

CS 150 (Closed-book) Midterm Test I

Oct. 29, Wednesday, 7:10-7:50pm, 2025

Total: 40 points

Name:

UCR Net ID:

QUESTION 1. [10 pts] Design a DFA to accept the following language:

$$L = \{x \mid x \in \{0,1\}^*, x \text{ contains at least one 0 and at most two 1's}\}$$

Answer:

In the following DFA, the subscripts a, b in state $q_{a,b}$ count the numbers of 0's and 1's in the input string, respectively.

	0	1
$\rightarrow q_{0,0}$	$q_{1,0}$	$q_{0,1}$
$*q_{1,0}$	$q_{1,0}$	$q_{1,1}$
$q_{0,1}$	$q_{1,1}$	$q_{0,2}$
$*q_{1,1}$	$q_{1,1}$	$q_{1,2}$
$q_{0,2}$	$q_{1,2}$	q_{dead}
$*q_{1,2}$	$q_{1,2}$	q_{dead}
q_{dead}	q_{dead}	q_{dead}

Either a state diagram or table would be acceptable. Give partial credits for DFAs with some relevant properties. *E.g.*, we may deduct 2 or 3 pts for mis-handling the dead state.

QUESTION 2. [10 pts] Design an NFA or DFA to accept the following language:

$$L = \{x \mid x \in \{0,1\}^*, x \text{ represents a binary number that is greater than } 7\}$$

Hint: For example, L contains strings 1000, 0010010 and 011011, but it does not contain strings 111, 000011 and 00110. You may want to consider the position (counting from the right) of the leftmost 1 in such binary numbers.

Answer:

The following NFA checks if the input contains a 1 bit that is at least four positions away from the end:

	0	1
$\rightarrow q_0$	$\{q_0\}$	$\{q_0, q_1\}$
q_1	$\{q_2\}$	$\{q_2\}$
q_2	$\{q_3\}$	$\{q_3\}$
q_3	$\{q_4\}$	$\{q_4\}$
*q_4	$\{q_4\}$	$\{q_4\}$

Note that the answer may not be unique. The nondeterminism on state q_0 can also be removed to make the model a DFA. In this case, the DFA checks if the first 1 bit in the input is at least four positions away from the end. Give partial credits for relevant constructs.

QUESTION 3. [10 pts] Convert the following NFA to a DFA:

	0	1
$\rightarrow q_0$	$\{q_1\}$	$\{q_0, q_2\}$
$*q_1$	$\{q_0, q_2\}$	$\{q_2\}$
q_2	$\{q_1, q_2\}$	$\emptyset$

Answer:

	0	1
$\rightarrow \{q_0\}$	$\{q_1\}$	$\{q_0, q_2\}$
$*\{q_1\}$	$\{q_0, q_2\}$	$\{q_2\}$
$\{q_2\}$	$\{q_1, q_2\}$	$\emptyset$
$\{q_0, q_2\}$	$\{q_1, q_2\}$	$\{q_0, q_2\}$
$*\{q_1, q_2\}$	$\{q_0, q_1, q_2\}$	$\{q_2\}$
$*\{q_0, q_1, q_2\}$	$\{q_0, q_1, q_2\}$	$\{q_0, q_2\}$
$\emptyset$	$\emptyset$	$\emptyset$
$*\{q_0, q_1\}$	$\{q_0, q_1, q_2\}$	$\{q_0, q_2\}$

It's okay to exclude/include the inaccessible state $\{q_0, q_1\}$. Give partial credits for correct steps. Deduct 1 pt for missing the state $\emptyset$.

QUESTION 4. [10 pts] Give a regular expression for the following language:

$$L = \{x \mid x \in \{0,1\}^*, x \text{ does not end with } 101\}$$

Answer:

$$(0+1)^*0 + (0+1)^*11 + (0+1)^*001 + 01 + 1 + \epsilon$$

The regex is not unique. Give partial credits for regex's containing some correct components.