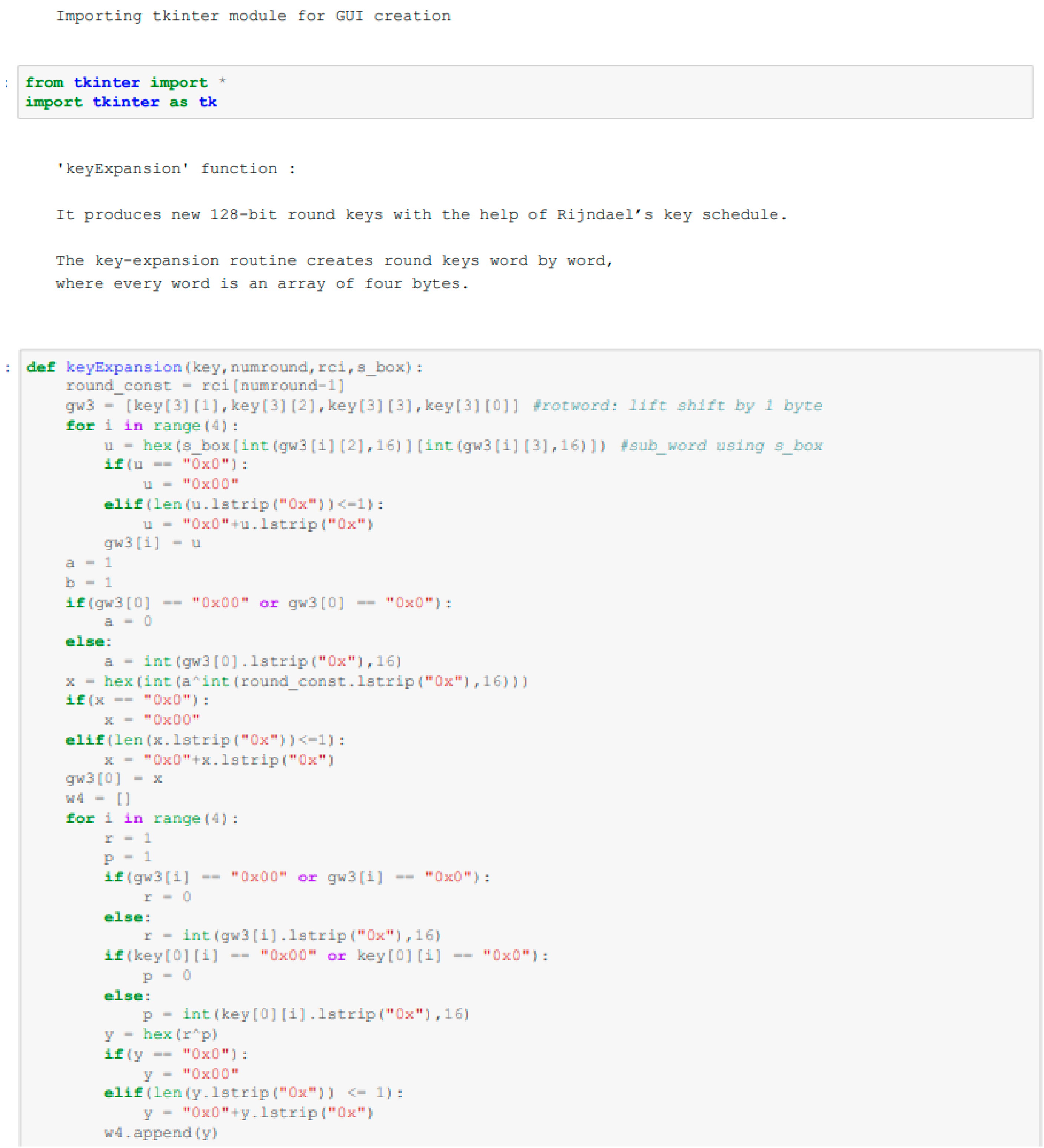
SOURCE CODE:



Importing tkinter module for GUI creation

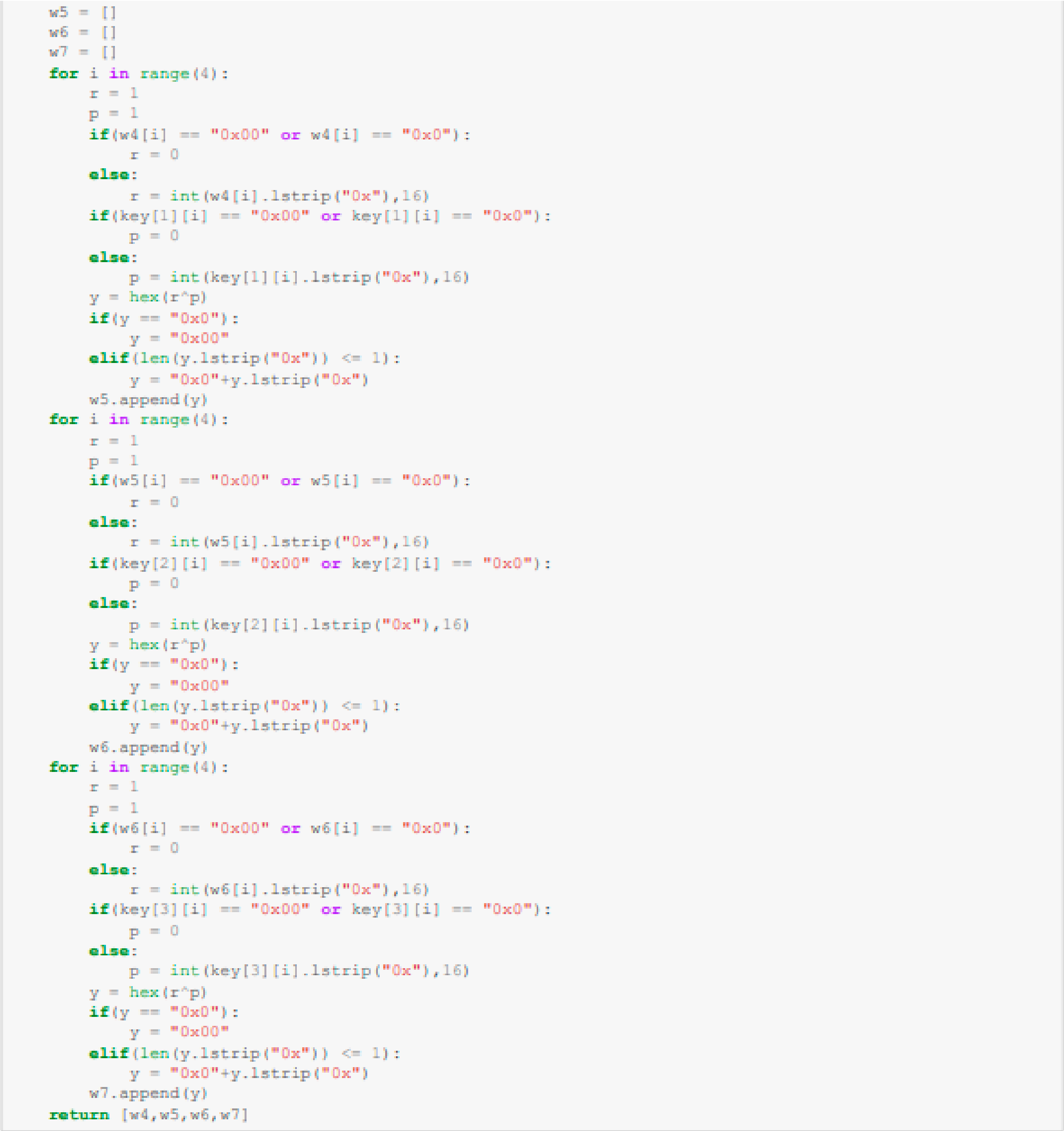
```
from tkinter import *
import tkinter as tk
```

'keyExpansion' function :

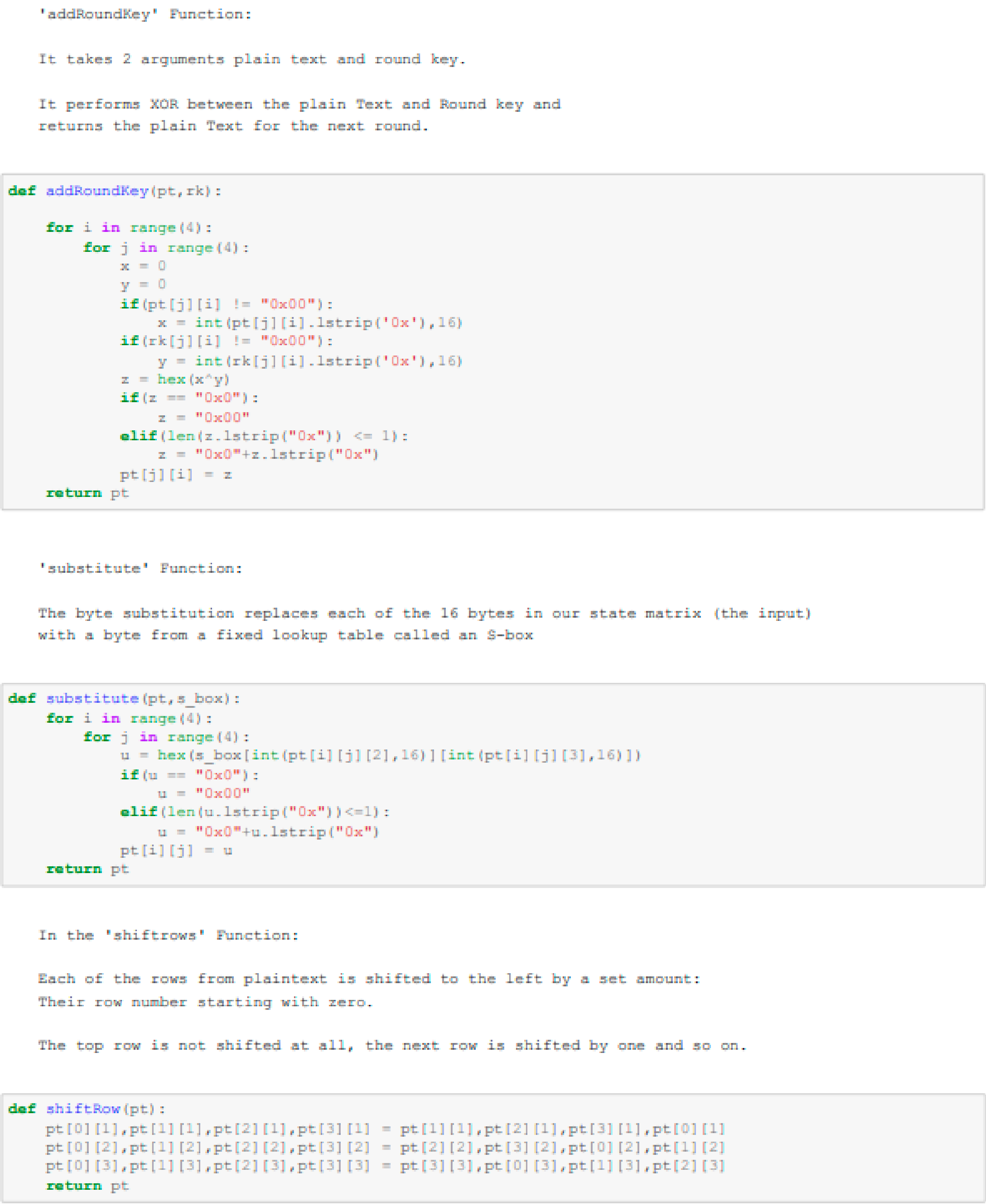
It produces new 128-bit round keys with the help of Rijndael’s key schedule.

The key-expansion routine creates round keys word by word,
where every word is an array of four bytes.

```
def keyExpansion(key,numround,rci,s_box):
    round_const = rci[numround-1]
    gw3 = [key[3][1],key[3][2],key[3][3],key[3][0]] #rotword: lift shift by 1 byte
    for i in range(4):
        u = hex(s_box[int(gw3[i][2],16)][int(gw3[i][3],16)]) #sub_word using s_box
        if(u == "0x0"):
            u = "0x00"
        elif(len(u.lstrip("0x"))<=1):
            u = "0x0"+u.lstrip("0x")
        gw3[i] = u
    a = 1
    b = 1
    if(gw3[0] == "0x00" or gw3[0] == "0x0"):
        a = 0
    else:
        a = int(gw3[0].lstrip("0x"),16)
    x = hex(int(a^int(round_const.lstrip("0x"),16)))
    if(x == "0x0"):
        x = "0x00"
    elif(len(x.lstrip("0x"))<=1):
        x = "0x0"+x.lstrip("0x")
    gw3[0] = x
    w4 = []
    for i in range(4):
        r = 1
        p = 1
        if(gw3[i] == "0x00" or gw3[i] == "0x0"):
            r = 0
        else:
            r = int(gw3[i].lstrip("0x"),16)
        if(key[0][i] == "0x00" or key[0][i] == "0x0"):
            p = 0
        else:
            p = int(key[0][i].lstrip("0x"),16)
        y = hex(r^p)
        if(y == "0x0"):
            y = "0x00"
        elif(len(y.lstrip("0x")) <= 1):
            y = "0x0"+y.lstrip("0x")
        w4.append(y)
```



```
    w5 = []
    w6 = []
    w7 = []
    for i in range(4):
        r = 1
        p = 1
        if(w4[i] == "0x00" or w4[i] == "0x0"):
            r = 0
        else:
            r = int(w4[i].lstrip("0x"),16)
        if(key[1][i] == "0x00" or key[1][i] == "0x0"):
            p = 0
        else:
            p = int(key[1][i].lstrip("0x"),16)
        y = hex(r^p)
        if(y == "0x0"):
            y = "0x00"
        elif(len(y.lstrip("0x")) <= 1):
            y = "0x0"+y.lstrip("0x")
        w5.append(y)
    for i in range(4):
        r = 1
        p = 1
        if(w5[i] == "0x00" or w5[i] == "0x0"):
            r = 0
        else:
            r = int(w5[i].lstrip("0x"),16)
        if(key[2][i] == "0x00" or key[2][i] == "0x0"):
            p = 0
        else:
            p = int(key[2][i].lstrip("0x"),16)
        y = hex(r^p)
        if(y == "0x0"):
            y = "0x00"
        elif(len(y.lstrip("0x")) <= 1):
            y = "0x0"+y.lstrip("0x")
        w6.append(y)
    for i in range(4):
        r = 1
        p = 1
        if(w6[i] == "0x00" or w6[i] == "0x0"):
            r = 0
        else:
            r = int(w6[i].lstrip("0x"),16)
        if(key[3][i] == "0x00" or key[3][i] == "0x0"):
            p = 0
        else:
            p = int(key[3][i].lstrip("0x"),16)
        y = hex(r^p)
        if(y == "0x0"):
            y = "0x00"
        elif(len(y.lstrip("0x")) <= 1):
            y = "0x0"+y.lstrip("0x")
        w7.append(y)
    return [w4,w5,w6,w7]
```



'addRoundKey' Function:

It takes 2 arguments plain text and round key.

It performs XOR between the plain Text and Round key and
returns the plain Text for the next round.

```
def addRoundKey(pt,rk):

    for i in range(4):
        for j in range(4):
            x = 0
            y = 0
            if(pt[j][i] != "0x00"):
                x = int(pt[j][i].lstrip('0x'),16)
            if(rk[j][i] != "0x00"):
                y = int(rk[j][i].lstrip('0x'),16)
            z = hex(x^y)
            if(z == "0x0"):
                z = "0x00"
            elif(len(z.lstrip("0x")) <= 1):
                z = "0x0"+z.lstrip("0x")
            pt[j][i] = z
    return pt
```

'substitute' Function:

The byte substitution replaces each of the 16 bytes in our state matrix (the input)
with a byte from a fixed lookup table called an S-box

```
def substitute(pt,s_box):
    for i in range(4):
        for j in range(4):
            u = hex(s_box[int(pt[i][j][2],16)][int(pt[i][j][3],16)])
            if(u == "0x0"):
                u = "0x00"
            elif(len(u.lstrip("0x"))<=1):
                u = "0x0"+u.lstrip("0x")
            pt[i][j] = u
    return pt
```

In the 'shiftrows' Function:

Each of the rows from plaintext is shifted to the left by a set amount:
Their row number starting with zero.

The top row is not shifted at all, the next row is shifted by one and so on.

```
def shiftRow(pt):
    pt[0][1],pt[1][1],pt[2][1],pt[3][1] = pt[1][1],pt[2][1],pt[3][1],pt[0][1]
    pt[0][2],pt[1][2],pt[2][2],pt[3][2] = pt[2][2],pt[3][2],pt[0][2],pt[1][2]
    pt[0][3],pt[1][3],pt[2][3],pt[3][3] = pt[3][3],pt[0][3],pt[1][3],pt[2][3]
    return pt
```

In 'mixMulCol' function:

Each column is multiplied with a specific matrix and thus the position of each byte in the column is changed as a result.

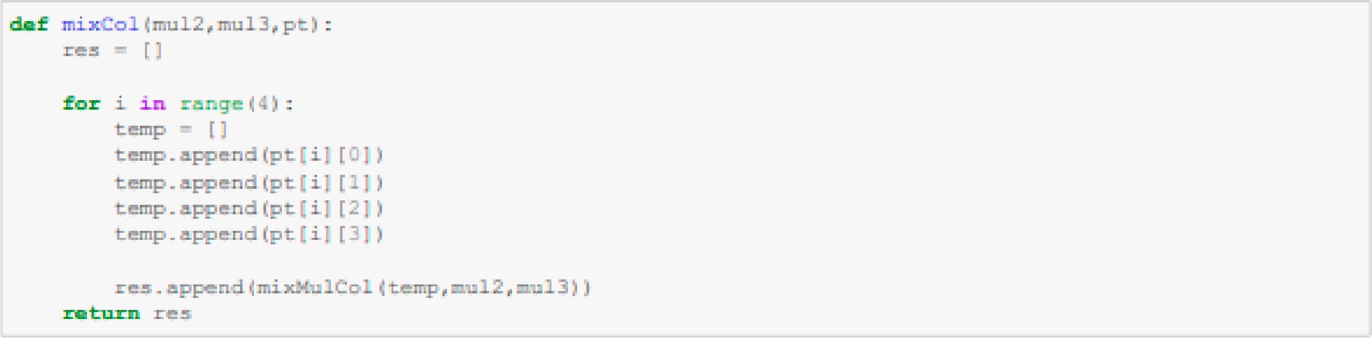
Once all the columns are multiplied with the same constant matrix, you get your state array for the next step.

This particular step is not to be done in the last round.

