LEX7: DFA Complexity

Lexical Analysis

CMPT 379: Compilers

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anoopsarkar.github.io/compilers-class

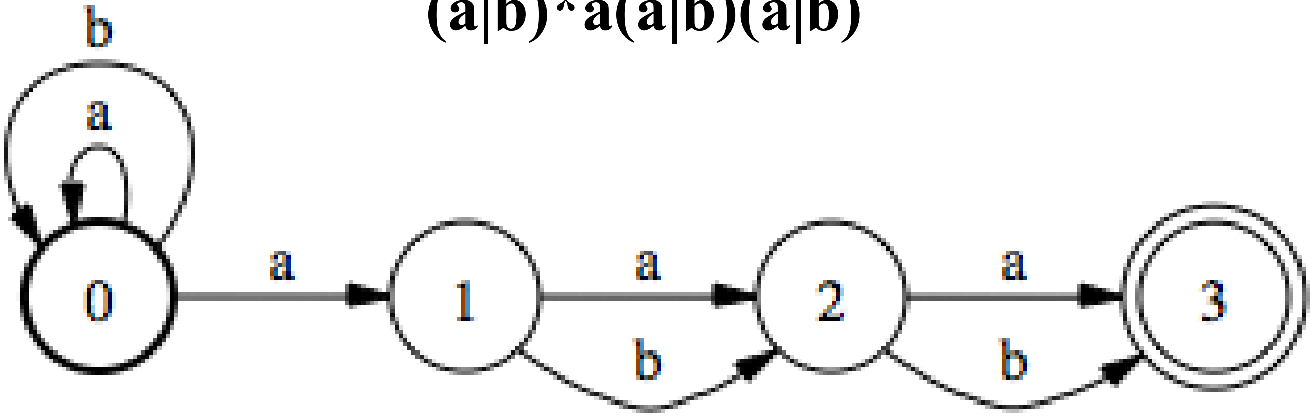
NFA to DFA

- converting NFA to DFA
- Complexity:
  - For FSAs, we measure complexity in terms of initial cost (creating the automaton) and per string cost
  - Let *r* be the length of the regexp and *n* be the length of the input string
  - NFA, Initial cost: O(r); Per string: O(rn)
  - DFA, Initial cost: O(r^2s); Per string: O(n)
  - DFA, common case, $s = r$, but worst case $s = 2^r$

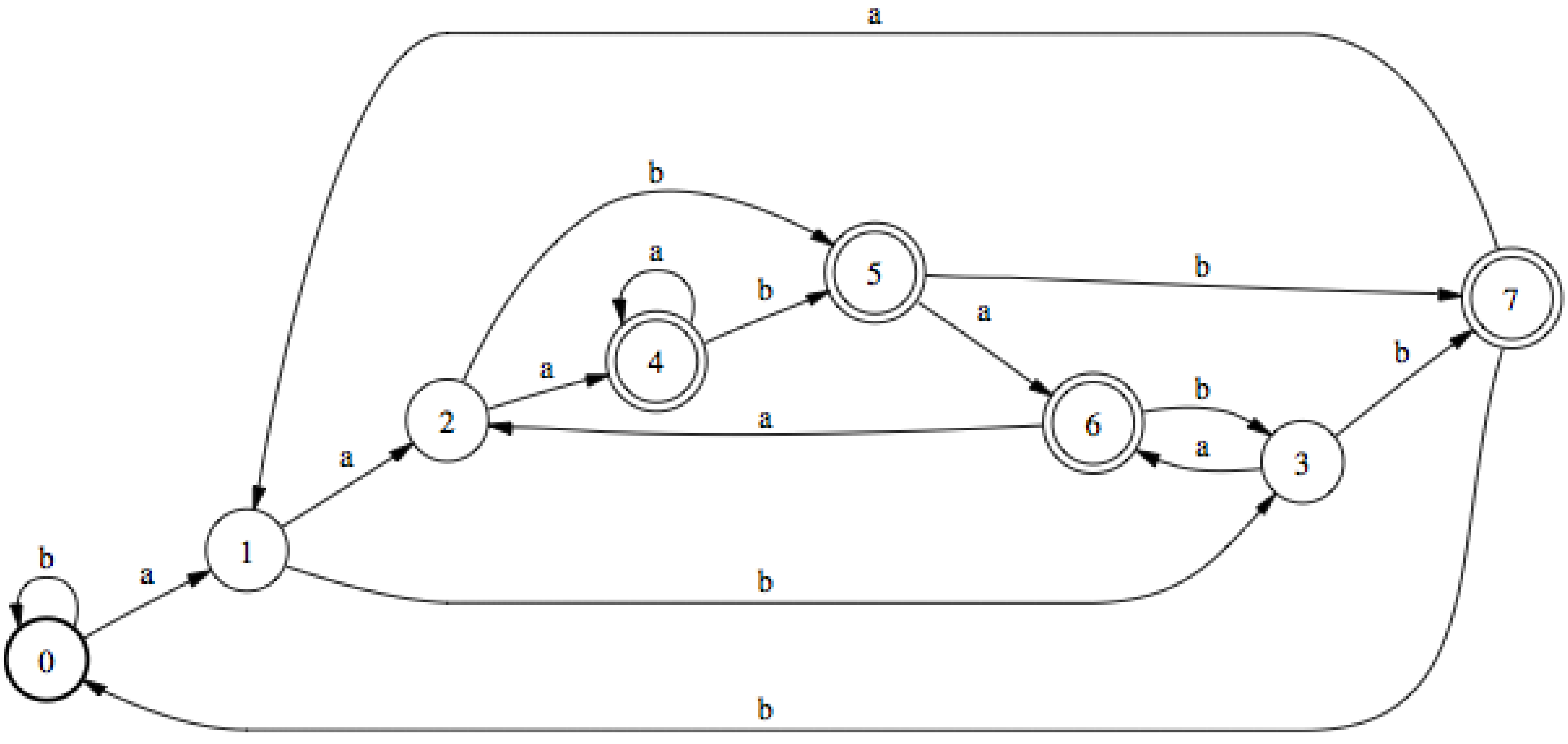
NFA to DFA

- A regexp of size *r* can become a *2^r* state DFA, an exponential increase in complexity
  - Try the subset construction on NFA built for the regexp **A*aA^{n-1}** where **A** is the regexp **(a|b)**

(a|b)*a(a|b)(a|b)



NFA to DFA



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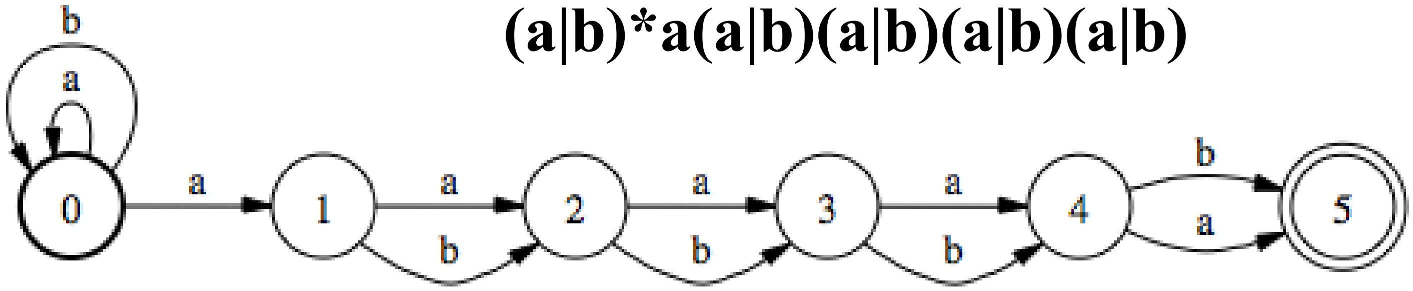

