구문분석행동
6	\$ E+E*	id \$	shift id
7	\$ E+E*id	\$	reduce $E \rightarrow id$
8	\$ E+E*E	\$	reduce $E \rightarrow E * E$
9	\$ E+E	\$	



# Shift-Reduce 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

(예)  $id+id*id$

단계	스택	입력	구문분석행동
6	\$ E+E*	id \$	shift id
7	\$ E+E*id	\$	reduce $E \rightarrow id$
8	\$ E+E*E	\$	reduce $E \rightarrow E * E$
9	\$ E+E	\$	reduce $E \rightarrow E + E$

# Shift-Reduce 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

(예)  $id+id*id$

단계	스택	입력	구문분석행동
6	\$ E+E*	id \$	shift id
7	\$ E+E*id	\$	reduce $E \rightarrow id$
8	\$ E+E*E	\$	reduce $E \rightarrow E * E$
9	\$ E+E	\$	reduce $E \rightarrow E + E$
10	\$ E	\$	

# Shift-Reduce 구문분석

$$E \rightarrow E + E$$
$$E \rightarrow E * E$$
$$E \rightarrow id$$

(예)  $id+id*id$

단계	스택	입력	구문분석행동
6	\$ E+E*	id \$	shift id
7	\$ E+E*id	\$	reduce $E \rightarrow id$
8	\$ E+E*E	\$	reduce $E \rightarrow E * E$
9	\$ E+E	\$	reduce $E \rightarrow E + E$
10	\$ E	\$	accept

단계	스택	입력	구문분석행동
0	\$	id+id*id \$	shift id
1	\$ id	+id*id \$	reduce $E \rightarrow id$
2	\$ E	+id*id \$	shift +
3	\$ E+	id*id \$	shift id
4	\$ E+id	*id \$	reduce $E \rightarrow id$
5	\$ E+E	*id \$	shift *
6	\$ E+E*	id \$	shift id
7	\$ E+E*id	\$	reduce $E \rightarrow id$
8	\$ E+E*E	\$	reduce $E \rightarrow E * E$
9	\$ E+E	\$	reduce $E \rightarrow E + E$
10	\$ E	\$	accept



# Shift / Reduce 결정?

◆ 순위관계 부여

- 연산자

- 터미널

- 기호

◆ 순위 문법 도입

파싱표

# Shift-Reduce 구문분석

