# DFAs and TMs

Tuesday, August 20, 2019 5:16 PM

Recall definition of DFA, TM.

Alphabet: finite set of symbols $\Sigma$

string: sequence of letters from $\Sigma$ (with repetition)

$\Sigma^*$ : set of all strings over $\Sigma$.

Language: collection of strings. $L \subseteq \Sigma^*$.

e.g. $\Sigma = \{0, 1\}$

$\Sigma^*$ = all finite binary strings

e.g. $L$ = { strings from $\Sigma^*$ with an even # 1's }.

<u>Regular</u> Language: a language accepted by some DFA.

Not all languages are regular! Why? E.g.?

$\boxed{\text{Not all languages are regular}}$ Why? E.g.?

Before that, lets understand the power of DFAs better.

DFA $A_1$ accepts $L_1$

—— $A_2$ accepts $L_2$

Q. Is there a DFA that accepts $L_1 \cup L_2$?

$Q_1$ $\delta_1$ $Q_2$ $\delta_2$

$Q = Q_1 \times Q_2$

$\delta = \{\text{transitions in } D \times \text{transitions in } D_2\}$

$\delta((q_1, q_2), a) = (\delta_1(q_1, a), \delta_2(q_2, a))$

$q_0 = q_{10} \times q_{20}$

$F = \{(q_1, q_2) : q_1 \in F \text{ or } q_2 \in F\}$

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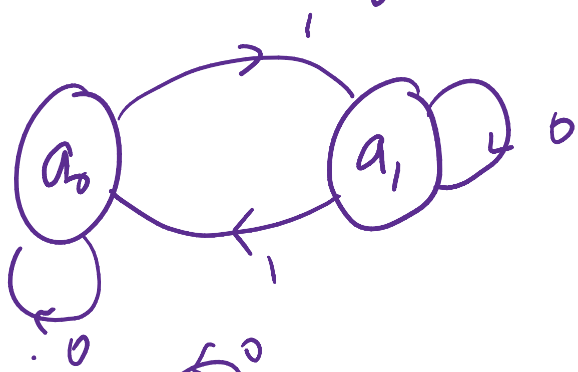
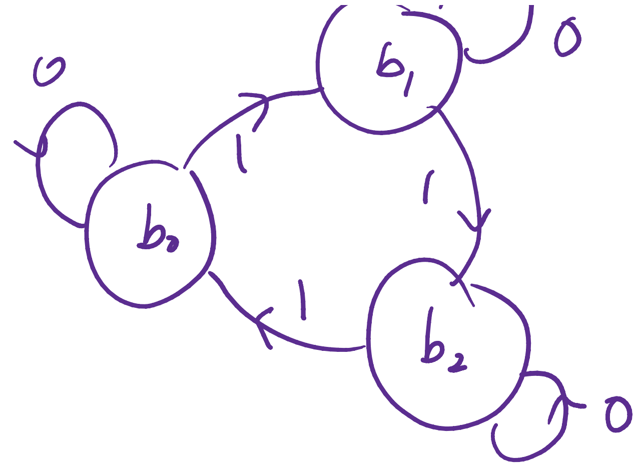
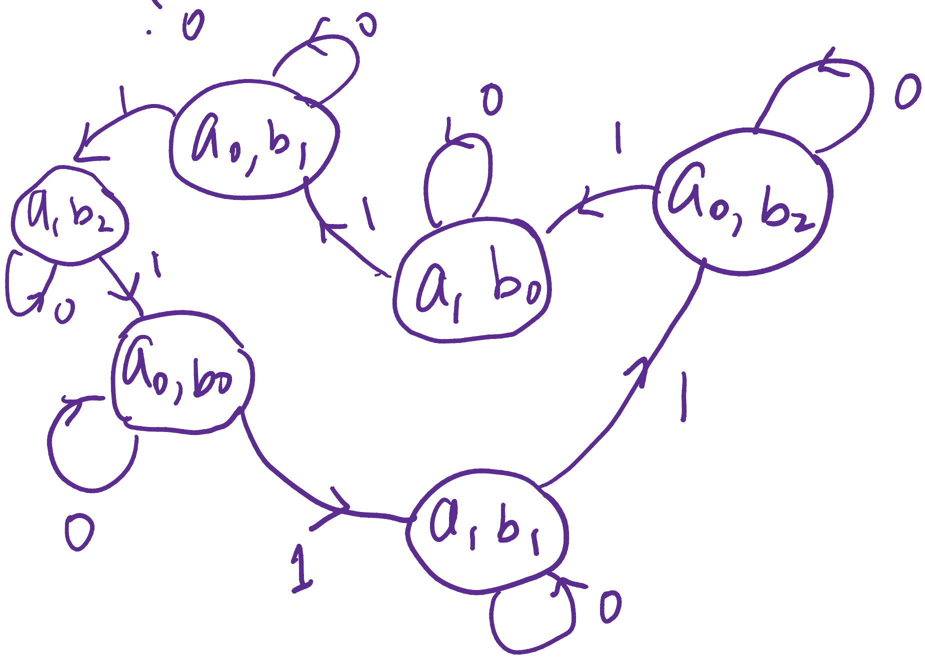
e.g. accept binary string if #1's is even or divisible by 3.

of divisible by 3.




$F = \{ (a_0, b_0)\ (a_0, b_1)\ (a_0, b_2)\ (a_1, b_0) \}$

\#1's even <u>and</u> divisible by 3

$F = \{ (a_0, b_0) \}$

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$L = \{$ binary strings : $\#1\text{'s} = \#0\text{'s} \}$ DFA?

Let's try a TM first!

| 0 1 1 0 1 0 1 1 1 0 0 0 1 0 1 0 0 1 1

erase first letter
go right till first opposite letter, erase; if none "NO".
Repeat till no more letters
"YES".

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What about a DFA?

Hmm....

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$\Sigma = \{a, b, \ldots, z\}$

$L = \{x \in \Sigma^* : x = \text{rev}(x)\}$ "Palindromes".

TM for L?

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$L = \{x \in \mathbb{N} : x \text{ is a prime}\}$

⋮

L accepted by DFA.

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Languages accepted by DFAs

$\subseteq$ L accepted by TMs $\subseteq$ all L.

proper? proper?