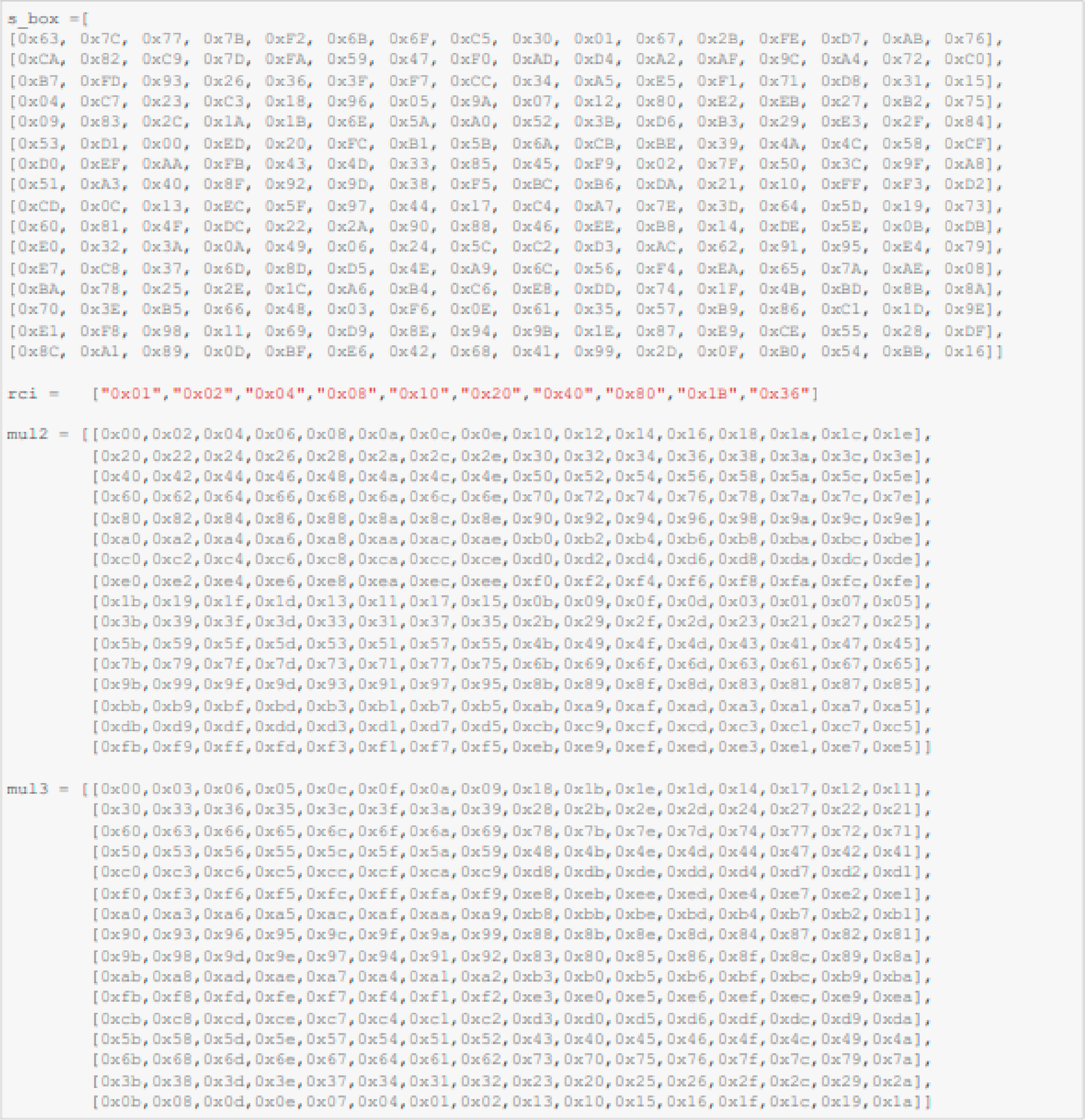
```
def mixMulCol(col,mul2,mul3):
    temp = []
    i = mul2[int(col[0][2],16)][int(col[0][3],16)]
    j = mul3[int(col[1][2],16)][int(col[1][3],16)]
    k = int(col[2],16)
    l = int(col[3],16)
    m = hex(i^j^k^l)
    if(m == "0x0"):
        m = "0x00"
    elif(len(m.lstrip("0x")) <= 1):
        m = "0x0"+m.lstrip("0x")
    temp.append(m) #d0

    i = int(col[0],16)
    j = mul2[int(col[1][2],16)][int(col[1][3],16)]
    k = mul3[int(col[2][2],16)][int(col[2][3],16)]
    l = int(col[3],16)
    m = hex(i^j^k^l)
    if(m == "0x0"):
        m = "0x00"
    elif(len(m.lstrip("0x")) <= 1):
        m = "0x0"+m.lstrip("0x")
    temp.append(m) #d1

    i = int(col[0],16)
    j = int(col[1],16)
    k = mul2[int(col[2][2],16)][int(col[2][3],16)]
    l = mul3[int(col[3][2],16)][int(col[3][3],16)]
    m = hex(i^j^k^l)
    if(m == "0x0"):
        m = "0x00"
    elif(len(m.lstrip("0x")) <= 1):
        m = "0x0"+m.lstrip("0x")
    temp.append(m) #d2

    i = mul3[int(col[0][2],16)][int(col[0][3],16)]
    j = int(col[1],16)
    k = int(col[2],16)
    l = mul2[int(col[3][2],16)][int(col[3][3],16)]
    m = hex(i^j^k^l)
    if(m == "0x0"):
        m = "0x00"
    elif(len(m.lstrip("0x")) <= 1):
        m = "0x0"+m.lstrip("0x")
    temp.append(m) #d3
    return temp
```

The 'mixCol' function takes each row from the Plaint Text.

