Cryptography & Network Security Lab

PRN/ Roll No: 2019BTECS00090

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Assignment No. 7

Title: Advanced Encryption Standard

Aim: To Demonstrate Advanced Encryption Standard

Theory:

AES algorithm (Rijndael algorithm) is a symmetric block cipher algorithm. The length of the data packet must be 128 bits, and the length of the key used should be 128, 192 or 256 bits. For three AES algorithms with different key lengths, they are called "AES-128", "AES-192", "AES-256".

Code:

AESencrypt

```
from AESencryptfunc import * #import AESencryptfunc module to use functions cr
eated for this program
import math #import math module to use function such as ceiling

#check that script is running with the two text files as the two parameters or
 else quit
if len(sys.argv) is not 3:#takes in two arguments for the plaintext.txt file n
ame and cipherhex.txt file name
    sys.exit("Error, script needs two command-
line arguments. (Plaintext.txt File and cipherhex.txt File)")

# set passphrase to be a 16 characters, 16 characters * 8 bits = 128 bits stre
ngth
PassPhrase=""
while(len(PassPhrase)!=16):
    print("Enter in the 16 character passphrase to encrypt your text file %s"
%sys.argv[1])
```

```
    PassPhrase=input()#takes in user input of char, eg. "Iwanttolearnkung"
    if(len(PassPhrase)<16):#check if less than 16 characters, if so add one sp
ace character until 16 chars
        while(len(PassPhrase)!=16):
            PassPhrase=PassPhrase+"\00"
    if(len(PassPhrase)>16):#check if bigger than 16 characters, if so then tru
ncate it to be only 16 chars from [0:16]
        print("Your passphrase was larger than 16, truncating passphrase.")
        PassPhrase=PassPhrase[0:16]

#open plaintext.txt file to read and encrypt
file=open(sys.argv[1], "r")
message=(file.read())
print("Inside your plaintext message is:\n%s\n" % message)
file.close()

message=BitVector(textstring=message)
message=message.get_bitvector_in_hex()
replacementptr=0
while(replacementptr<len(message)):
    if(message[replacementptr:replacementptr+2]=='0a'):
        message=message[0:replacementptr]+'0d'+message[replacementptr:len(mess
age)]
        replacementptr=replacementptr+4
    else:
        replacementptr=replacementptr+2

message=BitVector(hexstring=message)
message=message.get_bitvector_in_ascii()
#set up some parameters
start=0#set starting pointer for the part to encrypt of the plaintext
end=0#set ending pointer for the part to encrypt of the plaintex
length=len(message)#check the entire size of the message
loopmsg=0.00#create a decimal value
loopmsg=math.ceil(length/16)+1#use formula to figure how long the message is a
nd how many 16 character segmentss must be encrypted
outputhex=""#setup output message in hex

#need to setup roundkeys here
PassPhrase=BitVector(textstring=PassPhrase)
roundkey1=findroundkey(PassPhrase.get_bitvector_in_hex(),1)
roundkey2=findroundkey(roundkey1,2)
roundkey3=findroundkey(roundkey2,3)
roundkey4=findroundkey(roundkey3,4)
roundkey5=findroundkey(roundkey4,5)
roundkey6=findroundkey(roundkey5,6)
roundkey7=findroundkey(roundkey6,7)
roundkey8=findroundkey(roundkey7,8)
```

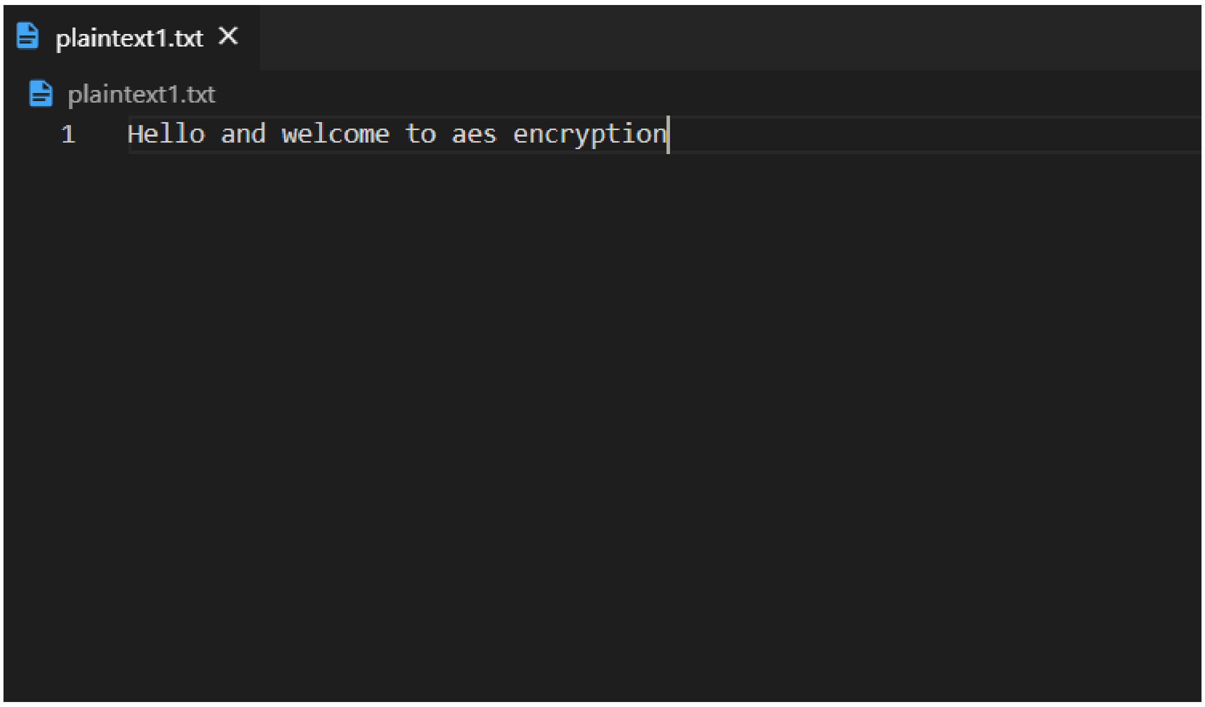
```python
roundkey9=findroundkey(roundkey8,9)
roundkey10=findroundkey(roundkey9,10)
roundkeys=[roundkey1,roundkey2,roundkey3,roundkey4,roundkey5,roundkey6,roundkey7,roundkey8,roundkey9,roundkey10]

#set up FILEOUT to write
FILEOUT = open(sys.argv[2], 'w')

# set up the segement message loop parameters
for y in range(1, loopmsg): # loop to encrypt all segments of the message
    if(end+16<length): #if the end pointer is less than the size of the message, then set the segment to be 16 characters
        plaintextseg = message[start:end + 16]
    else: #or else if the end pointer is equal to or greator than the size of the message
        plaintextseg = message[start:length]
        for z in range(0,((end+16)-length),1): #run a while loop to pad the message segement to become 16 characters, if it is 16 already the loop will not run
            plaintextseg = plaintextseg+"\00"
            #plaintextseg2=BitVector(textstring=plaintextseg)
            #print(plaintextseg2.get_bitvector_in_hex())

    #add round key zero/ find round key one
    bv1 = BitVector(textstring=plaintextseg)
    bv2 = PassPhrase
    resultbv=bv1^bv2
    myhexstring = resultbv.get_bitvector_in_hex()

    for x in range(1, 10):  # loop through 9 rounds
        # sub byte
        myhexstring = resultbv.get_bitvector_in_hex()
        temp1=subbyte(myhexstring)

        # shift rows
        temp2=shiftrow(temp1)

        # mix column
        bv3 = BitVector(hexstring=temp2)
        newbvashex=mixcolumn(bv3)
        newbv=BitVector(hexstring=newbvashex)

        #add roundkey for current round
        bv1 = BitVector(bitlist=newbv)
        bv2 = BitVector(hexstring=roundkeys[x-1])
        resultbv = bv1 ^ bv2
        myhexresult = resultbv.get_bitvector_in_hex()
    #start round 10
    # sub byte round 10
    myhexstring = resultbv.get_bitvector_in_hex()
    temp1=subbyte(myhexstring)

    # shift rows round 10
    temp2=shiftrow(temp1)

    # add round key round 10
    newbv = BitVector(hexstring=temp2)
    bv1 = BitVector(bitlist=newbv)
    bv2 = BitVector(hexstring=roundkeys[9])
    resultbv = bv1 ^ bv2
    myhexstring = resultbv.get_bitvector_in_hex()

    #set encrypted hex segement of message to output string
    outputhextemp = resultbv.get_hex_string_from_bitvector()
    FILEOUT.write(outputhextemp)
    start = start + 16 #increment start pointer
    end = end + 16 #increment end pointer

# encrypted output hex string to specified cipherhex file
FILEOUT.close()

file2=open(sys.argv[2], "r")
print("The output hex value for the entire message is:\n%s\n" % file2.read())
file2.close()
```

