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Minimization of finite automata

Chapter - 2: Regular languages and finite automata

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Introduction

- Finite Automata can have redundant states
- Minimization reduces the number of states
- Result: A minimal DFA which accepts the same language

Why Minimize a DFA?

- 🔄 Reduce memory and computation cost
- 📊 Simplify analysis and implementation
- ✅ Minimal DFA is unique (up to state renaming)
- ❗ DFA minimization does not change the language accepted

Minimization Procedure Using Equivalence Theorem

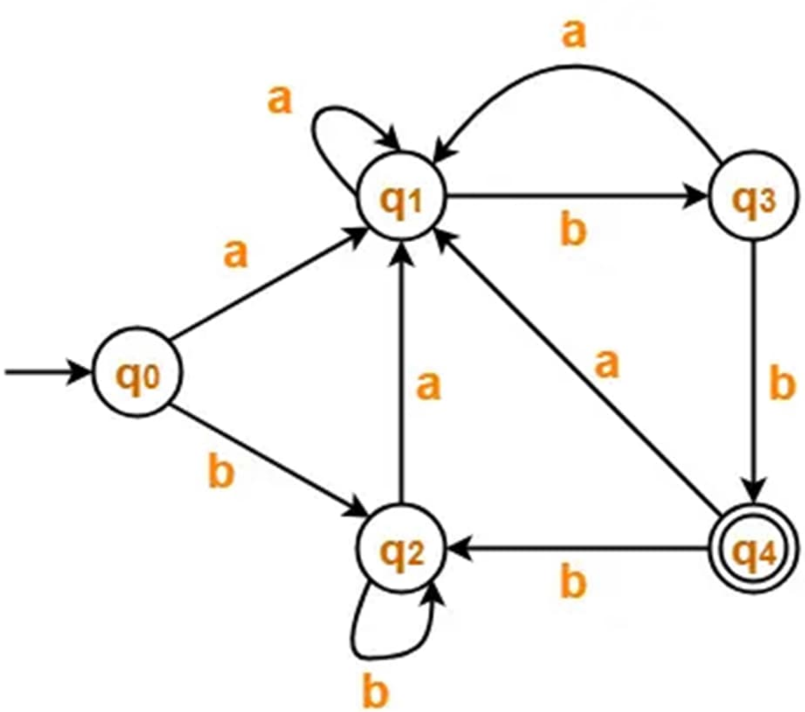
1. Eliminate Dead and Inaccessible States: Remove states that do not contribute to the acceptance of any string in the language.
2. Construct Transition Table: Create a table detailing transitions for each state on every input symbol.
3. Initial Partition (P_0): Divide the set of states into two groups: final (accepting) and non-final (non-accepting) states.
4. Refine Partitions:

- Iteratively split groups in the current partition if states within a group have transitions on the same input symbol leading to different groups in the previous partition.

Minimization Procedure Using Equivalence Theorem

5. Repeat Until Stable: Continue refining partitions until no further splits occur, i.e., the partition remains unchanged between iterations.
6. Merge Equivalent States: States that remain in the same group in the final partition are equivalent and can be merged.

Minimization of DFA - Example



Minimization of DFA - Example

Step-01:

The given DFA contains no dead states and inaccessible states.

Step-02:

Draw a state transition table-

a	b	
→q0	q1	q2
q1	q1	q3
q2	q1	q2
q3	q1	*q4
*q4	q1	q2

Minimization of DFA - Example

Step-03:

Now using Equivalence Theorem, we have-

$P_0 = \{ q_0 , q_1 , q_2 , q_3 \} \{ q_4 \}$

$P_1 = \{ q_0 , q_1 , q_2 \} \{ q_3 \} \{ q_4 \}$

$P_2 = \{ q_0 , q_2 \} \{ q_1 \} \{ q_3 \} \{ q_4 \}$

$P_3 = \{ q_0 , q_2 \} \{ q_1 \} \{ q_3 \} \{ q_4 \}$

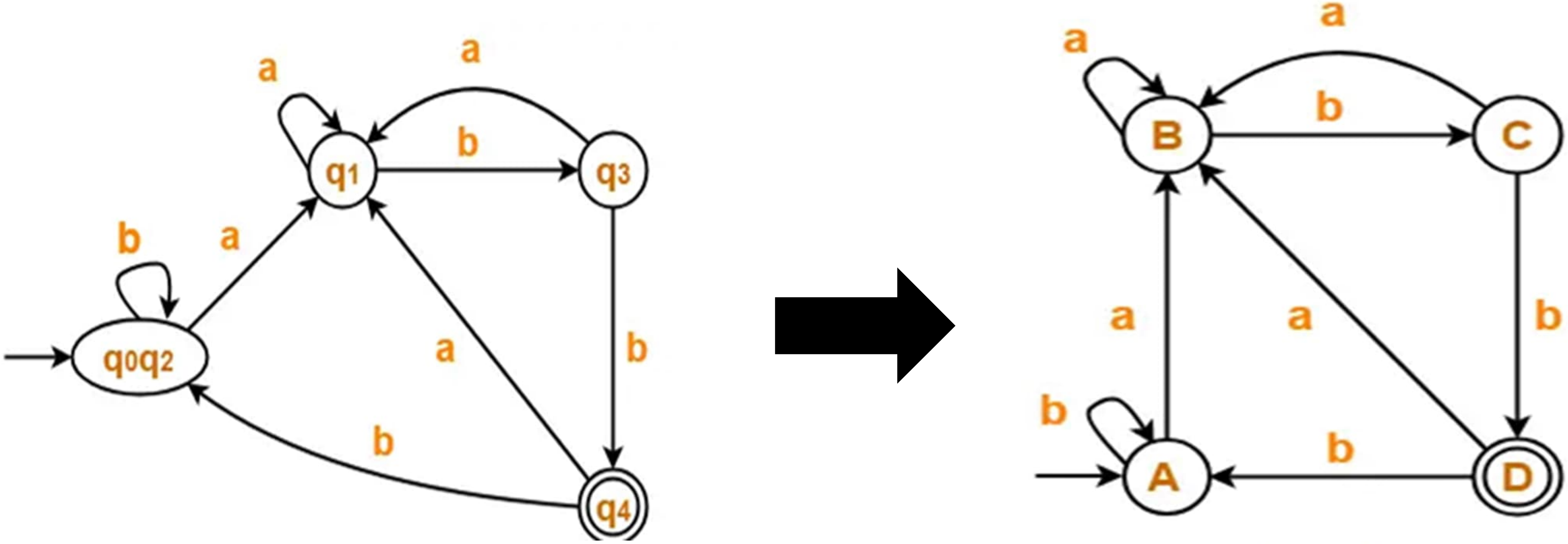
Since $P_3 = P_2$, so we stop.

From P_3, we infer that states q_0 and q_2 are equivalent and can be merged together.

Minimization of DFA - Example

<u>Step-03:</u>

So, Our minimal DFA is-



Minimal DFA

Properties of Minimal DFA

- Unique for a given regular language
- No equivalent states
- No unreachable states
- Used as canonical form of a regular language

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