k-Means, PCA, and Tree VQ

Thomas Breuel

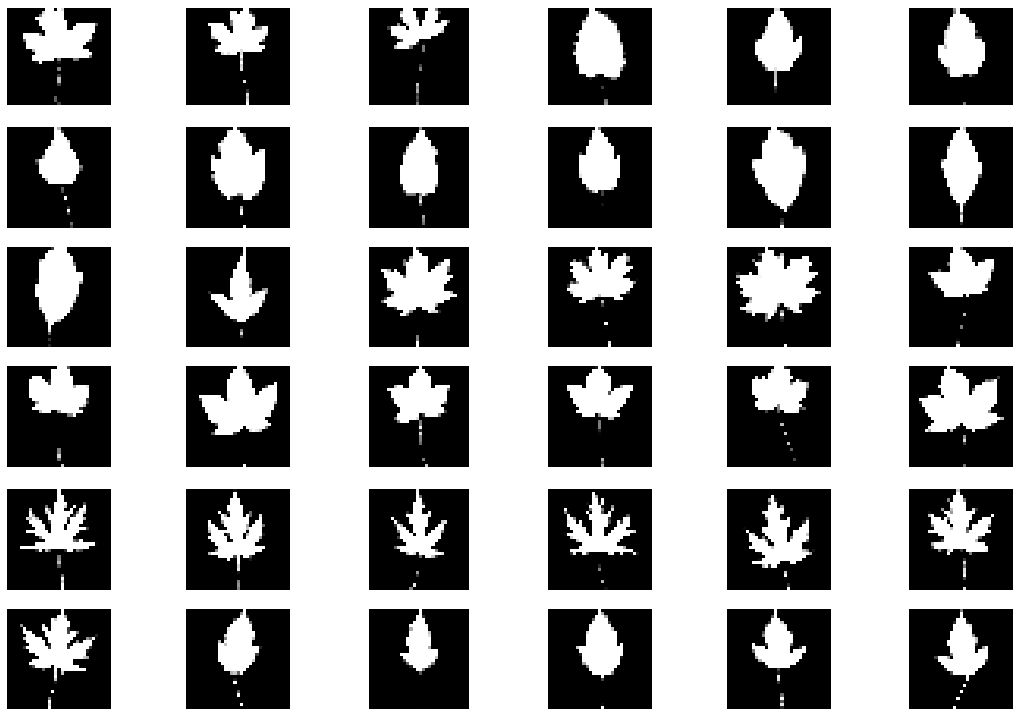
UniKL

```
1 import random as pyrand
2 import tables
3 matplotlib.rc("image",cmap="gray")
```

Clustering Shapes

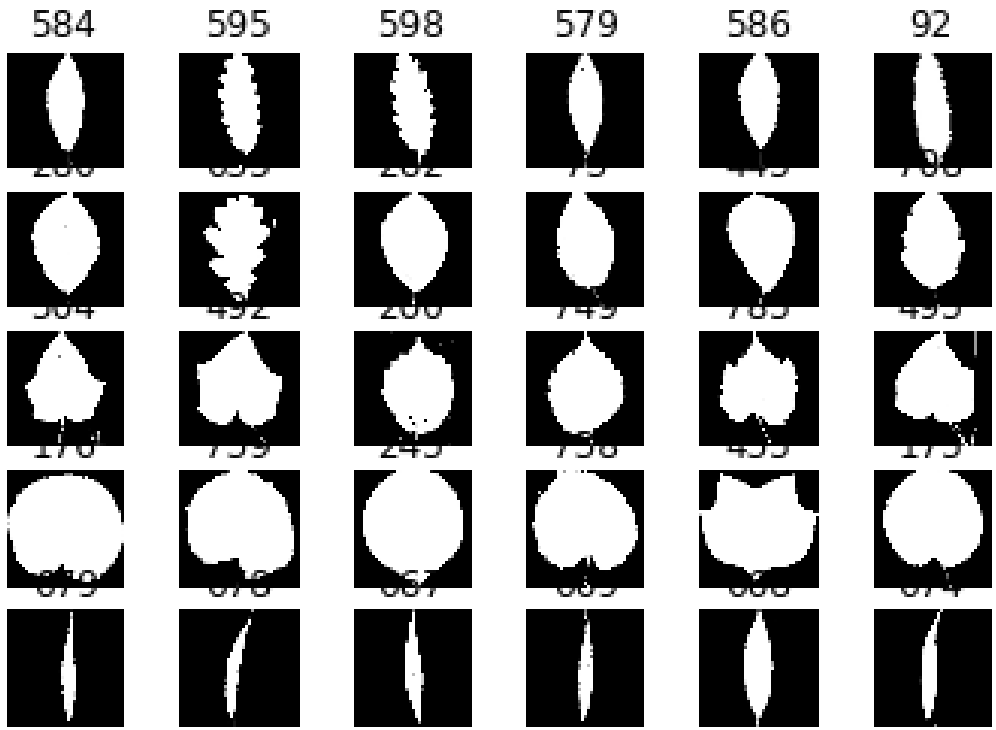
```
hdf = tables.openFile("leaves.h5","r")
nimages = len(hdf.root.icons)
images = hdf.root.icons[:,:,:]/256.0
data = images.reshape(nimages,-1)
```

```
for i in range(36):
    subplot(6,6,i+1); imshow(images[i]); axis("off")
```



```
from sklearn.cluster import KMeans,MiniBatchKMeans
km = MiniBatchKMeans(n_clusters=36)
km.fit(data)
assignments = km.predict(data)
nearest = [[i for i,j in enumerate(assignments) if j==c] for c in
    range(36)]
good = [l for l in nearest if len(l)>3]
```

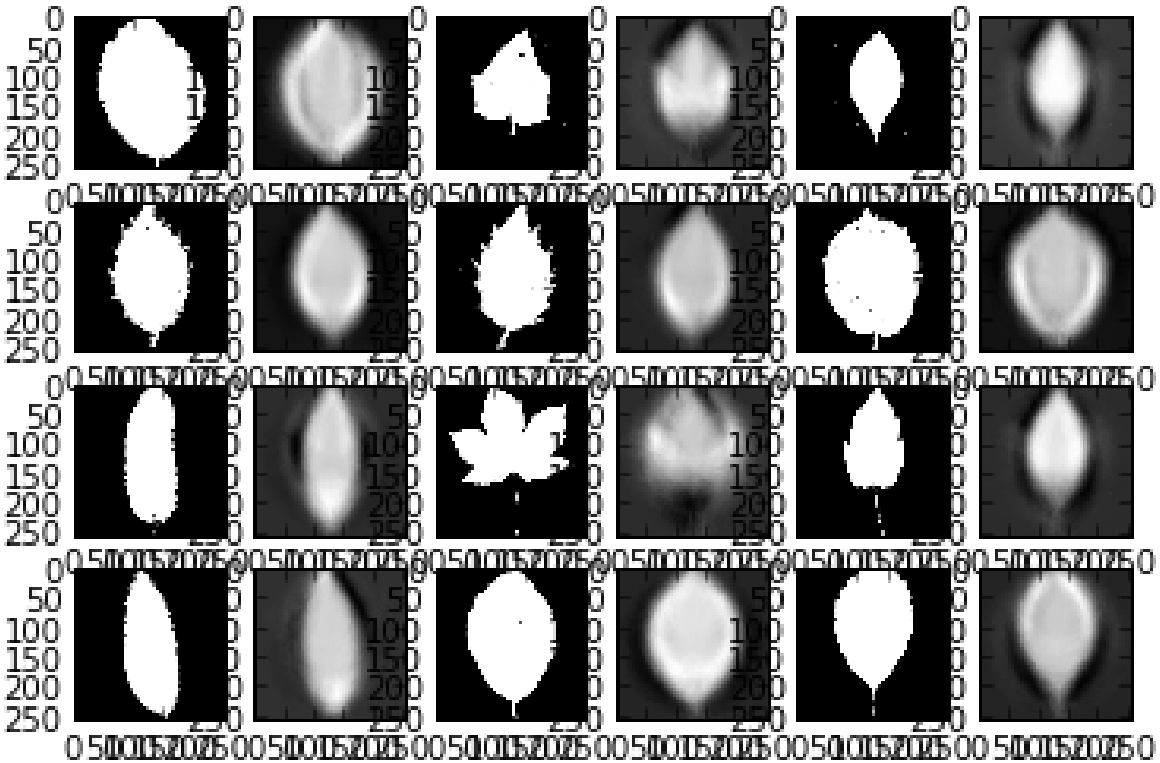
```
for i,l in enumerate(good[:5]):
    for j,k in enumerate(pyrand.sample(l,min(6,len(l)))):
        subplot(5,6,i*6+j+1)
        imshow(hdf.root.icons[k])
        title("%d"%(k,))
        axis("off")
```



Combining PCA and k-means

```
from sklearn.decomposition import RandomizedPCA
pca = RandomizedPCA(n_components=10)
pca.fit(data)
lo = pca.transform(data)
hi = pca.inverse_transform(lo)
```

```
for i,j in enumerate(pyrand.sample(range(len(images)),12)):
    subplot(4,6,2*i+1); imshow(images[j])
    subplot(4,6,2*i+2); imshow(hi[j].reshape(256,256))
```



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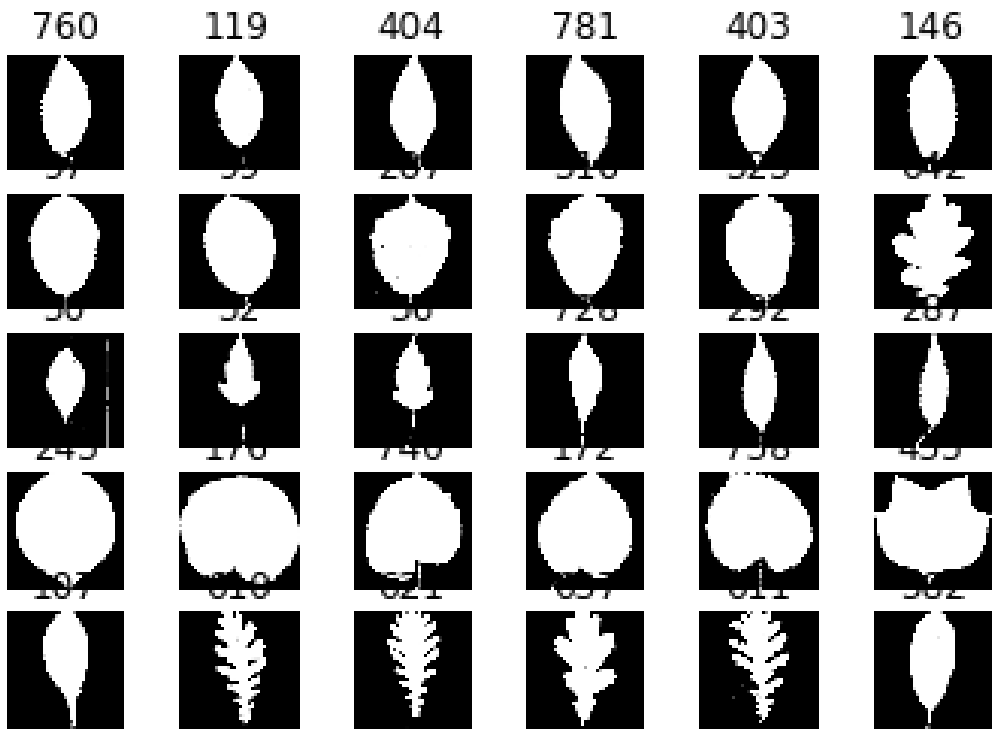
nearest = [[i for i,j in enumerate(assignments) if j==c] for c in
    range(36)]
good = [l for l in nearest if len(l)>3]
```

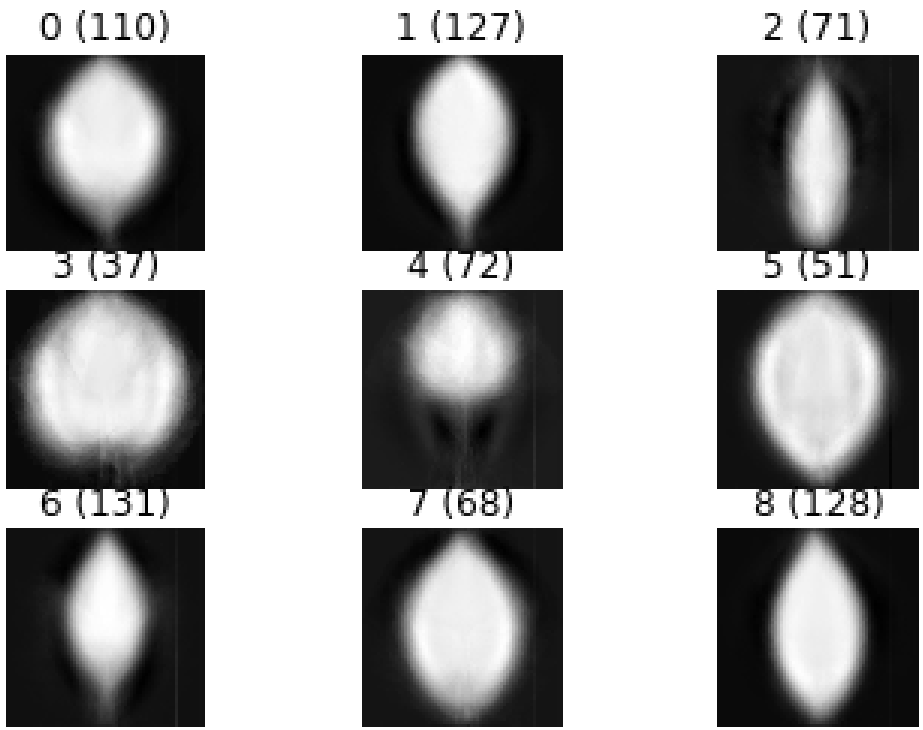
```
for i,l in enumerate(good[:5]):
    for j,k in enumerate(pyrand.sample(l,min(6,len(l)))):
        subplot(5,6,i*6+j+1)
        imshow(images[k])
        title("%d"%(k,))
        axis("off")
```



Hierarchical and Tree VQ

```
km = MiniBatchKMeans(n_clusters=9)
km.fit(lo)
assignments = km.predict(lo)
nearest = [[i for i,j in enumerate(assignments) if j==c] for c in
    range(9)]
```

```
for i,c in enumerate(km.cluster_centers_):
    im = pca.inverse_transform(c)
    subplot(3,3,i+1); axis("off"); imshow(im.reshape(256,256))
    title("%d (%d)"%(i,len(nearest[i])))
```



```
data0 = [data[i] for i in nearest[0]] # note data instead of lo
print len(data0)
km0 = MiniBatchKMeans(n_clusters=9)
km0.fit(data0)
assignments0 = km0.predict(data0)
nearest0 = [[i for i,j in enumerate(assignments0) if j==c] for c in
    range(9)]
```

```
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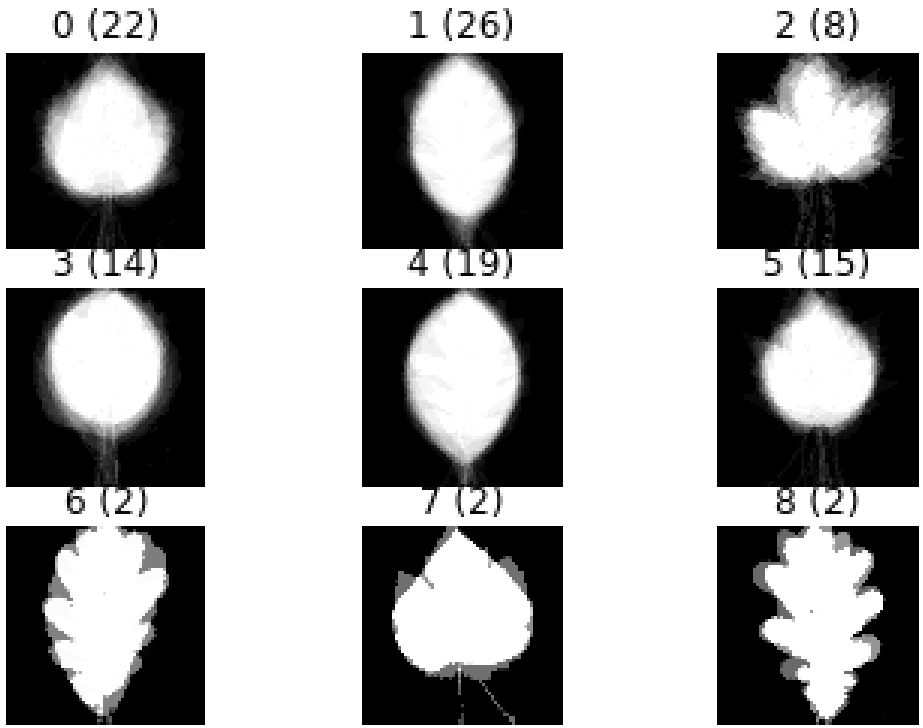
```

```
for i,c in enumerate(km0.cluster_centers_):
    subplot(3,3,i+1); axis("off"); imshow(c.reshape(256,256))
    title("%d (%d)"%(i,len(nearest0[i])))
```



Hierarchical Tree VQ

- we perform VQ in several stages
- a first, top-level VQ
- then we split the data based on the top-level assignments
- then we repeat the VQ for each split
- this can be continued recursively (tree VQ)
- if we use different resolutions or number of PCA components at each level, we are using a hierarchical VQ

Hierarchical tree VQ is a good way of clustering very large data sets.