CS345H: Programming Languages

Lecture 4: Implementation of Lexical Analysis

Thomas Dillig

Announcements

- WA1 and PA0 are due Today

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- WA2 and PA1 out today :-)

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- If you are not very, very busy right now, get started now

Outline

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- Today: How to recognize strings matching regular expressions using finite automata.
- We will see determinist finite automata (DFAs) and non-deterministic finite automata (NFAs)
- High-level story: RegEx -> NFA -> DFA -> Tables

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- We adapt regular expressions for this goal

Regular Expressions to Lexical Specifications (1)

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- Then, remove $x_1 ... x_j$ from input and repeat

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- This is known as "maximal munch"

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- Rule: Use rule listed first
- This is how `"if"` is matched as a keyword, not identifier

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- Better Solution: Write a rule matching all "bad" strings
- Question: What kind of rule and where to place it?

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- Next: How to decide if $s \in L(R)$

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  - A set of transitions state $\rightarrow^{\text{input}}$ state

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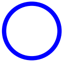
A state:



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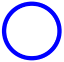
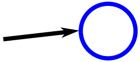
A state: 

The start state: 

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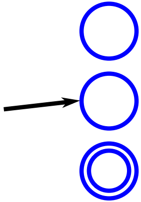

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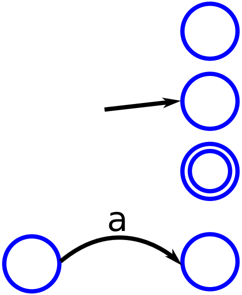

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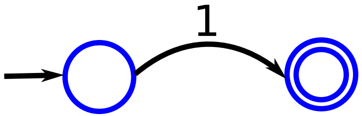

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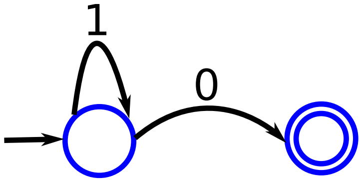

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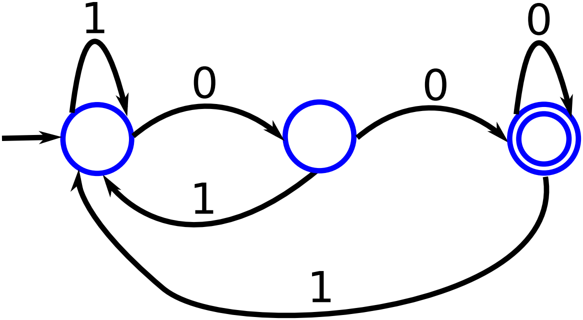

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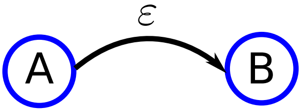

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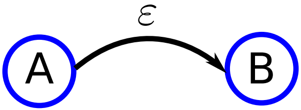

- Machine can move from state A to B without reading any input

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- NFAs can choose:
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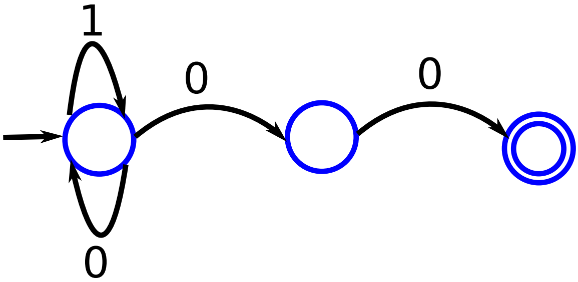

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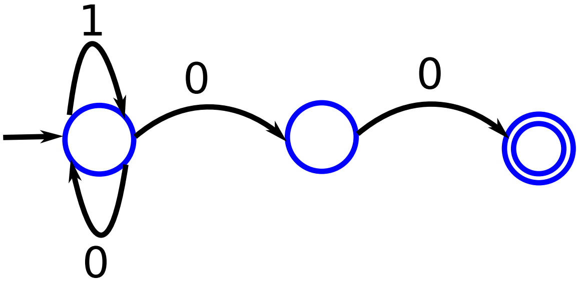