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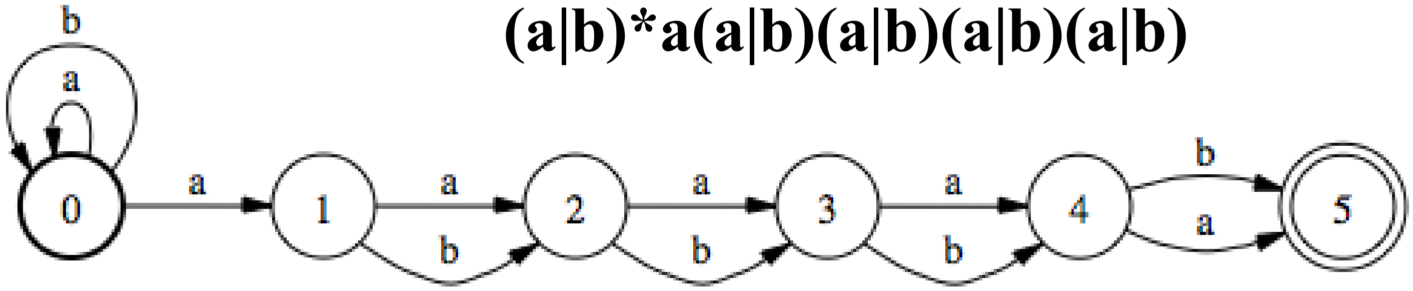

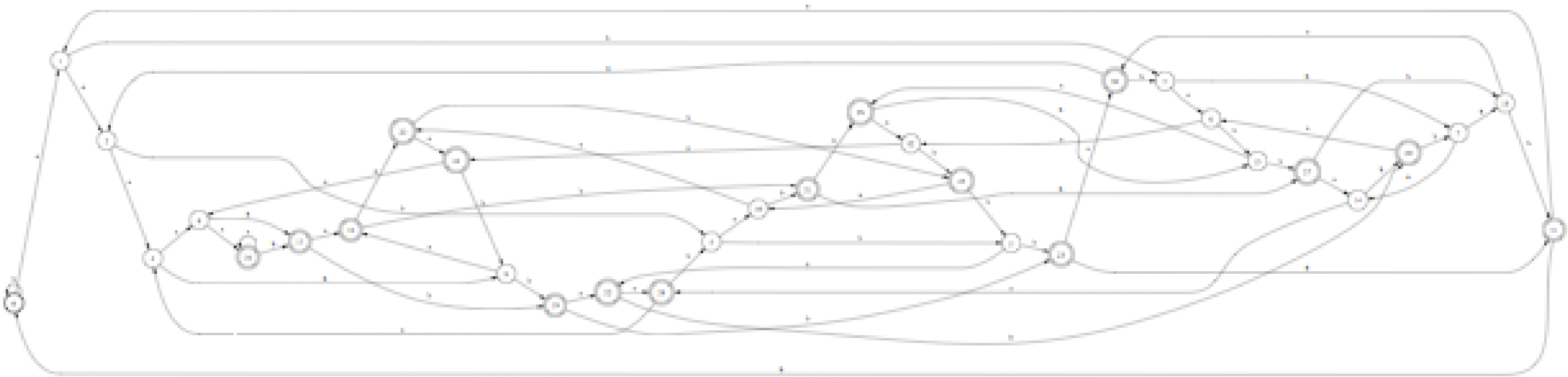

$2^5 = 32$ states

NFA vs. DFA in the wild

Engine Type	**Programs**
DFA	*awk* (most versions), *egrep* (most versions), *flex*, *lex*, MySQL, Procmail
Traditional NFA	GNU *Emacs*, Java, *grep* (most versions), *less*, *more*, .NET languages, PCRE library, Perl, PHP (pcre routines), Python, Ruby, *sed* (most versions), vi
POSIX NFA	*mawk*, MKS utilities, GNU *Emacs* (when requested)
Hybrid NFA/DFA	GNU *awk*, GNU *grep*/*egrep*, Tcl

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  - Extended regular expressions (including POSIX and Perl) are called REGEX to distinguish from regexp (which *are* regular)
- In order to capture these difficult cases, the algorithms used even for simple regexp matching run in time exponential in the length of the input

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  - Try the subset construction on NFA built for the regexp **A*aA**$^{\mathbf{n-1}}$ where **A** is the regexp **(a|b)**
- Note that the NFA for regexp of size *r* will have O(*r*) states
- Minimization can reduce the number of states
- But minimization requires determinization