# Лабораторная работа 6

## Сети Кохонена

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Цель работы: исследование свойств слоя Кохонена, карты Кохонена, а также сетей векторного квантования, обучаемых с учителем, алгоритмов обучения, а также применение сетей в задачах кластеризации и классификации.

Вариант 19

[ ]:
```
import numpy as np
import random
import matplotlib.pyplot as plt
```

[ ]:
```
!pip install matplotlib --upgrade
```

```
Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-
wheels/public/simple/
Requirement already satisfied: matplotlib in /usr/local/lib/python3.7/dist-
packages (3.5.3)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.7/dist-
packages (from matplotlib) (0.11.0)
Requirement already satisfied: fonttools>=4.22.0 in
/usr/local/lib/python3.7/dist-packages (from matplotlib) (4.38.0)
Requirement already satisfied: python-dateutil>=2.7 in
/usr/local/lib/python3.7/dist-packages (from matplotlib) (2.8.2)
Requirement already satisfied: pillow>=6.2.0 in /usr/local/lib/python3.7/dist-
packages (from matplotlib) (7.1.2)
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.7/dist-
packages (from matplotlib) (21.3)
Requirement already satisfied: pyparsing>=2.2.1 in
/usr/local/lib/python3.7/dist-packages (from matplotlib) (3.0.9)
Requirement already satisfied: kiwisolver>=1.0.1 in
/usr/local/lib/python3.7/dist-packages (from matplotlib) (1.4.4)
Requirement already satisfied: numpy>=1.17 in /usr/local/lib/python3.7/dist-
packages (from matplotlib) (1.21.6)
Requirement already satisfied: typing-extensions in
/usr/local/lib/python3.7/dist-packages (from kiwisolver>=1.0.1->matplotlib)
(4.1.1)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.7/dist-
packages (from python-dateutil>=2.7->matplotlib) (1.15.0)
```

[ ]:
```
class Kohonen:
    def __init__(self, dim, nodes_count, lr, nodes = None, r = None):
        self.dim = dim
        self.lr = lr
        self.nodes_count = nodes_count

        if r is None:
```

```
            self.r = int(nodes_count / 2)
        else:
            self.r = r
        self.nodes = (nodes.copy() if nodes is not None else np.random.
↪rand(nodes_count, dim))


    def fit(self, data, epochs):


        self.masr = []
        self.maslr = []

        rcpy = self.r
        lrcpy = self.lr

        for e in range(epochs):
            self.masr.append(self.r)
            self.maslr.append(self.lr)

            np.random.shuffle(data)
            for i in range(len(data)):

                min_dist = np.sqrt(np.sum((data[i] - self.nodes[0]) ** 2))
                index_min_node = 0

                for j in range(self.nodes_count):
                        dist = np.sqrt(np.sum((data[i] - self.nodes[j]) ** 2))
                        if (min_dist > dist):
                            min_dist = dist
                            index_min_node = j



                for j in range(self.nodes_count):

                    dist = np.sqrt(np.sum((self.nodes[index_min_node] - self.
↪nodes[j]) ** 2))
                    if  dist < self.r:
                        self.nodes[j] += self.lr * np.exp(- dist / (2 * self.r)) *␣
↪(- self.nodes[j] + data[i])

            self.lr = max(0.01, lrcpy * np.exp(-(e + 1) / epochs))
            self.r = rcpy * np.exp(- (e + 1) * np.log(rcpy) / epochs)

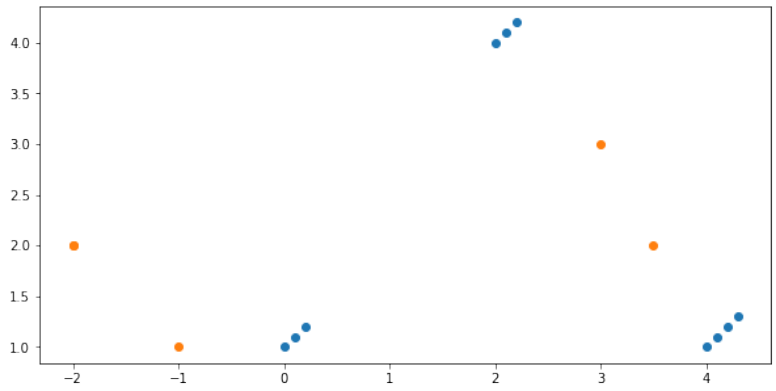
        self.masr = np.array(self.masr)
        self.maslr = np.array(self.maslr)
```

[ ]:
```
data = np.array(([[0, 1], [0.1, 1.1], [0.2, 1.2], [2, 4], [2.1, 4.1], [2.2, 4.2],␣
↪[4, 1], [4.1, 1.1], [4.2, 1.2], [4.3, 1.3]]))
nodes = np.array([[-1, 1], [3, 3], [-2, 2], [3.5, 2], [-2, 2]], dtype = float)
```

[ ]:
```
figure = plt.figure(figsize = (10, 5))

plt.scatter(data[:, 0], data[:, 1])
plt.scatter(nodes[:, 0], nodes[:, 1])

plt.show()
```




[ ]:
```
epochs = 100
```

[ ]:
```
kohonen = Kohonen(dim = 2, nodes_count = 5, lr = 1, nodes = nodes, r = 5)
kohonen.fit(data, epochs)
```

[ ]:
```
figure = plt.figure(figsize = (24, 10))

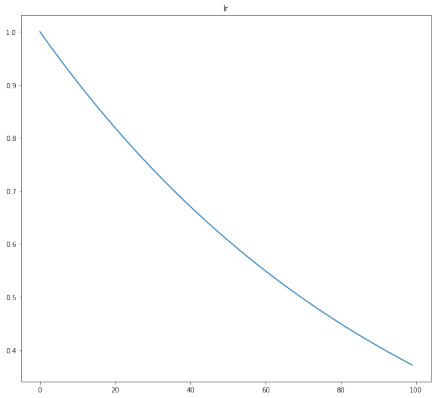
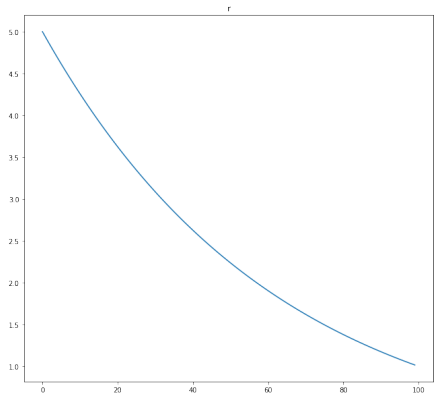
tt = np.arange(0, epochs, 1)

ax1 = figure.add_subplot(1, 2, 1)
ax2 = figure.add_subplot(1, 2, 2)

ax1.set_title('lr')
ax1.plot(tt, kohonen.maslr)

ax2.set_title('r')
ax2.plot(tt, kohonen.masr)

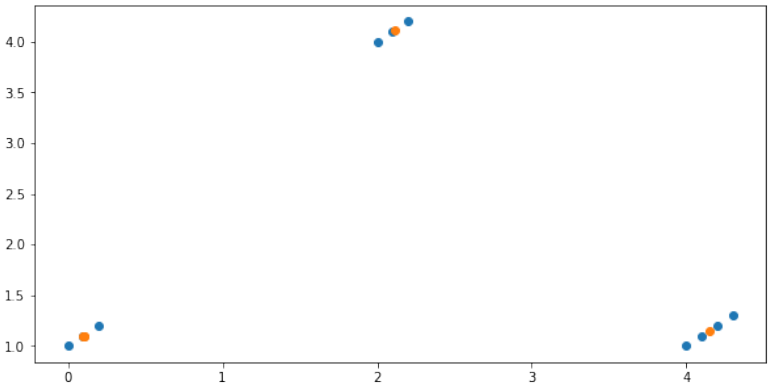
plt.show()
```

[ ]:
```
figure = plt.figure(figsize = (10, 5))

plt.scatter(data[:, 0], data[:, 1])
plt.scatter(kohonen.nodes[:, 0], kohonen.nodes[:, 1])

plt.show()
```



[ ]:
```
from sklearn.datasets import make_blobs

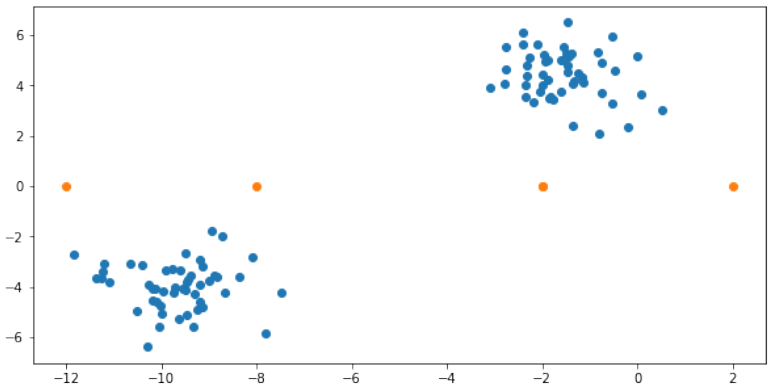
data, y = make_blobs(n_samples = 100, centers = 2, n_features = 2, random_state = 1)


nodes = np.array([[-12, 0], [-8, 0], [-2, 0], [-2, 0], [2, 0]], dtype = float)

figure = plt.figure(figsize = (10, 5))

plt.scatter(data[:, 0], data[:, 1])
plt.scatter(nodes[:, 0], nodes[:, 1])
```

```
plt.show()
```




[ ]:
```
kohonen = Kohonen(dim = 2, nodes_count = 5, lr = 1.5, nodes = nodes)
kohonen.fit(data, epochs)
```

[ ]:
```
figure = plt.figure(figsize = (24, 10))

tt = np.arange(0, epochs, 1)

ax1 = figure.add_subplot(1, 2, 1)
ax2 = figure.add_subplot(1, 2, 2)

ax1.set_title('lr')
ax1.plot(tt, kohonen.maslr)

ax2.set_title('r')
ax2.plot(tt, kohonen.masr)

plt.show()
```

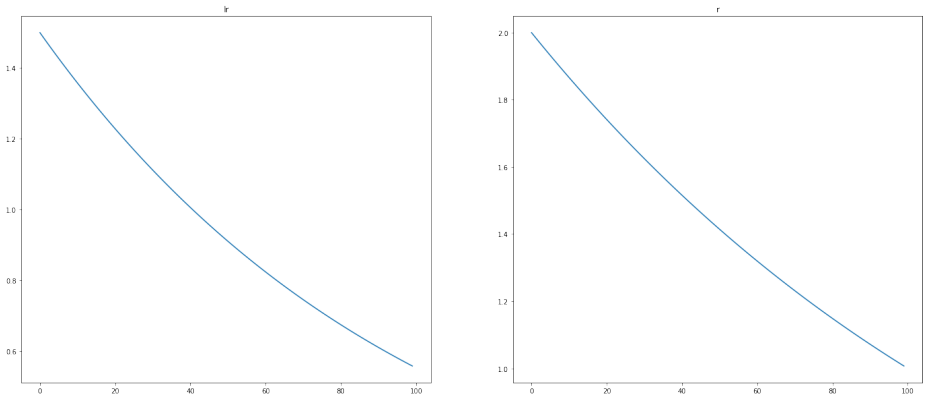


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figure = plt.figure(figsize = (10, 5))

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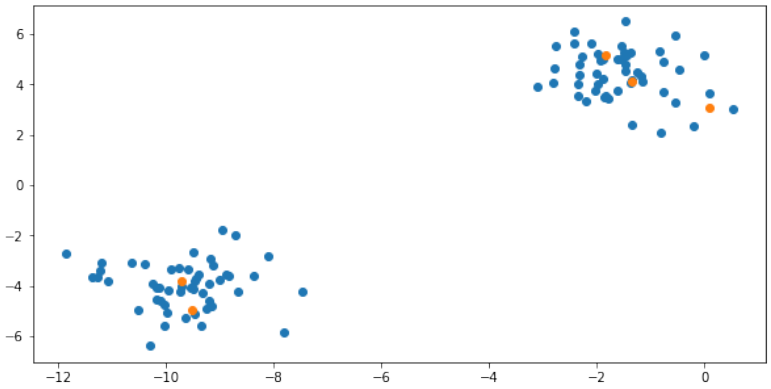
plt.scatter(kohonen.nodes[:, 0], kohonen.nodes[:, 1])

plt.show()
```




## Выводы

Выполнив данную лабораторную работу, я изучил строение сетей Кохонена, реализовал их, а также применил в задачах кластеризации и классификации.

[ ]: