Introduction to Artificial Intelligence

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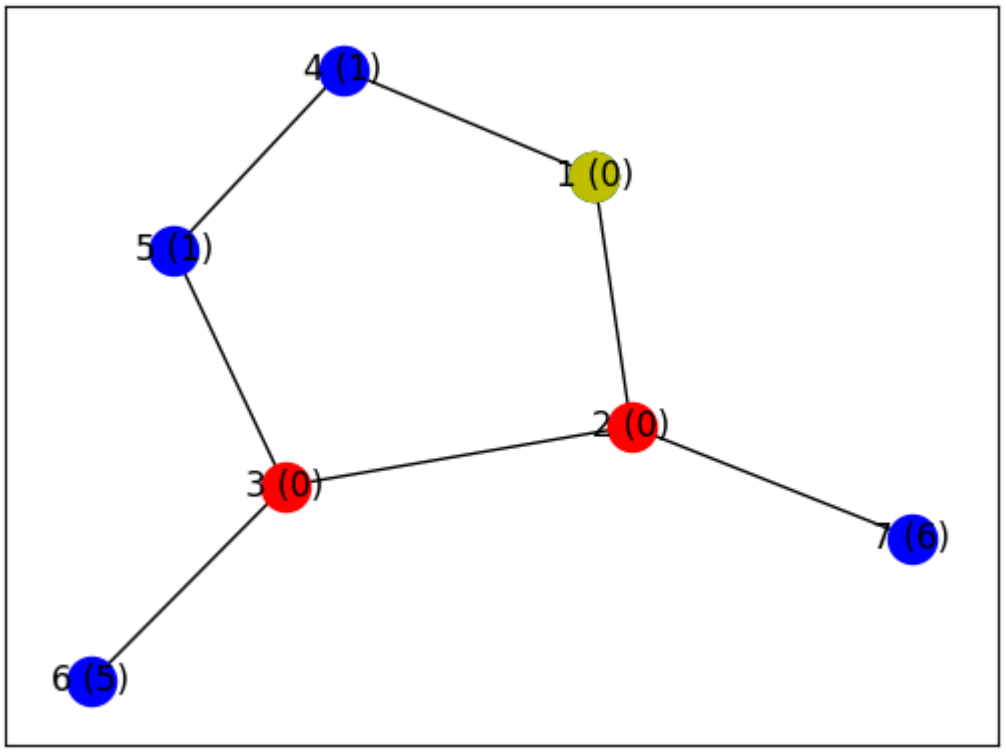
We used in our program a simple heuristic function as shown in class. The heuristic value of a state is the amount of people the agent already saved + the people he could save if the agent chose to move forward to this state.
For the different game mods the score of each agent is calculated differently and the utility value corresponds.

We will show example runs of the 3 different games:

First we will use this environment to demonstrate the difference between the adversarial game to the others.



In this example, both agents start at node 1. Nodes 2,3 are brittle, nodes 4,5 contain 1 person, node 7 contains 6 people, and node 6 contains 5 people.
Notice that nodes 6,7 contain the most people, so the agents will want to go to them.

In adversarial mode, when the depth is high enough, agent 1 will try to go to node 6, through nodes 2 and 3. That means that he will rather pick up 5 people (at node 7), rather than picking up 6 people (in node 7). That way, he will not pick up the 6 people at node 7, but rather only pick up the 5 people at node 6. He acts that way since that leaves node 7 unreachable, so agent 2 will not be able to pick up these people. Therefore, agent 1 will pick

up 5 people, agent 2 will pick up 2 people (nodes 4,5). If agent 1 would go to node 7, agent 2 would be able to pick up the rest 7 people.

In semi-cooperative mode, agent 1 would look at his score first, so he would prefer to go node 4 and take the long route to node 6, since that way he would pick up 7 people. That would leave agent 2 wanting to go to node 7 and pick up the 6 people there, making the final score agent1: 7, agent2:6

In fully-cooperative, when the depth is high enough, both agents will work together to pick up all people. They will first pick up the people at nodes 4,5 (they don't care who), and then 1 agent will break node 3 in order to go to node 6, and the other will break node 2 in order to go to node 7. In our run, agent 1 could have taken the path [1,4,5,6], where he would pick up 7 people, but he chose a path in which he picks up 6 people. He did that because he did not care how many people he picked up, but cared only about how many people both of them managed to pick up.

