Computing the **Heaviest Conflict-free Sub-DAG** in DAG-based DLTs

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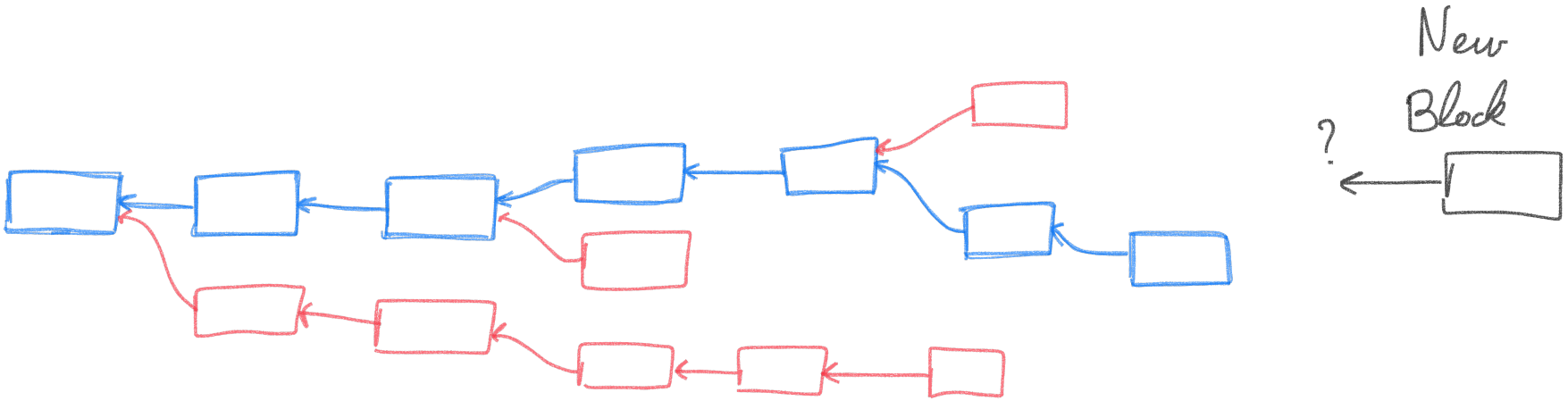
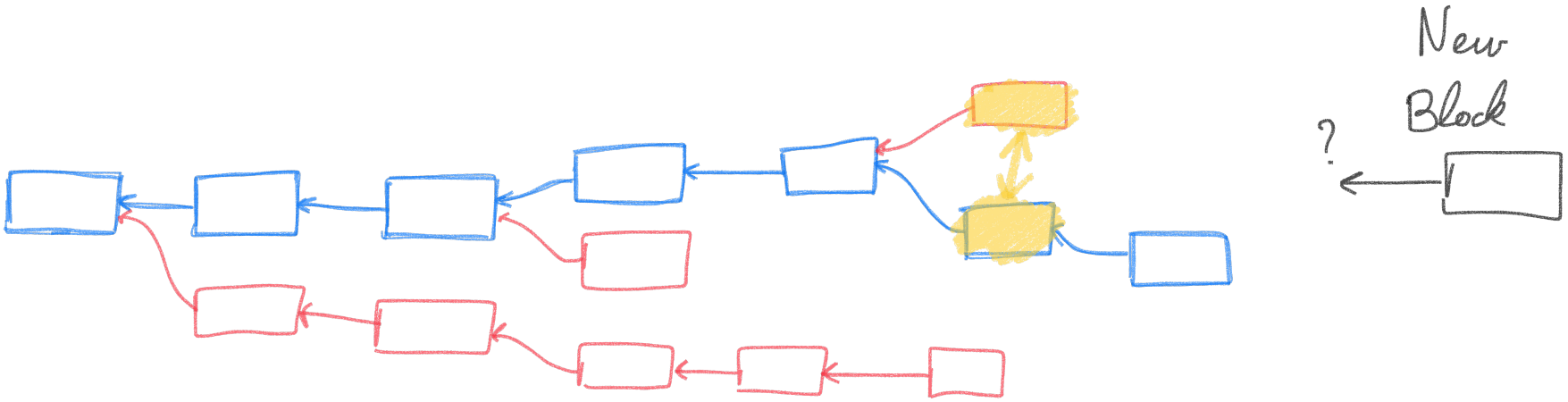
Context

Current state = parent I would select for a new block



= heaviest branch

Resolving conflicts in Blockchains



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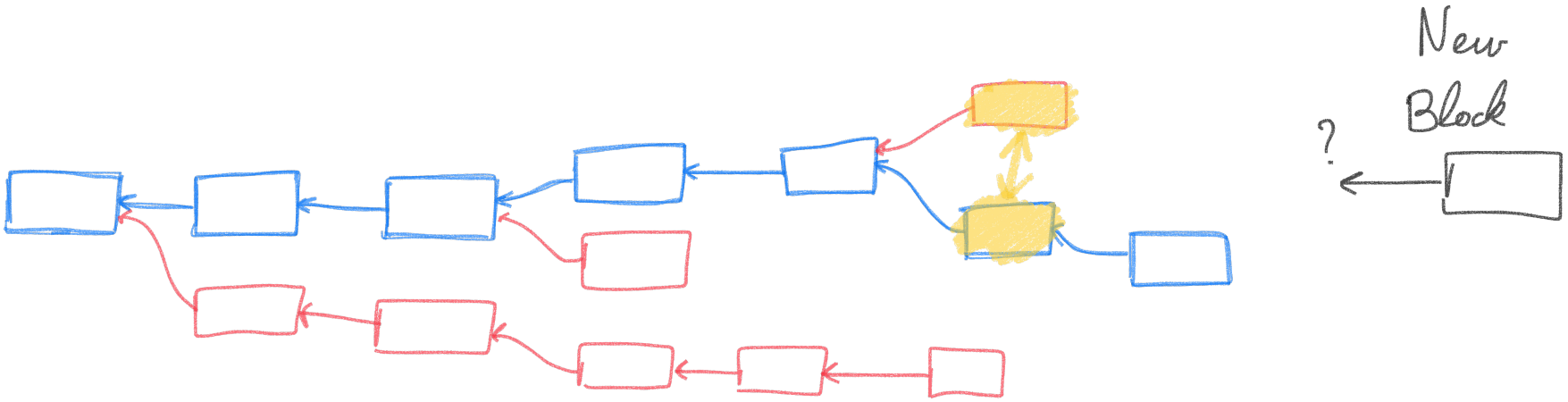

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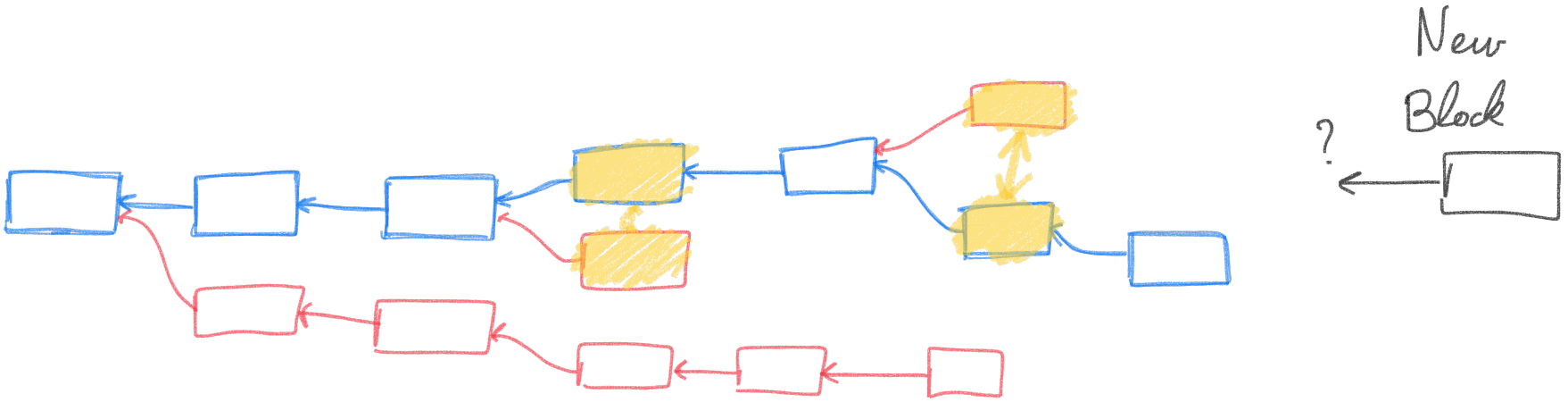

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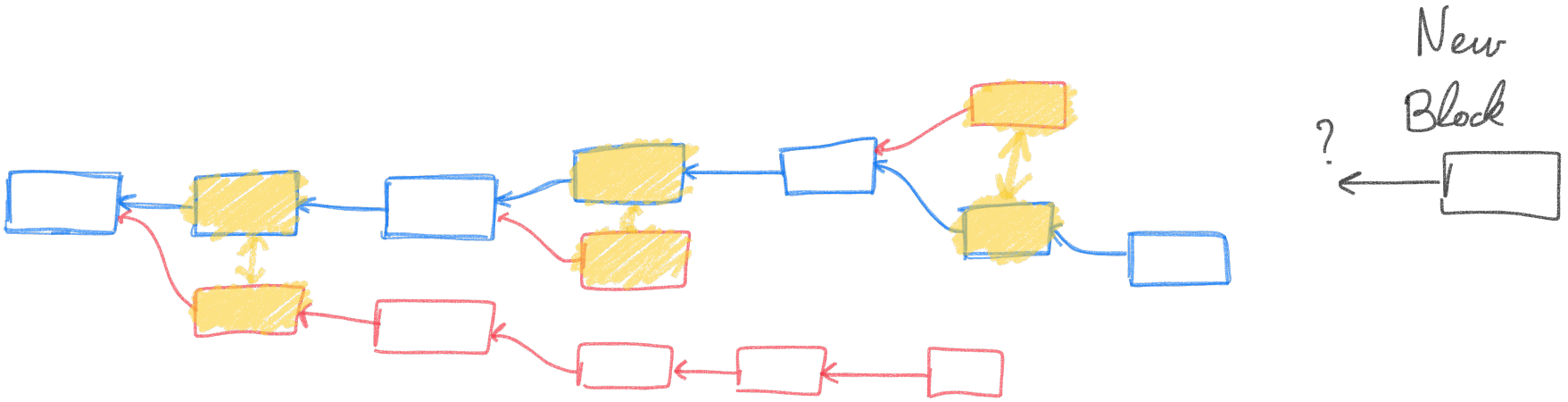

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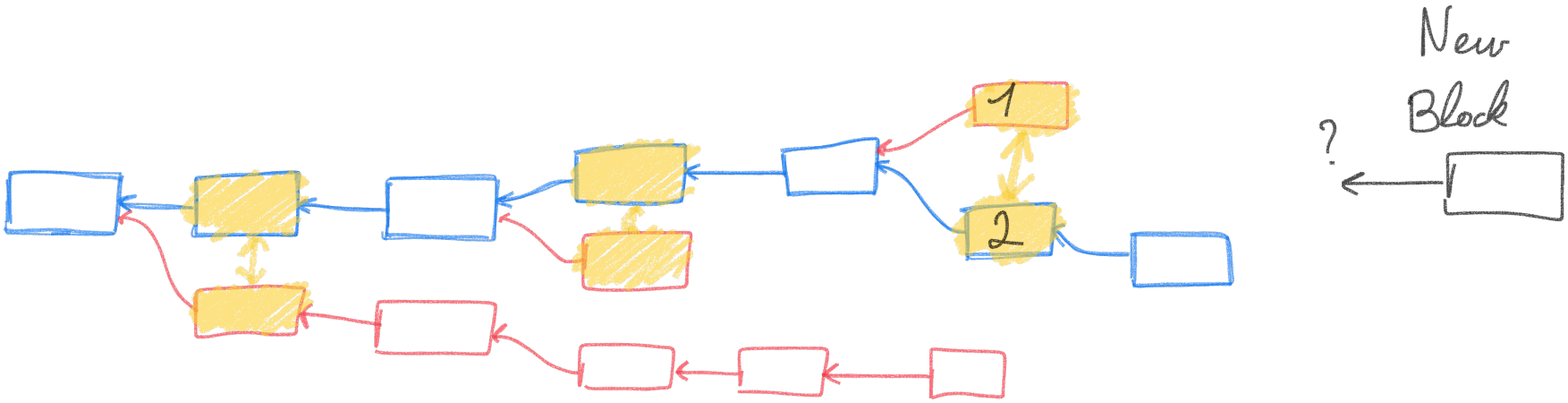

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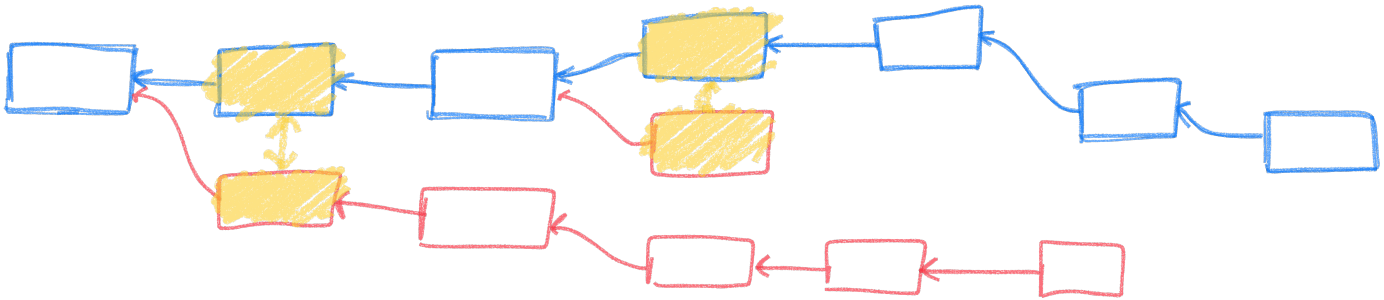

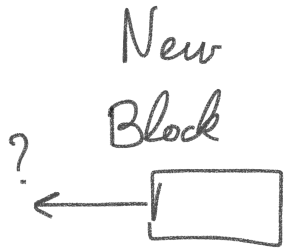

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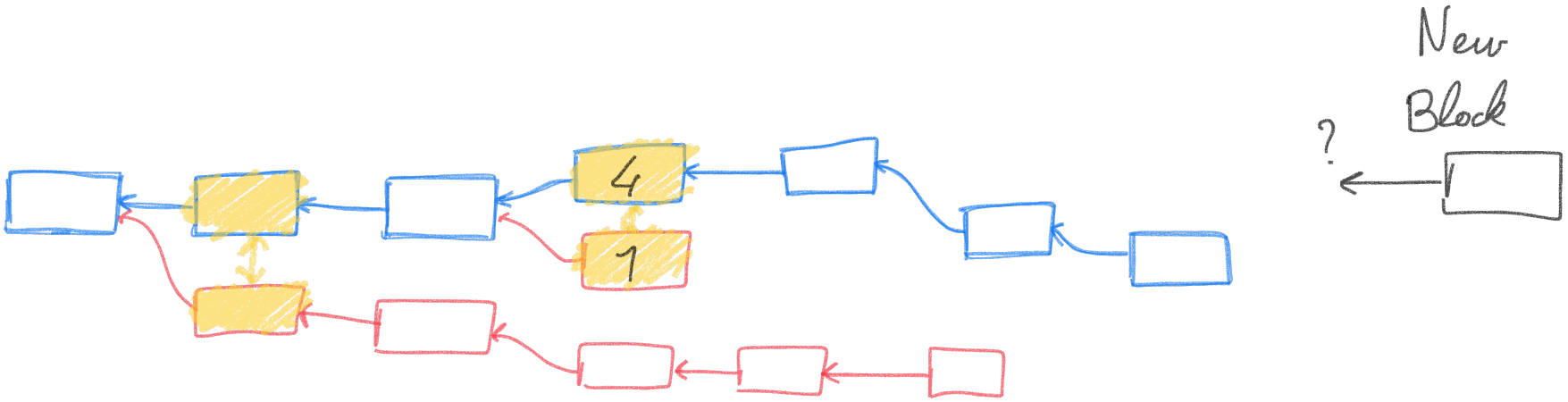

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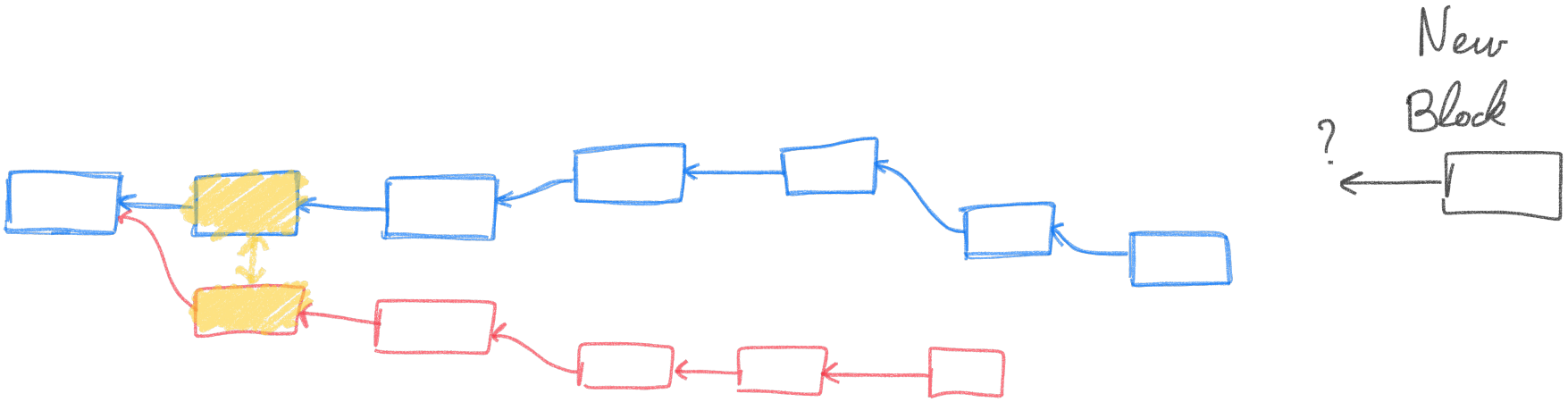

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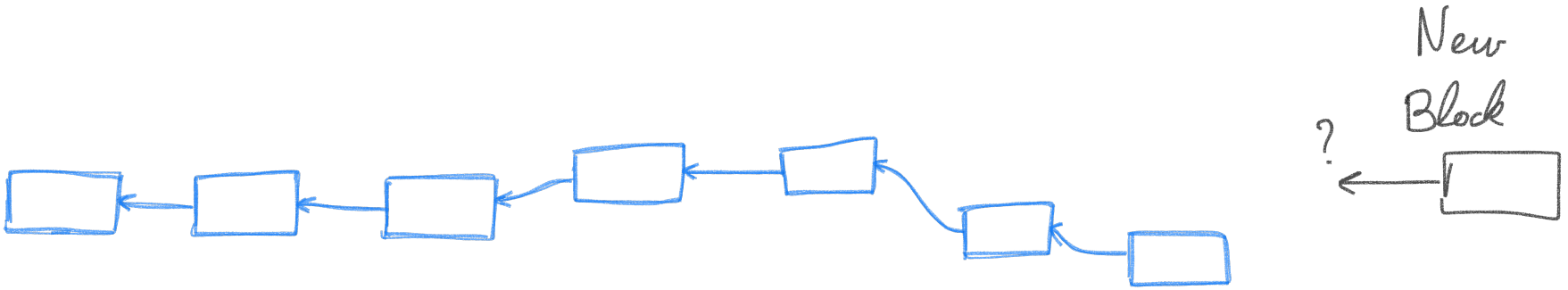

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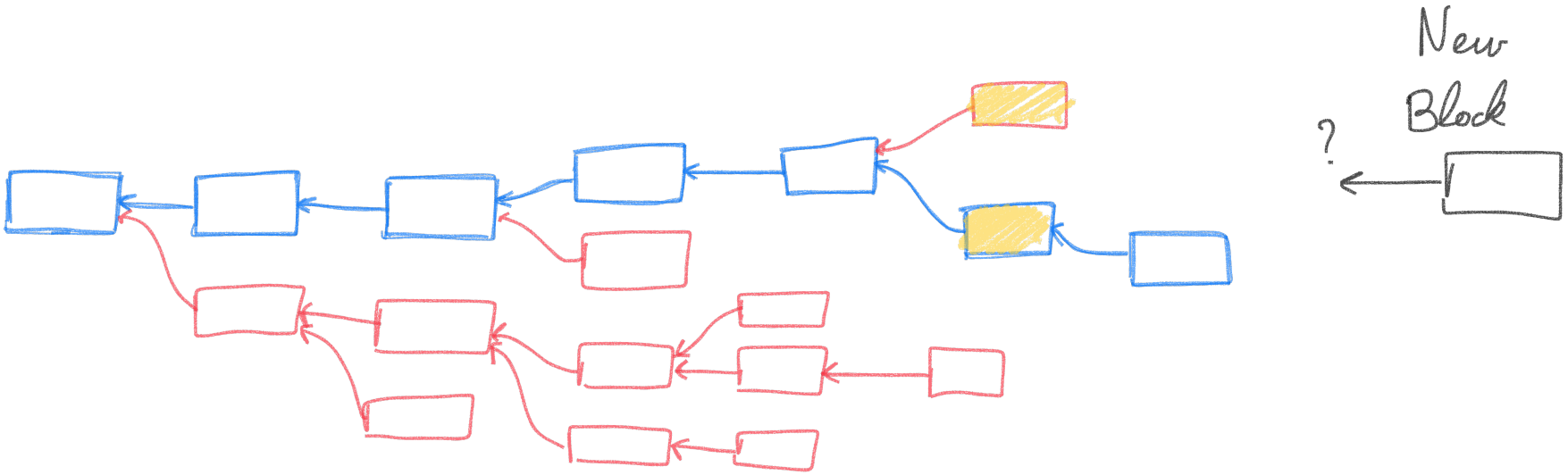

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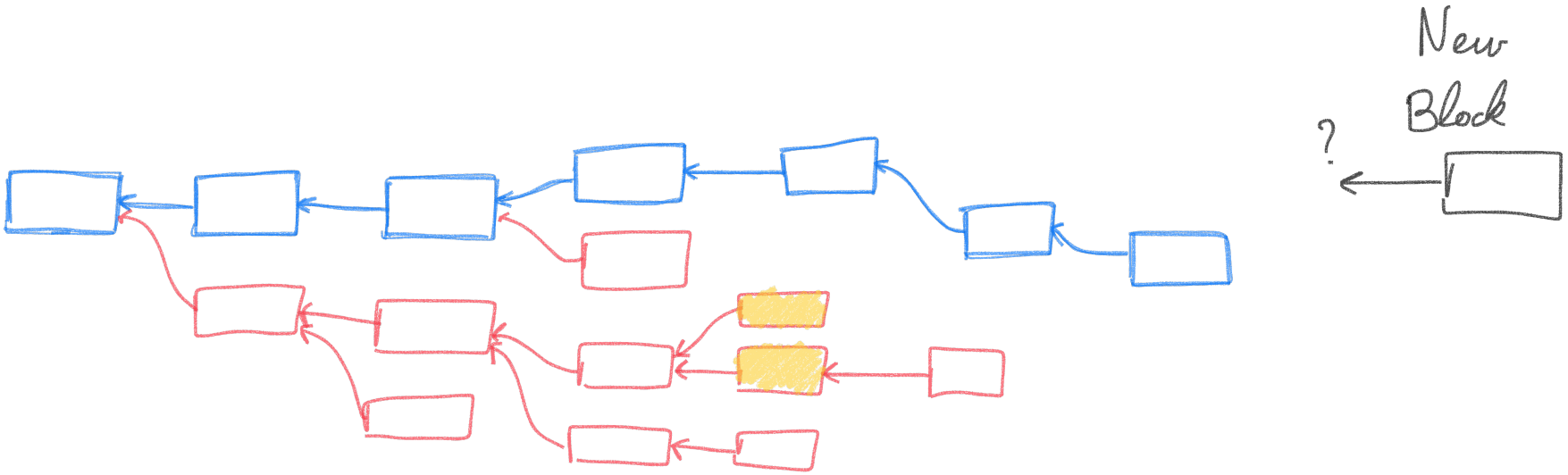

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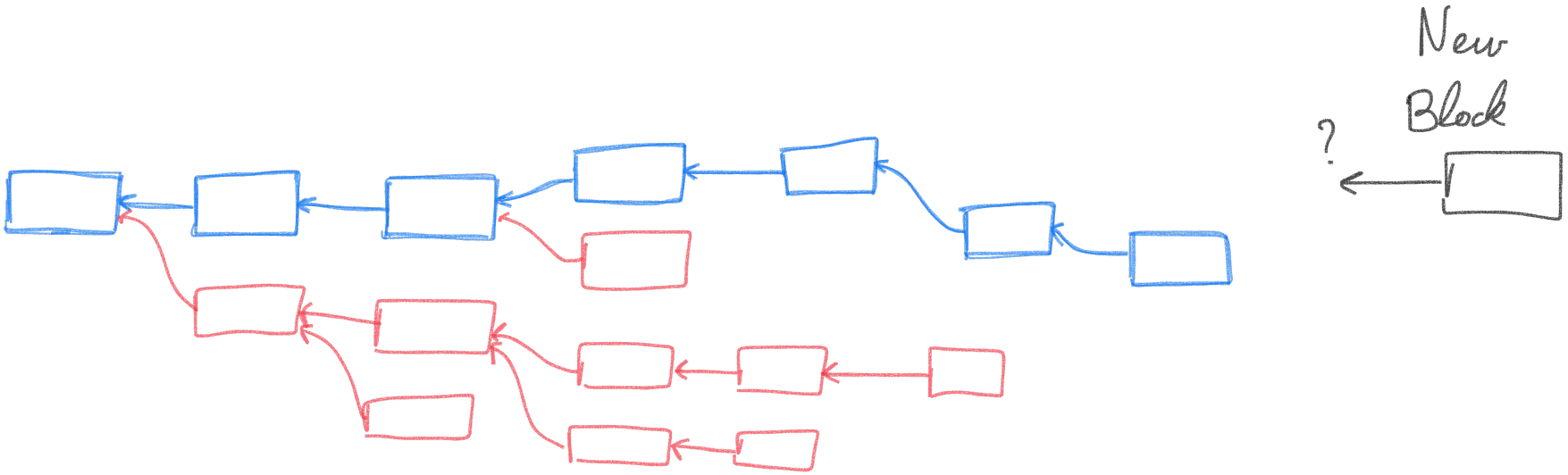

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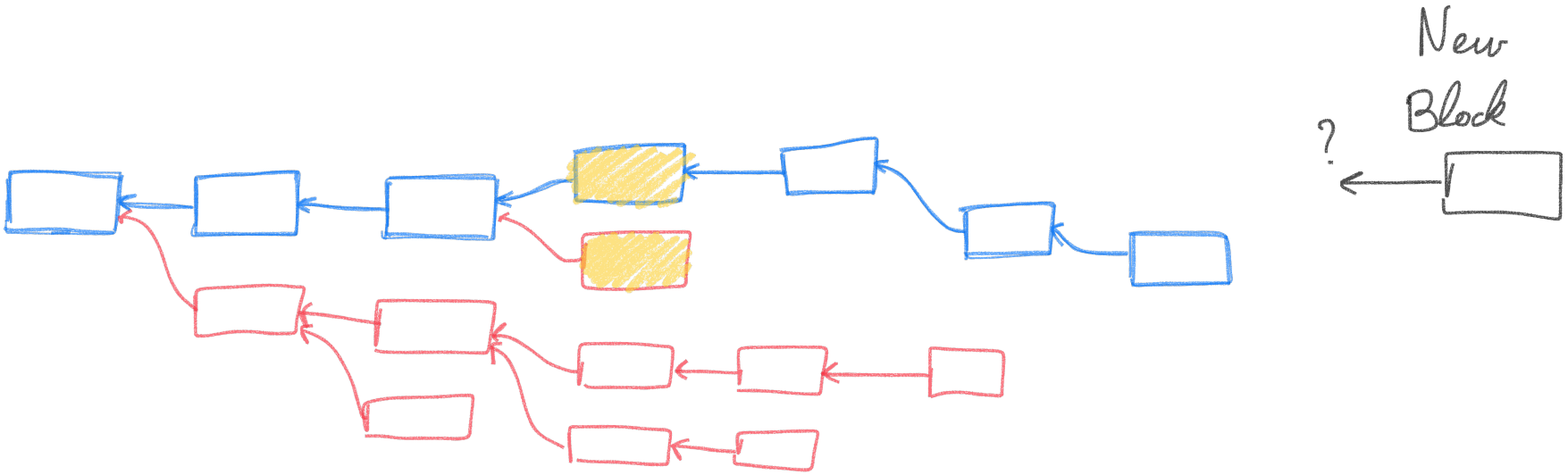

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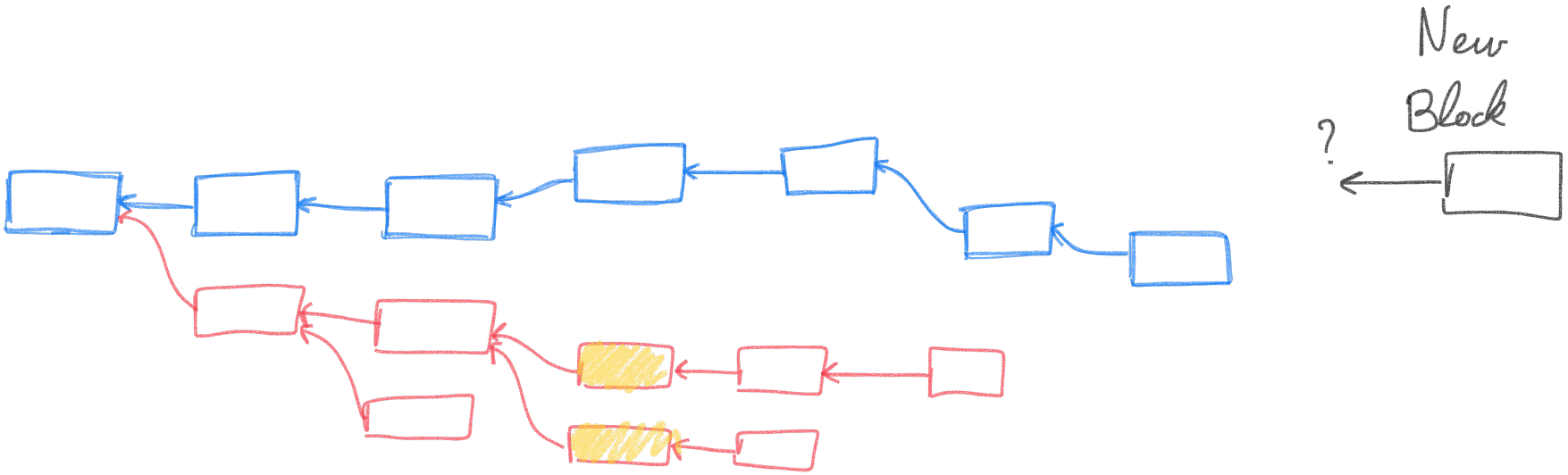

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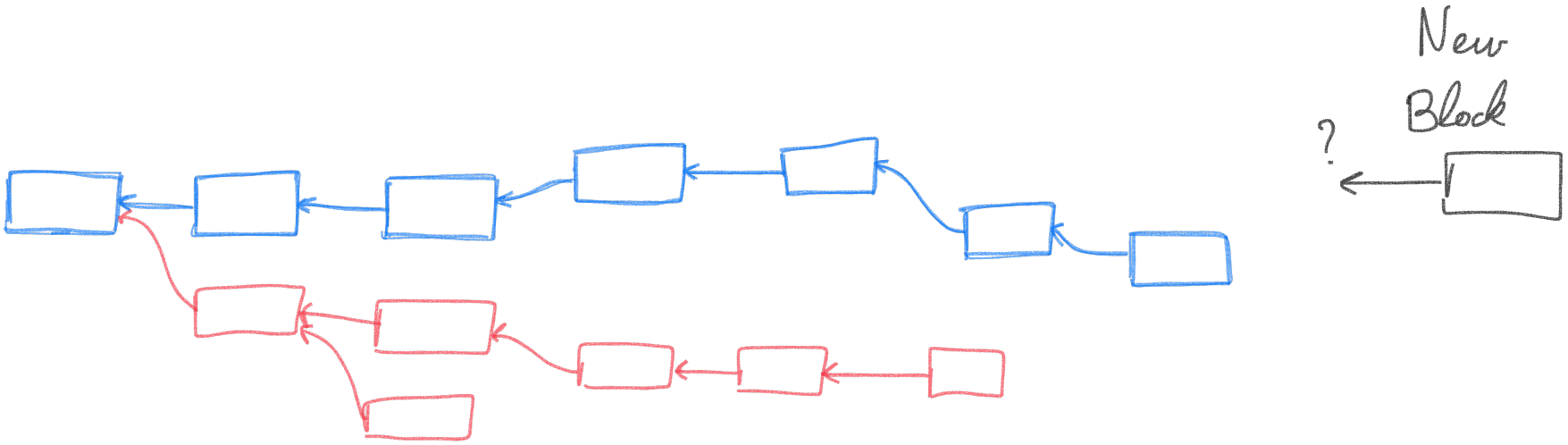

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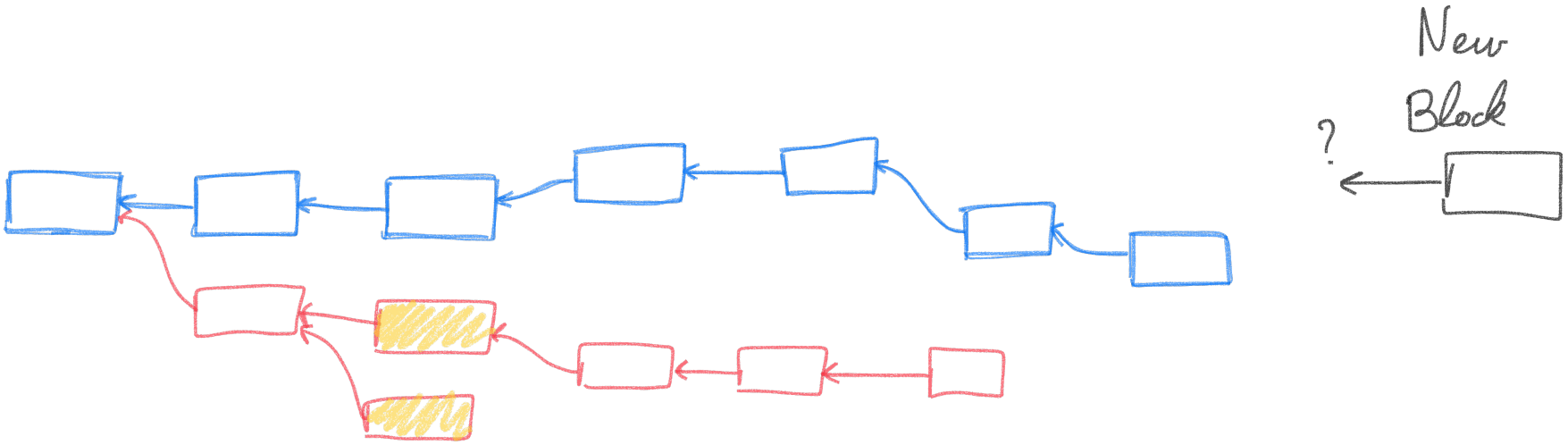

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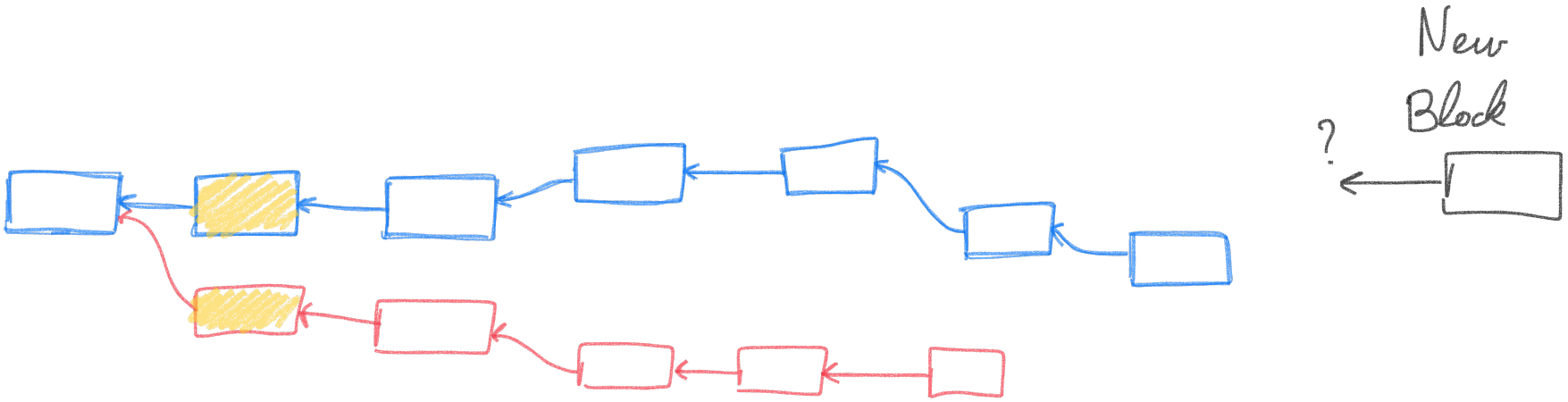

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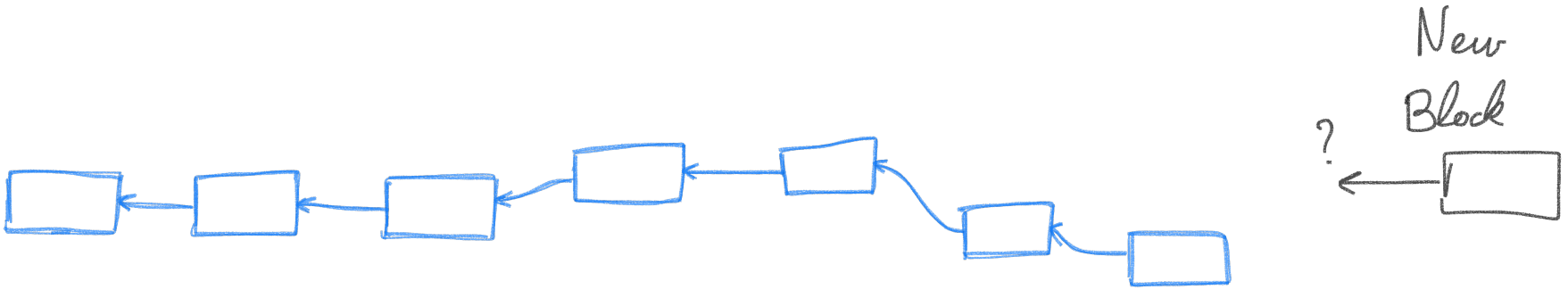

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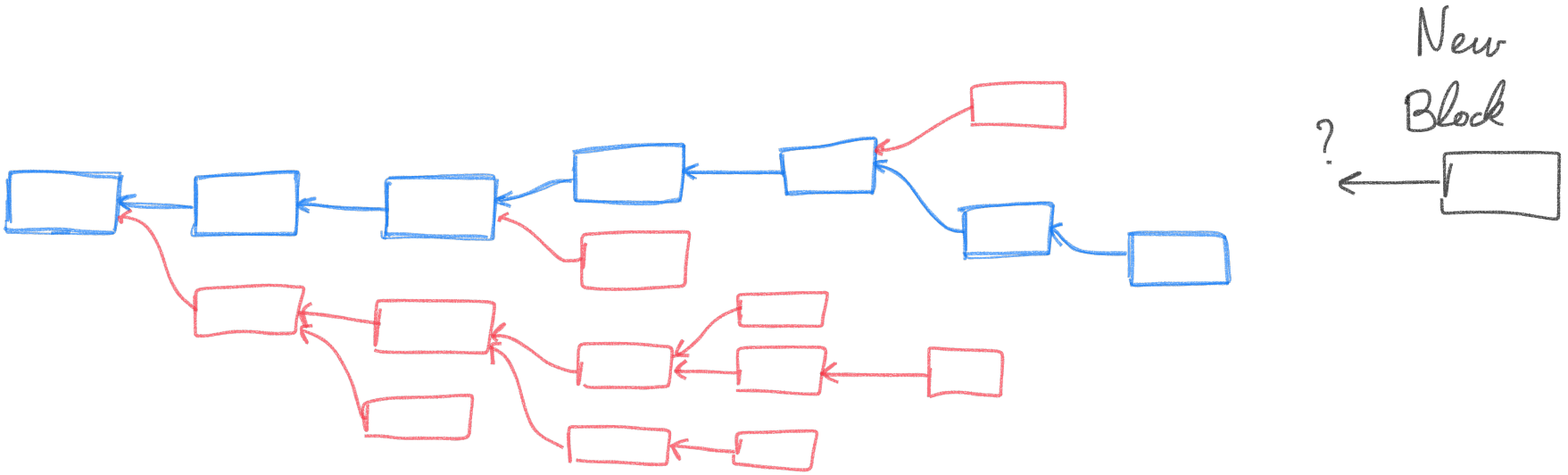

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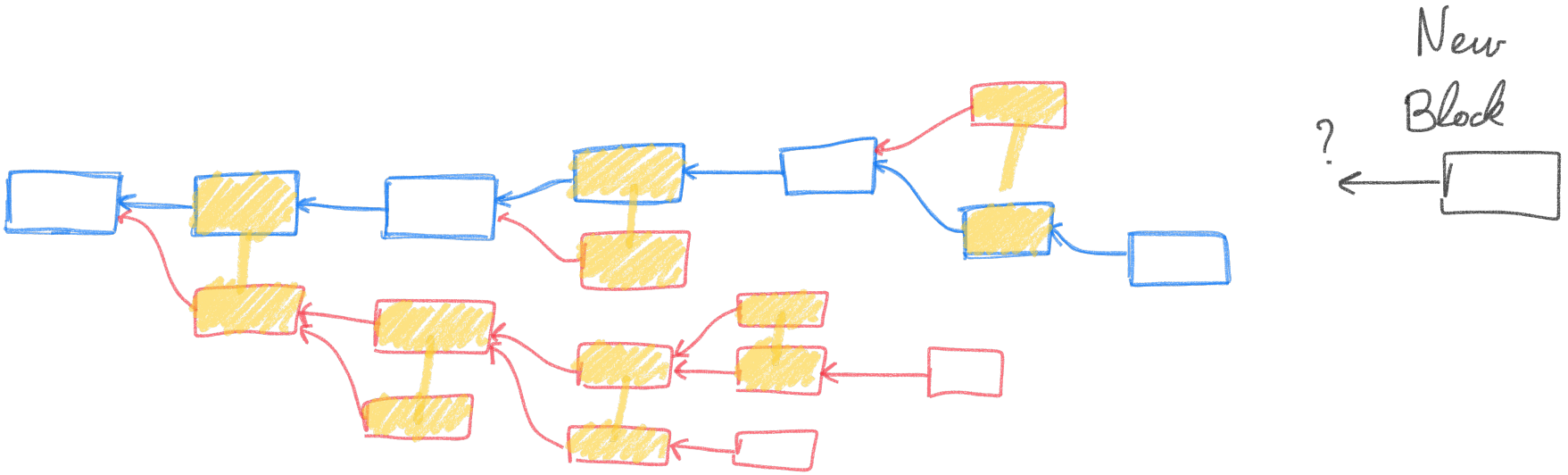

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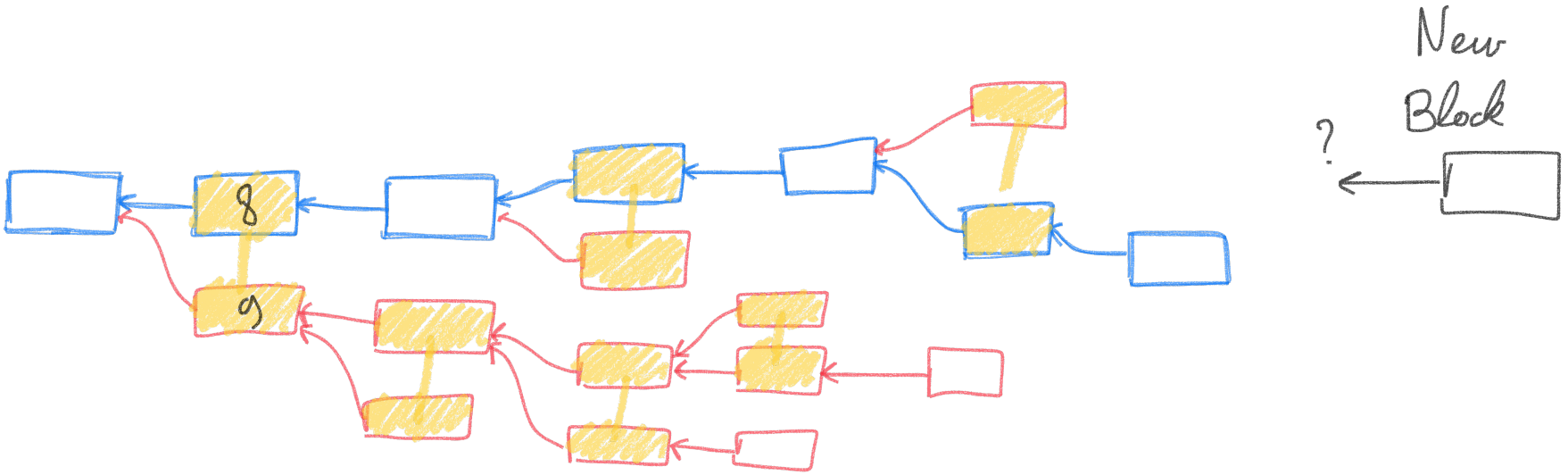

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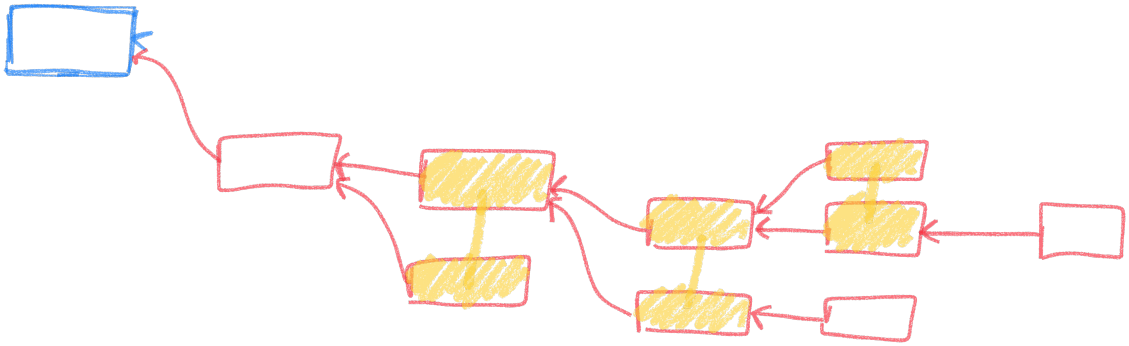

