TIP102 | Intermediate Technical Interview Prep

Intermediate Technical Interview Prep Spring 2025 (@ Section 3 | Tuesdays and Thursdays 6PM - 8PM PT)
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Session 1: Matrices

Session Overview

In this session, students will learn how to use graph concepts and algorithms to solve 2D matrix problems.

> You can find all resources from today including session slide decks, session recordings, and more on the resources tab

🎢 Part 1 : Instructor Led Session

We'll spend the first portion of the synchronous class time in large groups, where the instructor will lead class instruction for 30-45 minutes.

🧑‍💻 Part 2: Breakout Session

In breakout sessions, we will explore and collaboratively solve problem sets in small groups. Here, the **collaboration, conversation, and approach** are just as important as "solving the problem" - please engage warmly, clearly, and plentifully in the process!

In breakout rooms you will:

- Screen-share the problem/s, and verbally review them together
- Screen-share an interactive coding environment, and talk through the steps of a solution approach
    - ProTip: - An Integrated Development Environment (IDE) is a fancy name for a tool you could use for shared writing of code - like Replit.com, Collabed.it, CodePen.io, or other - your staff team will specify which tool to use for this class!
- Screen-share an implementation of your proposed solution
- Independently follow-along, or create an implementation, in your own IDE.

ur program leader/s will indicate which code sharing tool/s to use as a group, and will help break down or provide specific scaffolding with the main concepts above.

▶ **Note on Expectations**

🔎 Problem Solving Approach

To build a long-term organized approach to problem solving, we'll start with three main steps. We'll refer to them as **UPI: Understand, Plan, and Implement**.

We'll apply these three steps to most of the problems we'll see in the first half of the course.

We will learn to:

- **Understand** the problem,
- **Plan** a solution step-by-step, and
- **Implement** the solution

▶ **Comment on UPI**

▶ **UPI Example**

Breakout Problems Session 1

▼ Standard Problem Set Version 1

Problem 1: Seeking Safety

The city has been overrun by zombies, and you need to be very careful about how you move about the city. You have a map of the city `grid` represented by an `m x n` matrix of `1` s (safe zones) and `0` s (infected zones). Given a tuple `position` in the form `(row, column)` representing your current position in the city `grid`, implement a function `next_moves()` that returns a list of tuples representing safe next moves. You may return the moves in any order.

From your current `position`, you may move to any `(row, column)` index that is horizontally or vertically adjacent such that `row` and `column` are both valid indices in `grid`. A move is safe if it has value `1`.

```
def next_moves(position, grid):
    pass
```

Example Usage:

```
grid = [
    [0, 0, 0, 1, 1], # Row 0
    [0, 0, 0, 1, 1], # Row 1
    [1, 1, 1, 0, 0], # Row 2
    [1, 1, 1, 1, 0], # Row 3
    [0, 0, 0, 1, 0]  # Row 4
]

position_1 = (3, 2)
position_2 = (0, 4)
position_3 = (0, 1)

print(next_moves(position_1, grid))
print(next_moves(position_2, grid))
print(next_moves(position_3, grid))
```

Example Output:

```
[(3, 1), (3, 3), (2, 2)]
Example 1 Explanation: The cell to the left, right, and one up from (3, 2) all have 
are safe next moves. The cell one down from (3, 2) has value 0 and is thus unsafe.

[(0, 3), (1, 3)]
Example 2 Explanation: The cell to the left and one down from (0, 4) have value 1 an
The cells above and to the right are out of bounds of the grid.

[]
Example 3 Explanation: All the cell up, left, right, and down of (0, 1) are either 0
bounds.
```

Problem 2: Escape to the Safe Haven

You've just learned of a safe haven at the bottom right corner of the city represented by an `m x n` matrix `grid`. However, the city is full of zombie-infected zones. Safe travel zones are marked on the grid as `1` s and infected zones are marked as `0` s. Given your current `position` as a tuple in the form `(row, column)`, return `True` if you can reach the safe haven traveling only through safe zones and `False` otherwise. From any zone (cell) in the `grid` you may move up, down, left, or right.

Evaluate the time and space complexity of your solution. Define your variables and provide a rationale for why you believe your solution has the stated time and space complexity. Assume the input tree is balanced when calculating time and space complexity.

```
def can_move_safely(position, grid):
    pass
```

Example Usage:

```
grid = [
    [1, 0, 1, 1, 0], # Row 0
    [1, 1, 1, 1, 0], # Row 1
    [0, 0, 1, 1, 0], # Row 2
    [1, 0, 1, 1, 1]  # Row 3
]

position_1 = (0, 0)
position_2 = (0, 4)
position_3 = (3, 0)

print(can_move_safely(position_1, grid))
print(can_move_safely(position_2, grid))
print(can_move_safely(position_3, grid))
```

Example Output:

```
True
Example 1 Explanation: Can follow the path (0, 0) -> (1, 0) -> (1, 1) -> (1, 2) ->
(2, 2) -> (3, 2) -> (3, 3) -> (3, 4)

True
Example 2 Explanation: Although we start in an unsafe position, we can immediately
arrive in a safe position and from there safely travel to the bottom right corner (3

False
```

▶ 💡 **Hint: Transforming Matrices into Graphs**

▶ 💡 **Hint: Using `next_moves()` as a Helper Function**

Problem 3: List All Escape Routes

Having arrived at the safe haven, you are immediately put to work evaluating how many civilians can be evacuated to the safe haven. Given an `m x n` `grid` representing the city, return a list of tuples of the form `(row, column)` representing every starting position in the `grid` from which there exists a valid path of safe zones (`1` s) to the safe haven in the bottom-right corner of the grid.

If the starting cell has value `0`, they are considered infected and cannot reach the safe haven.

```
def list_all_escape_routes(grid):
    pass
```

Example Usage:

```
grid = [
    [1, 0, 1, 0, 1], # Row 0
    [1, 1, 1, 1, 0], # Row 1
    [0, 0, 1, 0, 0], # Row 2
    [1, 0, 1, 1, 1]  # Row 3
]

print(list_all_escape_routes(grid))
```

Example Output:

```
[(0, 0), (0, 2), (1, 0), (1, 1), (1, 2), (1, 3), (2, 2), (3, 2), (3, 3), (3, 4)]
```

▶ 💡 **Hint: Repeating Traversal**

Problem 4: Largest Safe Zone

With more and more civilians evacuating to the safe haven, you need more space! Given a `m x n` `grid` of the city where `1` s represent safe zones and `0` s represent infected zone, return the area of the largest group of safe zones in the `grid`. Any zone `grid[i][j]` has an area of `1` and its connected zones are the adjacent cells up, down, left, and right of it.

```
def largest_safe_zone(grid):
    pass
```

Example Usage:

```
grid = [
    [0, 0, 0, 1, 1], # Row 0
    [0, 0, 0, 1, 1], # Row 1
    [1, 1, 1, 0, 0], # Row 2
    [1, 1, 1, 1, 0], # Row 3
    [0, 0, 0, 1, 0]  # Row 4
]

print(largest_safe_zone(grid))
```

Example Output:

```
8
Explanation: There are two groups of connected 1s. The group beginning in Row 0 has
The group beginning in Row 2 has size 8, so we return 8.
```

Problem 5: Zombie Spread

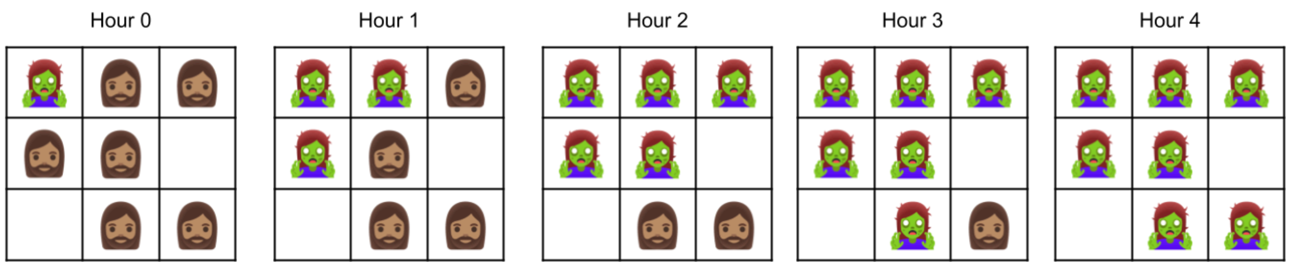
The zombie infection is spreading rapidly! Given a city represented as a 2D `grid` where `0` represents an obstacle where neither humans nor zombies can live, `1` represents a human safe zone and `2` represents a zone that has already been infected by zombies, determine how long it will take for the infection to spread across the entire city.

The infection spreads from each infected zone to its adjacent safe zones (up, down, left, right) in one hour. Return the number of hours it takes for all safe zones to be infected. If there are still safe zones remaining after the infection has spread everywhere it can, return `-1`.

```python
def time_to_infect(grid):
    pass
```

Example Usage:

Example 1:



```python
grid_1 = [
          [2,1,1],
          [1,1,0],
          [0,1,1]]

grid_2 = [
          [2,1,1],
          [0,1,1],
          [1,0,1]]

grid_3 = [[0,2]]

print(time_to_infect(grid_1))
print(time_to_infect(grid_2))
print(time_to_infect(grid_3))
```

Example Output:

```
4
Example 1 Explanation: See image included above.

-1
Example 2 Explanation: The safe zone in the bottom left corner (row 2, column 0)
is never infected because infection only happens up, left, right, and down.

0
Example 3 Explanation: Since there are already no safe zones at minute 0, the answer
```

Close Section

▾ Standard Problem Set Version 2

Problem 1: Battle Moves

You are in the midst of a battle with another neighboring kingdom and need to decide your next move. You have an `m x n` matrix `battle` representing a map of the battlefield where each cell holds either an `X` or an `O`. `X`s represent your kingdom's captured territory and `O`s represent the opposing kingdom's territory.

Given the `row` and `column` of your current position in the `battle` and a list of tuples `past_moves` of the form `(row, column)` representing moves you've already taken in battle, implement a function `next_moves()` that returns a list of tuples representing valid next moves.

From your current `row` and `column` position, you may move to any `(row, column)` index that is horizontally or vertically adjacent such that `row` and `column` are both valid indices in `grid` and part of your kingdom's captured territory. In this battle, you are not allowed to repeat moves, so any `past_moves[i]` should not be included in your output list.

```python
def next_moves(battle, row, column, past_moves):
    pass
```

Example Usage:

```
battle = [
    ['X', 'O', 'O', 'X', 'X'], # Row 0
    ['O', 'O', 'O', 'X', 'X'], # Row 1
    ['X', 'X', 'X', 'O', 'O'], # Row 2
    ['X', 'X', 'X', 'X', 'O'], # Row 3
    ['O', 'O', 'O', 'X', 'O']  # Row 4
]

position_1 = (3, 2)
position_2 = (0, 4)
position_3 = (0, 1)

print(next_moves(battle, 3, 2, []))
print(next_moves(battle, 3, 2, [(2, 2), (3, 3), (0, 0)]))
print(next_moves(battle, 0, 4, []))
print(next_moves(battle, 0, 0, []))
```

Example Output:

```
[(3, 1), (3, 3), (2, 2)]
Example 1 Explanation: The cell to the left, right, and one up from (3, 2) all have
value X and thusare valid moves. The cell one down from (3, 2) has value O and is th
invalid.

[(3, 1)]
Example 2 Explanation: Possible moves are [(3, 1), (3, 3), (2, 2)], but (3, 3) and (
are in the past_moves list, therefore the only possible next move is (3, 1)

[(0, 3), (1,4)]
Example 3 Explanation: Moving in the upwards or rightwards direction from position
(0, 4) moves us outside the bounds of the battlefield. Leftwards and downwards
both result in valid moves.

[]
Example 4 Explanation: Moving left, right, up, or down would either result in moving
into enemy territory or going out of bounds. Thus we return an empty list.
```

Problem 2: Castle Path

Your kingdom is represented by an `m x n` matrix `kingdom`. Each square in the matrix represents a different town in the kingdom. You wish to travel from a starting position `town` to the `castle`, however several towns have been overrun by bandits.

Towns that are safe to travel through are marked with `X`s and towns with dangerous bandits are marked with `O`s.

Given your current `town` and the `castle` location as tuples in the form `(row, column)`, return a list of tuples representing the shortest path from your `town` to the `castle` without traveling through any towns with bandits. If there are multiple paths with the shortest length, you may return any path. If no such path exists, return `None`.

From any town in the `grid` you may move to the neighboring towns up, down, left, or right. You may not move out of bounds of the `kingdom`.

Evaluate the time and space complexity of your solution. Define your variables and provide a rationale for why you believe your solution has the stated time and space complexity. Assume the input tree is balanced when calculating time and space complexity.

```
def path_to_castle(kingdom, town, castle):
    pass
```

Example Usage:

```
grid = [
    ['X', 'O', 'X', 'X', 'O'], # Row 'O'
    ['X', 'X', 'X', 'X', 'O'], # Row 1
    ['O', 'O', 'X', 'X', 'O'], # Row 2
    ['X', 'O', 'X', 'X', 'X']  # Row 3
]

town_1 = (0, 0)
town_2 = (0, 4)
town_3 = (3, 0)

print(path_to_castle(town_1, grid))
print(path_to_castle(town_2, grid))
print(path_to_castle(town_3, grid))
```

Example Output:

```
[0, 0, (10)]
Example 1 Explanation: Can follow the path (0, 0) -> (1, 0) -> (1, 1) -> (1, 2) ->
(2, 2) -> (3, 2) -> (3, 3) -> (3, 4)

True
Example 2 Explanation: Although we start in an unsafe position, we can immediately
arrive in a safe position and from there safely travel to the bottom right corner (3

False
```

▶ 💡 **Hint: Transforming Matrices into Graphs**

▶ 💡 **Hint: Using `next_moves()` as a Helper Function**

Problem 3: Walls and Gates

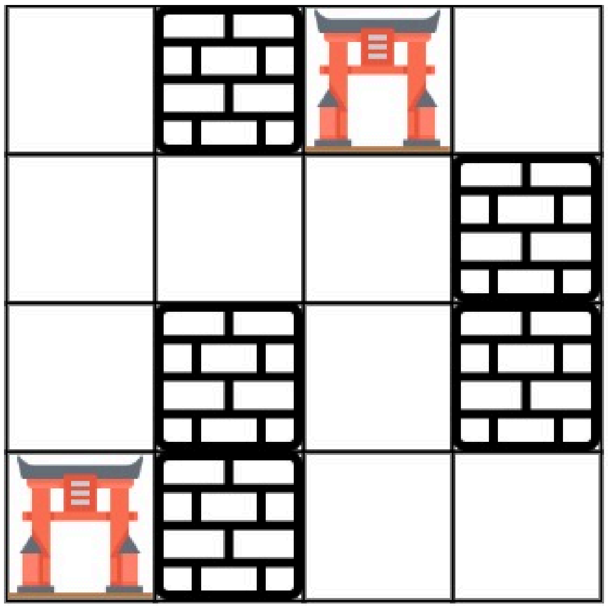
You have an `m x n` grid `castle` where each square represents a section of the castle. Each square has one of three possible values:

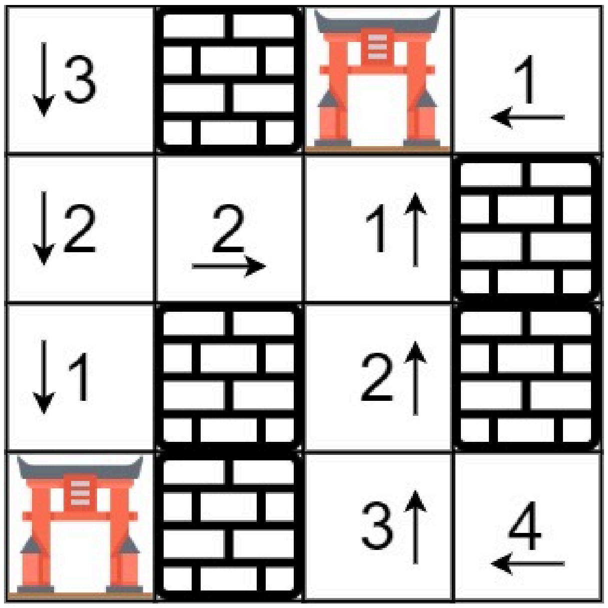
- `1` : a wall or an obstacle
- `0` : a gate
- `float('inf')` (infinity): an empty room

Return the `castle` matrix modified in-place such that each empty rooms value is its distance to its nearest gate. If it is impossible to reach a gate, it should have value infinity.

```
def walls_and_gates(castle):
    pass
```

Example Usage:





```
castle = [
    [float('inf'), -1, 0, float('inf')],            # Row 0
    [float('inf'), float('inf'), float('inf'), -1], # Row 1
    [float('inf'), -1, float('inf'), -1],           # Row 2
    [0, -1, float('inf'), float('inf')]             # Row 3
    ]

print(walls_and_gates(castle))
```

Example Output:

```
[
    [3, -1, 0, 1],
    [2, 2, 1, -1],
    [1, -1, 2, -1],
    [0, -1, 3, 4]
]
```

▶ 💡 **Hint: Repeating Traversal**

Problem 4: Surrounded Regions

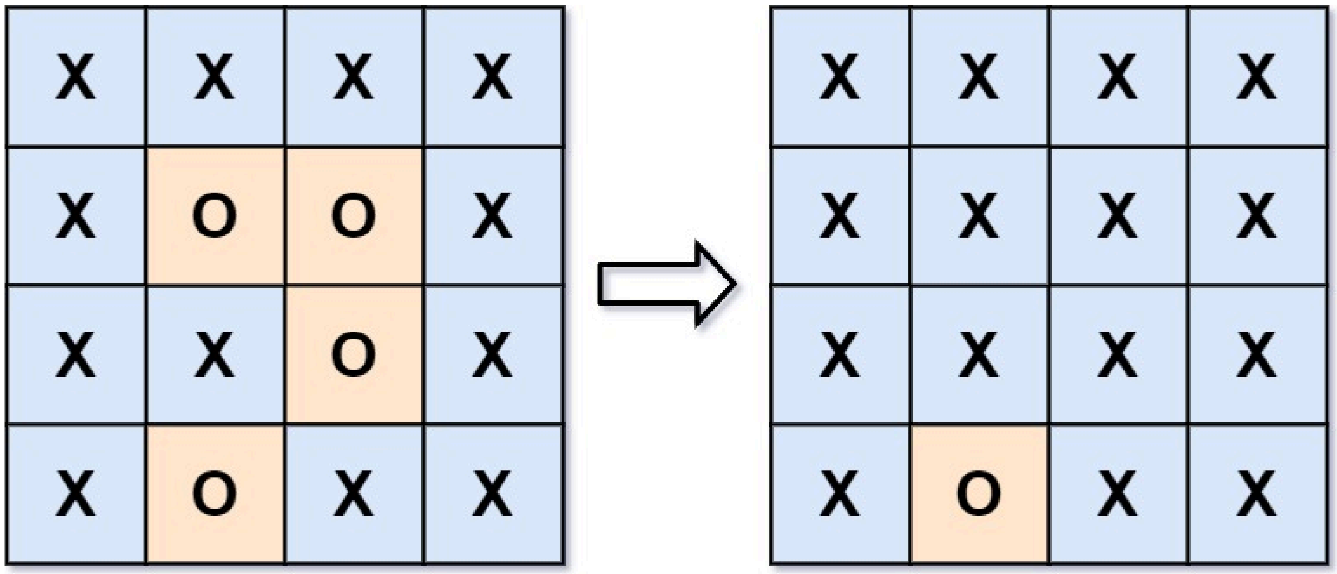
Your kingdom has been battling a neighboring kingdom. You are given an `m x n` matrix `map` containing letters `'X'` and `'O'`. Territory controlled by your kingdom is labeled with `'X'` while territory controlled by the opposing kingdom is labeled `'O'`.

Territories (cells) in the matrix are considered connected to horizontally and vertically adjacent territories. A *region* is formed by contiguously connected territories controlled by the same kingdom. Your kingdom can capture an `'O'` region if it is surrounded. The region is surrounded with `'X'` territories if you can connect the region with `'X'` cells and none of the region cells are on the edge of the `map`.

A surrounded region is captured by replacing all `'O'`s with `'X'`s in the input matrix `map`. Return `map` after modifying it in-place to capture all possible `'O'` regions.

```python
def capture(map):
    pass
```

Example Input:



```python
map = [
    ["X","X","X","X"],
    ["X","O","O","X"],
    ["X","X","O","X"],
    ["X","O","X","X"]]

print(capture(map))
```

Example Output:

```
[
    ["X","X","X","X"],
    ["X","X","X","X"],
    ["X","X","X","X"],
    ["X","O","X","X"]
    ]
Example Explanation: The bottom region cannot be captured because it is on the edge
of the board and cannot be surrounded.
```

Problem 5: Maximum Number of Troops Captured

You are given a 2D matrix `battlefield` of size `m x n`, where `(row, column)` represents:

- An impassable obstacle if `battlefield[row][column] = 0`, or
- An square containing `battlefield[row][column]` enemy troops, if `battlefield[row][column] > 0`.

Your kingdom can start at any non-obstacle square `(row, column)` and can do the following operations any number of times: - Capture all the troops at square `battlefield[row][column]` or - Move to any adjacent cell with troops up, down, left, or right.

Return the maximum number of troops your kingdom can capture if they choose the starting cell optimally. Return `0` if no troops exist on the `battlefield`.

```python
def capture_max_troops(battlefield):
    pass
```

Example Usage 1:

0	2	1	0
4	0	0	3
1	0	0	4
0	3	2	0

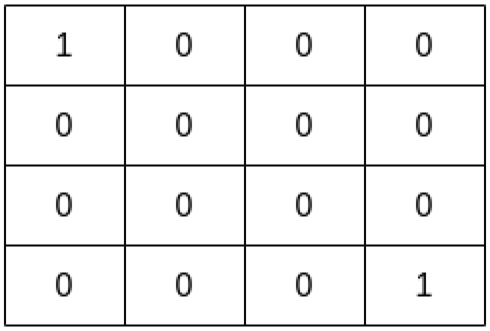
```python
battlefield_1 = [
    [0,2,1,0],
    [4,0,0,3],
    [1,0,0,4],
    [0,3,2,0]]

print(capture_max_troops(battlefield_1))
```

Example Output 1:

```
7
Example 1 Explanation: You can start at square (1, 3) and capture 3 troops, then
move to square (2, 3) and capture 4 troops.
```

Example Usage 2:



1	0	0	0
0	0	0	0
0	0	0	0
0	0	0	1

```python
battlefield_2 = [
    [1,0,0,0],
    [0,0,0,0],
    [0,0,0,0],
    [0,0,0,1]]

print(capture_max_troops(battlefield_2))
```

Example Output 2:

```
1
Example 2 Explanation: You can start at square (0,0) or (3,3) and capture a single
troop.
```

Close Section

Advanced Problem Set Version 1

Standard Problem Set Version 2