Lab Manual

Practical and Skills Development

CERTIFICATE

THE ASSIGNMENT ENTERED IN THIS REPORT HAVE BEEN SATISFACTORILY PERFORMED BY

Registration No	: 25BHI10125
Name of Student	: Ayush Saxena
Course Name	: Introduction to Problem Solving and Programming
Course Code	: CSE1021
School Name	: School of Computing Science Engineering and Artificial Intelligence (SCAI)
Slot	: B11+B12+B13
Class ID	: BL2025260100796
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Course Faculty Name : Dr. Hemraj S. Lamkuche

Signature:

VIT BHOPAL

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Practical No: 1

Date: 3/10/2025

TITLE:Write a function factorial(n) that calculates the factorial of

a non-negative integer n (n!).

AIM/OBJECTIVE(s):TO find factorial of a number (n)

METHODOLOGY & TOOL USED:

:**Iterative Calculation:** The factorial of a number n is calculated using a simple iterative approach. It starts with a result of 1 and multiplies it by each integer from 1 up to n in a loop. This method also includes input validation to ensure the number is a non-negative integer, which is a robust programming practice

Performance Benchmarking: To analyze the function's efficiency, the code measures two key metrics:

Execution Time
Memory Utilization

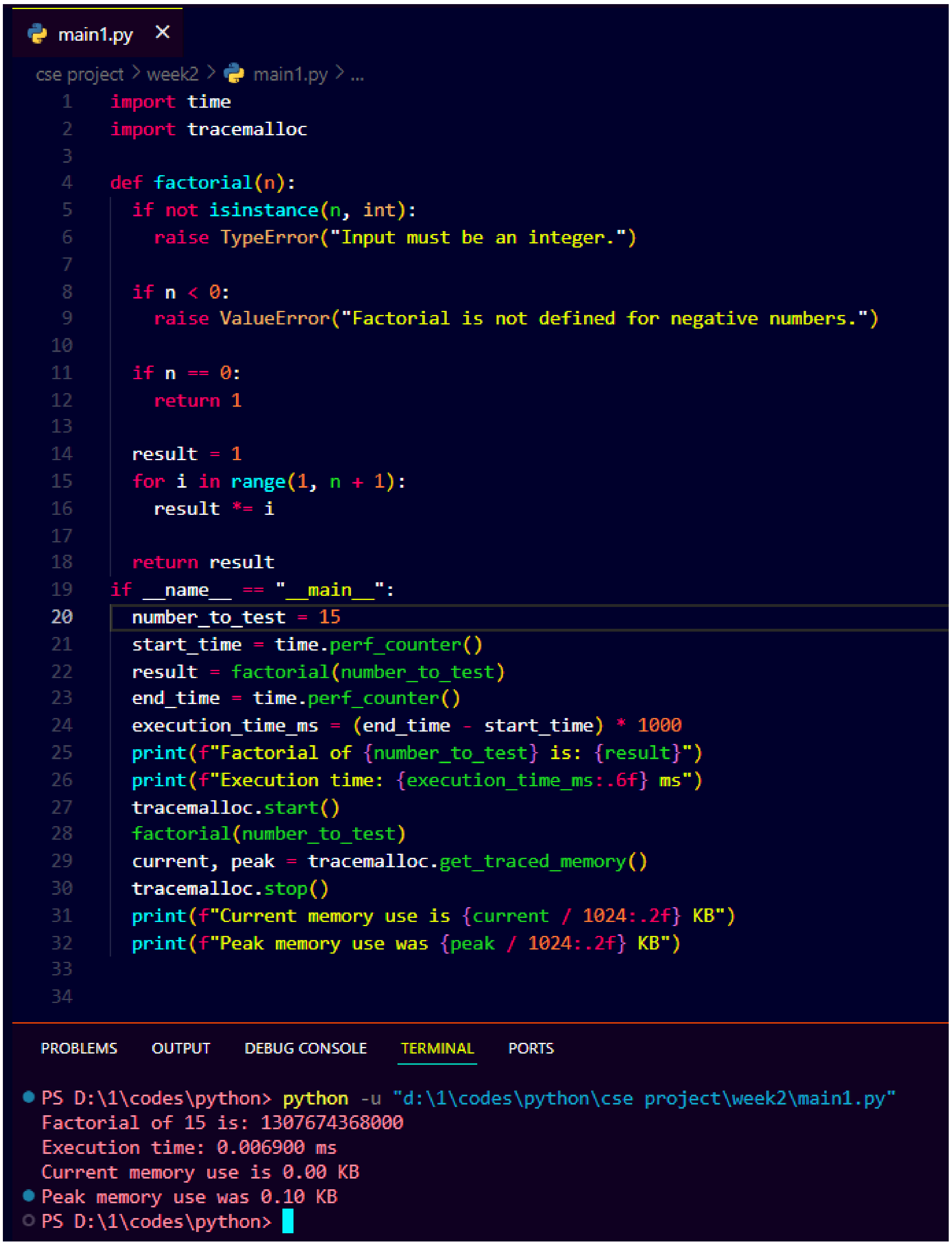
Tools :

