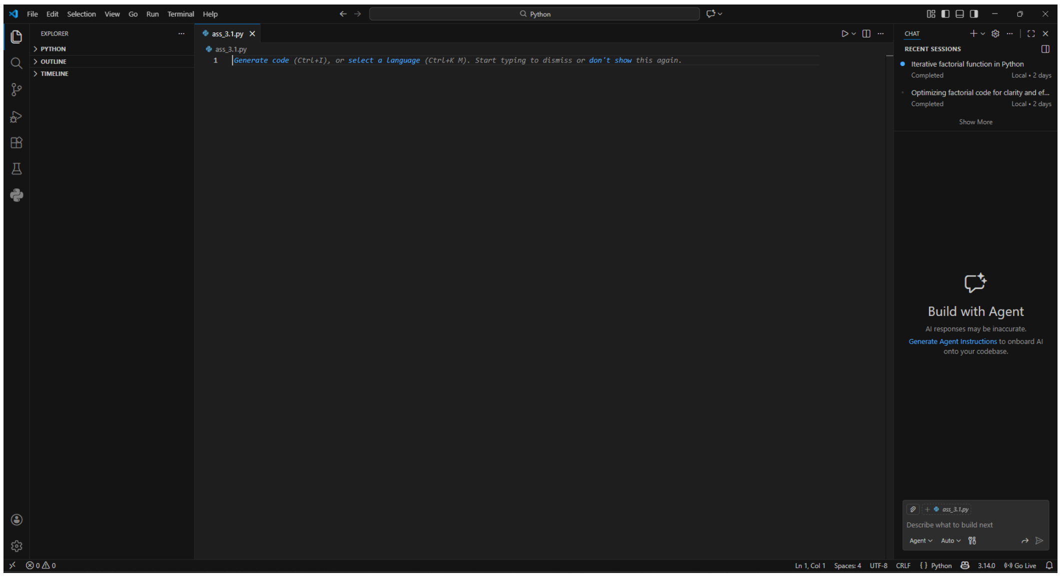
Lab Assignment 3.1

Question 1: Zero-Shot Prompting (Palindrome Number Program)

Write a zero-shot prompt (without providing any examples) to generate a Python function that checks whether a given number is a palindrome.

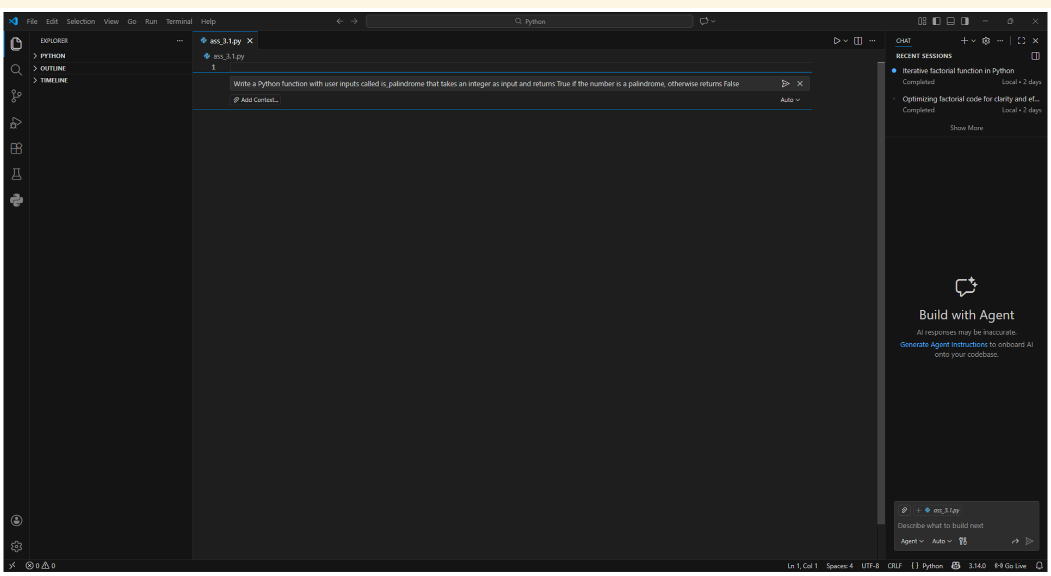
Task:

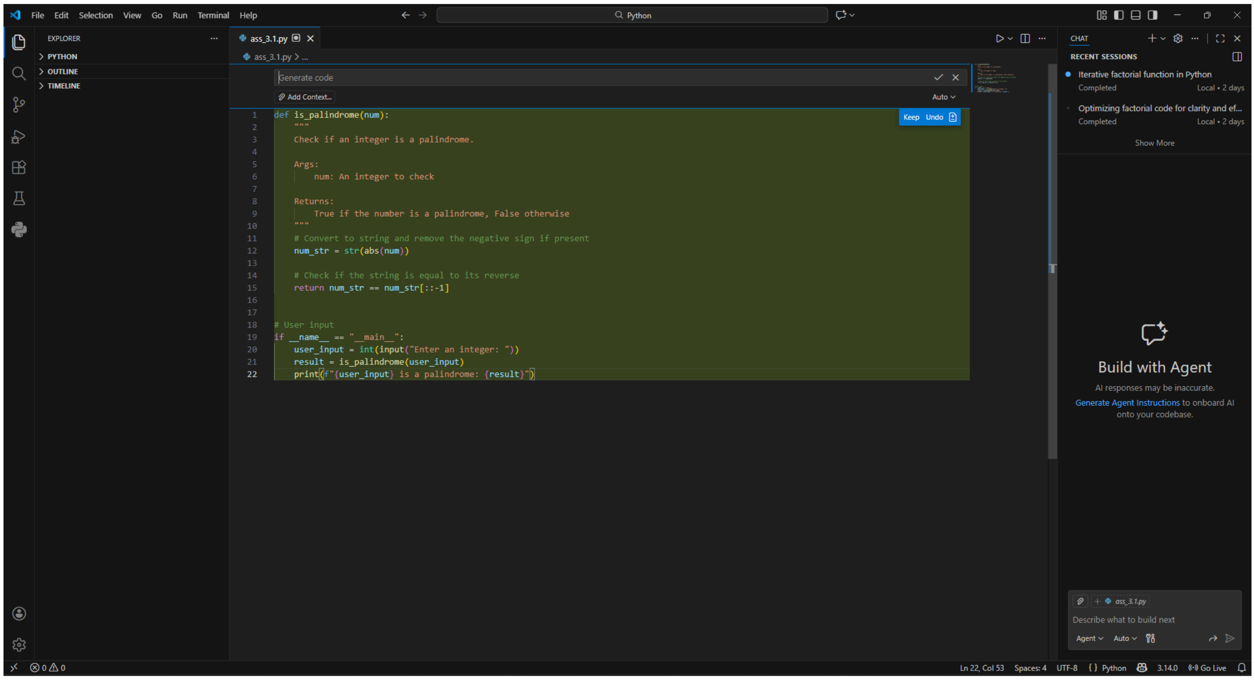
- Record the AI-generated code.
- Test the code with multiple inputs.
- Identify any logical errors or missing edge-case handling.

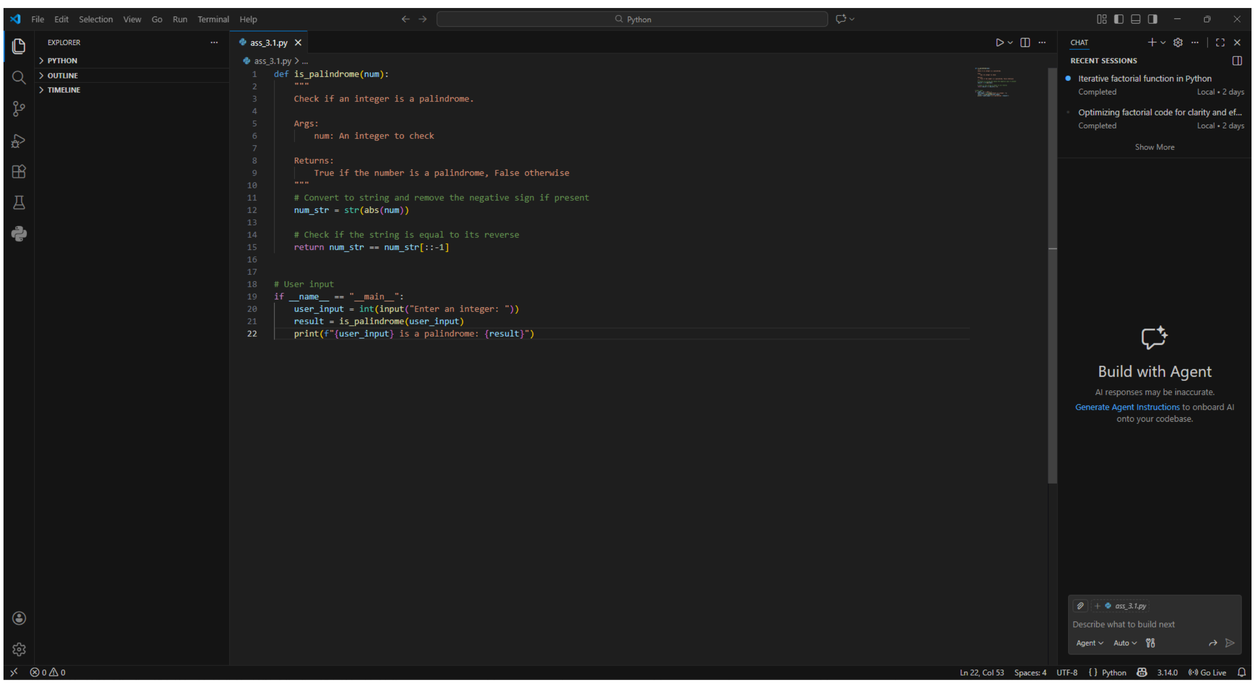


Prompt Instructed:

```
Write a Python function with user inputs called is_palindrome that takes an integer as input and returns True if the number is a palindrome, otherwise returns False
```







AI-generated code:

```
def is_palindrome(num):
    """

    Check if an integer is a palindrome.
```

```
    Args:
        num: An integer to check

    Returns:
        True if the number is a palindrome, False otherwise
    """

    # Check if the string is equal to its reverse
    return num == num[::-1]


# User input
if __name__ == "__main__":
    user_input = input("Enter an integer: ")
    result = is_palindrome(user_input)
    print(f"{user_input} is a palindrome: {result}")
```

Testing Code with multiple inputs:

```
Enter an integer: 0
0 is a palindrome: True
```

```
Enter an integer: 12
12 is a palindrome: False
```

```
Enter an integer: 11
11 is a palindrome: True
```

```
Enter an integer: -12
-12 is a palindrome: False
```

```
Enter an integer: -121
-121 is a palindrome: False
```

Identify any logical errors or missing edge-case handling:

- **Negative Numbers:** The function treats -121 as a palindrome by using abs(num). Mathematically, negative numbers are generally not considered palindromes because the negative sign breaks the symmetry. The prompt didn't specify this, so the AI made an arbitrary choice
- **Non-Integer Inputs:** No validation for non-integer inputs
- **Leading Zeros:** Numbers with leading zeros (like 00100) would be problematic, but in Python integers don't preserve leading zeros anyway
- **Single Digit Numbers:** The function correctly handles these, but it's worth noting as an edge case.

Question 2: One-Shot Prompting (Factorial Calculation)

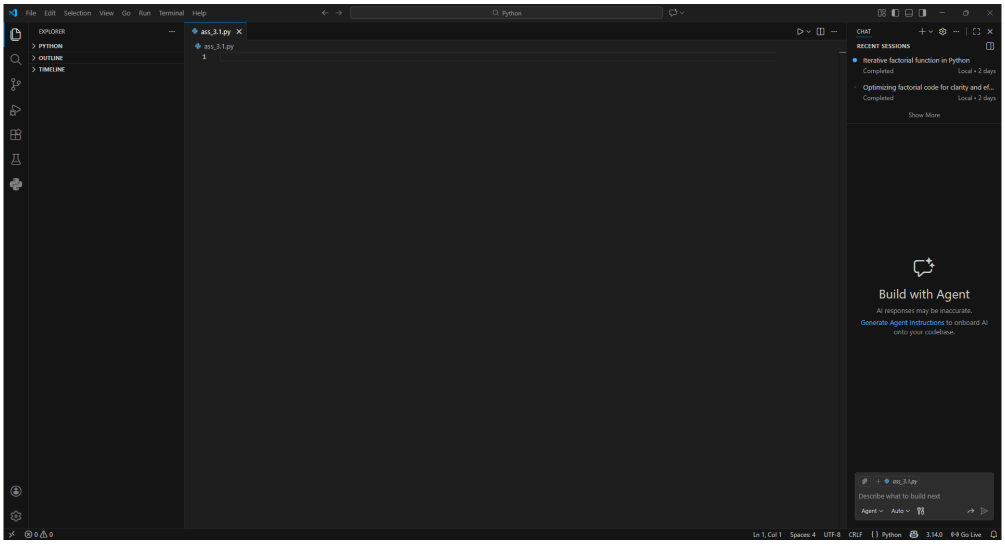
Write a one-shot prompt by providing one input-output example and ask the AI to generate a Python function to compute the factorial of a given number.

Example:

- Input: 5 → Output: 120

Task:

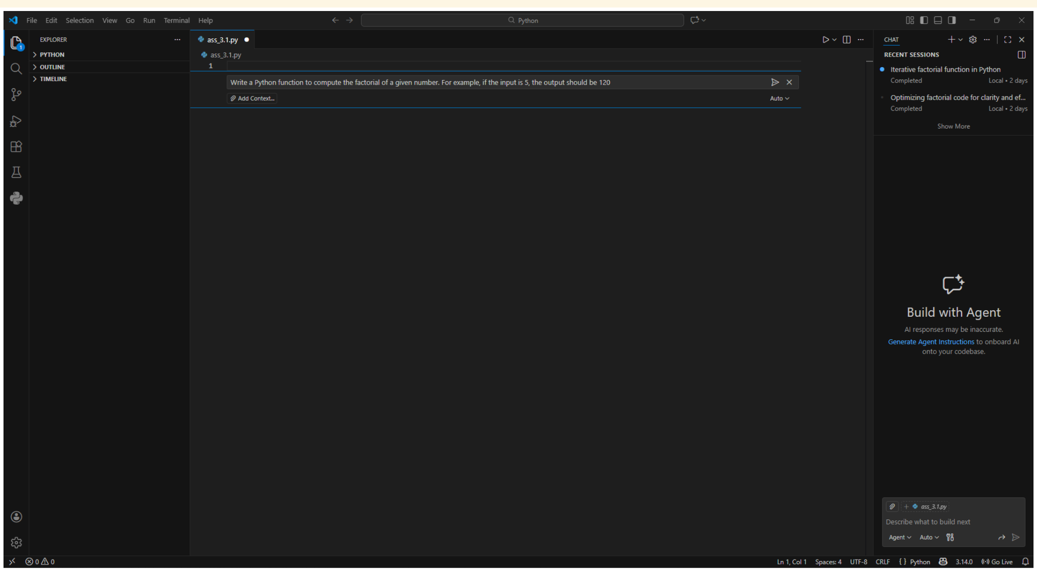
- Compare the generated code with a zero-shot solution.
- Examine improvements in clarity and correctness.

