The algorithm

In [162…

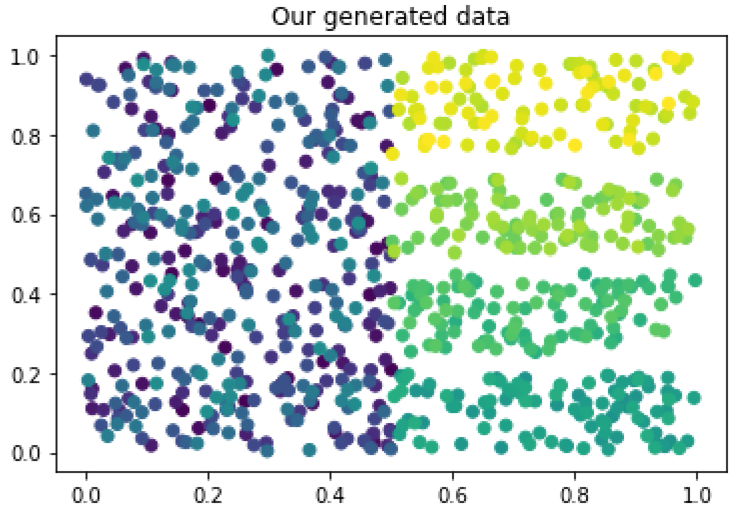
```
def SOM(X, map_size, iterations, lr=0.1, recived_map=None , weights=None, start_iter=0):
    lr = lr
    n_radius = 0.6
    if recived_map is None:
        k_map = []
        for i in range(map_size):
            for j in range(map_size):
                k_map.append([0.4*(i/map_size), (j/map_size)**2])
    else:
        k_map = recived_map

    for _iter in range(iterations+1):
        s_size = n_radius * (1 - _iter / iterations)
        if weights is None:
            point = random.choice(X)
        else:
            point = random.choices(X, weights=weights, k=1)[0]

        # Find the euclidian distance for all neurons
        dists = np.array([np.linalg.norm(point - neuron) for neuron in k_map])

        BMU = k_map[np.argmin(dists)]

        # Find the neighborhood by distance
        neighborhood = [i for i, c in enumerate(k_map) if sum(abs(p-q) for p,q in zip(BMU,c)) <= s_size]

        # Update
        for neighbor in neighborhood:
            new_x = (1 - lr) * k_map[neighbor][0] + lr * point[0]
            new_y = (1 - lr) * k_map[neighbor][1] + lr * point[1]
            k_map[neighbor] = (new_x, new_y)

        # Give each point a label
        y_values = [np.argmin([np.linalg.norm(point - neuron) for neuron in k_map]) for point in X]
        neurons = np.array(k_map)

        # Plot the points with the label
        unique_labels = list(set(y_values))
        labels = [unique_labels.index(label) for label in y_values]
        if _iter%10 == 0:
            plt.scatter(X[:, 0], X[:, 1], c=labels)
#                plt.scatter(neurons[:, 0], neurons[:, 1],c=list(range(len(neurons**2))), marker = (5,2), s = 500)
```

```
            plt.scatter(neurons[:, 0], neurons[:, 1],c='b', marker = (5,2), s = 200)
            plt.title("After %d iterations" %(start_iter+_iter))
            plt.show()
    return k_map
```

Our dataset is 500 points {(x,y)|0 <= x,y <= 1} with uniform distrobution.

In [163…

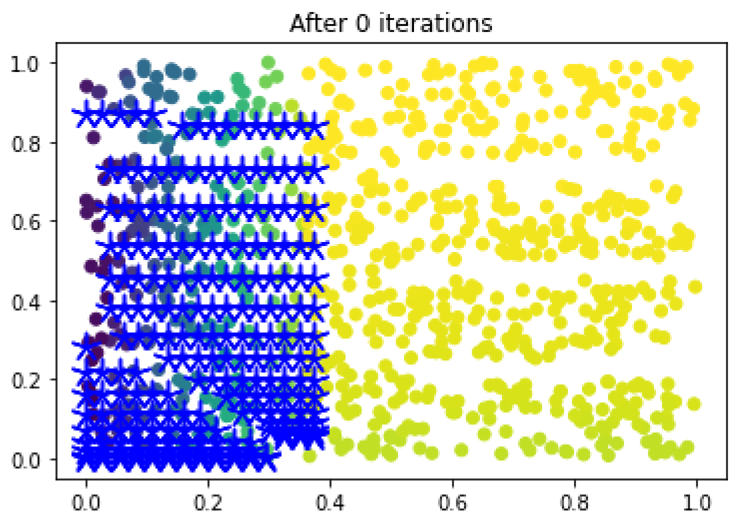
```
import numpy as np
import matplotlib.pyplot as plt
import random
points = 400
# Create a dataset
finger_size = int(points/4)
base_hand_x, base_hand_y = np.random.uniform(0, 0.5, points), np.random.uniform(0, 1, points)
f_1_x, f_1_y = np.random.uniform(0.5, 1, finger_size), np.random.uniform(0, 0.2, finger_size)
f_2_x, f_2_y = np.random.uniform(0.5, 1, finger_size), np.random.uniform(0.25, 0.45, finger_size)
f_3_x, f_3_y = np.random.uniform(0.5, 1, finger_size), np.random.uniform(0.5, 0.7, finger_size)
f_4_x, f_4_y = np.random.uniform(0.5, 1, finger_size), np.random.uniform(0.75, 1, finger_size)

full_X = np.zeros((2*points, 2))
full_X[:points, 0], full_X[:points, 1] = base_hand_x, base_hand_y
full_X[points:finger_size+points, 0],full_X[points:finger_size+points, 1] = f_1_x, f_1_y
full_X[finger_size+points:2*finger_size+points, 0], full_X[finger_size+points:2*finger_size+points, 1] = f_2_x, f_2_y
full_X[2*finger_size+points:3*finger_size+points, 0], full_X[2*finger_size+points:3*finger_size+points, 1] = f_3_x, f_3_y
partial_X = np.copy(full_X)

full_X[3*finger_size+points:4*finger_size+points, 0], full_X[3*finger_size+points:4*finger_size+points, 1] = f_4_x, f_4_y

# plot dataset
plt.scatter(full_X[:, 0], full_X[:, 1], c=list(range(800)))
plt.title("Our generated data")
plt.show()
```