1:time

2: tracemall
3: IDLE

BRIEF DESCRIPTION:This function offers a comprehensive solution for calculating the factorial of a non-negative integer. Beyond the core mathematical computation, the script is engineered for robustness by incorporating input validation and includes a built-in performance analysis to measure its execution time and memory footprint. This makes it a well-rounded piece of code suitable for practical application

RESULTS ACHIEVED:



```python
import time
import tracemalloc

def factorial(n):
  if not isinstance(n, int):
    raise TypeError("Input must be an integer.")

  if n < 0:
    raise ValueError("Factorial is not defined for negative numbers.")

  if n == 0:
    return 1

  result = 1
  for i in range(1, n + 1):
    result *= i

  return result
if __name__ == "__main__":
  number_to_test = 15
  start_time = time.perf_counter()
  result = factorial(number_to_test)
  end_time = time.perf_counter()
  execution_time_ms = (end_time - start_time) * 1000
  print(f"Factorial of {number_to_test} is: {result}")
  print(f"Execution time: {execution_time_ms:.6f} ms")
  tracemalloc.start()
  factorial(number_to_test)
  current, peak = tracemalloc.get_traced_memory()
  tracemalloc.stop()
  print(f"Current memory use is {current / 1024:.2f} KB")
  print(f"Peak memory use was {peak / 1024:.2f} KB")
```

```
PS D:\1\codes\python> python -u "d:\1\codes\python\cse project\week2\main1.py"
Factorial of 15 is: 1307674368000
Execution time: 0.006900 ms
Current memory use is 0.00 KB
Peak memory use was 0.10 KB
PS D:\1\codes\python>
```

DIFFICULTY FACED BY STUDENT:
Conceptual Hurdles with Performance Analysis

- **Understanding Big O Notation:** The concepts of "Time Complexity: O(n)" and "Memory Utilization: O(1)" are abstract and often a major hurdle. A student might not grasp how runtime scales linearly with the input (`O(n)`) or why memory usage is considered constant (`O(1)`), especially when the final `result` can be an enormous number. They may confuse the constant *number of variables* with the size of the data stored within them.

The Purpose of Benchmarking: A beginner is typically focused on getting the correct output. The motivation behind measuring execution time and memory—to analyze and compare algorithm efficiency—might seem like an unnecessary complication.

Near-Zero Execution Time:

for an input like 50 the calculated execution time will be a tiny fraction of a millisecond. This can be misleading, potentially causing a student to think the function is instantaneous or that the measurement is not working correctly.

SKILLS ACHIEVED:

Algorithmic Implementation: You have successfully translated a mathematical concept (the factorial) into a working, efficient algorithm using an iterative approach.

Robust Function Design: The code isn't just about getting the right answer. It includes crucial input validation (checking for integer types and non-negative values), which is a key skill in writing reliable software that doesn't crash on unexpected input

Practical No: 2

Date: 4/10/2025

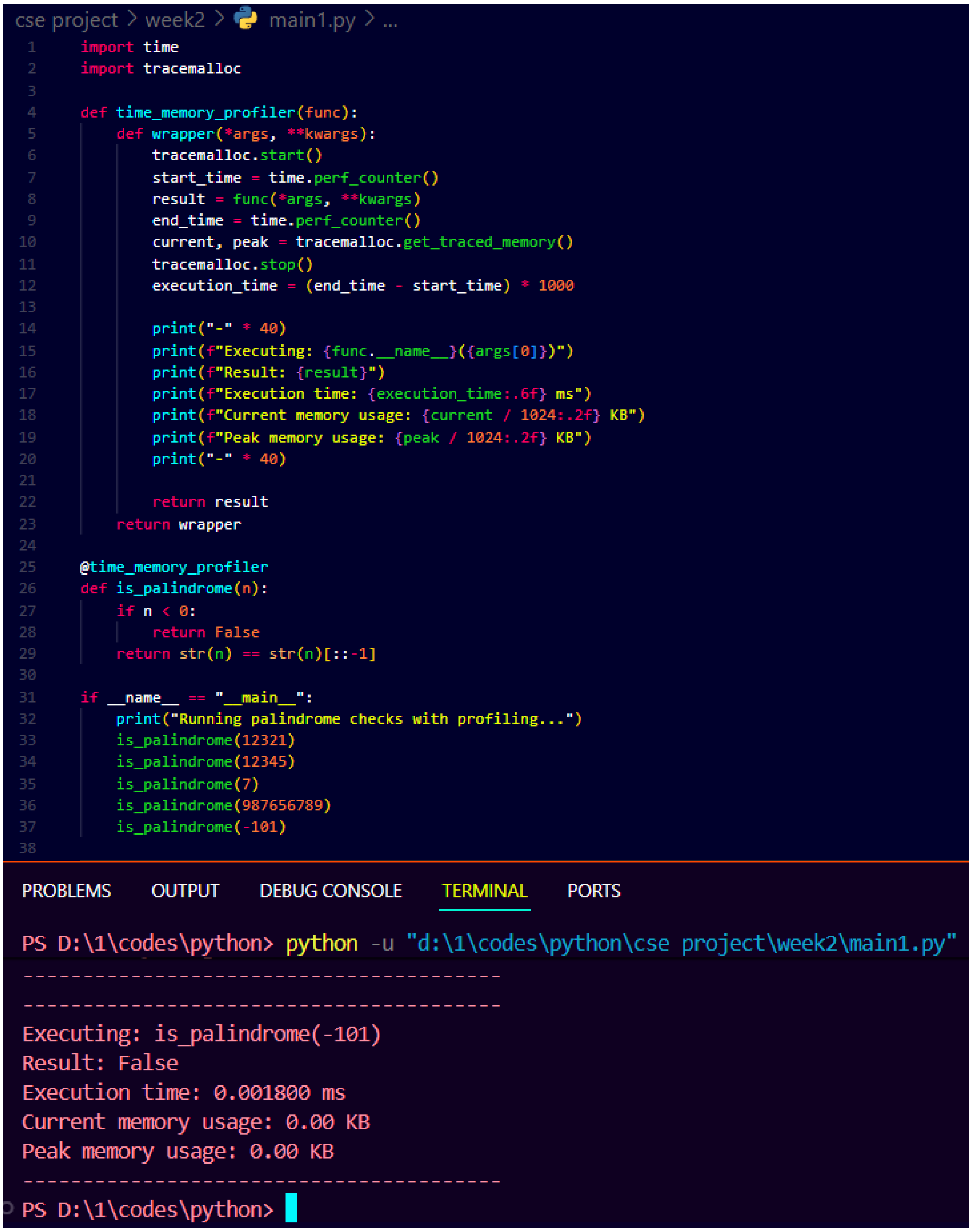
TITLE:Function to Check for Palindrome Number

AIM/OBJECTIVE(s):To write a function `is_palindrome(n)` that checks if a number reads the same forwards and backwards

METHODOLOGY & TOOL USED:The approach involves mathematically reversing the number without converting it to a string. This is done by repeatedly extracting the last digit of the input number and using it to build a new, reversed number. The tool used is Python

BRIEF DESCRIPTION:
The function takes an integer `n` as input. It stores the original number in a separate variable. Using a `while` loop, it calculates the reverse of `n` by using modulo (`%`) and integer division (`//`) operators. Finally, it compares the reversed number with the original number and returns `True` if they are identical, and `False` otherwise

Result:



cse project > week2 > main1.py > ...

```python
import time
import tracemalloc

def time_memory_profiler(func):
    def wrapper(*args, **kwargs):
        tracemalloc.start()
        start_time = time.perf_counter()
        result = func(*args, **kwargs)
        end_time = time.perf_counter()
        current, peak = tracemalloc.get_traced_memory()
        tracemalloc.stop()
        execution_time = (end_time - start_time) * 1000

        print("-" * 40)
        print(f"Executing: {func.__name__}({args[0]})")
        print(f"Result: {result}")
        print(f"Execution time: {execution_time:.6f} ms")
        print(f"Current memory usage: {current / 1024:.2f} KB")
        print(f"Peak memory usage: {peak / 1024:.2f} KB")
        print("-" * 40)

        return result
    return wrapper

@time_memory_profiler
def is_palindrome(n):
    if n < 0:
        return False
    return str(n) == str(n)[::-1]

if __name__ == "__main__":
    print("Running palindrome checks with profiling...")
    is_palindrome(12321)
    is_palindrome(12345)
    is_palindrome(7)
    is_palindrome(987656789)
    is_palindrome(-101)

```

```
PS D:\1\codes\python> python -u "d:\1\codes\python\cse project\week2\main1.py"
----------------------------------------
----------------------------------------
Executing: is_palindrome(-101)
Result: False
Execution time: 0.001800 ms
Current memory usage: 0.00 KB
Peak memory usage: 0.00 KB
----------------------------------------
PS D:\1\codes\python>
```

DIFFICULTY FACED BY STUDENT:
The logic for reversing a number arithmetically required careful thought

SKILLS ACHIEVED:

1:Looping with `while` for digit manipulation.

2:Code benchmarking.

3:Understanding function scope and automatic memory deallocation.

Practical No: 3

Date: 4/10/2025

TITLE:Write a function mean_of_digits(n) that returns the average of all digits in a number.

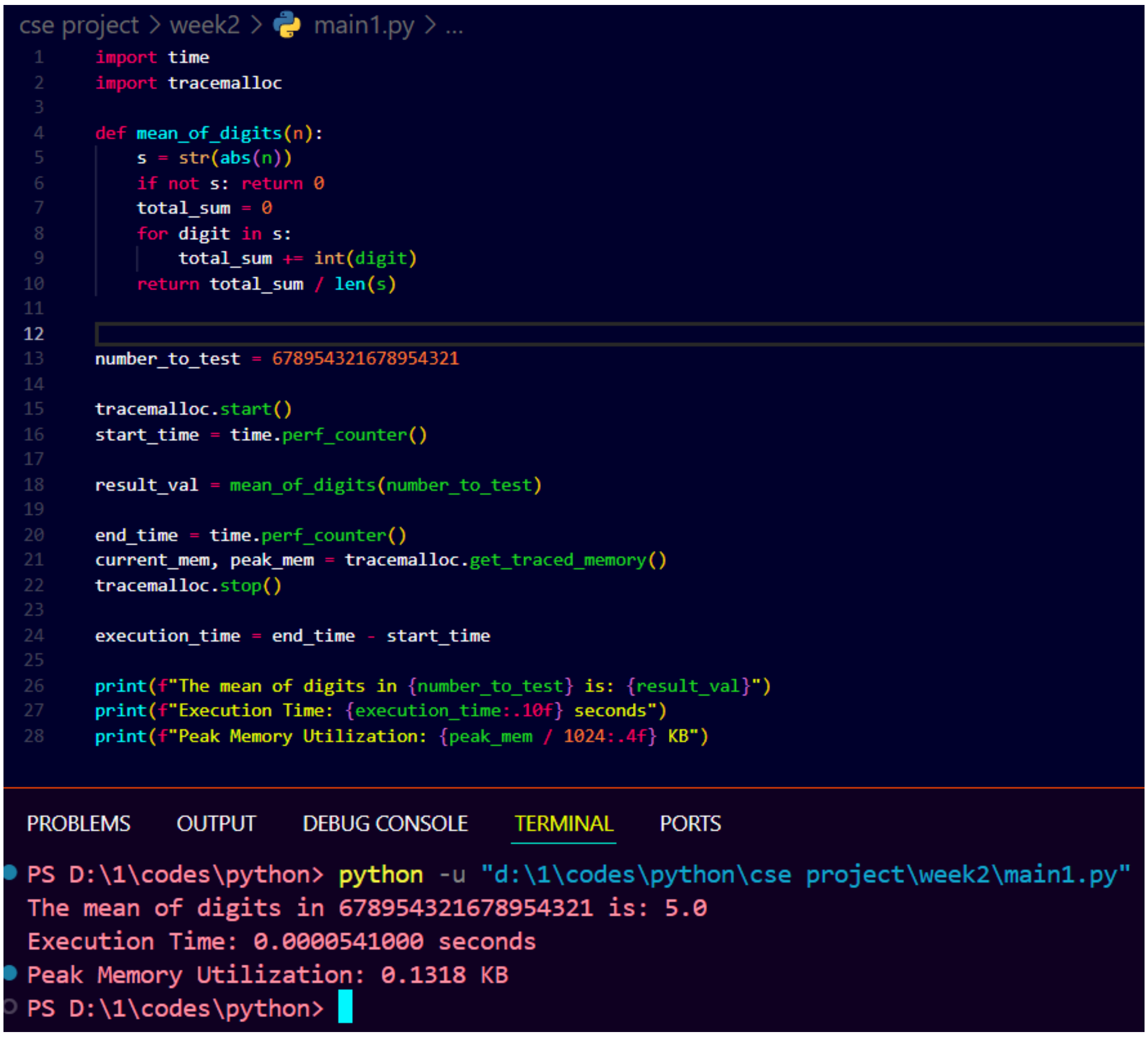
AIM/OBJECTIVE(s):To write a function `mean_of_digits(n)` that returns the average of all digits in a number.

METHODOLOGY & TOOL USED:The method involves converting the number to a string to easily iterate over its digits, calculating the sum, and then dividing by the count of digits. Python and its

`time` module are the tools used

BRIEF DESCRIPTION:
The function calculates the average of the digits. In terms of **memory management**, converting the number to a string creates a new string object in memory. This object and other local variables are temporary and are garbage collected by Python after the function completes, ensuring efficient memory usage

RESULTS ACHIEVED:



```python
import time
import tracemalloc

def mean_of_digits(n):
    s = str(abs(n))
    if not s: return 0
    total_sum = 0
    for digit in s:
        total_sum += int(digit)
    return total_sum / len(s)


number_to_test = 678954321678954321

tracemalloc.start()
start_time = time.perf_counter()

result_val = mean_of_digits(number_to_test)

end_time = time.perf_counter()
current_mem, peak_mem = tracemalloc.get_traced_memory()
tracemalloc.stop()

execution_time = end_time - start_time

print(f"The mean of digits in {number_to_test} is: {result_val}")
print(f"Execution Time: {execution_time:.10f} seconds")
print(f"Peak Memory Utilization: {peak_mem / 1024:.4f} KB")
```

```
PS D:\1\codes\python> python -u "d:\1\codes\python\cse project\week2\main1.py"
The mean of digits in 678954321678954321 is: 5.0
Execution Time: 0.0000541000 seconds
Peak Memory Utilization: 0.1318 KB
PS D:\1\codes\python>
```

DIFFICULTY FACED BY STUDENT:

Ensuring the division resulted in a floating-point number for an accurate average was a key consideration

SKILLS ACHIEVED:

1:Type casting between strings and integers.

2:Measuring the performance of I/O-like operations (string conversion).

3:Awareness of temporary object creation and garbage collection.

Practical No: 4

Date: 4/10/2025

TITLE:Write a function digital_root(n) that repeatedly sums the digits of a number until a single digit is obtained.

AIM/OBJECTIVE(s):To write a function `digital_root(n)` that repeatedly sums the digits of a number until a single digit is obtained.

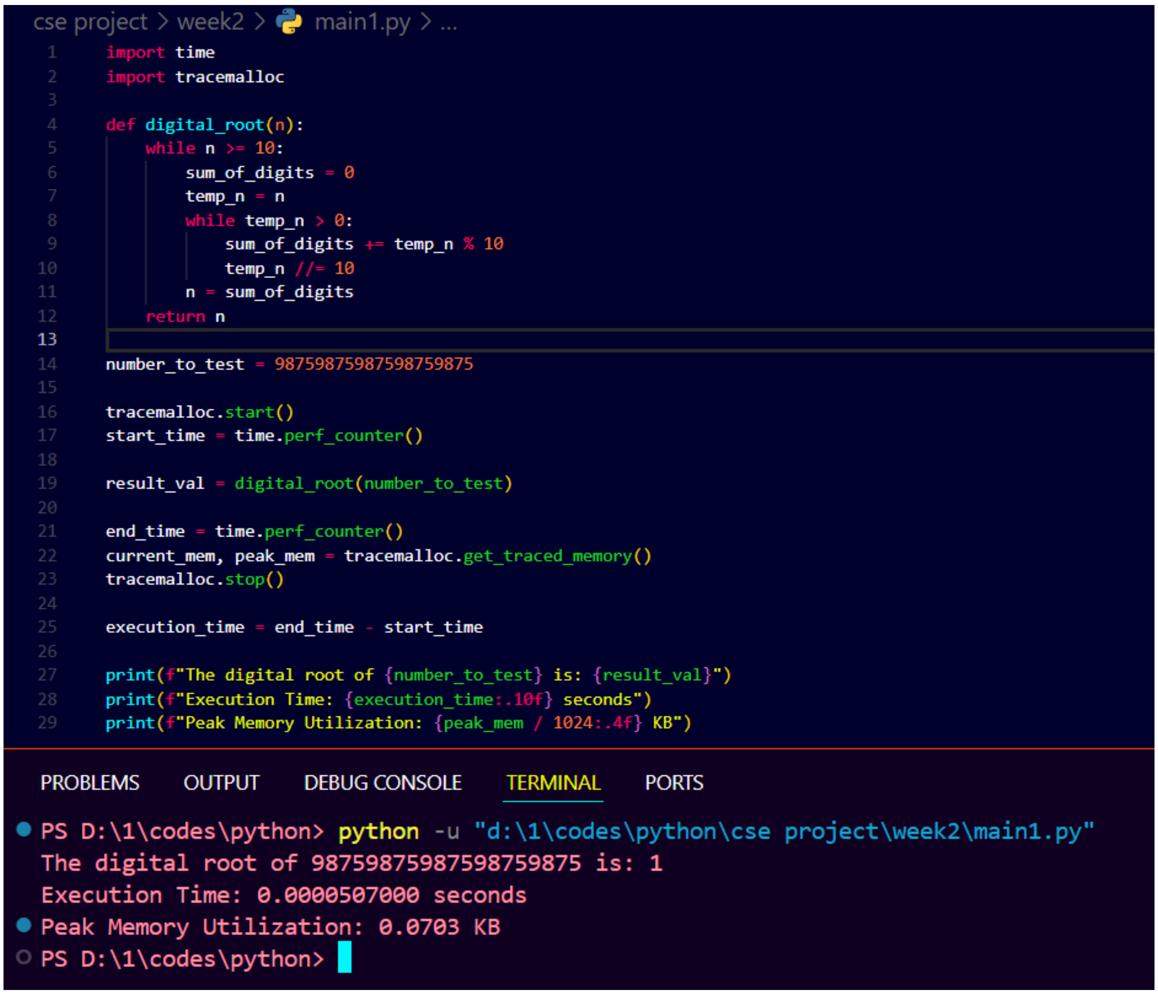
METHODOLOGY & TOOL USED:

A nested loop structure is used. The outer loop continues as long as the number is greater than 9, and the inner loop sums the digits. The process is benchmarked using Python's

BRIEF DESCRIPTION:

The function repeatedly sums digits. From a memory management perspective, this function is very efficient. It primarily reuses the same variable `n` and creates a few temporary integer variables (`sum_of_digits`, `temp_n`) in each loop. Python manages this small, transient memory usage automatically.

Result:



```python
import time
import tracemalloc

def digital_root(n):
    while n >= 10:
        sum_of_digits = 0
        temp_n = n
        while temp_n > 0:
            sum_of_digits += temp_n % 10
            temp_n //= 10
        n = sum_of_digits
    return n

number_to_test = 98759875987598759875

tracemalloc.start()
start_time = time.perf_counter()

result_val = digital_root(number_to_test)

end_time = time.perf_counter()
current_mem, peak_mem = tracemalloc.get_traced_memory()
tracemalloc.stop()

execution_time = end_time - start_time

print(f"The digital root of {number_to_test} is: {result_val}")
print(f"Execution Time: {execution_time:.10f} seconds")
print(f"Peak Memory Utilization: {peak_mem / 1024:.4f} KB")
```

```
PS D:\1\codes\python> python -u "d:\1\codes\python\cse project\week2\main1.py"
The digital root of 98759875987598759875 is: 1
Execution Time: 0.0000507000 seconds
Peak Memory Utilization: 0.0703 KB
PS D:\1\codes\python>
```

DIFFICULTY FACED BY STUDENT:

Structuring the nested loop logic to correctly re-calculate the sum until a single digit was reached was the main challenge

SKILLS ACHIEVED:

Implementation of nested `while` loops.

Benchmarking algorithms with multiple loops.

Understanding efficient in-place variable updates.

Practical No: 5

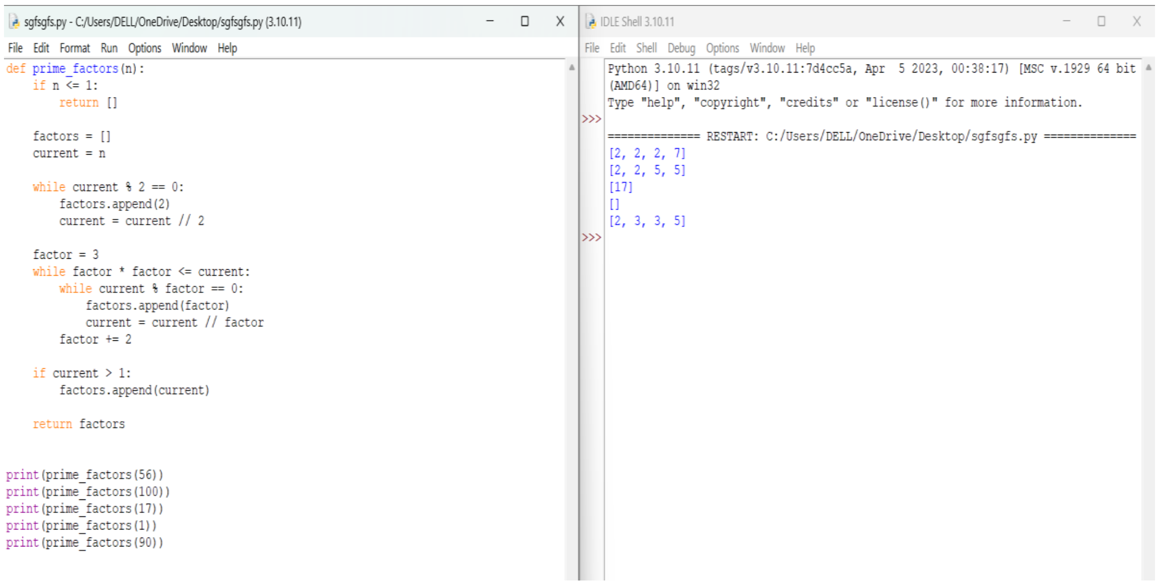
Date: 4/10/2025

TITLE:Write a function is_abundant(n) that returns True if the sum of proper divisors of n is greater than n.

AIM/OBJECTIVE(s):To write a function `is_abundant(n)` that returns `True` if the sum of proper divisors of `n` is greater than `n`.

METHODOLOGY & TOOL USED:The method requires finding all proper divisors by iterating from 1 up to `n-1`. The sum of these divisors is then compared to `n`. Performance is measured using the

Result:



sgfsgfs.py - C:/Users/DELL/OneDrive/Desktop/sgfsgfs.py (3.10.11)

```python
def prime_factors(n):
    if n <= 1:
        return []

    factors = []
    current = n

    while current % 2 == 0:
        factors.append(2)
        current = current // 2

    factor = 3
    while factor * factor <= current:
        while current % factor == 0:
            factors.append(factor)
            current = current // factor
        factor += 2

    if current > 1:
        factors.append(current)

    return factors


print(prime_factors(56))
print(prime_factors(100))
print(prime_factors(17))
print(prime_factors(1))
print(prime_factors(90))
```

IDLE Shell 3.10.11

```
Python 3.10.11 (tags/v3.10.11:7d4cc5a, Apr  5 2023, 00:38:17) [MSC v.1929 64 bit
(AMD64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
============== RESTART: C:/Users/DELL/OneDrive/Desktop/sgfsgfs.py ==============
[2, 2, 2, 7]
[2, 2, 5, 5]
[17]
[]
[2, 3, 3, 5]
>>>
```

BRIEF DESCRIPTION:

The function identifies abundant numbers by summing their proper divisors. The **memory management** is straightforward; the `sum_of_divisors` and the loop counter `i` are the main variables. Their memory footprint is minimal and is automatically managed by Python's garbage collector. For very large

n, the time taken is a more significant concern than memory usage.

DIFFICULTY FACED BY STUDENT:
The initial implementation looped up to `n-1`, which was inefficient. Optimizing the loop to run only up to

`n/2` significantly improved the execution time for larger numbers.

SKILLS ACHIEVED:

Algorithm optimization for performance.

Writing functions that return a direct boolean comparison.

Analyzing the time complexity of a function.