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AI Lab 3

**Aim-** Implementation of Constraint Satisfaction Problems

Problem formulation → Given a statement where two words add to give a third word. Assign unique digits (0-9) to each letter.

Here using the expression →

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

∴ letters are S, E, N, D, M, O, R, Y

$C_1, C_2, C_3$  represent the carry

Goal is to assign ~~that~~ unique value to the letters ~~and then~~ according to the expression.

$$\begin{array}{r} \overset{C_3}{S} \overset{C_2}{E} \overset{C_1}{N} D \\ + \text{MORE} \\ \hline \text{M O N E Y} \end{array}$$

Problem solving →

starting from left hand side, the terms are S and M

to assigning S as 9, M as 1

$$\begin{array}{r} S \qquad \qquad 9 \\ + M \qquad \Rightarrow + 1 \\ \hline M O \qquad \qquad 10 \end{array}$$

∴  $0 = 0$

now →

$$\begin{array}{r} E \\ + 0 \\ \hline N \end{array} \quad \begin{array}{l} \text{considering} \\ E \approx 5 \end{array} \quad \begin{array}{r} 5 \\ + 0 \\ \hline 5 \end{array}$$

not possible as  $E \neq N$

∴ assuming  $C_2 = 1$

$$\begin{array}{r} C_2 \\ E \\ + 0 \\ \hline N \end{array} \rightarrow \begin{array}{r} 1 \\ 5 \\ + 0 \\ \hline 6 \end{array}$$

∴  $N = 6$

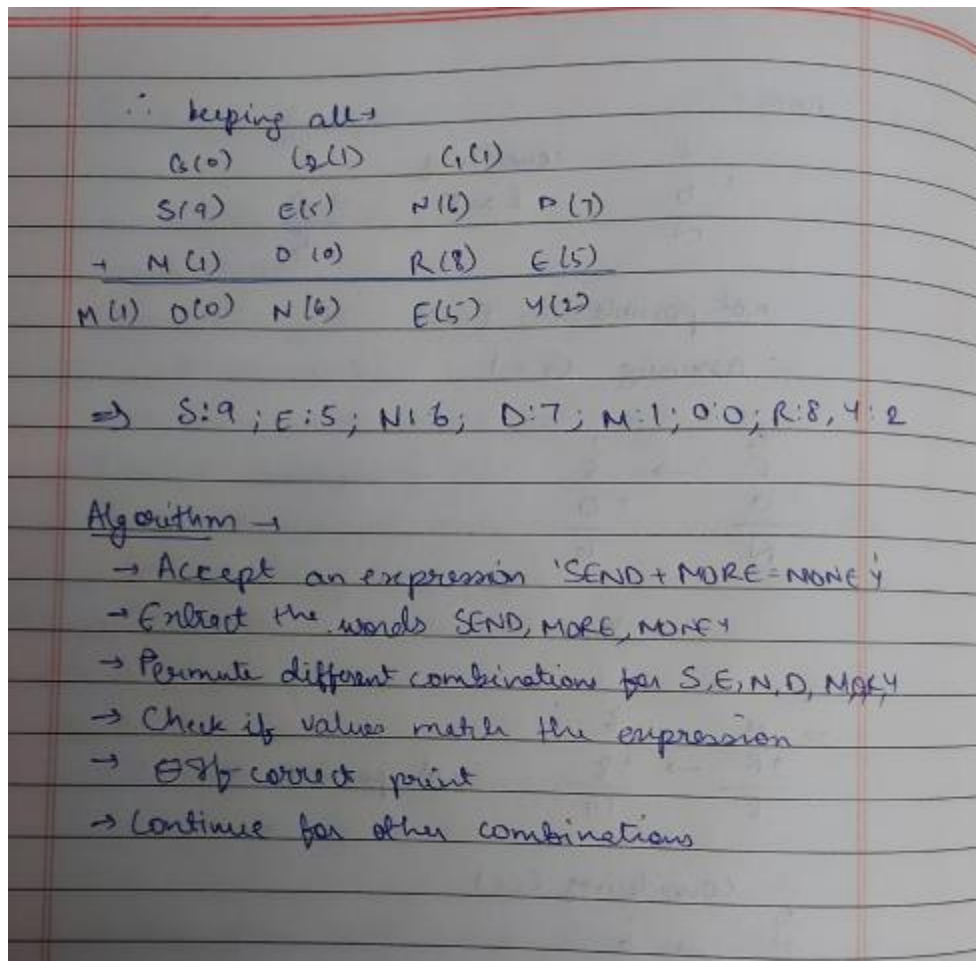
$$\Rightarrow \begin{array}{r} N \\ + R \\ \hline E \end{array} \rightarrow \begin{array}{r} 6 \\ + 8 \\ \hline 14 \end{array} \quad \text{not possible as } E = 5$$

∴ considering  $C_3 = 1$

$$\begin{array}{r} C_3 \\ N \\ + R \\ \hline E \end{array} \rightarrow \begin{array}{r} 1 \\ 6 \\ + 8 \\ \hline 15 \end{array} \quad \therefore R = 8$$

On last two, 1 carry must be produced.

$$\therefore \begin{array}{r} D \\ + E \\ \hline 4 \end{array} \rightarrow \begin{array}{r} 7 \\ + 5 \\ \hline 12 \end{array}$$



## Code-

```
import itertools
```

```
def get_value(word, substitution):
```

```
    s = 0
```

```
    factor = 1
```

```
    for letter in reversed(word):
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```
        s += factor * substitution[letter]
```

```
        factor *= 10
```

```
    return s
```

```
def solve2(equation):
```

```
    left, right = equation.lower().replace(' ', '').split('=')
```

```

left = left.split('+')

letters = set(right)

for word in left:
    for letter in word:
        letters.add(letter)

letters = list(letters)

digits = range(10)

for perm in itertools.permutations(digits, len(letters)):
    sol = dict(zip(letters, perm))

    if sum(get_value(word, sol) for word in left) == get_value(right, sol):
        print(' + '.join(str(get_value(word, sol)) for word in left) + " = {} (mapping:
{}))".format(get_value(right, sol), sol))

solve2('SEND + MORE = MONEY ')

```

## Output-

```

bash - "ip-172-31-6-77" × Immediate × RA1911003010660/LAB3 × RA1911003010660/LAB3
Run Command: RA1911003010660/LAB3\ CSP.py
7531 + 825 = 8356 (mapping: {'r': 2, 'm': 0, 'e': 5, 'n': 3, 'd': 1, 's': 7, 'y': 6, 'o': 8})
7534 + 825 = 8359 (mapping: {'r': 2, 'm': 0, 'e': 5, 'n': 3, 'd': 4, 's': 7, 'y': 9, 'o': 8})
7643 + 826 = 8469 (mapping: {'r': 2, 'm': 0, 'e': 6, 'n': 4, 'd': 3, 's': 7, 'y': 9, 'o': 8})
6853 + 728 = 7581 (mapping: {'r': 2, 'm': 0, 'e': 8, 'n': 5, 'd': 3, 's': 6, 'y': 1, 'o': 7})
6415 + 734 = 7149 (mapping: {'r': 3, 'm': 0, 'e': 4, 'n': 1, 'd': 5, 's': 6, 'y': 9, 'o': 7})
6524 + 735 = 7259 (mapping: {'r': 3, 'm': 0, 'e': 5, 'n': 2, 'd': 4, 's': 6, 'y': 9, 'o': 7})
5849 + 638 = 6487 (mapping: {'r': 3, 'm': 0, 'e': 8, 'n': 4, 'd': 9, 's': 5, 'y': 7, 'o': 6})
6851 + 738 = 7589 (mapping: {'r': 3, 'm': 0, 'e': 8, 'n': 5, 'd': 1, 's': 6, 'y': 9, 'o': 7})
5731 + 647 = 6378 (mapping: {'r': 4, 'm': 0, 'e': 7, 'n': 3, 'd': 1, 's': 5, 'y': 8, 'o': 6})
5732 + 647 = 6379 (mapping: {'r': 4, 'm': 0, 'e': 7, 'n': 3, 'd': 2, 's': 5, 'y': 9, 'o': 6})
3719 + 457 = 4176 (mapping: {'r': 5, 'm': 0, 'e': 7, 'n': 1, 'd': 9, 's': 3, 'y': 6, 'o': 4})
3829 + 458 = 4287 (mapping: {'r': 5, 'm': 0, 'e': 8, 'n': 2, 'd': 9, 's': 3, 'y': 7, 'o': 4})
3712 + 467 = 4179 (mapping: {'r': 6, 'm': 0, 'e': 7, 'n': 1, 'd': 2, 's': 3, 'y': 9, 'o': 4})
2817 + 368 = 3185 (mapping: {'r': 6, 'm': 0, 'e': 8, 'n': 1, 'd': 7, 's': 2, 'y': 5, 'o': 3})
2819 + 368 = 3187 (mapping: {'r': 6, 'm': 0, 'e': 8, 'n': 1, 'd': 9, 's': 2, 'y': 7, 'o': 3})
3821 + 468 = 4289 (mapping: {'r': 6, 'm': 0, 'e': 8, 'n': 2, 'd': 1, 's': 3, 'y': 9, 'o': 4})
9567 + 1085 = 10652 (mapping: {'r': 8, 'm': 1, 'e': 5, 'n': 6, 'd': 7, 's': 9, 'y': 2, 'o': 0})

```