The Queue Automaton Revisited

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CWI & TU/e

Juggling formal analysis, security, privacy and trust
Luxemburg, 10 April 2026

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Sjouke

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Pushdown automaton <=> context-free grammar

Sjouke looked at BPA (= pushdown processes), proving a decidability result.
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A pushdown process is a regular process interacting with a stack.

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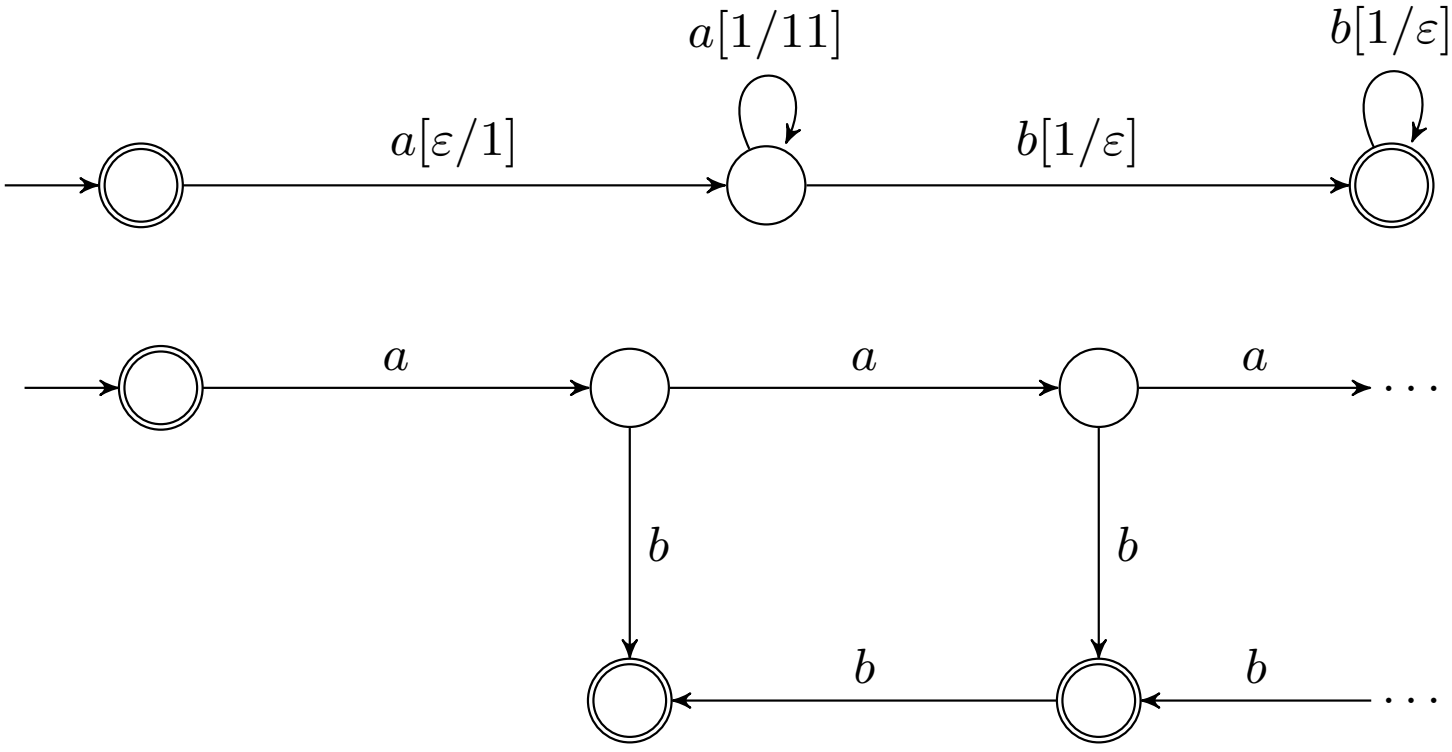

$$C = \mathbf{1} + C' \qquad C' = a.(b.\mathbf{1} + C' \,;\, (\mathbf{1} + b.\mathbf{1}))$$

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Parallel pushdown automaton

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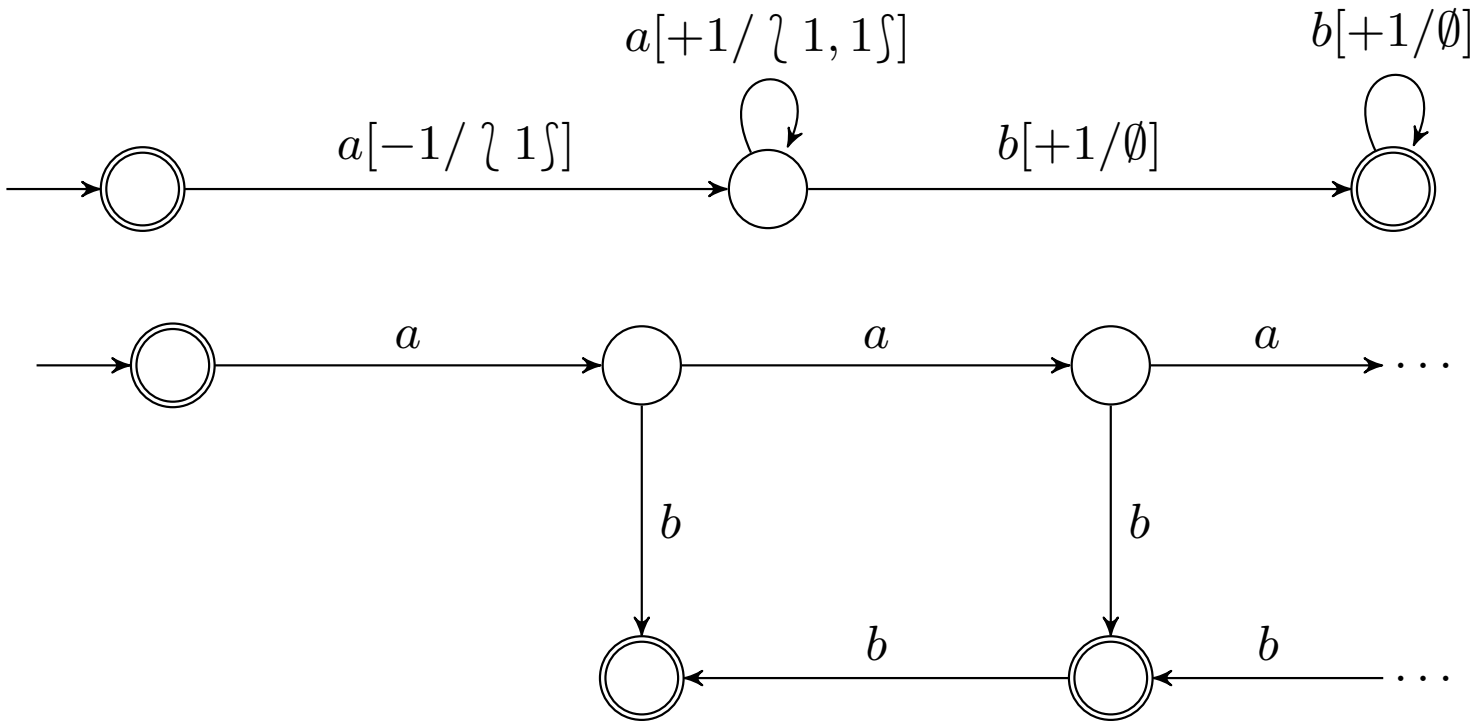

$$C = \mathbf{1} + \partial_b(C') \qquad C' = a.(b.B + C' \parallel (\mathbf{1} + b?.\mathbf{1})) \qquad B = \mathbf{1} + b!.B$$

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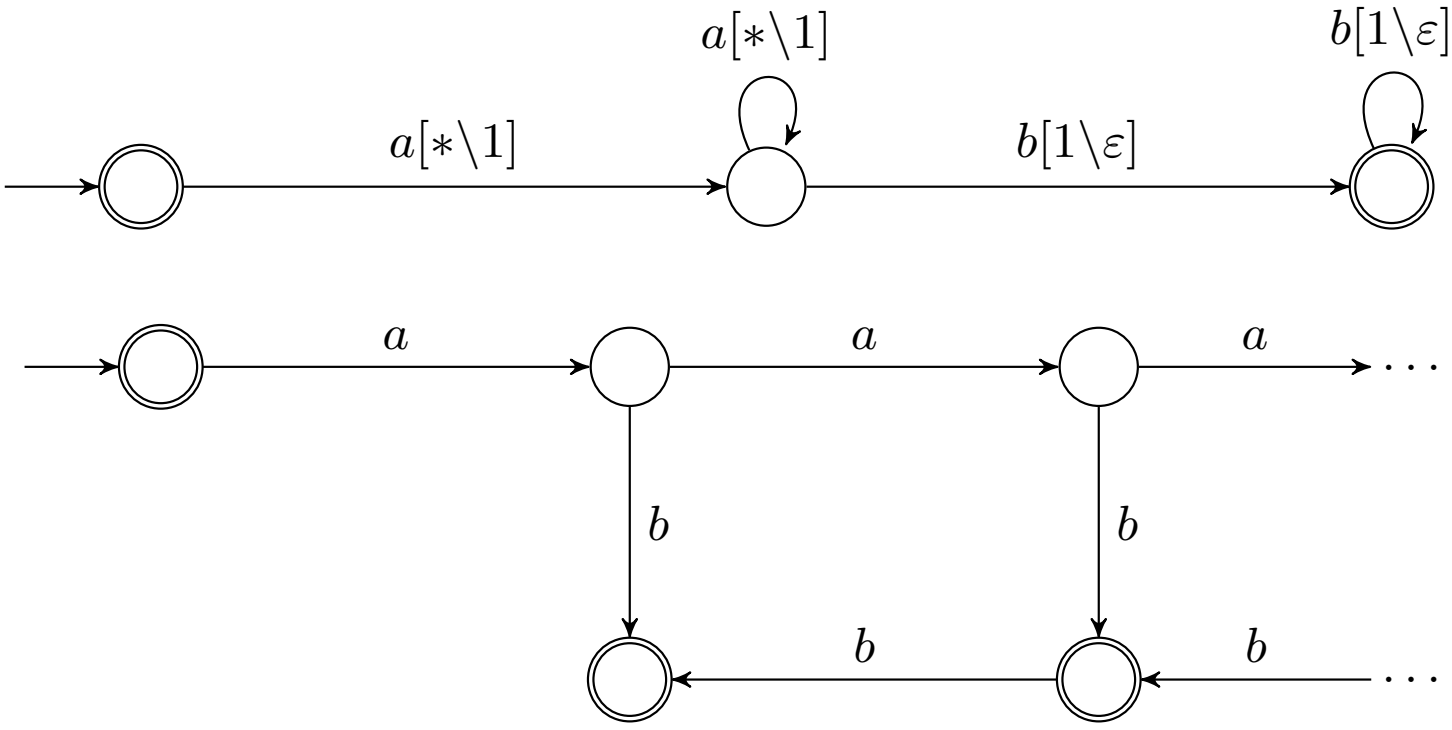
Queue automaton?



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Queue automaton

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This paper: non-deterministic queue automaton is equally expressive as a Reactive Turing Machine
With a queue automaton, we can define all computable functions and all executable processes
Definition of queue automaton is robust
Process algebra $\mathbf{0}, \mathbf{1}, a.\_, +$, parallel composition with communication, encapsulation, abstraction.
An executable process is a regular process interacting with a queue

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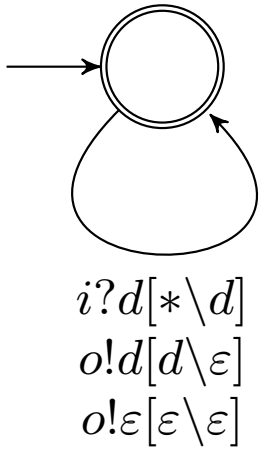
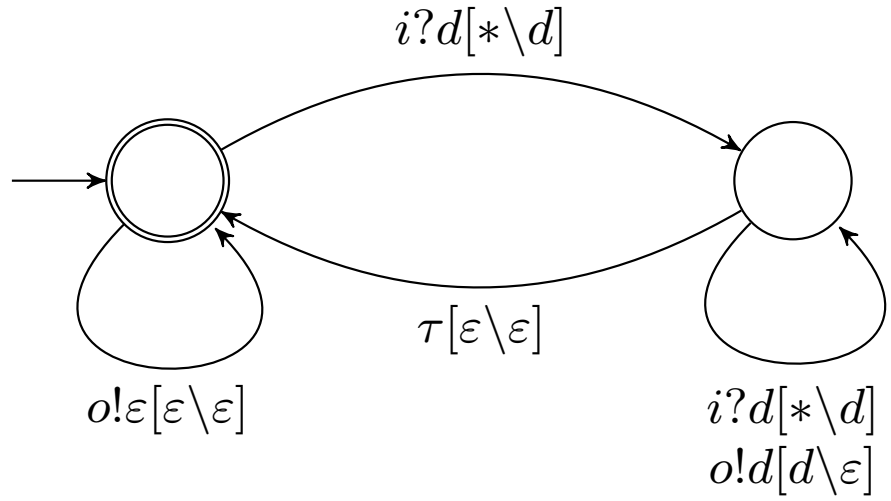
Queue





$$Q^{io} = \mathbf{1} + o!\varepsilon.Q^{io} + \sum_{d\in\mathcal{D}} i?d.\tau_{\mathcal{C}}(\partial_{\ell}(Q^{i\ell} \parallel o!d.Q^{\ell o}))$$

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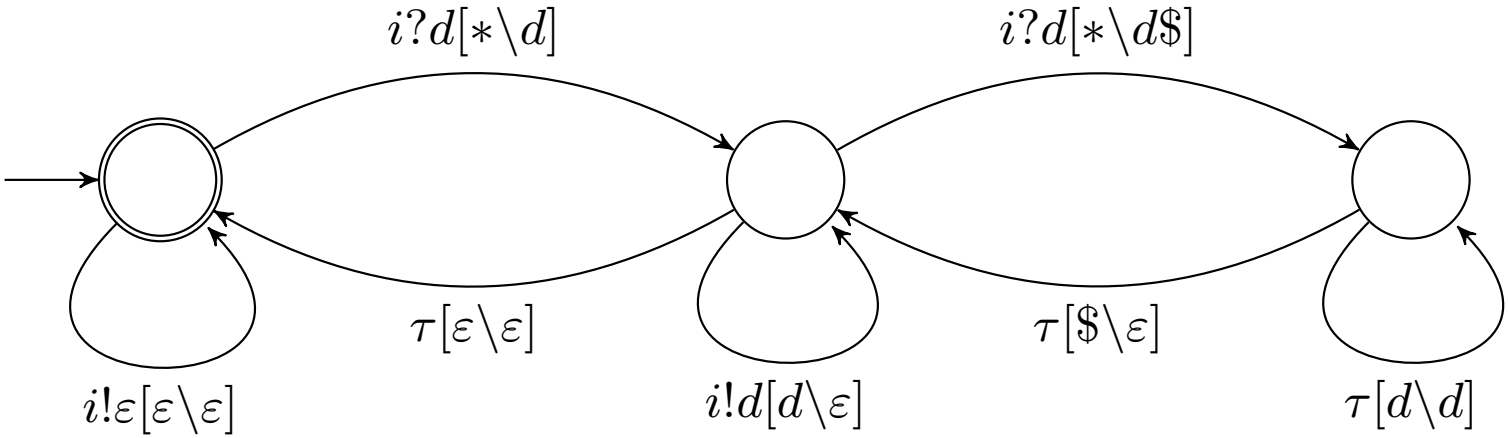
Stack



$$S^i = \mathbf{1} + i!\varepsilon.S^i + \sum_{d\in\mathcal{D}} i?d.\tau_{\mathcal{C}}(\partial_j(B_d^{ij} \parallel S^j))$$

$$B_d^{ij} = i!d.(j?\varepsilon.B_\varepsilon^{ij} + \sum_{e\in\mathcal{D}} j?e.B_e^{ij}) + \sum_{e\in\mathcal{D}} i?e.j!d.B_e^{ij}$$

$$B_\varepsilon^{ij} = \mathbf{1} + i!\varepsilon.B_\varepsilon^{ij} + \sum_{d\in\mathcal{D}} i?d.B_d^{ij}$$

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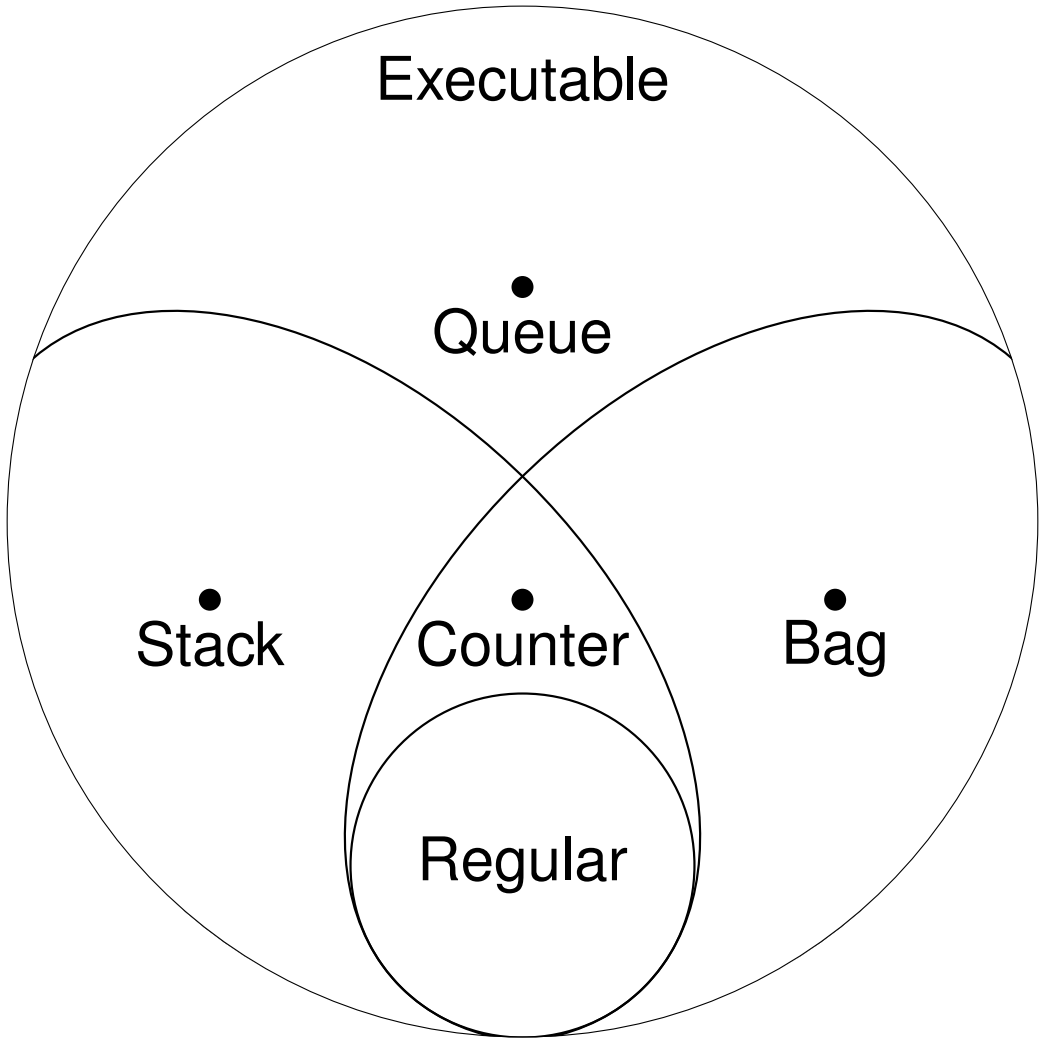
Chomsky-Turing hierarchy



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Conclusion

There is the book:
Models of Computation based on Automata: Formal Languages and Communicating Processes, pp. vi + 206.

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