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Department of Computer Science
University of Massachusetts Lowell
COMP.3040 Foundations of Computer Science
Fall 2018
Quiz 1 [5%]
9/27/2018

1. *[30 points]* Differentiate between
   - alphabet, string, language
   - Domain, Range
   - Empty set, Empty string
   - States, start state, accept state
2. *[15 points]* Write a formal description for the following sets
   - set containing 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024 = $\{w \mid w = 2^k, k = 0,1,2,\dots,10\}$
   - set containing 0-9, a-f = $\{w \mid w$ is the hexadecimal value from 0 to 15$\}$
   - set containing 0, 1, 1, 2, 3, 5, 8, 13, ... = $\{w_0, w_1, \dots, w_k \mid k \geq 0,\ w_k = w_{k+2} - w_{k+1}\}$
3. *[20 points]* Give the formal definition for
   - DFA
   - NFA
   - Regular Language
   - Regular Expression
4. *[5 points]* A NFA is more powerful than a DFA.
   - True
   - False
5. *[5 points]* Every NFA can be converted to a* DFA.
   - True
   - False
6. *[5 points]* A language is Regular if a DFA or NFA exists which can recognize it.
   - True
   - False
7. *[5 points]* All regular languages are infinite–contain infinite number of strings }
   - True

◉ False

8. *[15 points]* The class of regular languages is closed under the following operations:

Union: ∪

Concatenation: ∘

Star: *

1. alphabet: a set of finite, ~~characters~~ and nonzero objects called symbols.
   ~~single letters or single numbers~~.
   string: a set of ~~single or multi characters and single or multi numbers that go together~~ (~~syb~~) symbols which are from an alphabet
   language: consists of all strings that are possible generated from the alphabet.
   - Domain: is a set of possible inputs to a function
     Range: is a set (of) from which outputs of a function are drawn
   - Empty set: is a set with no members.
     Empty string: is a string of length zero.

of finite automata
states: all set of states that are in the set Q
start state: a state starts the process
final state: a state that the process stops by

3. DFA = $(Q, \Sigma, \delta, q_0, F)$
   Q: finite set called state
   Σ: finite set called alphabet
   $\delta: Q \times \Sigma \to Q$ is the transition function
   q_0: start state
   $F \subseteq Q$: is the set of accept states
   NFA = $(Q, \Sigma, \delta, q_0, F)$
   Q: finite set called state
   Σ: finite set called alphabet
   $\delta: Q \times \Sigma \to \mathcal{S}(Q)$ is the transition function
   q_0: start state
   $F \subseteq Q$: is the set of accept states

- Regular language: ~~consists of all strings~~ that a language same ~~Can~~ finite automation accepts.
  $A = L(M)$ with A is the language and M is a finite automation
- Regular Expression: regular operations used to ~~but~~ build up expressions describing language.

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Quiz 2 [5%]
11/29/2018

Q: set of states
Σ: input alphabet (not contain blank symbol ␣)
Γ: tape alphabet, where ␣ ∈ Γ and Σ ⊆ Γ

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1. Give the formal definition of a Turing Machine (TM)

Turing Machine is a 7-tuple $(Q, \Sigma, \Gamma, \delta, q_0, q_{accept}, q_{reject})$ where Q, Σ, Γ are all finite sets $\delta: Q \times \Gamma \to Q \times \Gamma \times \{L, R\}$ transition function; $q_0 \in Q$: start state; $q_{accept} \in Q$: accept state; $q_{reject} \in Q$: reject state where $q_{reject} \neq q_{accept}$

2. What is an Enumerator? Give an example.

Enumerator is a turing machine with an attached printer, which starts with a blank input on its work tape.

3. What is Church-Turing Thesis?

Church-Turing Thesis is the connection between the informal notion of algorithm and the precise definition.
Intuitive notion of algorithm equals Turing machine algorithm

4. A multi-tape TM is not more powerful than a single tape TM.

- (True)
- False

5. A Non-deterministic TM is more powerful than a Deterministic TM.

- True
- (False)

6. Order the class of languages in increasing order of power

- Context Free 2
- Regular 1
- Turing Recongnizable 4
- Turing Decidable 3

7. A = { $0^{2^n}, n >= 0$, is a decidable/recognizable language }

- Decidable
- (Recognizable)

8. A_{DFA} = { (B, w) | B is a DFA that accepts input string w, is a decidable/recognizable language }

   - Decidable
   - Recognizable

9. A_{REX} = { (R, w) | R is a Regular Expression that generates string w, is a decidable/recognizable language }

   - Decidable
   - Recognizable

10. A_{CFG} = { (G, w) | G is a CFG that generates string w, is a decidable/recognizable language }

    - Decidable
    - Recognizable

11. *[20 points]* Sketch an algorithm using a single tape TM to recognize the language L | ww^R, where w is a string and w^R is the reverse of the string. Assume $\sum = \{0, 1\}$

1. Scan the input from left to right till the end of the tape to determine whether the combined string (w and w^R) is odd or even in length. If it's odd, reject it; otherwise, move to stage 2.

2. Read the first character, replace it with an X to mark the position. Then, move the head to the right till the end of the tape and read the last character of the combined string. If it matches with the first character, mark it with an X as we did, then move the head to the left till it meets the marked X, then make the head read the character next to the right of the X; then, move the head to the right until it reaches the X that we've read, read the character next to the left of the X. If it matches with the last marked character, repeat stage 2 until the combined string becomes all Xs, then move to stage 3; if any of them doesn't match, reject it.

3. Accept it.

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Quiz 3

11/1/18

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Using the beer database in the slides, answer the following query in SQL: *find the name and price of the beers sold at the bar if the bar charges the minimum average price of beers.*

```
select name beer, price from sells where bar IN (select bar
from sells where avg(price) <= ALL(select avg(price) from sells));
```