Learning Domain-Independent Heuristics over Hypergraphs

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Motivation and Overview

Existing approaches to learning heuristics:
- Use features derived from existing heuristics
- Learn domain-dependent heuristics
- Difficult to generalise across problems of different sizes

Our approach STRIPS-HGN:
- Learns heuristics completely from scratch
- Generalises across problems of different sizes
- Capable of learning domain-independent heuristics which generalise to domains they were not trained on

STRIPS-HGN approximates the shortest path over the hypergraph induced by the delete-relaxation.

Delete-Relaxation Hypergraph

A hypergraph is a generalisation of a normal graph in which a hyperedge may connect any number of vertices together. We consider the hypergraph induced by the delete-relaxed problem \( P' \):
- Delete-Relaxation: Ignore negative effects of all actions
- Propositions are vertices
- Actions are hyperedges
  - Connect preconditions with positive effects

Used implicitly by \( h^{\max} \) & \( h^{\text{add}} \)

STRIPS-HGN

STRIPS-HGN uses a recurrent encode-process-decode architecture.

Training and Experiments

- Training: train on optimal heuristic values obtained from the optimal solution of the original problem (i.e., \( h^* \))
  - Train on small problems, evaluate on larger problems
- Baselines: \( h^{\text{add}} \), \( h^{\max} \), Landmark-cut and the blind heuristic
  - Have access to the same information (i.e., hypergraph)
- Setting: A* search with 5 minute timeout

Domain-Dependent Heuristics

8-puzzle: 10 training problems, 50 testing problems

Multi-domain Heuristics

Train a single network on Blocksworld (10 problems with 4 to 5 blocks) + Zenotravel (10 small problems) + Gripper (3 problems with 1 to 3 balls)

Evaluate on Blocksworld: 100 test problems with 4 to 10 blocks

Domain-Independent Heuristics

Train a single network on Zenotravel (10 small problems) + Gripper (3 problems with 1 to 3 balls)

Evaluate on unseen Blocksworld: 50 test problems with 4 to 8 blocks