

Registration Number: 19BCE2119

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Course: Communication and Networks (L15+L16)

Digital Assignment-2 (Error Detection and Correction)

Language Used: Python 3.8.5

Compiler Used: Visual Studio Code

PARITY

```
def getParity( n ):
```

```
    parity = 0
```

```
    while n:
```

```
        parity = ~parity
```

```
        n = n & (n - 1)
```

```
    return parity
```

```
n=input("Enter the number: ")
```

```
n=int(n)
```

```
parity_bit=( "1" if getParity(n) else "0")
```

```
print ("Even Parity bit of number ", n," = ", parity_bit)
```

```
bit=str("{0:b}".format(n))
```

```
bit=bit+str(parity_bit)
```

```
print("Encoded Message after appending parity bit: ", bit)
```

```
n=input("Enter the Encoded Message to check for Error: ")
```

```
n=str(n)
```

```
parity_bit=n[-1]
```

```
orig=""
```

```
for i in range(0,len(n)-1):
```

```
    orig=orig+n[i]
```

```
orig= int(orig,2)
```

```
chk=( "1" if getParity(orig) else "0")
```

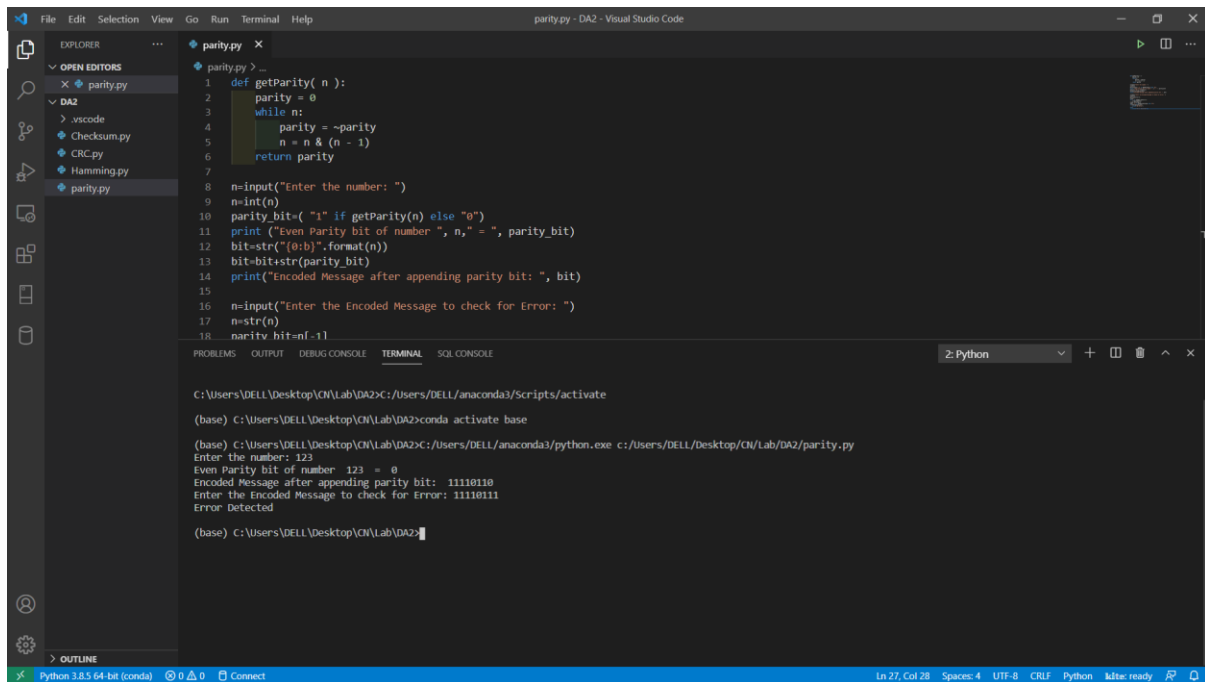
```
if(chk==parity_bit):
```

```
    print("No Error")
```

```
else:
```

```
    print("Error Detected")
```