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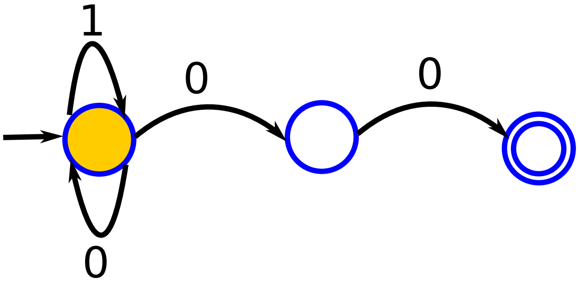

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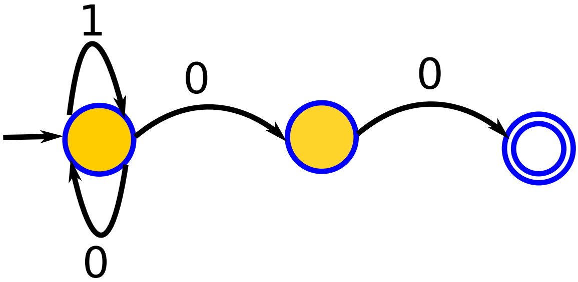

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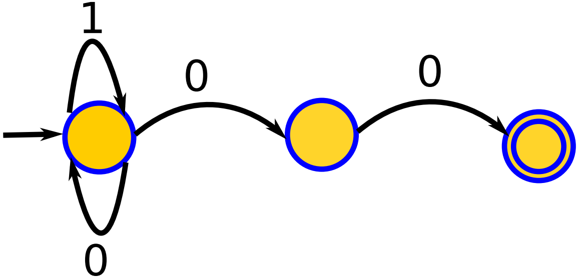

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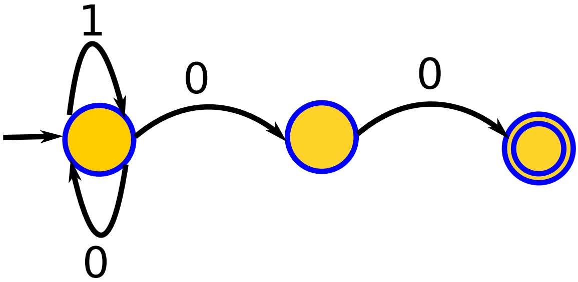

- Rule: NFA accepts if it can get to a final state

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- Result: DFAs can be exponentially larger than NFA recognizing same language

Regular Expressions to Finite Automata

- High-Level Sketch:

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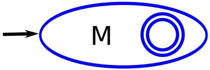

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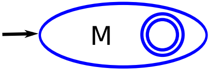

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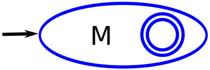

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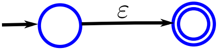
  - For ε : 

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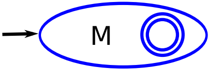

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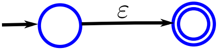
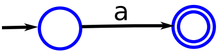


  - For input a:



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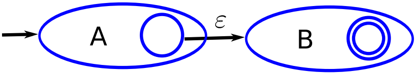
- For AB: 

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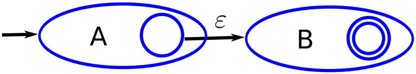
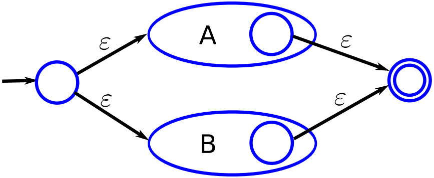
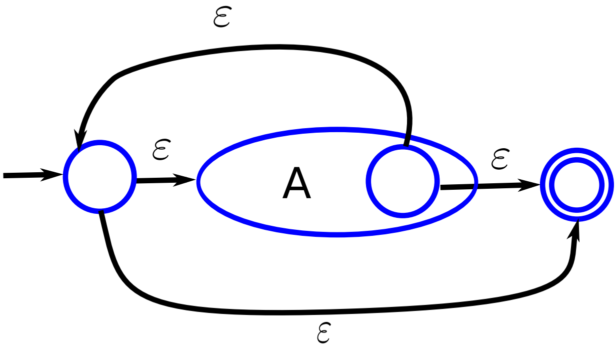
- For AB: 

- For $A + B$: 

Regular Expressions to NFA (3)

- For A^*:



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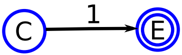

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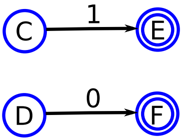

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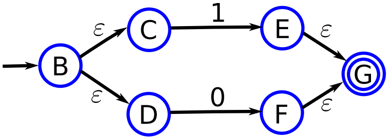

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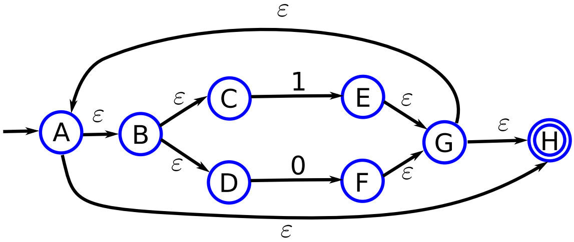

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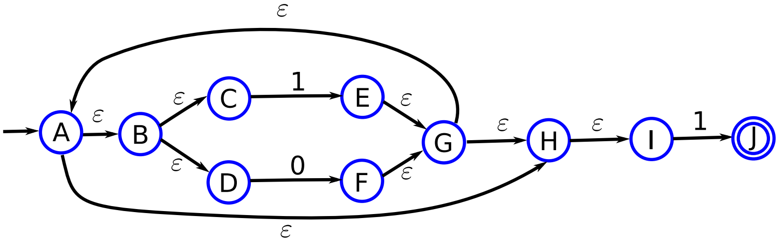

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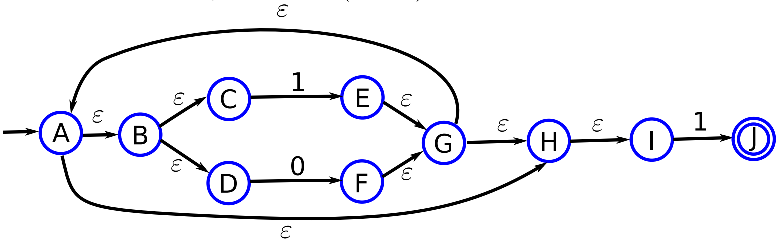

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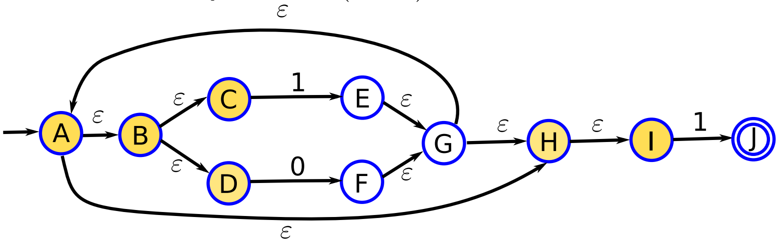

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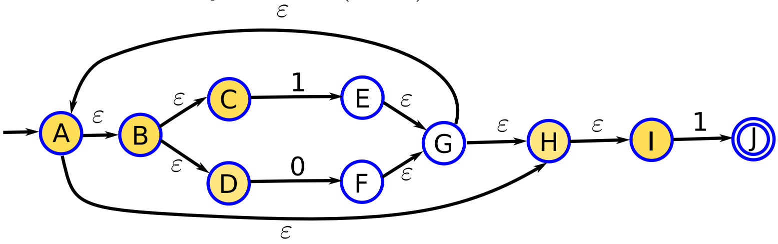

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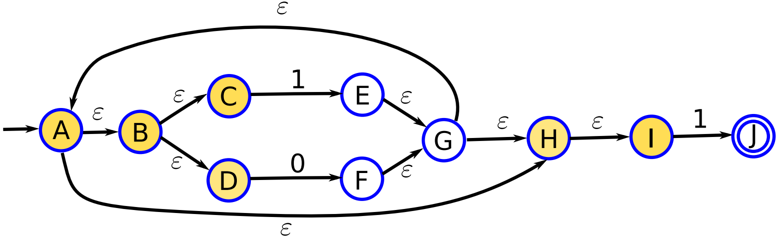

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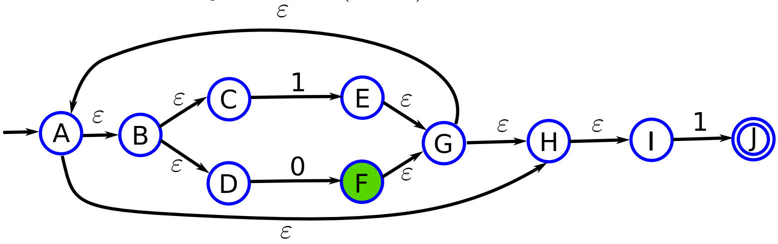

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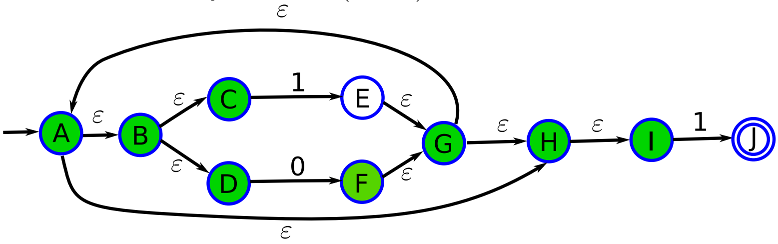

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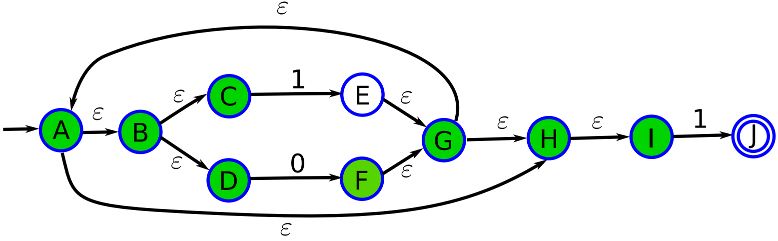

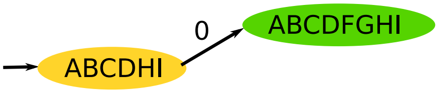

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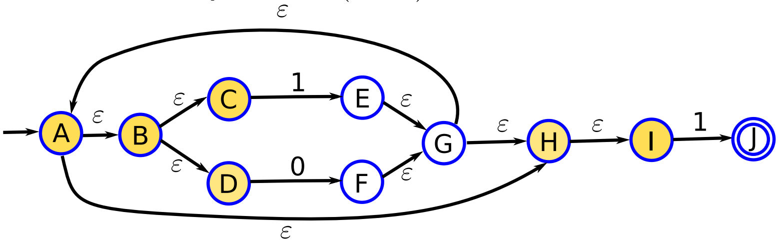

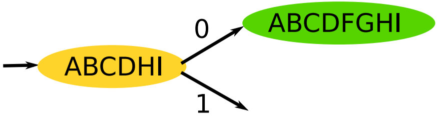

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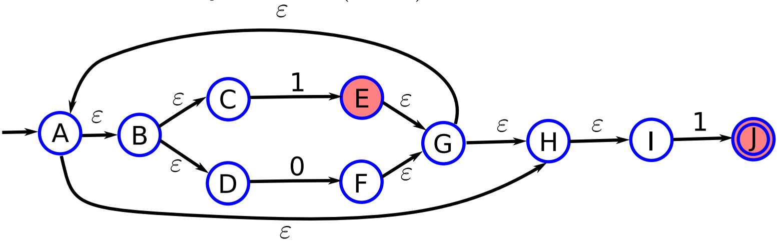

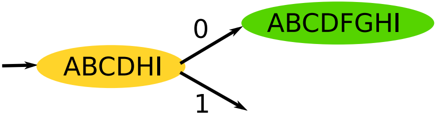

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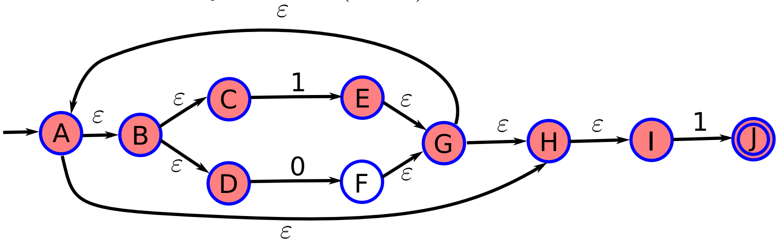

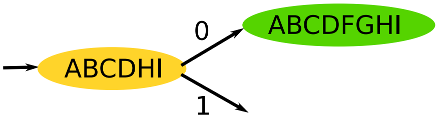

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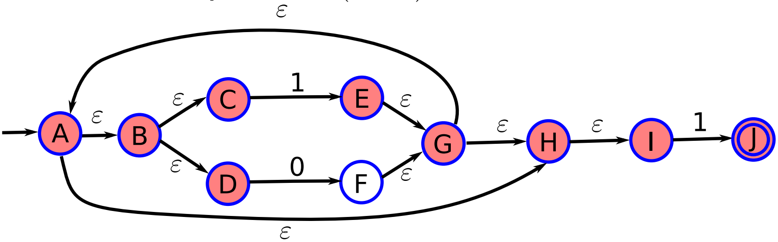

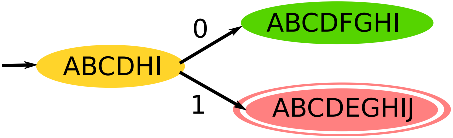

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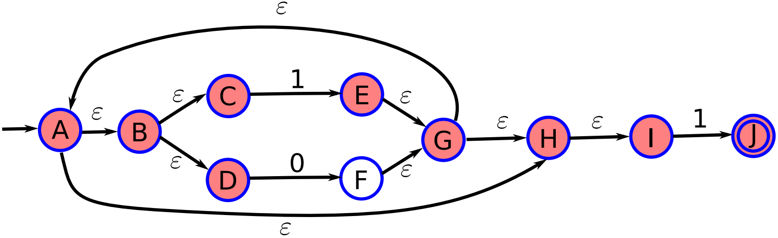

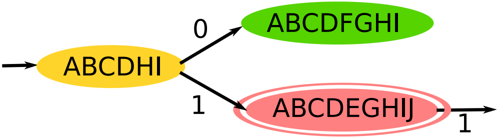

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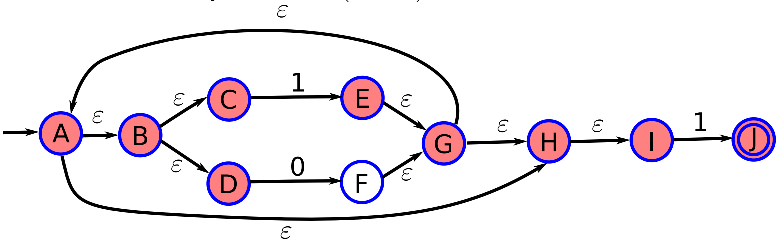

