

CS 2021 - Written Assignment 2

Due Monday, Nov 8, 2021 at 11:59 PM

This assignment covers context free grammars and parsing. You may discuss this assignment with other students and work on the problems together. However, your write-up should be your own individual work.

1. Page139 Ex3.1

- (a) *answer*: a simple string repeat a lot of times and not include the ϵ

$$S \rightarrow s; S \mid s;$$

- (b) *answer*: a leftmost derivation and a rightmost derivation

$$\begin{array}{ll} S \Rightarrow s; S & S \Rightarrow s; S \\ \Rightarrow s; s & \Rightarrow s; s \end{array}$$

2. Page139 Ex3.6

- (a) *answer*: a leftmost derivation and a rightmost derivation of (a 23 (m x y))

$$\begin{aligned} lexp &\Rightarrow list \\ &\Rightarrow (lexp - seq) \\ &\Rightarrow (lexp - seq lexp) \\ &\Rightarrow (lexp - seq lexp lexp) \\ &\Rightarrow (lexp lexp lexp) \\ &\Rightarrow (atom lexp lexp) \\ &\Rightarrow (identifier lexp lexp) \\ &\Rightarrow (identifier atom lexp) \\ &\Rightarrow (identifier number lexp) \\ &\Rightarrow (identifier number list) \\ &\Rightarrow (identifier number (lexp - seq)) \\ &\Rightarrow (identifier number (lexp - seq lexp)) \\ &\Rightarrow (identifier number (lexp - seq lexp lexp)) \\ &\Rightarrow (identifier number (lexp lexp lexp)) \\ &\Rightarrow (identifier number (atom lexp lexp)) \\ &\Rightarrow (identifier number (identify lexp lexp)) \\ &\Rightarrow (identifier number (identify identify lexp)) \\ &\Rightarrow (identifier number (identify identify identify)) \end{aligned}$$

$$\begin{aligned}
lexp &\Rightarrow list \\
&\Rightarrow (lexp - seq) \\
&\Rightarrow (lexp - seq lexp) \\
&\Rightarrow (lexp - seq list) \\
&\Rightarrow (lexp - seq (lexp - seq)) \\
&\Rightarrow (lexp - seq (lexp - seq lexp)) \\
&\Rightarrow (lexp - seq (lexp - seq atom)) \\
&\Rightarrow (lexp - seq (lexp - seq identify)) \\
&\Rightarrow (lexp - seq (lexp - seq lexp identify)) \\
&\Rightarrow (lexp - seq (lexp - seq atom identify)) \\
&\Rightarrow (lexp - seq (lexp - seq identify identify)) \\
&\Rightarrow (lexp - seq (lexp identify identify)) \\
&\Rightarrow (lexp - seq (atom identify identify)) \\
&\Rightarrow (lexp - seq (identify identify identify)) \\
&\Rightarrow (lexp - seq lexp (identify identify identify)) \\
&\Rightarrow (lexp - seq atom (identify identify identify)) \\
&\Rightarrow (lexp - seq number (identify identify identify)) \\
&\Rightarrow (lexp number (identify identify identify)) \\
&\Rightarrow (atom number (identify identify identify)) \\
&\Rightarrow (identify number (identify identify identify))
\end{aligned}$$

(b) *answer*: parse tree

Answer:

$$\begin{aligned}
S &\rightarrow TS' \\
S' &\rightarrow TSS' \mid TS' \mid \epsilon \\
T &\rightarrow cT' \\
T' &\rightarrow aT' \mid bT' \mid \epsilon
\end{aligned}$$

4. Consider the following CFG, where the set of terminals is $\{a, b, \#, \%, !\}$:

$$\begin{aligned}
S &\rightarrow \%aT \mid U! \\
T &\rightarrow aS \mid baT \mid \epsilon \\
U &\rightarrow \#aTU \mid \epsilon
\end{aligned}$$

- (a) Construct the FIRST sets for each of the nonterminals.

Answer:

$$\text{First}(S) = \{ \% , \# , ! \}$$

$$\text{First}(T) = \{ a , b , \epsilon \}$$

$$\text{First}(U) = \{ \# , \epsilon \}$$

- (b) Construct the FOLLOW sets for each of the nonterminals.

Answer:

$$\text{Follow}(S) = \{ \$, \# , ! \}$$

$$\text{Follow}(T) = \{ \$, \# , ! \}$$

$$\text{Follow}(U) = \{ ! \}$$

- (c) Construct the LL(1) parsing table for the grammar.

Answer:

| | a | b | # | % | ! | \$ |
|---|--------------------|---------------------|--------------------------|----------------------|--------------------------|--------------------------|
| S | | | $S \rightarrow U!$ | $S \rightarrow \%aT$ | $S \rightarrow U!$ | |
| T | $T \rightarrow aS$ | $T \rightarrow baT$ | $T \rightarrow \epsilon$ | | $T \rightarrow \epsilon$ | $T \rightarrow \epsilon$ |
| U | | | $U \rightarrow \#aTU$ | | $U \rightarrow \epsilon$ | |

- (d) Show the sequence of stack, input and action configurations that occur during an LL(1) parse of the string “#abaa%aba!”. At the beginning of the parse, the stack should contain a single S.

Answer:

| Stack | Input | Action |
|---------|--------------|--------------------------|
| \$S | #abaa%aba!\$ | $S \rightarrow U!$ |
| \$!U | #abaa%aba!\$ | $U \rightarrow \#aTU$ |
| \$!UTa# | #abaa%aba!\$ | match # |
| \$!UTa | abaa%aba!\$ | match a |
| \$!UT | baa%aba!\$ | $T \rightarrow baT$ |
| \$!UTab | baa%aba!\$ | match b |
| \$!UTa | aa%aba!\$ | match a |
| \$!UT | a%aba!\$ | $T \rightarrow aS$ |
| \$!USa | a%aba!\$ | match a |
| \$!US | %aba!\$ | $S \rightarrow \%aT$ |
| \$!UTa% | %aba!\$ | match % |
| \$!UTa | aba!\$ | match a |
| \$!UT | ba!\$ | $T \rightarrow baT$ |
| \$!UTab | ba!\$ | match b |
| \$!UTa | a!\$ | match a |
| \$!UT | !\$ | $T \rightarrow \epsilon$ |
| \$!U | !\$ | $U \rightarrow \epsilon$ |
| \$! | !\$ | match ! |
| \$ | \$ | accept! |

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