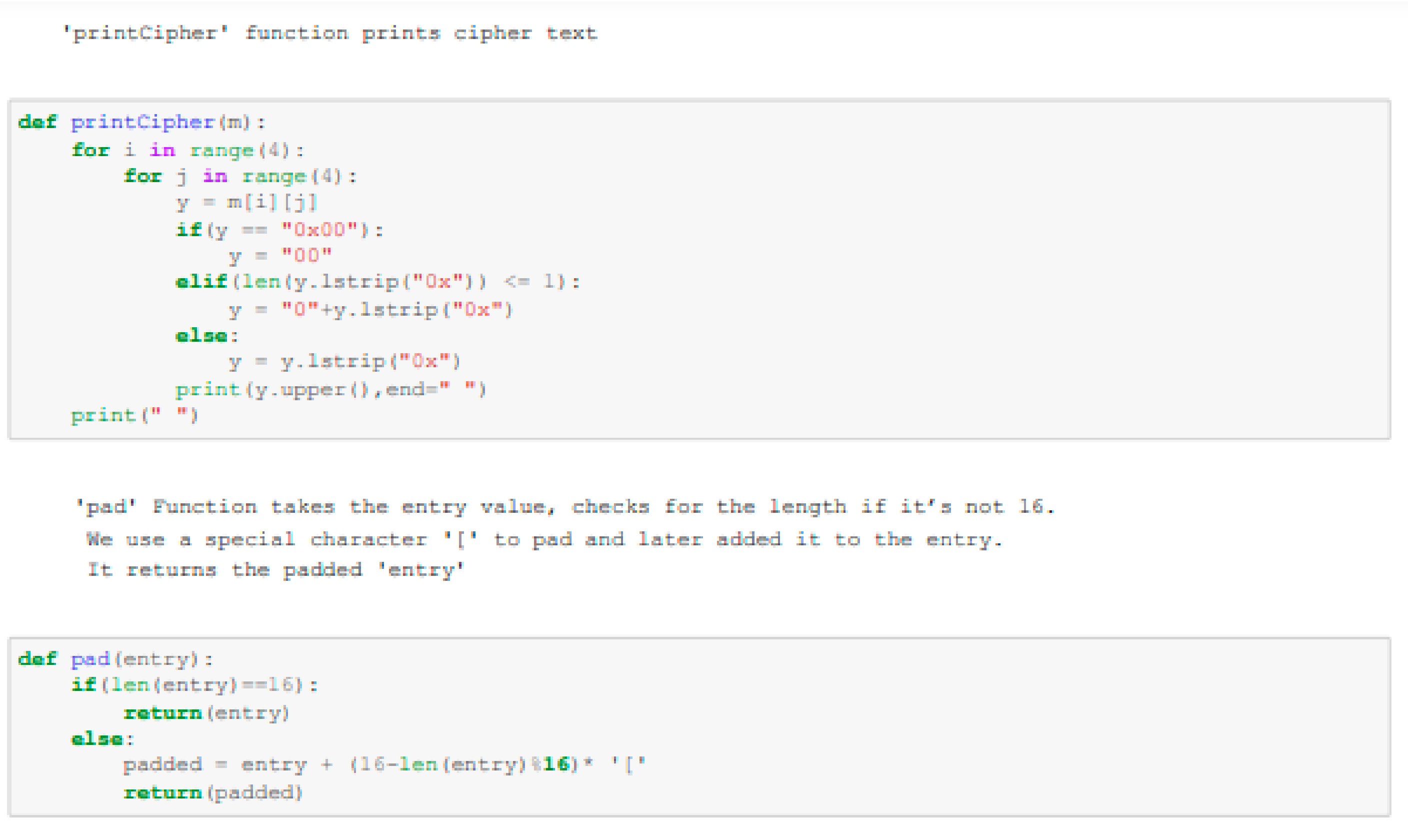
It calls the 'mixMulCol' function by passing row as temp variable, along with the predefined lookup tables mul2 and mul3.



```
def mixCol(mul2,mul3,pt):
    res = []

    for i in range(4):
        temp = []
        temp.append(pt[i][0])
        temp.append(pt[i][1])
        temp.append(pt[i][2])
        temp.append(pt[i][3])

        res.append(mixMulCol(temp,mul2,mul3))
    return res
```



```
s_box =[
[0x63, 0x7C, 0x77, 0x7B, 0xF2, 0x6B, 0x6F, 0xC5, 0x30, 0x01, 0x67, 0x2B, 0xFE, 0xD7, 0xAB, 0x76],
[0xCA, 0x82, 0xC9, 0x7D, 0xFA, 0x59, 0x47, 0xF0, 0xAD, 0xD4, 0xA2, 0xAF, 0x9C, 0xA4, 0x72, 0xC0],
[0xB7, 0xFD, 0x93, 0x26, 0x36, 0x3F, 0xF7, 0xCC, 0x34, 0xA5, 0xE5, 0xF1, 0x71, 0xD8, 0x31, 0x15],
[0x04, 0xC7, 0x23, 0xC3, 0x18, 0x96, 0x05, 0x9A, 0x07, 0x12, 0x80, 0xE2, 0xEB, 0x27, 0xB2, 0x75],
[0x09, 0x83, 0x2C, 0x1A, 0x1B, 0x6E, 0x5A, 0xA0, 0x52, 0x3B, 0xD6, 0xB3, 0x29, 0xE3, 0x2F, 0x84],
[0x53, 0xD1, 0x00, 0xED, 0x20, 0xFC, 0xB1, 0x5B, 0x6A, 0xCB, 0xBE, 0x39, 0x4A, 0x4C, 0x58, 0xCF],
[0xD0, 0xEF, 0xAA, 0xFB, 0x43, 0x4D, 0x33, 0x85, 0x45, 0xF9, 0x02, 0x7F, 0x50, 0x3C, 0x9F, 0xA8],
[0x51, 0xA3, 0x40, 0x8F, 0x92, 0x9D, 0x38, 0xF5, 0xBC, 0xB6, 0xDA, 0x21, 0x10, 0xFF, 0xF3, 0xD2],
[0xCD, 0x0C, 0x13, 0xEC, 0x5F, 0x97, 0x44, 0x17, 0xC4, 0xA7, 0x7E, 0x3D, 0x64, 0x5D, 0x19, 0x73],
[0x60, 0x81, 0x4F, 0xDC, 0x22, 0x2A, 0x90, 0x88, 0x46, 0xEE, 0xB8, 0x14, 0xDE, 0x5E, 0x0B, 0xDB],
[0xE0, 0x32, 0x3A, 0x0A, 0x49, 0x06, 0x24, 0x5C, 0xC2, 0xD3, 0xAC, 0x62, 0x91, 0x95, 0xE4, 0x79],
[0xE7, 0xC8, 0x37, 0x6D, 0x8D, 0xD5, 0x4E, 0xA9, 0x6C, 0x56, 0xF4, 0xEA, 0x65, 0x7A, 0xAE, 0x08],
[0xBA, 0x78, 0x25, 0x2E, 0x1C, 0xA6, 0xB4, 0xC6, 0xE8, 0xDD, 0x74, 0x1F, 0x4B, 0xBD, 0x8B, 0x8A],
[0x70, 0x3E, 0xB5, 0x66, 0x48, 0x03, 0xF6, 0x0E, 0x61, 0x35, 0x57, 0xB9, 0x86, 0xC1, 0x1D, 0x9E],
[0xE1, 0xF8, 0x98, 0x11, 0x69, 0xD9, 0x8E, 0x94, 0x9B, 0x1E, 0x87, 0xE9, 0xCE, 0x55, 0x28, 0xDF],
[0x8C, 0xA1, 0x89, 0x0D, 0xBF, 0xE6, 0x42, 0x68, 0x41, 0x99, 0x2D, 0x0F, 0xB0, 0x54, 0xBB, 0x16]]

rci =   ["0x01","0x02","0x04","0x08","0x10","0x20","0x40","0x80","0x1B","0x36"]

mul2 = [[0x00,0x02,0x04,0x06,0x08,0x0a,0x0c,0x0e,0x10,0x12,0x14,0x16,0x18,0x1a,0x1c,0x1e],
        [0x20,0x22,0x24,0x26,0x28,0x2a,0x2c,0x2e,0x30,0x32,0x34,0x36,0x38,0x3a,0x3c,0x3e],
        [0x40,0x42,0x44,0x46,0x48,0x4a,0x4c,0x4e,0x50,0x52,0x54,0x56,0x58,0x5a,0x5c,0x5e],
        [0x60,0x62,0x64,0x66,0x68,0x6a,0x6c,0x6e,0x70,0x72,0x74,0x76,0x78,0x7a,0x7c,0x7e],
