

## Homework 12 – Due Thursday, Apr. 28, 2016 before the lecture

Please refer to the general information handout for the full homework policy and options. This homework contains 3 problems, worth 10 points each. *Your solution to each problem should be handed in on a separate sheet of paper.*

**Reminder** Collaboration is permitted, but you must write the solutions *by yourself without assistance*, and be ready to explain them orally to the instructor if asked. You must also identify your collaborators. Getting solutions from outside sources such as the Web or students not enrolled in the class is strictly forbidden.

**Problems** Please practice on exercises and problems in Chapter 8: namely, 8.1-8.4, 8.6, 8.8, 8.11, 8.16. The material they cover may appear on exams.

1. (**Final practice**) Please enter the answer to this problem on Angel. It will be graded automatically.

Choose **T**, **F** or **U** for each of the following statements to indicate whether the statement is true, false or it is unknown whether it is true or false. (**On the final, you will be asked to justify your answers. But for this problem, we are just asking you to choose T, F or U.**)

- T F U** One **cannot** write a C++ program that, given a Boolean formula, outputs whether this formula has a satisfying assignment.
- T F U**  $\text{NSPACE}(n^5) \subseteq \text{PSPACE}$ .
- T F U** If we defined P with respect to multitape Turing machines instead of single-tape Turing machines, it would contain more languages.
- T F U** If we defined P with respect to nondeterministic Turing machines instead of deterministic Turing Machines, it would contain more languages.
- T F U**  $\text{PRIMES}^*$  is in P, where  $*$  denotes the *star* operation on languages.
- T F U**  $\{ww^R \mid w \in \{0,1\}^*\} \leq_P 0^*1^*$ .
- T F U**  $\text{CLIQUE}$  is NP-hard
- T F U**  $A_{\text{TM}}$  is NP-hard
- T F U**  $\text{TQBF}$  is NP-hard
- T F U**  $P \subseteq \text{TIME}(n^5)$ .

2. (**EQ<sub>NFA</sub>**) Recall that  $\text{EQ}_{\text{NFA}} = \{N_1, N_2 \mid N_1 \text{ and } N_2 \text{ are NFAs and } L(N_1) = L(N_2)\}$ . Show that  $\text{EQ}_{\text{NFA}}$  is in PSPACE.

3. (**A<sub>LBA</sub>**) Sipser, 8.13.

*Hint for the reduction:* How much space is needed to decide TQBF? Can it be decided with an LBA?