OUTPUT



The screenshot shows a Visual Studio Code window with a file named `parity.py` open. The code defines a `getParity` function and uses it to calculate a parity bit for a user input. The terminal output shows the script being run, the user entering the number 123, the calculated parity bit being 0, the encoded message being 11110110, and the final output being "Error Detected" because the parity bit (0) does not match the calculated parity bit (1).

```
1 def getParity( n ):  
2     parity = 0  
3     while n:  
4         parity = ~parity  
5         n = n & (n - 1)  
6     return parity  
7  
8 n=input("Enter the number: ")  
9 n=int(n)  
10 parity_bit=( "1" if getParity(n) else "0")  
11 print ("Even Parity bit of number ", n," = ", parity_bit)  
12 bit=str("{0:b}".format(n))  
13 bit=bit+str(parity_bit)  
14 print("Encoded Message after appending parity bit: ", bit)  
15  
16 n=input("Enter the Encoded Message to check for Error: ")  
17 n=str(n)  
18 parity_bit=nt-11
```

Terminal Output:

```
C:\Users\DELL\Desktop\CN\Lab\DA2>C:\Users\DELL\anaconda3\Scripts\activate  
(base) C:\Users\DELL\Desktop\CN\Lab\DA2>conda activate base  
(base) C:\Users\DELL\Desktop\CN\Lab\DA2>C:\Users\DELL\anaconda3\python.exe c:/Users/DELL/Desktop/CN/Lab/DA2/parity.py  
Enter the number: 123  
Even Parity bit of number 123 = 0  
Encoded Message after appending parity bit: 11110110  
Enter the Encoded Message to check for Error: 11110111  
Error Detected  
(base) C:\Users\DELL\Desktop\CN\Lab\DA2>
```

CRC

```
def intToBinary(var):
```

```
    return (bin(var).split("0b"))[1])
```

```
def binToInteger(var):
```

```
    return (int(var,2))
```

```
def stringToList(s):
```

```
    arr=[""]*(len(s))
```

```
    for i in range(len(s)):
```

```
        arr[i]=s[i]
```

```
    return arr
```

```
def listToString(arr):
```

```
    string = ""
```

```
    for element in arr:
```

```
        string += element
```

```
    return str(string)
```

```
def RemainderDecode(divisor,dividend):
```

```
    divisor=stringToList(divisor)
```

```
    dividend=stringToList(dividend)
```

```
    xorterm=""
```

```
    counter=0
```

```
    divisor=listToString(divisor)
```

```
    while (len(str(xorterm))<=len(divisor)):
```

```
        if (counter!=len(dividend)):
```

```
            xorterm = str(xorterm)+ dividend[counter]
```

```
            counter = counter + 1
```

```
        if (len(str(xorterm))==len(divisor)):
```

```
            xorterm=intToBinary(binToInteger(xorterm)^binToInteger(divisor))
```

```
            if (binToInteger(xorterm)==0):
```

```
                xorterm=""
```

```
        if (counter==len(dividend)):
```

```
            if xorterm==divisor:
```

```
                xorterm='0'
```

```
            return str(xorterm)
```

```
def Remainder(divisor, dividend):
```

```
    divisor=stringToList(divisor)
```

```
    dividend=stringToList(dividend)
```

```
    extension=len(divisor) - 1
```

```
    for i in range(extension):
```

```

        dividend.append('0')
xorterm=""
counter=0
divisor=listToString(divisor)
while (len(str(xorterm))<=len(divisor)):

    if (counter!=len(dividend)):
        xorterm = str(xorterm)+ dividend[counter]
        counter = counter + 1
    if (len(str(xorterm))==len(divisor)):
        xorterm=intToBinary(binToInteger(xorterm)^binToInteger(divisor))
        if (binToInteger(xorterm)==0):
            xorterm=""
    if (counter==len(dividend)):
        if xorterm==divisor:
            xorterm='0'
        return str(xorterm)

```

```

def CRCDecoder(divisor, dividend, remainder):

```

```

    n=len(divisor)-1
    remainder=str(remainder)
    while len(remainder)<n:
        remainder='0'+remainder
    dividend=dividend+remainder
    return dividend

```

```

#Encoding

```

```

divisor=str(input("Enter Divisor(in Binary Format): "))
dividend=str(input("Enter Dividend(in Binary Format): "))
print("The Remainder(error detection bit) is: ",Remainder(divisor,dividend))
print("The Encoded Message is: ",CRCDecoder(divisor,dividend,Remainder(divisor,dividend)))

```

#Decoding

```
dividend=str(input("Enter Encoded Message(in Binary Format): "))
```

```
divisor=str(input("Enter Divisor(in Binary Format): "))
```

```
if(RemainderDecode(divisor,dividend)==''):
```

```
    n='0'
```

```
else:
```

```
    n=RemainderDecode(divisor,dividend)
```

