Assessment 2

Context Free Grammars and Turing Machines

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Context Free Grammars

1. Consider the language

(a) Give a word that is in the language and a word that is not in the language

Answer:
a word not in the language: kkk
a word in the language: aabbbbcc

(b) Give a context-free grammar for the language above.

Answer:
$S \to B \mid aSc$
$B \to \epsilon \mid bBc$

(c) Use the Cocke-Younger-Kasami algorithm to determine whether **abbaa** is a word of the language of the following grammar. Give the table. State in one sentence whether the word is a word of the language of the grammar and how you obtain this conclusion from the table.

$$S \Rightarrow AX \mid BY \mid SS \mid BA$$
$$X \Rightarrow AS$$
$$Y \Rightarrow BS$$
$$A \Rightarrow a$$
$$B \Rightarrow b$$

Answer:

5	–	—	—	—	—
4	–	–	—	—	—
3	–	Y	–	—	—
2	–	–	S	–	—
1	A	B	B	A	A
–	a	b	b	a	a

Conclusion:
It's not, there is no way to parse it as S doesn't appear in the top row.

(d) Give a parse tree for the word abba with respect to the grammar above (for part c))

Answer:
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(e) What is $FIRST(SS)$ with respect to the grammar above (for part c))

Answer:
$FIRST(SS) = \{a, b\}$

2. Consider the following two context-free grammars

G2

$$S \Rightarrow DAd$$
$$A \Rightarrow aS \mid \epsilon$$
$$B \Rightarrow bD \mid \epsilon$$
$$D \Rightarrow cB$$

G1

$$S \Rightarrow SaS \mid SbS \mid c$$

(a) Draw two different parse trees for the word cacbc and the grammar $G1$

Answer:
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(b) Give the $LOOKAHEAD$ set for every rule of grammar $G2$

Answer:

rule	nullable	first set	lookahead set
S $\Rightarrow DAd$	0	$\{c\}$	$\{\}$
A $\Rightarrow aS \mid \epsilon$	1	$\{a, \epsilon\}$	$\{\}$
B $\Rightarrow bD \mid \epsilon$	1	$\{b, \epsilon\}$	$\{\}$
D $\Rightarrow cB$	0	$\{c\}$	$\{\}$

(c) Is the grammar $G2$ $LL(1)$?

Answer:
No it's not. It's ambiguous.

(d) Give the set of nullable nonterminals for the grammar $G2$

Answer:
$\{A, B\}$

(e) Give the context-free grammar that you obtain from replacing all ϵ-rules in grammar $G2$

Answer:

$$S \Rightarrow DAd$$
$$A \Rightarrow aS$$
$$B \Rightarrow bD$$
$$D \Rightarrow cB$$

Turing Machines

Consider the following Turing machine with input alphabet {a, b} and tape alphabet $\{a, b, \_\}$

(a) Give computations for the words ab and bb. State for each word whether the machine accepts it, rejects it or loops. If the machine loops, then give the first five configurations of the computation.

Answer:
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(b) Draw a Turing machine that decides the language of all words over the alphabet $\{a, b\}$ that have an odd number of as and an odd number of bs.

Answer:
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