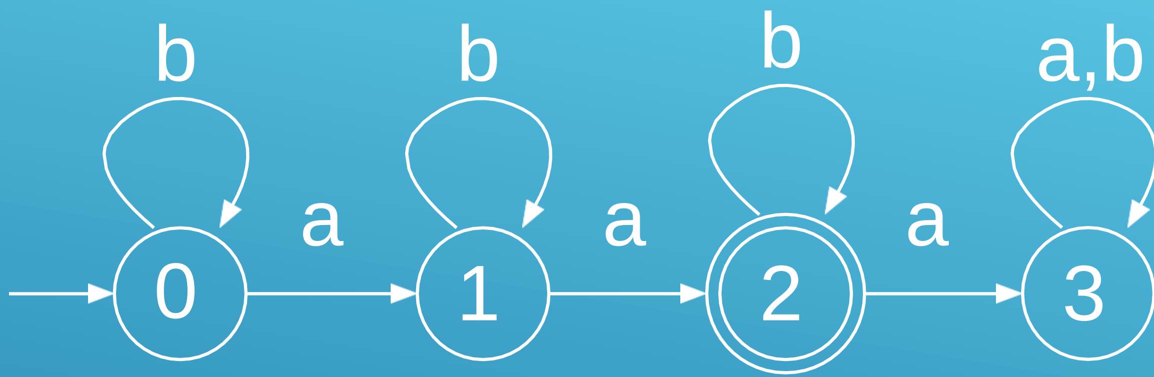
DFA DEFINITION

- A DFA is a 5-tuple $M = (Q, \Sigma, \delta, q, F)$
  - Q Set of states
  - Σ Alphabet
  - $\delta : (Q \times \Sigma) \rightarrow Q$ is a Transition function
  - $q \in Q$ Initial state
  - $F \subseteq Q$ Set of final states

DFA DEFINITION



- $Q = \{q_0, q_1, q_2, q_3\}$
- $\Sigma = \{\mathrm{a}, \mathrm{b}\}$
- $\delta =$ $\{((q_0, \mathrm{a}), q_1), ((q_0, \mathrm{b}), q_0), ((q_1, \mathrm{a}), q_2), ((q_1, \mathrm{b}), q_1),$ $((q_2, \mathrm{a}), q_3), ((q_2, \mathrm{b}), q_2), ((q_3, \mathrm{a}), q_3), ((q_3, \mathrm{b}), q_3)\}$
- $q = q_0$
- $F = \{q_2\}$

