2614. Prime In Diagonal

Matrix **Number Theory** Math

Problem Description

prime number that is present on either or both of the two main diagonals of this array. The first main diagonal runs from the top-left corner to the bottom-right corner and includes elements where the row and column

In this problem, we are given a square two-dimensional integer array nums which is 0-indexed. The task is to find the largest

indices are equal, i.e., nums[i][i]. The second main diagonal goes from the top-right corner to the bottom-left corner, consisting of elements nums[i][nums.length - i - 1]. A number is considered prime if it's greater than 1 and does not have any divisors other than 1 and itself. If no prime numbers are found on the diagonals, the function should return 0.

An example illustration provided in the problem statement shows a grid where the first diagonal is [1,5,9] and the second diagonal is [3,5,7].

The intuition behind the solution is straightforward. Since the problem requires us to only inspect elements along the diagonals of

a square matrix, we don't need to consider every element in the array. We define a utility function, is prime, that determines if a given number is prime. The function iterates from 2 to sqrt(x) where

x is the number we're testing for primality, and checks if x is divisible by any number in this range. If x is divisible, then it is not a

prime number. We use the square root of x as an optimization because a larger factor of x would have a corresponding smaller

factor that would have been identified by the time we reach sqrt(x). The solution approach involves iterating through each row of the array once, inspecting two elements in each row - one from each diagonal. For each of these elements, we use the is prime function to check if it's prime. If it is, we update our answer with this value if it happens to be greater than the current answer.

number encountered. The answer is the maximum prime number found; or 0 if there were no prime numbers on the diagonals. Solution Approach

This way, by the end of the iteration, we'll have checked all numbers on both diagonals and kept track of the largest prime

diagonals of the matrix and a prime-checking function. Here is a step-by-step breakdown of the implementation:

The algorithm follows the steps outlined in the intuition section. Specifically, we make use of a simple linear scan through the

We define a helper function is prime which takes an integer x as an argument. This function checks if x is a prime number

by attempting to find a divisor from 2 to sqrt(x).

def is prime(x: int) -> bool: if x < 2: return False return all(x % i for i in range(2, int(sqrt(x)) + 1))

o Otherwise, it uses the all function along with a generator expression to check for any divisors. If any divisor is found (the remainder is zero), all will return False, and the function will also return False, indicating that x is not prime.

nums[i][i] and nums[i][n - i - 1]:

ans = max(ans, row[n - i - 1])

for i, row in enumerate(nums):

Returning ans completes the function:

return ans

Example Walkthrough

If x is less than 2, it is not prime by definition, and the function returns False.

• If no divisors are found, the number is prime, and True is returned. The main diagonalPrime function scans the matrix's diagonals. It initializes ans to 0, which will store the largest prime found. n = len(nums)ans = 0

It then uses a loop to iterate through each element of the array, but only checks the values at the diagonal positions -

if is prime(row[i]): ans = max(ans, row[i]) if is prime(row[n - i - 1]):

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• In this loop, enumerate(nums) is used to get both the index i and the row of the matrix.

    We check both elements on the diagonals using our is_prime function.

• If the number on the diagonal is prime, we update ans with the larger of ans and the prime number found.
• The use of the max function ensures that we always have the largest prime number encountered.
After the for loop completes, we return ans, which by then contains the largest prime number found on the diagonals or
remains at its initial value, 0, if there were no prime numbers.
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linear iteration, which keeps the space complexity to O(1) and time complexity to O(n * sqrt(m)) (where n is the length of a side of the square matrix and m is the value of the largest number to be checked for primality).

No additional data structures are needed for this approach, and the patterns used are direct access of items in an array and

nums = [[11, 2, 5],1, 6, 3]

The first main diagonal elements are nums[0][0], nums[1][1], nums[2][2], which are 11, 7, 3, respectively. The second

Let's illustrate the solution approach using a small example. Consider the following 3×3 grid for the array nums:

Now, we define our is_prime function and use it to check each number along the diagonals for primality:

main diagonal elements are nums [0] [2], nums [1] [1], nums [2] [0], which are 5, 7, 1.

7 is prime (noted twice as it appears in both diagonals).

def diagonal prime(self, nums: List[List[int]]) -> int:

Helper function to check if a number is prime

return False # Numbers less than 2 are not prime

Check if the element in the primary diagonal is prime

Check if the element in the secondary diagonal is prime

max prime = max(max prime, row[n - i - 1])

Return the largest prime number found on the diagonals

max prime = max(max prime, row[i])

return True # Number is prime as it wasn't divisible by any i

for i in range(2, isgrt(x) + 1): # Iterating only up to the square root of x

return False # Number is divisible by i, hence not prime

// Method to find the maximum prime number on either of the diagonals of a square matrix

int size = matrix.length; // The length of the matrix (number of rows)

int maxPrime = 0; // Variable to store the maximum prime number found

return maxPrime; // Return the largest prime number found on the diagonals

// Loop through the matrix from the first row to the last row

def is prime(x: int) -> bool:

if x % i == 0:

if is prime(row[i]):

if is prime(row[n - i - 1]):

public int diagonalPrime(int[][] matrix) {

for (int i = 0; i < size; ++i) {

if (isPrime(matrix[i][size - i - 1])) {

// Check for factors from 2 to the square root of number

// If a divisor is found, number is not prime

// Helper method to check if an integer is prime

for (int i = 2; i <= number / i; ++i) {</pre>

// Numbers less than 2 are not prime

private boolean isPrime(int number) {

if (number % i == 0) {

• Finally, nums [2] [2] is 3, also prime, but less than the current ans of 11.

• 1 is not prime since it is less than 2.

Solution Implementation

if x < 2:

from typing import List

from math import isqrt

class Solution:

Python

Java

class Solution {

• 3 is prime. 5 is prime.

• 11 is prime.

• Checking nums [0] [2] gives us 5, which is prime but less than 11, so ans remains 11. • Next, both nums [1] [1] and nums [2] [0] yield a 7, which is prime, but still less than 11, so ans remains unchanged.

After inspecting all numbers on both diagonals, the largest prime number we found is 11, so our function returns 11. If no

As we iterate through the diagonals, we use the is_prime function and keep track of the largest prime number:

• When we check nums [0] [0], which is 11, it's prime, and since ans is initially 0, we now update ans to 11.

prime numbers had been encountered, ans would have remained 0, and the function would return 0.

- This example captures all steps in the algorithm, iterates over the diagonals while checking for primality, and concludes by returning the largest prime found or 0. It demonstrates how the is_prime function works in conjunction with the linear iteration over array elements, meeting the objective of the problem with efficiency in terms of time and space complexity.
- # Get the length of the square matrix n = len(nums)# Initialize the maximum prime number found on the diagonals as 0 max prime = 0 # Loop through each row of the matrix for i, row in enumerate(nums):

maxPrime = Math.max(maxPrime, matrix[i][size - i - 1]); // Update max if it's a new maximum

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// Check if the element on the primary diagonal is prime
if (isPrime(matrix[i][i])) {
    maxPrime = Math.max(maxPrime, matrix[i][i]); // Update max if it's a new maximum
// Check if the element on the secondary diagonal is prime
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if (number < 2) {

return false;

return max_prime

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return false;
        // No divisors were found; number is prime
        return true;
C++
class Solution {
public:
    // Function to find the maximum prime number on both diagonals of a square matrix.
    int diagonalPrime(vector<vector<int>>& matrix) {
        int size = matrix.size(); // The size of the NxN matrix.
        int maxPrime = 0; // Variable to keep track of the maximum prime found.
        // Loop through each element on the diagonals of the matrix.
        for (int i = 0; i < size; ++i) {
            // Check the primary diagonal element for primality.
            if (isPrime(matrix[i][i])) {
                maxPrime = max(maxPrime, matrix[i][i]);
            // Check the secondary diagonal element for primality.
            if (isPrime(matrix[i][size - i - 1])) {
                maxPrime = max(maxPrime, matrix[i][size - i - 1]);
        return maxPrime; // Return the maximum prime number found on the diagonals.
    // Helper function to check if a number is prime.
    bool isPrime(int num) {
        if (num < 2) {
            return false; // Numbers less than 2 are not prime.
        // Check divisibility of num from 2 to sqrt(num).
        for (int i = 2; i <= num / i; ++i) {
            if (num % i == 0) {
                return false; // num is divisible by i, hence not prime.
        return true; // num is prime as it wasn't divisible by any number from 2 to sgrt(num).
```

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// Example usage:
// const myMatrix: number[][] = [[3, 2, 3], [2, 7, 11], [17, 14, 5]];
// const maxDiagonalPrime: number = diagonalPrime(myMatrix);
// console.log(maxDiagonalPrime); // Outputs the maximum prime number found on the diagonals.
```

