Mahyar Mohammadi Matin – 610398166 – mini project report

First we must import library's and data:

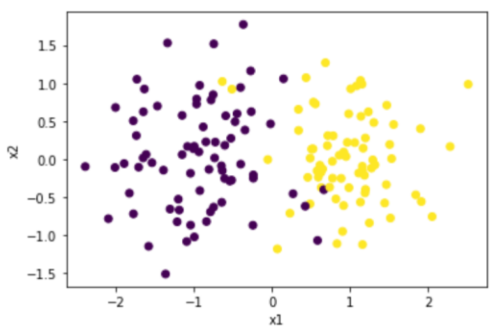
```python
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
```

```python
train = pd.read_csv('train.csv')
test = pd.read_csv('test.csv')
display(train.head())
```

	x1	x2	target
0	0.525642	0.133813	1.0
1	1.009394	0.925323	1.0
2	0.776517	-0.252655	1.0
3	-0.245693	-0.872614	0.0
4	-1.540663	-0.048947	0.0

Data's plot is like this:

```python
plt.scatter(train.x1,train.x2,c=train.target)
plt.xlabel('x1')
plt.ylabel('x2')
pass
```



Since we can see from diagram, they are not linearly separatable so the algorithms never converge. We must set a iteration limit for it.

For perceptron algorithms to work, we must change the labels from 0 to -1:

```python
X_train = train[['x1','x2']]
y_train = train['target'].apply(lambda x: -1 if x==0 else x)
X_test = test[['x1','x2']]
y_test = test['target'].apply(lambda x: -1 if x==0 else x)
y_train
```

```
]: 0      1.0
   1      1.0
   2      1.0
   3     -1.0
   4     -1.0
         ...
   145    1.0
   146   -1.0
   147   -1.0
   148   -1.0
   149   -1.0
   Name: target, Length: 150, dtype: float64
```

Now our main class:

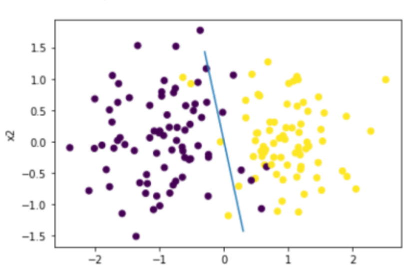
```
class Perceptron:
    def __init__(self, iteration=100, alpha=0.01):
        self.iteration = iteration
        self.alpha = alpha

    def fit(self, X, y):
        self.weights = np.zeros(X.shape[1])
        self.bias = 0
        self.X = X
        self.y = y
        self.best_accuracy = 0
        i,accuracy=0,0
        while accuracy<1 and i<self.iteration:
            accuracy = 0
            for x,label in zip(X,y):
                if label * self.predict(x) <= 0:
                    self.weights += self.alpha * label * x
                    self.bias += self.alpha * label
                else:
                    accuracy += 1
            accuracy = accuracy / len(X)
            if accuracy > self.best_accuracy:
                self.best_weights = self.weights.copy()
                self.best_bias = self.bias
                self.best_accuracy = accuracy
            i+=1
        self.weights = self.best_weights
        self.bias = self.best_bias

    def predict(self, x):
        return np.sign(x@self.weights + self.bias)

    def test_accuracy(self,X=None,y=None):
        if X is None:
            X = self.X
            y = self.y
        return f'{round(sum(model.predict(X)*y)*100/len(X),1)}%'

    def draw(self,x):
        if len(self.weights)==2:
            y = (self.weights[0]*x+self.bias)/self.weights[1]
            plt.plot(x,y)
        else:
            print("can't draw 3D shapes!")
```

The pocket algorithm maintains two sets of weights and biases during training: the current set and the best set. The current set is updated based on the prediction error as in a simple perceptron, but the best set is only updated if the new set leads to higher accuracy on the training data. This allows the pocket algorithm to capture the most accurate set of weights and biases encountered during training, reducing the risk of overfitting.

I also write 2 helping function test_accuracy that give accuracy of model for any given data and draw that draw the model separator line.

```
model = Perceptron()
model.fit(X_train.to_numpy(),y_train)
print(f'weights:',model.weights,',Bias:',model.bias)
print('train accuracy:',model.test_accuracy())
model.draw(np.array([-0.3,0.3]))
plt.scatter(train.x1,train.x2,c=train.target)
plt.xlabel('x1')
plt.ylabel('x2')
pass
```

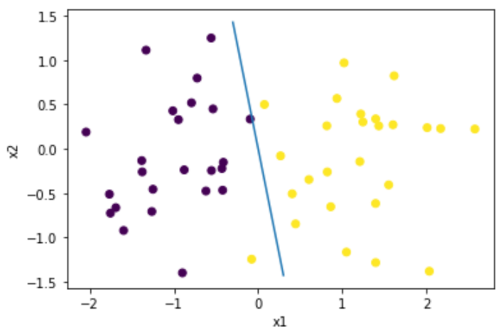
```
weights: [ 0.02244959 -0.00471331] ,Bias: 0.0
train accuracy: 90.7%
```



The result is interesting since our accuracy is 90.7% in just 100 iterations and the line is meaningful.

```
print('test accuracy:',model.test_accuracy(X_test,y_test))
model.draw(np.array([-0.3,0.3]))
plt.scatter(test.x1,test.x2,c=test.target)
plt.xlabel('x1')
plt.ylabel('x2')
pass
```

```
test accuracy: 96.0%
```



Also for test set we have just one missing point and the model works very well with 96% accuracy.