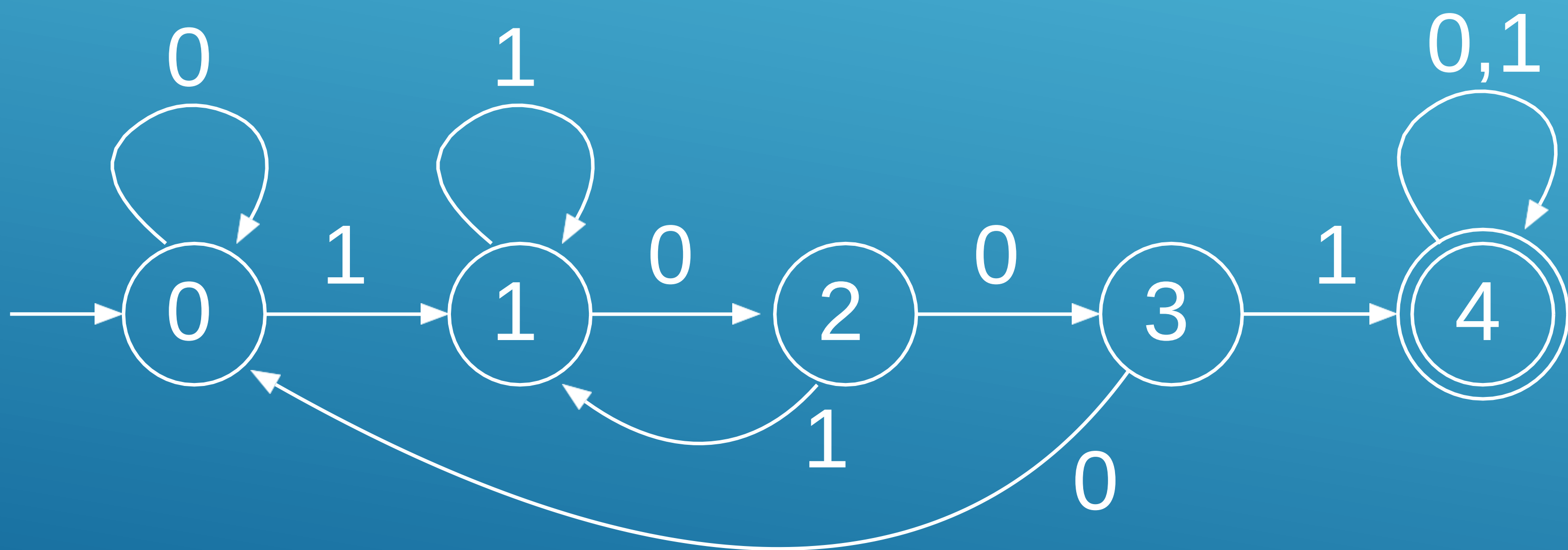
WHY DFA

- Why are these machines called “Deterministic Finite Automata”
  - Deterministic Each transition is completely determined by the current state and next input symbol. That is, for each state / symbol pair, there is exactly *one* state that is transitioned to
  - Every DFA has a finite number of states

EXAMPLE. DFA

Create a DFA for:

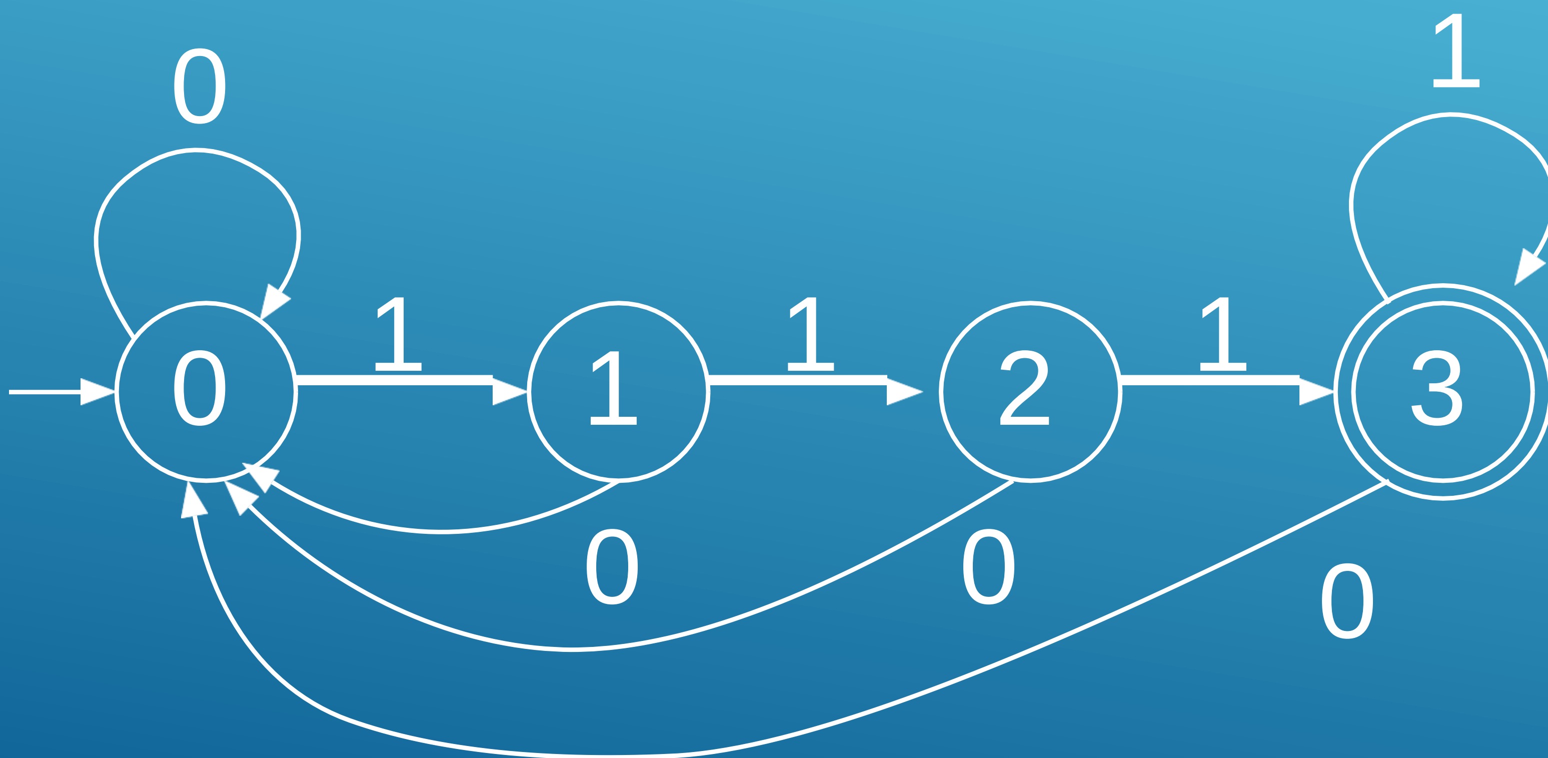
- All strings over {0, 1} that contain the substring 1001



EXAMPLE. DFA

Create a DFA for:

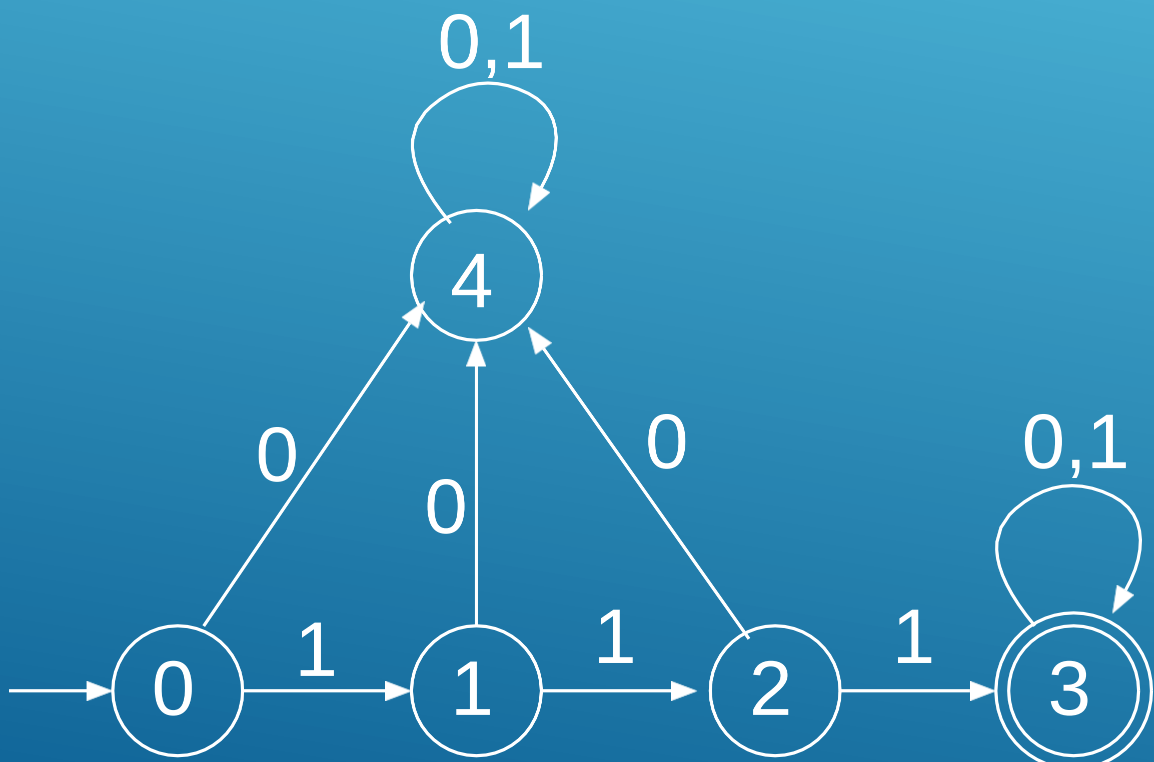
- All strings over {0, 1} that end with 111



EXAMPLE. DFA

Create a DFA for:

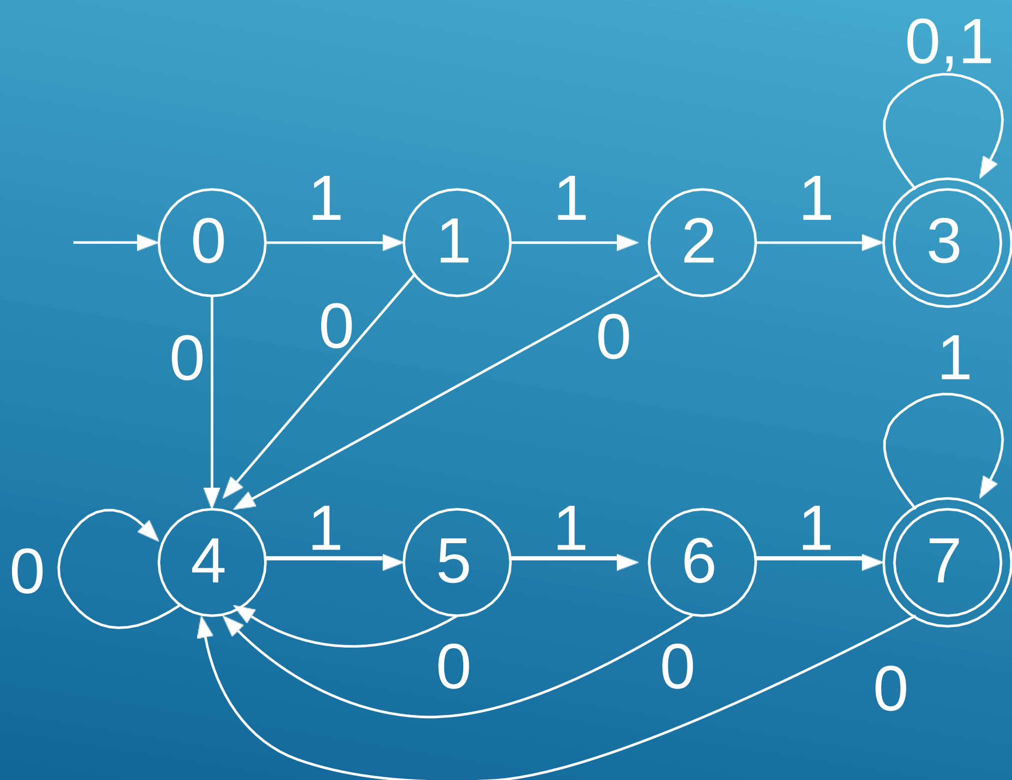
- All strings over {0, 1} that begin with 111



EXAMPLE. DFA

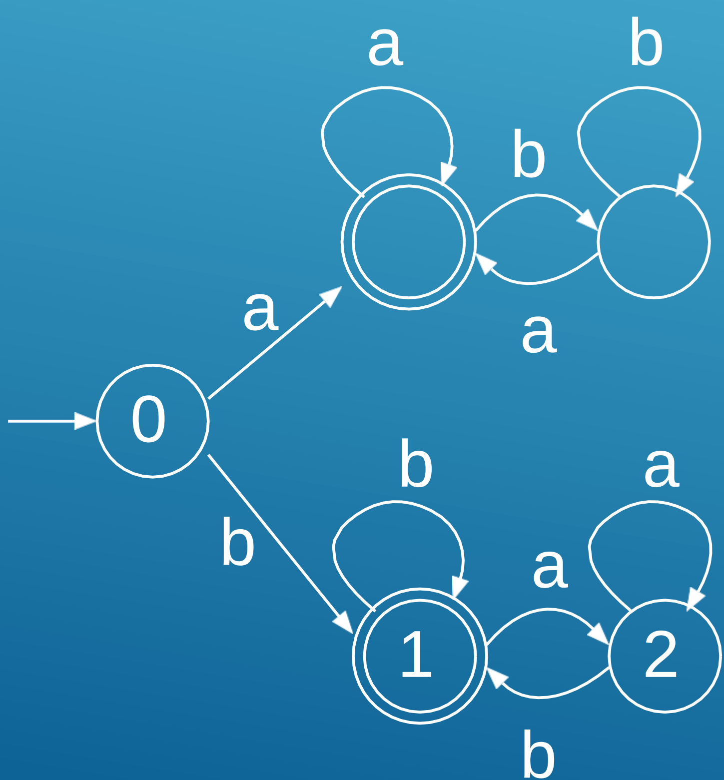
Create a DFA for:

- All strings over {0, 1} that begin or end with 111



EXAMPLE. DFA

- Create a DFA for:
  - All strings over {a, b} that begin and end with the same letter



Construct a minima DFA which interpreted as binary number is divisible by '3' over ∑ {0, 1}.

divisible by 3, therefore 3 states.

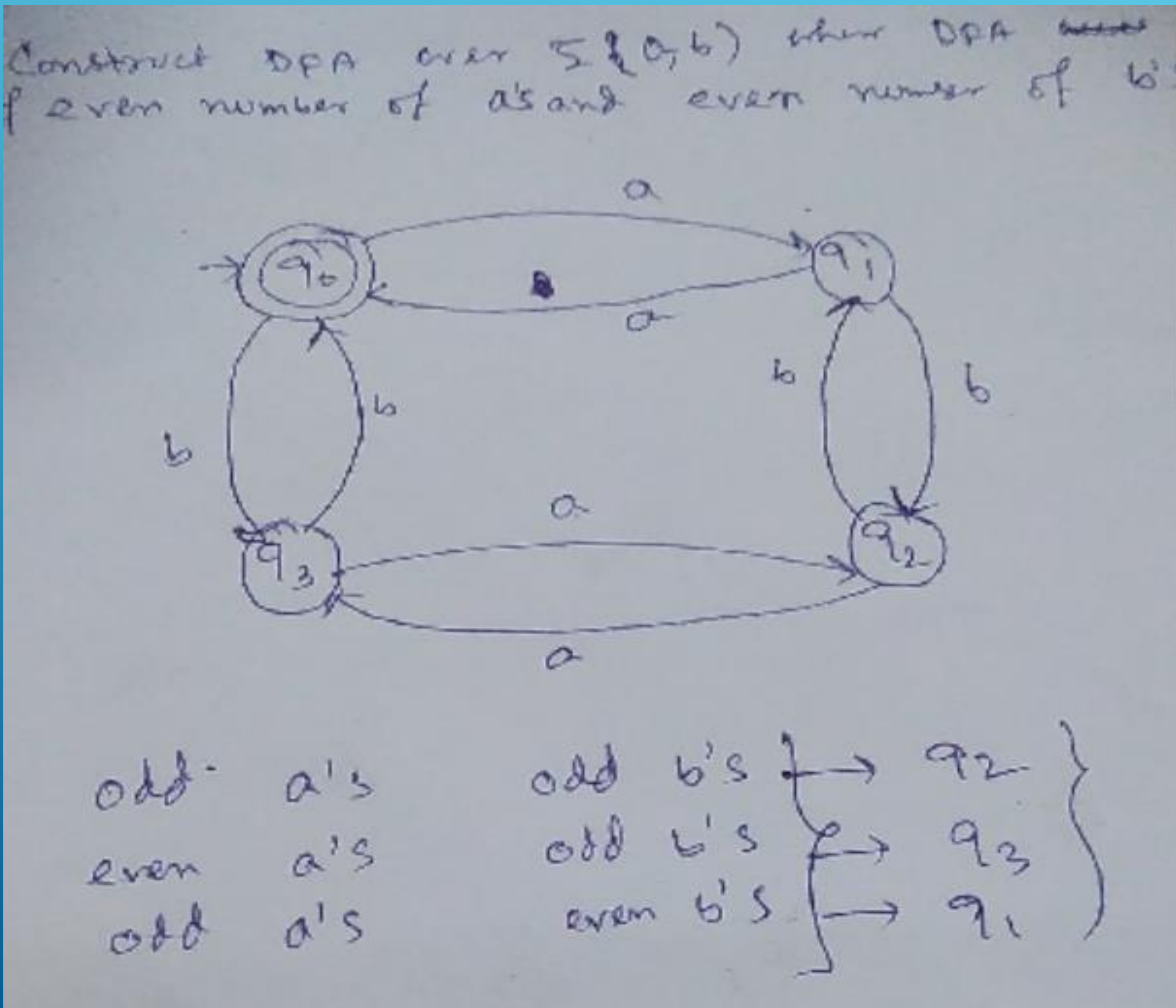
of δ: $\Rightarrow$

$q_0 \begin{cases} 0\times2+0 = 0 \rightarrow q_0 \\ 0\times2+1 = 1 \rightarrow q_1 \end{cases}$

$q_1 \begin{cases} 1\times2+0 = 2 \rightarrow q_2 \\ 1\times2+1 = 0 \rightarrow q_0 \end{cases}$

$q_2 \begin{cases} 2\times2+0 = 1 \rightarrow q_1 \\ 2\times2+1 \quad 2 \rightarrow q_2 \end{cases}$

Construct a DFA which accepts strings of even number of a’s and even number of b’s over ∑ {a, b}.



NONDETERMINISM

- A *nondeterministic finite automaton* has the ability to be in several states at once.
- Transitions from a state on an input symbol can be to any set of states.

- Start in one start state.
- Accept if any sequence of choices leads to a final state.

NFA DEFINITION

NFA is a 5-tuple $M = (Q, \Sigma, \delta, q, F)$

Q Set of states

Σ Alphabet

$\delta : (Q \times \Sigma) \rightarrow P(Q)$ is a Transition function

$q \in Q$ Initial state

$F \subseteq Q$ Set of final states

EXAMPLE NFA

- Set of all strings with two consecutive a's or two consecutive b's: