Simplified Planner Selection

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Workshop on Heuristics and Search for Domain-independent Planning

October 21, 2020

Motivation

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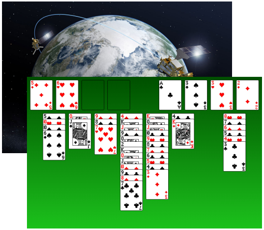

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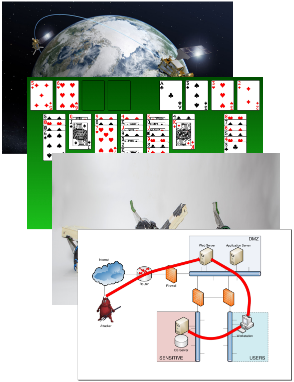

DMZ
Web Server
Application Server
Internet
Router
Firewall
Attacker
Workstation
DB Server
SENSITIVE
USERS

Motivation


DMZ
Web Server
Application Server
Internet
Router
Firewall

Motivation

SymBA*

Smarthouse ©LemnaTec GmbH

Motivation

SymBA*

Complementary1

Motivation

SymBA*

Complementary1

Symple-1

Smarthouse ©LemnaTec GmbH

Motivation

SymBA*

Complementary1

Symple-1

. . .

Motivation

?

SymBA*

Complementary1

Symple-1

...

Smarthouse ©LemnaTec GmbH

Portfolios

Given:

$P = \{\text{SymBA*}, \text{Complementary1}, \text{Symple-1}\}$
$T = 1800s$

Schedule:

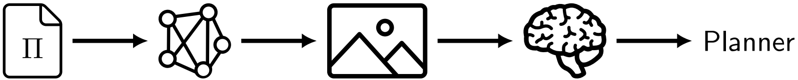
SymBA*	Complementary1	Symple-1

0s T

Mapping:

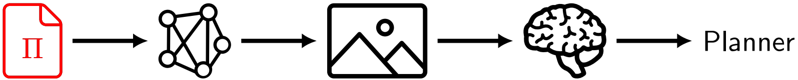
$f : Task \mapsto P$

Delfi (Katz et al., 2018)



Images from the Noun Project: RomStu (file), Agni (network),Alfa Design (image), Samuel Dion-Girardeau (brain)

Delfi (Katz et al., 2018)



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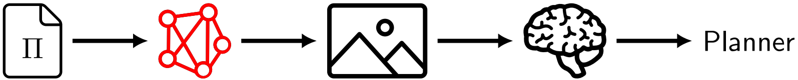

- Problem Description Graph (Pochter, Zohar, and Rosenschein, 2011)
- Abstract Structure Graph (Sievers et al., 2019)

Images from the Noun Project: RomStu (file), Agni (network),Alfa Design (image), Samuel Dion-Girardeau (brain)

Delfi (Katz et al., 2018)

- 128x128 pixels

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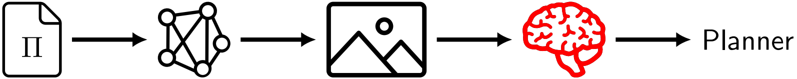
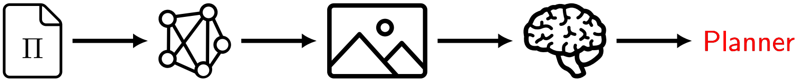


- Convolutional Neural Network (CNN)

Images from the Noun Project: RomStu (file), Agni (network),Alfa Design (image), Samuel Dion-Girardeau (brain)

Delfi (Katz et al., 2018)



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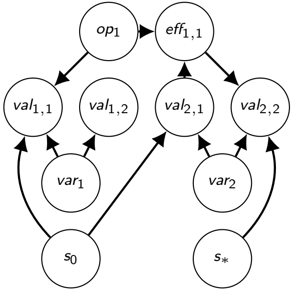
Contribution

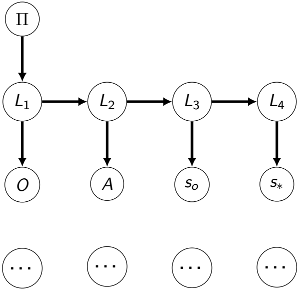
- **Simpler techniques** and **simple features** have a **similar performance**.
- Our approach is **robust** to data changes.
- We identify **important features**.
- We investigate which planners are selected

Graph Encodings

Problem Description Graph

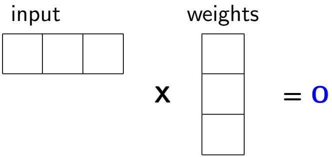


Abstract Structure Graph

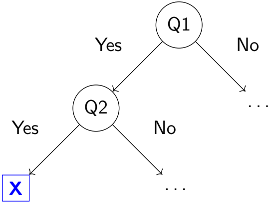


Machine Learning Techniques

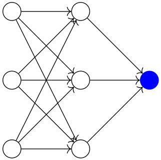
Linear Regression



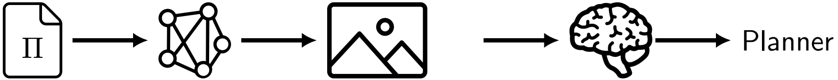
DecisionTree



Multi-Layer Perceptron



Training



- data set of Ferber et al. (2019)
  - tasks, graphs, runtimes
- extract properties
- labels: time, logtime, coverage
- 10 repetitions

Images from the Noun Project: RomStu (file), Agni (network),Alfa Design (image), Becris (Linear Regression),

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Training

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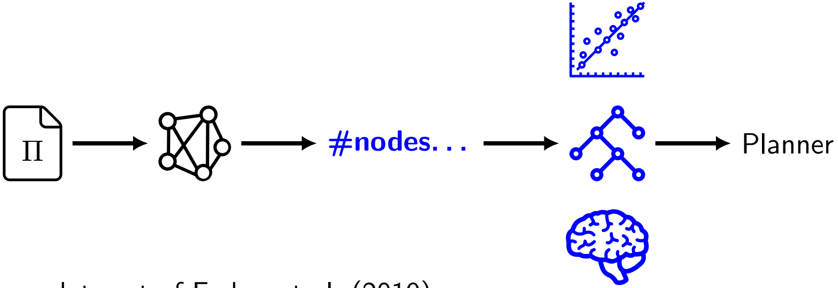

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Features

Graph:

- #nodes
- #edges
- density
- #connected components
- $max_{c \in \text{ConnComp}} |c|$

Node:

- eccentricity
- degree
- in-degree
- out-degree

Feature augmentations: log-scale, normalize

Delfi Setting

Grounded

	LR					RF	MLP		Delfi	
	0	0.1	1	2	5	50	3	5	CNN	GNN
Coverage	57.0	86.2	82.1	84.8	88.3	69.9	76.6	77.4	73.1	80.7
Log	62.8	67.6	**89.0**	80.7	81.4	66.6	64.8	64.2	–	–
Time	56.4	55.2	55.2	52.4	55.2	72.1	68.3	67.4	–	–

Lifted

	LR					RF	MLP		Delfi	
	0	0.1	1	2	5	50	3	5	CNN	GNN
Coverage	65.5	66.2	70.3	64.8	61.4	70.9	61.4	61.4	86.9	87.6
Log	58.6	69.7	69.7	69.7	70.3	73.7	65.2	64.8	–	–
Time	65.5	74.5	71.0	69.7	70.3	**79.6**	67.9	70.3	–	–

Delfi Setting

	Grounded				Delfi	
	LR	LR+L1	RF	MLP	CNN	GNN
Coverage	57.0	**85.4**	69.9	77.0	73.1	80.7
Log	62.8	**79.7**	66.6	64.5		
Time	56.4	54.5	**72.1**	67.9		

	Lifted				Delfi	
	LR	LR+L1	RF	MLP	CNN	GNN
Coverage	65.5	65.7	**70.9**	61.4	86.9	87.6
Log	58.6	69.9	**73.7**	65.0		
Time	65.5	71.4	**79.6**	69.1		

General Setting

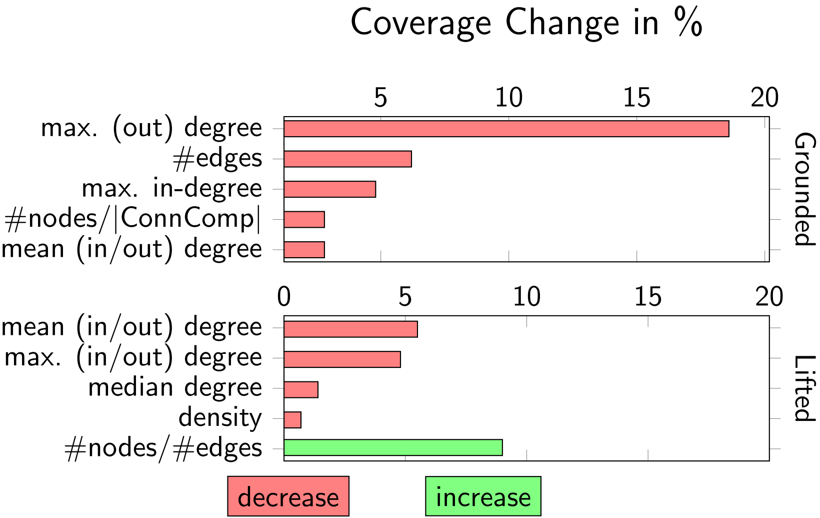
Grounded

	LR	LR+L1	RF	MLP
Binary	85.6	76.6	83.4	78.3
Log	86.7	81.1	83.4	84.3
Time	86.3	84.3	79.2	84.1

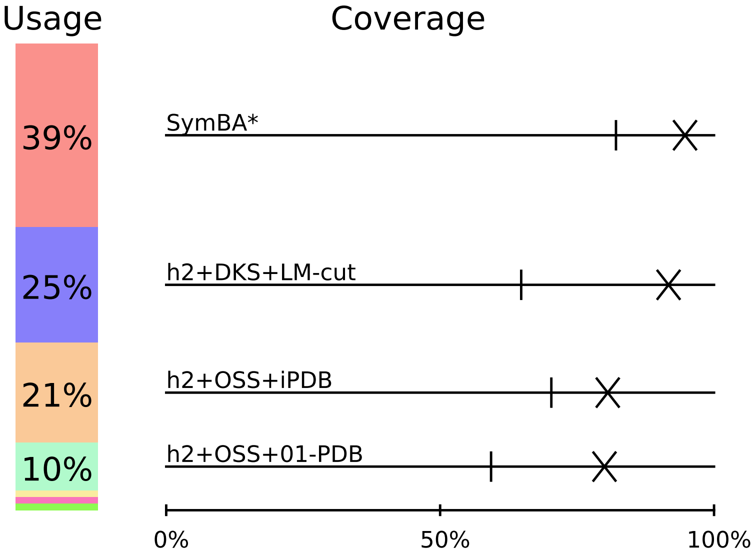
Lifted

	LR	LR+L1	RF	MLP
Binary	81.5	74.8	77.6	72.5
Log	81.0	80.3	75.9	82.2
Time	82.4	75.5	78.9	80.2

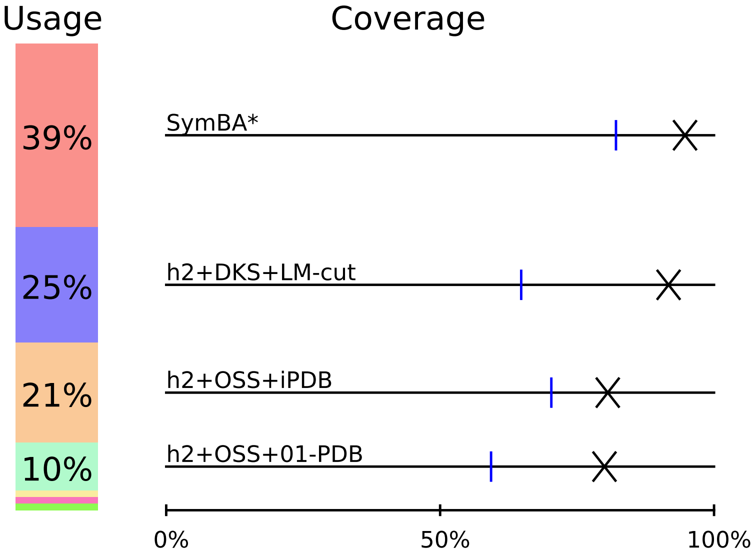
Feature Importance



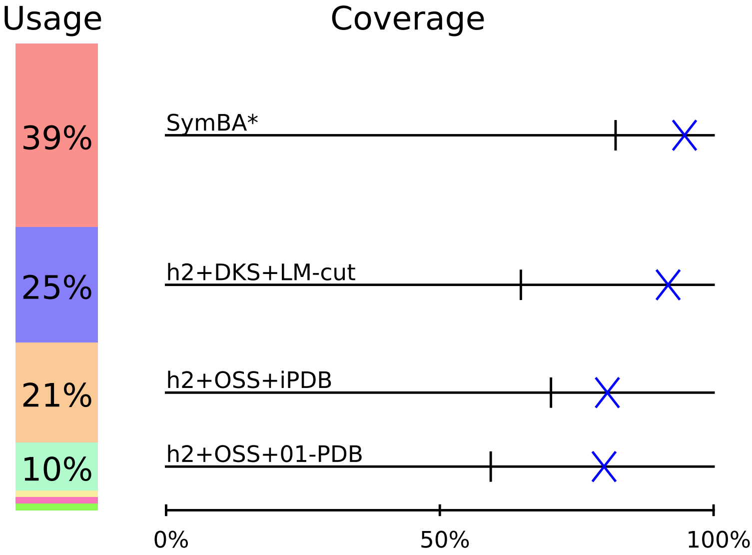
Planner Usage



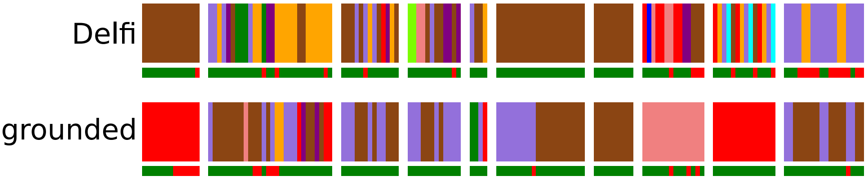
Planner Usage



Planner Usage



Planner Choices



Conclusion

Simple planner selection ...

- matches the state of the art!
- is robust!
- recognizes the strengths of individual planners!

In the future, we will ...

- use PDDL features.
- investigate why a planner is chosen.

References

Ferber, P.; Mai, T.; Huo, S.; Chen, J.; and Katz, M. 2019. IPC: A Benchmark Data Set for Learning with Graph- Structured Data. In *In Proceedings of the ICML-2019 Workshop on Learning and Reasoning with Graph-Structured Representations*.

Katz, M.; Sohrabi, S.; Samulowitz, H.; and Sievers, S. 2018. Delfi: Online Planner Selection for Cost-Optimal Planning. In *Ninth International Planning Competition (IPC-9): planner abstracts*, 57–64.

Pochter, N.; Zohar, A.; and Rosenschein, J. S. 2011. Exploiting Problem Symmetries in State-Based Planners. In Burgard, W.; and Roth, D., eds., *Proceedings of the Twenty-Fifth AAAI Conference on Artificial Intelligence (AAAI 2011)*, 1004–1009. AAAI Press.

Sievers, S.; Röger, G.; Wehrle, M.; and Katz, M. 2019. Theoretical Foundations for Structural Symmetries of Lifted PDDL Tasks. In Lipovetzky, N.; Onaindia, E.; and Smith, D. E., eds., *Proceedings of the Twenty-Ninth International Conference on Automated Planning and Scheduling (ICAPS 2019)*, 446–454. AAAI Press.