Validity of Tree Pattern Queries With Respect to Schema Information

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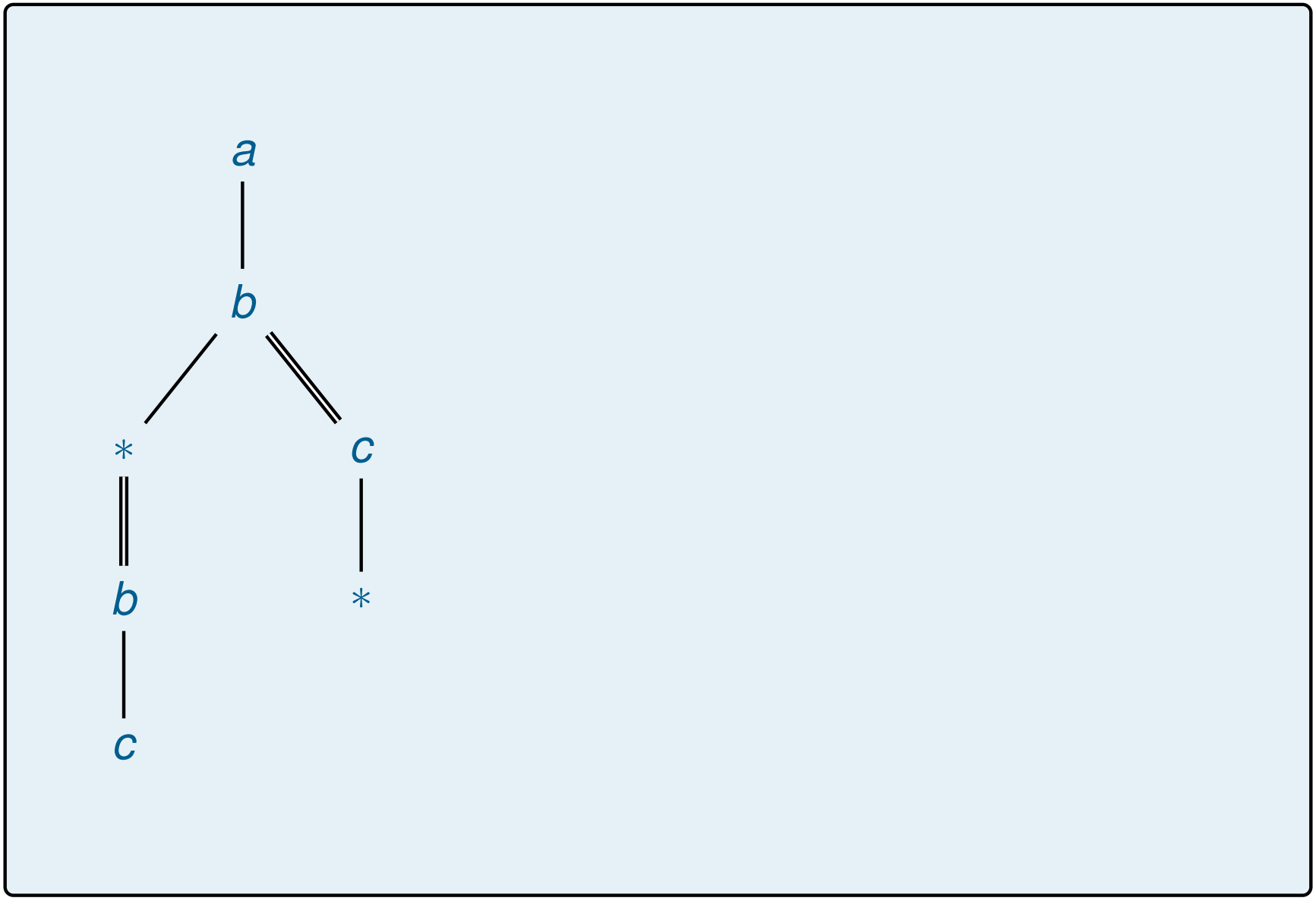
MFCS 2013

Tree pattern queries



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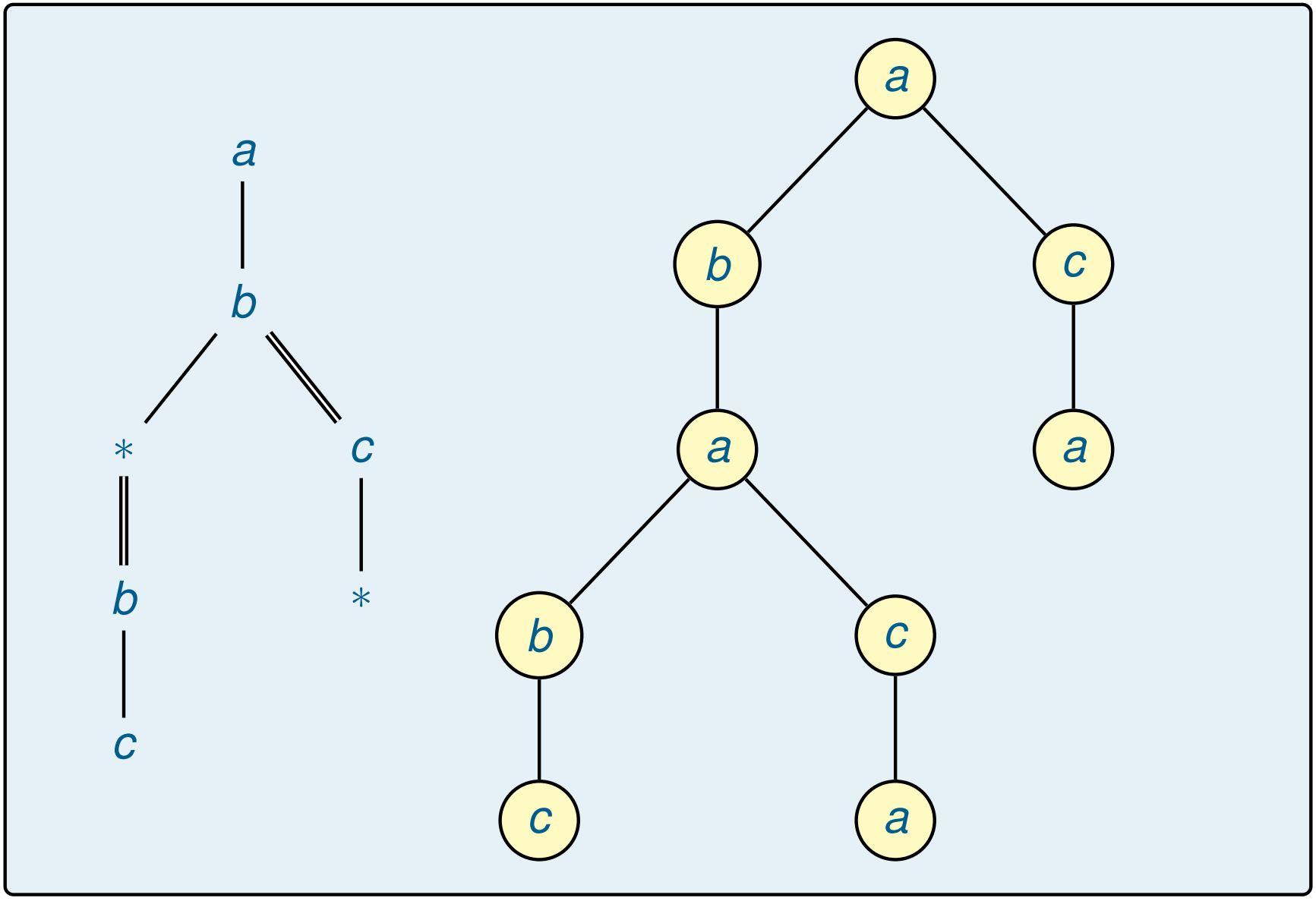

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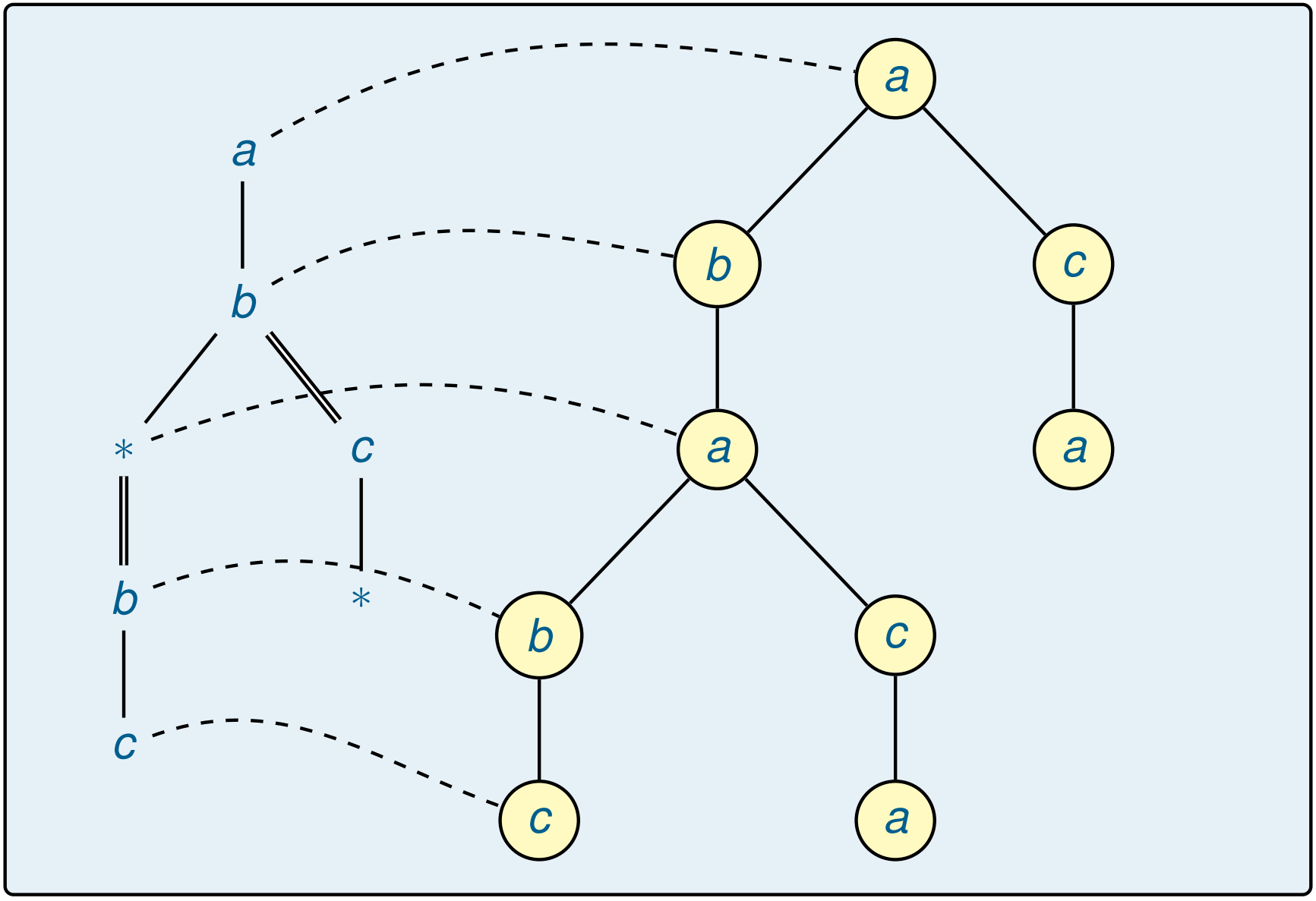

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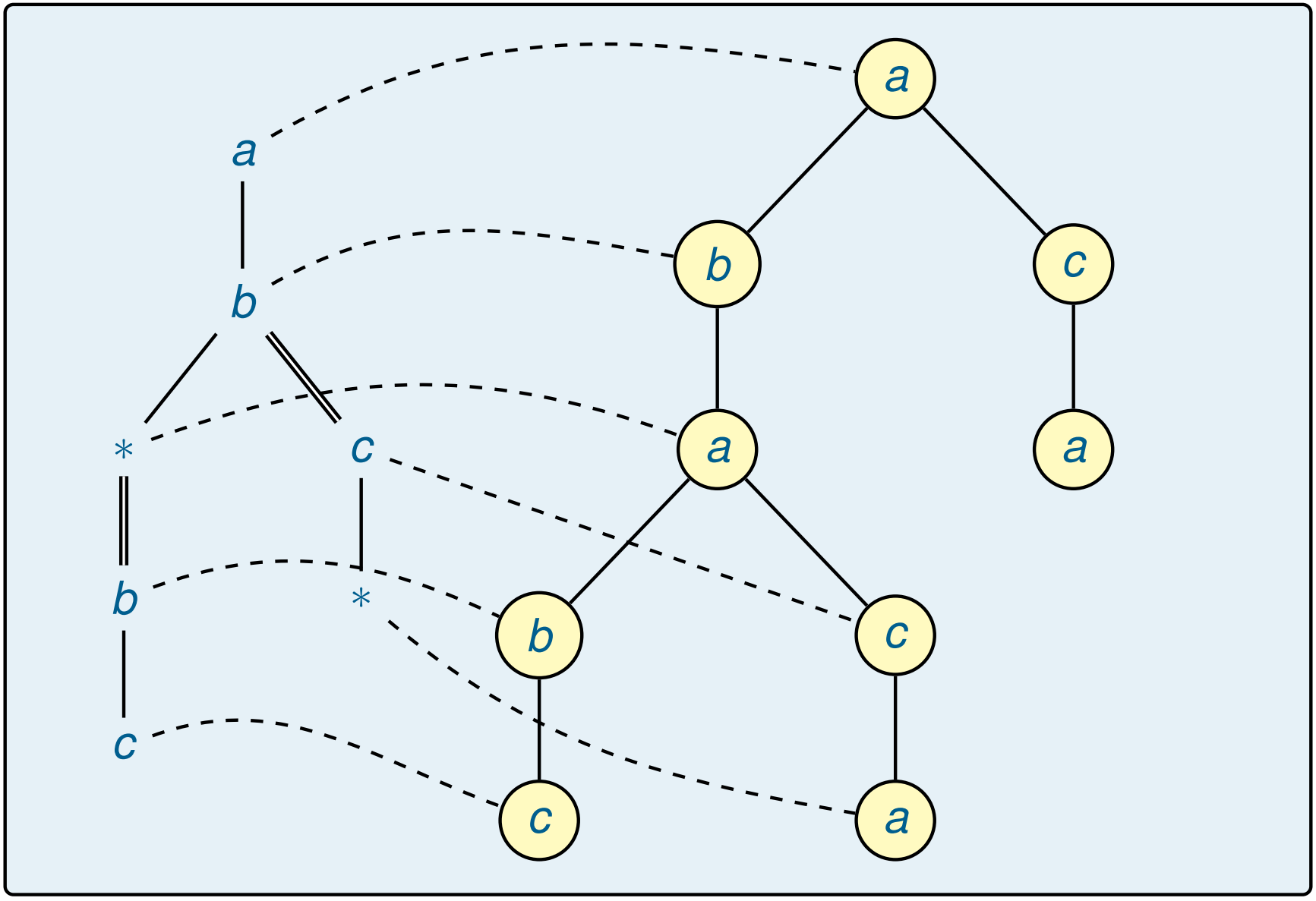


Schemas

Schemas define tree languges (i.e., sets of documents).

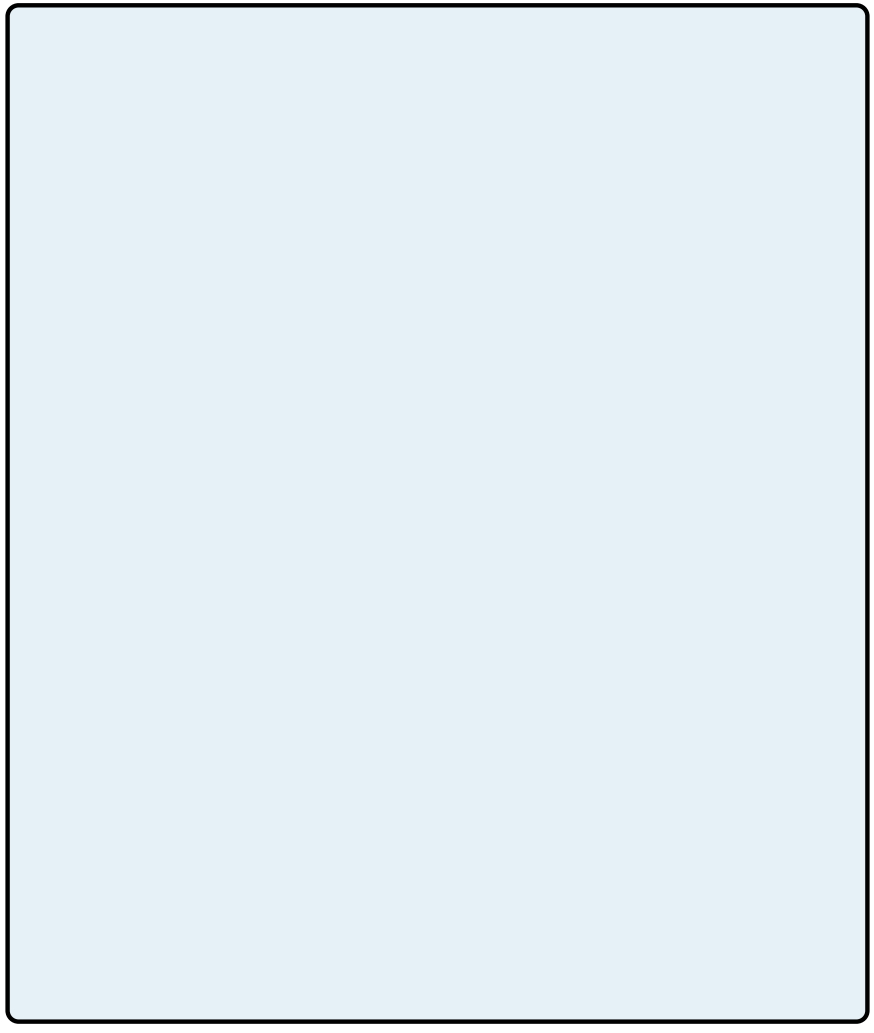
We consider three types of schemas:

- DTDs
- XSDs (corresponding to XML Schema Definitions)
- Tree automata (corresponding to Relax NG)

Validity with respect to a schema

Let Q be a TPQ.

Let S be a schema.



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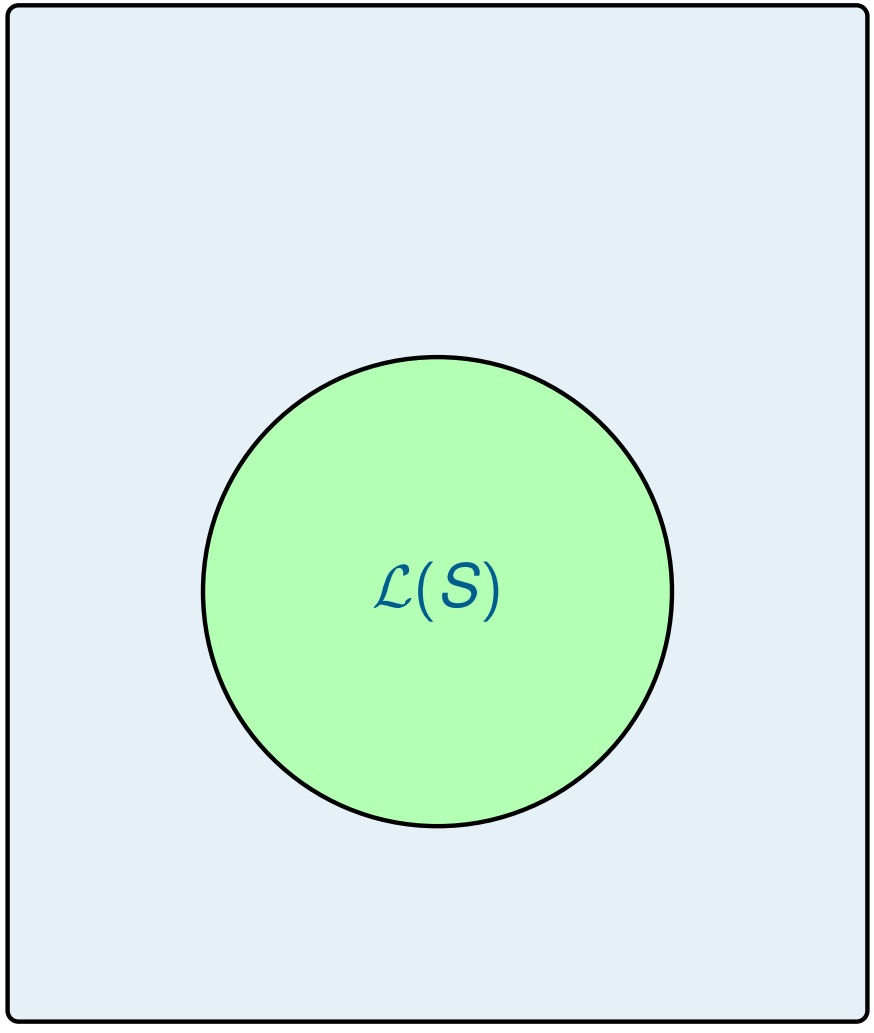

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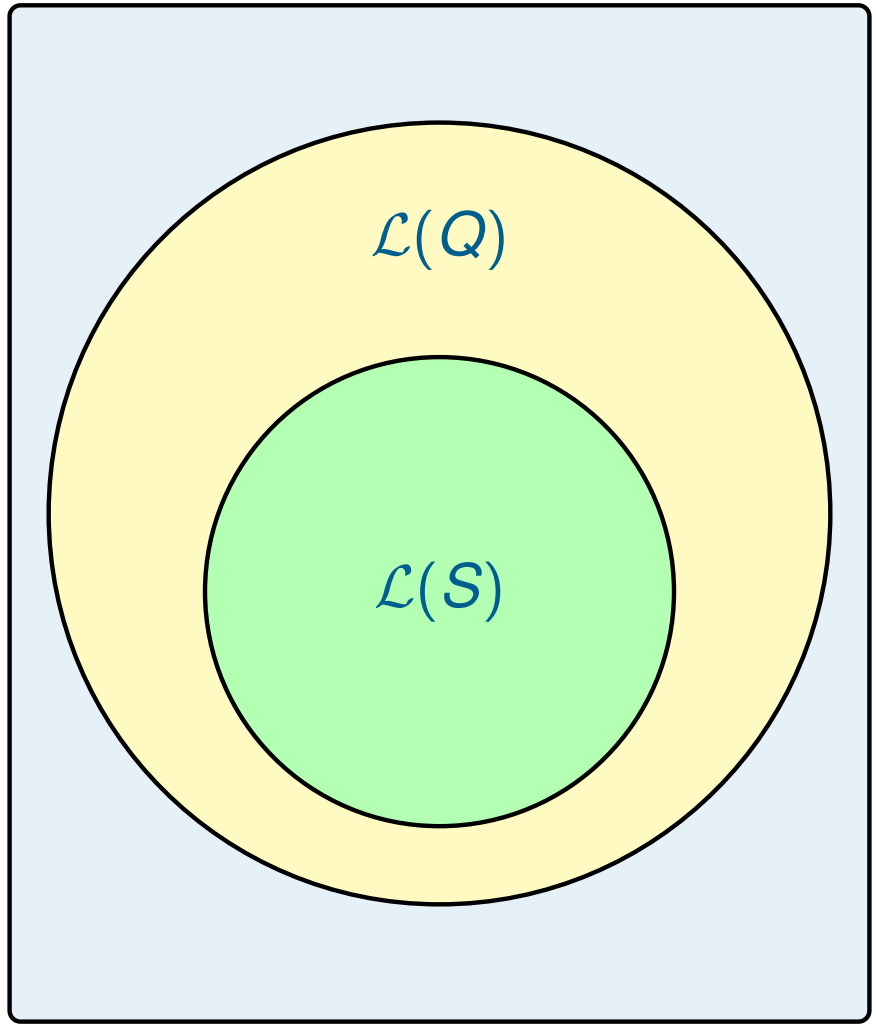

Some known results

Theorem (Hashimoto et al., 2011)

Validity of path queries w.r.t. DTDs is in PTIME.

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Theorem (Benedikt et al. 2012)

Validity of unions of conjunctive queries w.r.t. tree automata is in EXPTIME.

Our results (1)

Theorem

Validity of TPQs w.r.t. tree automata is EXPTIME-hard.

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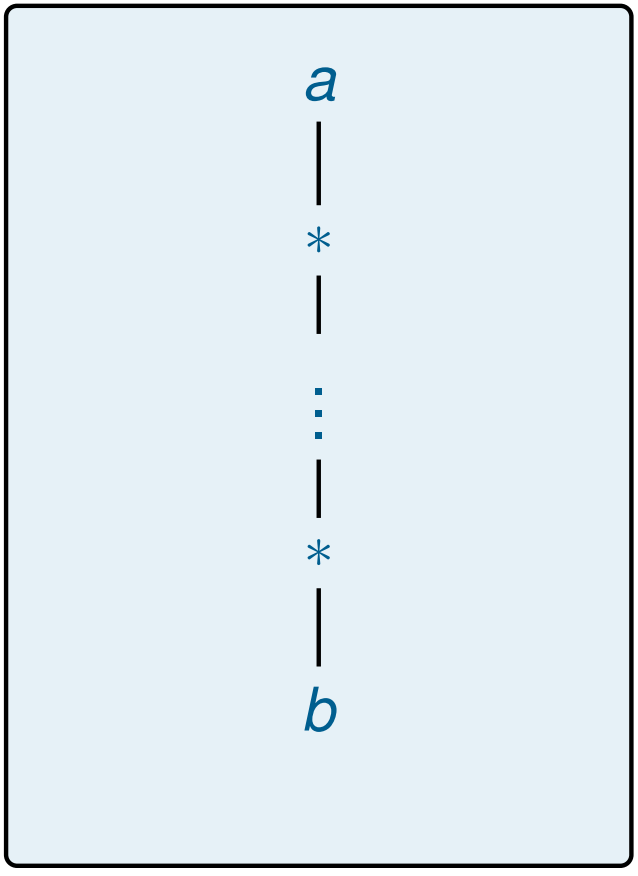

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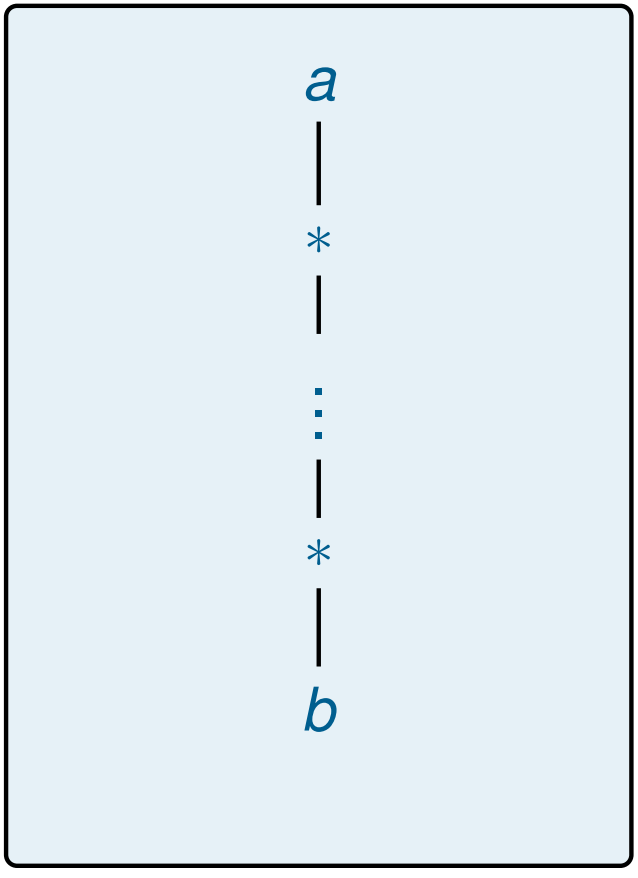

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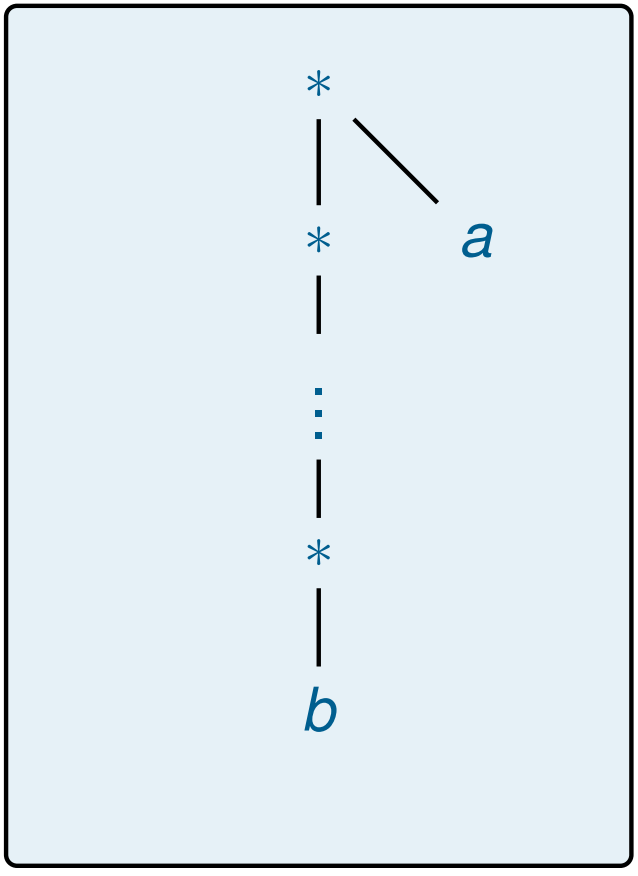

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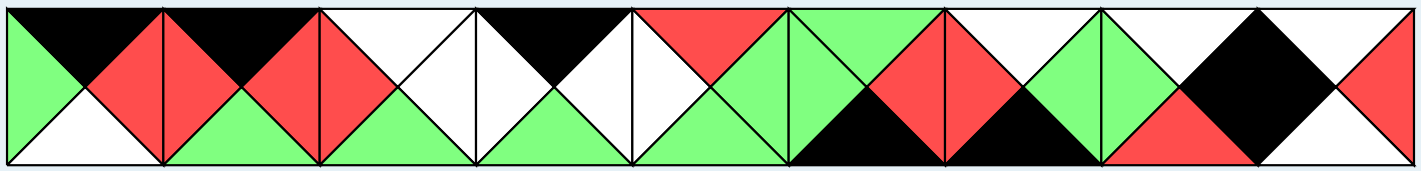
This holds even if the regexp looks like this.

$$\Sigma^* \cdot a \cdot \Sigma^n \cdot b \cdot \Sigma^*$$

Recommended reading

B. S. Chlebus. Domino-Tiling Games. Journal of Computer and System Sciences, 32(3):374-392, 1986.

Tiling systems



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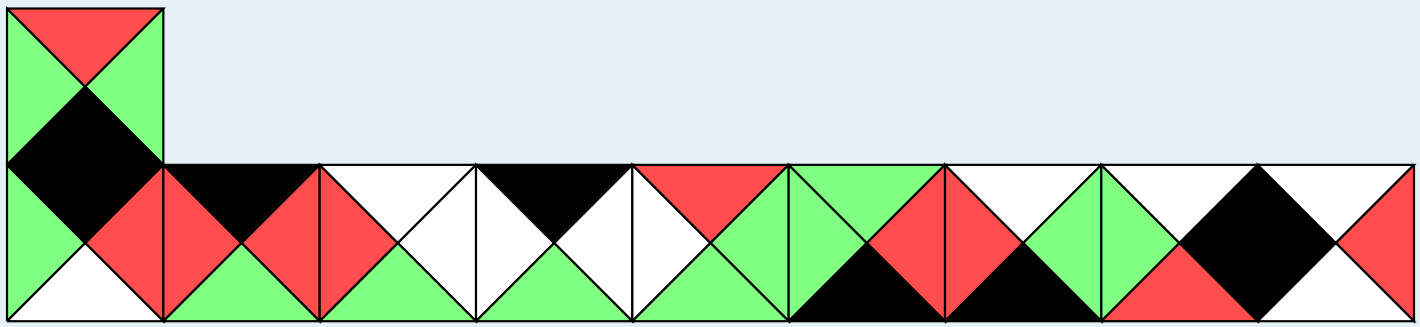

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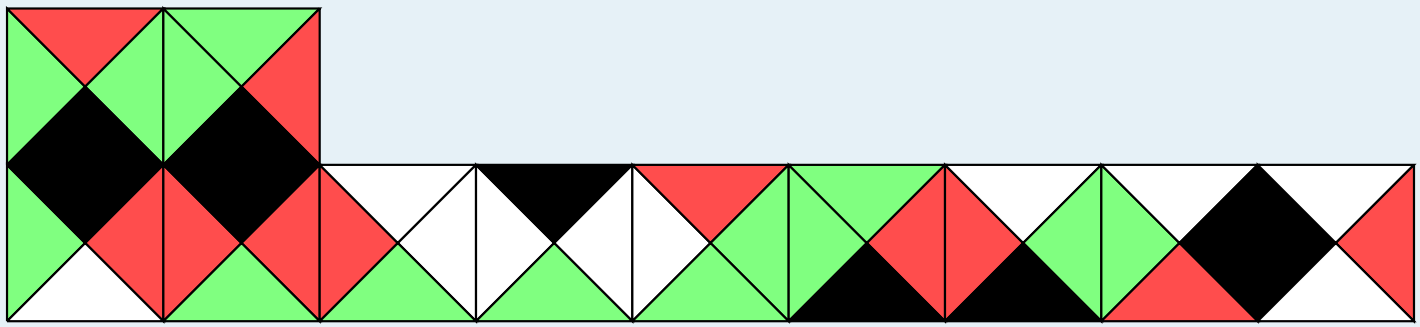

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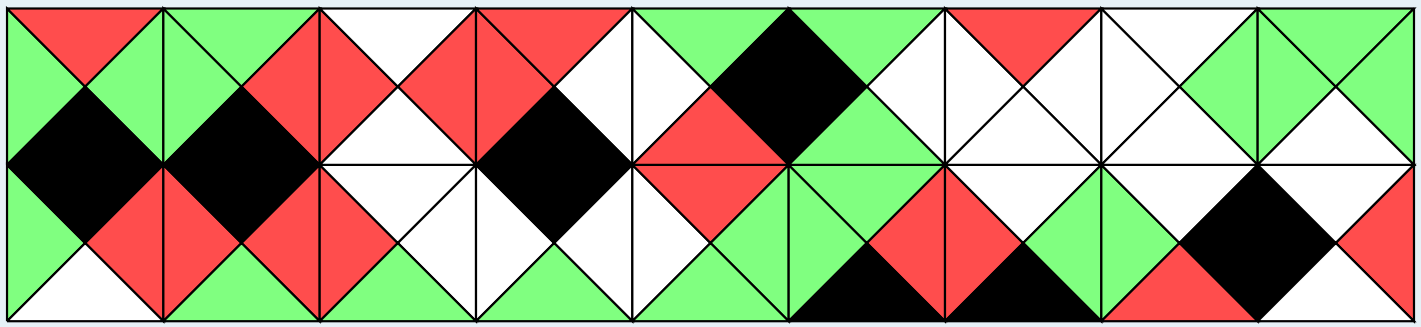

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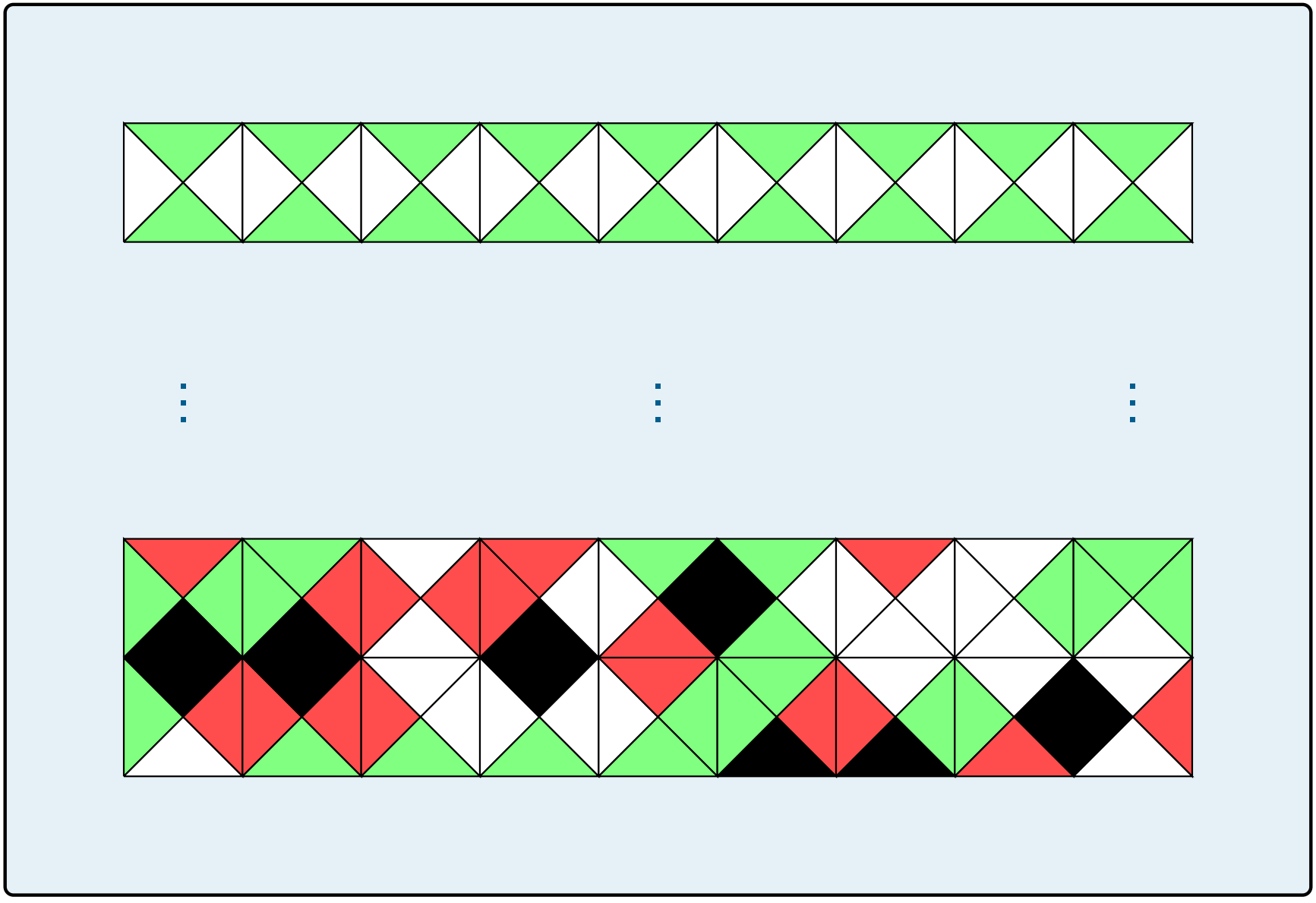
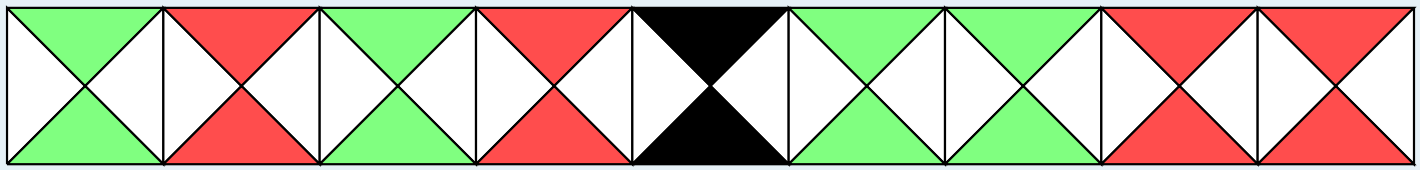


Tilings and TMs



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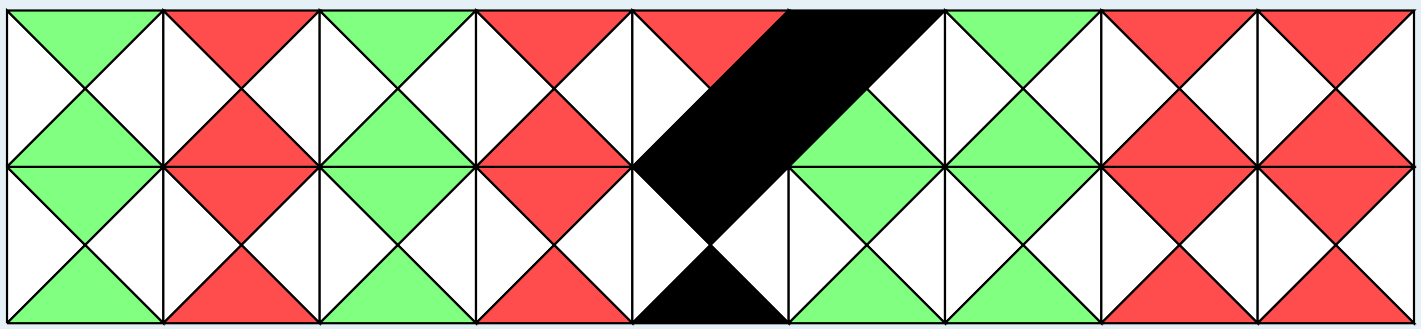

