Hitting Set Heuristics for Overlapping Landmarks

Clemens Büchner Remo Christen Salomé Eriksson Thomas Keller

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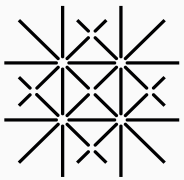
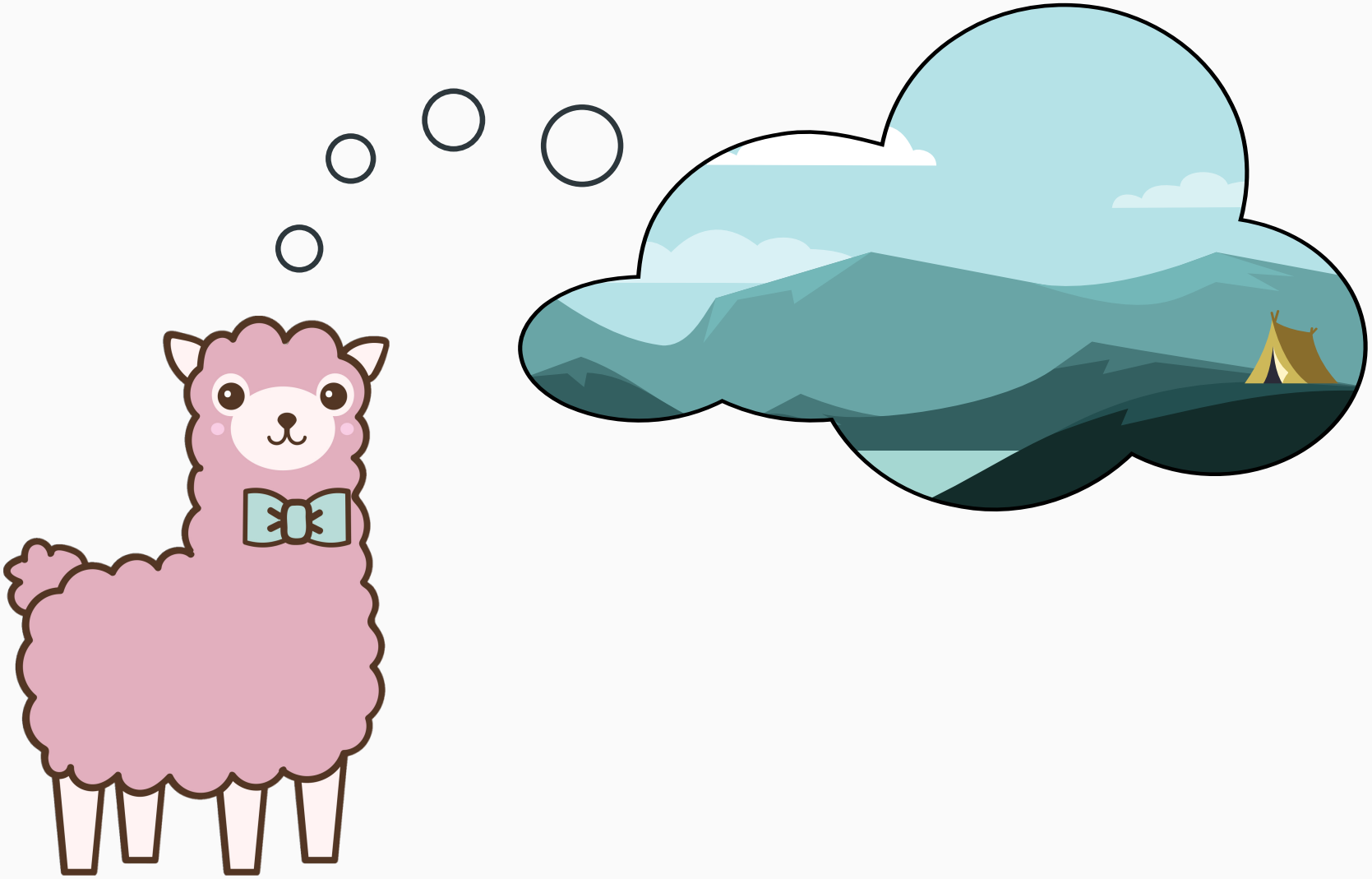


University of Basel

Planning a Camping Trip with LAMA



Planning a Camping Trip with LAMA

- ☐ knife
- ☐ can opener
- ☐ place to sleep
- ☐ weather protection
- ☐ flashlight
- ☐ navigation device

Different Options to Achieve Landmarks

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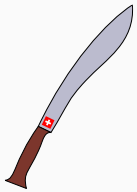
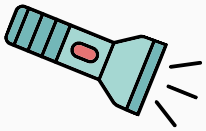
knife





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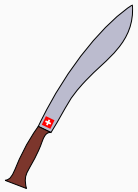

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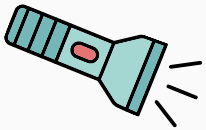

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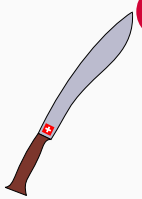

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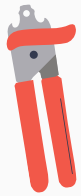

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place to sleep

7

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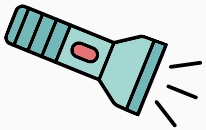
flashlight



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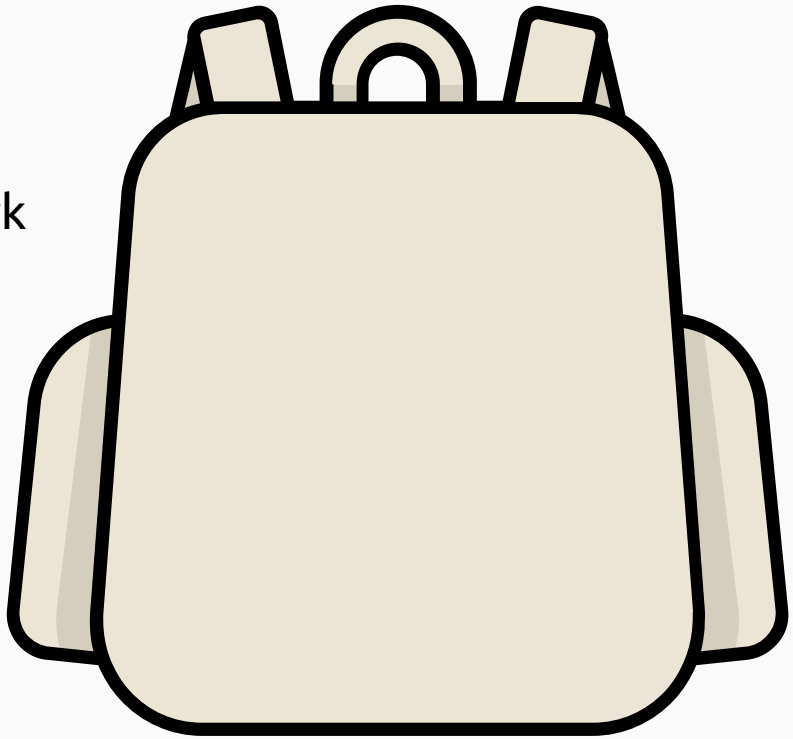
navigation device

What does LAMA pack?

- cheapest item from every landmark



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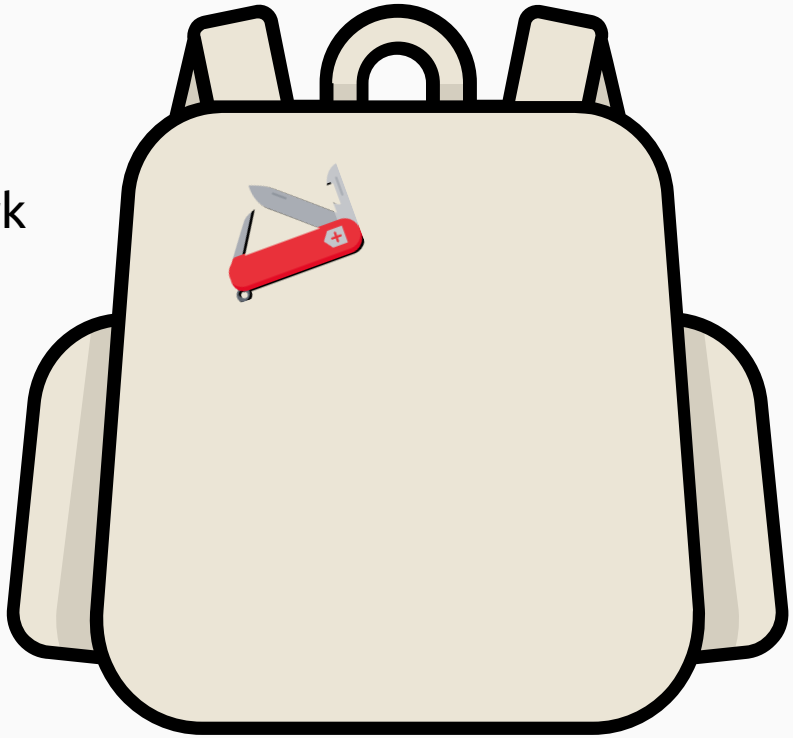

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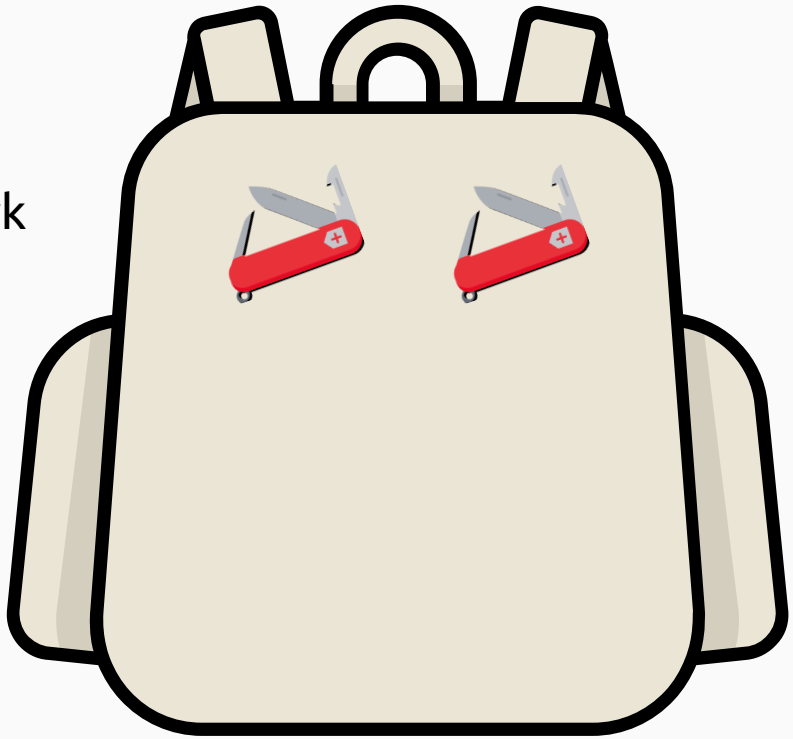

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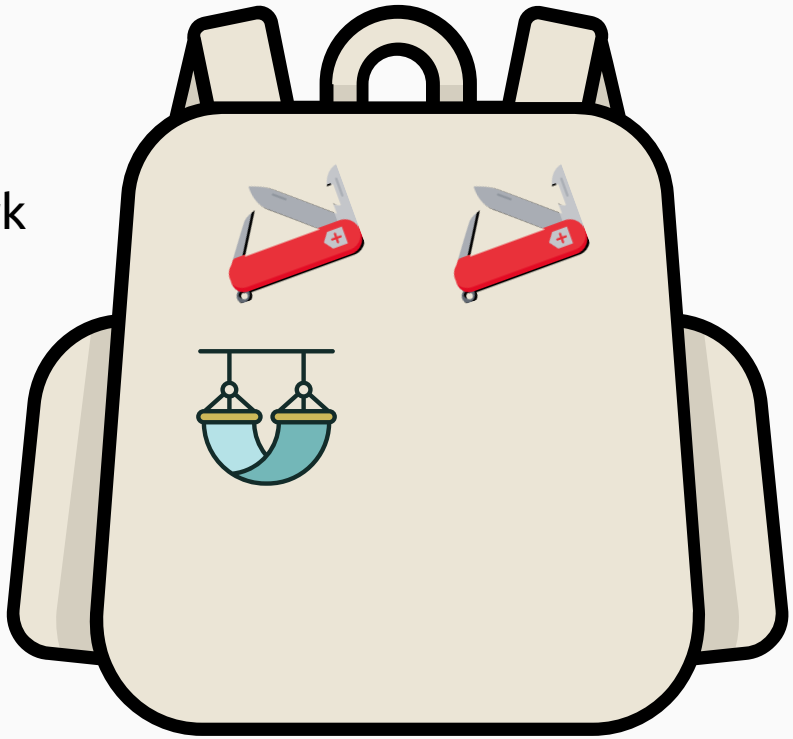

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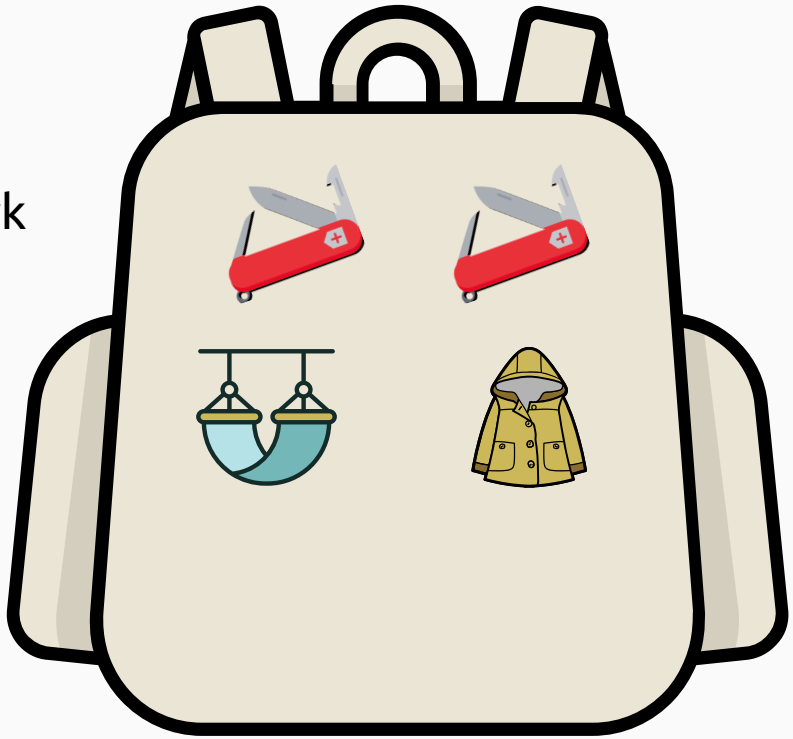

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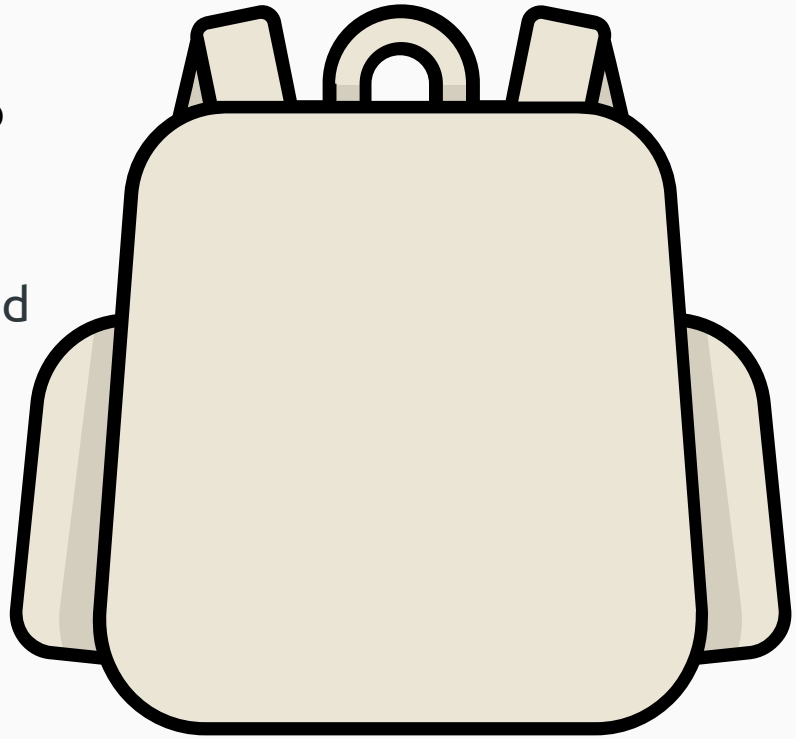
- remove duplicates: $h^{\text{HS}} = 23$

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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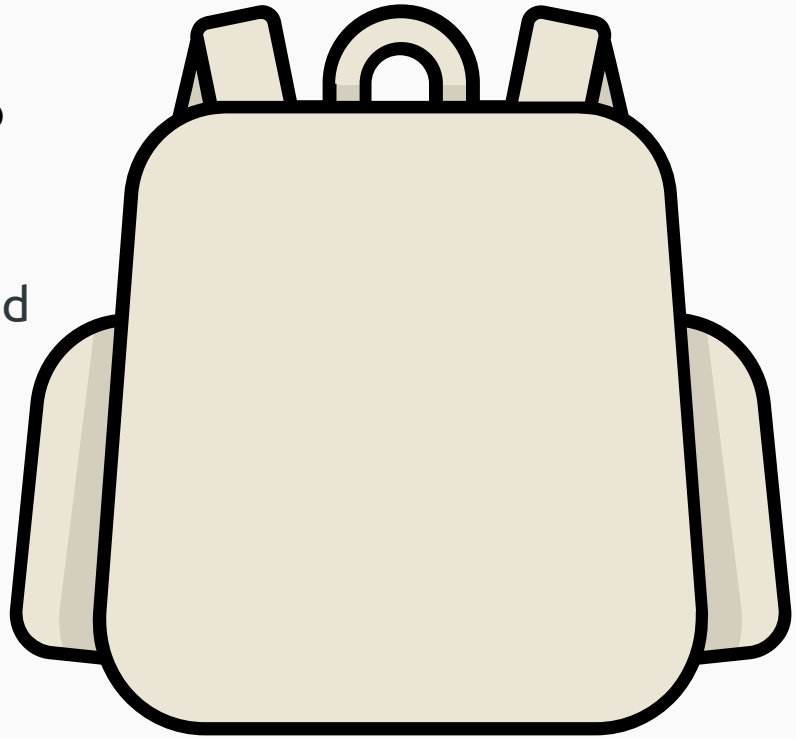

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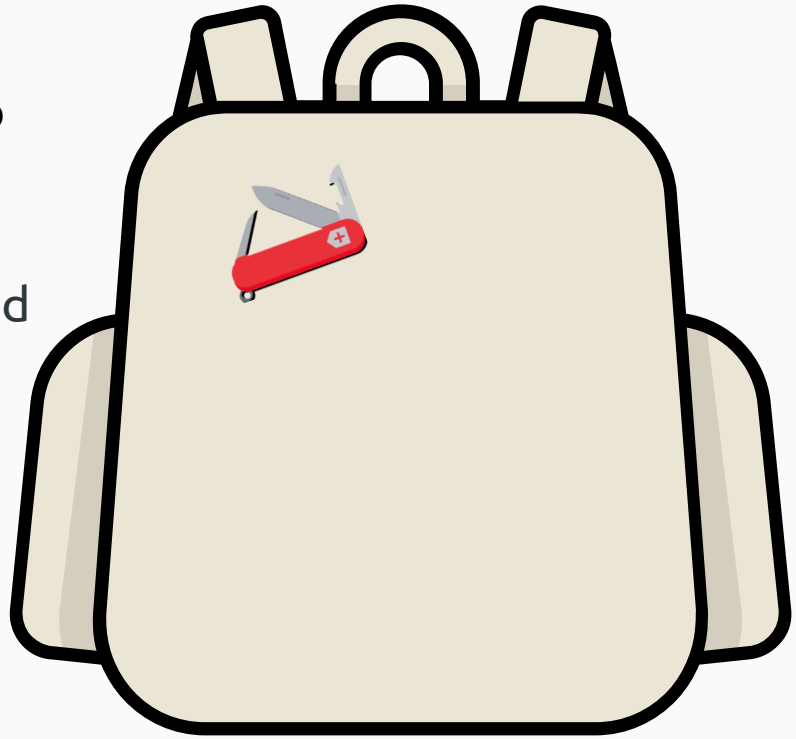

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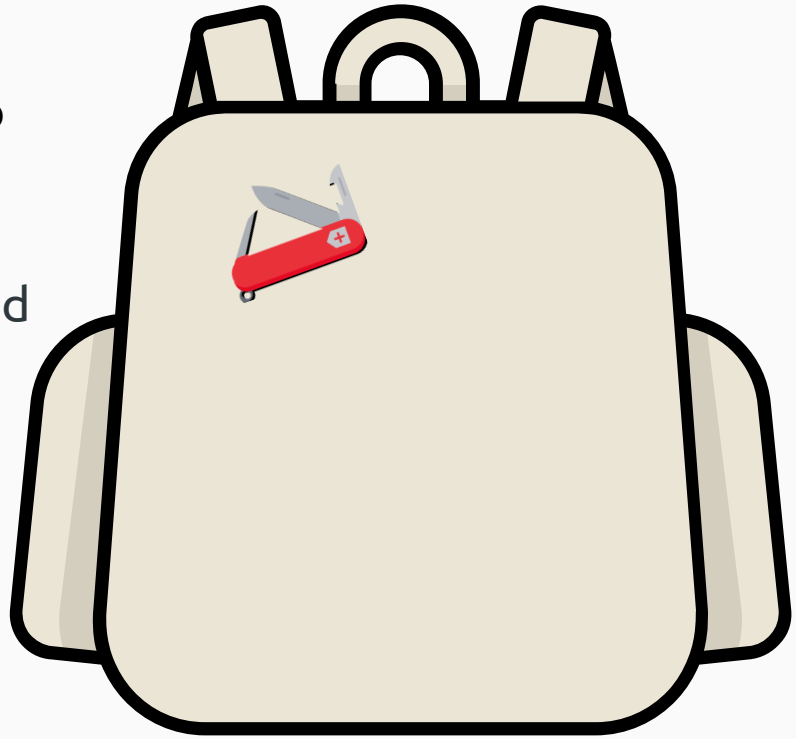

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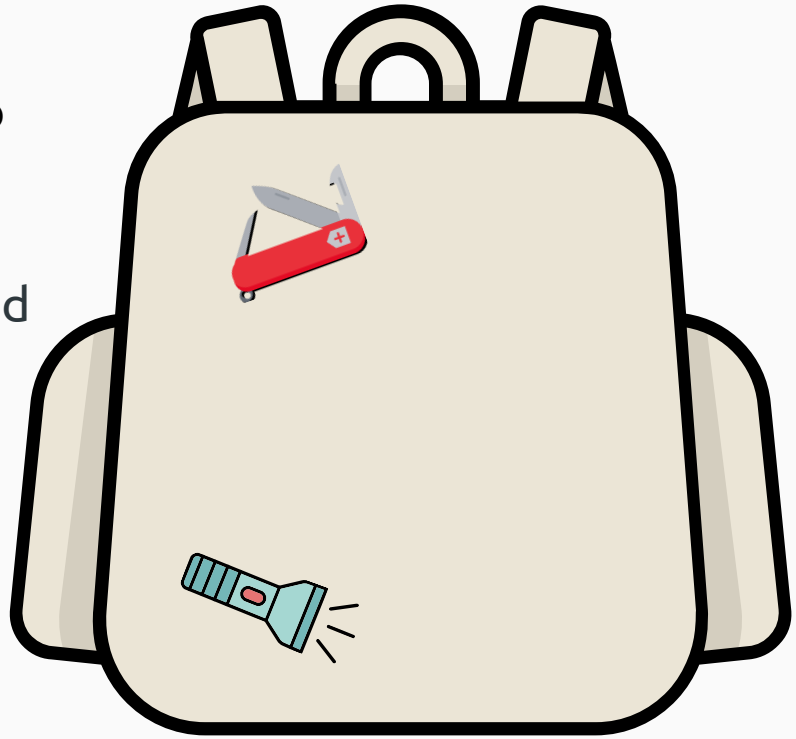

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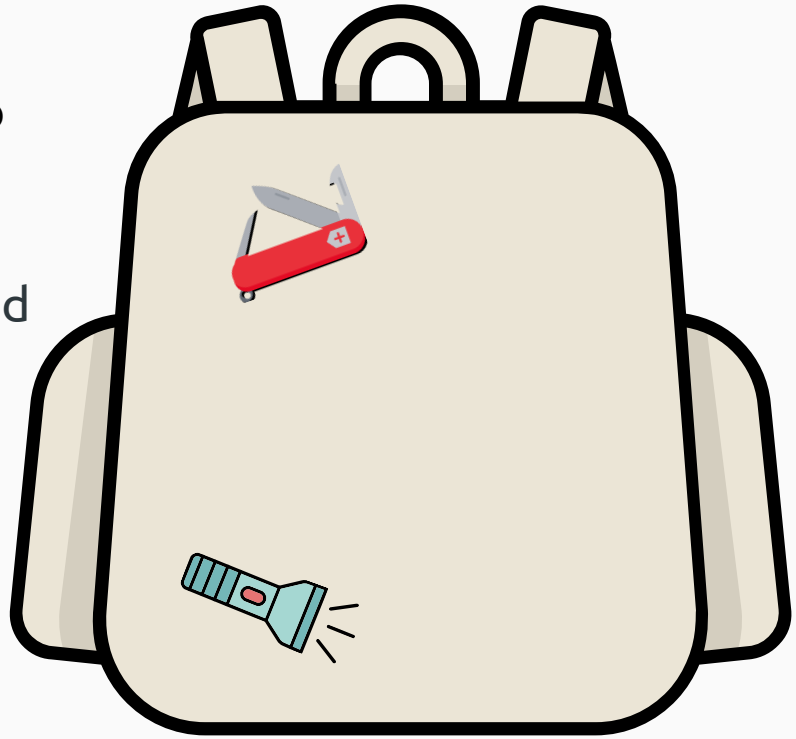

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- $h^{\text{GHS}} = 18$
- $h^{\text{MHS}} = 16$ $\rightsquigarrow$ NP-complete

Greedy Best First Search

	(total)	h^{LAMA}	h^{HS}	h^{GHS}
Coverage	(2804)	1998	2006	1983

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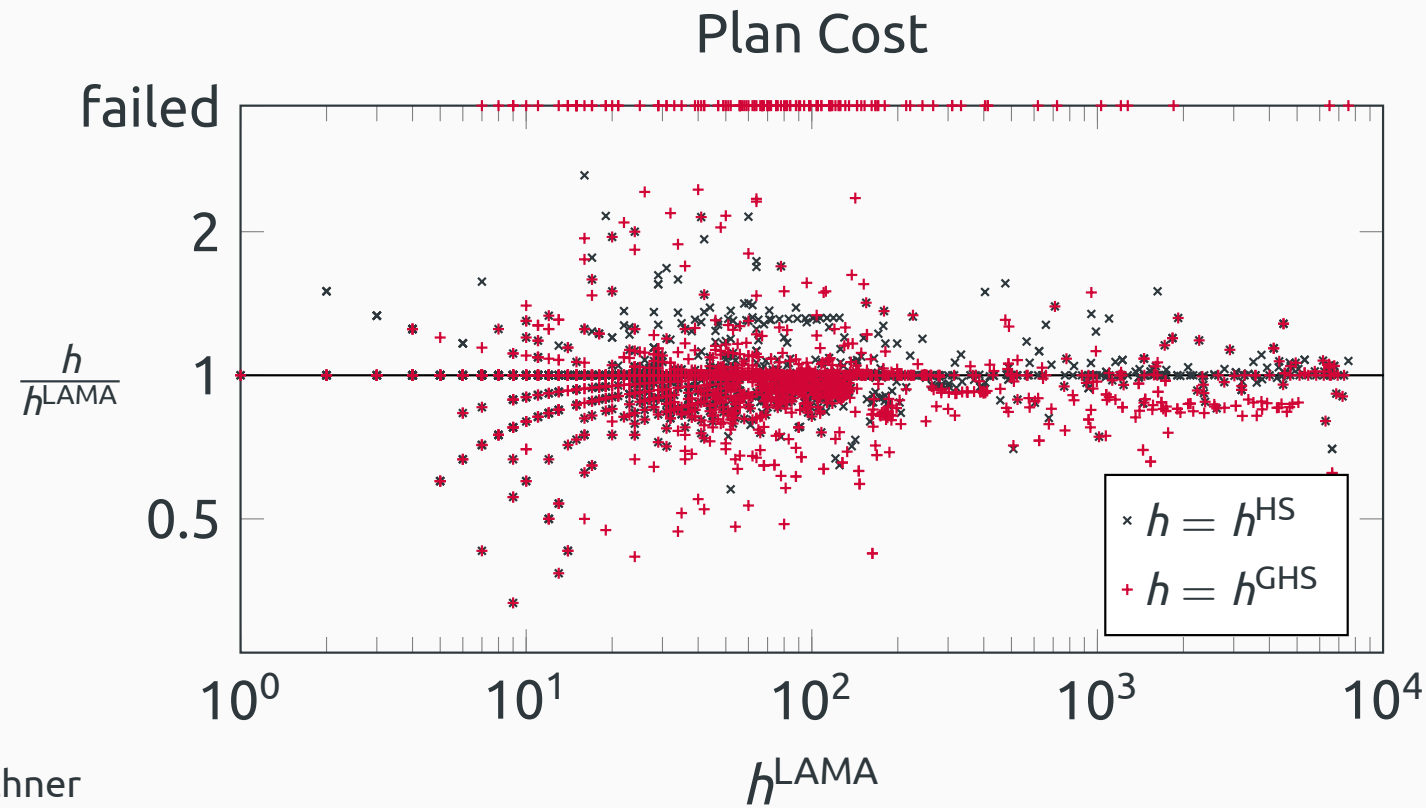

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- open lists for multiple heuristics
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	Coverage	Score
h^{LAMA}	2458	2357.3
h^{HS}	2426	2324.2
h^{GHS}	2444	2361.9

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h^{HS}	2426	2324.2
h^{GHS}	2444	2361.9
no derived variables		
h^{LAMA}	2056	1957.8
h^{HS}	2052	1952.0
h^{GHS}	2068	1987.3

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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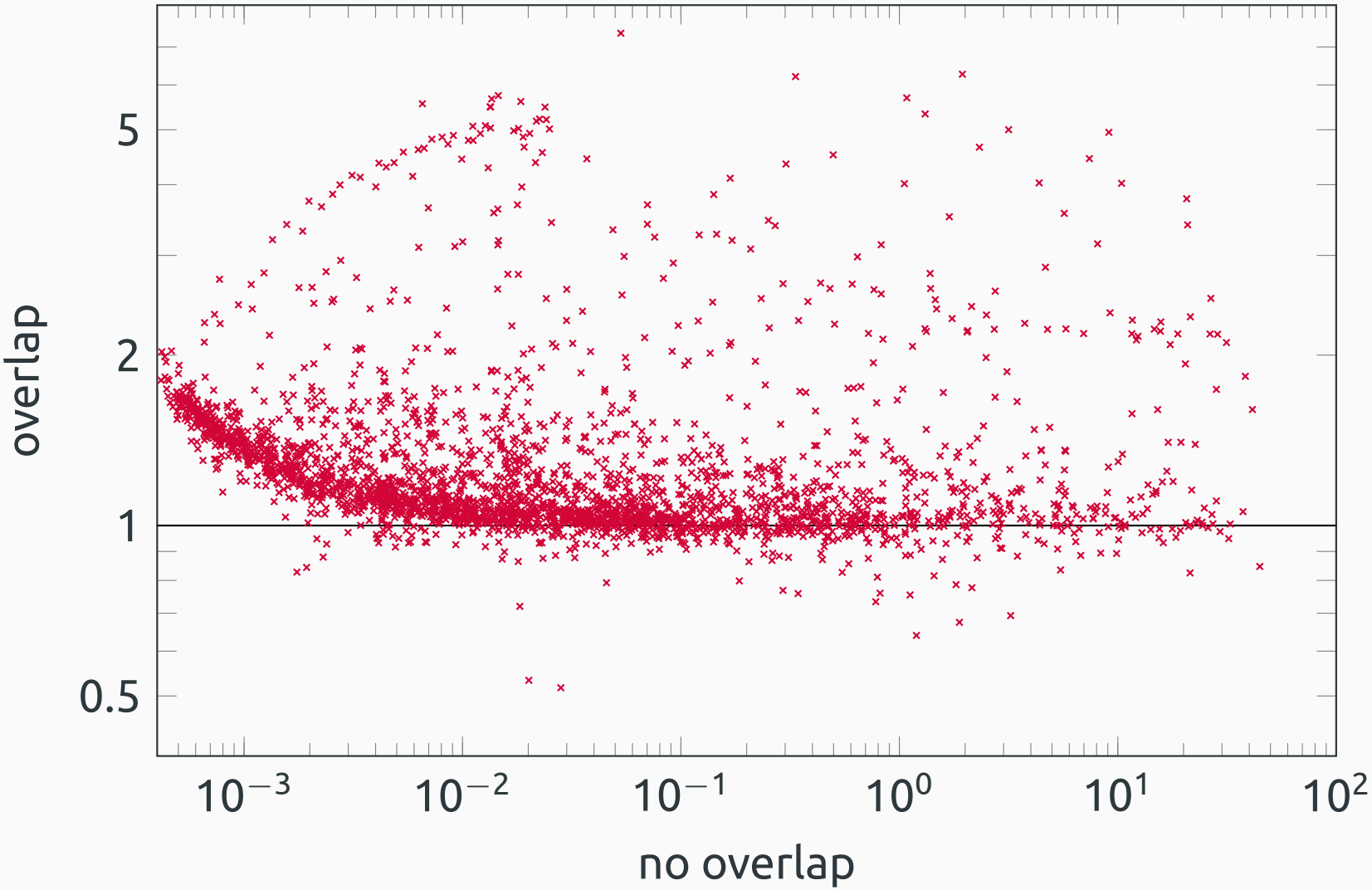
Our approach: keep everything, let the heuristic deal with it.

Landmark Generation Time



Optimal Planning

overapproximation of h^{GHS} bounded $\rightsquigarrow$ $h^{\text{GHS-opt}}$

	(total)	$h^{\text{GHS-opt}}$	h^{OCP}	h^{UCP}
Coverage	(1847)	904	907	1007

h^{OCP}: optimal cost partitioning $\approx h^{MHS}$

h^{UCP}: uniform cost partitioning