**Artificial Intelligence for Robotics 2**

**Assignment 1**

**Output problem 1**

**Problem 1 – standard configuration:**

Domain parsed  
Problem parsed  
Grounding..  
Light Validation Completed  
Simplification..  
(Pre Simplification) - |A|+|P|+|E|: 202  
(After Easy Simplification) - |A|+|P|+|E|: 78  
(After AIBR):76  
(Pre Simplification) - |A|+|P|+|E|: 202  
(After Easy Simplification) - |A|+|P|+|E|: 78  
(After AIBR):76  
Grounding and Simplification finished  
|A|:38  
|P|:19  
|E|:19  
Size(X):16  
Size(F):38  
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|:76  
h(n = s\_0)=600.0  
f(n) = 600.0 (Expanded Nodes: 0, Evaluated States: 0, Time: 0.008)  
f(n) = 719.0 (Expanded Nodes: 1, Evaluated States: 4, Time: 0.019)  
Starting Validation  
(Pre Simplification) - |A|+|P|+|E|: 202  
(After Easy Simplification) - |A|+|P|+|E|: 78  
(After AIBR):76  
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 crate2 m1 )  
0.00000: (m-move\_to\_crate-A crate2 m2 )  
(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-L\_F crate2 m1 m2 )§  
(2.00000,5.00000)------>waiting  
5.00000: (crate\_at\_loading\_bay-L\_F crate2 m1 m2 )  
5.00000: (m-download-F crate2 m1 m2 )  
5.00000: (l-load-F crate2 l )  
5.00000: (m-charging m1 )  
(5.00000,11.00000)------>waiting  
11.00000: (crate\_on\_conveyor\_belt\_fragile-F crate2 l )  
11.00000: (m-move\_to\_crate-A crate3 m1 )  
(11.00000,13.00000)------>waiting  
13.00000: (m-at\_crates-A crate3 m1 )  
13.00000: (m-load-A crate3 m1 )  
13.00000: (m-move\_create\_to\_loading\_bay crate3 m1 )  
(13.00000,17.00000)------>waiting  
17.00000: (crate\_at\_loading\_bay crate3 m1 )  
17.00000: (m-download crate3 m1 )  
17.00000: (l-load crate3 l )  
17.00000: (m-charging m1 )  
17.00000: (m-move\_to\_crate crate1 m1 )  
17.00000: (m-charging m2 )  
17.00000: (m-move\_to\_crate crate1 m2 )  
(17.00000,18.00000)------>waiting  
18.00000: (m-at\_crates crate1 m1 )  
18.00000: (m-at\_crates crate1 m2 )  
18.00000: (m-load-H crate1 m1 m2 )  
18.00000: (m-move\_create\_to\_loading\_bay-H crate1 m1 m2 )  
(18.00000,21.00000)------>waiting  
21.00000: (crate\_on\_conveyor\_belt crate3 l )  
(21.00000,25.00000)------>waiting  
25.00000: (crate\_at\_loading\_bay-H crate1 m1 m2 )  
25.00000: (m-download-H crate1 m1 m2 )  
25.00000: (l-load crate1 l )  
25.00000: (m-charging m1 )  
25.00000: (m-charging m2 )  
(25.00000,29.00000)------>waiting  
29.00000: (crate\_on\_conveyor\_belt crate1 l )

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 1 – opt-hmax configuration:**