Example runs:

```
Game mode: Adversarial
Player 1 starting node:  1
Player 2 starting node:  1
ACTIONS:
p1 node:  1  p1 score:  0  p2 node:  1  p2 score:  0  visited:  [1]  v:  -3
p1 node:  2  p1 score:  0  p2 node:  1  p2 score:  0  visited:  [1, 2]  v:  3
p1 node:  4  p1 score:  1  p2 node:  1  p2 score:  0  visited:  [1, 4]  v:  2
Best action chosen
Agent 1 node :  2  score :  0
Agent 2 node :  1  score :  0
------------------------------
ACTIONS:
p1 node:  2  p1 score:  0  p2 node:  1  p2 score:  0  visited:  [1, 2]  v:  -3
p1 node:  2  p1 score:  0  p2 node:  4  p2 score:  1  visited:  [1, 2, 4]  v:  -3
Best action chosen
Agent 1 node :  2  score :  0
Agent 2 node :  1  score :  0
------------------------------
ACTIONS:
p1 node:  2  p1 score:  0  p2 node:  1  p2 score:  0  visited:  [1, 2]  v:  0
p1 node:  1  p1 score:  0  p2 node:  1  p2 score:  0  visited:  [1, 2]  v:  0
p1 node:  3  p1 score:  0  p2 node:  1  p2 score:  0  visited:  [1, 2, 3]  v:  3
p1 node:  7  p1 score:  6  p2 node:  1  p2 score:  0  visited:  [1, 2, 7]  v:  -1
Best action chosen
Agent 1 node :  3  score :  0
Agent 2 node :  1  score :  0
------------------------------
```

```
ACTIONS:
p1 node:  3  p1 score:  0  p2 node:  1  p2 score:  0  visited:  [1, 2, 3]  v:  -3
p1 node:  3  p1 score:  0  p2 node:  4  p2 score:  1  visited:  [1, 2, 3, 4]  v:  -3
Best action chosen
Agent 1 node :  3  score :  0
Agent 2 node :  1  score :  0
------------------------------
ACTIONS:
p1 node:  3  p1 score:  0  p2 node:  1  p2 score:  0  visited:  [1, 2, 3]  v:  0
p1 node:  6  p1 score:  5  p2 node:  1  p2 score:  0  visited:  [1, 2, 3, 6]  v:  3
p1 node:  5  p1 score:  1  p2 node:  1  p2 score:  0  visited:  [1, 2, 3, 5]  v:  2
Best action chosen
Agent 1 node :  6  score :  5
Agent 2 node :  1  score :  0
------------------------------
ACTIONS:
p1 node:  6  p1 score:  5  p2 node:  1  p2 score:  0  visited:  [1, 2, 3, 6]  v:  -5
p1 node:  6  p1 score:  5  p2 node:  4  p2 score:  1  visited:  [1, 2, 3, 6, 4]  v:  -3
Best action chosen
Agent 1 node :  6  score :  5
Agent 2 node :  4  score :  1
------------------------------
ACTIONS:
p1 node:  6  p1 score:  5  p2 node:  4  p2 score:  1  visited:  [1, 2, 3, 4, 6]  v:  3
Best action chosen
Agent 1 node :  6  score :  5
Agent 2 node :  4  score :  1
------------------------------
ACTIONS:
p1 node:  6  p1 score:  5  p2 node:  4  p2 score:  1  visited:  [1, 2, 3, 4, 6]  v:  -4
p1 node:  6  p1 score:  5  p2 node:  1  p2 score:  1  visited:  [1, 2, 3, 4, 6]  v:  -4
p1 node:  6  p1 score:  5  p2 node:  5  p2 score:  2  visited:  [1, 2, 3, 4, 6, 5]  v:  -3
Best action chosen
Agent 1 node :  6  score :  5
Agent 2 node :  5  score :  2
------------------------------
ACTIONS:
p1 node:  6  p1 score:  5  p2 node:  5  p2 score:  2  visited:  [1, 2, 3, 4, 5, 6]  v:  3
Best action chosen
Agent 1 node :  6  score :  5
Agent 2 node :  5  score :  2
------------------------------
ACTIONS:
p1 node:  6  p1 score:  5  p2 node:  5  p2 score:  2  visited:  [1, 2, 3, 4, 5, 6]  v:  -3
p1 node:  6  p1 score:  5  p2 node:  4  p2 score:  2  visited:  [1, 2, 3, 4, 5, 6]  v:  -3
visited before
DONE :)
Game mode: Semi-cooperative
```

```
Player 1 starting node:  1
Player 2 starting node:  1
p1 node:  1  p1 score:  0  p2 node:  1  p2 score:  0  visited:  [1]  v:  7
p1 node:  2  p1 score:  0  p2 node:  1  p2 score:  0  visited:  [1, 2]  v:  6
p1 node:  4  p1 score:  1  p2 node:  1  p2 score:  0  visited:  [1, 4]  v:  8
Best action chosen
Agent 1 node :  4  score :  1
Agent 2 node :  1  score :  0
--------------------------------
p1 node:  4  p1 score:  1  p2 node:  1  p2 score:  0  visited:  [1, 4]  v:  6
p1 node:  4  p1 score:  1  p2 node:  2  p2 score:  0  visited:  [1, 4, 2]  v:  6
p1 node:  4  p1 score:  1  p2 node:  4  p2 score:  0  visited:  [1, 4]  v:  7
Best action chosen
Agent 1 node :  4  score :  1
Agent 2 node :  4  score :  0
--------------------------------
p1 node:  4  p1 score:  1  p2 node:  4  p2 score:  0  visited:  [1, 4]  v:  8
p1 node:  1  p1 score:  1  p2 node:  4  p2 score:  0  visited:  [1, 4]  v:  7
p1 node:  5  p1 score:  2  p2 node:  4  p2 score:  0  visited:  [1, 4, 5]  v:  8
TIE BROKEN : v:  8  opponent:  5 best[0]: 8 best[1]: 0
Best action chosen
Agent 1 node :  5  score :  2
Agent 2 node :  4  score :  0
--------------------------------
p1 node:  5  p1 score:  2  p2 node:  4  p2 score:  0  visited:  [1, 4, 5]  v:  6
p1 node:  5  p1 score:  2  p2 node:  1  p2 score:  0  visited:  [1, 4, 5]  v:  6
p1 node:  5  p1 score:  2  p2 node:  5  p2 score:  0  visited:  [1, 4, 5]  v:  6
Best action chosen
Agent 1 node :  5  score :  2
Agent 2 node :  4  score :  0
--------------------------------
p1 node:  5  p1 score:  2  p2 node:  4  p2 score:  0  visited:  [1, 4, 5]  v:  2
p1 node:  4  p1 score:  2  p2 node:  4  p2 score:  0  visited:  [1, 4, 5]  v:  8
p1 node:  3  p1 score:  2  p2 node:  4  p2 score:  0  visited:  [1, 4, 5, 3]  v:  8
Best action chosen
Agent 1 node :  4  score :  2
Agent 2 node :  4  score :  0
--------------------------------
p1 node:  4  p1 score:  2  p2 node:  4  p2 score:  0  visited:  [1, 4, 5]  v:  6
p1 node:  4  p1 score:  2  p2 node:  1  p2 score:  0  visited:  [1, 4, 5]  v:  6
p1 node:  4  p1 score:  2  p2 node:  5  p2 score:  0  visited:  [1, 4, 5]  v:  6
Best action chosen
Agent 1 node :  4  score :  2
Agent 2 node :  4  score :  0
--------------------------------
p1 node:  4  p1 score:  2  p2 node:  4  p2 score:  0  visited:  [1, 4, 5]  v:  2
p1 node:  1  p1 score:  2  p2 node:  4  p2 score:  0  visited:  [1, 4, 5]  v:  8
p1 node:  5  p1 score:  2  p2 node:  4  p2 score:  0  visited:  [1, 4, 5]  v:  2
```

Best action chosen
Agent 1 node : 1 score : 2
Agent 2 node : 4 score : 0
---
p1 node: 1 p1 score: 2 p2 node: 4 p2 score: 0 visited: [1, 4, 5] v: 5
p1 node: 1 p1 score: 2 p2 node: 1 p2 score: 0 visited: [1, 4, 5] v: 6
p1 node: 1 p1 score: 2 p2 node: 5 p2 score: 0 visited: [1, 4, 5] v: 6
Best action chosen
Agent 1 node : 1 score : 2
Agent 2 node : 1 score : 0
---
p1 node: 1 p1 score: 2 p2 node: 1 p2 score: 0 visited: [1, 4, 5] v: 8
p1 node: 2 p1 score: 2 p2 node: 1 p2 score: 0 visited: [1, 4, 5, 2] v: 8
p1 node: 4 p1 score: 2 p2 node: 1 p2 score: 0 visited: [1, 4, 5] v: 8
Best action chosen
Agent 1 node : 1 score : 2
Agent 2 node : 1 score : 0
---
p1 node: 1 p1 score: 2 p2 node: 1 p2 score: 0 visited: [1, 4, 5] v: 0
p1 node: 1 p1 score: 2 p2 node: 2 p2 score: 0 visited: [1, 4, 5, 2] v: 6
p1 node: 1 p1 score: 2 p2 node: 4 p2 score: 0 visited: [1, 4, 5] v: 5
Best action chosen
Agent 1 node : 1 score : 2
Agent 2 node : 2 score : 0
---
p1 node: 1 p1 score: 2 p2 node: 2 p2 score: 0 visited: [1, 2, 4, 5] v: 7
p1 node: 4 p1 score: 2 p2 node: 2 p2 score: 0 visited: [1, 2, 4, 5] v: 7
Best action chosen
Agent 1 node : 1 score : 2
Agent 2 node : 2 score : 0
---
p1 node: 1 p1 score: 2 p2 node: 2 p2 score: 0 visited: [1, 2, 4, 5] v: 0
p1 node: 1 p1 score: 2 p2 node: 1 p2 score: 0 visited: [1, 2, 4, 5] v: 5
p1 node: 1 p1 score: 2 p2 node: 3 p2 score: 0 visited: [1, 2, 4, 5, 3] v: 5
p1 node: 1 p1 score: 2 p2 node: 7 p2 score: 6 visited: [1, 2, 4, 5, 7] v: 6
Best action chosen
Agent 1 node : 1 score : 2
Agent 2 node : 7 score : 6
---
p1 node: 1 p1 score: 2 p2 node: 7 p2 score: 6 visited: [1, 2, 4, 5, 7] v: 2
p1 node: 4 p1 score: 2 p2 node: 7 p2 score: 6 visited: [1, 2, 4, 5, 7] v: 7
Best action chosen
Agent 1 node : 4 score : 2
Agent 2 node : 7 score : 6
---
p1 node: 4 p1 score: 2 p2 node: 7 p2 score: 6 visited: [1, 2, 4, 5, 7] v: 6
Best action chosen
Agent 1 node : 4 score : 2

```
Agent 2 node :  7  score :  6
------------------------------
p1 node:  4  p1 score:  2  p2 node:  7  p2 score:  6  visited:  [1, 2, 4, 5, 7]  v:  2
p1 node:  1  p1 score:  2  p2 node:  7  p2 score:  6  visited:  [1, 2, 4, 5, 7]  v:  2
p1 node:  5  p1 score:  2  p2 node:  7  p2 score:  6  visited:  [1, 2, 4, 5, 7]  v:  7
Best action chosen
Agent 1 node :  5  score :  2
Agent 2 node :  7  score :  6
------------------------------
p1 node:  5  p1 score:  2  p2 node:  7  p2 score:  6  visited:  [1, 2, 4, 5, 7]  v:  6
Best action chosen
Agent 1 node :  5  score :  2
Agent 2 node :  7  score :  6
------------------------------
p1 node:  5  p1 score:  2  p2 node:  7  p2 score:  6  visited:  [1, 2, 4, 5, 7]  v:  2
p1 node:  4  p1 score:  2  p2 node:  7  p2 score:  6  visited:  [1, 2, 4, 5, 7]  v:  2
p1 node:  3  p1 score:  2  p2 node:  7  p2 score:  6  visited:  [1, 2, 4, 5, 7, 3]  v:  7
Best action chosen
Agent 1 node :  3  score :  2
Agent 2 node :  7  score :  6
------------------------------
p1 node:  3  p1 score:  2  p2 node:  7  p2 score:  6  visited:  [1, 2, 3, 4, 5, 7]  v:  6
Best action chosen
Agent 1 node :  3  score :  2
Agent 2 node :  7  score :  6
------------------------------
p1 node:  3  p1 score:  2  p2 node:  7  p2 score:  6  visited:  [1, 2, 3, 4, 5, 7]  v:  2
p1 node:  6  p1 score:  7  p2 node:  7  p2 score:  6  visited:  [1, 2, 3, 4, 5, 7, 6]  v:  7
p1 node:  5  p1 score:  2  p2 node:  7  p2 score:  6  visited:  [1, 2, 3, 4, 5, 7]  v:  2
Best action chosen
Agent 1 node :  6  score :  7
Agent 2 node :  7  score :  6
------------------------------
reached goal
DONE :)
```

Game mode: Fully-cooperative

```
Player 1 starting node:  1
Player 2 starting node:  1
p1 node:  1  p1 score:  0  p2 node:  1  p2 score:  0  visited:  [1]  v:  13
p1 node:  2  p1 score:  0  p2 node:  1  p2 score:  0  visited:  [1, 2]  v:  13
p1 node:  4  p1 score:  1  p2 node:  1  p2 score:  0  visited:  [1, 4]  v:  13
Best action chosen
Agent 1 node :  1  score :  0
Agent 2 node :  1  score :  0
------------------------------
p1 node:  1  p1 score:  0  p2 node:  1  p2 score:  0  visited:  [1]  v:  13
p1 node:  1  p1 score:  0  p2 node:  2  p2 score:  0  visited:  [1, 2]  v:  13
p1 node:  1  p1 score:  0  p2 node:  4  p2 score:  1  visited:  [1, 4]  v:  13
Best action chosen
Agent 1 node :  1  score :  0
Agent 2 node :  1  score :  0
------------------------------
p1 node:  1  p1 score:  0  p2 node:  1  p2 score:  0  visited:  [1]  v:  0
p1 node:  2  p1 score:  0  p2 node:  1  p2 score:  0  visited:  [1, 2]  v:  13
p1 node:  4  p1 score:  1  p2 node:  1  p2 score:  0  visited:  [1, 4]  v:  13
Best action chosen
Agent 1 node :  2  score :  0
Agent 2 node :  1  score :  0
------------------------------
p1 node:  2  p1 score:  0  p2 node:  1  p2 score:  0  visited:  [1, 2]  v:  13
p1 node:  2  p1 score:  0  p2 node:  4  p2 score:  1  visited:  [1, 2, 4]  v:  13
Best action chosen
Agent 1 node :  2  score :  0
Agent 2 node :  1  score :  0
------------------------------
p1 node:  2  p1 score:  0  p2 node:  1  p2 score:  0  visited:  [1, 2]  v:  0
p1 node:  1  p1 score:  0  p2 node:  1  p2 score:  0  visited:  [1, 2]  v:  7
p1 node:  3  p1 score:  0  p2 node:  1  p2 score:  0  visited:  [1, 2, 3]  v:  7
p1 node:  7  p1 score:  6  p2 node:  1  p2 score:  0  visited:  [1, 2, 7]  v:  13
Best action chosen
Agent 1 node :  7  score :  6
Agent 2 node :  1  score :  0
------------------------------
p1 node:  7  p1 score:  6  p2 node:  1  p2 score:  0  visited:  [1, 2, 7]  v:  6
p1 node:  7  p1 score:  6  p2 node:  4  p2 score:  1  visited:  [1, 2, 7, 4]  v:  13
Best action chosen
Agent 1 node :  7  score :  6
Agent 2 node :  4  score :  1
------------------------------
p1 node:  7  p1 score:  6  p2 node:  4  p2 score:  1  visited:  [1, 2, 4, 7]  v:  13
Best action chosen
Agent 1 node :  7  score :  6
Agent 2 node :  4  score :  1
------------------------------
```

p1 node: 7 p1 score: 6 p2 node: 4 p2 score: 1 visited: [1, 2, 4, 7] v: 7
p1 node: 7 p1 score: 6 p2 node: 1 p2 score: 1 visited: [1, 2, 4, 7] v: 7
p1 node: 7 p1 score: 6 p2 node: 5 p2 score: 2 visited: [1, 2, 4, 7, 5] v: 13
Best action chosen
Agent 1 node : 7 score : 6
Agent 2 node : 5 score : 2
---
p1 node: 7 p1 score: 6 p2 node: 5 p2 score: 2 visited: [1, 2, 4, 5, 7] v: 13
Best action chosen
Agent 1 node : 7 score : 6
Agent 2 node : 5 score : 2
---
p1 node: 7 p1 score: 6 p2 node: 5 p2 score: 2 visited: [1, 2, 4, 5, 7] v: 8
p1 node: 7 p1 score: 6 p2 node: 4 p2 score: 2 visited: [1, 2, 4, 5, 7] v: 8
p1 node: 7 p1 score: 6 p2 node: 3 p2 score: 2 visited: [1, 2, 4, 5, 7, 3] v: 13
Best action chosen
Agent 1 node : 7 score : 6
Agent 2 node : 3 score : 2
---
p1 node: 7 p1 score: 6 p2 node: 3 p2 score: 2 visited: [1, 2, 3, 4, 5, 7] v: 13
Best action chosen
Agent 1 node : 7 score : 6
Agent 2 node : 3 score : 2
---
p1 node: 7 p1 score: 6 p2 node: 3 p2 score: 2 visited: [1, 2, 3, 4, 5, 7] v: 8
p1 node: 7 p1 score: 6 p2 node: 6 p2 score: 7 visited: [1, 2, 3, 4, 5, 7, 6] v: 13
p1 node: 7 p1 score: 6 p2 node: 5 p2 score: 2 visited: [1, 2, 3, 4, 5, 7] v: 8
Best action chosen
Agent 1 node : 7 score : 6
Agent 2 node : 6 score : 7
---
reached goal
DONE :)