United International University

Department of Computer Science & Engineering

CSE 3812: AL Lab | Assignment 1 | Modified A* Search

Assignment: Implementing A* Search with Modified Heuristics

Scenario
You are tasked with enhancing the A* search algorithm by modifying the heuristic function to adapt to a new scenario. Instead of the standard heuristic (straight-line distance to the goal), you will incorporate an additional factor: the difficulty level of the terrain between nodes.

Problem Statement
In this assignment, you will implement a modified A* search algorithm that considers the difficulty level of the terrain between nodes. The terrain difficulty is represented as an additional cost that must be added to the heuristic value for each node.

Requirements
1. **Graph Representation**: The graph will be provided as a dictionary where each node has a list of its neighbors, the cost to reach them, and the terrain difficulty between them.
2. **Heuristic Modification**: Modify the heuristic function to include the terrain difficulty. The modified heuristic \(h'(n) \) for each node will be:

[h'(n) = h(n) + {terrain difficulty}]

3. Algorithm Implementation: Implement the modified A* algorithm using this new heuristic.

Graph Example
Consider the following graph where the third value in the tuple represents the terrain difficulty:

```
graph = {
    'A': {'B': (1, 2), 'D': (3, 1), 'E': (8, 4)},
    'B': {'C': (3, 1), 'D': (1, 2)},
    'C': {},
    'D': {'C': (4, 2), 'E': (2, 3)},
    'E': {'C': (1, 1)}
}
```

Heuristic values (h) for each node

```
heuristic = {
    'A': 6,
    'B': 2,
    'C': 0,
    'D': 4,
    'E': 1
}
```

Terrain difficulties (additional cost for the heuristic)

```
terrain_difficulty = {
    'A': {'B': 2, 'D': 1, 'E': 4},
    'B': {'C': 1, 'D': 2},
    'C': {},
    'D': {'C': 2, 'E': 3},
    'E': {'C': 1}
}
```

Question:

Modify the A* search algorithm to consider the terrain difficulty in the heuristic calculation. The terrain difficulty is an additional cost added to the heuristic value of each node. Implement this modification and demonstrate your algorithm on the provided graph.

Detailed Instructions:

1. Modify the Heuristic Function: Update the heuristic calculation to include terrain difficulty.
2. Implement the Algorithm: Implement the A* algorithm with this modified heuristic.
3. Test the Algorithm: Use the provided graph and heuristic values to test your implementation.
4. Document Your Code: Add comments explaining the modifications and the logic of your implementation code.

Sample Input-Output

Input:
- Start Node: 'A'
- Goal Node: 'C'
- Graph:

```
graph = {
    'A': {'B': (1, 2), 'D': (3, 1), 'E': (8, 4)},
    'B': {'C': (3, 1), 'D': (1, 2)},
    'C': {},
    'D': {'C': (4, 2), 'E': (2, 3)},
    'E': {'C': (1, 1)}
}
```

- Heuristic Values:

```
heuristic = {
    'A': 6,
    'B': 2,
    'C': 0,
    'D': 4,
    'E': 1
}
```

- Terrain Difficulties:

```
terrain_difficulty = {
    'A': {'B': 2, 'D': 1, 'E': 4},
    'B': {'C': 1, 'D': 2},
    'C': {},
    'D': {'C': 2, 'E': 3},
    'E': {'C': 1}
}
```

Submission

Submit your modified A* search algorithm implementation in a .ipynb file. You may use Google Collaboratory to code it.

Name your file as Asn1_YourID.ipynb. For example, Asn1_0112331001.ipynb