Domain parsed  
Problem parsed  
Grounding..  
Light Validation Completed  
A\* with numeric hrmax  
Simplification..  
(Pre Simplification) - |A|+|P|+|E|: 202  
(After Easy Simplification) - |A|+|P|+|E|: 78  
(After AIBR):76  
(Pre Simplification) - |A|+|P|+|E|: 202  
(After Easy Simplification) - |A|+|P|+|E|: 78  
(After AIBR):76  
Grounding and Simplification finished  
|A|:38  
|P|:19  
|E|:19  
Size(X):16  
Size(F):38  
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: 6  
Simple Conditions: 57  
Reachable actions and processes: |A U P U E|:76  
h(n = s\_0)=17.0  
f(n) = 17.0 (Expanded Nodes: 0, Evaluated States: 0, Time: 0.014)  
f(n) = 21.0 (Expanded Nodes: 1, Evaluated States: 4, Time: 0.016)  
f(n) = 23.0 (Expanded Nodes: 3, Evaluated States: 9, Time: 0.018)  
f(n) = 24.0 (Expanded Nodes: 6, Evaluated States: 16, Time: 0.021)  
f(n) = 25.0 (Expanded Nodes: 10, Evaluated States: 21, Time: 0.022)  
f(n) = 26.0 (Expanded Nodes: 15, Evaluated States: 32, Time: 0.024)  
f(n) = 27.0 (Expanded Nodes: 25, Evaluated States: 50, Time: 0.026)  
f(n) = 28.0 (Expanded Nodes: 57, Evaluated States: 120, Time: 0.033)  
f(n) = 29.0 (Expanded Nodes: 68, Evaluated States: 144, Time: 0.035)  
f(n) = 30.0 (Expanded Nodes: 84, Evaluated States: 174, Time: 0.037)  
f(n) = 31.0 (Expanded Nodes: 104, Evaluated States: 208, Time: 0.039)  
f(n) = 32.0 (Expanded Nodes: 126, Evaluated States: 240, Time: 0.041)  
f(n) = 33.0 (Expanded Nodes: 152, Evaluated States: 282, Time: 0.043)  
f(n) = 34.0 (Expanded Nodes: 194, Evaluated States: 355, Time: 0.048)  
f(n) = 35.0 (Expanded Nodes: 245, Evaluated States: 443, Time: 0.053)  
f(n) = 36.0 (Expanded Nodes: 305, Evaluated States: 546, Time: 0.058)  
f(n) = 37.0 (Expanded Nodes: 435, Evaluated States: 857, Time: 0.069)  
f(n) = 38.0 (Expanded Nodes: 929, Evaluated States: 1913, Time: 0.106)  
f(n) = 39.0 (Expanded Nodes: 1427, Evaluated States: 2664, Time: 0.133)  
f(n) = 40.0 (Expanded Nodes: 1967, Evaluated States: 3649, Time: 0.165)  
f(n) = 41.0 (Expanded Nodes: 2717, Evaluated States: 4915, Time: 0.202)  
f(n) = 42.0 (Expanded Nodes: 3743, Evaluated States: 6156, Time: 0.247)  
f(n) = 43.0 (Expanded Nodes: 4417, Evaluated States: 6902, Time: 0.265)  
f(n) = 44.0 (Expanded Nodes: 4944, Evaluated States: 7585, Time: 0.279)  
Starting Validation  
(Pre Simplification) - |A|+|P|+|E|: 202  
(After Easy Simplification) - |A|+|P|+|E|: 78  
(After AIBR):76  
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 m2 )  
(0.00000,2.00000)------>waiting  
2.00000: (m-at\_crates-A crate3 m2 )  
2.00000: (m-load-A crate3 m2 )  
2.00000: (m-move\_create\_to\_loading\_bay crate3 m2 )  
(2.00000,6.00000)------>waiting  
6.00000: (crate\_at\_loading\_bay crate3 m2 )  
6.00000: (m-download crate3 m2 )  
6.00000: (m-charging m2 )  
6.00000: (m-move\_to\_crate-A crate2 m2 )  
6.00000: (m-move\_to\_crate-A crate2 m1 )  
(6.00000,8.00000)------>waiting  
8.00000: (m-at\_crates-A crate2 m1 )  
8.00000: (m-at\_crates-A crate2 m2 )  
8.00000: (m-load-F\_A crate2 m1 m2 )  
8.00000: (m-move\_create\_to\_loading\_bay-L\_F crate2 m1 m2 )  
(8.00000,11.00000)------>waiting  
11.00000: (crate\_at\_loading\_bay-L\_F crate2 m1 m2 )  
11.00000: (m-download-F crate2 m1 m2 )  
11.00000: (m-charging m2 )  
11.00000: (m-charging m1 )  
11.00000: (m-move\_to\_crate crate1 m1 )  
11.00000: (m-move\_to\_crate crate1 m2 )  
(11.00000,12.00000)------>waiting  
12.00000: (m-at\_crates crate1 m1 )  
12.00000: (m-at\_crates crate1 m2 )  
12.00000: (m-load-H crate1 m1 m2 )  
12.00000: (m-move\_create\_to\_loading\_bay-H crate1 m1 m2 )  
12.00000: (l-load\_cheap-L\_F crate2 ll )  
(12.00000,18.00000)------>waiting  
18.00000: (crate\_on\_conveyor\_belt\_cheap-L\_F crate2 ll )  
(18.00000,19.00000)------>waiting  
19.00000: (crate\_at\_loading\_bay-H crate1 m1 m2 )  
19.00000: (m-download-H crate1 m1 m2 )  
19.00000: (l-load\_cheap-L crate3 ll )  
19.00000: (l-load crate1 l )  
(19.00000,23.00000)------>waiting  
23.00000: (crate\_on\_conveyor\_belt\_cheap-L crate3 ll )  
23.00000: (crate\_on\_conveyor\_belt crate1 l )

