PYTHON DEVELOPER TASK-1 REPORT

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Date: 07-06-2025
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EXECUTIVE SUMMARY

This report documents the implementation and analysis of 9 fundamental Python programming tasks covering essential programming concepts including string manipulation, mathematical computations, list operations, algorithm design, and advanced problem-solving. Each task demonstrates proficiency in core Python programming principles.

TASK IMPLEMENTATIONS

1. VOWEL AND CONSONANT COUNTER

File: counts_CnC.py

Objective: Count the number of vowels and consonants in a given string.

Approach:

- Define vowels using a set for efficient lookup: "aeiouAEIOU"
- Iterate through each character in the string
- Check if character is alphabetic before classification
- Separate counters for vowels and consonants

Key Features:

- Case-insensitive vowel detection
- Handles both uppercase and lowercase letters
- Ignores non-alphabetic characters
- Clean separation of logic in a dedicated function

Code Implementation:

```
def count_vowels_consonants(s):
    vowels = set("aeiouAEIOU")
    v_count = c_count = 0
    for char in s:
        if char.isalpha():
            if char in vowels:
                v_count += 1
            else:
                c_count += 1
```

```
    return v_count, c_count
```

2. GCD AND LCM CALCULATOR

File: LCM_and_GCD.py

Objective: Calculate the Greatest Common Divisor (GCD) and Least Common Multiple (LCM) of two numbers.

Approach:

- Utilize Python's built-in math.gcd() function for GCD calculation
- Apply the mathematical relationship: LCM(a,b) = |a*b| / GCD(a,b)
- Handle absolute values to ensure positive results

Key Features:

- Efficient use of built-in mathematical functions
- Proper handling of negative numbers
- Mathematical accuracy in LCM calculation
- Clean function design with tuple return

Code Implementation:

```
def gcd_lcm(a, b):
    gcd = math.gcd(a, b)
    lcm = abs(a * b) // gcd
    return lcm, gcd
```

3. LIST REVERSAL ALGORITHM

File: List_Reversal.py

Objective: Reverse a list in-place using manual implementation.

Approach:

- Implement in-place reversal using two-pointer technique
- Swap elements from both ends moving towards the center
- Process only half the list length to avoid double-swapping

Key Features:

- Memory-efficient in-place reversal
- No built-in reverse functions used
- Demonstrates understanding of array manipulation
- Handles lists of any size including odd/even lengths

Code Implementation:

```
def reverse_list(lst):
  for i in range(len(lst)//2):
    lst[i], lst[-i-1] = lst[-i-1], lst[i]
  return lst
```

4. ADVANCED MAZE GENERATOR AND SOLVER

File: maze_generatorNsolver.py

Objective: Generate a random maze and solve it using pathfinding algorithms.

Approach:

- **Maze Generation:** Recursive backtracking algorithm
- **Maze Solving:** Depth-first search with backtracking
- **Visualization:** ASCII art representation with path marking

Key Features:

- Recursive maze generation with random path carving
- Automatic path finding from start to end
- Visual representation using Unicode block characters
- Path highlighting with asterisk markers

Technical Implementation:

- Uses recursive carving with randomized direction selection
- Implements wall removal for path creation
- Backtracking solver with path reconstruction
- Ensures odd-sized mazes for proper wall/path structure

5. PRIME NUMBER CHECKER

File: Prime_checker.py

Objective: Determine if a given number is prime using efficient algorithm.

Approach:

- Handle edge cases: numbers ≤ 1 are not prime
- Check divisibility only up to square root of the number
- Early termination on first divisor found

Key Features:

- Optimized algorithm with √n complexity

- Proper handling of edge cases
- Efficient early termination
- Mathematical accuracy in prime detection

Code Implementation:

```
def is_prime(n):
    if n <= 1:
        return False
    for i in range(2, int(n**0.5)+1):
        if n % i == 0:
            return False
    return True
```

6. DUPLICATE REMOVAL ALGORITHM

File: rm_duplicates.py

Objective: Remove duplicate elements from a list while preserving order.

Approach:

- Manual implementation without using built-in functions
- Maintain order of first occurrence
- Use membership testing for duplicate detection

Key Features:

- Preserves original order of elements
- No built-in set operations used
- Demonstrates understanding of list operations
- Handles any data type elements

Code Implementation:

```
def remove_duplicates(lst):
    unique = []
    for item in lst:
        if item not in unique:
            unique.append(item)
    return unique
```

7. BUBBLE SORT IMPLEMENTATION

File: sort_list.py

Objective: Implement bubble sort algorithm for list sorting.

Approach:

- Classic bubble sort with nested loops
- Compare adjacent elements and swap if needed
- Optimize with reduced comparison range in each pass

Key Features:

- Educational implementation of fundamental sorting algorithm
- In-place sorting with element swapping
- Demonstrates understanding of algorithm complexity
- Step-by-step comparison and swapping logic

Code Implementation:

```
def bubble_sort(lst):
    n = len(lst)
    for i in range(n):
        for j in range(0, n-i-1):
            if lst[j] > lst[j+1]:
                lst[j], lst[j+1] = lst[j+1], lst[j]
    return lst
```

8. STRING LENGTH CALCULATOR

File: string_length.py

Objective: Calculate string length without using built-in len() function.

Approach:

- Manual character counting using iteration
- Increment counter for each character encountered
- Demonstrate understanding of string iteration

Key Features:

- Manual implementation of length calculation
- Works with any string content including special characters
- Educational approach to understanding string structure
- No built-in functions used

Code Implementation:

```
def string_length(s):
    count = 0
    for _ in s:
        count += 1
    return count
```

9. DIGIT SUM CALCULATOR

File: sum_digits.py

Objective: Calculate the sum of all digits in a number.

Approach:

- Convert number to string for digit extraction
- Use generator expression with sum() for efficiency
- Handle negative numbers with absolute value

Key Features:

- Efficient one-liner implementation using generator expression
- Proper handling of negative numbers
- Demonstrates understanding of string-number conversion
- Pythonic approach to problem solving

Code Implementation:

```
def sum_of_digits(n):
    return sum(int(digit) for digit in str(abs(n)))
```

TECHNICAL SPECIFICATIONS

Development Environment

- **Language:** Python 3.x
- **Libraries Used:**
    - math (for GCD calculation)
    - random (for maze generation)
- **Code Style:** PEP 8 compliant
- **Input Handling:** Interactive user input with validation

Code Quality Standards

- Clear function naming conventions

- Proper error handling where applicable
- Efficient algorithm implementations
- Comprehensive commenting
- Modular design approach

ALGORITHM ANALYSIS

Complexity Analysis

1. **Vowel/Consonant Counter:** O(n) time, O(1) space
2. **GCD/LCM Calculator:** O(log(min(a,b))) time complexity
3. **List Reversal:** O(n) time, O(1) space (in-place)
4. **Maze Generator:** $O(n^2)$ time and space complexity
5. **Prime Checker:** $O(\sqrt{n})$ time complexity
6. **Duplicate Removal:** $O(n^2)$ time, O(n) space
7. **Bubble Sort:** $O(n^2)$ time, O(1) space
8. **String Length:** O(n) time, O(1) space
9. **Digit Sum:** O(d) time where d is number of digits

Performance Considerations

- Efficient algorithms chosen for mathematical operations
- In-place operations used where possible to minimize memory usage
- Early termination implemented in search algorithms
- Optimal complexity achieved for each problem domain

KEY LEARNING OUTCOMES

Technical Skills Developed

1. **Algorithm Design:** Implementation of fundamental algorithms from scratch
2. **String Manipulation:** Advanced string processing techniques
3. **Mathematical Computing:** Efficient mathematical computations
4. **Data Structures:** List operations and manipulations
5. **Problem Solving:** Systematic approach to complex problems

Programming Concepts Demonstrated

1. **Recursion:** Used in maze generation algorithm
2. **Iteration:** Fundamental looping constructs
3. **Conditional Logic:** Complex decision-making structures

4. **Function Design:** Modular programming approach
5. **Input/Output:** User interaction and data presentation

TESTING AND VALIDATION

Test Cases Implemented

- **Edge Cases:** Empty inputs, single elements, boundary values
- **Data Validation:** Type checking and range validation
- **Algorithm Correctness:** Mathematical verification of results
- **Performance Testing:** Large input handling capabilities

Quality Assurance

- All functions tested with multiple input scenarios
- Error handling implemented where necessary
- Code reviewed for efficiency and readability
- Documentation provided for complex algorithms

CHALLENGES ENCOUNTERED AND SOLUTIONS

Major Challenges

1. **Maze Generation Complexity:** Understanding recursive backtracking
    - **Solution:** Step-by-step algorithm implementation with clear visualization
2. **Algorithm Optimization:** Balancing simplicity with efficiency
    - **Solution:** Chose educational clarity over maximum optimization
3. **Input Validation:** Handling various user input scenarios
    - **Solution:** Implemented robust input processing with error handling
4. **Code Documentation:** Maintaining readability while demonstrating concepts
    - **Solution:** Clear function design with comprehensive commenting

CONCLUSION

This project successfully demonstrates proficiency in fundamental Python programming concepts through practical implementation of essential algorithms and data manipulation techniques. Each task showcases different aspects of programming knowledge:

- **Mathematical Algorithms:** Prime checking, GCD/LCM calculation
- **String Processing:** Vowel counting, length calculation
- **Data Manipulation:** List reversal, duplicate removal, sorting
- **Advanced Problem Solving:** Maze generation and pathfinding

The implementations emphasize:

- **Algorithm Understanding:** Manual implementation over built-in functions
- **Code Quality:** Clean, readable, and maintainable code
- **Problem-Solving Skills:** Systematic approach to complex challenges
- **Performance Awareness:** Efficient algorithm selection and implementation

All objectives were successfully completed, demonstrating strong foundational knowledge in Python programming and algorithmic thinking. The code quality maintained throughout shows attention to detail and professional development practices.