AESdecrypt

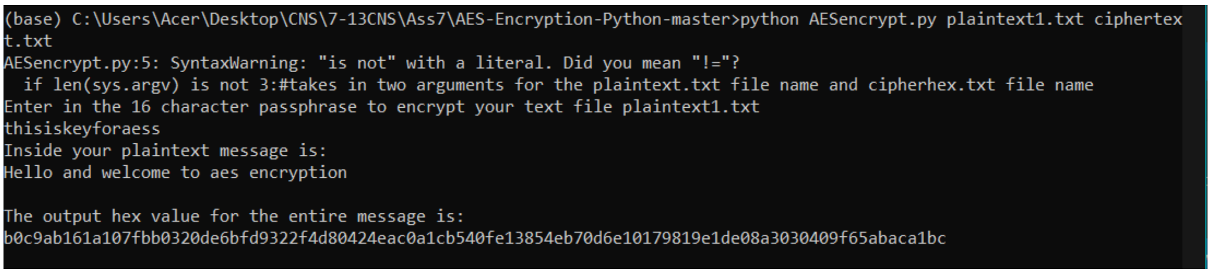
```
from AESdecryptfunc import * #import AESdecryptfunc module to use functions cr
eated for this program
import math #import math module to use function such as ceiling
import io

#check that script is running with the two text files as the two parameters or
 else quit
if len(sys.argv) is not 3:#takes in two arguments for the ciphertext.txt file
name and plainhex.txt file name
    sys.exit("Error, script needs two command-
line arguments. (Ciphertext.txt File and plainhex.txt File)")
PassPhrase=""

while(len(PassPhrase)!=16):
    print("Enter in the 16 character passphrase to decrypt your text file %s"
%sys.argv[1])
    PassPhrase=input()#takes in user input of char, eg. "Iwanttolearnkung"
    if(len(PassPhrase)<16):#check if less than 16 characters, if so add one sp
ace character until 16 chars
        while(len(PassPhrase)!=16):
            PassPhrase=PassPhrase+"\00"
    if(len(PassPhrase)>16):#check if bigger than 16 characters, if so then tru
ncate it to be only 16 chars from [0:16]
        print("Your passphrase was larger than 16, truncating passphrase.")
        PassPhrase=PassPhrase[0:16]

#open ciphertext.txt file to read and decrypt
file=open(sys.argv[1], "r")
message=(file.read())
print("Inside your ciphertext message is:\n%s\n" % message)
file.close()

#set up some parameters
start=0#set starting pointer for the part to decrypt of the ciphertext
end=32#set ending pointer for the part to decrypt of the plaintex
length=len(message)#check the entire size of the message
loopmsg=0.00#create a decimal value
loopmsg=math.ceil(length/32)+1#use formula to figure how long the message is a
nd how many 16 character segmentss must be decrypted
outputhex=""#setup output message segment in hex
asciioutput=""#setup compilation of output message in ascii

#need to setup roundkeys here
PassPhrase=BitVector(textstring=PassPhrase)
roundkey1=findroundkey(PassPhrase.get_bitvector_in_hex(),1)
roundkey2=findroundkey(roundkey1,2)
roundkey3=findroundkey(roundkey2,3)
roundkey4=findroundkey(roundkey3,4)
roundkey5=findroundkey(roundkey4,5)
roundkey6=findroundkey(roundkey5,6)
roundkey7=findroundkey(roundkey6,7)
roundkey8=findroundkey(roundkey7,8)
roundkey9=findroundkey(roundkey8,9)
roundkey10=findroundkey(roundkey9,10)
roundkeys=[roundkey1,roundkey2,roundkey3,roundkey4,roundkey5,roundkey6,roundke
y7,roundkey8,roundkey9,roundkey10]

FILEOUT = io.open(sys.argv[2], 'w', encoding='utf-8')

# set up the segement message loop parameters
for y in range(1, loopmsg): # loop to encrypt all segments of the message
    plaintextseg = message[start:end]

    # add round key
    bv1 = BitVector(hexstring=plaintextseg)
    bv2 = BitVector(hexstring=roundkeys[9])
    resultbv = bv1 ^ bv2
    myhexstring = resultbv.get_bitvector_in_hex()

    #inverse shift row
    myhexstring=invshiftrow(myhexstring)

    #inverse subbyte
    myhexstring=invsubbyte(myhexstring)

    for x in range(8, -1, -1):
        # add roundkey for current round
        bv1 = BitVector(hexstring=myhexstring)
        bv2 = BitVector(hexstring=roundkeys[x])
        resultbv = bv1 ^ bv2
        myhexstring = resultbv.get_bitvector_in_hex()

        # mix column
        bv3 = BitVector(hexstring=myhexstring)
        myhexstring=invmixcolumn(bv3)

        # shift rows
        myhexstring = invshiftrow(myhexstring)

        # sub byte
        myhexstring = invsubbyte(myhexstring)

    #add initial round key
    bv1 = BitVector(hexstring=myhexstring)
    bv2 = PassPhrase
    resultbv = bv1 ^ bv2
    myhexstring = resultbv.get_bitvector_in_hex()

    start = start + 32 #increment start pointer
    end = end + 32 #increment end pointer

    replacementptr = 0
    while (replacementptr < len(myhexstring)):
        if (myhexstring[replacementptr:replacementptr + 2] == '0d'):
            myhexstring = myhexstring[0:replacementptr] + myhexstring[replacem
entptr+2:len(myhexstring)]
        else:
            replacementptr = replacementptr + 2

    outputhex = BitVector(hexstring=myhexstring)
    asciioutput = outputhex.get_bitvector_in_ascii()
    asciioutput=asciioutput.replace('\x00','')
    FILEOUT.write(asciioutput)
FILEOUT.close()

file2=io.open(sys.argv[2], "r", encoding='utf-8')
print("The decrypted message for the entire ciphertext is:\n%s\n" % file2.read
())
file2.close()
```

