**Artificial Intelligence for Robotics 2**

**Assignment 1**

**Output problem 2**

**Problem 2 – standard configuration:**

Domain parsed  
Problem parsed  
Grounding..  
Light Validation Completed  
Simplification..  
(Pre Simplification) - |A|+|P|+|E|: 268  
(After Easy Simplification) - |A|+|P|+|E|: 110  
(After AIBR):104  
(Pre Simplification) - |A|+|P|+|E|: 268  
(After Easy Simplification) - |A|+|P|+|E|: 110  
(After AIBR):104  
Grounding and Simplification finished  
|A|:54  
|P|:25  
|E|:25  
Size(X):18  
Size(F):47  
Delta time heuristic model:1.0  
Delta time planning model:1.0  
Delta time search-execution model:1.0  
Delta time validation model:1  
Setting horizon to:NaN  
Running WA-STAR  
Reachable actions and processes: |A U P U E|:104  
h(n = s\_0)=1940.0  
f(n) = 1940.0 (Expanded Nodes: 0, Evaluated States: 0, Time: 0.01)  
f(n) = 2429.0 (Expanded Nodes: 1, Evaluated States: 6, Time: 0.054)  
Starting Validation  
(Pre Simplification) - |A|+|P|+|E|: 268  
(After Easy Simplification) - |A|+|P|+|E|: 110  
(After AIBR):104  
Epsilon set to be:0.0  
Resolution for validation:1.0  
(Pddl+ semantics) Plan is valid:true  
Problem Solved  
0.00000: (m-move\_to\_crate-A crate3 m1 )  
0.00000: (m-move\_to\_crate-A crate3 m2 )  
(0.00000,3.00000)------>waiting  
3.00000: (m-at\_crates-A crate3 m1 )  
3.00000: (m-at\_crates-A crate3 m2 )  
3.00000: (m-load\_H-A crate3 m1 m2 )  
3.00000: (m-move\_create\_to\_loading\_bay-H crate3 m1 m2 )  
(3.00000,22.00000)------>waiting  
22.00000: (crate\_at\_loading\_bay-H crate3 m1 m2 )  
22.00000: (m-download-H crate3 m1 m2 )  
22.00000: (l-load crate3 l )  
(22.00000,26.00000)------>waiting  
26.00000: (crate\_on\_conveyor\_belt crate3 l )  
26.00000: (m-charging m1 )  
26.00000: (m-charging m2 )  
26.00000: (m-move\_to\_crate-A crate2 m1 )  
26.00000: (m-move\_to\_crate-A crate2 m2 )  
(26.00000,28.00000)------>waiting  
28.00000: (m-at\_crates-A crate2 m1 )  
28.00000: (m-at\_crates-A crate2 m2 )  
28.00000: (m-load-F\_A crate2 m1 m2 )  
28.00000: (m-move\_create\_to\_loading\_bay-H crate2 m1 m2 )  
(28.00000,36.00000)------>waiting  
36.00000: (crate\_at\_loading\_bay-H crate2 m1 m2 )  
36.00000: (m-download-F crate2 m1 m2 )  
36.00000: (l-load-F crate2 l )  
36.00000: (m-charging m1 )  
36.00000: (m-move\_to\_crate-A crate1 m1 )  
36.00000: (m-charging m2 )  
36.00000: (m-move\_to\_crate-A crate1 m2 )  
(36.00000,38.00000)------>waiting  
38.00000: (m-at\_crates-A crate1 m1 )  
38.00000: (m-at\_crates-A crate1 m2 )  
38.00000: (m-load\_H-A crate1 m1 m2 )  
38.00000: (m-move\_create\_to\_loading\_bay-H crate1 m1 m2 )  
(38.00000,42.00000)------>waiting  
42.00000: (crate\_on\_conveyor\_belt\_fragile-F crate2 l )  
(42.00000,52.00000)------>waiting  
52.00000: (crate\_at\_loading\_bay-H crate1 m1 m2 )  
52.00000: (m-download-H crate1 m1 m2 )  
52.00000: (m-charging m1 )  
52.00000: (m-move\_to\_crate crate4 m1 )  
(52.00000,53.00000)------>waiting  
53.00000: (m-at\_crates crate4 m1 )  
53.00000: (m-charging m2 )  
53.00000: (m-load crate4 m1 )  
53.00000: (l-load crate1 l )  
53.00000: (m-move\_create\_to\_loading\_bay crate4 m1 )  
(53.00000,57.00000)------>waiting  
57.00000: (crate\_at\_loading\_bay crate4 m1 )  
57.00000: (crate\_on\_conveyor\_belt crate1 l )  
57.00000: (m-download crate4 m1 )  
57.00000: (l-load crate4 l )  
57.00000: (m-charging m1 )  
(57.00000,61.00000)------>waiting  
61.00000: (crate\_on\_conveyor\_belt crate4 l )  
  
