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Hw#5

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1. Define this planning domain in Blackbox.

2. Test your domain on a simple problem that requires moving a package from one location to another. Make sure that the package is not in two cities at the same time.

3. Turn in a print out of your domain, initial state, goal state, and trace of a successful run.

```
;domain.pddl

(define (domain trucks)
  (:requirements :strips)
  (:predicates
    (package ?obj)
    (truck ?truck)
    (location ?loc)
    (in-state ?obj ?state)
    (state ?state)
    (at ?obj ?loc)
    (in ?obj ?obj)
    (truckEmpty)
  )

  (:action load-truck
    :parameters (?obj ?truck ?loc)
    :precondition
    (and
      (package ?obj)
      (truck ?truck)
      (location ?loc)
      (at ?truck ?loc)
      (at ?obj ?loc)
      (truckEmpty)
    )
    :effect
    (and
      (not (at ?obj ?loc)) (in ?obj ?truck) (not (truckEmpty))
    )
  )

  (:action unload-truck
    :parameters (?obj ?truck ?loc)
    :precondition
    (and
      (package ?obj)
      (truck ?truck)
```

```

        (location ?loc)
        (at ?truck ?loc)
        (in ?obj ?truck)
        (not (truckEmpty))
    )
    :effect
    (and
        (not (in ?obj ?truck)) (at ?obj ?loc) (truckEmpty)
    )
)

(:action drive-truck
 :parameters (?truck ?loc-from ?loc-to ?state)
 :precondition
 (and
     (truck ?truck)
     (location ?loc-from)
     (location ?loc-to)
     (state ?state)
     (at ?truck ?loc-from)
     (in-state ?loc-from ?state)
     (in-state ?loc-to ?state)
 )
 :effect
 (and
     (not (at ?truck ?loc-from)) (at ?truck ?loc-to)
 )
)
)

```

```

;problem.pddl

```

```

(define (problem trucks)
  (:domain trucks)
  (:objects
    package1

    MD-truck1

    Maryland

    Baltimore
    Frederick

  )

  (:init
    (truckEmpty)

    (package package1)

    (truck MD-truck1)

    (state Maryland)

    (location Baltimore)
    (location Frederick)

    (in-state Baltimore Maryland)
    (in-state Frederick Maryland)

    (at package1 Baltimore)

    (at MD-truck1 Frederick)

  )

  (:goal
    (and
      (at package1 Frederick)
    )
  )
)

```

```
)
)
)
```

Output

```
z@z:~/Desktop/aa/Examples/logistics-strips$ ../../blackbox -o a.pddl -f b.pddl -solver
chaff
blackbox version 43
command line: ../../blackbox -o a.pddl -f b.pddl -solver chaff

Begin solver specification
    -maxint      0    -maxsec 0.000000  chaff
End solver specification
Loading domain file: a.pddl
Loading fact file: b.pddl
Problem name: trucks
Facts loaded.
time: 1, 11 facts and 1 exclusive pairs.
time: 2, 13 facts and 7 exclusive pairs.
time: 3, 13 facts and 5 exclusive pairs.
time: 4, 14 facts and 9 exclusive pairs.
Goals first reachable in 4 steps.
122 nodes created.

#####
goals at time 5:
    at_package1_frederick

-----
** Turning off completeness check **
Converting graph to wff
number of action variables = 34
number of fluent variables = 41
total number variables = 75
number clauses = 134
Result is Sat
Iteration was 0
Performing plan justification:
    0 actions were pruned in 0.00 seconds

-----

Begin plan
1 (drive-truck md-truck1 frederick baltimore maryland)
2 (load-truck package1 md-truck1 baltimore)
3 (drive-truck md-truck1 baltimore frederick maryland)
4 (unload-truck package1 md-truck1 frederick)
End plan
-----

4 total actions in plan
0 entries in hash table,
3 total set-creation steps (entries + hits + plan length - 1)
0 actions tried

#####
Total elapsed time:  0.00 seconds
Time in milliseconds: 1

#####
```

4. Test your domain on problems that require moving 1, 5 and 10 packages from one location to another. Use the statistics reported by

Blackbox to see how long the planner takes for each of these problems. What if you also increase the number of cities?

Output with 1 package with 2 locations (cities) and 1 truck

```
z@z:~/Desktop/aa/Examples/logistics-strips$ ../../blackbox -o a.pddl -f b.pddl -solver
chaff
blackbox version 43
command line: ../../blackbox -o a.pddl -f b.pddl -solver chaff

Begin solver specification
  -maxint      0      -maxsec 0.000000  chaff
End solver specification
Loading domain file: a.pddl
Loading fact file: b.pddl
Problem name: trucks
Facts loaded.
time: 1, 11 facts and 1 exclusive pairs.
time: 2, 13 facts and 7 exclusive pairs.
time: 3, 13 facts and 5 exclusive pairs.
time: 4, 14 facts and 9 exclusive pairs.
Goals first reachable in 4 steps.
122 nodes created.

#####
goals at time 5:
  at_package1_frederick

-----
** Turning off completeness check **
Converting graph to wff
number of action variables = 34
number of fluent variables = 41
total number variables = 75
number clauses = 134
Result is Sat
Iteration was 0
Performing plan justification:
  0 actions were pruned in 0.00 seconds

-----
Begin plan
1 (drive-truck md-truck1 frederick baltimore maryland)
2 (load-truck package1 md-truck1 baltimore)
3 (drive-truck md-truck1 baltimore frederick maryland)
4 (unload-truck package1 md-truck1 frederick)
End plan
-----

4 total actions in plan
0 entries in hash table,
3 total set-creation steps (entries + hits + plan length - 1)
0 actions tried

#####
Total elapsed time:  0.00 seconds
Time in milliseconds: 1

#####
```

Output with 1 package with 5 locations (cities) and 1 truck

```
z@z:~/Desktop/aa/Examples/logistics-strips$ ../../blackbox -o a.pddl -f b.pddl -solver
chaff
```

```
blackbox version 43
command line: ../../blackbox -o a.pddl -f b.pddl -solver chaff
```

```
Begin solver specification
  -maxint      0      -maxsec 0.000000  chaff
End solver specification
Loading domain file: a.pddl
Loading fact file: b.pddl
Problem name: trucks
Facts loaded.
time: 1, 20 facts and 10 exclusive pairs.
time: 2, 22 facts and 22 exclusive pairs.
time: 3, 22 facts and 14 exclusive pairs.
time: 4, 26 facts and 48 exclusive pairs.
Goals first reachable in 4 steps.
263 nodes created.
```

```
#####
goals at time 5:
  at_package1_frederick
```

```
-----
** Turning off completeness check **
Converting graph to wff
number of action variables = 73
number of fluent variables = 65
total number variables = 138
number clauses = 683
Result is Sat
Iteration was 0
Performing plan justification:
  0 actions were pruned in 0.00 seconds
```

```
-----
Begin plan
1 (drive-truck md-truck1 frederick baltimore maryland)
2 (load-truck package1 md-truck1 baltimore)
3 (drive-truck md-truck1 baltimore frederick maryland)
4 (unload-truck package1 md-truck1 frederick)
End plan
-----
```

```
4 total actions in plan
0 entries in hash table,
3 total set-creation steps (entries + hits + plan length - 1)
0 actions tried
```

```
#####
Total elapsed time: 0.00 seconds
Time in milliseconds: 4
```

```
#####
```

Output with 5 packages with 2 locations (cities) and 1 truck

```
z@z:~/Desktop/aa/Examples/logistics-strips$ ../../blackbox -o a.pddl -f b.pddl -solver
chaff
```

```
blackbox version 43
command line: ../../blackbox -o a.pddl -f b.pddl -solver chaff
```

```
Begin solver specification
  -maxint      0      -maxsec 0.000000  chaff
End solver specification
Loading domain file: a.pddl
Loading fact file: b.pddl
Problem name: trucks
Facts loaded.
```

time: 1, 19 facts and 1 exclusive pairs.
time: 2, 25 facts and 28 exclusive pairs.
time: 3, 25 facts and 22 exclusive pairs.
time: 4, 30 facts and 72 exclusive pairs.
Goals reachable at 4 steps but mutually exclusive.
time: 5, 30 facts and 67 exclusive pairs.
Goals reachable at 5 steps but mutually exclusive.
time: 6, 30 facts and 42 exclusive pairs.
Goals reachable at 6 steps but mutually exclusive.
time: 7, 30 facts and 32 exclusive pairs.
Goals first reachable in 7 steps.
492 nodes created.

#####

goals at time 8:

at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick

** Turning off completeness check **

Converting graph to wff
number of action variables = 221
number of fluent variables = 171
total number variables = 392
number clauses = 2278
Instance unsatisfiable
Result is Unsat
Iteration was 0

time: 8, 30 facts and 32 exclusive pairs.
82 new nodes added.

#####

goals at time 9:

at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick

Converting graph to wff
number of action variables = 273
number of fluent variables = 201
total number variables = 474
number clauses = 2979
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 8 steps
time: 9, 30 facts and 32 exclusive pairs.
82 new nodes added.

#####

goals at time 10:

at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick

Converting graph to wff
number of action variables = 325
number of fluent variables = 231
total number variables = 556
number clauses = 3640
Instance unsatisfiable

Result is Unsat
Iteration was 0

Can't solve in 9 steps
time: 10, 30 facts and 32 exclusive pairs.
82 new nodes added.

goals at time 11:
 at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick

Converting graph to wff
number of action variables = 377
number of fluent variables = 261
total number variables = 638
number clauses = 4301
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 10 steps
time: 11, 30 facts and 32 exclusive pairs.
82 new nodes added.

goals at time 12:
 at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick

Converting graph to wff
number of action variables = 429
number of fluent variables = 291
total number variables = 720
number clauses = 4962
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 11 steps
time: 12, 30 facts and 32 exclusive pairs.
82 new nodes added.

goals at time 13:
 at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick

Converting graph to wff
number of action variables = 481
number of fluent variables = 321
total number variables = 802
number clauses = 5623
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 12 steps

time: 13, 30 facts and 32 exclusive pairs.
82 new nodes added.

#####

goals at time 14:

at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick

Converting graph to wff
number of action variables = 533
number of fluent variables = 351
total number variables = 884
number clauses = 6284
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 13 steps
time: 14, 30 facts and 32 exclusive pairs.
82 new nodes added.

#####

goals at time 15:

at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick

Converting graph to wff
number of action variables = 585
number of fluent variables = 381
total number variables = 966
number clauses = 6945
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 14 steps
time: 15, 30 facts and 32 exclusive pairs.
82 new nodes added.

#####

goals at time 16:

at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick

Converting graph to wff
number of action variables = 637
number of fluent variables = 411
total number variables = 1048
number clauses = 7606
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 15 steps
time: 16, 30 facts and 32 exclusive pairs.
82 new nodes added.

#####

goals at time 17:

at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick

Converting graph to wff
number of action variables = 689
number of fluent variables = 441
total number variables = 1130
number clauses = 8267
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 16 steps
time: 17, 30 facts and 32 exclusive pairs.
82 new nodes added.

goals at time 18:
at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick

Converting graph to wff
number of action variables = 741
number of fluent variables = 471
total number variables = 1212
number clauses = 8928
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 17 steps
time: 18, 30 facts and 32 exclusive pairs.
82 new nodes added.

goals at time 19:
at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick

Converting graph to wff
number of action variables = 793
number of fluent variables = 501
total number variables = 1294
number clauses = 9589
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 18 steps
time: 19, 30 facts and 32 exclusive pairs.
82 new nodes added.

goals at time 20:
at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick

Converting graph to wff
number of action variables = 845
number of fluent variables = 531
total number variables = 1376
number clauses = 10250
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 19 steps
time: 20, 30 facts and 32 exclusive pairs.
82 new nodes added.

goals at time 21:
 at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick

Converting graph to wff
number of action variables = 897
number of fluent variables = 561
total number variables = 1458
number clauses = 10911
Result is Sat
Iteration was 0
Performing plan justification:
 0 actions were pruned in 0.00 seconds

Begin plan
1 (drive-truck md-truck1 frederick baltimore maryland)
2 (load-truck package2 md-truck1 baltimore)
3 (drive-truck md-truck1 baltimore frederick maryland)
4 (unload-truck package2 md-truck1 frederick)
5 (drive-truck md-truck1 frederick baltimore maryland)
6 (load-truck package5 md-truck1 baltimore)
7 (drive-truck md-truck1 baltimore frederick maryland)
8 (unload-truck package5 md-truck1 frederick)
9 (drive-truck md-truck1 frederick baltimore maryland)
10 (load-truck package1 md-truck1 baltimore)
11 (drive-truck md-truck1 baltimore frederick maryland)
12 (unload-truck package1 md-truck1 frederick)
13 (drive-truck md-truck1 frederick baltimore maryland)
14 (load-truck package4 md-truck1 baltimore)
15 (drive-truck md-truck1 baltimore frederick maryland)
16 (unload-truck package4 md-truck1 frederick)
17 (drive-truck md-truck1 frederick baltimore maryland)
18 (load-truck package3 md-truck1 baltimore)
19 (drive-truck md-truck1 baltimore frederick maryland)
20 (unload-truck package3 md-truck1 frederick)
End plan

20 total actions in plan
0 entries in hash table,
19 total set-creation steps (entries + hits + plan length - 1)
0 actions tried

Total elapsed time: 1.17 seconds
Time in milliseconds: 1172

Output with 5 packages with 5 locations (cities) and 1 truck

```
z@z:~/Desktop/aa/Examples/logistics-strips$ ../../blackbox -o a.pddl -f b.pddl -solver chaff
```

```
blackbox version 43
```

```
command line: ../../blackbox -o a.pddl -f b.pddl -solver chaff
```

```
Begin solver specification
```

```
-maxint 0 -maxsec 0.000000 chaff
```

```
End solver specification
```

```
Loading domain file: a.pddl
```

```
Loading fact file: b.pddl
```

```
Problem name: trucks
```

```
Facts loaded.
```

```
time: 1, 28 facts and 10 exclusive pairs.
```

```
time: 2, 34 facts and 55 exclusive pairs.
```

```
time: 3, 34 facts and 31 exclusive pairs.
```

```
time: 4, 54 facts and 441 exclusive pairs.
```

```
Goals reachable at 4 steps but mutually exclusive.
```

```
time: 5, 54 facts and 361 exclusive pairs.
```

```
Goals reachable at 5 steps but mutually exclusive.
```

```
time: 6, 54 facts and 261 exclusive pairs.
```

```
Goals reachable at 6 steps but mutually exclusive.
```

```
time: 7, 54 facts and 101 exclusive pairs.
```

```
Goals first reachable in 7 steps.
```

```
957 nodes created.
```

```
#####
```

```
goals at time 8:
```

```
at_package1_frederick at_package2_frederick at_package3_frederick
```

```
at_package4_frederick at_package5_frederick
```

```
-----  
** Turning off completeness check **
```

```
Converting graph to wff
```

```
number of action variables = 416
```

```
number of fluent variables = 252
```

```
total number variables = 668
```

```
number clauses = 10669
```

```
Instance unsatisfiable
```

```
Result is Unsat
```

```
Iteration was 0
```

```
-----  
time: 8, 54 facts and 101 exclusive pairs.
```

```
178 new nodes added.
```

```
#####
```

```
goals at time 9:
```

```
at_package1_frederick at_package2_frederick at_package3_frederick
```

```
at_package4_frederick at_package5_frederick
```

```
-----  
Converting graph to wff
```

```
number of action variables = 540
```

```
number of fluent variables = 306
```

```
total number variables = 846
```

```
number clauses = 15558
```

```
Instance unsatisfiable
```

```
Result is Unsat
```

```
Iteration was 0
```

```
-----  
Can't solve in 8 steps
```

```
time: 9, 54 facts and 101 exclusive pairs.
```

```
178 new nodes added.
```

```
#####
goals at time 10:
  at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick
```

```
-----
Converting graph to wff
number of action variables = 664
number of fluent variables = 360
total number variables = 1024
number clauses = 19912
Instance unsatisfiable
Result is Unsat
Iteration was 0
```

```
-----
Can't solve in 9 steps
time: 10, 54 facts and 101 exclusive pairs.
178 new nodes added.
```

```
#####
goals at time 11:
  at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick
```

```
-----
Converting graph to wff
number of action variables = 788
number of fluent variables = 414
total number variables = 1202
number clauses = 23876
Instance unsatisfiable
Result is Unsat
Iteration was 0
```

```
-----
Can't solve in 10 steps
time: 11, 54 facts and 101 exclusive pairs.
178 new nodes added.
```

```
#####
goals at time 12:
  at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick
```

```
-----
Converting graph to wff
number of action variables = 912
number of fluent variables = 468
total number variables = 1380
number clauses = 27840
Instance unsatisfiable
Result is Unsat
Iteration was 0
```

```
-----
Can't solve in 11 steps
time: 12, 54 facts and 101 exclusive pairs.
178 new nodes added.
```

```
#####
goals at time 13:
  at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick
```

Converting graph to wff
number of action variables = 1036
number of fluent variables = 522
total number variables = 1558
number clauses = 31804
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 12 steps
time: 13, 54 facts and 101 exclusive pairs.
178 new nodes added.

goals at time 14:
 at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick

Converting graph to wff
number of action variables = 1160
number of fluent variables = 576
total number variables = 1736
number clauses = 35768
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 13 steps
time: 14, 54 facts and 101 exclusive pairs.
178 new nodes added.

goals at time 15:
 at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick

Converting graph to wff
number of action variables = 1284
number of fluent variables = 630
total number variables = 1914
number clauses = 39732
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 14 steps
time: 15, 54 facts and 101 exclusive pairs.
178 new nodes added.

goals at time 16:
 at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick

Converting graph to wff

number of action variables = 1408
number of fluent variables = 684
total number variables = 2092
number clauses = 43696
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 15 steps
time: 16, 54 facts and 101 exclusive pairs.
178 new nodes added.

goals at time 17:
at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick

Converting graph to wff
number of action variables = 1532
number of fluent variables = 738
total number variables = 2270
number clauses = 47660
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 16 steps
time: 17, 54 facts and 101 exclusive pairs.
178 new nodes added.

goals at time 18:
at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick

Converting graph to wff
number of action variables = 1656
number of fluent variables = 792
total number variables = 2448
number clauses = 51624
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 17 steps
time: 18, 54 facts and 101 exclusive pairs.
178 new nodes added.

goals at time 19:
at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick

Converting graph to wff
number of action variables = 1780
number of fluent variables = 846
total number variables = 2626
number clauses = 55588
Instance unsatisfiable

Result is Unsat
Iteration was 0

Can't solve in 18 steps
time: 19, 54 facts and 101 exclusive pairs.
178 new nodes added.

goals at time 20:
 at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick

Converting graph to wff
number of action variables = 1904
number of fluent variables = 900
total number variables = 2804
number clauses = 59552
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 19 steps
time: 20, 54 facts and 101 exclusive pairs.
178 new nodes added.

goals at time 21:
 at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick

Converting graph to wff
number of action variables = 2028
number of fluent variables = 954
total number variables = 2982
number clauses = 63516
Result is Sat
Iteration was 0
Performing plan justification:
 0 actions were pruned in 0.00 seconds

Begin plan
1 (drive-truck md-truck1 frederick baltimore maryland)
2 (load-truck package4 md-truck1 baltimore)
3 (drive-truck md-truck1 baltimore frederick maryland)
4 (unload-truck package4 md-truck1 frederick)
5 (drive-truck md-truck1 frederick baltimore maryland)
6 (load-truck package2 md-truck1 baltimore)
7 (drive-truck md-truck1 baltimore frederick maryland)
8 (unload-truck package2 md-truck1 frederick)
9 (drive-truck md-truck1 frederick baltimore maryland)
10 (load-truck package1 md-truck1 baltimore)
11 (drive-truck md-truck1 baltimore frederick maryland)
12 (unload-truck package1 md-truck1 frederick)
13 (drive-truck md-truck1 frederick baltimore maryland)
14 (load-truck package3 md-truck1 baltimore)
15 (drive-truck md-truck1 baltimore frederick maryland)
16 (unload-truck package3 md-truck1 frederick)
17 (drive-truck md-truck1 frederick baltimore maryland)
18 (load-truck package5 md-truck1 baltimore)
19 (drive-truck md-truck1 baltimore frederick maryland)
20 (unload-truck package5 md-truck1 frederick)
End plan

```
-----
20 total actions in plan
0 entries in hash table,
19 total set-creation steps (entries + hits + plan length - 1)
0 actions tried
```

```
#####
Total elapsed time: 5.66 seconds
Time in milliseconds: 5660
#####
```

Trying Output with 10 packages with 2 locations (cities) and 1 truck

It awfully takes a long time to process....

Trying Output with 9 packages with 2 locations (cities) and 1 truck

It awfully takes a long time to process...

Trying Output with 8 packages with 2 locations (cities) and 1 truck

It awfully takes a long time to process...

Trying Output with 7 packages with 2 locations (cities) and 1 truck

```
z@z:~/Desktop/aa/Examples/logistics-strips$ ../../blackbox -o a.pddl -f b.pddl -solver
chaff
blackbox version 43
command line: ../../blackbox -o a.pddl -f b.pddl -solver chaff
```

```
Begin solver specification
-maxint 0 -maxsec 0.000000 chaff
End solver specification
Loading domain file: a.pddl
Loading fact file: b.pddl
Problem name: trucks
Facts loaded.
time: 1, 31 facts and 45 exclusive pairs.
time: 2, 31 facts and 37 exclusive pairs.
time: 3, 38 facts and 128 exclusive pairs.
Goals reachable at 3 steps but mutually exclusive.
time: 4, 38 facts and 121 exclusive pairs.
Goals reachable at 4 steps but mutually exclusive.
time: 5, 38 facts and 72 exclusive pairs.
Goals reachable at 5 steps but mutually exclusive.
time: 6, 38 facts and 51 exclusive pairs.
Goals first reachable in 6 steps.
578 nodes created.

#####
goals at time 7:
  at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick
at_package6_frederick at_package7_frederick
```

```
-----
** Turning off completeness check **
Converting graph to wff
number of action variables = 260
```


number of fluent variables = 192
total number variables = 452
number clauses = 3633
Instance unsatisfiable
Result is Unsat
Iteration was 0

time: 7, 38 facts and 51 exclusive pairs.
106 new nodes added.

goals at time 8:
 at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick
at_package6_frederick at_package7_frederick

Converting graph to wff
number of action variables = 328
number of fluent variables = 230
total number variables = 558
number clauses = 4801
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 7 steps
time: 8, 38 facts and 51 exclusive pairs.
106 new nodes added.

goals at time 9:
 at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick
at_package6_frederick at_package7_frederick

Converting graph to wff
number of action variables = 396
number of fluent variables = 268
total number variables = 664
number clauses = 5885
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 8 steps
time: 9, 38 facts and 51 exclusive pairs.
106 new nodes added.

goals at time 10:
 at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick
at_package6_frederick at_package7_frederick

Converting graph to wff
number of action variables = 464
number of fluent variables = 306
total number variables = 770
number clauses = 6969
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 9 steps
time: 10, 38 facts and 51 exclusive pairs.
106 new nodes added.

goals at time 11:
 at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick
at_package6_frederick at_package7_frederick

Converting graph to wff
number of action variables = 532
number of fluent variables = 344
total number variables = 876
number clauses = 8053
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 10 steps
time: 11, 38 facts and 51 exclusive pairs.
106 new nodes added.

goals at time 12:
 at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick
at_package6_frederick at_package7_frederick

Converting graph to wff
number of action variables = 600
number of fluent variables = 382
total number variables = 982
number clauses = 9137
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 11 steps
time: 12, 38 facts and 51 exclusive pairs.
106 new nodes added.

goals at time 13:
 at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick
at_package6_frederick at_package7_frederick

Converting graph to wff
number of action variables = 668
number of fluent variables = 420
total number variables = 1088
number clauses = 10221
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 12 steps
time: 13, 38 facts and 51 exclusive pairs.
106 new nodes added.

```
#####
goals at time 14:
  at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick
at_package6_frederick at_package7_frederick
```

```
-----
Converting graph to wff
number of action variables = 736
number of fluent variables = 458
total number variables = 1194
number clauses = 11305
Instance unsatisfiable
Result is Unsat
Iteration was 0
```

```
-----
Can't solve in 13 steps
time: 14, 38 facts and 51 exclusive pairs.
106 new nodes added.
```

```
#####
goals at time 15:
  at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick
at_package6_frederick at_package7_frederick
```

```
-----
Converting graph to wff
number of action variables = 804
number of fluent variables = 496
total number variables = 1300
number clauses = 12389
Instance unsatisfiable
Result is Unsat
Iteration was 0
```

```
-----
Can't solve in 14 steps
time: 15, 38 facts and 51 exclusive pairs.
106 new nodes added.
```

```
#####
goals at time 16:
  at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick
at_package6_frederick at_package7_frederick
```

```
-----
Converting graph to wff
number of action variables = 872
number of fluent variables = 534
total number variables = 1406
number clauses = 13473
Instance unsatisfiable
Result is Unsat
Iteration was 0
```

```
-----
Can't solve in 15 steps
time: 16, 38 facts and 51 exclusive pairs.
106 new nodes added.
```

```
#####
goals at time 17:
  at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick
```

at_package6_frederick at_package7_frederick

Converting graph to wff
number of action variables = 940
number of fluent variables = 572
total number variables = 1512
number clauses = 14557
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 16 steps
time: 17, 38 facts and 51 exclusive pairs.
106 new nodes added.

goals at time 18:
at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick
at_package6_frederick at_package7_frederick

Converting graph to wff
number of action variables = 1008
number of fluent variables = 610
total number variables = 1618
number clauses = 15641
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 17 steps
time: 18, 38 facts and 51 exclusive pairs.
106 new nodes added.

goals at time 19:
at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick
at_package6_frederick at_package7_frederick

Converting graph to wff
number of action variables = 1076
number of fluent variables = 648
total number variables = 1724
number clauses = 16725
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 18 steps
time: 19, 38 facts and 51 exclusive pairs.
106 new nodes added.

goals at time 20:
at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick
at_package6_frederick at_package7_frederick

Converting graph to wff

number of action variables = 1144
number of fluent variables = 686
total number variables = 1830
number clauses = 17809
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 19 steps
time: 20, 38 facts and 51 exclusive pairs.
106 new nodes added.

goals at time 21:
 at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick
at_package6_frederick at_package7_frederick

Converting graph to wff
number of action variables = 1212
number of fluent variables = 724
total number variables = 1936
number clauses = 18893
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 20 steps
time: 21, 38 facts and 51 exclusive pairs.
106 new nodes added.

goals at time 22:
 at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick
at_package6_frederick at_package7_frederick

Converting graph to wff
number of action variables = 1280
number of fluent variables = 762
total number variables = 2042
number clauses = 19977
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 21 steps
time: 22, 38 facts and 51 exclusive pairs.
106 new nodes added.

goals at time 23:
 at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick
at_package6_frederick at_package7_frederick

Converting graph to wff
number of action variables = 1348
number of fluent variables = 800
total number variables = 2148
number clauses = 21061
Instance unsatisfiable

Result is Unsat
Iteration was 0

Can't solve in 22 steps
time: 23, 38 facts and 51 exclusive pairs.
106 new nodes added.

goals at time 24:
 at_package1_frederick at_package2_frederick at_package3_frederick
 at_package4_frederick at_package5_frederick
 at_package6_frederick at_package7_frederick

Converting graph to wff
number of action variables = 1416
number of fluent variables = 838
total number variables = 2254
number clauses = 22145
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 23 steps
time: 24, 38 facts and 51 exclusive pairs.
106 new nodes added.

goals at time 25:
 at_package1_frederick at_package2_frederick at_package3_frederick
 at_package4_frederick at_package5_frederick
 at_package6_frederick at_package7_frederick

Converting graph to wff
number of action variables = 1484
number of fluent variables = 876
total number variables = 2360
number clauses = 23229
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 24 steps
time: 25, 38 facts and 51 exclusive pairs.
106 new nodes added.

goals at time 26:
 at_package1_frederick at_package2_frederick at_package3_frederick
 at_package4_frederick at_package5_frederick
 at_package6_frederick at_package7_frederick

Converting graph to wff
number of action variables = 1552
number of fluent variables = 914
total number variables = 2466
number clauses = 24313
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 25 steps

time: 26, 38 facts and 51 exclusive pairs.
106 new nodes added.

#####

goals at time 27:

at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick
at_package6_frederick at_package7_frederick

Converting graph to wff
number of action variables = 1620
number of fluent variables = 952
total number variables = 2572
number clauses = 25397
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 26 steps
time: 27, 38 facts and 51 exclusive pairs.
106 new nodes added.

#####

goals at time 28:

at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick
at_package6_frederick at_package7_frederick

Converting graph to wff
number of action variables = 1688
number of fluent variables = 990
total number variables = 2678
number clauses = 26481
Result is Sat
Iteration was 0
Performing plan justification:
0 actions were pruned in 0.00 seconds

Begin plan

1 (load-truck package6 md-truck1 baltimore)
2 (drive-truck md-truck1 baltimore frederick maryland)
3 (unload-truck package6 md-truck1 frederick)
4 (drive-truck md-truck1 frederick baltimore maryland)
5 (load-truck package2 md-truck1 baltimore)
6 (drive-truck md-truck1 baltimore frederick maryland)
7 (unload-truck package2 md-truck1 frederick)
8 (drive-truck md-truck1 frederick baltimore maryland)
9 (load-truck package3 md-truck1 baltimore)
10 (drive-truck md-truck1 baltimore frederick maryland)
11 (unload-truck package3 md-truck1 frederick)
12 (drive-truck md-truck1 frederick baltimore maryland)
13 (load-truck package7 md-truck1 baltimore)
14 (drive-truck md-truck1 baltimore frederick maryland)
15 (unload-truck package7 md-truck1 frederick)
16 (drive-truck md-truck1 frederick baltimore maryland)
17 (load-truck package1 md-truck1 baltimore)
18 (drive-truck md-truck1 baltimore frederick maryland)
19 (unload-truck package1 md-truck1 frederick)
20 (drive-truck md-truck1 frederick baltimore maryland)
21 (load-truck package5 md-truck1 baltimore)
22 (drive-truck md-truck1 baltimore frederick maryland)
23 (unload-truck package5 md-truck1 frederick)
24 (drive-truck md-truck1 frederick baltimore maryland)
25 (load-truck package4 md-truck1 baltimore)
26 (drive-truck md-truck1 baltimore frederick maryland)

```

27 (unload-truck package4 md-truck1 frederick)
End plan
-----

27 total actions in plan
0 entries in hash table,
26 total set-creation steps (entries + hits + plan length - 1)
0 actions tried

#####
Total elapsed time: 1 minutes, 53 seconds
Time in milliseconds: 113024
#####

```

Trying Output with 10 packages with 5 locations (cities) and 1 truck
It awfully takes a long time to process...

Trying Output with 9 packages with 5 locations (cities) and 1 truck
It awfully takes a long time to process...

Trying Output with 8 packages with 5 locations (cities) and 1 truck
It awfully takes a long time to process...

Trying Output with 7 packages with 5 locations (cities) and 1 truck
It awfully takes a long time to process...

Trying Output with 6 packages with 5 locations (cities) and 1 truck

```

z@z:~/Desktop/aa/Examples/logistics-strips$ ../../blackbox -o a.pddl -f b.pddl -solver
chaff
blackbox version 43
command line: ../../blackbox -o a.pddl -f b.pddl -solver chaff

```

```

Begin solver specification
-maxint 0 -maxsec 0.000000 chaff
End solver specification
Loading domain file: a.pddl
Loading fact file: b.pddl
Problem name: trucks
Facts loaded.
time: 1, 33 facts and 27 exclusive pairs.
time: 2, 37 facts and 51 exclusive pairs.
time: 3, 45 facts and 143 exclusive pairs.
time: 4, 61 facts and 469 exclusive pairs.
Goals reachable at 4 steps but mutually exclusive.
time: 5, 61 facts and 197 exclusive pairs.
Goals reachable at 5 steps but mutually exclusive.
time: 6, 61 facts and 101 exclusive pairs.
Goals first reachable in 6 steps.
909 nodes created.

#####
goals at time 7:
at_package1_frederick at_package2_woodland at_package3_glen-burnie
at_package4_towson at_package5_baltimore
at_package6_glen-burnie

```

```

** Turning off completeness check **
Converting graph to wff
number of action variables = 373

```

number of fluent variables = 233
total number variables = 606
number clauses = 8813
Instance unsatisfiable
Result is Unsat
Iteration was 0

time: 7, 61 facts and 101 exclusive pairs.
202 new nodes added.

goals at time 8:
 at_package1_frederick at_package2_woodland at_package3_glen-burnie
at_package4_towson at_package5_baltimore
at_package6_glen-burnie

Converting graph to wff
number of action variables = 513
number of fluent variables = 293
total number variables = 806
number clauses = 14712
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 7 steps
time: 8, 61 facts and 101 exclusive pairs.
202 new nodes added.

goals at time 9:
 at_package1_frederick at_package2_woodland at_package3_glen-burnie
at_package4_towson at_package5_baltimore
at_package6_glen-burnie

Converting graph to wff
number of action variables = 653
number of fluent variables = 353
total number variables = 1006
number clauses = 19481
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 8 steps
time: 9, 61 facts and 101 exclusive pairs.
202 new nodes added.

goals at time 10:
 at_package1_frederick at_package2_woodland at_package3_glen-burnie
at_package4_towson at_package5_baltimore
at_package6_glen-burnie

Converting graph to wff
number of action variables = 793
number of fluent variables = 413
total number variables = 1206
number clauses = 24016
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 9 steps
time: 10, 61 facts and 101 exclusive pairs.
202 new nodes added.

goals at time 11:
 at_package1_frederick at_package2_woodland at_package3_glen-burnie
at_package4_towson at_package5_baltimore
at_package6_glen-burnie

Converting graph to wff
number of action variables = 933
number of fluent variables = 473
total number variables = 1406
number clauses = 28551
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 10 steps
time: 11, 61 facts and 101 exclusive pairs.
202 new nodes added.

goals at time 12:
 at_package1_frederick at_package2_woodland at_package3_glen-burnie
at_package4_towson at_package5_baltimore
at_package6_glen-burnie

Converting graph to wff
number of action variables = 1073
number of fluent variables = 533
total number variables = 1606
number clauses = 33086
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 11 steps
time: 12, 61 facts and 101 exclusive pairs.
202 new nodes added.

goals at time 13:
 at_package1_frederick at_package2_woodland at_package3_glen-burnie
at_package4_towson at_package5_baltimore
at_package6_glen-burnie

Converting graph to wff
number of action variables = 1213
number of fluent variables = 593
total number variables = 1806
number clauses = 37621
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 12 steps
time: 13, 61 facts and 101 exclusive pairs.
202 new nodes added.

```
#####
goals at time 14:
  at_package1_frederick at_package2_woodland at_package3_glen-burnie
at_package4_towson at_package5_baltimore
at_package6_glen-burnie
```

```
-----
Converting graph to wff
number of action variables = 1353
number of fluent variables = 653
total number variables = 2006
number clauses = 42156
Instance unsatisfiable
Result is Unsat
Iteration was 0
```

```
-----
Can't solve in 13 steps
time: 14, 61 facts and 101 exclusive pairs.
202 new nodes added.
```

```
#####
goals at time 15:
  at_package1_frederick at_package2_woodland at_package3_glen-burnie
at_package4_towson at_package5_baltimore
at_package6_glen-burnie
```

```
-----
Converting graph to wff
number of action variables = 1493
number of fluent variables = 713
total number variables = 2206
number clauses = 46691
Instance unsatisfiable
Result is Unsat
Iteration was 0
```

```
-----
Can't solve in 14 steps
time: 15, 61 facts and 101 exclusive pairs.
202 new nodes added.
```

```
#####
goals at time 16:
  at_package1_frederick at_package2_woodland at_package3_glen-burnie
at_package4_towson at_package5_baltimore
at_package6_glen-burnie
```

```
-----
Converting graph to wff
number of action variables = 1633
number of fluent variables = 773
total number variables = 2406
number clauses = 51226
Instance unsatisfiable
Result is Unsat
Iteration was 0
```

```
-----
Can't solve in 15 steps
time: 16, 61 facts and 101 exclusive pairs.
202 new nodes added.
```

```
#####
goals at time 17:
  at_package1_frederick at_package2_woodland at_package3_glen-burnie
at_package4_towson at_package5_baltimore
```

at_package6_glen-burnie

Converting graph to wff
number of action variables = 1773
number of fluent variables = 833
total number variables = 2606
number clauses = 55761
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 16 steps
time: 17, 61 facts and 101 exclusive pairs.
202 new nodes added.

goals at time 18:
 at_package1_frederick at_package2_woodland at_package3_glen-burnie
at_package4_towson at_package5_baltimore
at_package6_glen-burnie

Converting graph to wff
number of action variables = 1913
number of fluent variables = 893
total number variables = 2806
number clauses = 60296
Instance unsatisfiable
Result is Unsat
Iteration was 0

Can't solve in 17 steps
time: 18, 61 facts and 101 exclusive pairs.
202 new nodes added.

goals at time 19:
 at_package1_frederick at_package2_woodland at_package3_glen-burnie
at_package4_towson at_package5_baltimore
at_package6_glen-burnie

Converting graph to wff
number of action variables = 2053
number of fluent variables = 953
total number variables = 3006
number clauses = 64831
Result is Sat
Iteration was 0
Performing plan justification:
 0 actions were pruned in 0.00 seconds

Begin plan
1 (load-truck package1 md-truck1 baltimore)
2 (drive-truck md-truck1 baltimore frederick maryland)
3 (unload-truck package1 md-truck1 frederick)
4 (load-truck package5 md-truck1 frederick)
5 (drive-truck md-truck1 frederick baltimore maryland)
6 (unload-truck package5 md-truck1 baltimore)
7 (load-truck package6 md-truck1 baltimore)
8 (drive-truck md-truck1 baltimore glen-burnie maryland)
9 (unload-truck package6 md-truck1 glen-burnie)
10 (load-truck package4 md-truck1 glen-burnie)
11 (drive-truck md-truck1 glen-burnie towson maryland)

```

12 (unload-truck package4 md-truck1 towson)
13 (load-truck package2 md-truck1 towson)
14 (drive-truck md-truck1 towson woodland maryland)
15 (unload-truck package2 md-truck1 woodland)
16 (load-truck package3 md-truck1 woodland)
17 (drive-truck md-truck1 woodland glen-burnie maryland)
18 (unload-truck package3 md-truck1 glen-burnie)
End plan
-----

18 total actions in plan
0 entries in hash table,
17 total set-creation steps (entries + hits + plan length - 1)
0 actions tried

#####
Total elapsed time: 56.69 seconds
Time in milliseconds: 56686
#####

```

Observation:

As observing when trying to increase the packages while having 2 cities and one truck, it seems that the time has increased greatly, especially looking at the 5 packages and the 10 packages. Literally, it doesn't even show up the result after 8 hours for 10 packages. That is a huge different.

Whenever increasing the number of cities, and trucks,, it will also increase the elapsed time as well.

5. Remove the restriction that a truck can only transport one package at a time. How does it affect Blackbox's performance for the different numbers of packages?

6. Turn in a description of the behavior of Blackbox when you increase the number of packages, cities, and trucks (assume no more than 5 trucks).

Observing:

Output with 1 package with 2 locations (cities) and 1 truck

```

z@z:~/Desktop/aa/Examples/logistics-strips$ ../../blackbox -o a.pddl -f b.pddl -solver
chaff
blackbox version 43
command line: ../../blackbox -o a.pddl -f b.pddl -solver chaff

```

```

Begin solver specification
-maxint 0 -maxsec 0.000000 chaff
End solver specification
Loading domain file: a.pddl
Loading fact file: b.pddl
Problem name: trucks
Facts loaded.
time: 1, 11 facts and 3 exclusive pairs.
time: 2, 11 facts and 2 exclusive pairs.
time: 3, 12 facts and 5 exclusive pairs.

```

Goals first reachable in 3 steps.
86 nodes created.

```
#####
goals at time 4:
  at_package1_frederick
```

```
-----
** Turning off completeness check **
Converting graph to wff
number of action variables = 19
number of fluent variables = 26
total number variables = 45
number clauses = 78
Result is Sat
Iteration was 0
Performing plan justification:
  0 actions were pruned in 0.00 seconds
```

```
-----
Begin plan
1 (load-truck package1 md-truck1 baltimore)
2 (drive-truck md-truck1 baltimore frederick maryland)
3 (unload-truck package1 md-truck1 frederick)
End plan
-----
```

```
3 total actions in plan
0 entries in hash table,
2 total set-creation steps (entries + hits + plan length - 1)
0 actions tried
```

```
#####
Total elapsed time:  0.00 seconds
Time in milliseconds: 2
```

```
#####
```

Observing:

Output with 1 package with 5 locations (cities) and 1 truck

```
z@z:~/Desktop/aa/Examples/logistics-strips$ ../../blackbox -o a.pddl -f b.pddl -solver
chaff
blackbox version 43
command line:  ../../blackbox -o a.pddl -f b.pddl -solver chaff
```

```
Begin solver specification
  -maxint      0      -maxsec 0.000000  chaff
End solver specification
Loading domain file: a.pddl
Loading fact file: b.pddl
Problem name: trucks
Facts loaded.
time: 1, 44 facts and 55 exclusive pairs.
time: 2, 48 facts and 81 exclusive pairs.
time: 3, 52 facts and 111 exclusive pairs.
Goals first reachable in 3 steps.
543 nodes created.
```

```
#####
goals at time 4:
  at_package1_frederick
```

```
-----
** Turning off completeness check **
Converting graph to wff
number of action variables = 31
number of fluent variables = 41
total number variables = 72
```

```
number clauses = 168
Result is Sat
Iteration was 0
Performing plan justification:
  0 actions were pruned in 0.00 seconds
```

```
-----
Begin plan
1 (load-truck package1 md-truck1 baltimore)
2 (drive-truck md-truck1 baltimore frederick maryland)
3 (unload-truck package1 md-truck1 frederick)
End plan
-----
```

```
3 total actions in plan
0 entries in hash table,
2 total set-creation steps (entries + hits + plan length - 1)
0 actions tried
```

```
#####
Total elapsed time:  0.01 seconds
Time in milliseconds: 12
```

```
#####
```

Observing:

Output with 5 packages with 2 locations (cities) and 5 trucks

```
z@z:~/Desktop/aa/Examples/logistics-strips$ ../../blackbox -o a.pddl -f b.pddl -solver
chaff
blackbox version 43
command line:  ../../blackbox -o a.pddl -f b.pddl -solver chaff
```

```
Begin solver specification
  -maxint 0 -maxsec 0.000000 chaff
End solver specification
Loading domain file: a.pddl
Loading fact file: b.pddl
Problem name: trucks
Facts loaded.
time: 1, 23 facts and 11 exclusive pairs.
time: 2, 23 facts and 6 exclusive pairs.
time: 3, 28 facts and 21 exclusive pairs.
Goals first reachable in 3 steps.
194 nodes created.
```

```
#####
goals at time 4:
  at_package1_frederick at_package2_frederick at_package3_frederick
at_package4_frederick at_package5_frederick
```

```
-----
** Turning off completeness check **
Converting graph to wff
number of action variables = 47
number of fluent variables = 58
total number variables = 105
number clauses = 214
Result is Sat
Iteration was 0
Performing plan justification:
  0 actions were pruned in 0.00 seconds
```

```
-----
Begin plan
1 (load-truck package3 md-truck1 baltimore)
1 (load-truck package4 md-truck1 baltimore)
1 (load-truck package1 md-truck1 baltimore)
```

```

1 (load-truck package2 md-truck1 baltimore)
1 (load-truck package5 md-truck1 baltimore)
2 (drive-truck md-truck1 baltimore frederick maryland)
3 (unload-truck package2 md-truck1 frederick)
3 (unload-truck package3 md-truck1 frederick)
3 (unload-truck package1 md-truck1 frederick)
3 (unload-truck package4 md-truck1 frederick)
3 (unload-truck package5 md-truck1 frederick)
End plan
-----

```

```

11 total actions in plan
0 entries in hash table,
2 total set-creation steps (entries + hits + plan length - 1)
0 actions tried

```

```

#####
Total elapsed time: 0.00 seconds
Time in milliseconds: 2

```

```

#####

```

Observing:

Output with 5 packages with 5 locations (cities) and 5 trucks

```

z@z:~/Desktop/aa/Examples/logistics-strips$ ../../blackbox -o a.pddl -f b.pddl -solver
chaff
blackbox version 43
command line: ../../blackbox -o a.pddl -f b.pddl -solver chaff

```

```

Begin solver specification
-maxint 0 -maxsec 0.000000 chaff
End solver specification
Loading domain file: a.pddl
Loading fact file: b.pddl
Problem name: trucks
Facts loaded.
time: 1, 56 facts and 75 exclusive pairs.
time: 2, 76 facts and 255 exclusive pairs.
time: 3, 96 facts and 445 exclusive pairs.
Goals first reachable in 3 steps.
847 nodes created.