        [0x80,0x82,0x84,0x86,0x88,0x8a,0x8c,0x8e,0x90,0x92,0x94,0x96,0x98,0x9a,0x9c,0x9e],
        [0xa0,0xa2,0xa4,0xa6,0xa8,0xaa,0xac,0xae,0xb0,0xb2,0xb4,0xb6,0xb8,0xba,0xbc,0xbe],
        [0xc0,0xc2,0xc4,0xc6,0xc8,0xca,0xcc,0xce,0xd0,0xd2,0xd4,0xd6,0xd8,0xda,0xdc,0xde],
        [0xe0,0xe2,0xe4,0xe6,0xe8,0xea,0xec,0xee,0xf0,0xf2,0xf4,0xf6,0xf8,0xfa,0xfc,0xfe],
        [0x1b,0x19,0x1f,0x1d,0x13,0x11,0x17,0x15,0x0b,0x09,0x0f,0x0d,0x03,0x01,0x07,0x05],
        [0x3b,0x39,0x3f,0x3d,0x33,0x31,0x37,0x35,0x2b,0x29,0x2f,0x2d,0x23,0x21,0x27,0x25],
        [0x5b,0x59,0x5f,0x5d,0x53,0x51,0x57,0x55,0x4b,0x49,0x4f,0x4d,0x43,0x41,0x47,0x45],
        [0x7b,0x79,0x7f,0x7d,0x73,0x71,0x77,0x75,0x6b,0x69,0x6f,0x6d,0x63,0x61,0x67,0x65],
        [0x9b,0x99,0x9f,0x9d,0x93,0x91,0x97,0x95,0x8b,0x89,0x8f,0x8d,0x83,0x81,0x87,0x85],
        [0xbb,0xb9,0xbf,0xbd,0xb3,0xb1,0xb7,0xb5,0xab,0xa9,0xaf,0xad,0xa3,0xa1,0xa7,0xa5],
        [0xdb,0xd9,0xdf,0xdd,0xd3,0xd1,0xd7,0xd5,0xcb,0xc9,0xcf,0xcd,0xc3,0xc1,0xc7,0xc5],
        [0xfb,0xf9,0xff,0xfd,0xf3,0xf1,0xf7,0xf5,0xeb,0xe9,0xef,0xed,0xe3,0xe1,0xe7,0xe5]]

mul3 = [[0x00,0x03,0x06,0x05,0x0c,0x0f,0x0a,0x09,0x18,0x1b,0x1e,0x1d,0x14,0x17,0x12,0x11],
        [0x30,0x33,0x36,0x35,0x3c,0x3f,0x3a,0x39,0x28,0x2b,0x2e,0x2d,0x24,0x27,0x22,0x21],
        [0x60,0x63,0x66,0x65,0x6c,0x6f,0x6a,0x69,0x78,0x7b,0x7e,0x7d,0x74,0x77,0x72,0x71],
        [0x50,0x53,0x56,0x55,0x5c,0x5f,0x5a,0x59,0x48,0x4b,0x4e,0x4d,0x44,0x47,0x42,0x41],
        [0xc0,0xc3,0xc6,0xc5,0xcc,0xcf,0xca,0xc9,0xd8,0xdb,0xde,0xdd,0xd4,0xd7,0xd2,0xd1],
        [0xf0,0xf3,0xf6,0xf5,0xfc,0xff,0xfa,0xf9,0xe8,0xeb,0xee,0xed,0xe4,0xe7,0xe2,0xe1],
        [0xa0,0xa3,0xa6,0xa5,0xac,0xaf,0xaa,0xa9,0xb8,0xbb,0xbe,0xbd,0xb4,0xb7,0xb2,0xb1],
        [0x90,0x93,0x96,0x95,0x9c,0x9f,0x9a,0x99,0x88,0x8b,0x8e,0x8d,0x84,0x87,0x82,0x81],
        [0x9b,0x98,0x9d,0x9e,0x97,0x94,0x91,0x92,0x83,0x80,0x85,0x86,0x8f,0x8c,0x89,0x8a],
        [0xab,0xa8,0xad,0xae,0xa7,0xa4,0xa1,0xa2,0xb3,0xb0,0xb5,0xb6,0xbf,0xbc,0xb9,0xba],
        [0xfb,0xf8,0xfd,0xfe,0xf7,0xf4,0xf1,0xf2,0xe3,0xe0,0xe5,0xe6,0xef,0xec,0xe9,0xea],
        [0xcb,0xc8,0xcd,0xce,0xc7,0xc4,0xc1,0xc2,0xd3,0xd0,0xd5,0xd6,0xdf,0xdc,0xd9,0xda],
        [0x5b,0x58,0x5d,0x5e,0x57,0x54,0x51,0x52,0x43,0x40,0x45,0x46,0x4f,0x4c,0x49,0x4a],
        [0x6b,0x68,0x6d,0x6e,0x67,0x64,0x61,0x62,0x73,0x70,0x75,0x76,0x7f,0x7c,0x79,0x7a],
        [0x3b,0x38,0x3d,0x3e,0x37,0x34,0x31,0x32,0x23,0x20,0x25,0x26,0x2f,0x2c,0x29,0x2a],
        [0x0b,0x08,0x0d,0x0e,0x07,0x04,0x01,0x02,0x13,0x10,0x15,0x16,0x1f,0x1c,0x19,0x1a]]
```

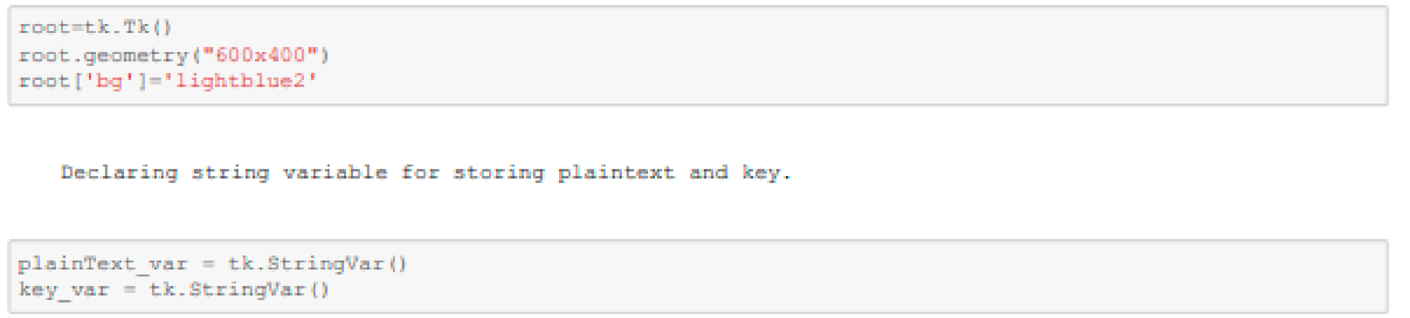


'printCipher' function prints cipher text

```
def printCipher(m):
    for i in range(4):
        for j in range(4):
            y = m[i][j]
            if(y == "0x00"):
                y = "00"
            elif(len(y.lstrip("0x")) <= 1):
                y = "0"+y.lstrip("0x")
            else:
                y = y.lstrip("0x")
            print(y.upper(),end=" ")
    print(" ")
```

'pad' Function takes the entry value, checks for the length if it's not 16.
We use a special character '[' to pad and later added it to the entry.
It returns the padded 'entry'

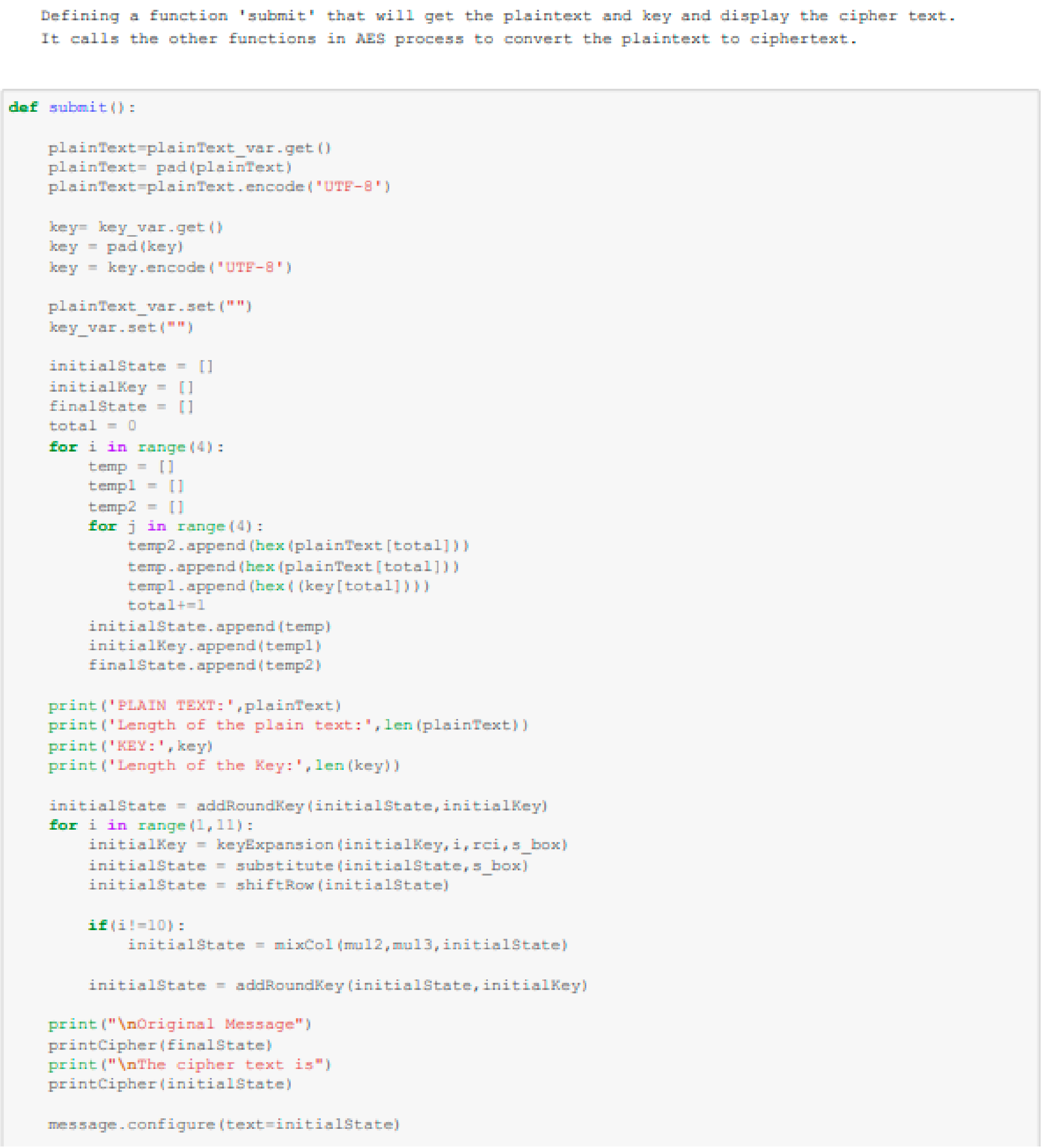
```
def pad(entry):
    if(len(entry)==16):
        return(entry)
    else:
        padded = entry + (16-len(entry)%16)* '['
        return(padded)
```



```
root=tk.Tk()
root.geometry("600x400")
root['bg']='lightblue2'
```

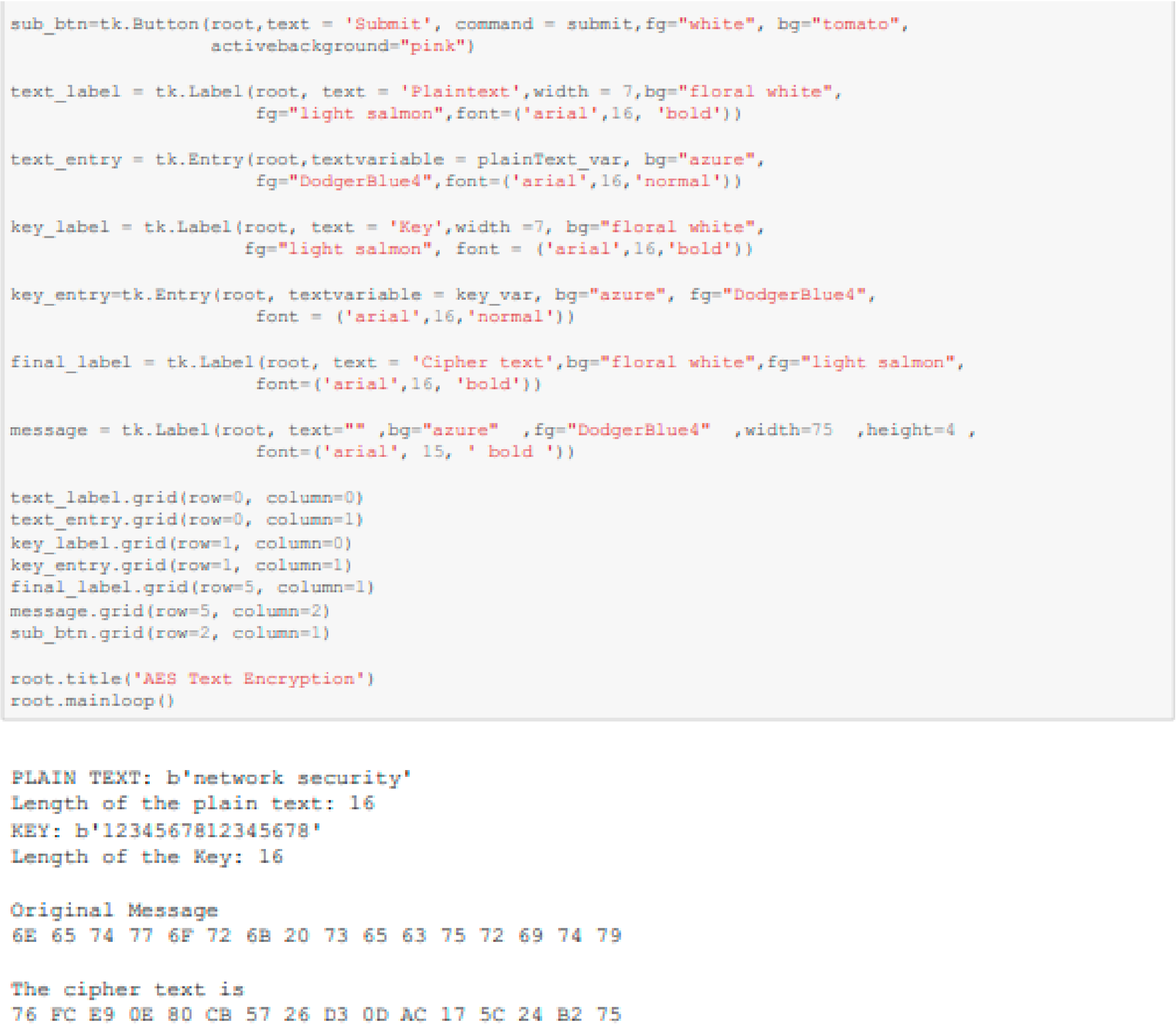
Declaring string variable for storing plaintext and key.

```
plainText_var = tk.StringVar()
key_var = tk.StringVar()
```



Defining a function 'submit' that will get the plaintext and key and display the cipher text.
It calls the other functions in AES process to convert the plaintext to ciphertext.

```python
def submit():

    plainText=plainText_var.get()
    plainText= pad(plainText)
    plainText=plainText.encode('UTF-8')

    key= key_var.get()
    key = pad(key)
    key = key.encode('UTF-8')

    plainText_var.set("")
    key_var.set("")

    initialState = []
    initialKey = []
    finalState = []
    total = 0
    for i in range(4):
        temp = []
        temp1 = []
        temp2 = []
        for j in range(4):
            temp2.append(hex(plainText[total]))
            temp.append(hex(plainText[total]))
            temp1.append(hex((key[total])))
            total+=1
        initialState.append(temp)
        initialKey.append(temp1)
        finalState.append(temp2)

    print('PLAIN TEXT:',plainText)
    print('Length of the plain text:',len(plainText))
    print('KEY:',key)
    print('Length of the Key:',len(key))

    initialState = addRoundKey(initialState,initialKey)
    for i in range(1,11):
        initialKey = keyExpansion(initialKey,i,rci,s_box)
        initialState = substitute(initialState,s_box)
        initialState = shiftRow(initialState)

        if(i!=10):
            initialState = mixCol(mul2,mul3,initialState)

        initialState = addRoundKey(initialState,initialKey)

    print("\nOriginal Message")
    printCipher(finalState)
    print("\nThe cipher text is")
    printCipher(initialState)

    message.configure(text=initialState)
```



```
sub_btn=tk.Button(root,text = 'Submit', command = submit,fg="white", bg="tomato",
                  activebackground="pink")

text_label = tk.Label(root, text = 'Plaintext',width = 7,bg="floral white",
                      fg="light salmon",font=('arial',16, 'bold'))

text_entry = tk.Entry(root,textvariable = plainText_var, bg="azure",
                      fg="DodgerBlue4",font=('arial',16,'normal'))

key_label = tk.Label(root, text = 'Key',width =7, bg="floral white",
                     fg="light salmon", font = ('arial',16,'bold'))

key_entry=tk.Entry(root, textvariable = key_var, bg="azure", fg="DodgerBlue4",
                      font = ('arial',16,'normal'))

final_label = tk.Label(root, text = 'Cipher text',bg="floral white",fg="light salmon",
                      font=('arial',16, 'bold'))

message = tk.Label(root, text="" ,bg="azure"  ,fg="DodgerBlue4"  ,width=75  ,height=4 ,
                      font=('arial', 15, ' bold '))

text_label.grid(row=0, column=0)
text_entry.grid(row=0, column=1)
key_label.grid(row=1, column=0)
key_entry.grid(row=1, column=1)
final_label.grid(row=5, column=1)
message.grid(row=5, column=2)
sub_btn.grid(row=2, column=1)

root.title('AES Text Encryption')
root.mainloop()
```

```
PLAIN TEXT: b'network security'
Length of the plain text: 16
KEY: b'1234567812345678'
Length of the Key: 16

Original Message
6E 65 74 77 6F 72 6B 20 73 65 63 75 72 69 74 79

The cipher text is
76 FC E9 0E 80 CB 57 26 D3 0D AC 17 5C 24 B2 75
```