AIAC-2

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Task-1: Word Frequency from Text File

Prompt:

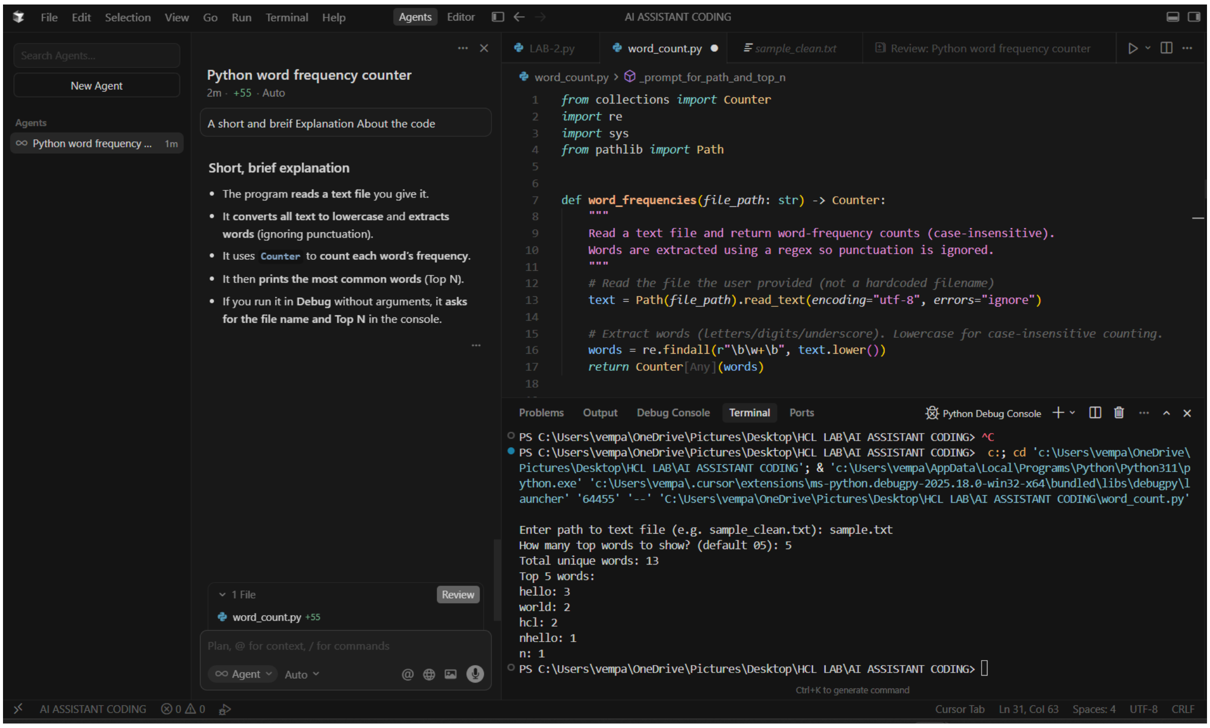
Generate Python code that reads a text file and counts word frequency

Code:

```
from collections import Counter

import re

import sys

from pathlib import Path

def word_frequencies(file_path:  str) -> Counter:

   text = Path(file_path).read_text(encoding="utf-8",  errors="ignore")

   # Extract words (letters/digits/underscore). Lowercase for case-insensitive counting.

   words = re.findall(r"\b\w+\b",  text.lower())

   return Counter(words)

def _prompt_for_path_and_top_n()  -> tuple[str, int]:

   path = input("Enter path to text file (e.g. sample_clean.txt):  ").strip().strip('"')

   if not path:

      if Path("sample_clean.txt").exists():

         path = "sample_clean.txt"

      elif Path("sample.txt").exists():
```

```python
        path = "sample.txt"
    else:
        raise SystemExit("No file path provided.")
  top_raw = input("How many top words to show? (default 05sa): ").strip()
  top_n = int(top_raw) if top_raw else 5
  return path, top_n
def main() -> None:
  if len(sys.argv) < 2:
    # Debug Console / no-args mode
    path, top_n = _prompt_for_path_and_top_n()
  else:
    path = sys.argv[1]
    top_n = int(sys.argv[2]) if len(sys.argv) >= 3 else 20
  counts = word_frequencies(path)
  print(f"Total unique words: {len(counts)}")
  print(f"Top {top_n} words:")
  for word, freq in counts.most_common(top_n):
    print(f"{word}: {freq}")
if __name__ == "__main__":
  main()
```

Output:



<u>Explanation:</u>

- The program **reads a text file** you give it.
- It **converts all text to lowercase** and **extracts words** (ignoring punctuation).
- It uses **Counter** to **count each word's frequency**.
- It then **prints the most common words** (Top N).
- If you run it in **Debug** without arguments
- It **asks for the file name and Top N** in the console.

<u>Task-02-</u> File Operations Using Cursor AI

<u>Prompt</u>: Generate a text file and writes sample text, reads and displays the content.

<u>Code</u>:

def **create_and_write_file**(*filename*: str, *content*: str) -> None:

with open(*filename*, 'w', *encoding*='utf-8') *as* file:

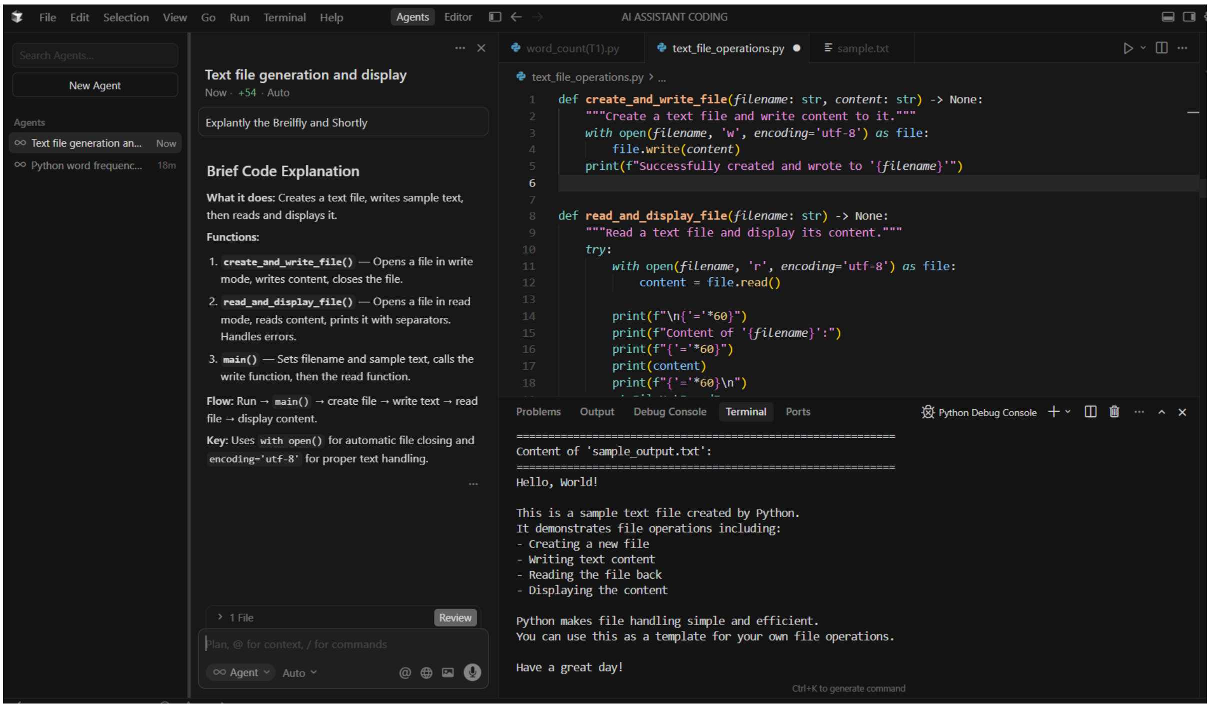
file.write(*content*)

print(f"Successfully created and wrote to '{*filename*}'")

```
def read_and_display_file(filename: str) -> None
    try:
        with open(filename, 'r', encoding='utf-8') as file:
            content = file.read()
        print(f"\n{'='*60}")
        print(f"Content of '{filename}':")
        print(f"{'='*60}")
        print(content)
        print(f"{'='*60}\n")
    except FileNotFoundError:
        print(f"Error: File '{filename}' not found.")
    except Exception as e:
        print(f"Error reading file: {e}")
def main():
    # Define the filename
    filename = "sample_output.txt"
     # Sample text content
    sample_text = """Hello, World!

This is a sample text file created by Python.
It demonstrates file operations including:
- Creating a new file
- Writing text content
- Reading the file back
- Displaying the content
```

```
Python makes file handling simple and efficient.
You can use this as a template for your own file operations.
Have a great day!"""
    # Step 1: Generate and write to the text file
    print("Step 1: Creating text file and writing sample text...")
    create_and_write_file(filename, sample_text)
    # Step 2: Read and display the content
    print("Step 2: Reading and displaying file content...")
    read_and_display_file(filename)
if __name__ == "__main__":
    main()
```

Output:



Explanation:

What it does: Creates a text file, writes sample text, then reads and displays it.

Functions:

1. **create_and_write_file()** — Opens a file in write mode, writes content, closes the file.
2. **read_and_display_file()** — Opens a file in read mode, reads content, prints it with separators. Handles errors.
3. **main()** — Sets filename and sample text, calls the write function, then the read function.

Flow: Run → main() → create file → write text → read file → display content.

Task-03- CSV Data Analysis

Prompt: To read a CSV file and calculate mean, min, and max.

Code:

```
import csv

import statistics

from typing import Dict, List, Any

def read_csv_file(filename: str) -> List[Dict[str, Any]]:

    data = []

    try:

        with open(filename, 'r', encoding='utf-8') as file:

            csv_reader = csv.DictReader(file)

            for row in csv_reader:

                data.append(row)

        print(f"Successfully read {len(data)} rows from '{filename}'")

        return data

    except FileNotFoundError:

        print(f"Error: File '{filename}' not found.")

        return []

    except Exception as e:
```

```python
        print(f"Error reading CSV file: {e}")
        return []
def convert_to_numeric(value: str) -> float:
    try:
        return float(value)
    except (ValueError, TypeError):
        return None
def calculate_statistics(data: List[Dict[str, Any]]) -> Dict[str, Dict[str, float]]:
    if not data:
        print("No data to process.")
        return {}
    # Get all column names from the first row
    columns = list(data[0].keys())
    # Dictionary to store statistics for each numeric column
    stats = {}
    for column in columns:
        # Extract values for this column
        values = [row[column] for row in data]
        # Convert to numeric values, filtering out None values
        numeric_values = [convert_to_numeric(val) for val in values]
        numeric_values = [val for val in numeric_values if val is not None]
        # Only calculate statistics if we have numeric values
        if numeric_values:
            stats[column] = {
                'mean': statistics.mean(numeric_values),
                'min': min(numeric_values),
```

```python
            'max': max(numeric_values),
            'count': len(numeric_values)
        }
    return stats
def display_statistics(stats: Dict[str, Dict[str, float]]) -> None:
    """Display the calculated statistics in a formatted way."""
    if not stats:
        print("No numeric columns found in the CSV file.")
        return
    print("\n" + "="*70)
    print("STATISTICS SUMMARY")
    print("="*70)
    for column, values in stats.items():
        print(f"\nColumn: {column}")
        print(f"  Count:   {values['count']}")
        print(f"  Mean:    {values['mean']:.2f}")
        print(f"  Min:     {values['min']:.2f}")
        print(f"  Max:     {values['max']:.2f}")
    print("="*70 + "\n")
def main():
    # CSV filename - change this to your CSV file name
    csv_filename = "data.csv"
    print(f"Reading CSV file: {csv_filename}")
    print("-" * 70)
    # Step 1: Read the CSV file
    data = read_csv_file(csv_filename)
```

```
    if not data:
        print("\nNo data was read. Please check if the file exists and is valid.")
        return
    # Step 2: Calculate statistics
    print("\nCalculating statistics...")
    stats = calculate_statistics(data)
    # Step 3: Display the results
    display_statistics(stats)
if __name__ == "__main__":
    main()
```

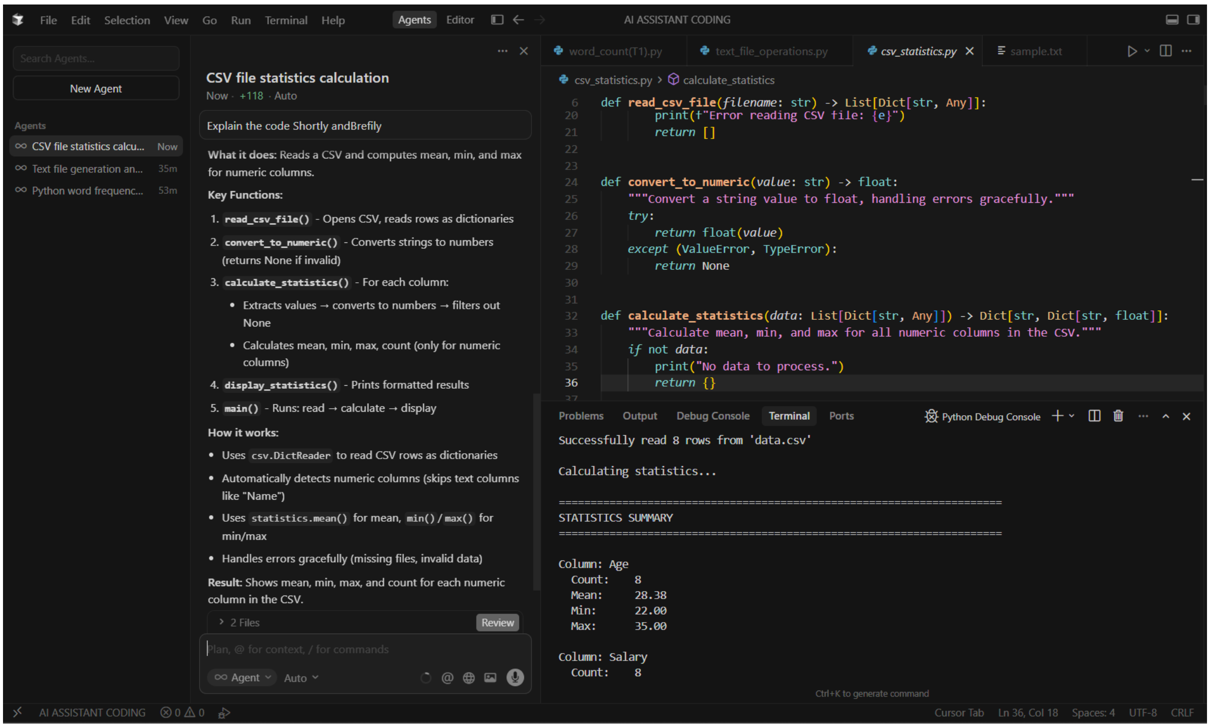
Output:

```
Calculating statistics...
STATISTICS SUMMARY
Column: Age
  Count:    8
  Mean:     28.38
  Min:      22.00
  Max:      35.00

Column: Salary
  Count:    8
  Mean:     56500.00
  Min:      45000.00
  Max:      70000.00

Column: Score
  Count:    8
```

Mean: 87.59

Min: 78.90

Max: 95.20



Explanation:

What it does: Reads a CSV and computes mean, min, and max for numeric columns.

Key Functions:

1. **read_csv_file()** - Opens CSV, reads rows as dictionaries
2. **convert_to_numeric()** - Converts strings to numbers (returns None if invalid)
3. **calculate_statistics()** - For each column:

- Extracts values → converts to numbers → filters out None
- Calculates mean, min, max, count (only for numeric columns)

4. **display_statistics()** - Prints formatted results
5. **main()** - Runs: read → calculate → display

How it works:

- Uses csv.DictReader to read CSV rows as dictionaries
- Automatically detects numeric columns (skips text columns like "Name")
- Uses statistics.mean() for mean, min()/max() for min/max
- Handles errors gracefully (missing files, invalid data)

Result: Shows mean, min, max, and count for each numeric column in the CSV.

Task-04: Sorting Lists – Manual vs Built-in

Prompt: To generate:1)Bubble sort,2) Python's built-in sort(),3)Compare both implementations.

Code:

```
import time
import random
from typing import List


def bubble_sort(arr: List[int]) -> List[int]:
    """
    Implement bubble sort algorithm.

    Bubble sort repeatedly steps through the list, compares adjacent elements
    and swaps them if they are in the wrong order. The pass through the list
    is repeated until the list is sorted.

    Time Complexity: O(n²)
    Space Complexity: O(1)
    """
    # Create a copy to avoid modifying the original list
```

```python
    arr = arr.copy()
    n = len(arr)

    # Traverse through all array elements
    for i in range(n):
        # Flag to optimize: if no swaps occur, array is already sorted
        swapped = False

        # Last i elements are already in place
        for j in range(0, n - i - 1):
            # Traverse the array from 0 to n-i-1
            # Swap if the element found is greater than the next element
            if arr[j] > arr[j + 1]:
                arr[j], arr[j + 1] = arr[j + 1], arr[j]
                swapped = True

        # If no two elements were swapped by inner loop, then break
        if not swapped:
            break

    return arr

def python_builtin_sort(arr: List[int]) -> List[int]:
    """
    Use Python's built-in sort() method.

    Python's built-in sort uses Timsort algorithm, which is a hybrid
    stable sorting algorithm derived from merge sort and insertion sort.
```

```
    Time Complexity: O(n log n) average case
    Space Complexity: O(n)
    """
    # Create a copy to avoid modifying the original list
    arr = arr.copy()
    arr.sort()
    return arr
def compare_sorting_algorithms(arr: List[int]) -> None:
    """
    Compare bubble sort and Python's built-in sort() in terms of:
    1. Correctness (both should produce the same result)
    2. Performance (execution time)
    """
    print("=" * 70)
    print("SORTING ALGORITHM COMPARISON")
    print("=" * 70)
    print(f"\nArray size: {len(arr)} elements")
    print(f"Original array (first 20 elements): {arr[:20]}")
    if len(arr) > 20:
        print(f"Original array (last 10 elements): ...{arr[-10:]}")
    # Test Bubble Sort (run multiple times for accuracy)
    print("\n" + "-" * 70)
    print("BUBBLE SORT")
    print("-" * 70)
    iterations = 10 if len(arr) < 1000 else 3
    start_time = time.time()
    for _ in range(iterations):
        bubble_sorted = bubble_sort(arr)
    bubble_time = (time.time() - start_time) / iterations
```

```
print(f"Time taken: {bubble_time:.6f} seconds")
print(f"Sorted array (first 20 elements): {bubble_sorted[:20]}")
if len(bubble_sorted) > 20:
    print(f"Sorted array (last 10 elements): ...{bubble_sorted[-10:]}")
# Test Python's Built-in Sort (run multiple times for accuracy)
print("\n" + "-" * 70)
print("PYTHON'S BUILT-IN SORT()")
print("-" * 70)
iterations = 10 if len(arr) < 1000 else 3
start_time = time.time()
for _ in range(iterations):
    builtin_sorted = python_builtin_sort(arr)
builtin_time = (time.time() - start_time) / iterations
print(f"Time taken: {builtin_time:.6f} seconds")
print(f"Sorted array (first 20 elements): {builtin_sorted[:20]}")
if len(builtin_sorted) > 20:
    print(f"Sorted array (last 10 elements): ...{builtin_sorted[-10:]}")
# Verify correctness
print("\n" + "-" * 70)
print("CORRECTNESS CHECK")
print("-" * 70)
is_correct = bubble_sorted == builtin_sorted
print(f"Both algorithms produce the same result: {is_correct}")
if is_correct:
    print("[OK] Both sorting algorithms are correct!")
else:
    print("[ERROR] Results don't match!")
# Performance comparison
print("\n" + "-" * 70)
```

```
    print("PERFORMANCE COMPARISON")
    print("-" * 70)
    print(f"Bubble Sort time:     {bubble_time:.6f} seconds (average over {iterations} runs)")
    print(f"Built-in Sort time:   {builtin_time:.6f} seconds (average over {iterations} runs)")
    if builtin_time > 0:
        speedup = bubble_time / builtin_time
        print(f"Speedup factor:       {speedup:.2f}x")
        if speedup > 1:
            print(f"\n-> Built-in sort() is {speedup:.2f}x faster than Bubble Sort")
        else:
            print(f"\n-> Bubble Sort is {1/speedup:.2f}x faster than built-in sort()")
    else:
        print("\n-> Built-in sort() is extremely fast (time too small to measure accurately)")
    print("\n" + "=" * 70)
def main():
    """Main function to demonstrate and compare sorting algorithms."""
    # Test with different array sizes
    test_sizes = [100, 500, 1000]
    for size in test_sizes:
        # Generate random array
        random_arr = [random.randint(1, 1000) for _ in range(size)]
        print(f"\n\n{'#' * 70}")
        print(f"TEST CASE: Random array of {size} elements")
        print(f"{'#' * 70}")
        compare_sorting_algorithms(random_arr)
    # Test with already sorted array
    print(f"\n\n{'#' * 70}")
    print("TEST CASE: Already sorted array (1000 elements)")
    print(f"{'#' * 70}")
```

```
    sorted_arr = list(range(1, 1001))
    compare_sorting_algorithms(sorted_arr)
    # Test with reverse sorted array
    print(f"\n\n{'#' * 70}")
    print("TEST CASE: Reverse sorted array (1000 elements)")
    print(f"{'#' * 70}")
    reverse_arr = list(range(1000, 0, -1))
    compare_sorting_algorithms(reverse_arr)
    # Summary
    print("\n\n" + "=" * 70)
    print("SUMMARY")
    print("=" * 70)
if __name__ == "__main__":
    main()
```

Output:

Array size: 1000 elements

Original array (first 20 elements): [1000, 999, 998, 997, 996, 995, 994, 993, 992, 991, 990, 989, 988, 987, 986, 985, 984, 983, 982, 981]

Original array (last 10 elements): ...[10, 9, 8, 7, 6, 5, 4, 3, 2, 1]

BUBBLE SORT

Time taken: 0.298021 seconds

Sorted array (first 20 elements): [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20]

Sorted array (last 10 elements): ...[991, 992, 993, 994, 995, 996, 997, 998, 999, 1000]

PYTHON'S BUILT-IN SORT()

Time taken: 0.000000 seconds

Sorted array (first 20 elements): [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20]

Sorted array (last 10 elements): ...[991, 992, 993, 994, 995, 996, 997, 998, 999, 1000]

CORRECTNESS CHECK

Both algorithms produce the same result: True

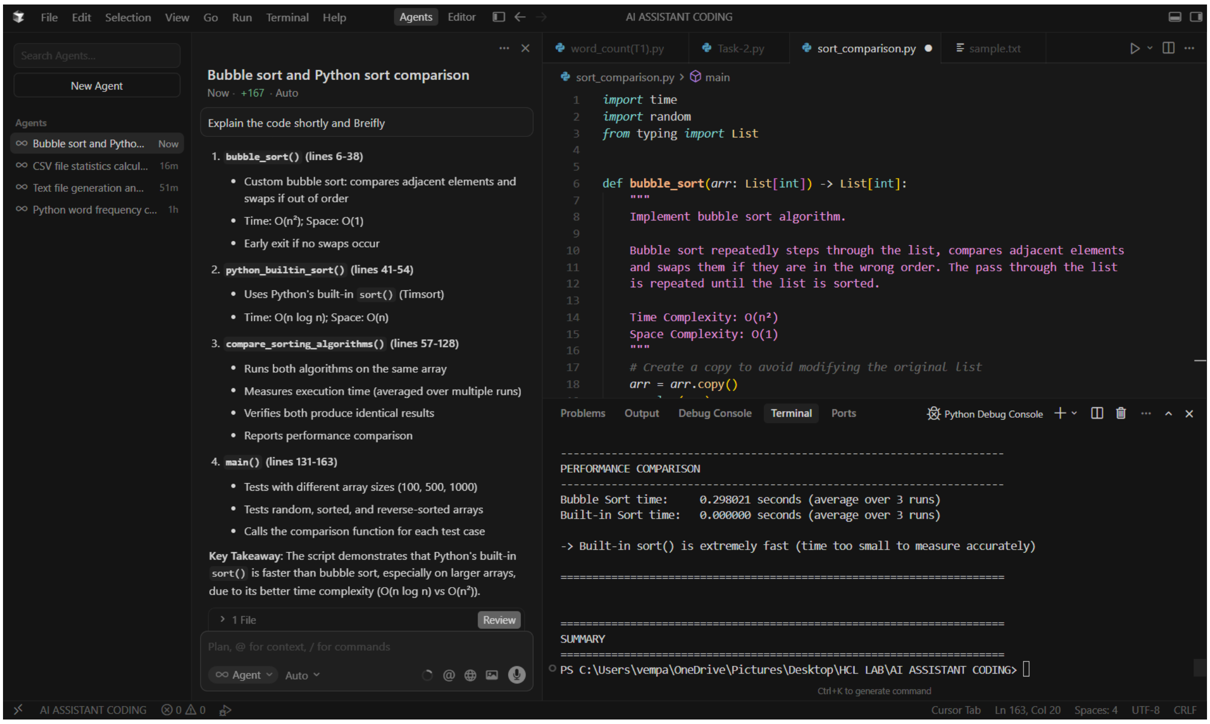
[OK] Both sorting algorithms are correct!

PERFORMANCE COMPARISON

Bubble Sort time: 0.298021 seconds (average over 3 runs)

Built-in Sort time: 0.000000 seconds (average over 3 runs)

-> Built-in sort() is extremely fast (time too small to measure accurately)



Explanation:

Purpose: Compares Bubble Sort with Python's built-in sort().

Main Components:

1. **bubble_sort() (lines 6-38)**

- Custom bubble sort: compares adjacent elements and swaps if out of order
- Time: $O(n^2)$; Space: O(1)
- Early exit if no swaps occur

2. **python_builtin_sort() (lines 41-54)**

- Uses Python's built-in sort() (Timsort)
- Time: O(n log n); Space: O(n)

3. **compare_sorting_algorithms() (lines 57-128)**

- Runs both algorithms on the same array
- Measures execution time (averaged over multiple runs)
- Verifies both produce identical results
- Reports performance comparison

4. **main() (lines 131-163)**

- Tests with different array sizes (100, 500, 1000)

- Tests random, sorted, and reverse-sorted arrays
- Calls the comparison function for each test case

Key Takeaway: The script demonstrates that Python's built-in sort() is faster than bubble sort, especially on larger arrays, due to its better time complexity ($O(n \log n)$ vs $O(n^2)$).