In [1]:

```python
import matplotlib.pyplot as plt
import numpy as np
```

In [2]:

```python
def generateLineplot(uniform_x, misplaced_x, manhattan_x, uniform_y,
        misplaced_y, manhattan_y, x_label, y_label, title):

    fig, ax = plt.subplots()

    # Plot a simple line chart
    ax.plot(uniform_x, uniform_y , label='Uniform Cost Search')
    ax.plot(misplaced_x, misplaced_y, label='A* Search with Misplaced Tiles Heuristic')
    ax.plot(manhattan_x, manhattan_y, label='A* Search with Manhattan Distance Heuristic')

    ax.set_xlabel(x_label, fontweight ='bold', fontsize = 15)
    ax.set_ylabel(y_label, fontweight ='bold', fontsize = 15)

    plt.legend()
    plt.title(title)
    plt.show()
```

In [3]:

```python
def generateBarplot(x, uniform_y, misplaced_y, manhattan_y,
                   x_label, y_label, title):

    # set width of bar
    barWidth = 0.25
    fig = plt.subplots(figsize =(12, 8))

    # set height of bar
#     uniform_y = [12, 30, 1, 8, 22]
#     misplaced_y = [28, 6, 16, 5, 10]
#     manhattan_y = [29, 3, 24, 25, 17]

    # Set position of bar on X axis
    br1 = np.arange(len(x))
    br2 = [p + barWidth for p in br1]
    br3 = [p + barWidth for p in br2]

    # Make the plot
    plt.bar(br1, uniform_y, color ='y', width = barWidth,
            edgecolor ='grey', label ='Uniform Cost Search')
    plt.bar(br2, misplaced_y, color ='c', width = barWidth,
            edgecolor ='grey', label ='A* Search with Misplaced Tiles Heuristic')
    plt.bar(br3, manhattan_y, color ='m', width = barWidth,
            edgecolor ='grey', label ='A* Search with Manhattan Distance Heuristic')

    # Adding Xticks
    plt.xlabel(x_label, fontweight ='bold', fontsize = 15)
    plt.ylabel(y_label, fontweight ='bold', fontsize = 15)
    plt.xticks([r + barWidth for r in range(len(x))],
            x)

    plt.title(title)
    plt.legend()
    plt.show()
```

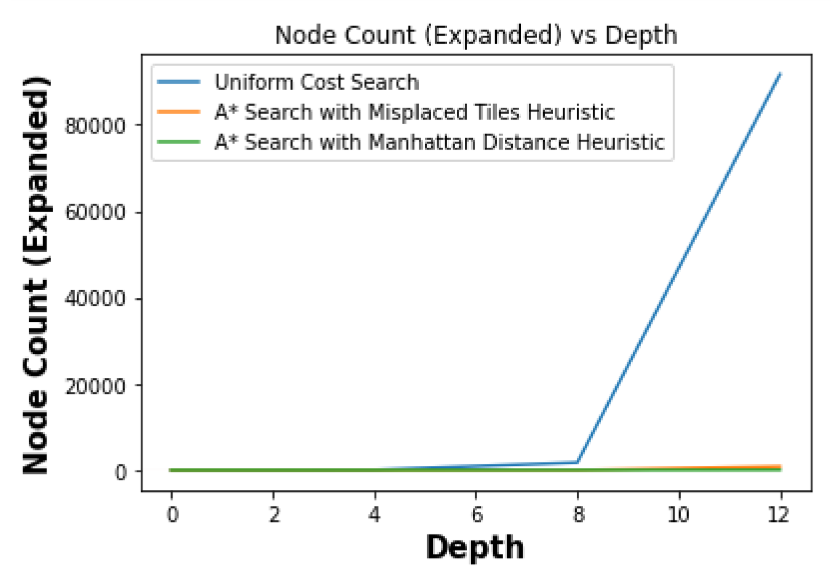
In [4]:

```python
# node expand vs depth
uniform_x = [0, 2, 4, 8, 12]
uniform_y = [0, 3, 57, 1743, 91661]

manhattan_x = [0, 2, 4, 8, 12]
manhattan_y = [0, 2, 4, 12, 54]

misplaced_x = [0, 2, 4, 8, 12]
misplaced_y = [0, 2, 4, 18, 818]

generateLineplot(uniform_x, misplaced_x, manhattan_x, uniform_y,
        misplaced_y, manhattan_y, 'Depth', 'Node Count (Expanded)', 'Node Count (Expanded) vs Depth')
```



