Reachability Problems in Multi-Queue Automata

Highlights on Games, Logic and Automata 2020, (not in) Aachen

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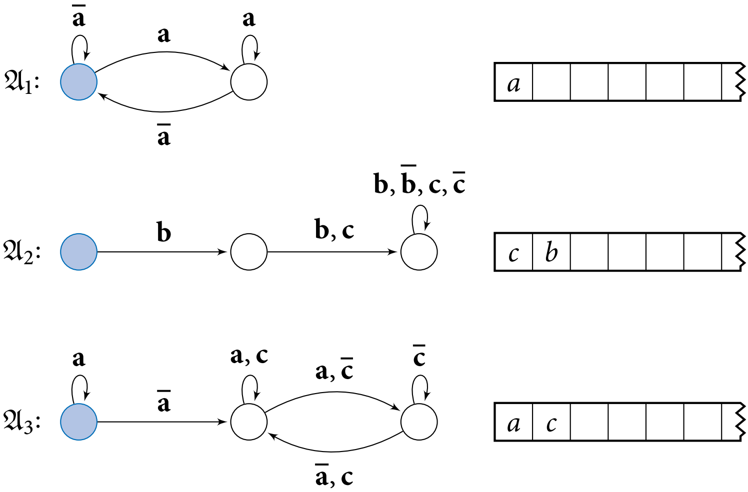
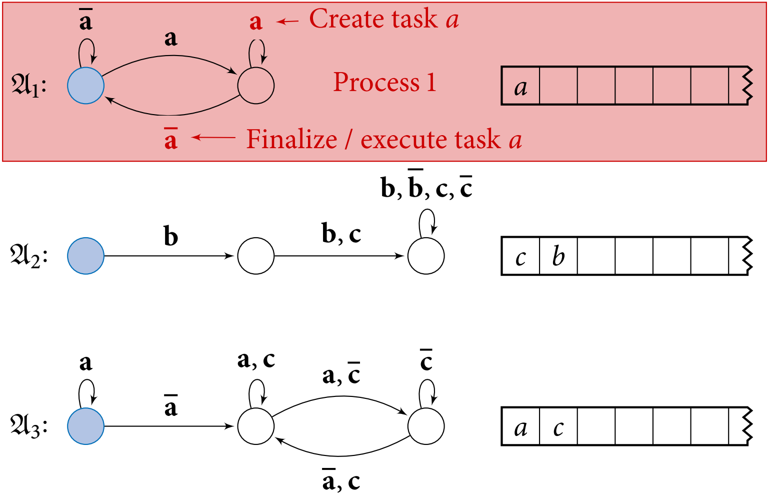
Multi-Queue Automata



Question

Given some configuration, is it possible to clear each queue?

Multi-Queue Automata



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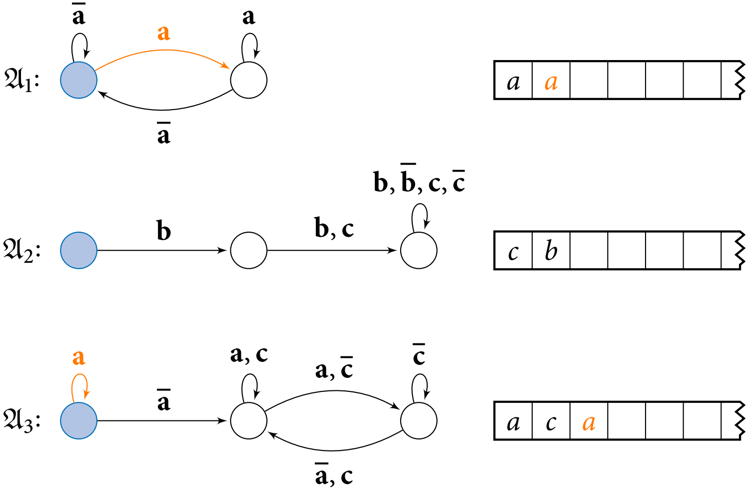

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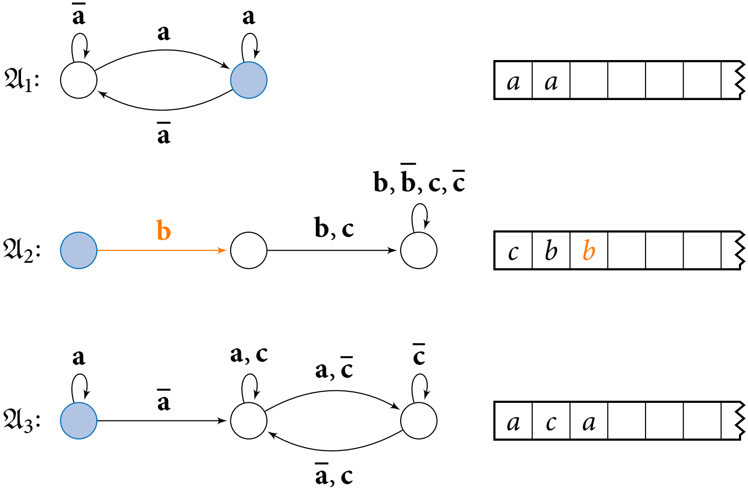

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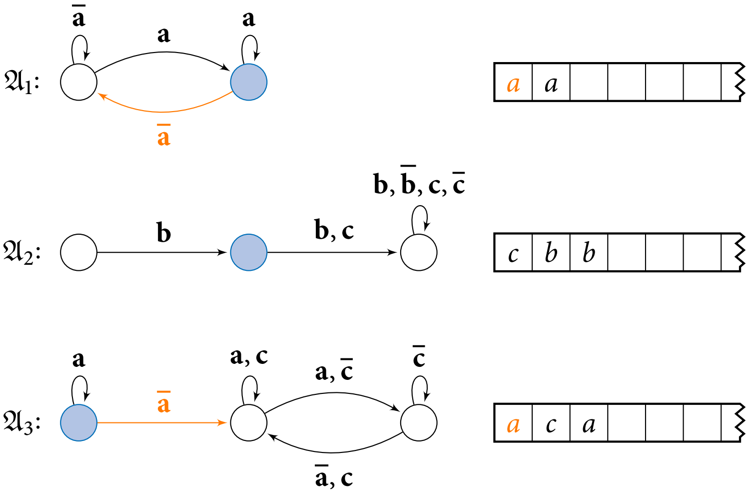

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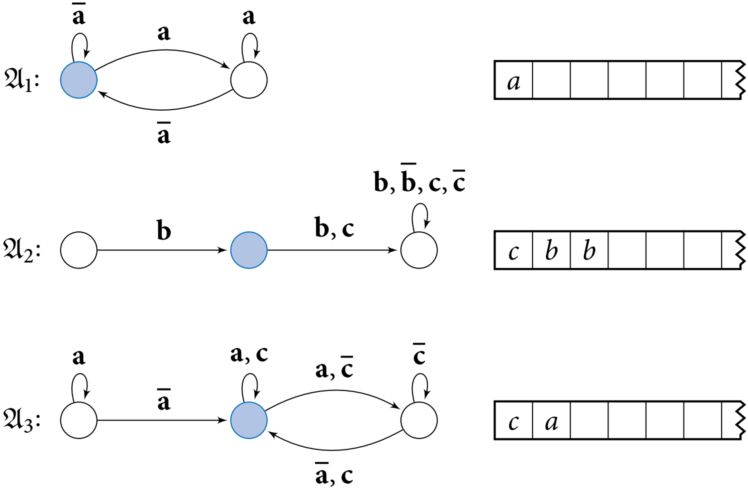

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Given some configuration, is it possible to clear each queue?

Inputs:

- $L \subseteq (A^*)^n$ a rational language of queue contents
- $\mathbf{T} \subseteq \{\mathbf{a}, \overline{\mathbf{a}} \mid a \in A\}^*$ a rational language of transformation sequences

Compute:

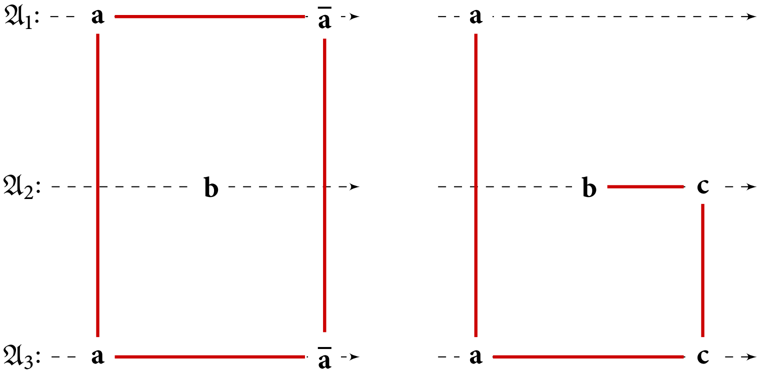
- $\textsc{Reach}(L, \mathbf{T}) \subseteq (A^*)^n$ the set of all queue contents after application of $\mathbf{T}$ on L

Theorem (Brand, Zafiropulo 1983)

There are L and $\mathbf{T}$ such that $\textsc{Reach}(L, \mathbf{T})$ is undecidable.

$\Rightarrow$ Approximate $\textsc{Reach}(L, \mathbf{T})$ step-by-step!

- A word w is connected if its *sequence diagram* is a connected graph:



$\Rightarrow$ **ab$\bar{\text{a}}$** is not connected, **abc** is connected

- A language L is connected if each $w \in L$ is connected

- A generalization of [Boigelot et al. 1997] and [K. 2019]:

Theorem

Let $L \subseteq (A^*)^n$ be recognizable, $W, R \subseteq A^*$ be recognizable such that W is connected. Then $\textsc{Reach}(L, (\mathbf{W}\overline{\mathbf{R}})^*)$ *is effectively recognizable. The construction is possible in polynomial time.*

- *Proof idea:* Simulate such multi-queue automaton by a 1-counter automaton.

Thank you!