

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 Cryptarithmic 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 ' $S=8 \text{ or } 9$ ' so ' $S+M=9 \text{ or } 10$ ' & so ' $O = 0 \text{ or } 1$ '. 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 ' $N+R=E \text{ mod } 10$ ' & ' $N=E+1$ ' so ' $E+1+R=E \text{ mod } 10$ ', so ' $R=9$ ' but ' $S=9$ ', so there must be carry from column 1 to 2. Therefore ' $c_1=1$ ' & ' $R=8$ '.

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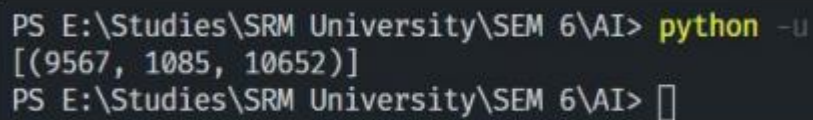
6. To produce carry ' $c_1=1$ ' from column 1 to 2, we must have ' $D+E=10+Y$ ' as Y cannot be 0/1 so $D+E$ is at least 12. As D is at most 7 & E is At least 5 (D cannot be 8 or 9 as it is already assigned). N is at most 7 & ' $N=E+1$ ' so ' $E=5 \text{ or } 6$ '.
7. If E were 6 & $D+E$ at least 12 then 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


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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:



```
PS E:\Studies\SRM University\SEM 6\AI> python -u
[(9567, 1085, 10652)]
PS E:\Studies\SRM University\SEM 6\AI> 
```

Result:

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