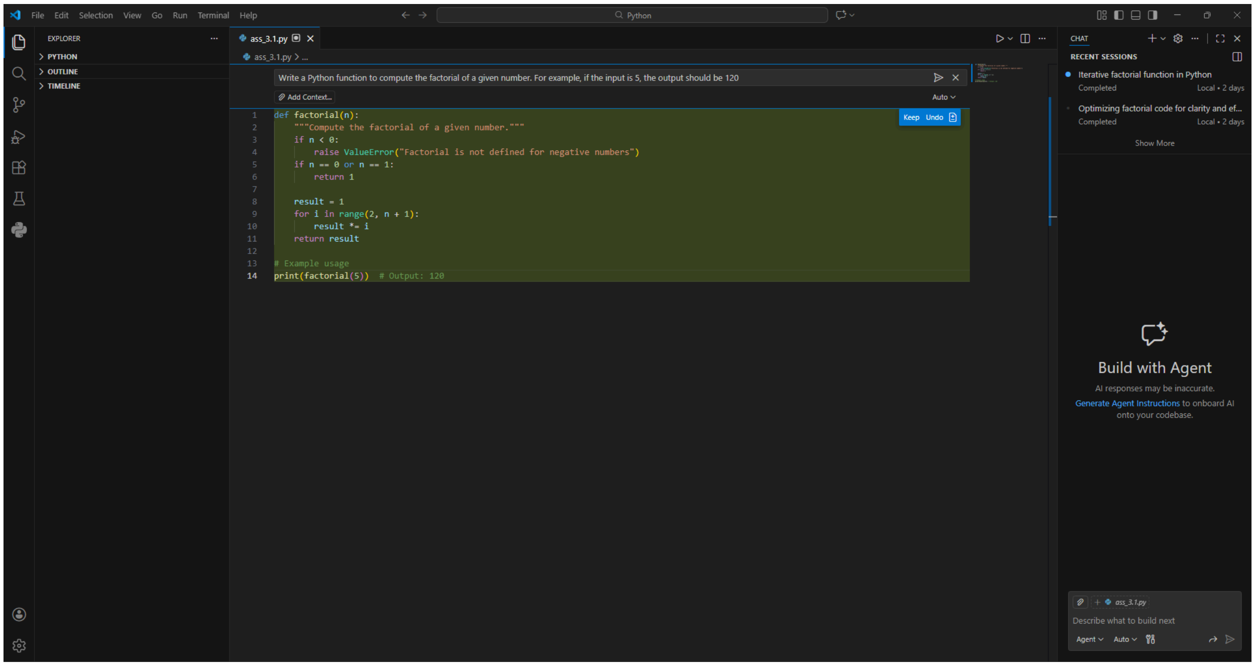


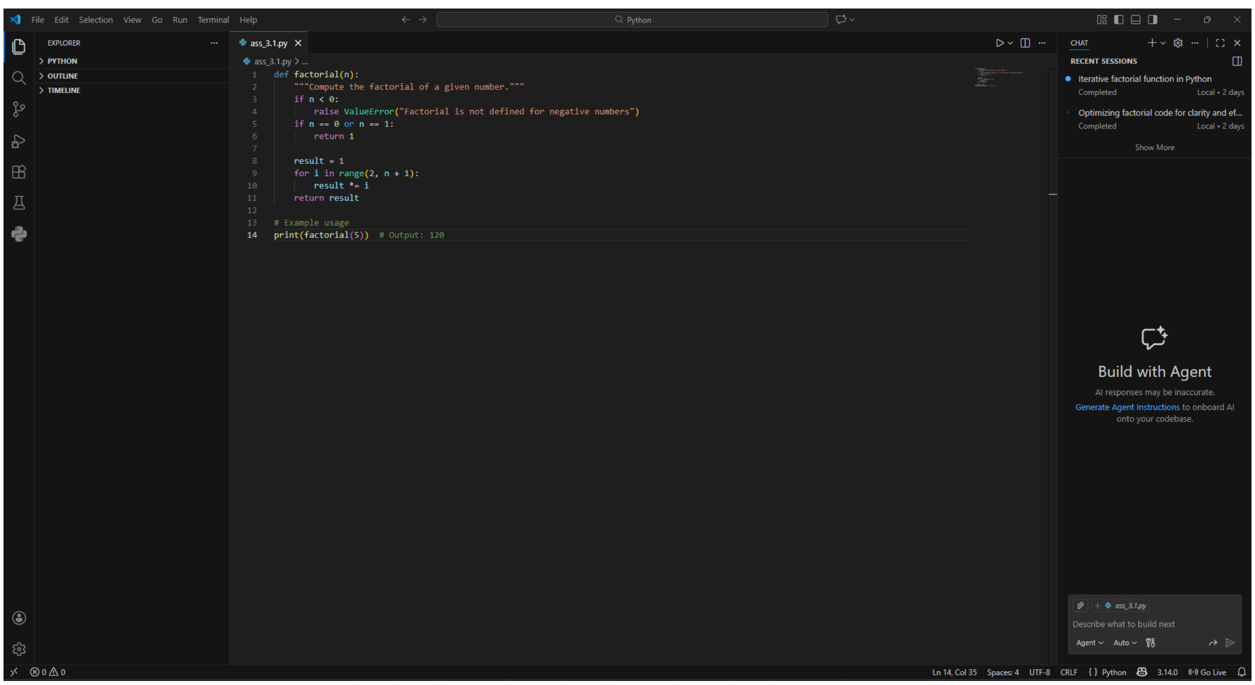
One shot:

Prompt Instructed:

```
Write a Python function to compute the factorial of a given number. For example, if the input is 5, the output should be 120Write a Python function to compute the factorial of a given number. For example, if the input is 5, the output should be 120
```







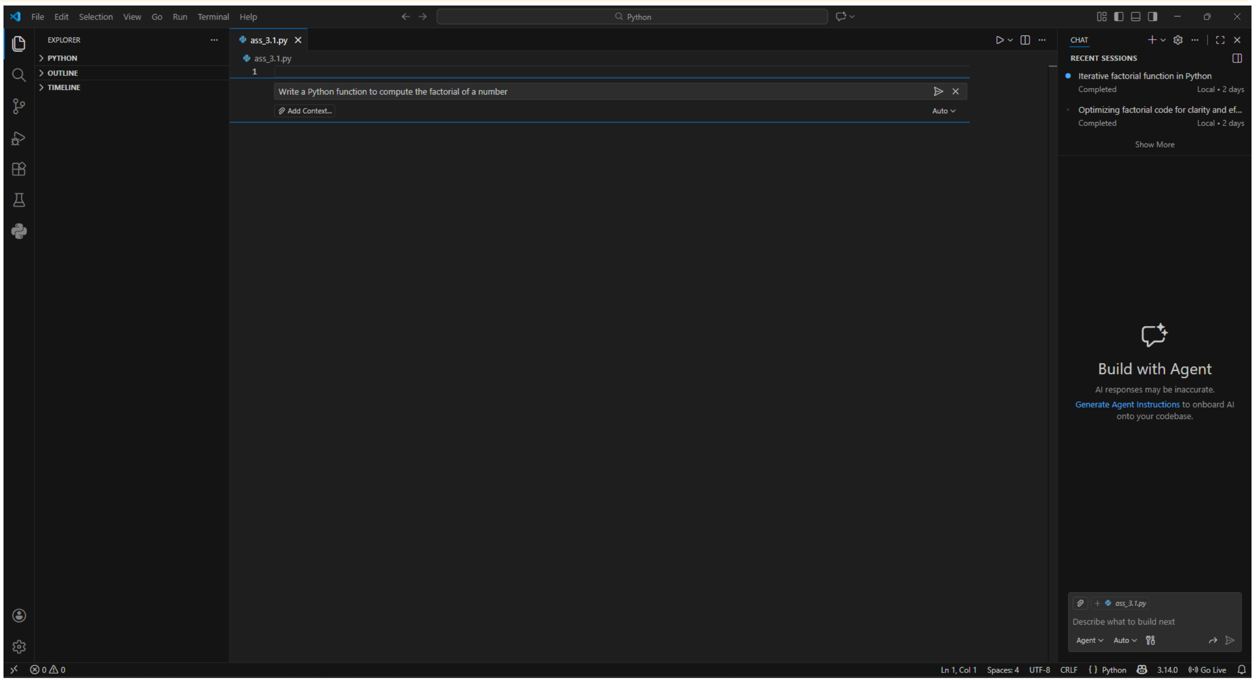

```python
def factorial(n):
    """Compute the factorial of a given number."""
    if n < 0:
        raise ValueError("Factorial is not defined for negative numbers")
    if n == 0 or n == 1:
        return 1

    result = 1
```

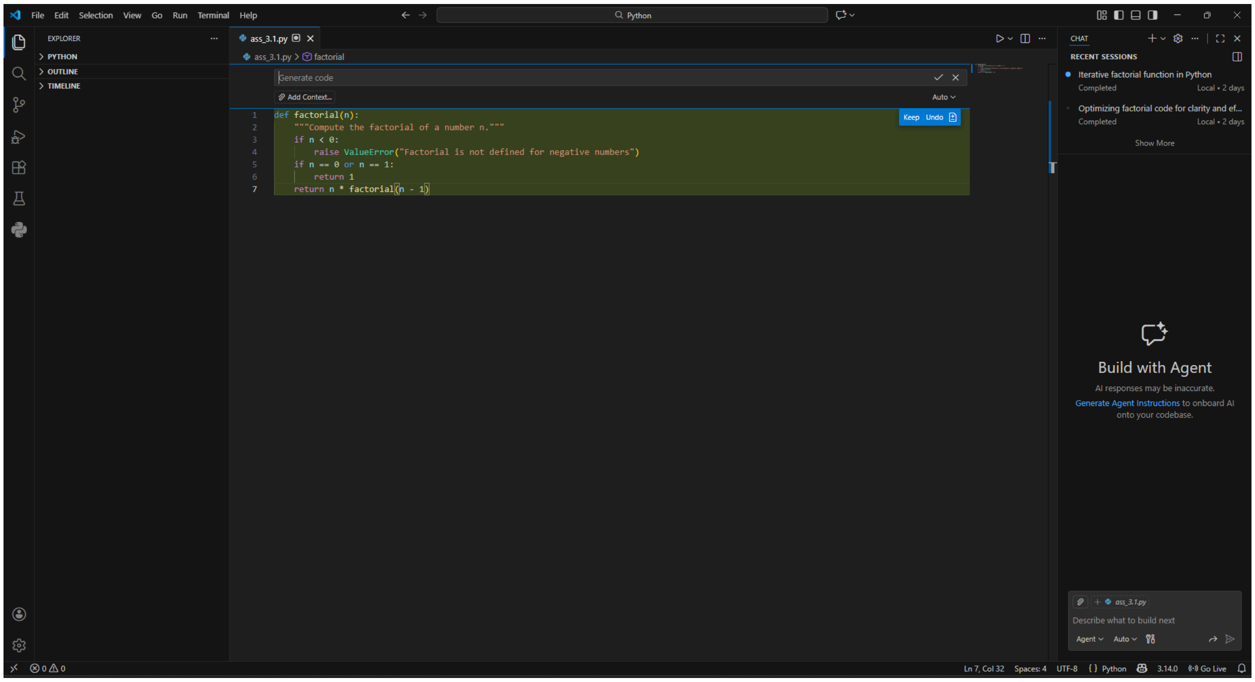
```python
    for i in range(2, n + 1):
        result *= i
    return result

# Example usage
print(factorial(5))  # Output: 120
```

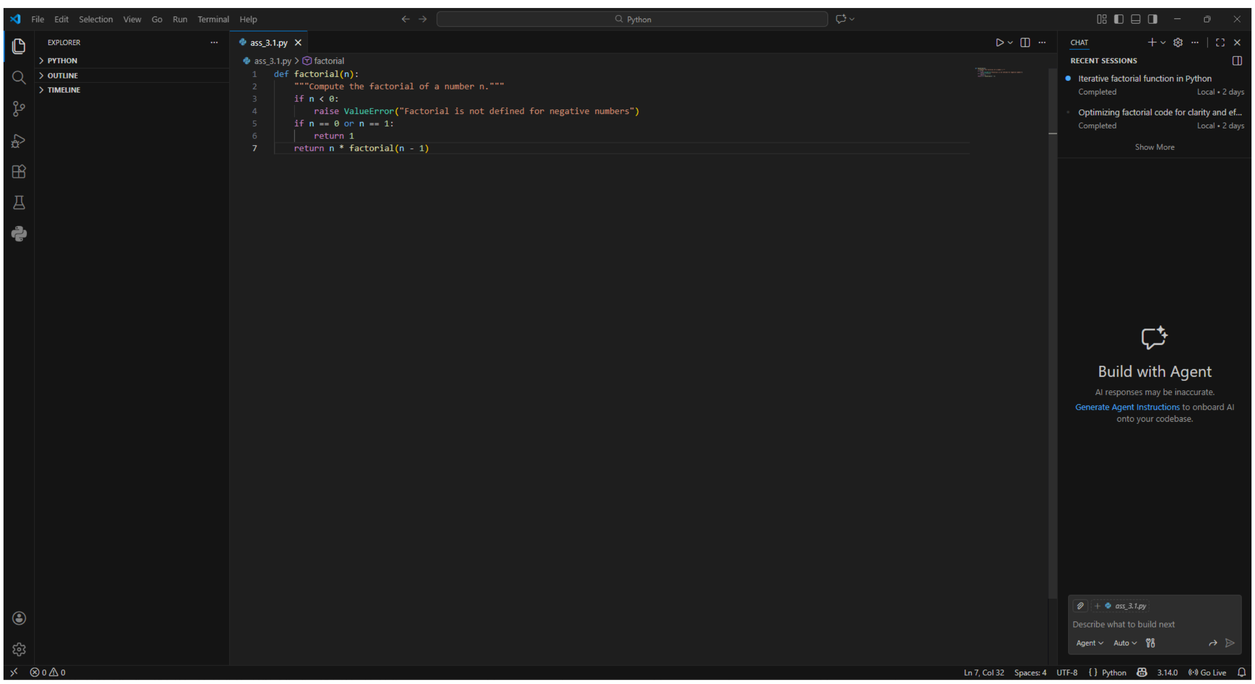
Zero-Shot:

Prompt Instructed:

```
Write a Python function to compute the factorial of a number
```








```python
def factorial(n):
    """Compute the factorial of a number n."""
    if n < 0:
        raise ValueError("Factorial is not defined for negative numbers")
    if n == 0 or n == 1:
        return 1
    return n * factorial(n - 1)
```

Comparison: One-Shot vs Zero-Shot Factorial Implementation, examining improvements in clarity and correctness

Evaluation Criteria	One-Shot Implementation (Iterative)	Zero-Shot Implementation (Recursive)
Algorithm Approach	Iterative (for-loop)	Recursive (self-referential)
Execution Transparency	Linear, visible step-by-step computation	Abstract, distributed across stack frames
Debugging Complexity	Low - single execution path	High - multiple stack frames
Memory Efficiency	O(1) - constant space	O(n) - linear space (call stack)
Scalability	Unlimited by recursion depth	Limited by system recursion depth (~1000)
Performance	Lower overhead, faster execution	Higher overhead, slower for large n
Error Handling	Explicit validation for negatives	Explicit validation for negatives
Production Readiness	Industry-standard, robust	Theoretically elegant but impractical
Maintainability	High - linear logic flow	Medium - requires recursion understanding
Edge Case Handling	Explicit 0/1 base cases	Explicit 0/1 base cases
Input Validation	Negative number validation	Negative number validation
System Resource Impact	Minimal, predictable	Potentially high (stack overflow risk)
Time Complexity	O(n)	O(n)
Space Complexity	O(1)	O(n)

Question 3: Few-Shot Prompting (Armstrong Number Check)

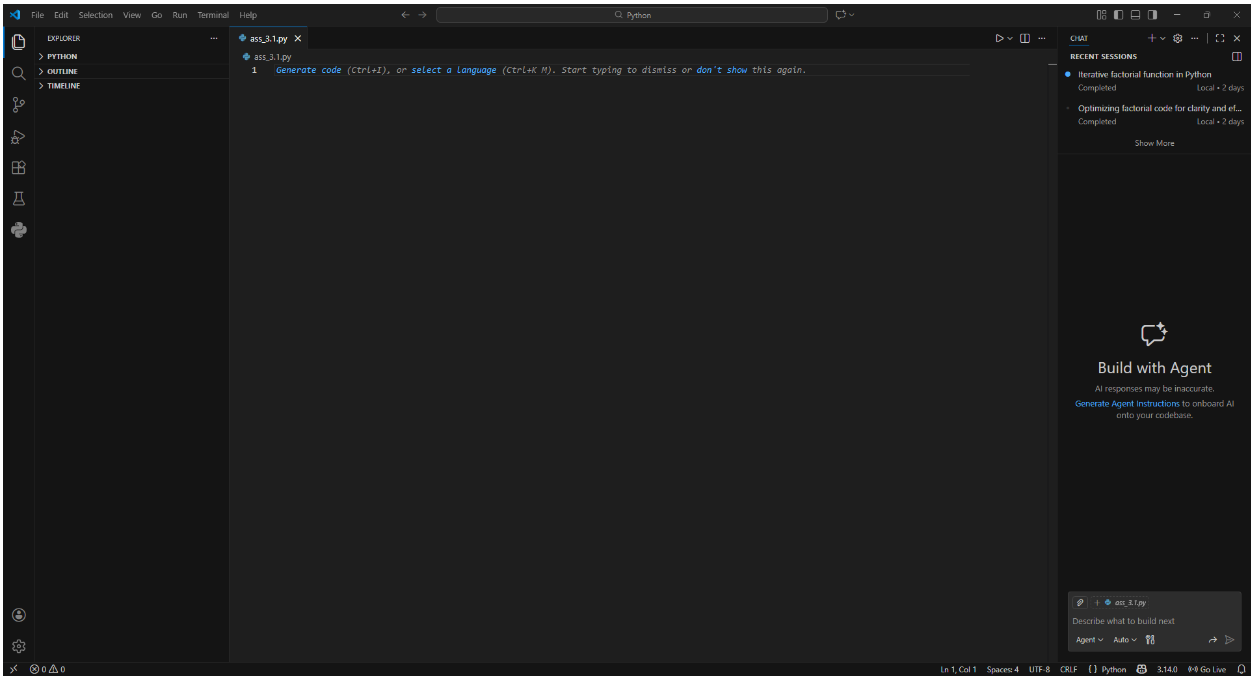
Write a few-shot prompt by providing multiple input-output examples to guide the AI in generating a Python function to check whether a given number is an Armstrong number.

Examples:

- Input: 153 → Output: Armstrong Number
- Input: 370 → Output: Armstrong Number
- Input: 123 → Output: Not an Armstrong Number

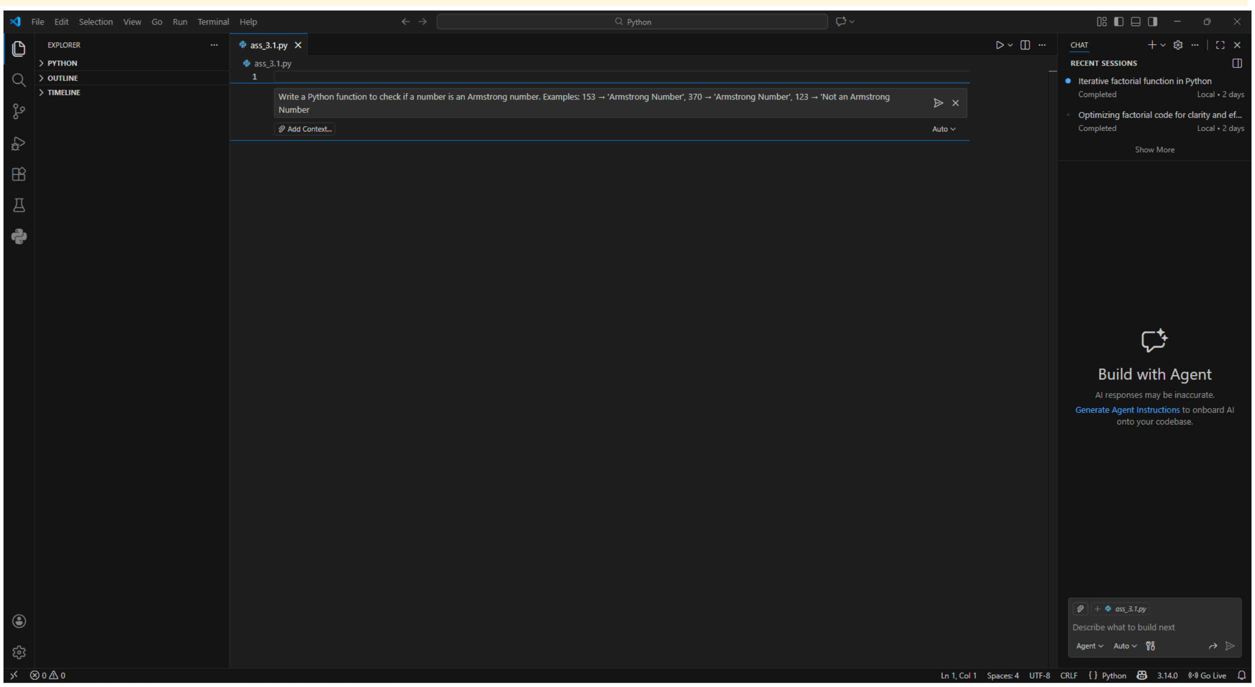
Task:

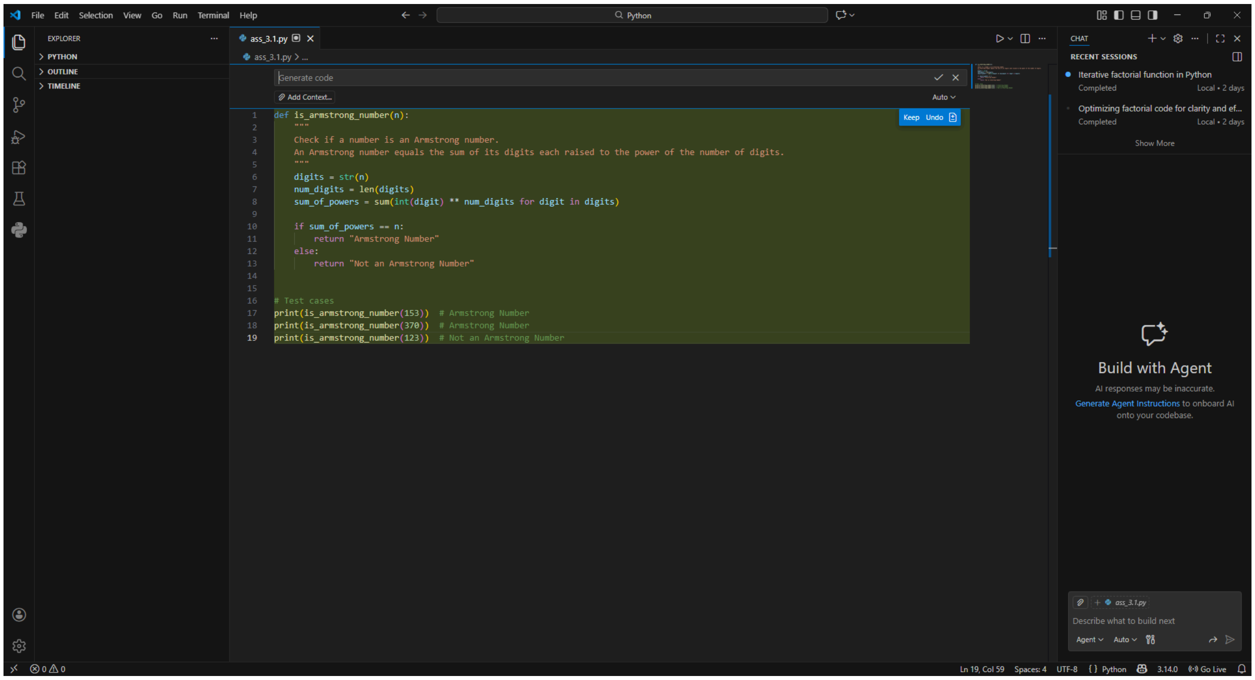
- Analyze how multiple examples influence code structure and accuracy.
- Test the function with boundary values and invalid inputs.

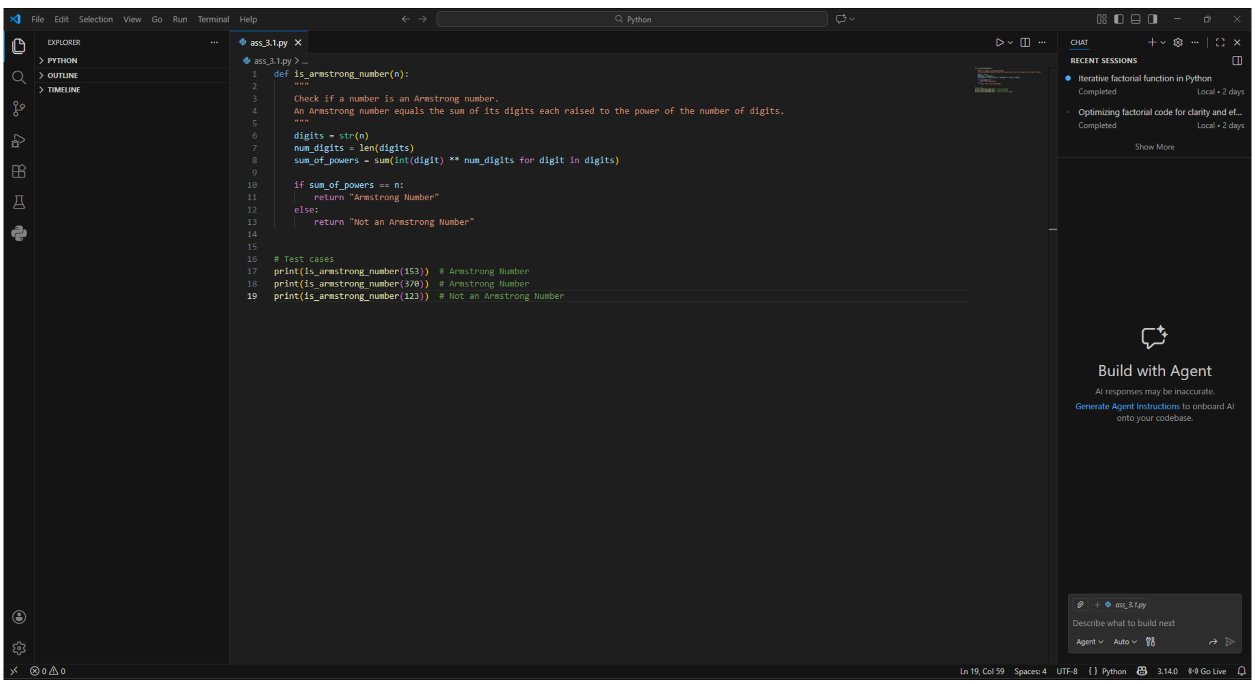


Prompt Instructed:

```
Write a Python function to check if a number is an Armstrong number.
Examples: 153 → 'Armstrong Number', 370 → 'Armstrong Number', 123 → 'Not
an Armstrong Number
```







Code:

```
def is_armstrong_number(n):
    """
    Check if a number is an Armstrong number.
    An Armstrong number equals the sum of its digits each raised to the power of the number of digits.
    """
    digits = str(n)
```

```python
    num_digits = len(digits)
    sum_of_powers = sum(int(digit) ** num_digits for digit in digits)

    if sum_of_powers == n:
        return "Armstrong Number"
    else:
        return "Not an Armstrong Number"

# Test cases
print(is_armstrong_number(153))  # Armstrong Number
print(is_armstrong_number(370))  # Armstrong Number
print(is_armstrong_number(123))  # Not an Armstrong Number
```

Examples and boundary values:

```
Enter a number: 153
Armstrong Number
```

```
Enter a number: 999
Not an Armstrong Number
```

```
Enter a number: 9474
Armstrong Number
```

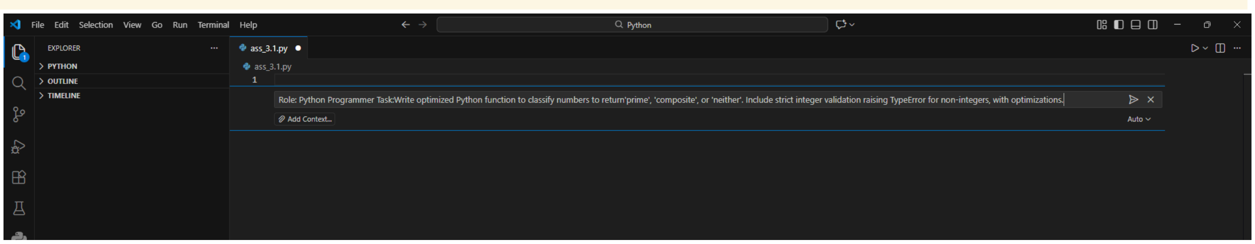
Question 4: Context-Managed Prompting (Optimized Number Classification)

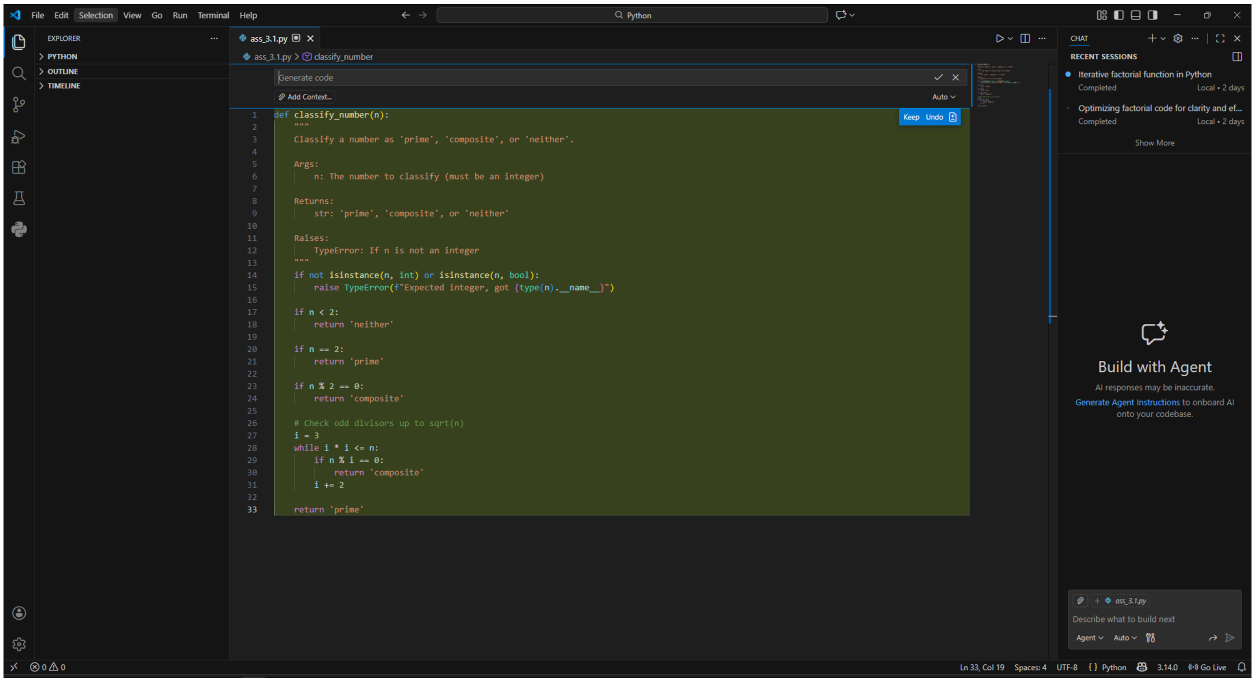
Design a context-managed prompt with clear instructions and constraints to generate an optimized Python program that classifies a number as prime, composite, or neither.
Task:

- Ensure proper input validation.
- Optimize the logic for efficiency.
- Compare the output with earlier prompting strategies.

Prompt Instructed:

```
Role: Python Programmer Task:Write optimized Python function to classify numbers to return'prime', 'composite', or 'neither'. Include strict integer validation raising TypeError for non-integers, with optimizations.
```





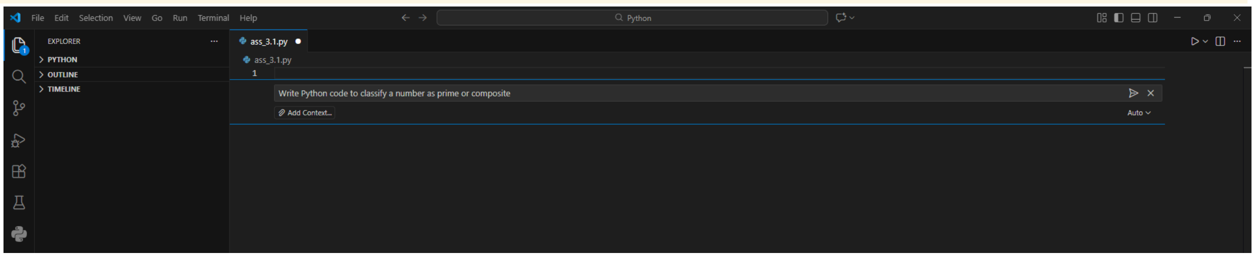
Code:

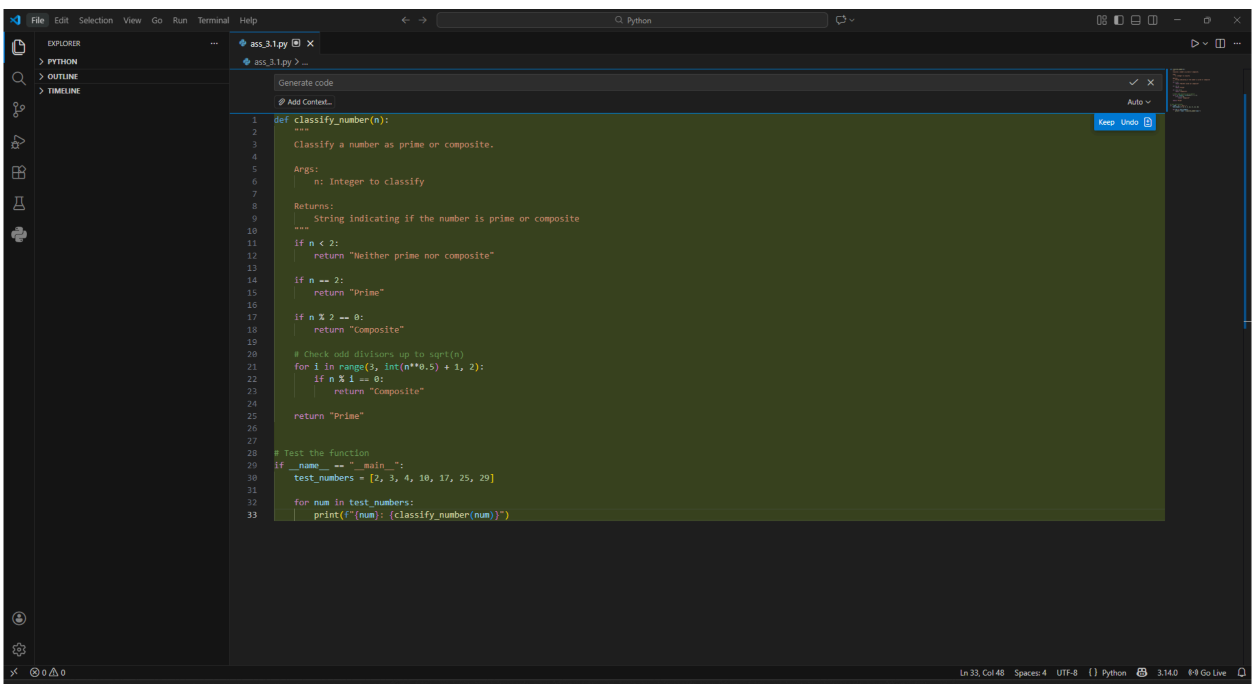
```
def classify_number(n):
    """
    Classify a number as 'prime', 'composite', or 'neither'.

    Args:
        n: The number to classify (must be an integer)

    Returns:
        str: 'prime', 'composite', or 'neither'

    Raises:
        TypeError: If n is not an integer
    """
    if not isinstance(n, int) or isinstance(n, bool):
        raise TypeError(f"Expected integer, got {type(n).__name__}")

    if n < 2:
        return 'neither'

    if n == 2:
        return 'prime'

    if n % 2 == 0:
```

```python
        return 'composite'

    # Check odd divisors up to sqrt(n)
    i = 3
    while i * i <= n:
        if n % i == 0:
            return 'composite'
        i += 2

    return 'prime'
```

Zero-Shot Prompt:

```
Write Python code to classify a number as prime or composite
```





Optimized changes (context-managed):

- **Algorithm:** Early case for 2, early even-number rejection, loops only odd divisors
- **Implementation:** Adds full docstring, clear error messages, comprehensive testing
- **Validation:** Strict integer type checking with TypeError for invalid inputs

Performance impact: Same O(√n) complexity but halves divisor checks (skips evens) with early termination; ~2x faster for large odd numbers.

Readability/correctness: Clearer intent with structured flow, safer validation prevents crashes, better maintainability with documentation.

Tradeoffs/next steps: Still deterministic trial division; for huge numbers consider Miller-Rabin (probabilistic) or optimized sieves for batch classification.

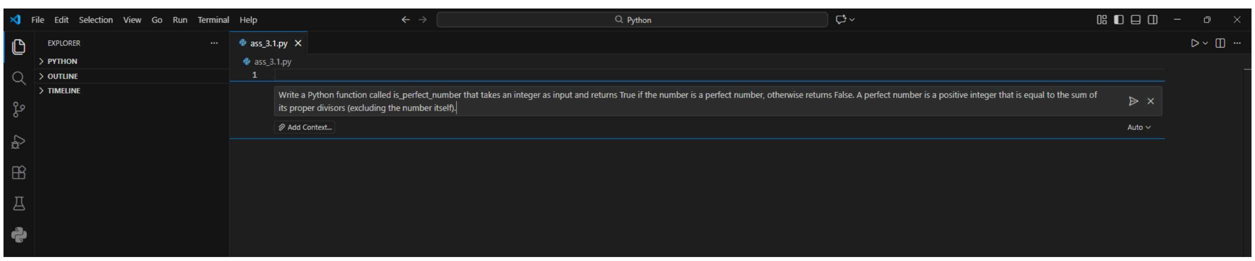
Question 5: Zero-Shot Prompting (Perfect Number Check)

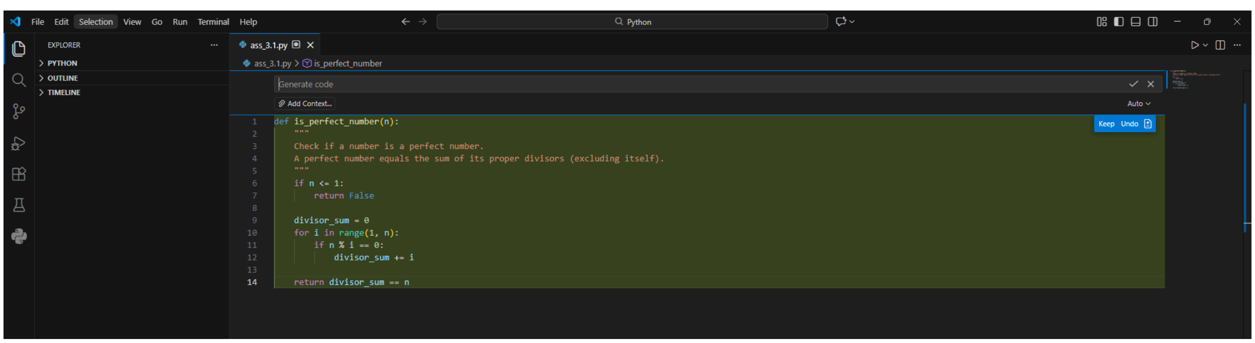
Write a zero-shot prompt (without providing any examples) to generate a Python function that checks whether a given number is a perfect number.

Task:

- Record the AI-generated code.
- Test the program with multiple inputs.
- Identify any missing conditions or inefficiencies in the logic.

Prompt Instructed:





AI-generated code:

```
def is_perfect_number(n):
    """
    Check if a number is a perfect number.
    A perfect number equals the sum of its proper divisors (excluding itself).
    """
    if n <= 1:
        return False
```

```
    divisor_sum = 0
    for i in range(1, n):
        if n % i == 0:
            divisor_sum += i

    return divisor_sum == n
```

Testing it with multiple inputs:

```
Test Results:
is_perfect_number(6) = True
is_perfect_number(28) = True
is_perfect_number(496) = True
is_perfect_number(8128) = True
is_perfect_number(12) = False
is_perfect_number(0) = False
is_perfect_number(1) = False
is_perfect_number(-6) = False
is_perfect_number(10) = False
is_perfect_number(33550336) = True
PS C:\Users\Himes\Documents\.Dev\Python>
```

Missing Conditions:

- No input validation (fails on strings, floats, None)
- No early termination when sum exceeds n
- No handling for very large numbers (impractical for >10^7)

Inefficiencies:

- O(n) time complexity → checks every number 1 to n-1
- No square root optimization → should only check up to √n
- No divisor pairing → duplicates checks (i and n//i)
- No mathematical property use → perfect numbers follow 2^(p-1)×(2^p-1) pattern
- Worst case: n=33,550,336 → 33.5 million iterations instead of ~5,800 with optimization.

Question 6: Few-Shot Prompting (Even or Odd Classification with Validation)

Write a few-shot prompt by providing multiple input-output examples to guide the AI in generating a Python program that determines whether a given number is even or odd, including proper input validation.

Examples:

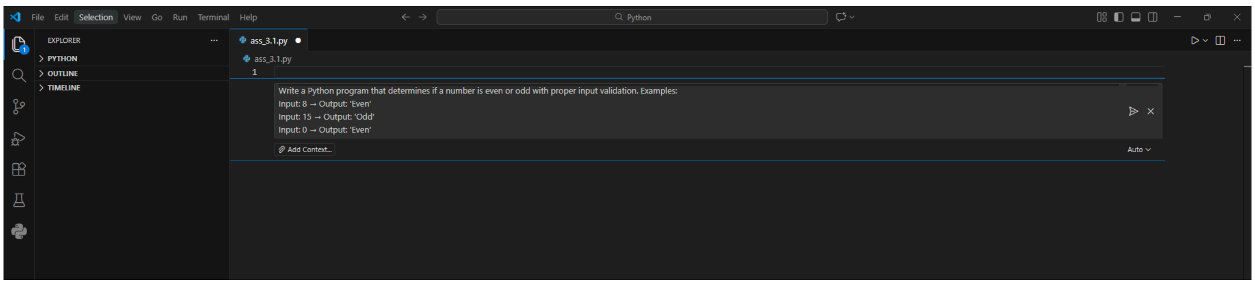
- Input: 8 → Output: Even
- Input: 15 → Output: Odd
- Input: 0 → Output: Even

Task:

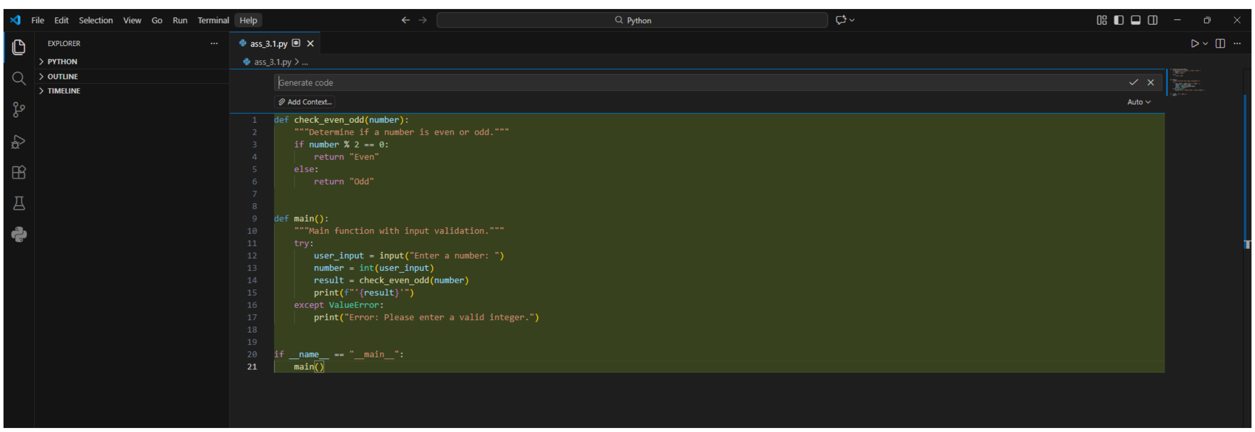
- Analyze how examples improve input handling and output clarity.
- Test the program with negative numbers and non-integer inputs.

Prompt Instructed:

```
Write a Python program that determines if a number is even or odd with
proper input validation. Examples:
Input: 8 → Output: 'Even'
Input: 15 → Output: 'Odd'
Input: 0 → Output: 'Even'
The program should handle invalid inputs gracefully and provide clear error
messages.
```



Code:




```python
def check_even_odd(number):
    """Determine if a number is even or odd."""
    if number % 2 == 0:
        return "Even"
    else:
        return "Odd"


def main():
    """Main function with input validation."""
    try:
        user_input = input("Enter a number: ")
        number = int(user_input)
```

```python
        result = check_even_odd(number)
        print(f"'{result}'")
    except ValueError:
        print("Error: Please enter a valid integer.")


if __name__ == "__main__":
    main()
```

Test Cases:

Negative Numbers: All work correctly

- -8 → "Even"
- -15 → "Odd"
- -0 → "Even"

Non-Integer Inputs:

- 3.5 → "Error: Please enter a valid integer."
- "abc" → "Error: Please enter a valid integer."
- "" → "Error: Please enter a valid integer."
- "2.0" → "Error: Please enter a valid integer." (should accept 2.0)

Edge Cases:

- " 8 " → "Error: Please enter a valid integer." (spaces cause failure)
- "+8" → "Even"
- "0" → "Even"

Examples improved code:

- Output format matches examples exactly ("Even"/"Odd" strings, not booleans)
- Zero handled correctly (0 → "Even" example ensured proper modulo logic)
- Clear function structure (separation of logic and validation)
- Error handling included (prompt mentioned "proper validation")

Missing from examples:

- No handling for floats like 2.0 (int() fails on floats)
- No whitespace stripping (examples didn't show spaces)

Comparison to Few-Shot Goal:

Conditions met:

- Returns "Even"/"Odd" exactly as examples show
- Handles all three provided examples (8, 15, 0)
- Includes error messages for invalid inputs

Conditions Not met:

- Doesn't accept floats that are integers (2.0)
- Doesn't strip whitespace
- Less robust than ideal few-shot implementation