Fast Pattern Matching in Quantum Circuits

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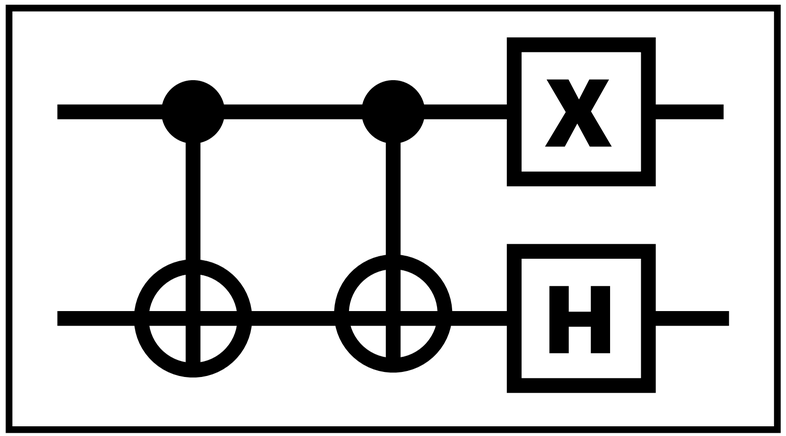
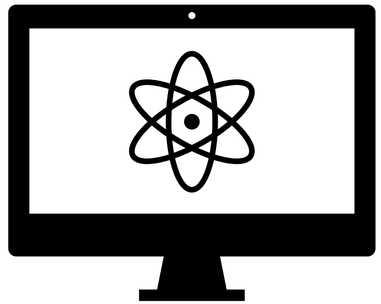
ICE-8 Conference, Santiago Spain, 1st June 2023

arXiv:2302.06717 [quant-ph]

Quantum Circuit compilation pipeline





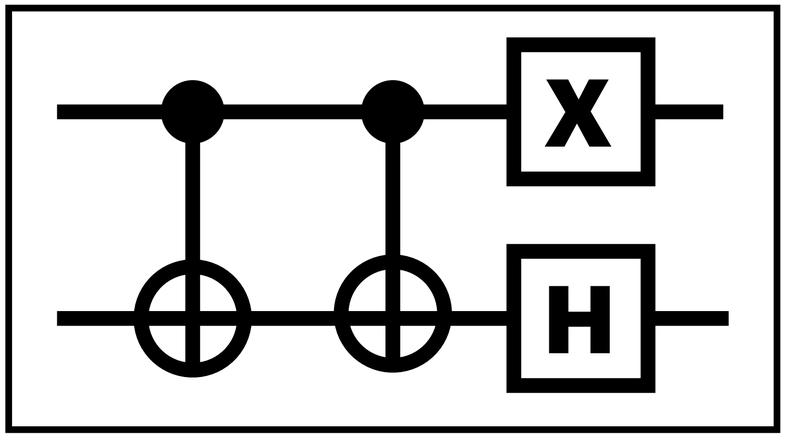
IBM Q™

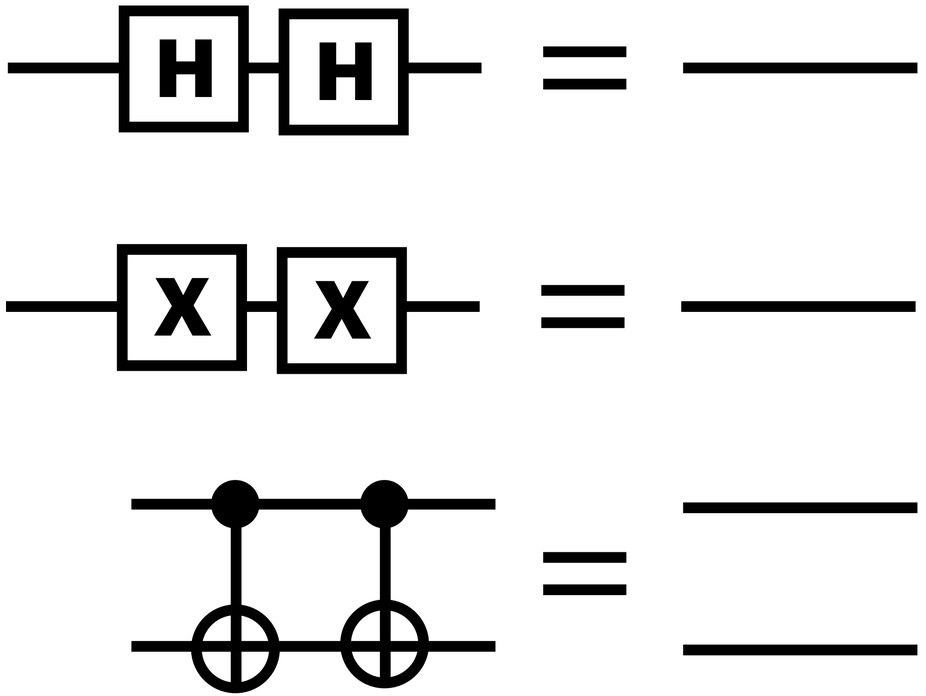
QUANTINUUM

Quantum Circuit optimisation
...is about to get a lot harder

1. Ever larger circuits
2. Ever larger instruction set
3. Every bit of optimisation will matter

a.k.a Quantum Circuit optimisation *the easy way*





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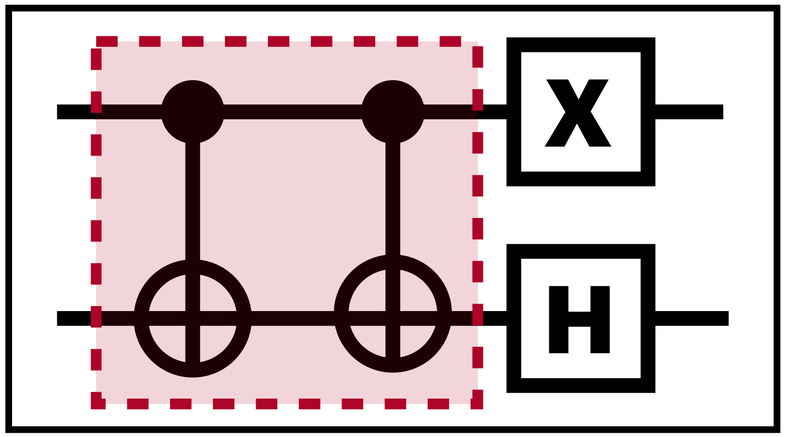

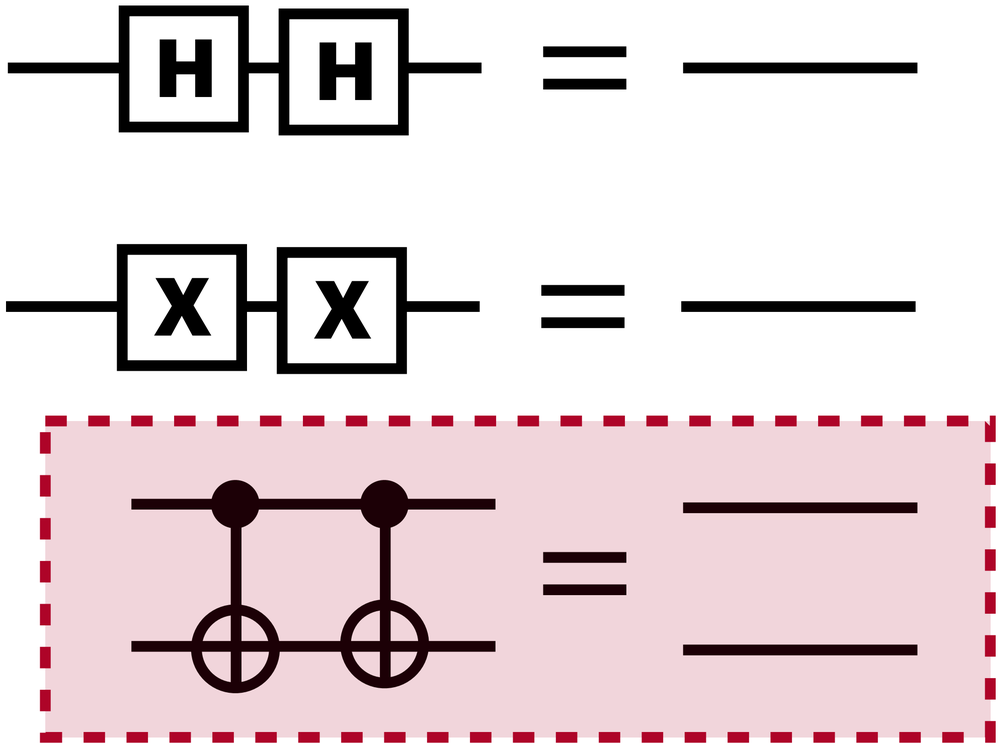

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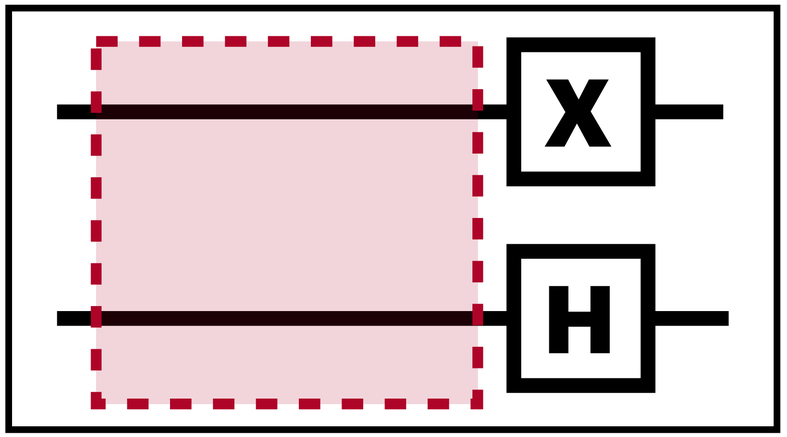
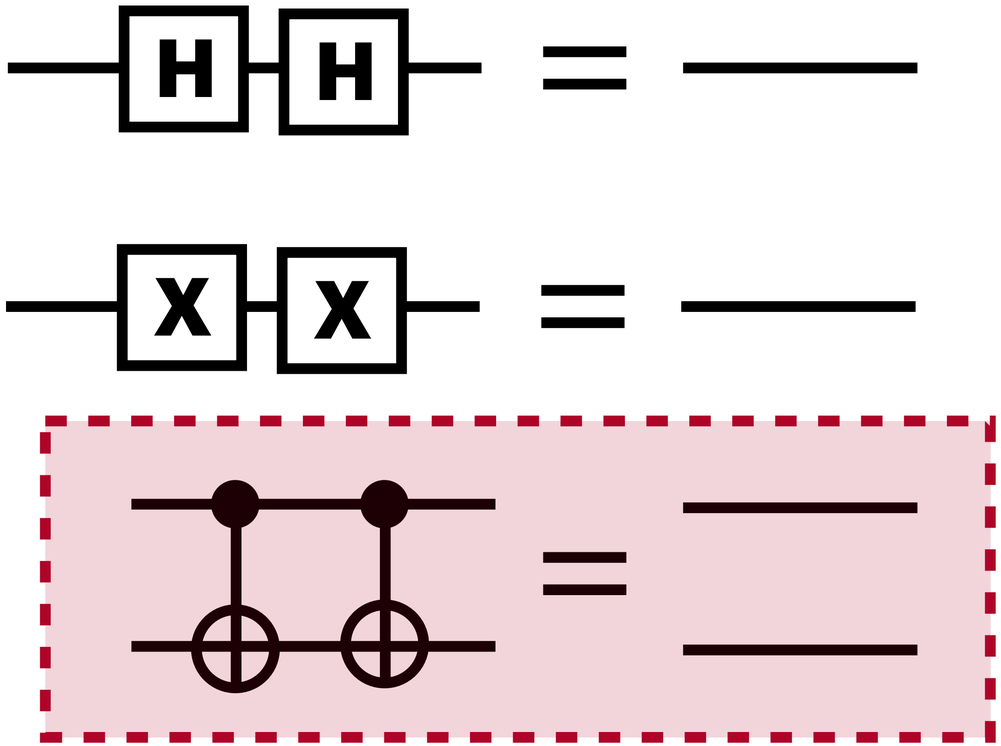


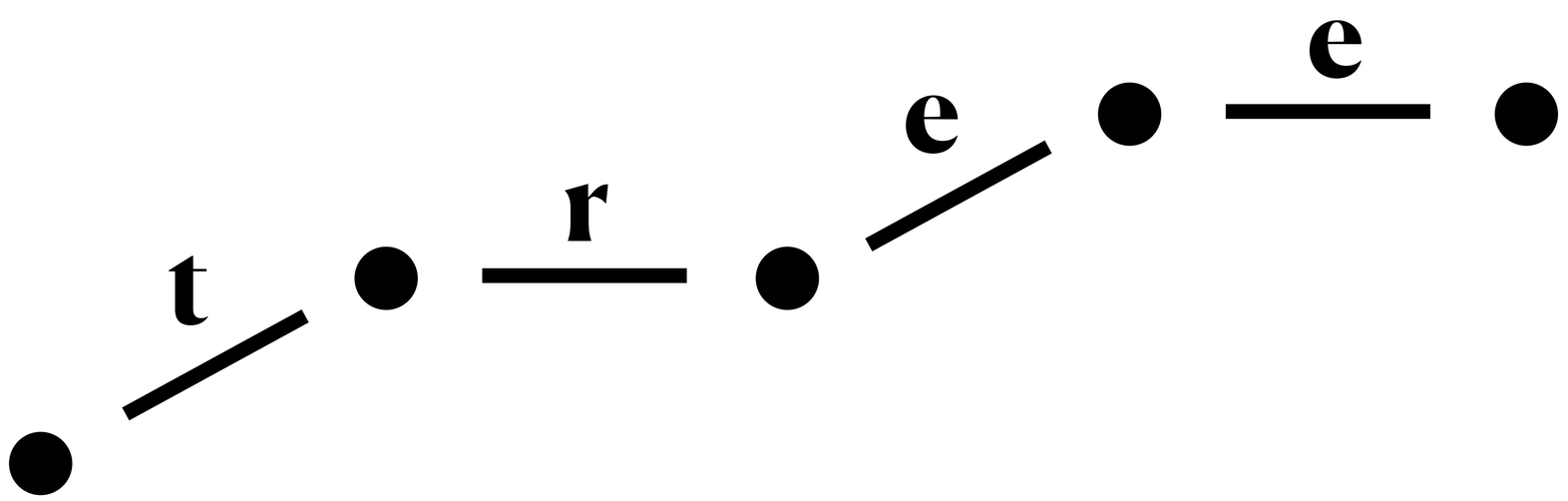


a.k.a Quantum Circuit optimisation *the easy way*

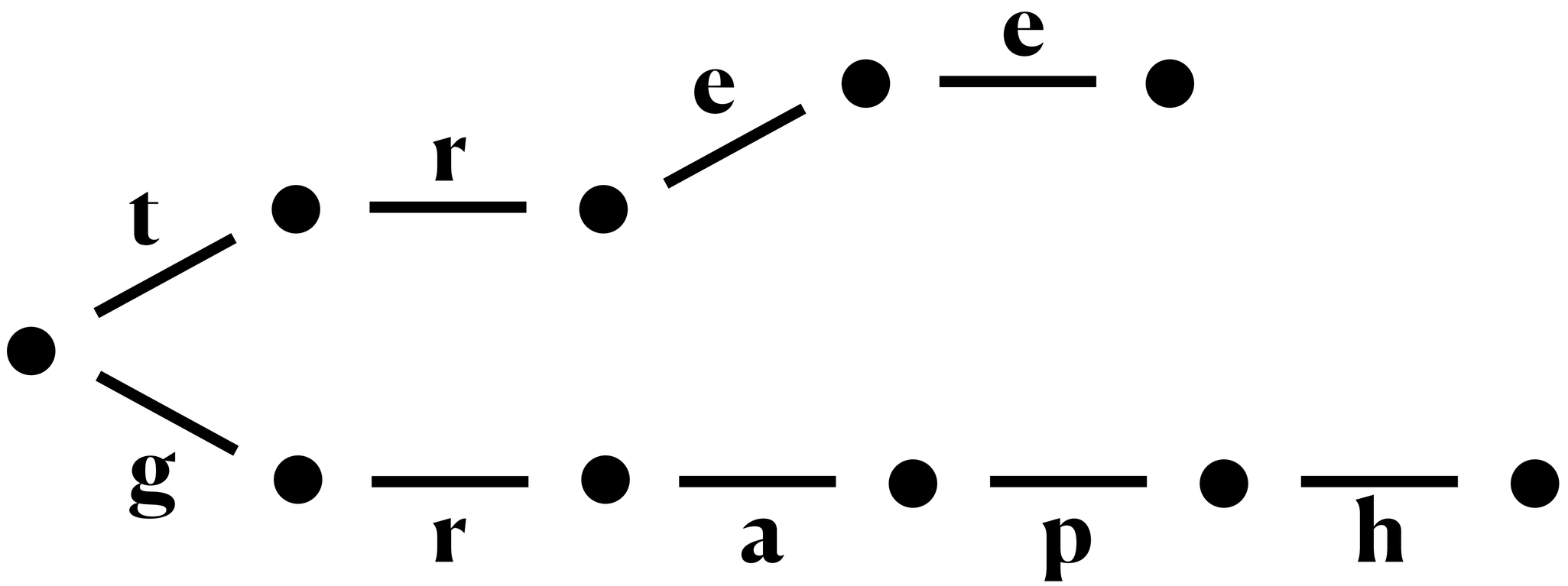
Digression

String pattern matching

Tries: storing string patterns



Tries: storing string patterns



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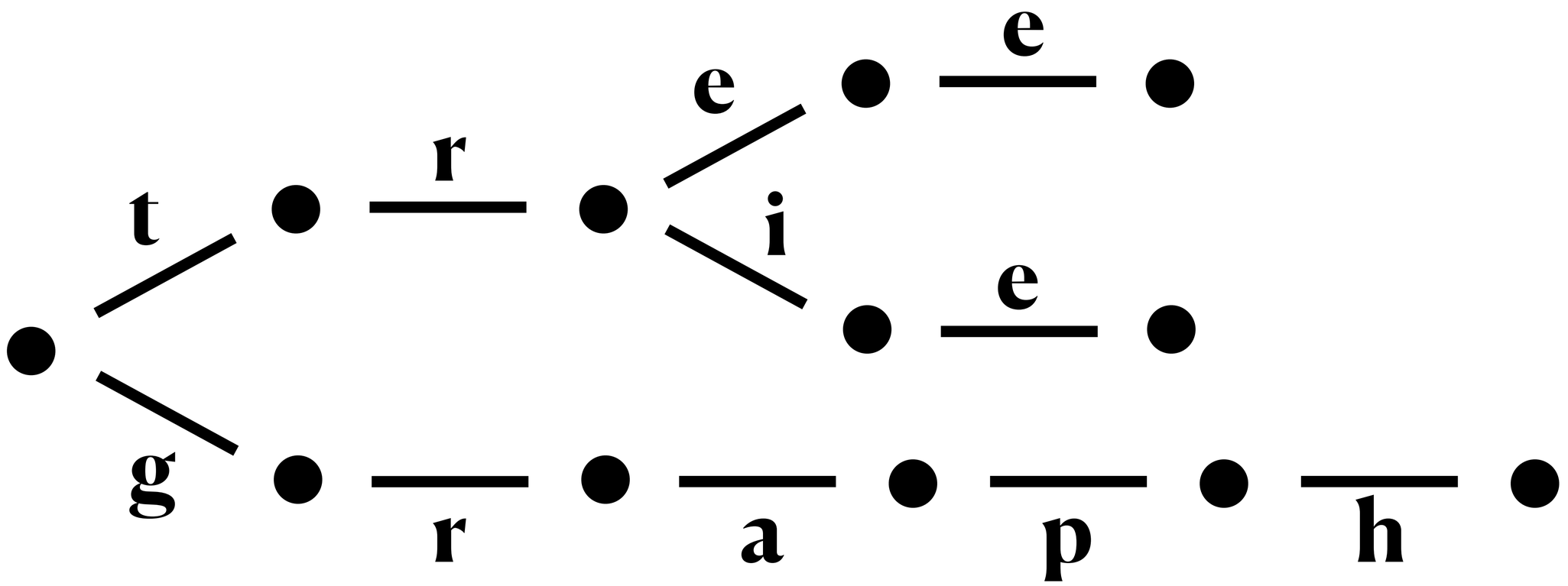
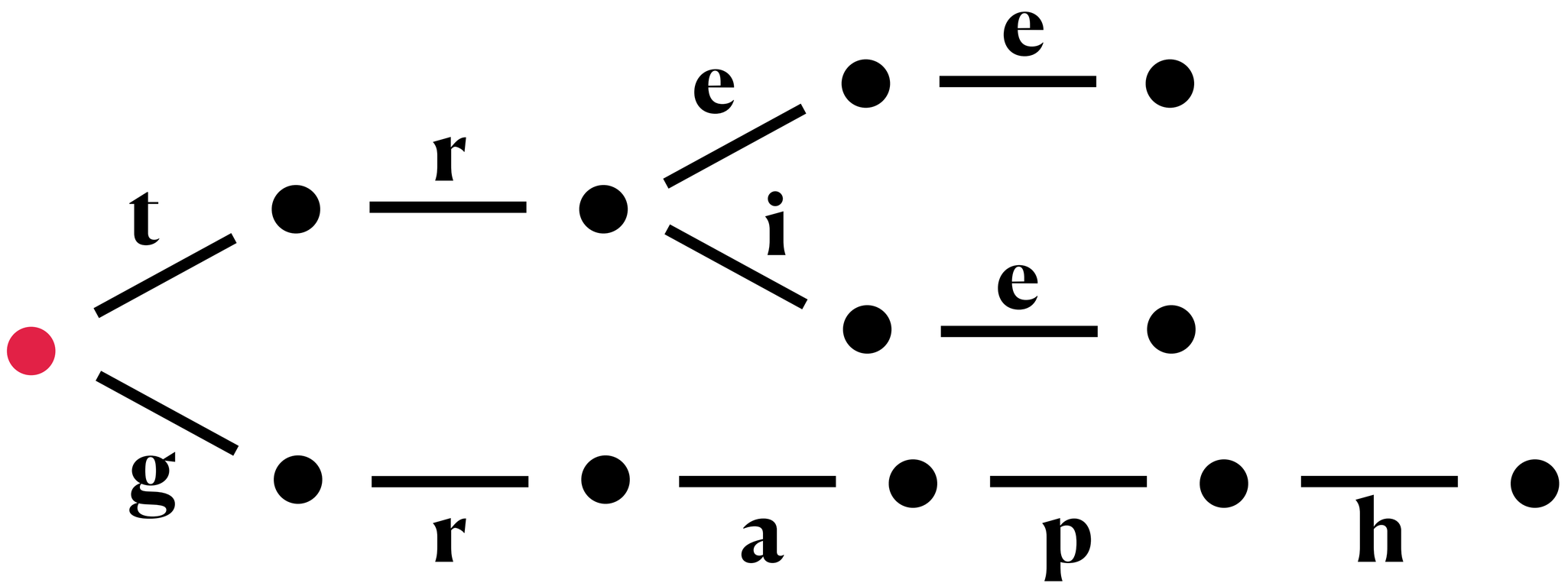
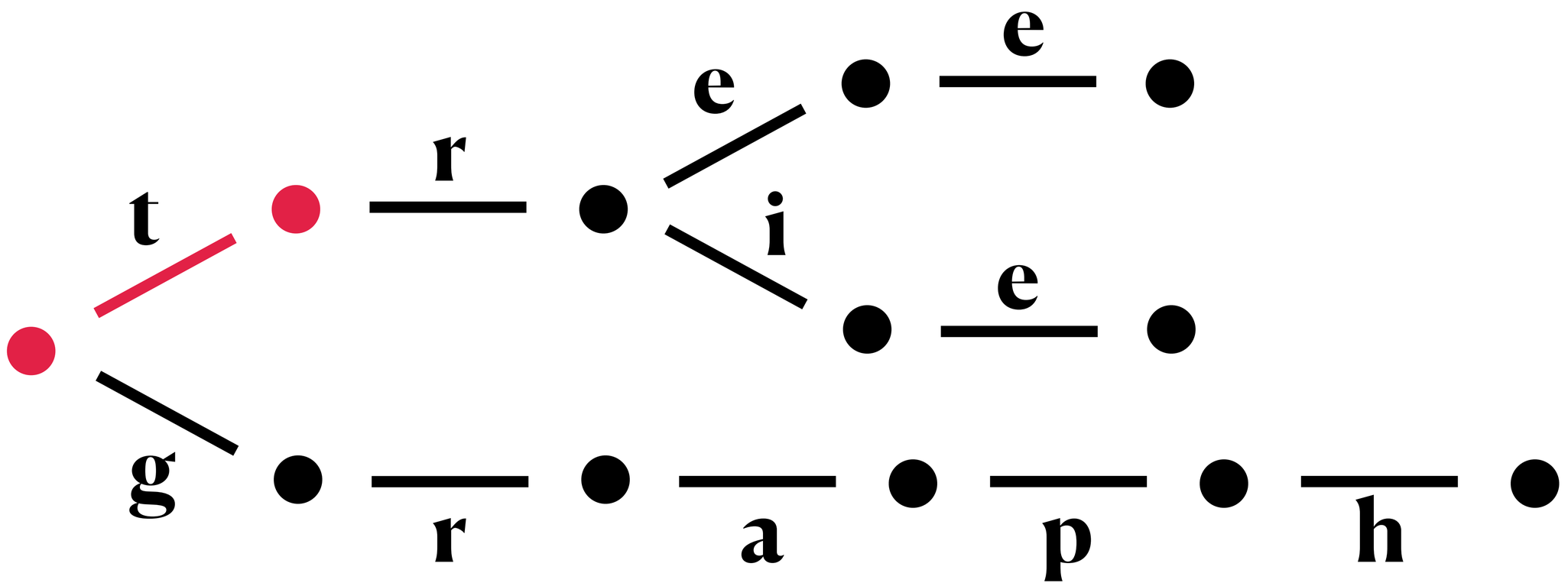


Tries are finite state machines



input: TRIVIAL

Tries are finite state machines



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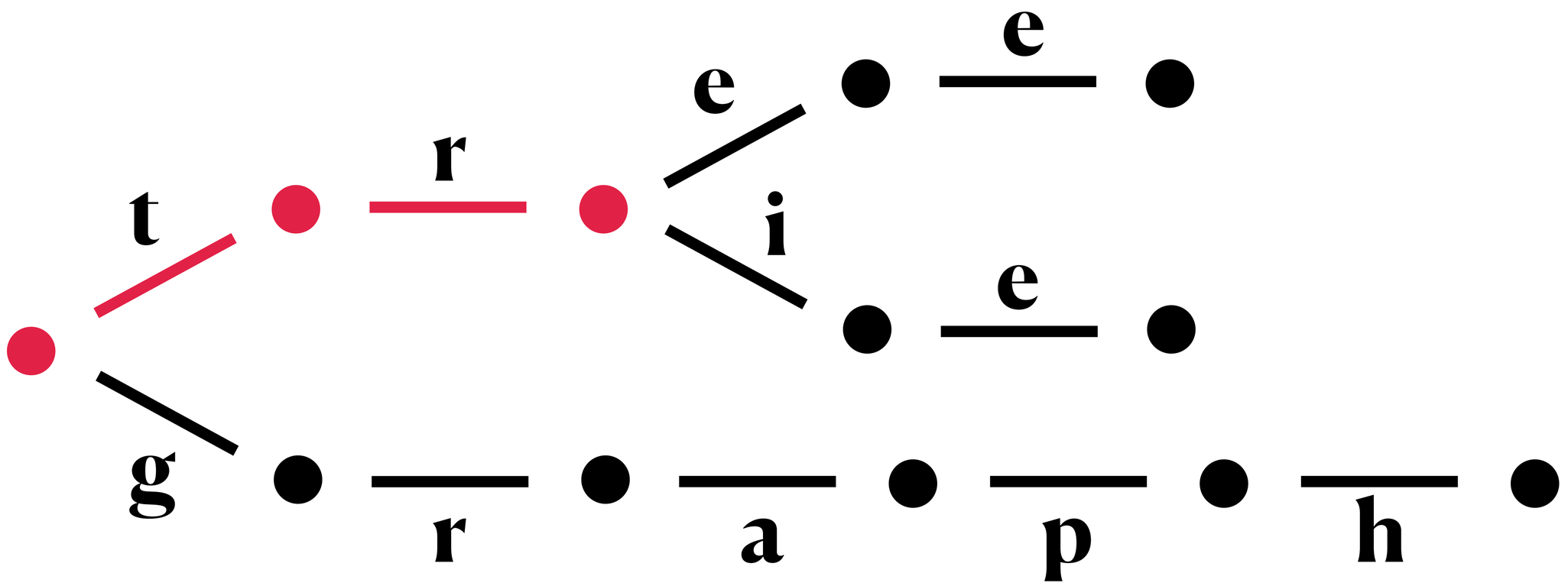

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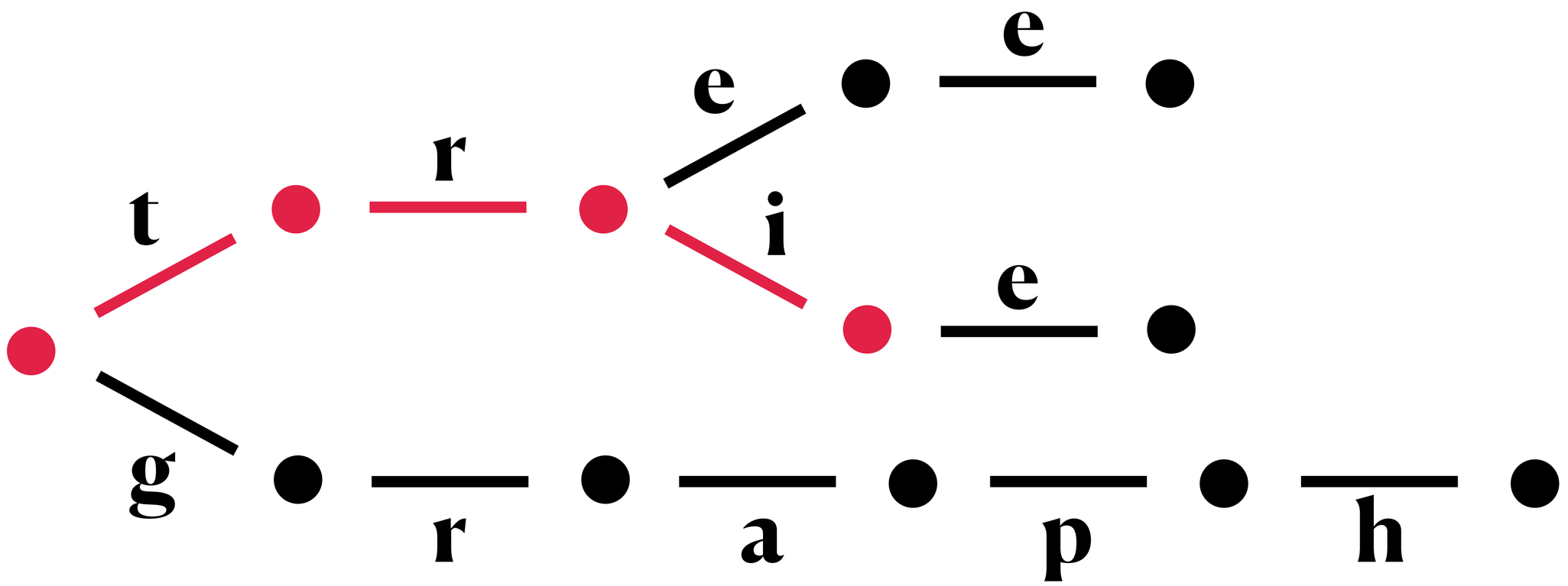
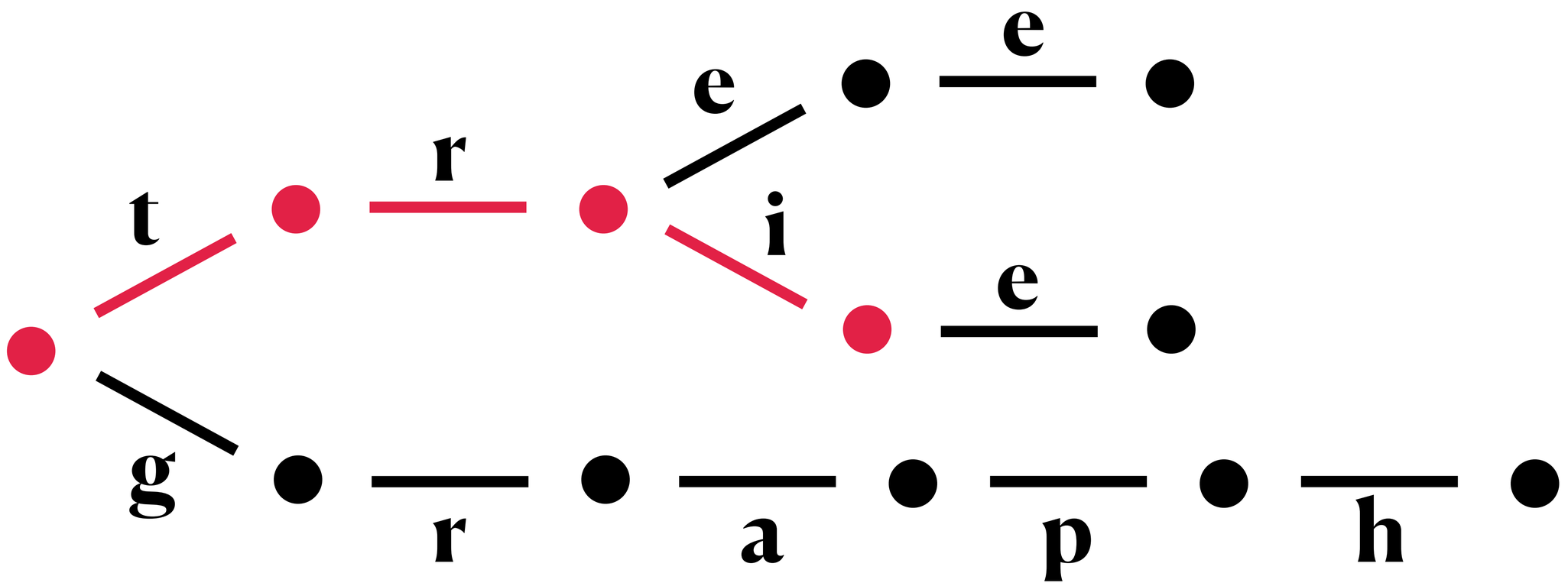


