CS 374 Midterm 1

Aldo Sanjoto

TOTAL POINTS

52 / 140

QUESTION 1

1 Multiple choice 14 / 20

- 0 pts Correct
- ✓ - 2 pts **1.A Incorrect**
- ✓ - 2 pts **1.B Incorrect**
- 2 pts 1.C Incorrect
- 2 pts 1.D Incorrect
- ✓ - 2 pts **1.E Incorrect**
- 2 pts 1.F Incorrect
- 2 pts 1.G Incorrect
- 2 pts 1.H Incorrect
- 2 pts 1.I Incorrect
- 2 pts 1.J Incorrect

QUESTION 2

Regular or not? 25 pts

2.1 Part (A) 10 / 10

- ✓ - 0 pts **Correct**
- 4 pts Incorrect answer for regularity
- 6 pts [Regularity] Wrong proof
- 6 pts [Non-regularity] Wrong proof
- 2 pts Minor mistake in proof (1)
- 2 pts Minor mistake in proof (2)
- 4 pts Proof without the math.
- 4 pts Major mistake in proof, but the idea is correct overall.
- 0 pts Click here to replace this description.
- 10 pts Points in IDK part.

2.2 Part (B) 4 / 10

- 0 pts Correct
- 4 pts Incorrect answer for regularity
- 6 pts Wrong proof [regularity]
- ✓ - 6 pts **Wrong proof [irregularity]**
- 2 pts Minor mistake
- 10 pts Points given in IDK part.
- 4 pts Major mistake.
- 10 pts No Solution.

💬 1^[a} is not the reverse of 0^{a}.

2.3 IDK 0 / 5

- + 2.5 pts IDK for Q2a
- + 2.5 pts IDK for Q2b
- ✓ + 0 pts **Not used.**

QUESTION 3

MID or PS 25 pts

3.1 Body 3 / 20

- + 20 pts Correct
- ✓ + 0 pts **Argument and construction impossible to follow**
- + 0 pts Proof strategy wrong such as proof by induction on size of language or the length of strings in the language, proof by contradiction, proof by claiming language is finite, proof by union of PREFIX(L), SUFFIX(L), etc / answering the wrong question
- + 0 pts Construction incorrect
- 2 pts Construction has minor errors
- + 6 pts MID: NFA correctly uses epsilon-transitions from start state
- ✓ + 3 pts **MID: NFA idea of making every state accepting (or e-transition to accepting state from every state), even though incorrect, reflects some understanding of MID(L); idea of excluding non-accepting states with only self loops from accepting states, even though incorrect, reflects some understanding of MID(L)**
- + 6 pts MID: NFA correctly makes only states that have paths to accepting states in original DFA accepting
- + 4 pts PS: Correctly transitioning along whole

words (Not single characters) or along a middle copy of the NFA

+ 4 pts PS: Correctly using parallel copies of the NFA

+ 4 pts PS: Correctly setting up epsilon-transitions to reachable states, not every state.

+ 0 pts No proof of correctness; proof of correctness wrong

+ 4 pts Proof of correctness for accepting all strings in MID(L)/PS(L), i.e., MID(L)/PS(L) in L(M)

+ 4 pts Proof of correctness for NFA not accepting strings it shouldn't, i.e, L(M) in MID(L)/PS(L)

+ 2 pts Using the proof framework of set inclusion in both directions

- 2 pts Minor errors/missing details in proof of correctness

+ 4 pts Proof by induction on regex: framework correct

+ 4 pts Proof by induction on regex: base case correct

+ 4 pts Proof by induction on regex: Inductive cases R=R1+R2 correct

+ 4 pts Proof by induction on regex: Inductive cases R=R1R2 correct

+ 4 pts Proof by induction on regex: Inductive cases R=R1* correct

- 5 pts Did not prove P(R) S(R) can be expressed by regex

+ 0 pts IDK

+ 8 pts Correctly identifies MID(L) = SUFFIX(PREFIX(L)) or PREFIX(SUFFIX(L))

+ 4 pts Correctly states that PREFIX and SUFFIX of a regular language is regular

+ 4 pts Proves that SUFFIX(PREFIX(L)) or PREFIX(SUFFIX(L)) in MID(L)

+ 4 pts Proves that MID(L) in SUFFIX(PREFIX(L)) or PREFIX(SUFFIX(L))

Too many incorrect statements in your proof. Length of the language is not a thing; MID(L) is exactly the set of substrings of strings in L, etc.