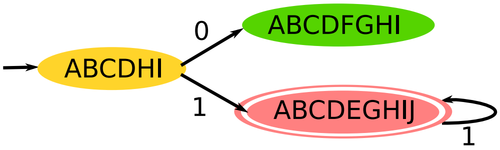

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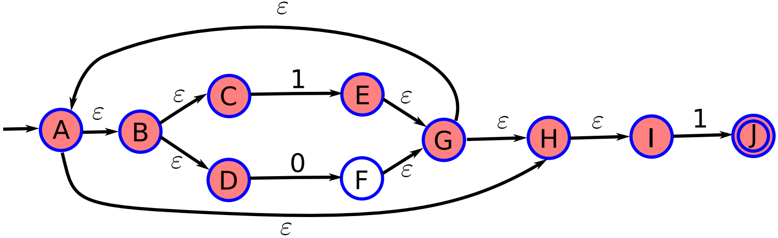

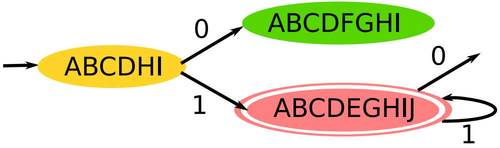

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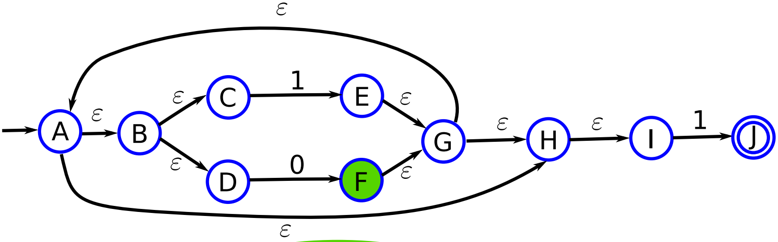

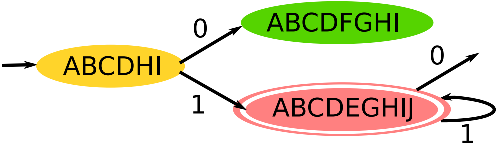

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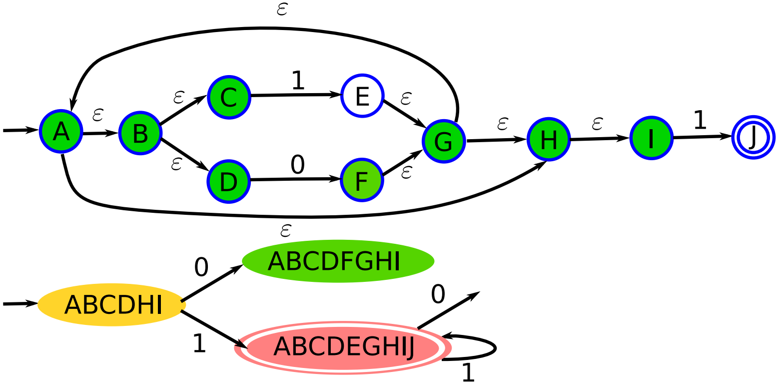

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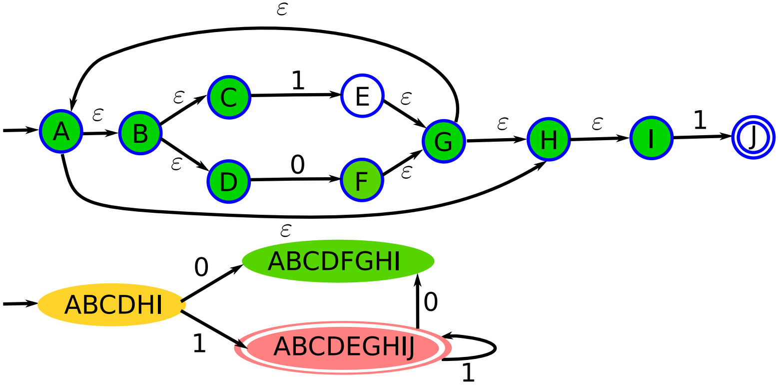

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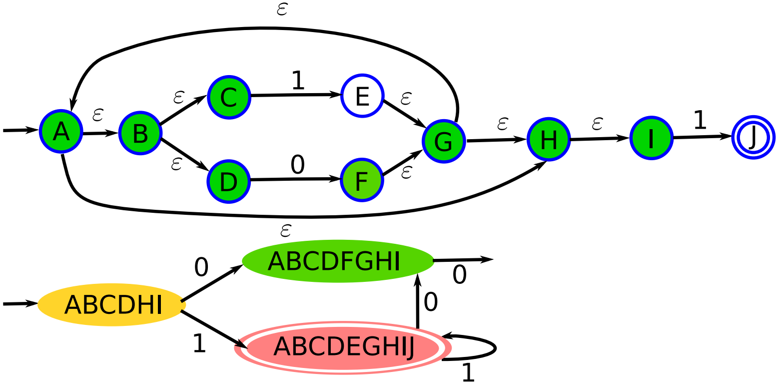

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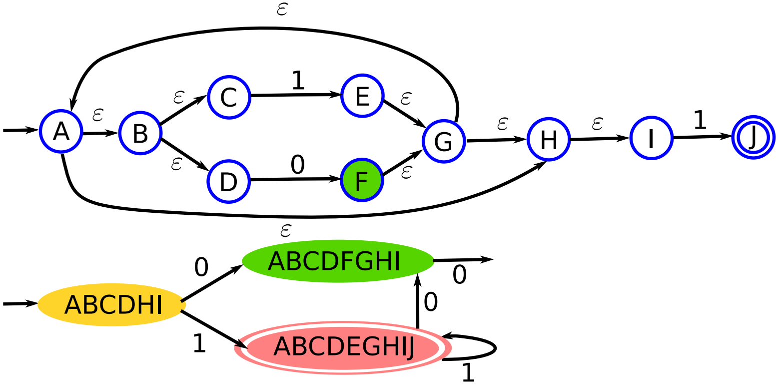

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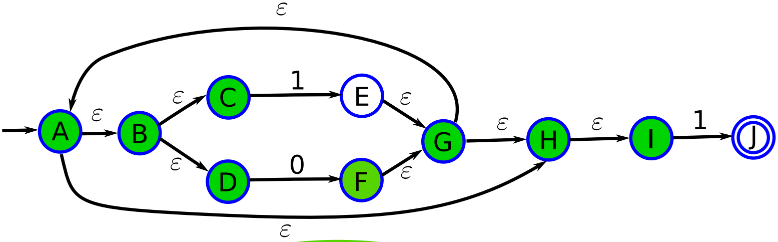

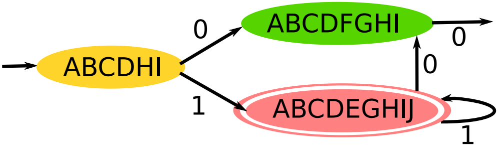

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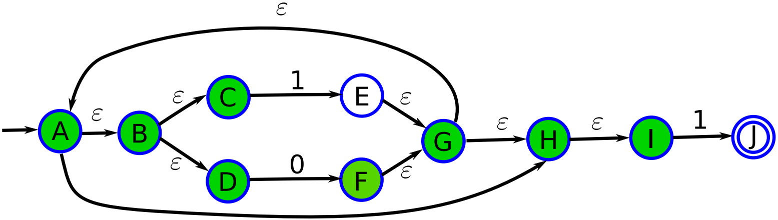

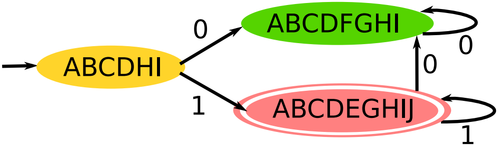

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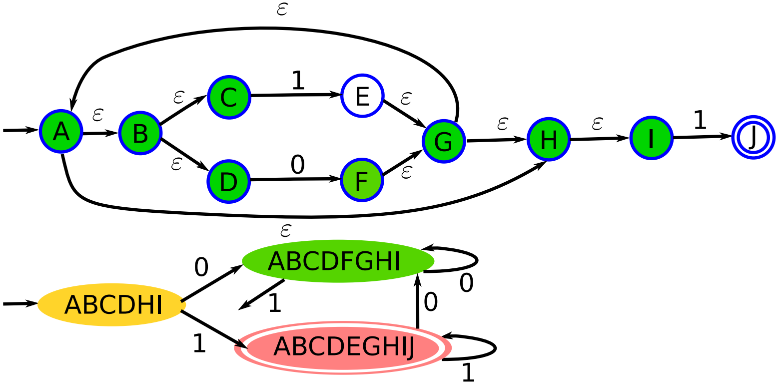

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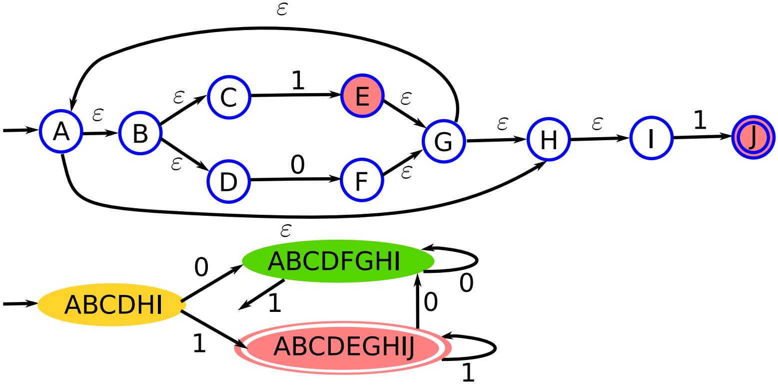

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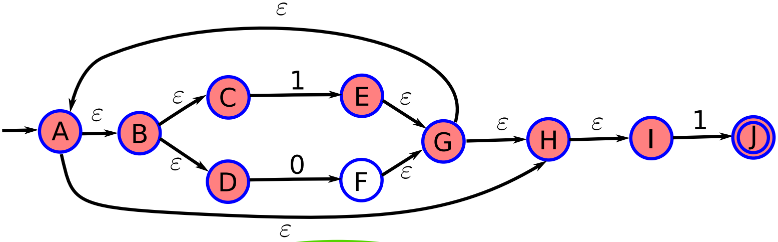

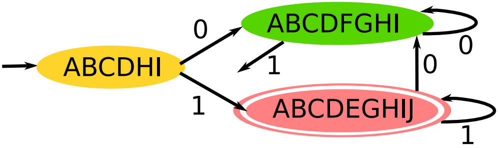

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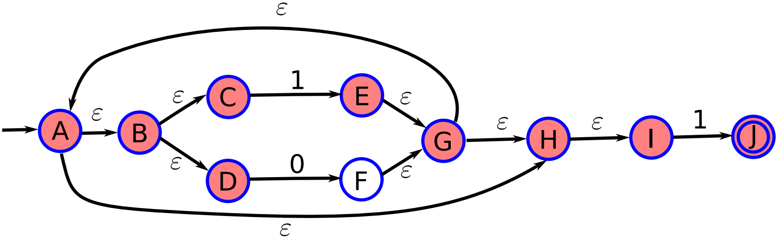

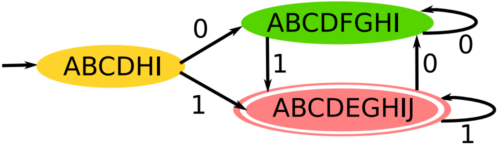

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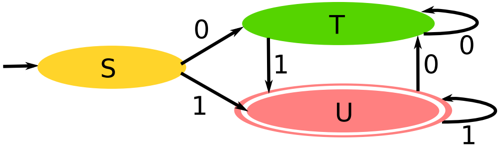

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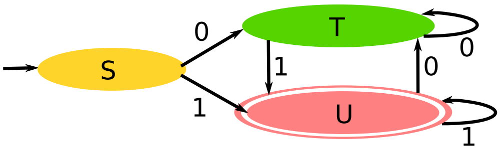

	0	1
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- In practice, flex-like tools trade off speed for space in the choice of NFA and DFA representations