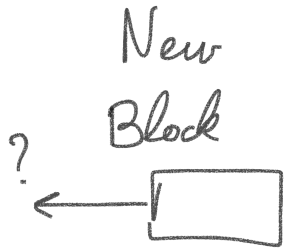

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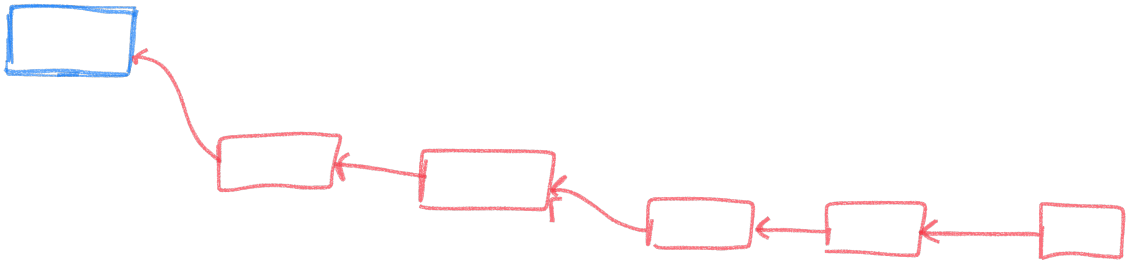
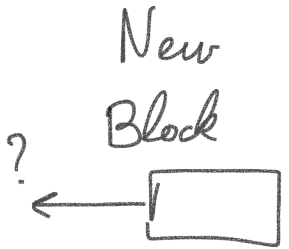
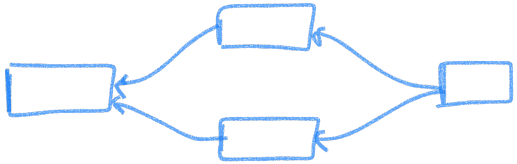




Resolving conflicts in BlockDAGs



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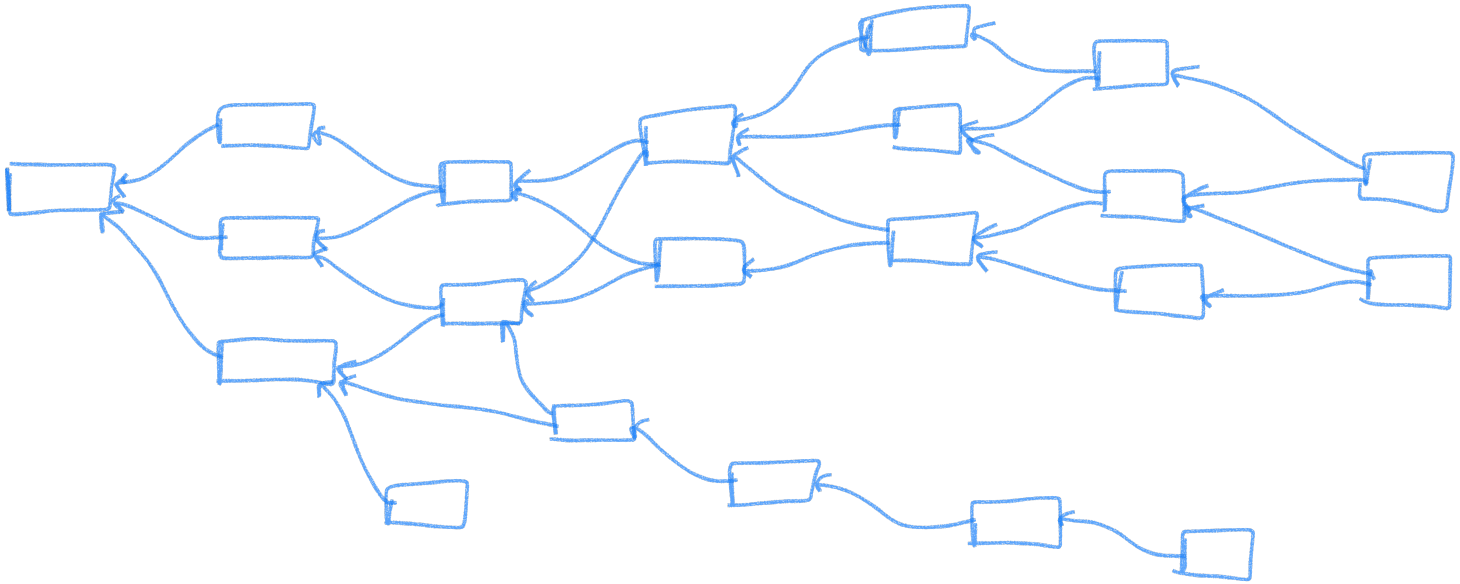

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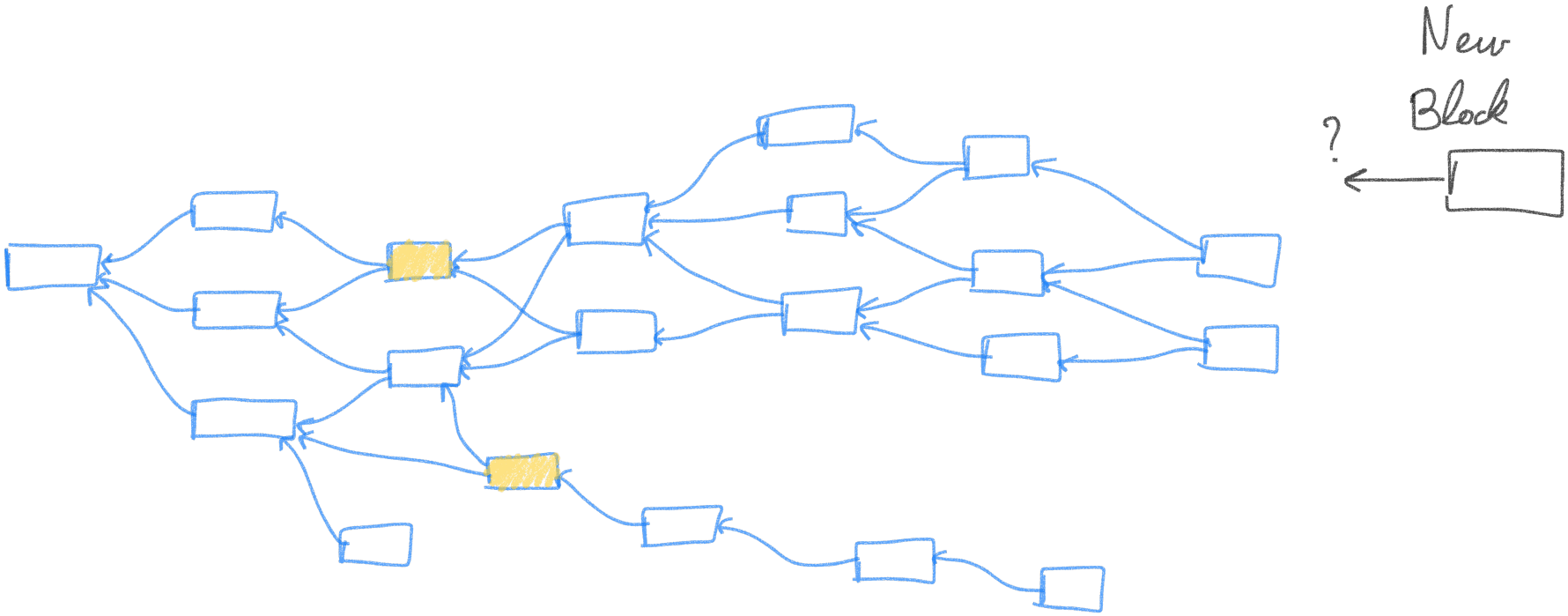

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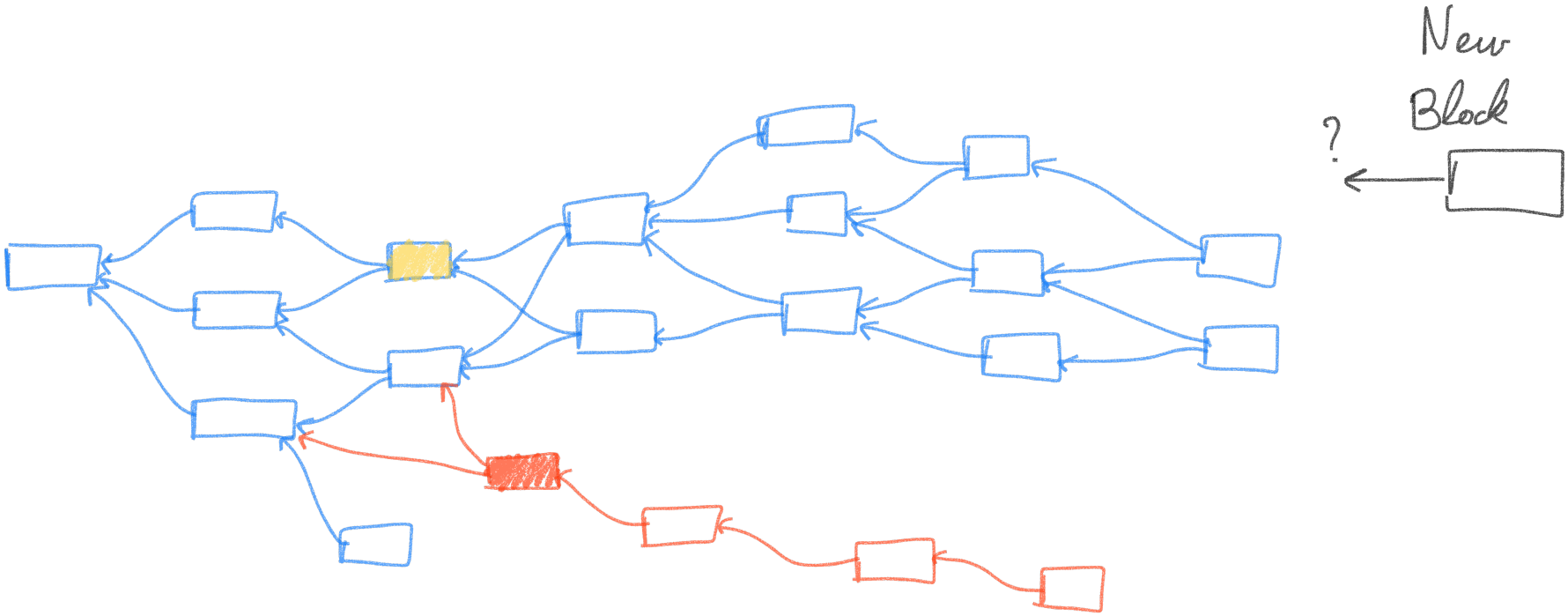

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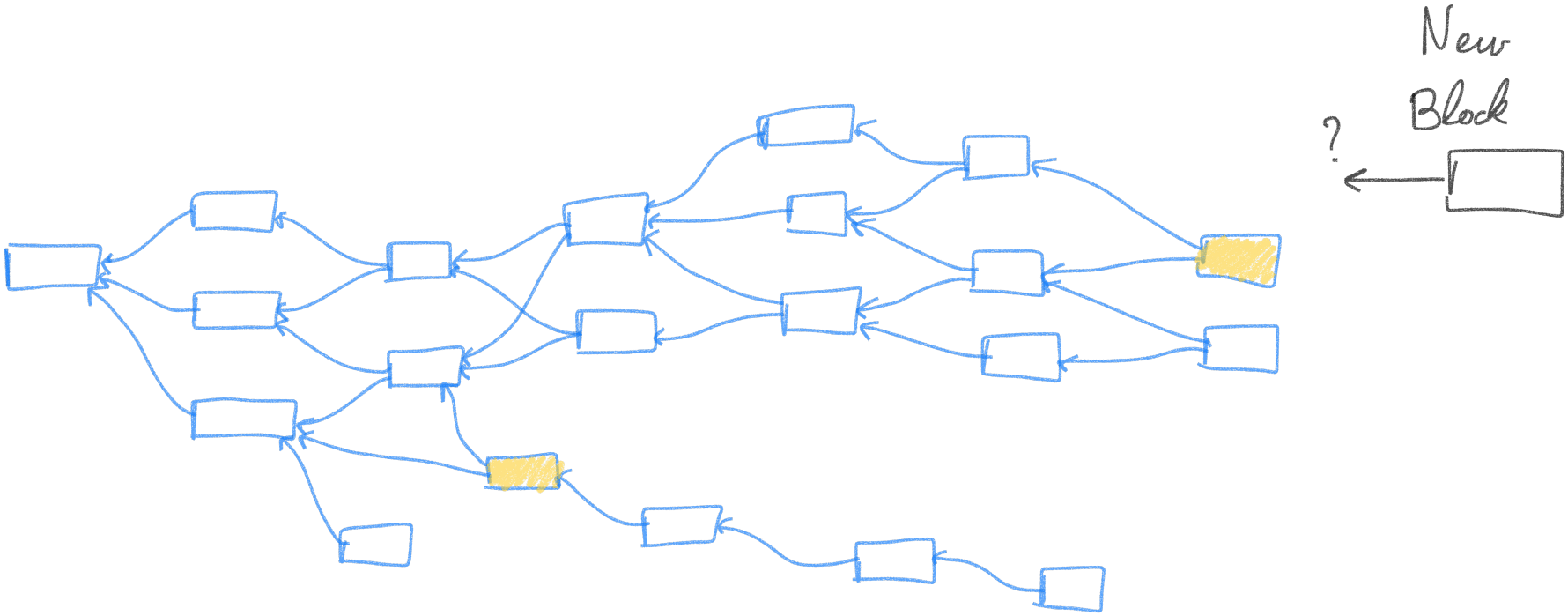

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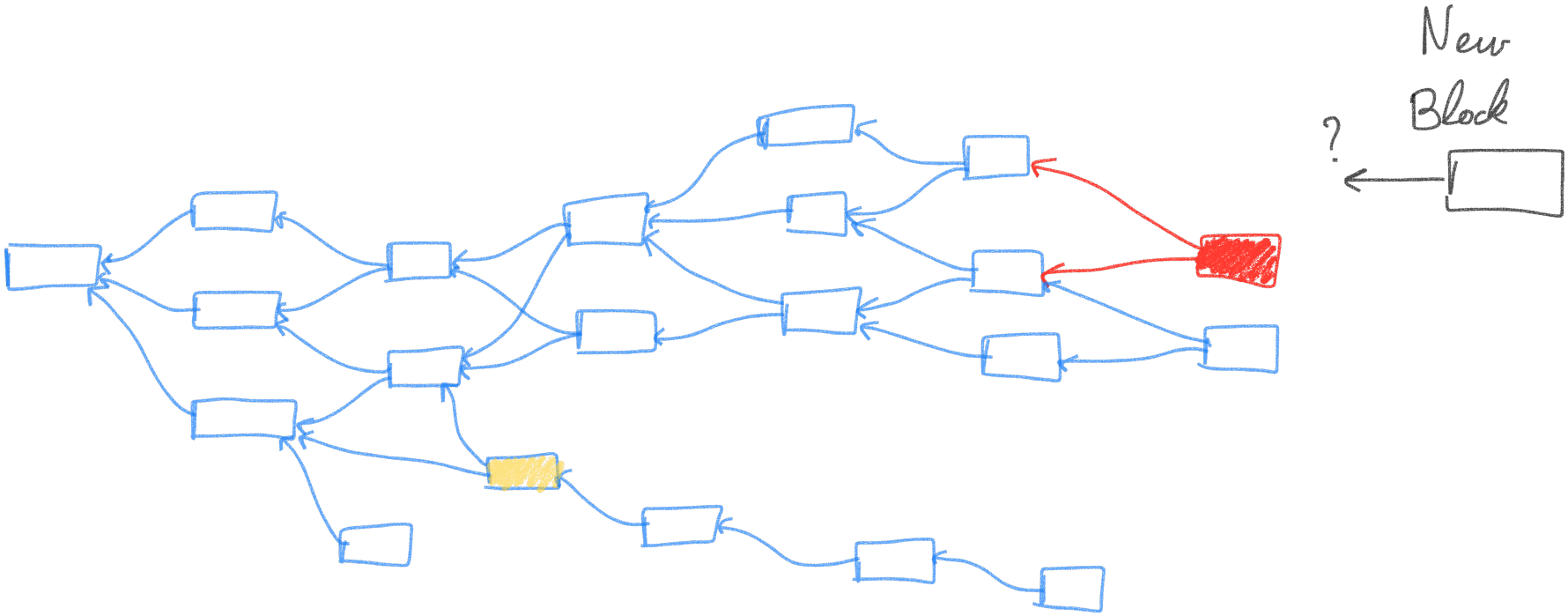
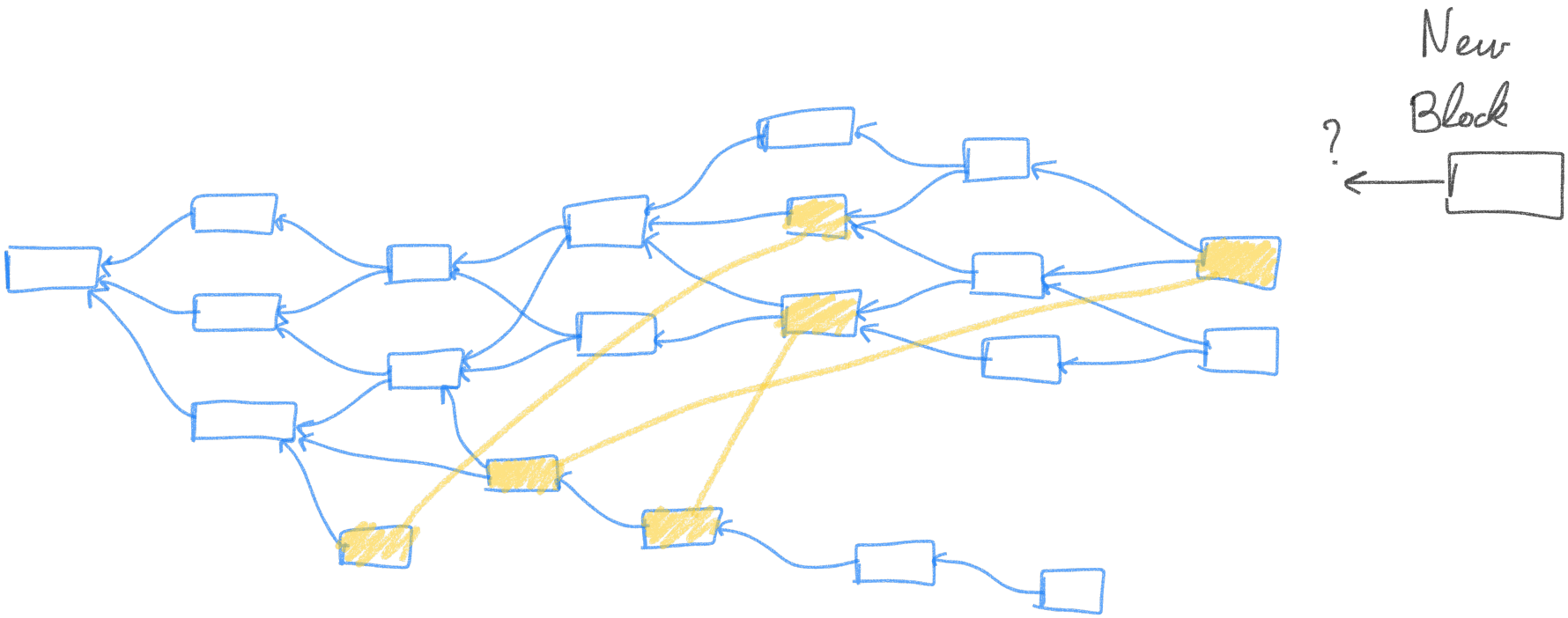


Problem: How to resolve conflicts?



Related Work

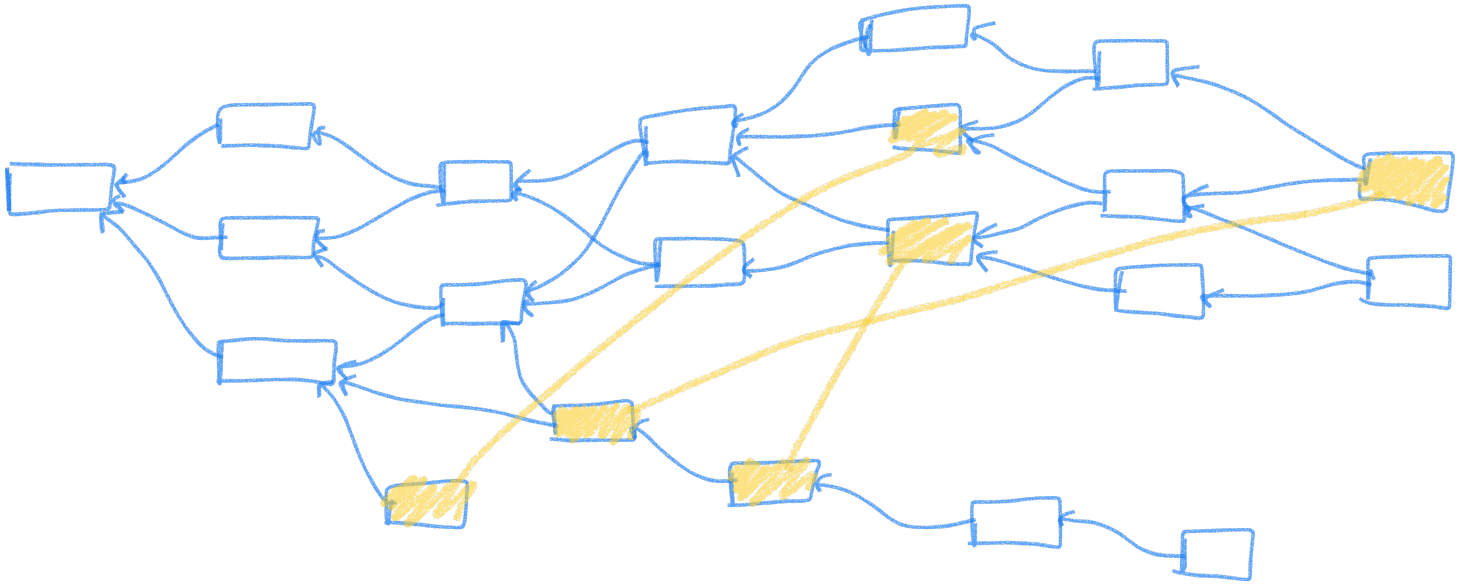
IOTA Tangle (v1): randomized, based on weight

GHOSTDAG: select a subDAG with « small » width (k-cluster)

Several other protocols using PoS or voting mechanisms (out of scope)

Sompolinsky, Yonatan, Shai Wyborski, and Aviv Zohar. "PHANTOM GHOSTDAG: a scalable generalization of Nakamoto consensus: September 2, 2021." Proceedings of the 3rd ACM Conference on Advances in Financial Technologies. 2021.

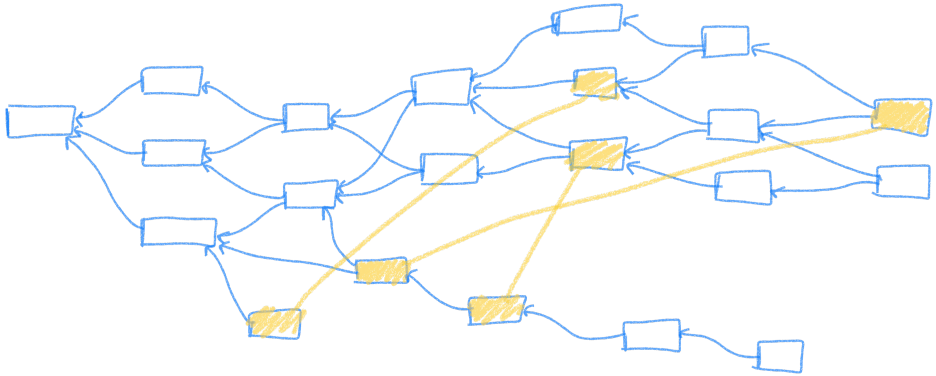
Heaviest blockDAG



Heaviest blockDAG

Given:

- A BlockDAG G
- A set of conflicting set $Conflicts$



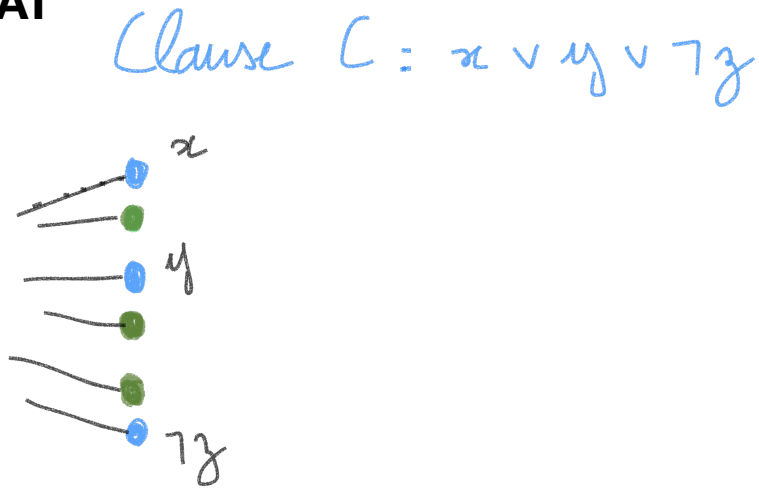
We want:

- The heaviest sub-blockDAG S that have no conflicts

Heaviest blockDAG

Theorem: NP-complete

Proof: From 3-SAT



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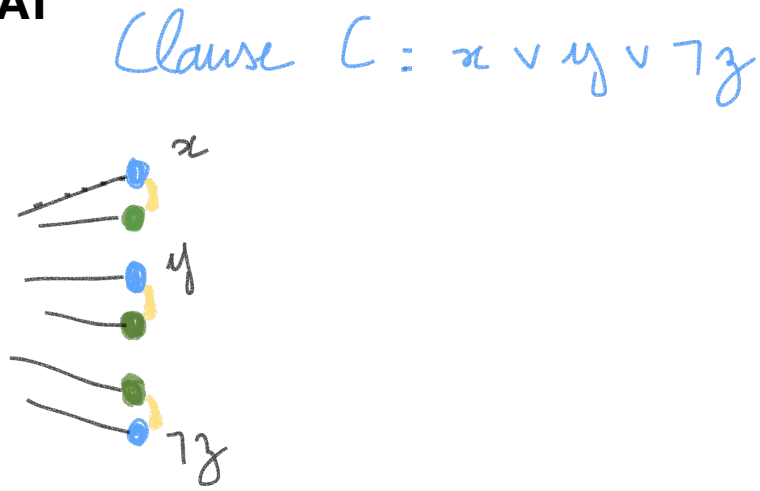

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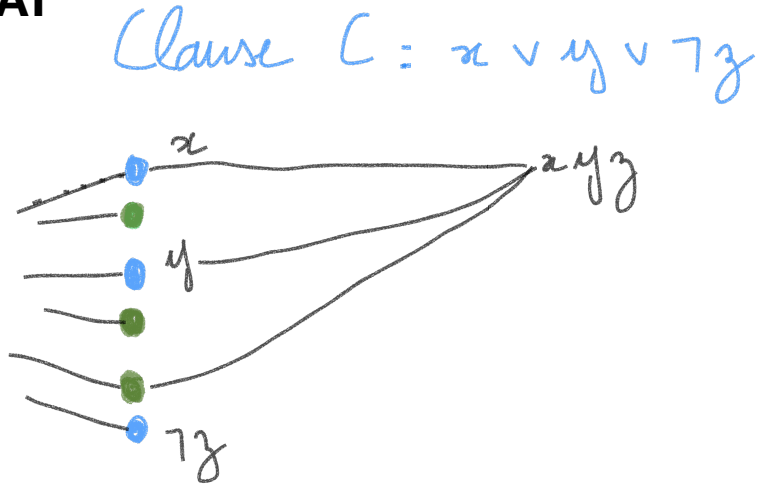

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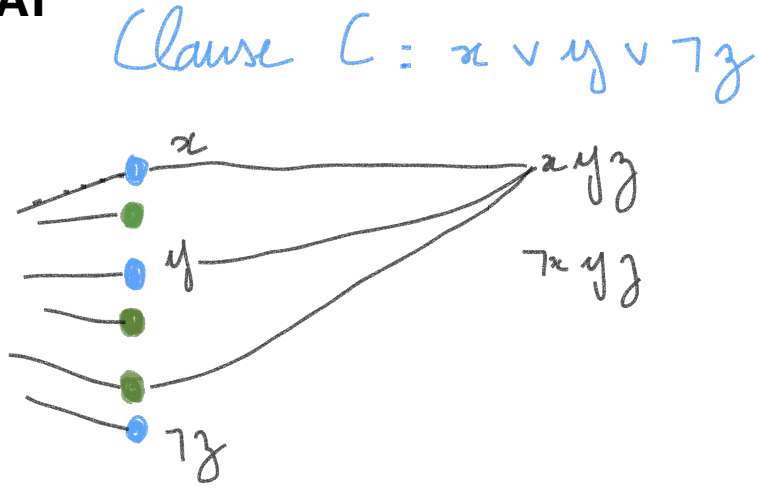

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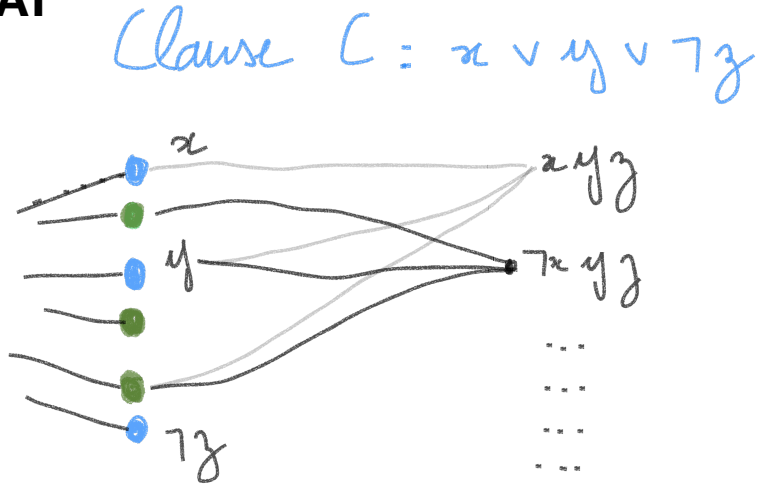

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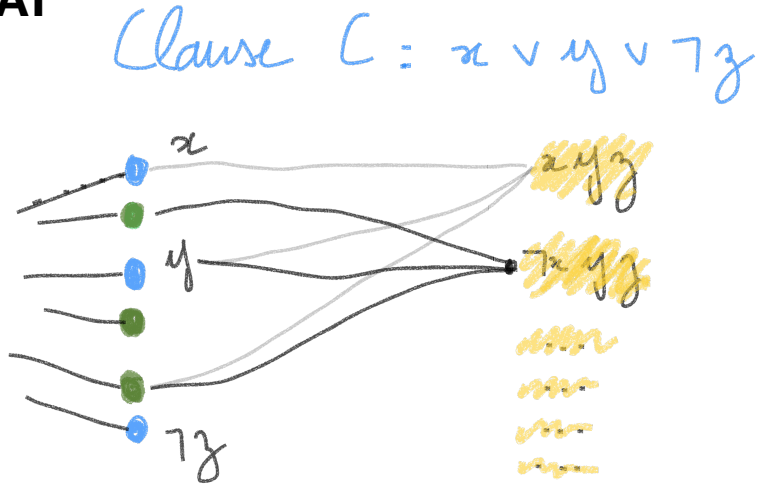

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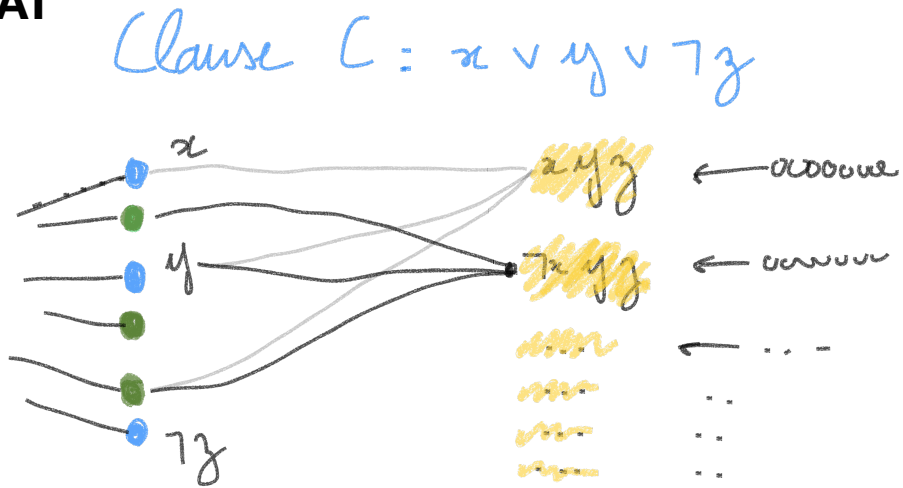

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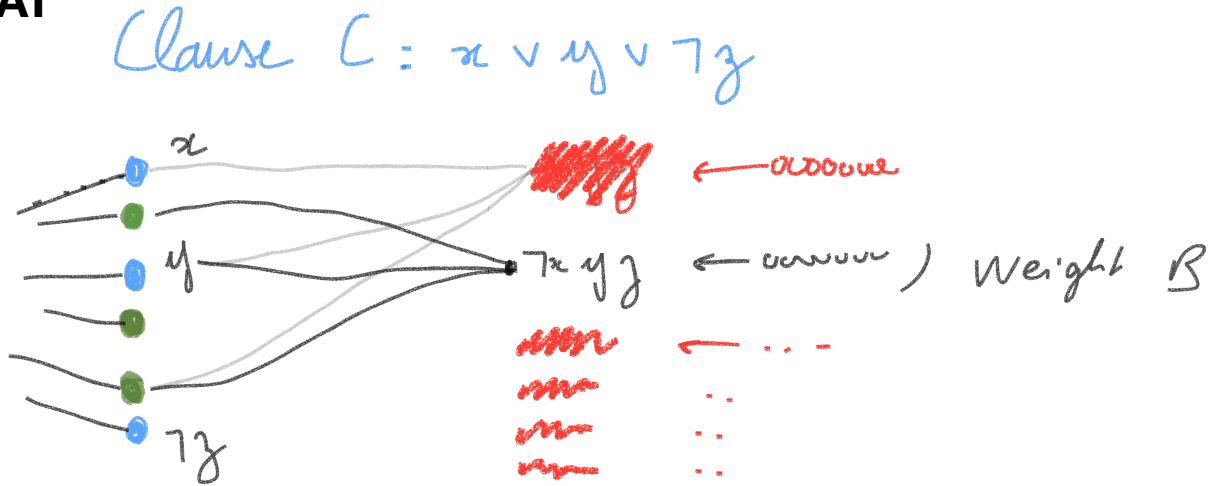

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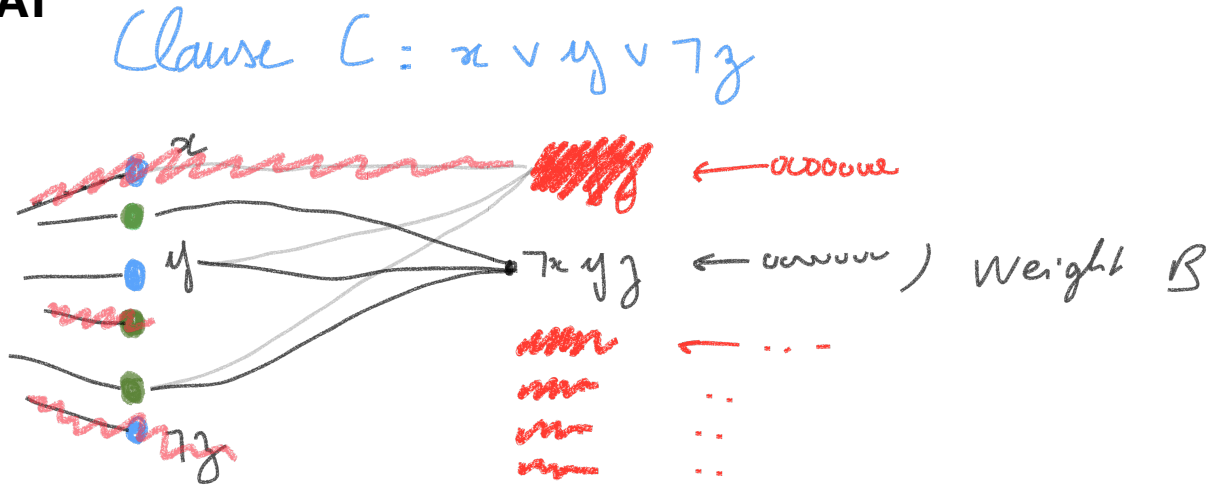

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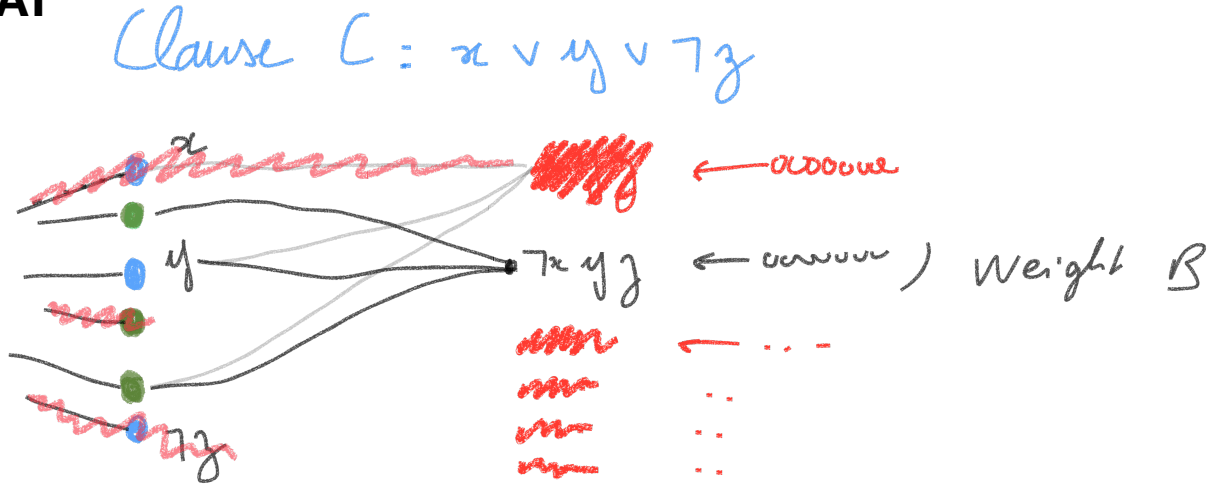
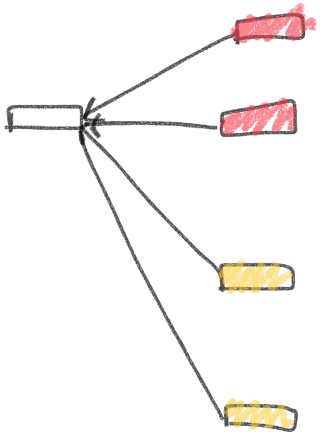


Boolean affectation Satisfying all clauses ⟺ total weight ≥ |clauses| × B

Concurrent conflicts



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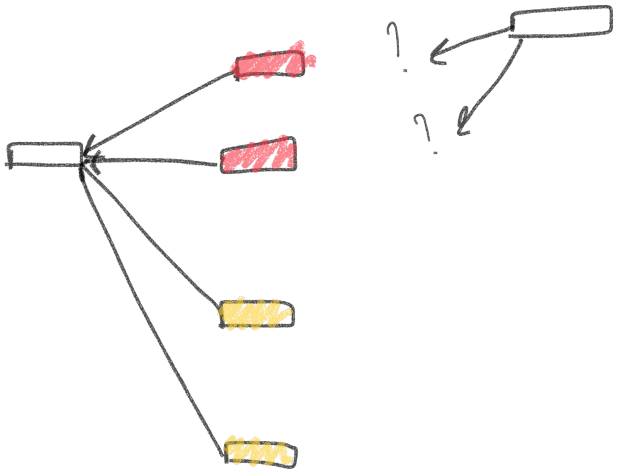

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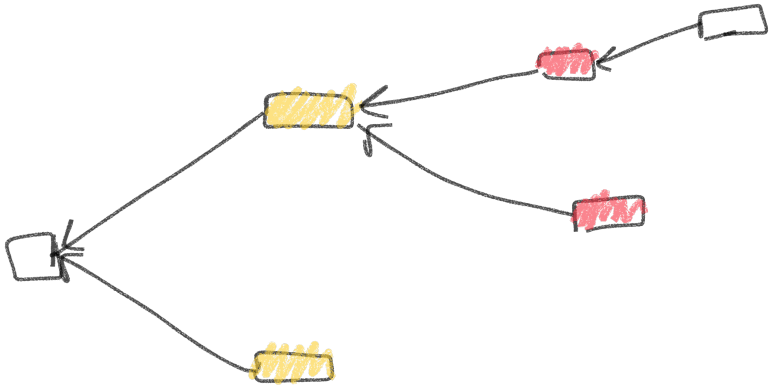

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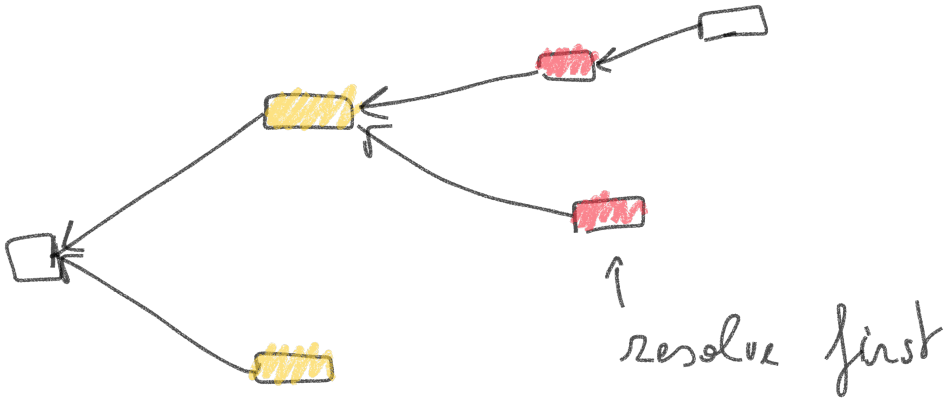

SeHes Algorithm

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"SEquential" HEaviest SubDAG

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- find a "small" set of conflicts C (not concurrent with the other conflicts)

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- find a "small" set of conflicts $\mathcal{C}$ (not concurrent with the other conflicts)
- Resolve $\mathcal{C}$ (exponential in $|\mathcal{C}|$)

SeHes Algorithm

"SEquential" HEaviest SubDAG

- find a "small" set of conflicts $\mathcal{C}$ (not concurrent with the other conflicts)
- Resolve $\mathcal{C}$ (exponential in $|\mathcal{C}|$)
- if conflicts remain, goto step 1

Evaluation

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Simulation :

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- SeHeS algorithm ;

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- SeHeS algorithm ;
- GHOSTDAG (with $k = \infty$) ;

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- two greedy approaches (min and max)

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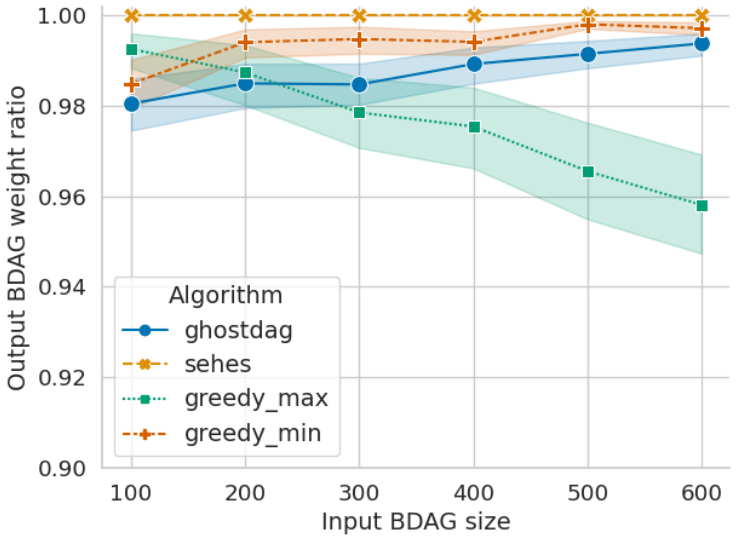
Random DAG generated by adding blocks 10 by 10 with a constant probability to have conflicts and a constant probability to be forgotten

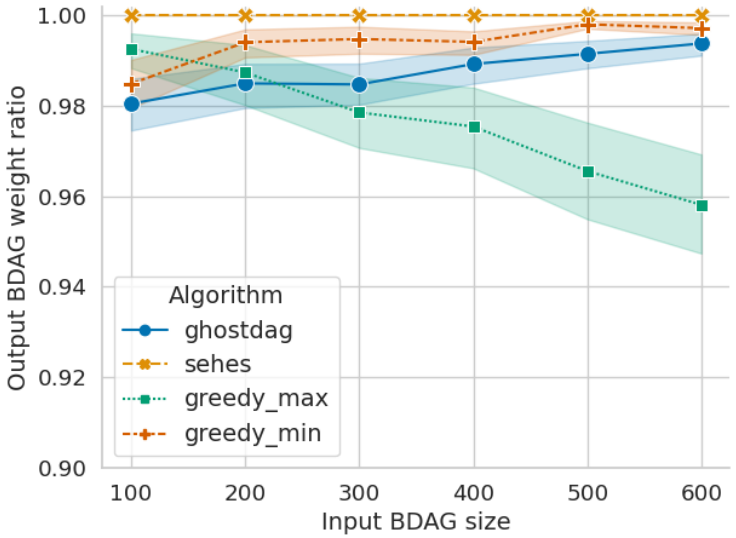
Evaluation

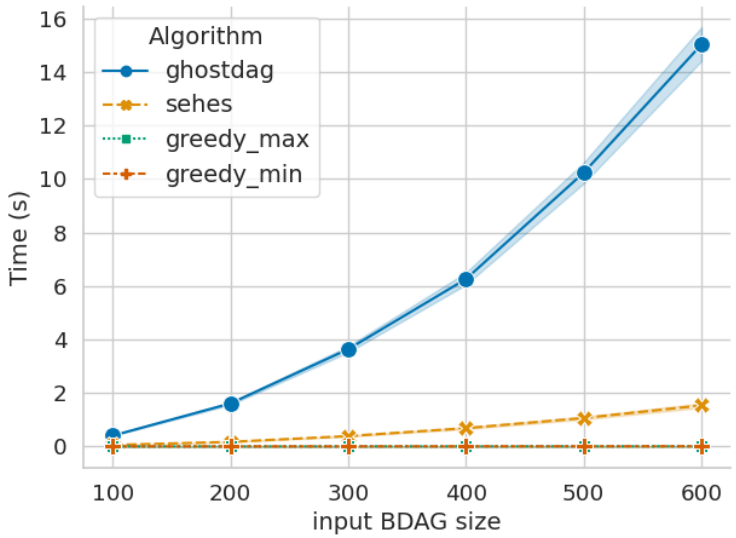


Run on MACbook pro 2,6 GHz Intel Core i7 6-core. 200 random BlockDAGs per size

Code available online: https://doi.org/10.5281/zenodo.8052827

Evaluation





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Conclusion

We proposed an efficient algorithm to find the heaviest sub-blockDAG

Future work

Find an efficient incremental algorithm

Evaluation on more topologies

Conclusion

We proposed an efficient algorithm to find the heaviest sub-blockDAG

Future work

Find an efficient incremental algorithm

Evaluation on more topologies

Merci !

Slides available at https://bramas.fr