Assignment 1

1. Flowchart

```
import random

def Get_value(x, y, z):
    print("We get the value = {}.".format(x+y-10*z))
def Print_values(a, b, c):
    print("a={} b={} c={}".format(a,b,c))
    if (a > b):
        if(b > c):
            Get_value(a, b, c)
        else:
            if (a > c):
                Get_value(a, c, b)
            else:
                Get_value(c, a, b)
    else:
        if (b > c):
            if (a > c):
                Get_value(b, a, c)
            else:
                Get_value(b, c, a)
        else:
            Get_value(c, b, a)

def main():
    a = round(random.random()*10)
    b = round(random.random()*10)
    c = round(random.random()*10)
    Print_values(a, b, c)
    a,b,c = 10,5,1
    Print_values(a, b, c)


if __name__ == '__main__':
    main()
```

Output :

```
a=4 b=8 c=1
We get the value = 2.
a=10 b=5 c=1
We get the value = 5.
```

2. Continuous celing function

```
from math import ceil

```

```
def Get_fx(x):
    if(x != 1):
        return(Get_fx(ceil(x/3)) + 2*x)
    else:
        return 1

def main():
    n = eval(input("Please input your list number(>0):"))
    i = 0
    x_lst = []
    answer_lst = []
    while(i < n):
        x = eval(input("Please input you number:"))
        x_lst.append(x)
        i = i + 1

    print("Your number list is :")
    for i in x_lst:
        answer = Get_fx(i)
        answer_lst.append(answer)
        print(i, end = " ")
    print() # get a blank line
    print("Your answer list is :")
    for i in answer_lst:
        print(i, end = " ")


if __name__ == '__main__':
    main()
```

Output :

```
Please input your list number(>0):9
Please input you number:1
Please input you number:6
Please input you number:88
Please input you number:22
Please input you number:16
Please input you number:3
Please input you number:5
Please input you number:77
Please input you number:68
Your number list is :
1 6 88 22 16 3 5 77 68
Your answer list is :
1 17 269 67 49 7 15 231 205
```

First we define a function get the $f(x) = f(ceil(x/3)) + 2x, (f(1) = 1)$, then we get input list(let user input the list size and number). When we input a list [1, 6, 88, 22, 16, 3, 5, 77, 49], we get the answer list [1, 17, 269, 67, 49, 7, 15, 231, 205]

3. Dice rollint

3.1

```
import random

def go_or_not(x,face_sum,count):
    remain_sum = x - face_sum
    remain_count = 10 - count
    if (remain_count * 6 < remain_sum):
        return False
    elif (remain_count > remain_sum):
        return False
    else:
        return True

def Find_number_of_ways(x):

    Face = [1,2,3,4,5,6]
    face_sum = 0
    count = 0
    ways = 0
    for dice1 in range(1, 7):
        face_sum = dice1
        count = 1
        if(not go_or_not(x,face_sum,count)):
            face_sum -= dice1
            count -= 1
            continue
        for dice2 in range(1,7):
            face_sum = dice2 + dice1
            count = 2
            if(not go_or_not(x,face_sum,count)):
                face_sum -= dice2
                count -= 1
                continue
            for dice3 in range(1,7):
                face_sum = dice3 + dice2 + dice1
                count = 3
                if(not go_or_not(x,face_sum,count)):
                    face_sum -= dice3
                    count -= 1
                    continue
                for dice4 in range(1,7):
                    face_sum = dice4 + dice3 + dice2 + dice1
                    count = 4
                    if(not go_or_not(x,face_sum,count)):
                        face_sum -= dice4
                        count -= 1
                        continue
                    for dice5 in range(1,7):
                        face_sum = dice5 + dice4 + dice3 + dice2 + dice1
                        count = 5
                        if(not go_or_not(x,face_sum,count)):
                            face_sum -= dice5
                            count -= 1
                            continue
                        for dice6 in range(1,7):
```

```
                                face_sum = dice6 + dice5 + dice4 + dice3 + dice2
+ dice1
                                count = 6
                                if(not go_or_not(x,face_sum,count)):
                                    face_sum -= dice6
                                    count -= 1
                                    continue
                                for dice7 in range(1,7):
                                    face_sum = dice7 + dice6 + dice5 + dice4 +
dice3 + dice2 + dice1
                                    count = 7
                                    if(not go_or_not(x,face_sum,count)):
                                        continue
                                    for dice8 in range(1,7):
                                        face_sum = dice8 + dice7 + dice6 + dice5
+ dice4 + dice3 + dice2 + dice1
                                        count = 8
                                        if(not go_or_not(x,face_sum,count)):
                                            continue
                                        for dice9 in range(1,7):
                                            face_sum = dice9 + dice8 + dice7 +
dice6 + dice5 + dice4 + dice3 + dice2 + dice1
                                            count = 9
                                            if(not go_or_not(x,face_sum,count)):
                                                continue
                                            for dice10 in range(1,7):
                                                face_sum = dice10 + dice9 +dice8
+ dice7 + dice6 + dice5 + dice4 + dice3 + dice2 + dice1
                                                if(face_sum == x):
                                                    face_sum = 0
                                                    count = 0
                                                    ways += 1
                                                    break
                                                else:
                                                    face_sum -= dice10
                                                    count -= 1

    return ways
```

We use the traversal method to obtain possible results, but we have 6^{10} possibilities, it's too big to computer all possibilities. So we define a function go_or_not to judge whether to continue.

3.2

Then we add some code to get Number_of_ways

```
def main():
    Number_of_ways = []
    for number in range(10,61):
        ways = Find_number_of_ways(number)
        Number_of_ways.append(ways)
    print(Number_of_ways)
    max_value = 0
    max_num = 0
    for i in range(len(Number_of_ways)):
        if(Number_of_ways[i] > max_value):
            max_value = Number_of_ways[i]
```

```
            max_num = i
    x = 10 + max_num
    print("x = {}".format(x))

if __name__ == '__main__':
    main()
```

Output :

```
[1, 10, 55, 220, 715, 2002, 4995, 11340, 23760, 46420, 85228, 147940, 243925, 383470, 576565, 831204, 1151370, 1535040, 1972630, 2446300, 2930455, 3393610, 3801535, 4121260, 4325310, 4395456, 4325310, 4121260, 3801535, 3393610, 2930455, 2446300, 1972630, 1535040, 1151370, 831204, 576565, 383470, 243925, 147940, 85228, 46420, 23760, 11340, 4995, 2002, 715, 220, 55, 10, 1]
x = 35
```

4. Dynamic programmint

4.1

```
import random

def Random_integer(N):
    lst = []
    for i in range(N):
        lst.append(round(random.random()*10))
    return lst
```

4.2

```
def Get_average(lst):
    lst_sum = 0
    lst_count = len(lst)
    for i in lst:
        lst_sum += i
    return lst_sum/lst_count

def Sum_averages(lst):
    lst_len = len(lst)
    sum_average = []
    #I got inspired by reading https://blog.csdn.net/weixin_43827397/article/details/107567071
    for i in range(lst_len ** 2):
        sub_lst = []
        for j in range(lst_len):
            if(i >> j) % 2:
                sub_lst.append(lst[j])
        if(len(sub_lst) <= 0):
            continue
        average = Get_average(sub_lst)
        sum_average.append(average)
    return sum(sum_average)
```

We define a function Get_average to get average of list.

4.3

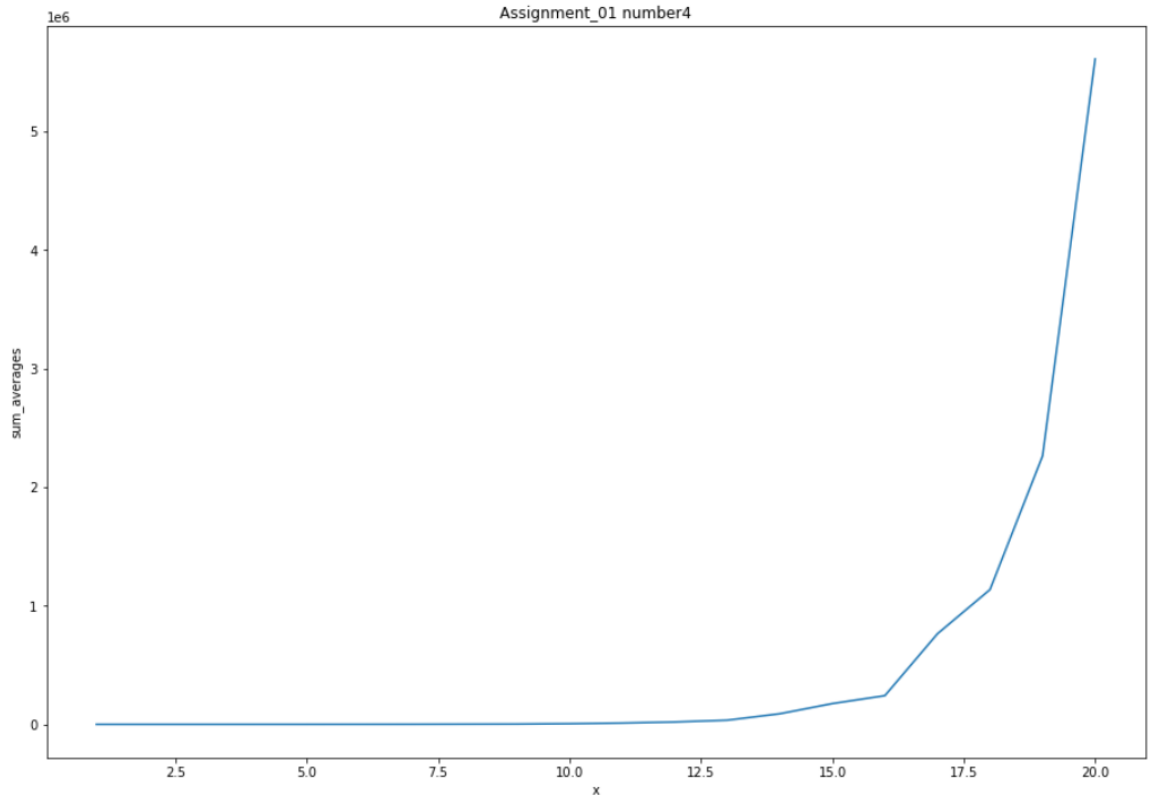
We add some codes to get a list called Total_sum_averages and plot Total_sum_averages.

```
import matplotlib.pyplot as plt
%matplotlib inline

def main():
#     lst1 = Random_integer(10)
#     print("Your list is :")
#     print(lst1)
#     Sum_averages(lst1)
    N_lst = []
    Total_sum_averages = []
    for i in range(1, 101):
        N_lst.append(i)
        Total_sum_averages.append(Sum_averages(Random_integer(i)))
    print(N_lst)
    print(Total_sum_averages)
    fig = plt.figure(figsize = (12,8),
                     )
    ax = fig.add_subplot(111)
    ax = fig.add_axes([0,0,1,1])
    ax.plot(N_lst, Total_sum_averages)
    ax.set_title("Assignment_01 number4")
    ax.set_xlabel("x")
    ax.set_ylabel("sum_averages")


if __name__ == '__main__':
    main()
```

