

EXPERIMENT No. 3 - IMPLEMENTATION OF CONSTRAINT SATISFACTION PROBLEM (CSP)

AIM

To implement the constraint satisfaction problem based on the given constraints

ALGORITHM

- 1 From column 5, $M=1$, since it is only carry-over possible from sum of 2 single digit numbers in column 4.
- 2 To produce a carry from column 4 to column 5 ' $S+M$ ' is atleast 9 so ' $S=8$ or 9 ' so ' $S+M=9$ or 10 ' & so ' $O=0$ or 1 '.
But ' $M=1$ ', so ' $O=0$ '.
- 3 If there is carry from column 3 to 4 then ' $E=9$ ' & so ' $N=0$ '.
But ' $O=0$ ' so there is no carry & ' $S=9$ ' & ' $C_3=0$ '.
- 4 If there is no carry from column 2 to 3 then ' $E=N$ ' which is impossible, therefore there is carry & ' $N=E+1$ ' & ' $C_2=1$ '.
- 5 If there is carry from column 1 to 2 then ' $N+R=E \bmod 10$ ' & ' $N=E+1$ ' so ' $E+1+R=E \bmod 10$ ', so ' $R=9$ ' but ' $S=9$ ', so there must be carry from column 1 to 2. Therefore, ' $C_1=1$ ' & ' $R=8$ '.
- 6 To produce carry ' $C_1=1$ ' from column 1 to 2, we must have ' $D+E=10$ ' as Y cannot be 0/1 so $D+E$ is atleast 12. As D is atleast 7 & E is atleast 5 (D cannot be 8 or 9 as it is already assigned).
 N is atleast 7 & ' $N=E+1$ ' so ' $E=5$ or 6 '.

7. If E were 6 & D+E atleast 12 then D would be 7, but 'N=E+1' & N would also be 7 which is impossible. Therefore 'E=5' & 'N=6'.
8. D+E is atleast 12 for that we get 'D=7' & 'Y=2'.

WORKING

$$\text{SEND} + \text{MORE} = \text{MONEY}$$

$$\begin{array}{r} \begin{array}{cccc} 5 & 4 & 3 & 2 & 1 \\ & S & E & N & D \\ & M & O & R & E \\ + & C_3 & C_2 & C_1 & \\ \hline M & O & N & E & Y \end{array} \end{array}$$

SOLUTION

$$\begin{array}{r} \begin{array}{cccc} 9 & 5 & 6 & 7 \\ + & 1 & 0 & 8 & 5 \\ \hline 1 & 0 & 6 & 5 & 2 \end{array} \end{array}$$

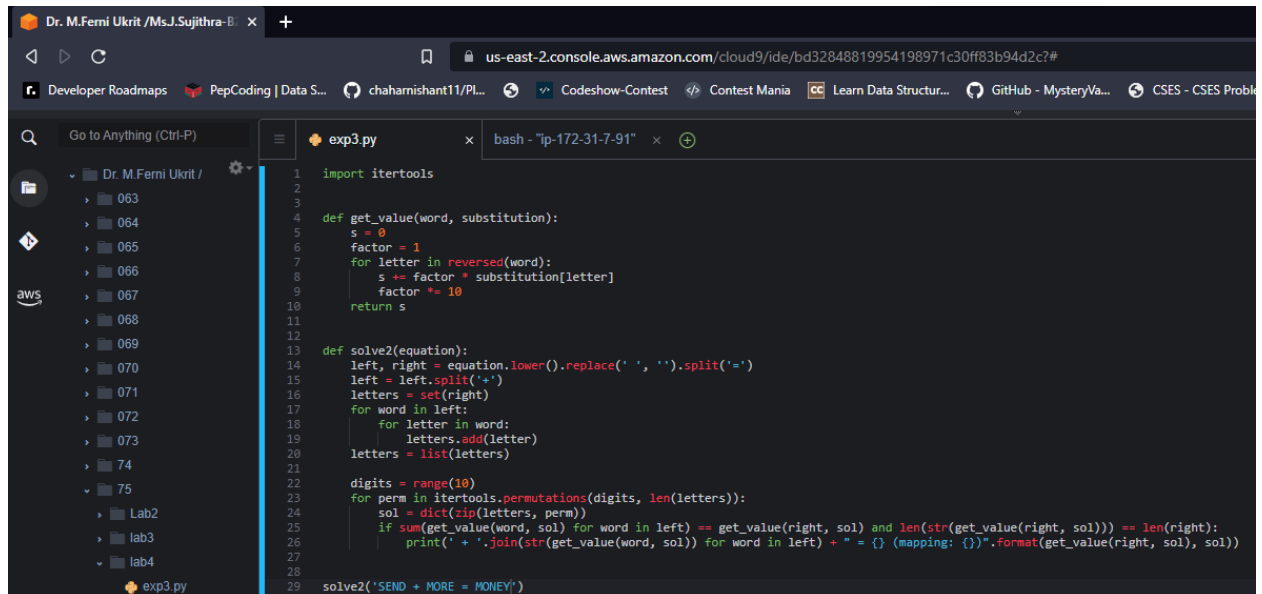
VALUES

$$\begin{array}{l} S = 9, N = 6, M = 1, R = 8 \\ E = 5, D = 7, O = 0, Y = 2. \end{array}$$

RESULTS

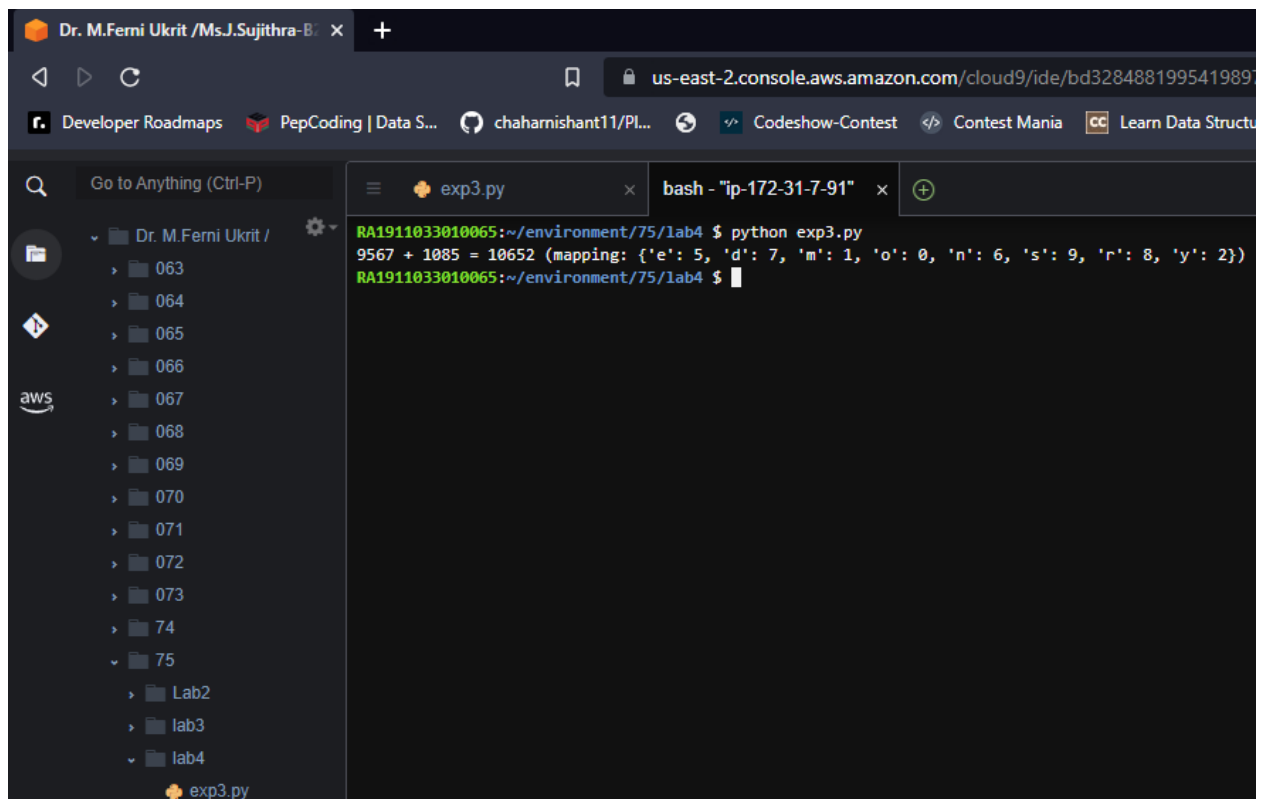
The Constraint Satisfaction Problem was implemented successfully where the possible solutions were displayed based on user input.

CODE SCREENSHOT :



```
1 import itertools
2
3
4 def get_value(word, substitution):
5     s = 0
6     factor = 1
7     for letter in reversed(word):
8         s += factor * substitution[letter]
9         factor *= 10
10    return s
11
12
13 def solve2(equation):
14     left, right = equation.lower().replace(' ', '').split('=')
15     left = left.split('+')
16     letters = set(right)
17     for word in left:
18         for letter in word:
19             letters.add(letter)
20     letters = list(letters)
21
22     digits = range(10)
23     for perm in itertools.permutations(digits, len(letters)):
24         sol = dict(zip(letters, perm))
25         if sum(get_value(word, sol) for word in left) == get_value(right, sol) and len(str(get_value(right, sol))) == len(right):
26             print(' + '.join(str(get_value(word, sol)) for word in left) + " = {} (mapping: {})".format(get_value(right, sol), sol))
27
28
29 solve2('SEND + MORE = MONEY')
```

OUTPUT SCREENSHOT :



```
RA1911033010065:~/environment/75/lab4 $ python exp3.py
9567 + 1085 = 10652 (mapping: {'e': 5, 'd': 7, 'm': 1, 'o': 0, 'n': 6, 's': 9, 'r': 8, 'y': 2})
RA1911033010065:~/environment/75/lab4 $
```