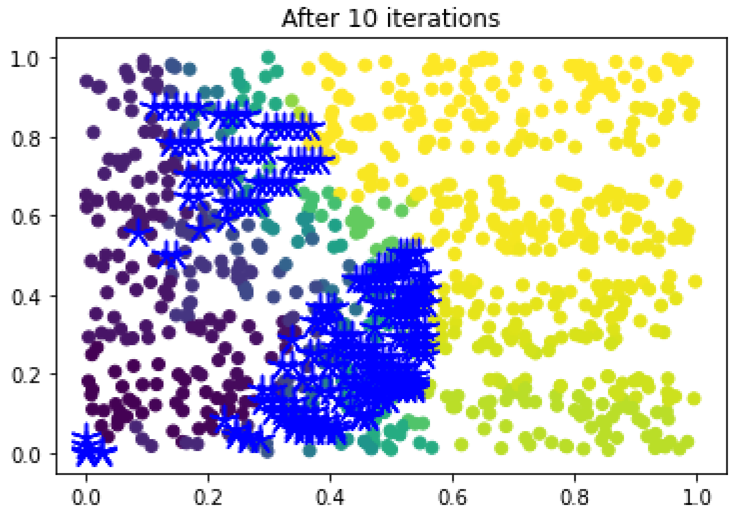


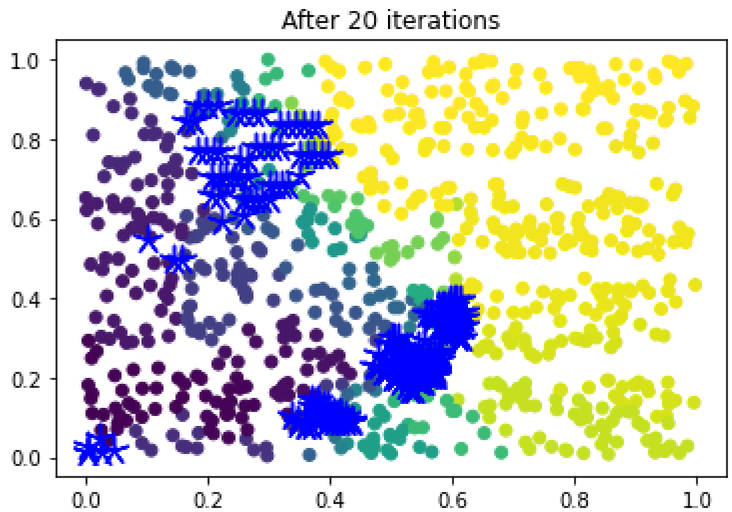
2000 Iterations, 15 neurons.

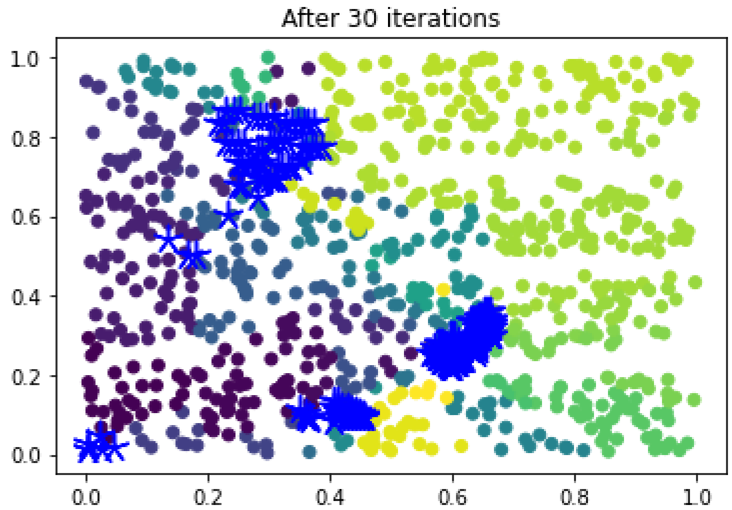
In [164…

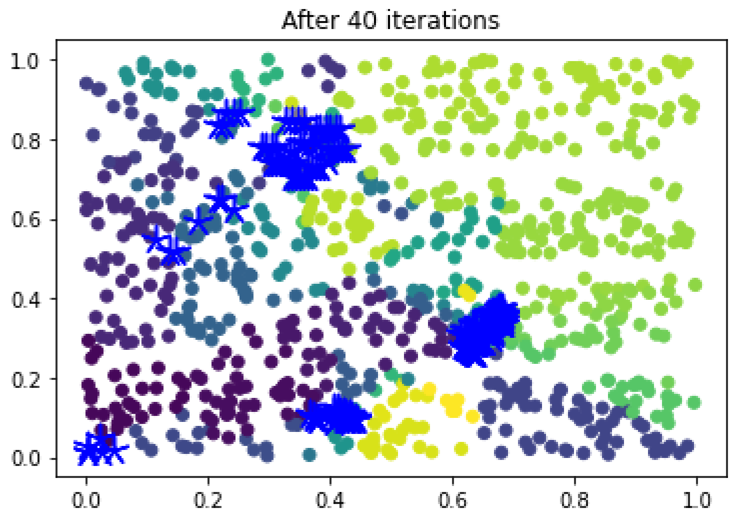
```
kmap = SOM(full_X,15,60)
```



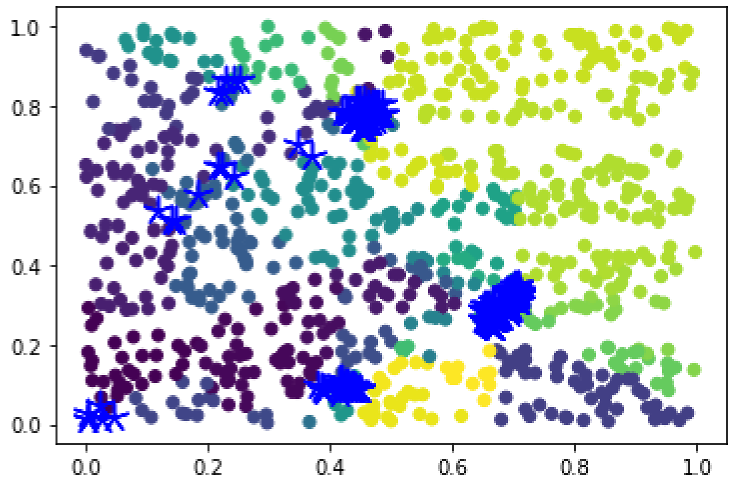

After 10 iterations
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0


After 20 iterations
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0

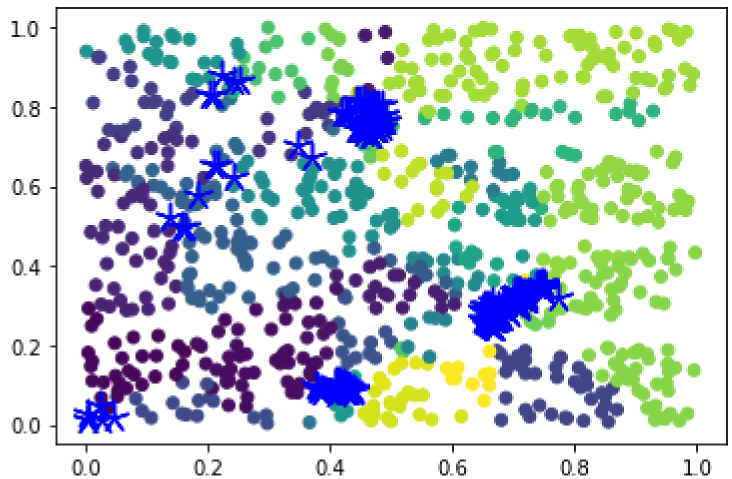

After 30 iterations
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0


After 40 iterations
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0

After 50 iterations



After 60 iterations

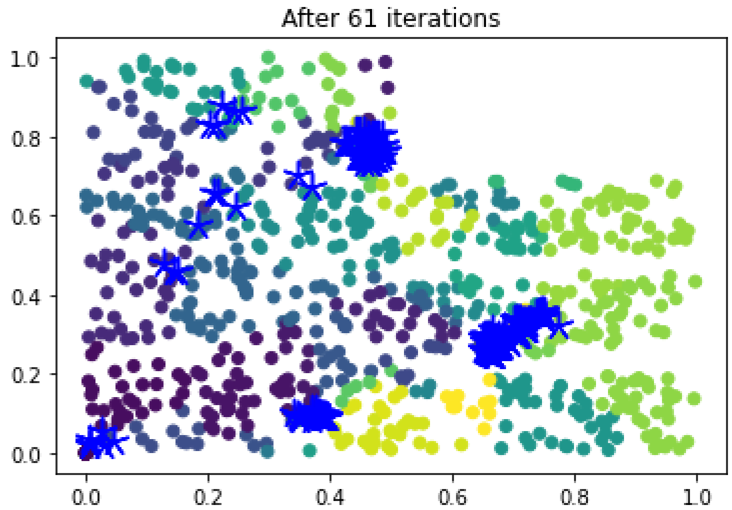


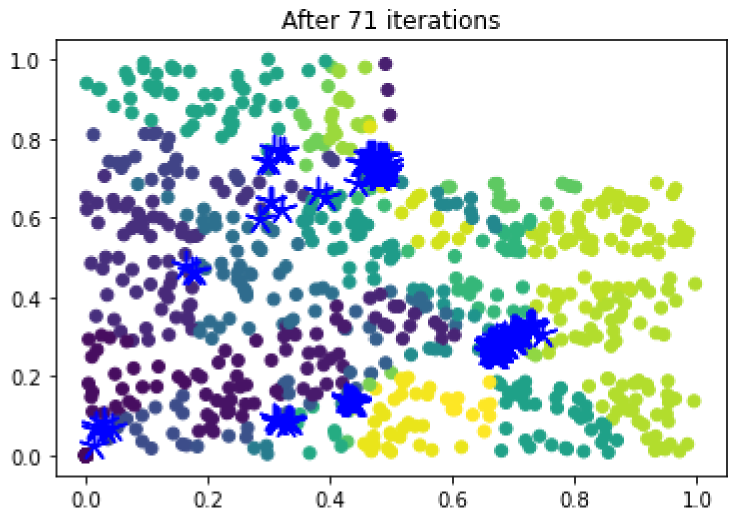
The neurons go towards the right side of the image (to the fingers) with group of clusters.

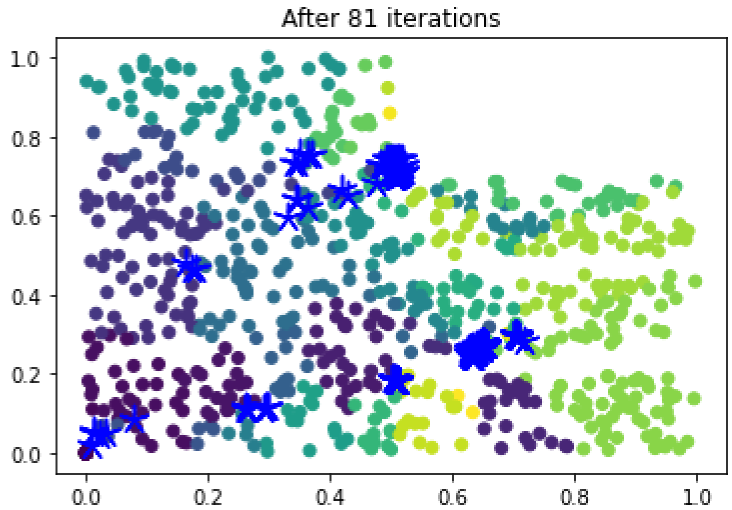
Continue with only 3 fingers for another 60 iters

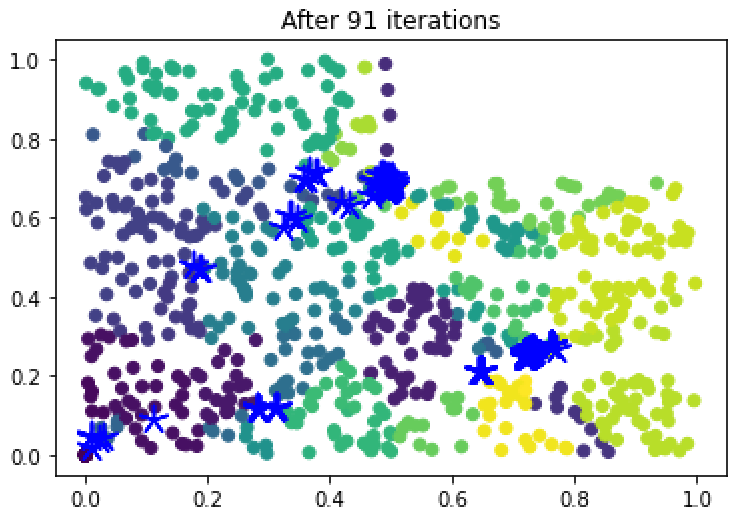
In [165…

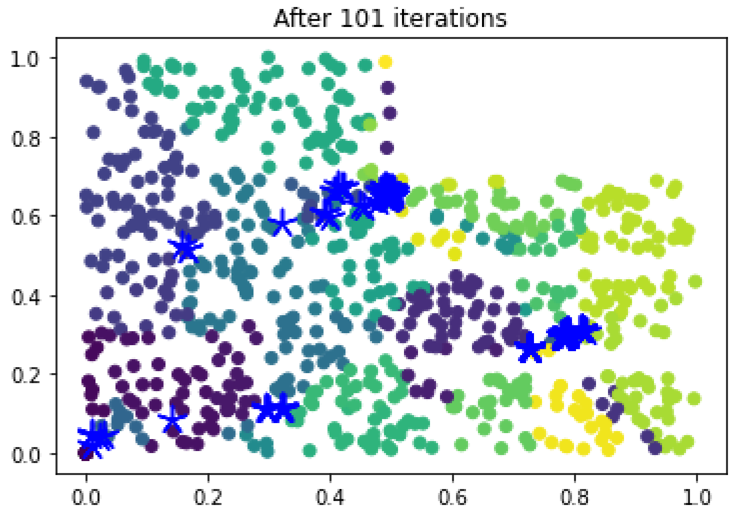
```
kmap = SOM(X=partial_X, map_size=15, iterations=60, recived_map=kmap, start_iter=61)
```

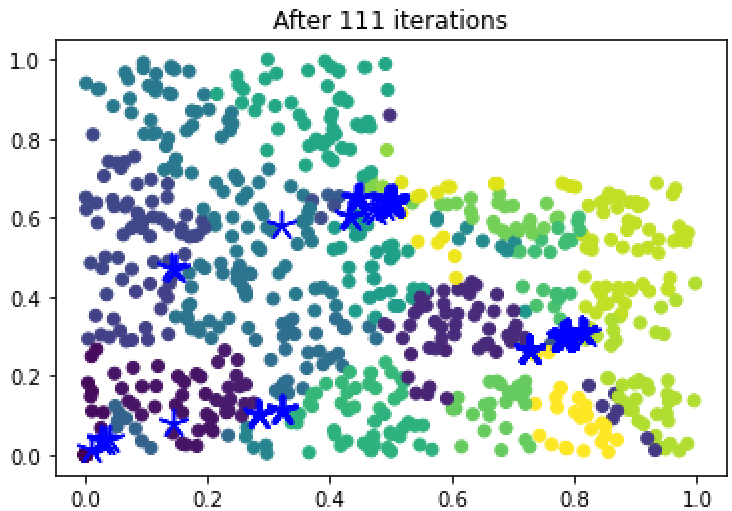

After 61 iterations
1.0
0.8
0.6
0.4
0.2
0.0
0.0 0.2 0.4 0.6 0.8 1.0

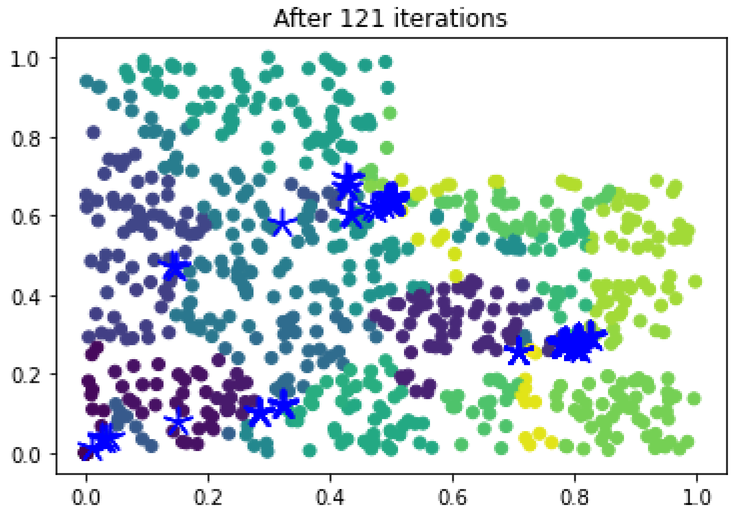

After 71 iterations
1.0
0.8
0.6
0.4
0.2
0.0
0.0 0.2 0.4 0.6 0.8 1.0


After 81 iterations
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0


After 91 iterations
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0


After 101 iterations
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0


After 111 iterations
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0



When removing the most upper finger, all neurons leaving the upper area and goind towards the x-axis. We expected this kind of behaviour from the neurons, because they have more likelyhood to go towards the x-axis.

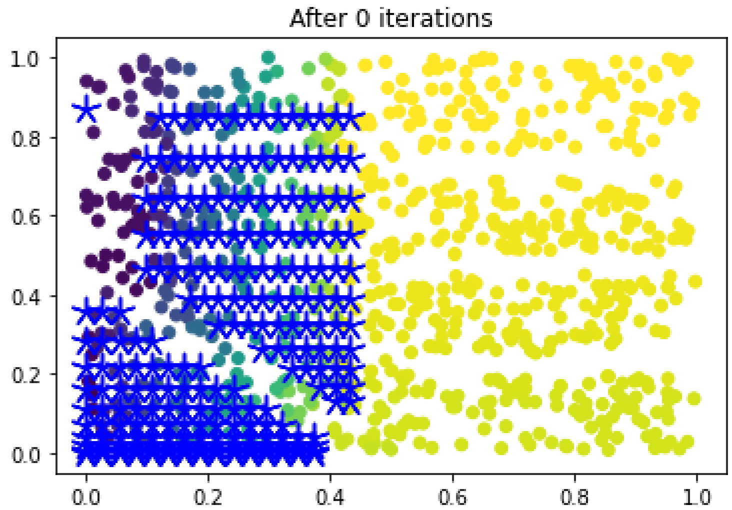
Same but taking from non-unifrom distribution: Proportinal to the size of x and y. We chose this distribution to see how it handles the missing finger.

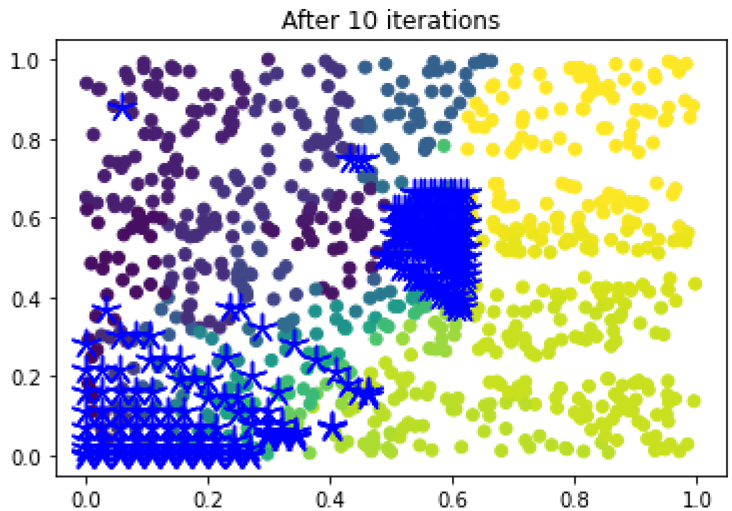
In [166...

```
weights=[x*y for x, y in full_X]
weights = weights/sum(weights)
```

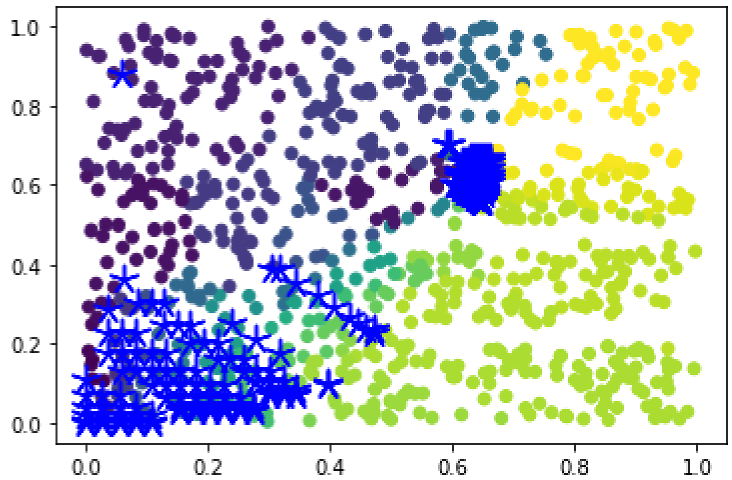
In [167...

```
kmap = SOM(full_X,15,60, weights=weights)
```

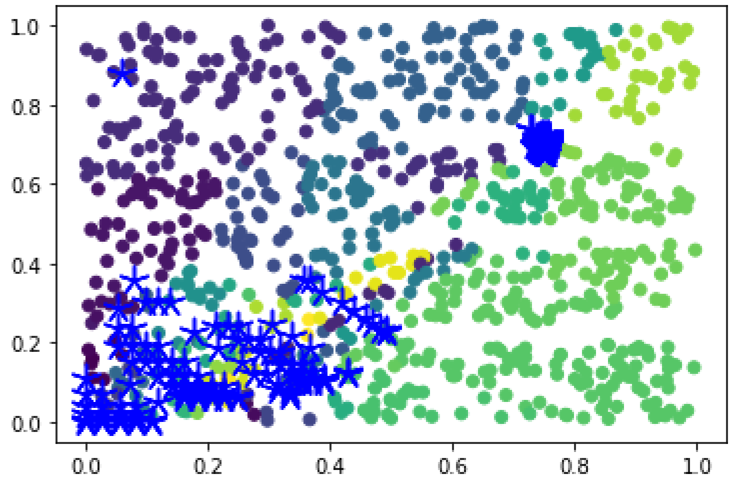

After 0 iterations
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0

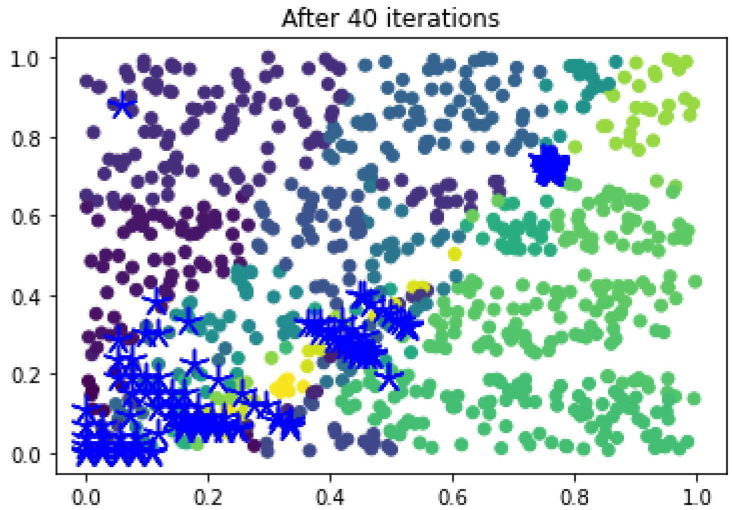

After 10 iterations
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0

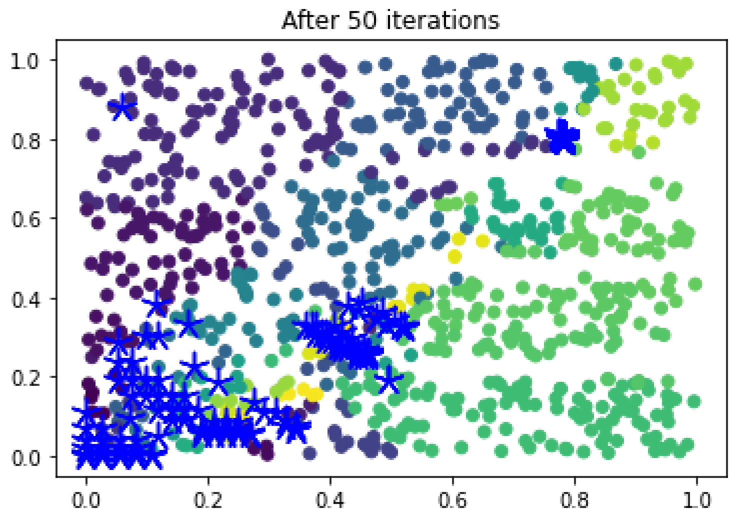
After 20 iterations

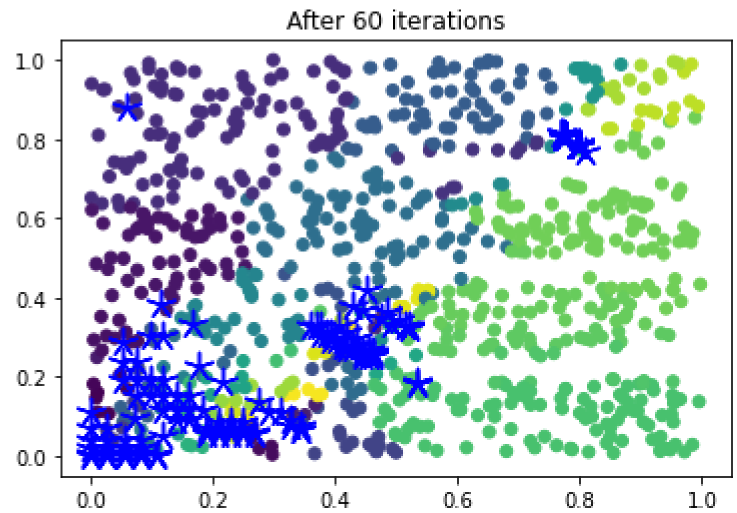


After 30 iterations



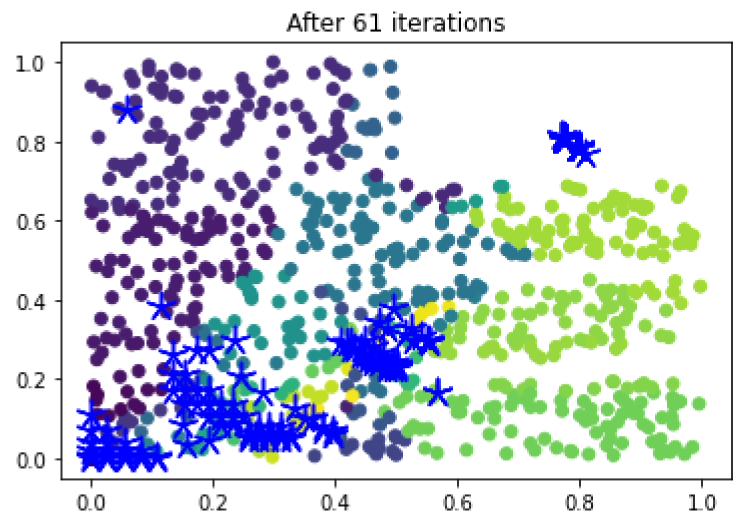

After 40 iterations
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0

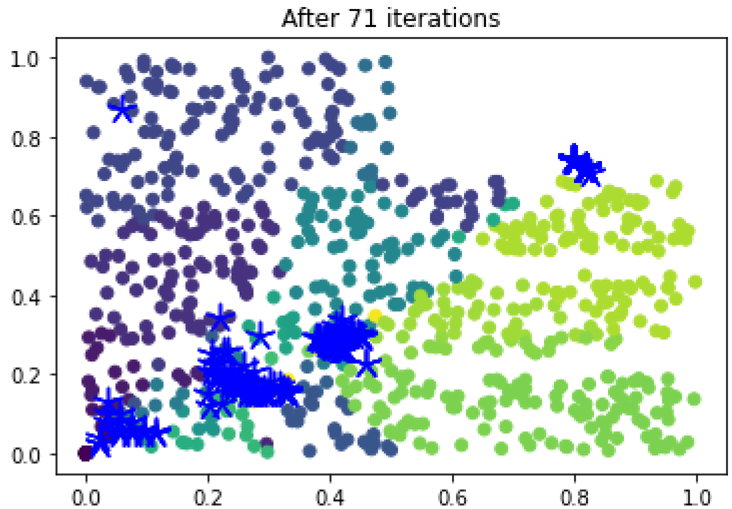

After 50 iterations
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0

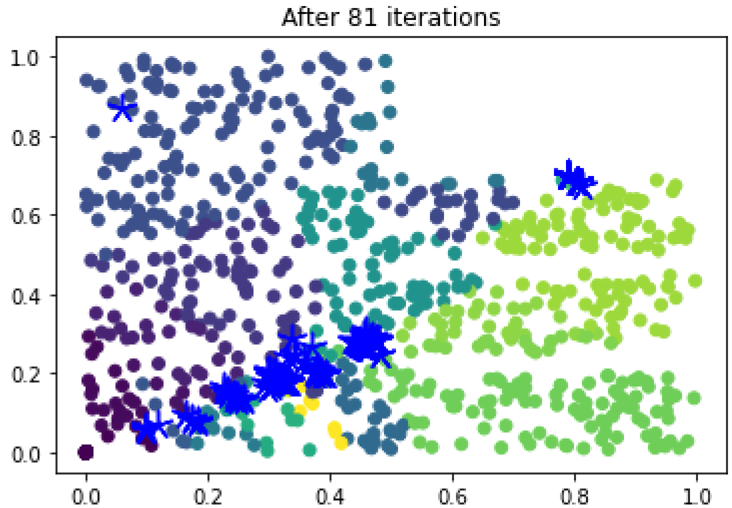


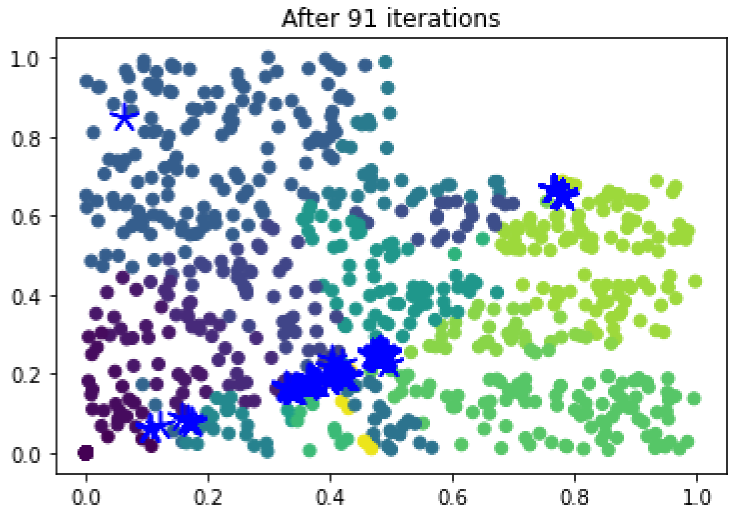
In [168…

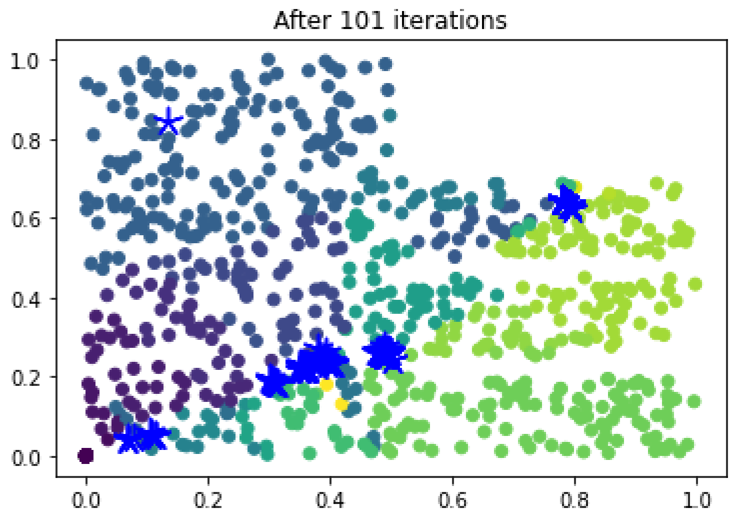
```
kmap = SOM(X=partial_X, map_size=15, iterations=60, recived_map=kmap, start_iter=61)
```

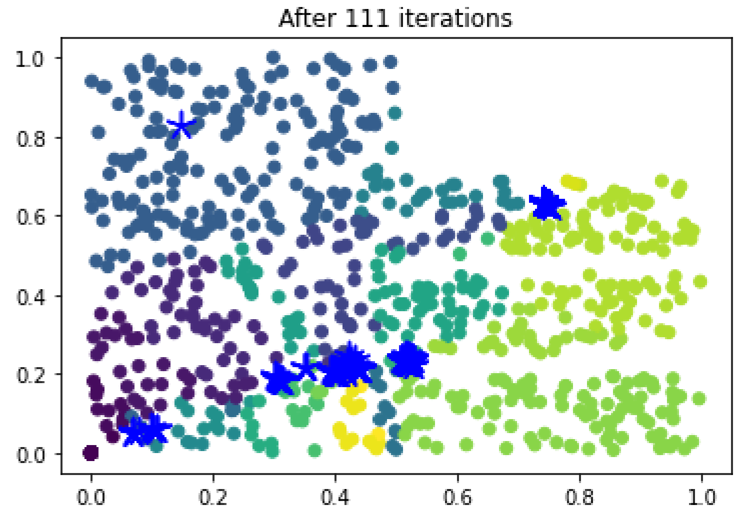


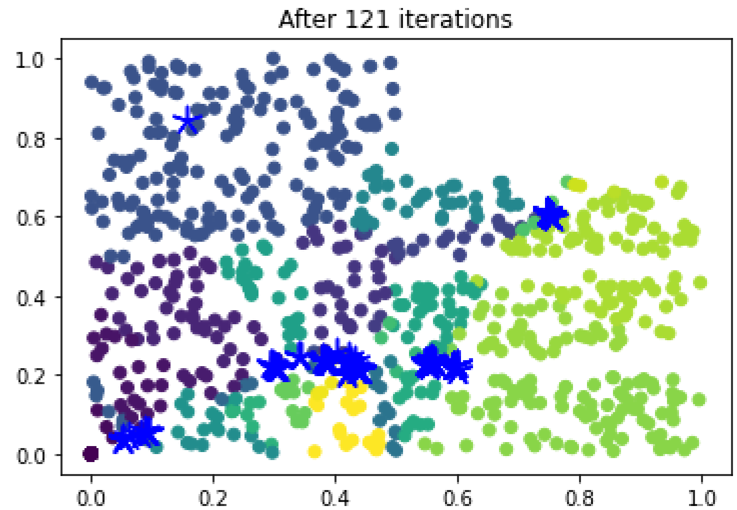

After 71 iterations
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0


After 81 iterations
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0


After 91 iterations
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0


After 101 iterations
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0





We can see that after removing the upper finger, the neurons are converging to the second most upper finger, which fits our distribution.