

## Study Sheet Exam 2

This exam will assume you know the material covered in lecture-recitation-homework-programming until 2016-11-04 and the recitation of 2016-11-08. The focus will be on the Chapter 1, Chapter 3, Chapter 4 and parts of Chapter 5 of the textbook.

In particular, you have to be able to:

- Be comfortable with all the concepts appearing on the study sheet exam 1.
- Prove closure properties of regular languages (union, intersection, complement, reversal).
- State the pumping lemma.
- Use the pumping lemma to prove or disprove that a language is regular.
- Use closure properties to prove or disprove that a language is regular.
- Trim an automaton.
- Minimize an automaton. Define the minimization using  $\equiv_k$ .
- Define transducers use them to solve problems.
- Give the definition of a Turing Machine.
- Give the definition of Turing-recognizable (semidecidable), decidable, undecidable language.
- Write Turing machines that decide, semidecide a given language or compute a function.
- Explain the Church-Turing thesis.
- Define extensions of Turing machines such as multiple-tape Turing machines, multiple-head Turing machines, two-way infinite tape Turing machines, Nondeterministic Turing machines and for each of them explain their equivalence with standard Turing machines (with the associated complexity analysis).
- Define decide and semidecide for NTMs.
- Define a Universal Turing Machine.
- Prove that  $A_{TM}$  is undecidable.
- Prove that a given language/problem is decidable or undecidable using reduction or other proof techniques (e.g.  $E_{TM}$ ,  $REGULAR_{TM}$ ,  $EQ_{TM}$ ,  $HALT_{TM}$ ).