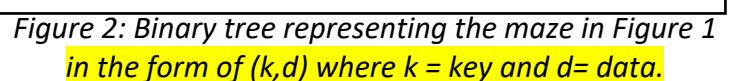
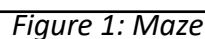


Due Date: Phase 1 (20 May 2023 11:59pm).  
Due Date: Phase 2 (3 June 2023 11:59 pm).

### Problem Definition:

Figure 1 shows a maze. The maze can be represented as a binary tree (after removing the walls and rotating the paths 45 degrees) as shown in Figure 2



In this maze, the exit can be reached by moving: “T-S-S-X” or “T-T-S-T-T-T-X” starting from the root.

## Phase 1:( 15 marks)

In the first phase of the project, you are asked to perform the following tasks:

Given the class MNode:

```
class MNode <T> {  
    public int key; //unique number for each added node  
    public T data;  
    public MNode <T> left, right;  
    ...  
}
```

1. Using Java programming language, implement the Binary Tree data structure, and add the following methods such that they are performed as fast as possible:
  - a. Write the method private boolean follow(MNode <T> t, String path), which tests if the path indicated by path and starting from t is valid. A path is valid if its directions are available (not necessarily leading to an exit).

For example, In the maze shown above, the following paths are valid:

"T-T", starting from node with key = 4,

"T-T-X", starting from node with key = 9,

"S-T", starting from node with key = 6,

whereas the paths "S-T-X", starting from node with key = 15, and "S-T-S", starting from node with key = 6, are not valid.

- b. Write the method private boolean escape(MNode <T> t), which searches for an exit starting at t using **preorder** traversal and returns true if it finds one. Note, t is not necessary the root. It can be any node in the tree, which can be identified by the key.
  - c. Write the method private String short(), which returns the shortest path to an exit starting at the root.

For example, In the maze shown above, the shortest path is: "B-T-S-S-X"

Then implement a main class with a proper menu to test the above methods.

### Note:

- Your code should be written with: proper indentation, comments, and proper naming of the variables, methods, and classes. All of these points will be graded.
- Using Java Collections **is not permitted** at this stage. All data structures used in this assignment must be implemented by you.

2. Provide the time complexity (worst case analysis) of all the three methods discussed above using Big O notation. Your answer should show the steps followed when calculating the growth rate function and the big O.

### **Phase 2:( 10 marks)**

In the second phase of the project, you are asked to perform the following tasks:

1. **Review and Critique:** After submitting phase 1, you will be given another group's code to review. You are asked to carefully review their code and provide 2-3 critiques about their code.
2. **Time complexity:** You are asked to provide the time complexity (worst case analysis) of all the three methods discussed above based on the other group's code that you reviewed. Your answer should show the steps followed when calculating the growth rate function and the big O.
3. **Demonstration:** You are asked to prepare a presentation demonstrating your own work. The presentation should include and discuss the following points:
  - The time complexity you provided in phase 1.
  - The challenges your ran into.
  - What you have learned from the project.

### **Submission Guidelines**

- You are expected to work in teams, each team must contain **3 students**.
- For Phase 1, submit a written report (in PDF format) answering the given questions. In addition to submitting your source code (compressed in ZIP format).
- After the submission of phase 1, you will present a demo that demonstrates your working code to your instructor on a scheduled session.
- For Phase 2, submit a written report (in PDF format) answering the given questions. You do not need to submit your presentation as you will be asked to present it in class in the following week after the submission.
- For both phases, your report should include a cover sheet including the names and IDs of your team members and the division of work among them.
- All submissions, should be made through LMS.
- The submitted work should be your own work. Contrary to what you might expect, it is relatively easy to find out if codes have been copied! **Any case of unethical conduct will result in an F in the class.**