```

```

#####
goals at time 4:
  at_package1_glen-burnie at_package2_woodland at_package3_towson
at_package4_frederick at_package5_baltimore

```

```

-----
** Turning off completeness check **
Converting graph to wff
number of action variables = 111
number of fluent variables = 117
total number variables = 228
number clauses = 708
Result is Sat
Iteration was 0
Performing plan justification:
  0 actions were pruned in 0.00 seconds

```

```

-----
Begin plan
1 (load-truck package3 md-truck4 woodland)
1 (load-truck package4 md-truck5 glen-burnie)
1 (load-truck package5 md-truck3 towson)
1 (load-truck package1 md-truck1 baltimore)

```



```

1 (load-truck package2 md-truck2 frederick)
2 (drive-truck md-truck3 towson baltimore maryland)
2 (drive-truck md-truck1 baltimore glen-burnie maryland)
2 (drive-truck md-truck4 woodland towson maryland)
2 (drive-truck md-truck2 frederick woodland maryland)
2 (drive-truck md-truck5 glen-burnie frederick maryland)
3 (unload-truck package2 md-truck2 woodland)
3 (unload-truck package4 md-truck5 frederick)
3 (unload-truck package5 md-truck3 baltimore)
3 (unload-truck package3 md-truck4 towson)
3 (unload-truck package1 md-truck1 glen-burnie)
End plan
-----

```

```

15 total actions in plan
0 entries in hash table,
2 total set-creation steps (entries + hits + plan length - 1)
0 actions tried

```

```

#####
Total elapsed time: 0.01 seconds
Time in milliseconds: 14

```

```

#####

```

Observing:

Output with 10 packages with 2 locations (cities) and 1 truck

```

z@z:~/Desktop/aa/Examples/logistics-strips$ ../../blackbox -o a.pddl -f b.pddl -solver
chaff

```

```

blackbox version 43

```

```

command line: ../../blackbox -o a.pddl -f b.pddl -solver chaff

```

```

Begin solver specification

```

```

    -maxint      0    -maxsec 0.000000  chaff

```

```

End solver specification

```

```

Loading domain file: a.pddl

```

```

Loading fact file: b.pddl

```

```

Problem name: trucks

```

```

Facts loaded.

```

```

time: 1, 38 facts and 21 exclusive pairs.

```

```

time: 2, 38 facts and 11 exclusive pairs.

```

```

time: 3, 48 facts and 41 exclusive pairs.

```

```

Goals first reachable in 3 steps.

```

```

329 nodes created.

```

```

#####
goals at time 4:

```

```

    at_package1_frederick at_package2_frederick at_package3_frederick

```

```

    at_package4_frederick at_package5_frederick

```

```

    at_package6_frederick at_package7_frederick at_package8_frederick

```

```

    at_package9_frederick at_package10_frederick

```

```

-----
** Turning off completeness check **

```

```

Converting graph to wff

```

```

number of action variables = 82

```

```

number of fluent variables = 98

```

```

total number variables = 180

```

```

number clauses = 384

```

```

Result is Sat

```

```

Iteration was 0

```

```

Performing plan justification:

```

```

    0 actions were pruned in 0.00 seconds

```

```

-----
Begin plan
1 (load-truck package8 md-truck1 baltimore)
1 (load-truck package10 md-truck1 baltimore)
1 (load-truck package3 md-truck1 baltimore)
1 (load-truck package4 md-truck1 baltimore)
1 (load-truck package6 md-truck1 baltimore)
1 (load-truck package7 md-truck1 baltimore)
1 (load-truck package9 md-truck1 baltimore)
1 (load-truck package1 md-truck1 baltimore)
1 (load-truck package2 md-truck1 baltimore)
1 (load-truck package5 md-truck1 baltimore)
2 (drive-truck md-truck1 baltimore frederick maryland)
3 (unload-truck package10 md-truck1 frederick)
3 (unload-truck package2 md-truck1 frederick)
3 (unload-truck package3 md-truck1 frederick)
3 (unload-truck package6 md-truck1 frederick)
3 (unload-truck package9 md-truck1 frederick)
3 (unload-truck package1 md-truck1 frederick)
3 (unload-truck package4 md-truck1 frederick)
3 (unload-truck package5 md-truck1 frederick)
3 (unload-truck package7 md-truck1 frederick)
3 (unload-truck package8 md-truck1 frederick)
End plan
-----

```

```

21 total actions in plan
0 entries in hash table,
2 total set-creation steps (entries + hits + plan length - 1)
0 actions tried

```

```

#####
Total elapsed time: 0.01 seconds
Time in milliseconds: 6

```

```

#####

```

Observing:

Output with 10 packages with 5 locations (cities) and 5 trucks

```

z@z:~/Desktop/aa/Examples/logistics-strips$ ../../blackbox -o a.pddl -f b.pddl -solver
chaff
blackbox version 43
command line: ../../blackbox -o a.pddl -f b.pddl -solver chaff

```

```

Begin solver specification
-maxint 0 -maxsec 0.000000 chaff
End solver specification
Loading domain file: a.pddl
Loading fact file: b.pddl
Problem name: trucks
Facts loaded.
time: 1, 71 facts and 100 exclusive pairs.
time: 2, 111 facts and 560 exclusive pairs.
time: 3, 151 facts and 1080 exclusive pairs.
Goals first reachable in 3 steps.
1227 nodes created.

```

```

#####
goals at time 4:
  at_package1_glen-burnie at_package2_glen-burnie at_package3_woodland
at_package4_woodland at_package5_baltimore
at_package6_baltimore at_package7_towson at_package8_towson at_package9_frederick
at_package10_frederick

```

```

-----
** Turning off completeness check **
Converting graph to wff
number of action variables = 146

```

```
number of fluent variables = 157
total number variables = 303
number clauses = 923
Result is Sat
Iteration was 0
Performing plan justification:
    0 actions were pruned in 0.00 seconds
```

```
-----
Begin plan
1 (load-truck package9 md-truck5 glen-burnie)
1 (load-truck package3 md-truck2 frederick)
1 (load-truck package5 md-truck3 towson)
1 (load-truck package7 md-truck4 woodland)
1 (load-truck package6 md-truck3 towson)
1 (load-truck package1 md-truck1 baltimore)
1 (load-truck package2 md-truck1 baltimore)
1 (load-truck package8 md-truck4 woodland)
1 (load-truck package10 md-truck5 glen-burnie)
1 (load-truck package4 md-truck2 frederick)
2 (drive-truck md-truck3 towson baltimore maryland)
2 (drive-truck md-truck1 baltimore glen-burnie maryland)
2 (drive-truck md-truck4 woodland towson maryland)
2 (drive-truck md-truck2 frederick woodland maryland)
2 (drive-truck md-truck5 glen-burnie frederick maryland)
3 (unload-truck package8 md-truck4 towson)
3 (unload-truck package10 md-truck5 frederick)
3 (unload-truck package6 md-truck3 baltimore)
3 (unload-truck package7 md-truck4 towson)
3 (unload-truck package5 md-truck3 baltimore)
3 (unload-truck package9 md-truck5 frederick)
3 (unload-truck package4 md-truck2 woodland)
3 (unload-truck package3 md-truck2 woodland)
3 (unload-truck package2 md-truck1 glen-burnie)
3 (unload-truck package1 md-truck1 glen-burnie)
End plan
-----
```

```
25 total actions in plan
0 entries in hash table,
2 total set-creation steps (entries + hits + plan length - 1)
0 actions tried
```

```
#####
Total elapsed time: 0.02 seconds
Time in milliseconds: 20
```

```
#####
```

Observation:

Overall, it drastically increases the performance if removing the truck's restriction. And so, even if increasing number of cities, packages, or trucks would not change much to the elapsed time.
