Instructions on how to run the program

Step 1: Store the source code and the input files in the same directory.

Step 2: Open Visual Studio Code - VSCode (can be installed from here: https://code.visualstudio.com/) and install the 'Python' extension. To do this, click on the extensions icon in the left hand-side menu bar, search for 'Python', and install the one provided by Microsoft.

Step 3: Open the directory with the source code and the input files.

Step 4: Run the source code

Step 5: When asked to input the input filename, enter the name of the input file (like Input1.txt, Input2.txt, etc.)

Step 6: The results will be stored in the output file within the same directory. The name of the output file where the answer is stored along with the assignment order and solution will be printed in the terminal.

Approach and Algorithm

1. The algorithm starts with reading the input file which is done using the 'readFromFile (fileName)' function which accepts the name of the file as its argument.
2. The function checks if the file exists, ensures the file contains only alphabetic characters, and returns the equation in the format of "lineOne + lineTwo = lineThree".
3. The 'splitEquation (equation)' function splits the equation into 3 different parts - operands, operator, and results and returns them in the form of a tuple.
4. In the 'fetchDistinctLetters (equation)' function, a list of unique alphabetic characters from the equation is returned with the help of a set data structure while the 'startingLetters (equation, letters)' returns a list of starting letters of words in the equation by calling the 'splitEquation' function.
5. To check if the values assigned to the letters in the equation are correct, the 'validateValues (assignment, equation)' function is used. This is done using a dictionary to store the assignments and substitute letter values to check if the equation holds true.
6. The 'chooseUnassignedVar (assignment, letters, domains)' makes use of the MRV and degree heuristic to choose the next variable for value assignment.

    a. First MRV is applied by sorting the list of unassigned variables according to the length of the domain values of each variable. If more than one variable has the same lowest MRV, then degree heuristics is applied.

    b. To compute the degree heuristic, the length of the list of oher unassigned variables the particular variable is constraining is considered and the variable with the maximum degree is chosen for assignment next.

7. ‘solveEquation (equation, outputFile)’ is the function that checks for the validity of the input equation and format requirements while initializing the domain values for each variable with all digits (0 - 9) following which it performs backtracking search. It writes the solution into the output file or prints a message if no solution is found.

