ML-HW2-ICA

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Assignment:2 Independent Component Analysis

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----- steps to take: - read all your file - define different source, mixer and separator matrix - define n and no of iterations - write the function with default source and mixer file - check the output, test with various other values - obtain your source sounds from mixed noise - plot (actual source, mixed sound and separated sound) for each of the source -------

In [1]:
```
# Let's import all the required packages
import matplotlib
import matplotlib.pyplot as plt
%matplotlib inline
import numpy as np
import matplotlib.pyplot as plt
import scipy.io
```

In [2]:
```
# Let's Read the Sound files

icaTest = scipy.io.loadmat('icaTest.mat')

Utest = icaTest['U'] # source
Atest = icaTest['A'] # Mixer
Mtest = np.matmul(Atest, Utest) #mixed sound
Wtest = np.random.rand(Utest.shape[0],Utest.shape[0])
#print("Wtest" + str(Wtest))
```

In [ ]:

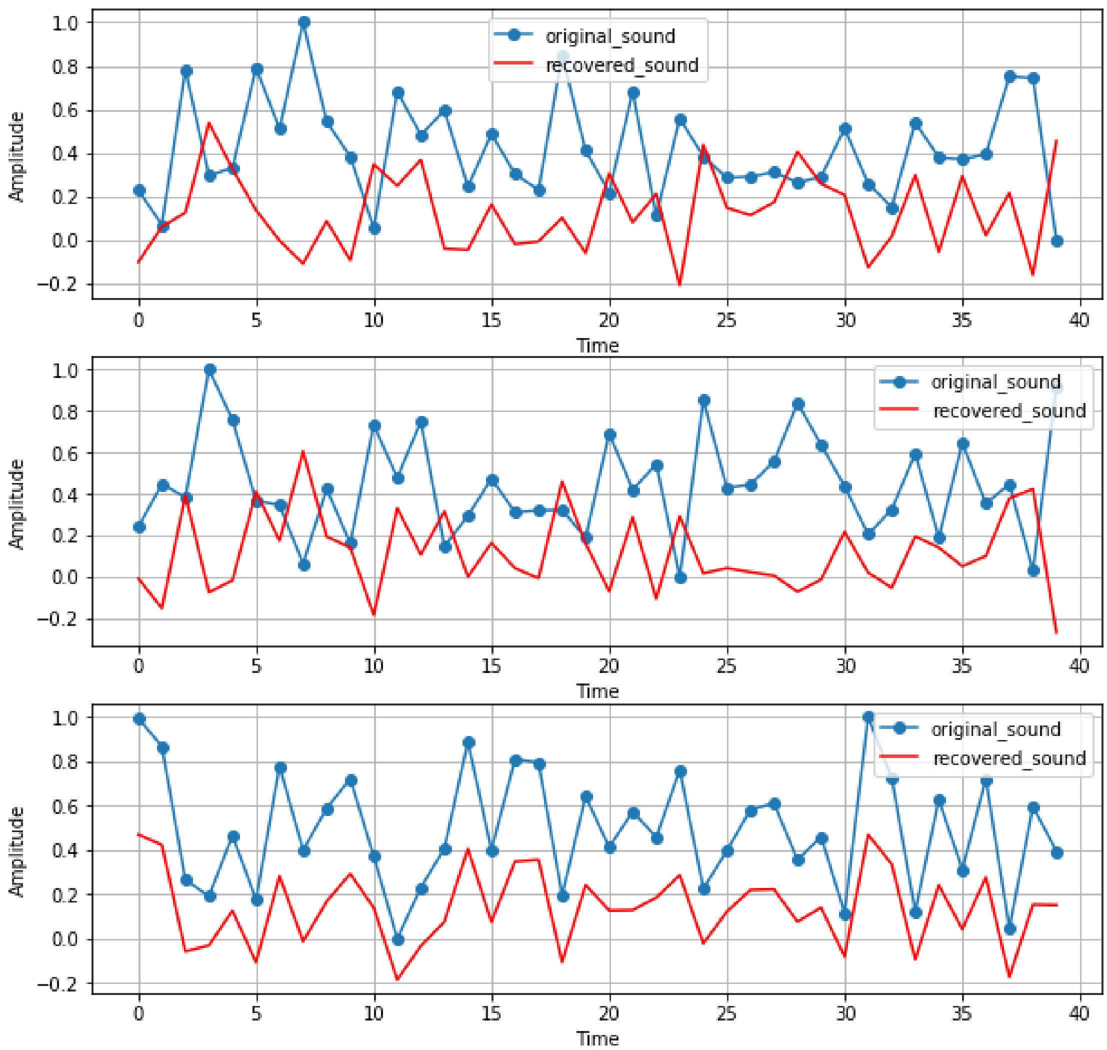
In [3]:
```
# let's write a function that will give us the optimal
# separato matrix W
def grad(sep, mix, alpha , iters ):
    for i in range(0,iters):
        #for j in range(i):
        #sep = ftr*sep
        Y = np.matmul(sep, mix) # distinct sounnds sources
        Z = 1/(1+np.exp((-1*Y)))
        I = np.identity(sep.shape[0])
        dW = alpha*(I + (np.matmul((1-(2*Z)), Y.T)))
        #print(type(dW), type(sep))
```

```
            sep += dW
                #print(sep)
        print('\nFor aplha:'+str(alpha) + ' iteration:'+str(iters) + ' separator:'+ str(sep.
        Y = np.matmul(sep, mix)
            #print('\nFinal seprator matrix: ')
        return Y
```

In [4]:
```
# Let's test our function for various sounds

original_sound = Utest
recovered_sound = grad(Wtest*0.1, Mtest, 0.01, 100000)
#print('\norigianl_source: ' +str(original_sound))
#print('\nrecovered_source: ' +str(recovered_sound))
```

```
For aplha:0.01 iteration:100000 separator:[ 2.46395114 -0.3219162  -1.20668954  0.80272218  0.60
 -3.63937741  0.15648449  3.02183712]
```

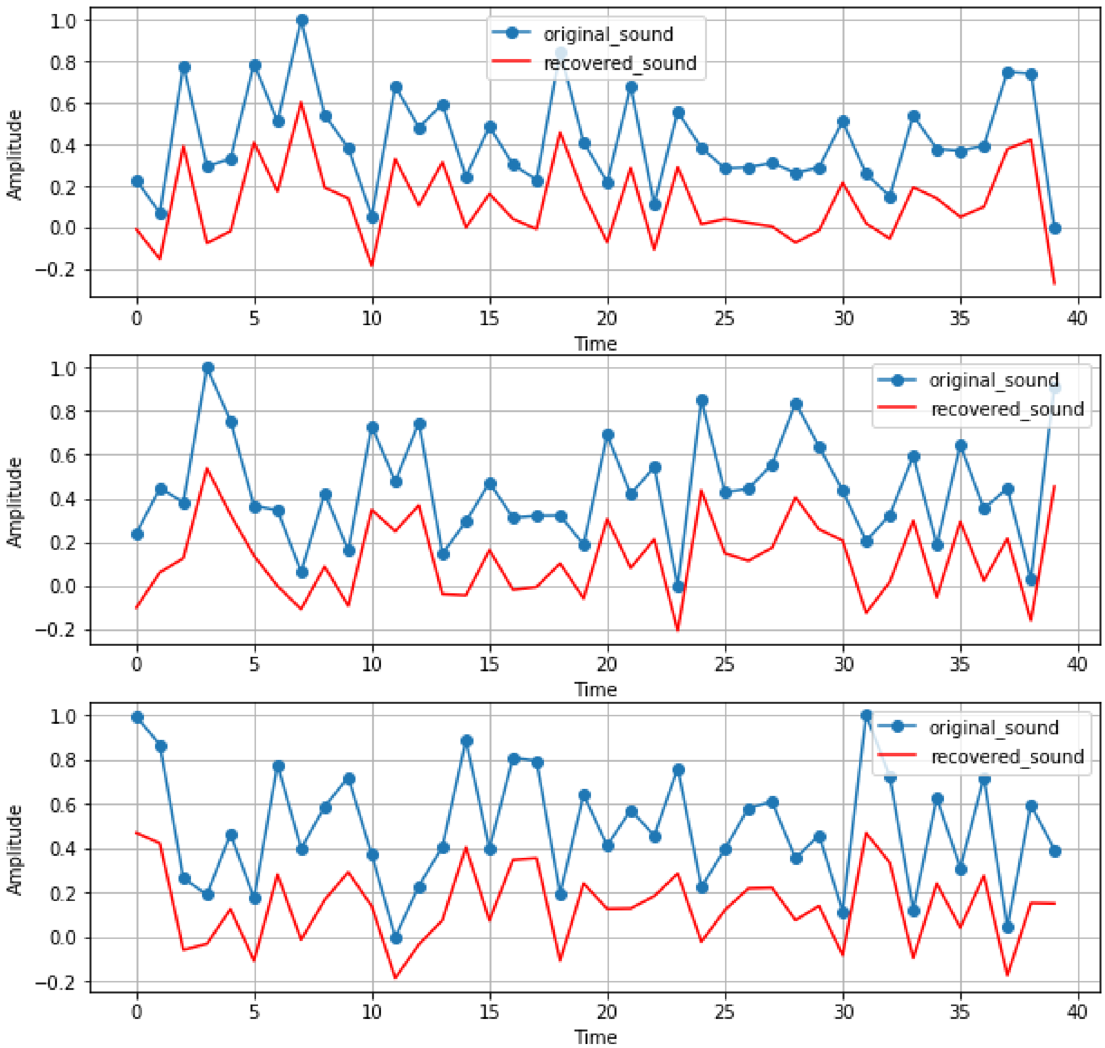
In [5]:
```
# Let's make some awesome plots
# for the given test sound matrix: having three sound sources
fig = plt.figure(figsize=(10,10))
plt.subplot(311)
plt.plot(original_sound[0,:], 'o-', label = 'original_sound')
plt.plot(recovered_sound[0,:], 'r-', label = 'recovered_sound')
plt.legend()
plt.xlabel('Time')
plt.ylabel('Amplitude')
plt.grid(True)

plt.subplot(312)
plt.plot(original_sound[1,:], 'o-', label = 'original_sound')
plt.plot(recovered_sound[1,:], 'r-', label = 'recovered_sound')
plt.legend()
plt.xlabel('Time')
plt.ylabel('Amplitude')
plt.grid(True)

plt.subplot(313)
plt.plot(original_sound[2,:], 'o-', label = 'original_sound')
plt.plot(recovered_sound[2,:], 'r-', label = 'recovered_sound')
plt.legend()
plt.grid(True)
plt.xlabel('Time')
plt.ylabel('Amplitude')
plt.savefig('plot1.png', dpi = 100)
plt.show()
```



It's calearly evident that second source sound and first sound sounds have flipped. Let's plot the second recovered sound with the first source sound'

```
In [6]: # Let's make some awesome plots
        # for the given test sound matrix: having three sound sources
        fig = plt.figure(figsize=(10,10))
        plt.subplot(311)
        plt.plot(original_sound[0,:], 'o-', label = 'original_sound')
        plt.plot(recovered_sound[1,:], 'r-', label = 'recovered_sound')
        plt.legend()
        plt.xlabel('Time')
        plt.ylabel('Amplitude')
        plt.grid(True)

        plt.subplot(312)
```

```
plt.plot(original_sound[1,:], 'o-', label = 'original_sound')
plt.plot(recovered_sound[0,:], 'r-', label = 'recovered_sound')
plt.legend()
plt.xlabel('Time')
plt.ylabel('Amplitude')
plt.grid(True)

plt.subplot(313)
plt.plot(original_sound[2,:], 'o-', label = 'original_sound')
plt.plot(recovered_sound[2,:], 'r-', label = 'recovered_sound')
plt.legend()
plt.grid(True)
plt.xlabel('Time')
plt.ylabel('Amplitude')
plt.savefig('plot2.png', dpi = 100)


plt.show()
```




```
In [7]: #U - source, A - mixer, W - separator, Y-mixed sund
        sounds = scipy.io.loadmat('sounds.mat')

        U = sounds['sounds'][:,0:25] # a matrix of five sound wave
        A = np.random.rand(U.shape[0],U.shape[0])
        #A = np.random.uniform(0,0.1, (U.shape[0]*U.shape[0])).reshape(U.shape[0], U.shape[0])
        M = np.matmul(A, U) # Mixed Sound
        W = np.random.rand(U.shape[0],U.shape[0])[:,0:25]
        print(U.shape, A.shape, M.shape, W.shape)


        #W = np.random.uniform(0,0.1, (U.shape[0]*U.shape[0])).reshape(U.shape[0], U.shape[0])

        U12 = U[0:2,:].reshape(2, U.shape[1])
```

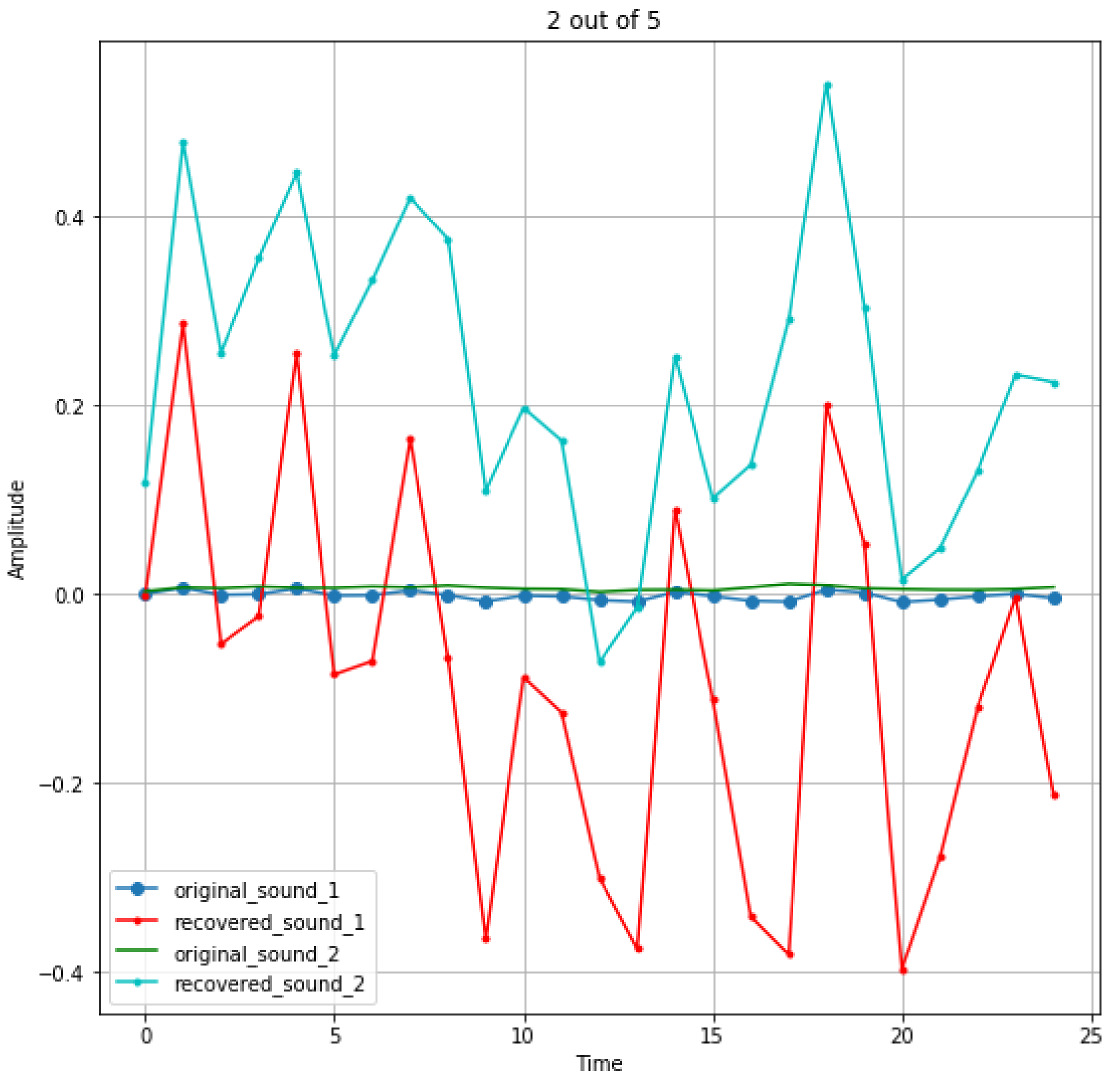
```
A12 = A[0:2,0:2].reshape(2,2)
M12 = np.matmul(A12,U12) #mixed sound
W12 = W[0:2,0:2].reshape(2,2)
print(U12.shape, A12.shape, M12.shape, W12.shape)

U123 = U[0:3,:].reshape(3, U.shape[1])
A123 = A[0:3,0:3].reshape(3,3)
M123 = np.matmul(A123,U123)#mixed sound
W123 = W[0:3,0:3].reshape(3,3)
print(U123.shape, A123.shape, M123.shape, W123.shape)
```

```
(5, 25) (5, 5) (5, 25) (5, 5)
(2, 25) (2, 2) (2, 25) (2, 2)
(3, 25) (3, 3) (3, 25) (3, 3)
```

In [50]:
```
# Taking two sound: first and second sound, from the source
original_sound12 = np.array(U12)
recovered_sound12 = grad(np.array(W12*0.1), np.array(M12), 0.01, 10000)
```

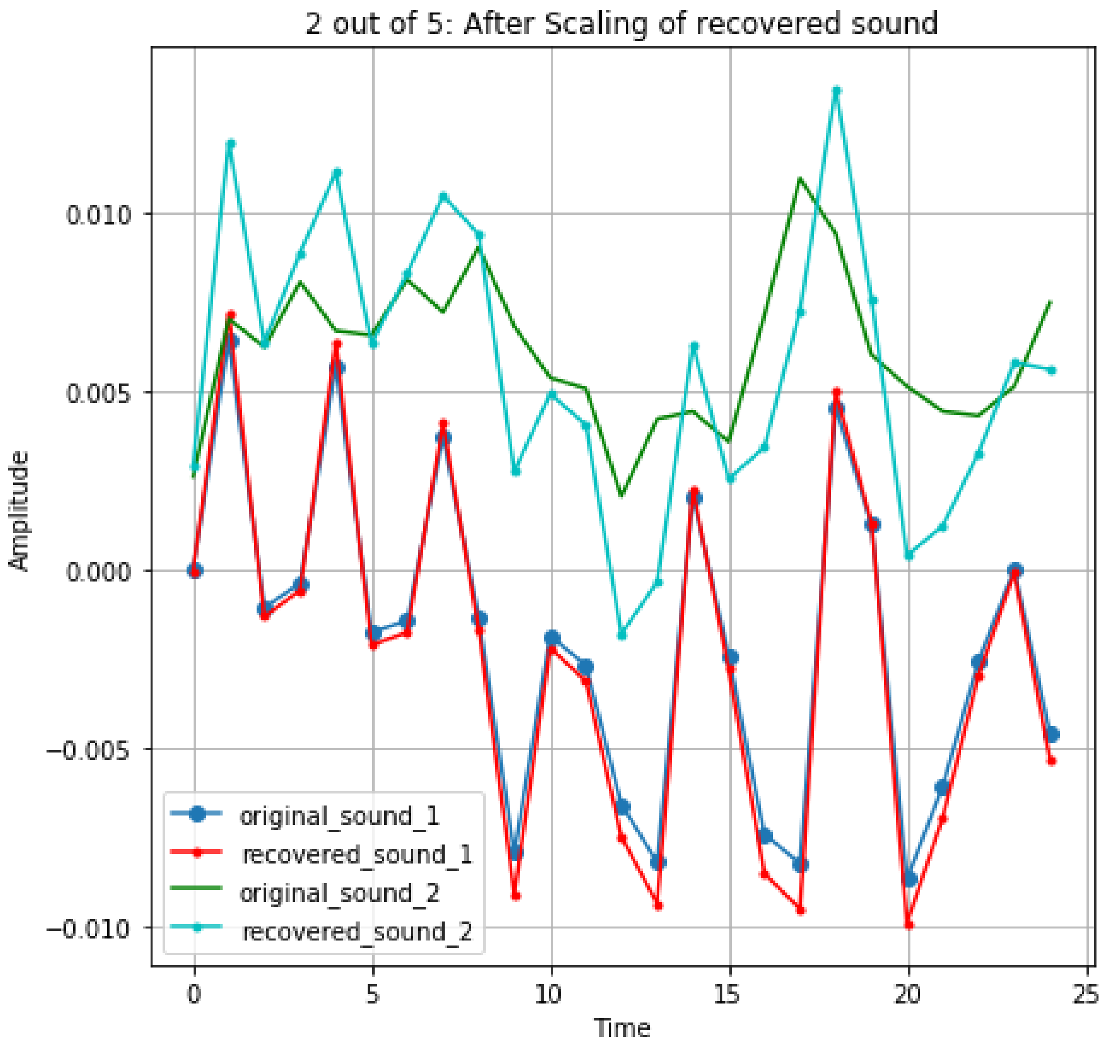
```
For aplha:0.01 iteration:10000 separator:[ 75.35738054  -2.80003306  -2.6109101   47.55009266]
```

