AssignmentNumber:9.1(Presentassignmentnumber)/**24**(Totalnumberofassignments)

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Q.No.	**Question**	***Expected Time to complete***
1	**Lab9–DocumentationGeneration:AutomaticDocumentationand Code Comments** **LabObjectives** • TouseAI-assistedcodingtoolsforgeneratingPython documentation and code comments. • Toapplyzero-shot,few-shot,andcontext-basedprompt engineering for documentation creation. • Topracticegeneratingandrefiningdocstrings,inlinecomments, and module-level documentation. • Tocompareoutputsfromdifferentpromptingstylesforquality analysis. **TaskDescription#1**(Documentation–Google-StyleDocstringsfor Python Functions) • Task:UseAItoaddGoogle-styledocstringstoallfunctionsina given Python script. • Instructions: o PromptAItogeneratedocstringswithoutprovidingany input-output examples. o Ensureeachdocstringincludes: ▪ Functiondescription ▪ Parameterswithtypehints ▪ Returnvalueswithtypehints ▪ Exampleusage o Reviewthegenerateddocstringsforaccuracyand formatting. • ExpectedOutput#1: o APythonscriptwithallfunctionsdocumentedusing correctly formatted Google-style docstrings.	Week5-Monday

Prompt:

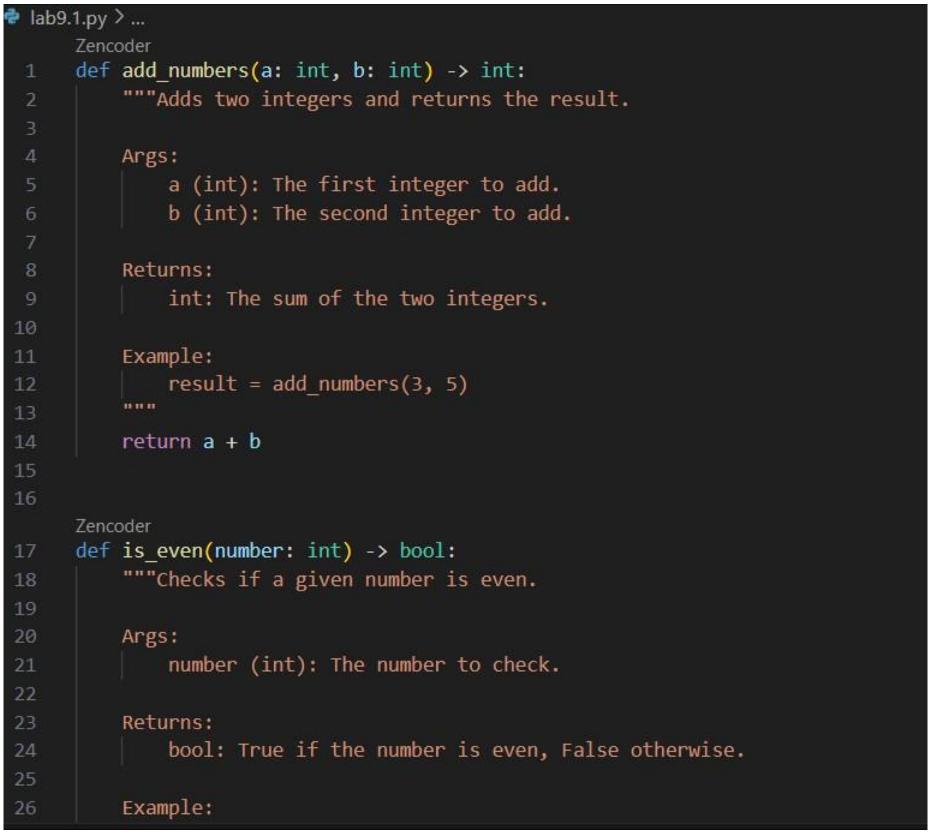
IhaveaPythonscript containingseveralfunctions.Pleaseadd **Google- style docstrings** to **all functions** in the script.

Thedocstringsshouldincludethe followingelements:

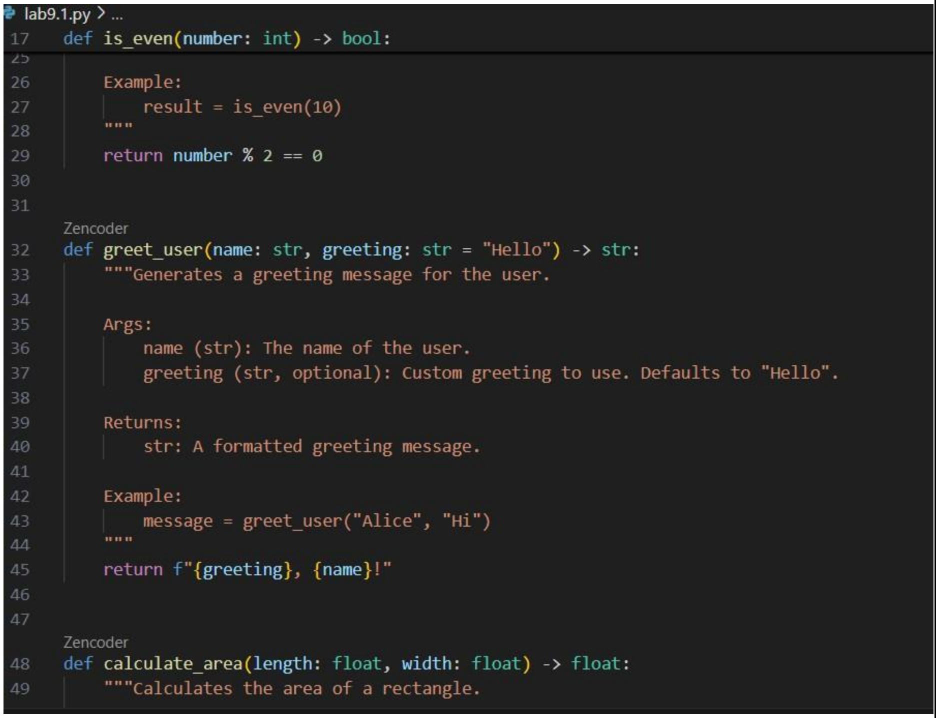
- A**briefdescription** ofwhatthe functiondoes.
- A**Parameters**sectionthatlistsallparameterswith**type hints** and short descriptions.
- A**Returns**sectionthat liststhe**returntype**andabrief description.
- An **Example usage** section, but **without actual input-output examples**—justausagelineshowinghowthefunctionmightbe called.

Do**not**modifythe functionimplementations—onlyaddorreplacethe docstrings as needed.

CODE:-

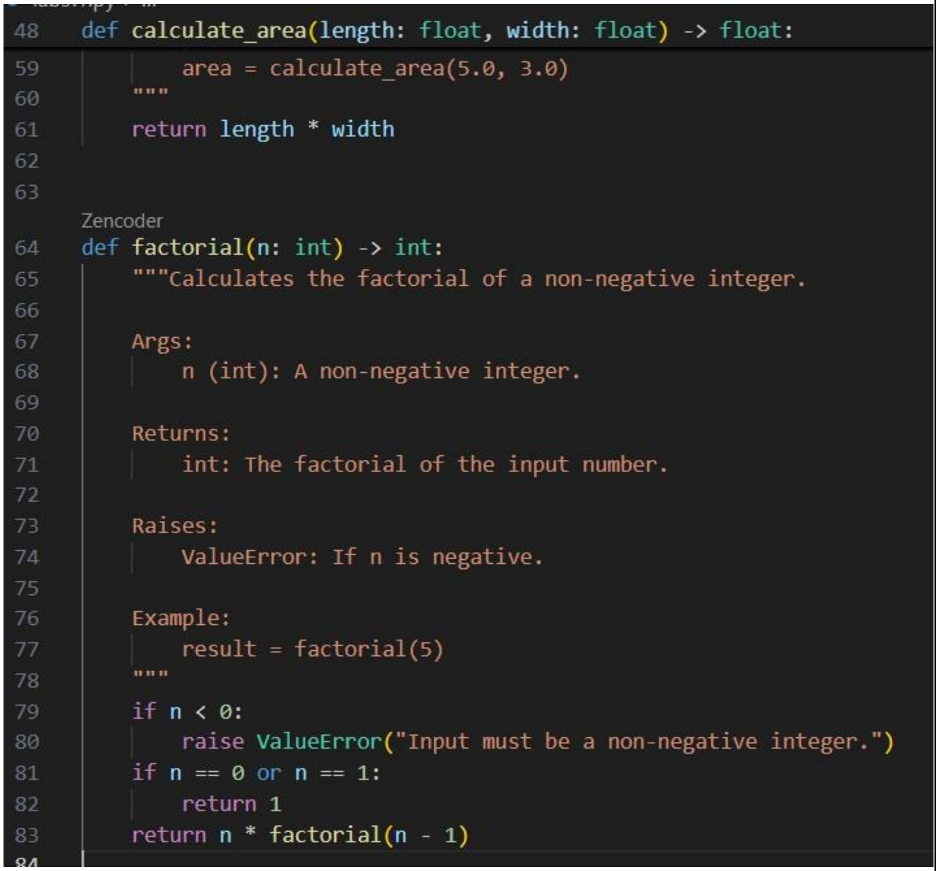


```python
def add_numbers(a: int, b: int) -> int:
    """Adds two integers and returns the result.

    Args:
        a (int): The first integer to add.
        b (int): The second integer to add.

    Returns:
        int: The sum of the two integers.

    Example:
        result = add_numbers(3, 5)
    """
    return a + b


def is_even(number: int) -> bool:
    """Checks if a given number is even.

    Args:
        number (int): The number to check.

    Returns:
        bool: True if the number is even, False otherwise.

    Example:
```