3.2 IDK 0 / 5

+ 5 pts Used IDK

✓ + 0 pts **Did not use IDK**

QUESTION 4

DFA or regular expression 45 pts

4.1 Part (A) 10 / 10

✓ - 0 pts **Correct DFA**

- 1 pts Very Minor Mistake in DFA (Couple of Transitions not shown)

- 2 pts Few minor mistakes in DFA (Couple of Incorrect Transitions)

- 3 pts Major mistakes in DFA

- 5 pts No DFA / Completely Incorrect DFA

✓ - 0 pts **Correct Regex**

- 3 pts Regex doesn't allow ending/starting with 1/a

- 1 pts Very Minor Mistake in Regex (A mistake which I am convinced was accidental, or using undefined operators in regex)

- 2 pts Few mistakes in Regex (A minute case missed out by regex)

- 5 pts No Regex / Completely Incorrect Regex

- 3 pts Regex doesn't allow starting with 1/a

- 10 pts Not the same version

4.2 Part (B) 6 / 10

- 0 pts Correct

- 2 pts Forgot to add one of *aa*ab* and *ab*aa*(resp. *11*01* and *01*11* for the other version)

✓ - 4 pts **forgot to add *aab*(resp *011* in the other version)**

- 4 pts Did not have any of *aa*ab* and *ab*aa* terms(resp. *11*01* and *01*11*)

- 10 pts Answer not a regex(eg: Providing an nfa/dfa instead of regular expression)

- 1 pts mistake in the *aa*ab* term

- 1 pts mistake in the *ab*aa* term

- 1 pts mistake in the *aab* term

- 4 pts strings not in the language also accepted

- 10 pts Wrong(no terms match, logic incorrect)

- 10 pts Not the same version

4.3 IDK 0 / 5

- 0 pts Used IDK

✓ - 5 pts Did not use IDK

4.4 Late Conflict Exam Version 0 / 20

+ 12 pts Construction Correct

+ 4 pts Proves L(M') in MID(L)

+ 4 pts Proves MID(L) in L(M')

✓ + 0 pts Not Conflict Exam

QUESTION 5

Silly or idiotic 25 pts

5.1 Body 0 / 20

- 0 pts Correct

- 10 pts Incorrect construction

- 5 pts Minor error in construction

- 10 pts Incorrect justification

- 5 pts Minor error in justification

✓ - 20 pts IDK

- 20 pts Wrong

- 15 pts Correct basic idea but wrong implementation/usage

- 0 pts Conflict Exam Grading

+ 3 pts A few more points for answer

5.2 IDK 5 / 5

- 5 pts Did not say IDK

✓ - 0 pts Said IDK

QUESTION 6

6 Version 0 / 0

✓ - 0 pts Correct

CS/ECE 374: Algorithms & Models of Computation, Fall 2017
Midterm 1 October 2: 7–9pm, 2017

A	B	C	D	E	F	G	H	J	K	?
9am	10am	11am	noon	1pm	1pm	2pm	2pm	3pm	3pm	Waiting
Rucha	Rucha	Srihita	Shant	Abhishek	Xilin	Shalan	Phillip	Vishal	Phillip	list
SC 1404	SC 1404	SC 1404	DCL 1320	DCL 1320	DCL 1320	ECE 1002	ECE 1002	ECE 1002	ECE 1002	ECE 1002

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#	1	2	3	4	5	Total
Score						
IDK Score						
Max	20	20	20	20	20	100
Grader						

- ***Don't panic!***
- Please print your name and NetID **in each page** in the appropriate fields, and circle your discussion section in the boxes above. We will return your exam at the indicated section.
- If you brought anything except your writing implements, your double-sided **handwritten** (in the original) 8½" × 11" cheat sheet, and your university ID, please put it away for the duration of the exam. In particular, you please turn off and put away *all* medically unnecessary electronic devices.
  - Submit your cheat sheet together with your exam. An exam without your cheat sheet attached to it will not be graded.
  - If you are NOT using a cheat sheet, please indicate so in large friendly letters on this page.
- Please ask for clarification if any question is unclear.
- **This exam lasts 120 minutes.** The clock started when you got the questions.
- If you run out of space for an answer, feel free to use the blank pages at the back of this booklet, but please tell us where to look.
- As usual, answering any (sub)problem with I don't know (and nothing else) is worth 25% partial credit. Correct, complete, but sub-optimal solutions are *always* worth more than 25%. A blank answer is not the same as I don't know.
- Total IDK points for the whole exam would not exceed 10.
- **Beware the Three Deadly Sins.** Give complete solutions, not examples. Declare all your variables. If you don't know the answer admit it and use IDK.
- **Style counts.** Please use the backs of the pages or the blank pages at the end for scratch work, so that your actual answers are clear.
- Please return ***all*** paper with your answer booklet: your cheat sheet, and all scratch paper. We will return everything with your graded exam.
- ***Good luck!***

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1 For each statement below, check "True" if the statement is ***always*** true and "False" otherwise. Each correct answer is worth 2 points; each incorrect answer is worth 0 points; and flipping a coin is (on average) worth 1 point. **There is no IDK for this question.**

1.A. Consider the logical statement "If the moon is made of silver, then the sun is made of chicken." This expression is: False: ☒ True: ☐

1.B. Let L be a regular language over alphabet Σ, and consider the language

$$L' = \{xy \mid x, y \in \Sigma^*, \alpha \in \Sigma, \text{ and } x\alpha y \in L\}.$$

The language L' is regular. False: ☒ True: ☐

1.C. For all context-free languages L and L', the language $(L \bullet L') \cup (L' \bullet L)$ is also context-free. False: ☐ True: ☒

1.D. If a language $L \subseteq \{0,1\}^*$ contains a string of length one, then L^* is regular. False: ☒ True: ☐

1.E. If $L_1, L_2, \ldots$ are all regular languages, then $L = \bigcup_{i=0}^{\infty} L_i$ is regular. False: ☐ True: ☒

1.F. For all languages L, if L is regular, then L does not have an infinite fooling set. False: ☐ True: ☒

1.G. For all languages $L, L' \subset \Sigma^*$, if L and L' are recognized by DFAs M and M', respectively, then $L' \setminus L$ can be represented by a regular expression. False: ☐ True: ☒

1.H. $\{0^i 1^j 0^k 1^\ell \mid i, j, k, \ell \geq 0\}$ is not regular. False: ☒ True: ☐

1.I. Let $M = (\Sigma, Q, s, A, \delta)$ and $M' = (\Sigma, Q, s, Q \setminus A, \delta)$ be arbitrary NFAs with identical alphabets, states, starting states, and transition functions, but with complementary accepting states. Then $L(M) \setminus L(M') = L(M)$. False: ☒ True: ☐

1.J. The strings 010 and 101 are distinguishable by the language $L = \{x \in \Sigma^* \mid |x| \text{ is even}\}$. False: ☒ True: ☐

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2 For each of the following languages over the alphabet $\Sigma = \{0, 1\}$, either ***prove*** that the language is regular or ***prove*** that the language is not regular. ***Exactly one of these two languages is regular.*** [This is a tricky question.]

2.A. $L = \{1^n w 0^{m-n} \mid w \in \Sigma^+ \text{ and } m \geq n > 0\}$.

This language is Regular.

The following regex describes the above language:

$(1)^+(0+1)^+(0)^*$

2.B. $L = \{x 0^n x^R \mid x \in \Sigma^+ \text{ and } n > 0\}$, where x^R is the *reverse* string of x.

let F be $\{0^p \mid p \geq 1\}$

WLOG, let $i \neq j$

$x = 0^i \in F$ $z = 01^i$

$y = 0^j \in F$

$xz = 0^i 01^i \in L$

$yz = 0^j 01^i \notin L$

Thus, F is an infinite fooling set for L.

Not Regular.

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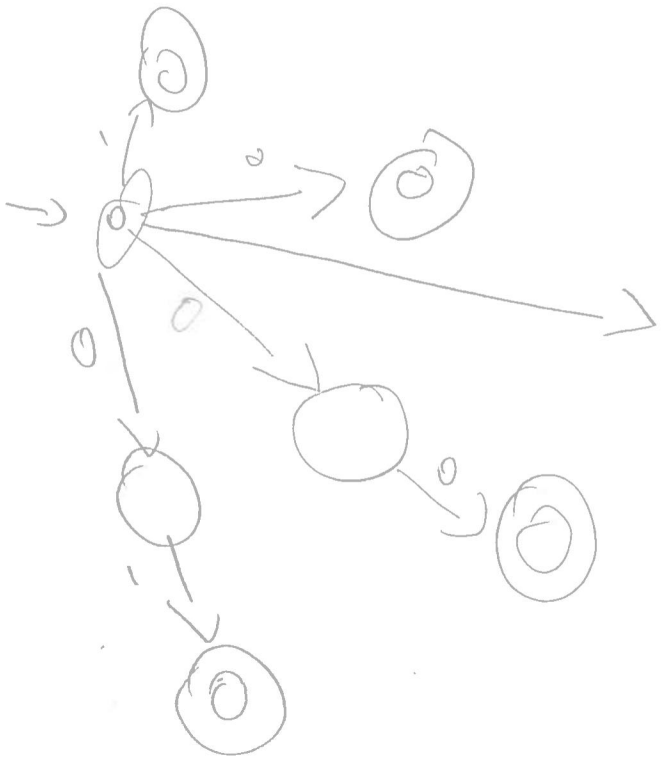
$L = \{ 1^n \omega 0^{m-n} \mid \omega \in \Sigma^+ \text{ and } m \geq n > 0 \}$

m

$L = \{ 000, 110, 100, 111 \}$



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3 For any language L, let $\text{MID}(L) = \{y \mid xyz \in L \text{ for some } x, y, z \in \Sigma^*\}$ be the language containing all substrings of all strings in L. For example, if $L = \{000, 100, 110, 111\}$, then $\text{MID}(L) = \{\varepsilon, 0, 00, 000, 1, 10, 100, 11, 110, 111\}$. 00, 10, 11, 01 |L| = 12

Prove that for any regular language L, the language $\text{MID}(L)$ is also regular (suggestion: first describe the necessary construction, and then prove the correctness of the construction).

Let $M = (\Sigma, Q, s, A, \delta)$ be a DFA that accepts mid(L).
We construct an NFA $M = (\Sigma, Q, s, A, \delta)$ with ε transitions.
as follows:

$\Sigma = \{0,1\}^*$

$Q := \{q_i \mid 0 \leq i \leq |X|\}$ X = the total length of the language consisting in L.

$s := q_0$

$A := Q$

$$\delta(q_i, a) = \begin{cases} q_0 & \text{if } a = \varepsilon \\ \delta(\delta(q_i a), a) & \text{if } a \in \Sigma^* \end{cases}$$

The Language Mid(L) is regular because we can construct an NFA for each strings in L. Since the Mid(L) consists only the substrings of L, the states of each path to the end is an Accepting state. This would work because no substrings of L would be accepted by Mid(L) because no path exist. The #of state will be the total length of the language consist in L (because we're making individual path for each strings) plus the starting state which is also an accepting state because it accepts epsilon.

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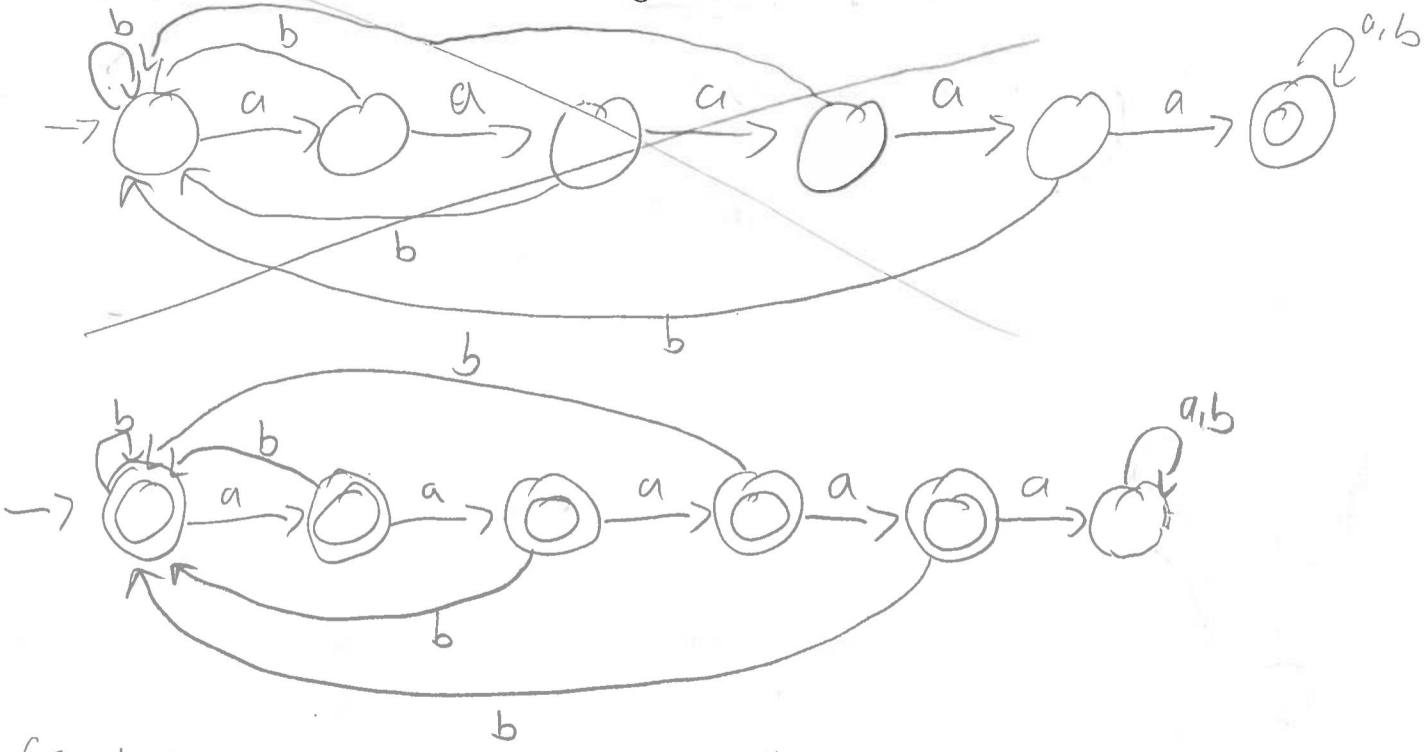
4 In the following, you do ***not*** need to prove that your answers are correct.

4.A. Provide a DFA and a regular expression for the following language: The set of all strings in $\{a, b\}^*$ that do not contain the substring $aaaaa$.



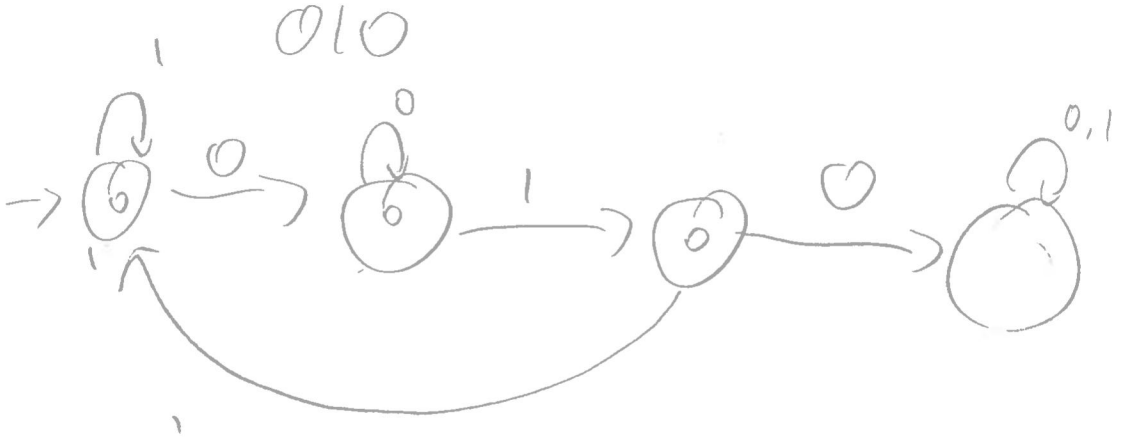
$(\Sigma + b + ab + aab + aaab + aaaab)^*(\Sigma + a + aa + aaa + aaaa)$ //

4.B. Provide a regular expression for the following language: The set of all strings in $\{a, b\}^*$ that contain both ab and aa as substrings. 01 00

$(a+b)^* ab(a+b)^* aa(a+b)^* +$

$(a+b)^* aa(a+b)^* ab(a+b)^*$ //

NETID: NAME:



$$\left((\varepsilon + 1 + 011)(\varepsilon + 00^* + 00^*1) \right)^*$$

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5 A CFG G is *silly* if all production rules are of the form $A \to cB$ or $A \to \epsilon$, where $c \in \Sigma$ and A and B are variables (i.e.., non-terminals) of G. For a given silly CFG grammar G, provide a construction that shows that the language of $L(G)$ is regular. Provide a convincing argument why this is true (you do not need to provide a formal proof).

[If you do not know the answer - just use IDK – no need to waste your and our time.]

kindof

IDK

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