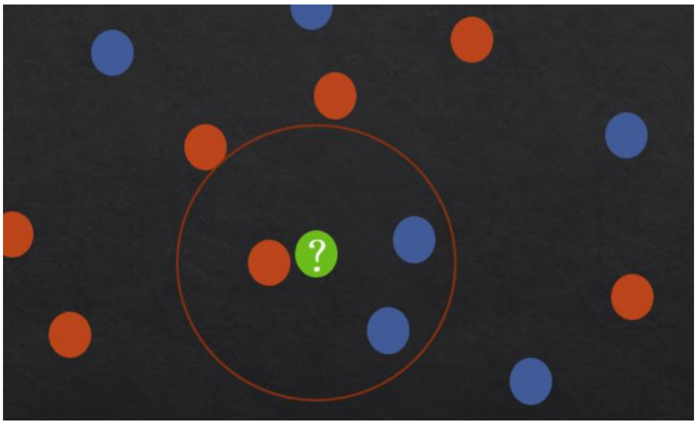
21374389 牛鹏军 210711

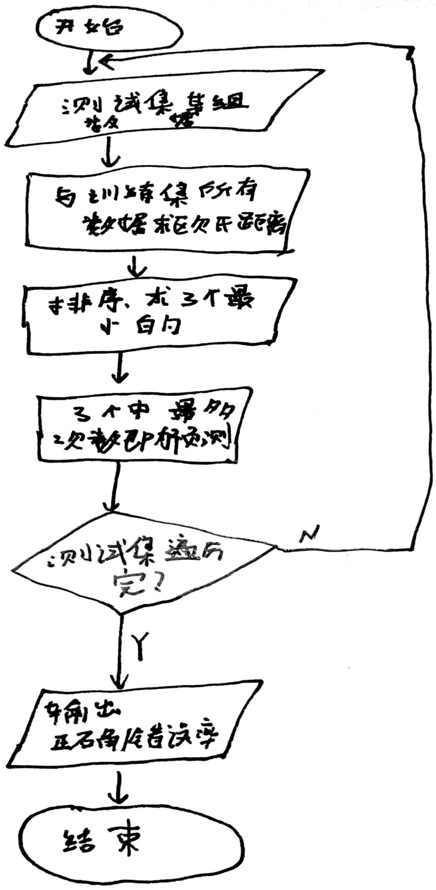
理论分析

用 C 语言基于 KNN 算法实现 Iris 鸢尾花分类方法。要求用训练集 构建模型，用测试集进行验证，得出分类错误率，即 误分类实例数/测试实例总数的比率。 输入：IrisTrain.txt,IrisTest.txt 输出：ErrorRatio

用 KNN 进行鸢尾花分类训练，令 K=3，即将测试集中某组数据与训练集上的各组数据求欧氏距离，将测试集中的每组数据与训练集中各组数据的距离数据排序后，取出最小的三个距离对应的训练集的分类状况，取这三组中最多出现的标签，即为对测试集该组数据的预测情况。



算法设计



编程实现

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <math.h>
#include <time.h>

#define TEST_SIZE 26
#define TRAIN_SIZE 124
#define FEATURE_COUNT 4
#define K_NEIGHBORS 3

typedef struct {
    double features[FEATURE_COUNT]; // 每种花的 4 个特征数据
    char species[20];      // 存放花的种类
    int label;             // 用于设置标签 为了方便检测
} Iris;

typedef struct {
    double value;   // 距离数据
```

```
    int label;         // 用于绑定训练集标签
} Distance;

Iris testSet[TEST_SIZE];
Iris forecastSet[TEST_SIZE];
Iris trainSet[TRAIN_SIZE];
Distance distances[TRAIN_SIZE];

// 将花的种类转换为标签
void labelSpecies(char *type, int *label);
// 将数组随机重排
void shuffle(Iris iris[], int n);
// 从文件中加载数据集
void loadData(const char *trainPath, const char *testPath);
// 计算两个花之间的欧氏距离
double calculateDistance(const Iris *iris1, const Iris *iris2);
// 用于比较两个 Distance 结构的函数，用于排序
int compareDistances(const void *d1, const void *d2);
// 统计前 K 个最近邻居中出现次数最多的标签
int countMostFrequentLabel(Distance *distances, int k);
// 函数用于返回指定标签的字符串表示
const char* getSpeciesLabel(int label);
// 打印比较结果，包括原始标签、预测标签和准确率
void printResults(int k, int count);

int main() {
    srand((unsigned int)time(NULL));

    // 加载数据
    loadData("IrisTrain.txt", "IrisTest.txt");
    int count = 0;

    // 对每个测试样本进行预测
    for (int i = 0; i < TEST_SIZE; i++) {
        // 计算测试样本与训练集中每个样本的距离
        for (int j = 0; j < TRAIN_SIZE; j++) {
            distances[j].value = calculateDistance(&testSet[i], &trainSet[j]);
            distances[j].label = trainSet[j].label;
        }

        // 对距离进行排序
        qsort(distances, TRAIN_SIZE, sizeof(Distance), compareDistances);

        // 统计最近的 K 个邻居中出现次数最多的标签
```

```
        forecastSet[i].label = countMostFrequentLabel(distances, K_NEIGHBORS);

        // 检查预测结果是否正确
        if (forecastSet[i].label == testSet[i].label) {
            count++;
        }
    }

    // 打印比较结果
    printResults(K_NEIGHBORS, count);
    return 0;
}

void labelSpecies(char *type, int *label) {
    if (strcmp(type, "Iris-setosa") == 0) *label = 0;
    else if (strcmp(type, "Iris-versicolor") == 0) *label = 1;
    else if (strcmp(type, "Iris-virginica") == 0) *label = 2;
}

void shuffle(Iris iris[], int n) {
    int i;
    for (i = n - 1; i > 0; i--) {
        int j = rand() % (i + 1);
        Iris temp = iris[i];
        iris[i] = iris[j];
        iris[j] = temp;
    }
}

void loadData(const char *trainPath, const char *testPath) {
    FILE *fpTrain = fopen(trainPath, "r");
    FILE *fpTest = fopen(testPath, "r");
    char species[20];
    double features[FEATURE_COUNT];
    int i, j;

    if (!fpTrain || !fpTest) {
        fprintf(stderr, "Error opening files.\n");
        exit(1);
    }

    for (i = 0; i < TRAIN_SIZE; i++) {
        fscanf(fpTrain, "%lf,%lf,%lf,%lf,%s", &features[0], &features[1], &features[2],
&features[3], species);
```

```
        for (j = 0; j < FEATURE_COUNT; j++) {
            trainSet[i].features[j] = features[j];
        }
        labelSpecies(species, &trainSet[i].label);
    }

    for (i = 0; i < TEST_SIZE; i++) {
        fscanf(fpTest, "%lf,%lf,%lf,%lf,%s", &features[0], &features[1], &features[2],
&features[3], species);
        for (j = 0; j < FEATURE_COUNT; j++) {
            testSet[i].features[j] = features[j];
        }
        labelSpecies(species, &testSet[i].label);
    }

    fclose(fpTrain);
    fclose(fpTest);
}

double calculateDistance(const Iris *iris1, const Iris *iris2) {
    double sum = 0.0;
    for (int i = 0; i < FEATURE_COUNT; i++) {
        sum += (iris1->features[i] - iris2->features[i]) * (iris1->features[i] - iris2->features[i]);
    }
    return sqrt(sum);
}

int compareDistances(const void *d1, const void *d2) {
    const Distance *distance1 = (const Distance *)d1;
    const Distance *distance2 = (const Distance *)d2;

    if (distance1->value > distance2->value) {
        return 1;
    } else if (distance1->value < distance2->value) {
        return -1;
    } else {
        return 0;
    }
}

int countMostFrequentLabel(Distance *distances, int k) {
    int labelCount[3] = {0};
    for (int i = 0; i < k; i++) {
        labelCount[distances[i].label]++;
```

```
	}
	int maxCount = labelCount[0];
	int label = 0;
	for (int i = 1; i < 3; i++) {
		if (labelCount[i] > maxCount) {
			maxCount = labelCount[i];
			label = i;
		}
	}
	return label;
}

const char* getSpeciesLabel(int label) {
	switch(label) {
		case 0:
			return "Iris-setosa";
		case 1:
			return "Iris-versicolor";
		case 2:
			return "Iris-virginica";
		default:
			return "Unknown";
	}
}

void printResults(int k, int count) {
	printf("Comparison Results for K = %d:\n", k);
	for (int i = 0; i < TEST_SIZE; i++) {
		const char* predictedSpecies = getSpeciesLabel(forecastSet[i].label);
		const char* trueSpecies = getSpeciesLabel(testSet[i].label);
		const char* correctness = (forecastSet[i].label == testSet[i].label) ? "Correct" : 
"Incorrect";

		printf("%-20s%-20s%-10s\n", predictedSpecies, trueSpecies, correctness);
	}
	double accuracy = ((double)count / TEST_SIZE) * 100.0;
	printf("Accuracy:      %.2f%%\n", accuracy);
	printf("ErrorRatio: %.2f%%\n", 100-accuracy);
	printf("Correctly Classified Instances: %d out of %d\n", count, TEST_SIZE);
}
```

测试分析

```
Comparison Results for K = 3:
Iris-virginica      Iris-virginica      Correct
Iris-virginica      Iris-virginica      Correct
Iris-setosa         Iris-setosa         Correct
Iris-setosa         Iris-setosa         Correct
Iris-setosa         Iris-setosa         Correct
Iris-setosa         Iris-setosa         Correct
Iris-setosa         Iris-setosa         Correct
Iris-versicolor     Iris-versicolor     Correct
Iris-virginica      Iris-virginica      Correct
Iris-setosa         Iris-setosa         Correct
Iris-setosa         Iris-setosa         Correct
Iris-versicolor     Iris-versicolor     Correct
Iris-virginica      Iris-virginica      Correct
Iris-versicolor     Iris-versicolor     Correct
Iris-setosa         Iris-setosa         Correct
Iris-versicolor     Iris-versicolor     Correct
Iris-versicolor     Iris-versicolor     Correct
Iris-setosa         Iris-setosa         Correct
Iris-versicolor     Iris-versicolor     Correct
Iris-versicolor     Iris-versicolor     Correct
Iris-virginica      Iris-versicolor     Incorrect
Iris-versicolor     Iris-versicolor     Correct
Iris-setosa         Iris-setosa         Correct
Iris-versicolor     Iris-versicolor     Correct
Iris-setosa         Iris-setosa         Correct
Iris-versicolor     Iris-versicolor     Correct
Accuracy:   96.15%
ErrorRatio: 3.85%
Correctly Classified Instances: 25 out of 26

--------------------------------
Process exited after 0.1226 seconds with return value 0
请按任意键继续. . .
```

将两 txt 文件放在源代码同一目录下，训练集共有 124 组数据，测试集共有 26 组数据，最终测试集中 25 组成功预测，成功率为 96.15%，失败率为 3.85%，仅在第 21 组数据预测失败，成功率还是很可以的。

结论

KNN 是一个经典的监督学习分类算法，在对简单数据分类时比较适用。