Q1 Finite State Automata

5 Points

The following questions concern both deterministic and non-deterministic finite state automata.

Q1.1 Finite state machine basics

1 Point

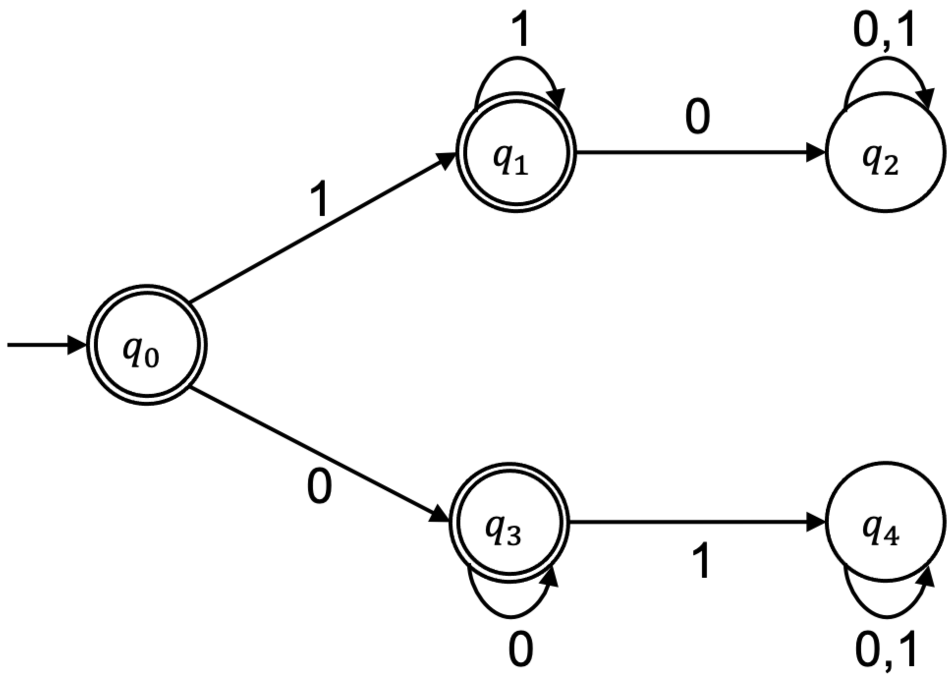
From the following statements select all that are true.

- [x] The alphabet of a finite state machine is finite.
- [ ] A finite state machine must have an accepting state.
- [ ] A finite state machine may have more than one start state.
- [ ] The empty string (ϵ) is accepted by every finite state machine.
- [x] A finite state machine may either $accept$, $reject$ or $decline$ a string.
- [ ] A finite state machine accepts a string when the machine transitions to an accepting state.
- [x] A finite state machine will terminate on every input.The following questions concern both deterministic and non-deterministic finite state automata.

Q1.2 Finite state machine diagrams

1 Point

Consider the following finite state automata with alphabet $\Sigma = \{1, 0\}$.



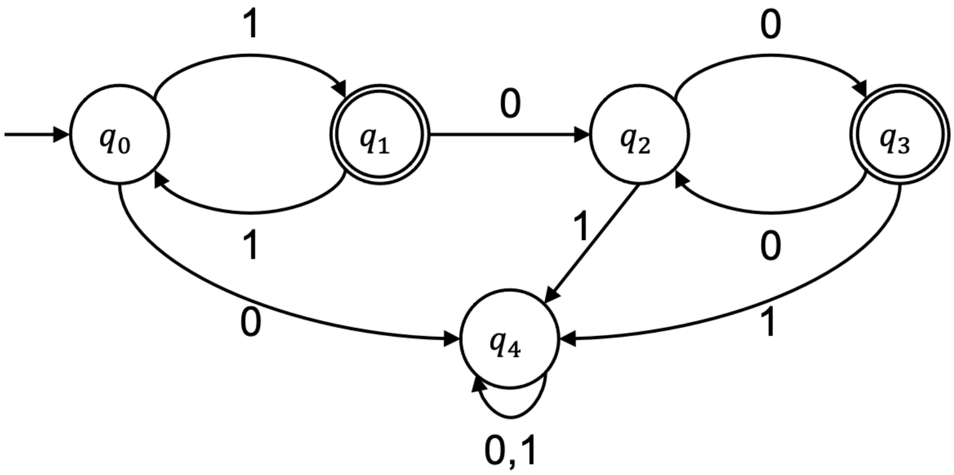
From the following statements select all that are true.

- [x] q_0 is the start state.
- [ ] The language of the machine is empty.
- [ ] The machine is non-deterministic.
- [x] The machine accepts the empty string (ϵ).
- [x] The machine accepts all strings over $\{0, 1\}^*$ containing neither the substring 10 nor 01.
- [ ] The alphabet of the machine is $\{0, 1, \epsilon\}$.
- [ ] The machine accepts all strings of even length.
- [x] q_0, q_1, and q_3 are "accept" states.

Q1.3 Acceptance of strings

1 Point

Consider the following deterministic finite state automata.



Which of the following strings are in the language of the above machine?

- [ ] 0
- [ ] ϵ
- [x] 111
- [x] 100000000
- [x] 11111111111
- [ ] 11100101

Q1.4 Non-deterministic finite state machine basics

1 Point

Which of the following statements about non-deterministic finite state automata are true?

- [x] A deterministic finite state automata is a non-deterministic finite state automata.
- [x] For every non-deterministic finite state automata there exists a deterministic finite state automata that is equivalent.
- [x] The codomain of the transition function is the powerset of the set of states.
- [x] The set of accepting states maybe empty.
- [ ] A non-deterministic finite automata accepts a string if and only if every computation terminates in an accepting state.
- [ ] A non-deterministic finite automata always accepts the empty string.
- [ ] A non-deterministic finite automata may have many initial states.

Q1.5 Finite state machine design

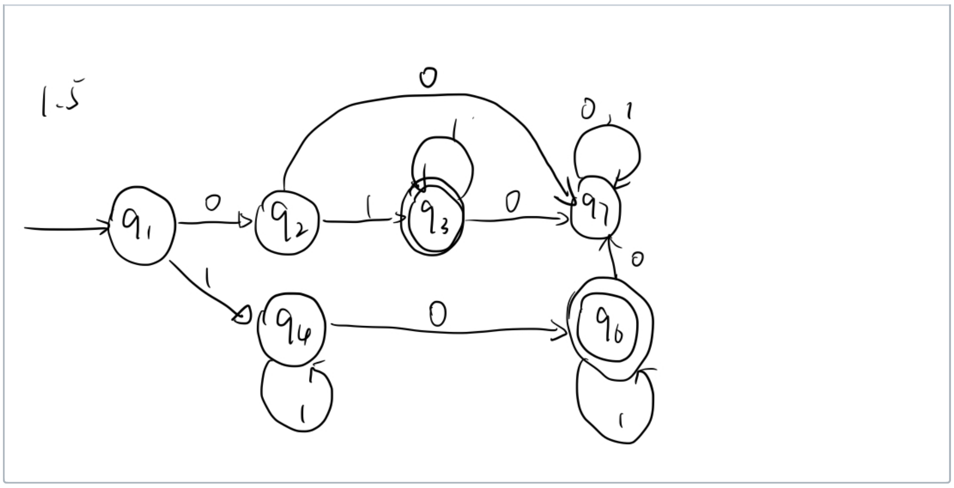
1 Point

Design a deterministic finite state machine that accepts the following language.

$$\{w \in \{0,1\}^* \mid w \text{ contains at least one 1 and exactly one } 0\}$$

Provide a finite state automata diagram of your machine.

▾ 1.5.png Download



Q2 Regular Languages

5 Points

Q2.1 Regular languages

1 Point

Which of the following languages are regular languages?

- [ ] $\{w \in \{0,1\}^* \mid w \text{ is a palindrome}\}$
- [x] $\{\epsilon\}$
- [x] $\{w \in \{a,b,c\}^* \mid abc \text{ is not a substring of } w\}$
- [x] $\{w \in \{0,1\}^* \mid |w| > 7\}$
- [x] $\{w_1 abba w_2 \mid w_1 \in \{0,1\}^*, w_2 \in \{0,1\}^*\}$
- [ ] $\{0^n 1^l 0^k \mid k \leq n + l\}$
- [x] $\{w \mid w \in (A \cup B) \wedge w \in C\}$ where A, B, C are regular languages.

Q2.2 Properties of regular languages

1 Point

Which of the following are properties of regular languages?

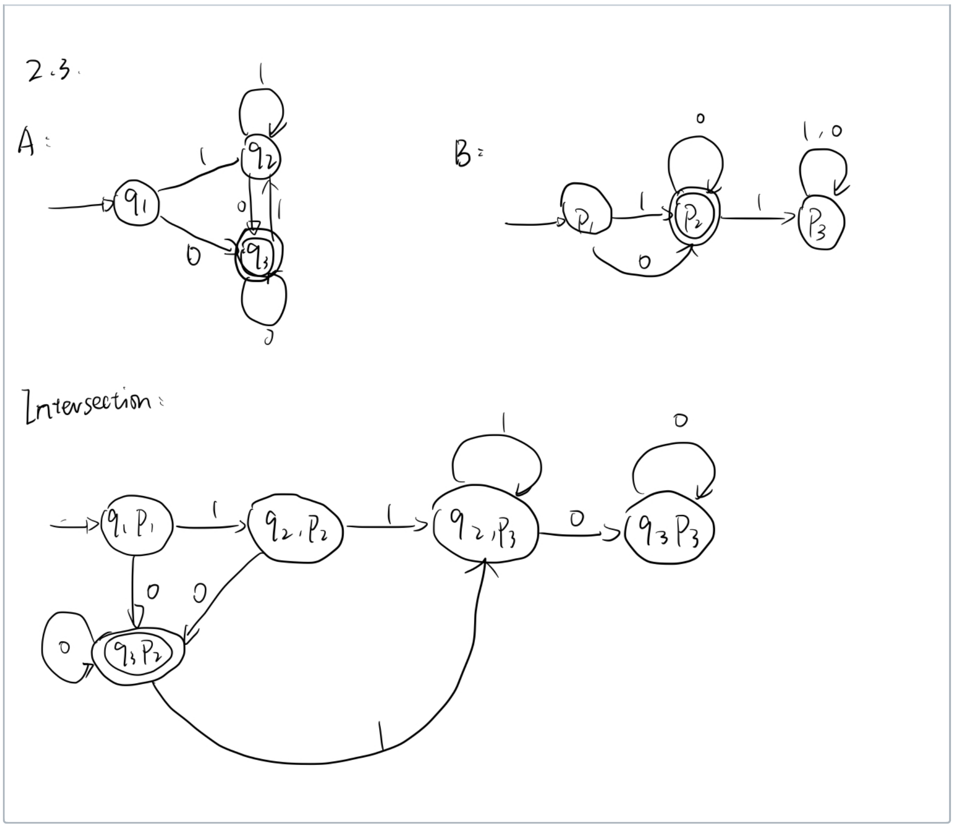
- [ ] For every regular language there exists a non-deterministic finite state automata with 3 states that recognises it.
- [x] For every regular language there exists a minimal deterministic finite state machine that recognises it.
- [ ] There exists a regular language such that no non-deterministic finite state machine recognises it.
- [x] For every two regular languages A and B we have that $\{w_1 w_2 \mid w_1 \in A \wedge w_2 \in B\}$ is regular.
- [x] Regular languages are closed with respect to every binary operator.

Q2.3 Intersection of regular languages

2 Points

Using the intersection closure property of regular languages, provide a diagram of a finite state machine that recognises $A \cap B$, where $\Sigma = \{0, 1\}$,
$A = \{w \mid w \text{ ends with a } 0\}$, and
$B = \{w \mid w \text{ has at most one } 1\}$.

▾ 2.3.png Download



Q2.4 Pumping lemma

1 Point

Which of the following statements are true.

- [x] The pumping lemma applies to all regular languages.
- [x] Given a regular language A, every $w \in A$ can be "pumped".
- [x] Let A be a regular language and let $w \in A$ such that $|w| \geq p$, where p is the pumping length. Let xyz be a division of w as described in the pumping lemma, then $xz \in A$.
- [x] Let A be a regular language and let $w \in A$ such that $|w| \geq p$, where p is the pumping length. Let xyz be a division of w as described in the pumping lemma, then $xy^{11}z \in A$.
- [ ] The pumping lemma proves all languages are regular.

Q3 Generalised finite state automata descriptions

5 Points

Let $L_n = \{0^k \mid k \mod n = 0\}$. Prove that L_n is a regular language for every $n \in \mathbb{N}$.

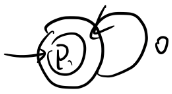
Alternatively you may upload a pdf of your answer.

3.PNG Download

3.

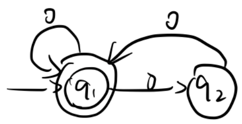
Whatever the value of n, we can find an automata to accept the language.

when $n=1$, $k \bmod n = 0 \Rightarrow k \in N$,



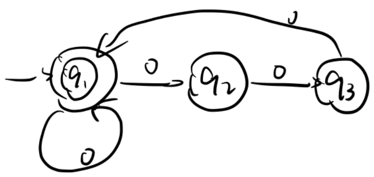
can accept it.

when $n=2$, $k \bmod n = 0 \Rightarrow k \in 2N$



can accept it

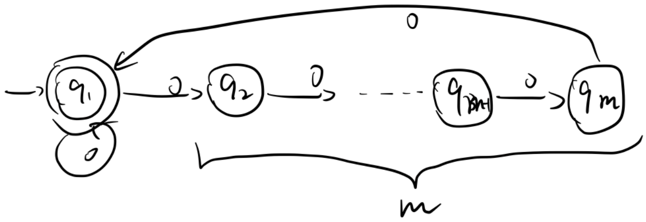
when $n=3$, $k \bmod n = 0 \Rightarrow k \in 3N$



can accept it

⋮

when $n=m$, $m \in N$, $k \bmod n = 0 \Rightarrow k \in mN$



So, L_n is a regular language for every $n \in N$

Q4 Taking advantage of non-determinism

5 Points

Prove the following statement.

For every deterministic finite state automata there exists a equivalent non-deterministic finite state automata with exactly one accepting state.

Alternatively you may upload a pdf of your answer.

4.png

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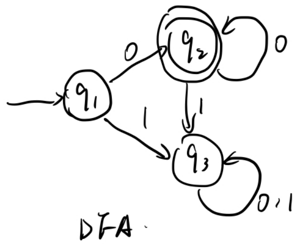
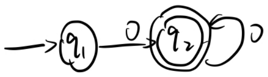
4. We can design a DFA to accept a string only containing 0 where $\Sigma = \{0,1\}$.



DFA.

And we can find a equivalent NFA with DFA



NFA

According to the theorem we know that DFA is equal to NFA. so in this diagram we know that there is only 1 accept in it, and also only 1 accepting state in NFA.

Coursework 1 - Regular Languages & Finite State Automata

UNGRADED

STUDENT

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TOTAL POINTS

- / 20 pts

QUESTION 1

Finite State Automata — 5 pts

1.1	Finite state machine basics	1 pt
1.2	Finite state machine diagrams	1 pt
1.3	Acceptance of strings	1 pt
1.4	Non-deterministic finite state machine basics	1 pt
1.5	Finite state machine design	1 pt

QUESTION 2

Regular Languages — 5 pts

2.1	Regular languages	1 pt
2.2	Properties of regular languages	1 pt
2.3	Intersection of regular languages	2 pts
2.4	Pumping lemma	1 pt

QUESTION 3

Generalised finite state automata descriptions — 5 pts

QUESTION 4

Taking advantage of non-determinism — 5 pts