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Exercises to the lecture
Concurrency Theory
Sheet 6

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Peter Chini Delivery until 14.01.2020 at 12:00

Exercise 6.1 (Well Quasi Orderings?)
Prove or disprove that the following are well quasi orderings:

a) The quasi ordering $(\mathbb{N}, |)$, where $a \mid b$ means that a divides b.

b) The quasi ordering $(Bin, <_{lex})$. Here $Bin = \{0,1\}^*$ is the set of all binary strings and $<_{lex}$ is the lexicographical ordering, defined by:

$u <_{lex} v$ if and only if u is a prefix of v or the first symbol $u[\ell]$ that does not coincide with $v[\ell]$ satisfies $u[\ell] < v[\ell]$.

Note that $u[\ell]$ refers to the ℓ-th symbol of u.

c) The colexicographical ordering $(Bin, <_{colex})$ defined by:

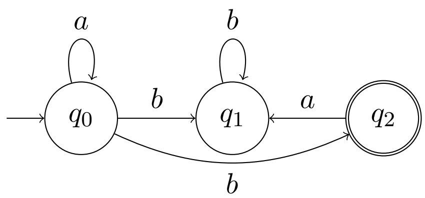
$u <_{colex} v$ if and only if u is a postfix of v or the last symbol $u[\ell]$ that does not coincide with $v[\ell]$ satisfies $u[\ell] < v[\ell]$.

Exercise 6.2 (Upward and Downward closed sets)
Let Σ be a finite alphabet. From the lecture we know that $(\Sigma^*, \leq)$ is a well quasi ordering, where $\leq$ is the subword relation.

a) Let L be a regular language over Σ. Explain how to construct a finite automaton for the upward closure $L\uparrow$.

b) Let L be any language in Σ^*. Show that $L\uparrow$ and $L\downarrow$ are regular.

Exercise 6.3 (Downward closure of a regular language)
Let the following automaton A be given:



Give an automaton for the language $L(A)\downarrow$.

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