In [51]:
```
# Let's make some awesome plots
# for the given test sound matrix: having three sound sources
fig = plt.figure(figsize=(9,9))

plt.plot(original_sound12[0,:], 'o-', label = 'original_sound_1')
plt.plot(recovered_sound12[0,:], 'r.-', label = 'recovered_sound_1')
plt.plot(original_sound12[1,:], 'g-', label = 'original_sound_2')
plt.plot(recovered_sound12[1,:], 'c.-', label = 'recovered_sound_2')
plt.legend()
plt.grid(True)

plt.xlabel('Time')
plt.ylabel('Amplitude')
plt.legend()
plt.title(" 2 out of 5")
plt.grid(True)
plt.savefig('plot3.png', dpi = 100)
plt.show()
```




```
In [52]: # Let's do the scaling of the recoered sound
         recovered_sound12 = 0.025*recovered_sound12
         original_sound12 = original_sound12

In [53]: fig = plt.figure(figsize=(7,7))

         plt.plot(original_sound12[0,:], 'o-', label = 'original_sound_1')
         plt.plot(recovered_sound12[0,:], 'r.-', label = 'recovered_sound_1')
         plt.plot(original_sound12[1,:], 'g-', label = 'original_sound_2')
         plt.plot(recovered_sound12[1,:], 'c.-', label = 'recovered_sound_2')
         plt.legend()
         plt.grid(True)

         plt.legend()
```

```
plt.title("2 out of 5: After Scaling of recovered sound")
plt.xlabel('Time')
plt.ylabel('Amplitude')
plt.grid(True)
plt.savefig('plot4.png', dpi = 100)

plt.show()
```

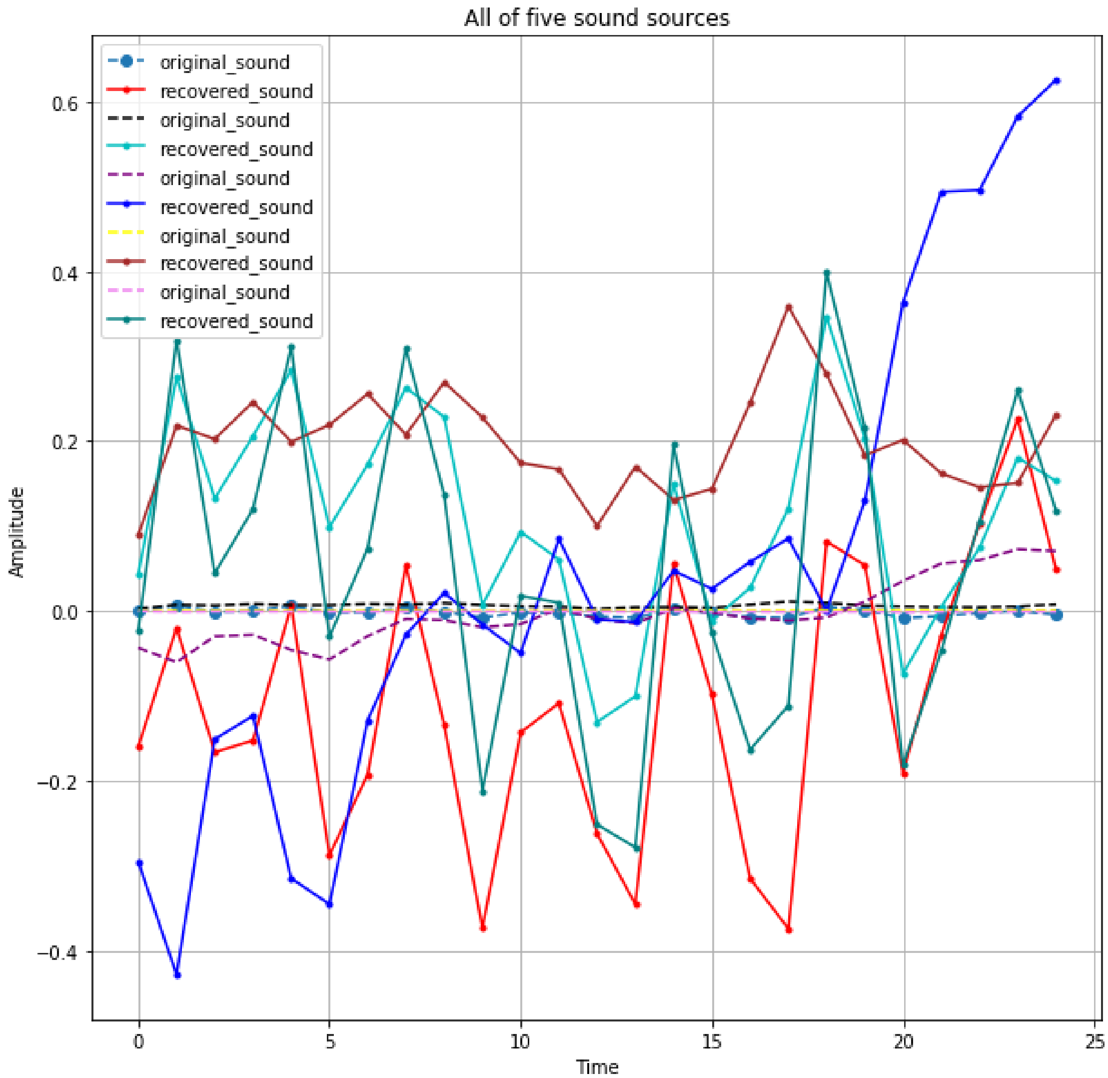



```
In [54]: # Let's do with all five sounds at once and with 10000 iterations
         original_sound = U
         recovered_sound = grad(W*0.1, M, 0.01, 10000)
```

```
For aplha:0.01 iteration:10000 separator:[ 73.8444446    2.73055783 -19.03155182  16.34876775 -1
   2.80006793  77.56605871   0.14541079 -22.7910019  -20.86199918
```

```
-18.71346562   0.37497515  20.56930125  -5.53660702  -3.87631211
 16.30025835 -22.7715103   -5.88138485  65.63189198 -13.39950493
-10.31098712 -20.9317526   -4.12448785 -13.40149822  73.68759337]
```

```
In [55]: # Let's make some awesome plots
         # for the given test sound matrix: having three sound sources
         fig = plt.figure(figsize=(10,10))

         plt.plot(original_sound[0,:], 'o--', label = 'original_sound')
         plt.plot(recovered_sound[0,:], 'r.-', label = 'recovered_sound')

         plt.plot(original_sound[1,:], 'k--', label = 'original_sound')
         plt.plot(recovered_sound[1,:], 'c.-', label = 'recovered_sound')

         plt.plot(original_sound[2,:], '--', color = 'purple',label = 'original_sound')
         plt.plot(recovered_sound[2,:], '.-', color = 'blue',label = 'recovered_sound')

         plt.plot(original_sound[3,:],'--',  color = 'yellow',label = 'original_sound')
         plt.plot(recovered_sound[3,:], '.-',color = 'brown', label ='recovered_sound')

         plt.plot(original_sound[4,:], '--', color = 'violet',label = 'original_sound')
         plt.plot(recovered_sound[4,:],  '.-',color ='teal',label = 'recovered_sound')

         plt.legend()
         plt.grid(True)
         plt.xlabel('Time')
         plt.ylabel('Amplitude')
         plt.title('All of five sound sources')
         plt.savefig('plot5.png', dpi = 100)


         plt.show()
```


All of five sound sources
original_sound
recovered_sound
original_sound
recovered_sound
original_sound
recovered_sound
original_sound
recovered_sound
original_sound
recovered_sound
Amplitude
Time
0.6
0.4
0.2
0.0
−0.2
−0.4
0
5
10
15
20
25

In [ ]:

In [ ]:

In [ ]:

In [ ]: