

# Problem set 4 - Magnus Halvorsen - TDT4205

## Part 1 - Theory

### Problem 1

This grammar can produce the following strings:

x  
yz  
z  
zz  
zzz

a) The grammar is not left-recursive. Since none of the productions have the left-side symbol as the first symbol on the right side, it's not directly left-recursive. And since you can't start with any of the left side symbols and then wind up with the same symbol as the left-most symbol of the derivation - there is no indirect left recursion either.

It's also worth noting that this grammar can only produce a finite set of strings (even if we include  $\epsilon$ ), thus there is no left-recursion.

b) The grammar is ambiguous. When deriving the string "zz", we can achieve this by either  $A \rightarrow BC \rightarrow zCC \rightarrow zzC \rightarrow CC$  or  $A \rightarrow BC \rightarrow zCC \rightarrow zC \rightarrow zz$ . Thus we can two parse trees, which makes this grammar ambiguous.

### Problem 2

a)

Both A) and B) follows the conditions mentioned at page 223 in the Dragon Book.

C) No, it's not. It's left recursive, thus it not LL(1).

b) Yes it is. It can be represented by  $(aa)^*$

### Problem 3

a)  $S \Rightarrow B \Rightarrow Sb \Rightarrow Ab \Rightarrow xAyb \Rightarrow xxAyyb \Rightarrow xxzyyb$ .

b)

$S ::= A \mid B$

$A ::= xAy \mid z$

$B ::= Sb \mid b$

Has to replace  $B ::= Sb \mid b$ , since it's the part that creates the left recursion. Following algorithm 4.19, page 213 in the Dragon book, we get:

$B ::= Sb \mid b \Rightarrow B ::= Ab \mid Bb \mid b$

We now have a direct left recursion, which is easily solved by:

$B ::= AbB' \mid bB'$

$B' ::= bB' \mid \varepsilon$

As a result we end up with:

$S ::= A \mid B$

$A ::= xAy \mid z$

$B ::= AbB' \mid bB'$

$B' ::= bB' \mid \varepsilon$

### Problem 4

The difference is mainly that a recursive descent parser without backtracking is predictive and uses a lookahead, while a recursive descent parser with backtracking does not need to - since it backtracks every time something goes "wrong".

### Problem 5

a) Fast lookup, deletion and expanding.

**b)** Name of the id, it's type, scope and location.