Output :

Because we can't calculate (2^{10}-1) subsets, so we only calculate N increasing from 1 to 20. We can see the result:

```
[1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20]
[7.0, 18.0, 23.333333333333332, 93.75, 142.59999999999997, 388.5000000000001, 671.2857142857144, 1498.1250000000007, 2271.111111111111, 5421.900000000015, 10793.272727272686, 19792.499999999978, 34654.23076923069, 88936.28571428558, 174757.33333333375, 241660.31249999916, 763295.8235294124, 1135952.9999999884, 2262712.3157894793, 5609876.2500000475]
```



We can see that the sum of the average values of all subsets increase with the increase of the array capacity.

5. Path counting

5.1

```
import numpy as np

def Get_matrix(N, M):
    a = np.random.choice(a = [0,1], size = [N,M])
    a[0][0] = 1
    a[-1][-1] = 1
    return a
```

5.2

```
import numpy as np

def Get_matrix(N, M):
    a = np.random.choice(a = [0,1], size = [N,M])
    a[0][0] = 1
    a[-1][-1] = 1
    return a

path = 0
okay = 0
def Count_path(Matrix,x,y,endx,endy):
    global path
    global okay

    if (okay == 1):
        return path
```

```
17
18      if(x == endx and y == endy):
19          okay = 1
20          print("find ways")
21          print("path = {}".format(path))
22          return path
23
24      if(y != endy and Matrix[x][y+1] != 0 and okay!=1):
25          print("right")
26          path += 1
27          Move(Matrix,x,y+1,endx,endy)
28      if (okay == 1):
29          return path
30
31      if(x != endx and Matrix[x+1][y] != 0 and okay!=1):
32          print("down")
33          path += 1
34          Move(Matrix,x+1 ,y,endx,endy)
35      if (okay == 1):
36          return path
37
38      if (okay == 0):
39          print("no way")
40          path -= 1
41          return 0
42
43
44  a = Get_matrix(3,3)
45  print(a)
46  Count_path(a,0,0,2,2)
47  if(not okay):
48      print("path = 0");
```

5.2 Output :

situation01 :

```
[[1 0 0]
 [0 1 1]
 [0 0 1]]
no way
path = 0
```

situation02 :

```
[[1 1 1]
 [0 1 0]
 [1 1 1]]
right
right
no way
down
down
right
find ways
path = 4
```

5.3

```python
import numpy as np

def Get_matrix(N, M):
    a = np.random.choice(a = [0,1], size = [N,M])
    a[0][0] = 1
    a[-1][-1] = 1
    return a

path = 0
okay = 0
def Count_path(Matrix,x,y,endx,endy):
    global path
    global okay

    if (okay == 1):
        return path

    if(x == endx and y == endy):
        okay = 1
        print("find ways")
        print("path = {}".format(path))
        return path

    if(y != endy and Matrix[x][y+1] != 0 and okay!=1):
        #print("right")
        path += 1
        Count_path(Matrix,x,y+1,endx,endy)
    if (okay == 1):
        return path

    if(x != endx and Matrix[x+1][y] != 0 and okay!=1):
        #print("down")
        path += 1
        Count_path(Matrix,x+1 ,y,endx,endy)
    if (okay == 1):
        return path

    if (okay == 0):
        #print("no way")
        path -= 1
        return 0

def main():
    global path
    global okay
    N = 10
    M = 8
    path_lst = []
    for i in range(1000):
        a = Get_matrix(N,M)
        path_ans = Count_path(a,0,0,N-1,M-1)
        path_lst.append(path_ans);
        if(okay):
            print(a)
        path = 0
```

```
            okay = 0
        print(path_lst)
        total_num = sum(path_lst)
        print(total_num)


if __name__ == '__main__':
    main()
```

Output :