**St. Francis Xavier University**
**Department of Computer Science**

# CSCI 356: Theory of Computing
# Assignment 1
# Due October 1, 2021 at 11:15am

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**Assignment Regulations.**

- This assignment may be completed individually or in a group of up to four people. If you are collaborating on an assignment as a group, your group must submit exactly one joint set of answers.
- Please include your full name and email address on your submission. For groups, every member must include their full name and email address on the joint submission.
- You may either handwrite or typeset your submission. If your submission is handwritten, please ensure that the handwriting is neat and legible.

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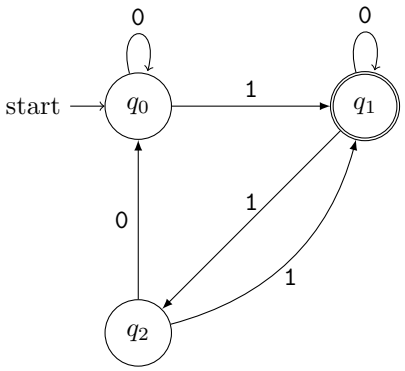
[6 marks] 1. For each of the following languages over the alphabet $\Sigma = \{\texttt{0}, \texttt{1}\}$, show how to define the language using only the empty word $\epsilon$, the symbols `0` and `1`, and the operations of union ($\cup$), concatenation ($\cdot$), and Kleene star ($^*$).

(a) $L_1 = \{w \mid w \text{ contains } \texttt{01101001} \text{ as a subword}\}$.

(b) $L_2 = \{w \mid |w| \text{ is even}\}$. (Note that zero is an even number.)

(c) $L_3 = \{w \mid w \text{ begins with } \texttt{0}, \text{ ends with } \texttt{0}, \text{ and does not contain } \texttt{010} \text{ as a subword}\}$.

[6 marks] 2. Consider the following finite automaton.

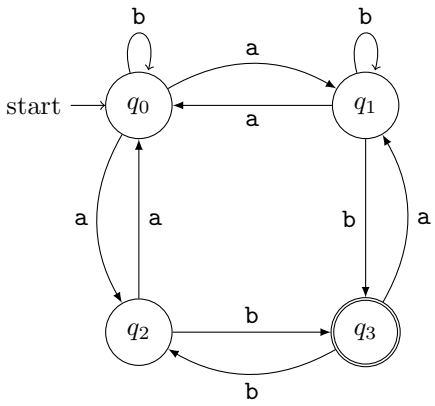



(a) Give three examples of input words accepted by this finite automaton, and give three examples of input words rejected by this automaton.

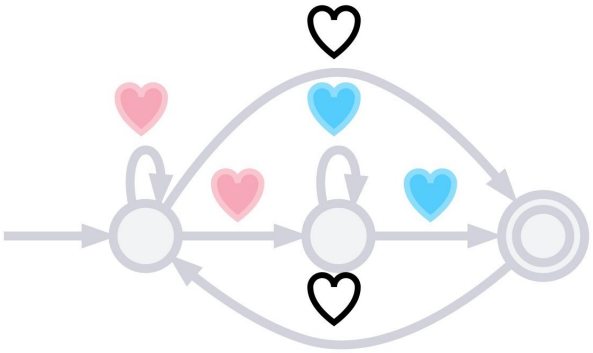
(b) Draw the transition table corresponding to this finite automaton.

(c) What language does this finite automaton recognize?
*Hint.* You may be able to identify a pattern by writing out all binary words up to a certain length (say, 4) and checking which words are accepted/rejected.

[8 marks] 3. Given the following nondeterministic finite automaton $\mathcal{M}$, convert it to a deterministic finite automaton $\mathcal{M}'$ recognizing the same language. Show all your work in addition to giving the deterministic finite automaton.




[5 marks] 4. The Twitter account @happyautomata (`https://twitter.com/happyautomata`) automatically generates examples of finite automata over both the English alphabet and the "emoji alphabet". An example of an "emoji automaton" is shown below:



Visit the Twitter account, choose your favourite "emoji automaton" with at least three states, and convert the finite automaton to an equivalent regular expression. Show all your work in addition to giving the regular expression.

If you don't use Twitter, then you are welcome to use the above "emoji automaton" to form your answer.

If you don't wish to use emoji in your regular expression (or you can't get it to work nicely), you can convert emoji to letters; for example, 💙 = `b`, ❤️ = `p`, and 🤍 = `w`.