Midterm Exam 1 Study Guide

CSE 30151 Spring 2022

Exam Date: February 10, 2022

Instructions

- The exam will be worth a total of 90 points, or 15% of your final grade.
- You will have the whole class period of 75 minutes to write your solutions.
- You may consult the following materials during the exam: the Sipser textbook, your notes, and homework solutions. All of these materials must be printed on paper. If you have a digital copy of the textbook, you must print out any sections you want to use beforehand.
- The following materials may *not* be used during the exam: solutions to problems taken from the Internet; any electronic devices (including smart watches, phones, tablets, computers, and other Turing-equivalent machines).
- You may re-use any theorems or proofs provided in class, in the textbook, or in the homework assignments. If you re-use a theorem or proof from the textbook not used in class, please cite the page number. Example: (Sipser p. 42).
- If you think any problem contains typos or is unclear, please ask the instructor for clarification.

Topics

This exam covers HW1, HW2, and regular expressions (including converting to/from finite automata). It does not cover the Myhill-Nerode theorem, DFA minimization, the pumping lemma, or non-regular languages.

The exam may include any of the following topics or types of question:

- Given a language, design a DFA or NFA that recognizes it. Your solutions do not need to have the minimal number of states. You do not need to label states.
- Given a language, write a regular expression that describes it. Since we have not covered regular expressions in the homework assignments, it is recommended that you attempt the practice problems given below. You may use any of the syntax extensions used in class or in the textbook, including using Σ as shorthand for the union of all symbols in the alphabet. Note that regular expressions do *not* have operators for complement or intersection.
- Convert an NFA to a DFA. In your solution, you may omit any states that are not reachable from the start state.
- Convert a regular expression to an NFA using the standard constructions from the textbook and class.

- Convert a DFA/NFA to a GNFA to a regular expression. You do not need to draw transitions on $\emptyset$ in the GNFA, and you may simplify expressions during the conversion process as you see fit.
- Proofs about regular languages, finite automata, regular expressions, or closures on regular languages.

Practice Problems

- Design a DFA or NFA. Book problems: 1.4–7.
- Design a regular expression. Book problems: 1.18 (solutions provided on next page).
- Proofs about regular languages. Book problems: 1.11 (single accept state), 1.40a (intl. 1.45a), 1.44 (intl. 1.34), 1.66a (intl. 1.60a).
  - Prove that all finite languages are regular. (We will prove this during the review session.)
  - Prove that regular languages are closed under reversal (book problem 1.31 (intl. 1.46)). (We will prove this during the review session.)

Solutions to Selected Exercises

1.18 (a) $\mathtt{1}\Sigma^*\mathtt{0}$

(b) $\Sigma^*\mathtt{1}\Sigma^*\mathtt{1}\Sigma^*\mathtt{1}\Sigma^*$

(c) $\Sigma^*\mathtt{0101}\Sigma^*$

(d) $\Sigma\Sigma\mathtt{0}\Sigma^*$

(e) $(\mathtt{0} \cup \mathtt{1}\Sigma)(\Sigma\Sigma)^*$

(f) $\mathtt{0}^*(\mathtt{100}^*)^*\mathtt{1}^*$

(g) $(\Sigma \cup \epsilon)(\Sigma \cup \epsilon)(\Sigma \cup \epsilon)(\Sigma \cup \epsilon)(\Sigma \cup \epsilon)$

(h) $\Sigma^*\mathtt{0}\Sigma^* \cup \epsilon \cup \mathtt{1} \cup \mathtt{11111}^*$

(i) $(\mathtt{1}\Sigma)^*(\mathtt{1} \cup \epsilon)$

(j) $\mathtt{0}^*(\mathtt{00} \cup \mathtt{100} \cup \mathtt{010} \cup \mathtt{001})\mathtt{0}^*$

(k) $\epsilon \cup \mathtt{0}$

(l) $\mathtt{1}^*(\mathtt{01}^*\mathtt{01}^*)^* \cup \mathtt{0}^*\mathtt{10}^*\mathtt{10}^*$

(m) $\emptyset$

(n) $\Sigma\Sigma^*$