cID
lID

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Example

grammars can have if/else statements.
for example:

$$S \rightarrow iEtS \mid iEtSeS \mid a$$

where i is if, t is then, and e is else.
we can then apply left factoring on the grammar as, it cannot be parsed with recursive descent parsing, which we want. It would result in

$$S \rightarrow iEtSS' \mid a$$

$$S' \rightarrow eS \mid a$$

but we still cannot use recursive descent parsing on this grammar as: $e \in FOLLOW(S')$

$$S \implies iEtSS' \implies iEtiEtSS'S' \implies iEtiEtSS'eS$$

it violates RD2.

Left Recursive Productions

given the grammar:

$$< expr > \rightarrow < expr > + < term > | < term >$$

$$< term > \rightarrow ...$$

in this grammar, the parser goes into an infinite loop when $< expr >$ is at the top of the stack. we an then modify the rules to avoid this.

$$< expr > \rightarrow < term > < expTail >$$

$$< expTail > \rightarrow + < tem > < expTail > | \ \epsilon$$

However, left recursion can be sometimes be replaced by right recursion.

Eliminate Left Recursion

the forula for eliminating left recursion from a grammar is:

$$A \rightarrow A\alpha_1 \mid ... \mid A\alpha_m \mid B_1 \mid ... \mid B_n$$

where B_i does not begin with A, $\alpha_j \neq \epsilon, i \leq j \leq m$ such that:

$$A \rightarrow B_i A' \mid ... \mid B_n A'$$

$$A' \rightarrow \alpha_1 A' \mid ... \mid \alpha_m A' \mid \epsilon$$

Example

given the grammar:

$$S \rightarrow bSa \mid ccaSb \mid ccbSa \mid abc \mid \epsilon$$

we can use left factoring and recursion elimination to convert it to the following grammar:

$$\begin{aligned} S &\rightarrow ccS' \mid abc \mid \epsilon \mid bSa \\ S' &\rightarrow aSb \mid bSa \end{aligned}$$

Example

given:

$$S \rightarrow Sabc \mid Sabd \mid ccb \mid cca$$

we will first elimiate the left recursion:

$$S \rightarrow ccbS' \mid ccaS' \quad S' \rightarrow abcS' \mid abdS' \mid \epsilon$$

we will then do left factoring twice (as we can see that there are 2 common prefixes in the new above grammar: cc, ab)

$$\begin{aligned} S &\rightarrow ccX \\ X &\rightarrow bS' \mid aS' \\ S' &\rightarrow abY \mid \epsilon \\ Y &\rightarrow cS' \mid dS' \end{aligned}$$