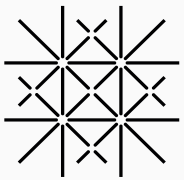
Hitting Set Heuristics for Overlapping Landmarks

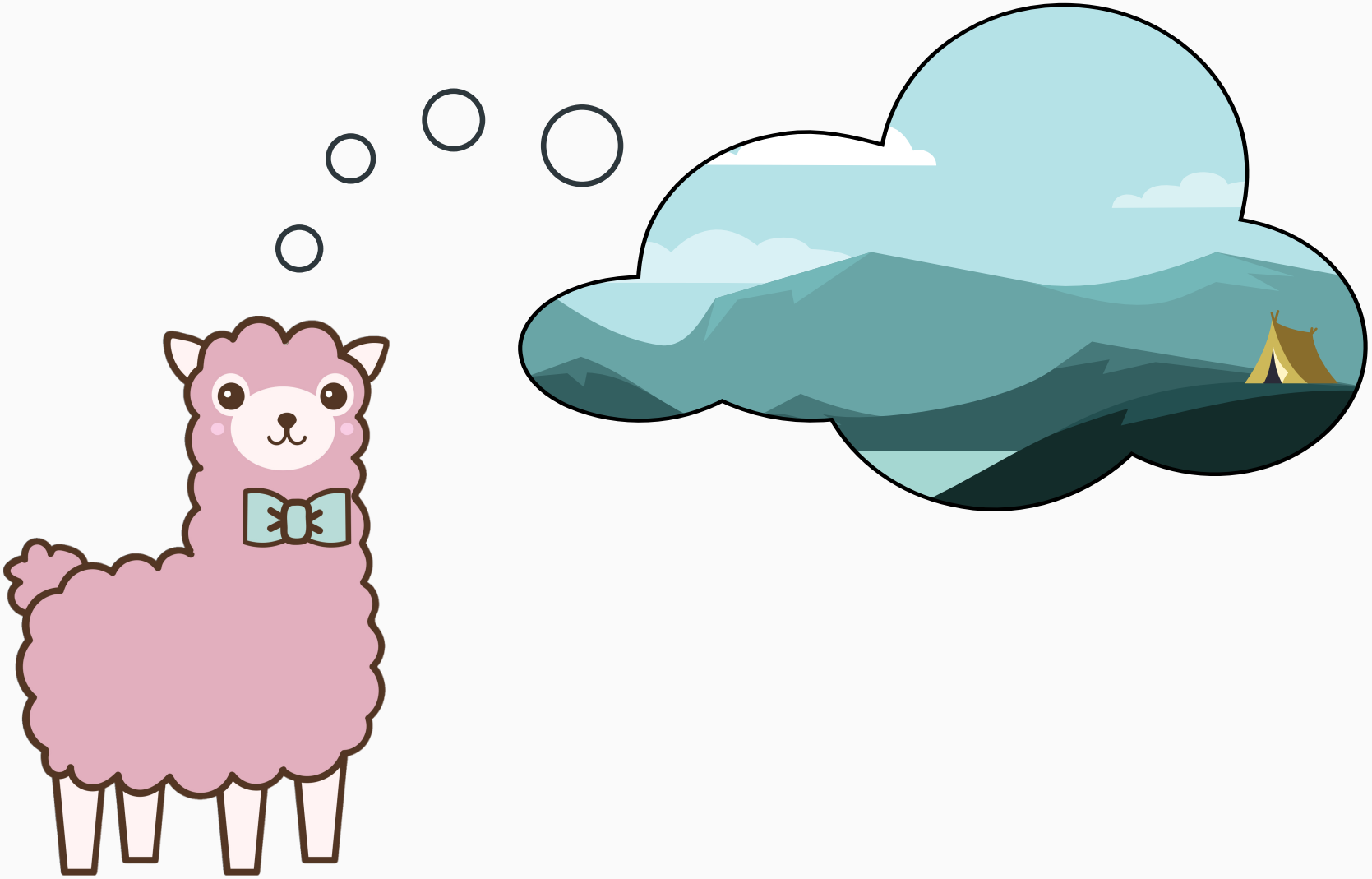
Clemens Büchner Remo Christen Salomé Eriksson Thomas Keller

June 7, 2024



University of Basel

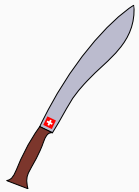
Planning a Camping Trip with LAMA



Planning a Camping Trip with LAMA

- ☐ knife
- ☐ can opener
- ☐ place to sleep
- ☐ weather protection

Different Options to Achieve Landmarks



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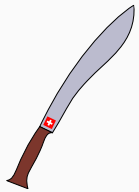

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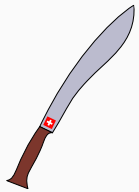

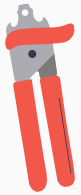

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Different Options to Achieve Landmarks

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- cheapest item from every landmark

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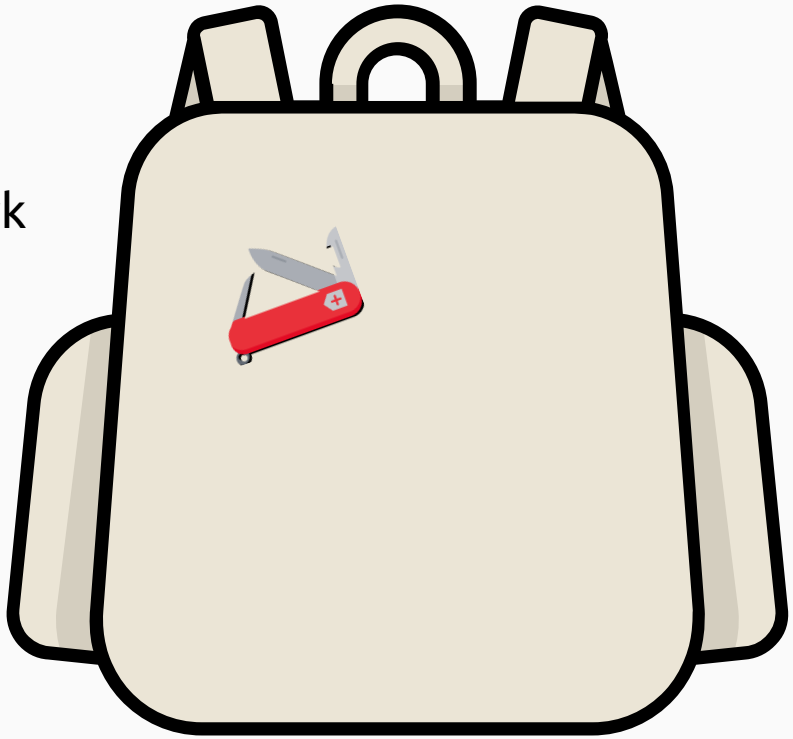

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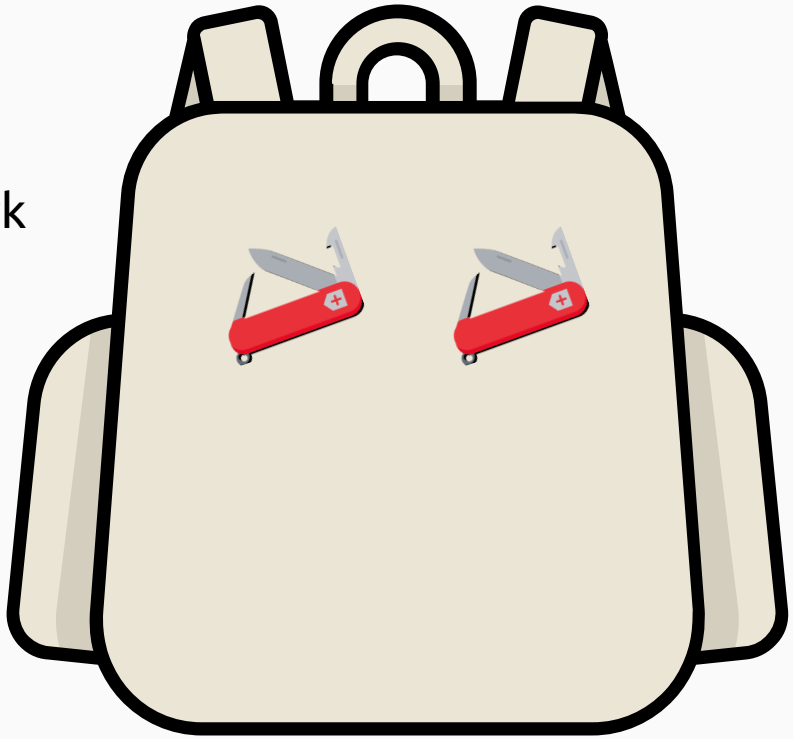

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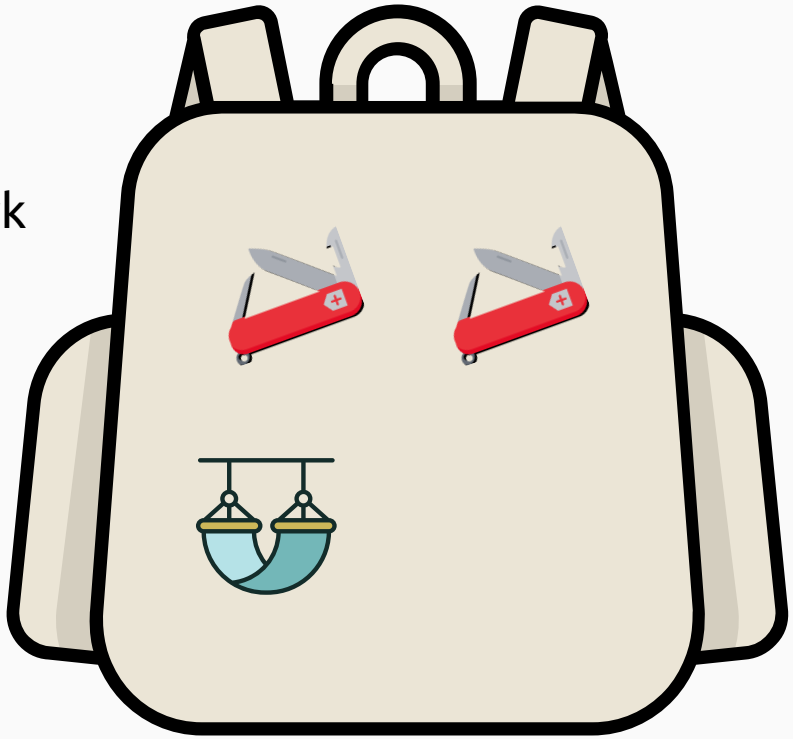
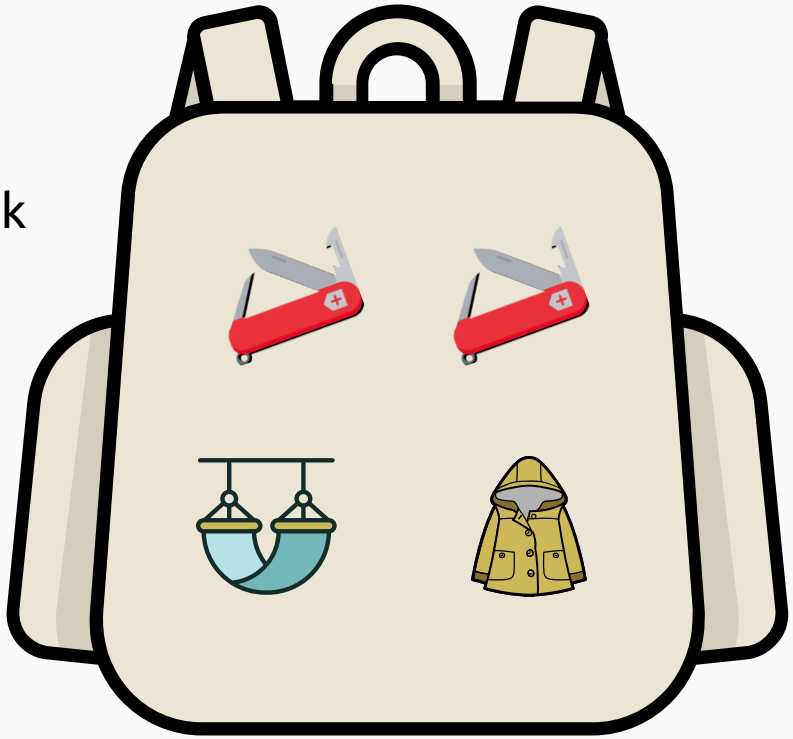


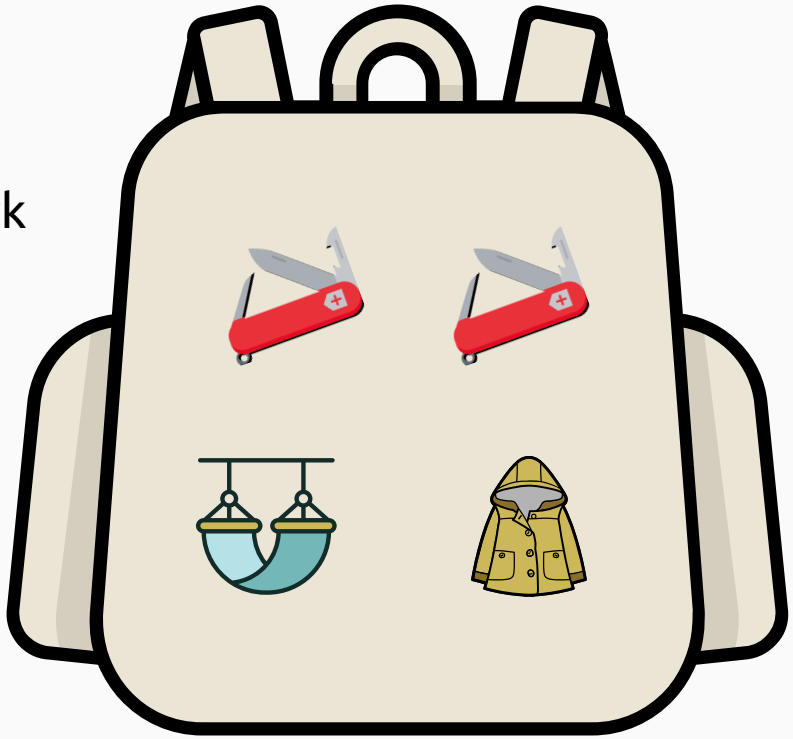
What does LAMA pack?

- cheapest item from every landmark
- $h^{\text{LAMA}} = 17$



What does LAMA pack?

- cheapest item from every landmark
- $h^{\text{LAMA}} = 17$
- That's more stuff than necessary!

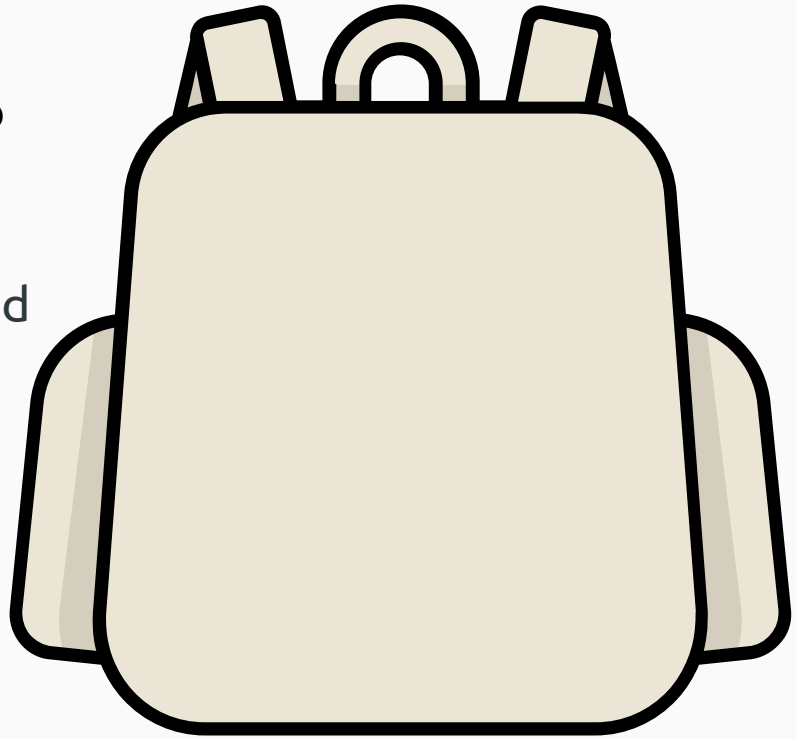


What does LAMA pack?

- cheapest item from every landmark
- $h^{\text{LAMA}} = 17$
- That's more stuff than necessary!
- remove duplicates: $h^{\text{HS}} = 15$

Greedy Hitting Set

1. pick item with best $\frac{cost}{\#landmarks}$ ratio
2. discard achieved landmarks
3. repeat until all landmarks achieved



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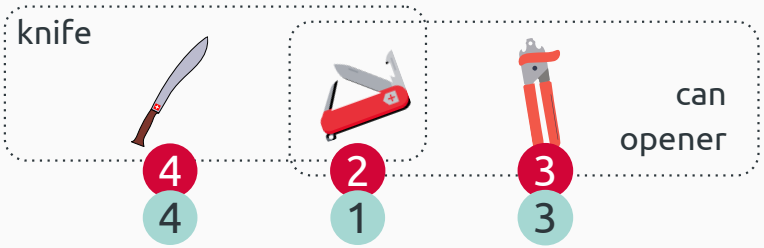

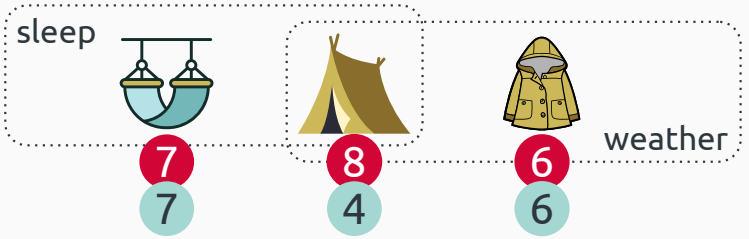

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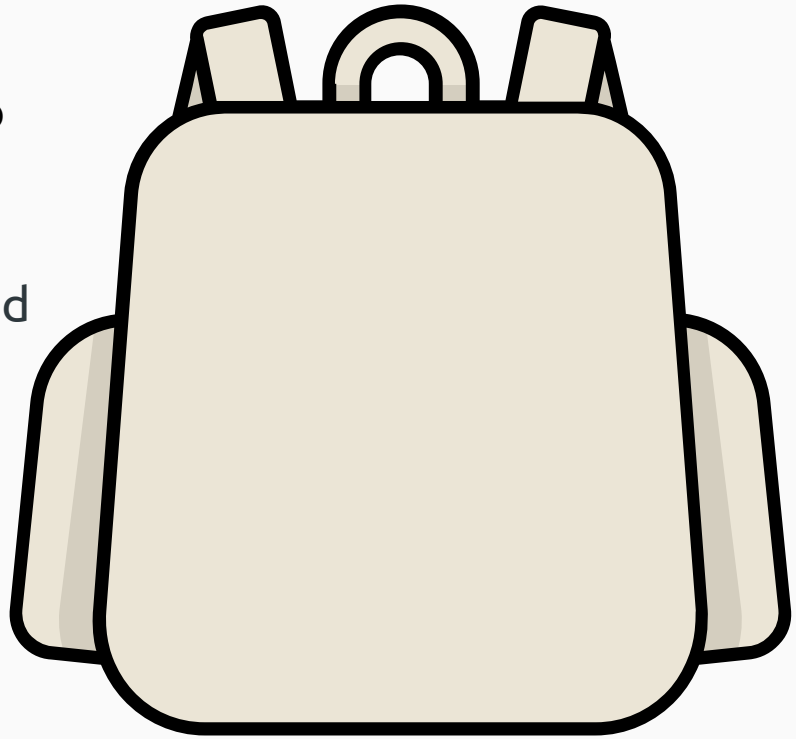

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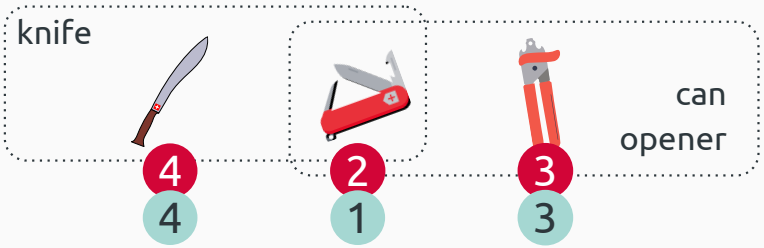

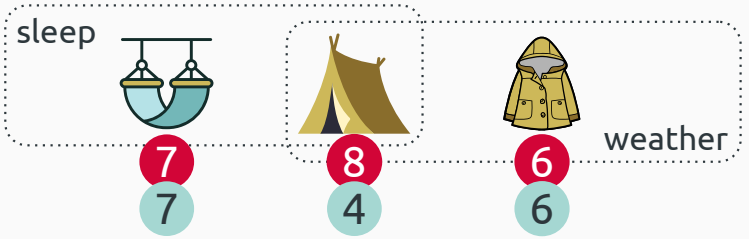

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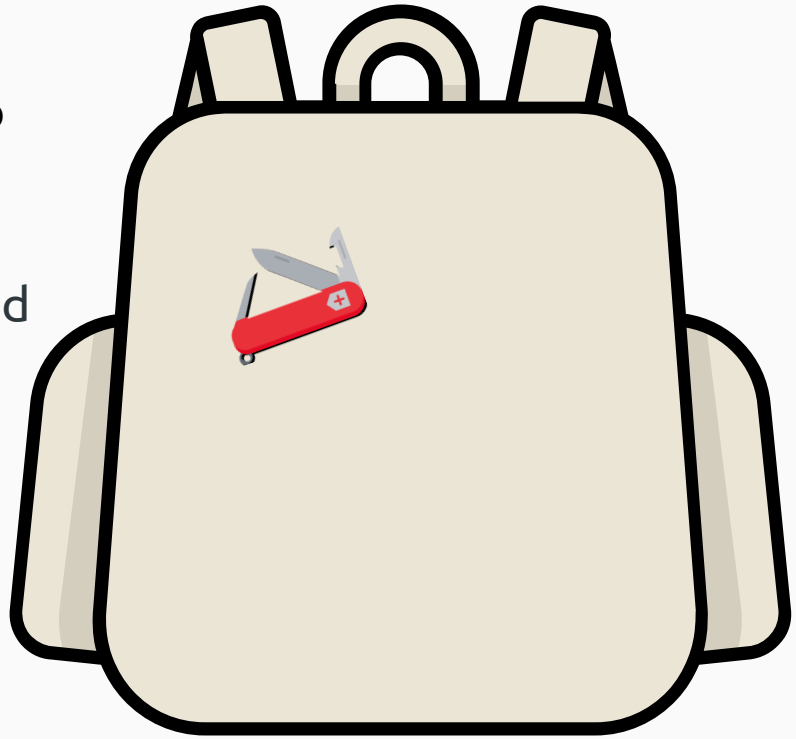

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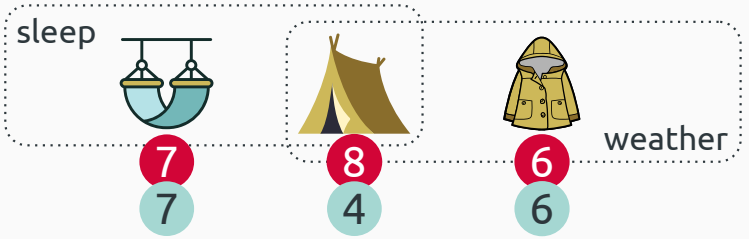

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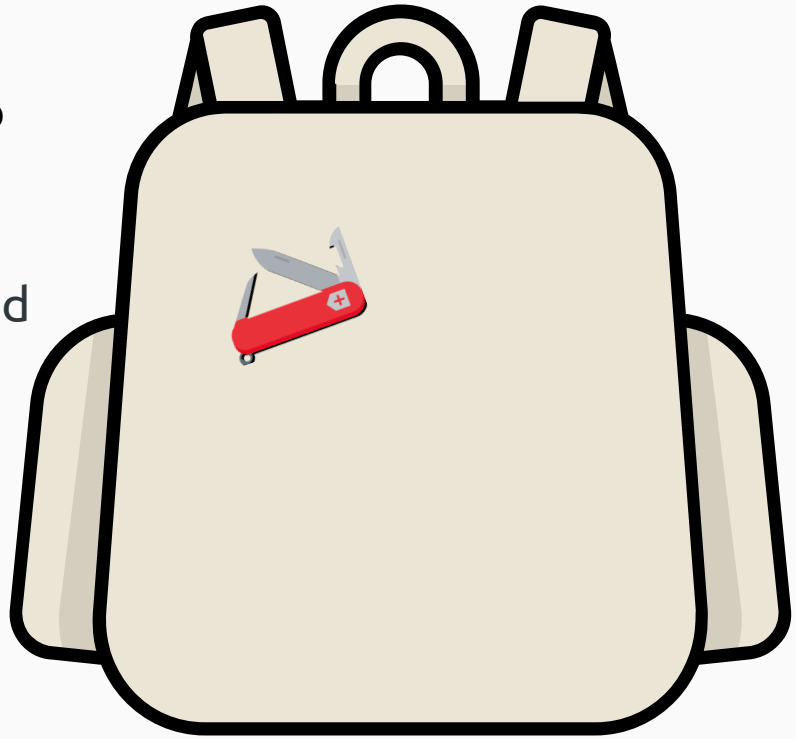