Plan-Length:106  
Duration:61.0  
Metric (Plan):0.0  
Metric (Search):91.0  
Planning Time:547  
Heuristic Time:322  
Search Time:349  
Expanded Nodes:111  
States Evaluated:200  
Fixed constraint violations during search (zero-crossing):0  
Number of Dead-Ends detected:9  
Number of Duplicates detected:50  
Plan-Length:62  
Duration:29.0  
Metric (Plan):0.0  
Metric (Search):51.0  
Planning Time:487  
Heuristic Time:261  
Search Time:283  
Expanded Nodes:221  
States Evaluated:317  
Fixed constraint violations during search (zero-crossing):0  
Number of Dead-Ends detected:12  
Number of Duplicates detected:129

**Problem 2 – opt-hmax configuration:**

Domain parsed  
Problem parsed  
Grounding..  
Light Validation Completed  
A\* with numeric hrmax  
Simplification..  
(Pre Simplification) - |A|+|P|+|E|: 273  
(After Easy Simplification) - |A|+|P|+|E|: 121  
(After AIBR):117  
(Pre Simplification) - |A|+|P|+|E|: 273  
(After Easy Simplification) - |A|+|P|+|E|: 121  
(After AIBR):117  
Grounding and Simplification finished  
|A|:59  
|P|:29  
|E|:29  
Size(X):19  
Size(F):48  
Delta time heuristic model:1.0  
Delta time planning model:1.0  
Delta time search-execution model:1.0  
Delta time validation model:1  
w\_h set to be 1  
g\_h set to be 1  
Setting horizon to:NaN  
Running WA-STAR  
Hard Conditions: 8  
Simple Conditions: 71  
Reachable actions and processes: |A U P U E|:117  
h(n = s\_0)=28.0  
f(n) = 28.0 (Expanded Nodes: 0, Evaluated States: 0, Time: 0.017)  
f(n) = 34.0 (Expanded Nodes: 1, Evaluated States: 4, Time: 0.019)  
f(n) = 35.0 (Expanded Nodes: 3, Evaluated States: 9, Time: 0.021)  
f(n) = 36.0 (Expanded Nodes: 4, Evaluated States: 10, Time: 0.021)  
f(n) = 37.0 (Expanded Nodes: 6, Evaluated States: 16, Time: 0.023)  
f(n) = 38.0 (Expanded Nodes: 10, Evaluated States: 22, Time: 0.024)  
f(n) = 39.0 (Expanded Nodes: 13, Evaluated States: 29, Time: 0.025)  
f(n) = 40.0 (Expanded Nodes: 115, Evaluated States: 193, Time: 0.045)  
f(n) = 41.0 (Expanded Nodes: 123, Evaluated States: 202, Time: 0.046)  
f(n) = 42.0 (Expanded Nodes: 128, Evaluated States: 209, Time: 0.047)  
f(n) = 43.0 (Expanded Nodes: 149, Evaluated States: 263, Time: 0.051)  
f(n) = 44.0 (Expanded Nodes: 272, Evaluated States: 495, Time: 0.073)  
f(n) = 45.0 (Expanded Nodes: 353, Evaluated States: 647, Time: 0.086)  
f(n) = 46.0 (Expanded Nodes: 478, Evaluated States: 909, Time: 0.107)  
f(n) = 47.0 (Expanded Nodes: 685, Evaluated States: 1265, Time: 0.137)  
f(n) = 48.0 (Expanded Nodes: 956, Evaluated States: 1680, Time: 0.181)  
f(n) = 49.0 (Expanded Nodes: 1296, Evaluated States: 2149, Time: 0.229)  
f(n) = 50.0 (Expanded Nodes: 1698, Evaluated States: 2688, Time: 0.264)  
f(n) = 51.0 (Expanded Nodes: 3782, Evaluated States: 5917, Time: 0.434)  
f(n) = 52.0 (Expanded Nodes: 5134, Evaluated States: 7777, Time: 0.524)  
f(n) = 53.0 (Expanded Nodes: 7198, Evaluated States: 10944, Time: 0.64)  
f(n) = 54.0 (Expanded Nodes: 9964, Evaluated States: 15422, Time: 0.785)  
f(n) = 55.0 (Expanded Nodes: 14429, Evaluated States: 22693, Time: 0.976)  
Starting Validation  
(Pre Simplification) - |A|+|P|+|E|: 273  
(After Easy Simplification) - |A|+|P|+|E|: 121  
(After AIBR):117  
Epsilon set to be:0.0  
Resolution for validation:1.0  
(Pddl+ semantics) Plan is valid:true  
Problem Solved  
0.00000: (m-move\_to\_crate-A crate1 m2 )  
0.00000: (m-move\_to\_crate-A crate1 m1 )  
(0.00000,1.00000)------>waiting  
1.00000: (m-at\_crates-A crate1 m1 )  
1.00000: (m-at\_crates-A crate1 m2 )  
1.00000: (m-load\_H-A crate1 m1 m2 )  
1.00000: (m-move\_create\_to\_loading\_bay-H crate1 m1 m2 )  
(1.00000,8.00000)------>waiting  
8.00000: (crate\_at\_loading\_bay-H crate1 m1 m2 )  
8.00000: (m-download-H crate1 m1 m2 )  
8.00000: (m-charging m2 )  
8.00000: (m-charging m1 )  
8.00000: (m-move\_to\_crate-A crate2 m1 )  
8.00000: (m-move\_to\_crate-A crate2 m2 )  
(8.00000,10.00000)------>waiting  
10.00000: (m-at\_crates-A crate2 m1 )  
10.00000: (m-at\_crates-A crate2 m2 )  
10.00000: (m-load-F\_A crate2 m1 m2 )  
10.00000: (m-move\_create\_to\_loading\_bay-H crate2 m1 m2 )  
(10.00000,14.00000)------>waiting  
14.00000: (l-load crate1 l )  
(14.00000,18.00000)------>waiting  
18.00000: (crate\_at\_loading\_bay-H crate2 m1 m2 )  
18.00000: (crate\_on\_conveyor\_belt crate1 l )  
18.00000: (m-download-F crate2 m1 m2 )  
18.00000: (m-charging m2 )  
18.00000: (m-charging m1 )  
18.00000: (m-move\_to\_crate-B crate3 m1 )  
18.00000: (m-move\_to\_crate-B crate4 m2 )  
18.00000: (l-load-F crate2 l )  
(18.00000,19.00000)------>waiting  
19.00000: (m-at\_crates-B crate4 m2 )  
19.00000: (m-load-B crate4 m2 )  
19.00000: (m-move\_create\_to\_loading\_bay crate4 m2 )  
(19.00000,20.00000)------>waiting  
20.00000: (m-at\_crates-B crate3 m1 )  
20.00000: (m-load-B crate3 m1 )  
20.00000: (m-move\_create\_to\_loading\_bay crate3 m1 )  
(20.00000,23.00000)------>waiting  
23.00000: (crate\_at\_loading\_bay crate4 m2 )  
23.00000: (m-download crate4 m2 )  
23.00000: (l-load\_cheap-L crate4 ll )  
(23.00000,24.00000)------>waiting  
24.00000: (crate\_at\_loading\_bay crate3 m1 )  
24.00000: (crate\_on\_conveyor\_belt\_fragile-F crate2 l )  
24.00000: (m-download crate3 m1 )  
24.00000: (l-load crate3 l )  
(24.00000,27.00000)------>waiting  
27.00000: (crate\_on\_conveyor\_belt\_cheap-L crate4 ll )  
(27.00000,28.00000)------>waiting  
28.00000: (crate\_on\_conveyor\_belt crate3 l )

Plan-Length:68  
Duration:28.0  
Metric (Plan):0.0  
Metric (Search):54.0  
Planning Time:1178  
Heuristic Time:647  
Search Time:984  
Expanded Nodes:14751  
States Evaluated:23067  
Fixed constraint violations during search (zero-crossing):0  
Number of Dead-Ends detected:194  
Number of Duplicates detected:16322

**Problem 2 – opt-hmax configuration:**

Domain parsed  
Problem parsed  
Grounding..  
Light Validation Completed  
A\* with 0-1 goal heuristic  
Simplification..  
(Pre Simplification) - |A|+|P|+|E|: 273  
(After Easy Simplification) - |A|+|P|+|E|: 121  
(Pre Simplification) - |A|+|P|+|E|: 273  
(After Easy Simplification) - |A|+|P|+|E|: 121  
(After AIBR):117  
Grounding and Simplification finished  
|A|:59  
|P|:31  
|E|:31  
Size(X):20  
Size(F):50  
Delta time heuristic model:1.0  
Delta time planning model:1.0  
Delta time search-execution model:1.0  
Delta time validation model:1  
w\_h set to be 1  
g\_h set to be 1  
Setting horizon to:NaN  
Running WA-STAR  
Reachable actions and processes: |A U P U E|:117  
h(n = s\_0)=1.0  
f(n) = 1.0 (Expanded Nodes: 0, Evaluated States: 0, Time: 0.001)  
f(n) = 2.0 (Expanded Nodes: 1, Evaluated States: 3, Time: 0.002)  
f(n) = 3.0 (Expanded Nodes: 4, Evaluated States: 9, Time: 0.003)  
f(n) = 4.0 (Expanded Nodes: 10, Evaluated States: 19, Time: 0.004)  
f(n) = 5.0 (Expanded Nodes: 20, Evaluated States: 36, Time: 0.005)  
f(n) = 6.0 (Expanded Nodes: 37, Evaluated States: 56, Time: 0.006)  
f(n) = 7.0 (Expanded Nodes: 57, Evaluated States: 70, Time: 0.006)  
f(n) = 8.0 (Expanded Nodes: 71, Evaluated States: 74, Time: 0.007)  
f(n) = 9.0 (Expanded Nodes: 75, Evaluated States: 76, Time: 0.007)  
f(n) = 10.0 (Expanded Nodes: 77, Evaluated States: 78, Time: 0.007)  
f(n) = 11.0 (Expanded Nodes: 79, Evaluated States: 80, Time: 0.007)  
f(n) = 12.0 (Expanded Nodes: 81, Evaluated States: 82, Time: 0.008)  
f(n) = 13.0 (Expanded Nodes: 83, Evaluated States: 84, Time: 0.008)  
f(n) = 14.0 (Expanded Nodes: 85, Evaluated States: 86, Time: 0.008)  
f(n) = 15.0 (Expanded Nodes: 87, Evaluated States: 88, Time: 0.008)  
f(n) = 16.0 (Expanded Nodes: 89, Evaluated States: 92, Time: 0.008)  
f(n) = 17.0 (Expanded Nodes: 93, Evaluated States: 99, Time: 0.008)  
f(n) = 18.0 (Expanded Nodes: 100, Evaluated States: 112, Time: 0.009)  
f(n) = 19.0 (Expanded Nodes: 113, Evaluated States: 135, Time: 0.009)  
f(n) = 20.0 (Expanded Nodes: 136, Evaluated States: 173, Time: 0.01)  
f(n) = 21.0 (Expanded Nodes: 174, Evaluated States: 229, Time: 0.012)  
f(n) = 22.0 (Expanded Nodes: 230, Evaluated States: 304, Time: 0.013)  
f(n) = 23.0 (Expanded Nodes: 305, Evaluated States: 395, Time: 0.015)  
f(n) = 24.0 (Expanded Nodes: 396, Evaluated States: 484, Time: 0.017)  
f(n) = 25.0 (Expanded Nodes: 485, Evaluated States: 574, Time: 0.02)  
f(n) = 26.0 (Expanded Nodes: 575, Evaluated States: 659, Time: 0.021)  
f(n) = 27.0 (Expanded Nodes: 660, Evaluated States: 745, Time: 0.023)  
f(n) = 28.0 (Expanded Nodes: 746, Evaluated States: 831, Time: 0.025)  
f(n) = 29.0 (Expanded Nodes: 832, Evaluated States: 921, Time: 0.027)  
f(n) = 30.0 (Expanded Nodes: 922, Evaluated States: 1006, Time: 0.029)  
f(n) = 31.0 (Expanded Nodes: 1007, Evaluated States: 1094, Time: 0.031)  
f(n) = 32.0 (Expanded Nodes: 1095, Evaluated States: 1192, Time: 0.033)  
f(n) = 33.0 (Expanded Nodes: 1193, Evaluated States: 1350, Time: 0.035)  
f(n) = 34.0 (Expanded Nodes: 1351, Evaluated States: 1608, Time: 0.039)  
f(n) = 35.0 (Expanded Nodes: 1609, Evaluated States: 2016, Time: 0.044)  
f(n) = 36.0 (Expanded Nodes: 2017, Evaluated States: 2612, Time: 0.054)  
f(n) = 37.0 (Expanded Nodes: 2613, Evaluated States: 3402, Time: 0.068)  
f(n) = 38.0 (Expanded Nodes: 3403, Evaluated States: 4410, Time: 0.086)  
f(n) = 39.0 (Expanded Nodes: 4411, Evaluated States: 5635, Time: 0.108)  
f(n) = 40.0 (Expanded Nodes: 5636, Evaluated States: 7068, Time: 0.135)  
f(n) = 41.0 (Expanded Nodes: 7069, Evaluated States: 8681, Time: 0.167)  
f(n) = 42.0 (Expanded Nodes: 8682, Evaluated States: 10434, Time: 0.196)  
f(n) = 43.0 (Expanded Nodes: 10435, Evaluated States: 12371, Time: 0.229)  
f(n) = 44.0 (Expanded Nodes: 12372, Evaluated States: 14716, Time: 0.263)  
f(n) = 45.0 (Expanded Nodes: 14717, Evaluated States: 17506, Time: 0.312)  
f(n) = 46.0 (Expanded Nodes: 17507, Evaluated States: 21046, Time: 0.35)  
f(n) = 47.0 (Expanded Nodes: 21047, Evaluated States: 25846, Time: 0.4)  
f(n) = 48.0 (Expanded Nodes: 25847, Evaluated States: 32530, Time: 0.466)  
f(n) = 49.0 (Expanded Nodes: 32531, Evaluated States: 41708, Time: 0.547)  
f(n) = 50.0 (Expanded Nodes: 41709, Evaluated States: 53516, Time: 0.674)  
f(n) = 51.0 (Expanded Nodes: 53517, Evaluated States: 67566, Time: 0.824)  
f(n) = 52.0 (Expanded Nodes: 67567, Evaluated States: 82584, Time: 0.969)  
f(n) = 53.0 (Expanded Nodes: 82585, Evaluated States: 97080, Time: 1.144)  
f(n) = 54.0 (Expanded Nodes: 97081, Evaluated States: 109728, Time: 1.313)  
f(n) = 55.0 (Expanded Nodes: 109729, Evaluated States: 120502, Time: 1.457)  
Starting Validation  
(Pre Simplification) - |A|+|P|+|E|: 273  
(After Easy Simplification) - |A|+|P|+|E|: 121  
(After AIBR):117  
Epsilon set to be:0.0  
Resolution for validation:1.0  
Precondition not satisfied. Action:  
Action Name:m-charging Parameters: m1 - mover   
Pre: (AND (m-at-loading\_bay m1)(> ((+ (\* -1.0 ((charge m1)))20.0)) ((+ 0.0)))(free\_m m1))  
Effetti positivi: (AND )  
Effetti negativi: (AND )  
Numeric Effects: (AND (assign (charge m1) (+ 20.0)))  
 Conditional Effects:(AND )  
(Pddl+ semantics) Plan is valid:false  
Problem Solved  
0.00000: (m-charging m1 )  
0.00000: (m-move\_to\_crate-A crate2 m2 )  
0.00000: (m-move\_to\_crate-A crate2 m1 )  
(0.00000,2.00000)------>waiting  
2.00000: (m-at\_crates-A crate2 m1 )  
2.00000: (m-at\_crates-A crate2 m2 )  
2.00000: (m-load-F\_A crate2 m1 m2 )  
2.00000: (m-move\_create\_to\_loading\_bay-H crate2 m1 m2 )  
(2.00000,10.00000)------>waiting  
10.00000: (crate\_at\_loading\_bay-H crate2 m1 m2 )  
10.00000: (m-download-F crate2 m1 m2 )  
10.00000: (m-charging m1 )  
10.00000: (m-move\_to\_crate-A crate1 m1 )  
10.00000: (m-charging m2 )  
10.00000: (m-move\_to\_crate-A crate1 m2 )  
(10.00000,11.00000)------>waiting  
11.00000: (m-at\_crates-A crate1 m1 )  
11.00000: (m-at\_crates-A crate1 m2 )  
11.00000: (m-load\_H-A crate1 m1 m2 )  
11.00000: (m-move\_create\_to\_loading\_bay-H crate1 m1 m2 )  
(11.00000,13.00000)------>waiting  
13.00000: (l-load-F crate2 l )  
(13.00000,18.00000)------>waiting  
18.00000: (crate\_at\_loading\_bay-H crate1 m1 m2 )  
18.00000: (m-download-H crate1 m1 m2 )  
18.00000: (m-charging m2 )  
18.00000: (m-charging m1 )  
18.00000: (m-move\_to\_crate-B crate4 m2 )  
18.00000: (m-move\_to\_crate-B crate3 m1 )  
(18.00000,19.00000)------>waiting  
19.00000: (m-at\_crates-B crate4 m2 )  
19.00000: (crate\_on\_conveyor\_belt\_fragile-F crate2 l )  
19.00000: (l-load crate1 l )  
19.00000: (m-load-B crate4 m2 )  
19.00000: (m-move\_create\_to\_loading\_bay crate4 m2 )  
(19.00000,20.00000)------>waiting  
20.00000: (m-at\_crates-B crate3 m1 )  
20.00000: (m-load-B crate3 m1 )  
20.00000: (m-move\_create\_to\_loading\_bay crate3 m1 )  
(20.00000,23.00000)------>waiting  
23.00000: (crate\_at\_loading\_bay crate4 m2 )  
23.00000: (crate\_on\_conveyor\_belt crate1 l )  
23.00000: (m-download crate4 m2 )  
23.00000: (l-load crate4 l )(23.00000,24.00000)------>waiting  
24.00000: (crate\_at\_loading\_bay crate3 m1 )  
24.00000: (m-download crate3 m1 )  
24.00000: (l-load\_cheap-L crate3 ll )  
(24.00000,27.00000)------>waiting  
27.00000: (crate\_on\_conveyor\_belt crate4 l )  
(27.00000,28.00000)------>waiting  
28.00000: (crate\_on\_conveyor\_belt\_cheap-L crate3 ll )

Plan-Length:69  
Duration:0.0  
Metric (Plan):0.0  
Metric (Search):55.0  
Planning Time:1675  
Heuristic Time:6  
Search Time:1479  
Expanded Nodes:111771  
States Evaluated:122264  
Fixed constraint violations during search (zero-crossing):0  
Number of Dead-Ends detected:0  
Number of Duplicates detected:121460

Rivi Alice 5135011

Scamarcia Angelica 5290802

Vaselli Alessandro 5320822