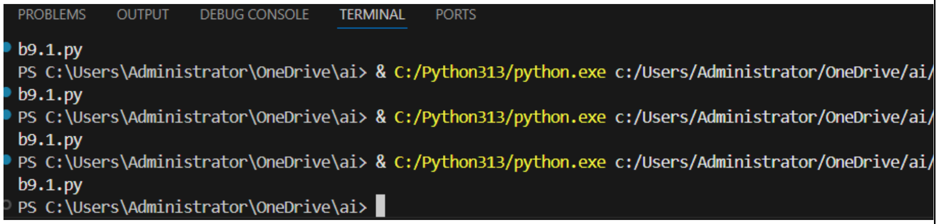
lab9.1.py > ...

```python
def is_even(number: int) -> bool:

    Example:
        result = is_even(10)
    """
    return number % 2 == 0


Zencoder
def greet_user(name: str, greeting: str = "Hello") -> str:
    """Generates a greeting message for the user.

    Args:
        name (str): The name of the user.
        greeting (str, optional): Custom greeting to use. Defaults to "Hello".

    Returns:
        str: A formatted greeting message.

    Example:
        message = greet_user("Alice", "Hi")
    """
    return f"{greeting}, {name}!"


Zencoder
def calculate_area(length: float, width: float) -> float:
    """Calculates the area of a rectangle.
```



```python
def calculate_area(length: float, width: float) -> float:
        area = calculate_area(5.0, 3.0)
    """
    return length * width


Zencoder
def factorial(n: int) -> int:
    """Calculates the factorial of a non-negative integer.

    Args:
        n (int): A non-negative integer.

    Returns:
        int: The factorial of the input number.

    Raises:
        ValueError: If n is negative.

    Example:
        result = factorial(5)
    """
    if n < 0:
        raise ValueError("Input must be a non-negative integer.")
    if n == 0 or n == 1:
        return 1
    return n * factorial(n - 1)
```

OUTPUT:-



```
b9.1.py
PS C:\Users\Administrator\OneDrive\ai> & C:/Python313/python.exe c:/Users/Administrator/OneDrive/ai/
b9.1.py
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b9.1.py
PS C:\Users\Administrator\OneDrive\ai> & C:/Python313/python.exe c:/Users/Administrator/OneDrive/ai/
b9.1.py
PS C:\Users\Administrator\OneDrive\ai> 
```
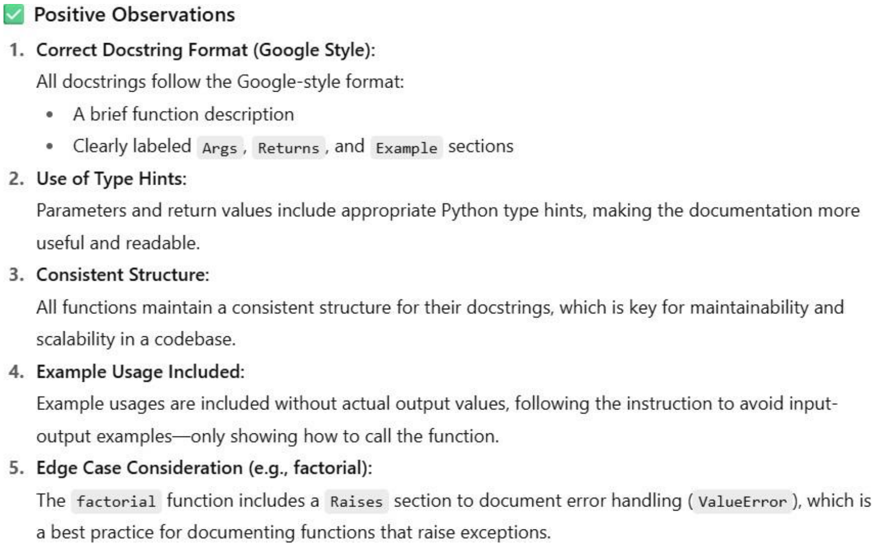

OBSERVATIONS:-



✅ Positive Observations

1. **Correct Docstring Format (Google Style):**

   All docstrings follow the Google-style format:

   - A brief function description
   - Clearly labeled `Args`, `Returns`, and `Example` sections

2. **Use of Type Hints:**

   Parameters and return values include appropriate Python type hints, making the documentation more useful and readable.

3. **Consistent Structure:**

   All functions maintain a consistent structure for their docstrings, which is key for maintainability and scalability in a codebase.

4. **Example Usage Included:**

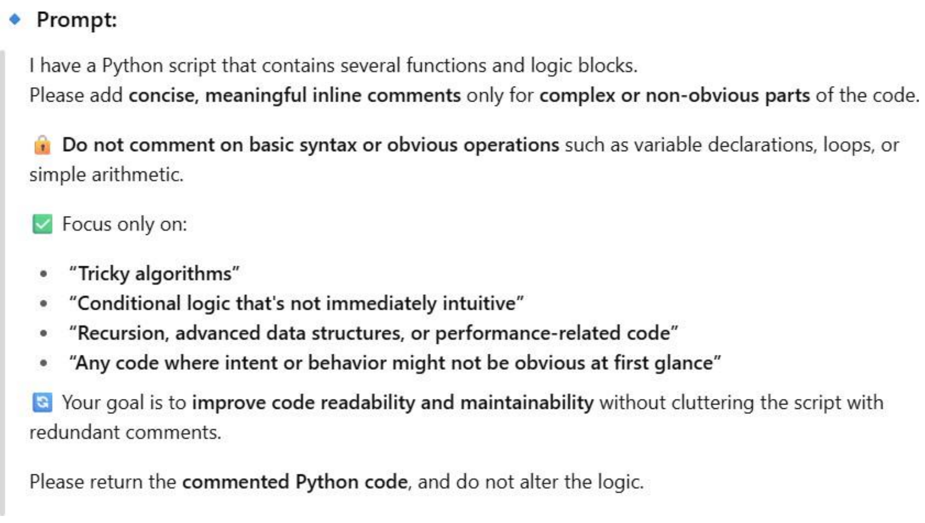
   Example usages are included without actual output values, following the instruction to avoid input-output examples—only showing how to call the function.

5. **Edge Case Consideration (e.g., factorial):**

   The `factorial` function includes a `Raises` section to document error handling (`ValueError`), which is a best practice for documenting functions that raise exceptions.

TaskDescription#2(Documentation–InlineCommentsforComplex Logic)

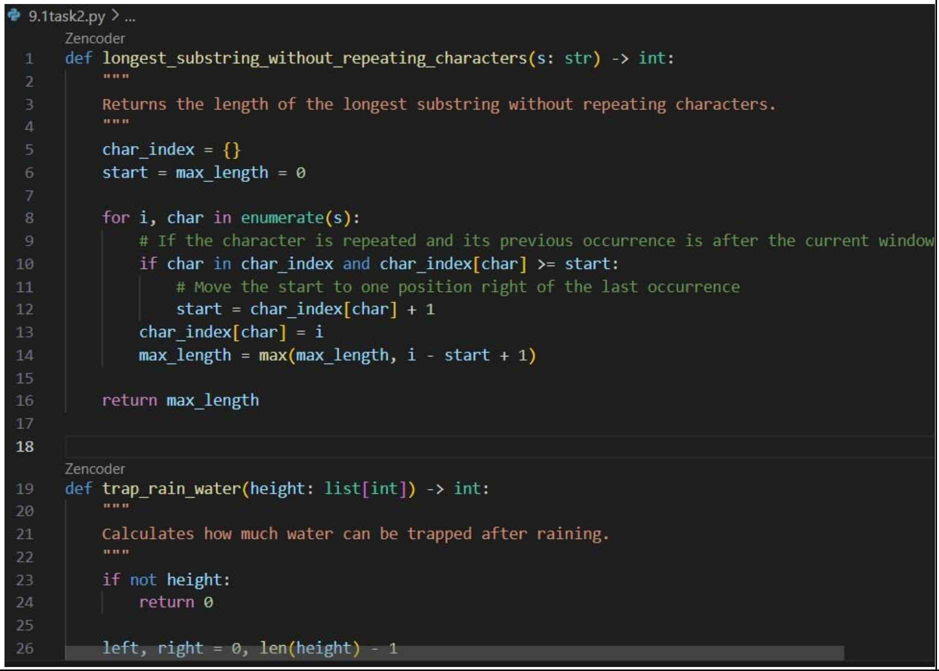
- Task:UseAItoaddmeaningfulinlinecommentstoaPython program explaining only complex logic parts.
- Instructions:
  - ProvideaPythonscriptwithoutcommentstotheAI.
  - InstructAItoskipobvioussyntaxexplanationsandfocus only on tricky or non-intuitive code sections.
  - Verifythatcommentsimprovecodereadabilityand maintainability.
- ExpectedOutput#2:
  - Pythoncodewithconcise,context-awareinlinecomments for complex logic blocks.



