- 主程式

建立一個三維矩陣 freq，將明文以每 3 個 letter 記錄下來 (往右 shift 1 格)，跑 for 迴圈加總後算出 frequence 字詞的 weight。

```
freq = np.zeros((26, 26, 26))

for i in range(len(plain) - 2):
    freq[ord(plain[i])-ord('A')][ord(plain[i+1])-ord('A')][ord(plain[i+2])-ord('A')] += 1

for i in range(26):
    for j in range(26):
        sum = 0
        for k in range(26):
            sum += freq[i][j][k]
        if (sum == 0):
            continue
        for k in range(26):
            freq[i][j][k] = freq[i][j][k]/sum
```

密文一: ECDTMECAERAUOOLEDSAMMERNENASSODYTNRVBNLCRLTIQLAETRIGAWEBAAEIHOR

密文二: EOEYEGTRNPSECEHHETYHSNGNDDDDETOCRAERAEMHTECSEUSIARWKDRIRNYARANUEYICNTTCEIETUS

rectangle 函式回傳 data、row、column，分別為密文之矩形行列(長寬)以及矩形之二維矩陣內容。

getAnswer 函式將密文破解為明文，後面的兩個參數代表密文算出權重會是最大值的前兩行。以第一個密文來舉例，下圖有 7 列(0~6)，左邊為密文，右邊為明文，密文第六列(5)對應明文之第一列，密文第三列(2)代表明文之第二列，透過此函式可推算出其完整明文答案。

```
data, row, column = rectangle(c1)
print("Cipher: ECDTM ECAER AUOOL EDSAM MERNE NASSO DYTNR VBNLC RLTIQ LAETR IGAWE BAAEI HOR")
print("Ans: ", end = '')
getAnswer(freq, data, row, column, 5, 2)

data, row, column = rectangle(c2)
print("\nCipher: EOEYE GTRNP SECEH HETYH SNGND DDDET OCRAE RAEMH TECSE USIAR WKDRI RNYAR ANUEY ICNTT CEIET US")
print("Ans: ", end = '')
getAnswer(freq, data, row, column, 2, 5)
```

0	1	2	3	4	5	6
E	R	A	S	B	L	E
C	A	M	S	N	A	B
D	U	M	O	L	E	A
T	O	E	D	C	T	A
M	O	R	Y	R	R	E
E	L	N	T	L	I	I
C	E	E	N	T	G	H
A	D	N	R	I	A	O
E	S	A	V	Q	W	R

5	2					
L	A	S	E	R	B	E
A	M	S	C	A	N	B
E	M	O	D	U	L	A
T	E	D	T	O	C	A
R	R	Y	M	O	R	E
I	N	T	E	L	L	I
G	E	N	C	E	T	H
A	N	R	A	D	I	O
W	A	V	E	S	Q	R

- Rectangle function

前半部分使用 Quiz2 的 q1，通過計算母音數量來檢測出密文之矩形，而後半部程式是將密文之矩形內容存放至一二維陣列中並回傳給主程式中的 data、row 以及 column。

```
def rectangle(text):
    Column = 0
    Row = 0
    min = 100
    L = len(text)
    for i in range(4, L+1):
        if(L%int(i) == 0):
            #print("For", i, "x", int(L/i) ,"rectangle, the sum of the difference is ", end='')
            vowel = L/i*0.4
            freq = [0] * i
            diff = 0.0
            for j in range(L):
                if(text[j] == "A" or text[j] == "E" or text[j] == "I" or text[j] == "O" or text[j] == "U"):
                    freq[j%i] += 1
            for j in range(i):
                diff += abs(freq[j]-vowel)
            #print(round(diff, 2))
            if diff < min:
                min  = diff
                Column = i
                Row = int(L/i)

    Matrix = [['']*Column for i in range(Row)]
    for i in range(Row):
        for j in range(Column):
            Matrix[i][j] += text[(i*Column + j)]
    return Matrix, Row, Column
```

- getAnswer function

在此函式中，first 及 second 代表明文前兩列之數值，由 freq 推算出下一個明文答案的 probability(prob)，根據 prob 的權重結果對應密文位置，反覆執行後即可得出明文答案。

```
def getAnswer(freq, data, row, column, first, second):
    check = [False]*row
    ans = [['']*column for i in range(row)]
    ans[0] = data[first]
    ans[1] = data[second]
    check[first] = True
    check[second] = True
    count = 2
    while (count < row):
        prob = [0]*row
        for i in range(row):
            if check[i]:
                continue
            for j in range(column):
                if (freq[ord(ans[count-2][j])-ord('A')][ord(ans[count-1][j])-ord('A')][ord(data[i][j])-ord('A')] == 0):
                    continue
                prob[i] += math.log10(26*freq[ord(ans[count-2][j])-ord('A')][ord(ans[count-1][j])-ord('A')][ord(data[i][j])-ord('A')])
        ans[count] = data[np.argmax(prob)]
        check[np.argmax(prob)] = True
        count += 1

    for line in np.array(ans).T:
        for c in line:
            print(c, end='')
```

WORD	Frequency
THE	***A*** ***5***
THA	***B*** ***2***
CAR	***C***
CAN	***D***

W(THE)=
Log Pc(THE/TH) / Random
=log (***A*** / ***A***+***B***)/(1/26)
= log 26*(5/7)

```
PS C:\Users\JasmineLu\Desktop> & C:/Users/JasmineLu/AppData/Local/Microsoft/WindowsApps/python3.8.exe
Cipher: ECDTM ECAER AUOOL EDSAM MERNE NASSO DYTNR VBNLC RLTIQ LAETR IGAWE BAAEI HOR
Ans: LASERBEAMSCANBEMODULATEDTOCARRYMOREINTELLIGENCETHANRADIOWAVESQR
Cipher: EOEYE GTRNP SECEH HETYH SNGND DDDET OCRAE RAEMH TECSE USIAR WKDRI RNYAR ANUEY ICNTT CEIET US
Ans: GREECEANNOUNCEDYESTERDAYITHADREACHEDAGREEMENTWITHTURKEYTOENDTHECYPRUSCRISISNS
```