

*This homework **Monday, November 16.***

There is a test on Wednesday, November 18.

For problems 1 and 2, consider the following grammars. In each case, the start symbol is S:

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|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| a) $S \rightarrow Tb$ | b) $S \rightarrow TR$ | c) $S \rightarrow SS$ | d) $S \rightarrow TaT$ |
| $S \rightarrow Tbb$ | $T \rightarrow aTb$ | $S \rightarrow ASb$ | $T \rightarrow aTb$ |
| $T \rightarrow aTb$ | $T \rightarrow \varepsilon$ | $S \rightarrow bSA$ | $T \rightarrow bTa$ |
| $T \rightarrow \varepsilon$ | $R \rightarrow cRd$ | $S \rightarrow \varepsilon$ | $T \rightarrow TT$ |
| | $R \rightarrow c$ | $A \rightarrow a$ | $T \rightarrow \varepsilon$ |
| | | $A \rightarrow \varepsilon$ | |

- For this problem you will find derivations of some strings from the above grammars
 - Write a derivation for the string *aabbb* using grammar a).
 - Write a derivation for the string *abccdd* using grammar b).
 - Write a derivation for the string *baabbb* using grammar c).
 - Write a derivation for the string *aabbbaa* using grammar d).
- For each of the four Context-Free Grammars shown above, find the language generated by the grammar. Briefly justify your answers.
- For each of the following languages, create a Context-Free Grammar that generates that language. Explain in words why your grammar works.

a) $\{a^n b a^m \mid m = n\}$	b) $\{a^n b^m \mid n \neq m\}$
c) $\{a^n b^m c^k d^l \mid m = k \text{ and } n = l\}$	d) $\{a^n b^m c^k d^l \mid n + m = k + l\}$
- Given the following (very incomplete) BNF grammar for “names” in Java, write down **six** “names” generated by this grammar. Your examples should demonstrate all the possibilities represented in the rules.

$$\begin{aligned}
 \langle name \rangle &::= \langle object_ref \rangle [\text{“.”} \langle identifier \rangle] \\
 \langle object_ref \rangle &::= \langle identifier \rangle \mid \langle method_call \rangle \\
 \langle identifier \rangle &::= \text{“a”} \mid \text{“x”} \mid \text{“y”} \mid \text{“z”} \\
 \langle method_call \rangle &::= \langle identifier \rangle \text{“("} \langle name \rangle [\text{“,”} \langle name \rangle] \dots \text{“)”}
 \end{aligned}$$

- Suppose that L is a context-free language. Suppose that L is generated by the CFG G , where $G = (V, \Sigma, P, S)$. Show how to construct from G a CFG that generates the language L^* . Explain why your construction works; you do not have to give a proof. (This shows that for any context-free language L , L^* is also context-free.)