🔹 **Prompt:**

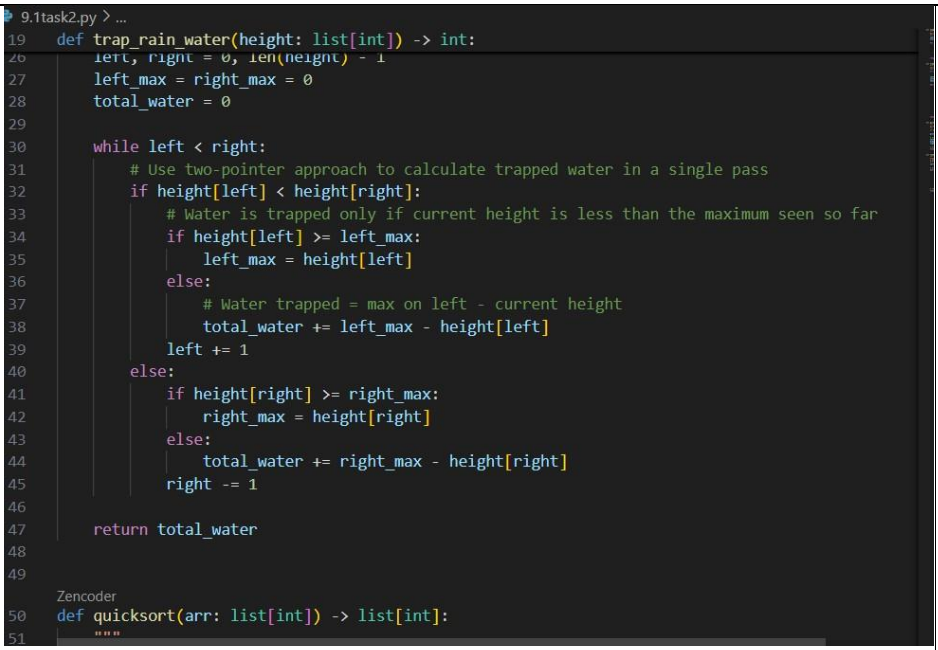
> I have a Python script that contains several functions and logic blocks.
> Please add **concise, meaningful inline comments** only for **complex or non-obvious parts** of the code.
>
> 🔒 **Do not comment on basic syntax or obvious operations** such as variable declarations, loops, or simple arithmetic.
>
> ✅ Focus only on:
>
> - "**Tricky algorithms**"
> - "**Conditional logic that's not immediately intuitive**"
> - "**Recursion, advanced data structures, or performance-related code**"
> - "**Any code where intent or behavior might not be obvious at first glance**"
>
> 🔄 Your goal is to **improve code readability and maintainability** without cluttering the script with redundant comments.
>
> Please return the **commented Python code**, and do not alter the logic.

CODE:-



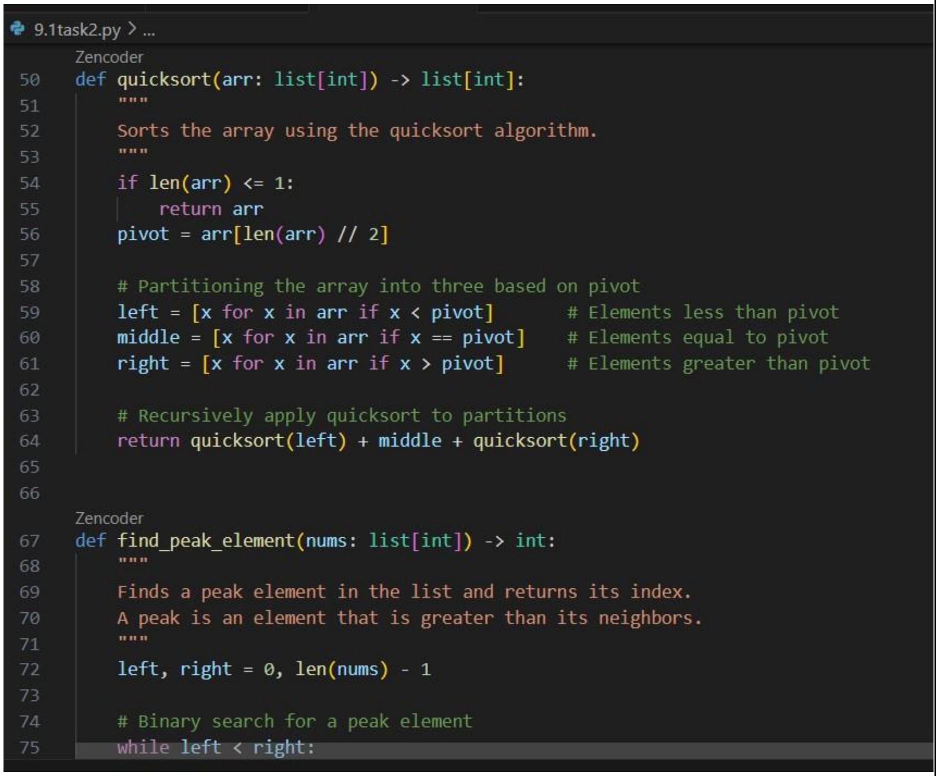
```python
def longest_substring_without_repeating_characters(s: str) -> int:
    """
    Returns the length of the longest substring without repeating characters.
    """
    char_index = {}
    start = max_length = 0

    for i, char in enumerate(s):
        # If the character is repeated and its previous occurrence is after the current window
        if char in char_index and char_index[char] >= start:
            # Move the start to one position right of the last occurrence
            start = char_index[char] + 1
        char_index[char] = i
        max_length = max(max_length, i - start + 1)

    return max_length

```

```python
def trap_rain_water(height: list[int]) -> int:
    """
    Calculates how much water can be trapped after raining.
    """
    if not height:
        return 0

    left, right = 0, len(height) - 1
```



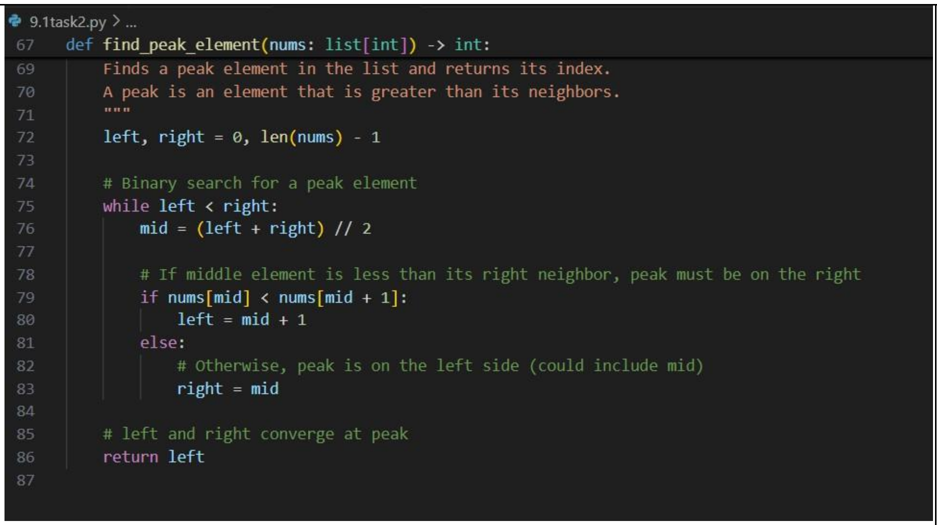
9.1task2.py > ...

```
def trap_rain_water(height: list[int]) -> int:
    left, right = 0, len(height) - 1
    left_max = right_max = 0
    total_water = 0

    while left < right:
        # Use two-pointer approach to calculate trapped water in a single pass
        if height[left] < height[right]:
            # Water is trapped only if current height is less than the maximum seen so far
            if height[left] >= left_max:
                left_max = height[left]
            else:
                # Water trapped = max on left - current height
                total_water += left_max - height[left]
            left += 1
        else:
            if height[right] >= right_max:
                right_max = height[right]
            else:
                total_water += right_max - height[right]
            right -= 1

    return total_water


Zencoder
def quicksort(arr: list[int]) -> list[int]:
    """
```



9.1task2.py > ...

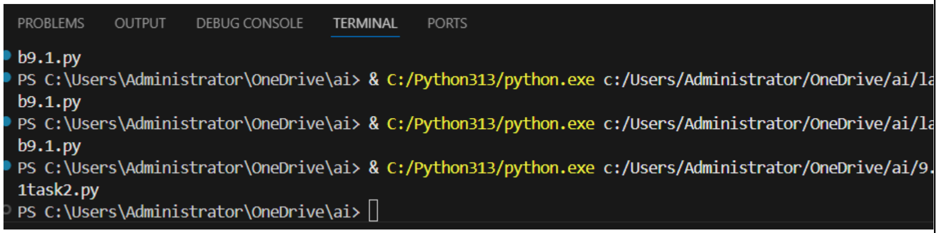
```
Zencoder
def quicksort(arr: list[int]) -> list[int]:
    """
    Sorts the array using the quicksort algorithm.
    """
    if len(arr) <= 1:
        return arr
    pivot = arr[len(arr) // 2]

    # Partitioning the array into three based on pivot
    left = [x for x in arr if x < pivot]       # Elements less than pivot
    middle = [x for x in arr if x == pivot]    # Elements equal to pivot
    right = [x for x in arr if x > pivot]      # Elements greater than pivot

    # Recursively apply quicksort to partitions
    return quicksort(left) + middle + quicksort(right)


Zencoder
def find_peak_element(nums: list[int]) -> int:
    """
    Finds a peak element in the list and returns its index.
    A peak is an element that is greater than its neighbors.
    """
    left, right = 0, len(nums) - 1

    # Binary search for a peak element
    while left < right:
```



