HW1 ME5501 – Robotics and Unmanned Systems

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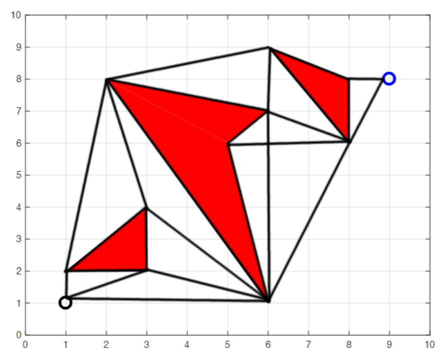
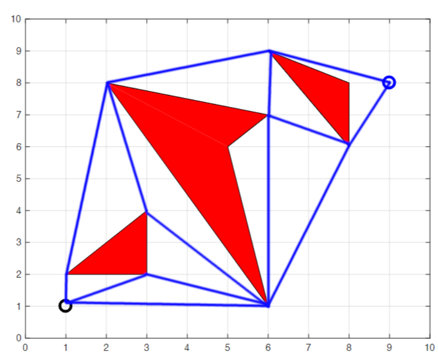
Problem 1

Using the map shown below, generate the visibility graph (include the start and end nodes). Additionally, show the reduced visibility graph with a different color (i.e. blue for reduced graph, black for remaining standard edges). You do not need to compute the edge costs.



Visibility Graph



Reduced Visibility Graph

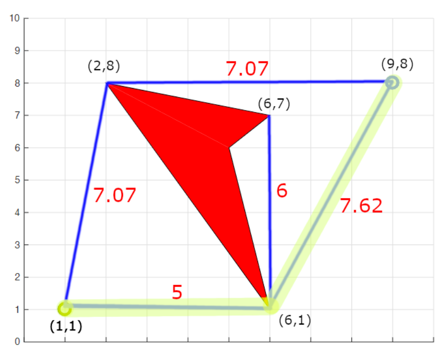
Problem 2

Using the Python Class tutorial available at `https://docs.python.org/3/tutorial/classes.html`, create a class called node that has the following instance variables, x, y, parent_cost, and index Provide your short Python script that contains this class.

```
class Node:
    def __init__(self, x: float, y: float, parent_node, index : int):
        self.x = x
        self.y = y

        self.parent_node = parent_node
        self.index = index

        self.cost = math.inf

    def distance(self, other) -> float:
        return math.sqrt( (self.x - other.x)**2 + (self.y - other.y) ** 2 )

    def __lt__(self, other) -> bool:
        return self.cost < other.cost
```

Problem 3

Using the map shown below, show the reduced visibility graph along with the Euclidean distance for each edge. Highlight the shortest path from the start (1,1) to the goal (9,8).



Reduced Visibility Graph
Shortest path is highligted in yellow!

Problem 4

Given the following map parameters, generate a figure similar to the one shown in which you are computing each node index and plotting the index at the corresponding node location. The node index is simply the unique name/value associated with the node. You need to write your Python script such that any node location (x and y pair) returns the node index. I.e. simply making counter that plots at each node location will not work. Use the equation(s) developed in class to assist in this problem. This node index is crucial in generating grid-based path planning techniques. A small function that computes the node index is an efficient method for computing the index.

Grid Spacing = 0.5
Min X = 0 Max X = 10 (include both 0 and 10 in your grid)
Min Y = 0 Max Y = 10

Notes:
When generating the x and y values (that span from 0 to 10), the NumPy command arange is particularly useful. Make sure that you capture the end point by adding an extra "grid_size" onto the end value.

Matplotlib.text(x, y, str(int(number to display)), color="red", fontsize=8) is a good function to use to stick the text in the figure.

As discussed in class I did inplement a function to get an index from (x,y) coordinates, however I opted to generate the indicies differently, when creating the grid
The following code gets an index from (x, y) coordinates

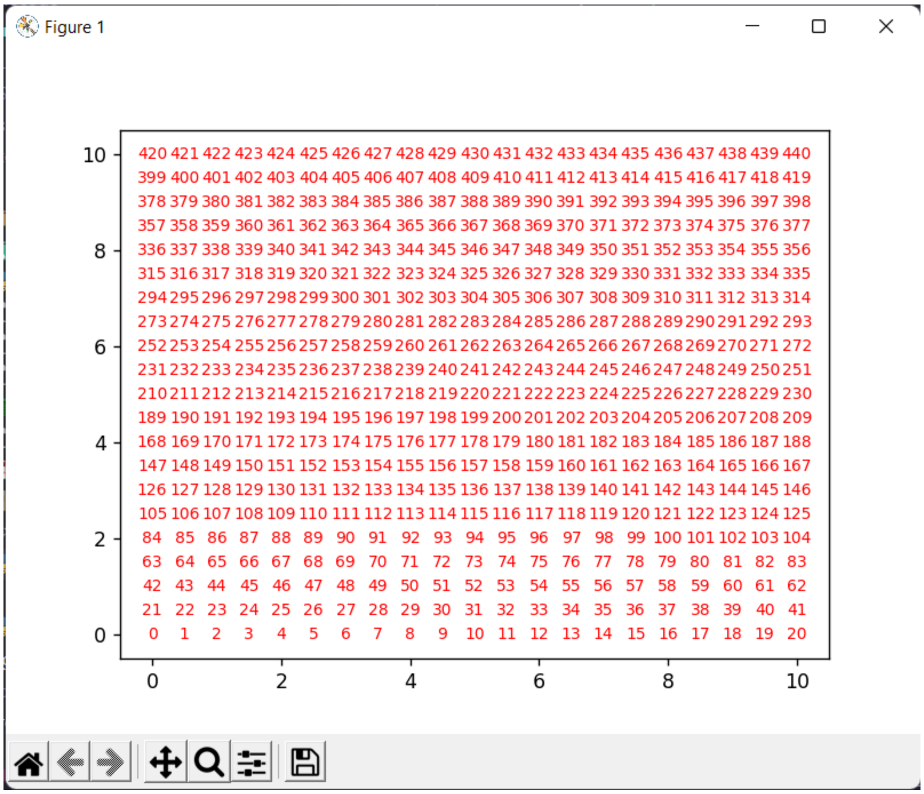
```
def get_node_index(self, x: float, y : float) -> int:
    """Gets index of node at an x,y coordinate"""
    index = (y - self.min_y) / self.spacing * \
        (self.max_x / self.spacing + 1) + \
        x / self.spacing

    return int(index)
```

In order to actually draw the grid, I assigned a all Nodes an index when the grid is created. I then call the Grid.draw() method which looks like this:

```
def draw(self):
    """draws the grid with node indicies displayed in their corresponding (x, y) coordinates
    for node in self.Nodes:
        plt.text(node.x, node.y, str(node.index), color="red", fontsize=8, \
         horizontalalignment="center", verticalalignment = "center")
```

```
plt.xlim([self.min_x - self.spacing, self.max_x + self.spacing])
plt.ylim([self.min_y - self.spacing, self.max_y + self.spacing])
plt.xticks(ticks = [ x for x in np.arange(self.min_x, self.max_x + self.spacing, self.wi
plt.yticks(ticks = [ y for y in np.arange(self.min_y, self.max_y + self.spacing, self.he
plt.show()
```

The entire code may be found in week1.py. An image of the execution is seen below.



Problem 5

Create a function that calculates the distance from one node to another. Pass two nodes to the function and return the Euclidean distance. Test your function by having it calculate the distance from (2,1) to (3,2). Make sure the answer is correct.

Submit your Python code.

```python
# the method below is defined within the node class
def distance(self, other):
    """Returns the euclidean distance from one node to another"""
    return math.sqrt( (self.x - other.x)**2 + (self.y - other.y) ** 2 )

node1 = Node(2, 1, None, 0)
```

```python
node2 = Node(3, 2, None, 0)
print(node1.distance(node2))
```

Output: 1.4142135623730951