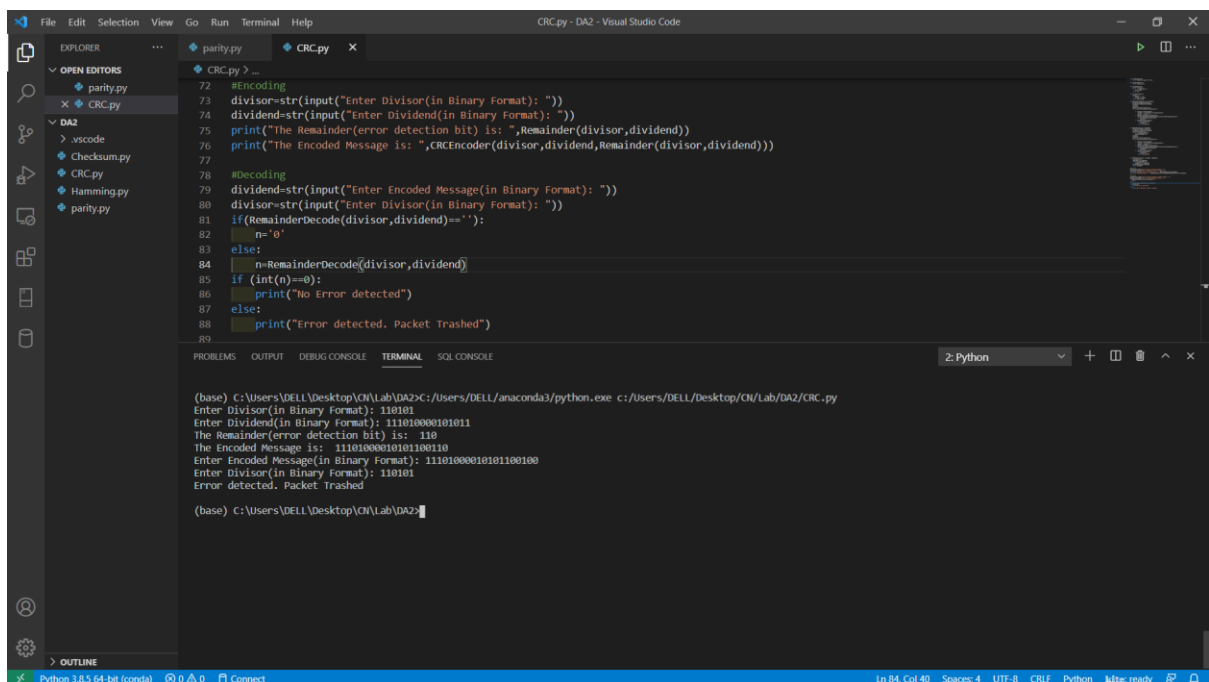
```
if (int(n)==0):
```

```
    print("No Error detected")
```

```
else:
```

```
    print("Error detected. Packet Trashed")
```

OUTPUT



The screenshot shows a Visual Studio Code window with a file named `CRC.py` open. The code is a Python script for CRC decoding. It includes a function `RemainderDecode` (not fully visible) and a main execution block. The main block prompts the user for a divisor and a dividend, calculates the remainder, and prints the encoded message. It then prompts for an encoded message and a divisor, and checks if the remainder is zero. If zero, it prints "No Error detected". Otherwise, it prints "Error detected. Packet Trashed".

```
72 #Encoding
73 divisor=str(input("Enter Divisor(in Binary Format): "))
74 dividend=str(input("Enter Dividend(in Binary Format): "))
75 print("The Remainder(error detection bit) is: ",Remainder(divisor,dividend))
76 print("The Encoded Message is: ",CRCEncoder(divisor,dividend,Remainder(divisor,dividend)))
77
78 #Decoding
79 dividend=str(input("Enter Encoded Message(in Binary Format): "))
80 divisor=str(input("Enter Divisor(in Binary Format): "))
81 if(RemainderDecode(divisor,dividend)==''):
82     n='0'
83 else:
84     n=RemainderDecode(divisor,dividend)
85 if (int(n)==0):
86     print("No Error detected")
87 else:
88     print("Error detected. Packet Trashed")
89
```

The terminal output shows the execution of the script. It prompts for the divisor and dividend, calculates the remainder (110), and prints the encoded message (11101000010101100110). It then prompts for the encoded message and divisor, and prints "Error detected. Packet Trashed".

```
(base) C:\Users\DELL\Desktop\CN\Lab\DA2>python.exe c:/Users/DELL/Desktop/CN/Lab/DA2/CRC.py
Enter Divisor(in Binary Format): 110101
Enter Dividend(in Binary Format): 111010000101011
The Remainder(error detection bit) is: 110
The Encoded Message is: 11101000010101100110
Enter Encoded Message(in Binary Format): 11101000010101100110
Enter Divisor(in Binary Format): 110101
Error detected. Packet Trashed
(base) C:\Users\DELL\Desktop\CN\Lab\DA2>
```

CHECKSUM

```
def flip(c):
```

```
    return '1' if (c == '0') else '0'
```

```
def maximum(a, b):
```

```
    if a >= b:
```

```
        return a
```

```
    else:
```

```
        return b
```

```
def getOnes(bina):
```

```
    ones = ""
```

```
    for i in range(len(bina)):
```

```
        ones += flip(bina[i])
```

```
    return ones
```

```
def intToBinary(var):
```

```
    return (bin(var).split("0b")[1])
```

```
def binToInteger(var):
```

```
    return (int(var,2))
```

```
def BinaryAddition(binarr):
```

```
    sum=0
```

```
    for i in range(len(binarr)):
```

```
        temp=binToInteger(binarr[i])
```

```
        sum=sum+temp
```

```
    return(bin(sum).split('0b')[1])
```

```
def additionCompression(bina,length):
```

```
    arr=[""]*2
```

```
    counter=0
```

```
    while len(bina)>length:
```

```
        while (counter < length):
```

```
            arr[1]=bina[len(bina)-(counter+1)]+str(arr[1])
```

```

        counter=counter+1
    while(counter>=length and counter<len(bina)):
        arr[0]=bina[len(bina)-(counter+1)]+str(arr[0])
        counter=counter+1
    bina=BinaryAddition(arr)
    while len(bina)<length:
        bina='0'+bina
    return getOnes(bina)

```

#CHECKSUM SENDING SIDE

```

n=input("Enter the number of numbers: ")
n=int(n)
arr=[""]*n
length=0
for i in range(n):
    arr[i]=input("Enter Number (in integer without conversion to binary): ")
    arr[i]=intToBinary(int(arr[i]))
    length=maximum(length,len(arr[i]))
for i in range(n):
    while len(arr[i])<length:
        arr[i]='0'+arr[i]
Sum=BinaryAddition(arr)
print("Sum of the numbers:",Sum)
checksum=additionCompression(Sum,length)
print("Ones complement after compressing the addition: ",checksum)
arr.append(checksum)
print("Encoded Message:", arr)

```

#CHECKSUM RECIEVING SIDE

```

n=input("Enter the no. of words in the packet received (including checksum): ")
n=int(n)

```

```

arr=[""]*n

for i in range(n-1):

    print("Enter ",i+1," word in binary: ")

    arr[i]=input()

print("Enter checksum in binary: ")

arr[n-1]=input()

Sum=BinaryAddition(arr)

length=len(arr[0])

Check=additionCompression(Sum,length)

if binToInteger(Check)==0:

    print("No Error found")

    print("The encoded message is: ")

    for i in range(n-1):

        print(binToInteger(arr[i]),"\t")

else:

    print("Error Detected")

```

OUTPUT

```

Checksum.py X
69 print("Enter ",i+1," word in binary: ")
70 arr[i]=input()
71 print("Enter checksum in binary: ")
72 arr[n-1]=input()
73 Sum=BinaryAddition(arr)
74 length=len(arr[0])
75 Check=additionCompression(Sum,length)
76 if binToInteger(Check)==0:
77     print("No Error found")
78     print("The encoded me
79     for i in range(n-1):
80         print(binToInteger(arr[i]),"\t")
81 else:
82     print("Error Detected")

```

```

(base) C:\Users\DELL\Desktop\ON\Lab\DA2>C:\Users\DELL\anaconda3\python.exe c:/Users/DELL/Desktop/ON/Lab/DA2/Checksum.py
Enter the number of numbers: 4
Enter Number (in integer without conversion to binary): 124
Enter Number (in integer without conversion to binary): 256
Enter Number (in integer without conversion to binary): 234
Enter Number (in integer without conversion to binary): 342
Sum of the numbers: 1110111100
Ones complement after compressing the addition: 0010000010
Encoded Message: ['001111100', '100000000', '011101010', '101010110', '001000010']
Enter the no. of words in the packet received (including checksum): 5
Enter 1 word in binary:
001111100
Enter 2 word in binary:
100000000
Enter 3 word in binary:
011101010
Enter 4 word in binary:
101010110
Enter checksum in binary:
001000010
No Error found
The encoded message is:
124
256
234
342

```


HAMMING CODE

```
def calcRedundantBits(m):
```

```
    for i in range(m):
```

```
        if(2**i >= m + i + 1):
```

```
            return i
```

```
def DecodeProcessing(arr):
```

```
    del arr[0]
```

```
    temp=(reverseArray(arr))
```

```
    return temp
```

```
def reverseArray(arr):
```

```
    temp=['']*len(arr)
```

```
    for i in range(len(arr)):
```

```
        temp[i]=arr[-(i+1)]
```

```
    return temp
```

```
def getParity( n ):
```

```
    parity = 0
```

```
    while n:
```

```
        parity = ~parity
```

```
        n = n & (n - 1)
```

```
    return parity
```

```
def intToBinary(var):
```

```
    return (bin(var).split("0b")[1])
```

```
def binToInteger(var):
```

```
    return (int(var,2))
```

```
def listToString(arr):
```

```
    string = ""
```

```
    for element in arr:
```

```
        string += element
```

```
    return string
```

```

def arrRedundantPosition(r):
    arrRedundantPos=[]
    for i in range(r):
        arrRedundantPos.append(2**i-1)
    return arrRedundantPos

def getParitybit(arr, r):
    temp=""
    for i in range(len(arr)):
        if (i & r == r) :
            temp += arr[i]
    return "1" if getParity(binToInteger(temp)) else "0"

def Hamming(message):
    print("Original message is: ", message)
    message=intToBinary(message)
    print("Message in binary is: ",message)
    m=len(message)
    r=calcRedundantBits(m)
    print("Number of redundant bits is: ",r)
    n=m+r
    arr=["0"]*n
    arrRedundantPos=arrRedundantPosition(r)
    counter=0
    for i in range(n):
        if i not in arrRedundantPos:
            counter= counter+1
            arr[i]=message[-counter]
    arr.insert(0,'START')
    for i in range(len(arrRedundantPos)):
        arrRedundantPos[i] = arrRedundantPos[i]+1
    for i in arrRedundantPos:
        arr[i]=getParitybit(arr,i)

```

```

    for i in range(len(arr)-1):
        arr[i]=arr[i+1]
    arr.pop(-1)
    HammingArr=reverseArray(arr)
    print("The Hamming Code encoded message is: ",listToString(HammingArr))
def checkArrayRedundantBits(arr):
    n=len(arr)
    arr=[]
    for i in range(n):
        if 2**i < n:
            arr.append(2**i)
    return arr
#Encoding
n=int(input("Enter the number which you want to encode(in Decimals): "))
Hamming(n)
#Decoding
n=input("Enter the Encoded Message: ")
print("The Encoded Message is: ", n)
arr=[""]*(len(n))
for i in range(len(n)):
    arr[i]=n[i]
arr=reverseArray(arr)
RedArr=checkArrayRedundantBits(arr)
arr.insert(0,'START')
ErrorPos=[]
for i in RedArr:
    ErrorPos.append(getParitybit(arr, i))
if binToInteger(listToString(reverseArray(ErrorPos)))==0:
    print("No Error Found")
    arr=DecodeProcessing(arr)
else:

```

```

errordet=binToInteger(listToString(reverseArray(ErrorPos)))

print("Error Found at ",errordet, " position from the left(Big Endian)")

arr=DecodeProcessing(arr)

if (arr[-(errordet)]=='1'):

    arr[-errordet]='0'

else:

    arr[-errordet]='1'

print("The Corrected Encoded Message is: ",listToString(arr))

CArrBin=[]

for i in range(len(RedArr)):

    RedArr[i]=~RedArr[i]

for i in range(len(arr)):

    if -(i+1) not in RedArr:

        CArrBin.append(arr[-(i+1)])

CArrBin=reverseArray(CArrBin)

print("The Decoded Message in binary is: ", listToString(CArrBin))

print("The Message Recieved is: ", binToInteger(listToString(CArrBin)))

```

OUTPUT

```

Hamming.py
83 n=int(input("Enter the number which you want to encode(in Decimals): "))
84 Hamming(n)
85
86
87 #Decoding
88 n=input("Enter the Encoded Message: ")
89 print("The Encoded Message is: ", n)
90 arr=['']*(len(n))
91 for i in range(len(n)):
92     arr[i]=n[i]
93 arr=reverseArray(arr)
94 RedArr=checkArrayRedundantBits(arr)
95 arr.insert(0,'START')
96 ErrorPos=[]
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