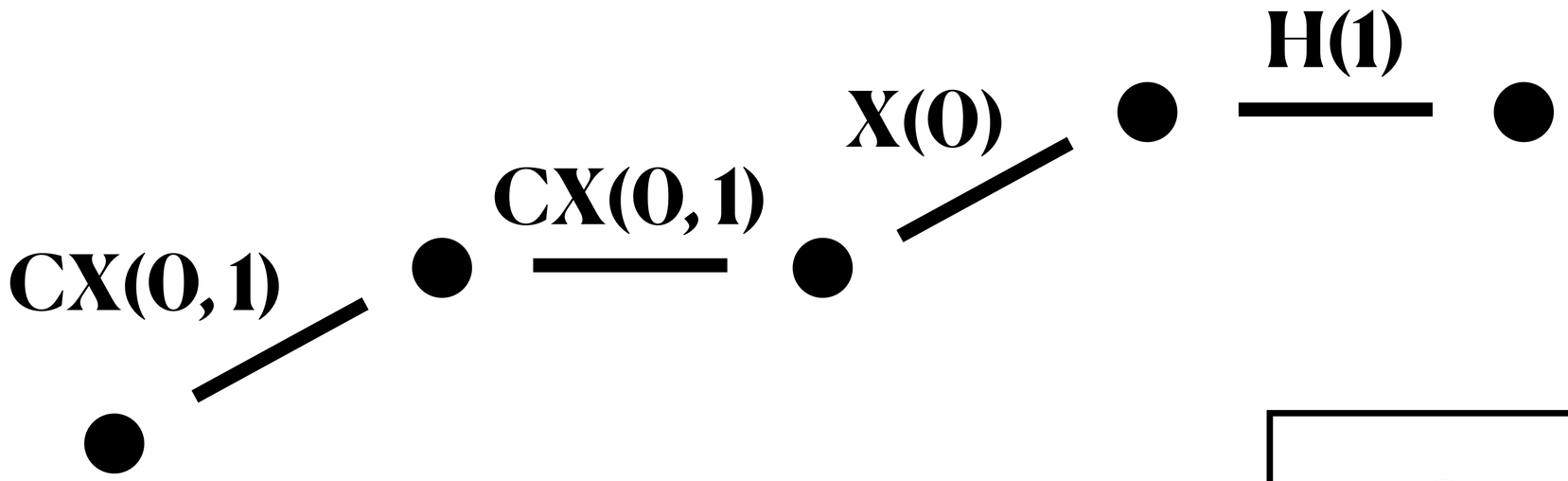
input: TRIVIAL

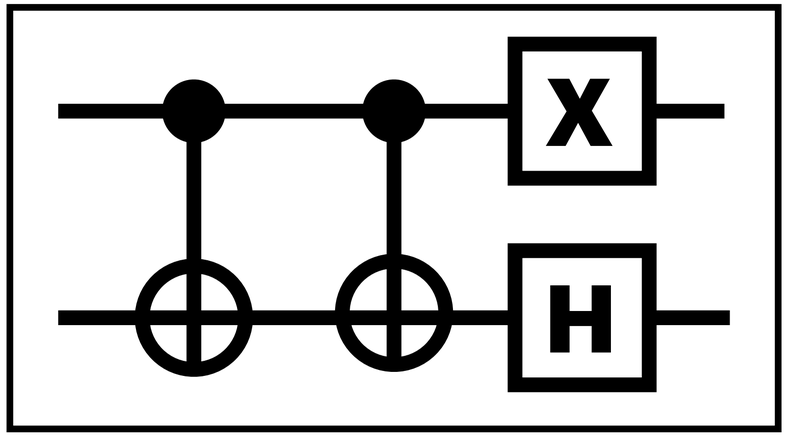
Tries are *deterministic* finite state machines



input: TRIVIAL

Tries also work for circuits!





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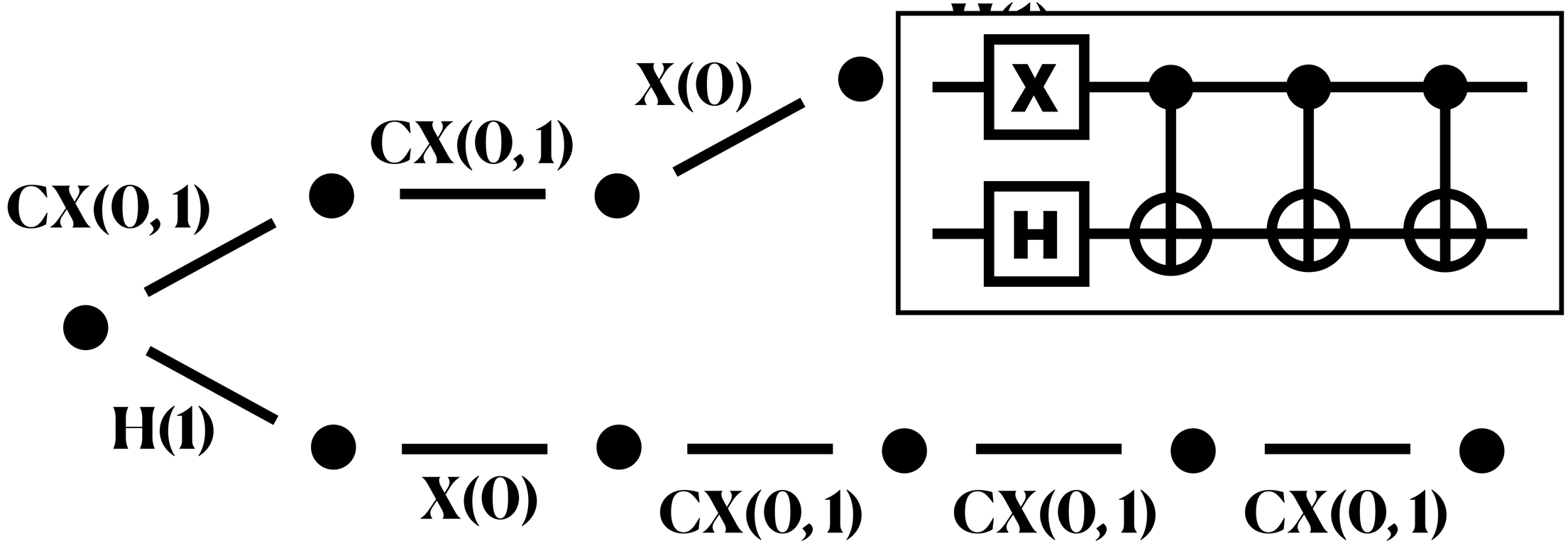

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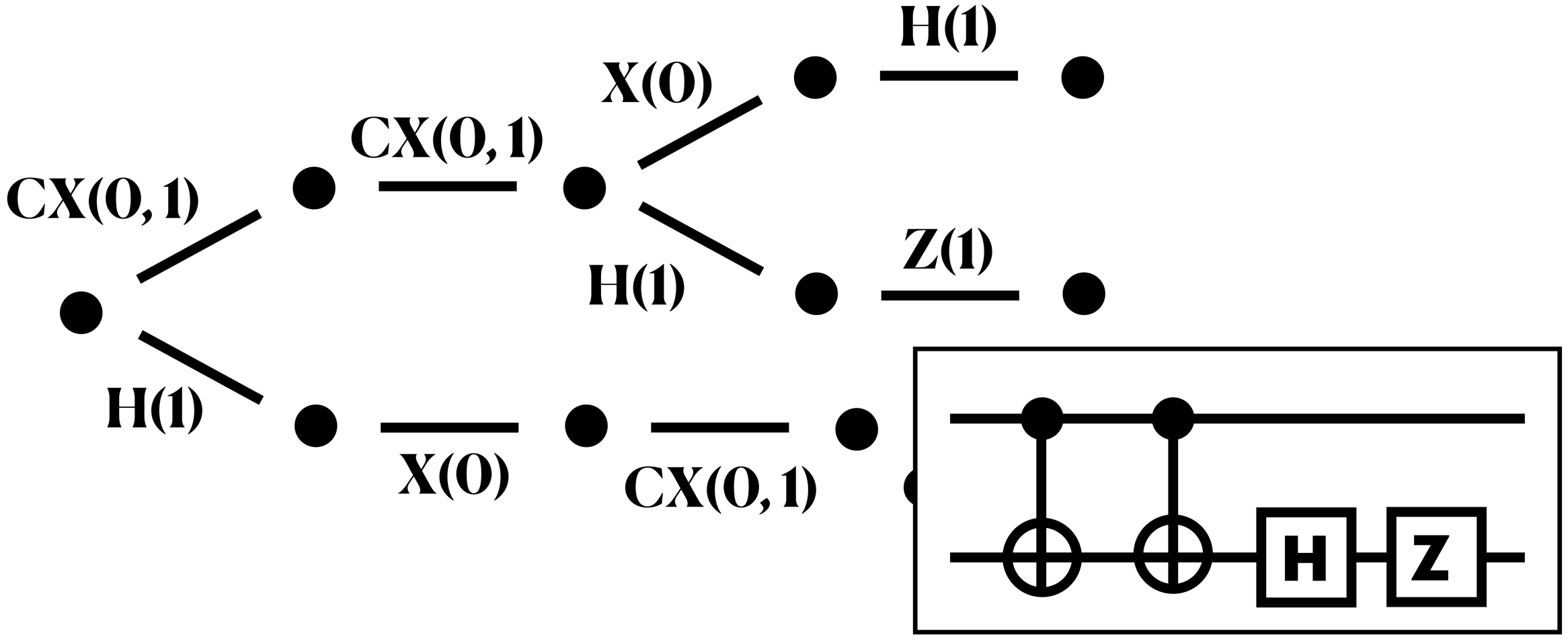
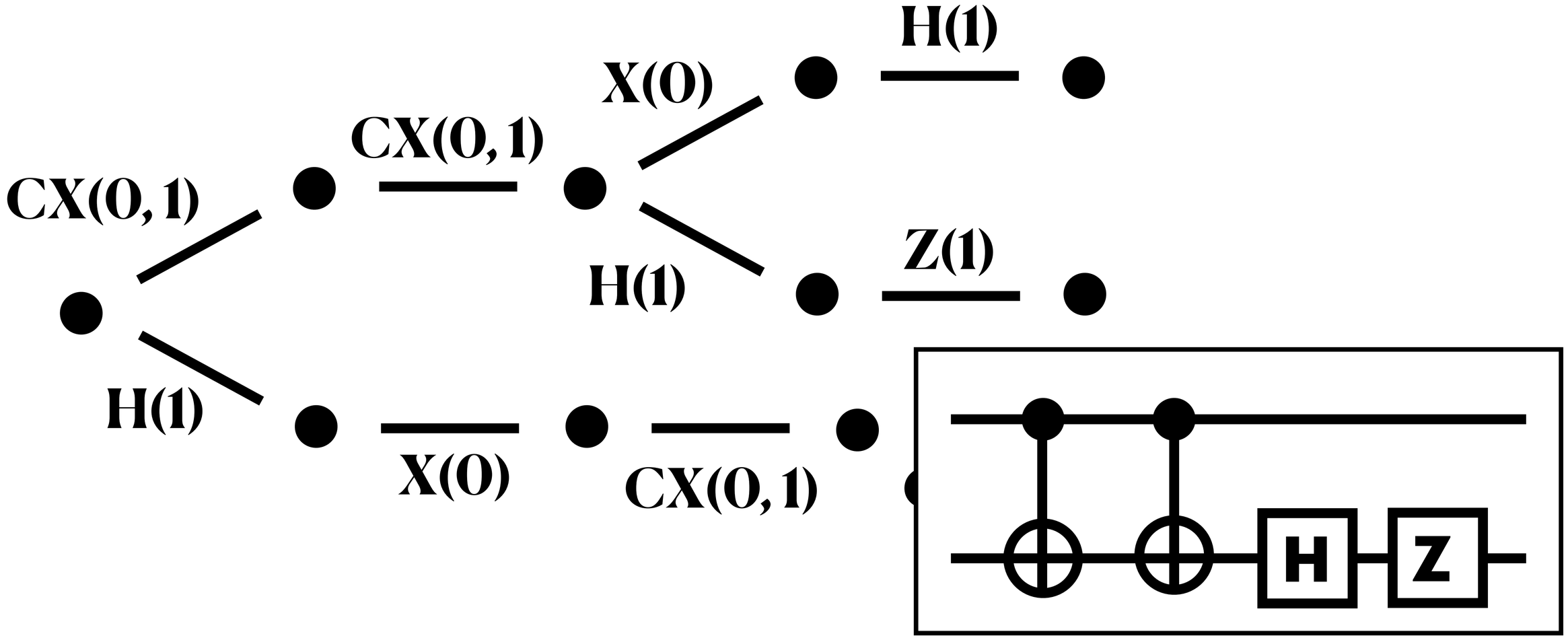


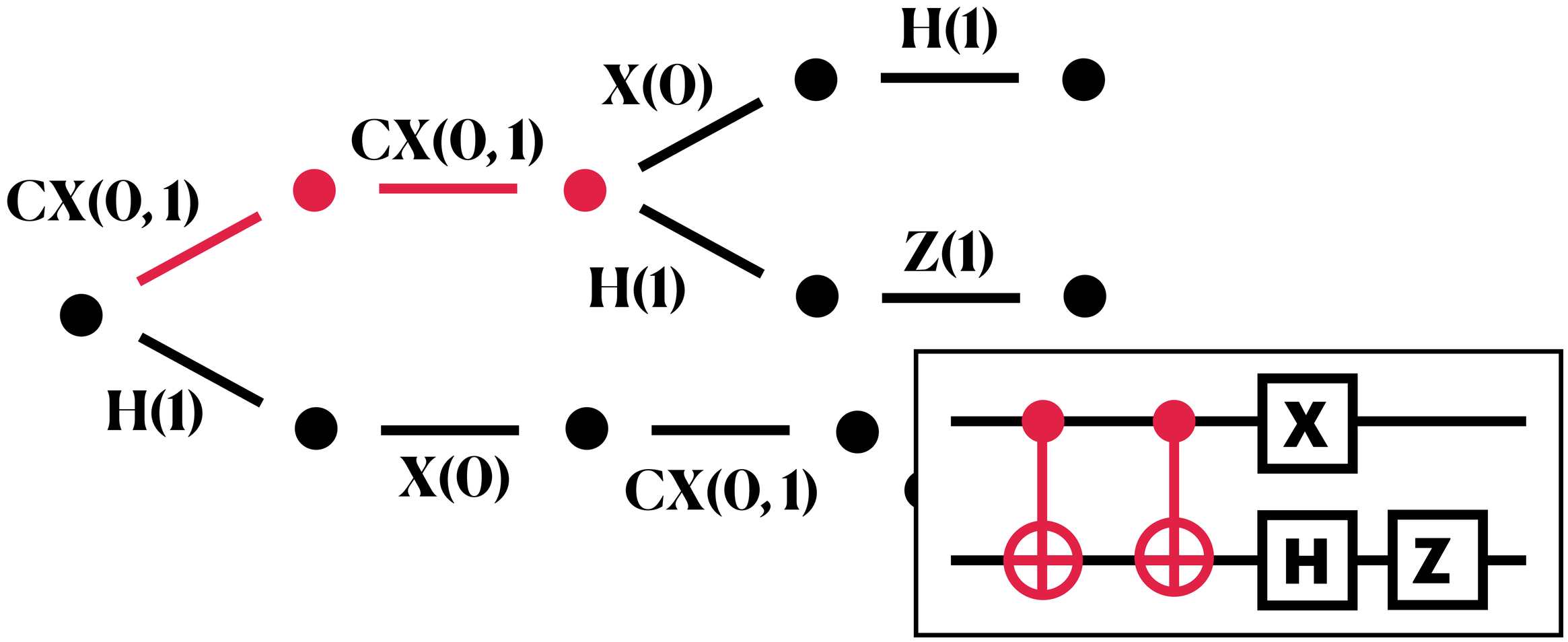
Tries also work for *(port)graphs*!



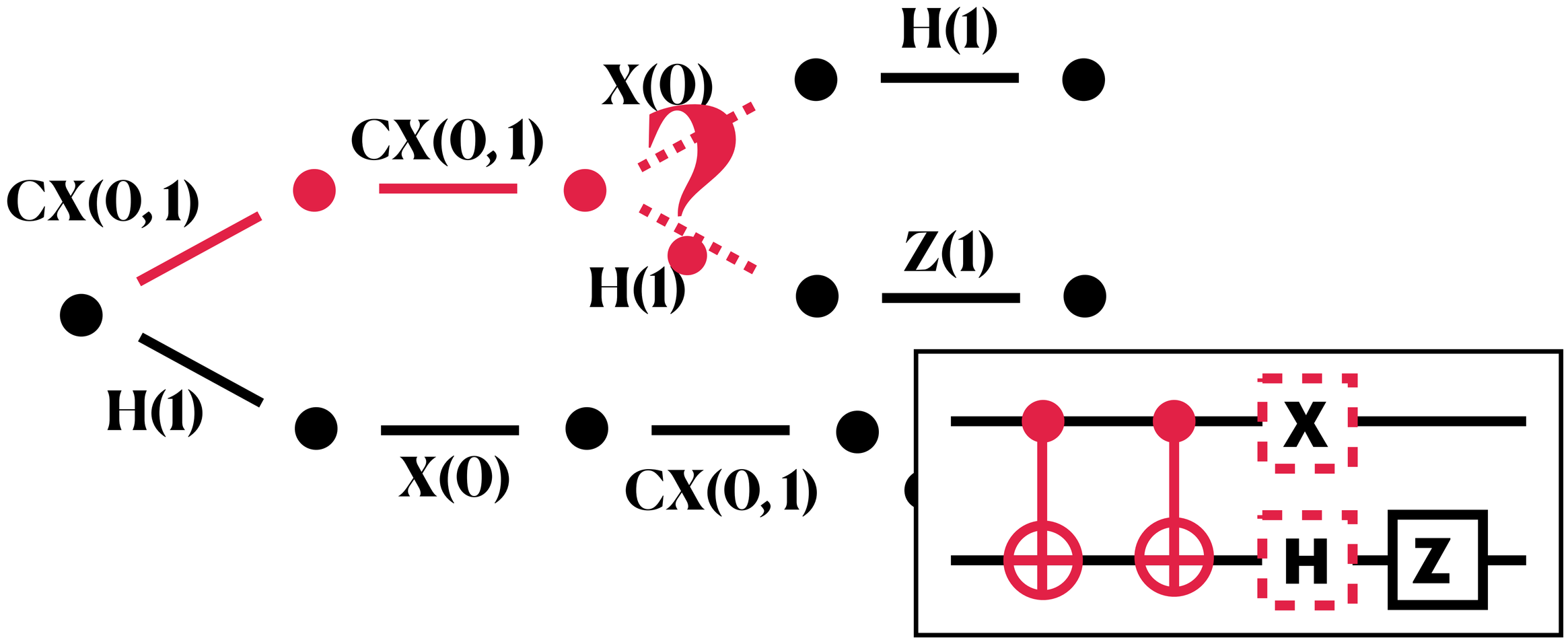
Tries also work for *(port)graphs*!

- No total ordering of the nodes
- No qubits
- No fixed node degrees

Graph Tries are finite state machines



Graph Tries are *non-deterministic* FSM



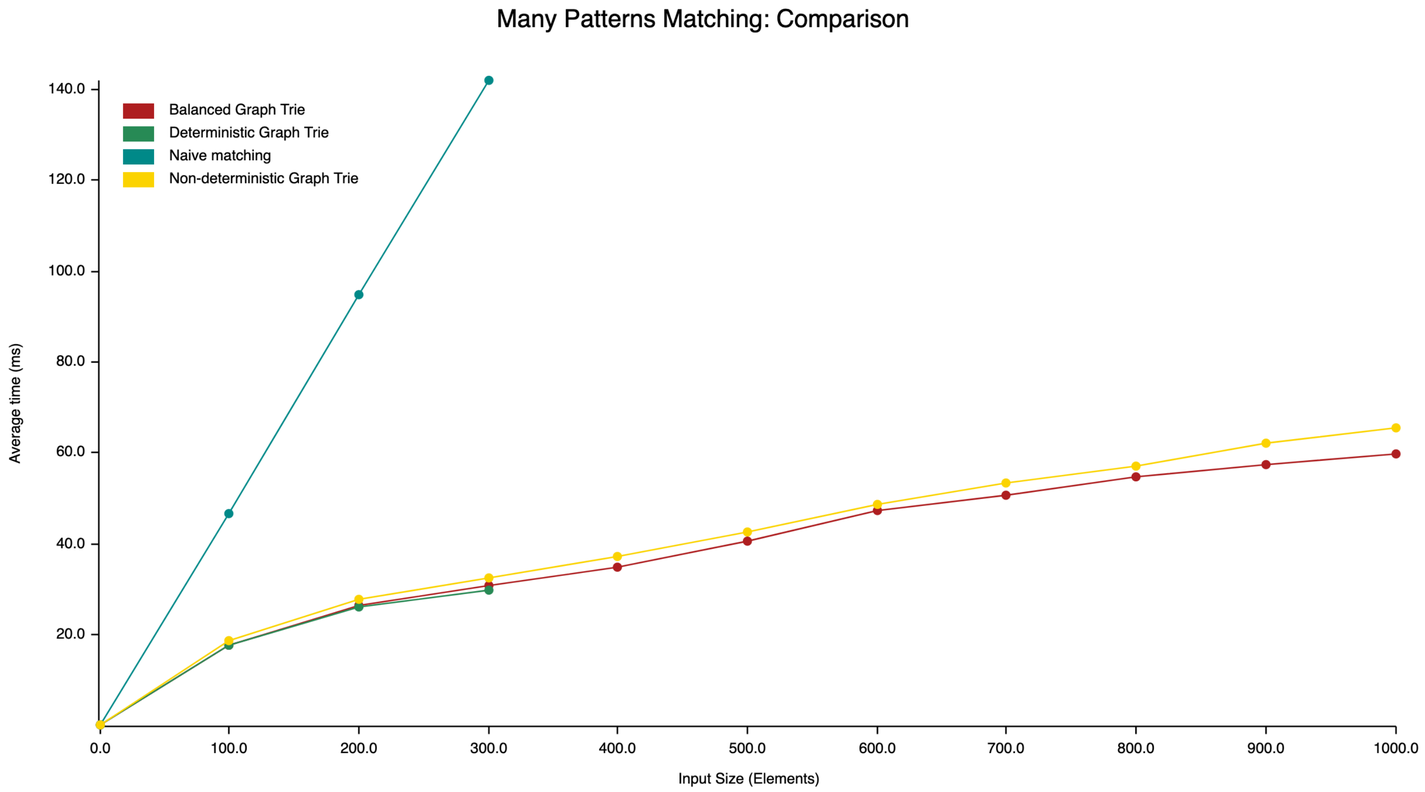
Bound the number of non-deterministic states!

Thm. If every pattern circuit has at most Q qubits, then any path from root to leaf in the graph trie will have at most Q non-deterministic states.

- Bound independent of input circuit size
- Graph trie depth bound by $Q \cdot d$

All code available at

`github.com/lmondada/portmatching`



Please reach out!

luca@mondada.net