Multiple animals PCA

April 16, 2020

Analysis of PCA of several animals

[1]:

```
cd ../utilities/
```

```
/home/gustav/Documents/DD142X/code/utilities
```

[2]:

```
from features import ffv
from matlab_util import str_lfp, gp_lfp
from plotting import rasterize
```

[3]:

```
cd ../_data/matlabData
```

```
/home/gustav/Documents/DD142X/code/_data/matlabData
```

[4]:

```
files = !ls
print(files)
```

```
['NPR-075.b11.mat', 'NPR-075.b13.mat', 'NPR-075.c013.mat', 'NPR-075.c08.mat',
'NPR-075.d07.mat', 'NPR-076.b05.mat', 'NPR-076.b09.mat', 'NPR-076.c09.mat',
'NPR-076.d07.mat']
```

[5]:

```
import numpy as np
import matplotlib.pyplot as plt

ep = 2 ** 11
print("Epoch length: " + str(1000 * ep / 16000) + "ms")

str_epochs = np.concatenate([
    str_lfp(filename, ep).reshape((-1, ep)) for filename in files
], axis = 0)

gp_epochs = np.concatenate([
    gp_lfp(filename, ep).reshape((-1, ep)) for filename in files
], axis = 0)

print(str_epochs.shape)
print(gp_epochs.shape)
```

```
Epoch length: 128.0ms
```

```
(65872, 2048)
(97678, 2048)
```

[8]:

```
strides = 10
lo = 10
hi = 45
fft_n = 2 ** 13


incr_str = int(str_epochs.shape[0] / strides)
strs = [
    ffv(
        str_epochs[i * incr_str : (i + 1) * incr_str],
        epoch_size = ep,
        lo = lo,
        hi = hi,
        fft_n = fft_n
    ) for i in range(0, strides)
]

incr_gp = int(gp_epochs.shape[0] / strides)
gps = [
    ffv(
        gp_epochs[i * incr_gp : (i + 1) * incr_gp],
        epoch_size = ep,
        lo = lo,
        hi = hi,
        fft_n = fft_n
    ) for i in range(0, strides)
]
```

[9]:

```
frqs = strs[0][1]
print(frqs)
```

```
[11.71875  13.671875 15.625    17.578125 19.53125  21.484375 23.4375
 25.390625 27.34375  29.296875 31.25     33.203125 35.15625  37.109375
 39.0625   41.015625 42.96875  44.921875]
```

[10]:

```
strs = [str_ for str_, _ in strs]
gps = [ gp_ for gp_, _ in gps]
```

[11]:

```
strs = np.array(strs)
gps = np.array(gps)
features = strs.shape[2]
```

[12]:

```
strs = strs.reshape((-1, features))
gps = gps.reshape((-1, features))
```

```
print(strs.shape)
print(gps.shape)
```

```
(65870, 18)
(97670, 18)
```

[13]:
```
from sklearn.decomposition import PCA

all_lfp = np.concatenate((strs, gps), axis = 0)
print(all_lfp.shape)
```

```
(163540, 18)
```

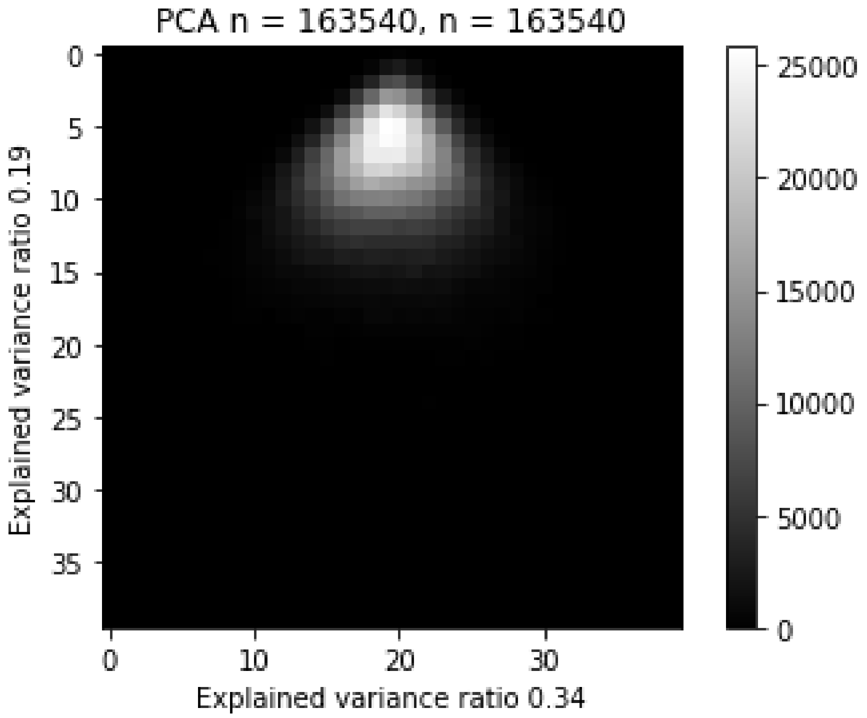
[14]:
```
pca = PCA(n_components = 10).fit(all_lfp.copy())
```

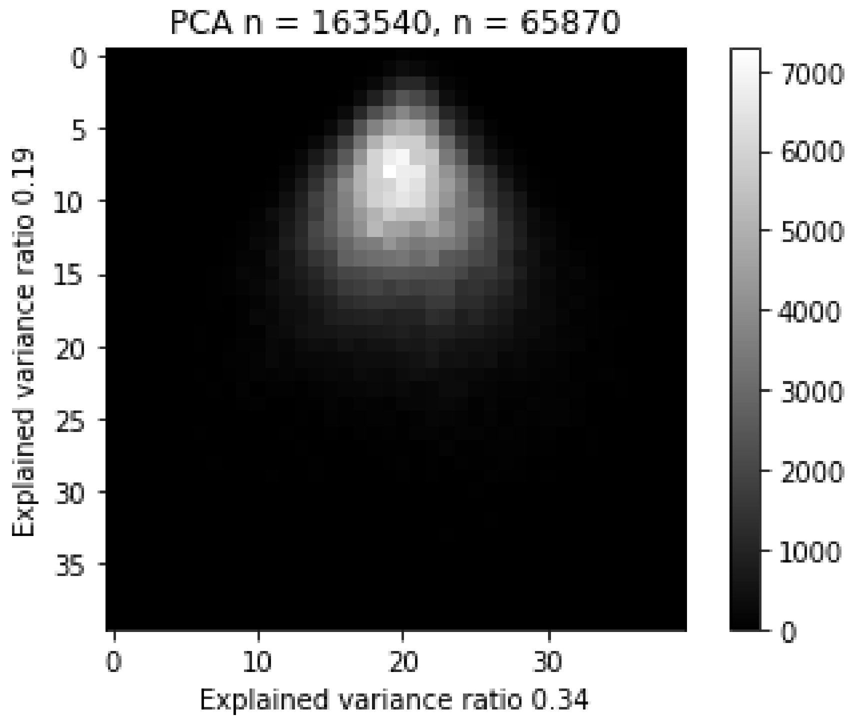
[15]:
```
pca_all = pca.transform(all_lfp.copy())
pca_str = pca.transform(strs.copy())
pca_gp  = pca.transform(gps.copy())

print(pca_all.shape)
print(pca_str.shape)
print(pca_gp.shape)
```

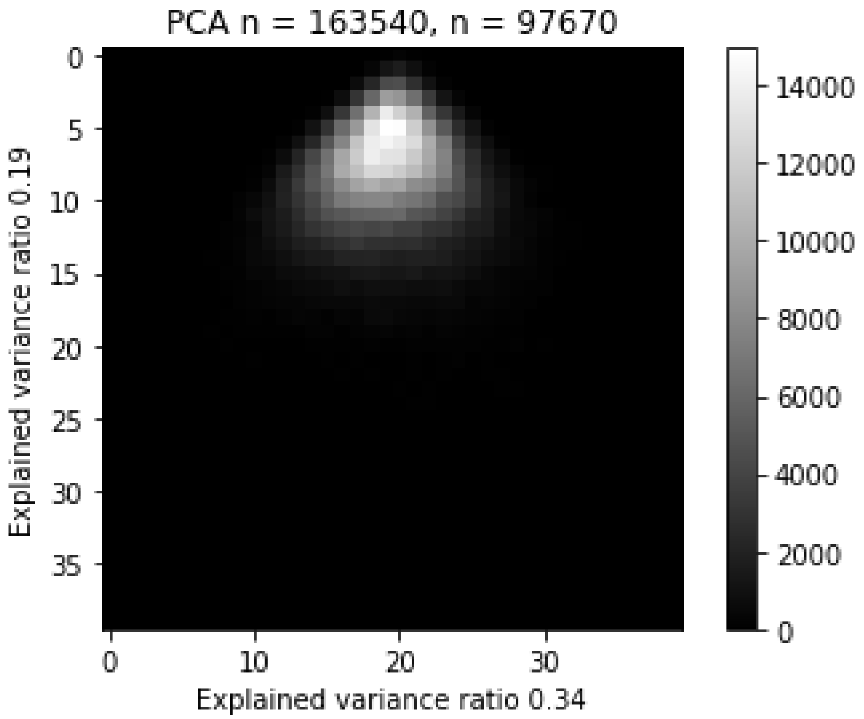
```
(163540, 10)
(65870, 10)
(97670, 10)
```

[16]:
```
print("PCA n = " + str(pca_all.shape[0]))
x1var, x2var = pca.explained_variance_ratio_[0:2]
x1var = round(x1var, 2)
x2var = round(x2var, 2)

raster_all = rasterize(pca_all)
plt.imshow(raster_all, cmap = 'gray', vmin = np.min(raster_all), vmax = np.
 ↪max(raster_all))
plt.title("PCA n = " + str(pca_all.shape[0]) + ", n = " + str(pca_all.shape[0]))
plt.xlabel("Explained variance ratio " + str(x1var))
plt.ylabel("Explained variance ratio " + str(x2var))
plt.colorbar()
plt.show()

raster_str = rasterize(pca_str)
plt.imshow(raster_str, cmap = 'gray', vmin = np.min(raster_str), vmax = np.
 ↪max(raster_str))
plt.title("PCA n = " + str(pca_all.shape[0]) + ", n = " + str(pca_str.shape[0]))
plt.xlabel("Explained variance ratio " + str(x1var))
plt.ylabel("Explained variance ratio " + str(x2var))
plt.colorbar()
plt.show()

raster_gp = rasterize(pca_gp)
plt.imshow(raster_gp, cmap = 'gray', vmin = np.min(raster_gp), vmax = np.
 ↪max(raster_gp))
plt.title("PCA n = " + str(pca_all.shape[0]) + ", n = " + str(pca_gp.shape[0]))
plt.xlabel("Explained variance ratio " + str(x1var))
plt.ylabel("Explained variance ratio " + str(x2var))
plt.colorbar()
plt.show()
```

```
PCA n = 163540
```




PCA n = 163540, n = 65870
Explained variance ratio 0.19
0
5
10
15
20
25
30
35
0
10
20
30
Explained variance ratio 0.34
7000
6000
5000
4000
3000
2000
1000
0

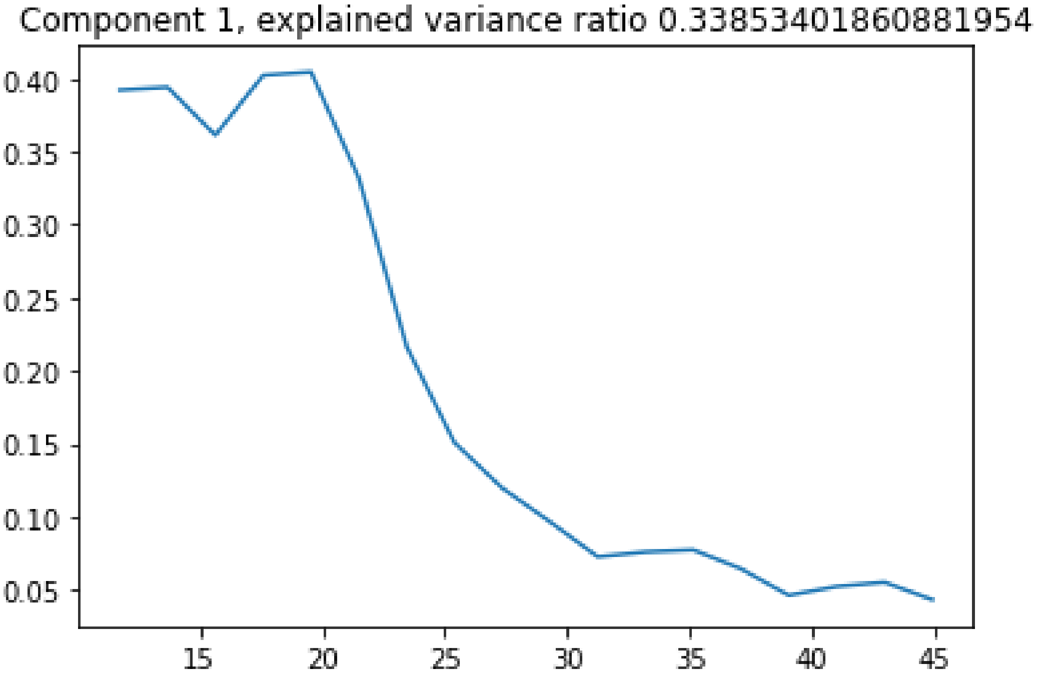

PCA n = 163540, n = 97670
Explained variance ratio 0.19
0
5
10
15
20
25
30
35
0
10
20
30
Explained variance ratio 0.34
14000
12000
10000
8000
6000
4000
2000
0

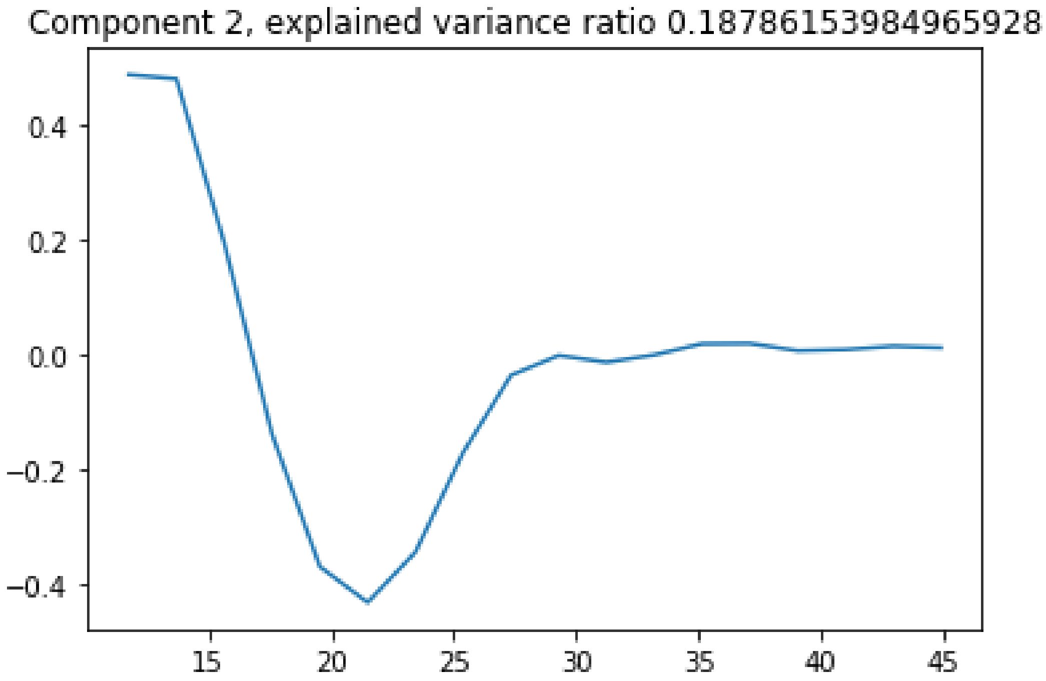
[18]:
```
print(pca.explained_variance_ratio_.sum())
for ratio, component in zip(pca.explained_variance_ratio_, pca.components_):
    print("Explained variance ratio: " + str(ratio))
    print(component)
```

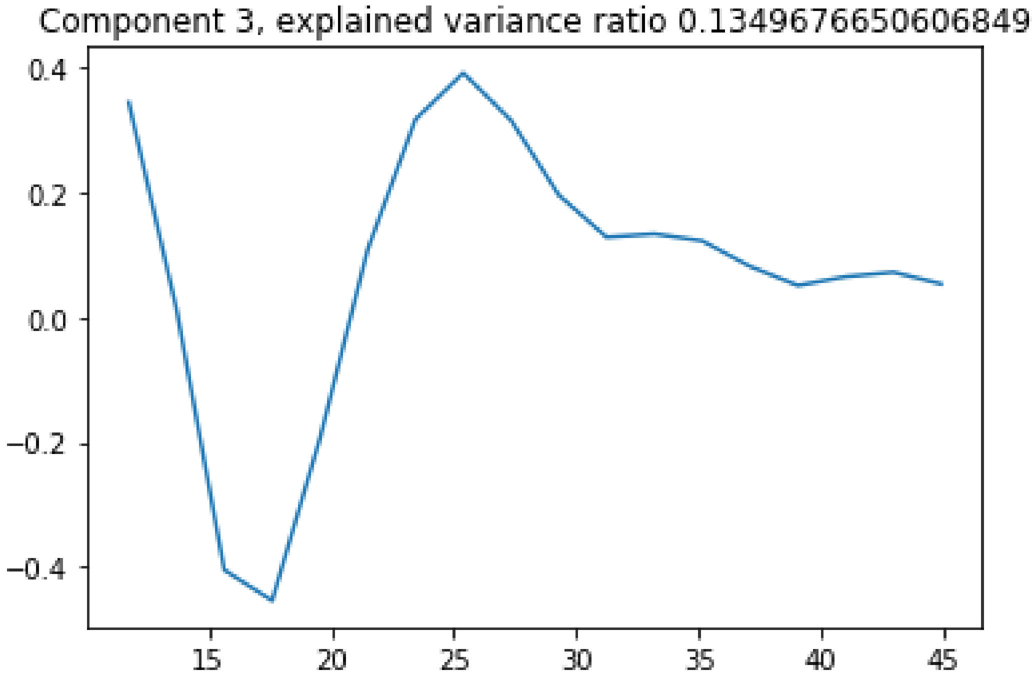
```
0.9869634961341543
Explained variance ratio: 0.33853401860881954
[0.39212593 0.39401825 0.36134882 0.4022094  0.40447235 0.33199875
 0.21685454 0.15107723 0.11991238 0.0968328  0.07283884 0.07614492
 0.0775653  0.06466004 0.04655164 0.05260338 0.05548948 0.0435956 ]
Explained variance ratio: 0.18786153984965928
[ 0.48754878  0.48027475  0.19459046 -0.13952614 -0.36993521 -0.43237002
 -0.344503   -0.1707158  -0.036513   -0.00185845 -0.01375279 -0.00098093
  0.01846692  0.01900809  0.00638057  0.00833747  0.01424236  0.01162344]
Explained variance ratio: 0.1349676650606849
[ 0.34411304  0.01290947 -0.40453292 -0.45360127 -0.19417197  0.10843329
  0.31709991  0.3912658   0.31563567  0.1958373   0.12840862  0.13368216
  0.12248813  0.08161508  0.05096519  0.06500495  0.07230124  0.05351637]
Explained variance ratio: 0.08559713603424826
[-0.38529064 -0.06896713  0.25769548  0.17757928 -0.11869246 -0.27867685
 -0.16895884  0.10796095  0.34784766  0.42158925  0.36607469  0.28291591
  0.21463742  0.16705513  0.122242    0.08949851  0.06637653  0.05271437]
Explained variance ratio: 0.07497025141606775
[ 0.30679994 -0.2417458  -0.39609099  0.06144992  0.32580414  0.0764841
 -0.3410027  -0.42434996 -0.1654092   0.09113506  0.18463538  0.2374724
  0.25923595  0.20724181  0.12057835  0.10170239  0.10680561  0.07630956]
Explained variance ratio: 0.05300909824409449
[ 0.2218414  -0.16756327 -0.16925495  0.16914581  0.19430977 -0.10874671
 -0.26590444  0.02601697  0.40041252  0.37209226  0.00438076 -0.25436796
 -0.3156163  -0.33001265 -0.32236873 -0.23030747 -0.10979997 -0.05865978]
Explained variance ratio: 0.04412443459602488
[ 0.04641975 -0.15551312 -0.05439913  0.16899055  0.05981204 -0.17936755
 -0.14362251  0.19108911  0.26544901 -0.12171136 -0.47989966 -0.35759487
  0.0081181   0.23357887  0.28742629  0.33337035  0.33289198  0.21588144]
Explained variance ratio: 0.033123110871297996
[ 0.08420224 -0.11035968 -0.02646202  0.14504565  0.0309341  -0.14674125
 -0.05533018  0.20587119  0.13983894 -0.22787555 -0.30021528  0.12798371
  0.47625845  0.30518936 -0.17029838 -0.4212324  -0.36117415 -0.23710549]
Explained variance ratio: 0.024911914521536613
[ 0.01860376 -0.07973737  0.01500051  0.10142353 -0.02592769 -0.11331346
  0.00826558  0.13352664 -0.04750221 -0.23965791 -0.03259294  0.3131113
  0.18621164 -0.32070294 -0.50131358 -0.05754093  0.4328881   0.46155969]
Explained variance ratio: 0.009864326931720591
[-0.18244517  0.21675656  0.00323701 -0.19934203  0.03725726  0.18447382
 -0.02688102 -0.19041641  0.04811142  0.19905141 -0.07305347 -0.24539868
  0.04985676  0.29892668 -0.03088589 -0.42892664 -0.08844491  0.64458676]
```

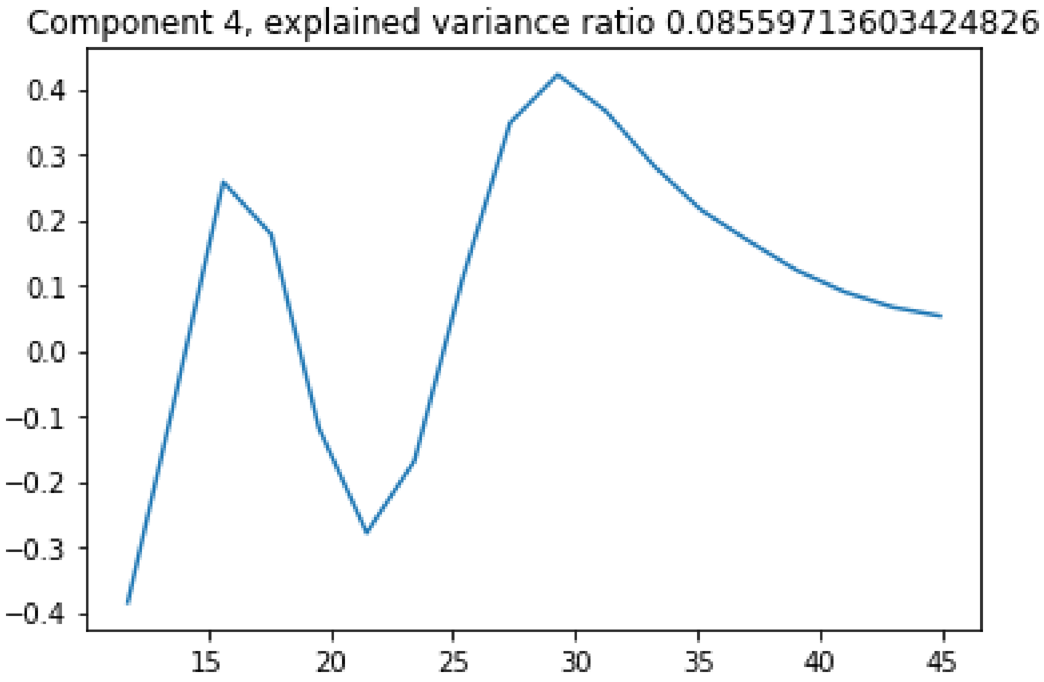
[20]:

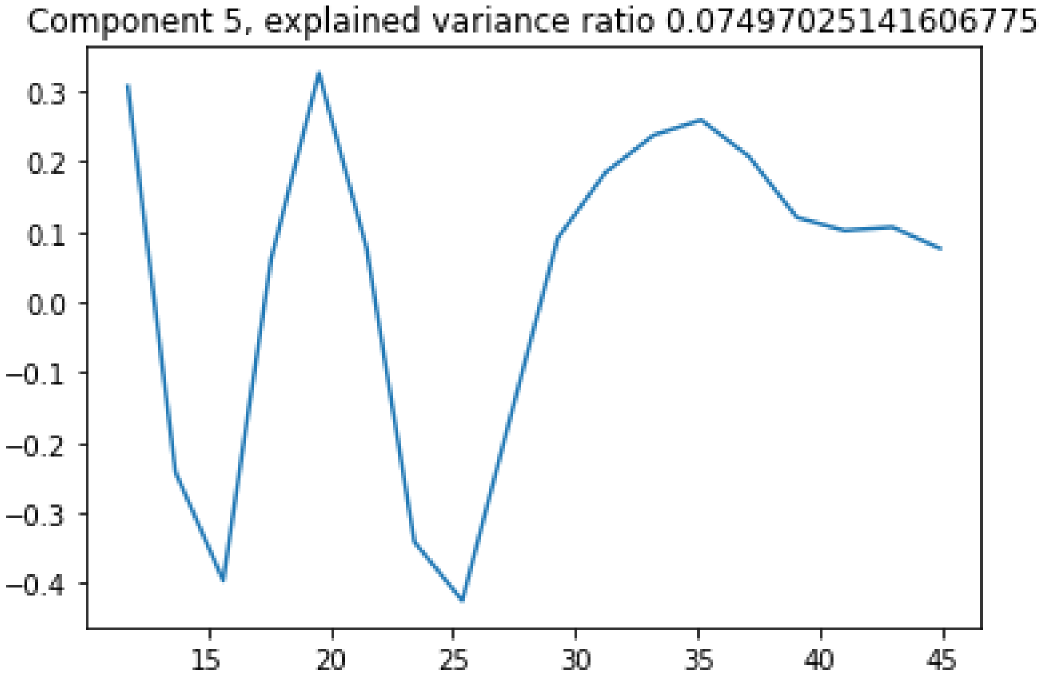
```
for idx, (ratio, component) in enumerate(zip(pca.explained_variance_ratio_, pca.
↪components_)):
    plt.clf()
    plt.title("Component " + str(idx + 1) + ", explained variance ratio " +␣
↪str(ratio))
    plt.plot(frqs, component)
    plt.show()
```

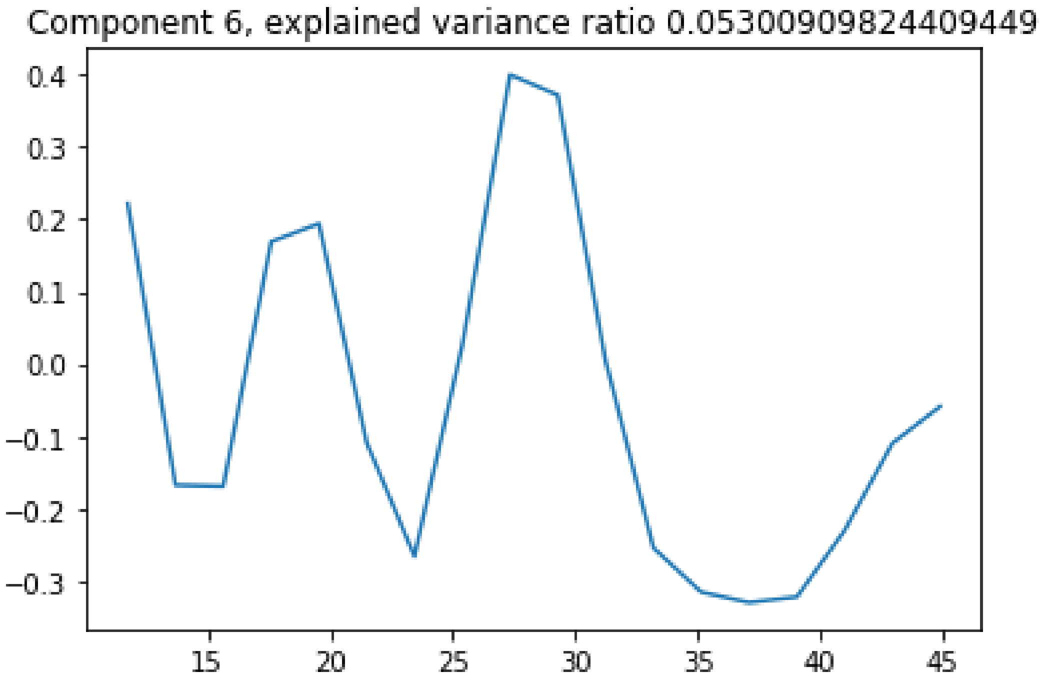


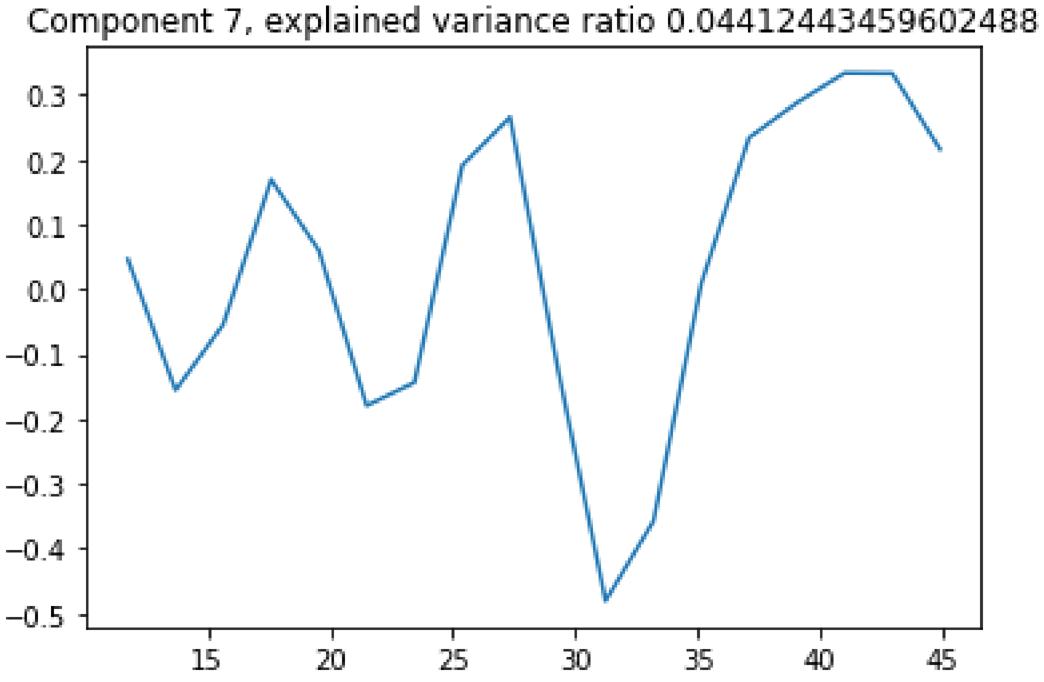

Component 2, explained variance ratio 0.18786153984965928
0.4
0.2
0.0
−0.2
−0.4
15
20
25
30
35
40
45

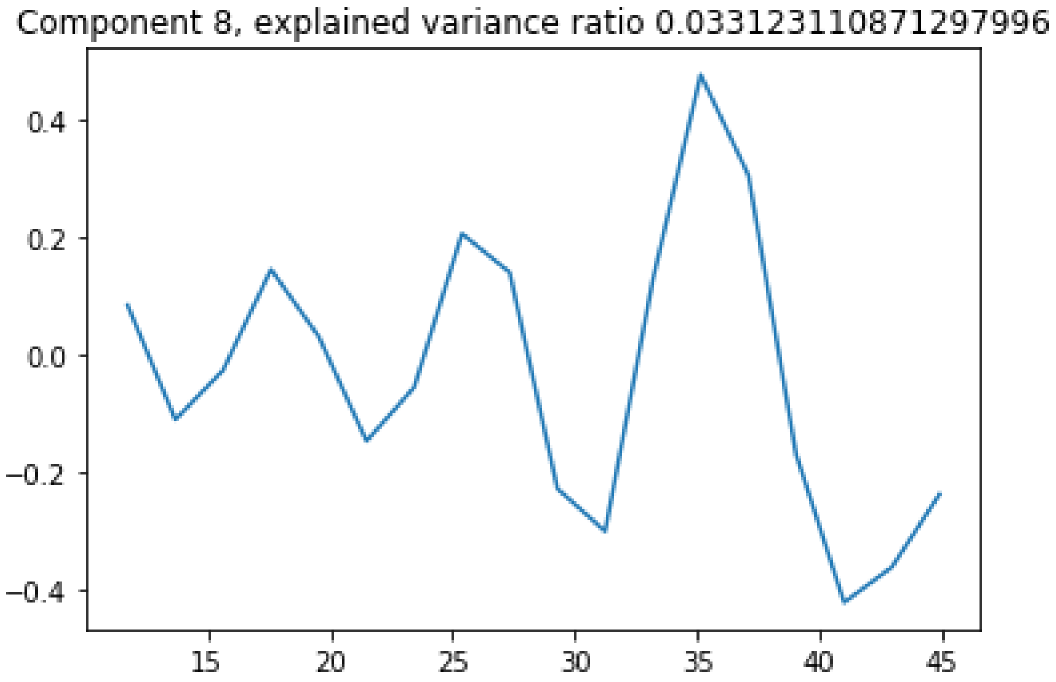

Component 3, explained variance ratio 0.1349676650606849
0.4
0.2
0.0
−0.2
−0.4
15
20
25
30
35
40
45


Component 4, explained variance ratio 0.08559713603424826

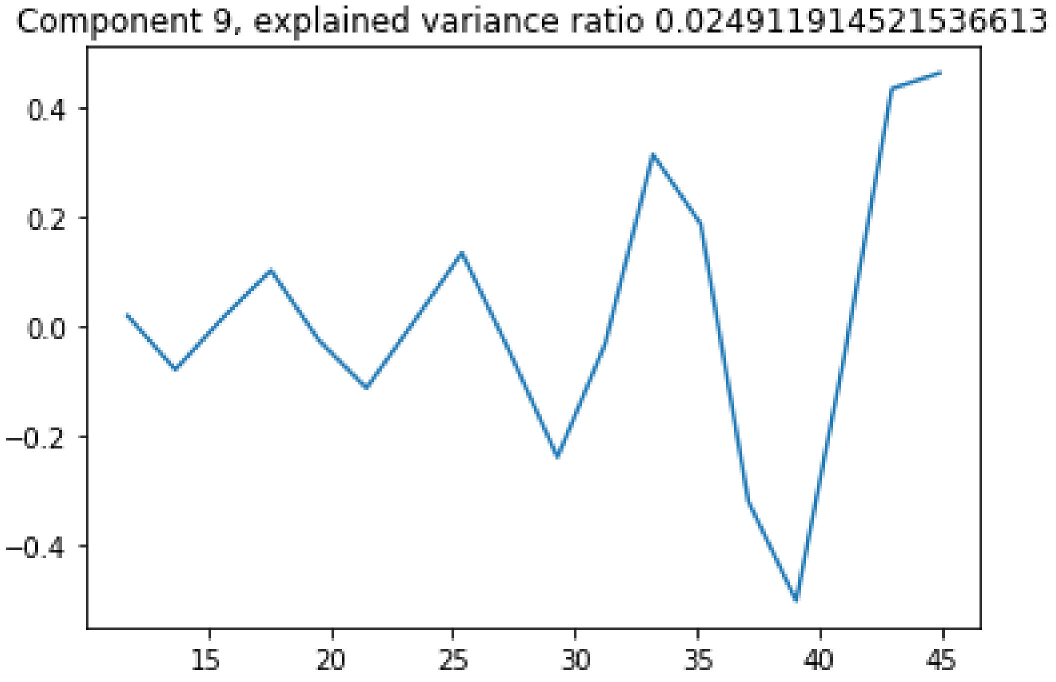

Component 5, explained variance ratio 0.07497025141606775


Component 6, explained variance ratio 0.05300909824409449
0.4
0.3
0.2
0.1
0.0
−0.1
−0.2
−0.3
15
20
25
30
35
40
45

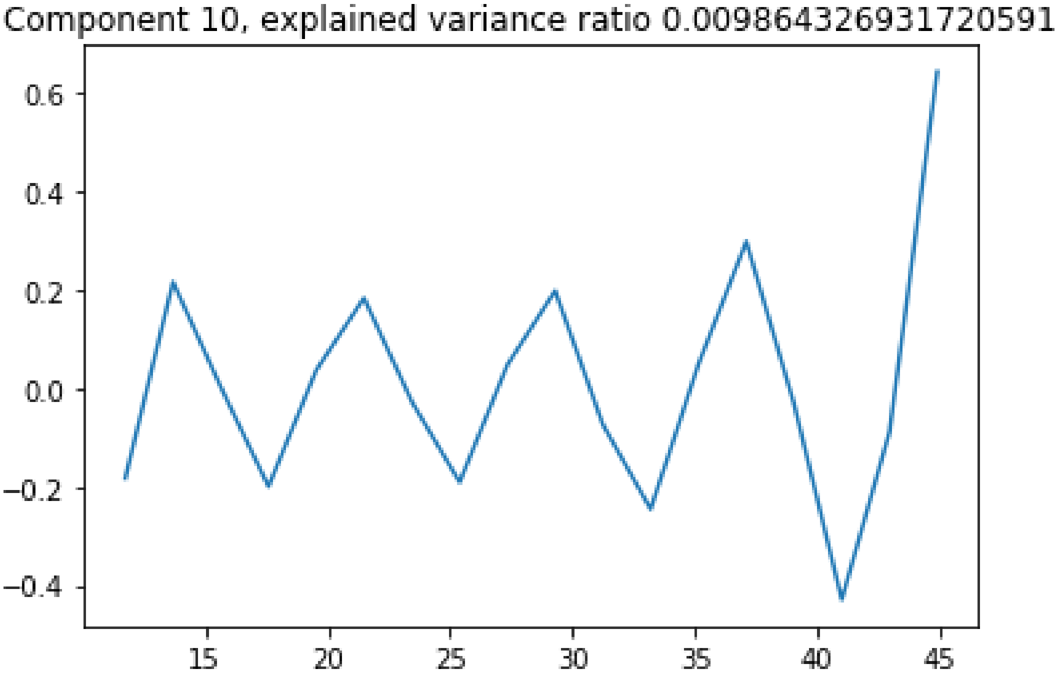

Component 7, explained variance ratio 0.04412443459602488
0.3
0.2
0.1
0.0
−0.1
−0.2
−0.3
−0.4
−0.5
15
20
25
30
35
40
45



Component 8, explained variance ratio 0.033123110871297996

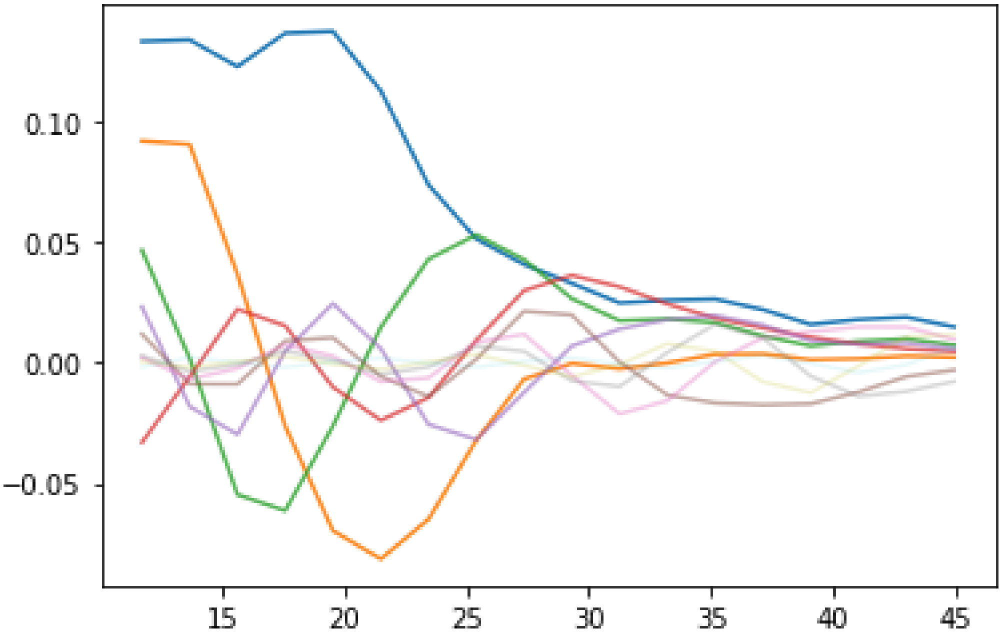


Component 9, explained variance ratio 0.024911914521536613



Component 10, explained variance ratio 0.009864326931720591

```
[22]: plt.clf()
      for idx, (ratio, component) in enumerate(zip(pca.explained_variance_ratio_, pca.
       ↪components_)):
          plt.plot(frqs, ratio * component, alpha = 1 - idx/10)
      plt.show()
```



0.10
0.05
0.00
−0.05
15
20
25
30
35
40
45