<u>Output</u>:

PlainText:

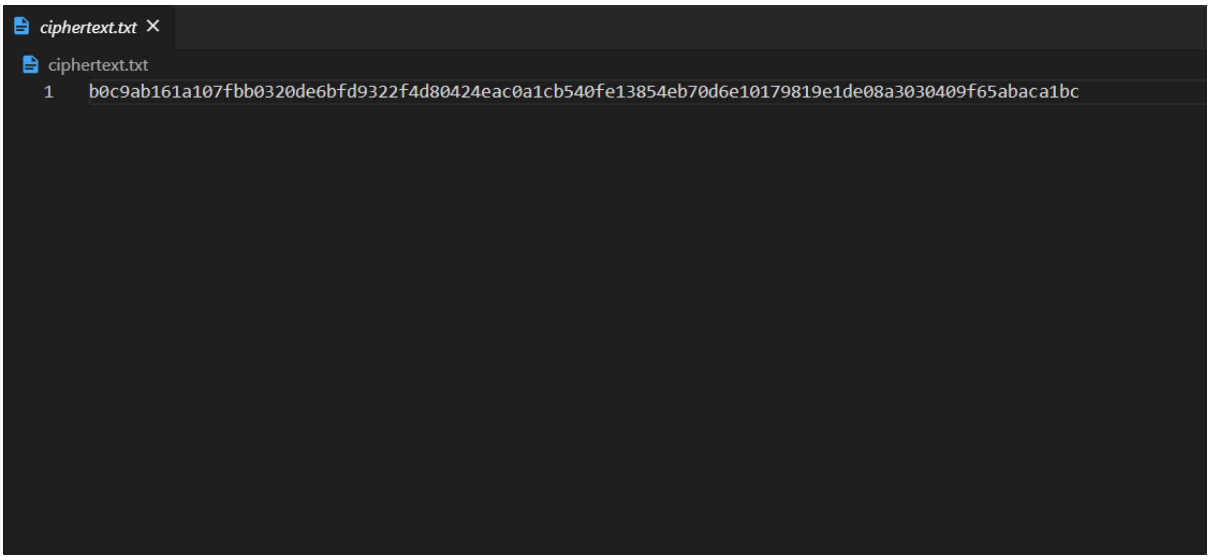


```
Hello and welcome to aes encryption
```

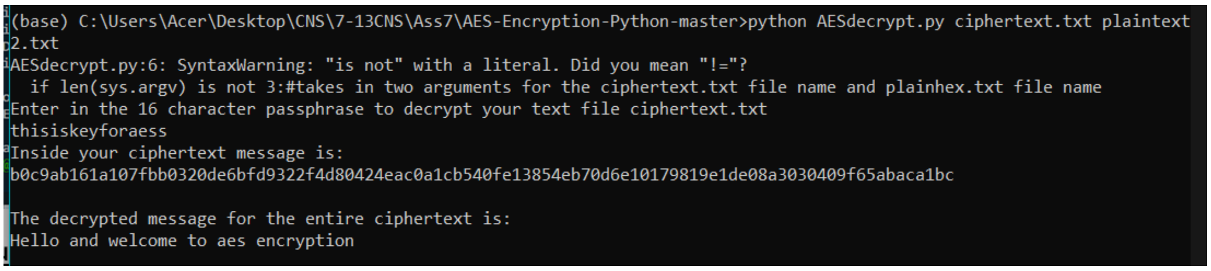


```
(base) C:\Users\Acer\Desktop\CNS\7-13CNS\Ass7\AES-Encryption-Python-master>python AESencrypt.py plaintext1.txt ciphertex
t.txt
AESencrypt.py:5: SyntaxWarning: "is not" with a literal. Did you mean "!="?
  if len(sys.argv) is not 3:#takes in two arguments for the plaintext.txt file name and cipherhex.txt file name
Enter in the 16 character passphrase to encrypt your text file plaintext1.txt
thisiskeyforaess
Inside your plaintext message is:
Hello and welcome to aes encryption

The output hex value for the entire message is:
b0c9ab161a107fbb0320de6bfd9322f4d80424eac0a1cb540fe13854eb70d6e10179819e1de08a3030409f65abaca1bc
```

Cipher Text:

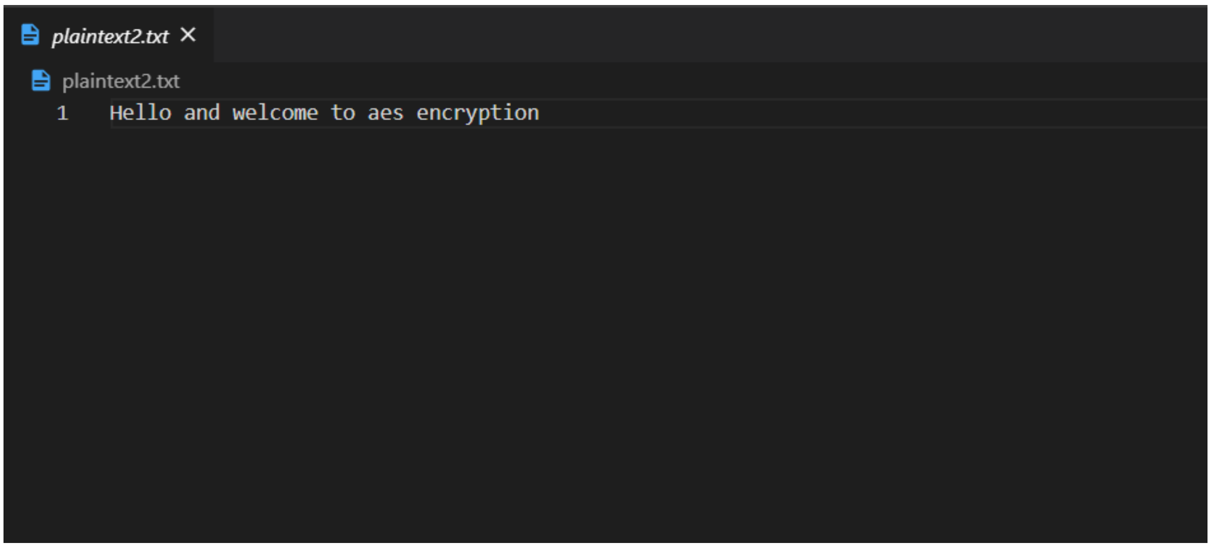


```
ciphertext.txt
1    b0c9ab161a107fbb0320de6bfd9322f4d80424eac0a1cb540fe13854eb70d6e10179819e1de08a3030409f65abaca1bc
```



```
(base) C:\Users\Acer\Desktop\CNS\7-13CNS\Ass7\AES-Encryption-Python-master>python AESdecrypt.py ciphertext.txt plaintext
2.txt
AESdecrypt.py:6: SyntaxWarning: "is not" with a literal. Did you mean "!="?
  if len(sys.argv) is not 3:#takes in two arguments for the ciphertext.txt file name and plainhex.txt file name
Enter in the 16 character passphrase to decrypt your text file ciphertext.txt
thisiskeyforaess
Inside your ciphertext message is:
b0c9ab161a107fbb0320de6bfd9322f4d80424eac0a1cb540fe13854eb70d6e10179819e1de08a3030409f65abaca1bc

The decrypted message for the entire ciphertext is:
Hello and welcome to aes encryption
```

Decrypted Plaintext2 :-



```
Hello and welcome to aes encryption
```

Conclusion:

AES instruction set is now integrated into the CPU (offers throughput of several GB/s) to improve the speed and security of applications that use AES for encryption and decryption. Even though it's been 20 years since its introduction we have failed to break the AES algorithm as it is infeasible even with the current technology.