

0.1 Introduction

Finite automata are a long established computation model that dates back to sources such as [10] and [13]. A known problem for finite automata is state space reduction, referring to the search of a language-equivalent automaton which uses fewer states than the original object. For deterministic finite automata (DFA), not just reduction but minimization was solved in [7]. Regarding nondeterministic finite automata (NFA), [8] proved the PSPACE-completeness of the minimization problem, which is why reduction algorithms such as [4] and [1] are a popular alternative.

In his prominent work [2], Büchi introduced the model of Büchi automata (BA) as an extension of finite automata to read words of one-sided infinite length. As these ω -automata tend to have higher levels of complexity in comparison to standard finite automata, the potential gain of state space reduction is even greater. Similar to NFAs, exact minimization for deterministic Büchi automata was shown to be NP-complete in [14] and spawned heuristic approaches such as [14], [9], or [5].

As [16] displays, deterministic Büchi automata are a strictly weaker model than nondeterministic Büchi automata. It is therefore interesting to consider different models of ω -automata in which determinism is possible while maintaining enough power to describe all ω -regular languages. Parity automata (PA) are one such model, a mixture of Büchi automata and Moore automata ([11]), that use a parity function rather than the usual acceptance set. [12] showed that deterministic parity automata are in fact sufficient to recognize all ω -regular languages. As for DBAs, the exact minimization problem for DPAs is NP-complete ([14]).

Our goal in this publication is to develop new algorithms for state space reduction of DPAs, partially adapted from existing algorithms for Büchi or Moore automata. We perform theoretical analysis of the algorithms in the form of proofs of correctness and analysis of run time complexity, as well as practical implementation of the algorithms in code to provide empirical data for or against their actual efficiency.

Chapter 1

Experiments

This chapter focuses on the analysis of the different algorithms in the form of implementation and empirical data.

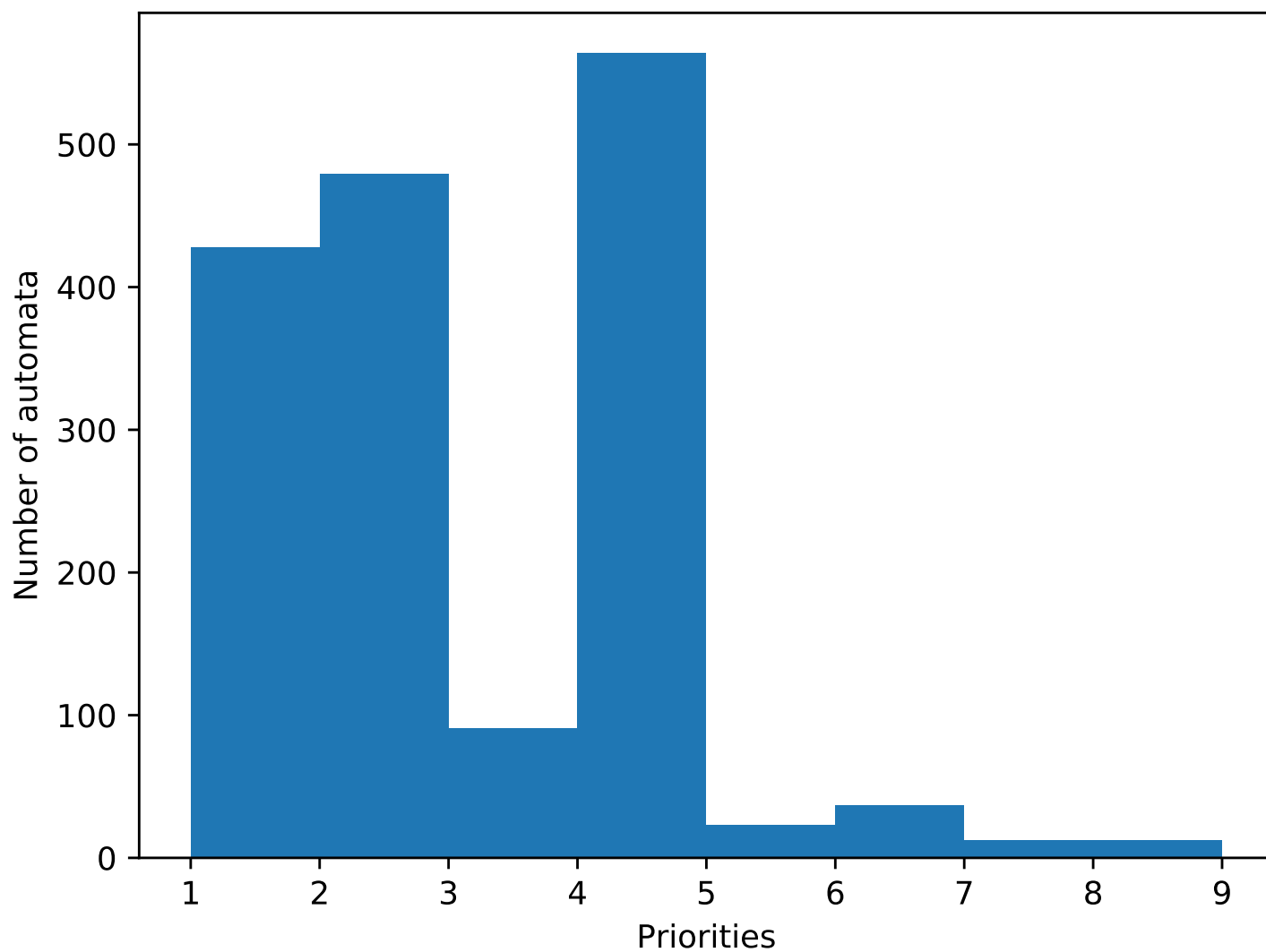
All techniques for state space reduction were implemented in C++14. The source code can be found in [\[1\]](#). The computer used to run the tests was an Arch Linux 4.19.4 64 bit machine powered by an AMD Ryzen 5 1600 processor and 16 GB DDR4-2400 RAM.

1.1 Test Automata

Several automata generated randomly using different parameters were used in the testing process. Three major different techniques of generation were used:

1. Use Spot ([\[2\]](#)) to generate a random DPA.
2. Use Spot to generate a random non-deterministic Büchi automaton and use Spot again to convert it to a DPA.
3. Use Spot to generate a random non-deterministic Büchi automaton and use nbautils ([\[3\]](#)) to convert it to a DPA.

Histogram of the number of priorities of all automata.



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