CSE 105
THEORY OF COMPUTATION

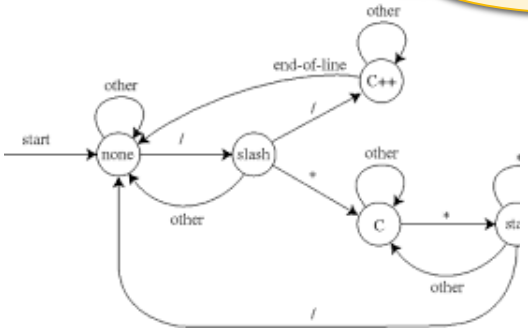
"Winter" 2018

http://cseweb.ucsd.edu/classes/wi18/cse105-ab/

First model

Code input as strings
Model memory using states

- Text processing
  grep, regexp



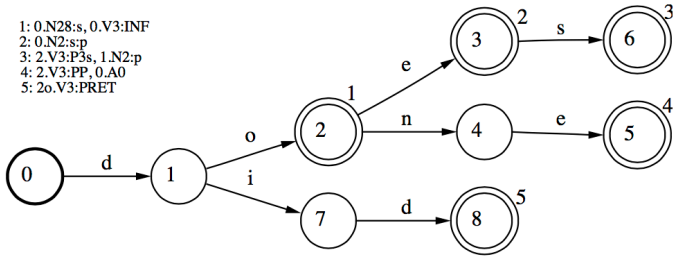
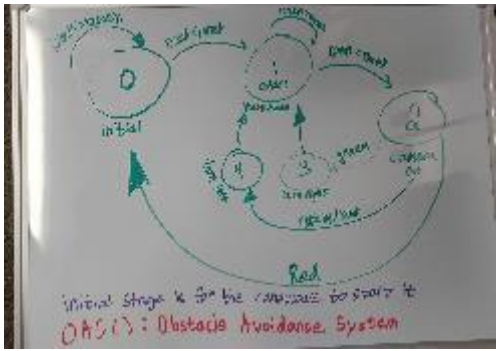


Fig. 1. Representation of dictionaries by automata.

- Natural language processing

- Hardware design
  Moore machines, Mealy machines: CSE 140
- Controllers / Robots
  SPIS!



Regular expressions

Which regular expressions describe languages that include the string a ?

A. a*b*
B. a(ba)*b
C. a* U b*
D. (aaa)*
E. (ε U a)b

Frequency: AB

To change your remote frequency
1. Press and hold power button until flashing
2. Enter two-letter code
3. Checkmark / green light indicates success

Pre-class reading

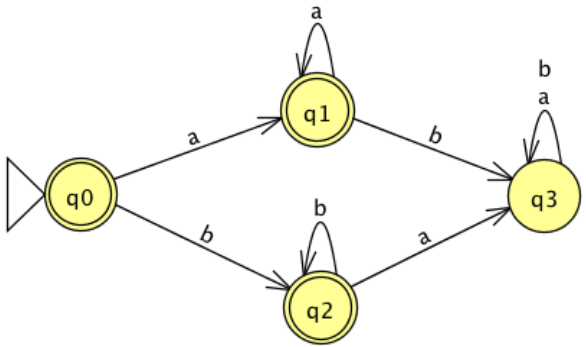
- Tracing the computation of a finite automata using its state diagram.
- Formal definition of finite automaton.

From the website:

DFA *Reading* Sec 1.1: Figure 1.4 (p. 34), Definition 1.5 (p. 35)
Optional extra practice: Chapter 1 Exercise # 1, 2, 3

Deterministic Finite Automaton

Sipser p. 34



Start state(s)?

Accept state(s)?

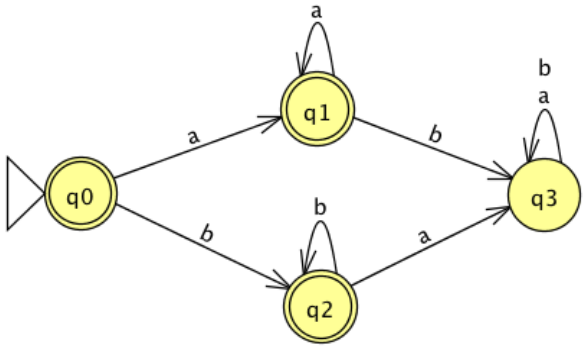
Transitions?

Deterministic Finite Automaton

Sipser p. 34, 40

Input:

Output:



Computation of the machine on an input string

Sequence of states in the machine, starting with the initial state, determined by transitions of the machine as it reads additional input symbols.

Deterministic Finite Automaton

Sipser p. 34, 40

Computation of the machine on an input string

Sequence of states in the machine, starting with the initial state, determined by transitions of the machine as it reads additional input symbols.

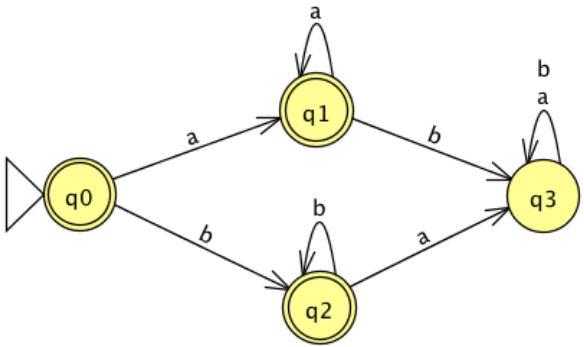
Machine accepts the input string if

Machine rejects the input string if

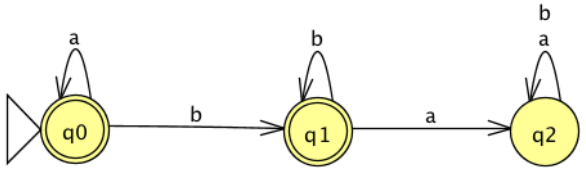
The **language recognized by the machine** is the set of strings it accepts.

Examples

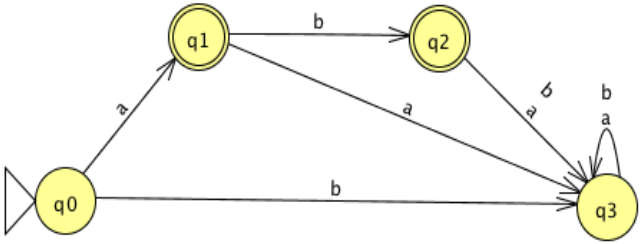
1.



2.



3.



Which of these automata recognize **the same** language?

A. All of them.
B. 1. and 2.
C. 1. and 3.
D. 2. and 3.
E. None of them (they each recognize different languages).

Deterministic finite automaton

Sipser p. 35 Def 1.5

A **finite automaton** is a 5-tuple $(Q, \Sigma, \delta, q_0, F)$ where

1. Q is a finite set called the states
2. Σ is a finite set called the alphabet
3. $\delta : Q \times \Sigma \to Q$ is the transition function
4. $q_0 \in Q$ is the start state
5. $F \subseteq Q$ is the set of accept states.

No circles and arrows, same information!

Deterministic finite automaton

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Can there be more than one **start state** in a finite automaton?

A. Yes, because of line 4.
B. No, because of line 4.
C. I don't know

Deterministic finite automaton

Sipser p. 35 Def 1.5

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How many outgoing arrows from each state?

A. May be different number at each state.
B. Must be 2.
C. Must be |Q|.
D. Must be |Σ|
E. I don't know.

An example

Define M = $(\{q1, q2, q3, q4\}, \{a, b\}, \delta, q1, \{q4\})$ where the function δ is specified by its table of values:

Input in Q x Σ	Output in Q
(q1,a)	q3
(q2,a)	q2
(q3,a)	q3
(q4,a)	q2

Input in Q x Σ	Output in Q
(q1,b)	q2
(q2,b)	q2
(q3,b)	q4
(q4,b)	q4

Draw the state diagram for the DFA with this formal definition.

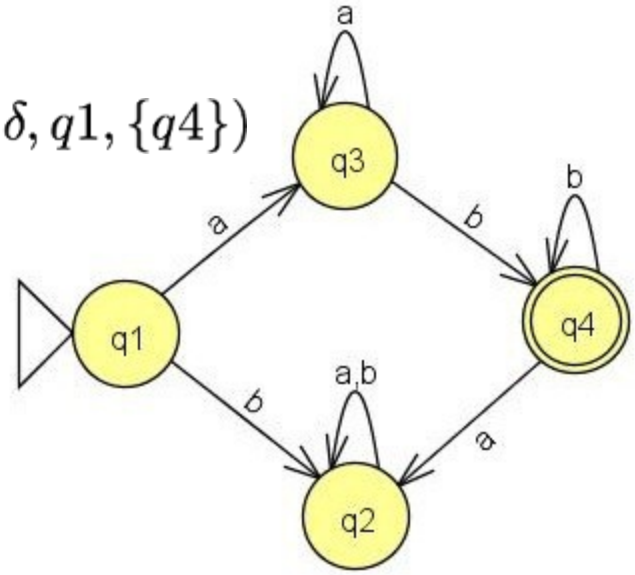
An example

$(\{q1, q2, q3, q4\}, \{a, b\}, \delta, q1, \{q4\})$

What's an example of a

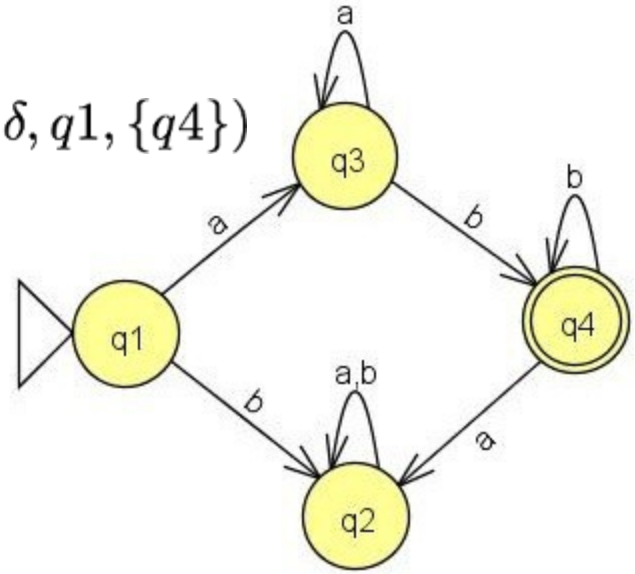
- length 1 string accepted by this DFA?
- length 1 string rejected by this DFA?

- length 2 string accepted by this DFA?
- length 2 string rejected by this DFA?



An example

$(\{q1, q2, q3, q4\}, \{a, b\}, \delta, q1, \{q4\})$



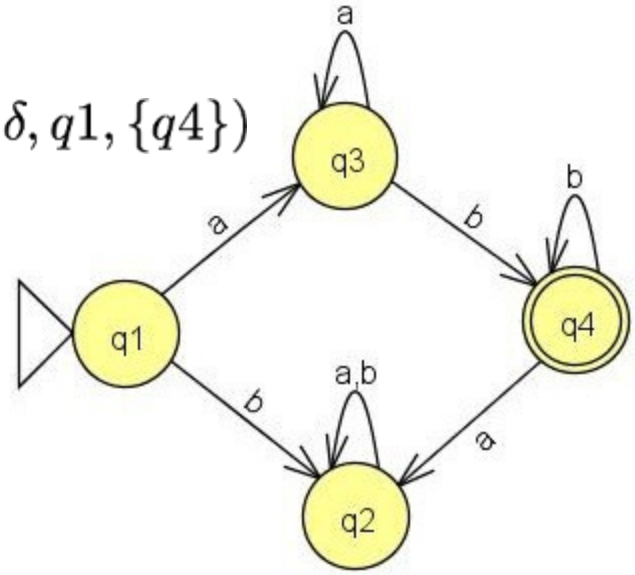
What's the best description of the language recognized by this DFA?

A. Starts with b and ends with a or b
B. Starts with a and ends with a or b
C. a's followed by b's
D. More than one of the above
E. I don't know.

and using set notation?

An example

$(\{q1, q2, q3, q4\}, \{a, b\}, \delta, q1, \{q4\})$

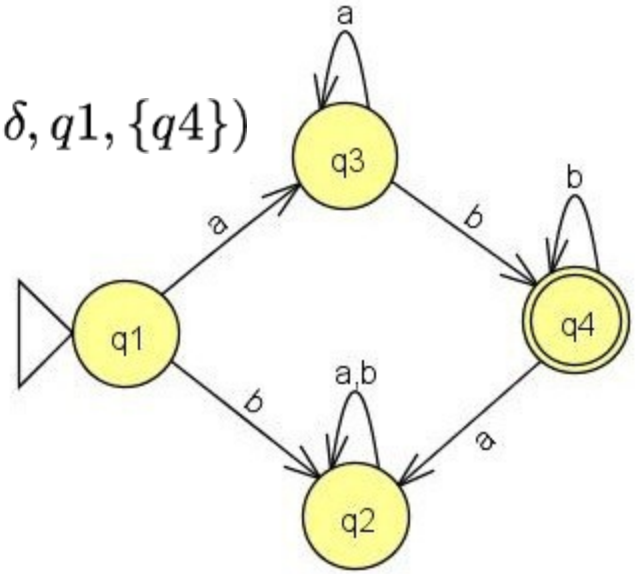


This DFA recognizes
the language of all strings
of the form a's followed by b's

i.e. { $a^n b^k$ | n,k ≥ 1}

An example

$(\{q1, q2, q3, q4\}, \{a, b\}, \delta, q1, \{q4\})$



{ $a^n b^k$ | n,k ≥ 1}

Is this the same as the language described by

A. a*b*
B. a(ba)*b
C. a* U b*
D. (aaa)*
E. (ε U a)b

For next time

- Individual Homework 0 **due Saturday**
  - Set up course tools: *Gradescope*, Piazza
  - Read all the questions + relevant examples in the book
  - Start working ☺
  - *Review CSE 20 / Math 109 / CSE 21 / Sipser Ch 0 as needed.*
- Discussion section Thursday **"Breadth"**
  - Regular expressions and DFAs

Pre class-reading for Friday: Example 1.21