18th_Version BB84 Protocol [July 11 2021]

July 12, 2021

[11]:
```
import numpy as np
# Importing standard Qiskit libraries
from qiskit import QuantumCircuit, transpile, Aer, IBMQ
from qiskit.tools.jupyter import *
from qiskit.visualization import *
from ibm_quantum_widgets import *

# Loading your IBM Quantum account(s)
#bishwajitprasadgond@gmail.com
provider = IBMQ.load_account()
```

```
ibmqfactory.load_account:WARNING:2021-07-10 18:43:27,230: Credentials are
already in use. The existing account in the session will be replaced.
```

[1]:
```
from qiskit.tools.monitor import backend_monitor
from qiskit import *
from qiskit.visualization import plot_histogram
from random import randrange, seed, sample
from sys import argv, exit
import random

data = int(input('ENTER LENGTH OF BIT STREAM (example 5 For 10110):'))
##########################################################################
#print('Enter  1 or 0 bit stream ')
#h=int(input())
def bit_stream(p):
    key1 = ""
    for i in range(p):
        temp = str(random.randint(0,1))
        key1 += temp
    return(key1)

bitstream= bit_stream(data)
digits = [int(x) for x in str(bitstream)]
##########################################################################
print('List of Bit Stream to transfer over Quantum Channel')
print(digits)
print('\n')
n = len(digits)
print('Enter  1 for H-bases and 0 for Z-bases ')
##########################################################################
g=int(input())
def random_bases(p):
    key1 = ""
    for i in range(p):
        temp = str(random.randint(g,g))
        key1 += temp
    return(key1)
##########################################################################
Alice_bases= random_bases(data)
Bob_bases= random_bases(data)
print('List of ALICE bases where 1 represent H-bases and 0 represent Z-bases ')
alice = [int(x) for x in str(Alice_bases)]
print(alice)
print('\n')
print('List of BOB bases where 1 represent H-bases and 0 represent Z-bases ')
bob = [int(x) for x in str(Bob_bases)]
print(bob)
###########################################################################
def check_bases(b1,b2):
    check = ''
    matches = 0
    for i in range(len(b1)):
        if b1[i] == b2[i]:
            check += "Y"
            matches += 1
        else:
            check += "X"
    return [check,matches]
print('\n')
print('ALICE and BOB bases matching where X= not matched, Y= matched ')
check_bases(Alice_bases,Bob_bases)
%matplotlib inline
###########################################################################
bob_bits=[]
m = int(input('Enter the length of Identity Gate Between Quantum Channel: '))
from random import choice
for i in range(n):
    if digits[i] == 1:
        qc= QuantumCircuit(1,1)
        qc.x(0)
        qc.barrier()
        if alice[i]==1:
            qc.h(0)
        if alice[i]==0:
            qc.z(0)
        qc.barrier()
        for j in range(m):
            qc.id(0)
            qc.barrier()
        if bob[i]==1:
            qc.h(0)
        if bob[i]==0:
            qc.z(0)
        qc.barrier()
        qc.measure(list(range(1)),list(range(1)))
        from qiskit.tools.monitor import backend_monitor
        IBMQ.load_account()
        provider = IBMQ.get_provider(hub='ibm-q')
        device = provider.get_backend('ibmq_armonk')       # Enable for Real␣
↪Quantum Device
        #device = Aer.get_backend('qasm_simulator')           # Enable for␣
↪simulator
        job = execute(qc, backend=device, shots=1000)
        print(job.job_id())
        from qiskit.tools.monitor import job_monitor
        job_monitor(job)
        device_result = job.result()
        plot_histogram(device_result.get_counts(qc))
        bits = (device_result.get_counts(qc))
        itemMaxValue = max(bits.items(), key=lambda x : x[1])
        print(itemMaxValue)
        # Iterate over all the items in dictionary to find keys with max value
        for key, value in bits.items():
            if value == itemMaxValue[1]:
                bob_bits.append(key)

    if digits[i] == 0:
        qc = QuantumCircuit(1,1)
        qc.barrier()
        if alice[i]==1:
            qc.h(0)
        if alice[i]==0:
            qc.z(0)
        qc.barrier()
        for j in range(m):
            qc.id(0)
            qc.barrier()
        if bob[i]==1:
            qc.h(0)
        if bob[i]==0:
            qc.z(0)
        qc.barrier()
        qc.measure(list(range(1)),list(range(1)))
        from qiskit.tools.monitor import backend_monitor
        IBMQ.load_account()
        provider = IBMQ.get_provider(hub='ibm-q')
        device = provider.get_backend('ibmq_armonk')       # Enable for Real Quantum Device
        #device = Aer.get_backend('qasm_simulator')          # Enable for simulator
        job = execute(qc, backend=device, shots=1000)
        print(job.job_id())
        from qiskit.tools.monitor import job_monitor
        job_monitor(job)
        device_result = job.result()
        plot_histogram(device_result.get_counts(qc))
        bits =(device_result.get_counts(qc))
        itemMaxValue = max(bits.items(), key=lambda x : x[1])
        print(itemMaxValue)
        # Iterate over all the items in dictionary to find keys with max value
        for key, value in bits.items():
            if value == itemMaxValue[1]:
                bob_bits.append(key)
    #print(qc)
    #qc.draw(output='mpl')
    print("\n")
########################################################################
def check_bits(b1,b2,bck):
    check = ''
    for i in range(len(b1)):
        if b1[i] == b2[i] and bck[i] == 'Y':
            check += 'Y'
        elif b1[i] == b2[i] and bck[i] != 'Y':
            check += 'R'
        elif b1[i] != b2[i] and bck[i] == 'Y':
            check += '!'
        elif b1[i] != b2[i] and bck[i] != 'Y':
            check += '-'
    return check
########################################################################
def transferredbits(b1,b2,bck):
    check = ''
    for i in range(len(b1)):
        if b1[i] == b2[i] and bck[i] == 'Y':
            check += 'Y'
        elif b1[i] != b2[i] and bck[i] == 'Y':
            check += '!'
    return check
########################################################################
def bob_measurement(qc,b):
    backend = Aer.get_backend('qasm_simulator')
    l = len(b)
    for i in range(l):
        if b[i] == '1':
            qc.h(i)
    qc.measure(list(range(l)),list(range(l)))
    result = execute(qc,backend,shots=1).result()
    bits = list(result.get_counts().keys())[0]

    bits = ''.join(list(reversed(bits)))
    qc.barrier()
    return [qc,bits]
```

```
ENTER LENGTH OF BIT STREAM (example 5 For 10110):8
List of Bit Stream to transfer over Quantum Channel
[1, 0, 0, 0, 1, 0, 1, 0]


Enter  1 for H-bases and 0 for Z-bases
1
List of ALICE bases where 1 represent H-bases and 0 represent Z-bases
[1, 1, 1, 1, 1, 1, 1, 1]


List of BOB bases where 1 represent H-bases and 0 represent Z-bases
[1, 1, 1, 1, 1, 1, 1, 1]


ALICE and BOB bases matching where X= not matched, Y= matched
Enter the length of Identity Gate Between Quantum Channel: 1800
60ec5e06a124804e84f38f28
Job Status: job has successfully run

ibmqfactory.load_account:WARNING:2021-07-12 15:22:03,803: Credentials are
already in use. The existing account in the session will be replaced.

('0', 559)


60ec5e1ea728f73f8d5450a2
Job Status: job has successfully run

ibmqfactory.load_account:WARNING:2021-07-12 15:22:59,655: Credentials are
already in use. The existing account in the session will be replaced.

('0', 511)
```

```
60ec5e56a124808653f38f2d
Job Status: job has successfully run
```

```
ibmqfactory.load_account:WARNING:2021-07-12 15:23:21,315: Credentials are
already in use. The existing account in the session will be replaced.
```

```
('1', 508)
```

```
60ec5e6c3cdfa326d562768e
Job Status: job has successfully run
('0', 524)
```

```
ibmqfactory.load_account:WARNING:2021-07-12 15:24:28,828: Credentials are
already in use. The existing account in the session will be replaced.
```

```
60ec5eaf3115fd36b29e92f5
Job Status: job has successfully run
```

```
ibmqfactory.load_account:WARNING:2021-07-12 15:24:50,722: Credentials are
already in use. The existing account in the session will be replaced.
```

```
('1', 534)
```

```
60ec5ec53115fd215b9e92f6
Job Status: job has successfully run
```

```
ibmqfactory.load_account:WARNING:2021-07-12 15:26:40,529: Credentials are
already in use. The existing account in the session will be replaced.
```

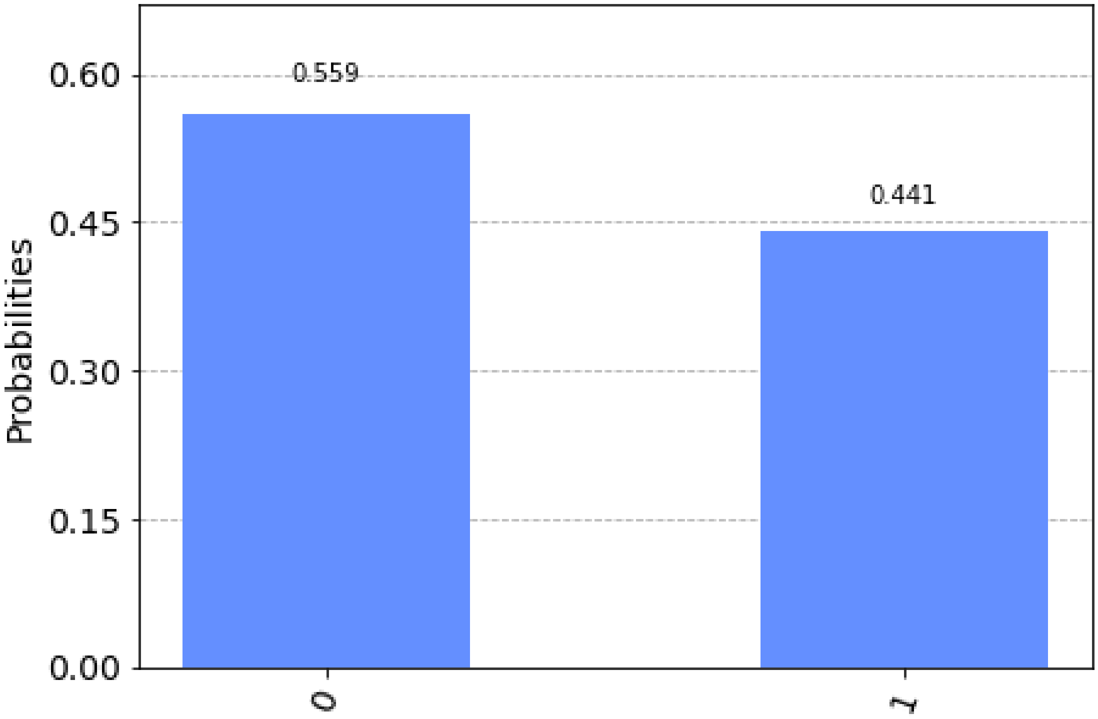
```
('1', 511)
```

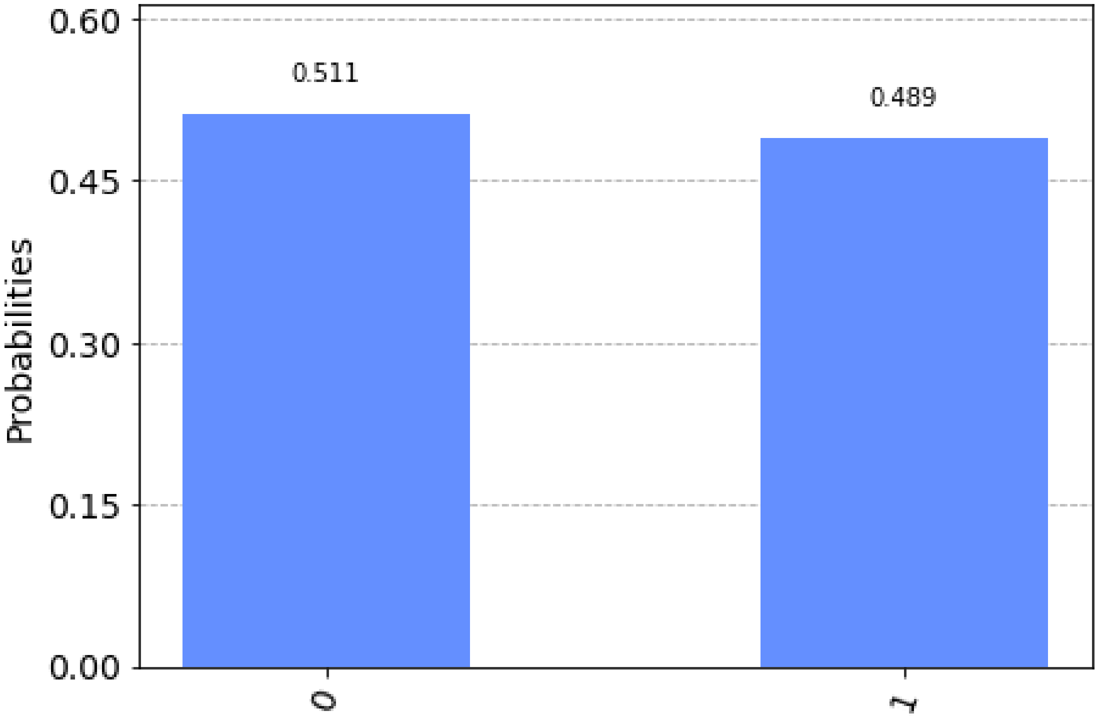
```
60ec5f333cdfa34205627693
Job Status: job has successfully run
```

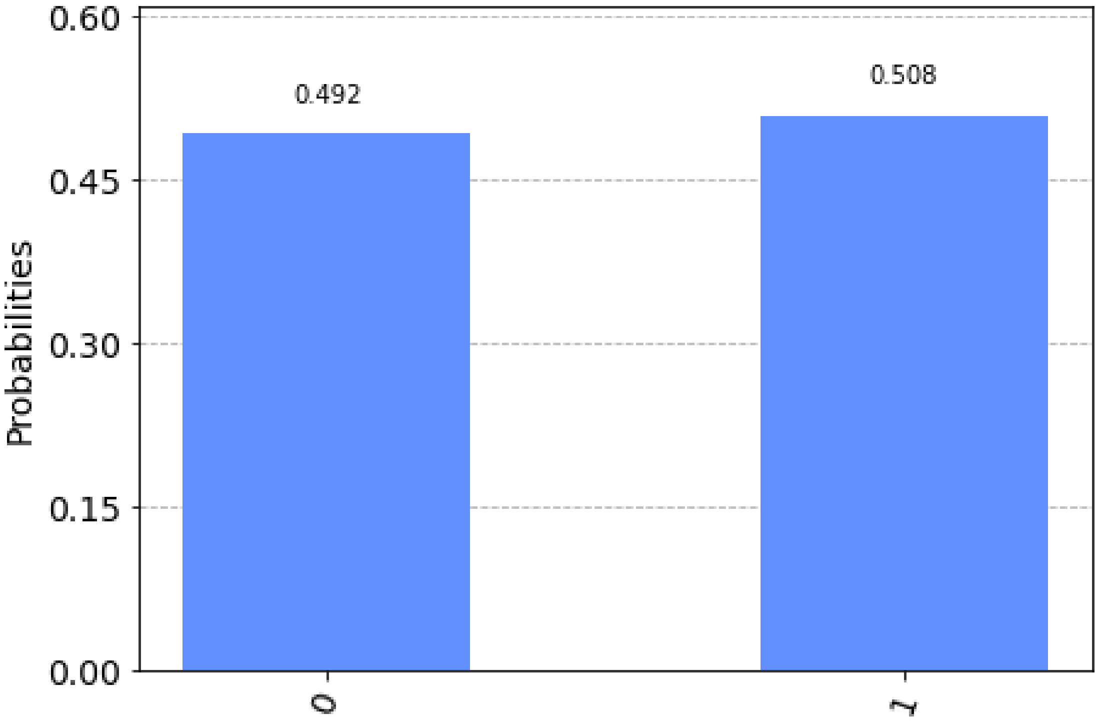
```
ibmqfactory.load_account:WARNING:2021-07-12 15:27:15,970: Credentials are
already in use. The existing account in the session will be replaced.
```

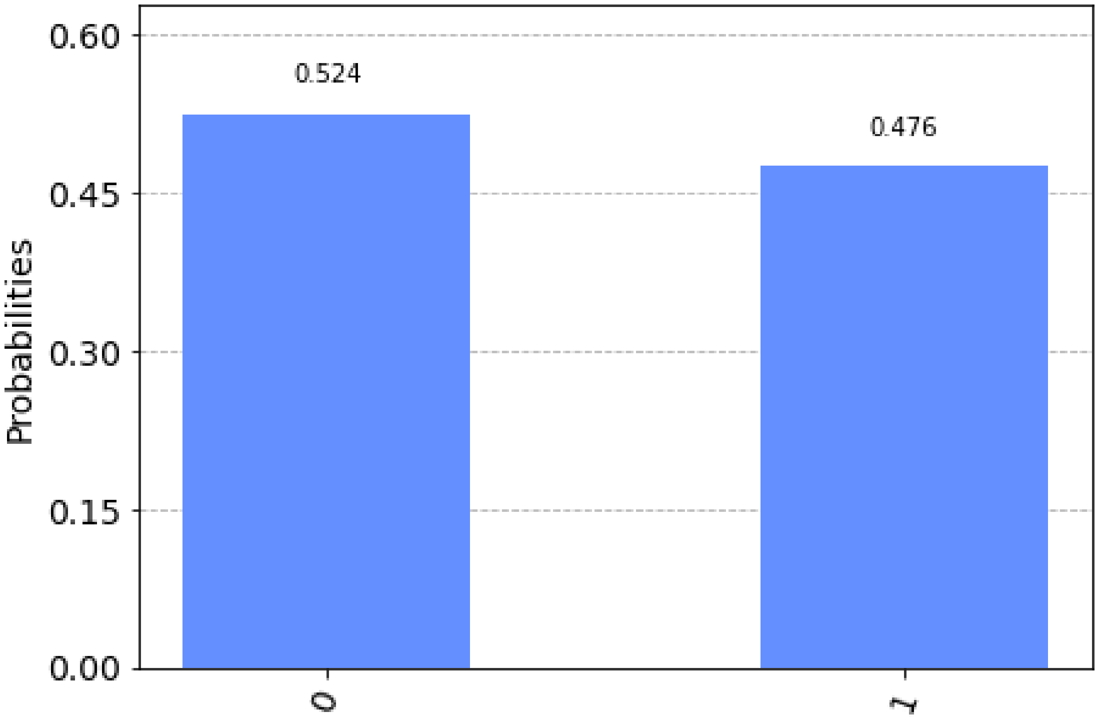
```
('1', 551)
```

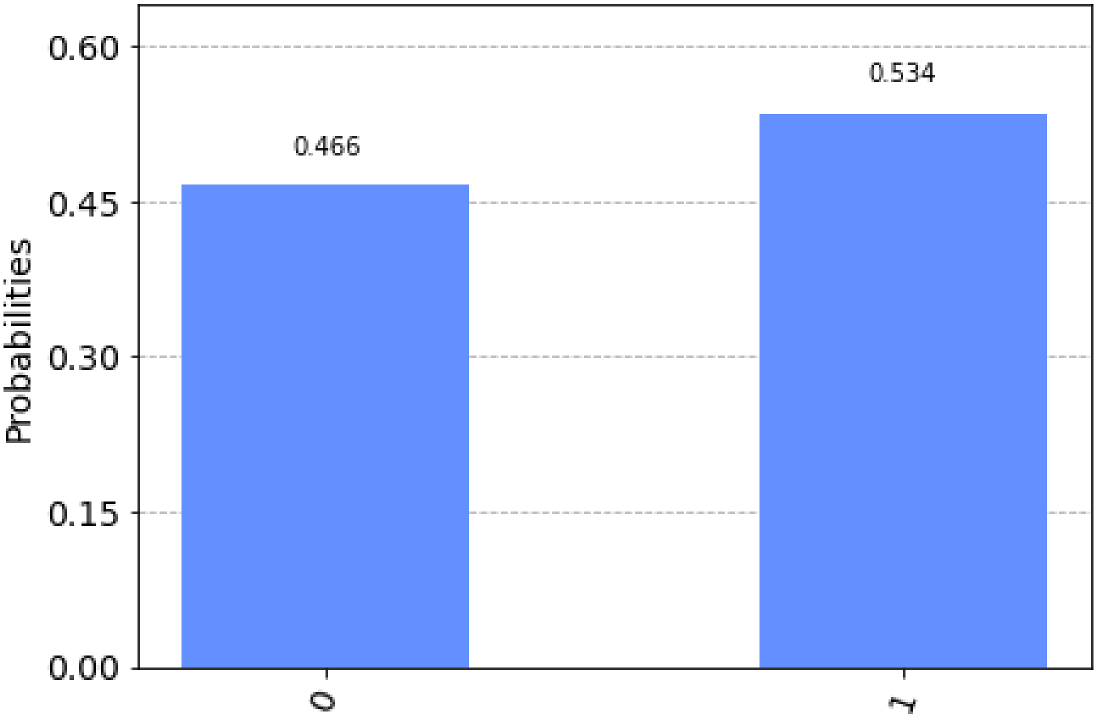
```
60ec5f563cdfa387d6627697
Job Status: job has successfully run
('0', 562)
```


0.60
0.45
0.30
0.15
0.00
Probabilities
0.559
0.441
0
1

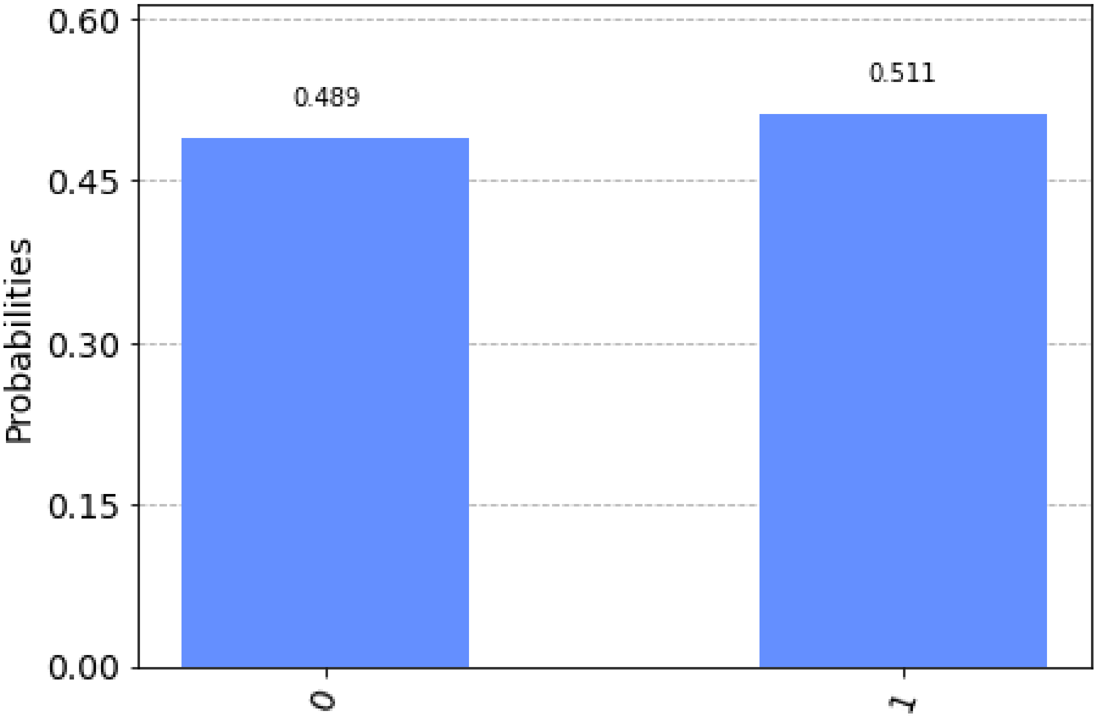

0.60
0.45
0.30
0.15
0.00
Probabilities
0.511
0.489
0
1


0.60
0.45
0.30
0.15
0.00
Probabilities
0.492
0.508
0
1

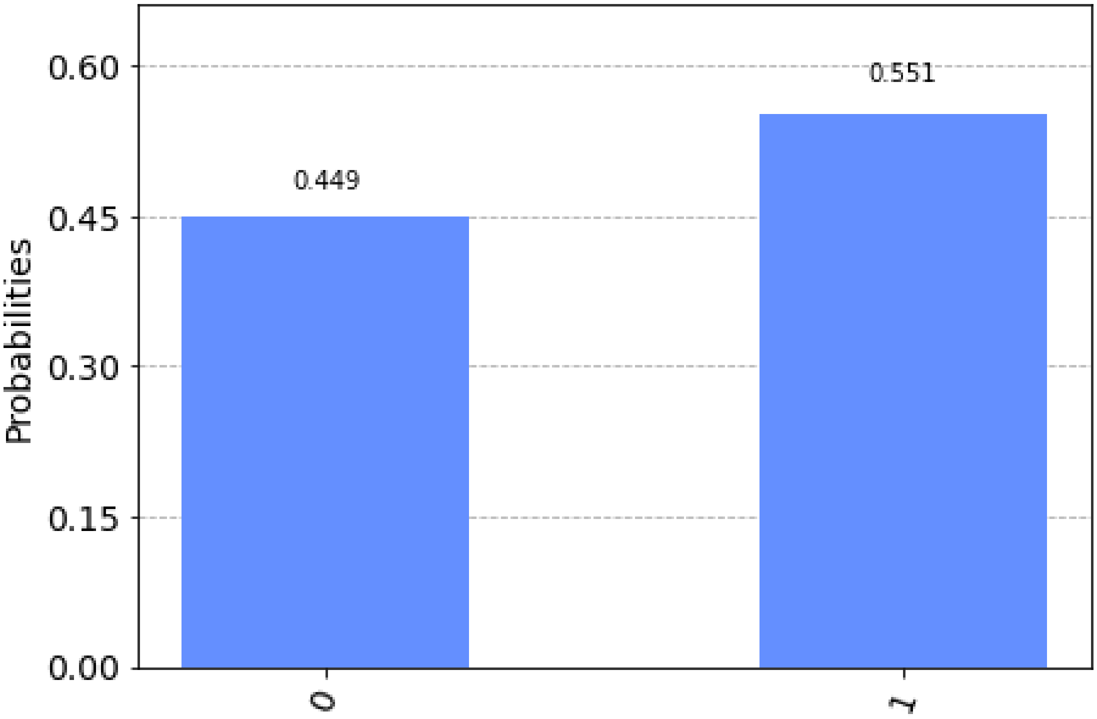

0.60
0.45
0.30
0.15
0.00
Probabilities
0.524
0.476
0
1

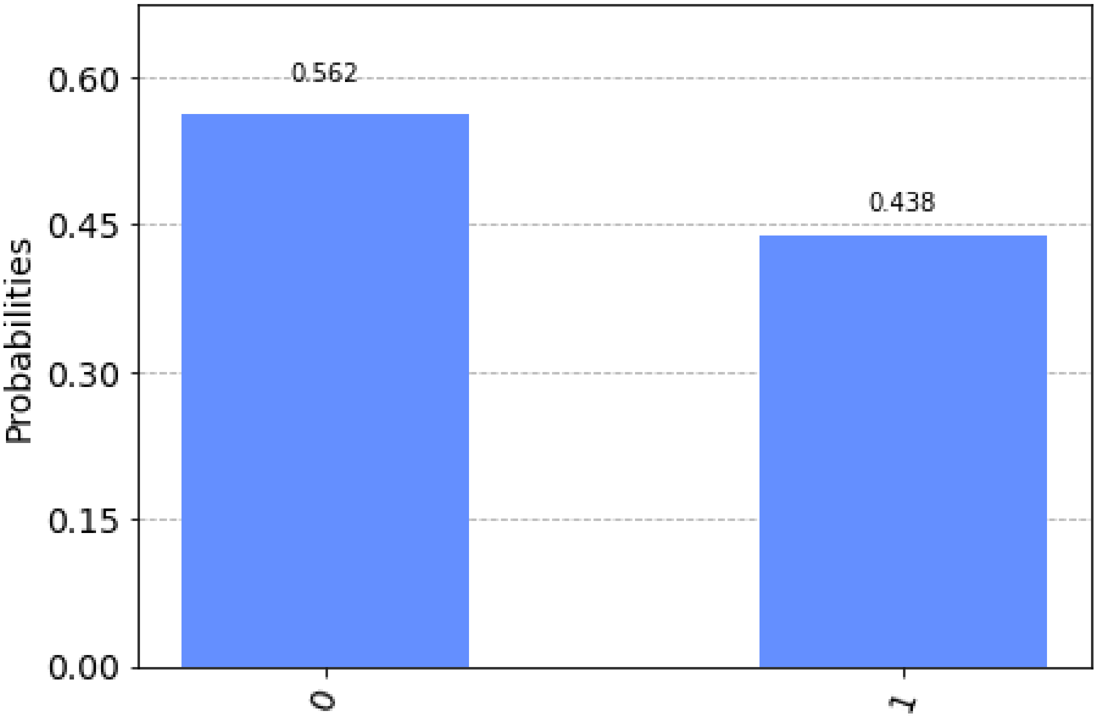


0.60
0.45
0.30
0.15
0.00
Probabilities
0.466
0.534
0
1



0.60
0.45
0.30
0.15
0.00
Probabilities
0.489
0.511
0
1


0.60
0.45
0.30
0.15
0.00
Probabilities
0.449
0.551
0
1


0.60
0.45
0.30
0.15
0.00
Probabilities
0.562
0.438
0
1

[3]:

```
ab_bases, ab_matches = check_bases(Alice_bases,Bob_bases)
print('ALICE and BOB bases matching where X= not matched, Y= matched ')
print("A-B bases: " + ab_bases)
print("\n")
print("Bit sent by ALICE Over Quantum Channel: " )
print(digits)
print("\n")
