GOOSE: Learning Domain-Independent Heuristics

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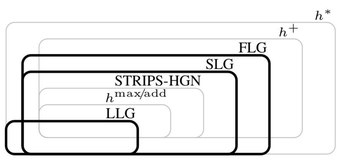
Background

see ***Graph Neural Networks and Graph Kernels For Learning Heuristics: Is there a difference?***

Contributions

- first graph representation of lifted planning tasks for learning domain-independent heuristics
- theoretical expressivity results for learning domain-independent heuristics
- large scale training of domain-independent heuristics on IPC dataset, consisting of 30000 states

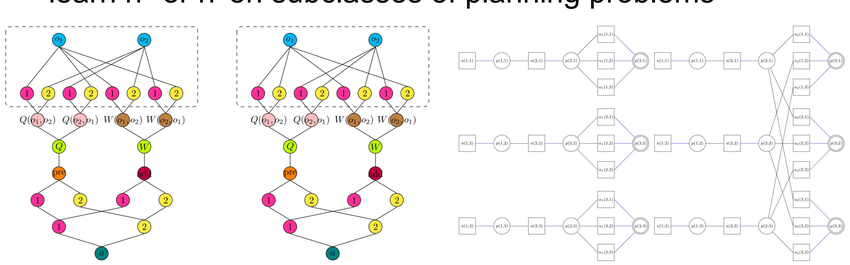
Theoretical Expressivity Results



GNNs

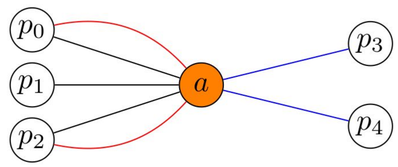
+ can learn h^{add}/h^{max} on grounded graphs [Thm. 4.1]
  - Pf: encode VI into GNNs + universal approximation theorem
- cannot learn h^{add}/h^{max} on lifted graphs [Thm. 4.3]
- cannot learn h^+ and h^* [Thm. 4.4]
- cannot learn an approximation of h^+ and h^* [Thm. 4.5]
  - Pf: counterexample tasks

- *note:* these are worst case scenarios; it is possible to learn h^+ or h^* on subclasses of planning problems

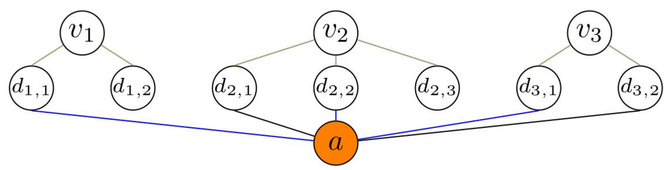


Domain-Independent Graphs for Planning Tasks

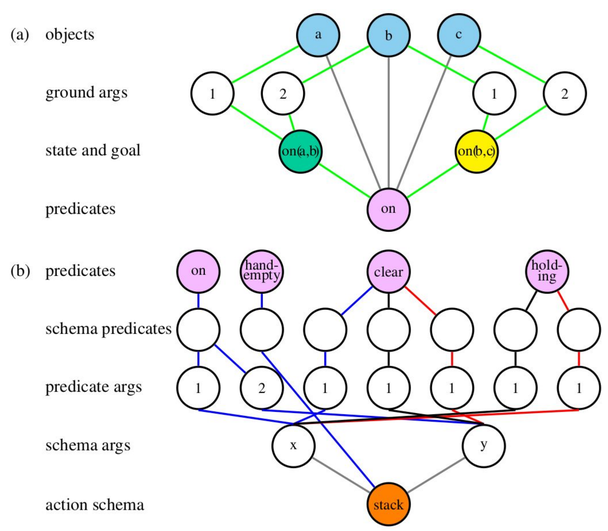
STRIPS Learning Graph (SLG)



FDR Learning Graph (FLG)



Lifted Learning Graph (LLG)



Grounded vs Lifted Graphs

Grounded graphs: SLG, FLG

+ more informative for domain-independent learning
- large and slow to construct and evaluate
- requires grounded representation of planning tasks

Lifted graphs: LLG

+ small and quick to evaluate
+ can be used with planners which do not ground
- less informative for domain-independent learning

Search Guidance Performance

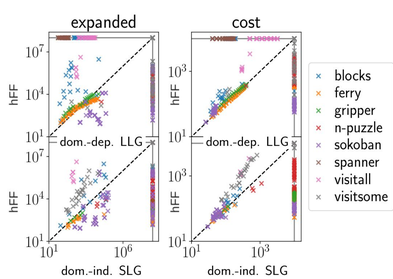
Training setting: given a planning domain *d*

- **domain-dependent (DD)**: train on small tasks from *d*
- **domain-independent (DI)**: train on tasks not from *d*

Testing setting:

- eager GBFS, GPUs w/ batch evaluation, 600s timeout
- 4 message passing layers, max aggregator

	baseline					domain-dep.			domain-ind.		
	blind	FD-h^{FF}	S-HGN	DLG-DD	DLG-DI	SLG	FLG	LLG	SLG	FLG	LLG
blocks (90)	-	19	-	15	6	10	11	**29**	14	14	16
ferry (90)	-	**90**	-	4	3	33	33	78	15	6	12
gripper (18)	1	**18**	-	3	6	5	9	**18**	4	5	9
n-puzzle (50)	-	**36**	-	4	1	10	10	1	3	3	-
sokoban (90)	74	**90**	-	12	37	52	56	34	48	42	39
spanner (90)	-	-	-	-	-	-	-	**55**	-	-	10
visitall (90)	-	6	-	41	15	**52**	35	39	**44**	24	38
visitsome (90)	3	26	-	73	25	**78**	23	3	37	14	-



- no graph planner best overall
  - LLG best for DD; SLG best for DI
- domain-independent heuristics somewhat informative
  - better than blind search (except Sokoban)