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- $h^{\text{GHS}} = 10$

Greedy Best First Search

	(total)	h^{LAMA}	h^{HS}	h^{GHS}
Coverage	(2323)	1680	1742	1718

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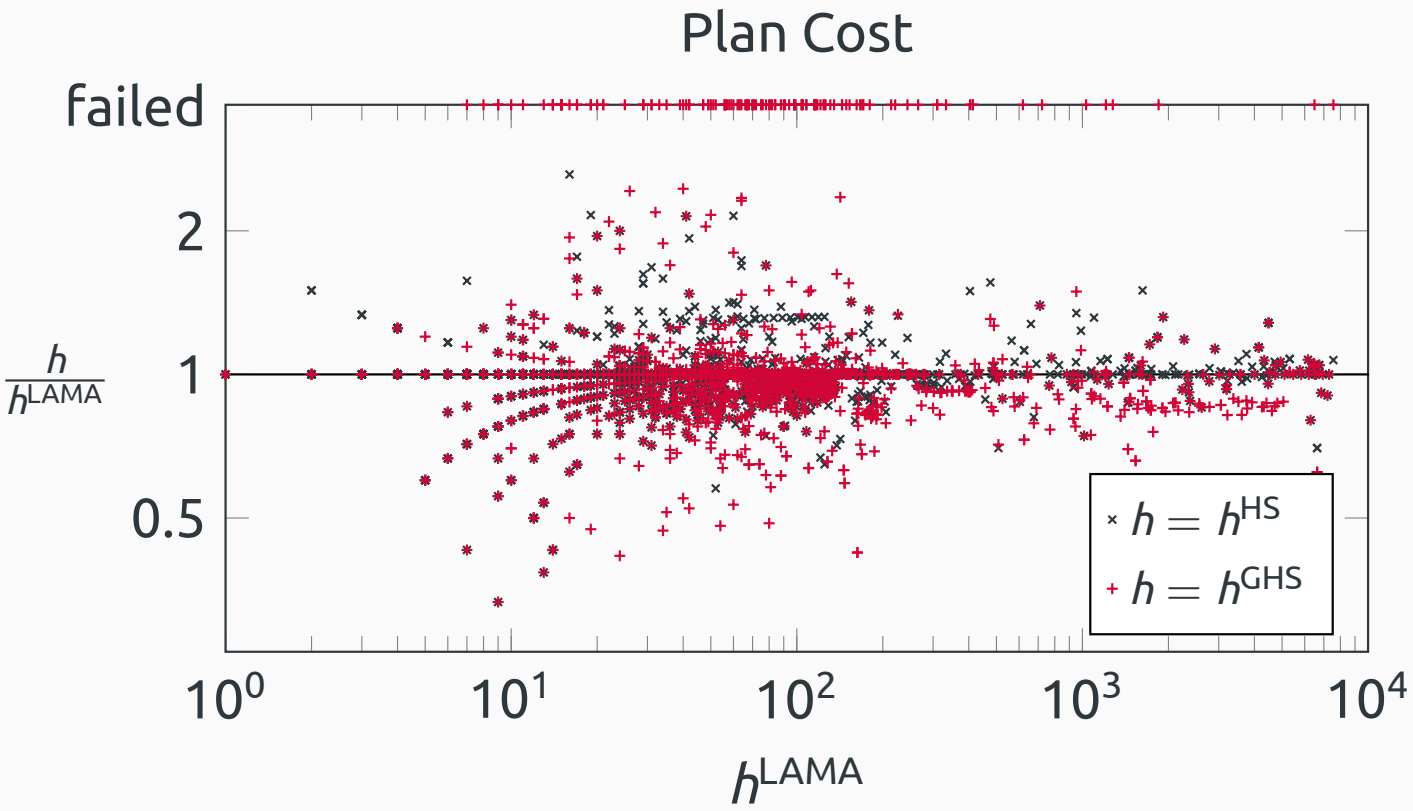

Full LAMA Configurations

- open lists for multiple heuristics
- preferred operators
- improve plans by restarting weighted A* search

	Coverage	Score
h^{LAMA}	2056	1957.8
h^{HS}	2052	1952.0
h^{GHS}	2068	1987.3

score per task: $0 \leq \frac{c^*}{c} \leq 1$

Summary

- overlapping landmarks express synergies
- hitting set heuristics exploit these synergies
- tradeoff between heuristic accuracy and computation time
- plan quality improves with more accurate heuristics in practice

Hitting Set Problem

Definition

Given:

- universe U 
- set of sets $\mathcal{S} \subseteq 2^U$ knives: {  }
- cost function $cost\colon U \to \mathbb{R}_0^+$ $cost($  $) = 2$

Problem:

- Find hitting set $H \subseteq U$ s.t. $H \cap S \neq \emptyset$ for all $S \in \mathcal{S}$.
- minimal hitting set: no cheaper hitting set exists

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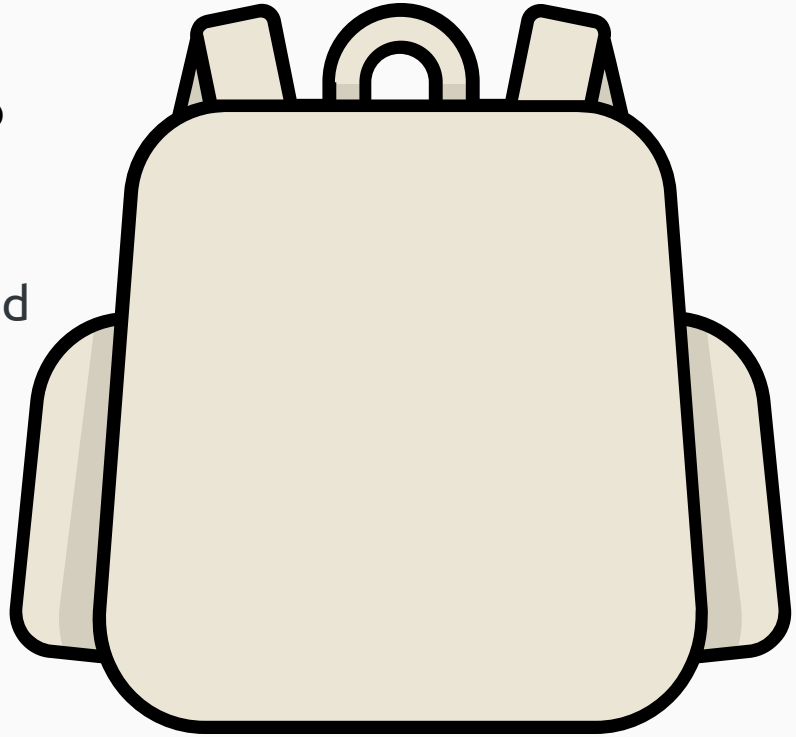

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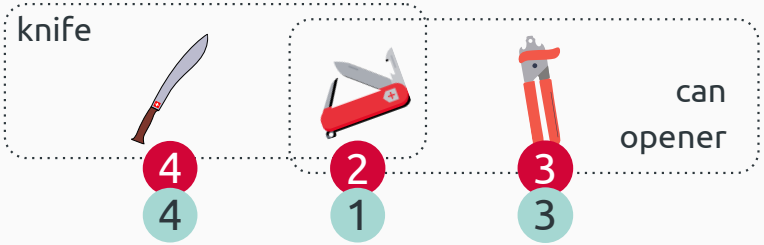

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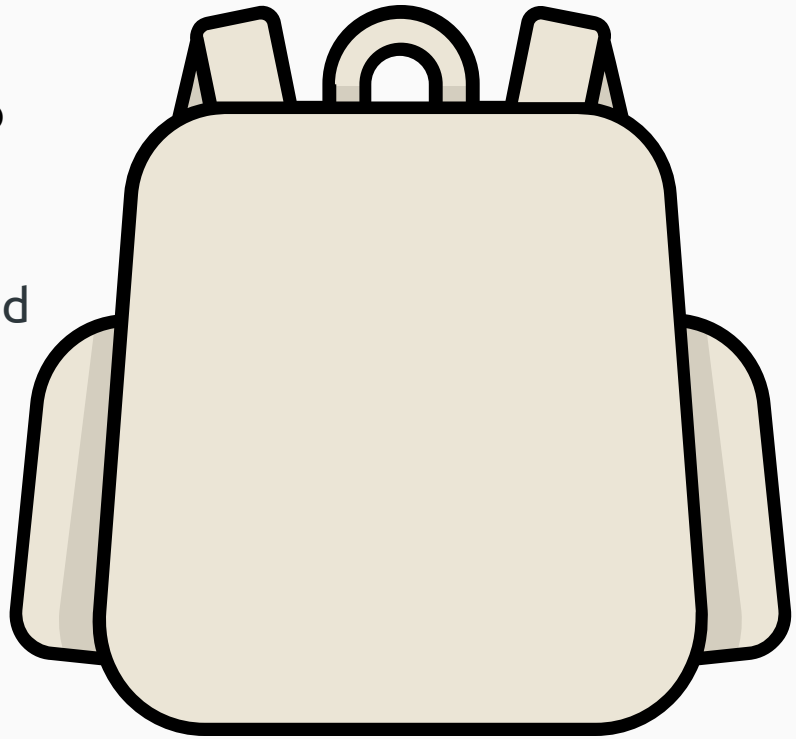

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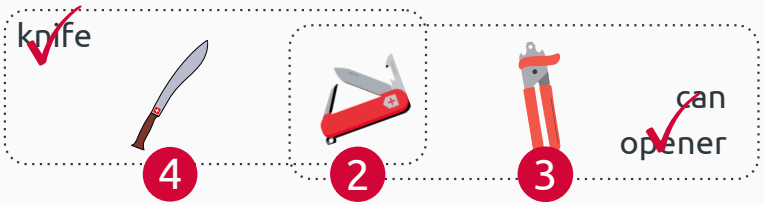

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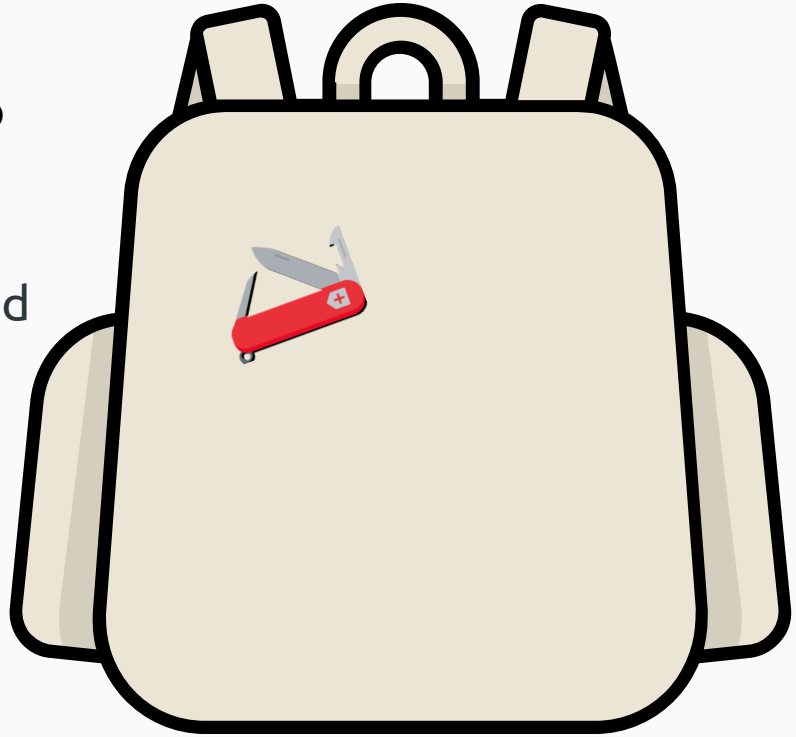

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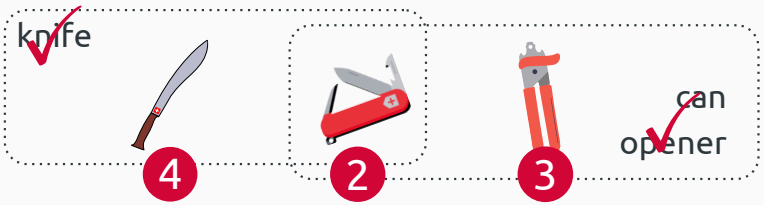

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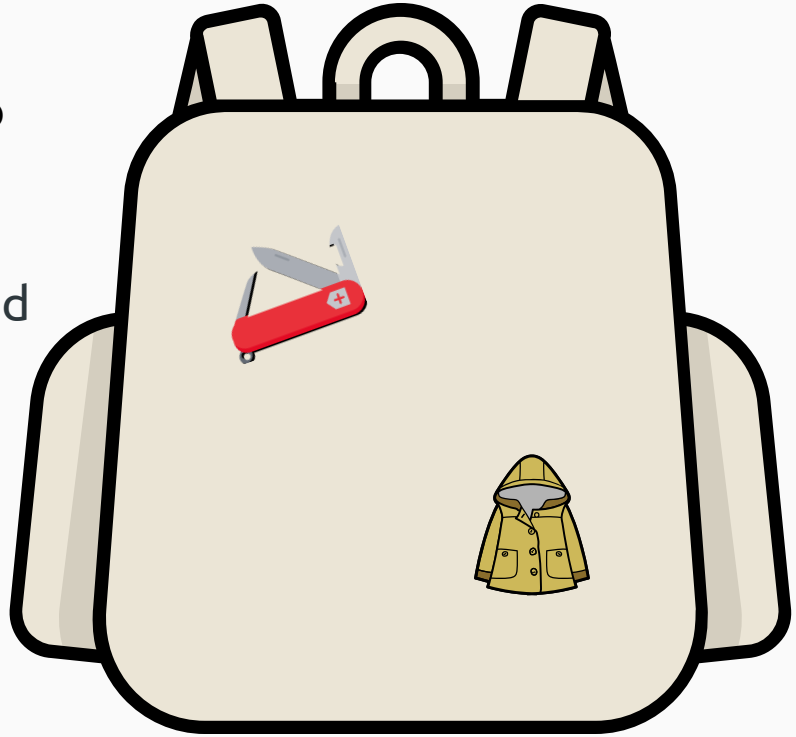

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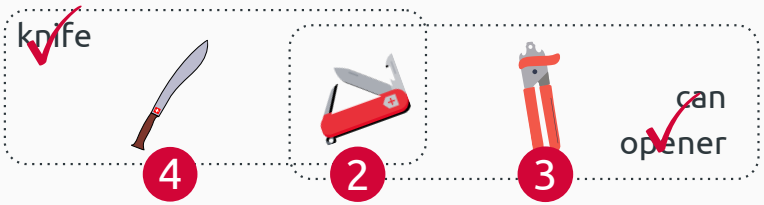

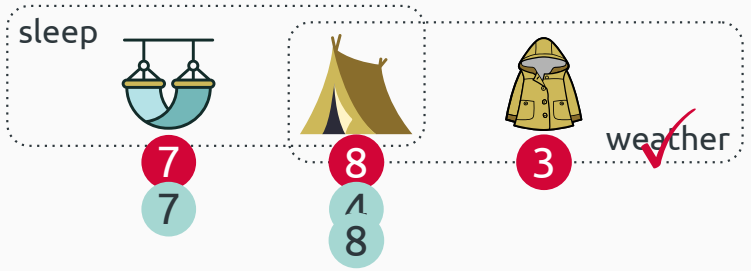

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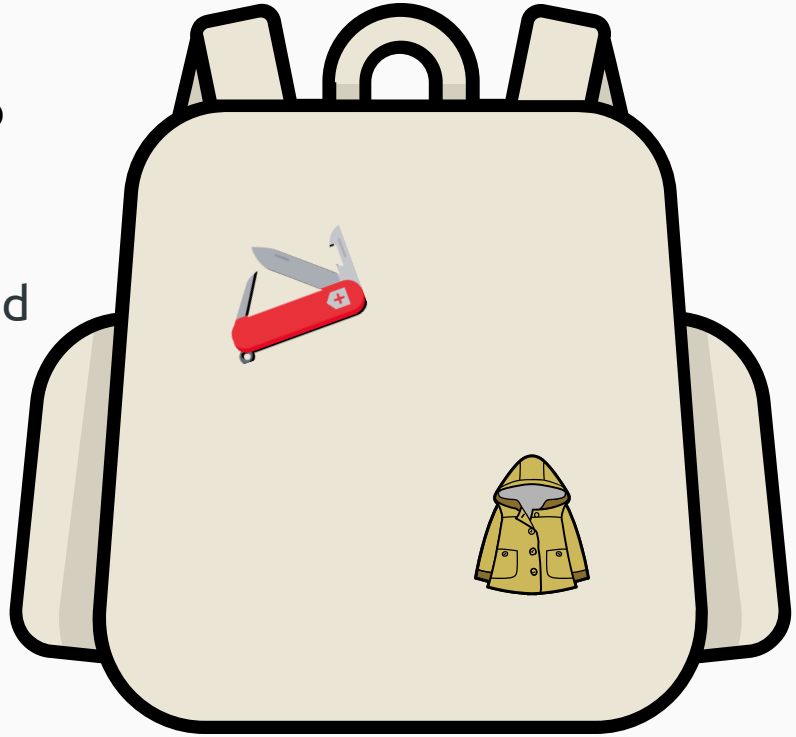

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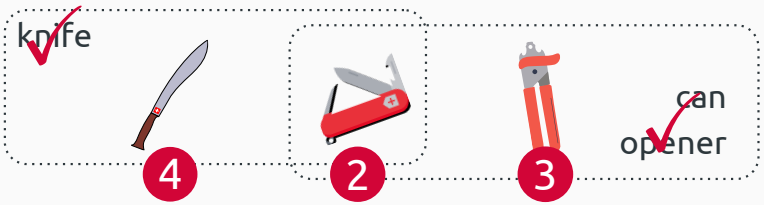

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