ica

October 6, 2021

0.1 Adopted from https://towardsdatascience.com/independent-component-analysis-ica-in-python-a0ef0db0955e

[2]:
```
import numpy as np
np.random.seed(0)
from scipy import signal
from scipy.io import wavfile
from matplotlib import pyplot as plt
import seaborn as sns
sns.set(rc={'figure.figsize':(11.7,8.27)})
```

[3]:
```
def g(x):
    return np.tanh(x)
```

[4]:
```
def g_der(x):
    return 1 - g(x) * g(x)
```

[5]:
```
def center(x):
    x = np.array(x)

    mean = x.mean(axis=1, keepdims=True)

    return x - mean
```

[6]:
```
def whitening(x):
    cov = np.cov(x)

    d, E = np.linalg.eigh(cov)

    D = np.diag(d)

    D_inv = np.sqrt(np.linalg.inv(D))

    x_whiten = np.dot(E, np.dot(D_inv, np.dot(E.T, x)))

    return x_whiten
```

[7]:
```
def calculate_new_w(w, X):
    w_new = (X * g(np.dot(w.T, X))).mean(axis=1) - g_der(np.dot(w.T, X)).mean()␣
↪* w

    w_new /= np.sqrt((w_new ** 2).sum())

    return w_new
```

[8]:
```
def ica(X, iterations, tolerance=1e-5):
    X = center(X)

    X = whitening(X)

    components_nr = X.shape[0]

    W = np.zeros((components_nr, components_nr), dtype=X.dtype)

    for i in range(components_nr):

        w = np.random.rand(components_nr)

        for j in range(iterations):

            w_new = calculate_new_w(w, X)

            if i >= 1:
                w_new -= np.dot(np.dot(w_new, W[:i].T), W[:i])

            distance = np.abs(np.abs((w * w_new).sum()) - 1)

            w = w_new

            if distance < tolerance:
                break

        W[i, :] = w

    S = np.dot(W, X)

    return S
```

[9]:
```
def plot_mixture_sources_predictions(X, original_sources, S):
    fig = plt.figure()

    plt.subplot(3, 1, 1)
    for x in X:
        plt.plot(x)
```

```
    plt.title("mixtures")

    plt.subplot(3, 1, 2)
    for s in original_sources:
        plt.plot(s)
    plt.title("real sources")

    plt.subplot(3,1,3)
    for s in S:
        plt.plot(s)
    plt.title("predicted sources")

    fig.tight_layout()
    plt.show()
```

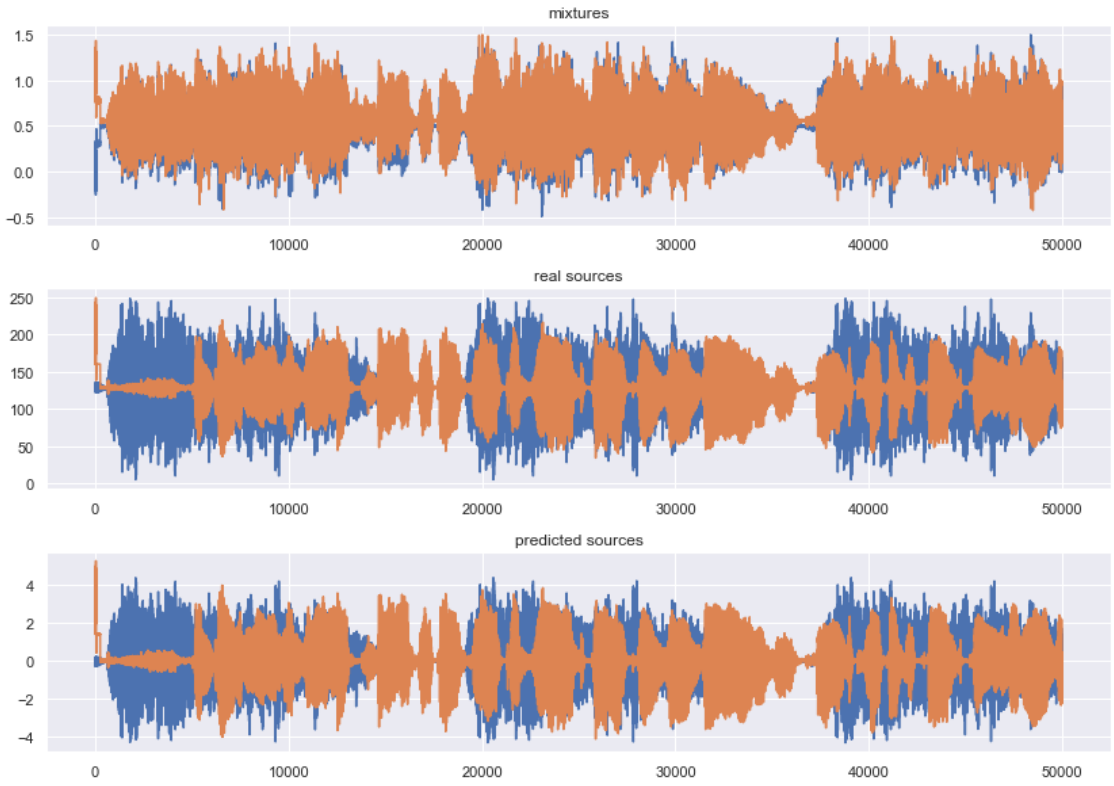
[10]:
```
def mix_sources(mixtures, apply_noise=False):
    for i in range(len(mixtures)):

        max_val = np.max(mixtures[i])

        if max_val > 1 or np.min(mixtures[i]) < 1:

            mixtures[i] = mixtures[i] / (max_val / 2) - 0.5

    X = np.c_[[mix for mix in mixtures]]

    if apply_noise:

        X += 0.02 * np.random.normal(size=X.shape)

    return X
```

[11]:
```
n_samples = 2000
time = np.linspace(0, 8, n_samples) #steps of 8/2000 = 0.004 seconds/400␣
 ↪milliseconds
s1 = np.sin(2 * time)
s2 = np.sign(np.sin(3 * time)) # square signal
s3 = signal.sawtooth(2 * np.pi * time)
```

[14]:
```
X = np.c_[s1, s2, s3] #X is 2000x3
A = np.array(([[1, 1, 1], [0.5, 2, 1.0], [1.5, 1.0, 2.0]]))
A.T
# X = np.dot(X, A.T)
# X = X.T
# S = ica(X, iterations=1000)
# actual = mix_sources([s1,s2,s3])
# plot_mixture_sources_predictions(X, [s1, s2, s3], S)
```

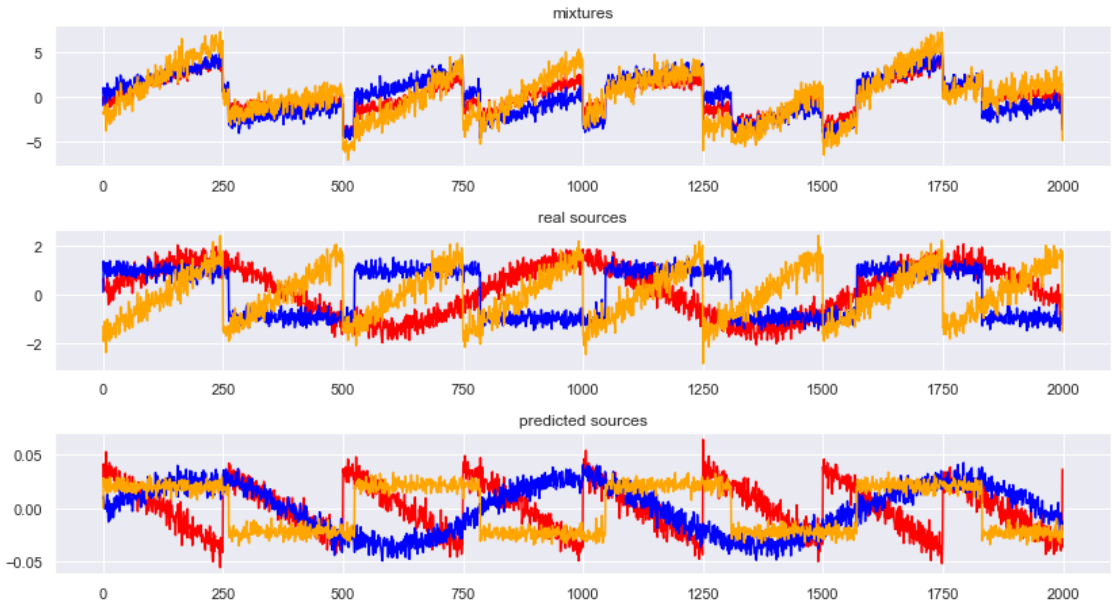
[14]:
```
array([[1. , 0.5, 1.5],
       [1. , 2. , 1. ],
       [1. , 1. , 2. ]])
```

[46]:
```
sampling_rate, mix1 = wavfile.read('mix1.wav')
sampling_rate, mix2 = wavfile.read('mix2.wav')
sampling_rate, source1 = wavfile.read('source1.wav')
sampling_rate, source2 = wavfile.read('source2.wav')
actual = mix_sources([source1, source2], False)
X = mix_sources([mix1, mix2])
S = ica(X, iterations=1000)

plot_mixture_sources_predictions(X, [source1, source2], S)

wavfile.write('out1.wav', sampling_rate, S[0])
wavfile.write('out2.wav', sampling_rate, S[1])
```



[47]:
```
from sklearn.decomposition import FastICA

np.random.seed(0)
n_samples = 2000
time = np.linspace(0, 8, n_samples)
```

```
s1 = np.sin(2 * time)
s2 = np.sign(np.sin(3 * time))
s3 = signal.sawtooth(2 * np.pi * time)

S = np.c_[s1, s2, s3]
S += 0.2 * np.random.normal(size=S.shape)
S /= S.std(axis=0)
A = np.array([[1, 1, 1], [0.5, 2, 1.0], [1.5, 1.0, 2.0]])
X = np.dot(S, A.T)

ica = FastICA(n_components=3)
S_ = ica.fit_transform(X)

fig = plt.figure()

models = [X, S, S_]

names = ['mixtures', 'real sources', 'predicted sources']

colors = ['red', 'blue', 'orange']

for i, (name, model) in enumerate(zip(names, models)):
    plt.subplot(4, 1, i+1)
    plt.title(name)
    for sig, color in zip (model.T, colors):
        plt.plot(sig, color=color)

fig.tight_layout()
plt.show()
```


mixtures
5
0
−5
0
250
500
750
1000
1250
1500
1750
2000
real sources
2
0
−2
0
250
500
750
1000
1250
1500
1750
2000
predicted sources
0.05
0.00
−0.05
0
250
500
750
1000
1250
1500
1750
2000

[ ]: