Ex No.3: *Crypto-arithmetic Puzzle*

Problem1- Base + Ball = Games:

Problem:

```
  SEND
+ MORE
.....
 MONEY
```

Initial State:

No two letters have the same value.
The sums of the digits must be as shown in the problem.

A Cryptarithmetic Problem

- Solve the following puzzle by assigning numeral (0-9) in such a way that each letter is assigned unique digit which satisfy the following addition.
- Constraints : No two letters have the same value. (The constraints of arithmetic).

Algorithm:

5 4 3 2 1

S E N D

+ M O R E

c3 c2 c1

M O N E Y

1. From Column 5, M=1, since it is only carry-over possible from sum of 2 single digit number in column 4.

2. To produce a carry from column 4 to column 5 'S + M' is at least 9 so 'S=8or9' so 'S+M=9or10' & so 'O = 0 or 1'. But 'M=1', so 'O = 0'.

3. If there is c+rry from Column 3 to 4 then 'E=9' & so 'N=0'. But 'O = 0' so there is no carry & 'S=9' & 'c3=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' & 'c2=1'.

5. If there is carry from column 1 to 2 then 'N+R=E mod 10' & 'N=E+1' so 'E+1+R=E mod 10', so 'R=9' but 'S=9', so there must be c+rry from column 1 to 2. Therefore 'c1=1' & 'R=8'.

6. To produce carry 'c1=1' from column 1 to 2, we must h+ve 'D+E=10+Y' as Y cannot be 0/1 so D+E is at least 12. As D is at most 7 & E is

At least 5 (D cannot be 8 or 9 as it is already assigned). N is at most 7 & 'N=E+1' so 'E=5or6'.

7. If E were 6 & D+E at least 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 at least 12 for that we get 'D=7' & 'Y=2'.

Solution:

9 5 6 7

+ 1 0 8 5

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1 0 6 5 2

Values:

S=9

E=5

N=6

D=7

M=1

O=0

R=8

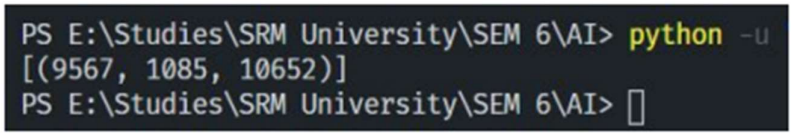
Y=2

Code:

```
def solutions():
 # letters = ('s', 'e', 'n', 'd', 'm', 'o', 'r', 'y')
 all_solutions = list()
 for s in range(9, -1, -1):
 for e in range(9, -1, -1):
 for n in range(9, -1, -1):
 for d in range(9, -1, -1):
 for m in range(9, 0, -1):
 for o in range(9, -1, -1):
 for r in range(9, -1, -1):
 for y in range(9, -1, -1):
```

```
    if len(set([s, e, n, d, m, o, r, y])) == 8:
        send = 1000 * s + 100 * e + 10 * n + d
        more = 1000 * m + 100 * o + 10 * r + e
        money = 10000 * m + 1000 * o + 100 * n + 10 * e + y
        if send + more == money:
            all_solutions.append((send, more, money))
    return all_solutions
print(solutions())
```

Output:



Result:

The crypto-arithmetic puzzle SEND + MORE = MONEY was solved using the carry over technique and values for the alphabets were obtained successfully.