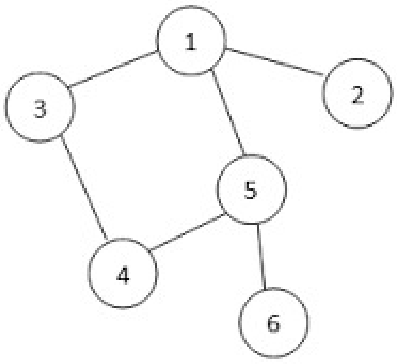
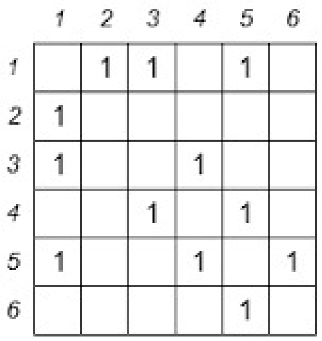
Algorithms and Data Structures № 13

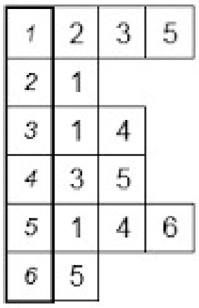
Graph representation

Graphs $G = (V, E)$ can be represented with adjacency matrices and adjacency lists:





	1	2	3	4	5	6
1		1	1		1	
2	1					
3	1			1		
4			1		1	
5	1			1		1
6					1	

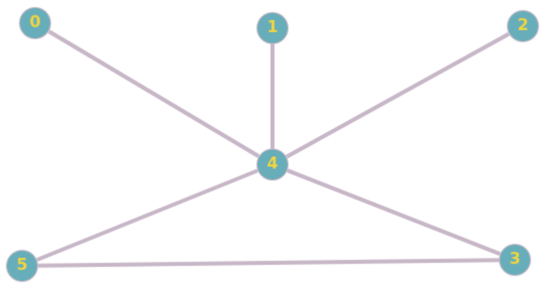


1	2	3	5
2	1		
3	1	4	
4	3	5	
5	1	4	6
6	5		

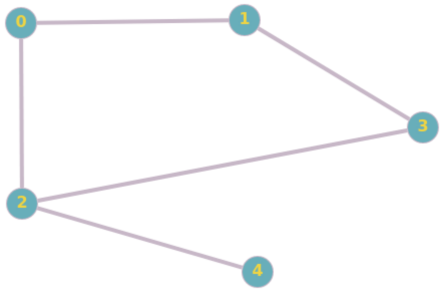
Problem 1

Represent an undirected graph with adjacency matrix and an adjacency list:

- graph 1:



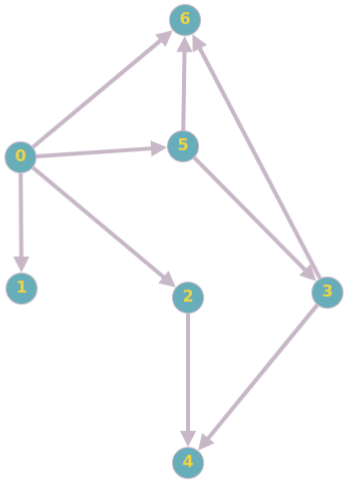
- graph 2:



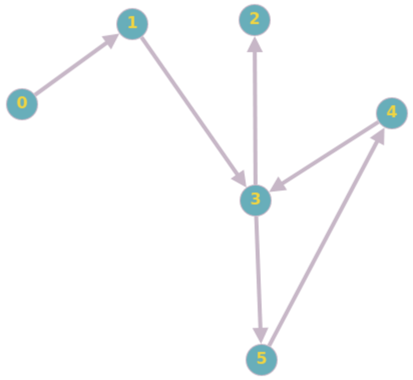
Problem 2

Represent a directed graph with adjacency matrix and an adjacency list:

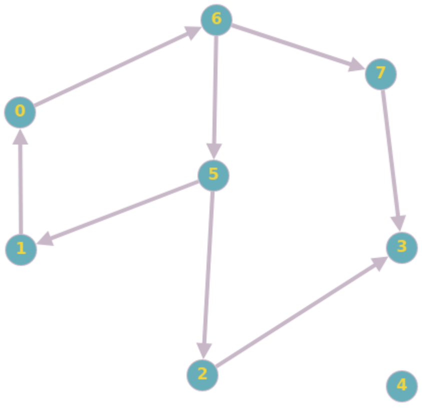
- graph 1:



- graph 2:



- graph 3:



Problem 3

Represent a full binary tree of 7 nodes with adj. matrix and adj. list.

