Albert-Ludwigs-Universität, Inst. für Informatik
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Theoretical Computer Science - Bridging Course
Summer Term 2018
Exercise Sheet 3

for getting feedback submit electronically by 06:00 am, Friday, May 11th, 2018

Exercise 1: Regular Expresions *(6 Points)*

Give a regular expression for each of the following three languages.

(a) $L_1 = \{w_1 w_2 w_3 \mid w_1, w_2, w_3 \in \{a, b, c\}^*,\ w_1 \text{ contains no } a,\ w_2 \text{ contains no } b,\ w_3 \text{ contains no } c\}$

(b) $L_2 \subseteq \{a, b\}^*$ is the language of all words that do not have any of the words in $\{aaa, aaaa, \ldots\}$ as a consecutive substring.

(c) L_3 is the language, over alphabet $\{a, b\}$, of all strings not ending with aa.

Exercise 2: The Pumping Lemma: Sufficiency or Necessity? *(4 Points)*

Consider the language $L = \{c^m a^n b^n \mid m, n \geq 0\} \cup \{a, b\}^*$ over the alphabet $\Sigma = \{a, b, c\}$.

(a) Describe in words (not using the pumping lemma), why L cannot be a regular language.

(b) Show that the property described in the Pumping Lemma is a necessary condition for regularity but not sufficient for regularity.

Hint: Use L as counter example, i.e., show that it can be 'pumped' (in the sense of the pumping lemma), but is still not regular.

Exercise 3: Application of The Pumping Lemma *(6 Points)*

Show that the following languages over the alphabet $\Sigma = \{a, b\}$ are not regular:

(a) $L = \{a^m \mid \text{m is a square number}\}$ *(m being a square number means that $m = n^2$ for some non negative integer n)*

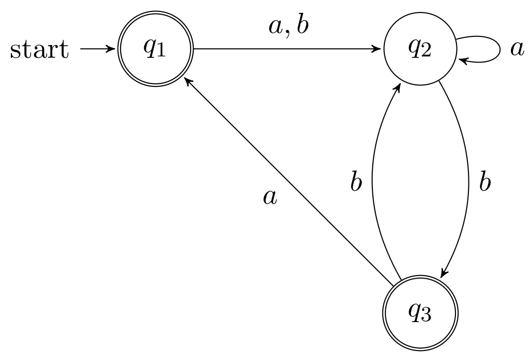
Hint: Use the Pumping Lemma.

(b) $L = \{a^m b^n \mid m \neq n\}$

Hint: Have a look at the languages $\{a^n b^n \mid n \in \mathbb{N}\}$ and $a^* b^*$ and use the fact that the class of regular languages is closed under intersection, complement, concatenation and the Kleene star.

Exercise 4: NFAs to Regular Expressions *(4 Points)*

Consider the following NFA:



Give the regular expression defining the language recognized by this NFA by *stepwise* converting it into an equivalent GNFA with only two nodes.