State complexity of partially nondeterministic automata - Nondeterministic choice of initial states

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Definitions

${}_k$DFA[1]

k-entry deterministic finite-state automaton (${}_kDFA$) is a quintuple $M = (Q, \Sigma, I, F, \delta)$ where

- Q is a finite set of states
- Σ is a finite set of input symbols
- I is a set of initial states, $I \subseteq Q$
- σ is a transition function, $\sigma : Q \times \Sigma \to Q$
- F is a set of final states, $F \subseteq Q$

State complexity

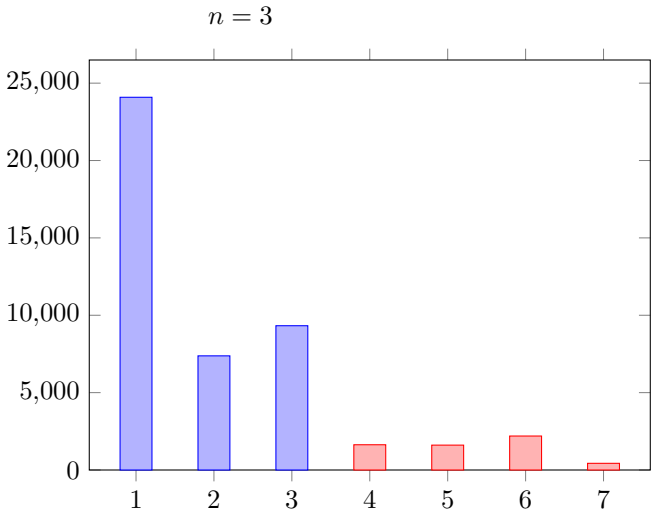
The state complexity of a language L accepted by some ${}_kDFA$ is the number of states in the minimal deterministic finite automaton (DFA) accepting the same language.

[1] (M. Holzer, K. Salomaa, and S. Yu. "On the State Complexity of k-Entry Deterministic Finite Automata". In: *Journal of Automata, Languages and Combinatorics* 6.4 [2001], pp. 453–466)

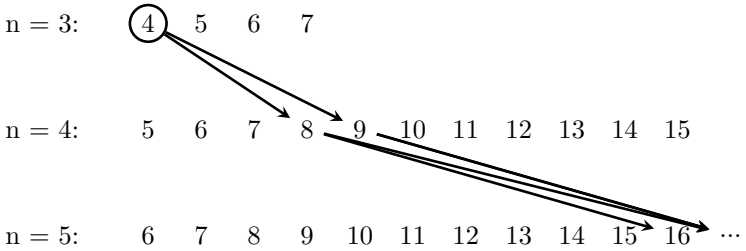
Goals

1. Develop a program that accepts an automaton as input and generates all automata with various choices of initial states. Expand this program to generate all n-state automata. Additionally, create a program capable of determinizing and minimizing the automaton to ascertain the state complexity of the language it represents. Furthermore, ensure that the program is designed to leverage parallel computing.
2. Investigate the deterministic state complexity of automata represented by nondeterministic automata, where the only nondeterminism is from a choice of initial states.
3. Examine the worst-case state complexity identified in 2.
4. Explore the range of all obtainable state complexities from 2.
5. Study the average state complexity from 2.

Magic nubmers



Magic numbers



Average state complexity

n	average s.c. (computations)	average s.c. (formula)	2^n (for comparison)
2	1.29	2.34	4
3	2.09	4.86	8
4	3.63	9.80	16
5	6.20	19.55	32
6	10.09	38.83	64
7	15.70	77.01	128

Note: Alphabet of size 2 (computations).
Does not depend on alphabet size (formula).

Theorem 2

Average state complexity of a language represented by an n-state ${}_kDFA$ is at most $\frac{5}{8}2^n$.

Thank you for your attention