

*The DFA minimization is the process of reducing states in a deterministic finite automaton (DFA) and maintaining its language recognition abilities.*

That means, DFA minimization is aimed at finding a DFA with the least number of states that can recognize the same language as the original DFA.

### Some of the benefits of minimizing DFA:

- Reduced memory usage: DFAs with fewer states require less memory to store. This can be important for applications where memory usage is a constraint.
- Improved computational efficiency: DFAs with fewer states can process strings more quickly. This can be important for applications where processing speed is a concern.
- Enhanced understanding: DFAs with fewer states are generally easier to understand and analyze. This can be helpful for debugging and maintaining DFAs.
- Simplified hardware implementation: DFAs with fewer states are more amenable to hardware implementation. This can be important for applications where performance is critical.

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### Example of DFA minimization:

Construct a minimum state automata equivalent to given automata?

(RGPV 2008)



Solution:

Transition table for above automata.

State	Input = a	Input = b
->q0 Initial state	q1	q3
q1	q2	q4
q2	q1	q1
q3	q2	q4

q4 Final state	q4	q4
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Step 01: Remove steps which are unreachable from initial states.

Step 02: Split final states and non final states.

- $A_0 = \{q_4\}$
- $A_1 = \{q_0, q_1, q_2, q_3\}$
- $\pi_0 = \{q_4\}, \{q_0, q_1, q_2, q_3\}$
- $A_0$  cannot be partition further.

In  $A_1$ ,

- $q_0$  is 1 equivalent to  $q_2$  for input  $a$ , but not equivalent to  $q_1$  and  $q_3$ .
- $q_1$  is 1 equivalent to  $q_3$  for input  $a$  and  $b$ , but not to  $q_0$  and  $q_2$ .

So,  $A_1$  can be partitioned as,

- $B_0 = \{q_0, q_2\}$
- $B_1 = \{q_1, q_3\}$
- $\pi_1 = \{q_4\}, \{q_0, q_2\}, \{q_1, q_3\}$

Now,  $B_0$  and  $B_1$  can not be partitioned further.

- $\pi_2 = \{q_4\}, \{q_0, q_2\}, \{q_1, q_3\}$
- $\pi_2 = \pi_1$

In minimized DFA, we have three states,

- {q4},
- {q0,q2},
- {q1,q3}

Minimized DFA:

State	Input = a	Input = b
->{q0,q2} Initial state	{q1,q3}	{q1,q3}
{q1,q3}	{q0,q2}	{q4}
{q4} Final state	{q4}	{q4}



Reference:

- Introduction to the Theory of Computation” by Michael Sipser.

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49. Grammar is ambiguous.  $S \rightarrow aSbS|bSaS|\epsilon$

50. leftmost and rightmost derivations
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52. RGPV TOC PYQs
53. Introduction to Automata Theory