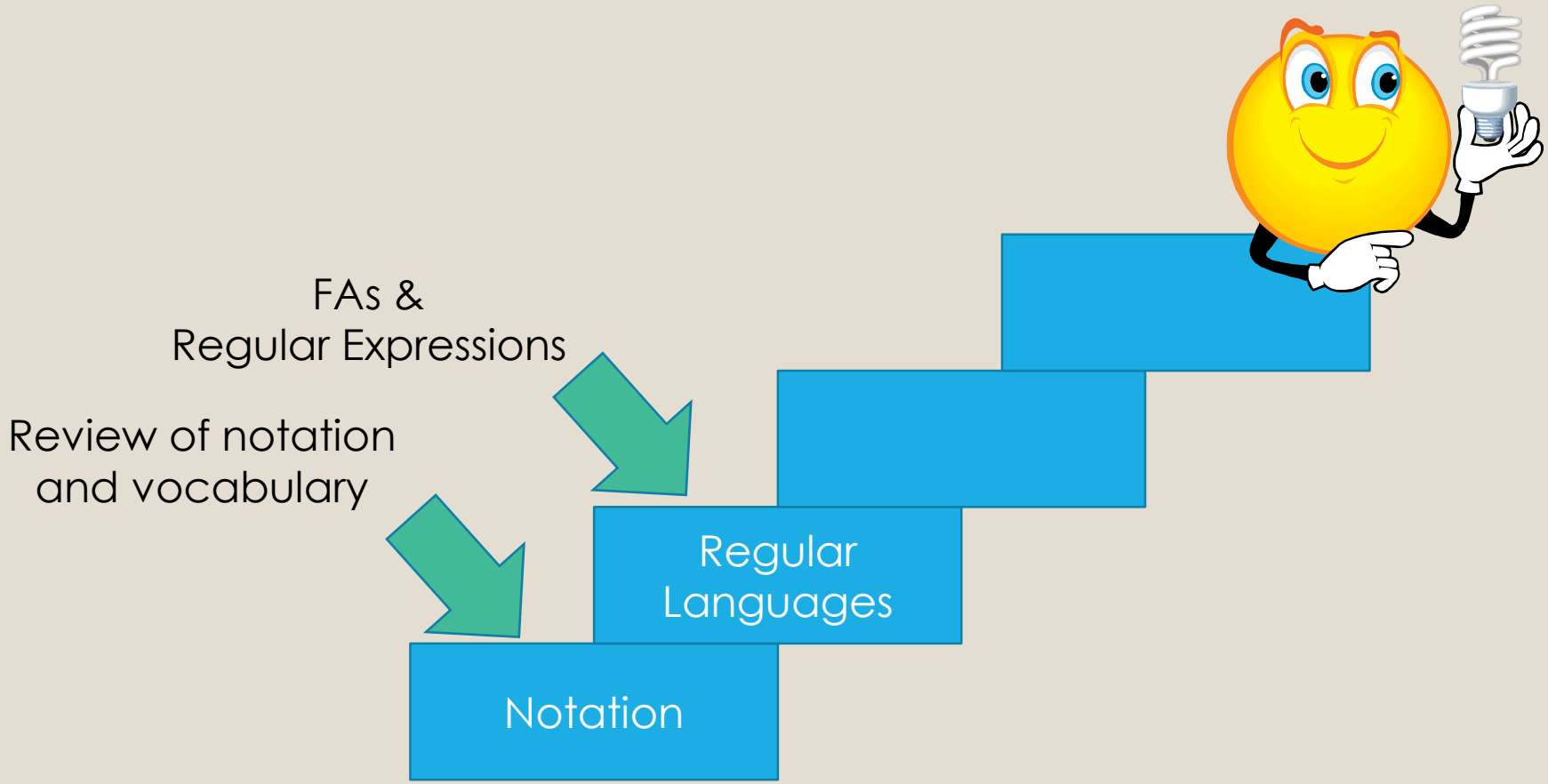
# MIDTERM REVIEW

# Chapter 0 and Chapter 1



# Topics

- **Review**
  - Set notation
  - Set operations
- **Languages**
  - Alphabet symbols, strings
- **Regular Languages**
  - DFA and NFA
  - NFA to DFA (Theorem 1.39 and lecture notes)
  - Regular Expressions
  - NFA to Regular Expression (Lemma 1.60 and lecture notes)
  - Pumping lemma for regular languages (Theorem 1.70  and lecture notes)

# Recognizing Languages

- Regular (R) , Not Regular (N)

| No. | Language | Type |
|---|---|---|
| 1 | $\{a^i b^j c^k d^l \mid (i< j) \text{ or } (k < l)\}$ | |
| 2 | $\{a^i b^j \mid (i< j)\}$ | |
| 3 | $\{a^i b^j c^k d^l \mid (i\neq j) \text{ and } (k \neq l)\}$ | |
| 4 | $\{a^i b^j \mid (i= j)\}$ | |
| 5 | $\{a^i b^j c^k d^l \mid (i= j)<4 \text{ and } (k =l)<2\}$ | |
| 6 | $\{a^i b^j c^k \mid i+ j < k\}$ | |
| 7 | $\{a^i b^j \mid i \bmod 3 = 0 \text{ and } j \bmod 4 =0\}$ | |

# Regular or Non Regular?

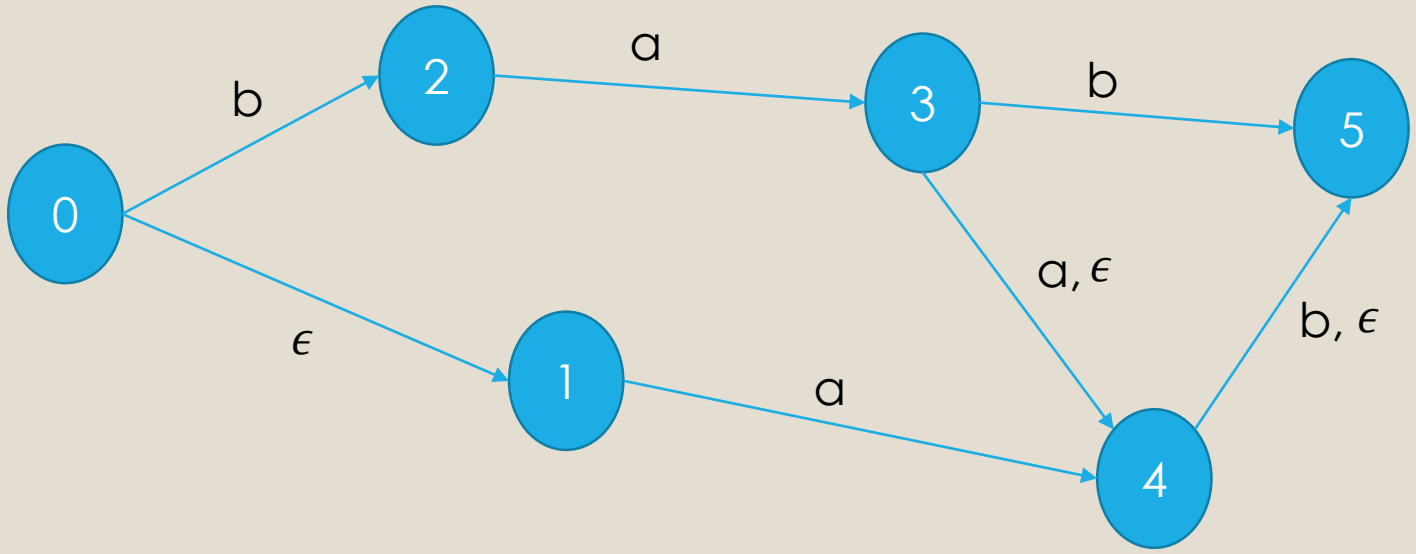
- A=$\{ab^n c^m | \ n \geq m; m = 3\}$. If A is regular, create the corresponding FA. If A is not a regular language, then use the pumping lemma to demonstrate it is not.