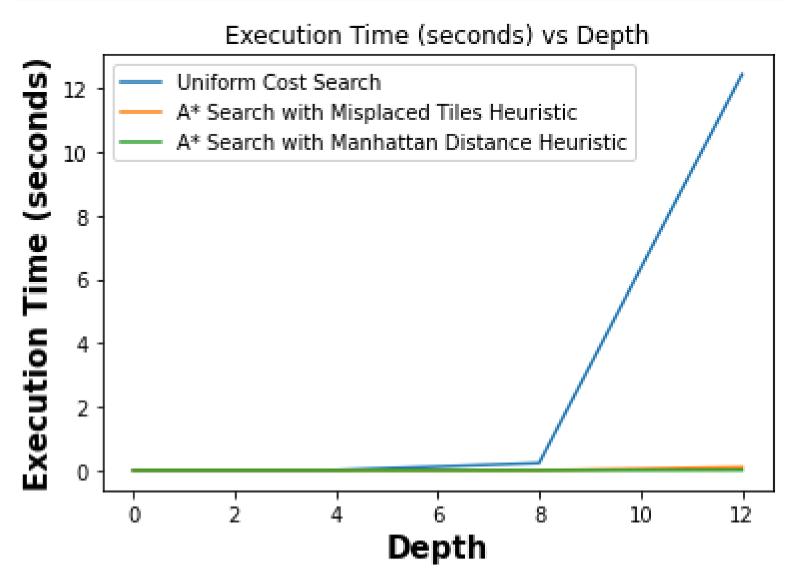
In [5]:

```python
# time in seconds vs depth
uniform_x = [0, 2, 4, 8, 12]
uniform_y = [0, 0, 0.01, 0.23, 12.44]

manhattan_x = [0, 2, 4, 8, 12]
manhattan_y = [0, 0, 0, 0, 0.01]

misplaced_x = [0, 2, 4, 8, 12]
misplaced_y = [0, 0, 0, 0, 0.1]

generateLineplot(uniform_x, misplaced_x, manhattan_x, uniform_y,
        misplaced_y, manhattan_y, 'Depth', 'Execution Time (seconds)', 'Execution Time (seconds) vs Depth')
```



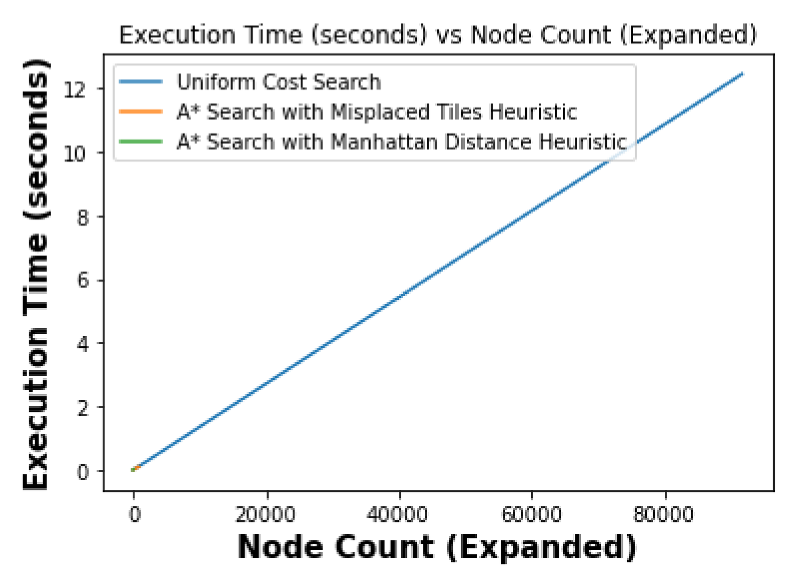
In [6]:

```python
# time in seconds vs node expand
uniform_x = [0, 3, 57, 1743, 91661]
uniform_y = [0, 0, 0.01, 0.23, 12.44]

manhattan_x = [0, 2, 4, 12, 54]
manhattan_y = [0, 0, 0, 0, 0.01]

misplaced_x = [0, 2, 4, 18, 818]
misplaced_y = [0, 0, 0, 0, 0.1]

generateLineplot(uniform_x, misplaced_x, manhattan_x, uniform_y,
        misplaced_y, manhattan_y, 'Node Count (Expanded)', 'Execution Time (seconds)', \
            'Execution Time (seconds) vs Node Count (Expanded)')
```



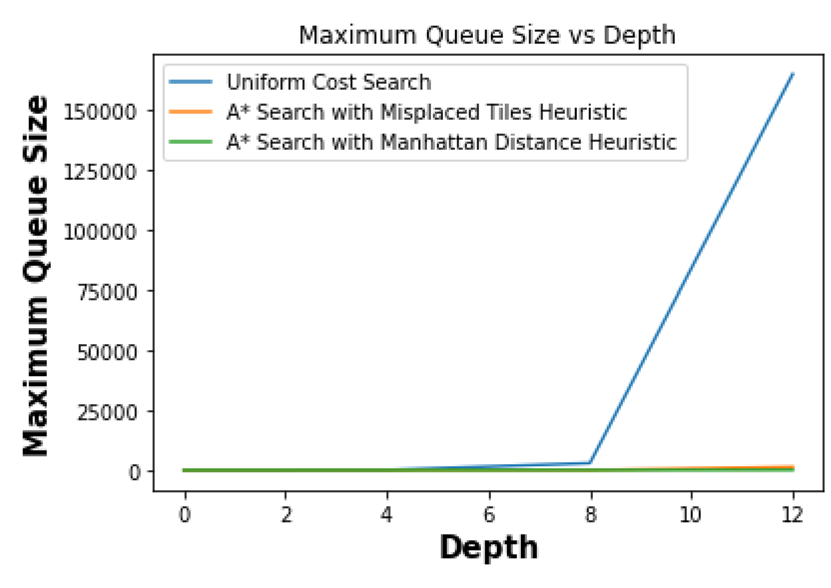
In [7]:

```python
# max queue size vs depth
uniform_x = [0, 2, 4, 8, 12]
uniform_y = [1, 4, 82, 2918, 165004]

manhattan_x = [0, 2, 4, 8, 12]
manhattan_y = [1, 3, 8, 21, 82]

misplaced_x = [0, 2, 4, 8, 12]
misplaced_y = [1, 3, 8, 29, 1325]

generateLineplot(uniform_x, misplaced_x, manhattan_x, uniform_y,
        misplaced_y, manhattan_y, 'Depth', 'Maximum Queue Size', \
            'Maximum Queue Size vs Depth')
```



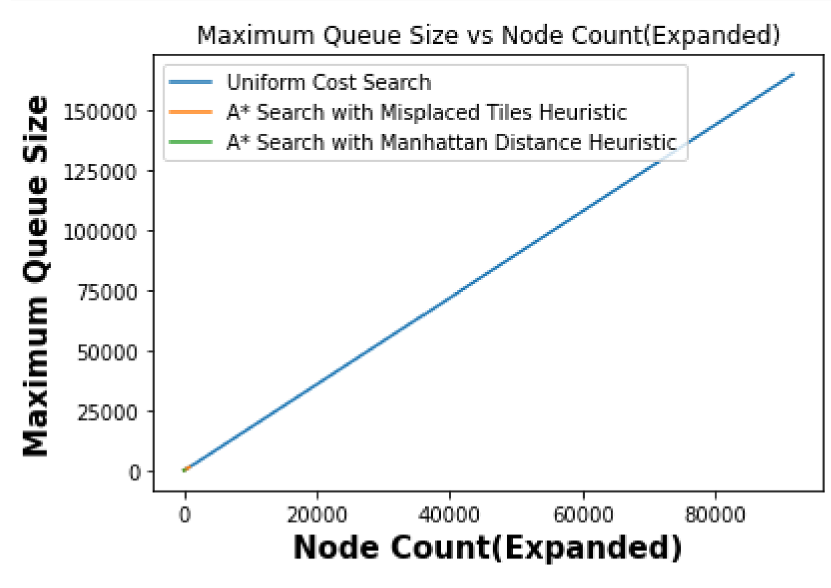
In [8]:

```python
# max queue size vs node expand
uniform_x = [0, 3, 57, 1743, 91661]
uniform_y = [1, 4, 82, 2918, 165004]

manhattan_x = [0, 2, 4, 12, 54]
manhattan_y = [1, 3, 8, 21, 82]

misplaced_x = [0, 2, 4, 18, 818]
misplaced_y = [1, 3, 8, 29, 1325]

generateLineplot(uniform_x, misplaced_x, manhattan_x, uniform_y,
        misplaced_y, manhattan_y, 'Node Count(Expanded)', 'Maximum Queue Size', \
            'Maximum Queue Size vs Node Count(Expanded)')
```

