FCM

December 17, 2019

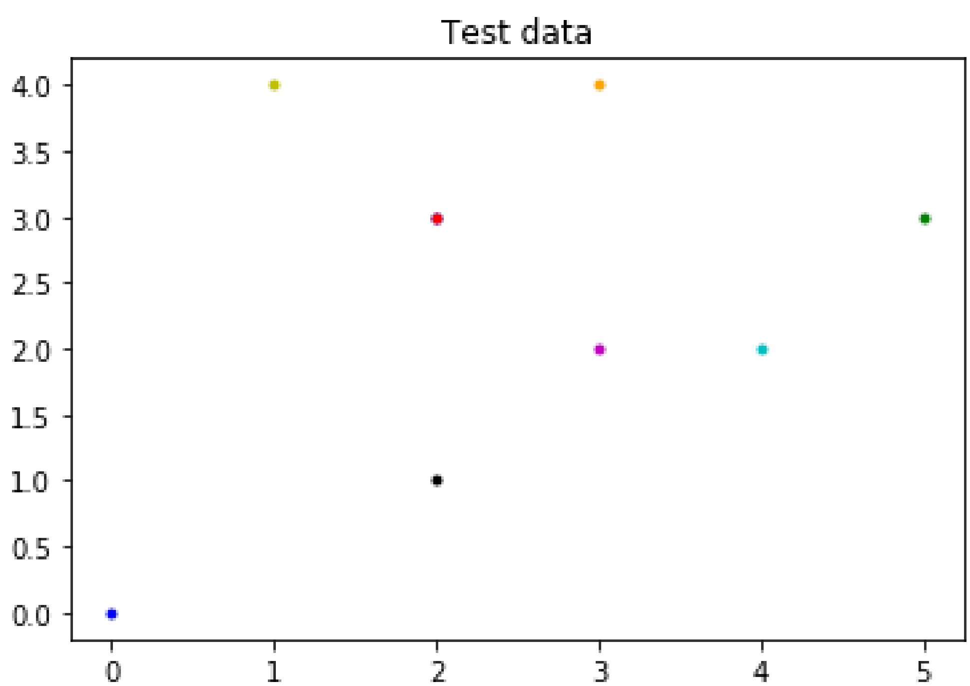
0.0.1 Fuzzy c-means clustering

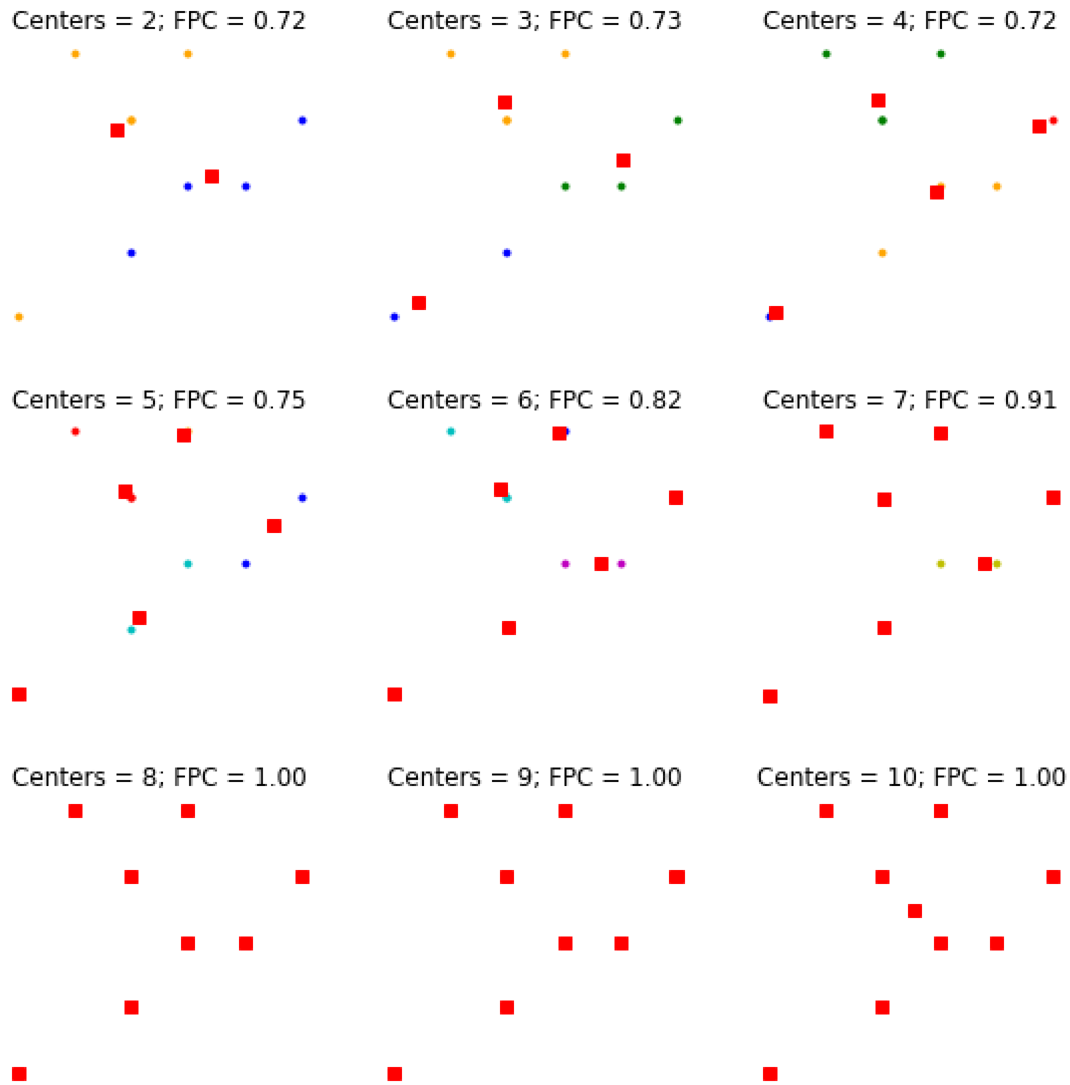
Fuzzy logic principles can be used to cluster multidimensional data, assigning each point a membership in each cluster center from 0 to 100 percent. This can be very powerful compared to traditional hard-thresholded clustering where every point is assigned a crisp, exact label.

Fuzzy c-means clustering is accomplished via skfuzzy.cmeans, and the output from this function can be repurposed to classify new data according to the calculated clusters (also known as prediction) via skfuzzy.cmeans_predict

[2]:
```
from __future__ import division, print_function
import numpy as np
import matplotlib.pyplot as plt
import skfuzzy as fuzz

colors = ['b', 'orange', 'g', 'r', 'c', 'm', 'y', 'k', 'Brown', 'ForestGreen']

xpts = np.zeros(1)
ypts = np.zeros(1)
labels = np.zeros(1)
##############################
####           ########
##############################
points = [[2,3], [3,4], [5,3], [2,3], [4,2], [3,2], [1, 4], [2,1]]
##############################
##                 ###
##############################
for i in range(len(points)):
    xpts = np.hstack((xpts, points[i][0]))
    ypts = np.hstack((ypts, points[i][1]))
    labels = np.hstack((labels, np.ones(1) * i))

#
fig0, ax0 = plt.subplots()
for label in range(len(points)):
    ax0.plot(xpts[labels == label], ypts[labels == label], '.',
             color=colors[label])
ax0.set_title('Test data')
```

```
#
fig1, axes1 = plt.subplots(3, 3, figsize=(8, 8))
alldata = np.vstack((xpts, ypts))
fpcs = []

for ncenters, ax in enumerate(axes1.reshape(-1), 2):
    cntr, u, u0, d, jm, p, fpc = fuzz.cluster.cmeans(
        alldata, ncenters, 2, error=0.005, maxiter=1000, init=None)

    #            fpc
    fpcs.append(fpc)

    #
    cluster_membership = np.argmax(u, axis=0)
    for j in range(ncenters):
        ax.plot(xpts[cluster_membership == j],
                ypts[cluster_membership == j], '.', color=colors[j])

    #
    for pt in cntr:
        ax.plot(pt[0], pt[1], 'rs')

    ax.set_title('Centers = {0}; FPC = {1:.2f}'.format(ncenters, fpc))
    ax.axis('off')

fig1.tight_layout()
```





