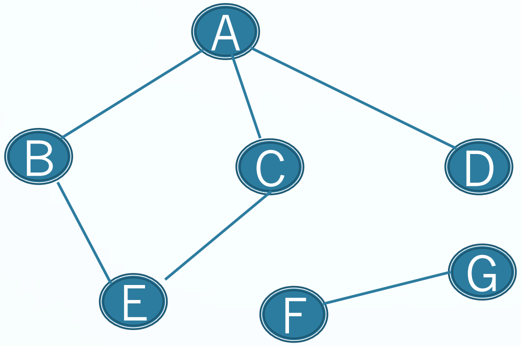
COMP20007 Workshop Week 6

1	**Topic 1:** DFS & Topological Sorting ***Exercise:*** Q6.1 (toposort)
2	**Topic 2:** Binary Trees & BST ***Group/Individual Exercises:*** Q 6.2, 6.4, 6.3
	Lab: ASSIGNMENT 1 • Finish ass1 if not yet done, or • review workshops week 5-6 and ask questions • on request: understanding BFS and Prim’s, Dijkstra’s

DFS review: Q&A on algorithm & complexity



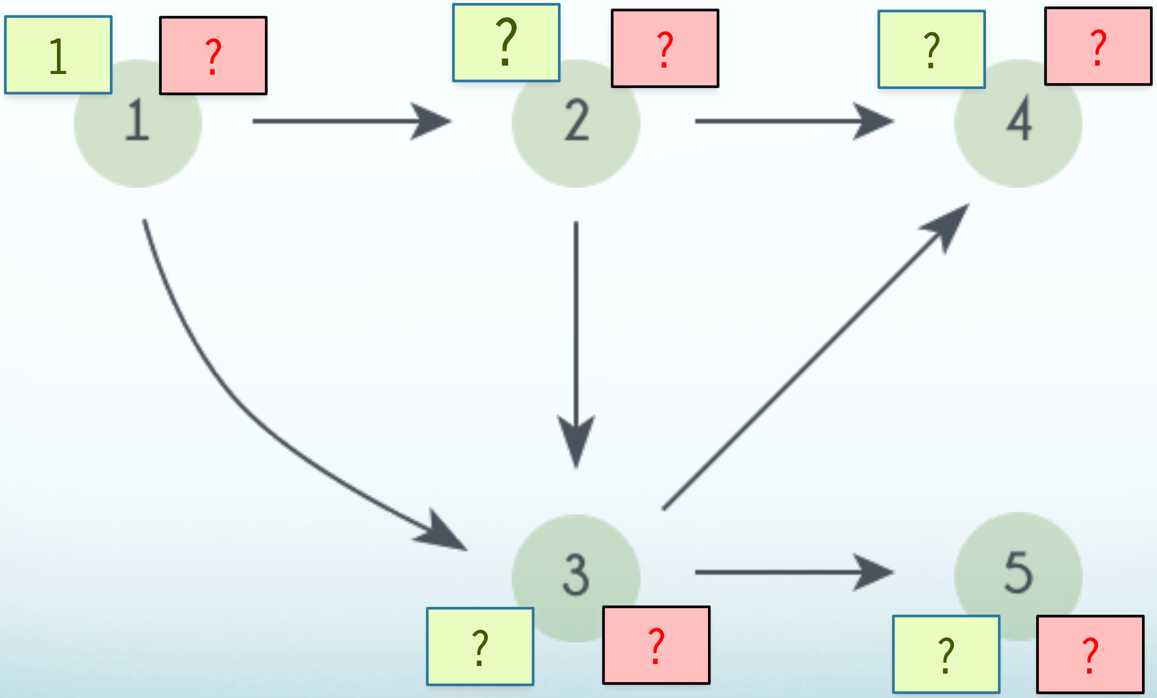
```
function DFS(G=(V,E))
   for each v in V do
      mark v with 0
   for each v in V do
      if v is marked with 0 then
         DFSExplore(v)

function DFSExplore(v)
   // start visiting v
   mark v with 1
   for each edge (v,w) in E do
      if w is marked with 0 then
         DFSExplore(w)
   // end visiting v
```

DFS exercise: push- and pop-order (pre- and post-order)

Problem:

- *For the graph below, write the push and pop order for DFS, starting from node 1*
  Method 1: *Fill in the yellow boxes with push-orders, pink boxes with pop-orders.*

Note that you can start pop orders with 1, you can also use a timestamps for both push- and pop-orders.

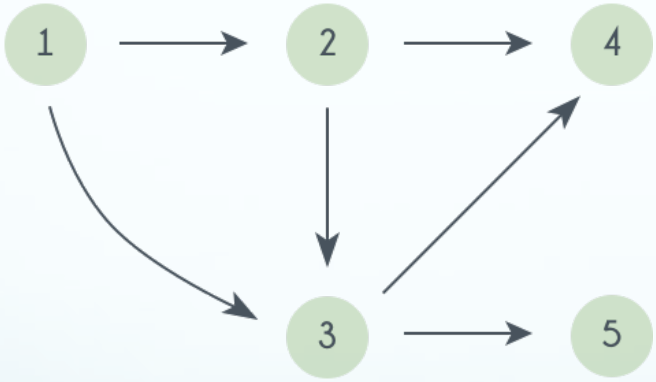


DFS exercise: push- and pop-order (pre- and post-order)

Problem:

- *For the graph below, write the push and pop order for DFS, starting from node 1*

Method 2: *Explicitly show the order of the push and pop operations, and also show the content of the stack. Fill in the yellow box. orders.*

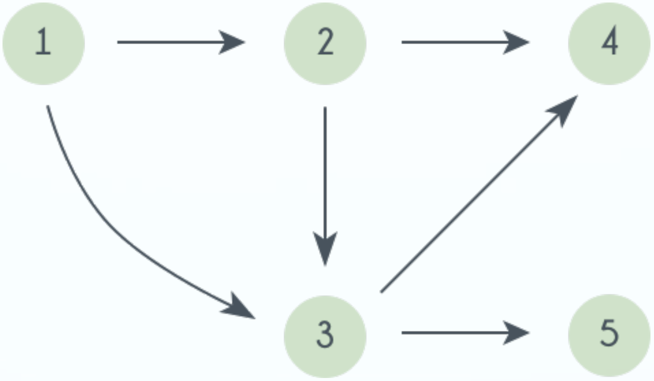


```
The PUSH and POP, using $
for the bottom of stacks.

ops     stack content
init      $
push 1    $1
?
```

DFS exercise: push- and pop-order, DFS complexity

Problem: *Modify the DFS algorithm so that it also builds the arrays* `push[V]` *and* `pop[V]` *to store the push- and the pop-order of the vertices.*

Example graph:



```
// building push[V] and pop[V]
function DFS(G=(V,E))
  for each v in V do
    mark v with 0
  for each v in V do
    if v is marked with 0 then
      DFSEXPLORE(v)

function DFSEXPLORE(v)
  mark v with 1
  for each edge (v,w) in E do
    if w is marked with 0 then
      DFSEXPLORE(w)
```

Homework: Complexity of the algorithm:

using adjacency matrix

?

using adjacency list

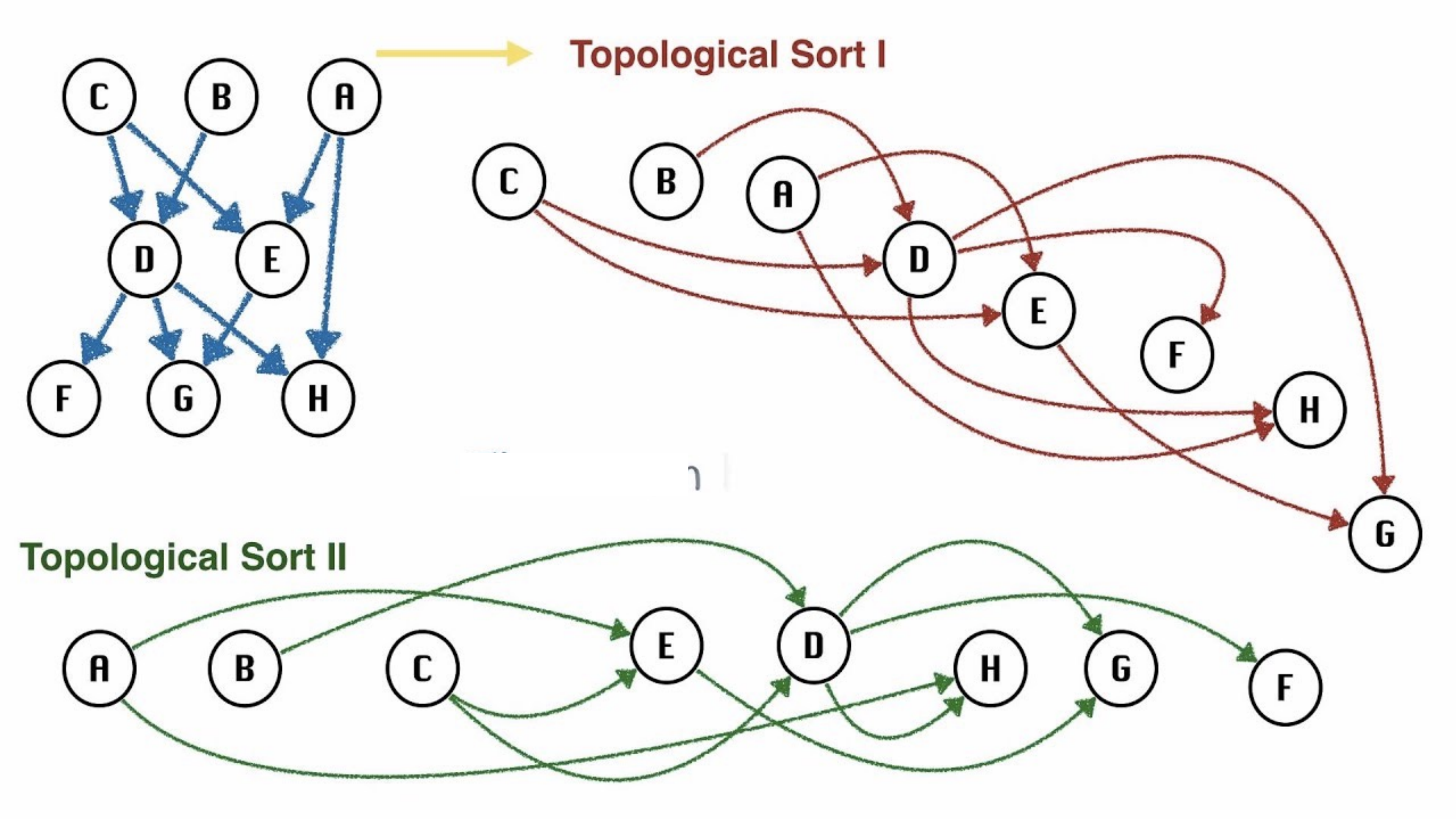
?

Homework: What's the complexity of

```
BFS          :
Prim's       :
Dijkstra's   :
```

Topological Sorting (for DAG only!)

A *topological ordering:* sorting the nodes of the graph such that all edges point in one direction, to nodes later in the ordering.



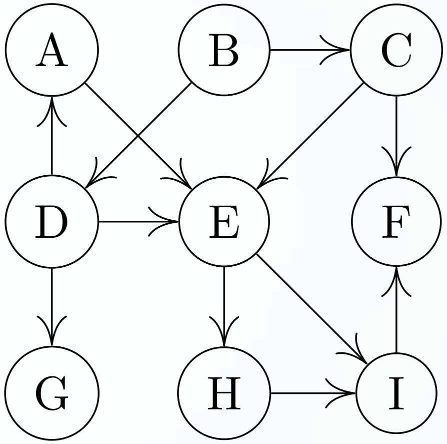
Group Work: Q 6.1

T1: *Finding a topological order for the graph by running a DFS.*

YOUR ANSWER:

First, run the DFS

(you can also just draw graph and write down push and pop order on the left and right of each node like we did earlier)

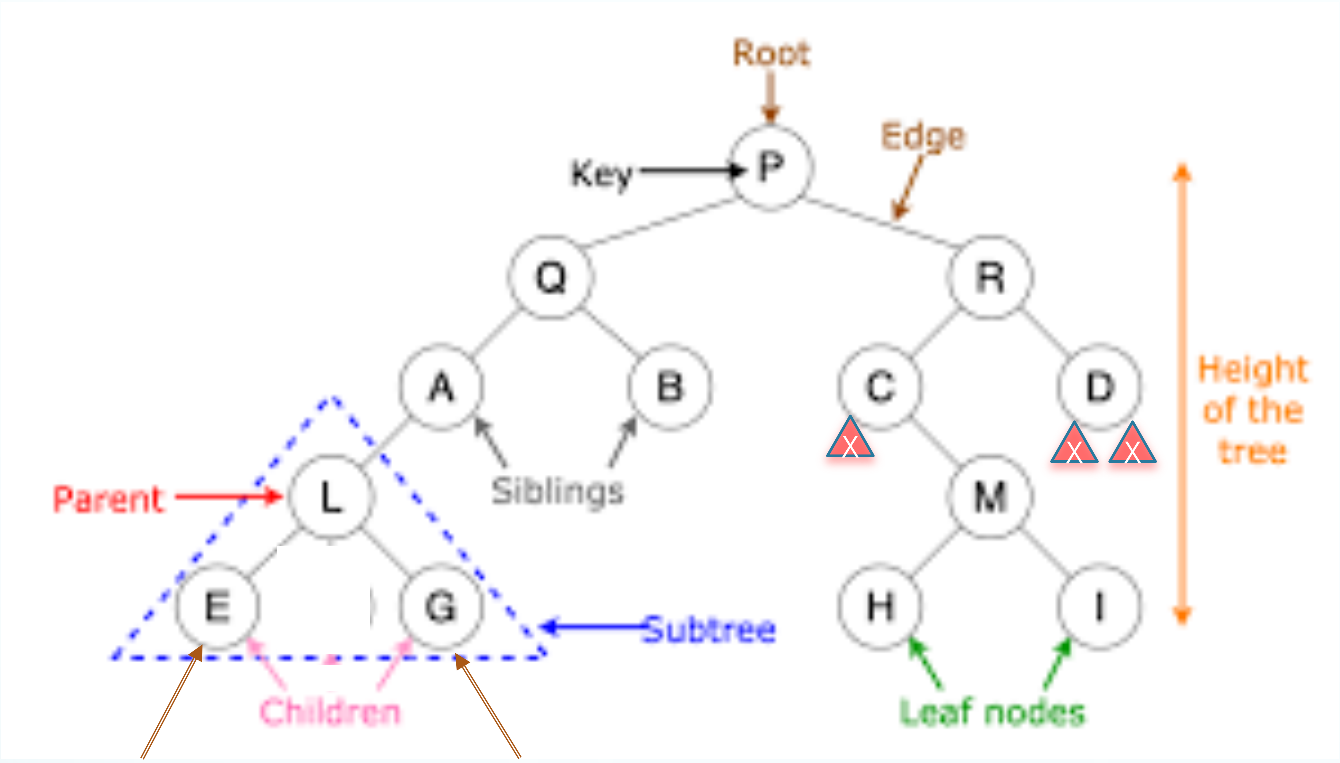


operation	content	operation	content
init stack push A	$ $A		

The topological order resulted from the above DFS run:

???

Topic 2 Binary Trees as Special Graphs



Notes:

△ denotes a NULL node, aka. *external node*, only a few of them drawn here. If the tree has n internal nodes, it has n+1 external nodes

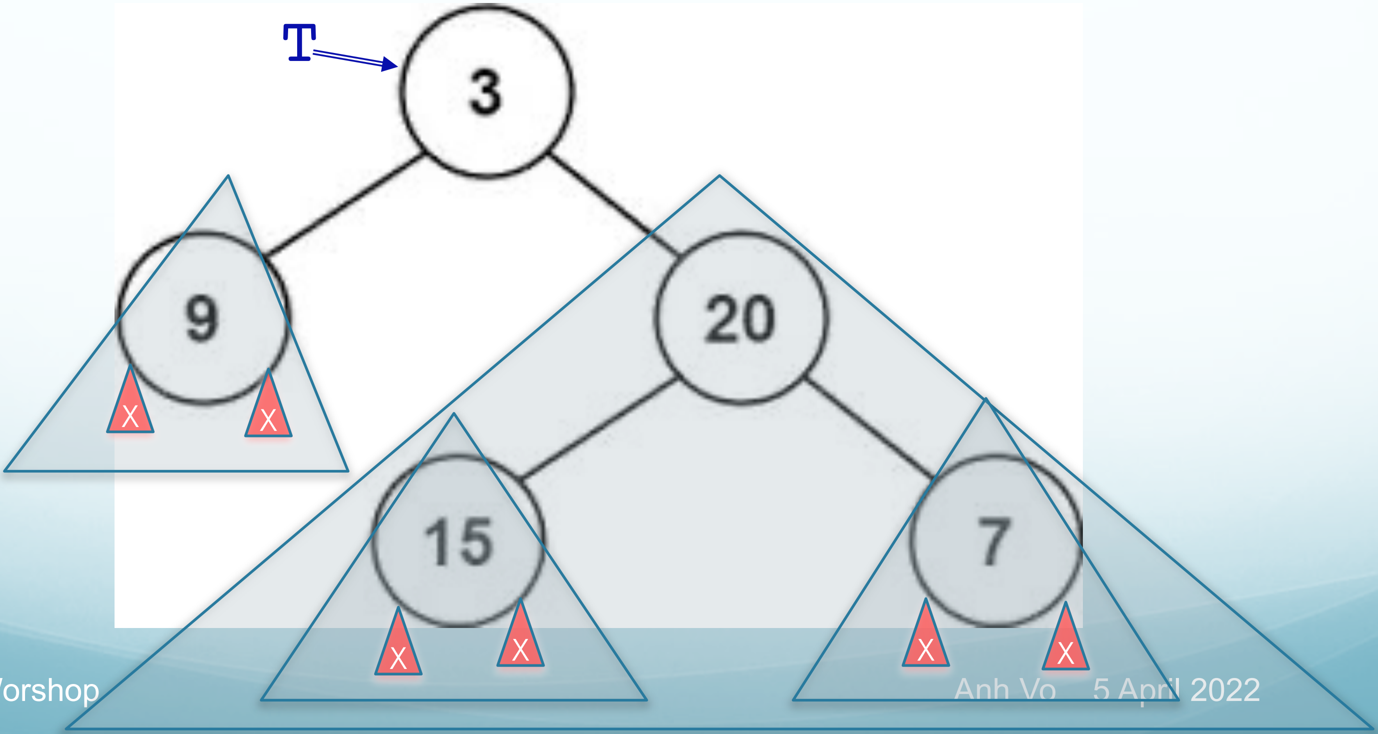
Make differences between:

- *leaf nodes* and *external nodes*
- *none-leaf nodes* and *internal nodes*

Binary Tree: Recursive Definition

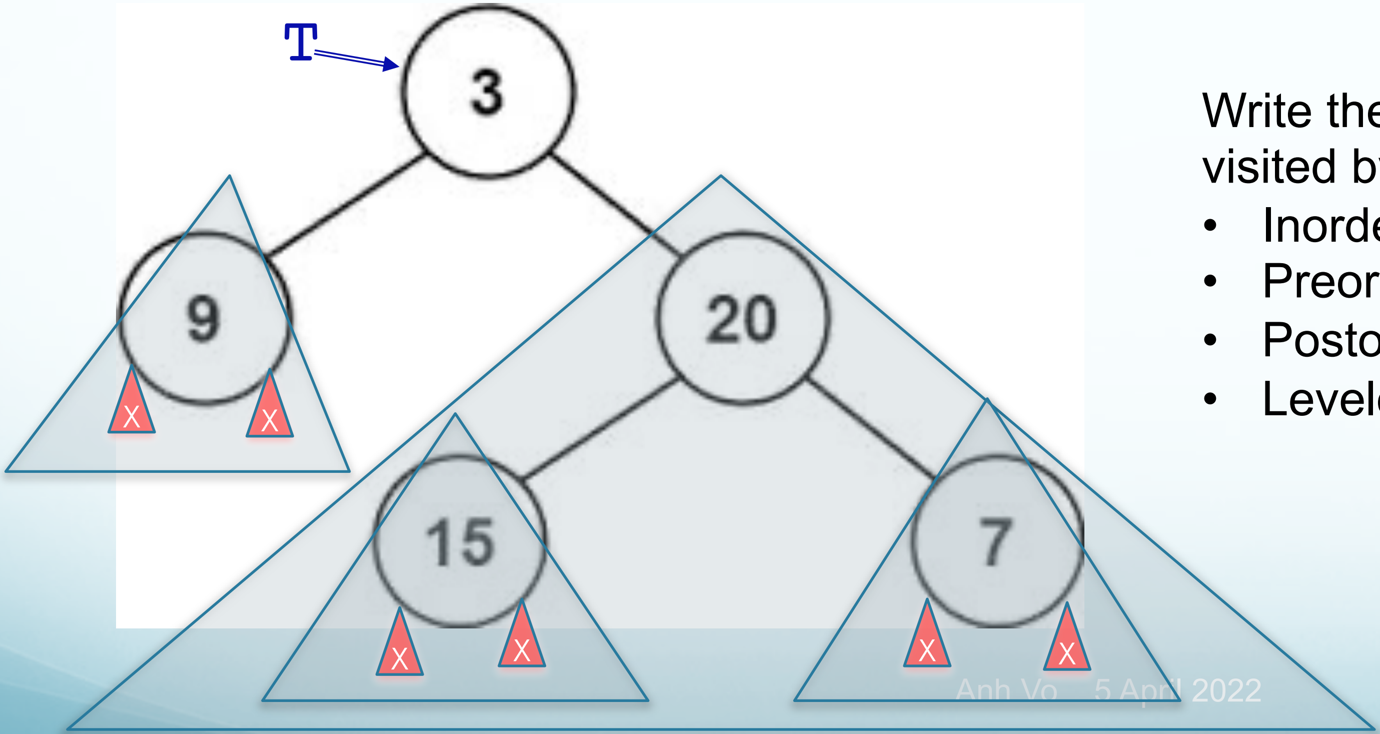
A binary tree is:

- NULL, or
- a node, called the tree's *root node*, that contains some data and:
  - a link to another binary tree called the root's *left child*, and
  - a link to another binary tree called the root's *right child*



Binary tree traversal

What is tree traversal?
For a tree T, what job we need to do with Traversal(T)?
What is *inorder*, *preorder*, *postorder* traversal? Are they BFS or DFS?
What is *level-order* traversal? Is it BFS or DFS?

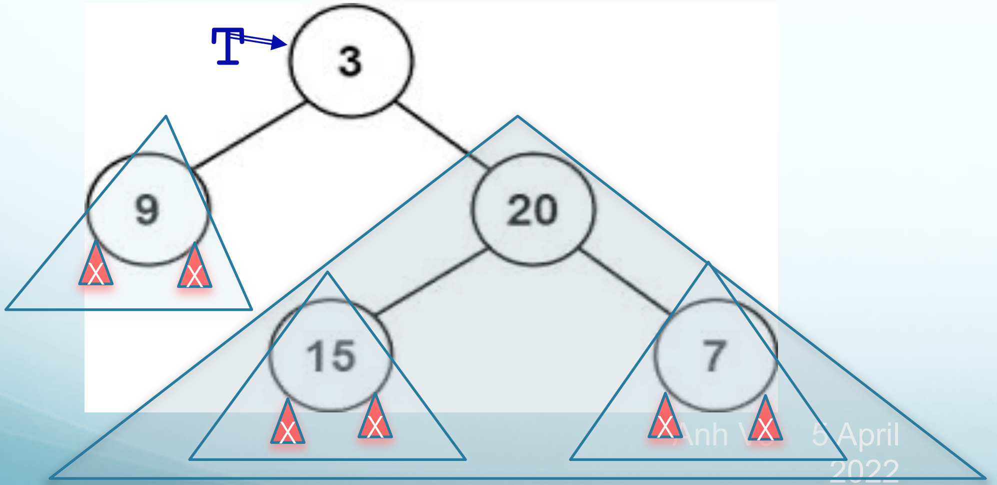


Write the nodes in order visited by:

- Inorder :
- Preorder :
- Postorder :
- Levelorder:

Binary tree traversal

What is tree traversal? visiting all nodes of a tree
For a tree T, what job we need to do with Traversal(T)? 3 jobs: visit the root, traverse the left child, traverse the right child
What is *inorder*, *preorder*, *postorder* traversal? just depends on when we visit the root: in-between, before, or after traversing the children. All of them are DFS.
What is *level-order* traversal? Think of the tree as a graph, and start traversal from the root. In level-order, we visit level by level, left to right, starting from the root. This is BFS.



Write the nodes in order visited by:

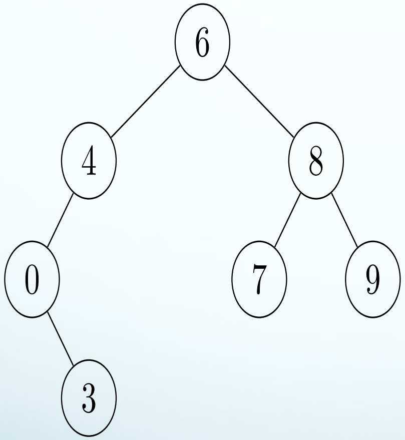
- Inorder : 9 3 15 20 7
- Preorder : 3 9 20 15 7
- Postorder : 9 15 7 20 3
- Levelorder: 3 9 20 15 7

Q 6.4: Binary Tree Sum

Write an algorithm to calculate the sum of a binary tree where each node contains a number.

YOUR ANSWER: The pseudocode:

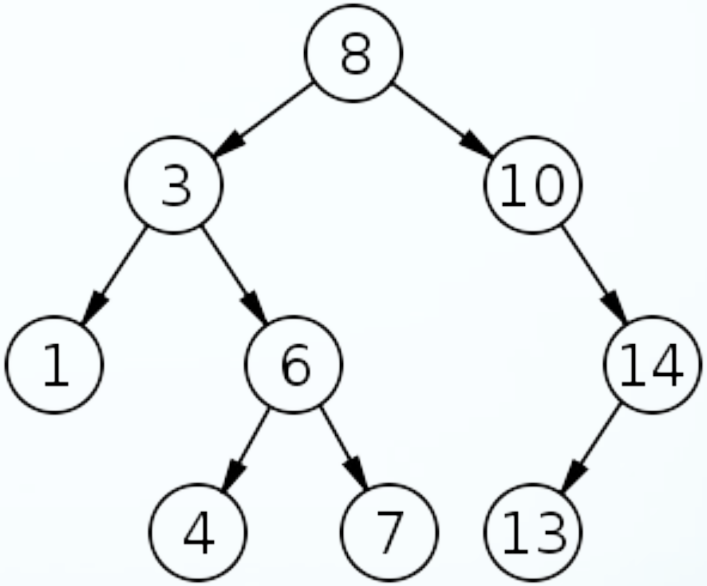
```
function Sum( T )
  ???
```



Binary (Search) Tree

How to:

1. print the keys in increasing order?
2. print in decreasing order?
3. copy the tree?
4. free the tree?



Your answers:

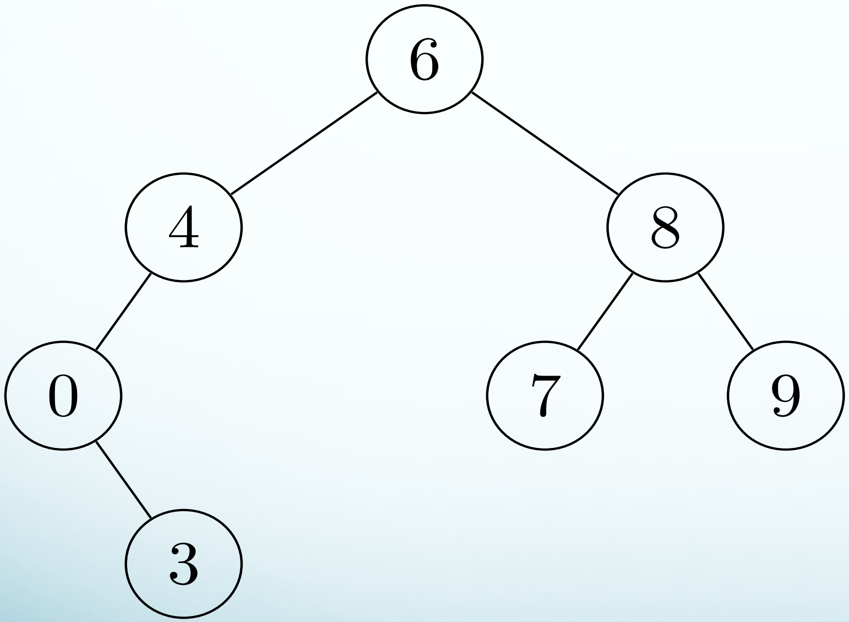
1.
2.
3.
4.

Group/Individual work

Questions 6.2, 6.3.

Q 6.2: conventional traversal

Write the *inorder*, *preorder* and *postorder* traversals of the following binary tree:



YOUR ANSWER:

In-order:

?

Pre-order:

?

Post-order:

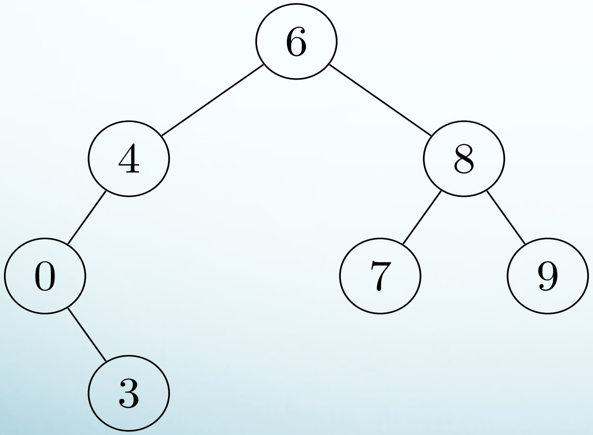
?

Q 6.3: level-order traversal

Level-order: visit level-by-level, left-to-right, starting from the root (which is in 0-th level).

a) For the tree below, what's the visited order?

b) Write the level-order pseudo-code.



YOUR ANSWER:

a) Level-order: ???

```
b)
// level order traversal for binary tree T
// supposing a non-empty tree has 3 components
//     T.root, T.left, T.right
function LevelOrder(T)
  ???

// for reference
function BFS(G=(V,E))
  mark each node in V with 0
  for each v in V do
    if v is marked with 0 then
      Q := empty queue
      mark v with 1
      inject(Q, v)        //=enqueue
      while Q ≠ ∅  do
        u := eject(Q)   //=dequeue
        // visit u
        for each (u,w) in E do
          if w is marked 0 then
            mark w with 1
            inject(Q, w)//=enqueue
```

LAB

Questions on Dijkstra’s and BFS?

Assignment 1:

- do assignment 1 if not yet done
- make sure that you can finish on time
- note that you can discuss general problems with your friends but please do not reveal or show your solution and code

OR:

- do not-yet-done problems (if any) of previous workshops/lab/lectures