from typing import List

from math import isqrt

class Solution:

};

TypeScript

if (num < 2) {

// Function to check if a number is prime.

const isPrime = (num: number): boolean => {

for (let i = 2; i * i <= num; i++) {

for (let i = 0; i < size; i++) {

if (isPrime(matrix[i][i])) {

if (num % i === 0) {

return false; // Numbers less than 2 are not prime.

const diagonalPrime = (matrix: number[][]): number => {

// Check the divisibility of num from 2 to the square root of num.

return false; // num is divisible by i, hence not prime.

const size: number = matrix.length; // The size of the NxN matrix.

// Loop through each element on the diagonals of the matrix.

// Check the primary diagonal element for primality.

// Check the secondary diagonal element for primality.

def diagonal prime(self, nums: List[List[int]]) -> int:

Helper function to check if a number is prime

maxPrime = Math.max(maxPrime, matrix[i][size - i - 1]);

maxPrime = Math.max(maxPrime, matrix[i][i]);

if (isPrime(matrix[i][size - i - 1])) {

def is prime(x: int) -> bool:

if x % i == 0:

if x < 2:

check for prime numbers.

primality.

return true; // num is prime as it wasn't divisible by any number from 2 to sgrt(num).

// Function to find the maximum prime number on both diagonals of a square matrix.

let maxPrime: number = 0; // Variable to keep track of the maximum prime found.

return maxPrime; // Return the maximum prime number found on the diagonals.

return False # Numbers less than 2 are not prime

return True # Number is prime as it wasn't divisible by any i

for i in range(2, isqrt(x) + 1): # Iterating only up to the square root of x

return False # Number is divisible by i, hence not prime

```
# Get the length of the square matrix
        n = len(nums)
        # Initialize the maximum prime number found on the diagonals as 0
        max prime = 0
       # Loop through each row of the matrix
        for i, row in enumerate(nums):
           # Check if the element in the primary diagonal is prime
           if is prime(row[i]):
               max prime = max(max prime, row[i])
           # Check if the element in the secondary diagonal is prime
           if is prime(row[n - i - 1]):
               max prime = max(max prime, row[n - i - 1])
       # Return the largest prime number found on the diagonals
        return max_prime
Time and Space Complexity
Time Complexity
  The time complexity of the given code is primarily influenced by two operations: the iteration over the rows of the matrix and the
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1. There is a loop over the n rows of the input matrix nums. For each row, the code checks if the elements at the primary diagonal (row[i]) and

2. The function is_prime is used to determine if a number is prime, which operates in O(sqrt(x)), where x is the number being checked for

Given that the method is_prime is called at most twice for each of the n rows of the matrix, the overall time complexity is 0(n *

sqrt(M)). Here, M represents the value of the largest number within the matrix, which is being checked for primality. Thus, the resulting formula for time complexity is: 0(n * sqrt(M)).

the secondary diagonal (row[n - i - 1]) are prime.

Space Complexity The space complexity is determined by the amount of extra memory space required by the algorithm.

- No extra space is needed apart from a few variables (n, ans, i, and row), which are not dependent on the size of the input. • The is_prime function uses a range within a loop, but since Python's range function generates values on the fly, it does not add to space complexity.
 - As a result, the space complexity of the algorithm is 0(1), indicating constant space usage regardless of input size.