

# Fundamentals of Computer Science, Spring 2014

## Assignment 5

Due date: March 11, 2014

### Mandatory exercises

1) The *state-use problem* is the following. Given a Turing machine  $M$ , a state  $q$  of  $M$  and an input  $w$  of  $M$ , answer whether  $M$ , when started with input  $w$ , will ever enter the state  $q$ .

Argue that the state-use problem is undecidable.

2) Suppose that  $A \leq_m B$ , i.e., that  $A$  is reducible to  $B$ . Argue that  $\overline{A} \leq_m \overline{B}$ , where  $\overline{A}$  is the compliment of  $A$  and  $\overline{B}$  is the compliment of  $B$ .

### Voluntary exercises (for higher grades than 3)

3) The *CFG containment problem* is the following: Given a context-free grammar  $G$  and another context-free grammar  $H$ , is the language of  $G$  a subset of the language of  $H$ ? In other words, does  $L(G) \subseteq L(H)$  hold?

The *CFG universality problem* is the following: Given a CFG  $G$  with terminal alphabet  $T$ , is the language of  $G$  all the words over  $T$ ? In other words, does  $L(G) = T^*$  hold?

Describe a reduction from the CFG universality problem to the CFG containment problem.