决策边界

```
In [1]: import numpy as np
        import matplotlib.pyplot as plt
```

```
In [2]: x, y = np.meshgrid(np.arange(1, 2, 0.2), np.arange(2, 3, 0.2))
```

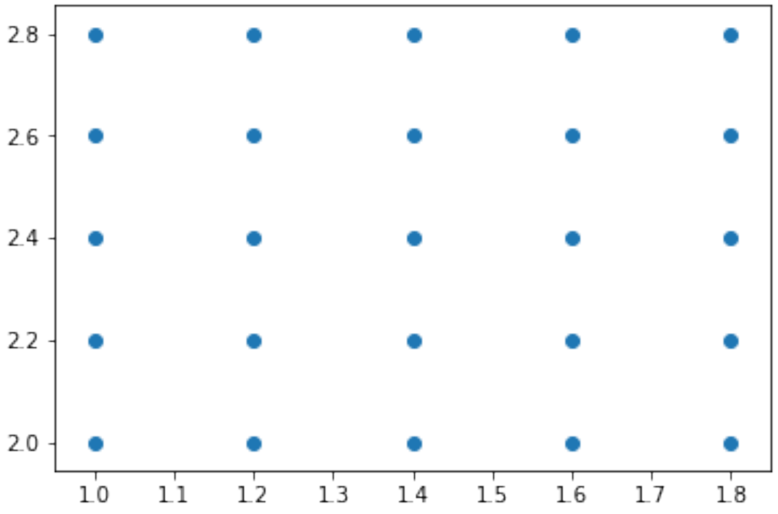
```
In [3]: x
```

```
Out[3]: array([[1. , 1.2, 1.4, 1.6, 1.8],
               [1. , 1.2, 1.4, 1.6, 1.8],
               [1. , 1.2, 1.4, 1.6, 1.8],
               [1. , 1.2, 1.4, 1.6, 1.8],
               [1. , 1.2, 1.4, 1.6, 1.8]])
```

```
In [4]: y
```

```
Out[4]: array([[2. , 2. , 2. , 2. , 2. ],
               [2.2, 2.2, 2.2, 2.2, 2.2],
               [2.4, 2.4, 2.4, 2.4, 2.4],
               [2.6, 2.6, 2.6, 2.6, 2.6],
               [2.8, 2.8, 2.8, 2.8, 2.8]])
```

```
In [5]: plt.scatter(x, y)
        plt.show()
```



```
In [6]: X = np.concatenate([x.reshape(-1, 1), y.reshape(-1, 1)], axis=1)
```

In [7]:

```
X
```

Out[7]:

```
array([[1. , 2. ],
       [1.2, 2. ],
       [1.4, 2. ],
       [1.6, 2. ],
       [1.8, 2. ],
       [1. , 2.2],
       [1.2, 2.2],
       [1.4, 2.2],
       [1.6, 2.2],
       [1.8, 2.2],
       [1. , 2.4],
       [1.2, 2.4],
       [1.4, 2.4],
       [1.6, 2.4],
       [1.8, 2.4],
       [1. , 2.6],
       [1.2, 2.6],
       [1.4, 2.6],
       [1.6, 2.6],
       [1.8, 2.6],
       [1. , 2.8],
       [1.2, 2.8],
       [1.4, 2.8],
       [1.6, 2.8],
       [1.8, 2.8]])
```

In [8]:

```
def height(x):
    # 1  2
    return np.abs((x[0] - 1) * (x[1] - 2))
```

In [9]:

```
z = np.array([height(x) for x in X])
z
```

Out[9]:

```
array([0.  , 0.  , 0.  , 0.  , 0.  , 0.  , 0.04, 0.08, 0.12, 0.16,
0.  ,
       0.08, 0.16, 0.24, 0.32, 0.  , 0.12, 0.24, 0.36, 0.48, 0.  ,
0.16,
       0.32, 0.48, 0.64])
```

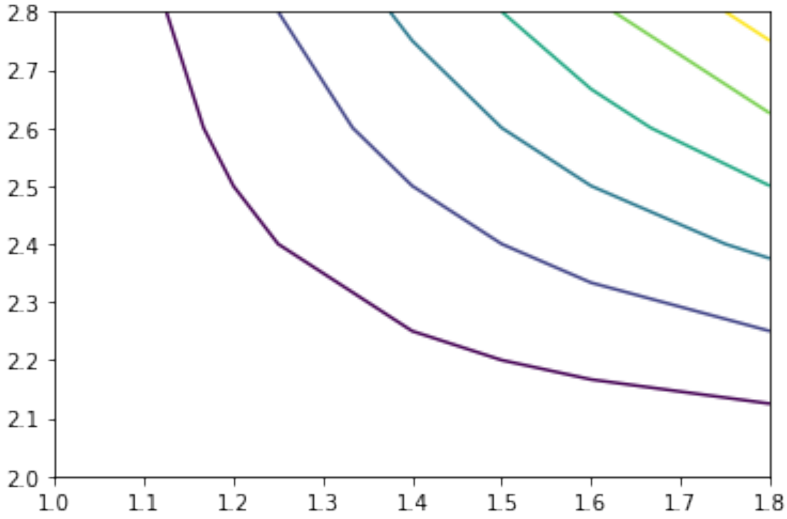
In [10]:

```
z = z.reshape(x.shape)
z
```

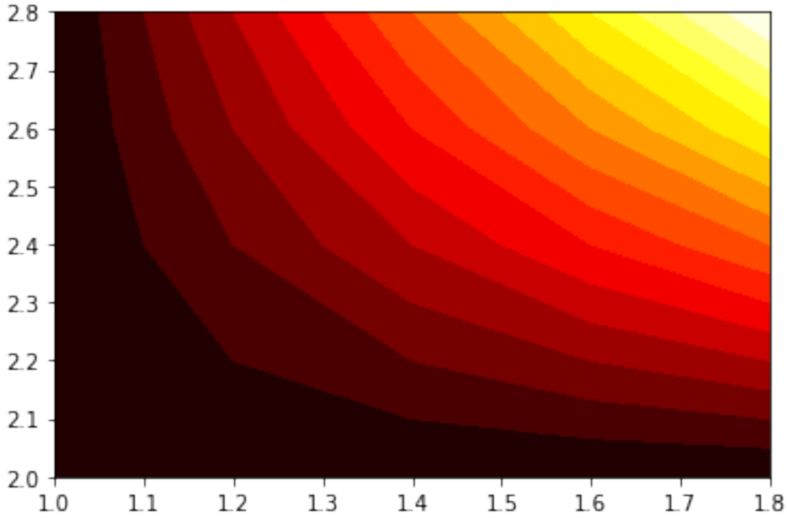
Out[10]:

```
array([[0.  , 0.  , 0.  , 0.  , 0.  ],
       [0.  , 0.04, 0.08, 0.12, 0.16],
       [0.  , 0.08, 0.16, 0.24, 0.32],
       [0.  , 0.12, 0.24, 0.36, 0.48],
       [0.  , 0.16, 0.32, 0.48, 0.64]])
```

In [11]:
```
plt.contour(x, y, z)
plt.show()
```

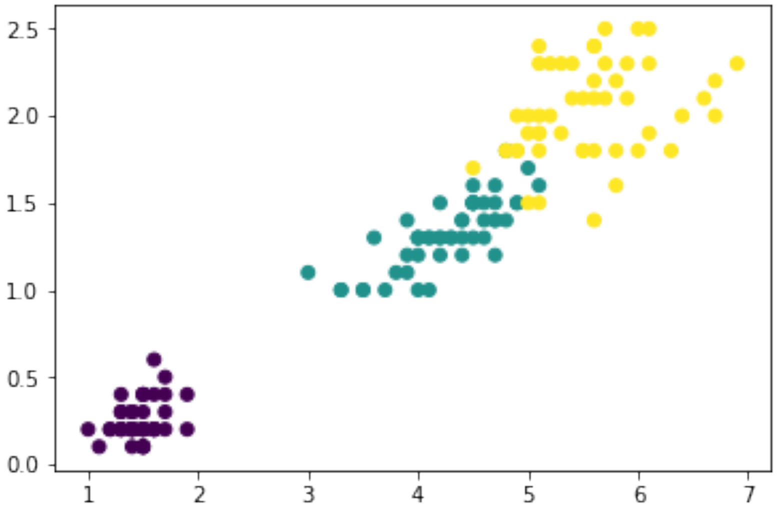


In [12]:
```
plt.contourf(x, y, z, 20, cmap=plt.cm.hot)        #  分20个梯度，热力图
plt.show()
```



In [13]:
```
X = np.loadtxt('x.txt')
X = X[:, 2:]
y = np.loadtxt('y.txt')
```

In [14]:
```
plt.scatter(X[:, 0], X[:, 1], c=y)   # c=y 表示颜色根据 y 的分类值来区
别
plt.show()
```



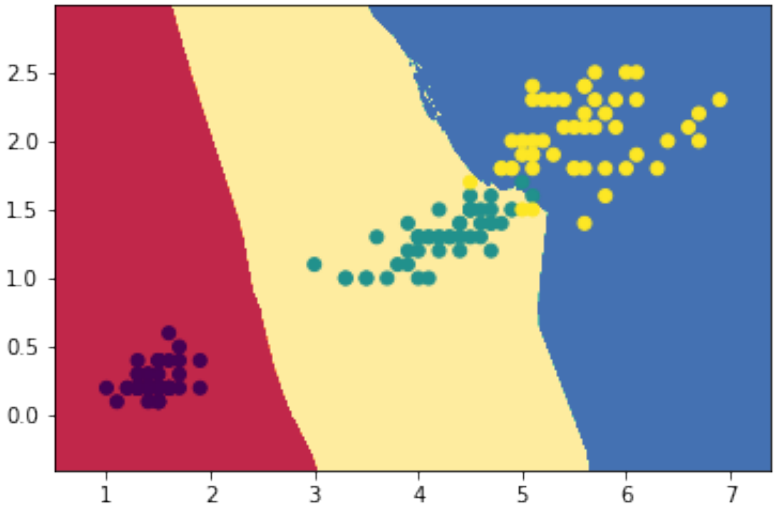
In [15]:
```
def plot_decision_boundary(X, y, predict_fun, step=0.1):
    x_min = X[:, 0].min() - 0.5
    x_max = X[:, 0].max() + 0.5
    y_min = X[:, 1].min() - 0.5
    y_max = X[:, 1].max() + 0.5

    x_mesh, y_mesh = np.meshgrid(np.arange(x_min, x_max, step), np.
arange(y_min, y_max, step))      # 画网格
    labels = predict_fun(np.concatenate([x_mesh.reshape(-1, 1), y_m
esh.reshape(-1, 1)], axis = 1))         # 获取预测值
    z = labels.reshape(x_mesh.shape)         # 将预测值转为与x_mesh相
同的维度

    plt.contourf(x_mesh, y_mesh, z, cmap = plt.cm.Spectral)
# 画梯度图

    plt.scatter(X[:, 0], X[:, 1], c=y)                  # 绘制散点图
    plt.show()
```

In [16]:
```
from ML.knn import KNeighborsClassifier
```

In [17]:
```
knn_clf = KNeighborsClassifier()
knn_clf.fit(X, y)
```

Out[17]:
```
<ML.knn.KNeighborsClassifier at 0x117ca3780>
```

```
In [22]: %%time
         plot_decision_boundary(X, y, lambda x: knn_clf.predict(x), step=0.0
         1)
```

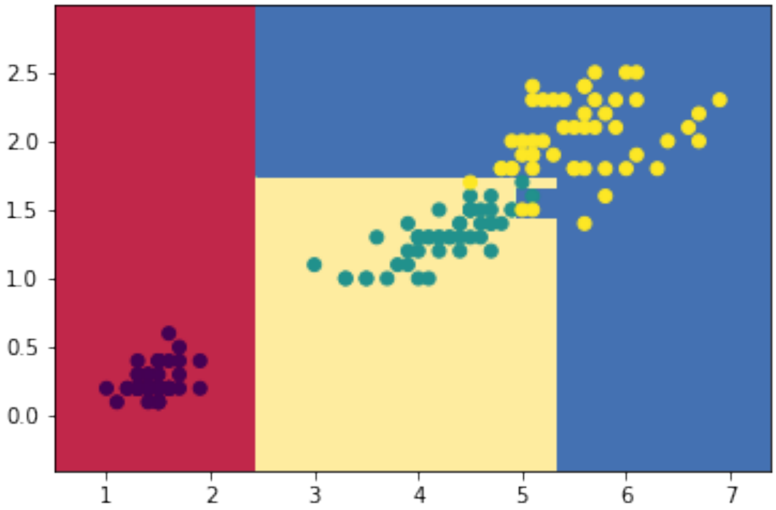


```
CPU times: user 5min 21s, sys: 2.3 s, total: 5min 23s
Wall time: 5min 33s
```

```
In [19]: from ML.decision_tree import DecisionTreeClassifier
```

```
In [20]: dt_clf = DecisionTreeClassifier()
         dt_clf.fit(X, y)

Out[20]: d=0, v=2.45, g=0.5, l=None
```

```
In [21]: plot_decision_boundary(X, y, lambda x: dt_clf.predict(x), step=0.01
         )
```


2.5
2.0
1.5
1.0
0.5
0.0
1
2
3
4
5
6
7