# DFA

- Create a DFA for the following regular expression: (a U b)* abb
- Do any of the following strings are accepted by the DFA? (Trace each string to show accept/reject): aab, babba, abb

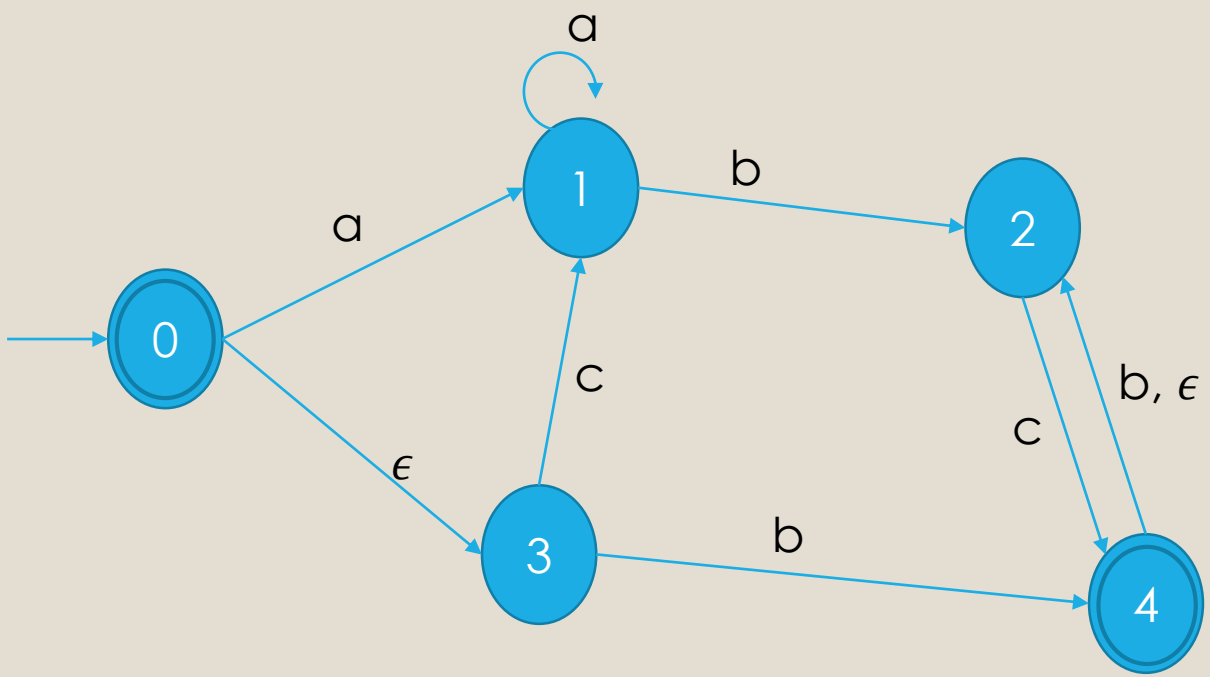
# Closure

- Consider the following NFA and compute the closure of $q_0$, $q_1$ and $q_3$.



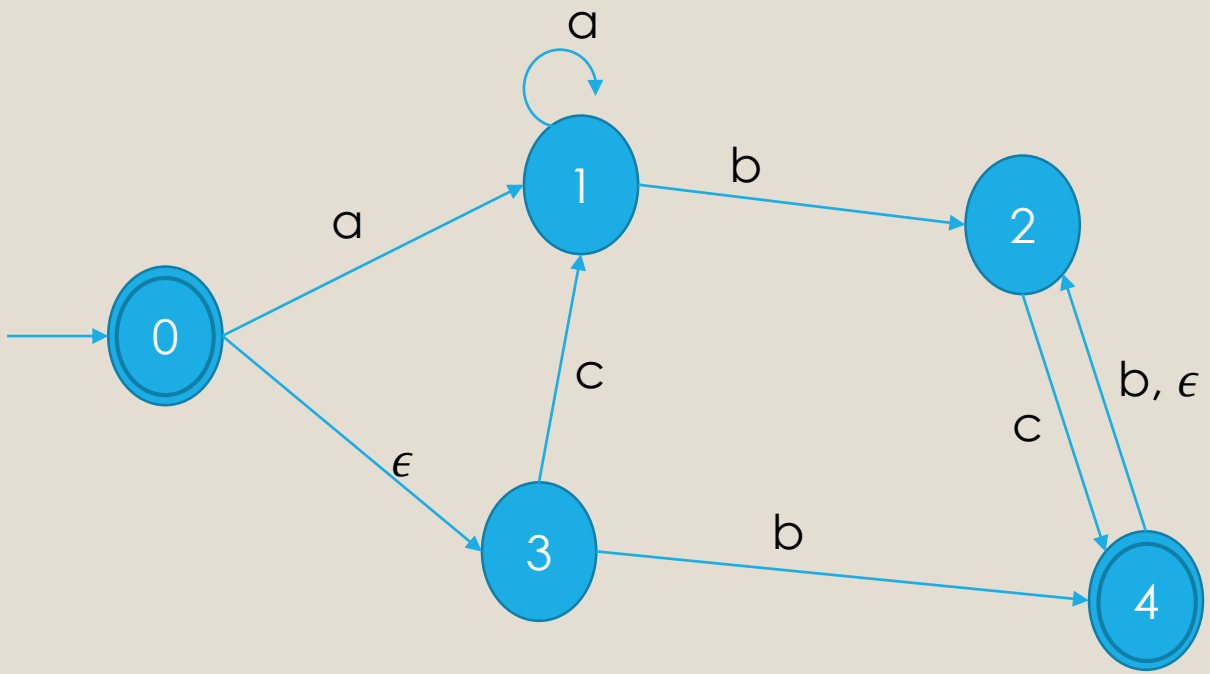
# NFA (to DFA)

- Construct the equivalent DFA



# NFA (to DFA)

- Construct the regular expression



# Regular Expression to NFA

- Consider the following regular expression: **((bb U ba)$^{+}$c*)U ((ba)*c)**

# Regular or Non Regular?

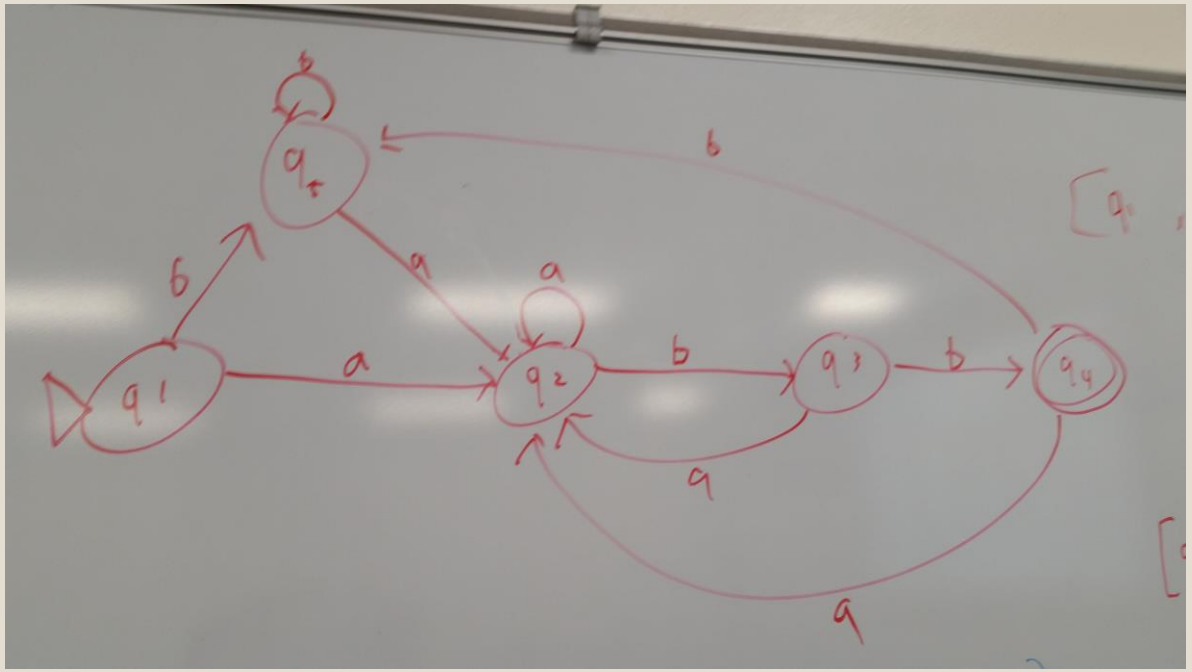
- B={ww | w □ {a, b}∗}. If A is regular, create the corresponding FA. If B is not a regular language, then use the pumping lemma to demonstrate it is not.

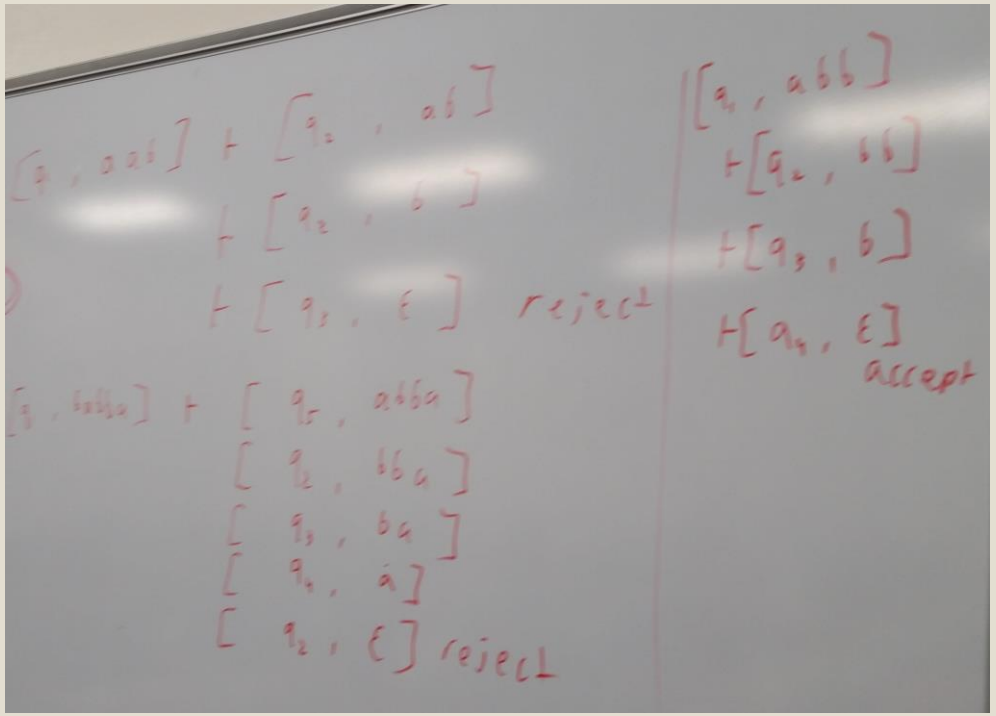
# Regular or Non Regular?

1. For the purpose of contradiction, assume thatBis regular
2. Let p be the pumping length
3. Pick a string s in B with $|s| \geq p$
   - Let $s = a^p b a^p b$, and we have
     $a^p b a^p b \in L$, and $|a^p b a^p b| = 2p+2 \geq p$
4. Identify all possible decompositions of s into xyz, with $|xy| \leq p$ and $|y| > 0$
   - Since $s = a^p b a^p b$, for any possible decomposition, y must consist of one or more a's but no b's
   - $x=a^{p-k}$ $(p \geq k > 0)$, $y = a^k$ , $z=ba^p b$
5. Show that for each decomposition, there exists an $i \geq 0$ such that $xy^iz \notin B$
   - Let i = 2, we see that $xy^2z = a^{p+k}ba^p b$, since $p+k> p$, then $s \notin B$
6. Conclude that the assumption is wrong. That is L is not regular

# DFA

- Create a DFA for the following regular expression: (a U b)* abb
- Do any of the following strings are accepted by the DFA? (Trace each string to show accept/reject): aab, babba, abb



# Creating Languages

- Given an example of $L_1$, $L_2$, and $L_3$, such that
  - $L_1$ is a non-regular language
  - $L_2$ is a non-regular language
  - $L_3 = L_1 \cap L_2$ and $L_3$ is regular

- Given an example of $L_1$, $L_2$, and $L_3$, such that
  - $L_1$ is a non-regular language
  - $L_2$ is a non-regular language
  - $L_3 = L_1 \cup L_2$ and $L_3$ is regular