

CSCI 4325
Review 1

Problem 1: What is the minimum number of shots needed to guarantee hitting a battleship (a 4×1 rectangle) on a 10×10 board? The battleship can be located anywhere on the board and may be oriented either horizontally or vertically. You may assume that there are no other ships. A “shot” is a blind guess of a square on the board.

Problem 2: Give state diagrams of DFAs recognizing the following languages. The alphabet is $\Sigma = \{0,1\}$.

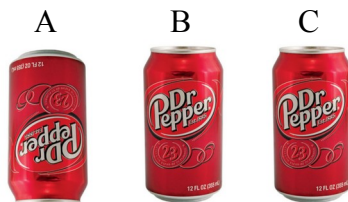
- (a) $L_1 = \{w \mid \text{every odd position of } w \text{ is a } 1\}$
- (b) $L_2 = \{w \mid w \text{ contains an odd number of } 0\text{'s, or exactly two } 1\text{'s}\}$

Problem 3: Give a state diagram of a DFA recognizing the following language.

- (a) $Id = \{w \mid w \text{ is a string beginning with } A\dots Z, a\dots z \text{ and followed by any character in the alphabet}\}$. The alphabet is $\Sigma = \{0\dots 9, A\dots Z, a\dots z\}$
- (b) $Num = \{w \mid w \text{ contains } 0\dots 9\}$, The alphabet is $\Sigma = \{0, \dots, 9\}$.
- (c) $Semicolon = \{w \mid w \text{ is the string } \text{' ; '}\}$, The alphabet is $\Sigma = \{ ; \}$.
- (d) $And = \{w \mid w \text{ is the string } \text{' \& \& '}\}$, The alphabet is $\Sigma = \{ \& \}$.
- (e) $While = \{w \mid w \text{ is the string } \text{' while '}\}$, The alphabet is $\Sigma = \{w, h, i, l, e\}$

Problem 4: For Problem 3, can you combine the languages, and then determine after scanning a word which language it belongs to? Why not? Is there a workaround based on looking ahead?

Problem 5: Suppose there are three cans of soda (obviously Dr. Pepper, otherwise just throw them in the trash), which we'll label A, B, and C. You notice that can A is upside down. If you are required to flip two cans at a time, can you get all the cans facing right-side up in no more than 6 moves? If yes, give the sequence. If not, prove that it can't be done. Make a DFA to support your answer.



Problem 6: First, design NFAs to recognize the following regular languages, and then convert the NFAs to DFAs.

- (a) $(a \cup b)^* abb(a \cup b)^*$
- (b) $((aa)^* (bb) \cup ab)^*$
- (c) $(ab)^* a(ba)^*$
- (d) $(b(aaaaa)^* bb \cup bab)$
- (e) Give a description (english) of the languages accepted by (c) and (d).

Problem 7: Give a regular expression for the following, and then convert the expressions to NFAs.

- (a) $A = \{w \mid w \text{ has two } 0\text{'s}\}$ where $\Sigma = \{0,1\}$
- (b) $B = \{w \mid w \text{ ends in "txt"}\}$ where $\Sigma = \{a,b,\dots,z\}$
- (c) $C = \{w \mid w \text{ starts with "aa" and ends with any number of "z"s}\}$ where $\Sigma = \{a,b,\dots,z\}$
- (d) $D = \{w \mid w \text{ is a string representing an even binary number}\}$ where $\Sigma = \{0,1\}$