COMP90054 Workshop 1

Geye Guo

Icebreaker

Classical Planning Problem

Not every problem belongs to classical planning problem!!

Requirements:

- Single-agent
- Static environment
- **<u>Deterministic action:</u>**
  - o Every action only has a certain outcome, and you know what that outcome will be
  - o Counterexample: coin toss -> probabilistic actions
- ……

How to solve a Classical Planning Problem

- The idea of general AI solving problem: Problem => solver => solution
- Comes to AI planning: 1. Problem (Model) => 2. Planner => 3. Plan

1. Model

- **State-space model**: any Classical Planning Problem can be represented by a state-space model
- **STRIPS:** PDDL

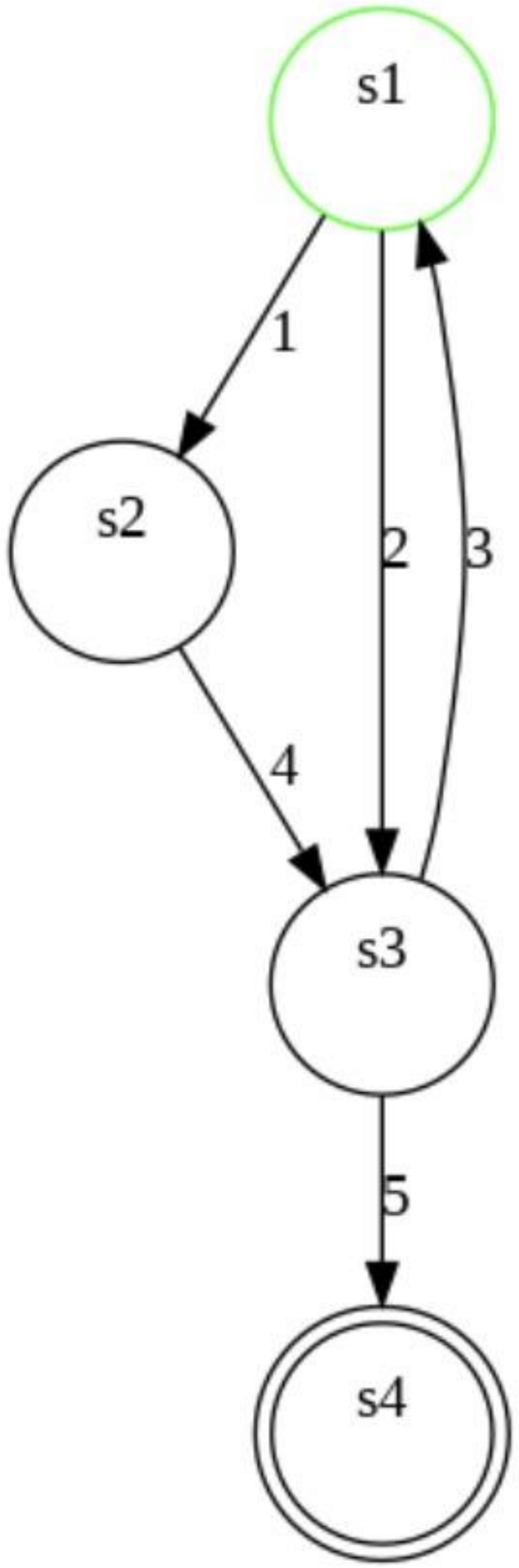
2. Planner => powered by the search algorithms

- **Blind search**: BFS, DFS, ID, Uniform-Cost, IW….
- **Heuristic Search** (Informed search)

3. Plan

- A sequence of actions: a1-> a2 ->….
- Not a set of actions

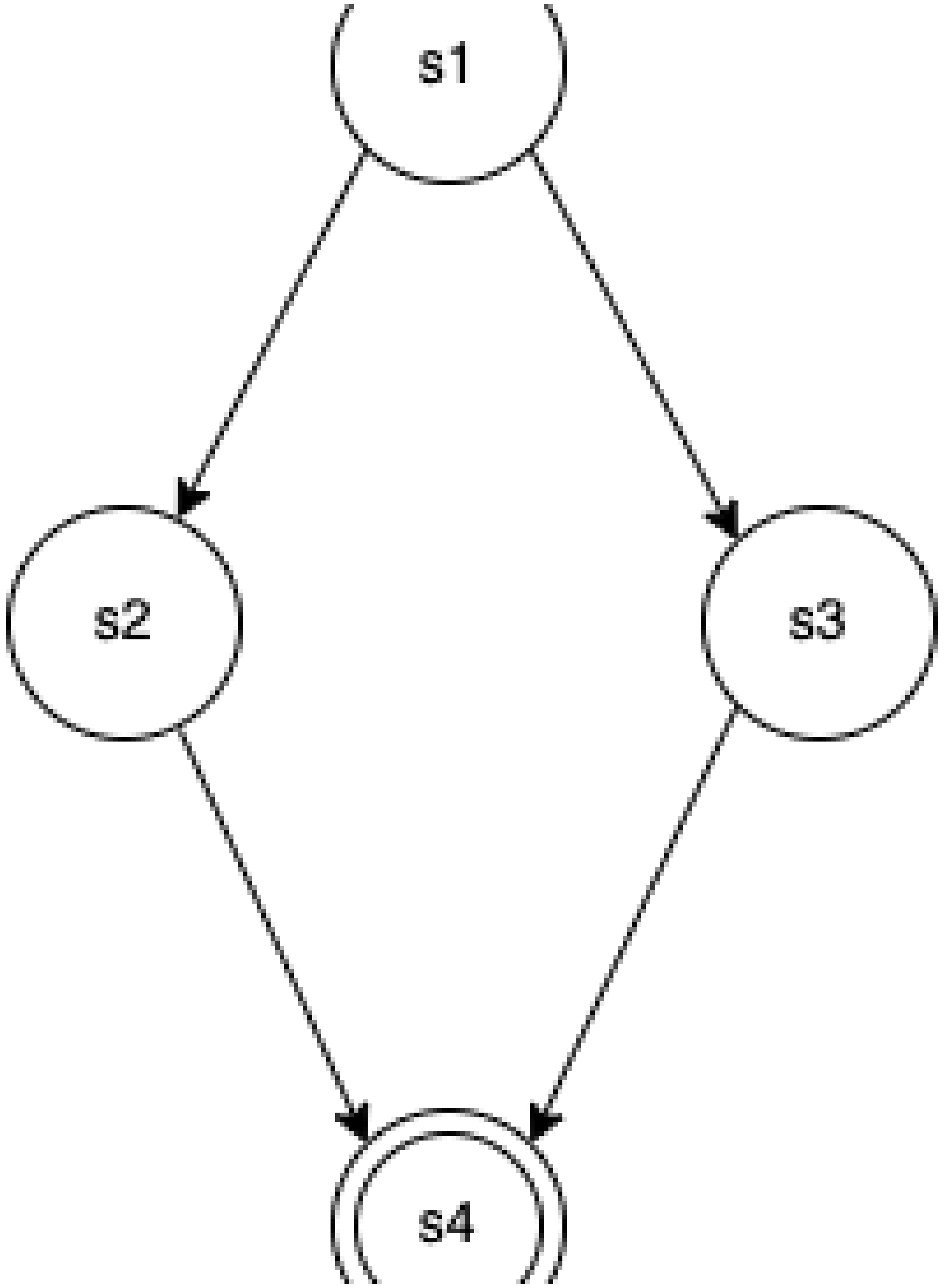
Problem 1: State-transition graph



- State space S = { ? }
- Initial State
- Goal State
- Action
- Transition Function
- Cost Function

Search Node vs State

What is the difference between a node and a state?



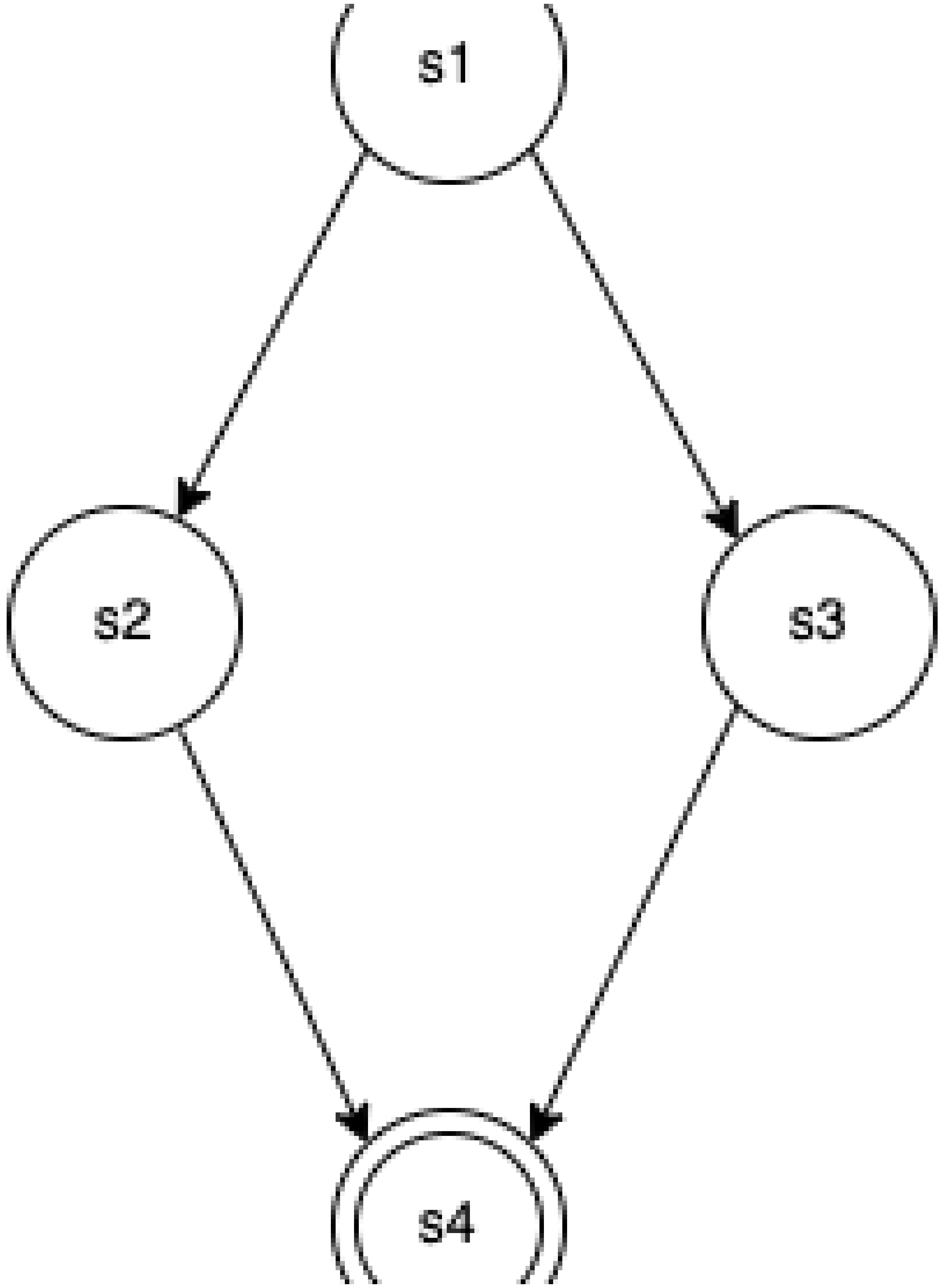
Search Node vs State

What is the difference between a node and a state?

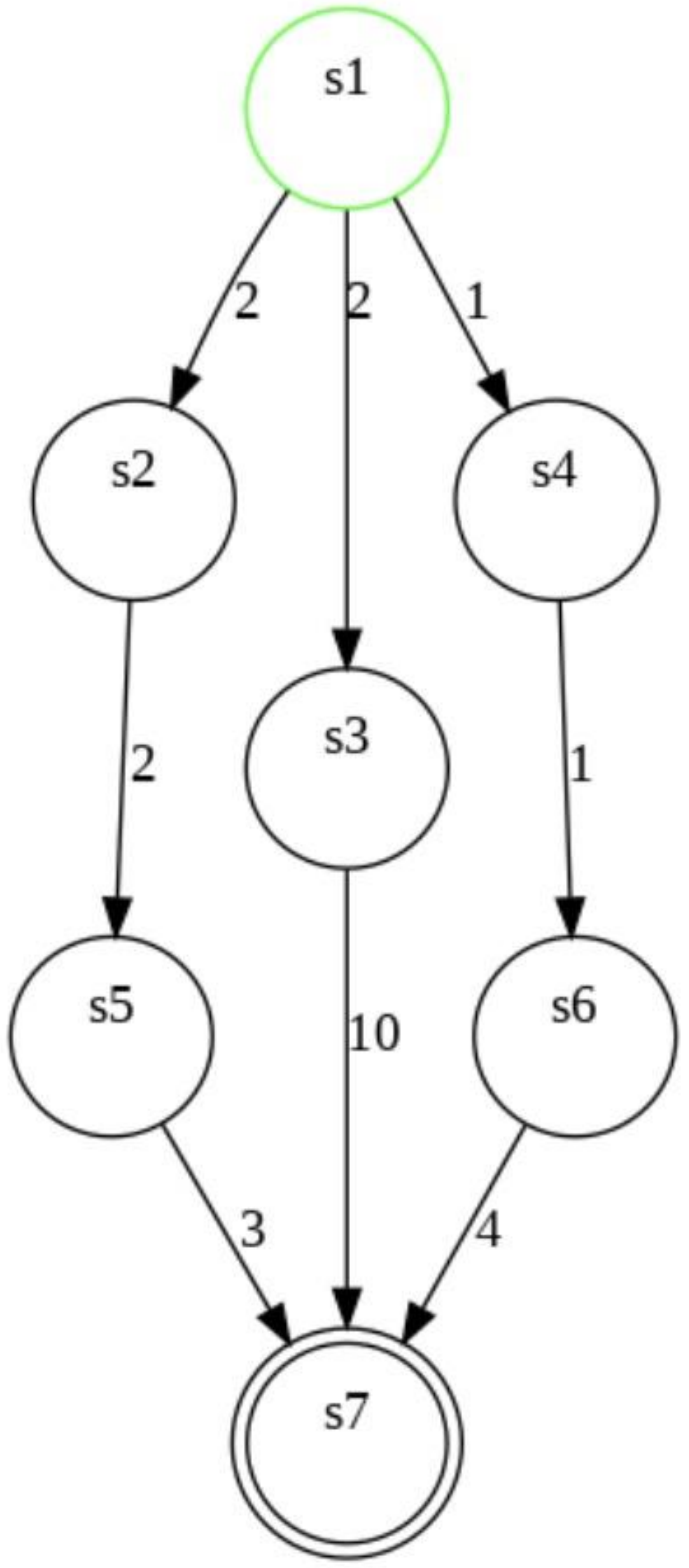
Node contains more information than a state, it may contain:

- State
- Accumulated cost
- Parent information

Why we need nodes?



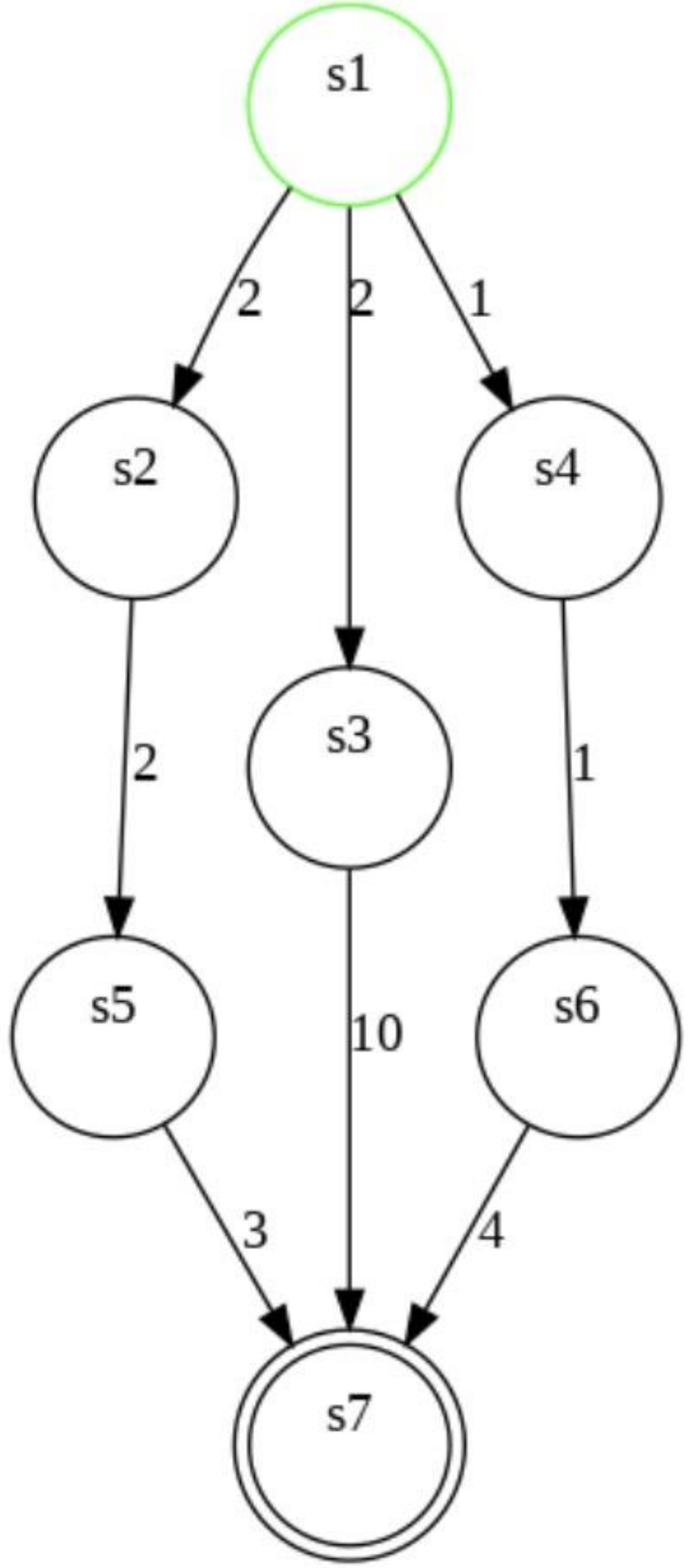
Problem 2



Task 1

Discuss with others, and finish the node expansion order for each algorithm

BFS Expansion



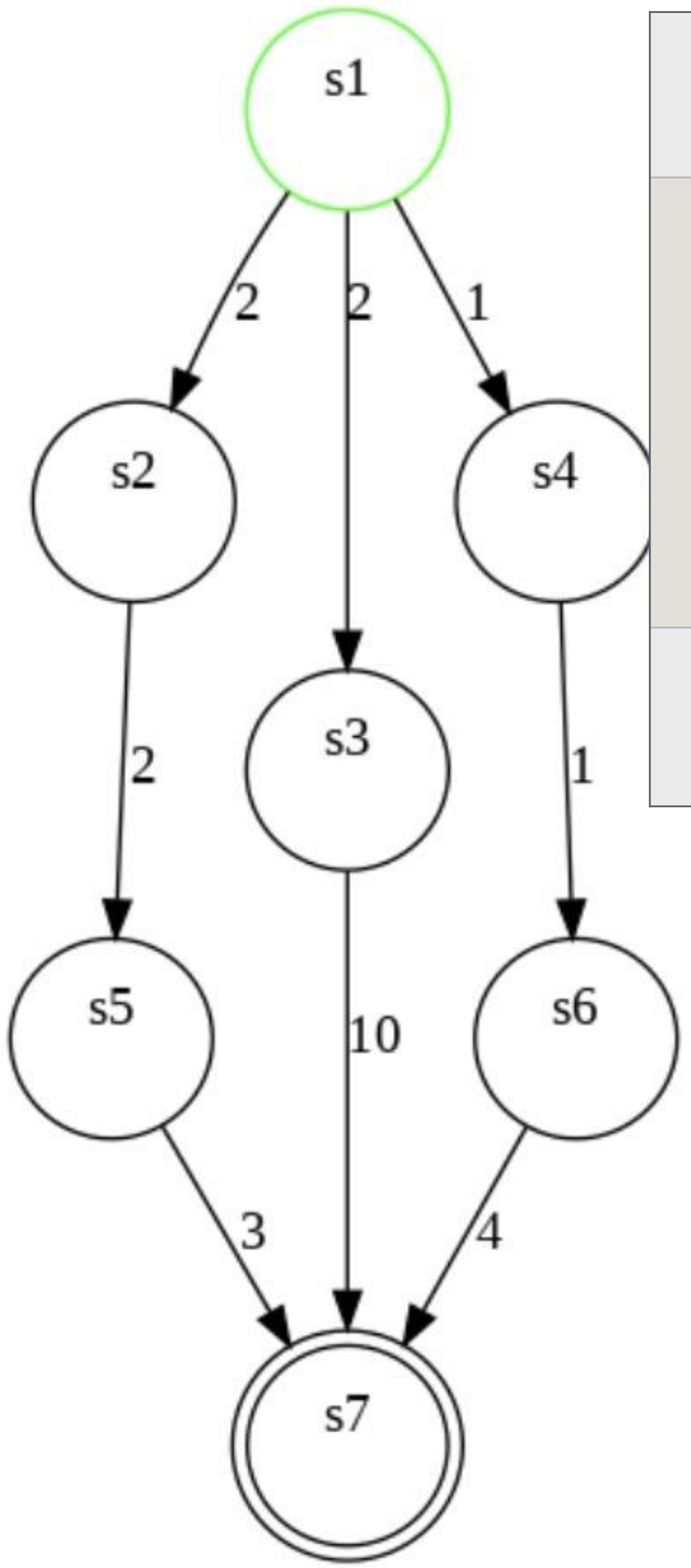
	Iteration 0	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5	Iteration 6
Open							
Closed							

When pop up a node from the queue:

1. Check if current node n contains the goal state

2. Generate children nodes, and put into data structure

BFS Expansion



	Iteration 0	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5	Iteration 6
Open	n0 =<s1, 0, null>	n1 =<s2, 2, n0> n2 =<s3, 2, n0> n3 =<s4, 1, n0>	n2 n3 n4 =<s5, ? , n1>	n3 n4 n5 =<**s7,** 12, n2>	n4 n5 n6 =<s6, 2, n3>	n5 n6 n7 =<s7, 7, n4>	n6 n7
Closed		n0	n0, n1	n0, n1, n2	n0, n1, n2, n3	n0, n1, n2, n3, n4	n0, n1, n2, n3, n4, **n5**

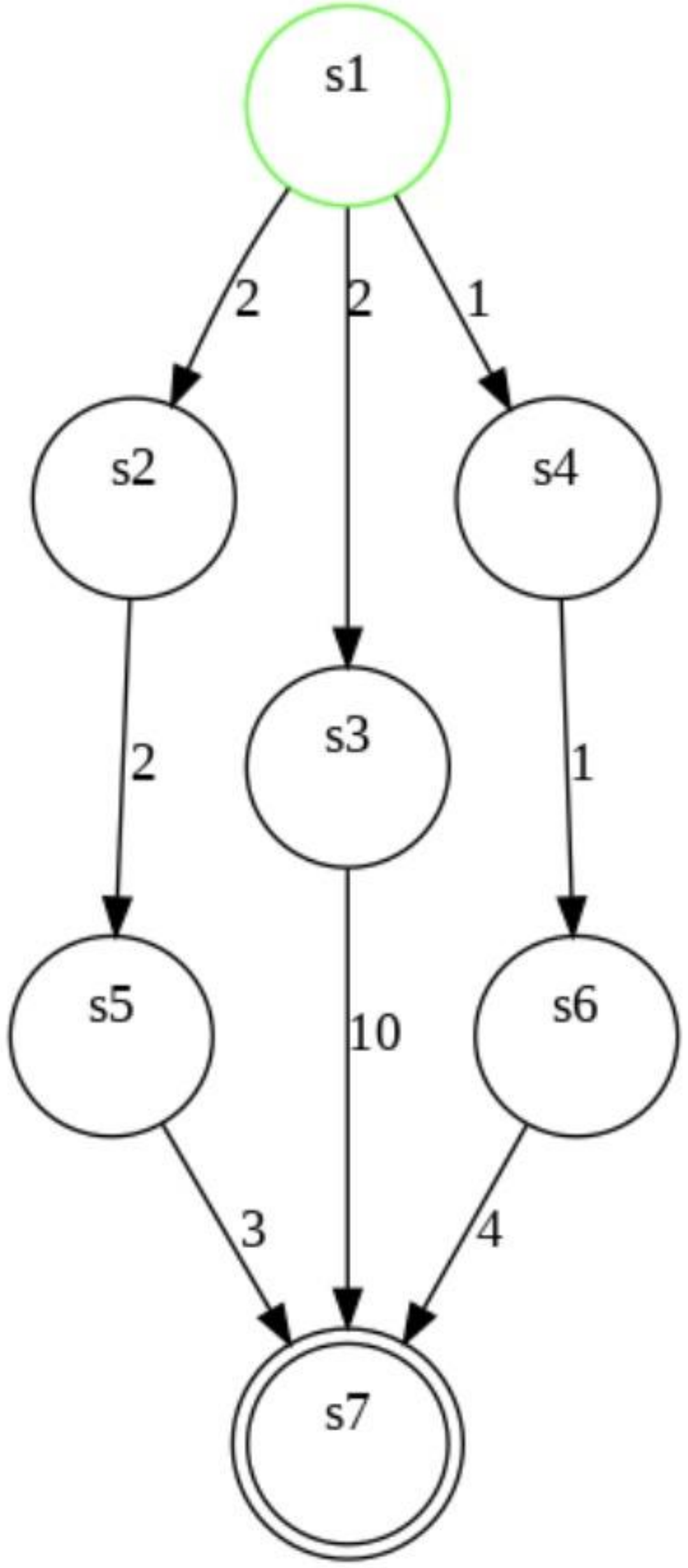
Queue: n0, n1, n2, n3, n4, **n5**, n6, n7

When pop up a node from the queue:

1. Check if current node n contains the goal state

2. Generate children nodes, and put into data structure

Problem 2: Search Algorithm

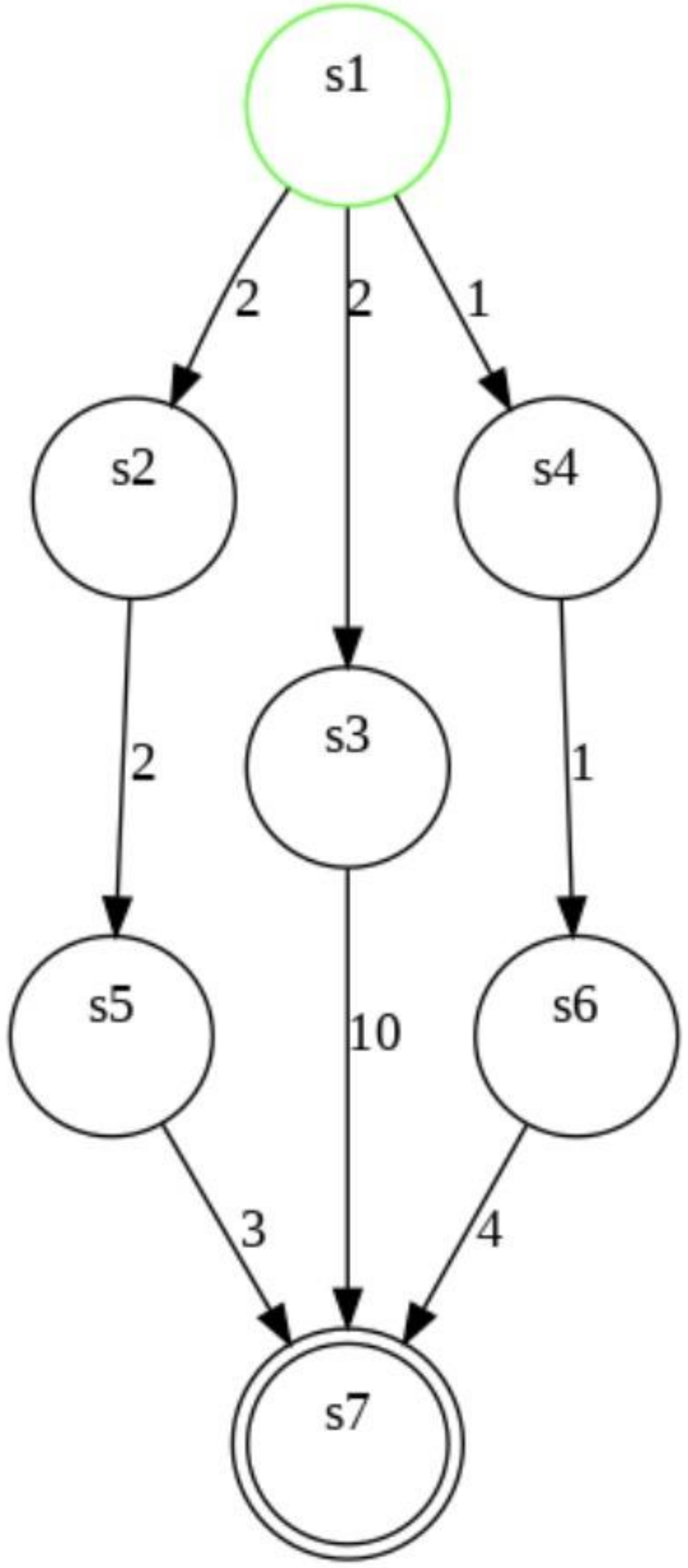


- Task 1 Expansion Order:
- **Breadth-First Search (BFS):**

```
Nodes = [
('s1',0,None),
('s2',2,0),
('s3',2,0),
('s4',1,0),
('s5',4,1),
('s7',12,2)]
```

- # (state, accumulated cost, id of parent node)

Problem 2 Task 1

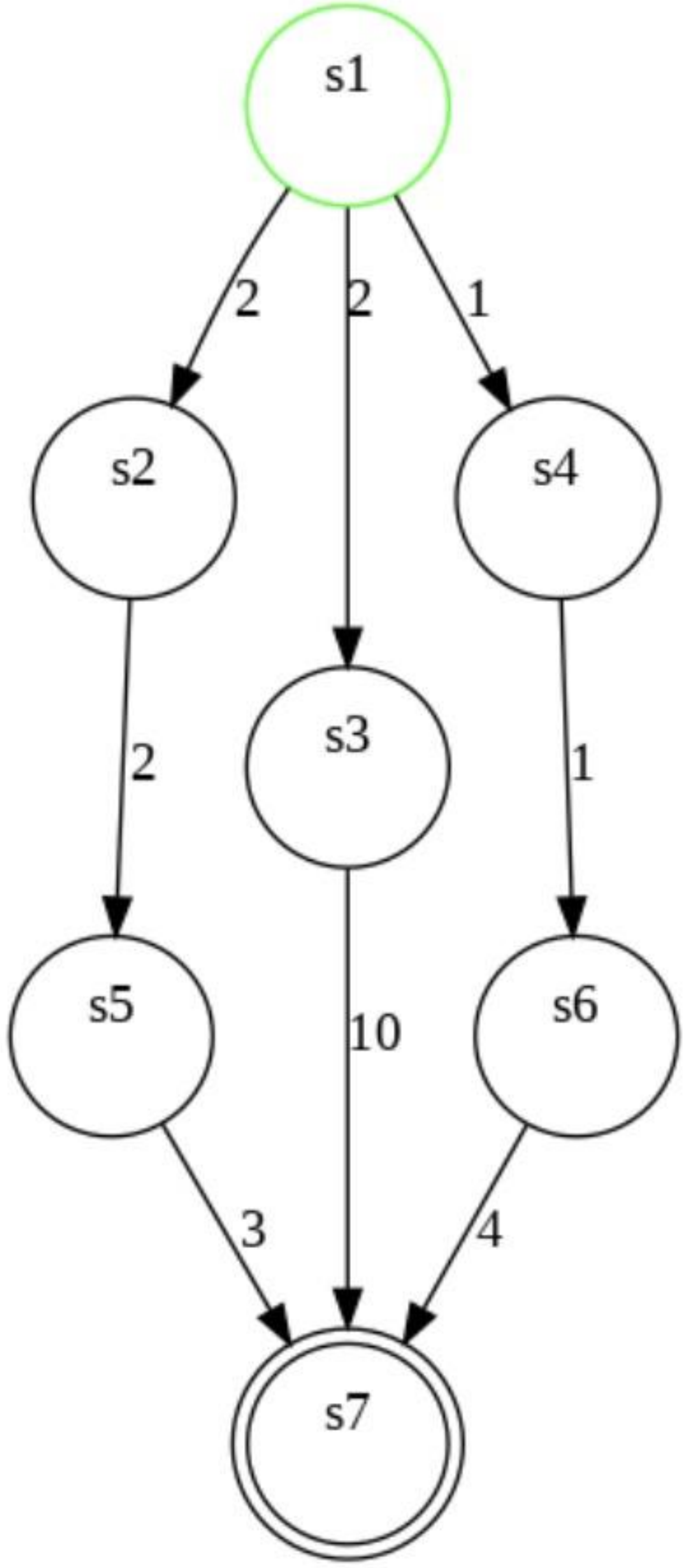


- **Depth-First Search**

```
Nodes = [
('s1',0,None),
('s2',2,0),
('s5',4,1),
('s7',7,2)]
```

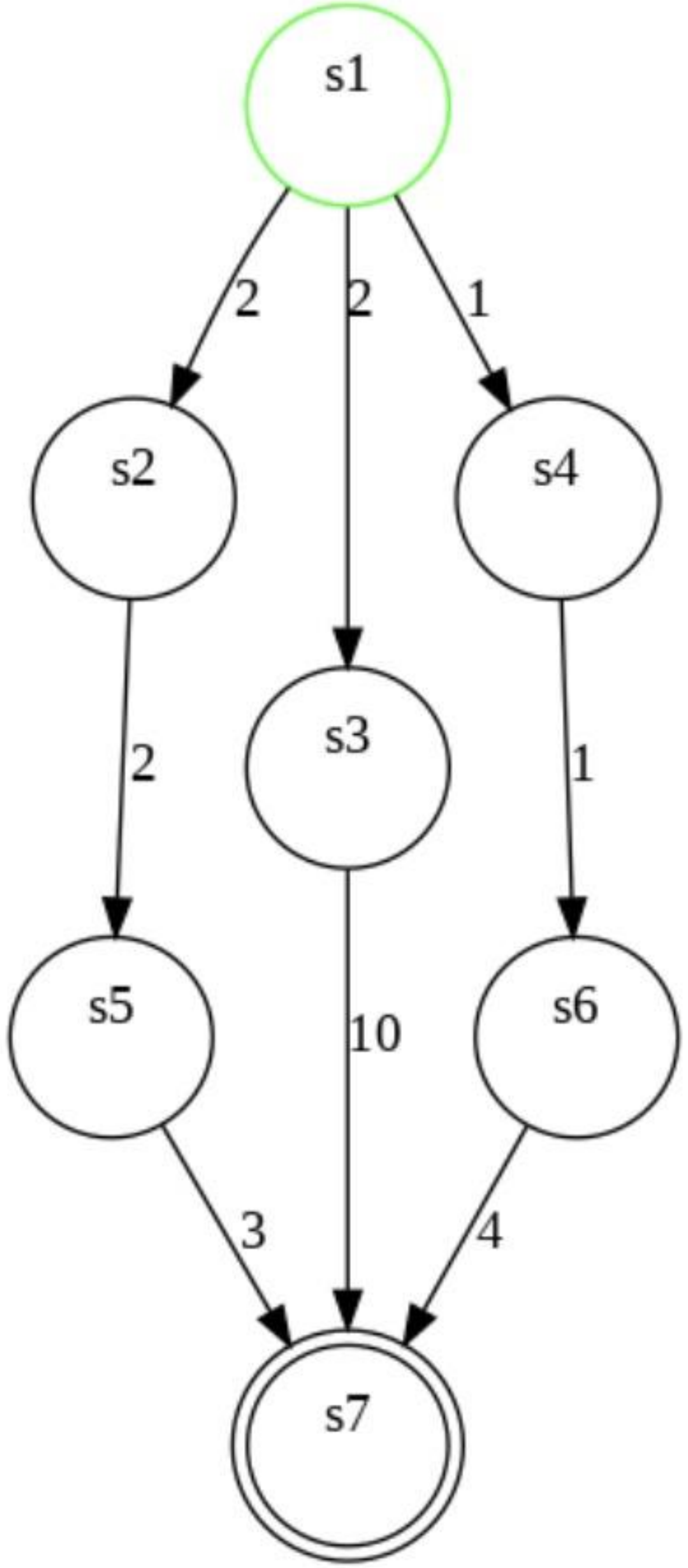
- # (state, accumulated cost, index of parent node)

Problem 2 Task 1



- **ID (iterative deepening)**

```
Nodes = [
 ('s1',0,None),#depth limit = 0
 ('s1',0,None),#depth limit = 1
 ('s2',2,1),
 ('s3',2,1),
 ('s4',1,1),
 ('s1',0,None),#depth limit = 2
 ('s2',2,5),
 ('s5',4,6),
 ('s3',2,5),
 ('s7',12,8)]
```



Problem 2

Task 2

Q1: What is the solution found by each algorithm?
Q2: What is the actual optimal solution?
Q3: Explain under which conditions the algorithms guarantee optimality.
Q4: Can any of the previous algorithms be adapted to account for g(n) in order to make it optimal?

	Complete	Optimal	Time Complexity	Space Complexity
BFS	T	T*	O(b^d)	O(b^d)
DFS	F	F	O(b^D)	O(b*d)
ID	T	T*	O(b^d)	O(b*d)

b = branching factor
d = depth of the optimal path
D = maximum depth of the problem
(D would be infinity if there exists a loop)

Problem 3

Describe a simple example of *Travelling Salesman Problem* along with its corresponding **State Space Model**.

Definition should be brief, clear, and *compact* (*compact* means using mathematical notation to define sets, i.e. $S = \{x | x \in V\}$ to define that there are as many states as elements in the set V, and pseudo-code, i.e. to define the transition function.)

1. State space S
2. Initial state $s_0 \in S$
3. Set of goal states $S_G \subseteq S$
4. Applicable actions function $A(s)$ for each state $s \in S$
5. Transition function $f(s, a)$ for $s \in S$ and $a \in A(s)$
6. Cost of each action $c(a)$ for $a \in A(s)$

Hint: Consider a set of cities V to visit in any order, a starting city location v_{start}, and a set of edges E specifying if there's an edge from two cities $\langle v_1, v_2 \rangle$. Let V' be the set of cities has been visited.

Problem 3

Let V' be the set contain visited cities:

- $S = \{\langle v_{current}, V'\rangle \mid v_{current} \in V \wedge V' \subseteq V\}$
- $s_0 = \langle v_{start}, \{v_{start}\}\rangle$
- $S_G = \{\langle v_{current}, V\rangle | v_{current} \in V\}$
- $A(\langle v_{current}, V'\rangle) = \{\langle v_{current}, v_{next}\rangle \mid \langle v_{current}, v_{next}\rangle \in E\}$
- $f(\langle v_{current}, V'\rangle, \langle v_{current}, v_{next}\rangle) = \langle v_{next}, V' \cup \{v_{next}\}\rangle$
- $c(\langle v_{current}, v_{next}\rangle) = cost(\langle v_{current}, v_{next}\rangle)$