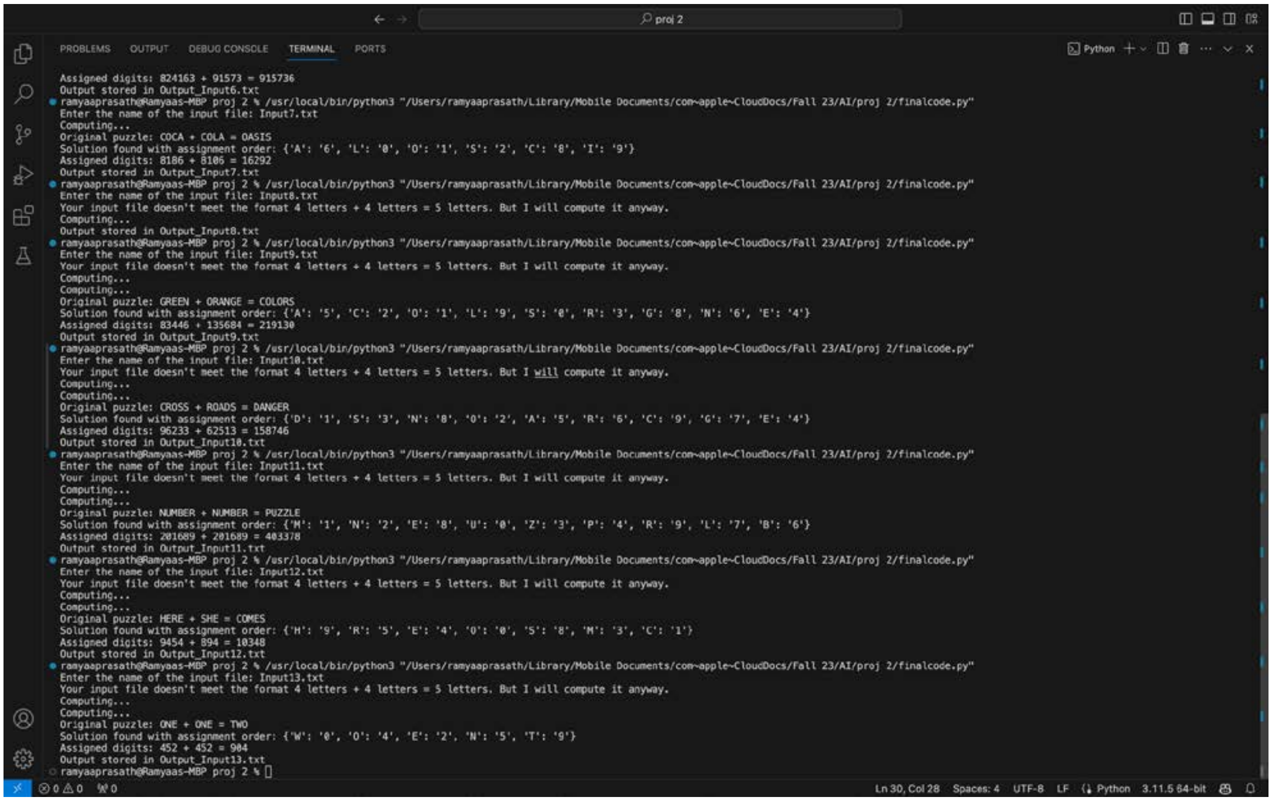
8. To execute the algorithm, input file is read from the user and the filename is passed as an argument to the ‘readFromFile’ function which then calls the ‘solveEquation’ function to solve the problem and stores the result in the output file.

Output

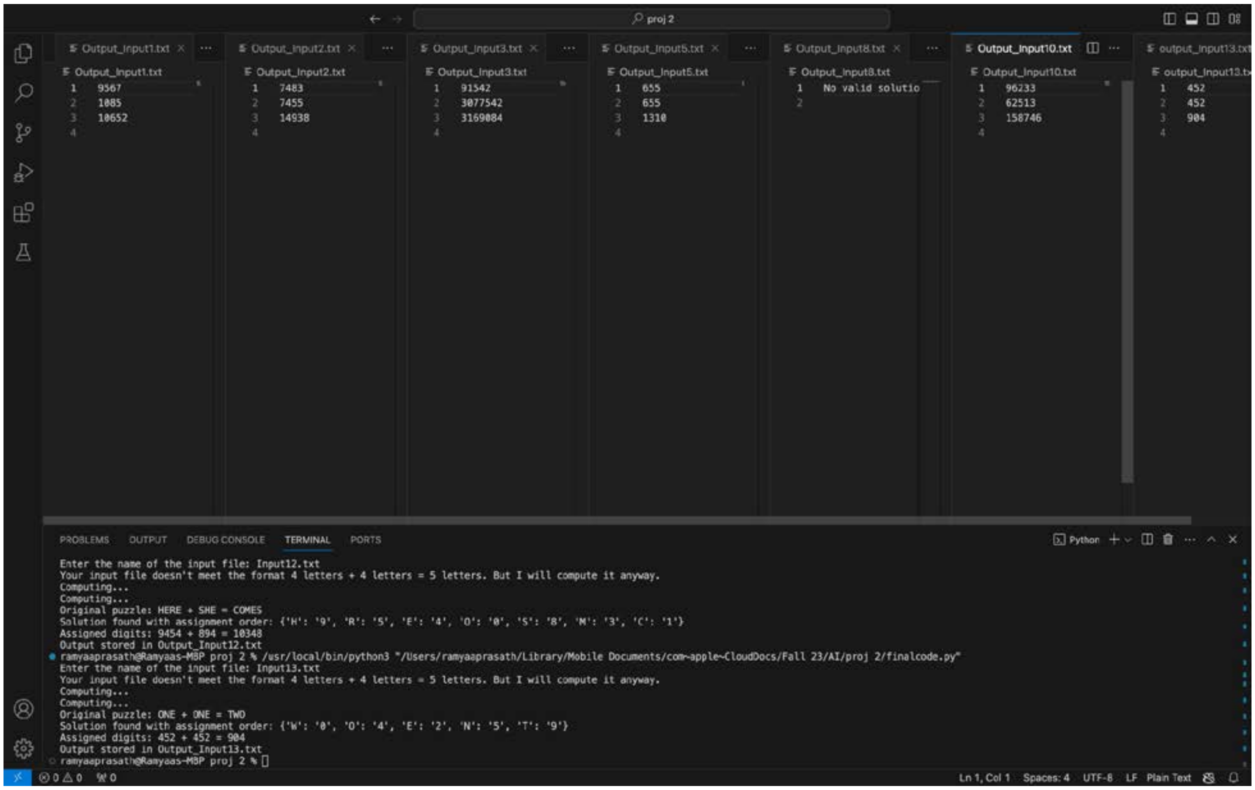
Below are the test cases that we have run. The Outputs we got for the inputs are also listed below.

Tests	Input	Output
1	SEND MORE MONEY	9567 1085 10653
2	BASE BALL GAMES	7483 7455 14938

Screenshots of Output



```
Assigned digits: 824163 + 91573 = 915736
Output stored in Output_Input6.txt
ramyaaprasath@Ramyaas-MBP proj 2 % /usr/local/bin/python3 "/Users/ramyaaprasath/Library/Mobile Documents/com~apple~CloudDocs/Fall 23/AI/proj 2/finalcode.py"
Enter the name of the input file: Input7.txt
Computing...
Original puzzle: COCA + COLA = OASIS
Solution found with assignment order: {'A': '6', 'L': '0', 'O': '1', 'S': '2', 'C': '8', 'I': '9'}
Assigned digits: 8186 + 8106 = 16292
Output stored in Output_Input7.txt
ramyaaprasath@Ramyaas-MBP proj 2 % /usr/local/bin/python3 "/Users/ramyaaprasath/Library/Mobile Documents/com~apple~CloudDocs/Fall 23/AI/proj 2/finalcode.py"
Enter the name of the input file: Input8.txt
Your input file doesn't meet the format 4 letters + 4 letters = 5 letters. But I will compute it anyway.
Computing...
Output stored in Output_Input8.txt
ramyaaprasath@Ramyaas-MBP proj 2 % /usr/local/bin/python3 "/Users/ramyaaprasath/Library/Mobile Documents/com~apple~CloudDocs/Fall 23/AI/proj 2/finalcode.py"
Enter the name of the input file: Input9.txt
Your input file doesn't meet the format 4 letters + 4 letters = 5 letters. But I will compute it anyway.
Computing...
Computing...
Original puzzle: GREEN + ORANGE = COLORS
Solution found with assignment order: {'A': '5', 'C': '2', 'O': '1', 'L': '9', 'S': '0', 'R': '3', 'G': '8', 'N': '6', 'E': '4'}
Assigned digits: 83446 + 135684 = 219130
Output stored in Output_Input9.txt
ramyaaprasath@Ramyaas-MBP proj 2 % /usr/local/bin/python3 "/Users/ramyaaprasath/Library/Mobile Documents/com~apple~CloudDocs/Fall 23/AI/proj 2/finalcode.py"
Enter the name of the input file: Input10.txt
Your input file doesn't meet the format 4 letters + 4 letters = 5 letters. But I will compute it anyway.
Computing...
Computing...
Original puzzle: CROSS + ROADS = DANGER
Solution found with assignment order: {'D': '1', 'S': '3', 'N': '8', 'O': '2', 'A': '5', 'R': '6', 'C': '9', 'G': '7', 'E': '4'}
Assigned digits: 96233 + 62513 = 158746
Output stored in Output_Input10.txt
ramyaaprasath@Ramyaas-MBP proj 2 % /usr/local/bin/python3 "/Users/ramyaaprasath/Library/Mobile Documents/com~apple~CloudDocs/Fall 23/AI/proj 2/finalcode.py"
Enter the name of the input file: Input11.txt
Your input file doesn't meet the format 4 letters + 4 letters = 5 letters. But I will compute it anyway.
Computing...
Computing...
Original puzzle: NUMBER + NUMBER = PUZZLE
Solution found with assignment order: {'M': '1', 'N': '2', 'E': '8', 'U': '0', 'Z': '3', 'P': '4', 'R': '9', 'L': '7', 'B': '6'}
Assigned digits: 201689 + 201689 = 403378
Output stored in Output_Input11.txt
ramyaaprasath@Ramyaas-MBP proj 2 % /usr/local/bin/python3 "/Users/ramyaaprasath/Library/Mobile Documents/com~apple~CloudDocs/Fall 23/AI/proj 2/finalcode.py"
Enter the name of the input file: Input12.txt
Your input file doesn't meet the format 4 letters + 4 letters = 5 letters. But I will compute it anyway.
Computing...
Computing...
Original puzzle: HERE + SHE = COMES
Solution found with assignment order: {'H': '9', 'R': '5', 'E': '4', 'O': '0', 'S': '8', 'M': '3', 'C': '1'}
Assigned digits: 9454 + 894 = 10348
Output stored in Output_Input12.txt
ramyaaprasath@Ramyaas-MBP proj 2 % /usr/local/bin/python3 "/Users/ramyaaprasath/Library/Mobile Documents/com~apple~CloudDocs/Fall 23/AI/proj 2/finalcode.py"
Enter the name of the input file: Input13.txt
Your input file doesn't meet the format 4 letters + 4 letters = 5 letters. But I will compute it anyway.
Computing...
Computing...
Original puzzle: ONE + ONE = TWO
Solution found with assignment order: {'W': '0', 'O': '4', 'E': '2', 'N': '5', 'T': '9'}
Assigned digits: 452 + 452 = 904
Output stored in Output_Input13.txt
ramyaaprasath@Ramyaas-MBP proj 2 % ▯
```



Output_Input1.txt

```
9567
1085
10652
```

Output_Input2.txt

```
7483
7455
14938
```

Output_Input3.txt

```
91542
3077542
3169084
```

Output_Input5.txt

```
655
655
1310
```

Output_Input8.txt

```
No valid solutio
```

Output_Input10.txt

```
96233
62513
158746
```

output_Input13.tx

```
452
452
904
```

```
Enter the name of the input file: Input12.txt
Your input file doesn't meet the format 4 letters + 4 letters = 5 letters. But I will compute it anyway.
Computing...
Computing...
Original puzzle: HERE + SHE = COMES
Solution found with assignment order: {'H': '9', 'R': '5', 'E': '4', 'O': '0', 'S': '8', 'M': '3', 'C': '1'}
Assigned digits: 9454 + 894 = 10348
Output stored in Output_Input12.txt
ramyaaprasath@Ramyaas-MBP proj 2 % /usr/local/bin/python3 "/Users/ramyaaprasath/Library/Mobile Documents/com~apple~CloudDocs/Fall 23/AI/proj 2/finalcode.py"
Enter the name of the input file: Input13.txt
Your input file doesn't meet the format 4 letters + 4 letters = 5 letters. But I will compute it anyway.
Computing...
Computing...
Original puzzle: ONE + ONE = TWO
Solution found with assignment order: {'W': '0', 'O': '4', 'E': '2', 'N': '5', 'T': '9'}
Assigned digits: 452 + 452 = 904
Output stored in Output_Input13.txt
ramyaaprasath@Ramyaas-MBP proj 2 % ▯
```