类中心，重新分为第二类。

$$G_1(4)=(x_1,x_2,\cdots,x_8),N_1=8$$
$$G_2(4)=(x_9,x_{10},\cdots,x_{20}),N_2=12$$

更新聚类中心：

$$Z_1(4)=Z_1(3)=(1.375,1.13)^T$$
$$Z_1(4)=Z_1(3)=(7.67,7.33)^T$$

计算结束。

2.4.4 K－均值聚类实例

本程序中含20个样本，每个样本有两个特征，使用K－均值法实现样本分类（$K=2$），具体的C++代码如下：

```
#include "stdafx.h"
#include "math.h"
#define NUM 2
#define NN 20
#define cnum 2
typedef struct {
    double x[NUM];
} PATTERN;
PATTERN p[NN] = {
    {0,0},{1,0},{0,1},{1,1},{2,1},{1,2},{2,2},{3,2},{6,6},{7,6},
    {8,6},{6,7},{7,7},{8,7},{9,7},{7,8},{8,8},{9,8},{8,9},{9,9}
};
PATTERN z[cnum],oldz[cnum];
int nj[cnum];
int cindex[cnum][NN];
double Eucliden(PATTERN x,PATTERN y)
{
    int i;
    double d;
    d=0.0;
    for(i=0;i<NUM;i++) {
        d+=(x.x[i]-y.x[i])*(x.x[i]-y.x[i]);
    }
    d=sqrt(d);
    return d;
}
bool zequal(PATTERN z1[],PATTERN z2[])
{
    int j;
    double d;
```

```
    d = 0.0;
    for(j = 0;j < cnum;j ++ ) {
        d + = Eucliden(z1[j],z2[j]);
    }
    if(d < 0.00001) return true;
    else return false;
}
void C_mean( )
{
    int i,j,l;
    double d,dmin;
    for(j = 0;j < cnum;j ++ ) {
        z[j] = p[j];
    }
    do {
        for(j = 0;j < cnum;j ++ ) {
            nj[j] = 0;
            oldz[j] = z[j];
        }
        for(i = 0;i < NN;i ++ ) {
            for(j = 0;j < cnum;j ++ ) {
                d = Eucliden(z[j],p[i]);
                if(j == 0) {dmin = d;l = 0;}
                else {
                    if(d < dmin) {
                        dmin = d;
                        l = j;
                    }
                }
            }
            cindex[l][nj[l]] = i;
            nj[l] ++ ;
        }
        for(j = 0;j < cnum;j ++ ) {
            if(nj[j] == 0) continue;
            for(i = 0;i < NUM;i ++ ) {
                d = 0.0;
                for(l = 0;l < nj[j];l ++ ) {
                    d + = p[cindex[j][l]].x[i];
                }
                d/ = nj[j];
                z[j].x[i] = d;
            }
```

```
            }
        } while(!zequal(z,oldz));
    }
    void Out_Result()
    {
        int i,j;
        printf("Result: \n");
        for(j=0;j<cnum;j++) {
            printf("nj[%d]=%d\n",j,nj[j]);
            for(i=0;i<nj[j];i++) {
                printf("%d,",cindex[j][i]);
            }
        printf("\n");
        }
    }
    int main(int argc, char* argv[])
    {
            C_mean();
            Out_Result();
            return 0;
    }
```

程序运行结果如图 2-10 所示。

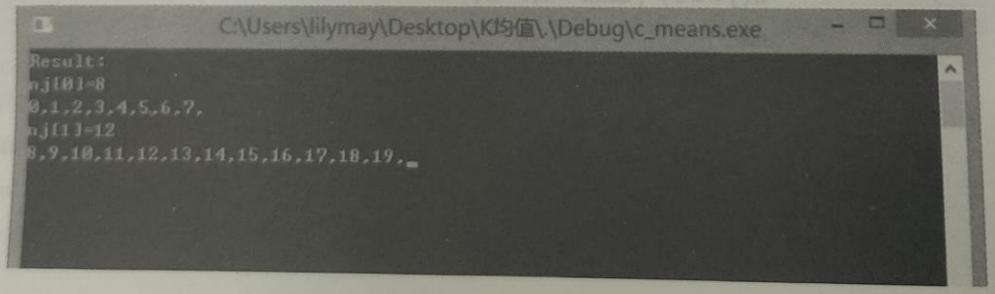

图 2-10　K－均值聚类程序运行结果