CS 421 — LL Grammar Problems

Question 1: What advantage does it give the programmer if a grammar turns out to be LL?

Question 2: What are the two conditions that will cause a grammar to **not** be LL?

Question 3: Consider the following grammar.

$$\begin{aligned} S &\to x\ E\ a \\ &\mid y\ E\ z \\ E &\to x\ F \\ &\mid x\ E\ q \\ F &\to q \\ &\mid F\ z \end{aligned}$$

This grammar is not LL. There are two reasons for that. What are they?

Question 4: Convert the following grammar into an equivalent LL grammar.

$$\begin{aligned} S &\to x\ E\ a \\ &\mid y\ E\ z \\ E &\to x\ F \\ &\mid x\ E\ q \\ F &\to q \\ &\mid F\ z \end{aligned}$$

Question 5: Convert the following non-LL grammar into an equivalent LL grammar.

$$\begin{aligned} S &\to S\ x \\ &\mid a\ E \\ E &\to y\ a\ y \\ &\mid y\ a\ z \end{aligned}$$

Question 6: Convert the following non-LL grammar into an equivalent LL grammar.

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

Question 7: Convert the following non-LL grammar into an equivalent LL grammar.

$$\begin{aligned} S &\to S\ x \\ &\mid a\ E \\ E &\to x\ y \\ &\mid x\ z \end{aligned}$$

Question 8: Convert the following non-LL grammar into an equivalent LL grammar.

$$\begin{aligned} S &\to S\ x \\ &\mid x\ E \\ E &\to y\ y \\ &\mid y\ z \end{aligned}$$

Question 9: Convert the following non-LL grammar into an equivalent LL grammar.

$$\begin{aligned} S &\to y\ E \\ &\mid y\ z \\ E &\to E\ z\ z \\ &\mid x\ a\ a \end{aligned}$$

Question 10: Convert the following non-LL grammar into an equivalent LL grammar.

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

1 Solutions to exercises

Solution 1 If the grammar is LL, then we can write a parser for it very simply using recursive descent.

Solution 2

1. two rules for the same symbol that have overlapping first sets (The "common prefix" problem.)

2. a left recursive rule

Solution 3 The E productions share a common prefix, x; and one of the F rules is left recursive.

Solution 4

$$\begin{array}{rcl} S & \to & x\ E\ a \\ & | & y\ E\ z \\ E & \to & x\ E' \\ E' & \to & F \\ & | & E\ q \\ F & \to & q\ F' \\ F' & \to & z\ F' \\ & | & \epsilon \end{array}$$

Solution 5

$$\begin{array}{rcl} S & \to & a\ E\ S' \\ S' & \to & x\ S' \\ & | & \epsilon \\ E & \to & y\ a\ E' \\ E' & \to & y \\ & | & z \end{array}$$

Solution 6

$$\begin{array}{rcl} S & \to & y\ S' \\ S' & \to & y \\ & | & E \\ E & \to & x\ a\ E' \\ E' & \to & x\ E' \\ & | & \epsilon \end{array}$$

Solution 7

$$\begin{array}{rcl} S & \to & a\ E\ S' \\ S' & \to & x\ S' \\ & | & \epsilon \\ E & \to & x\ E' \\ E' & \to & y \\ & | & z \end{array}$$

Solution 8

$$\begin{array}{rcl} S & \to & x\ E\ S' \\ S' & \to & x\ S' \\ & | & \epsilon \\ E & \to & y\ E' \\ E' & \to & y \\ & | & z \end{array}$$

Solution 9

$$\begin{array}{rcl} S & \to & y\ S' \\ S' & \to & z \\ & | & E \\ E & \to & x\ a\ a\ E' \\ E' & \to & z\ z\ E' \\ & | & \epsilon \end{array}$$

Solution 10

$$\begin{array}{rcl} S & \to & a\ E\ S' \\ S' & \to & x\ S' \\ & | & \epsilon \\ E & \to & z\ b\ E' \\ E' & \to & b \\ & | & z \end{array}$$