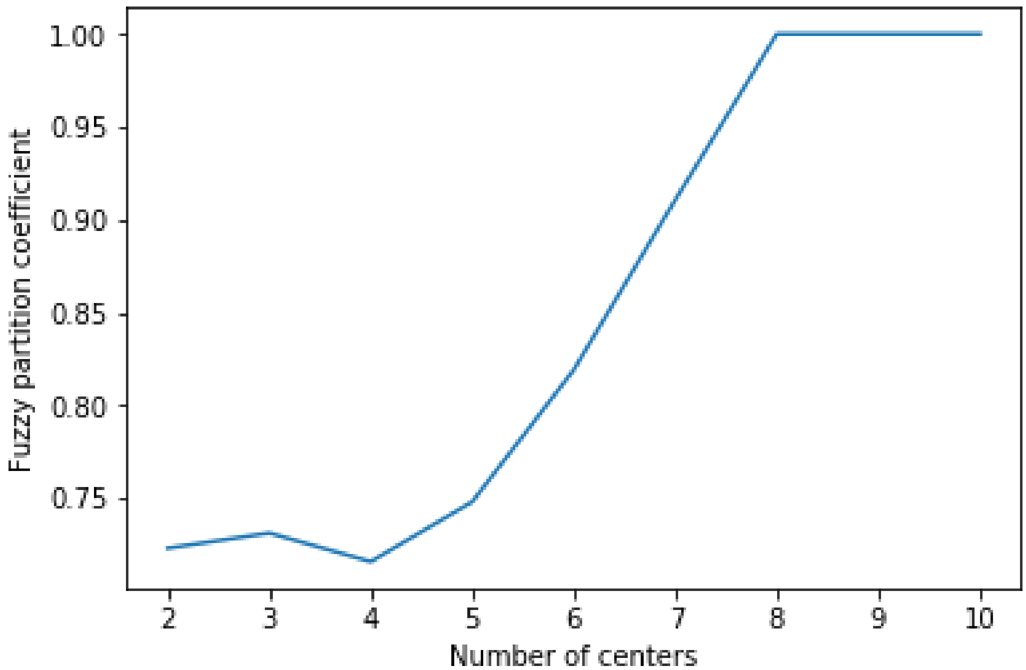
0.0.2 The fuzzy partition coefficient (FPC)

The FPC is defined on the range from 0 to 1, with 1 being best. It is a metric which tells us how cleanly our data is described by a certain model. Next we will cluster our set of data - which we know has three clusters - several times, with between 2 and 9 clusters. We will then show the results of the clustering, and plot the fuzzy partition coefficient. When the FPC is maximized, our data is described best.

[3]:
```
ig2, ax2 = plt.subplots()
ax2.plot(np.r_[2:11], fpcs)
```

```
ax2.set_xlabel("Number of centers")
ax2.set_ylabel("Fuzzy partition coefficient")
```

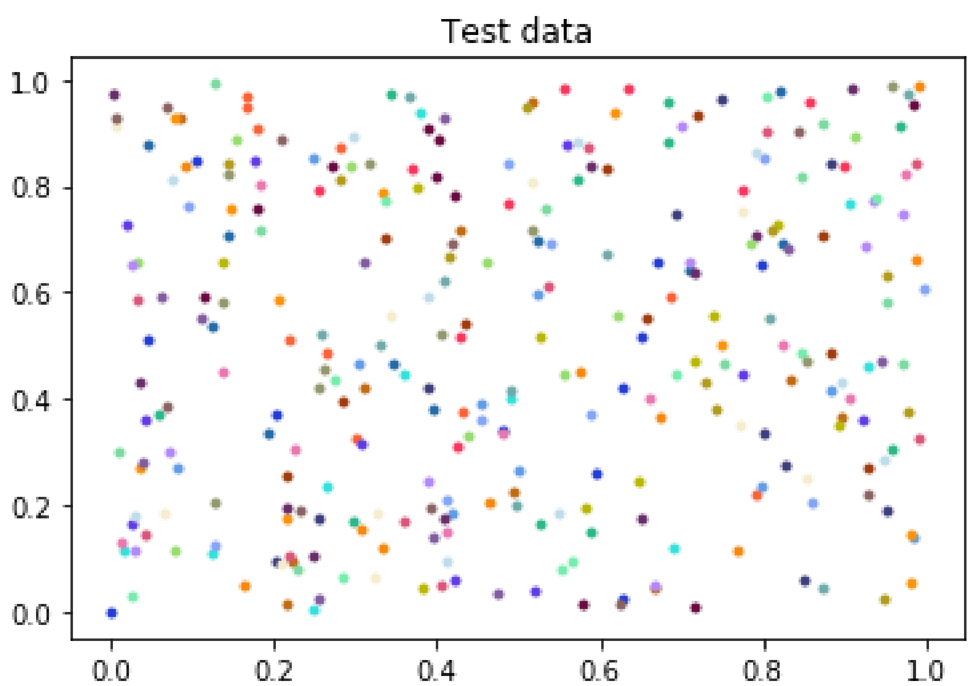
[3]: Text(0,0.5,'Fuzzy partition coefficient')

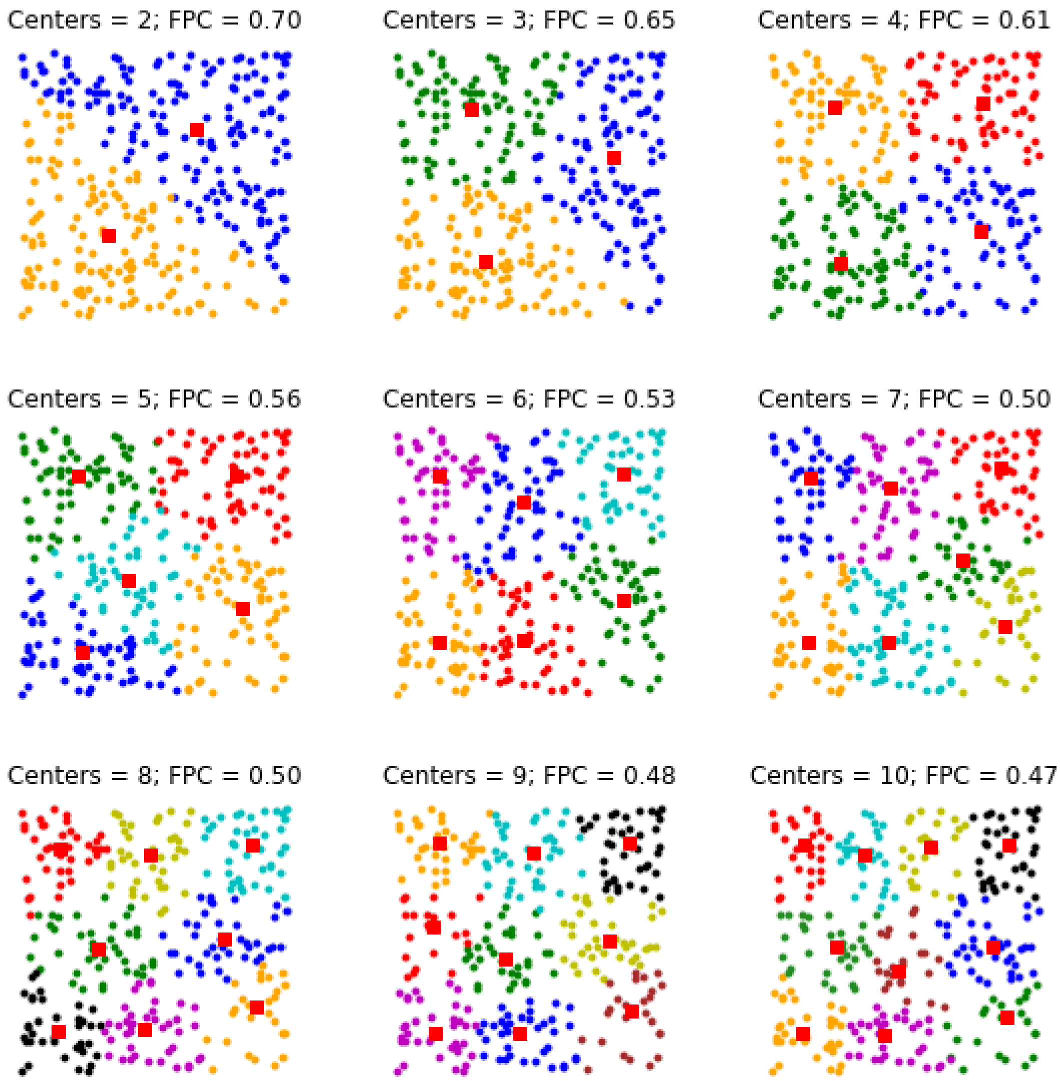


0.0.3

[4]:
```
xpts = np.zeros(1)
ypts = np.zeros(1)
labels = np.zeros(1)
for i in range(30):
    xpts = np.hstack((xpts, np.random.random_sample(10)))
    ypts = np.hstack((ypts, np.random.random_sample(10)))
    labels = np.hstack((labels, np.ones(10) * i))
#
fig0, ax0 = plt.subplots()
for label in range(len(labels)):
    ax0.plot(xpts[labels == label], ypts[labels == label], '.',
             color=np.random.rand(3,))
ax0.set_title('Test data')

#
fig1, axes1 = plt.subplots(3, 3, figsize=(8, 8))
alldata = np.vstack((xpts, ypts))
```

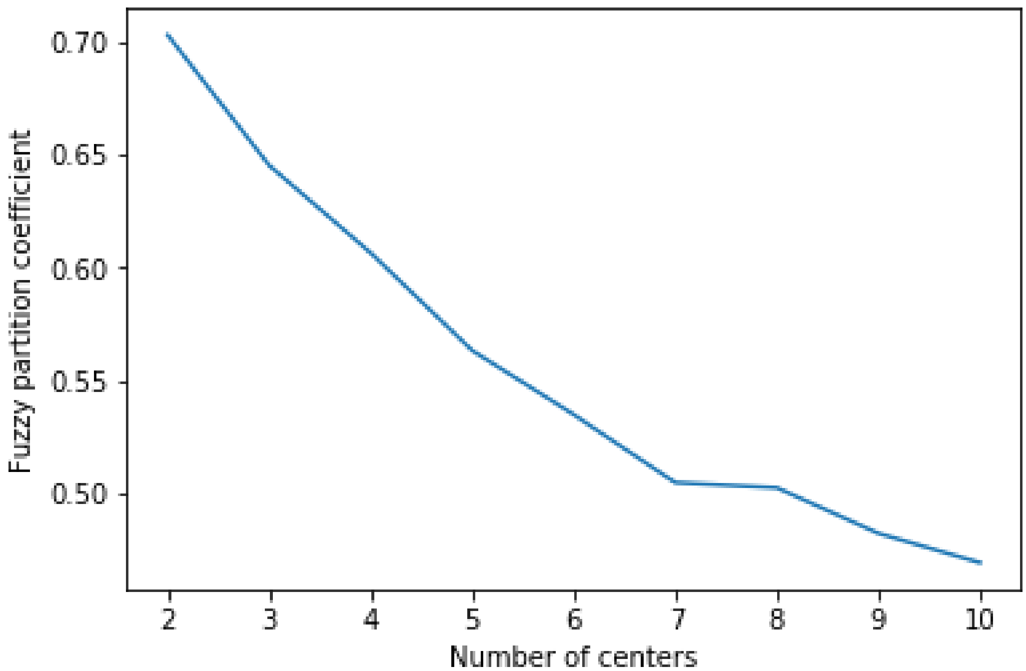
```
fpcs = []

for ncenters, ax in enumerate(axes1.reshape(-1), 2):
    cntr, u, u0, d, jm, p, fpc = fuzz.cluster.cmeans(
        alldata, ncenters, 2, error=0.005, maxiter=1000, init=None)

    #           fpc
    fpcs.append(fpc)

    #
    cluster_membership = np.argmax(u, axis=0)
    for j in range(ncenters):
        ax.plot(xpts[cluster_membership == j],
                ypts[cluster_membership == j], '.', color=colors[j])

    #
    for pt in cntr:
        ax.plot(pt[0], pt[1], 'rs')

    ax.set_title('Centers = {0}; FPC = {1:.2f}'.format(ncenters, fpc))
    ax.axis('off')

fig1.tight_layout()
```





[5]:
```
ig2, ax2 = plt.subplots()
ax2.plot(np.r_[2:11], fpcs)
ax2.set_xlabel("Number of centers")
ax2.set_ylabel("Fuzzy partition coefficient")
```

[5]: Text(0,0.5,'Fuzzy partition coefficient')


0.70
0.65
0.60
0.55
0.50
Fuzzy partition coefficient
2
3
4
5
6
7
8
9
10
Number of centers