Plan-Length:54  
Duration:23.0  
Metric (Plan):0.0  
Metric (Search):43.0  
Planning Time:469  
Heuristic Time:162  
Search Time:280  
Expanded Nodes:4988  
States Evaluated:7638  
Fixed constraint violations during search (zero-crossing):0  
Number of Dead-Ends detected:1198  
Number of Duplicates detected:4813

**Problem 1 – opt-blind configuration:**

Domain parsed  
Problem parsed  
Grounding..  
Light Validation Completed  
A\* with 0-1 goal heuristic  
Simplification..  
(Pre Simplification) - |A|+|P|+|E|: 202  
(After Easy Simplification) - |A|+|P|+|E|: 78  
(Pre Simplification) - |A|+|P|+|E|: 202  
(After Easy Simplification) - |A|+|P|+|E|: 78  
(After AIBR):76  
Grounding and Simplification finished  
|A|:38  
|P|:20  
|E|:20  
Size(X):16  
Size(F):39  
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|:76  
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: 4, Time: 0.001)  
f(n) = 3.0 (Expanded Nodes: 5, Evaluated States: 12, Time: 0.002)  
f(n) = 4.0 (Expanded Nodes: 13, Evaluated States: 28, Time: 0.004)  
f(n) = 5.0 (Expanded Nodes: 29, Evaluated States: 52, Time: 0.005)  
f(n) = 6.0 (Expanded Nodes: 53, Evaluated States: 79, Time: 0.007)  
f(n) = 7.0 (Expanded Nodes: 80, Evaluated States: 96, Time: 0.008)  
f(n) = 8.0 (Expanded Nodes: 97, Evaluated States: 111, Time: 0.009)  
f(n) = 9.0 (Expanded Nodes: 112, Evaluated States: 124, Time: 0.01)  
f(n) = 10.0 (Expanded Nodes: 125, Evaluated States: 137, Time: 0.01)  
f(n) = 11.0 (Expanded Nodes: 138, Evaluated States: 150, Time: 0.011)  
f(n) = 12.0 (Expanded Nodes: 151, Evaluated States: 170, Time: 0.011)  
f(n) = 13.0 (Expanded Nodes: 171, Evaluated States: 215, Time: 0.012)  
f(n) = 14.0 (Expanded Nodes: 216, Evaluated States: 291, Time: 0.013)  
f(n) = 15.0 (Expanded Nodes: 292, Evaluated States: 410, Time: 0.015)  
f(n) = 16.0 (Expanded Nodes: 411, Evaluated States: 595, Time: 0.018)  
f(n) = 17.0 (Expanded Nodes: 596, Evaluated States: 848, Time: 0.022)  
f(n) = 18.0 (Expanded Nodes: 849, Evaluated States: 1141, Time: 0.025)  
f(n) = 19.0 (Expanded Nodes: 1142, Evaluated States: 1397, Time: 0.029)  
f(n) = 20.0 (Expanded Nodes: 1398, Evaluated States: 1652, Time: 0.032)  
f(n) = 21.0 (Expanded Nodes: 1653, Evaluated States: 1920, Time: 0.035)  
f(n) = 22.0 (Expanded Nodes: 1921, Evaluated States: 2185, Time: 0.039)  
f(n) = 23.0 (Expanded Nodes: 2186, Evaluated States: 2447, Time: 0.042)  
f(n) = 24.0 (Expanded Nodes: 2448, Evaluated States: 2759, Time: 0.045)  
f(n) = 25.0 (Expanded Nodes: 2760, Evaluated States: 3163, Time: 0.051)  
f(n) = 26.0 (Expanded Nodes: 3164, Evaluated States: 3781, Time: 0.056)  
f(n) = 27.0 (Expanded Nodes: 3782, Evaluated States: 4687, Time: 0.067)  
f(n) = 28.0 (Expanded Nodes: 4688, Evaluated States: 5797, Time: 0.08)  
f(n) = 29.0 (Expanded Nodes: 5798, Evaluated States: 7031, Time: 0.096)  
f(n) = 30.0 (Expanded Nodes: 7032, Evaluated States: 8121, Time: 0.112)  
f(n) = 31.0 (Expanded Nodes: 8122, Evaluated States: 8787, Time: 0.126)  
f(n) = 32.0 (Expanded Nodes: 8788, Evaluated States: 9269, Time: 0.134)  
f(n) = 33.0 (Expanded Nodes: 9270, Evaluated States: 9577, Time: 0.14)  
f(n) = 34.0 (Expanded Nodes: 9578, Evaluated States: 9791, Time: 0.143)  
f(n) = 35.0 (Expanded Nodes: 9792, Evaluated States: 9975, Time: 0.147)  
f(n) = 36.0 (Expanded Nodes: 9976, Evaluated States: 10159, Time: 0.149)  
f(n) = 37.0 (Expanded Nodes: 10160, Evaluated States: 10343, Time: 0.151)  
f(n) = 38.0 (Expanded Nodes: 10344, Evaluated States: 10531, Time: 0.154)  
f(n) = 39.0 (Expanded Nodes: 10532, Evaluated States: 10789, Time: 0.156)  
f(n) = 40.0 (Expanded Nodes: 10790, Evaluated States: 11211, Time: 0.159)  
f(n) = 41.0 (Expanded Nodes: 11212, Evaluated States: 11519, Time: 0.164)  
f(n) = 42.0 (Expanded Nodes: 11520, Evaluated States: 11711, Time: 0.167)  
f(n) = 43.0 (Expanded Nodes: 11712, Evaluated States: 11905, Time: 0.169)  
Starting Validation  
(Pre Simplification) - |A|+|P|+|E|: 202  
(After Easy Simplification) - |A|+|P|+|E|: 78  
(After AIBR):76  
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 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-L\_F crate2 m1 m2 )  
(2.00000,5.00000)------>waiting  
5.00000: (crate\_at\_loading\_bay-L\_F crate2 m1 m2 )  
5.00000: (m-download-F crate2 m1 m2 )  
5.00000: (m-charging m1 )  
5.00000: (m-move\_to\_crate-A crate3 m1 )  
5.00000: (m-charging m2 )  
(5.00000,7.00000)------>waiting  
7.00000: (m-at\_crates-A crate3 m1 )  
7.00000: (m-load-A crate3 m1 )  
7.00000: (m-move\_create\_to\_loading\_bay crate3 m1 )  
(7.00000,10.00000)------>waiting  
10.00000: (m-move\_to\_crate crate1 m2 )  
(10.00000,11.00000)------>waiting  
11.00000: (m-at\_crates crate1 m2 )  
11.00000: (crate\_at\_loading\_bay crate3 m1 )  
11.00000: (m-download crate3 m1 )  
11.00000: (m-charging m1 )  
11.00000: (m-move\_to\_crate crate1 m1 )  
(11.00000,12.00000)------>waiting  
12.00000: (m-at\_crates crate1 m1 )  
12.00000: (l-load\_cheap-L crate3 ll )  
12.00000: (m-load-H crate1 m1 m2 )  
12.00000: (m-move\_create\_to\_loading\_bay-H crate1 m1 m2 )  
(12.00000,16.00000)------>waiting  
16.00000: (crate\_on\_conveyor\_belt\_cheap-L crate3 ll )  
16.00000: (l-load\_cheap-L\_F crate2 ll )  
(16.00000,19.00000)------>waiting  
19.00000: (crate\_at\_loading\_bay-H crate1 m1 m2 )  
19.00000: (m-download-H crate1 m1 m2 )  
19.00000: (l-load crate1 l )  
(19.00000,22.00000)------>waiting  
22.00000: (crate\_on\_conveyor\_belt\_cheap-L\_F crate2 ll )  
(22.00000,23.00000)------>waiting  
23.00000: (crate\_on\_conveyor\_belt crate1 l )

Plan-Length:54  
Duration:23.0  
Metric (Plan):0.0  
Metric (Search):43.0  
Planning Time:351  
Heuristic Time:0  
Search Time:170  
Expanded Nodes:11774  
States Evaluated:11974  
Fixed constraint violations during search (zero-crossing):0  
Number of Dead-Ends detected:0  
Number of Duplicates detected:13964

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