Home Work 2 Solutions

**4.6.2:**

Augmented grammar:

S’ -> S (1)

S -> S S + (2)| S S \* (3) | a (4)

SLR sets of items:

S

I1: S’ -> S.

S -> S. S +

S -> S. S \*

S -> .S S +

S -> .S S \*

S -> .a

I0: S’ -> .S

S -> .S S +

S -> .S S \*

S -> .a

S

I3: S -> S S. +

S -> S S. \*

S -> S. S +

S -> S. S \*

S -> .S S +

S -> .S S \*

S -> .a

S

+

\*

a

a

a

I4: S -> S S +.

I5: S -> S S \*.

I2: S -> a.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| State | Action | | | | GOTO |
|  | a | + | \* | $ | S |
| 0 | s2 |  |  |  | 1 |
| 1 | s2 |  |  | r1 (Accept) | 3 |
| 2 | r4 | r4 | r4 | r4 |  |
| 3 | s2 | s4 | s5 |  | 3 |
| 4 | r2 | r2 | r2 | r2 |  |
| 5 | r3 | r3 | r3 | r3 |  |

**4.6.4: c)**

S’ -> S (1)

S -> S ( S ) S (2) | ε (3)

S

)

(

S

(

S

I0: S’ -> .S

S -> .S ( S ) S

S -> .

I1: S’ -> S.

S -> S. ( S ) S

I2: S -> S (. S ) S

S -> .S ( S ) S

S -> .

I3: S -> S ( S. ) S

S -> S. ( S ) S

I4: S -> S ( S ). S

S -> .S ( S ) S

S -> .

I5: S -> S ( S ) S.

S -> S. ( S ) S

(

First(S) = { (, ε}

Follow(S) = { (, ), $}

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| State | Action | | | GOTO |
|  | ( | ) | $ | S |
| 0 | r3 | r3 | r3 | 1 |
| 1 | s2 |  | r1 (Accept) |  |
| 2 | r3 | r3 | r3 | 3 |
| 3 | s2 | s4 |  |  |
| 4 | r3 | r3 | r3 | 5 |
| 5 | s2/r2 | r2 | r2 |  |

Shift reduce conflict in state 5. ( Can be resolved by only considering reduce here, why?)

**d)**

S’ -> S (1)

S -> S + S (2)| S S (3)| ( S ) (4)| S \* (5)| a (6)

)

S

a

a

a

a

a

a

a

S

(

(

(

(

(

(

\*

\*

\*

\*

\*

+

(

S

+

+

S

S

I7: S -> ( S. )

S -> S. + S

S -> S. S

S -> S. \*

S -> .S + S

S -> .S S

S -> .( S )

S -> .S \*

S -> .a

I5: S -> (. S )

S -> .S + S

S -> .S S

S -> .( S )

S -> .S \*

S -> .a

S

+

S

I8: S -> S + S.

S -> S. + S

S -> S. S

S -> S. \*

S -> .S + S

S -> .S S

S -> .( S )

S -> .S\*

S -> .a

I9: S -> ( S ).

I1: S’ -> S.

S -> S. + S

S -> S. S

S -> S. \*

S -> .S + S

S -> .S S

S -> .( S )

S -> .S \*

S -> .a

I2: S -> S S.

S -> S. + S

S -> S. S

S -> S. \*

S -> .S + S

S -> .S S

S -> .( S )

S -> .S \*

S -> .a

I0: S’ -> .S

S -> .S + S

S -> .S S

S -> .( S )

S -> .S \*

S -> .a

I6: S -> a.

I4: S -> S \*.

I3: S -> S + .S

S -> .S + S

S -> .S S

S -> .( S )

S -> .S \*

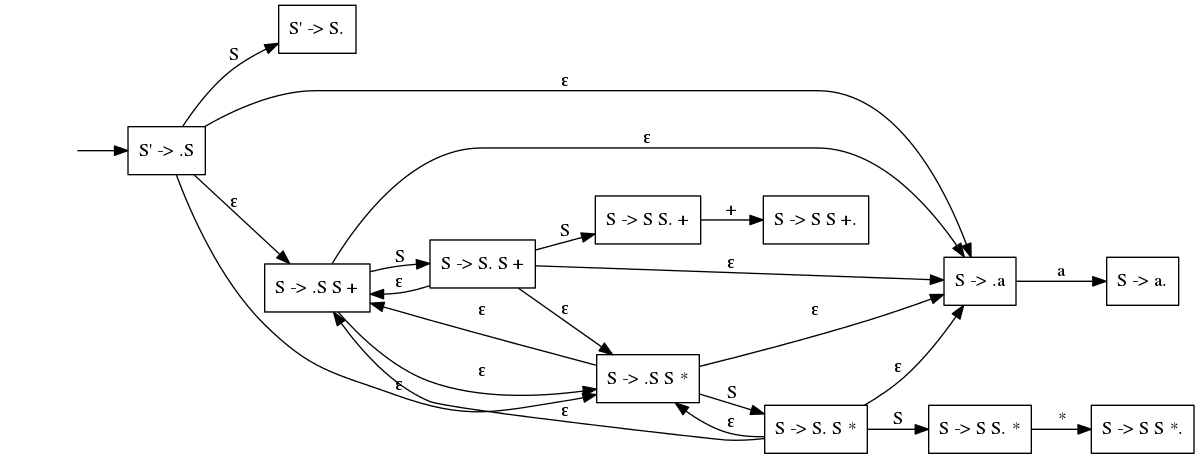
S -> .a

First (S) = { (, a }

Follow(S) = { (, ), a, +, \*, $ }

Shift reduce conflicts in I2 and I8.

**4.6.8: a)**



**b)**

You will obtain the same figure as in problem 4.6.2 on applying the algorithm.

**4.6.9:**

S -> A S (2)| b (3)

A -> S A (4)| a (5)

S’ -> S (1)

|  |  |  |
| --- | --- | --- |
| I0: S’ -> .S  S -> .A S  S -> .b  A -> .S A  A -> .a | I1: S’ -> S.  A -> S. A  A -> .S A  A -> .a  S -> .A S  S -> .b | I2: S -> A. S  S -> .A S  S -> .b  A -> .S A  A -> .a |
| I3: S -> b. | I4: A -> a. | I5: A -> S. A  A -> .S A  A -> .a  S -> .A S  S -> .b |
| I6: S -> A S.  A -> S. A  A -> .S A  A -> .a  S -> .A S  S -> .b | I7: A -> S A.  A -> A. S  S -> .A S  S -> .b  A -> .S A  A -> .a |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| State | Action | | | GOTO | |
|  | a | b | $ | S | A |
| 0 | s4 | s3 |  | 1 | 2 |
| 1 | s4 | s3 | r1 (Accept) | 5 | 7 |
| 2 | s4 | s3 |  | 6 | 2 |
| 3 | r3 | r3 | r3 |  |  |
| 4 | r5 | r5 | r5 |  |  |
| 5 | s4 | s3 |  | 5 | 7 |
| 6 | s4/r2 | s3/r2 | r2 | 5 | 7 |
| 7 | s4/r4 | s3/r4 | r4 | 6 | 2 |

string abab:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Stack | Symbols | Input | Action |
| 1 | 0 |  | abab$ | s4 |
| 2 | 0 4 | a | bab$ | r5 |
| 3 | 0 2 | A | bab$ | s3 |
| 4 | 0 2 3 | A b | ab$ | r3 |
| 5 | 0 2 6 | A S | ab$ | r2\* |
| 6 | 0 1 | S | ab$ | s4 |
| 7 | 0 1 4 | S a | b$ | r5 |
| 8 | 0 1 7 | S A | b$ | r4\* |
| 9 | 0 2 | A | b$ | s3 |
| 10 | 0 2 3 | A b | $ | r3 |
| 11 | 0 2 6 | A S | $ | r2 |
| 12 | 0 1 | S | $ | Accept |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Stack | Symbols | Input | Action |
| 1 | 0 |  | abab$ | s4 |
| 2 | 0 4 | a | bab$ | r5 |
| 3 | 0 2 | A | bab$ | s3 |
| 4 | 0 2 3 | A b | ab$ | r3 |
| 5 | 0 2 6 | A S | ab$ | r2\* |
| 6 | 0 1 | S | ab$ | s4 |
| 7 | 0 1 4 | S a | b$ | r5 |
| 8 | 0 1 7 | S A | b$ | s3\* |
| 9 | 0 1 7 3 | S A b | $ | r3 |
| 10 | 0 1 7 6 | S A S | $ | r2 |
| 11 | 0 1 5 | S S | $ | Reject |
|  |  |  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Stack | Symbols | Input | Action |
| 1 | 0 |  | abab$ | s4 |
| 2 | 0 4 | a | bab$ | r5 |
| 3 | 0 2 | A | bab$ | s3 |
| 4 | 0 2 3 | A b | ab$ | r3 |
| 5 | 0 2 6 | A S | ab$ | s4\* |
| 6 | 0 2 6 4 | A S a | b$ | r5 |
| 7 | 0 2 6 7 | A S A | b$ | s3\* |
| 8 | 0 2 6 7 3 | A S A b | $ | r3 |
| 9 | 0 2 6 7 6 | A S A S | $ | r2 |
| 10 | 0 2 6 5 | A S S | $ | Reject |
|  |  |  |  |  |
|  |  |  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Stack | Symbols | Input | Action |
| 1 | 0 |  | abab$ | s4 |
| 2 | 0 4 | a | bab$ | r5 |
| 3 | 0 2 | A | bab$ | s3 |
| 4 | 0 2 3 | A b | ab$ | r3 |
| 5 | 0 2 6 | A S | ab$ | s4\* |
| 6 | 0 2 6 4 | A S a | b$ | r5 |
| 7 | 0 2 6 7 | A S A | b$ | r4\* |
| 8 | 0 2 2 | A A | b$ | s3 |
| 9 | 0 2 2 3 | A A b | $ | r3 |
| 10 | 0 2 2 6 | A A S | $ | r2 |
| 11 | 0 2 6 | A S | $ | r2 |
| 12 | 0 1 | S | $ | Accept |

The above tables indicate execution of the parser with all possible combinations of choices. It can be seen that it accepts twice and rejects twice. There is no particular choice of shift or reduce when conflict occurs which can lead to correct parsing of all valid strings for LL(0) parsing.

**4.7.1:**

S -> S S + | S S \* | a

S’ -> S

First(S) = { a }

Follow(S) = {+, \*, a, $}

1. Canonical LR

|  |  |  |
| --- | --- | --- |
| I0: S’ -> .S, $  S -> .S S +, $  S -> .S S \*, $  S -> .a, $  S -> .S S +, a  S -> .S S \*, a  S -> .a, a  GOTO: a - 2, S - 1, + - none, \* - none | I1: S’ -> S., $  S -> S. S +, $  S -> S. S \*, $  S -> S. S +, a  S -> S. S \*, a  S -> . S S +, +  S -> . S S \*, +  S -> . a, +  S -> . S S +, \*  S -> . S S \*, \*  S -> . a, \*  S -> .S S +, a  S -> .S S \*, a  S -> .a, a  GOTO: a - 3, S - 4, + - none, \* - none | I2: S -> a., $  S -> a., a  GOTO: none |
| I3: S -> a., a  S -> a., +  S -> a., \*  GOTO: none | I4: S -> S S. +, $  S -> S S. \*, $  S -> S S. +, a  S -> S S. \*, a  S -> S. S +, +  S -> S. S \*, +  S -> S. S +, \*  S -> S. S \*, \*  S -> S. S +, a  S -> S. S \*, a  S -> . S S +, +  S -> . S S \*, +  S -> . a, +  S -> . S S +, \*  S -> . S S \*, \*  S -> . a, \*  S -> .S S +, a  S -> .S S \*, a  S -> .a, a  GOTO: a - 3, S - 5, + - 6, \* - 7 | I5: S -> S S. +, +  S -> S S. \*, +  S -> S S. +, \*  S -> S S. \*, \*  S -> S S. +, a  S -> S S. \*, a  S -> S. S +, +  S -> S. S \*, +  S -> S. S +, \*  S -> S. S \*, \*  S -> S. S +, a  S -> S. S \*, a  S -> . S S +, +  S -> . S S \*, +  S -> . a, +  S -> . S S +, \*  S -> . S S \*, \*  S -> . a, \*  S -> .S S +, a  S -> .S S \*, a  S -> .a, a  GOTO: a – 3, S - 5, + - 8, \* - 9 |
| I6: S -> S S +., $  S -> S S +., a  GOTO: none | I7: S -> S S \*., $  S -> S S \*., a  GOTO: none | I8: S -> S S +., +  S -> S S +.,\*  S -> S S +., a  GOTO: none |
| I9: S -> S S \*., +  S -> S S \*.,\*  S -> S S \*., a  GOTO: none |  |  |

LALR sets:

I0, I1, (I2 ∪ I3), (I4 ∪ I5), (I6 ∪ I8), (I7 ∪ I9)

Note: This is the table generated using LL(0) items too as this language is LL(0).

**4.7.2: c)**

S’ -> S

S -> S ( S ) S | ε

|  |  |  |
| --- | --- | --- |
| I0: S’ -> .S, $  S -> .S ( S ) S, $  S -> ., $  S -> .S ( S ) S, (  S -> ., (  GOTO: S – 1, ( - none, ) - none | I1: S’ -> S., $  S -> S. ( S ) S, $  S -> S. ( S ) S, (  GOTO: ( - 2, ) – none, S - none | I2: S -> S (. S ) S, $  S -> S (. S ) S, (  S -> .S ( S ) S, )  S -> ., )  S -> .S ( S ) S, (  S -> ., (  GOTO: ( - none, ) - none, S - 3 |
| I3: S -> S ( S. ) S, $  S -> S ( S. ) S, (  S -> S. ( S ) S, )  S -> S. ( S ) S, (  GOTO: ) - 4, ( - 5, S - none | I4: S -> S ( S ). S, $  S -> S ( S ). S, (  S -> .S ( S ) S, $  S -> ., $  S -> .S ( S ) S, (  S -> ., (  GOTO: S – 6, (,) - none | I5: S -> S (. S ) S, )  S -> S (. S ) S, (  S -> .S ( S ) S, )  S -> ., )  S -> .S ( S ) S, (  S -> ., (  GOTO: S – 7, (,) - none |
| I6: S -> S ( S ) S., $  S -> S ( S ) S., (  S -> S. ( S ) S, $  S -> S. ( S ) S, ( | I7: S -> S ( S. ) S, )  S -> S ( S. ) S, (  S -> S. ( S ) S, )  S -> S. ( S ) S, (  GOTO: S – none, ( - 5, ) - 8 | I8: S -> S ( S ). S, )  S -> S ( S ). S, (  S -> .S ( S ) S, )  S -> ., )  S -> .S ( S ) S, (  S -> ., (  GOTO: S – 9, (,) - none |
| I9: S -> S ( S ) S., )  S -> S ( S ) S., (  S -> S. ( S ) S, )  S -> S. ( S ) S, (  GOTO: none |  |  |

Both I6 and I9 have shift reduce conflicts for both their follow sets ({$,(} and {(,)} respectively). This language is not LL(1) (infact it is ambiguous and thus always will present conflicts).

LALR sets:

I0, I1, (I2 ∪ I5), (I3 ∪ I7), (I4 ∪ I8), (I6 ∪ I9)