A General Theory of Additive State Space Abstractions

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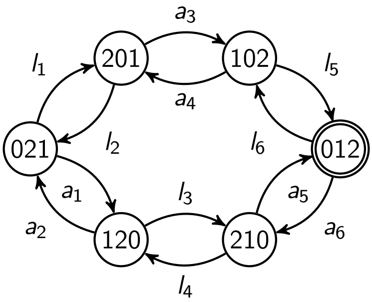
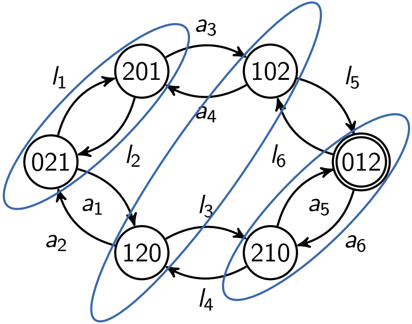
Introduction

Example Pancake Puzzle

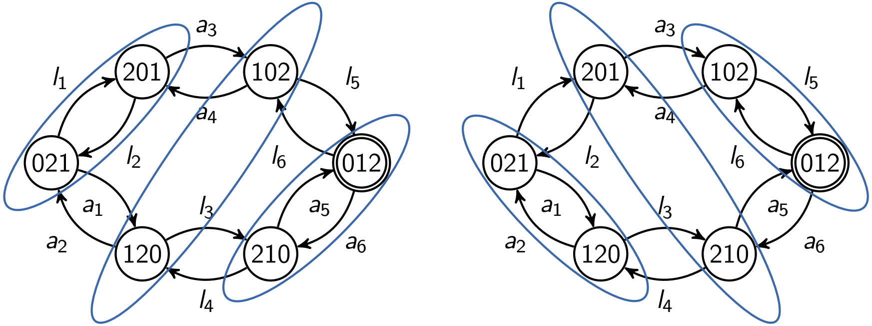


Abstractions



- Coarser version of state space (e. g. PDB)
- Homomorphic mapping
- Preserve paths
- Underestimate goal-distances
- Goal-distance heuristic admissible

Multiple abstractions



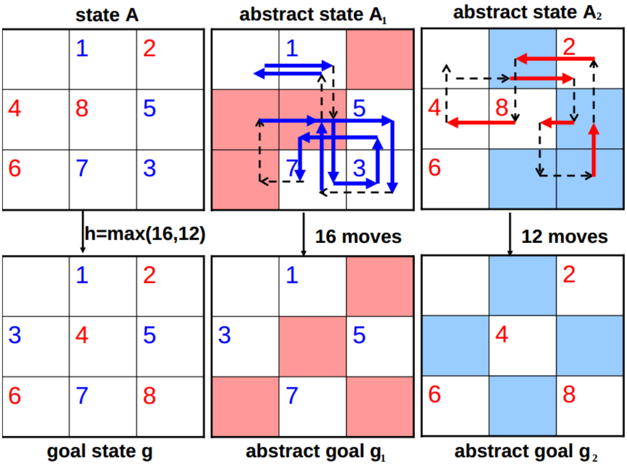
- Max of estimates is admissible
- Sum is usually not admissible
- Costs counted multiple times

Outline

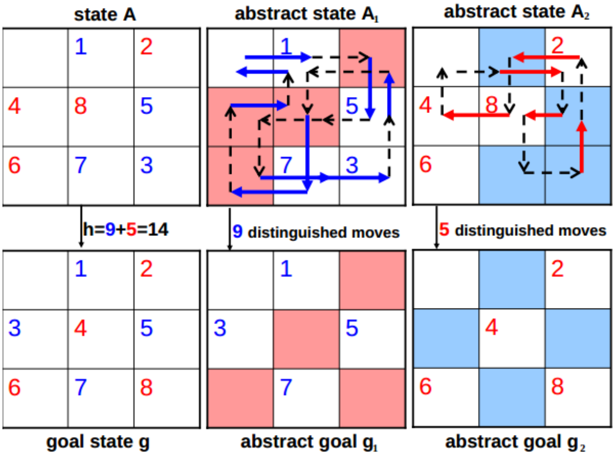
$\Rightarrow$ Divide each operator's cost among abstractions

All-or-nothing

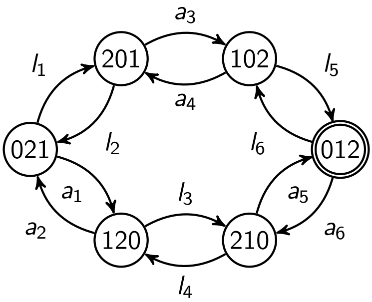
8-Puzzle – Maximum



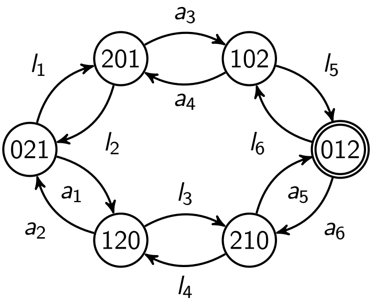
8-Puzzle – Sum


state A
abstract state A_1
abstract state A_2
h=9+5=14
9 distinguished moves
5 distinguished moves
goal state g
abstract goal g_1
abstract goal g_2

Pancake Puzzle



Pancake Puzzle

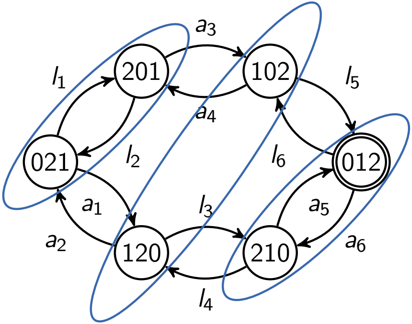


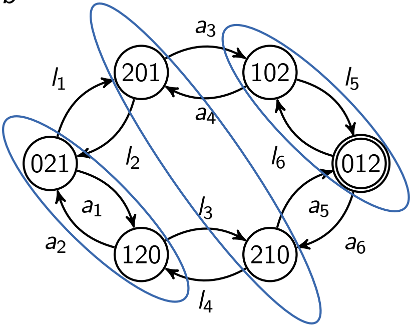
- All operators change more than one object

Cost-splitting

Cost-splitting

$$c_i(o) = \frac{b_i^o \times c(o)}{b^o}$$





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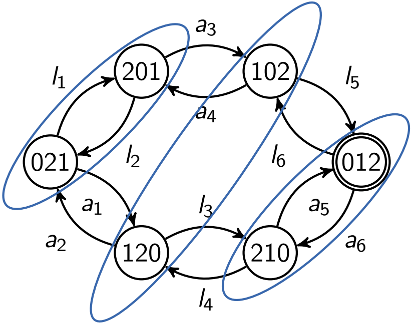

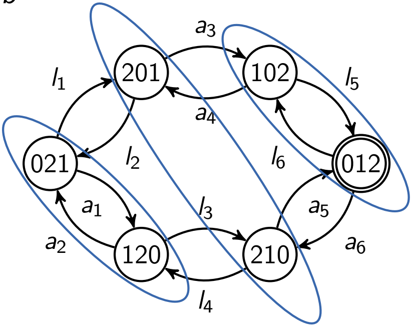

- $b^l = 2,\ b^a = 3 \rightarrow c_i(l) = 1/2, c_i(a) = 1/3$
- $h(021) = (1/3 + 1/2) + (1/2 + 1/3) = 5/3$

Location-based costs

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- Assign each operator o a location loc_o
- $c_i(o) = c(o)$ if o changes loc_o to a distinguished value in abstraction i and 0 otherwise

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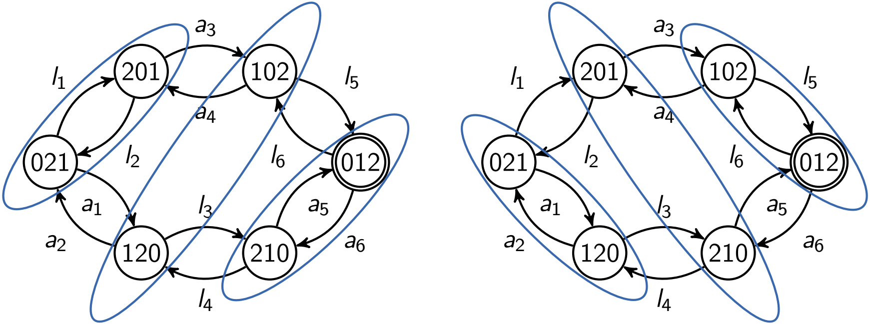

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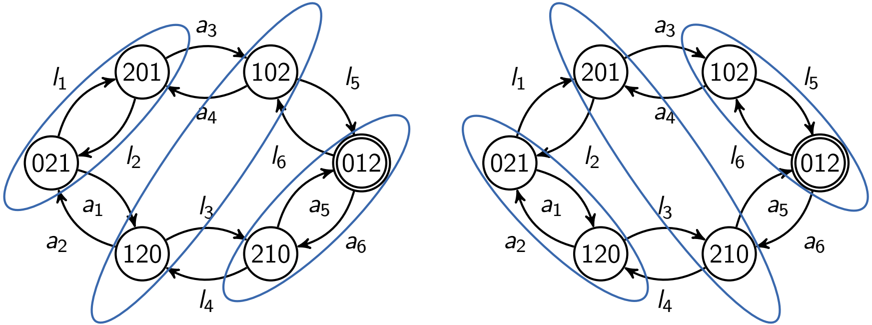

- $loc(o)$ = left-most position. Move to middle state costs 1, everything else 0
- $h(021) = (1+0) + (1+0) = 2$

Results

Results

	cost	loc
TopSpin Puzzle	✓	X
Pancake Puzzle	X	✓
Rubik's Cube	X	X

Cost saturation

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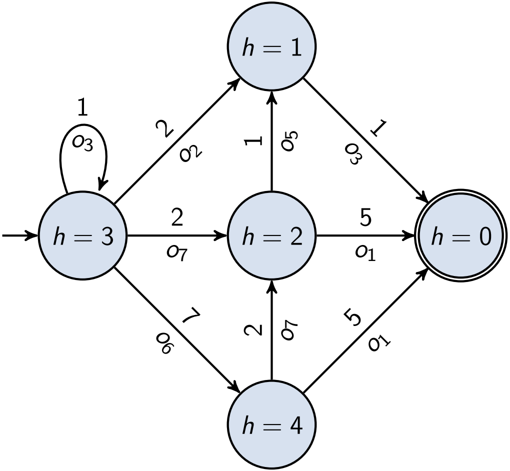
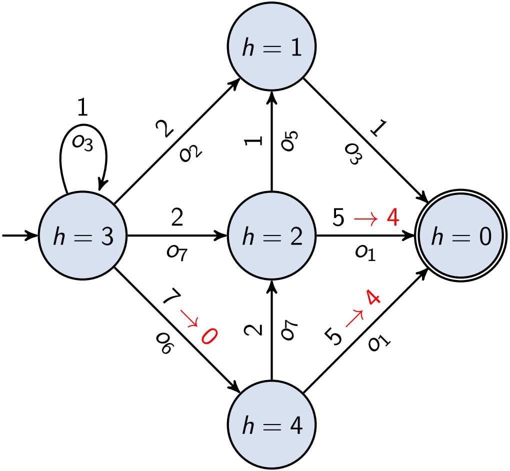


Cost saturation



Conclusion

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- Cost partitioning $\rightarrow$ additive abstractions
- Usefulness varies between problems