Abstractions += Landmarks

C. Domshlak M. Katz S. Lefler

Faculty of Industrial Engineering and Management
Technion - Israel Institute of Technology

Background

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Experimental Evaluation

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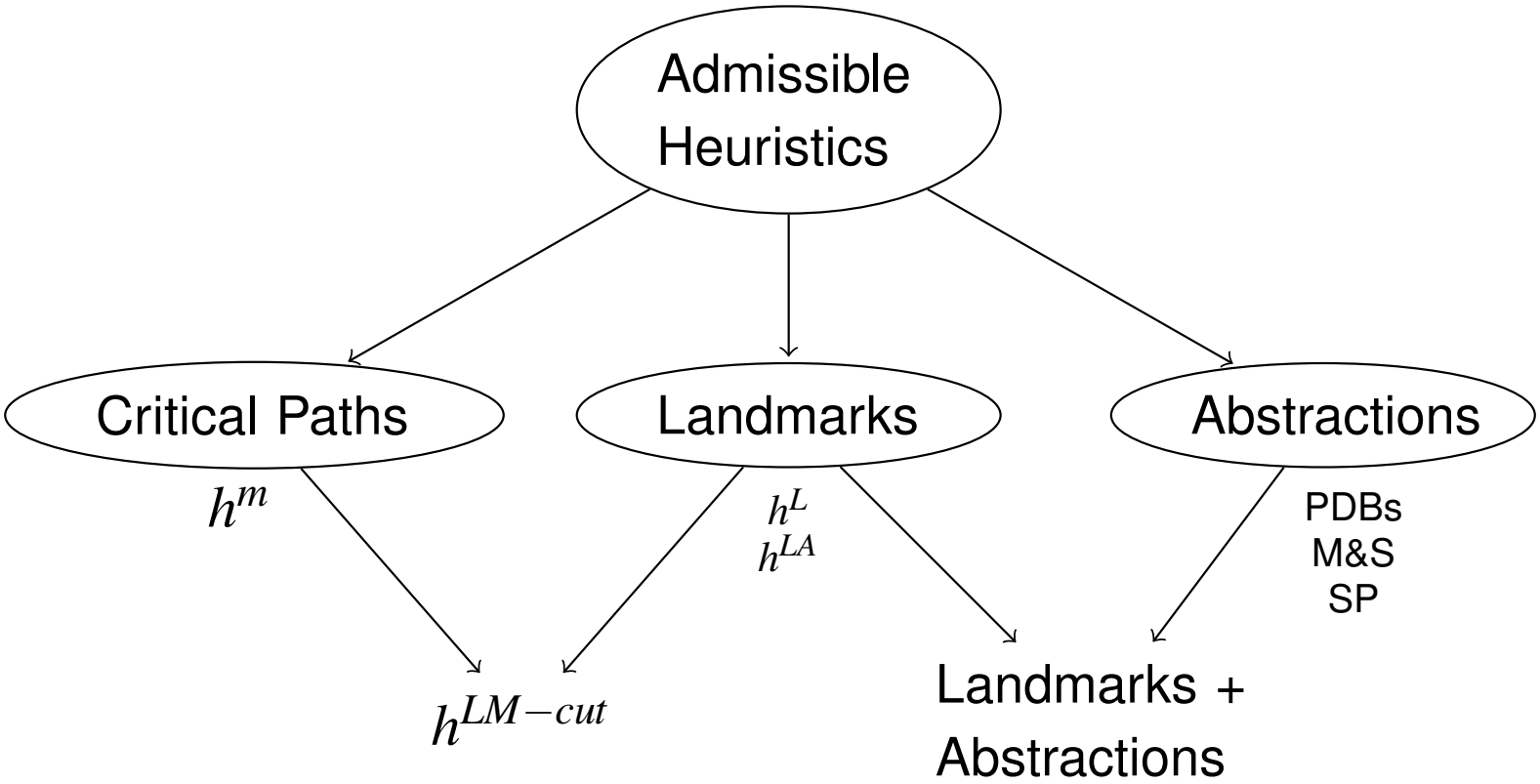
Context



