Tree search algorithms for the sequential ordering problem

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Contributions

Very simple yet competitive tree search algorithm

- **Sequential Ordering Problem** (ATSP + precedence constraints)

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- **Iterative beam search**

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- Dynamic Programming inspired prunings

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- **Sequential Ordering Problem** (ATSP + precedence constraints)
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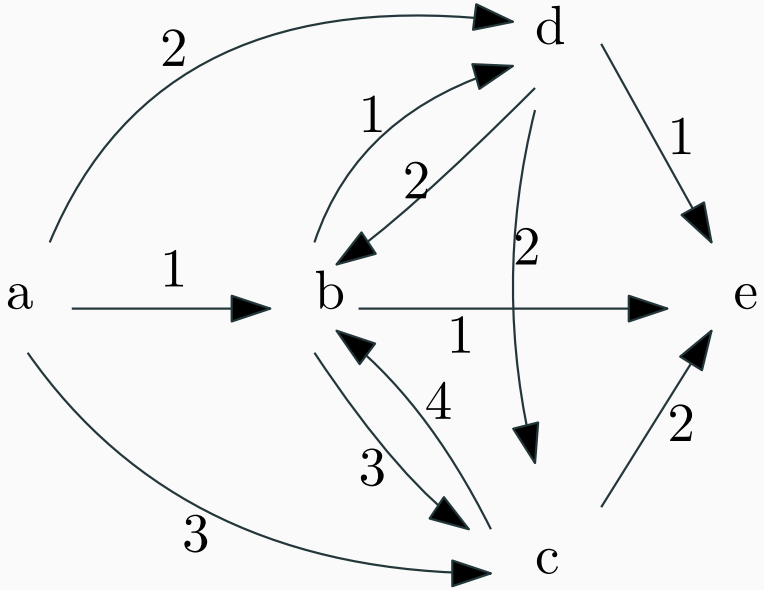
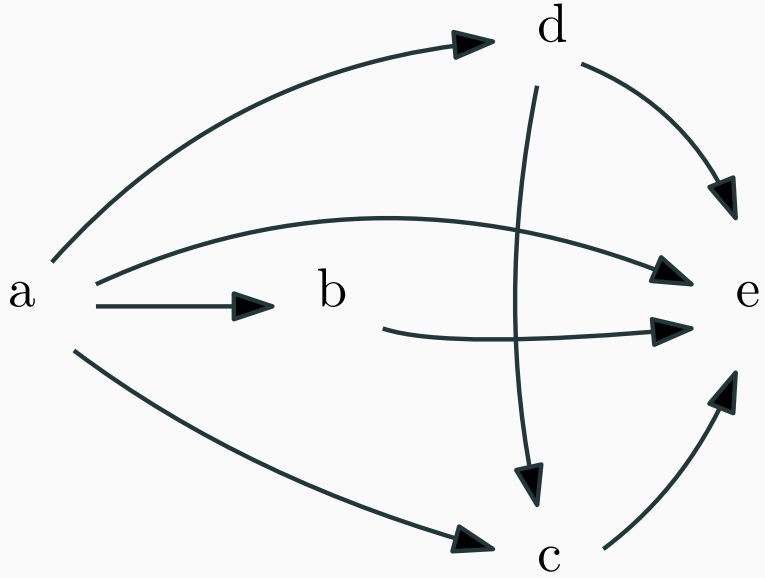
- Simple branching scheme: **Forward search**
- **Simple bounds** (selected edge costs)
- Dynamic Programming inspired prunings
- New-best-known solutions on 6/7 open instances

The Sequential Ordering Problem (SOP)

Asymmetric Traveling Salesman Problem with precedence constraints





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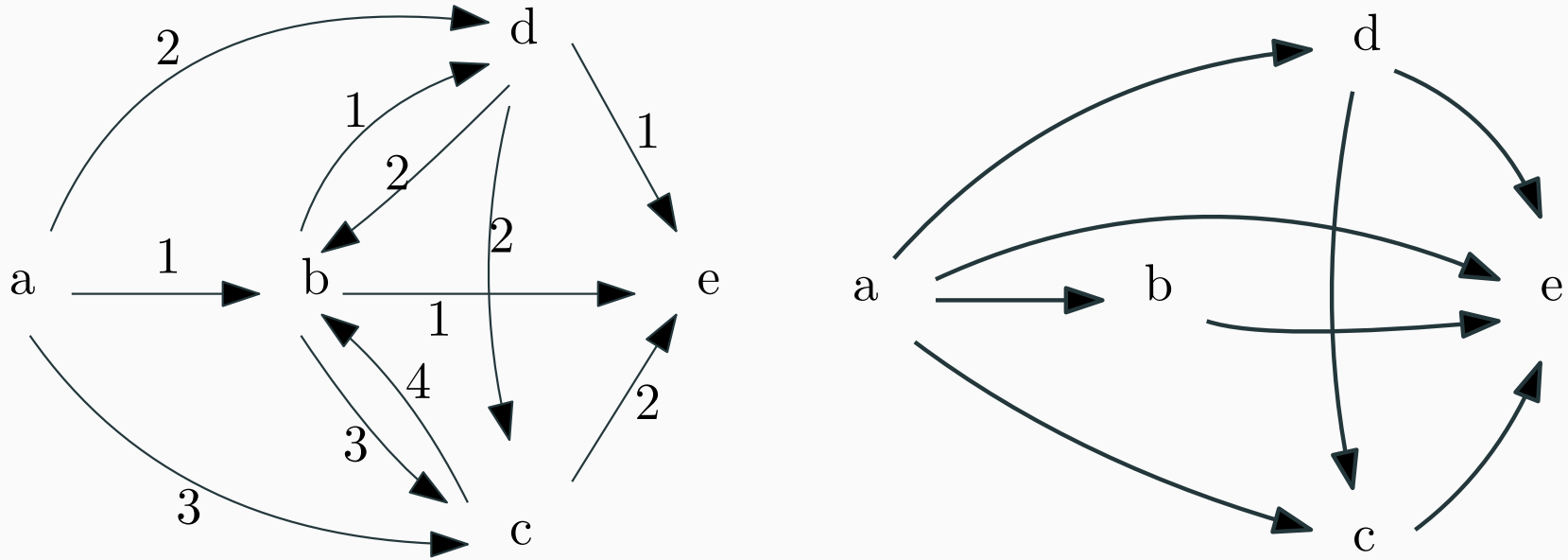

Large benchmark: SOPLIB $n = \{200, 300 \ldots 700\}$, 7 open instances
Studied a lot over the last 30 years

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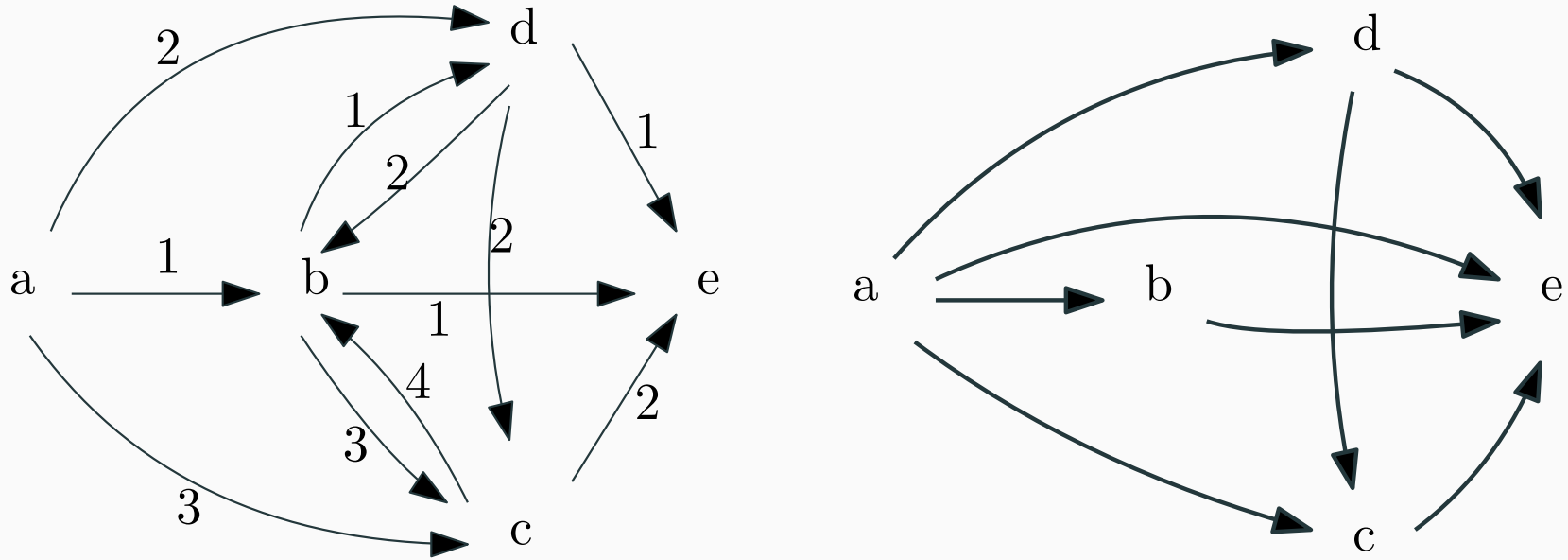

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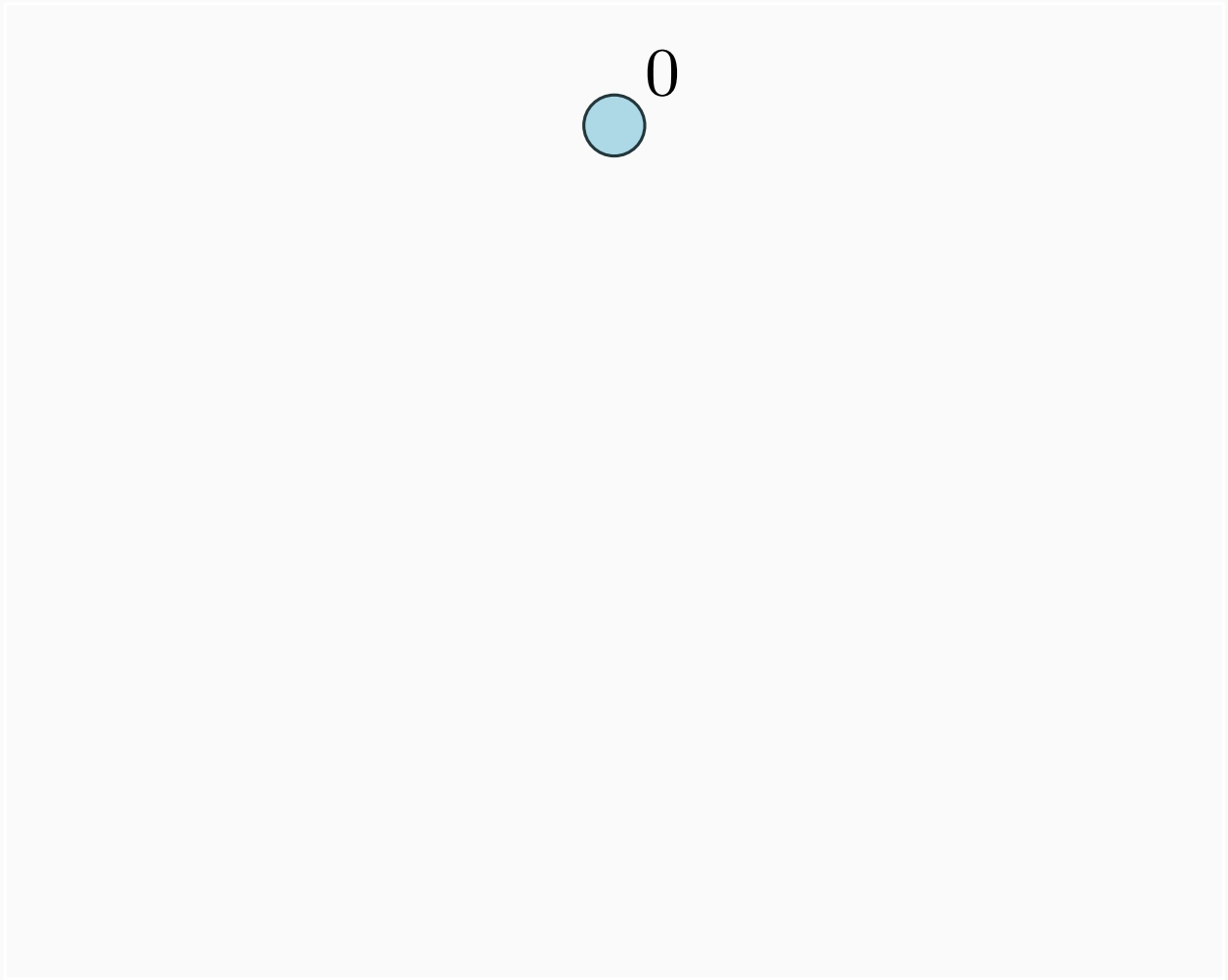
- Branch & Cut, MDD+CP, etc.
- LKH3, ACO+SA, 3-opt moves, etc.

Beam Search ($D = 3$)



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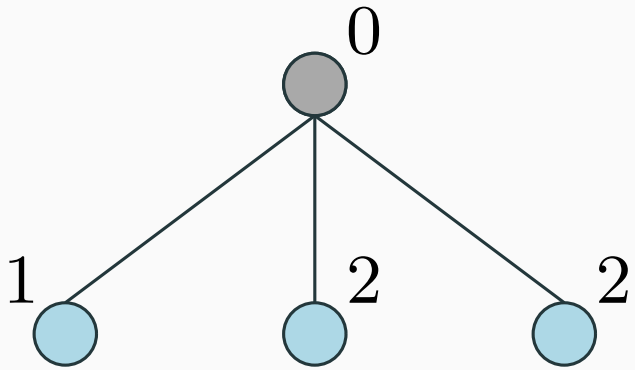

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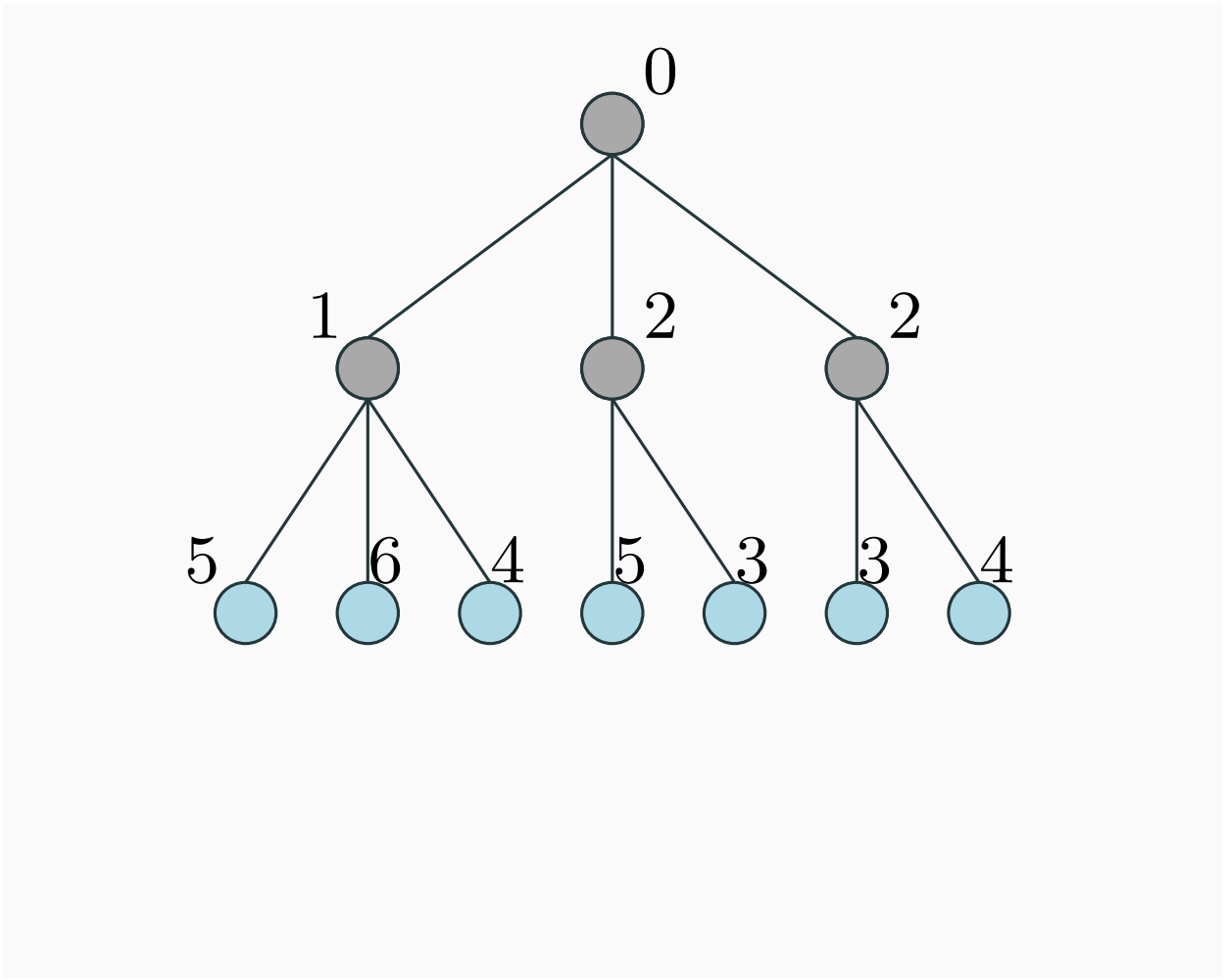

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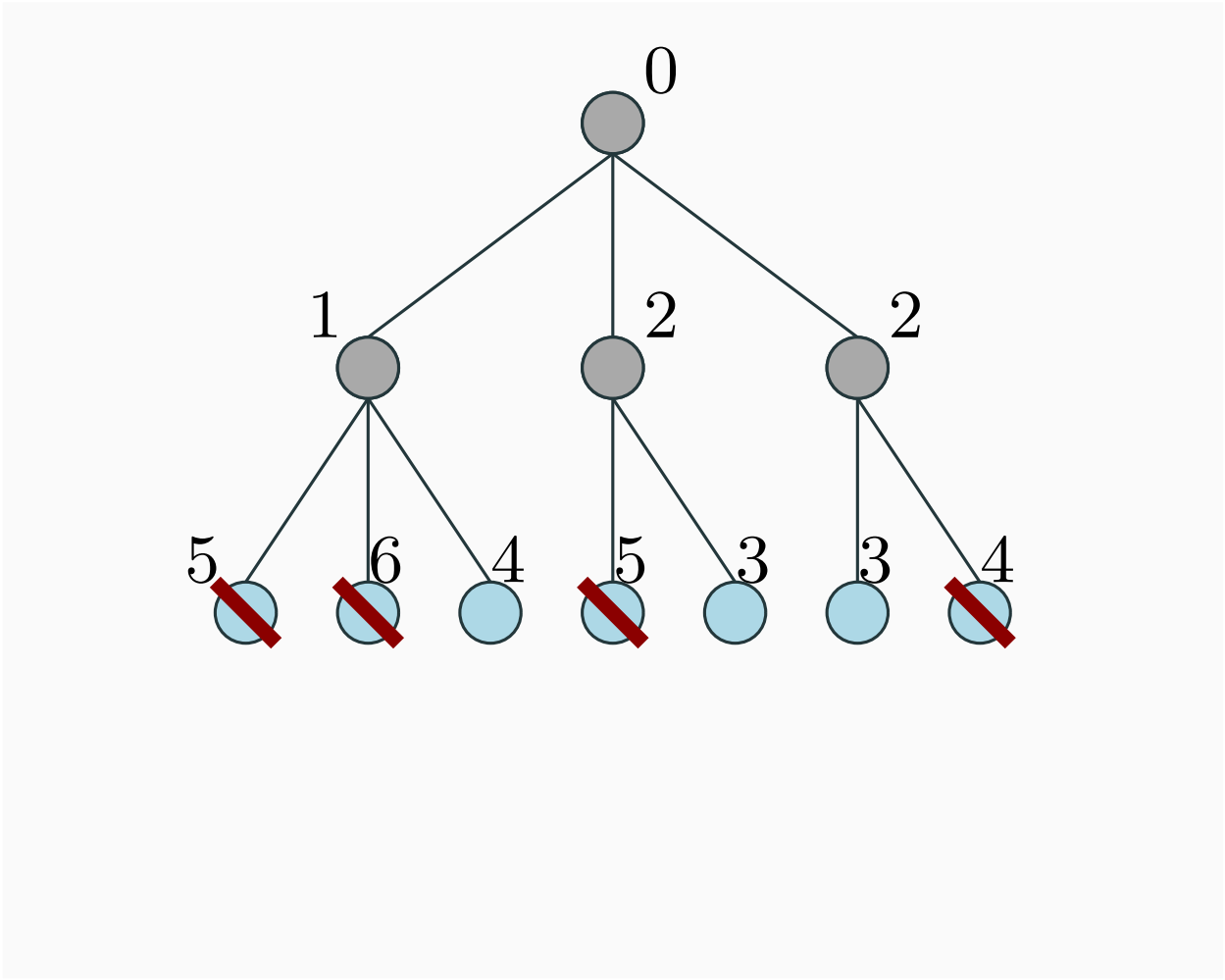

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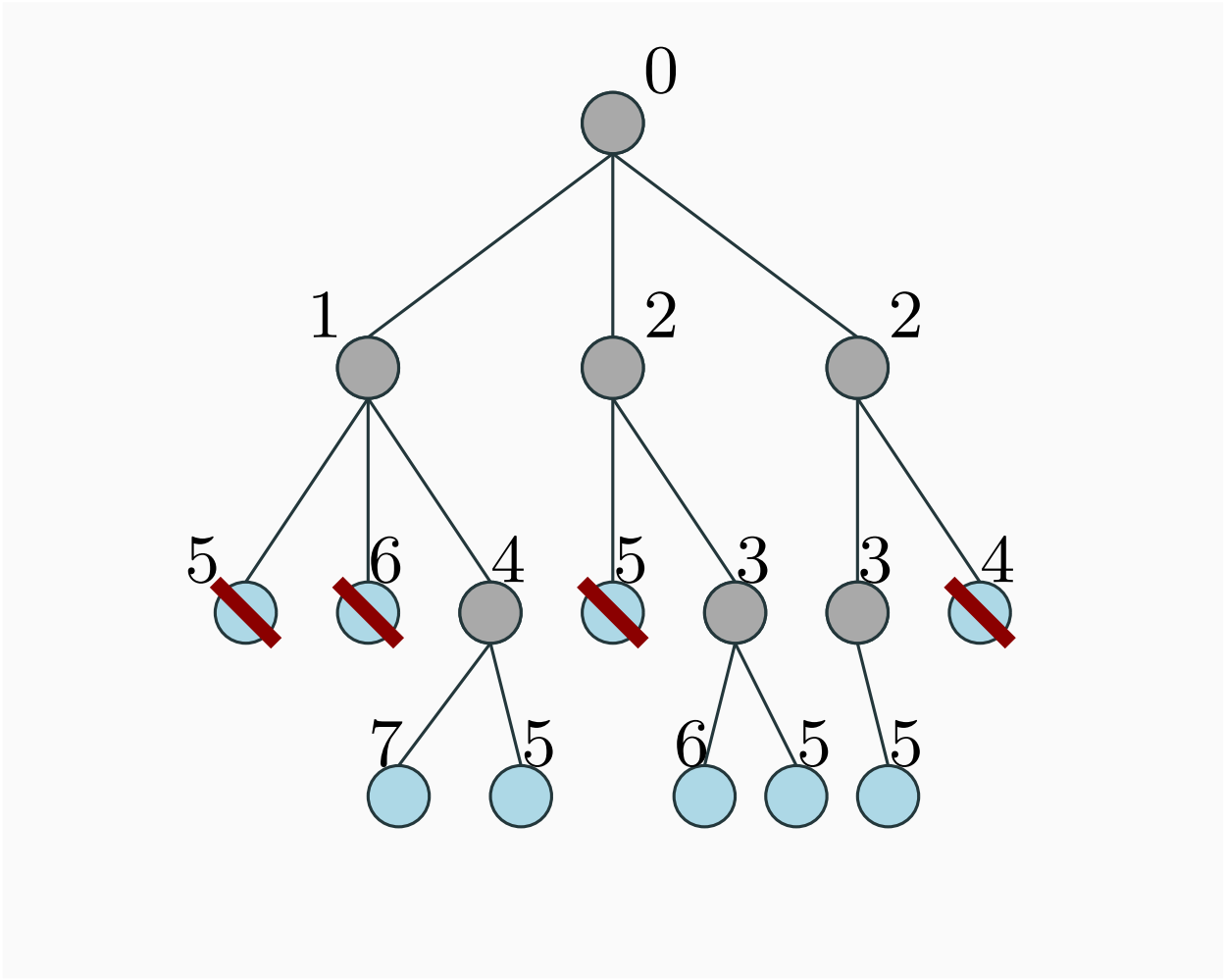

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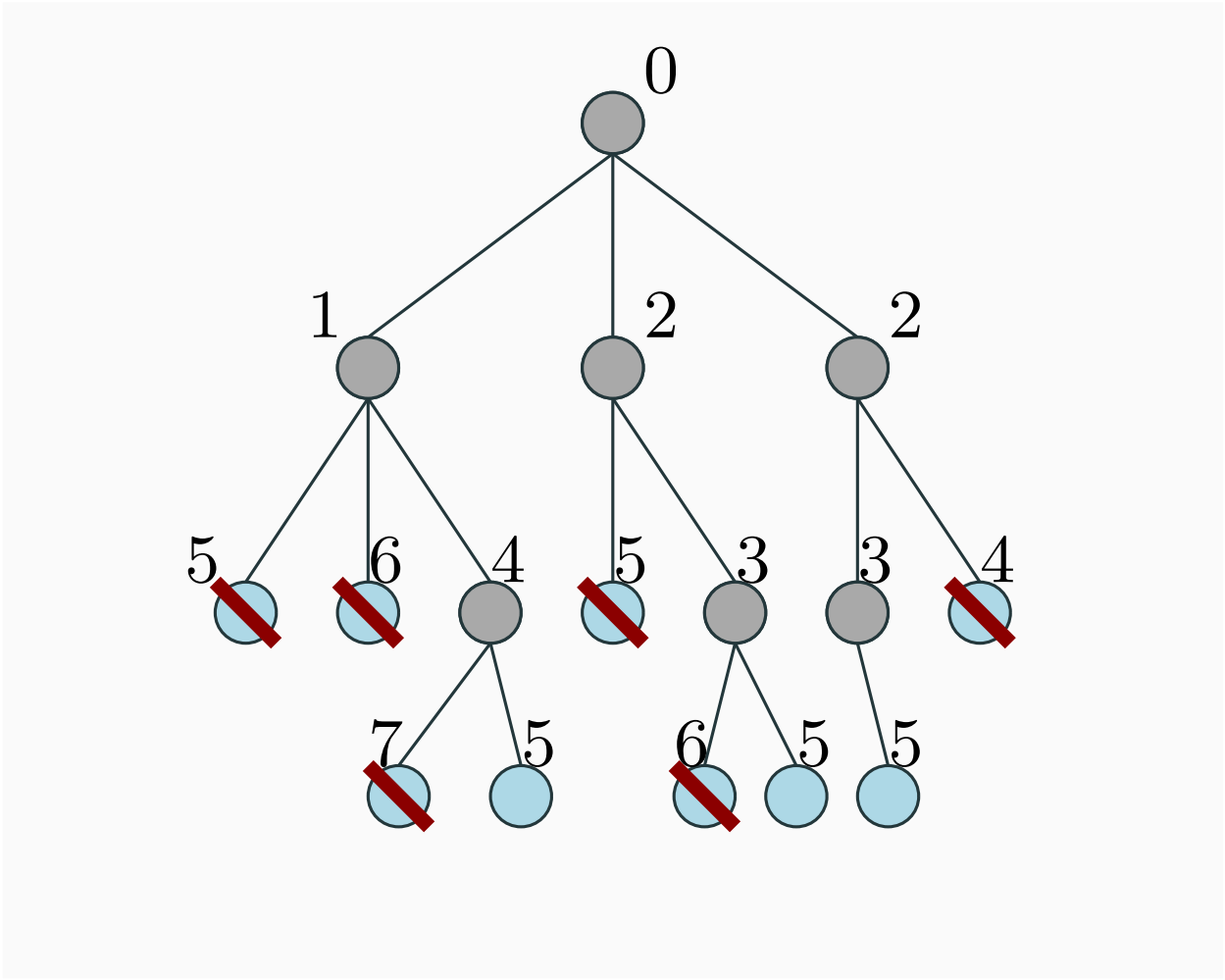

Iterative Beam Search

- Runs a beam of size 1 (greedy)
- Then runs a beam of size 2, then 4, then 8 ...

Stops when no heuristic fathoming is done (proves optimality)

Results - New best-so-far solutions

6 over 7 new-best-so-far solutions
(the other one is probably optimal)

Instance	best known	BS+PE (600s)
R.500.100.15	5.284	**5.261**
R.500.1000.15	49.504	**49.366**
R.600.100.15	5.472	**5.469**
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Overall:

- Works best with lots of precedence constraints (different to MIP/LS approaches)
- Not so well with few precedence constraints

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