Midterm

Pro1

(a) Warming up. Plot the first 1000 samples of each category.

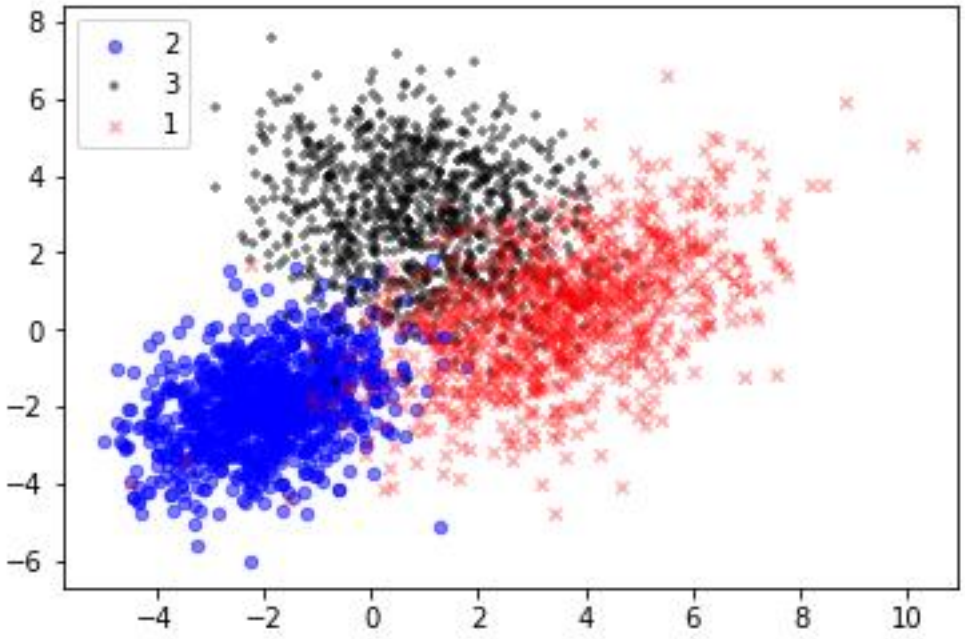

Figure 1:plot

(b)Use the first 1000 samples of each category to estimate p(x|ωi) and plot the resulting class-conditional densities

These are parameters of p(x|ωi)

u 0 :

[3.53672 0.4450107]

sigma 0 :

[3.12976724 1.44543531]

[1.44543531 2.78177208]

u 1 :

[-1.95993 -1.96812698]

sigma 1 :

[1.3268395 0.47739889]

[0.47739889 1.36722817]

u 2 :

[0.98903 2.95887701]

sigma 2 :

[2.14672556 -0.43720507]

[-0.43720507 2.4367052]

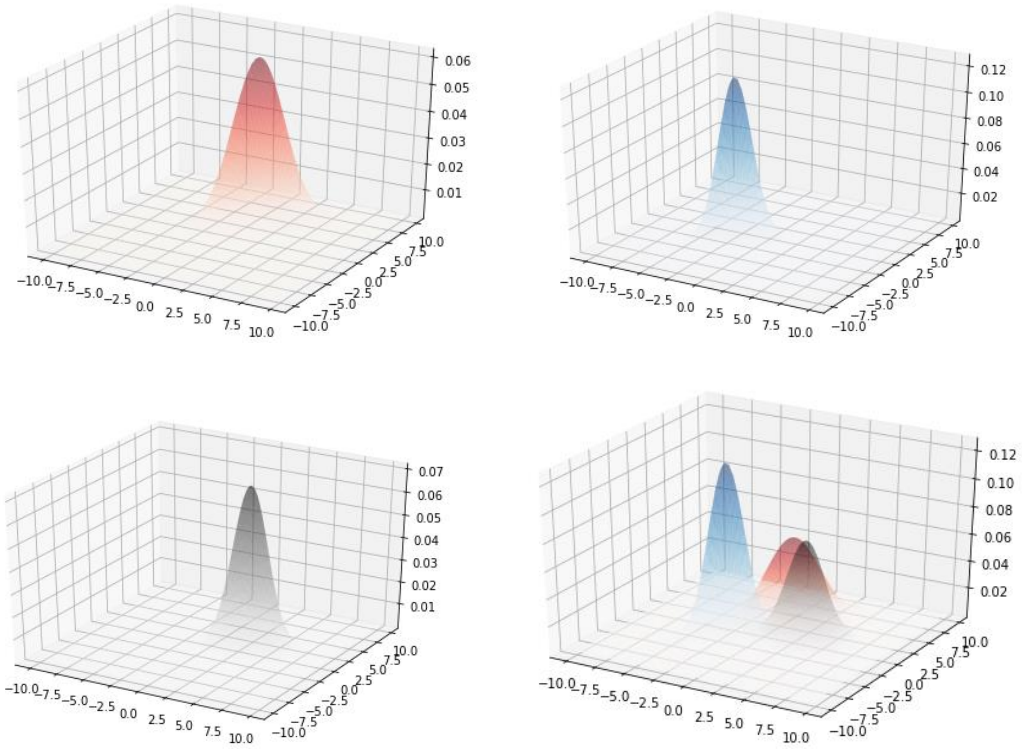

Figure 2: probability density function

(c) Use MAP decision rule to classify the rest of the samples and show the rate of misclassification in each category.

Miss simple num means the numbers of miss classification for every category. For class1 is 134, class2 is 25, class3 is 130.

```
miss simple num:  [134, 25, 130]
total miss classficarion rate:  0.09633333333333334
```

(d) If we use the first 500 samples of each category for training, and the rest for testing. Repeat (b) and (c), and show the rate of misclassification in each category.

u 0 :

[3.54422 0.40918848]

sigma 0 :

[3.06619839 1.52345392]

[1.52345392 2.83268655]

u 1 :

[-1.94924 -1.91821341]

sigma 1 :

[1.39082582 0.45978997]

[0.45978997 1.40433943]

u 2 :

[0.92734 2.99771721]

sigma 2 :

[2.12579832 -0.36196843]

[-0.36196843 2.37058425]

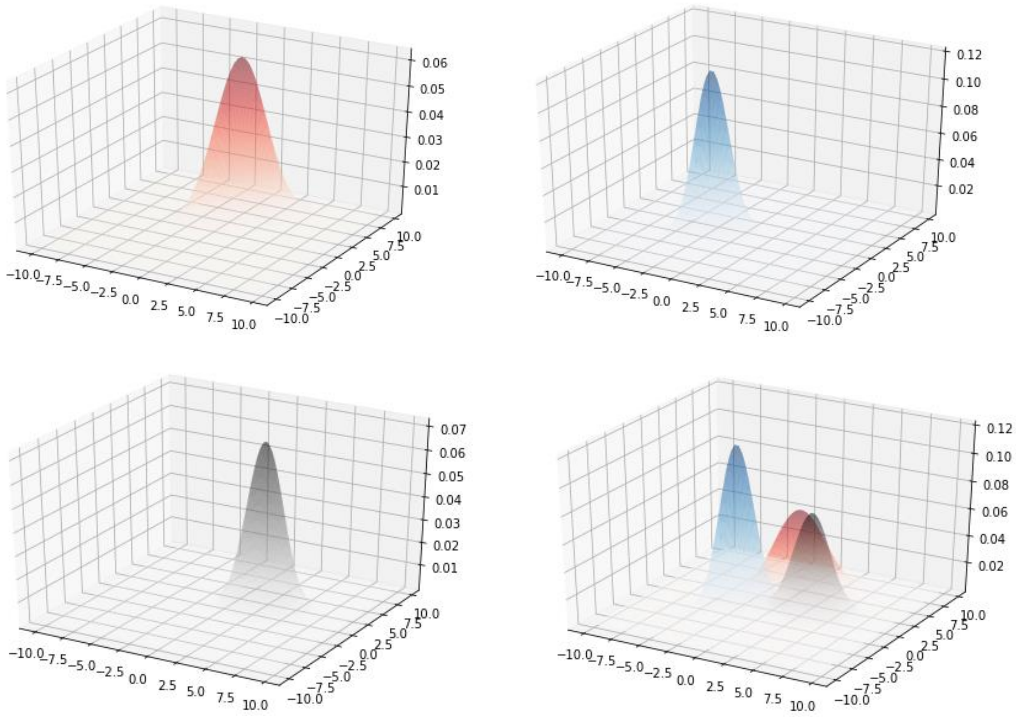

Figure 2: Density function when use 500 train simples

Result:

```
miss simple num:  [193, 37, 205]
total miss classficarion rate:  0.09666666666666666
```

(e) Describe and interpret your findings by comparing the results of (c) and (d).

In (c) and (d), misclassification rate are higher in class 1 and 3 than in class 2. Because when we give class-conditional density results, calss1 and 3 have a large overlap. When use 1000 simples for training, the miss classification rate is 0.963333333334, and when use 500 simples for training, the miss classification rate is 0.966666666666, which is bigger than using 1000 simples. This means training with more data generally results in better results.

Pro2

(a) Use the first 1000 samples of each category to obtain pn(x) for each category and plot the parzen window estimate of the density function of each category.

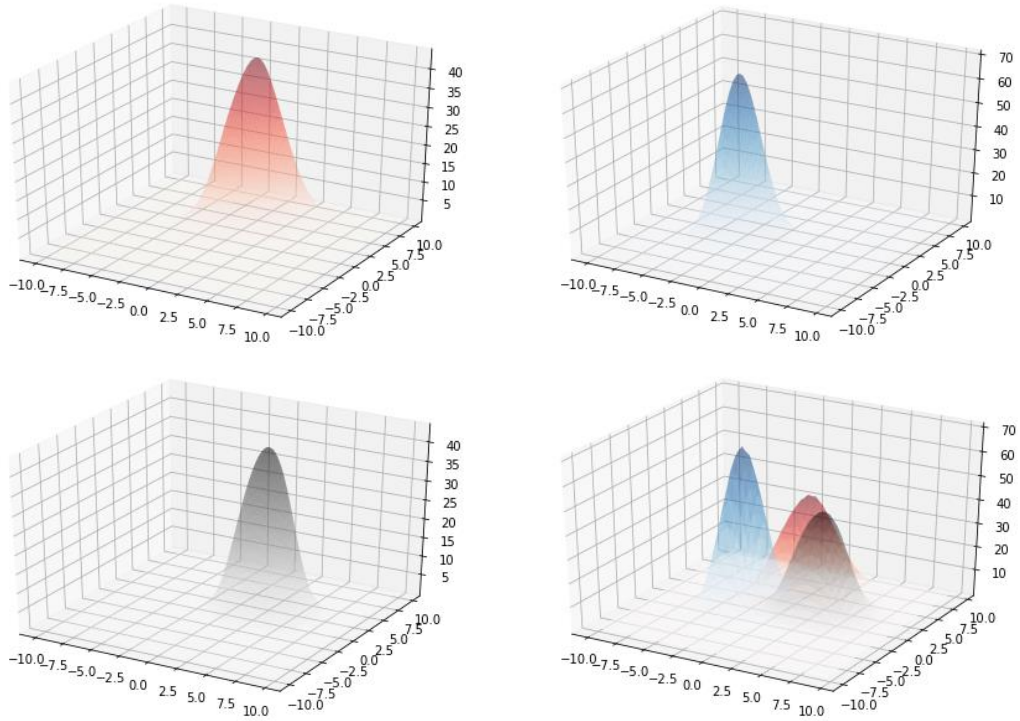

Figure3： parzen plot

Because of the complexity of Parzen window is vary high, only a low-resolution parzenou diagram is drawn here

(b) Use the results of (a) and Maximizing-A-Posterior (MAP) decision rule to classify the rest of the samples and show the misclassification rate of each category.

```
miss: [149, 19, 133]
total miss classficarion rate:  0.10033333333333333
```

(c) In Chapter 5, we also introduced how to use k-NN method to estimate the posterior distribution. Suppose we are given the first 1000 samples of each category as training samples, and asked to classify the rest of the samples using NN classifier (i.e. k=1). Show the misclassification rate of each category.

Here is a comparison with KNN provided by scipy

```
SCIPY knn miss: [193, 49, 169]  k: 1
scipy total miss classficarion rate:  0.137
my knn miss: [193, 49, 169]  k: 1
my knn total miss classficarion rate:  0.137
```

(d) Repeat (c) when k = 10

```
SCIPY knn miss: [142, 25, 150]  k: 10
scipy total miss classficarion rate:  0.10566666666666667
my knn miss: [157, 24, 136]  k: 10
my knn total miss classficarion rate:  0.10566666666666667
```

(e) Describe and interpret your findings by comparing the results of (c) and (d)

It can be seen from the table that the misclassification rate of class 1 and class 3 is higher than that of class 2, whether in (c) or (d).Because of the original data distribution (Figure 1), class 1 and 3 have many overlapping areas, confusing the classification results.

I tried the data from k= 2 to 9, and it could be seen that the error rate was slightly higher when K = 2, and the rest were around 0.11, which was basically the lowest when K =8. This indicates that the results are more

stable when there are more adjacent points for voting, but the results are disturbed when there are too many points for voting.

```
SCIPY knn miss: [105, 67, 242]  k: 2
scipy total miss classficarion rate:  0.138
my knn miss: [193, 49, 169]  k: 2
my knn total miss classficarion rate:  0.137
SCIPY knn miss: [162, 30, 148]  k: 3
scipy total miss classficarion rate:  0.11333333333333333
my knn miss: [168, 29, 148]  k: 3
my knn total miss classficarion rate:  0.115
SCIPY knn miss: [119, 31, 176]  k: 4
scipy total miss classficarion rate:  0.10866666666666666
my knn miss: [171, 27, 142]  k: 4
my knn total miss classficarion rate:  0.11333333333333333
SCIPY knn miss: [163, 27, 138]  k: 5
scipy total miss classficarion rate:  0.10933333333333334
my knn miss: [168, 26, 137]  k: 5
my knn total miss classficarion rate:  0.11033333333333334
SCIPY knn miss: [133, 26, 154]  k: 6
scipy total miss classficarion rate:  0.10433333333333333
my knn miss: [166, 25, 137]  k: 6
my knn total miss classficarion rate:  0.10933333333333334
SCIPY knn miss: [157, 26, 132]  k: 7
scipy total miss classficarion rate:  0.105
my knn miss: [162, 27, 132]  k: 7
my knn total miss classficarion rate:  0.107
SCIPY knn miss: [135, 24, 146]  k: 8
scipy total miss classficarion rate:  0.10166666666666667
my knn miss: [154, 25, 135]  k: 8
my knn total miss classficarion rate:  0.10466666666666667
SCIPY knn miss: [155, 26, 132]  k: 9
scipy total miss classficarion rate:  0.10433333333333333
my knn miss: [156, 25, 132]  k: 9
my knn total miss classficarion rate:  0.10433333333333333
```