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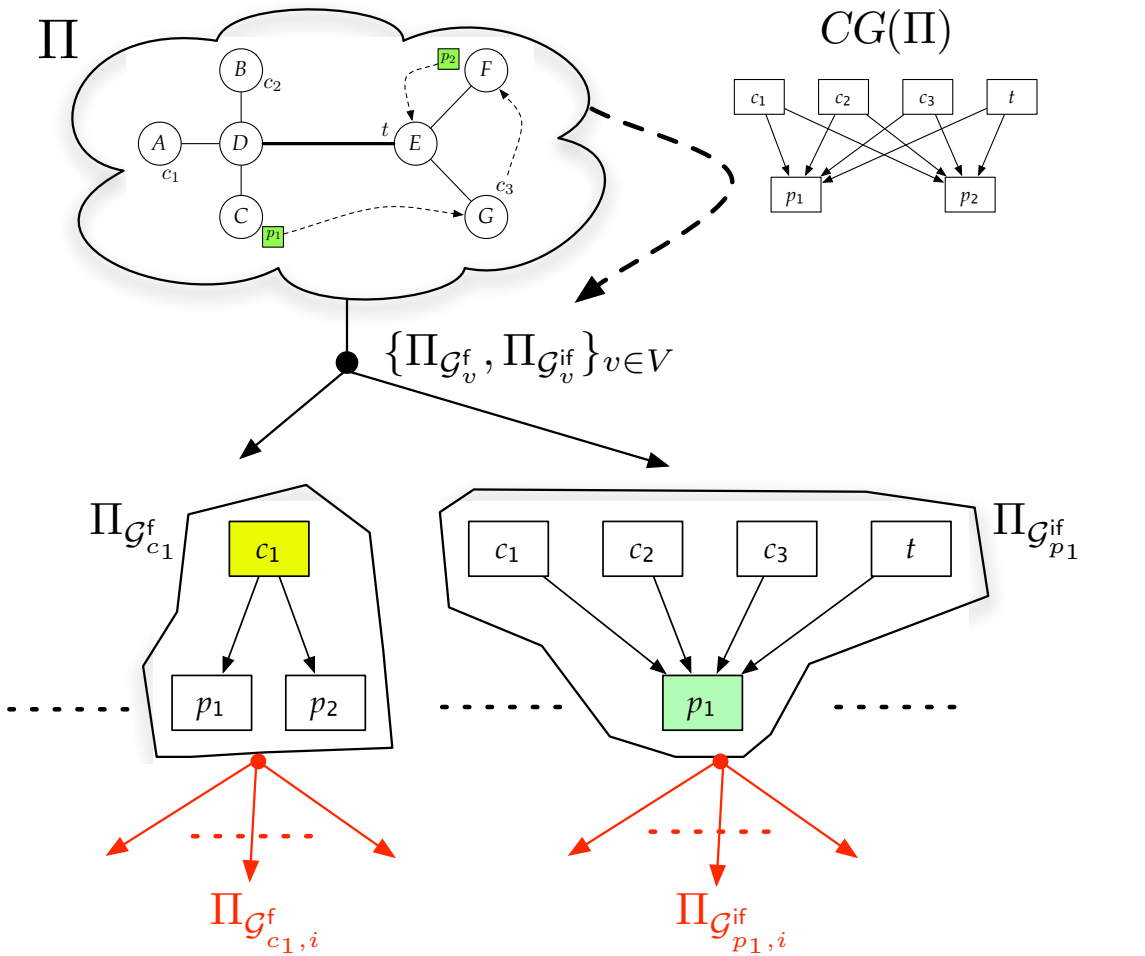
Fork Abstractions
(K & Domshlak, ICAPS08)



+ ensuring proper action cost partitioning

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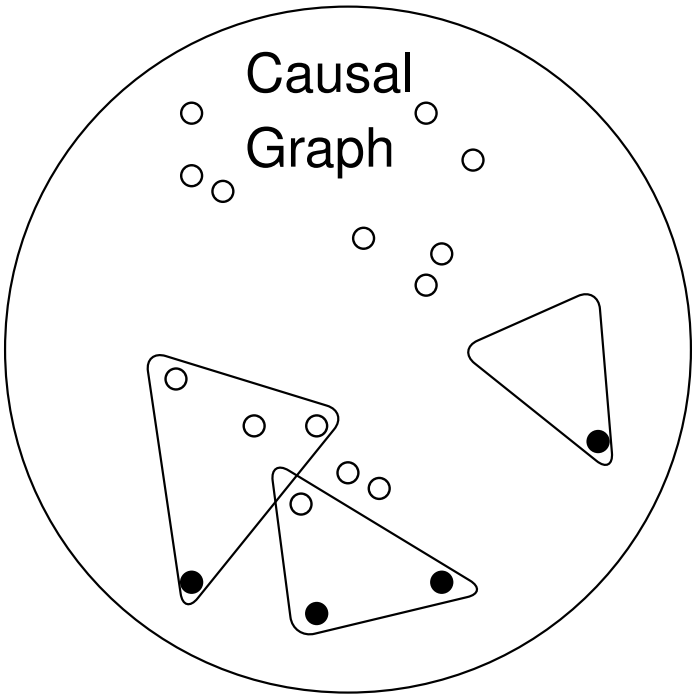
Goal Sensitivity



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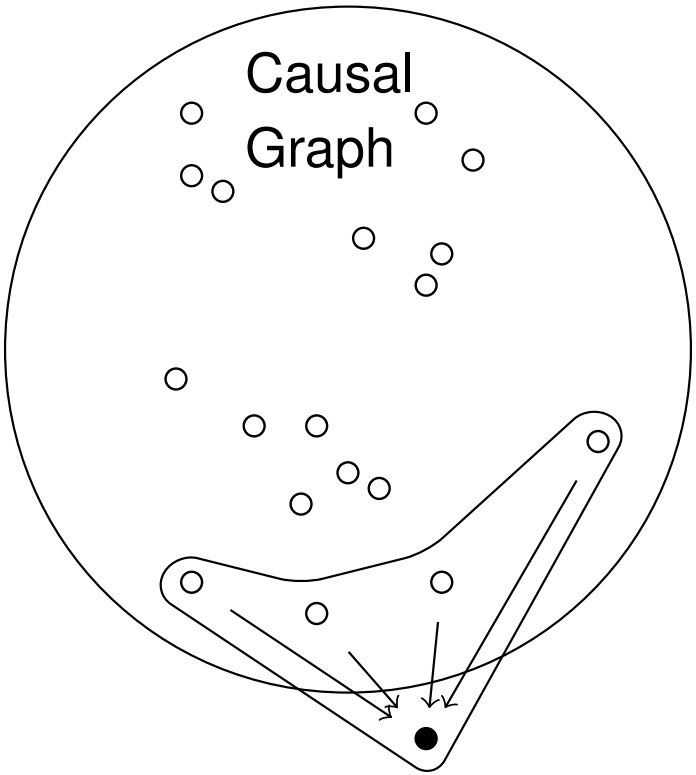

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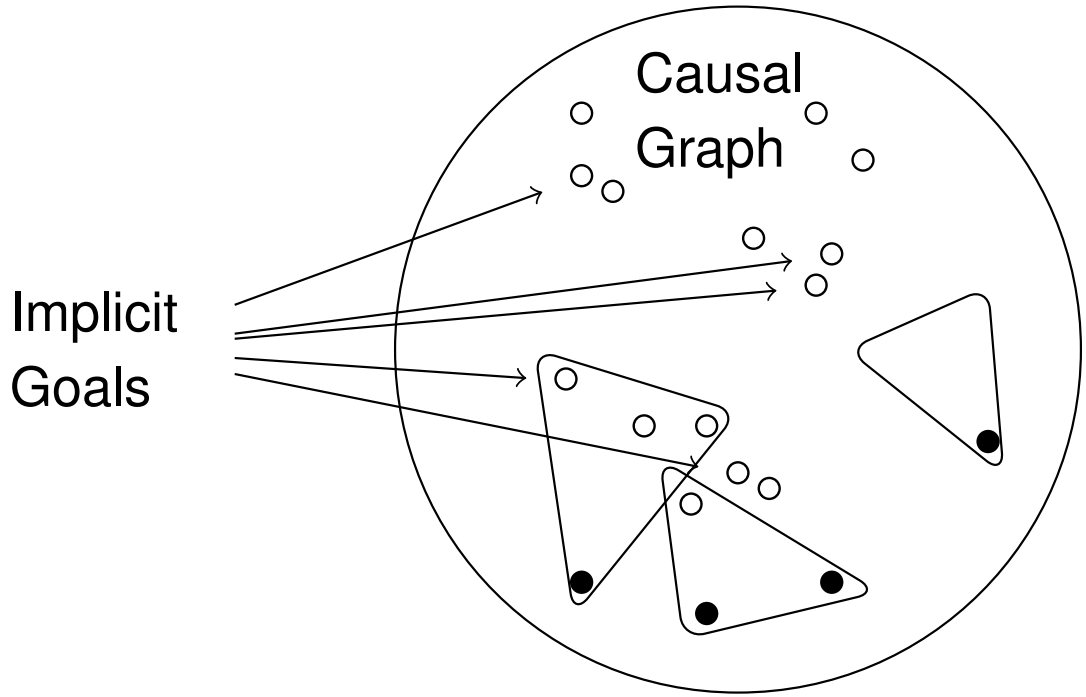

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Landmarks

Landmark = Implicit Goal

- A landmark is a fact that must be true at some point in every valid plan (Hoffmann, Porteous and Sebastia 2004)
- *Some* landmarks can be discovered automatically (Hoffmann, Porteous and Sebastia 2004, Richter, Helmert and Westphal 2008)

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Enriching Planning Task

Classical Planning Task

$\Pi = \langle V, A, \mathscr{C}, I, G \rangle$

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Landmarks Set

$L = \{l_1 \ldots l_k\}$

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$\searrow$ $\swarrow$

Landmark Enriched Task

$\Pi_L = \langle V_L, A_L, \mathscr{C}_L, I_L, G_L \rangle$

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Landmark Enriched Task

$\Pi_L = \langle V_L, A_L, \mathscr{C}_L, I_L, G_L \rangle$

1. Solve Π_L instead of solving Π

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Using Landmarks

- Given state s, the number of "to be achieved from s" landmarks $|L(s)|$ can be used as an (inadmissible) estimate (Richter et. al.)

  ♠ used by $LAMA$ - a state of the art satisficing planner, and winner of the IPC-2008 sequential satisficing track

  ♠ proper cost partitioning between landmarks $\Rightarrow$ admissible estimate (Karpas & Domshlak, IJCAI09)

- multi-path-dependent search LM-A* (Karpas & Domshlak, IJCAI09) maintains the "to be achieved from s" landmark sets $L(s)$ well

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Landmark Enriched Task

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1. Solve Π_L instead of solving Π
2. Solve Π while using Π_L for heuristic estimate
   - Run LM-A* on Π
   - Given state s of Π and "to be achieved from s" landmarks $L(s)$
     - map $(s, L(s))$ to the corresponding state s' of Π_L
     - compute $h^{\mathcal{F}}(s')$ [wrt Π_L]

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domain ($\mathscr{D}$)	$h^{\mathcal{F}}$	$h^{\mathcal{F}}$ on Π_L		*LM*-$h^{\mathcal{F}}$	
	s	s	$\%S$	s	$\%S$
airport-ipc4 (17)	20	18	0.76	17	0.64
blocks-ipc2 (17)	21	18	78.21	17	12.19
depots-ipc3 (4)	7	4	5.80	4	1.33
driverlog-ipc3 (10)	12	11	1.26	11	0.67
freecell-ipc3 (5)	5	5	0.28	5	0.29
grid-ipc1 (2)	2	2	0.52	2	0.10
gripper-ipc1 (5)	7	5	23.34	6	0.84
logistics-ipc1 (5)	6	6	1.19	5	0.61
logistics-ipc2 (20)	22	20	24.21	20	28.47
miconic-strips-ipc2 (48)	51	52	0.63	108	0.17
mprime-ipc1 (22)	23	22	12.21	23	4.46
mystery-ipc1 (20)	20	20	2.59	20	1.14
openstacks-ipc5 (7)	7	7	0.18	7	0.18
pathways-ipc5 (4)	4	4	1.00	4	1.00
pipesworld-notankage-ipc4 (15)	16	15	1.42	15	0.64
pipesworld-tankage-ipc4 (10)	10	10	1.57	10	0.67
psr-small-ipc4 (48)	49	49	1.01	48	0.99
rovers-ipc5 (5)	6	6	0.43	5	0.40
satellite-ipc4 (6)	6	7	0.35	7	0.17
tpp-ipc5 (5)	6	6	1.21	5	1.21
trucks-ipc5 (6)	6	7	0.30	7	0.14
zenotravel-ipc3 (9)	11	9	1.12	9	0.59
$s(p)$	317	303		355	

♠ $\%S$ denotes the average of ratios of expanded nodes.

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Conclusions

1. Additional information from landmarks integrated into planning task increases informativeness
2. Landmark enriched heuristics should use landmark enriched search procedures

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