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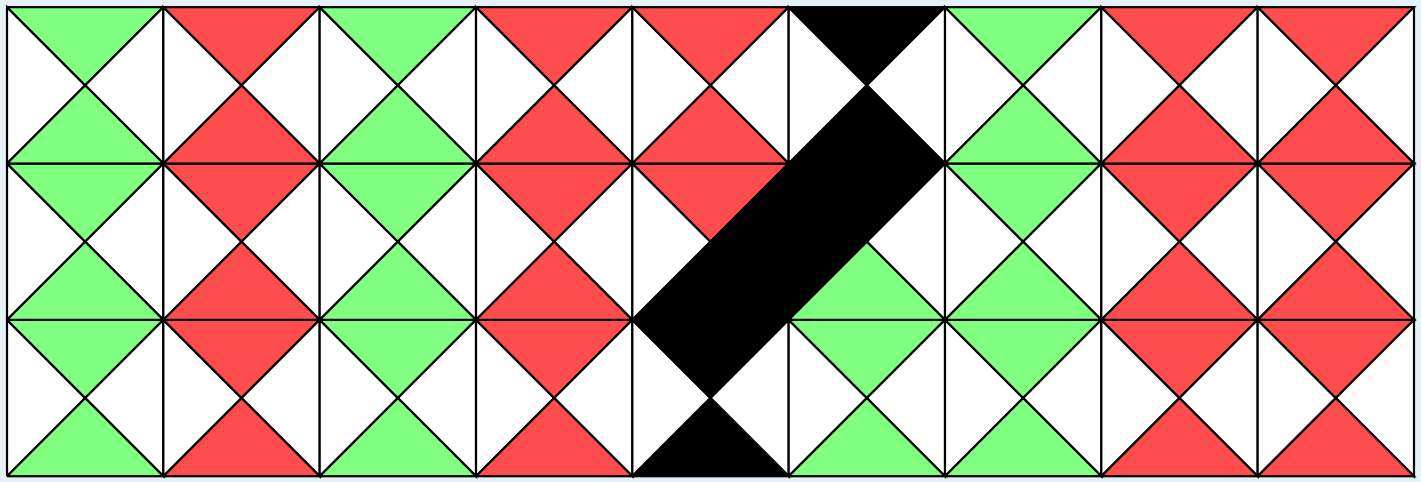

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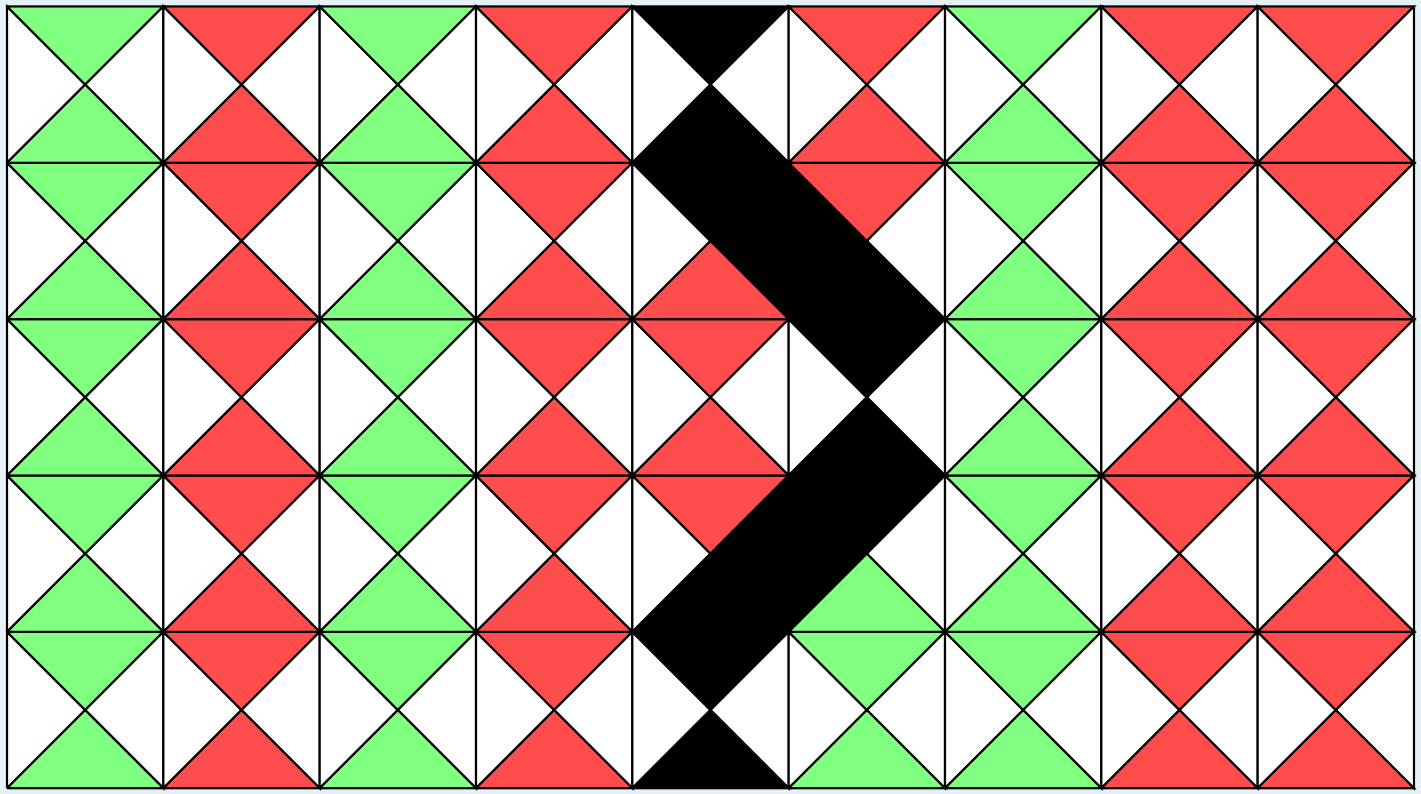

Tilings and complexity

Theorem (Chlebus, 1986)

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- *The corridor tiling problem is PSPACE-complete.*
- *The corridor tiling game problem is EXPTIME-complete.*
- *There is a tiling system S such that Tilings(S) is PSPACE-complete.*
- *There is a tiling system S such that TilingWinner(S) is EXPTIME-complete.*

- Tilings(S): the set of initial rows for which there is a solution S.
- TilingWinner(S): the set of initial rows for which Player 1 has a winning strategy in the tiling game on S.

Restricted tiling systems

A tiling system is restricted if

- it has even length,
- at each point, there are exactly two continuations such that the row can be completed, and
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Theorem

There is a restricted tiling system S such that TilingWinner(S) is EXPTIME-complete.

Theorem

Inclusion of a DFA language in a regexp language is PSPACE-hard, even for expressions of the form

$$\Sigma^* \cdot a \cdot \Sigma^n \cdot b \cdot \Sigma^*.$$

Strings

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First step: consider tilings as strings.

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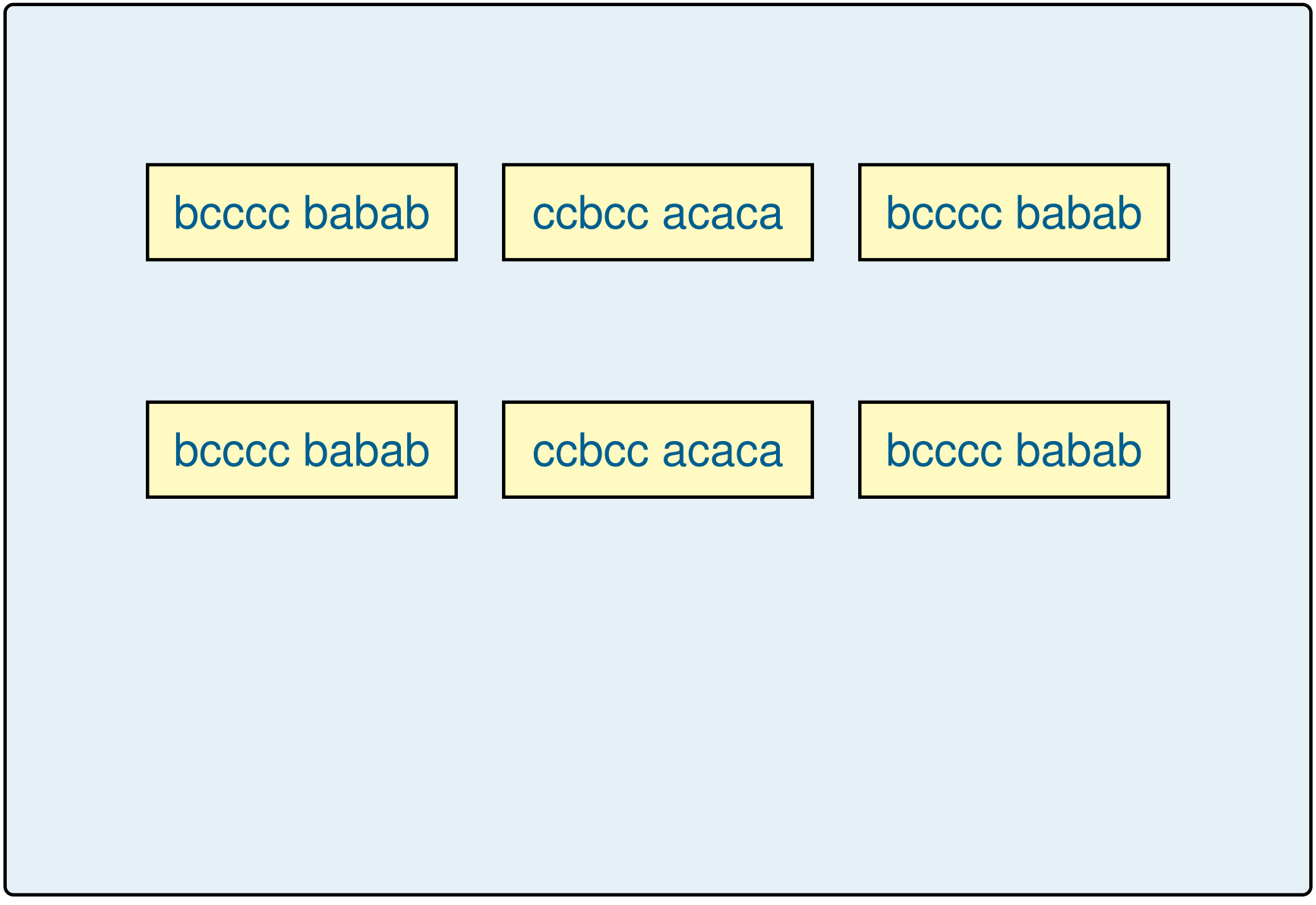
3. respect all horizontal constraints, and
4. have the final row as suffix.

Encoding tiles

We will encode tiles by strings of length $2k$, where k is the number of tiles in S.
Suppose S has 5 tiles and that tiles 2 and 4 are the only ones allowed on top of tile 3. Then we encode tile 3 by

ccbcc acaca

Detecting vertical errors



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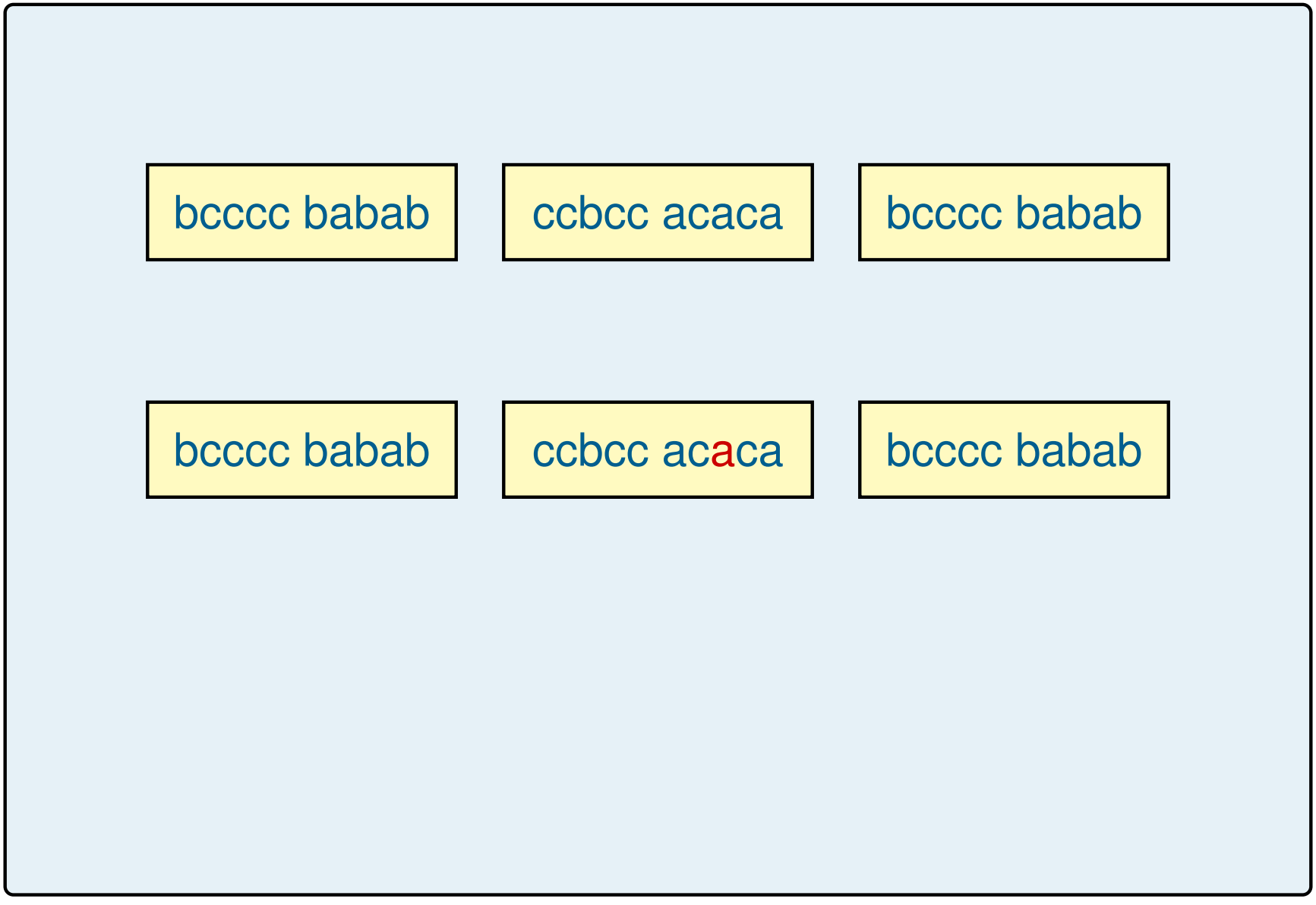

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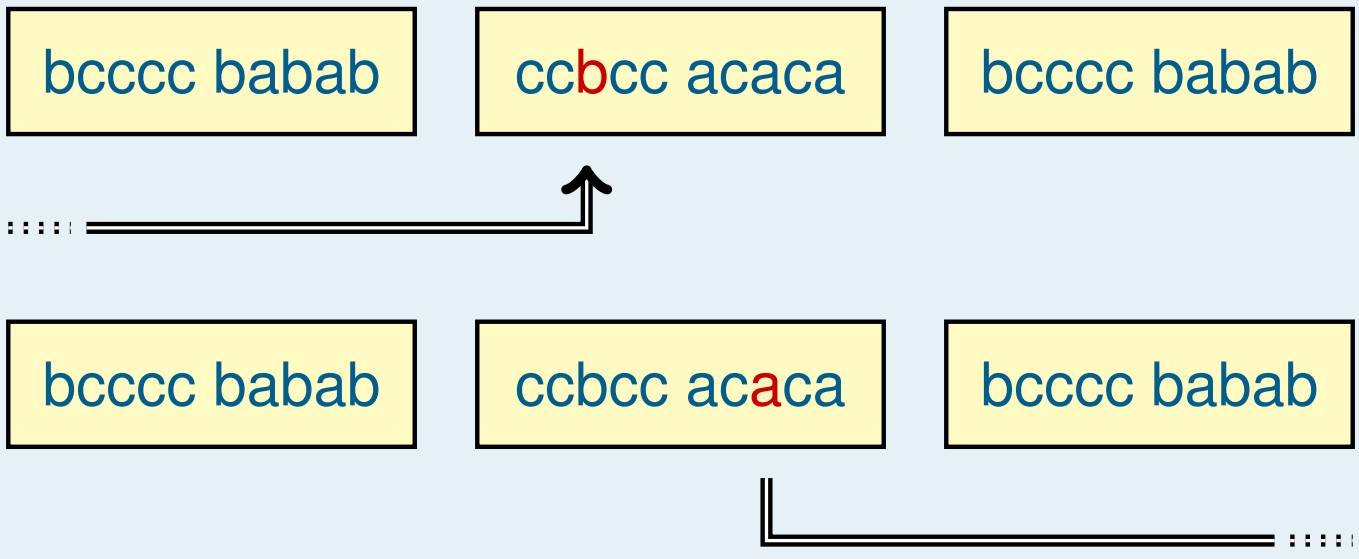

$(2n-1)k = 5 \cdot 5 = 25$ steps

Putting the pieces together

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Since PSPACE is closed under complement, this gives us what we need.

