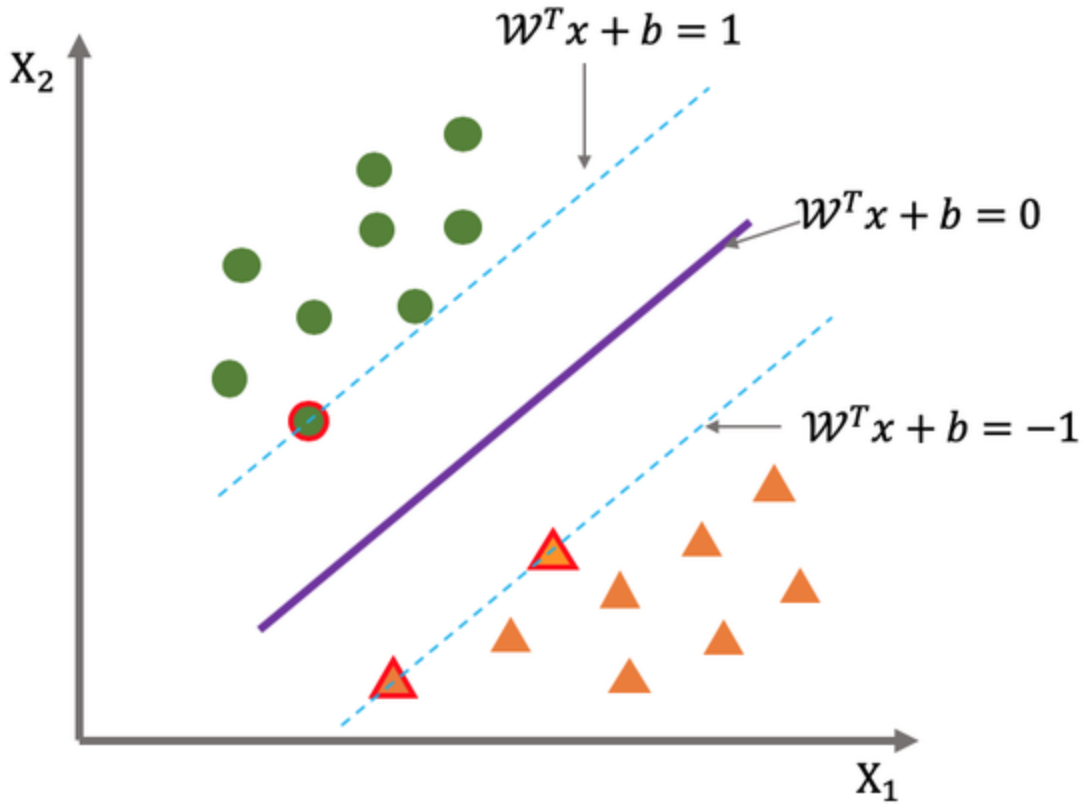
SVM支持向量机



在样本空间中寻找一个超平面 $w^T x + b = 0$ 使得

$w^T x_i + b >= +1, y_i = +1$

$w^T x_i + b <= -1, y_i = -1$

$\gamma = \frac{2}{||w||}$ 被称为间隔 我们的目标是找到最大间隔

即$\underset{w,b}{max}\ \frac{2}{||w||}$

等价于$\underset{w,b}{min}\ \frac{1}{2}||w||^2$ (似乎机器学习中求最大值的问题都转化成了求最小值)

使用拉格朗日乘数法求解 $L(w,b,\lambda) = \frac{1}{2}||w||^2 + \sum_{i=1}^{m} \lambda_i \left(1 - y_i \left(w^T x_i + b\right)\right)$

$\frac{\partial L}{\partial w} = ||w|| + \sum_{i=1}^{m} \lambda_i (-y_i x_i) = 0$

$\frac{\partial L}{\partial b} = \sum_{i=1}^{m} -\lambda_i y_i = 0$

解得

$$w = \sum_{i=1}^{m} \lambda_i y_i x_i$$

$$0 = \sum_{i=1}^{m} \lambda_i y_i$$

带入原方程即得到

$$\max_{\lambda} \sum_{i=1}^{m} \lambda_i - \frac{1}{2} \sum_{i=1}^{m} \sum_{j=1}^{m} \lambda_i \lambda_j y_i y_j {x_i}^T x_j$$

使用SMO算法求解λ_i

1.选出λ中最不好的两个参数λ_i, λ_j

2.只把λ_i, λ_j视作参数 其他的视作常数，求解λ_i, λ_j

使用SVM实现mnist手写数字识别

In [1]:
```
import numpy as np
import pandas as pd
from sklearn import svm
from sklearn.datasets import load_digits
from sklearn.model_selection import train_test_split
```

这里直接调用sklearn (不用框架的版本还没写好)

In [7]:
```
mnist = load_digits()
x,test_x,y,test_y = train_test_split(mnist.data,mnist.target,test_size=0.25,random_state
```

In [30]:
```
def load_mnist():
    train_data = pd.read_csv('./dataset/mnist/mnist_train.csv').values
    test_data = pd.read_csv('./dataset/mnist/mnist_test.csv').values

    train_images = train_data[:, 1:]
    train_images = train_images / 255.0
    train_labels_tmp = train_data[:, :1]
    train_images = np.array([i.reshape(-1) for i in train_images])
#     train_labels = np.zeros((len(train_labels_tmp), 10))
#     for i in range(len(train_labels_tmp)):
#         train_labels[i][train_labels_tmp[i]] = 1
#     train_labels = np.array([i.reshape(-1, 1) for i in train_labels])
    train_labels = train_labels_tmp

    test_images = test_data[:, 1:]
    test_images = test_images / 255.0
    test_labels_tmp = test_data[:, :1]
    test_images = np.array([i.reshape(-1) for i in test_images])
#     test_labels = np.zeros((len(test_labels_tmp), 10))
#     for i in range(len(test_labels_tmp)):
#         test_labels[i][test_labels_tmp[i]] = 1
#     test_labels = np.array([i.reshape(-1, 1) for i in test_labels])
    test_labels = test_labels_tmp
    return train_images, train_labels, test_images, test_labels

X_train, y_train, X_test, y_test = load_mnist()
```

In [36]:
```
print(X_train.shape, x.shape)
print(y_train.reshape(-1).shape, y.shape)
```

```
print(X_test.shape, test_x.shape)
```

```
(60000, 784) (1347, 64)
(60000,) (1347,)
(10000, 784) (450, 64)
```

In [37]:
```
model = svm.LinearSVC()
model.fit(X_train, y_train.reshape(-1))
z = model.predict(X_test)
```

```
C:\Users\13526\AppData\Roaming\Python\Python37\site-packages\sklearn\svm\_base.py:1208:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  ConvergenceWarning,
```

没收敛 问题不大

In [49]:
```
print(f'accuracy {np.sum(z == y_test.reshape(-1)) / z.size}')
```

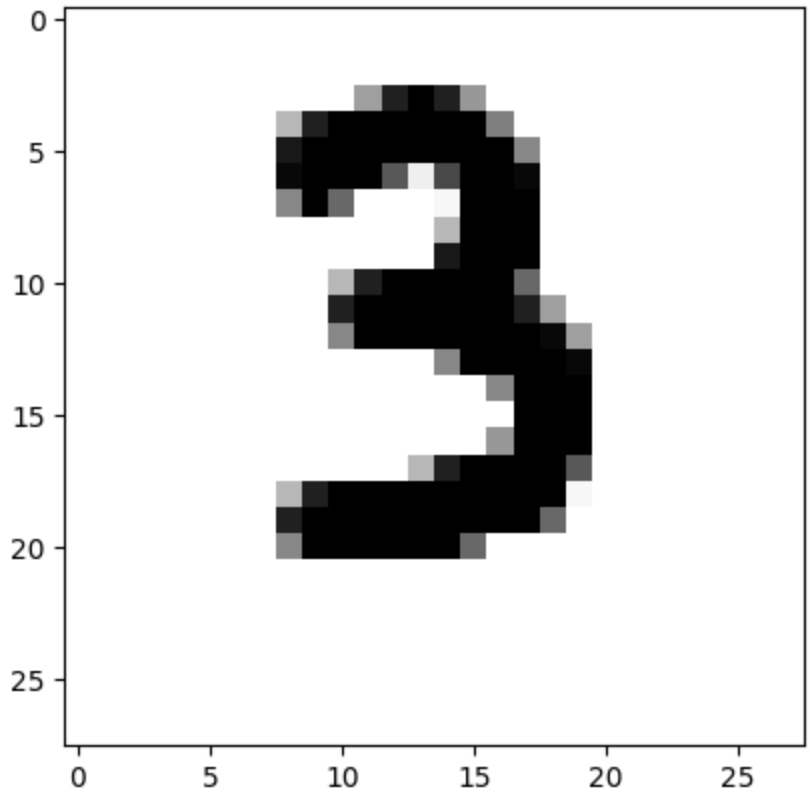
```
accuracy 0.9176
```

还是来个手写数字

In [44]:
```
from PIL import Image
import matplotlib.pyplot as plt

image = Image.open('digit.png')
plt.imshow(image)
```

Out[44]:
```
<matplotlib.image.AxesImage at 0x1fa84e5ac88>
```



In [48]:
```
img = np.dot(np.array(image)[...,:3], [0.299, 0.587, 0.114])
img = 255 - img

r = model.predict(img.reshape(1, -1) / 255.0)
print(r)
```

```
[3]
```