

CSE 311: Foundations of Computing I

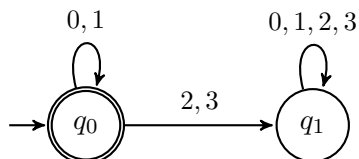
Section : FSMs and NFAs Solutions

1. DFAs, Stage 1

Construct DFAs to recognize each of the following languages. Let $\Sigma = \{0, 1, 2, 3\}$.

(a) All binary strings.

Solution:

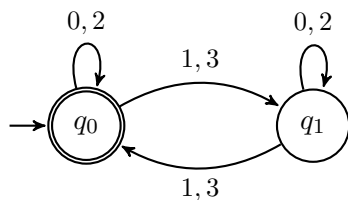


q_0 : binary strings

q_1 : strings that contain a character which is not 0 or 1.

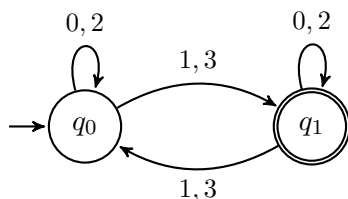
(b) All strings whose digits sum to an even number.

Solution:



(c) All strings whose digits sum to an odd number.

Solution:

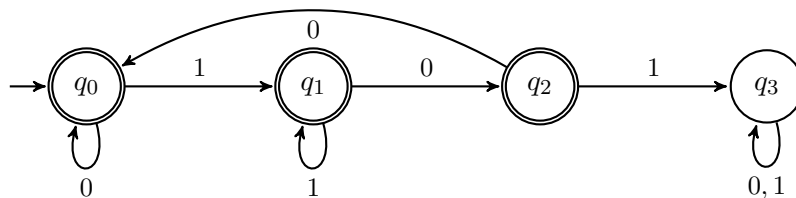


2. DFAs, Stage 2

Construct DFAs to recognize each of the following languages. Let $\Sigma = \{0, 1\}$.

(a) All strings which do not contain the substring 101.

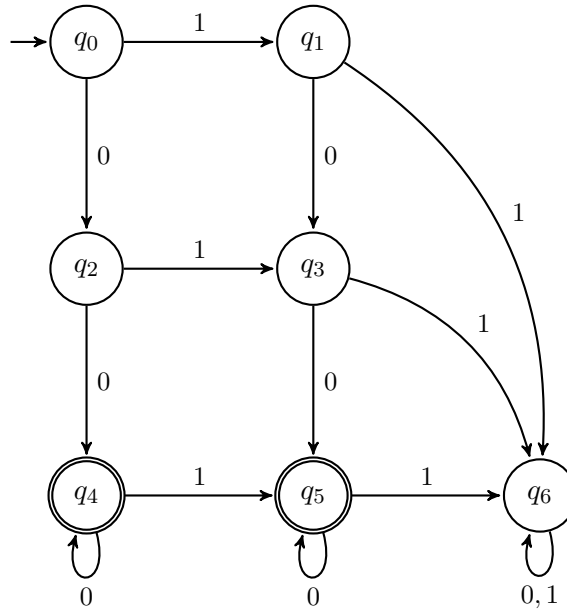
Solution:



- q_3 : strings that contain 101.
- q_2 : strings that don't contain 101 and end in 10.
- q_1 : strings that don't contain 101 and end in 1.
- q_0 : ϵ , 0, strings that don't contain 101 and end in 00.

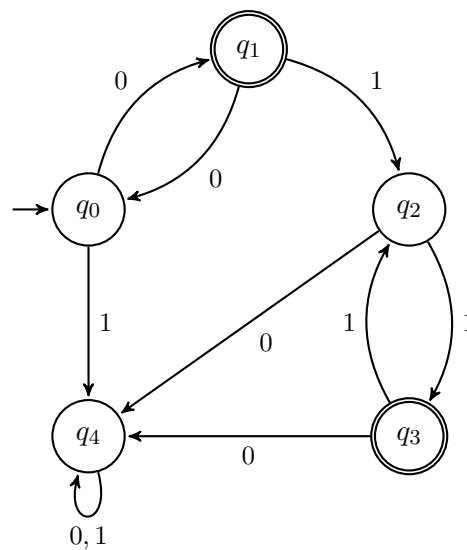
(b) All strings containing at least two 0's and at most one 1.

Solution:



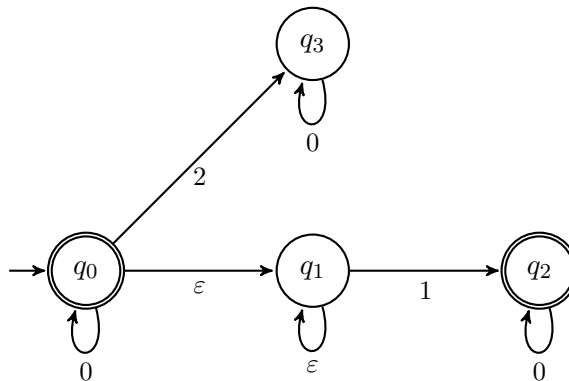
(c) All strings containing an even number of 1's and an odd number of 0's and not containing the substring 10.

Solution:



3. NFAs

(a) What language does the following NFA accept?



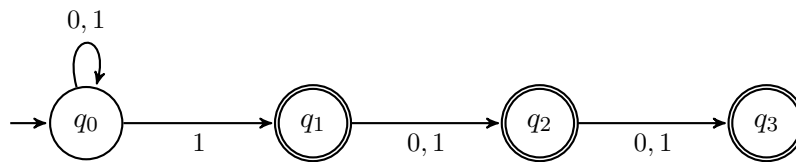
Solution:

All strings of only 0's and 1's not containing more than one 1.

(b) Create an NFA for the language "all binary strings that have a 1 as one of the last three digits".

Solution:

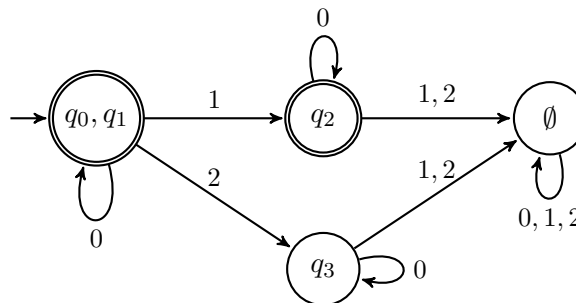
The following is one such NFA:



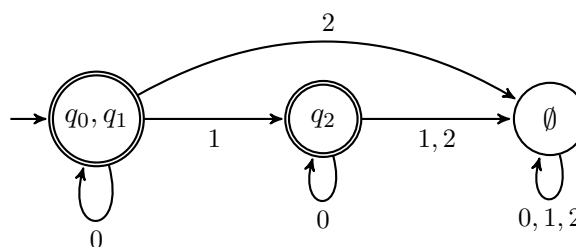
4. DFAs & Minimization

(a) Convert the NFA from 3a to a DFA, then minimize it.

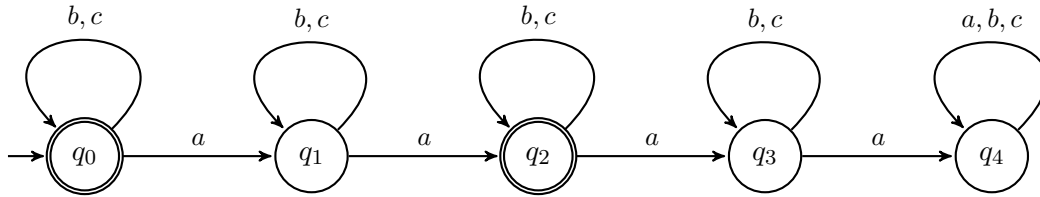
Solution:



Here is the minimized form:



(b) Minimize the following DFA:



Solution:

Step 1: q_0, q_2 are final states and the rest are not final. So, we start with the initial partition with the following groups: group 1 is $\{q_0, q_2\}$ and group 2 is $\{q_1, q_3, q_4\}$.

Step 2: q_1 is sending a to group 1 while q_3, q_4 are sending a to group 2. So, we divide group 2. We get the following groups: group 1 is $\{q_0, q_2\}$, group 3 is $\{q_1\}$ and group 4 is $\{q_3, q_4\}$.

Step 3: q_0 is sending a to group 3 and q_2 is sending a to group 4. So, we divide group 1. We will have the following groups: group 3 is $\{q_1\}$, group 4 is $\{q_3, q_4\}$, group 5 is $\{q_0\}$ and group 6 is $\{q_2\}$.

The minimized DFA is the following:

