Homework 1

Uninformed and Informed Search

Due: 11:59 pm, February 14

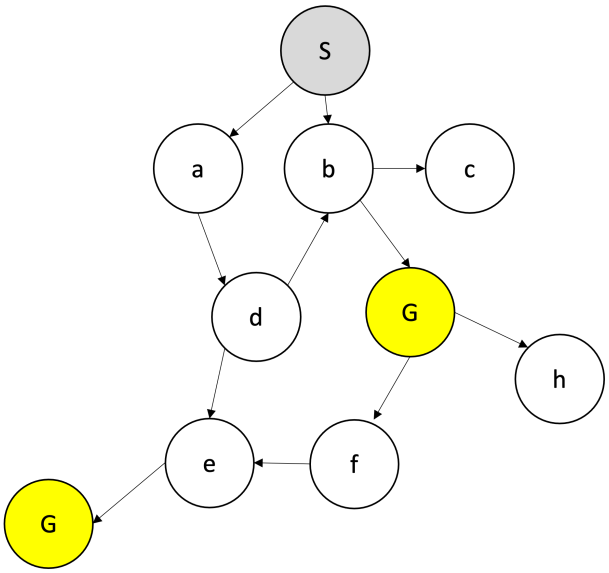
Exercise 1

For each of the following activities, give a PEAS description of the task environment (10 points).

1. Playing a chess game
2. Finding the best route from the campus to an airport
3. Providing an answer to questions from a kid
4. Providing recommendations to a customer on a shopping website.

Exercise 2

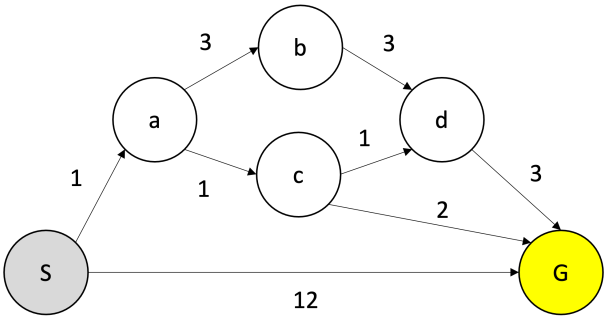
Given the state space graph with an initial state `S` and a goal state `G`, answer the following questions. Note that the search algorithms end when the goal node is generated. (15 points)



1. Draw a final search tree from the **depth-first search** and write the number of all "expanded" nodes throughout the search (do not include generated, but not expanded nodes). If you find multiple answers, provide only one of them.
2. Draw a final search tree from the **breadth-first search** and write the number of all "expanded" nodes throughout the search (do not include generated, but not expanded nodes). If you find multiple answers, provide only one of them.
3. Draw search trees from the **iterative deepening search**. Write the number of "expanded" nodes throughout the search (do not include generated, but not expanded nodes).
   The search tree and the number of expanded nodes should be elaborated **for each depth limit**. If you find multiple answers, provide only one of them.

Exercise 3

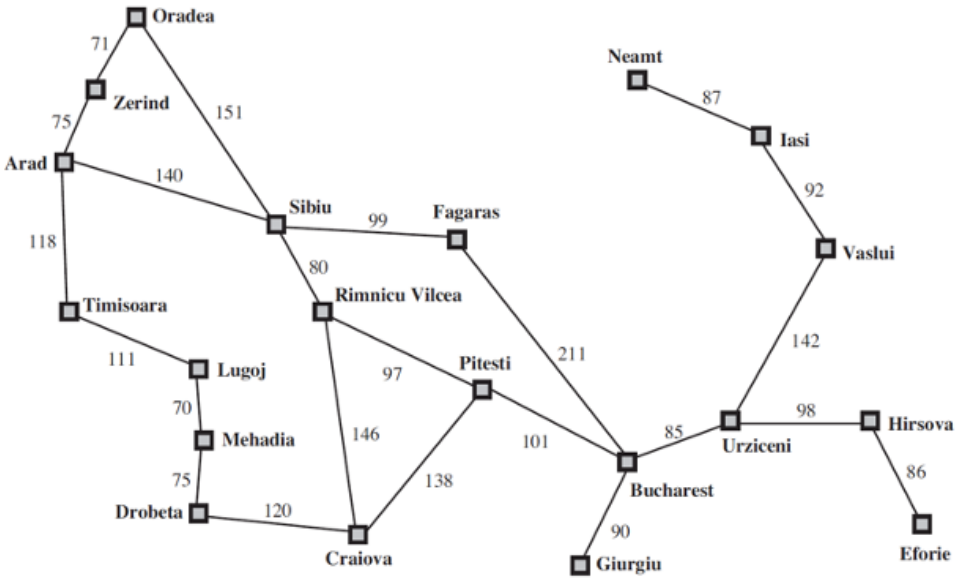
Answer the following questions, given the state space graph with an initial state `S` and goal state `G`. (15 points)



1. What is the search tree from a uniform-cost search (UCS)? Include the cost for each node (*i.e.*, costs from the goal node to the corresponding node) in your search tree.
2. How many nodes are expanded in your search tree?
3. What is the path found by UCS?
4. What is the path cost found by UCS?

Exercise 4

Imagine an agent in the city of Arad, Romania, enjoying a touring holiday. The figure below shows the map of Romania. (20 points)



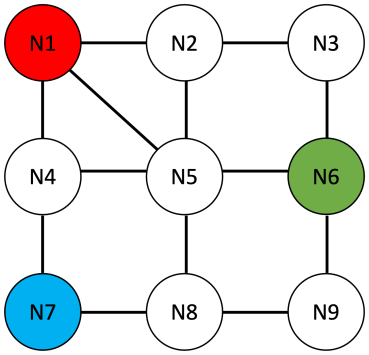
Arad	360	Mehadia	240	Bucharest	0
Neamt	230	Craiova	160	Oradea	380
Drobeta	240	Pitesti	100	Eforie	160
Rimnicu Vilcea	190	Fagaras	170	Sibiu	250
Giurgiu	70	Timisoara	320	Hirsova	150
Urziceni	80	Iasi	220	Vaslui	190
Lugoj	240	Zerind	370		

Table 1: Straight-line distance to Bucharest.

1. What is the search tree from **A∗ search** of finding a path from `Zerind` to `Bucharest`? Include the values of the evaluation function ($f(n) = g(n) + h(n)$) for each node in your search tree. Use the straight-line distance heuristic below. (Apply cycle checking to avoid cycles.)

Exercise 5

Consider the state of the 3-coloring of this graph. Check the arc consistency of this graph by hand. Write the result and steps for checking the arc consistency. (You do not need to find a solution to the 3-coloring problem.) (20 points)



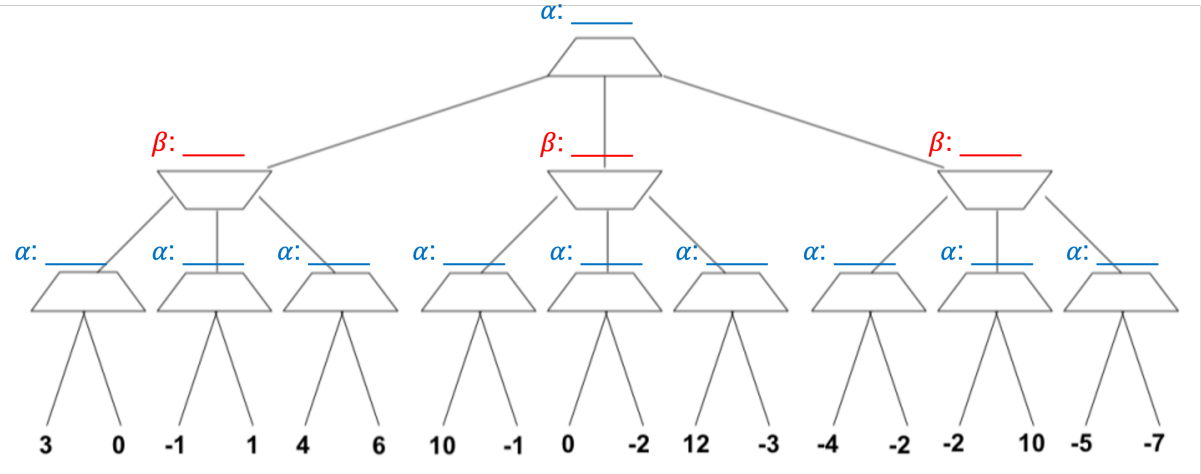
Exercise 6

Use the alpha-beta pruning to explore the following game tree. The root node is MAX. Visit the successors from left to right. The pseudo-codes of the alpha-beta pruning is below.

```
def value(state):
    if the state is a terminal state: return the state's utility
    if the next agent is MAX: return max-value(state)
    if the next agent is MIN: return min-value(state)
```

```
def max-value(state, α, β):
    initialize v = -∞
    for each successor of state:
        v = max(v, value(successor, α, β))
        if v ≥ β return v
        α = max(α, v)
    return v
```

```
def min-value(state , α, β):
    initialize v = +∞
    for each successor of state:
        v = min(v, value(successor, α, β))
        if v ≤ α return v
        β = min(β, v)
    return v
```



- Write the final values (*i.e.*, values after calling max-value() or min-value() function at the corresponding node) of alpha or beta at each node that is not pruned. The initial values of alpha and beta are $-\infty$ and ∞, respectively.
- Write the utility value being returned at each node inside the trapezoid. Leave it blank if it is pruned. If its child node is pruned, ignore the utility value of the child node to get the utility value of the current node.
- Put an 'X' through the edges that are pruned off.