Back to tree pattern queries

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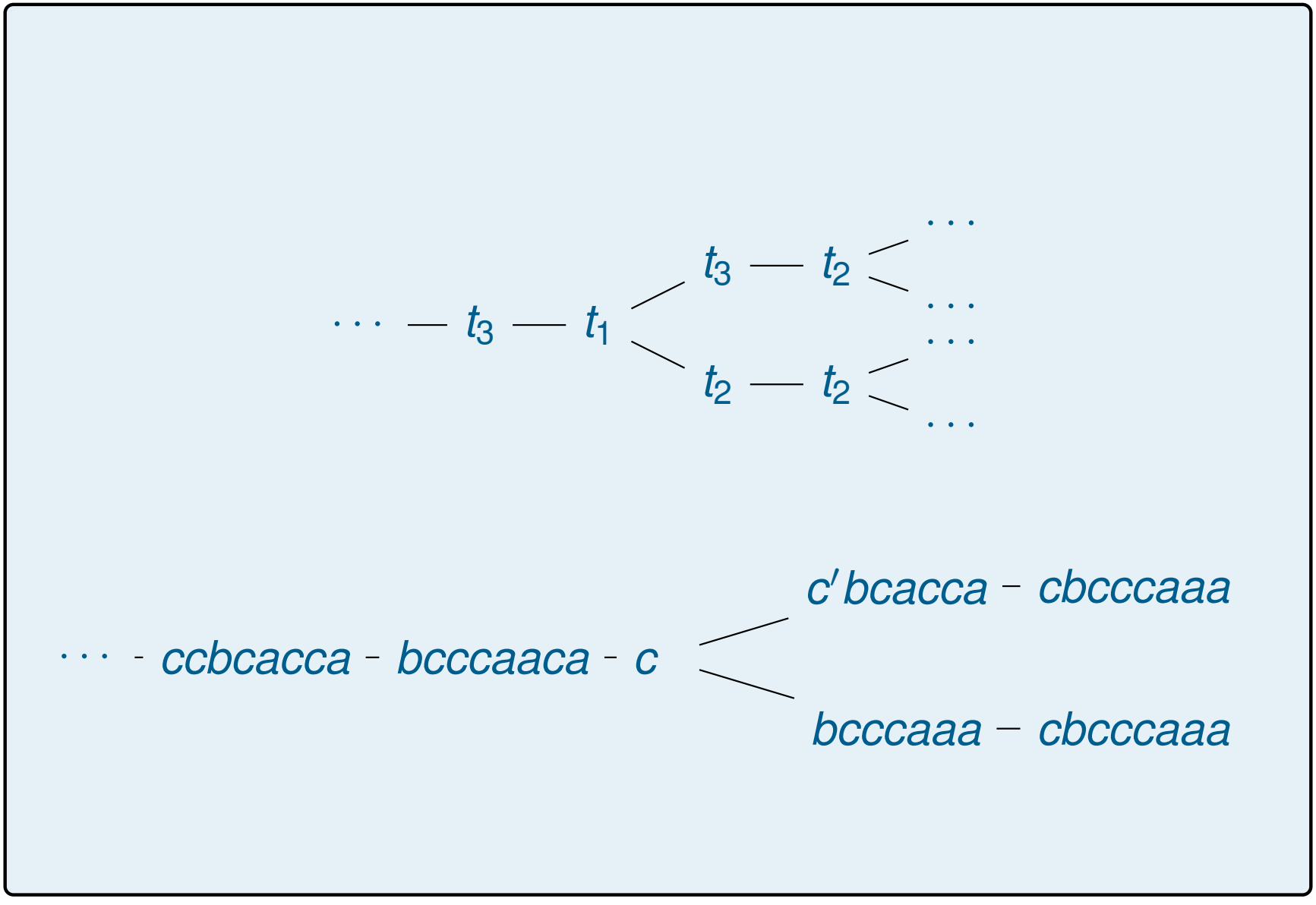
We reduce from tiling games and use strategy trees where each branch encodes a possible tiling.

Encoding strategy trees



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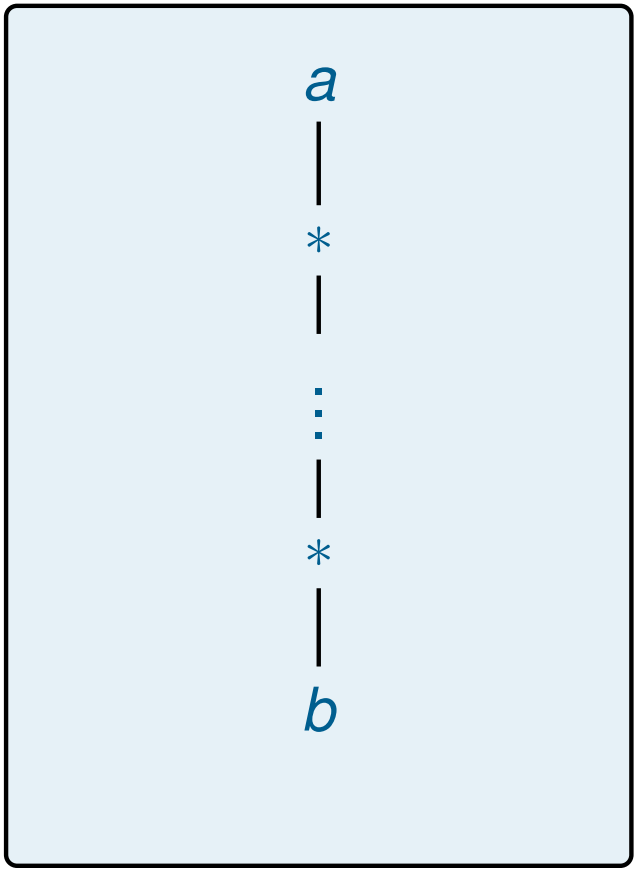

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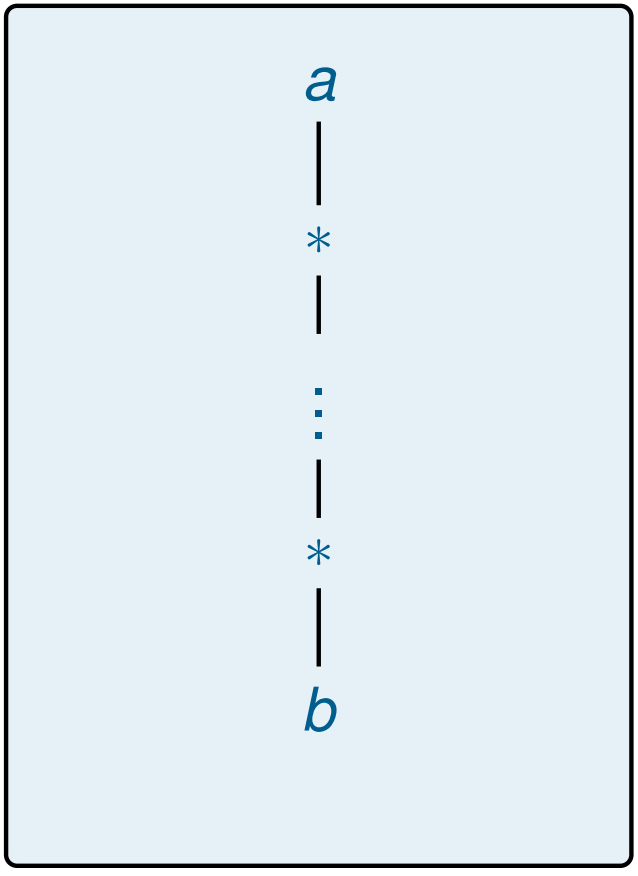

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