

AU 332 ARTIFICIAL INTELLIGENCE: PRINCIPLES AND TECHNIQUES

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HW#: 4

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I. INTRODUCTION

A. Purpose

The goal of this week's lab is to review the four methods of search including bfs,dfs,ucs and astar search.And it needs you to realize those algorithms with python.Besides that,you also need calculate the complexity or path with the medthods mentuone below.

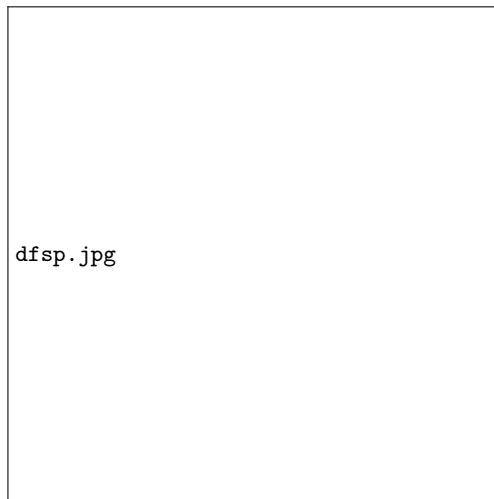
B. Equipment

There is a minimal amount of equipment to be used in this homework. The few requirements are listed below:

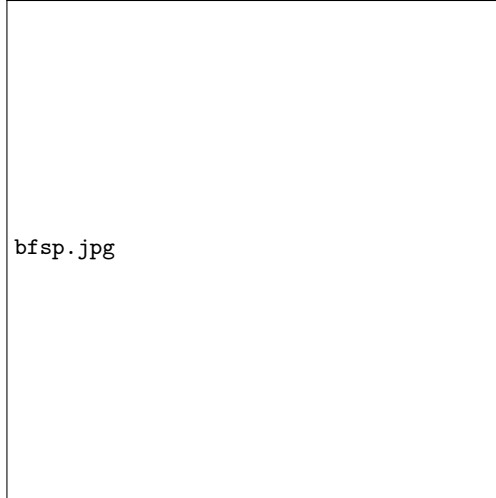
- python
- queue (priority queue and LIFO queue))

II. HOMEWORK

A. Graph Traversal



(a) DFS



(b) BFS

- bfs time complexy $O(n*d)$
- bfs space complexy $O(n)$
- dfs time complexy $O(n*d)$
- dfs space complexy $O(n)$

B. Uniform Cost Search Algorithm

- step1 'A': None
[(0, 'A')]
- step2 'A': None, 'B': 'A'
[(10, 'B')]
- step3 'A': None, 'B': 'A', 'D': 'A'
[(10, 'B'), (20, 'D')]
- step4 'A': None, 'B': 'A', 'D': 'A', 'C': 'A'
[(3, 'C'), (20, 'D'), (10, 'B')]
- step5 'A': None, 'B': 'C', 'D': 'A', 'C': 'A'
[(5, 'B'), (20, 'D'), (10, 'B')]
- step6 'A': None, 'B': 'C', 'D': 'A', 'C': 'A', 'E': 'C'
[(5, 'B'), (18, 'E'), (10, 'B'), (20, 'D')]
- step7 'A': None, 'B': 'C', 'D': 'B', 'C': 'A', 'E': 'C'
[(10, 'B'), (10, 'D'), (20, 'D'), (18, 'E')]

C. A* Algorithm

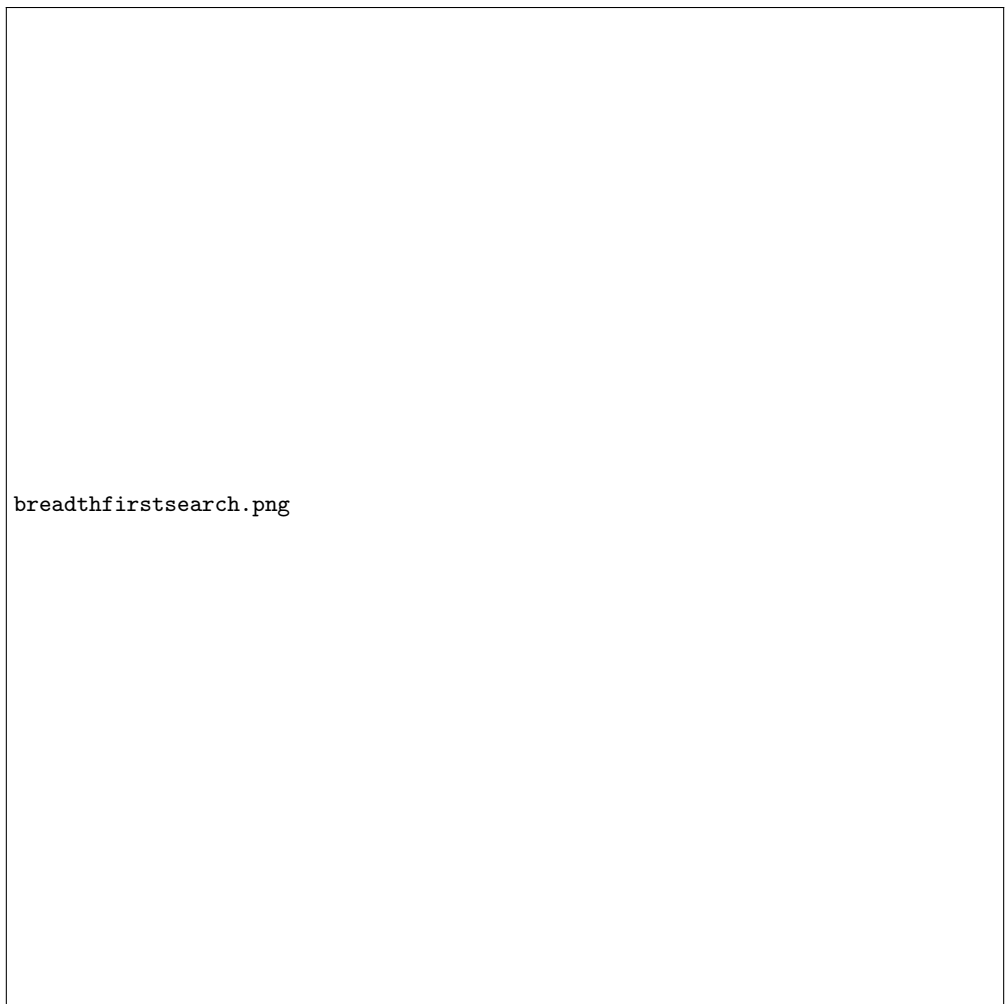
- heuristic function = Euclidean distances
- step1 [(1,2)]
[(4,(2,2)),(5.12,(1,1)), (5.12,(1,3)),(6,(0,2))]

- step2 [(1,2),(2,2)]
[(5.16,(2,1)),(5.16,(2,3)),(5.12,(1,1)), (5.12,(1,3)),(6,(0,2))]
- step3 [(1,2),(2,2),(1,1)]
[(6.47,(1,0)),(7.09,(0,1)),(5.16,(2,1)),(5.16,(2,3)), (5.12,(1,3)),(6,(0,2))]
- step4 [(1,2),(2,2),(1,1),(1,3)]
[(6.47,(1,4)),(7.09,(0,3)),(6.47,(1,0)),(7.09,(0,1)),(5.16,(2,1)),(5.16,(2,3)), (6,(0,2))]
- step5 [(1,2),(2,2),(1,1),(1,3),(2,1)]
[(6.6,(2,0)),(6.47,(1,4)),(7.09,(0,3)),(6.47,(1,0)),(7.09,(0,1)),(5.16,(2,3)), (6,(0,2))]
- step6 [(1,2),(2,2),(1,1),(1,3),(2,1),(2,3)]
[(6.6,(2,4)),(6.6,(2,0)),(6.47,(1,4)),(7.09,(0,3)),(6.47,(1,0)),(7.09,(0,1)), (6,(0,2))]
- step7 [(1,2),(2,2),(1,1),(1,3),(2,1),(2,3),(0,2)]
[(6.6,(2,4)),(6.6,(2,0)),(6.47,(1,4)),(7.09,(0,3)),(6.47,(1,0)),(7.09,(0,1))]
- step8 [(1,2),(2,2),(1,1),(1,3),(2,1),(2,3),(0,2),(1,4)]
[(8.38,(0,4)),(6.6,(2,4)),(6.6,(2,0)),(7.09,(0,3)),(6.47,(1,0)),(7.09,(0,1))]
- step9 [(1,2),(2,2),(1,1),(1,3),(2,1),(2,3),(0,2),(1,4),(1,0)]
[(8.38,(0,0)),(8.38,(0,4)),(6.6,(2,4)),(6.6,(2,0)),(7.09,(0,3)),(7.09,(0,1))]
- step10 [(1,2),(2,2),(1,1),(1,3),(2,1),(2,3),(0,2),(1,4),(1,0),(2,0)]
[(6.82,(3,0)),(8.38,(0,0)),(8.38,(0,4)),(6.6,(2,4)),(7.09,(0,3)),(7.09,(0,1))]
- step11 [(1,2),(2,2),(1,1),(1,3),(2,1),(2,3),(0,2),(1,4),(1,0),(2,0),(2,4)]
[(6.82,(3,4)),(6.82,(3,0)),(8.38,(0,0)),(8.38,(0,4)),(7.09,(0,3)),(7.09,(0,1))]
- step12 [(1,2),(2,2),(1,1),(1,3),(2,1),(2,3),(0,2),(1,4),(1,0),(2,0),(2,4),(3,0)]
[(7.23,(4,0)),(6.82,(3,4)),(8.38,(0,0)),(8.38,(0,4)),(7.09,(0,3)),(7.09,(0,1))]
- step13 [(1,2),(2,2),(1,1),(1,3),(2,1),(2,3),(0,2),(1,4),(1,0),(2,0),(2,4),(3,0),(3,4)]
[(7.23,(4,4)),(7.23,(4,0)),(8.38,(0,0)),(8.38,(0,4)),(7.09,(0,3)),(7.09,(0,1))]
- step14 [(1,2),(2,2),(1,1),(1,3),(2,1),(2,3),(0,2),(1,4),(1,0),(2,0),(2,4),(3,0),(3,4),(0,3)]
[(7.23,(4,4)),(7.23,(4,0)),(8.38,(0,0)),(8.38,(0,4)),(7.09,(0,1))]
- step15 [(1,2),(2,2),(1,1),(1,3),(2,1),(2,3),(0,2),(1,4),(1,0),(2,0),(2,4),(3,0),(3,4),(0,3),(0,1)]
[(7.23,(4,4)),(7.23,(4,0)),(8.38,(0,0)),(8.38,(0,4))]
- step16 [(1,2),(2,2),(1,1),(1,3),(2,1),(2,3),(0,2),(1,4),(1,0),(2,0),(2,4),(3,0),(3,4),(0,3),(0,1),(4,0)]
[(7.41,(4,1)),(8,(5,0)),(7.23,(4,4)),(8.38,(0,0)),(8.38,(0,4))]
- step17 [(1,2),(2,2),(1,1),(1,3),(2,1),(2,3),(0,2),(1,4),(1,0),(2,0),(2,4),(3,0),(3,4),(0,3),(0,1),(4,0),(4,4)]
[(7.41,(4,3)),(8,(5,4)),(7.41,(4,1)),(8,(5,0)),(8.38,(0,0)),(8.38,(0,4))]
- step18 [(1,2),(2,2),(1,1),(1,3),(2,1),(2,3),(0,2),(1,4),(1,0),(2,0),(2,4),(3,0),(3,4),(0,3),(0,1),(4,0),(4,4),(4,3)]
[(8,(4,2)),(8,(5,3)),(8,(5,4)),(7.41,(4,1)),(8,(5,0)),(8.38,(0,0)),(8.38,(0,4))]
- step19 [(1,2),(2,2),(1,1),(1,3),(2,1),(2,3),(0,2),(1,4),(1,0),(2,0),(2,4),(3,0),(3,4),(0,3),(0,1),(4,0),(4,4),(4,3),(4,1)]
[(8,(5,1)),(8,(4,2)),(8,(5,3)),(8,(5,4)),(8,(5,0)),(8.38,(0,0)),(8.38,(0,4))]
- step20 [(1,2),(2,2),(1,1),(1,3),(2,1),(2,3),(0,2),(1,4),(1,0),(2,0),(2,4),(3,0),(3,4),(0,3),(0,1),(4,0),(4,4),(4,3),(4,1),(5,1)]
[(8,(5,2)),(8,(4,2)),(8,(5,3)),(8,(5,4)),(8,(5,0)),(8.38,(0,0)),(8.38,(0,4))]
- step20 [(1,2),(2,2),(1,1),(1,3),(2,1),(2,3),(0,2),(1,4),(1,0),(2,0),(2,4),(3,0),(3,4),(0,3),(0,1),(4,0),(4,4),(4,3),(4,1),(5,1)]
[(9.41,(6,1)),(8,(5,2)),(8,(4,2)),(8,(5,3)),(8,(5,4)),(8,(5,0)),(8.38,(0,0)),(8.38,(0,4))]
- step21 [(1,2),(2,2),(1,1),(1,3),(2,1),(2,3),(0,2),(1,4),(1,0),(2,0),(2,4),(3,0),(3,4),(0,3),(0,1),(4,0),(4,4),(4,3),(4,1),(5,1),(5,2)]
[(9.41,(6,1)),(8,(4,2)),(8,(5,3)),(8,(5,4)),(8,(5,0)),(8.38,(0,0)),(8.38,(0,4))]

D. Codes

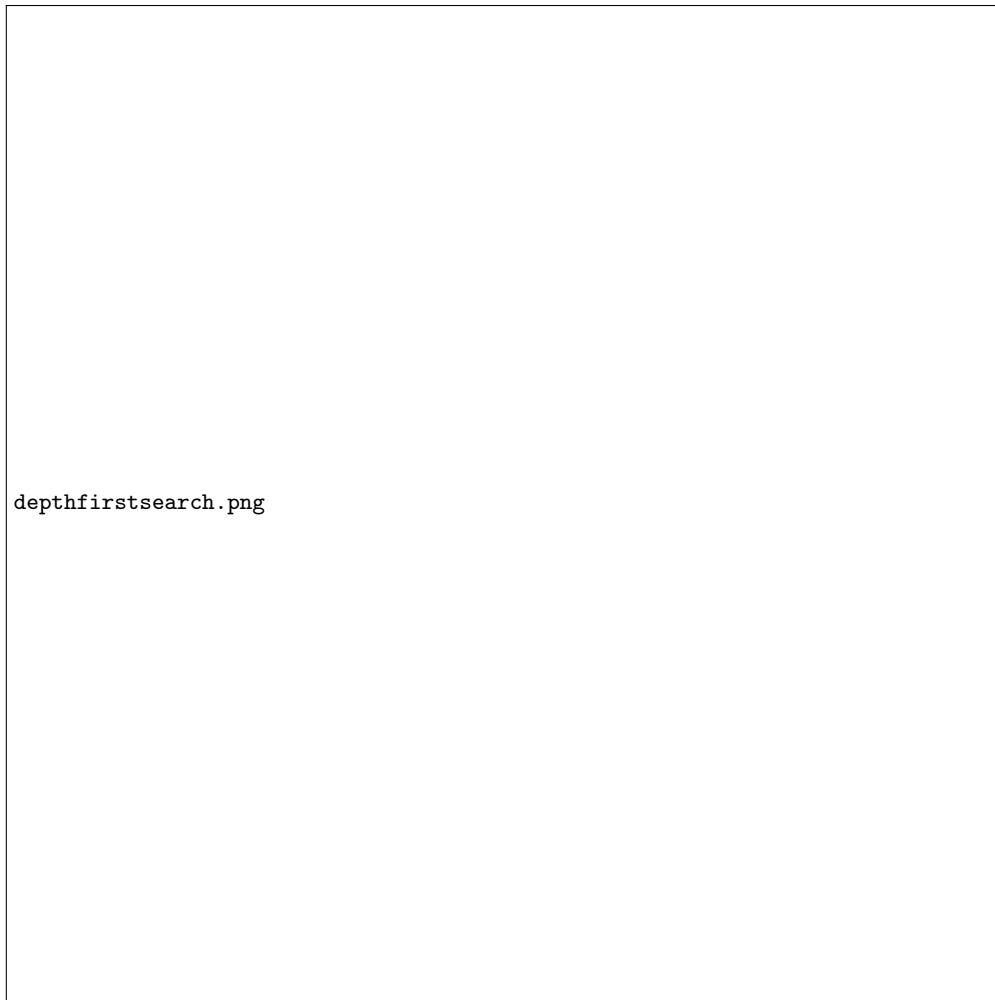


(c) reconstructpath



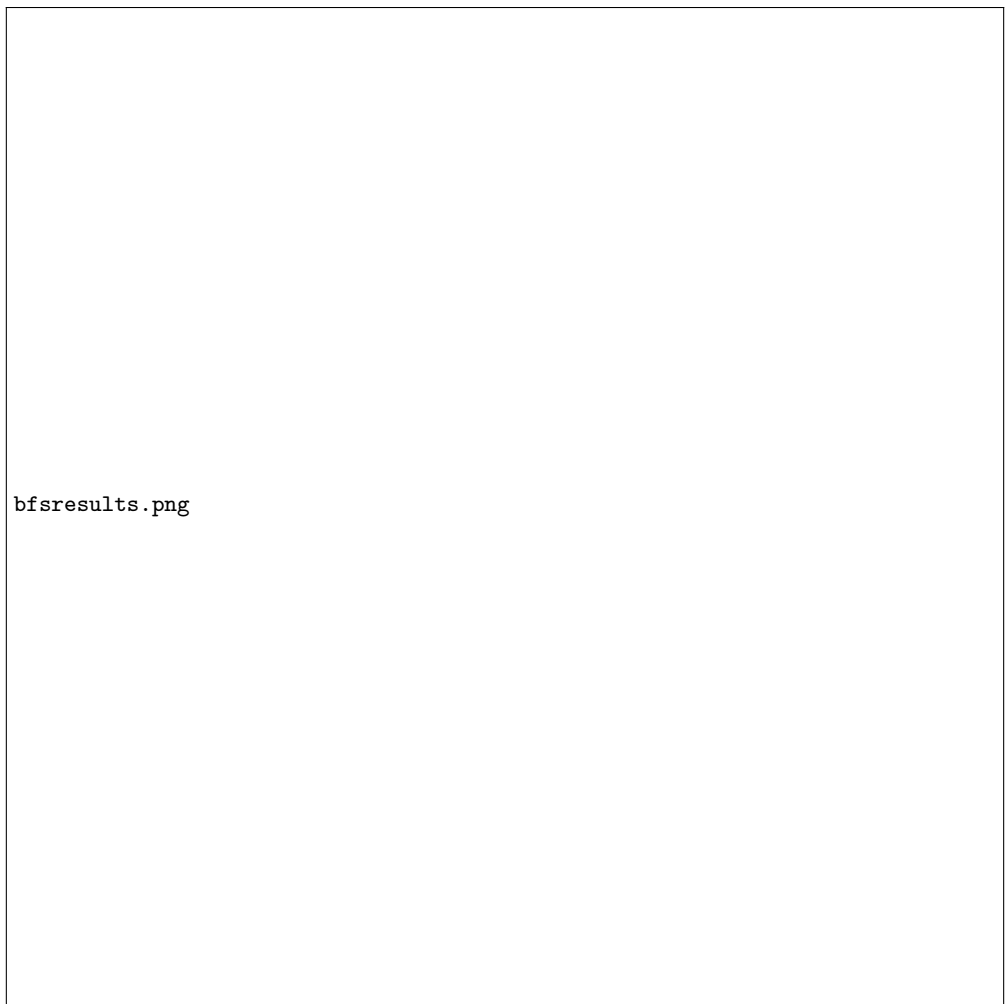
breadthfirstsearch.png

(d) breadth first search



depthfirstsearch.png

(e) depth first search



bfsresults.png

(f) Results of bfs and dfs



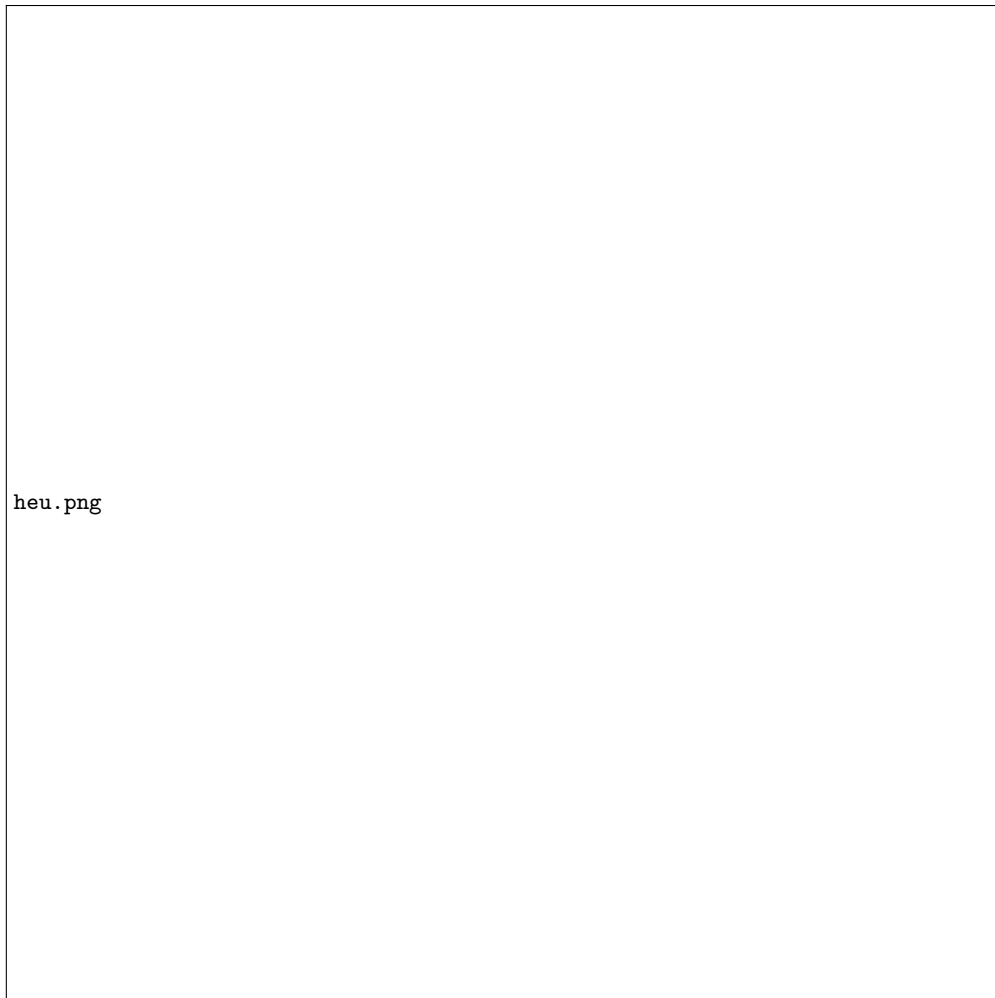
ucs.png

(g) uniform cost search



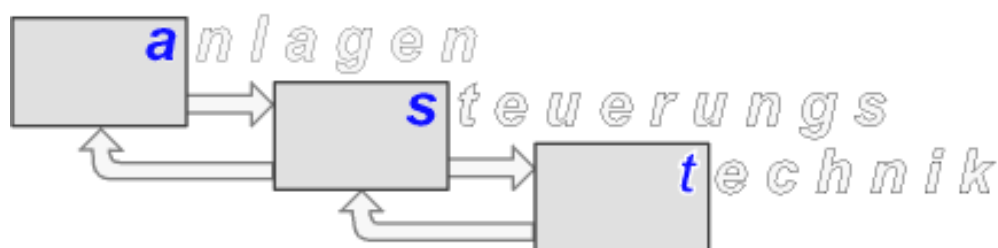
ucsresults.png

(h) Results of ucs

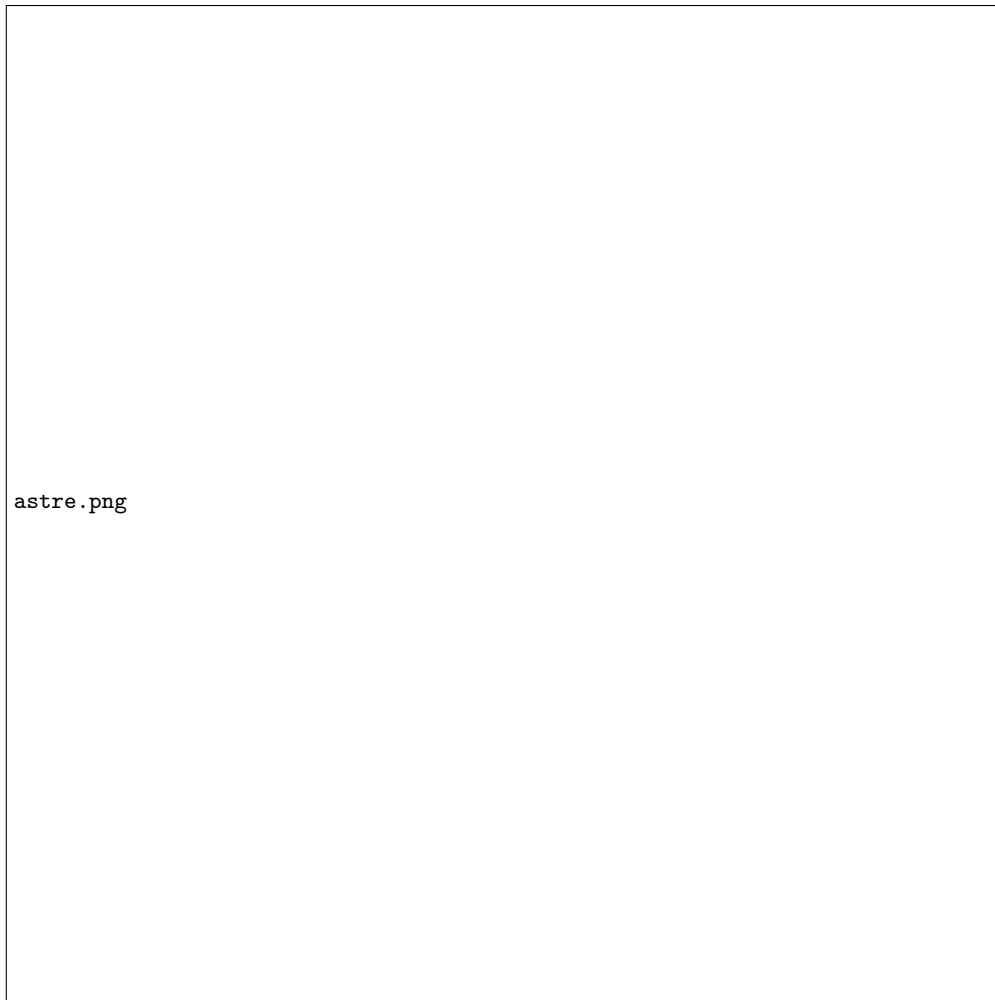


heu.png

(i) heuristic



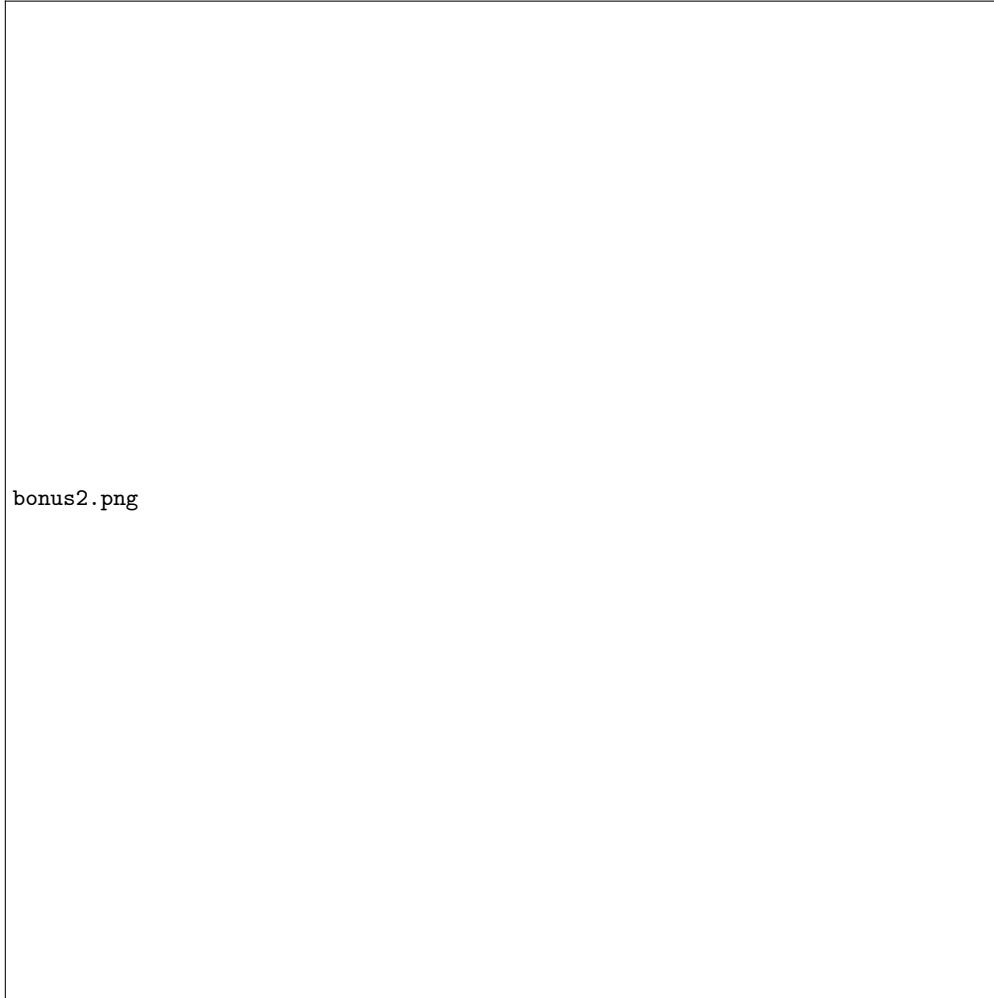
(j) A star search



(k) Results of astar search

E. bonus solution

1. *bonus1 solution*



bonus2.png

(1) Extra credit 5.1

2. *bonus2 solution*

It can be proved that the graph satisfies the consistency of heuristics. because what I choose to be the heuristics is Euclidean distances. As we all know, if $h(A) \leq \text{cost}(A \text{ to } C) + h(C)$. The heuristics is consistent. In this graph, the cost of every step is 1, so $\text{cost}(A \text{ to } C) \geq \text{Euclidean distances}(A \text{ to } C)$. Because of Triangle law, $h(A) - h(C) \leq \text{Euclidean distances}(A \text{ to } C) \leq \text{cost}(A \text{ to } C)$.