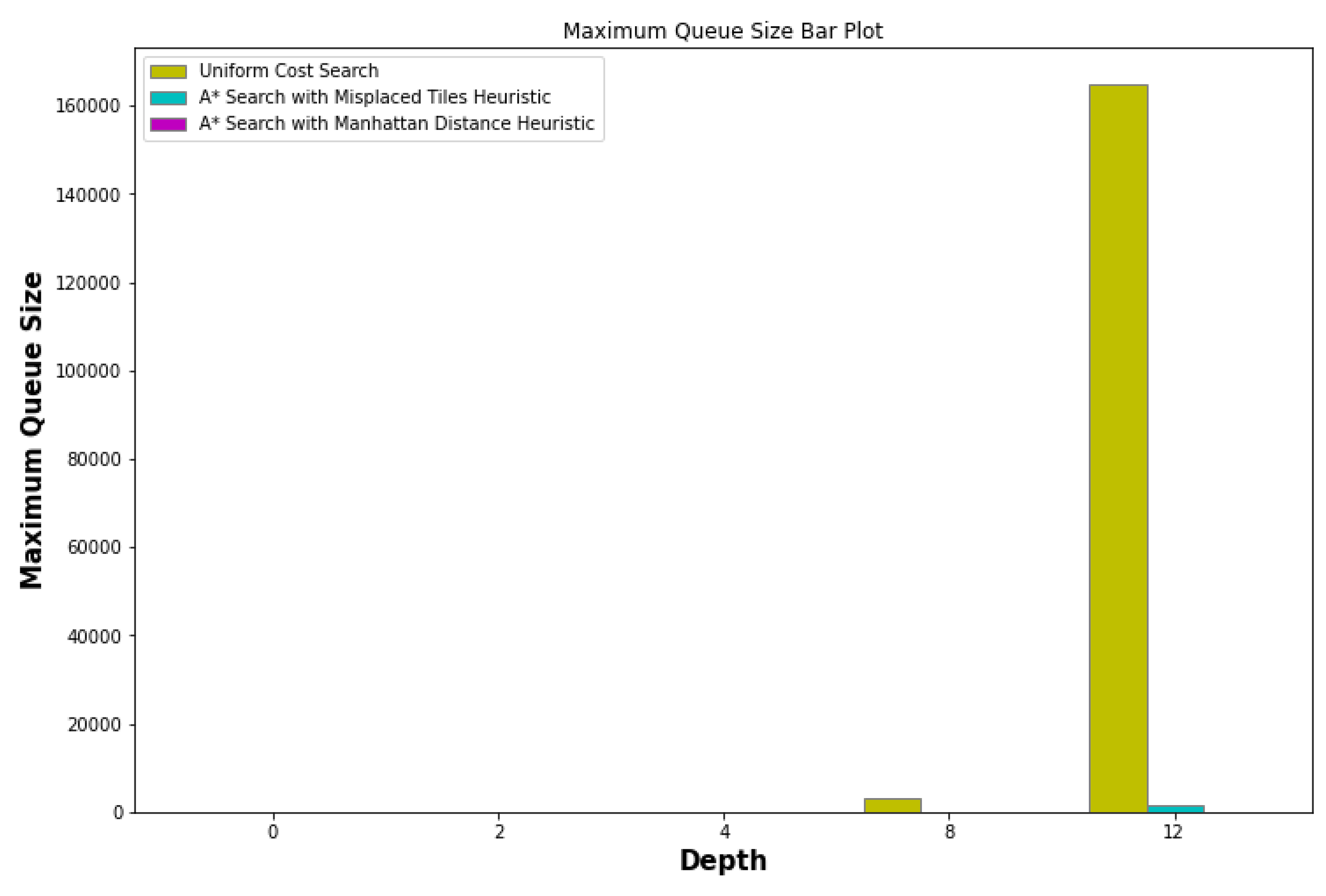


In [9]:

```python
# x = depth
# y = max_queue_size

x = [0, 2, 4, 8, 12]
uniform_y = [1, 4, 82, 2918, 165004]
manhattan_y = [1, 3, 8, 21, 82]
misplaced_y = [1, 3, 8, 29, 1325]

generateBarplot(x, uniform_y, misplaced_y, manhattan_y,
                    'Depth', 'Maximum Queue Size', 'Maximum Queue Size Bar Plot')
```

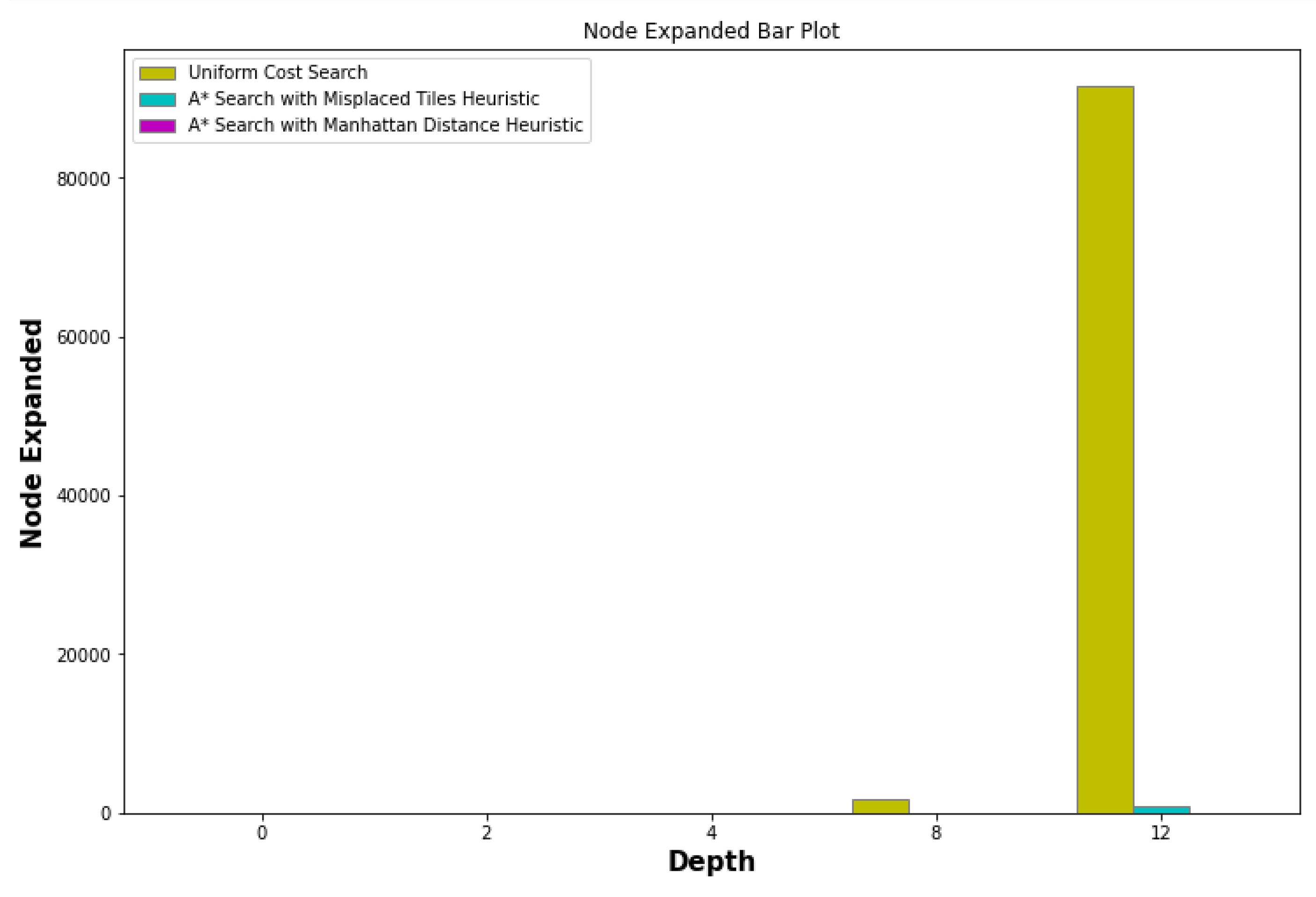


In [10]:

```python
# x = depth
# y = node_expanded

x = [0, 2, 4, 8, 12]
uniform_y = [0, 3, 57, 1743, 91661]
manhattan_y = [0, 2, 4, 12, 54]
misplaced_y = [0, 2, 4, 18, 818]

generateBarplot(x, uniform_y, misplaced_y, manhattan_y,
                    'Depth', 'Node Expanded', 'Node Expanded Bar Plot')
```

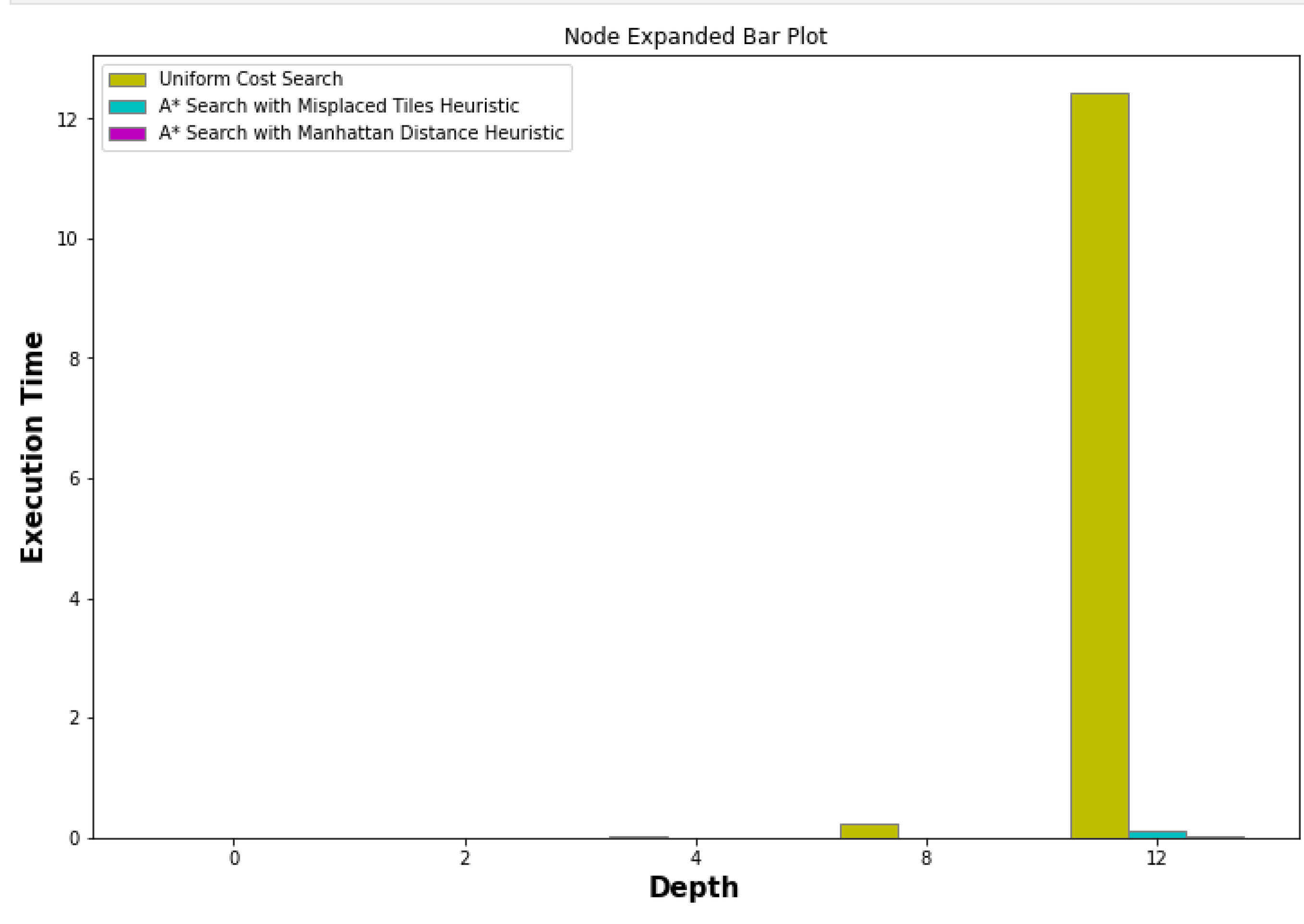


In [11]:

```python
# x = depth
# y = execution_time

x = [0, 2, 4, 8, 12]
uniform_y = [0, 0, 0.01, 0.23, 12.44]
manhattan_y = [0, 0, 0, 0, 0.01]
misplaced_y = [0, 0, 0, 0, 0.1]

generateBarplot(x, uniform_y, misplaced_y, manhattan_y,
                    'Depth', 'Execution Time', 'Node Expanded Bar Plot')
```



In [ ]: