CS301 Assignment-0

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1 Question-1

1.1 Define SMP as a computational problem: What is the input? What is the output?

The Stable Marriage Problem illustrates that if there are N men and N women, where each person has ranked the members of the opposite sex. And each person married someone of the opposite sex. If men and women married such that there are no two people of the opposite sex who would prefer to married with each other. Then, all the marriages are "stable".

Input: A group of females and their sorted preference list in the male group.

A group of males and their sorted preference list in the female group.
Output: Stable pairings of the females and males in which no two people would

prefer each other.

1.2 Give an example for SMP.

A group of two males and two females.
W1 prefer list=M1, M2
W2 prefer list=M1, M2
M1 prefer list=W1, W2
M2 prefer list=W1, W2

Output should be m1-w1, m2-w2 since in this pairing no two people would prefer each other. On the other hand, m1-w2, m2-w1 is not stable since m1 and w1 would prefer each other. So the stable pairing is m1-w1, m2-w2.

2 Question-2

2.1 Present the Gale-Shapley algorithm with a pseudocode.

Initialization of all of the women and the men as free (single).
While (there is a single men (m) and there exist a women that he can propose)
    let w= the first women that in the preference list of m that is not proposed by m.
    if (w is single)
        m and w engaged.
    else some pair m' and w already exist
        if w prefers m to m'
            m' becomes single
            m and w become engaged
        else
            m' and w remains engaged

2.2 Analyze the asymptotic time complexity of this algorithm.

For finding the first women that is in the preference list of m that is not yet proposed by m will take O(1) time at best whereas O(N) time at worst and O(N/2) = O(N) time in average.

if we analyze the time complexity from inside to outside. Checking the woman whether single or engaged will take constant time, so its time complexity is O(1). If she is not engaged, making she engaged will take constant time as well. On the other hand, if women is already engaged comparing the mans will take O(1) time at best whereas O(N) time at worst and O(N/2) = O(N) time in average.

Total running time of the algorithm will be multiplied by N since the outer while loop at least iterate N times.

At best: O(N)*(O(1)+O(1))=O(N)
At worst: O(N)*(O(N)+O(N))=O(N^2)
On average: O(N)*(O(N)+O(N))=O(N^2)

3 Question-3: Implementation

```
N = 2
def wPrefers(prefer, w, m, m1):
for i in range(N):
if (prefer[w][i] == m1):
    return True
if (prefer[w][i] == m):
    return False
```

```
def stableMarriage(WomenpreferMen, MenpreferWomen):
    wPartner = [-1 for i in range(N)]
    mFree = [False for i in range(N)]
    freeCount = N

    while (freeCount ¿ 0):
        m = 0
        while (m ¡ N):
        if (mFree[m] == False):
            break
        m += 1
    i = 0

    while i ¡ N and mFree[m] == False:
        w = MenpreferWomen[m][i]
        if (wPartner[w] == -1):
            wPartner[w] = m
            mFree[m] = True
            freeCount -= 1
        else:
            m1 = wPartner[w]
            if (wPrefers(WomenpreferMen, w, m, m1) == False):
                wPartner[w] = m
                mFree[m] = True
                mFree[m1] = False
        i += 1

    print("Woman ", " Man")
    for i in range(N):
        print(i, "", wPartner[i])



MAIN
WomenpreferMen = [[0, 1], [0, 1]]
MenpreferWomen = [[0, 1], [0, 1]]
stableMarriage(WomenpreferMen, MenpreferWomen)
```

4 References

https://towardsdatascience.com/gale-shapley-algorithm-simply-explained-caa344e643c2

geeksforgeeks.org/stable-marriage-problem/