Problem 4

What are the advantages and disadvantages of adjacency matrices? What are the advantages and disadvantages of adjacency lists?

Problem 5

How to represent a **weighted graph** with adj. matrix and adj. list?

Graph traversal. Breadth-first search (BFS)

```
BFS($V$, $E$, $s$)
for each $u \in V - \{s\}$
    do $d[u] \leftarrow \infty$
$d[s] \leftarrow 0$
$Q \leftarrow \emptyset$
ENQUEUE($Q$, $s$)
while $Q \neq \emptyset$
    do $u \leftarrow$ DEQUEUE($Q$)
       for each $v \in Adj[u]$
           do if $d[v] = \infty$
                 then $d[v] \leftarrow d[u] + 1$
                      ENQUEUE($Q$, $v$)
```

Problem 6

Solve the challenge https://www.hackerrank.com/challenges/bfsshortreach/ on Hackerrank.

Graph traversal. Depth-first search (DFS)

```
DFS($V$, $E$)
for each $u \in V$
    do $color[u] \leftarrow$ WHITE
$time \leftarrow 0$
for each $u \in V$
    do if $color[u] =$ WHITE
          then DFS-VISIT($u$)

DFS-VISIT($u$)
$color[u] \leftarrow$ GRAY          ▷ discover $u$
$time \leftarrow time + 1$
$d[u] \leftarrow time$
for each $v \in Adj[u]$           ▷ explore $(u, v)$
    do if $color[v] =$ WHITE
          then DFS-VISIT($v$)
$color[u] \leftarrow$ BLACK
$time \leftarrow time + 1$
$f[u] \leftarrow time$            ▷ finish $u$
```

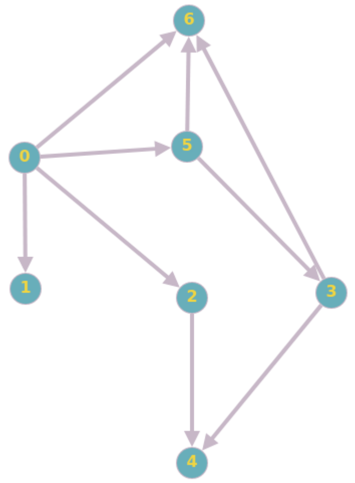
Problem 7

Write the DFS procedure without recursion, using a stack.

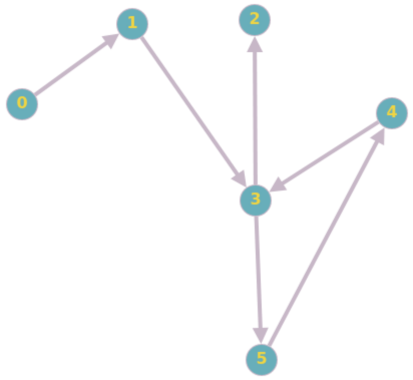
Problem 8

Write down the order in which the nodes will be visited with BFS and DFS (start from node ”0“).

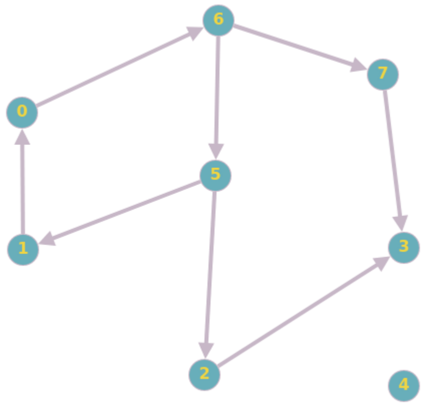
- graph 1:



- graph 2:



- graph 3:



Problem 9

Why is the complexity of BFS and DFS in order $O(E+V)$, where E is the set of edges and V is the set of vertices?

Problem 10 (extra credit)

Sign up to https://csacademy.com/.
Solve the challenge: https://csacademy.com/contest/archive/task/check-dfs/.