print("Bit Recieved by BOB Over Quantum Channel:")
integer_map = map(int, bob_bits)
bob_bit = list(integer_map)
print(bob_bit)
print("\n")
ab_bits = check_bits(bitstream,bob_bits,ab_bases)
print("A-B bits: " + ab_bits)
print("\n")
print("'Y' = Same bit recieve and both bases are same. \n'R' = Same bit recieve␣
 ↪and both bases are not same ")
print("'!' = Opposite bit recieve and both bases are same. \n'-' = Opposite bit␣
 ↪recieve and both bases are not same. ")
tbits= transferredbits(bitstream,bob_bits,ab_bases)
print("\n")
print("Successful A-B bits in Quantum Channel " + tbits)
print("\n")
err_found = 0
for i in range(len(ab_bits)):
    if digits[i] != bob_bit[i]:
        err_found += 1
#print(err_found)
print("Bit Flip Found:" + str(err_found) + " Bits")

error=((err_found)/(len(tbits))*100)
print("Error % of Channel")
print(error)
print("Number of Bits sent by ALICE:",len(ab_bits))
print("Correct number of Bits Recieved by BOB Over Quantum Channel",␣
 ↪(len(tbits)-err_found))
```

```
ALICE and BOB bases matching where X= not matched, Y= matched
A-B bases: YYYYYYYY


Bit sent by ALICE Over Quantum Channel:
[1, 0, 0, 0, 1, 0, 1, 0]


Bit Recieved by BOB Over Quantum Channel:
[0, 0, 1, 0, 1, 1, 1, 0]
```

```
A-B bits: !Y!YY!YY


'Y' = Same bit recieve and both bases are same.
'R' = Same bit recieve and both bases are not same
'!' = Opposite bit recieve and both bases are same.
'-' = Opposite bit recieve and both bases are not same.


Successful A-B bits in Quantum Channel !Y!YY!YY


Bit Flip Found:3 Bits
Error % of Channel
37.5
Number of Bits sent by ALICE: 8
Correct number of Bits Recieved by BOB Over Quantum Channel 5
```

```
[ ]:
```

```
[ ]:
```