

Assignment 15: LR Parsing

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다음 문법에 대해 물음에 답하여라.

$$S \rightarrow (S) S$$

$$S \rightarrow \varepsilon$$

(1) 모든 비단말 기호에 대해 FIRST 집합과 FOLLOW 집합을 구하라.

A. FIRST 집합

$$\text{FIRST}(S) = \{ (, \varepsilon \}$$

B. FOLLOW 집합

S는 시작기호이므로 $\text{FOLLOW}(S) = \{\$ \}$

또한 $S \rightarrow (S) S$ 에 의해 $\text{FOLLOW}(S) = \{ \}$

따라서

$$\text{FOLLOW}(S) = \{), \$ \}$$

(2) 이 문법을 확장하면 다음 생성규칙을 추가해야 한다. [1]

$$S' \rightarrow S$$

확장된 문법에 대해 표준 LR(0) 모음(canonical LR(0) collection)을 구하라.

A. LR(0) items

$$S' \rightarrow S : [S' \rightarrow \bullet S], [S' \rightarrow S \bullet]$$

$$S \rightarrow (S) S : [S \rightarrow \bullet (S) S], [S \rightarrow (\bullet S) S], [S \rightarrow (S \bullet) S], [S \rightarrow (S) \bullet S], [S \rightarrow (S) S \bullet]$$

$$S \rightarrow \varepsilon : [S \rightarrow \bullet]$$

B. 표준 LR(0) 모음 구하기

$$S_0 : \text{CLOSURE}([S' \rightarrow \bullet S]) = ([S' \rightarrow \bullet S], [S \rightarrow \bullet (S)S], [S \rightarrow \bullet])$$

$$\text{GOTO}(S_0, S) = S_1 = \text{CLOSURE}([S' \rightarrow S \bullet]) = ([S' \rightarrow S \bullet])$$

$$\text{GOTO}(S_0, () = S_2 = \text{CLOSURE}([S \rightarrow (\bullet S) S]) = ([S \rightarrow (\bullet S) S], [S \rightarrow \bullet (S)S], [S \rightarrow \bullet])$$

$$\text{GOTO}(S_2, S) = S_3 = \text{CLOSURE}([S \rightarrow (S \bullet) S]) = ([S \rightarrow (S \bullet) S])$$

$$\text{GOTO}(S_2, () = S_2 = \text{CLOSURE}([S \rightarrow (\bullet S) S])$$

$$GOTO(S_3,) = S_4 = CLOSURE([S \rightarrow (S) \cdot S]) = ([S \rightarrow (S) \cdot S], [S \rightarrow \cdot (S)S], [S \rightarrow \cdot])$$

$$GOTO(S_4, S) = S_5 = CLOSURE([S \rightarrow (S)S \cdot]) = ([S \rightarrow (S)S \cdot])$$

$$GOTO(S_4, () = S_2 = CLOSURE([S \rightarrow (\cdot S)S])$$

(3) SLR(1) 구문분석 표를 작성하라.[1]

- 1) $GOTO(S_0, S) = S_1 = CLOSURE([S' \rightarrow S \cdot]) = ([S' \rightarrow S \cdot])$ 이므로 $action(1, \$) \leftarrow accept$
- 2) $GOTO(S_0, S) = S_1, GOTO(S_0, () = S_2$ 이므로 $goto(0, S) \leftarrow 1, action(0, () \leftarrow shift\ 2$
- 3) $GOTO(S_2, S) = S_3, GOTO(S_2, () = S_2$ 이므로 $goto(2, S) \leftarrow 3, action(2, () \leftarrow shift\ 2$
- 4) $GOTO(S_3,) = S_4$ 이므로 $action(3,) \leftarrow shift\ 4$
- 5) $GOTO(S_4, S) = S_5, GOTO(S_4, () = S_2$ 이므로 $goto(4, S) \leftarrow 5, action(4, () \leftarrow shift\ 2$
- 6) $S_5 = CLOSURE([S \rightarrow (S)S \cdot]) = ([S \rightarrow (S)S \cdot])$ 이고, $FOLLOW(S) = \{ (), \$ \}$ 이므로
 $action(5,) \leftarrow reduce\ S \rightarrow (S) S, action(5, \$) \leftarrow reduce\ S \rightarrow (S) S$
- 7) $[S \rightarrow \cdot]$ 가 S_0, S_2, S_4 에 있고 $FOLLOW(S) = \{ (), \$ \}$ 이므로
 $action(0, (), action(0, \$), action(2, (), action(2, \$), action(4, (), action(4, \$) \leftarrow reduce\ S \rightarrow \epsilon$

	action			goto
	()	\$	S
0	shift 2	reduce $S \rightarrow \epsilon$	reduce $S \rightarrow \epsilon$	1
1			accept	
2	shift 2	reduce $S \rightarrow \epsilon$	reduce $S \rightarrow \epsilon$	3
3		shift 4		
4	shift 2	reduce $S \rightarrow \epsilon$	reduce $S \rightarrow \epsilon$	5
5	reduce $S \rightarrow (S) S$		reduce $S \rightarrow (S) S$	

<표1: SLR(1) 구문분석표>

(4) 작성한 구문분석 표에 따라 문장 00를 구문분석하고 우파스를 구하라.

No.	Stack	Input	Action
1	S_0	$()()$ \$	shift 2
2	$S_0(S_2$	$)()$ \$	reduce $S \rightarrow \epsilon$
3	$S_0(S_2SS_3$	$)()$ \$	shift 4
4	$S_0(S_2SS_3)S_4$	$()$ \$	shift 2
5	$S_0(S_2SS_3)S_4(S_2$	$)$ \$	reduce $S \rightarrow \epsilon$
6	$S_0(S_2SS_3)S_4(S_2SS_3$	$)$ \$	shift 4
7	$S_0(S_2SS_3)S_4(S_2SS_3)S_4$	$\$$	reduce $S \rightarrow \epsilon$
8	$S_0(S_2SS_3)S_4(S_2SS_3)S_4SS_5$	$\$$	reduce $S \rightarrow (S) S$
9	$S_0(S_2SS_3)S_4SS_5$	$\$$	reduce $S \rightarrow (S) S$
10	S_0SS_1	$\$$	accept

<표2: 00 문장 구문 분석>

우파스는 다음과 같다(reduce action의 역순).

$$S \rightarrow (S) S$$

$$S \rightarrow (S) S$$

$$S \rightarrow \epsilon$$

$$S \rightarrow \epsilon$$

$$S \rightarrow \epsilon$$

위 우파스를 이용하면 아래와 같이 rightmost derivation할 수 있다.

$$S$$

$$\Rightarrow (S) S \quad (S \rightarrow (S) S)$$

$$\Rightarrow (S) (S) S \quad (S \rightarrow (S) S)$$

$$\Rightarrow (S) (S) \quad S \rightarrow \epsilon$$

$$\Rightarrow (S) () \quad S \rightarrow \epsilon$$

$$\Rightarrow () \quad S \rightarrow \epsilon$$

References

[1] Alfred V. Aho 외. "컴파일러: 원리 기법 도구". 2판. 유원희 등역. 교보문고. 2009