2016302580320-任思远-第四次作业

3.5

交替对 $w1, w2$ 的样本训练 100 次。

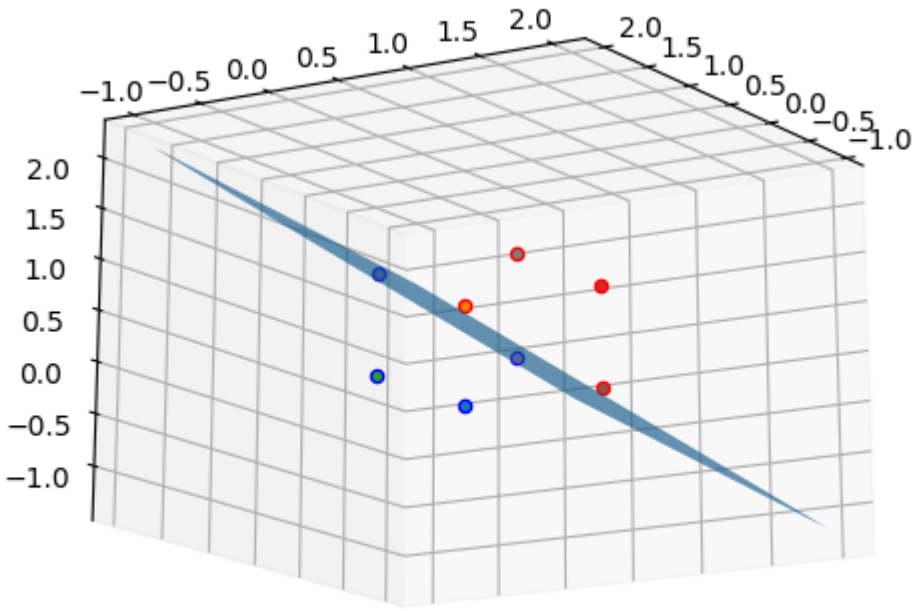
权向量和判别函数为：

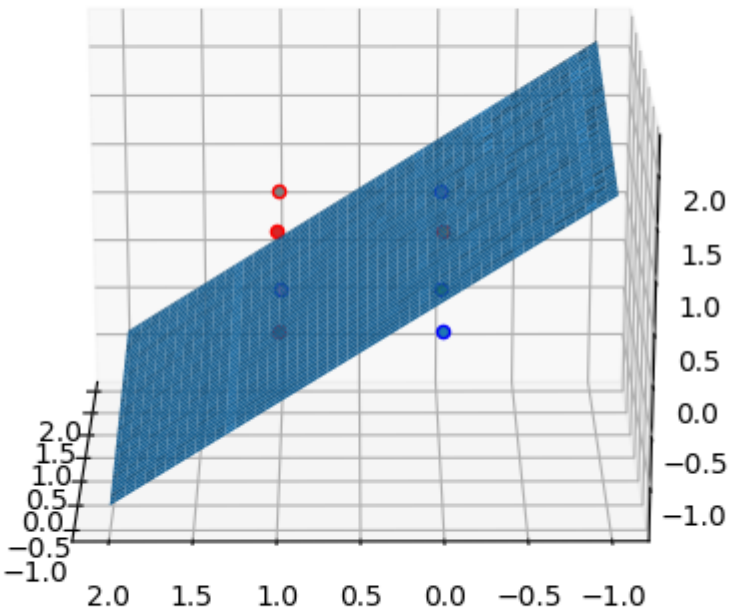
$$w = (0.2, -1.5, -1.5, 1.3)^T$$
$$d(\boldsymbol{X}) = 0.2x_1 - 1.5x_2 - 1.5x_3 + 1.3$$

代码：[4_1.py]

```python
import numpy as np
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D

w1 = np.array([[0, 0, 0, 1],
               [1, 0, 0, 1],
               [1, 0, 1, 1],
               [1, 1, 0, 1]])
w2 = np.array([[0, 0, 1, 1],
               [0, 1, 1, 1],
               [0, 1, 0, 1],
               [1, 1, 1, 1]])
w2 = w2 * -1
```

```
W = np.array([-1, -2, -2, 0])
c = 0.1

for times in range(100):
    for i in range(4):
        if W.T.dot(w1[i]) <= 0:
            W = W + c * w1[i]
        if W.T.dot(w2[i]) <= 0:
            W = W + c * w2[i]

print(W)
for i in range(4):
    print(W.T.dot(w1[i]))
    print(W.T.dot(w2[i]))

fig = plt.figure()
ax = fig.add_subplot(1, 1, 1, projection='3d')
for i in range(4):
    ax.scatter(w1[i, 0], w1[i, 1], w1[i, 2], edgecolors='b')
    ax.scatter(-w2[i, 0], -w2[i, 1], -w2[i, 2], edgecolors='r')  # anti-normalization
x = np.linspace(-1, 2, 100)
y = np.linspace(-1, 2, 100)
X, Y = np.meshgrid(x, y)
Z = (-W[3] - W[0] * X - W[1] * Y) / W[2]
ax.plot_surface(X, Y, Z)
plt.show()
```


−1.0 −0.5 0.0 0.5 1.0 1.5 2.0
2.0 1.5 1.0 0.5 0.0 −0.5 −1.0
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0


2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
2.0 1.5 1.0 0.5 0.0 −0.5 −1.0

3.9

$$K(\boldsymbol{X}, \boldsymbol{X}_k) = 1 + (4\boldsymbol{X}_{(2)}^2 - 2)(4\boldsymbol{X}_{k_{(2)}}^2 - 2) + (4\boldsymbol{X}_{(1)}^2 - 2)(4\boldsymbol{X}_{k_{(1)}}^2 - 2)$$

$\boldsymbol{X}_1 = \{0, 1\}$
$\boldsymbol{X}_2 = \{0, -1\}$
$\boldsymbol{X}_3 = \{1, 0\}$
$\boldsymbol{X}_4 = \{-1, 0\}$
$k(\boldsymbol{X}) = 0$
$iteration:$
1. $k(\boldsymbol{X}_1) = 0 \leq 0,\ update:$
   $k(\boldsymbol{X}) = k(\boldsymbol{X}) + K(\boldsymbol{X}, \boldsymbol{X}_1) = -8X_{(1)}^2 + 8X_{(2)}^2 + 1$
2. $k(\boldsymbol{X}_2) = -7 < 0,\ ok.$
3. $k(\boldsymbol{X}_3) = 9 > 0,\ ok.$
4. $k(\boldsymbol{X}_4) = -7 < 0,\ ok.$

$Thus,\ k = -8X_{(1)}^2 + 8X_{(2)}^2 + 1$

代码：[4_2.cpp]

```cpp
#include <vector>
#include <functional>
#include <iostream>
#include <numeric>

void test()
{
    const std::vector<std::vector<double>> w1 = { { 0, 1 }, { 0, -1 } };
```

```
    const std::vector<std::vector<double>> w2 = { { 1, 0 }, { -1, 0 } };

    const std::function<double(double)> h[3] = {
        [](double) { return 1.0; },
        [](double x) { return 2 * x; },
        [](double x) { return 4 * x * x - 2; },
    };

    std::function<double(const std::vector<double>& X)> phi[3] = {
        [&h](const std::vector<double>& X) { return h[0](X[0]) * h[0](X[1]); },
        [&h](const std::vector<double>& X) { return h[0](X[0]) * h[2](X[1]); },
        [&h](const std::vector<double>& X) { return h[2](X[0]) * h[0](X[1]); },
    };

    const std::function<double(const std::vector<double>& X, const std::vector<double>& Xk)> K =
        [&phi](const std::vector<double>& X, const std::vector<double>& Xk)
    {
        return std::accumulate(std::begin(phi), std::end(phi), 0.0,
            [&X, &Xk](double val, const std::function<double(const std::vector<double>& X)>& phi)
        { return val + phi(X) * phi(Xk); });
```

```
29      };
30
31      std::function<double(const std::vector<double>&
    X)> k = [](const std::vector<double>&) { return 0; };
32
33      for (int times = 0; times < 1; times++)
34          for (int i = 0; i < 2; i++)
35          {
36              if (k(w1[i]) <= 0)
37                  k = [k, i, &w1, &K](const
    std::vector<double>& X) { return k(X) + K(X, w1[i]);
    };
38              if (k(w2[i]) >= 0)
39                  k = [k, i, &w2, &K](const
    std::vector<double>& X) { return k(X) - K(X, w2[i]);
    };
40          }
41
42      // check
43      for (int i = 0; i < 2; i++)
44      {
45          std::cout << "w1[" << i << "]: " << k(w1[i])
    << std::endl;
46          std::cout << "w2[" << i << "]: " << k(w2[i])
    << std::endl;
47      }
48
49  }
50
51  int main()
52  {
```

```
53      test();
54      printf("\n%s\n", "done");
55      getchar();
56      return 0;
57  }
```

输出: