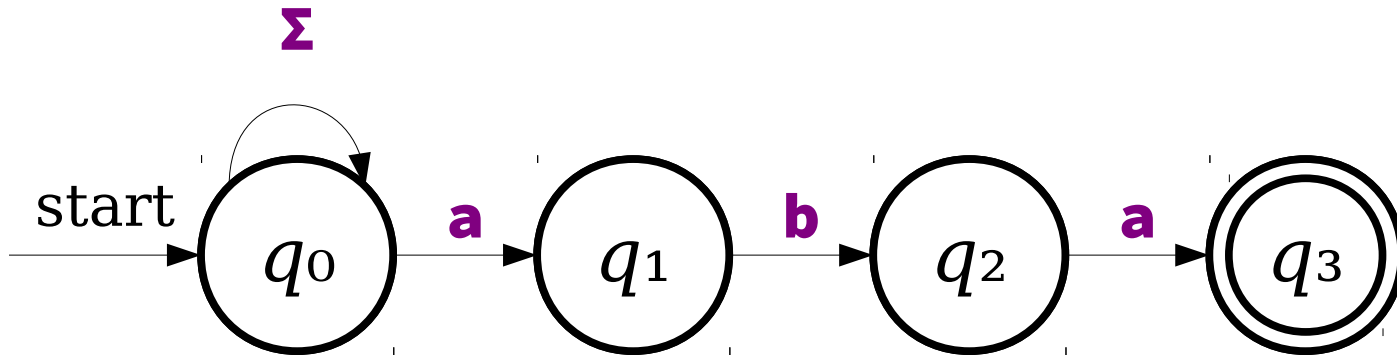


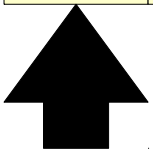
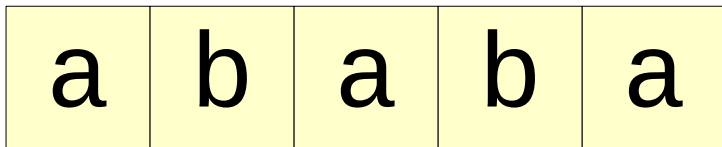
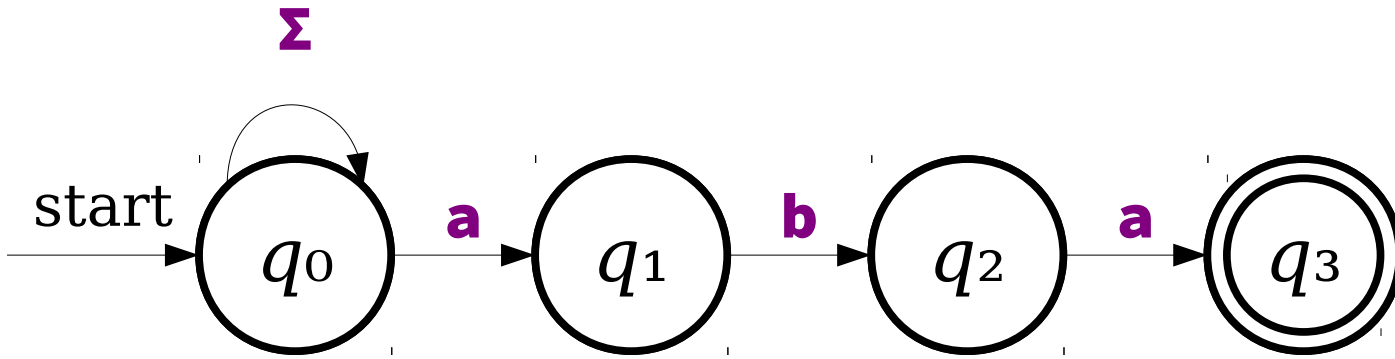
Intuiting Nondeterminism

- Nondeterministic machines are a serious departure from physical computers. How can we build up an intuition for them?
- There are two particularly useful frameworks for interpreting nondeterminism:
 - *Perfect guessing*
 - *Massive parallelism*

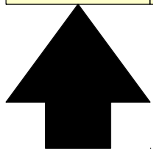
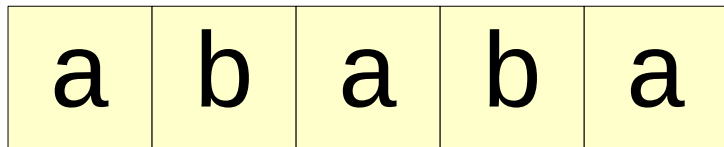
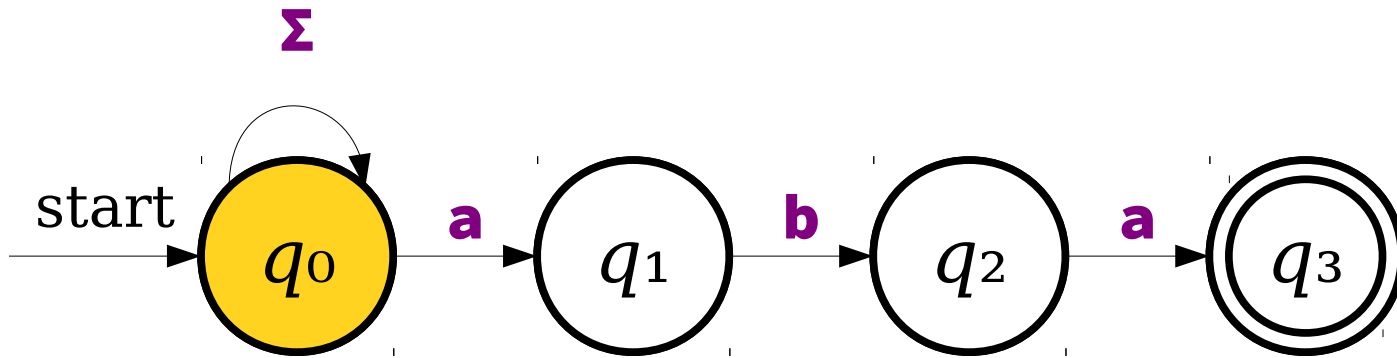
Perfect Guessing



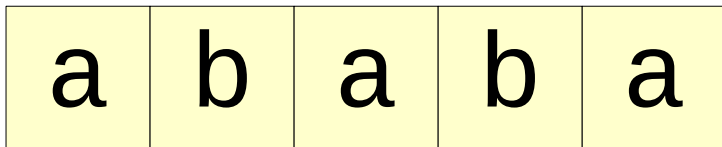
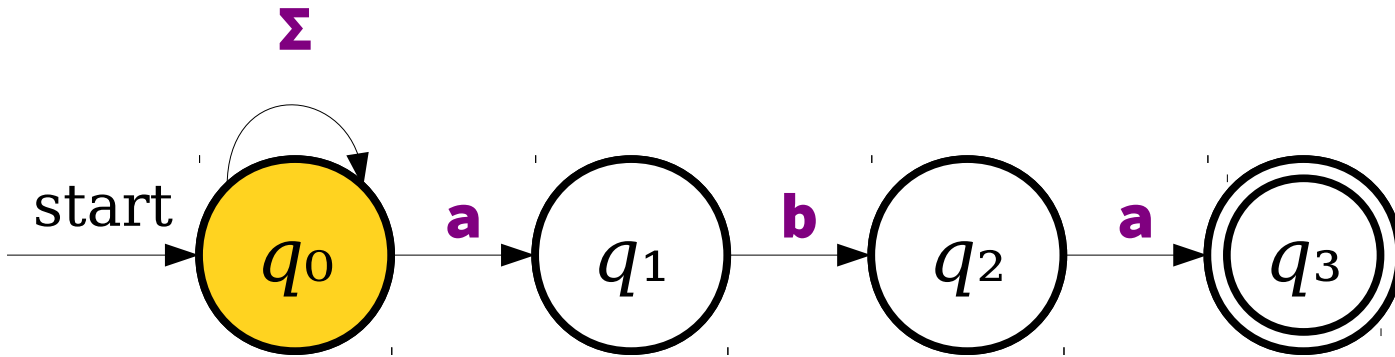
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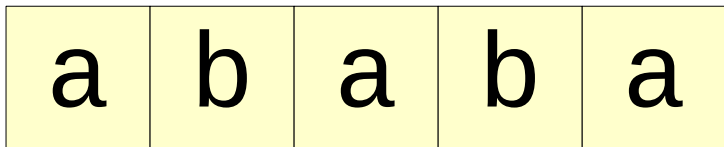
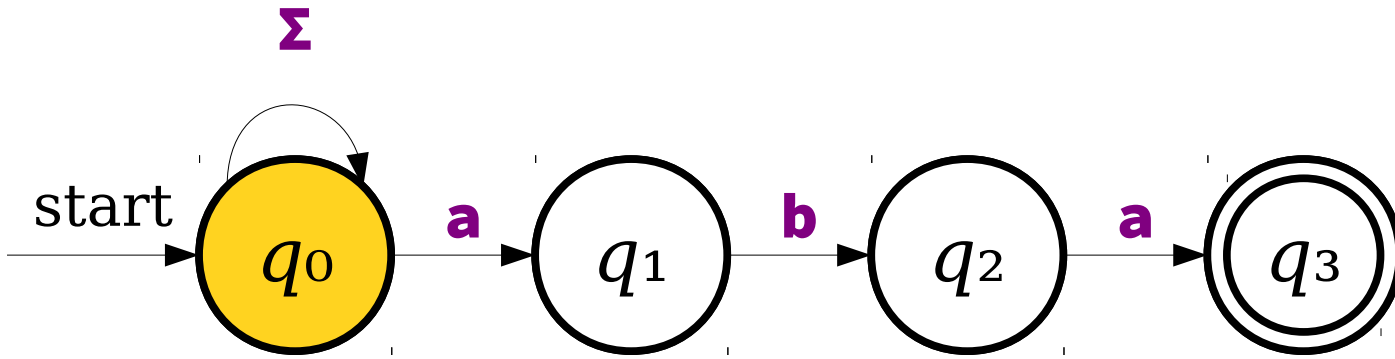
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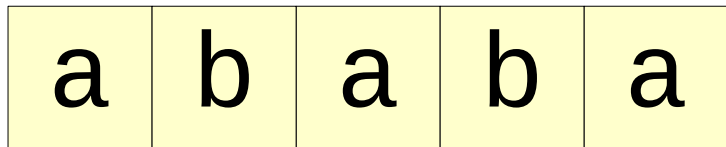
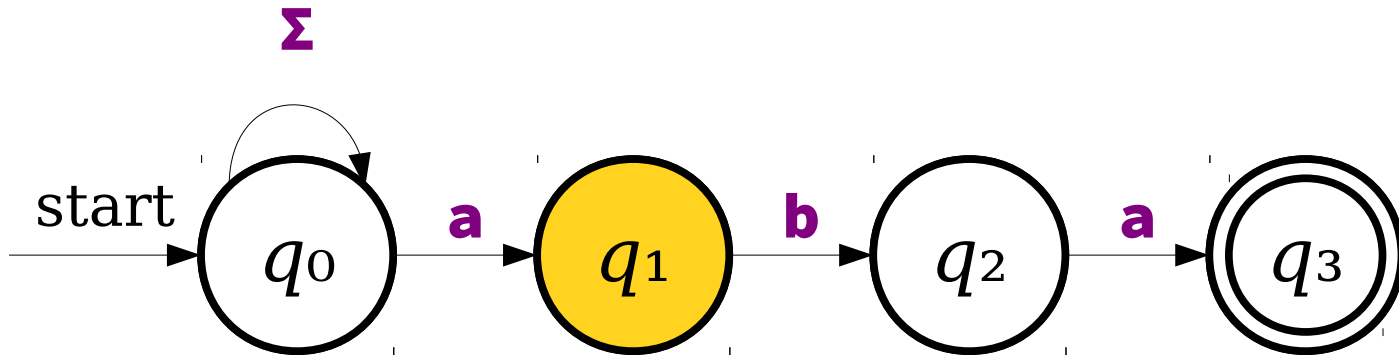
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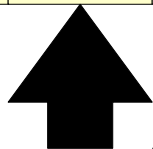
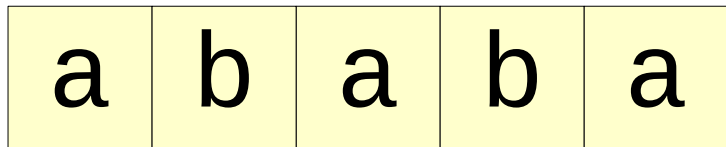
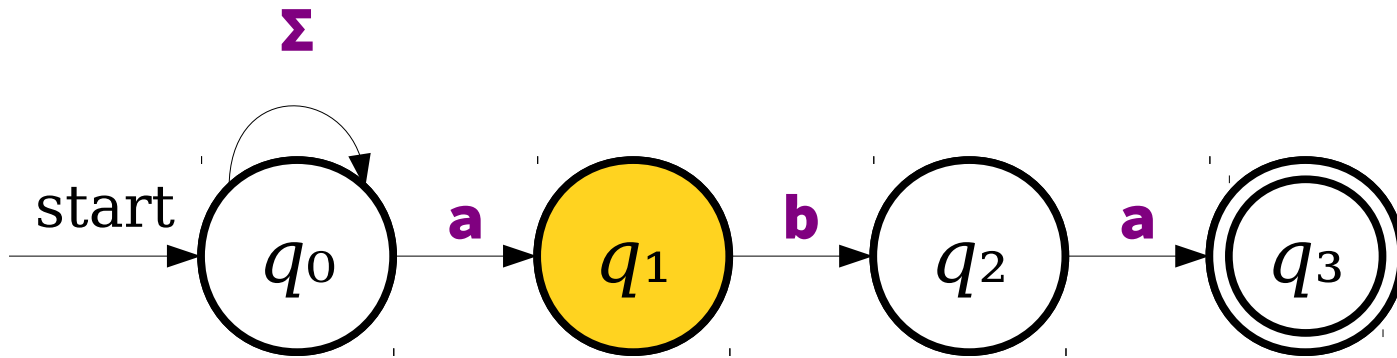
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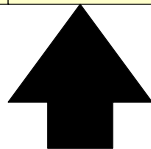
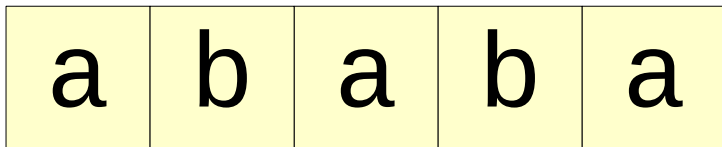
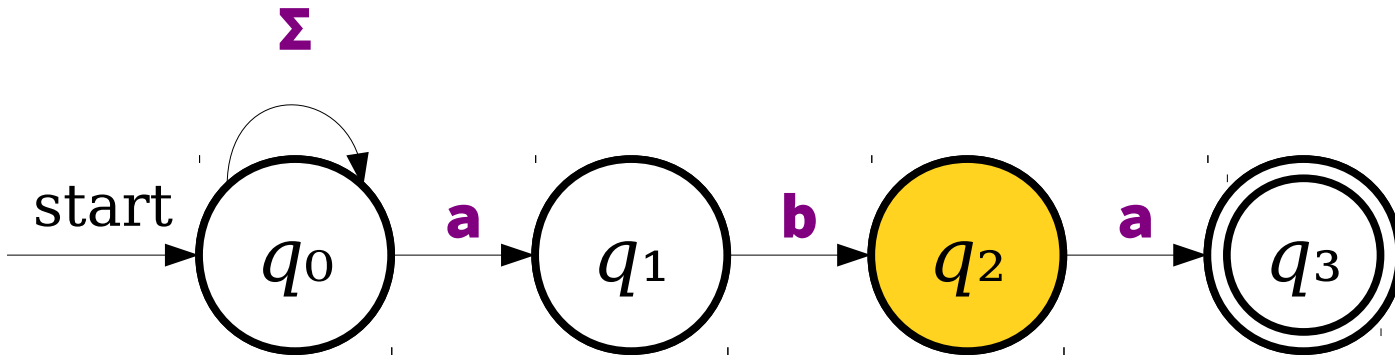
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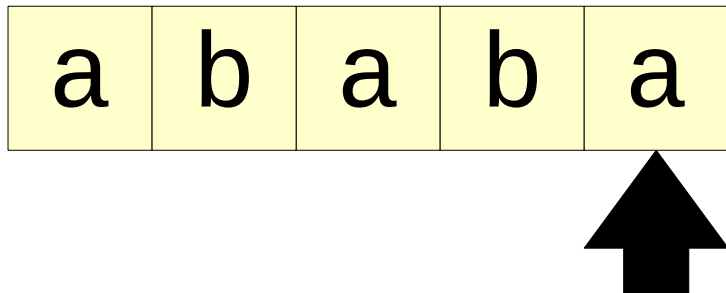
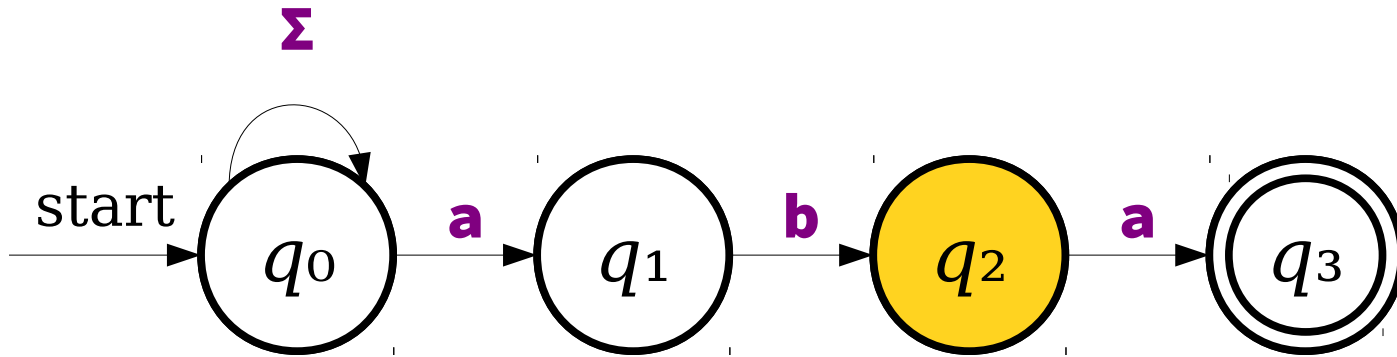
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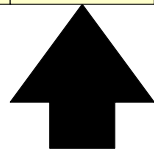
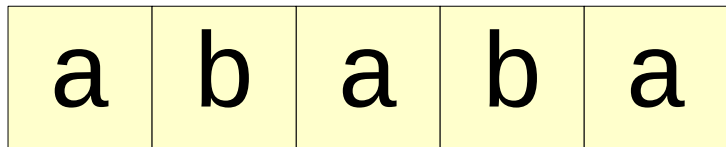
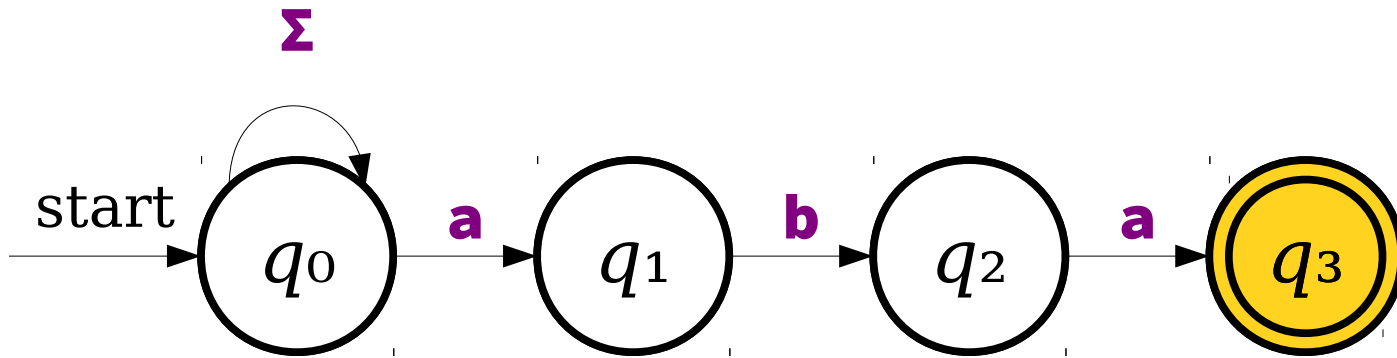
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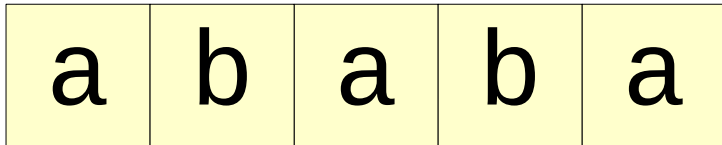
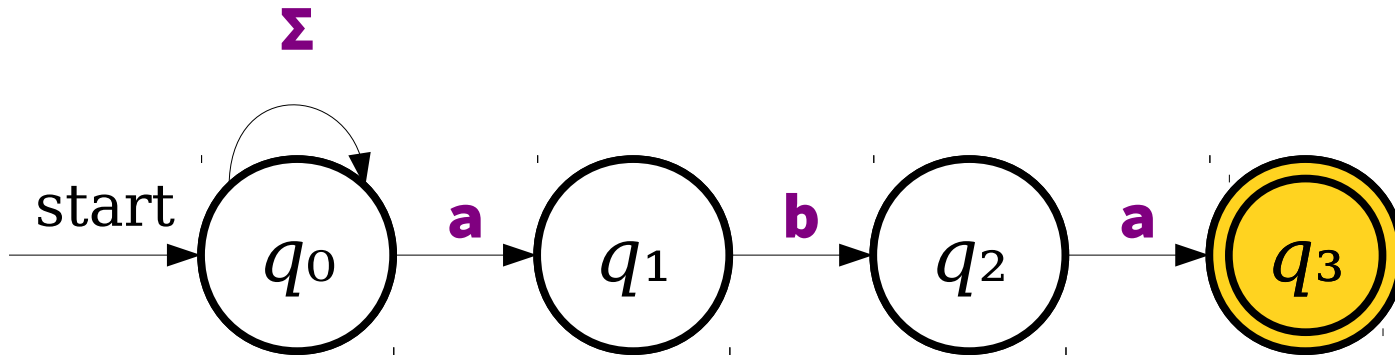
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Perfect Guessing



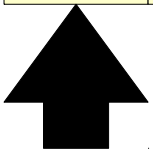
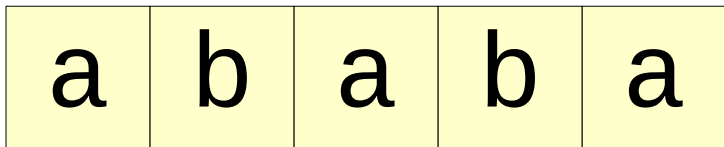
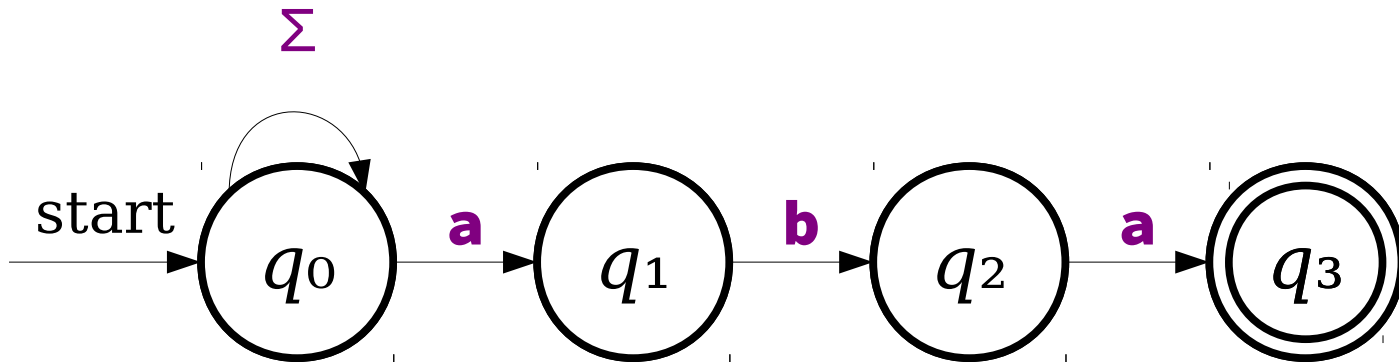
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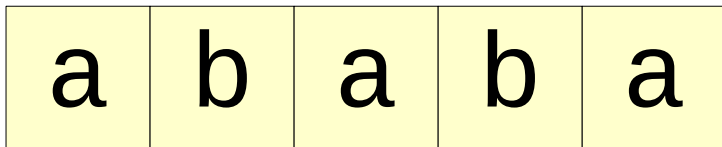
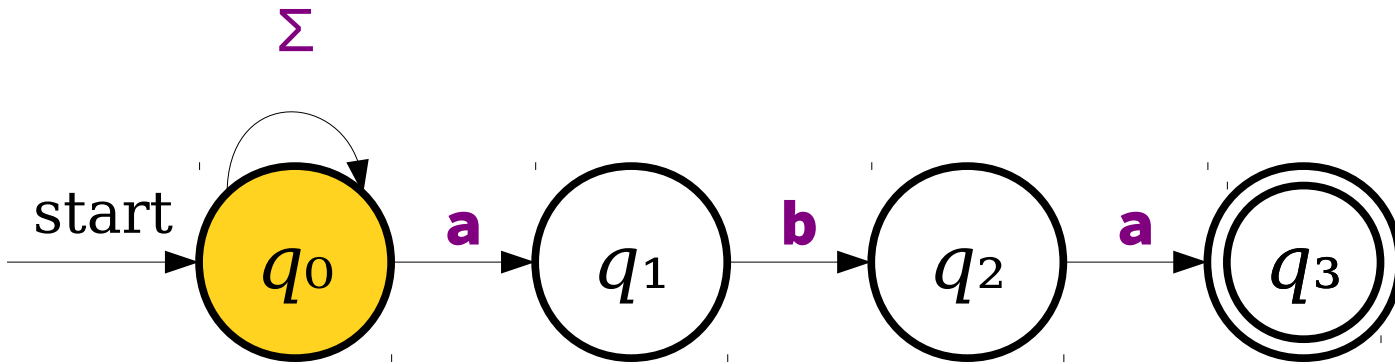
Perfect Guessing

- We can view nondeterministic machines as having *Magic Superpowers* that enable them to guess choices that lead to an accepting state.
 - If there is at least one choice that leads to an accepting state, the machine will guess it.
 - If there are no choices, the machine guesses any one of the wrong guesses.
- No known physical analog for this style of computation – this is totally new!

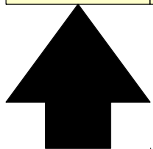
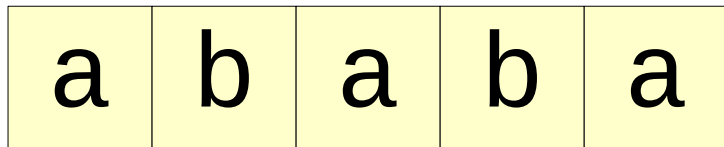
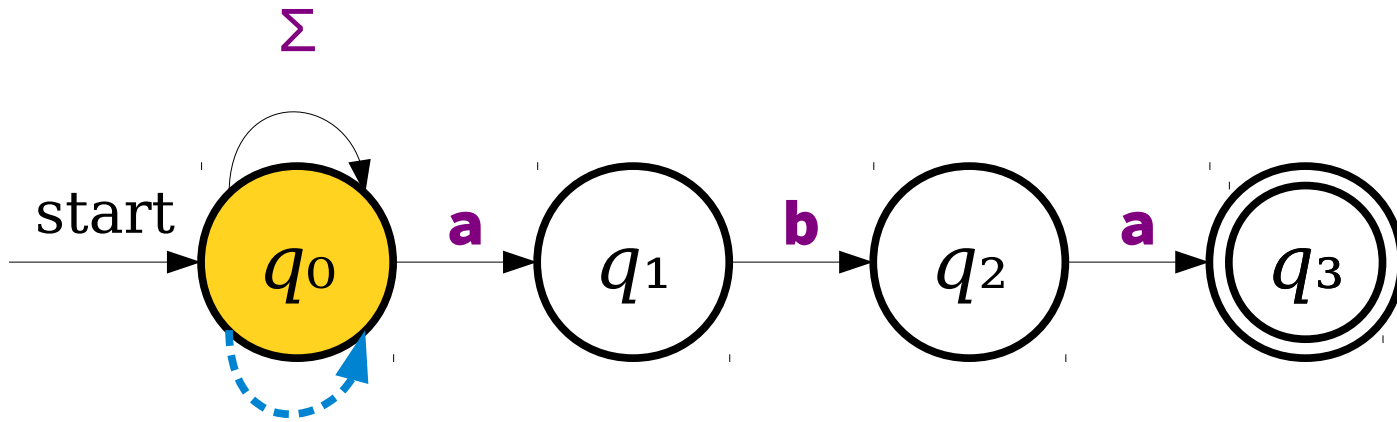
Massive Parallelism



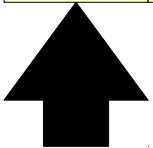
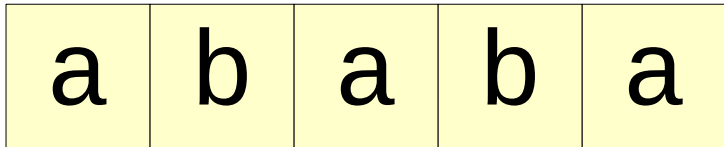
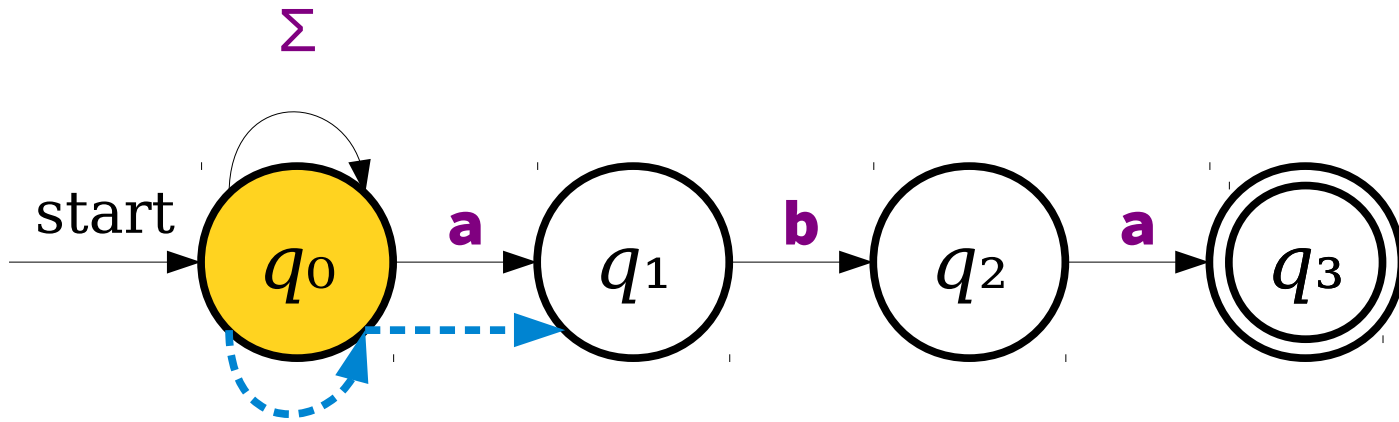
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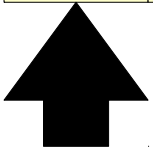
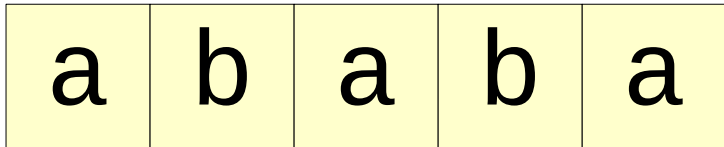
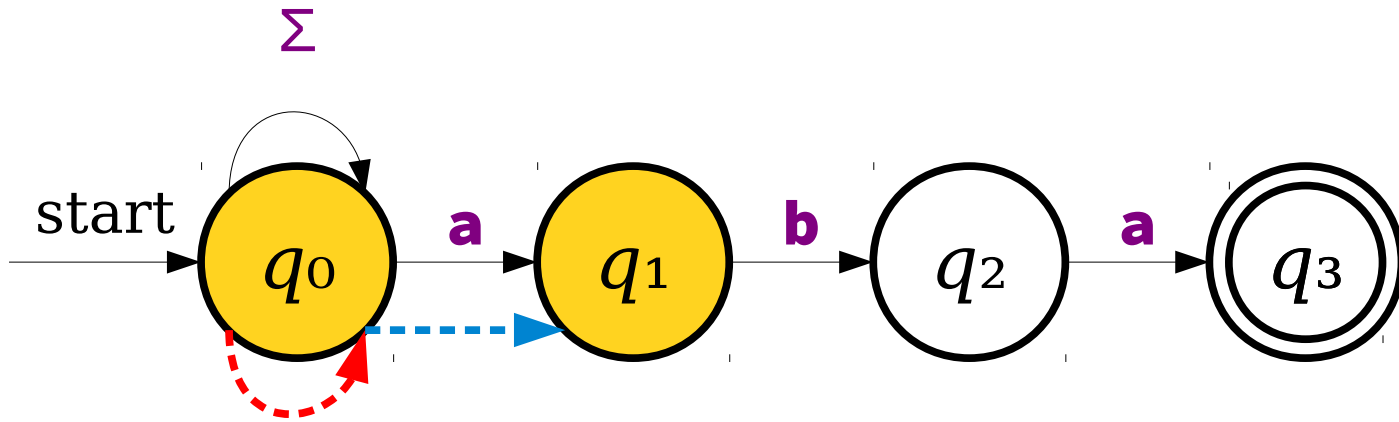
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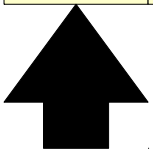
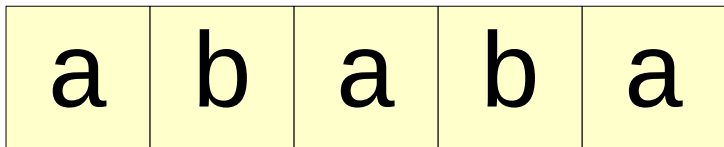
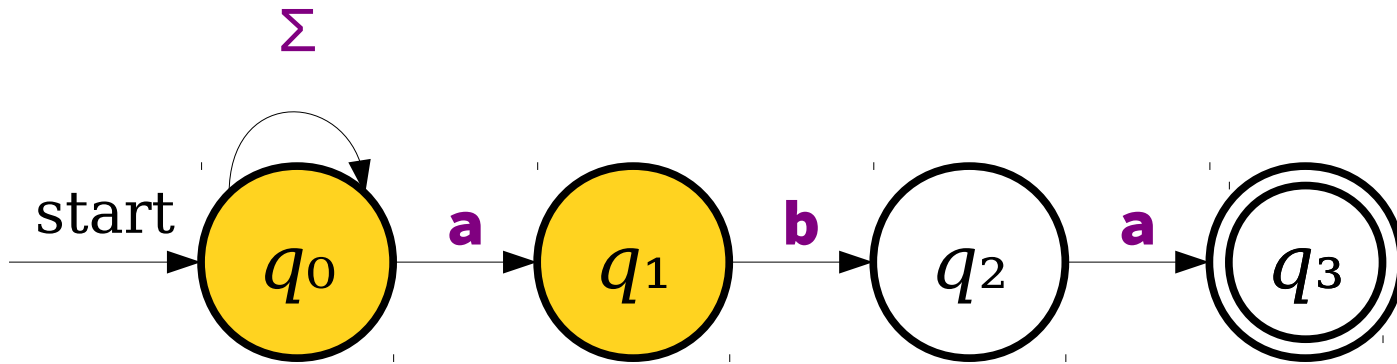
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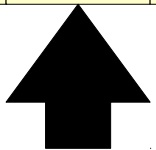
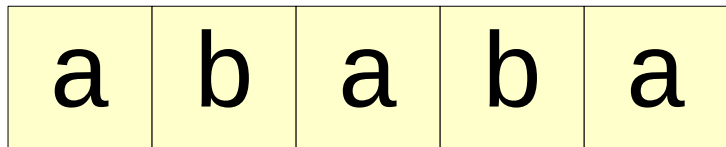
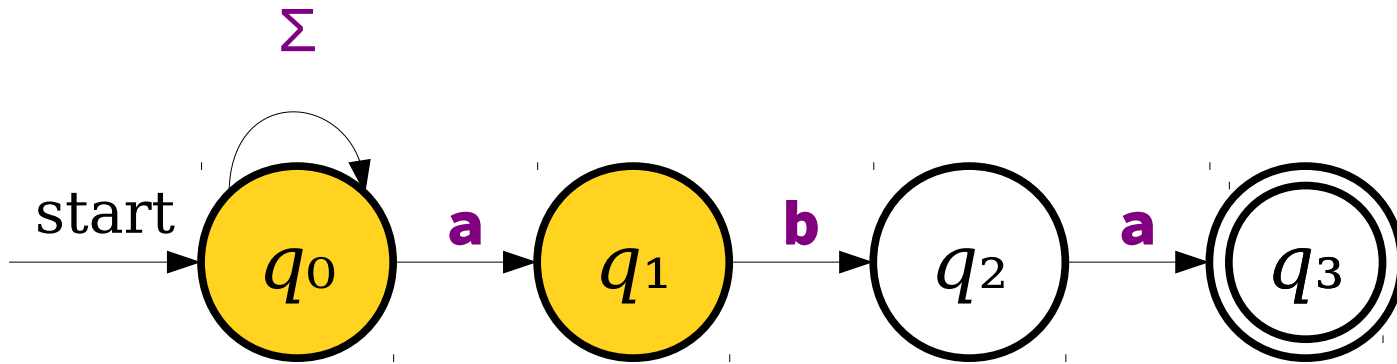
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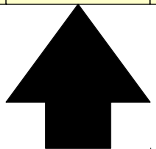
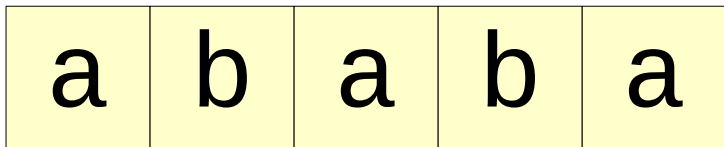
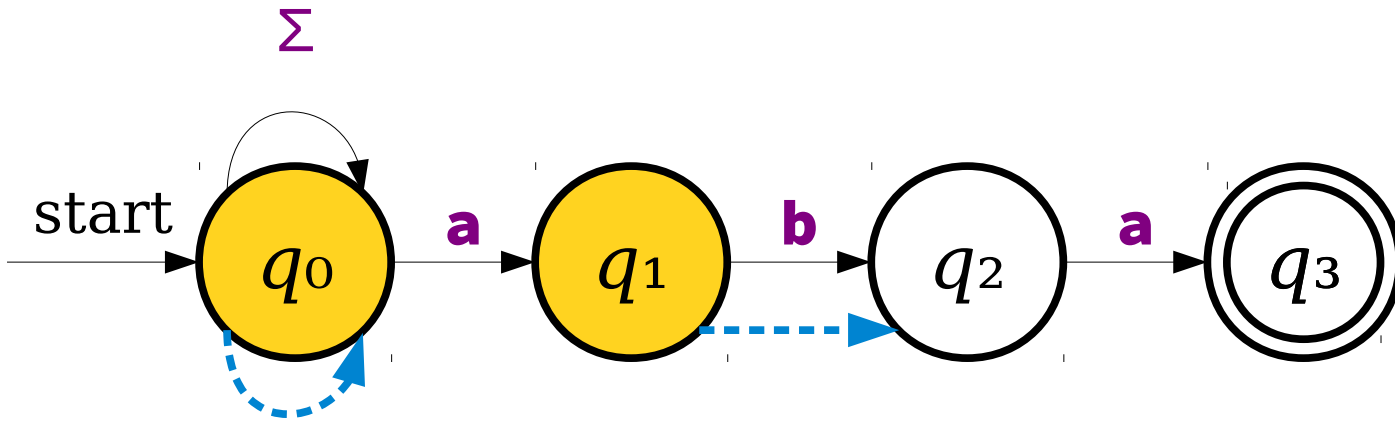
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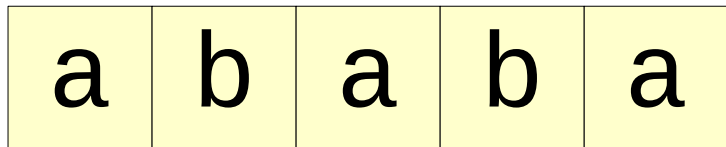
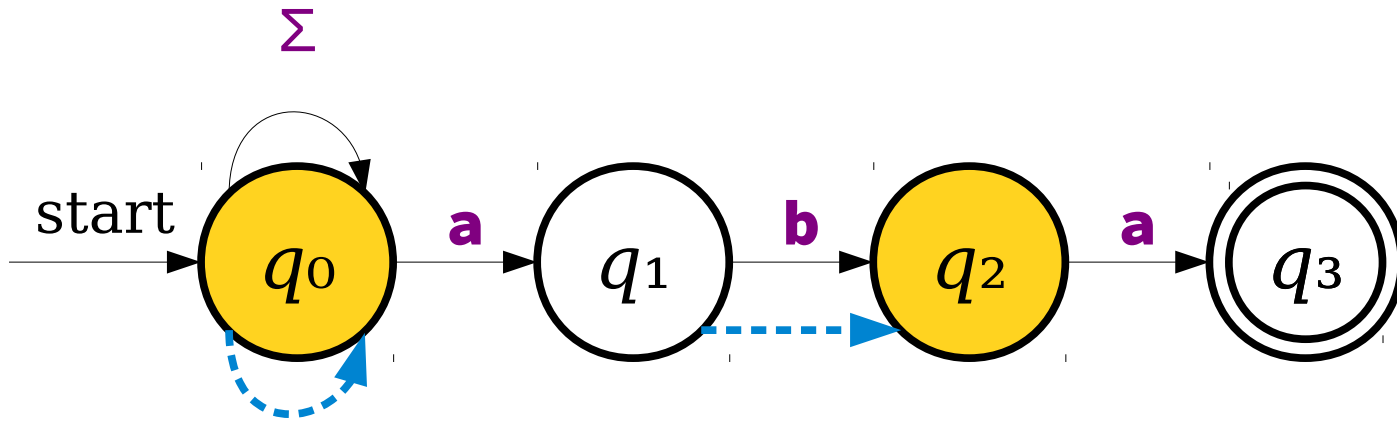
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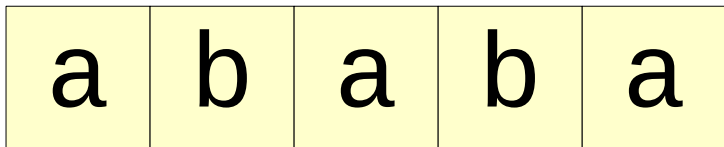
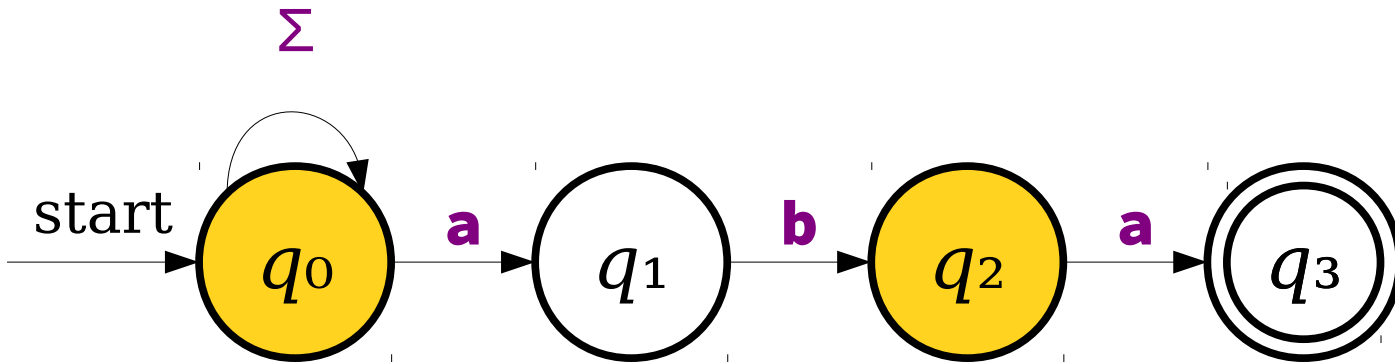
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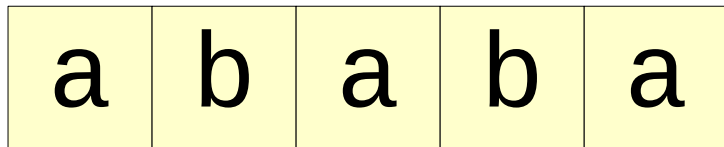
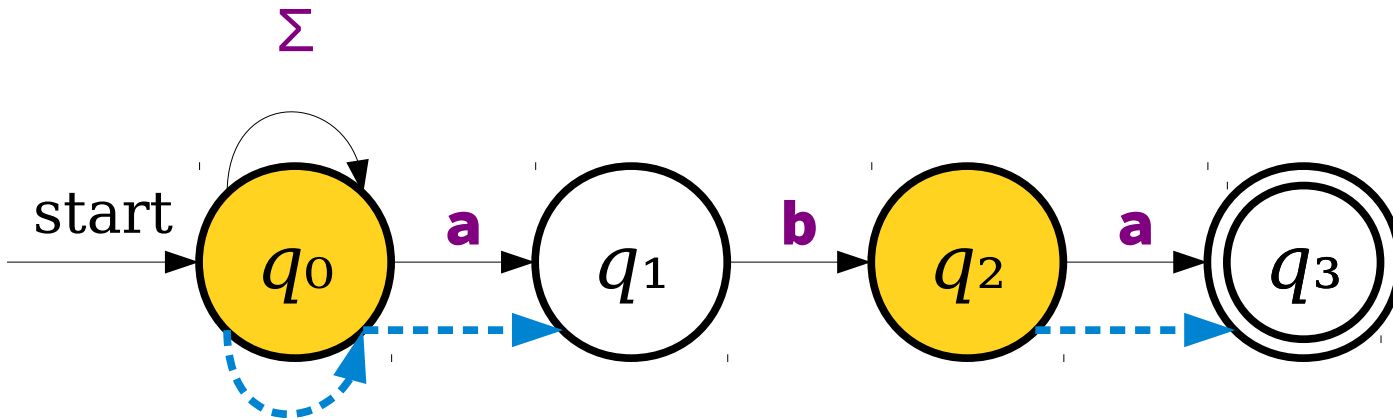
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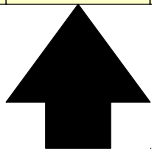
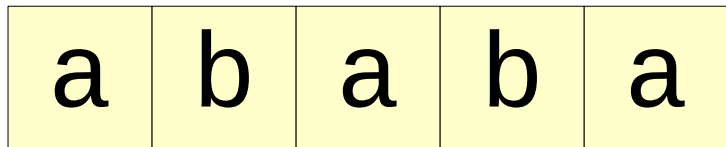
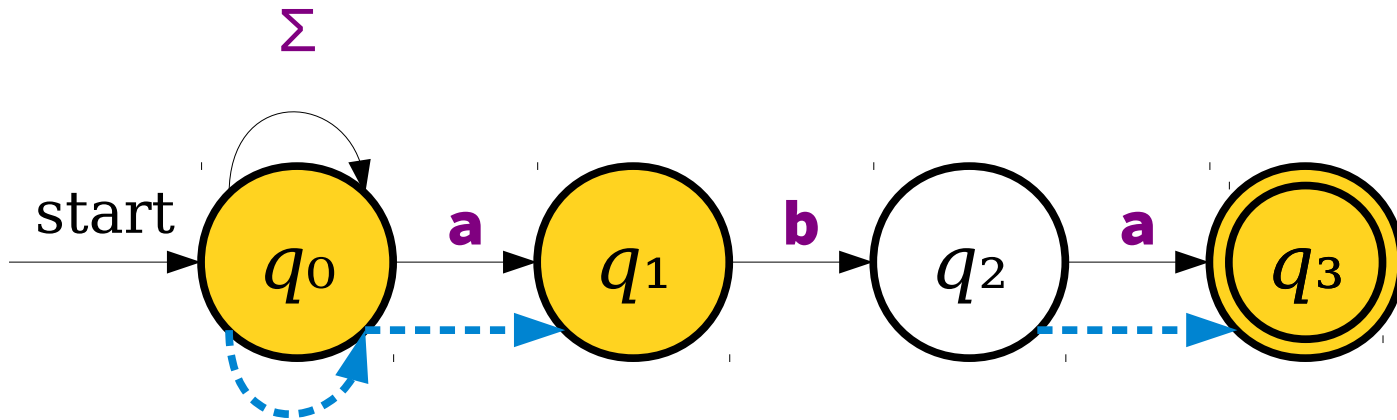
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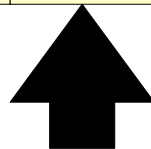
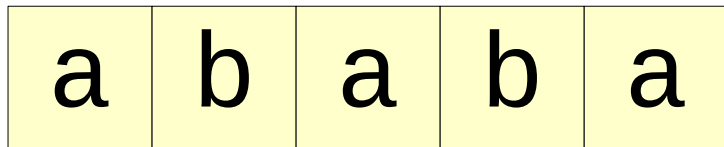
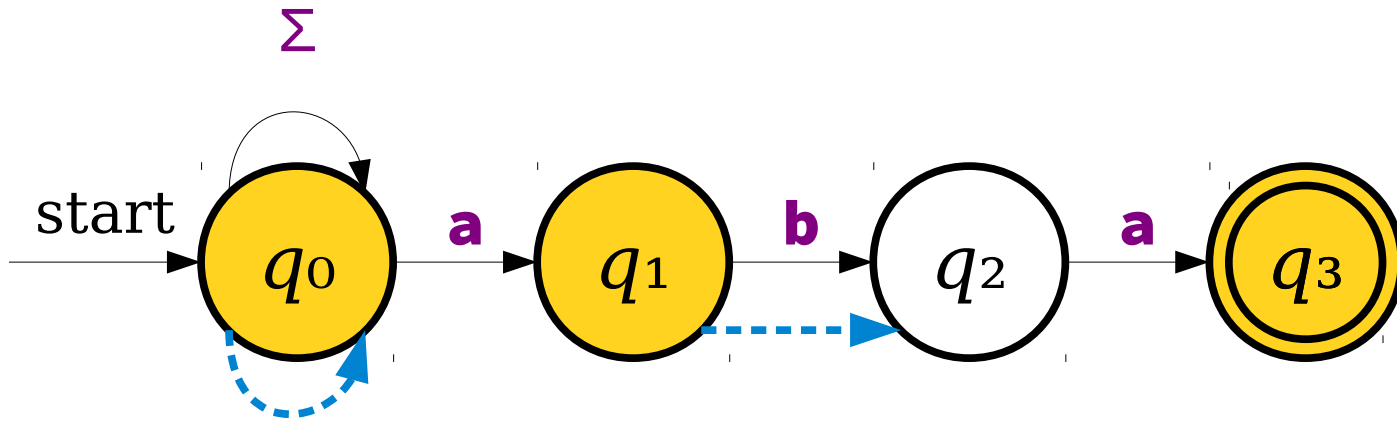
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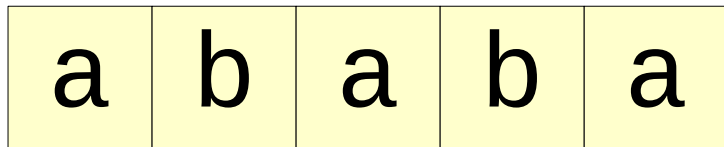
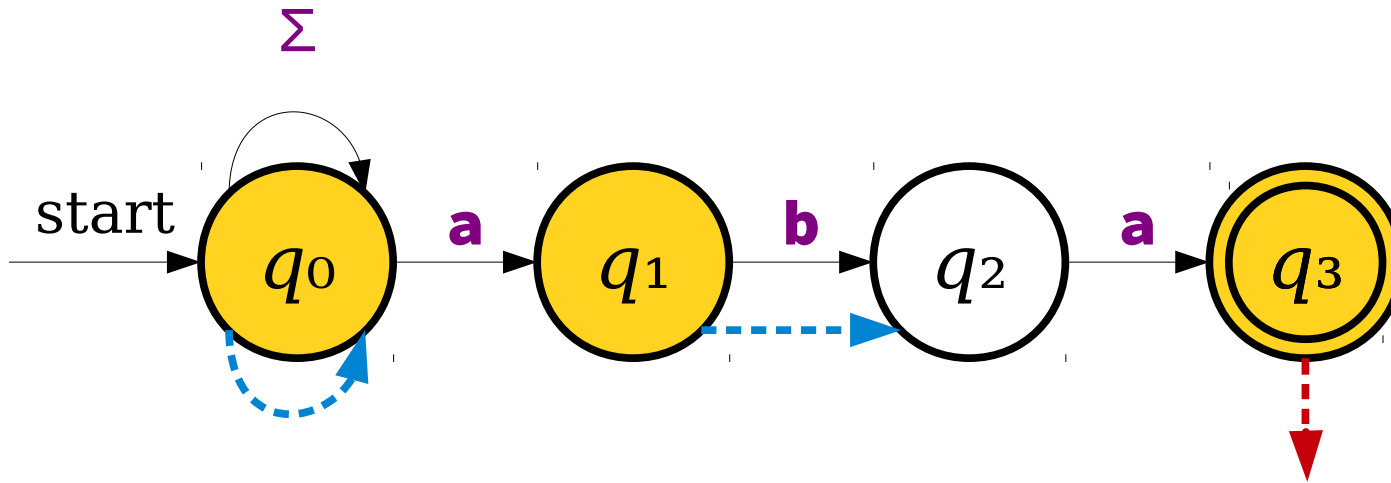
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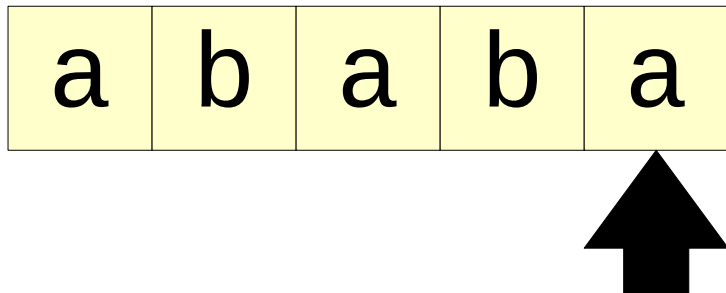
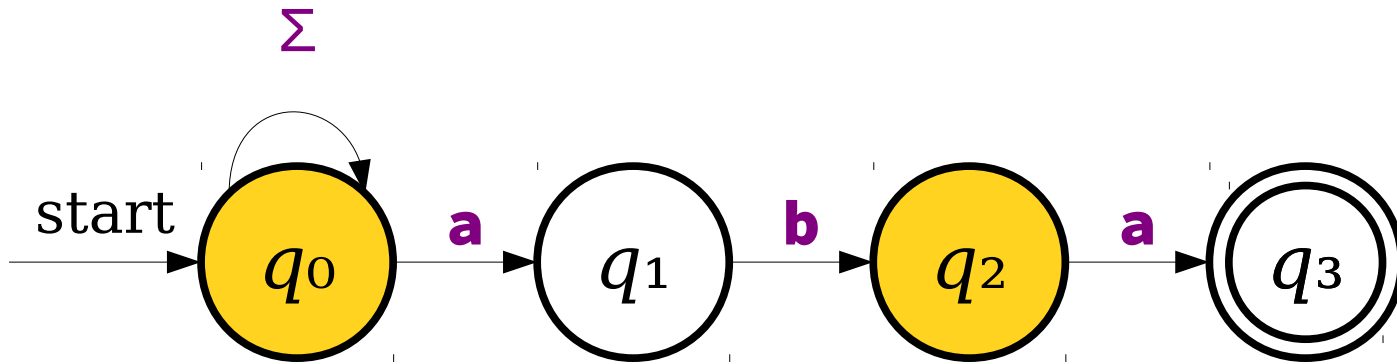
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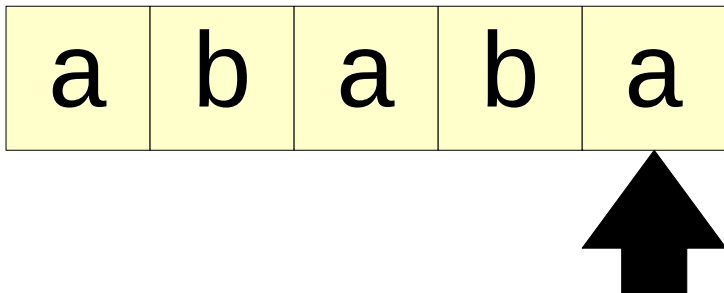
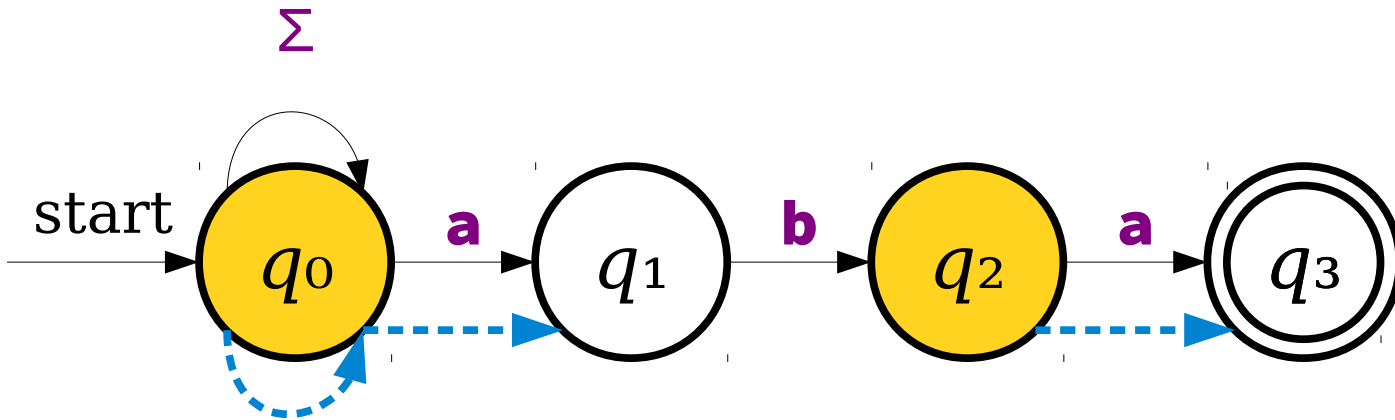
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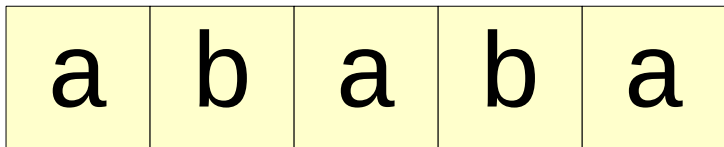
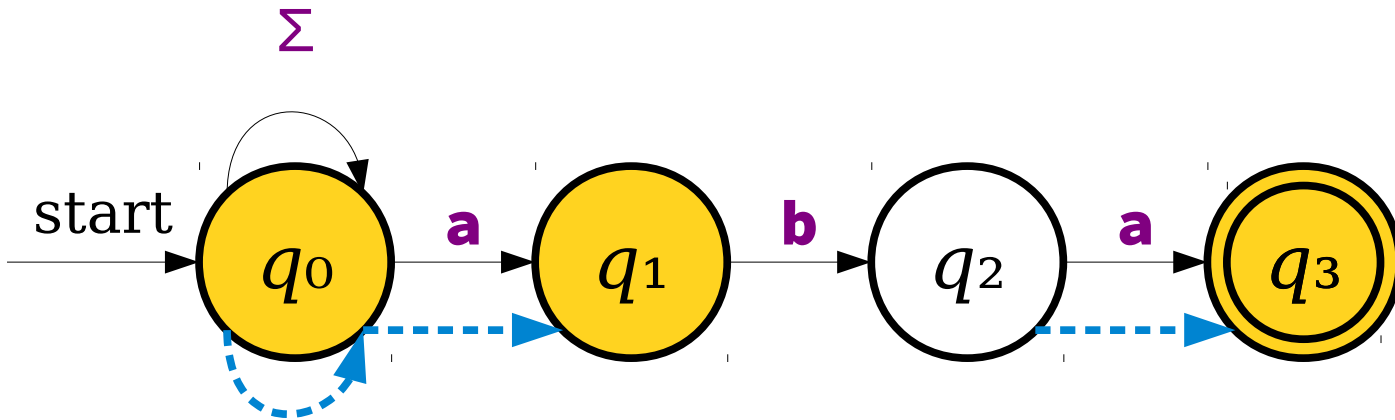
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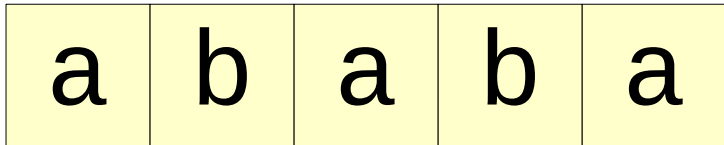
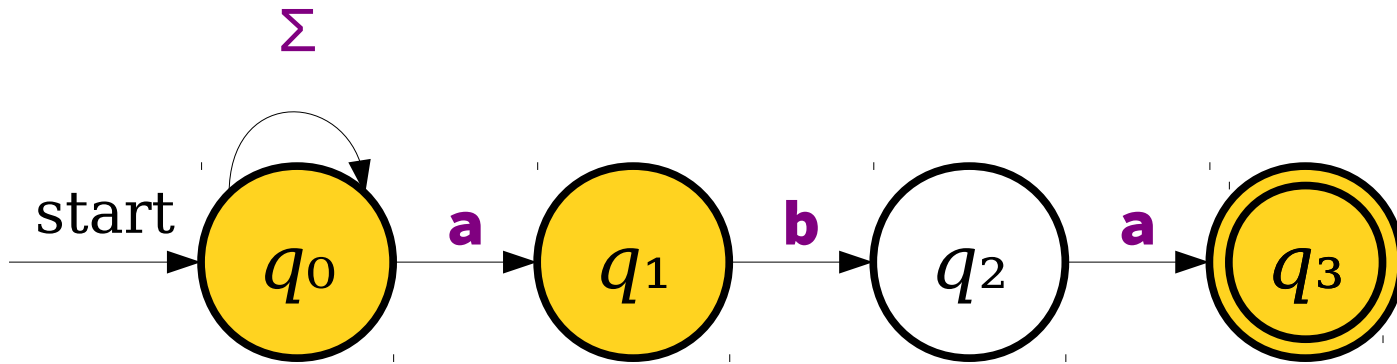
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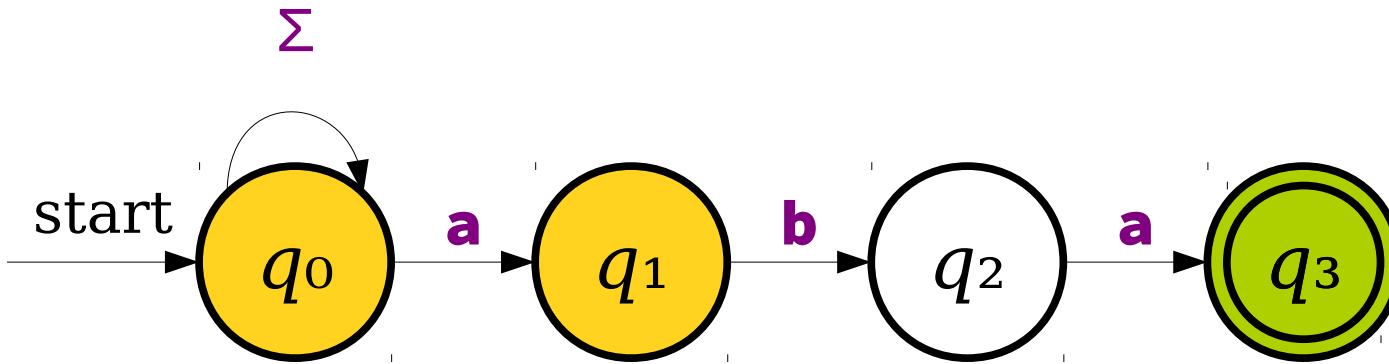
Massive Parallelism



Massive Parallelism



Massive Parallelism



a	b	a	b	a
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We're in at least one accepting state, so there's some path that gets us to an accepting state.

Therefore, we accept!

Massive Parallelism

- An NFA can be thought of as a DFA that can be in many states at once.
- At each point in time, when the NFA needs to follow a transition, it tries all the options at the same time.
- (Here's a rigorous explanation about how this works; for reading after class).
 - Start off in the set of all states formed by taking the start state and including each state that can be reached by zero or more ϵ -transitions.
 - When you read a symbol **a** in a set of states S :
 - Form the set S' of states that can be reached by following a single **a** transition from some state in S .
 - Your new set of states is the set of states in S' , plus the states reachable from S' by following zero or more ϵ -transitions.

So What?

- Each intuition of nondeterminism is useful in a different setting:
 - Perfect guessing is a great way to think about how to design a machine.
 - Massive parallelism is a great way to test machines – and has nice theoretical implications.
- Nondeterministic machines may not be feasible, but they give a great basis for interesting questions:
 - Can any problem that can be solved by a nondeterministic machine be solved by a deterministic machine?
 - Can any problem that can be solved by a nondeterministic machine be solved *efficiently* by a deterministic machine?
- The answers vary from automaton to automaton.