

Inf 2D Coursework 2

Planning in PDDL

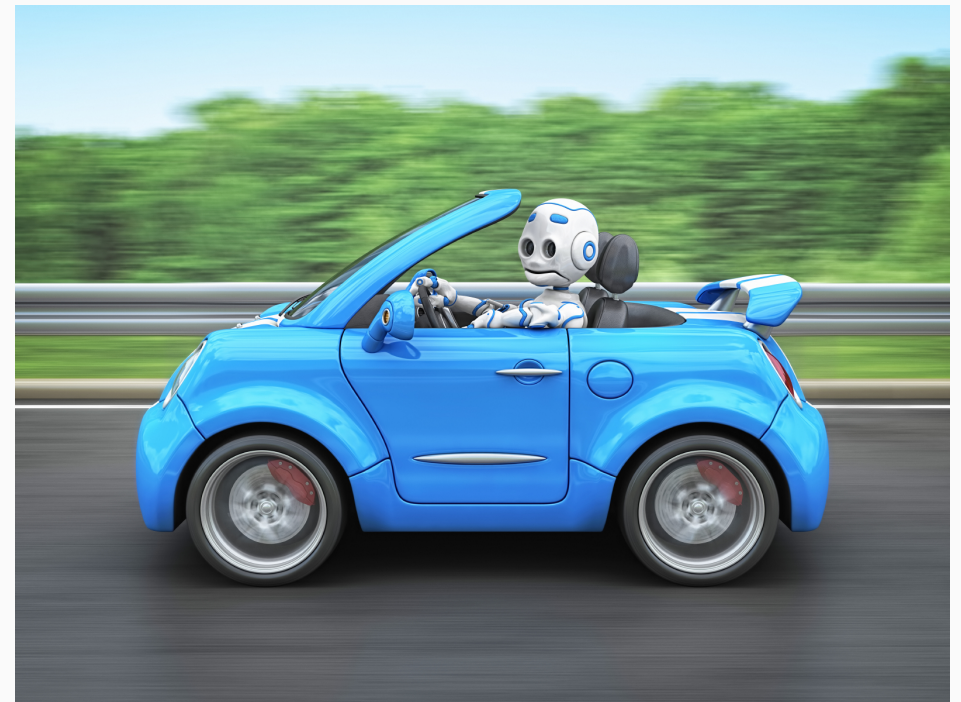
- Deadline : 3pm Thursday 26th March 2020
- Drop-in Labs : Fridays 12 noon - 2pm Appleton Tower 6.06

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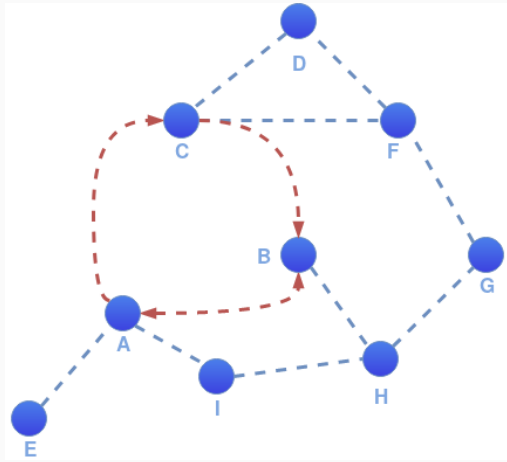
Coursework Goals

- Formalize a reasonably sized planning problem
- Balance trade-offs in model design
- Actually implement and debug some PDDL

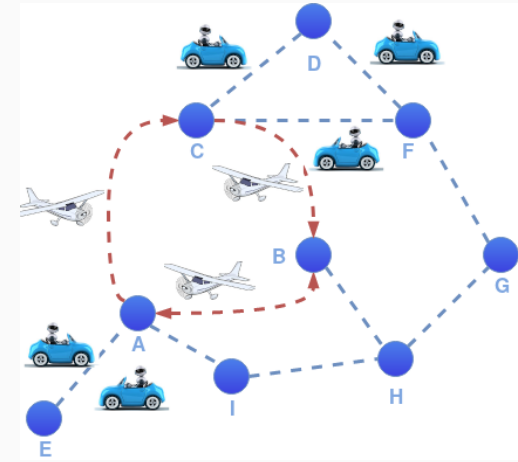


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Assignment Outline

- Part 1a - Formalize problem in PDDL
- Part 1b - Backward State Space Search
- Parts 2 and 3 - Implement and extend model in PDDL for FF planner
- Part 4 - Theoretical extension

Action(Move(block, from, to)) :

PRECOND : On(b, from) ∧ Clear(block) ∧ Clear(to) ∧

Block(block) ∧ Block(to) ∧

(block ≠ from) ∧ (block ≠ to) ∧ (from ≠ to)

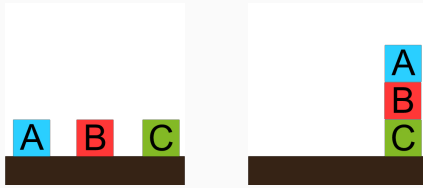
EFFECT : On(block, to) ∧ ¬On(block, from) ∧

Clear(from) ∧ ¬Clear(to)

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- $g_1 = On(A, B) \wedge On(B, C)$

**Initial**

$On(A, Table) \wedge On(B, Table) \wedge On(C, Table) \wedge Block(A) \wedge$
 $Block(B) \wedge Block(C) \wedge Clear(A) \wedge Clear(B) \wedge Clear(C)$

Goal

$On(A, B) \wedge On(B, C)$

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- $g_1 = On(A, B) \wedge On(B, C)$
- Available Actions: $Move(A, x, B), Move(B, x, C)$

- $g_1 = On(A, B) \wedge On(B, C)$
- Available Actions: $Move(A, x, B), Move(B, x, C)$
- Choose : $Move(A, x, B)$

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- $g_1 = On(A, B) \wedge On(B, C)$
- Available Actions: $Move(A, x, B), Move(B, x, C)$
- Choose : $Move(A, x, B)$
- $g_2 = On(A, x) \wedge Clear(A) \wedge Clear(B) \wedge Block(A) \wedge Block(B) \wedge A \neq x \wedge A \neq B \wedge x \neq B \wedge On(B, C)$

- $g_1 = On(A, B) \wedge On(B, C)$
- Available Actions: $Move(A, x, B), Move(B, x, C)$
- Choose : $Move(A, x, B)$
- $g_2 = On(A, x) \wedge Clear(A) \wedge Clear(B) \wedge Block(A) \wedge Block(B) \wedge A \neq x \wedge A \neq B \wedge x \neq B \wedge On(B, C)$
- Available actions :
 $Move(B, x', C), Move(x', B, y), Move(x', A, y), Move(A, x', x)$

- $g_1 = On(A, B) \wedge On(B, C)$
- Available Actions: $Move(A, x, B), Move(B, x, C)$
- Choose : $Move(A, x, B)$
- $g_2 = On(A, x) \wedge Clear(A) \wedge Clear(B) \wedge Block(A) \wedge Block(B) \wedge A \neq x \wedge A \neq B \wedge x \neq B \wedge On(B, C)$
- Available actions :
 $Move(B, x', C), Move(x', B, y), Move(x', A, y), Move(A, x', x)$
- Choose : $Move(B, x', C)$

- $g_1 = On(A, B) \wedge On(B, C)$
- Available Actions: $Move(A, x, B), Move(B, x, C)$
- Choose : $Move(A, x, B)$
- $g_2 = On(A, x) \wedge Clear(A) \wedge Clear(B) \wedge Block(A) \wedge Block(B) \wedge A \neq x \wedge A \neq B \wedge x \neq B \wedge On(B, C)$
- Available actions :
 $Move(B, x', C), Move(x', B, y), Move(x', A, y), Move(A, x', x)$
- Choose : $Move(B, x', C)$
- $g_3 = On(A, x) \wedge Clear(A) \wedge Clear(B) \wedge Block(A) \wedge Block(B) \wedge A \neq x \wedge A \neq B \wedge x \neq B \wedge On(B, x') \wedge Clear(B) \wedge Clear(C) \wedge Block(C) \wedge B \neq x' \wedge B \neq C \wedge x' \neq C$

- $g_1 = On(A, B) \wedge On(B, C)$
- Available Actions: $Move(A, x, B), Move(B, x, C)$
- Choose : $Move(A, x, B)$
- $g_2 = On(A, x) \wedge Clear(A) \wedge Clear(B) \wedge Block(A) \wedge Block(B) \wedge A \neq x \wedge A \neq B \wedge x \neq B \wedge On(B, C)$
- Available actions :
 $Move(B, x', C), Move(x', B, y), Move(x', A, y), Move(A, x', x)$
- Choose : $Move(B, x', C)$
- $g_3 = On(A, x) \wedge Clear(A) \wedge Clear(B) \wedge Block(A) \wedge Block(B) \wedge A \neq x \wedge A \neq B \wedge x \neq B \wedge On(B, x') \wedge Clear(B) \wedge Clear(C) \wedge Block(C) \wedge B \neq x' \wedge B \neq C \wedge x' \neq C$
- g_3 satisfies initial state by substituting
 $\{x = Table, x' = Table\}$

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MetricFF planner

- $g_1 = On(A, B) \wedge On(B, C)$
- Available Actions: $Move(A, x, B), Move(B, x, C)$
- Choose : $Move(A, x, B)$
- $g_2 = On(A, x) \wedge Clear(A) \wedge Clear(B) \wedge Block(A) \wedge Block(B) \wedge A \neq x \wedge A \neq B \wedge x \neq B \wedge On(B, C)$
- Available actions :
 $Move(B, x', C), Move(x', B, y), Move(x', A, y), Move(A, x', x)$
- Choose : $Move(B, x', C)$
- $g_3 = On(A, x) \wedge Clear(A) \wedge Clear(B) \wedge Block(A) \wedge Block(B) \wedge A \neq x \wedge A \neq B \wedge x \neq B \wedge On(B, x') \wedge Clear(B) \wedge Clear(C) \wedge Block(C) \wedge B \neq x' \wedge B \neq C \wedge x' \neq C$
- g_3 satisfies initial state by substituting
 $\{x = Table, x' = Table\}$
- Done! Final Plan: $Move(B, Table, C), Move(A, Table, B)$

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```
mappelgren@mappelgren-HP-EliteDesk-800-G2-SFF: ~/Documents/teaching/teaching/inf2d/inf2d_assignment_2019-20/inf2d-coursework2
mappelgren@mappelgren-HP-EliteDesk-800-G2-SFF:~/Documents/teaching/teaching/inf2d/inf2d_assignment_2019-20/inf2d-coursework2$ chmod u+x ff
mappelgren@mappelgren-HP-EliteDesk-800-G2-SFF:~/Documents/teaching/teaching/inf2d/inf2d_assignment_2019-20/inf2d-coursework2$ ls -l
total 1788
-rw-r--r-- 1 mappelgren mappelgren  0 Dec 2 15:09 answer.txt
-rw-r--r-- 1 mappelgren mappelgren 781 Dec 10 2018 blocks-world-domain.pddl
-rw-r--r-- 1 mappelgren mappelgren 334 Dec 10 2018 blocks-world-problem.pddl
-rw-r--r-- 1 mappelgren mappelgren 618 Dec 2 15:03 domain_example.pddl
-rwxr-xr-x 1 mappelgren mappelgren 1810256 Dec 2 15:09 ff
-rw-r--r-- 1 mappelgren mappelgren 225 Dec 2 15:08 problem-example.pddl
-rw-r--r-- 1 mappelgren mappelgren 627 Dec 2 15:22 README
mappelgren@mappelgren-HP-EliteDesk-800-G2-SFF:~/Documents/teaching/teaching/inf2d/inf2d_assignment_2019-20/inf2d-coursework2$
```

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```

PDDL Editor  File  Session  Import  Solve  Plugins  Help  planning.domains

blocks-world-
domain.pddl
1 (define (domain blocks-world)
2   (:requirements :adl)
3
4   (:types table block)
5
6- (:predicates
7   (On ?x - block ?y - object)
8   (Clear ?b - object)
9
10  )
11  (:constants Table - table)
12
13- (:action MOVE
14   :parameters (?b -block ?x - object ?y - block)
15   :precondition (and (On ?b ?x) (Clear ?b) (Clear ?y) (not (= ?b ?x)) (not (= ?b ?y)) (not (= ?x ?y)))
16   :effect (and (On ?b ?y) (Clear ?x) (not (On ?b ?x)) (not (Clear ?y)))
17
18  )
19- (:action MOVE-TO-TABLE
20   :parameters (?b - block ?x - block)
21   :precondition (and (On ?b ?x) (Clear ?b) (not (= ?b ?x)))
22   :effect (and (On ?b Table) (Clear ?x) (not (On ?b ?x)))
23
24  )

```

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```

PDDL Editor  File  Session  Import  Solve  Plugins  Help  planning.domains

blocks-world-
domain.pddl
1 (define (problem block-problem)
2   (:domain blocks-world)
3-  (:objects
4   A - block
5   B - block
6   C - block
7  )
8
9-  (:init
10   (On A Table)
11   (On B Table)
12   (On C Table)
13   (Clear A)
14   (Clear B)
15   (Clear C)
16  )
17-  (:goal (and
18   (On A B)
19   (On B C)
20  ))
21 )

```

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```

mappelgren@mappelgren-HP-ElliteDesk-800-G2-SFF: ~/Documents/teaching/teaching/inf2d/inf2d_assignment_2019-20/inf2d-coursework2
File Edit View Search Terminal Help
mappelgren@mappelgren-HP-ElliteDesk-800-G2-SFF:~/Documents/teaching/teaching/inf2d/inf2d_assignment_2019-20$ cd inf2d-coursework2/
mappelgren@mappelgren-HP-ElliteDesk-800-G2-SFF:~/Documents/teaching/teaching/inf2d/inf2d_assignment_2019-20/inf2d-coursework2$ ls
answer.txt blocks-world-domain.pddl blocks-world-problem.pddl domain example.pddl ff problem-example.pddl README
mappelgren@mappelgren-HP-ElliteDesk-800-G2-SFF:~/Documents/teaching/teaching/inf2d/inf2d_assignment_2019-20/inf2d-coursework2$ ./ff
-o blocks-world-domain.pddl -f blocks-world-problem.pddl

ff: parsing domain file
domain 'BLOCKS-WORLD' defined
... done.
ff: parsing problem file
problem 'BLOCK-PROBLEM' defined
... done.

no metric specified. plan length assumed.
checking for cyclic := effects --- OK.
ff: search configuration is EHC, if that fails then best-first on 1*g(s) + 5*h(s) where
metric is plan length
Cueing down from goal distance:  2 into depth [1]
                                1      [1]
                                0
ff: found legal plan as follows
step  0: MOVE B TABLE C
      1: MOVE A TABLE B

time spent:  0.00 seconds instantiating 18 easy, 0 hard action templates
            0.00 seconds reachability analysis, yielding 13 facts and 18 actions
            0.00 seconds creating final representation with 13 relevant facts, 0 relevant fluents
            0.00 seconds computing LNF
            0.00 seconds building connectivity graph
            0.00 seconds searching, evaluating 4 states, to a max depth of 1
            0.00 seconds total time

```

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```

(:action MOVE
:parameters (
  ?b - block
  ?x - object
  ?y - block
)
:precondition (and
  (On ?b ?x)
  (Clear ?b)
  (Clear ?y)
  (not (= ?b ?x))
  (not (= ?b ?y))
  (not (= ?x ?y))
)
:effect (and
  (On ?b ?y)
  (Clear ?x)
  (not (On ?b ?x))
  (not (Clear ?y))
))

Action(Move(b, x, y)) :
PRECOND : On(b, x) ∧
          Clear(b) ∧ Clear(y) ∧
          Block(b) ∧ Block(y) ∧
          (b ≠ x) ∧ (b ≠ y) ∧ (x ≠ y)
EFFECT : On(b, y) ∧ Clear(x) ∧
        ¬On(b, x) ∧ ¬Clear(y)

```

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```
Inf2d-ass2-s1202144/  
  answers.txt  
  domain-solution2.pddl  
  problem-solution21.pddl  
  problem-solution22.pddl  
  problem-solution23.pddl  
  domain-solution31.pddl  
  problem-solution31.pddl  
  ...
```

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Compress

```
tar cvzf Inf2d-ass2-s1202144.tar.gz Inf2d-ass2-s1202144
```

Submit via LEARN

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Questions?

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