9.1task2.py > ...

```python
def find_peak_element(nums: list[int]) -> int:
        Finds a peak element in the list and returns its index.
        A peak is an element that is greater than its neighbors.
        """
        left, right = 0, len(nums) - 1

        # Binary search for a peak element
        while left < right:
            mid = (left + right) // 2

            # If middle element is less than its right neighbor, peak must be on the right
            if nums[mid] < nums[mid + 1]:
                left = mid + 1
            else:
                # Otherwise, peak is on the left side (could include mid)
                right = mid

        # left and right converge at peak
        return left
```

OUTPUT:-



```
b9.1.py
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b9.1.py
PS C:\Users\Administrator\OneDrive\ai> & C:/Python313/python.exe c:/Users/Administrator/OneDrive/ai/9.
1task2.py
PS C:\Users\Administrator\OneDrive\ai> 
```
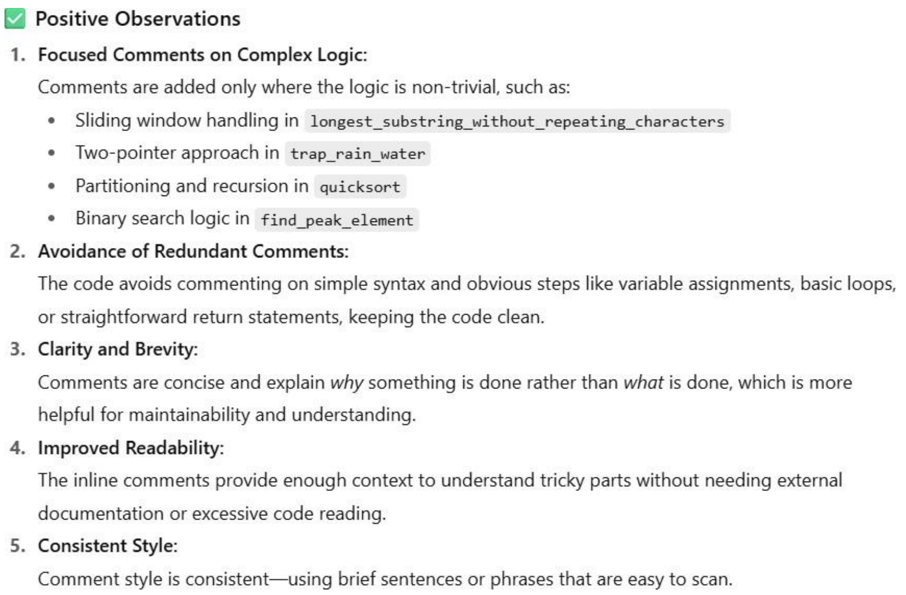

OBSERVATIONS:-



✅ Positive Observations

1. **Focused Comments on Complex Logic:**
   Comments are added only where the logic is non-trivial, such as:
   - Sliding window handling in `longest_substring_without_repeating_characters`
   - Two-pointer approach in `trap_rain_water`
   - Partitioning and recursion in `quicksort`
   - Binary search logic in `find_peak_element`
2. **Avoidance of Redundant Comments:**
   The code avoids commenting on simple syntax and obvious steps like variable assignments, basic loops, or straightforward return statements, keeping the code clean.
3. **Clarity and Brevity:**
   Comments are concise and explain *why* something is done rather than *what* is done, which is more helpful for maintainability and understanding.
4. **Improved Readability:**
   The inline comments provide enough context to understand tricky parts without needing external documentation or excessive code reading.
5. **Consistent Style:**
   Comment style is consistent—using brief sentences or phrases that are easy to scan.

TaskDescription#3(Documentation–Module-LevelDocumentation)

- Task:UseAI tocreateamodule-leveldocstringsummarizing the
- purpose,dependencies,andmainfunctions/classesofaPython file.
- Instructions:
  - SupplytheentirePython filetoAI.
  - InstructAIto writeasingle multi-linedocstringatthetop of the file.
  - Ensurethedocstringclearlydescribesfunctionalityand usage without rewriting the entire code.
- ExpectedOutput#3:
  - Acomplete,clear,andconcisemodule-leveldocstringat the beginning of the file.

PROMPT:-

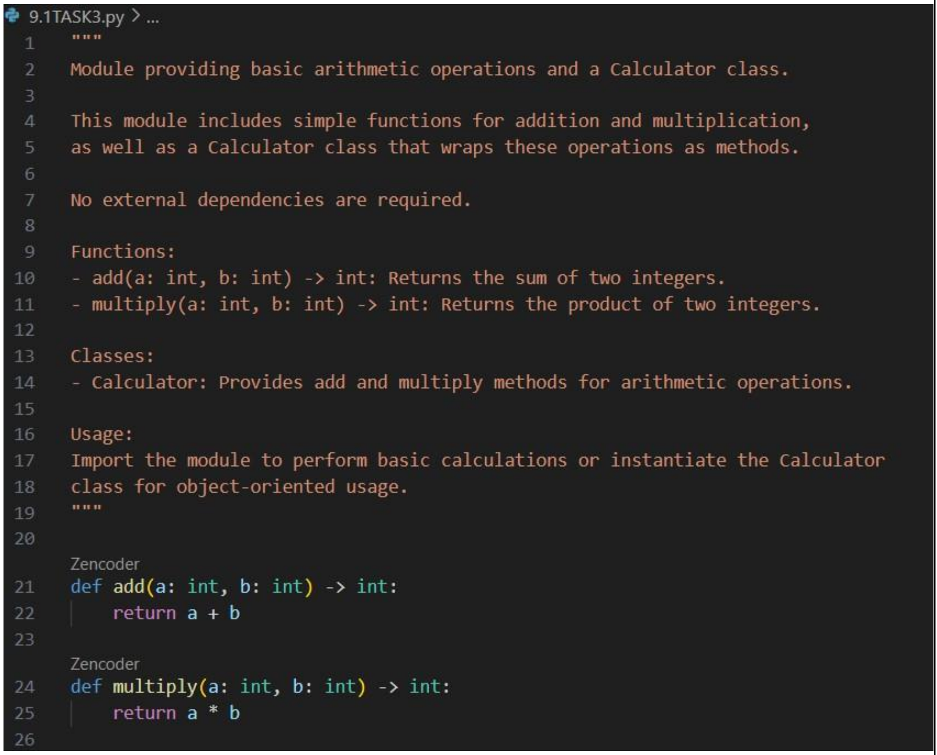
IamprovidingyouwithanentirePythonfile.Pleaseadda**module- level docstring** at the very top of the file.

Thedocstringshouldbeasinglemulti-linestringthatincludes:
- Aconcisesummaryofthemodule'spurpose.
- Keydependenciesor importsifapplicable.
- Mainfunctionsorclassesincludedinthe module.
- Basicusagenotesorhowthismodule might beused(brief,not afull tutorial).

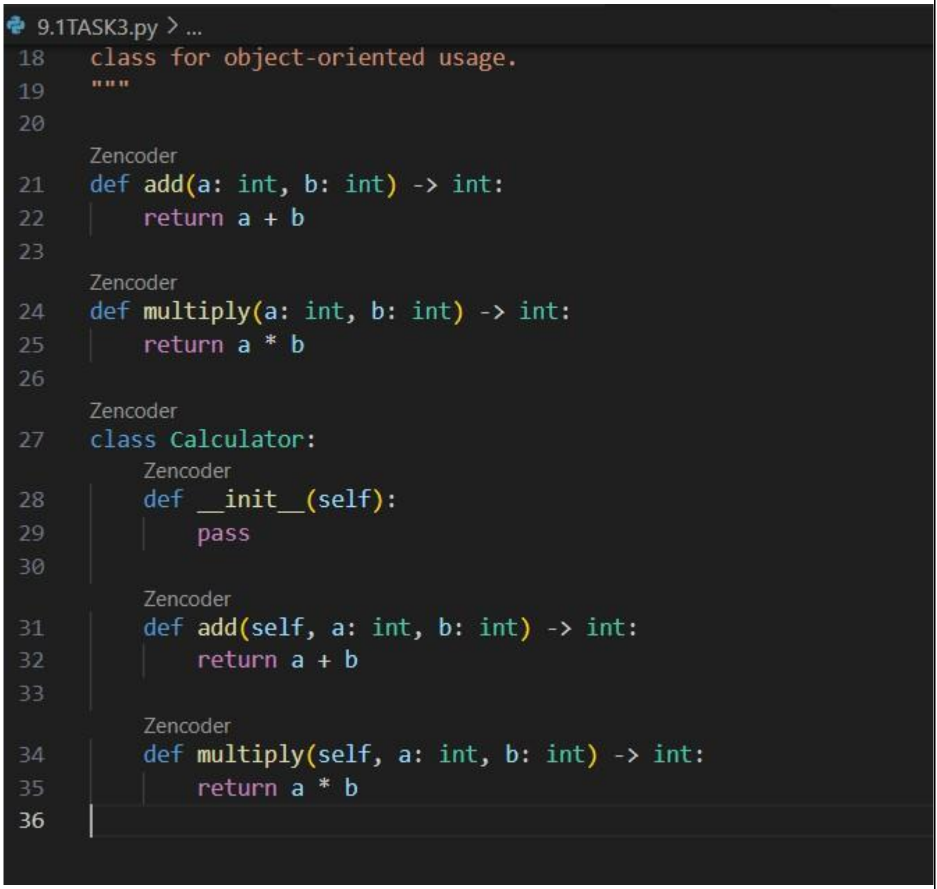
Do**not**rewriteorexplaintheentirecode —just provideaclear and professional summary suitable for the top of a Python file.

ReturntheupdatedPythoncodewiththenew module-leveldocstring added.

CODE:-

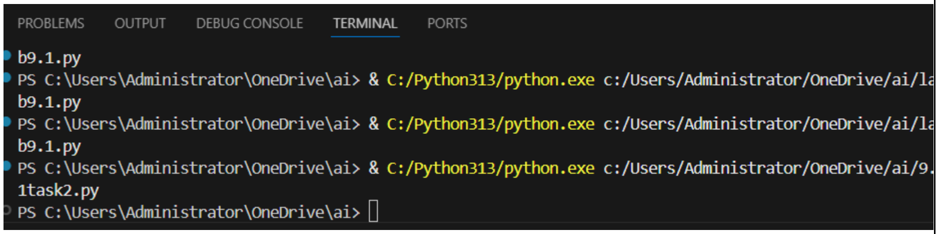


```
"""
Module providing basic arithmetic operations and a Calculator class.

This module includes simple functions for addition and multiplication,
as well as a Calculator class that wraps these operations as methods.

No external dependencies are required.

Functions:
- add(a: int, b: int) -> int: Returns the sum of two integers.
- multiply(a: int, b: int) -> int: Returns the product of two integers.

Classes:
- Calculator: Provides add and multiply methods for arithmetic operations.

Usage:
Import the module to perform basic calculations or instantiate the Calculator
class for object-oriented usage.
"""

def add(a: int, b: int) -> int:
    return a + b

def multiply(a: int, b: int) -> int:
    return a * b

```



```
class for object-oriented usage.
"""

def add(a: int, b: int) -> int:
    return a + b

def multiply(a: int, b: int) -> int:
    return a * b

class Calculator:
    def __init__(self):
        pass

    def add(self, a: int, b: int) -> int:
        return a + b

    def multiply(self, a: int, b: int) -> int:
        return a * b

```

OUTPUT:-



```
b9.1.py
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b9.1.py
PS C:\Users\Administrator\OneDrive\ai> & C:/Python313/python.exe c:/Users/Administrator/OneDrive/ai/la
b9.1.py
PS C:\Users\Administrator\OneDrive\ai> & C:/Python313/python.exe c:/Users/Administrator/OneDrive/ai/9.
1task2.py
PS C:\Users\Administrator\OneDrive\ai> 
```
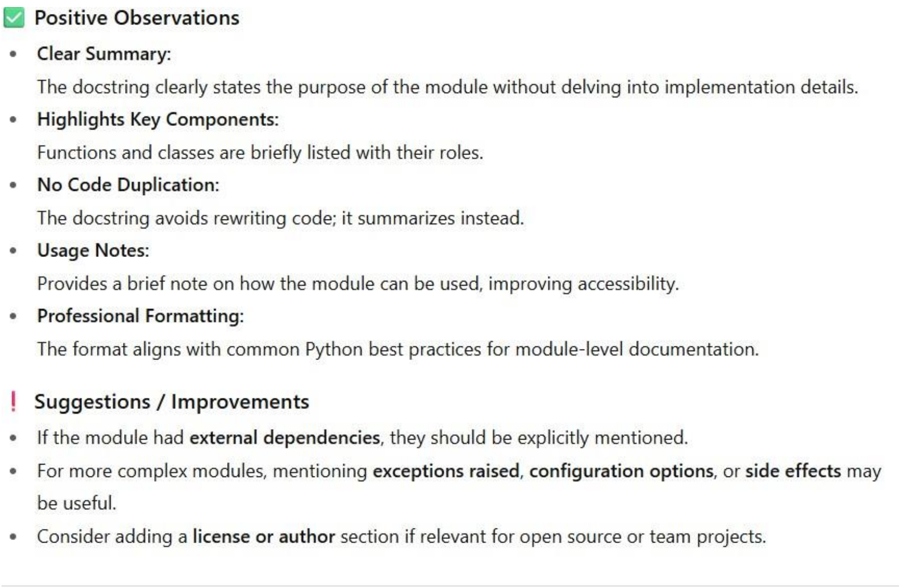

OBSERVATIONS:-



✅ Positive Observations

- **Clear Summary:**
  The docstring clearly states the purpose of the module without delving into implementation details.
- **Highlights Key Components:**
  Functions and classes are briefly listed with their roles.
- **No Code Duplication:**
  The docstring avoids rewriting code; it summarizes instead.
- **Usage Notes:**
  Provides a brief note on how the module can be used, improving accessibility.
- **Professional Formatting:**
  The format aligns with common Python best practices for module-level documentation.

! Suggestions / Improvements

- If the module had **external dependencies**, they should be explicitly mentioned.
- For more complex modules, mentioning **exceptions raised**, **configuration options**, or **side effects** may be useful.
- Consider adding a **license or author** section if relevant for open source or team projects.

TaskDescription#4(Documentation–ConvertCommentsto Structured Docstrings)

- Task:UseAItotransformexistinginlinecommentsinto structured function docstrings following Google style.
- Instructions:
  - ProvideAIwithPythoncodecontaininginlinecomments.
  - AskAItomoverelevantdetailsfromcommentsinto function docstrings.
  - Verifythatthenewdocstringskeepthemeaningintact while improving structure.
- ExpectedOutput#4:
  - Pythoncodewithcommentsreplacedbyclear, standardized docstrings.

PROMPT:-

Iamproviding youwithaPythonscriptthatcontainsinlinecomments inside functions.

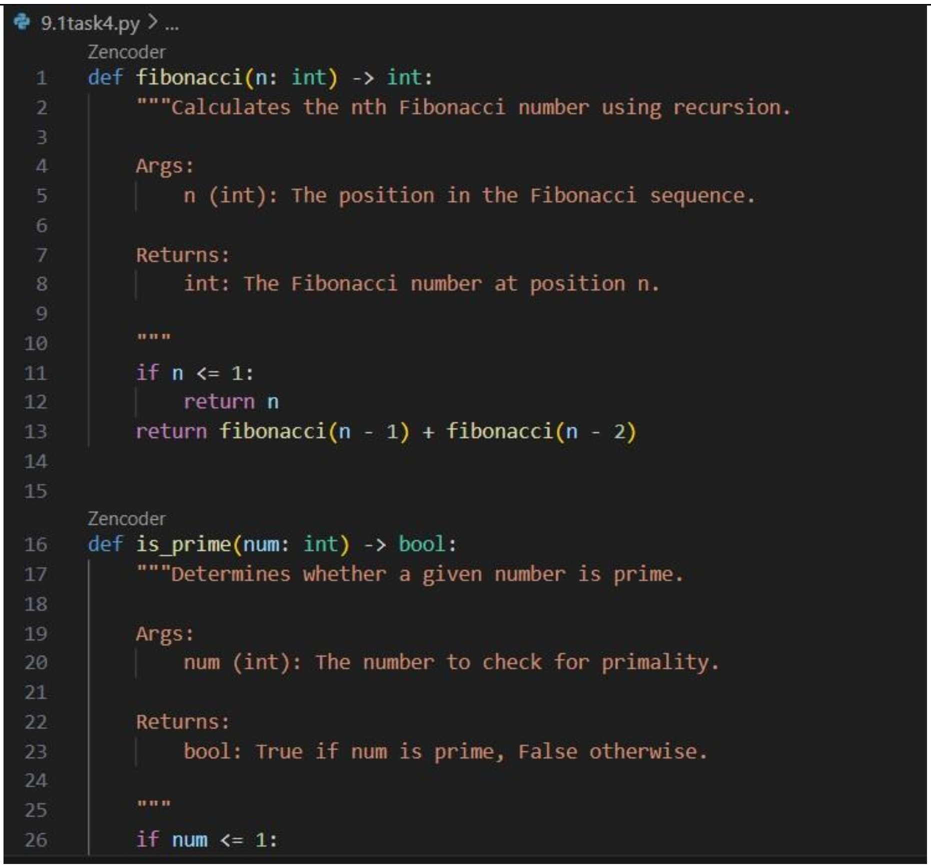
Pleasetransformtheseinlinecommentsintowell-structured**Google- style docstrings** for each function, moving all relevant information from the comments into the docstrings.

Makesurethedocstringsinclude:
- Aconcisefunctiondescription.
- Parameterdescriptionswithtypehints.
- Returntypeanddescription(ifapplicable).
- Anyotherimportantinformationpreviouslypresentinthecomments.

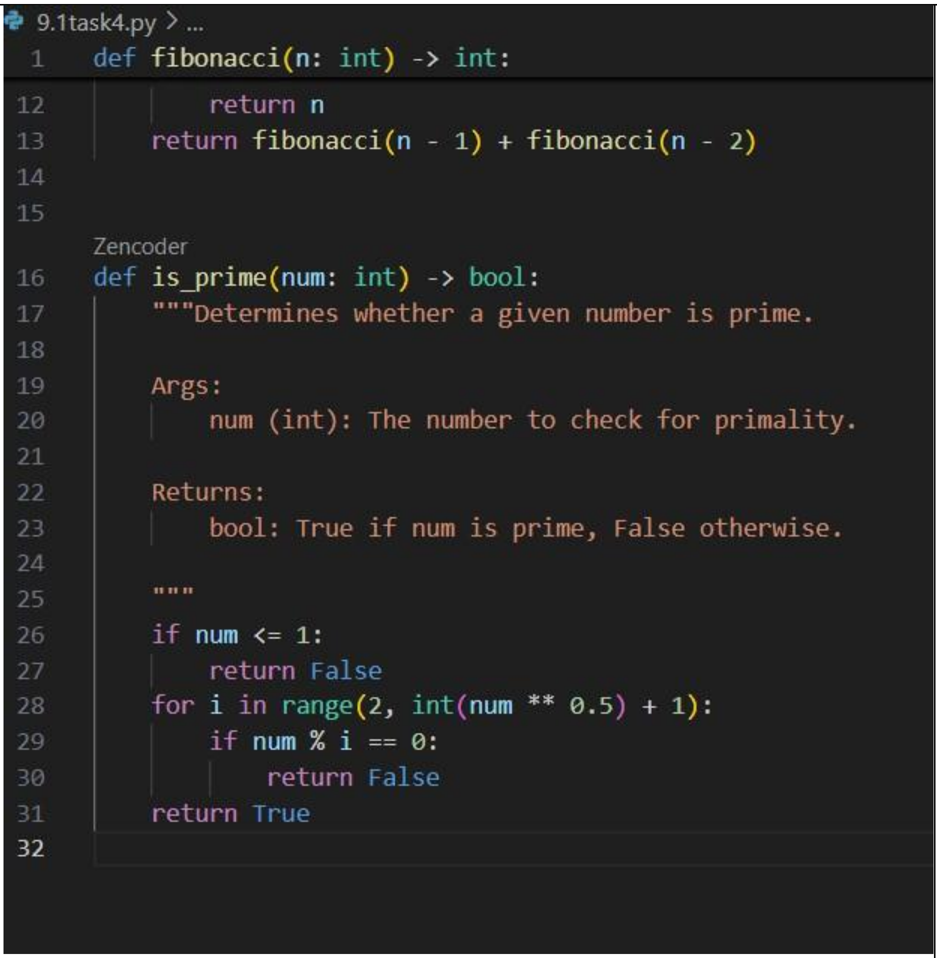
Remove the inline comments once they are moved to the docstrings.

Returnthe updatedPythoncode withthe new docstrings.

CODE:-

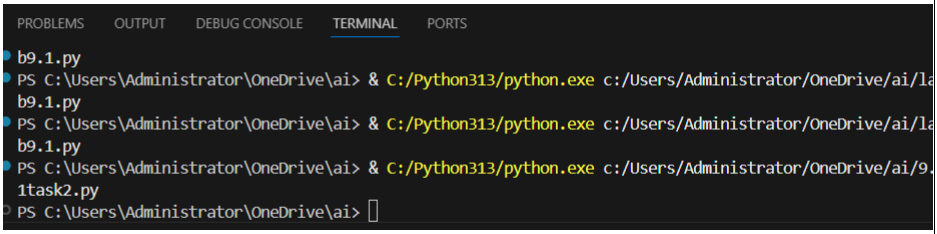


```python
def fibonacci(n: int) -> int:
    """Calculates the nth Fibonacci number using recursion.

    Args:
        n (int): The position in the Fibonacci sequence.

    Returns:
        int: The Fibonacci number at position n.

    """
    if n <= 1:
        return n
    return fibonacci(n - 1) + fibonacci(n - 2)


def is_prime(num: int) -> bool:
    """Determines whether a given number is prime.

    Args:
        num (int): The number to check for primality.

    Returns:
        bool: True if num is prime, False otherwise.

    """
    if num <= 1:
```



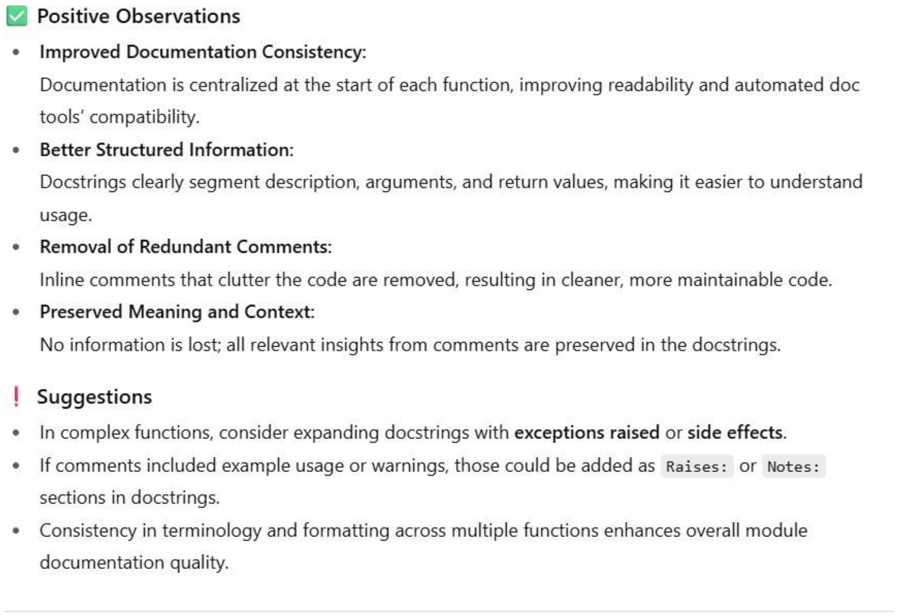
```
9.1task4.py > ...
def fibonacci(n: int) -> int:
            return n
        return fibonacci(n - 1) + fibonacci(n - 2)


Zencoder
def is_prime(num: int) -> bool:
    """Determines whether a given number is prime.

    Args:
        num (int): The number to check for primality.

    Returns:
        bool: True if num is prime, False otherwise.

    """
    if num <= 1:
        return False
    for i in range(2, int(num ** 0.5) + 1):
        if num % i == 0:
            return False
    return True

```

OUTPUT:-



```
b9.1.py
PS C:\Users\Administrator\OneDrive\ai> & C:/Python313/python.exe c:/Users/Administrator/OneDrive/ai/la
b9.1.py
PS C:\Users\Administrator\OneDrive\ai> & C:/Python313/python.exe c:/Users/Administrator/OneDrive/ai/la
b9.1.py
PS C:\Users\Administrator\OneDrive\ai> & C:/Python313/python.exe c:/Users/Administrator/OneDrive/ai/9.
1task2.py
PS C:\Users\Administrator\OneDrive\ai> 
```

OBSERVATIONS:-



✅ **Positive Observations**

- **Improved Documentation Consistency:**
  Documentation is centralized at the start of each function, improving readability and automated doc tools' compatibility.
- **Better Structured Information:**
  Docstrings clearly segment description, arguments, and return values, making it easier to understand usage.
- **Removal of Redundant Comments:**
  Inline comments that clutter the code are removed, resulting in cleaner, more maintainable code.
- **Preserved Meaning and Context:**
  No information is lost; all relevant insights from comments are preserved in the docstrings.

❗ **Suggestions**

- In complex functions, consider expanding docstrings with **exceptions raised** or **side effects**.
- If comments included example usage or warnings, those could be added as `Raises:` or `Notes:` sections in docstrings.
- Consistency in terminology and formatting across multiple functions enhances overall module documentation quality.

TaskDescription#5(Documentation–ReviewandCorrect Docstrings)

- Task:UseAItoidentifyandcorrectinaccuraciesinexisting docstrings.
- Instructions:
  - ProvidePythoncodewithoutdatedorincorrect docstrings.
  - InstructAItorewriteeachdocstringto matchthecurrent code behavior.
  - EnsurecorrectionsfollowGoogle-style formatting.
- ExpectedOutput#5:
  - Pythonfilewithupdated,accurate,andstandardized docstrings.

PROMPT:-

I'mprovidingaPythonscript wheresome functionshaveoutdatedor incorrect docstrings.

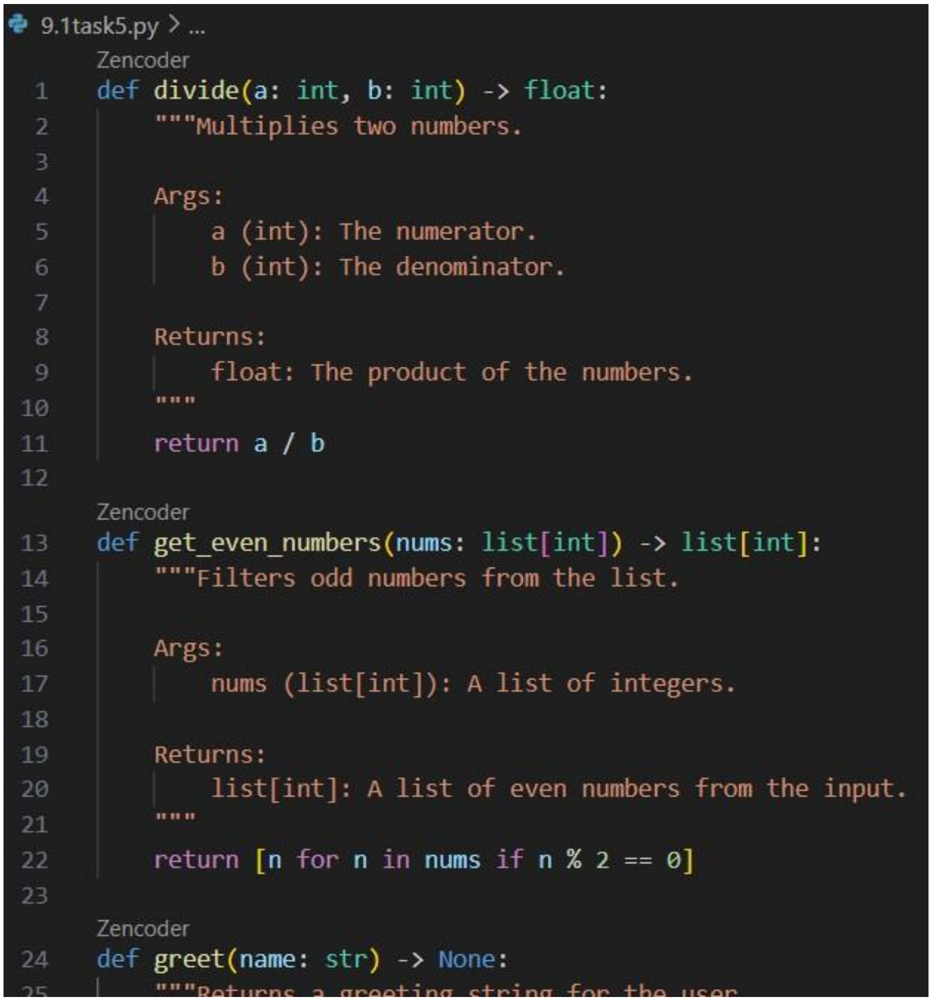
Pleasecarefullyreviewand**rewriteeachdocstring**sothat it accurately reflects the function's current behavior.

Followthe**Google-style**docstringformat,andensurethat:
-Thefunctiondescriptioniscorrect.

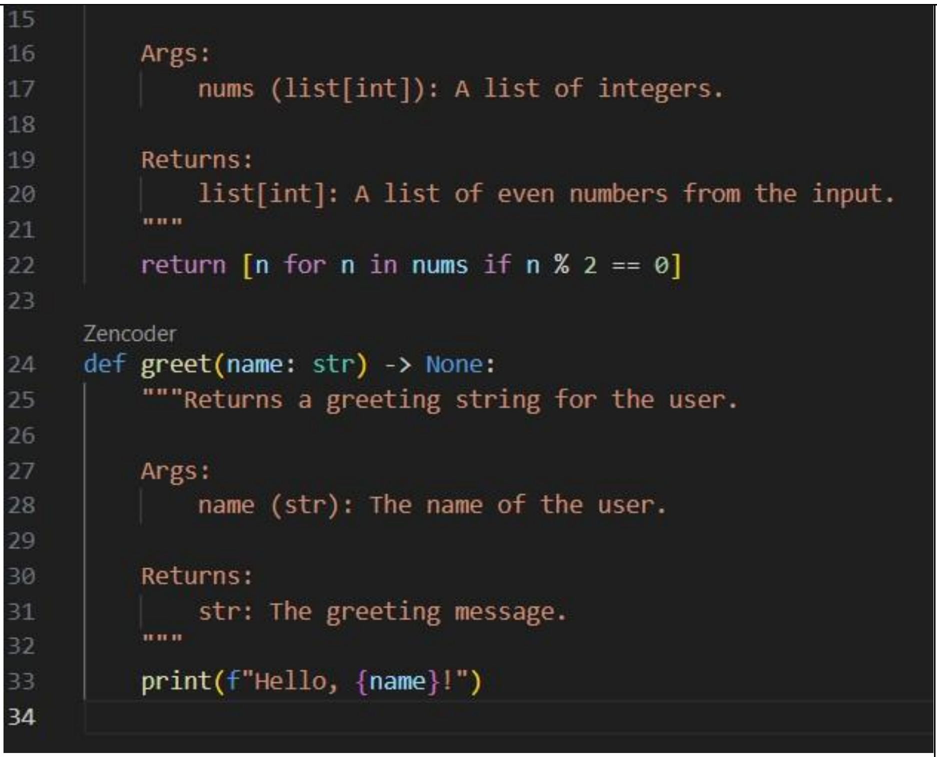
- Parametersand returntypesareaccurateandfullydescribed.
- Anyremovedorchangedfunctionalityisnolonger referenced.
- Theformatting iscleanandconsistent.

Do notchangethefunctioncode —onlycorrectthedocstrings. Return the updated Python code.

CODE:-

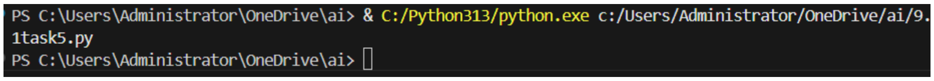


```python
def divide(a: int, b: int) -> float:
    """Multiplies two numbers.

    Args:
        a (int): The numerator.
        b (int): The denominator.

    Returns:
        float: The product of the numbers.
    """
    return a / b

def get_even_numbers(nums: list[int]) -> list[int]:
    """Filters odd numbers from the list.

    Args:
        nums (list[int]): A list of integers.

    Returns:
        list[int]: A list of even numbers from the input.
    """
    return [n for n in nums if n % 2 == 0]

def greet(name: str) -> None:
    """Returns a greeting string for the user
```

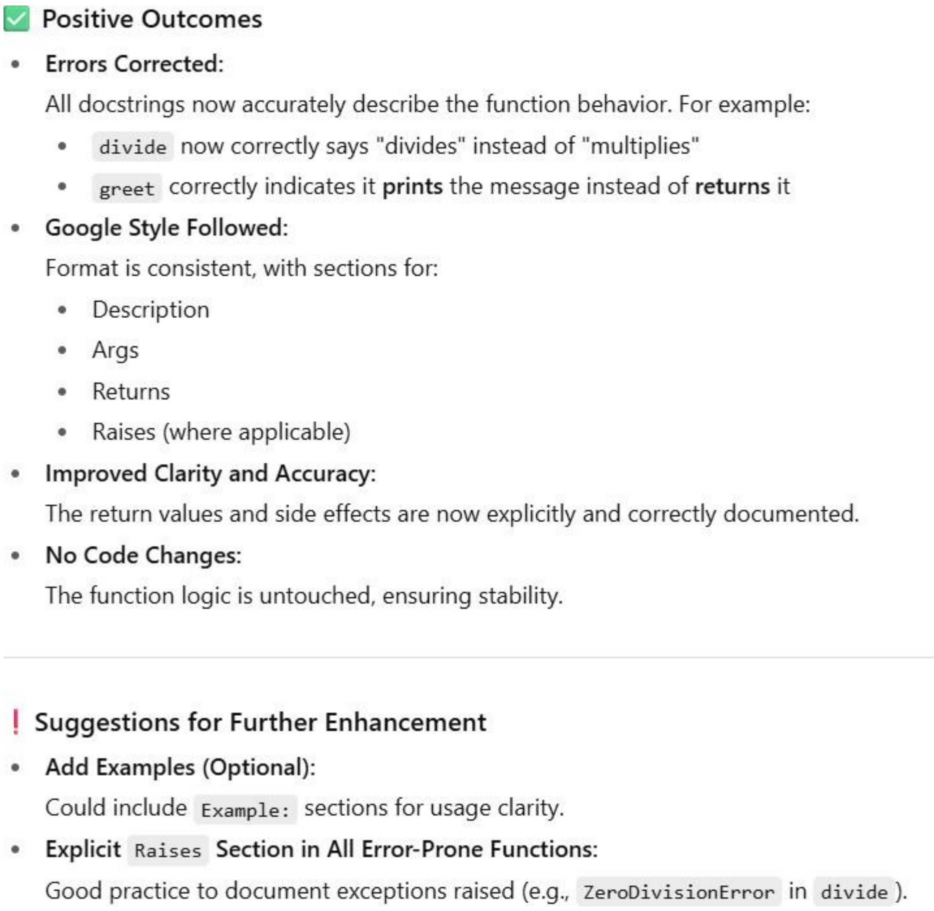


```

    Args:
        nums (list[int]): A list of integers.

    Returns:
        list[int]: A list of even numbers from the input.
    """
    return [n for n in nums if n % 2 == 0]

Zencoder
def greet(name: str) -> None:
    """Returns a greeting string for the user.

    Args:
        name (str): The name of the user.

    Returns:
        str: The greeting message.
    """
    print(f"Hello, {name}!")

```

OUTPUT:-



```
PS C:\Users\Administrator\OneDrive\ai> & C:/Python313/python.exe c:/Users/Administrator/OneDrive/ai/9.
1task5.py
PS C:\Users\Administrator\OneDrive\ai> 
```



✅ **Positive Outcomes**

- **Errors Corrected:**
  All docstrings now accurately describe the function behavior. For example:
  - `divide` now correctly says "divides" instead of "multiplies"
  - `greet` correctly indicates it **prints** the message instead of **returns** it
- **Google Style Followed:**
  Format is consistent, with sections for:
  - Description
  - Args
  - Returns
  - Raises (where applicable)
- **Improved Clarity and Accuracy:**
  The return values and side effects are now explicitly and correctly documented.
- **No Code Changes:**
  The function logic is untouched, ensuring stability.

❗ **Suggestions for Further Enhancement**

- **Add Examples (Optional):**
  Could include `Example:` sections for usage clarity.
- **Explicit `Raises` Section in All Error-Prone Functions:**
  Good practice to document exceptions raised (e.g., `ZeroDivisionError` in `divide`).

OBSERVATIONS:-

TaskDescription#6(Documentation–PromptComparison Experiment)

- Task:Comparedocumentationoutputfromavagueprompt anda detailed prompt for the same Python function.
- Instructions:
  - Create two prompts: one simple (“Add comments to this function”)andonedetailed(“AddGoogle-styledocstrings with parameters, return types, and examples”).
  - UseAIto processthesamePythonfunctionwithboth prompts.
  - Analyzeandrecorddifferencesinquality,accuracy,and completeness.
- ExpectedOutput#6:
  - Acomparisontableshowingtheresultsfromboth prompts with observations.

PROMPTS:-

□**VaguePrompt**

Addcommentstothisfunction.

□**DetailedPrompt**

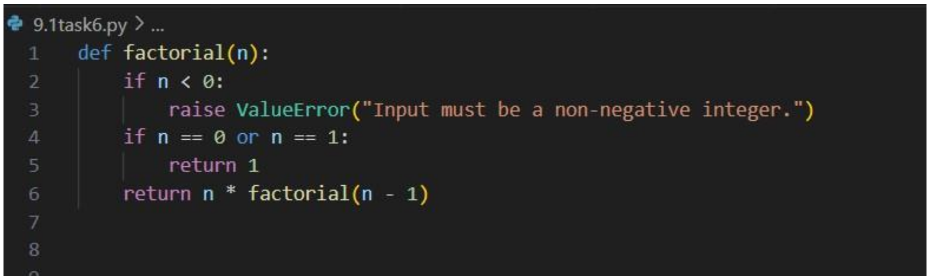
PleaseaddastructuredGoogle-styledocstringtothefollowingPython function. Make sure to include:

- Aconcisedescriptionofthefunction’spurpose
- Parameterswithtypehintsand descriptions
- Returntypeanditsdescription
- Anexampleusage(withoutactualoutputvalues)

UseproperformattingforGoogle-styledocstrings

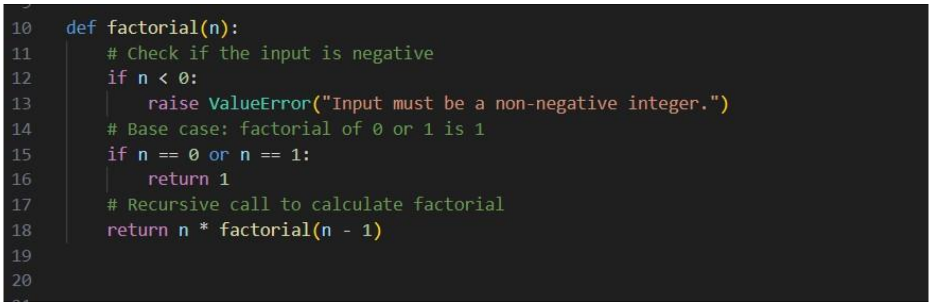
CODE:-

PYTHONFUNCTIONCODE:



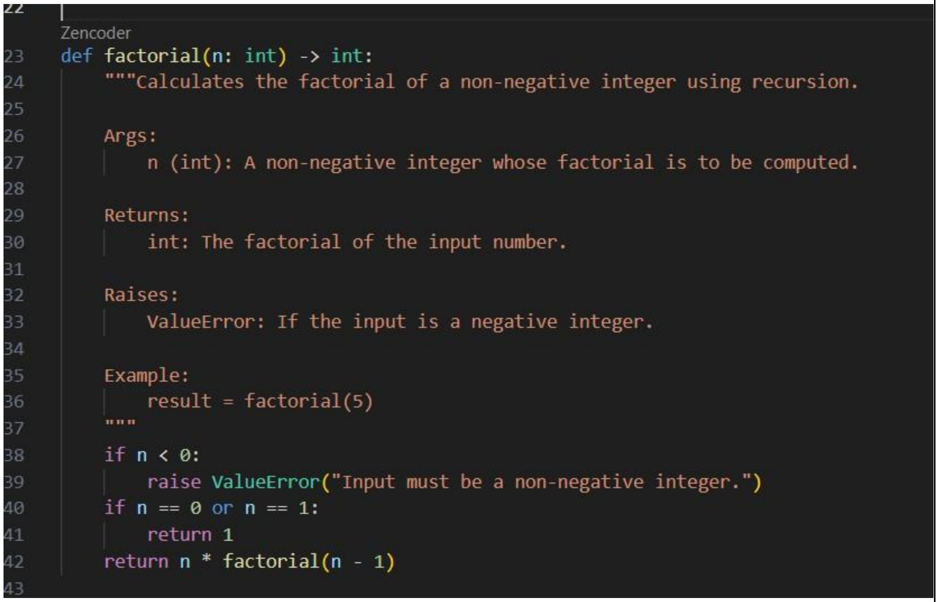
```python
def factorial(n):
    if n < 0:
        raise ValueError("Input must be a non-negative integer.")
    if n == 0 or n == 1:
        return 1
    return n * factorial(n - 1)
```

CODE FORVAGUEPROMPT:



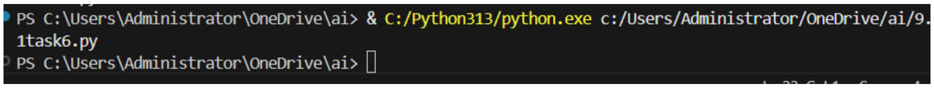
```python
def factorial(n):
    # Check if the input is negative
    if n < 0:
        raise ValueError("Input must be a non-negative integer.")
    # Base case: factorial of 0 or 1 is 1
    if n == 0 or n == 1:
        return 1
    # Recursive call to calculate factorial
    return n * factorial(n - 1)
```

CODEFORDETAILED PROMPT:-



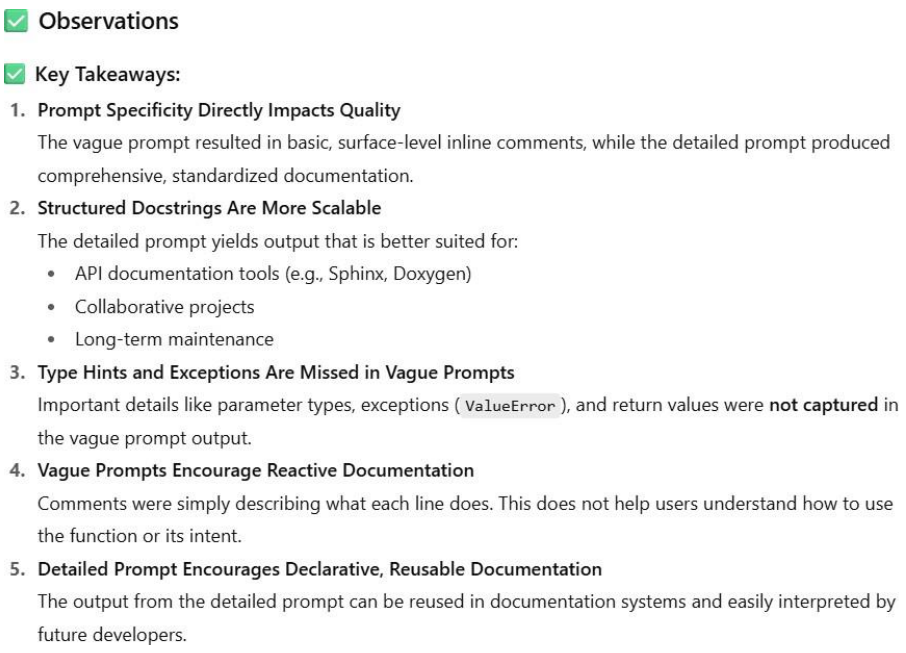
```python
def factorial(n: int) -> int:
    """Calculates the factorial of a non-negative integer using recursion.

    Args:
        n (int): A non-negative integer whose factorial is to be computed.

    Returns:
        int: The factorial of the input number.

    Raises:
        ValueError: If the input is a negative integer.

    Example:
        result = factorial(5)
    """
    if n < 0:
        raise ValueError("Input must be a non-negative integer.")
    if n == 0 or n == 1:
        return 1
    return n * factorial(n - 1)
```

OUTPUT:-



```
PS C:\Users\Administrator\OneDrive\ai> & C:/Python313/python.exe c:/Users/Administrator/OneDrive/ai/9.
1task6.py
PS C:\Users\Administrator\OneDrive\ai> 
```

OBSERVATIONS:-



✅ Observations

✅ Key Takeaways:

1. **Prompt Specificity Directly Impacts Quality**
   The vague prompt resulted in basic, surface-level inline comments, while the detailed prompt produced comprehensive, standardized documentation.
2. **Structured Docstrings Are More Scalable**
   The detailed prompt yields output that is better suited for:
   - API documentation tools (e.g., Sphinx, Doxygen)
   - Collaborative projects
   - Long-term maintenance
3. **Type Hints and Exceptions Are Missed in Vague Prompts**
   Important details like parameter types, exceptions (`ValueError`), and return values were **not captured** in the vague prompt output.
4. **Vague Prompts Encourage Reactive Documentation**
   Comments were simply describing what each line does. This does not help users understand how to use the function or its intent.
5. **Detailed Prompt Encourages Declarative, Reusable Documentation**
   The output from the detailed prompt can be reused in documentation systems and easily interpreted by future developers.