

RIP HW 1

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1 Problem 1

(a) Compare the Methods of the Two Planners:

Blackbox Planner

This planner operated by turning the given problem into a set of boolean satisfiability problems through two mechanisms. The front end is a graphplan technique where instead of state nodes and edges representing possible traversal, we have nodes of actions/facts and edges from facts \rightarrow actions or from actions \rightarrow facts affected by said action. Arranged in an alternating fashion: Facts, to possible actions, back to facts. It also uses backward chaining and iterative depth probing to keep from exploring too many extraneous nodes.

VHPOP Planner

VHPOP is a partial-order planner. This means it generates a lists of actions necessary to get to the goal, only constraining their order when absolutely necessary (One has preconditions, an earlier action must synthesize) Based off POCL it eliminates flaws in a partial plan until all preconditions for each action are satisfied. Its given list of features (From the VHPOP website) are as follows:

Can plan with either ground or lifted actions.

Can enforce joint parameter domain constraints when using lifted actions.

Has several different plan ranking heuristics to choose from that can be combined into complex plan ranking functions.

Efficiently implements all common flaw selection strategies, including LCFR and ZLIFO, and many novel ones, and allows flaw selection strategies to be specified using a concise notation.

Several flaw selection strategies can be used simultaneously.

Implements A*, IDA*, and hill climbing search.

(b) **Which Planner was Fastest:**

Both took very little time, as this is a relatively small problem in terms of search space, but the Blackbox planner was still undoubtedly faster at 12 milliseconds versus the 5160 milliseconds of the VHPOP planner.

(c) **Why Might this Planner be Faster?**

2 Problem 2

(a) **Solutions for Sokoban Problems:**

2.1

step 0: MOVE SOUTH BOT B4 B3

1: MOVE EAST BOT B3 C3

2: MOVE EAST BOT C3 D3

3: MOVE SOUTH BOT D3 D2

4: PUSH WEST BOT BLOCK1 D2 C2 B2

5: MOVE NORTH BOT C2 C3

6: MOVE WEST BOT C3 B3

7: MOVE WEST BOT B3 A3

8: MOVE SOUTH BOT A3 A2

9: MOVE SOUTH BOT A2 A1

10: MOVE EAST BOT A1 B1

11: PUSH NORTH BOT BLOCK1 B1 B2 B3

12: PUSH NORTH BOT BLOCK1 B2 B3 B4

13: PUSH NORTH BOT BLOCK1 B3 B4 B5

2.2

step 0: MOVE NORTH BOT A5 A6

1: MOVE EAST BOT A6 B6

2: MOVE EAST BOT B6 C6

3: PUSH SOUTH BOT BLOCKB C6 C5 C4

4: MOVE NORTH BOT C5 C6

5: MOVE WEST BOT C6 B6

6: MOVE WEST BOT B6 A6

7: MOVE SOUTH BOT A6 A5

8: PUSH EAST BOT BLOCKA A5 B5 C5

9: MOVE SOUTH BOT B5 B4

10: PUSH EAST BOT BLOCKB B4 C4 D4

11: MOVE WEST BOT C4 B4

12: MOVE NORTH BOT B4 B5

13: MOVE NORTH BOT B5 B6
 14: MOVE EAST BOT B6 C6
 15: PUSH SOUTH BOT BLOCKA C6 C5 C4
 16: MOVE EAST BOT C5 D5
 17: PUSH SOUTH BOT BLOCKB D5 D4 D3
 18: PUSH SOUTH BOT BLOCKB D4 D3 D2
 19: PUSH SOUTH BOT BLOCKB D3 D2 D1
 20: MOVE NORTH BOT D2 D3
 21: MOVE WEST BOT D3 C3
 22: PUSH NORTH BOT BLOCKA C3 C4 C5
 23: MOVE EAST BOT C4 D4
 24: MOVE NORTH BOT D4 D5
 25: PUSH WEST BOT BLOCKA D5 C5 B5
 26: MOVE SOUTH BOT C5 C4
 27: MOVE WEST BOT C4 B4
 28: PUSH NORTH BOT BLOCKA B4 B5 B6
 29: MOVE EAST BOT B5 C5
 30: MOVE NORTH BOT C5 C6
 31: PUSH WEST BOT BLOCKA C6 B6 A6

2.3

step 0: MOVE EAST BOT B3 C3

1: MOVE SOUTH BOT C3 C2
 2: MOVE SOUTH BOT C2 C1
 3: MOVE EAST BOT C1 D1
 4: MOVE EAST BOT D1 E1
 5: MOVE NORTH BOT E1 E2
 6: MOVE NORTH BOT E2 E3
 7: PUSH WEST BOT BLOCK3 E3 D3 C3
 8: PUSH WEST BOT BLOCK3 D3 C3 B3
 9: MOVE EAST BOT C3 D3
 10: MOVE EAST BOT D3 E3
 11: MOVE SOUTH BOT E3 E2
 12: MOVE SOUTH BOT E2 E1
 13: MOVE EAST BOT E1 F1
 14: MOVE EAST BOT F1 G1
 15: MOVE NORTH BOT G1 G2
 16: MOVE NORTH BOT G2 G3
 17: MOVE NORTH BOT G3 G4
 18: MOVE NORTH BOT G4 G5
 19: MOVE NORTH BOT G5 G6
 20: MOVE EAST BOT G6 H6
 21: MOVE EAST BOT H6 I6
 22: MOVE SOUTH BOT I6 I5
 23: MOVE SOUTH BOT I5 I4

24: MOVE SOUTH BOT I4 I3
25: PUSH WEST BOT BLOCK1 I3 H3 G3
26: MOVE EAST BOT H3 I3
27: MOVE NORTH BOT I3 I4
28: MOVE NORTH BOT I4 I5
29: MOVE NORTH BOT I5 I6
30: MOVE WEST BOT I6 H6
31: MOVE WEST BOT H6 G6
32: MOVE SOUTH BOT G6 G5
33: MOVE SOUTH BOT G5 G4
34: PUSH SOUTH BOT BLOCK1 G4 G3 G2
35: PUSH WEST BOT BLOCK2 G3 F3 E3
36: PUSH WEST BOT BLOCK2 F3 E3 D3
37: MOVE SOUTH BOT E3 E2
38: MOVE SOUTH BOT E2 E1
39: MOVE EAST BOT E1 F1
40: MOVE EAST BOT F1 G1
41: PUSH NORTH BOT BLOCK1 G1 G2 G3
42: PUSH NORTH BOT BLOCK1 G2 G3 G4
43: PUSH NORTH BOT BLOCK1 G3 G4 G5
44: PUSH NORTH BOT BLOCK1 G4 G5 G6
45: MOVE SOUTH BOT G5 G4
46: MOVE SOUTH BOT G4 G3
47: MOVE WEST BOT G3 F3
48: MOVE WEST BOT F3 E3
49: MOVE SOUTH BOT E3 E2
50: MOVE SOUTH BOT E2 E1
51: MOVE WEST BOT E1 D1
52: MOVE WEST BOT D1 C1
53: MOVE NORTH BOT C1 C2
54: MOVE NORTH BOT C2 C3
55: PUSH EAST BOT BLOCK2 C3 D3 E3
56: PUSH EAST BOT BLOCK2 D3 E3 F3
57: PUSH EAST BOT BLOCK2 E3 F3 G3
58: MOVE WEST BOT F3 E3
59: MOVE SOUTH BOT E3 E2
60: MOVE SOUTH BOT E2 E1
61: MOVE EAST BOT E1 F1
62: MOVE EAST BOT F1 G1
63: MOVE NORTH BOT G1 G2
64: PUSH NORTH BOT BLOCK2 G2 G3 G4
65: PUSH NORTH BOT BLOCK2 G3 G4 G5
66: MOVE SOUTH BOT G4 G3
67: MOVE WEST BOT G3 F3
68: MOVE WEST BOT F3 E3
69: MOVE WEST BOT E3 D3

70: MOVE WEST BOT D3 C3
71: MOVE SOUTH BOT C3 C2
72: MOVE SOUTH BOT C2 C1
73: MOVE WEST BOT C1 B1
74: MOVE WEST BOT B1 A1
75: MOVE NORTH BOT A1 A2
76: MOVE NORTH BOT A2 A3
77: PUSH EAST BOT BLOCK3 A3 B3 C3
78: PUSH EAST BOT BLOCK3 B3 C3 D3
79: PUSH EAST BOT BLOCK3 C3 D3 E3
80: PUSH EAST BOT BLOCK3 D3 E3 F3
81: PUSH EAST BOT BLOCK3 E3 F3 G3
82: MOVE WEST BOT F3 E3
83: MOVE SOUTH BOT E3 E2
84: MOVE SOUTH BOT E2 E1
85: MOVE EAST BOT E1 F1
86: MOVE EAST BOT F1 G1
87: MOVE NORTH BOT G1 G2
88: PUSH NORTH BOT BLOCK3 G2 G3 G4

- (b) **Compare two Planners:**
- (c) **Challenges of Expressing in PDDL:**
- (d) **Describe a Problem to be used in Semantic Planing:**

3 Problem 3

- (a) **Solutions for Sokoban Problems:**
- (b) **Compare our Planner vs Previous Planners:**
- (c) **Proof of our Planner's Completeness:**
- (d) **How did we Speed up our Planner?:**

4 Problem 4

- (a) **Solutions for Large Hanoi Problems:**
- (b) **Notes on the Structure of the Plan:**
- (c) **General Planning Strategy using Problem Structure:**

5 Problem 5

- (a) **HTN Planning Problem for Hanoi:**
- (b) **Describe Encoded Domain Knowledge:**
- (c) **Solve HTN for 3 12 discs:**
- (d) **Compare with non HTN Planner:**
- (e) **Observations:**